DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY (AFMC)

February 8, 2016

Air Force Research Laboratory, Directed Energy Directorate
3550 Aberdeen Ave. SE
Kirtland AFB, NM 87117

Mr. Scott Glenn, Interim Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Mr. Glenn,

The Air Force Research Laboratory (AFRL) has prepared the draft environmental assessment (EA) for The Modernization of Maui Space Surveillance Site (MSSC) Research Equipment at Haleakala, Maui Hawaii and antcicpates a Finding of No Significant Impact (FONSI) determination. This Federal Draft Environmental Assessment (EA) has been revised from the original Draft EA published February 23, 2015 to clarify the scope of proposed activities. Please publish the draft EA and draft FONSI on the OEQC site for notice of availability for public comment on this project in the February 23, 2016 Environmental Notice. We have enclosed a completed OEQC Publication form, four copies of the draft EA and draft FONSI, and the project summary on a disk. Please call the Mr. Joseph Volza, at 505-846-4050 if you have any questions.

Sincerely,

Michelle Hedrick

Michelle L. Hedrick, DRIV
Lead Test & Environmental Engineer

Attachments:
OEQC Publication Form
Draft EA (4copies)
Draft FONSI (4 copies)
Project Summary (disk)

NEPA Action EA/EIS
Publication Form

The Modernization of Maui Space Surveillance Site (MSSC) Equipment, Haleakala, Maui, HI DEA (AFONSI)

Island: Maui
District: Haleakala
TMK: (2) 2-2-002:084
Permits: N/A
Applicant or Proposing
Agency: Det 15, Air Force Research Laboratory, 550 Lipoa Parkway, Kihei, HI 96753
Contact: Jim Gardner, 808-891-7748
Approving
Agency:
Air Force Research Laboratory, 3550 Aberdeen SE, Kirtland AFB, New Mexico 87117
Contact: Joseph Volza, 505-846-4050
Consultant: N/A
Status: 20-day public review and comment period starts February 23, 2016; comments are due by March 14, 2016. Please send comments to the applicant, approving agency.

This Draft Environmental Assessment (EA) is prepared under the National Environmental Policy Act (NEPA) and has been revised from the original Draft EA published February 23, 2015 to clarify the scope of proposed activities. Specifically, the Air Force Research Laboratory Directed Energy Directorate, Detachment 15 proposes the modernization of research equipment at the Maui Space Surveillance Complex (MSSC) located on Haleakalā, Maui, HI over the next five to ten years. The modernization of research equipment consists of: (1) the replacement of sensors and instrumentation, (2) operation of a sodium laser known as Frequency Addition Source of Optical Radiation (FASOR) propagated from the existing AEOS 3.6m telescope, and (3) installation and operation of an improved adaptive optics system which would be used throughout the year for the observation of stars and satellites. The improved instrumentation would be operated and supported by the existing staff, so no increase in MSSC personnel would occur and no additional Anti-Terrorism/Force Protection standoff would be required. The upgrade of this equipment will be installed within existing buildings and would not exceed current exterior structure dimensions. No federal or state permits or approvals will be required for this action. This action does not trigger compliance with Hawai'i Revised Statutes ("HRS") Chapter 343, the Hawai'i Environmental Policy Act, because the action does not require an approval, defined under Hawai'i law as a discretionary consent required from a state or county agency prior to actual implementation of the action, HRS § 343-2, 343-5(e). It is anticipated that no significant short or long-term adverse environmental impacts on Biological Resources, Cultural Resources, Visual Resources, Land Use, Air Quality, Safety and Occupational Health, Infrastructure, Traffic and Roads, Hazardous Materials and Waste, and Socioeconomics would result from the proposed action.

FINDING OF NO SIGNIFICANT IMPACT

MODERNIZATION OF MAUI SPACE SURVEILLANCE COMPLEX (MSSC) EQUIPMENT
Haleakalā, Maui, Hawaii

Pursuant to Section 102(2) (c) of the National Environmental Policy Act (NEPA) of 1969 and the implementing regulations of the Council on Environmental Quality (CEQ) (40 Code of Federal Regulations, Parts 1500-1508), the Air Force Research Laboratory (AFRL) gives notice that a DRAFT Environmental Assessment (EA) has been prepared to address the potential environmental consequences of the Modernization of Maui Space Surveillance Complex Research Equipment in Haleakalā, Maui, Hawai'i. The Proposed Action is to install and operate a sodium laser known as Frequency Addition Source of Optical Radiation (FASOR); install new sensors and instrumentation including an improved adaptive optics system. The improved instrumentation would be operated and supported by the existing staff, so no increase in MSSC personnel would occur and no additional Anti-Terrorism/Force Protection standoff would be required. The upgrade of this equipment would occur over the next five – ten years and will be installed within existing buildings and would not exceed current exterior structure dimensions. No federal or state permits or approvals will be required for this action. This action does not trigger compliance with Hawai'i Revised Statutes ("HRS") Chapter 343, the Hawaii Environmental Policy Act, because the action does not require an approval, defined under Hawaii law as a discretionary consent required from a state or county agency prior to actual implementation of the action, HRS § 343-2, 343-5(e).

This Finding of No Significant Impact (FONSI) summarizes the Proposed Action and alternatives and the results of the environmental analysis.

Site Location

The modernization of research equipment will occur at the Maui Space Surveillance Complex located at the Haleakalā Observatory at the summit of Mount Haleakalā in Maui.

Purpose of and Need for the Proposed Action

The purpose of this action is for AFRL/DET 15 to modernize research equipment in order to continue meeting its DoD operational requirements and research objectives. The MSSC mission is required for the space monitoring network of the U.S. Air Force serving a dual role:

1) Providing electro-optical facilities for the collection of data from suborbital, near earth, and deep–space objects; and
2) Serving as a test site for sensor/laser research.

Modernization and upgrade of equipment at MSSC is needed to accomplish state-of-the-art space observation, illumination, and ranging capabilities.

Description of the Proposed Action and Alternatives

Proposed Action.
The Air Force is proposing to continue space object viewing, data collection, and site operations at MSSC on Haleakalā with the following improvements: (1) replacement of sensors and instrumentation, (2) operation of a sodium laser known as FASOR propagated from the existing AEOS 3.6m telescope, and (3) installation and operation of an improved adaptive optics system which would be used throughout the year for the observation of stars and satellites. All of the equipment would be installed by qualified scientists, engineers, technicians and electricians within the existing buildings previously constructed at the MSSC, on Haleakalā in Maui, Hawaii. When activities require the integration with facility electrical power, licensed electricians would follow National Electric Code requirements. The instrumentation sensors, cameras, and other research equipment are relatively small and can be installed by one to two individuals and will not alter the existing structure dimensions.

Site Alternatives.
Alternative sites were considered for the research activities that require the modernization at Maui. Modernization includes installation and operation of a sodium laser known as FASOR and installation of improved sensors and instrumentation. The Starfire Optical Range at Kirtland AFB, New Mexico could be a potential location to perform the AFRL/DET 15 MSSC research activities. Operations at SOR consist of optical research and advanced imaging R&D experiments. These research efforts and associated experiments utilize similar equipment in the form of 3.5 m and 1.5 m telescopes and various lasers to obtain optical images. The facility is operated primarily from dusk to dawn including infrequent daylight operational experiments that do not require totally dark conditions.

The SOR was eliminated as an alternative to the proposed action due to its current and projected future operations tempo, which is heavily programmed and scheduled for its current the R&D mission. SOR operates 5 days a week for 42 weeks out of the year. A typical night of testing encompasses approximately 10-12 hours per night with 6-8 hours being scheduled test hours. The SOR facility is shut down for approximately 8 weeks for engineering/maintenance and there is a 2 week shutdown during the holidays. Additionally, SOR does not have the same climate and seeing conditions that MSSC has, nor can SOR provide the AF Space Command operational data and information for the on-going DoD operational mission due to its current and future workload.

No-Action Alternative.
Under the No-Action Alternative, modernization of the equipment would not occur, and operations with new equipment/sensors to include the FASOR sodium guide star laser would not be propagated outdoors at the MSSC. The objective to modernize current equipment at MSSC

necessary to accomplish state-of-the-art space observation, illumination, and ranging capabilities will not be met. Critical operational mission data collection, and research and development pertaining to improved image resolution would not occur. The MSSC capabilities would fall behind in its ability to provide relevant, high quality data to support Air Force mission needs and eventually become obsolete.

SUMMARY OF ANTICIPATED ENVIRONMENTAL EFFECTS

The following resources or issues of concern were evaluated: Land Use, Infrastructure, Traffic and Roads, Biological Resources, Cultural Resources, Safety and Occupational Health, Visual Resources and Cumulative Impacts. A summary of potential impacts from the Proposed Action and alternatives follows. The Area of Potential Effect (APE) for determining the affected environment for the proposed action includes the 4.4 acres of land leased by the United States Air Force and owned by the University of Hawai'i where MSSC is located within the HO on Haleakalā. Additionally, based upon experimental testing at Kirtland AFB, Albuquerque NM the APE would include visual perception of the FASOR at a maximum distance of 1200 m.
The following resources were not evaluated in the EA since it was determined that the nature of the proposed action will no impact or negligible impact on the environment. These resources are; Air Quality, Water Quality, Hazardous Materials/Waste, Geology and Soils and Socioeconomics.

Proposed Action

Land Use. The Proposed Action is to modernize AF research equipment at existing MSSC facilities, including the installation of a FASOR laser on the AEOS telescope, the installation of improved sensors and instrumentation, and an improved adaptive optics system would be located internal to the facility. Improvements would not change the current structure dimensions, nor would research mission activities change from those currently performed.

The Proposed Action complies with UH IfA Haleakalā High Altitude Observatory Site Management Plan (HOMP), USFWS and Haleakalā National Park Service plans, is consistent with Conservation District General Subzone designation for Astronomy as research activities are similar to those allowed/performed at Haleakalā Observatories. The proposed action would have no significant impact on land use. It would not restrict access to any areas that are currently open to the general public. MSSC buildings are considered secured military facilities and will continue to have restricted access. The 4.4 acres managed by the AF is not fenced and does not have any archeological sites. Access for native Hawaiians to cultural areas would not change from current practices as the ahu are outside the AF property.

Safety. To ensure the light emissions do not cause hazards for personnel, AFRL strictly adheres to OSHA, Air Force, and ANSI laser safety Standards and imposes strict safety protocols for all of its laser operations. For example, AFRL imposes a 30-degree above the horizon minimum pointing angle for all laser operations—resulting in the elimination of laser hazards to the Public on the ground. The MSSC incorporates this multi-tiered safety system to address inadvertent lasing of personnel on aircraft and space optical assets, by incorporating human outdoor safety spotters, monitoring Federal Aviation Administration (FAA) radar feed, and a space asset Predictive Avoidance (PA) system during all outdoor laser operations. Implementation of these safe guards has allowed MSSC to operate without incident for over twenty years. No adverse or significant safety impacts are anticipated from the implementation of the proposed action to modernize the MSSC research equipment. Established site safety policies and procedures will be continued for outdoor laser operations.

Biological Resources. The proposed modernization of the MSSC equipment would have no significant impact on biological resources. The potential threat to fauna from the installation and operation of the FASOR laser is from the visible light (589nm orange color) that would be propagated from the AFRL, MSSC 3.6 m AEOS telescope. Past and existing visible lasers have been used at the MSSC and HO, however these lasers have been in the blue and green visible spectrum. Since the FASOR is in the orange spectrum, and could possibly be a source of distraction to avifauna, additional analysis was performed. To determine the impact on fauna, specifically the ua'u, nēnē and hoary bat, an analysis of proposed operations and behavioral information for these species was analyzed with consideration for: 1) Direct laser illumination where the animal would be exposed by flying through the laser beam; and/or 2) distraction or disorientation by back scattered laser light.

Our analysis has determined that the operation of the sodium guidestar laser at MSSC is highly unlikely to adversely affect the wellbeing or flying behavior of any threatened or endangered species. Analysis shows the proposed equipment/sensor installation and operation of the sodium guidestar laser, "FASOR", poses no surface or skin hazard due to the beam size, power, and notional exposure duration. While possible, it is extremely unlikely that a bird inflight near the laser projection (beam diameter 20 cm (7.874 in.)) would intersect resulting in retinal injury or surface injury, due to: tracking and slewing of the laser beam, short exposure time to the beam; relative low bird activity over the MSSC; 30 degree laser elevation pointing limitation; and typical flight altitude (15m) of the petrel – below normal beam height above the ground. The AFRL's MSSC has been performing outdoor laser and optical system testing since 2000 with negligible impact on environmental resources and no recorded impacts on any u'au or other wildlife from.

Consultation under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.) was completed with the U.S. Fish and Wildlife Service on 3 Jan 2015. Based on AFRL's

avoidance and minimizing measures, USFWS has concurred with our determination that the proposed project may affect, but is not likely to adversely affect the Hawaiian petrel, Haleakalā Silversword, Hawaiian goose, and Hawaiian hoary bat. For these reasons, and the established practices designed to prevent impacts to flora and fauna, no significant impacts on biological resources are anticipated from the Proposed Action.

Cultural Resources. The archaeological resources at Haleakalā Observatories are described in several studies conducted at the summit. No archaeological features have been identified within the boundaries of the MSSC; however, archaeological features at Haleakalā Observatories include four sites identified near the MSSC. An archaeological reconnaissance survey was carried out by Pacific Northwest Laboratory on behalf of the U.S. Air Force Maui Space Surveillance Site or MSSS in 1991 and has been reconfirmed by additional surveys performed by UH, the most recent being performed in 2006. During the course of the surveys, four archaeological sites were identified outside MSSC, primarily along the western side of Kolekole Hill. These sites were described as wind shelters, typically constructed against the existing rock outcrop of the hill. As all activities performed for the proposed action will occur within existing facilities and no soil will be disturbed, there will be no significant impact on cultural resources/archaeological sites.

The primary impact on visual resources and view planes that would result from the operation of the FASOR laser is the visible light (589 nm orange color) propagated from the AFRL MSSC AEOS telescope. The FASOR laser would be visible from a few locations on the summit; mainly the Visitor's Center and the Summit Overlook starting at dusk. Experimental testing at Kirtland AFB, Albuquerque NM was conducted to determine the Area of Potential Effect for proposed FASOR operations at Haleakalā. Results of this testing indicate visual perception of the FASOR would be a maximum distance of 1200 m from the AEOS telescope. The beam becomes faintly visible at dusk and more apparent as the night sky darkens. Operations cease as dawn approaches and the visibility of the beam becomes invisible as the sky lightens. As mentioned in this EA, past and existing visible lasers have been used at the MSSC and HO, currently other HO organizations conduct operations using a visible green (532nm) laser almost continuously 10-hours a day. These existing laser operations are conducted during day and nighttime hours. Adding the FASOR laser operation would not significantly increase visible laser operations.

Based upon detailed analysis in section 4.3 of the DRAFT EA, the proposed action would not affect visual resources and view planes from distances greater than 1200 m. The Proposed Action would have no significant impact on cultural or visual resources. The AF has determined the proposed action will have No Adverse Effect on Cultural or Visual Resources within the defined APE and is awaiting concurrence from Hawaii SHPO in accordance with Title 36, Code of Federal Regulations, Part 800.3(c) and National Historic Preservation Act, Section 106.

Cumulative Impacts. Past, Present, and Reasonably Forseeable Future Actions Associated with HO and Adjacent Neighbors and this Proposed Action was evaluated. This analysis identifies likely impact on the environment, including short- and long-term impacts, and direct, indirect, and cumulative impacts. The analysis focused only on those environmental issues that have potential impact and are associated with the MSSC Modernization of Research Equipment activity. Installation of instrumentation, cameras and other research equipment within existing facilities would have no cumulative impact on the environment. Cumulative impacts associated with this Proposed Action were evaluated for the operation of the FASOR laser as it would be visible to a maximum distance of 1200 m from the AEOS telescope on Haleakalā. There is a potential for visitors to the summit during nighttime hours to see the visible beam. The FASOR sodium guide star laser would only be used intermittently and the duration of the laser beam projection would be short (5-10 minutes in duration) but would occur multiple times per hour over a 6-8 hour period. Laser usage has been in place at HO for decades. Currently lasers are being used for outdoor propagation by numerous entities on HO. The proposed visible FASOR laser is an addition to existing and previously used lasers in the HO. Visible lasers in the green spectrum are currently used by the AF and the University of Hawaii. The only difference is that the FASOR laser will be a different color (orange) than is currently being used. Overall, AFRL/Det 15 has significantly reduced the number of lasers used at the MSSC. Adding the FASOR does not increase the operations tempo, but does create an intermittent new visual image that visitors to the summit at during dark sky conditions would potentially see. The proposed action would result in negligible impacts on Visual resources and View Planes, Visitor Use and Experience, and Biological Resources and these impacts are considered to be negligible, adverse, and short term; as the impacts would only exist when the laser is actively being projected into the sky. This action would not significantly increase the cumulative impact on the HO and surrounding areas.

No-Action Alternative

Under this alternative, there would be no significant impact on existing environmental resources, since the proposed MSSC modernization would not be accomplished. However, the *purpose* of the Proposed Action – to modernize and upgrade the equipment, instrumentation and facilities at MSSC to provide relevant, high quality data to support Air Force mission needs would not be met.

CONCLUSION

After careful review of the EA, I have concluded that the Proposed Action would not have a significant impact either by itself or cumulatively (with other nearby projects) on the quality of the natural or human environment. Therefore, issuance of a FONSI is warranted, and an Environmental Impact Statement is not required. This analysis fulfills the requirements of NEPA and implementing regulations promulgated by the CEQ. Accordingly, the requirements

of the National Environmental Policy Act of 1969 and the Council on Environmental Quality, and the Code of Federal Regulations, Title 32, Part 989, Environmental Impact Assessment Process, have been fulfilled, and an Environmental Impact Statement is not necessary and will not be prepared.

Accepted by:	MICHELLE L. HEDRICK Lead Test & Environmental Engineer AFRL Directed Energy Directorate	Date:
Approved by:	ANDREW J. EMERY, LtCol, USAF Commander, AFRL Detachment 15	Date:

COVER SHEET

Lead Agency for the EA: United States Air Force Research Laboratory, Directed Energy Directorate (AFRL/RD Detachment 15, Maui)

Title of Proposed Action: Modernization of USAF Research Equipment at the MSSC, Haleakalā, Maui, Hawai‘i, Environmental Assessment (EA)

Affected Jurisdiction: U.S. Department of Defense and Air Force Research Laboratory Maui Space Surveillance Site, Haleakalā, Maui, Hawai‘i

Designation: Revised Draft Environmental Assessment

For Additional Information:

Air Force Research Laboratory Detachment 15

(AFRL/DET 15 Maui)

550 Lipoa Parkway,

Kihei, Hawai‘i 96753

ABSTRACT:
This Draft Environmental Assessment (EA) is prepared under the National Environmental Policy Act (NEPA) and has been revised from the original Draft EA published February 23, 2015 to clarify the scope of proposed activities. Specifically, the Air Force Research Laboratory Directed Energy Directorate, Detachment 15 proposes the modernization of research equipment at the Maui Space Surveillance Complex (MSSC) located on Haleakalā, Maui, HI over the next five to ten years. The modernization of research equipment consists of: (1) the replacement of sensors and instrumentation, (2) operation of a sodium laser known as Frequency Addition Source of Optical Radiation (FASOR) propagated from the existing AEOS 3.6m telescope, and (3) installation and operation of an improved adaptive optics system which would be used throughout the year for the observation of stars and satellites. The improved instrumentation would be operated and supported by the existing staff, so no increase in MSSC personnel would occur and no additional Anti-Terrorism/Force Protection standoff would be required. The upgrade of this equipment will be installed within existing buildings and would not exceed current exterior structure dimensions. No federal or state permits or approvals will be required for this action. This action does not trigger compliance with Hawai‘i Revised Statutes (“HRS”) Chapter 343, the Hawai‘i Environmental Policy Act, because the action does not require an approval, defined under Hawai‘i law as a discretionary

consent required from a state or county agency prior to actual implementation of the action, HRS § 343-2, 343-5(e).

It is anticipated that no significant short or long-term adverse environmental impacts on Biological Resources, Cultural Resources, Visual Resources, Land Use, Air Quality, Safety and Occupational Health, Infrastructure, Traffic and Roads, Hazardous Materials and Waste, and Socioeconomics would result from the proposed action.

The purpose and need of the proposed action is to allow the Air Force to modernize equipment for state-of-the-art space observation, illumination, and ranging capabilities at MSSC. Additionally, the AF would operate the proven FASOR sodium guide star laser technology from the Advanced Electro-Optical System (AEOS) 3.6 m telescope to enhance current data collection. The AEOS was constructed under Conservation District Use Permit number MA-2705 issued 8/26/1994 and is the primary telescope used by the AF at MSSC. The equipment modernization would enhance current capabilities and will not significantly change the operational tempo of the facility.

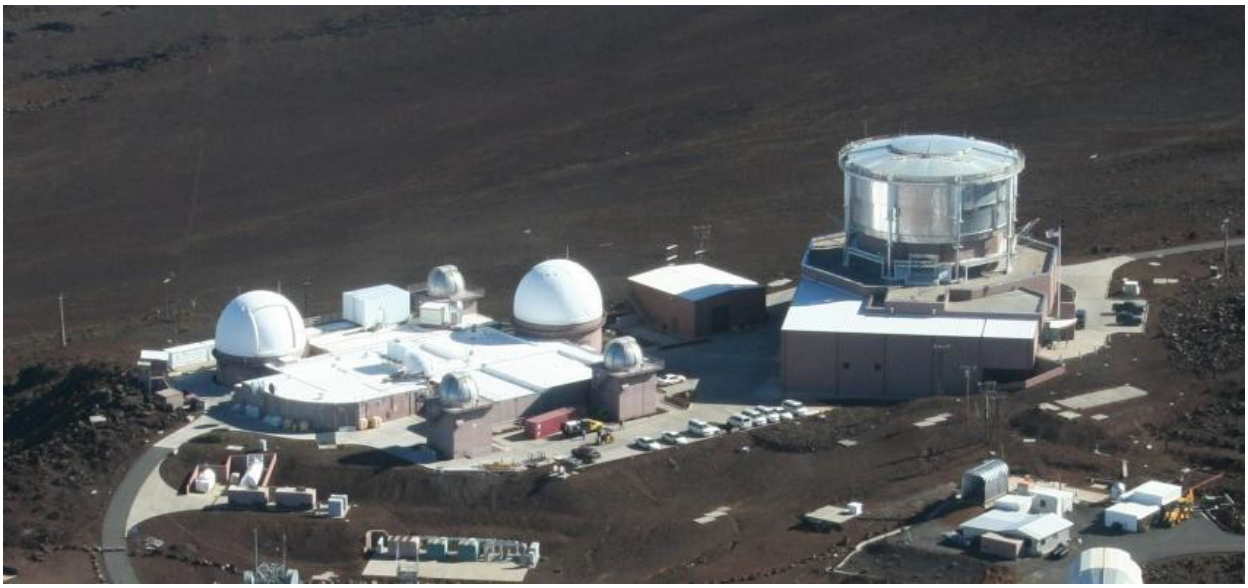
The MSSC mission is to enhance the space monitoring network of the U.S. Air Force, by serving a dual role:

1) Providing electro-optical facilities for the collection of data from suborbital, near earth, and deep–space objects; and

2) Serving as a test site for sensor/laser research.

Comments to the previously published draft EA have been considered and revisions have been made in this draft EA. Responses to comments on the previous EA will be provided directly to individual commenters at the culmination of this comment period. All comments associated with this draft EA will be responded to at the end of the comment period.

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED MODERNIZATION OF MAUI SPACE SURVEILLANCE COMPLEX EQUIPMENT



Revised Draft

January 2016

CONTENTS

ACRONYMS AND ABBREVIATIONS

^{o}c	degree Celsius
^{o}f	degree Fahrenheit
ac	acre
AEOS	Advanced Electro-Optical System
AFRL	Air Force Research Laboratory (U.S.)
AFMC	Air Force Material Command
AMOS	Air Force Maui Optical and Supercomputing Site
ATST	Advanced Technology Solar Telescope
CDUP	Conservation District Use Permit
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CZM	Coastal Zone Management
dB	decibels
DKIST	Daniel K. Inouye Solar Telescope
dBA	decibels A-weighted scale for sound level
DLNR	Department of Land and Natural Resources
DBEDT	Department of Business, Economic Development and Tourism
DoD	Department of Defense
DOE	Department of Energy (U.S)
DOH	Department of Health
DRMO	Defense reutilization and Marketing Office
EA	Environmental Assessment

EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
GEODSS	Ground-Based Electro-Optical Deep Space Surveillance System
HAR	Hawai‘i Administrative Rules
HAZMAT	Hazardous Material Emergency Planning and Response Plan
HECO	Hawaiian Electric and Light Company
HOMP	Haleakalā High Altitude Observatory Site Management Plan
HRS	Hawai‘i Revised Statutes
IfA	Institute for Astronomy
INRMP	Integrated Natural Resources Management Plan
kV	kilovolt
kW	kilowatt
LASER	Light Amplification by Stimulated Emission of Radiation
LURE	Lunar and Satellite Ranging Observatory
MAGNUM	Multi-color Active Galactic Nuclei Monitor
MCS	Mirror Coati ng Shop
MECO	Maui Electrical Company, Inc.
MSO	Kenneth Mees Solar Observatory
MSSC	Maui Space Surveillance Complex
MSSS	Maui Space Surveillance System

NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
RCRA	Resource Conservation and Recovery Act (Federal)
SHPD	State Historic Preservation Division
SHPO	State Historic Preservation Office
SIHP	State Inventory of Historic Places
SOR	Starfire Optical Range (AFRL/Kirtland AFB)
TU	Tohoku University
UH	University of Hawai‘i
U.S.	United States
USA CE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Glossary of Hawaiian Words

‘ahinahina	Haleakalā Silversword plant
Ali‘i	royalty, Chief
Haleakalā	House of the Sun
Iwi	bones
K a h u	clergyman, Spiritual Advisor
Kahuna	priest
Kanaka maoli	true aboriginal person, Native to Hawai‘i
ko‘i	adze, a bladed tool, Tool used to carve out (Ko‘i)
Kumu Hula	hula teacher, Source of Hula Learning
Kupuna	elder
Makahiki	ancient annual festivals; according to moon phase to give honor
Mana	spirit, supernatural or divine power
Mele	Chants, songs or poems
Mo‘olelo	Story, tale, legend or narrative
Nene	Hawaiian Goose
‘ope‘ape‘a	Hawaiian hoary bat
Oli	Hawaiian chant
Pa Ka‘oao	White Hill
Pa‘ele Ku Ai I Ka Moku	East-facing ahu
Paliku	an order of priesthood, Steep Cliff
Piko	navel
Pu‘u	hill

Pu‘u Ula‘ula	Red Hill
‘ua‘u	Hawaiian Dark-rumped Petrel
wahi pana	legendary place

CHAPTER 1.0 PURPOSE OF AND NEED FOR ACTION

1.1 Proposed Action

The U.S. Air Force Research Laboratory, Detachment 15 (AFRL/DET 15) proposes to modernize the research equipment at the Maui Space Surveillance Complex (MSSC) located at Haleakalā, Maui, Hawai‘i, Figure 1. In this action, AFRL proposes to update research equipment over the next five - ten years. The primary piece of equipment AFRL/DET 15 proposes to install and operate is a sodium laser known as Frequency Addition Source of Optical Radiation (FASOR) for enhanced research and development activities associated with space observation, illumination, and ranging capability by the spring of 2016. Other equipment needed to support research is described below in Chapter 2 “Description of Proposed Action and Alternatives”. All of this supporting equipment would be installed within existing buildings located at MSSC.

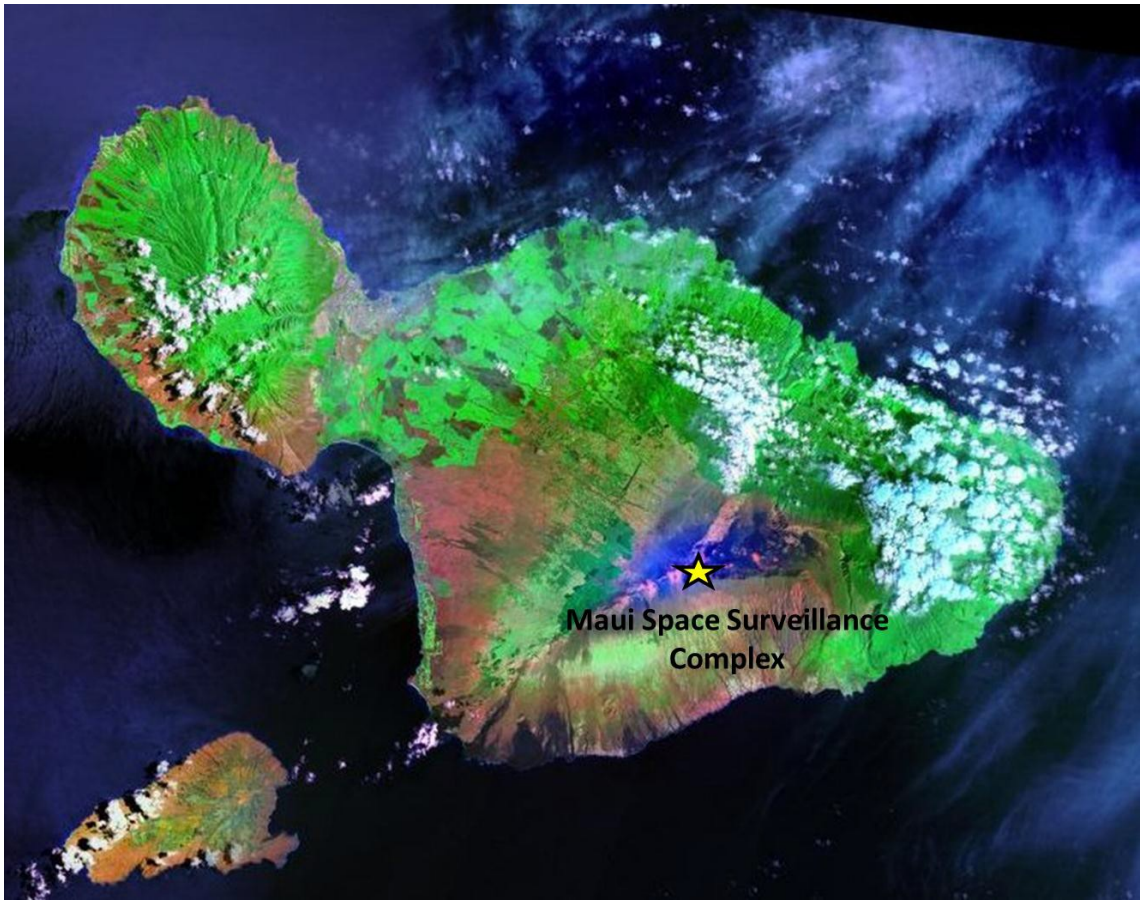


Figure 1: The Maui Space Surveillance Complex (MSSC) is located on the top of Haleakalā on Maui, Hawai‘i.

1.2 Background

The AFRL/DET 15 currently operates three main facilities within the Maui Space Surveillance Complex and a variety of visible and invisible lasers and sensors for the purpose of conducting research and development (R&D) for tracking, ranging, illuminating, communicating with, and observing space objects. These existing and past research efforts have included the use of sensors, cameras, and lasers focused on satellites, stars, space debris, missiles, spacecraft and static ground targets. These activities and all MSSC operations have been previously evaluated for their impact on the environment (see section 1.11 below), to determine if they created adverse impacts on cultural and natural resources, and for compliance with the National Environmental Policy Act (NEPA) (42 United States Code (USC) §4321 *et seq.*) and the implementing regulations of the Council on Environmental Quality (CEQ) (40 Code of Federal Regulations (CFR), 2014).

The proposed action includes FASOR, which is called a sodium laser because it has the ability to propagate light into the sodium layer of the atmosphere and create an artificial star. The FASOR light enters the sodium layer of the atmosphere located approximately 90 km from the earth's surface. Sodium atoms are present in this layer that is about 10 km wide in an area known as the Mesosphere-lower thermosphere (MLT). The sodium layer is created by the ablation of approximately 30 tons of interplanetary dust which enters the atmosphere every day. Interplanetary dust is created by meteoroids undergoing rapid frictional heating by collision with air molecules, leading to vaporization of their constituents and minerals. This process provides the major source of metals, sodium, in the MLT.

1.3 History of Activities at the MSSC

The MSSC was established by the Advanced Research Projects Agency (ARPA) under the Department of Defense (DoD), Public Law 85-325 in February of 1958. Some of ARPA's programs formed the foundation of sensor, surveillance and directed energy research and development; particularly in the study of radars, infrared sensing, and x-ray/gamma ray detection. The first telescope facility at MSSC was constructed in 1963. Around 1966, routine Midcourse Optical Station missions were performed using laser sensors for tracking and collecting data from missiles and other targets. Lasers are used to illuminate objects and reflected photons are collected using a telescope and instrumentation to improve the image resolution. Additional telescopes were installed and the use of directed energy laser or light emission sources to sense, track and collect data has continued to the present time. This research has led to significant discoveries in the fields of telecommunications, signal processing, and space object identification and imaging.

The most prominent structure at the MSSC is the Advanced Electro-Optical System (AEOS) telescope, designed and built by the USAF in 1995. Conservation District Use Permit number MA-2705 was issued for AEOS on 8/26/1994. AEOS is the primary telescope used by the AF at MSSC. AEOS houses a 3.67-meter (~12 foot) diameter telescope mirror, considered the largest and most sensitive telescope in the DoD. It provides superb spatial and temporal resolution and atmospheric measurement capabilities. Its sensors produce simultaneous images in the visible and infrared spectrum, and it has the capability to track both satellites and missiles. This world-class national asset was used by NASA when they suspected a problem with the Passive Thermal Control System on the Space Shuttle Mission, STS-134 in 2011. The AFRL/DET 15 team was able to discover a

leak that helped NASA formulate a response that contributed to the safety of six astronauts and the health of NASA's STS 134, a $150B asset.

The MSSC is an integral part of the space monitoring network of the U.S. Air Force and serves a dual role: (1) an electro-optical facility for the collection of imagery and space situational awareness data from suborbital, near earth, and deep–space objects, supporting real-world operations; and (2) a test site for sensor/laser technology research. The term laser is used to describe a device that has characteristics to generate light that can coherently propagate to greater distances than normal light sources. Normal everyday light disperses in three dimensions, the light intensity reduces, and the light is absorbed in the environment. Therefore, the AF has been performing research to design and fabricate lasers to overcome these barriers. Lasers have numerous applications; they are used in CD/DVD drives, in electronics for appliances and medical devices. The AF uses lasers as to enhance capabilities to capture high resolution images of space objects.

The MSSC is located in the University of Hawaii's Haleakalā High Altitude Observatory (HO) site, located just outside Haleakalā National Park on Pu‘u Kolekole at an altitude of 3050 m (10,010 feet) on the Island of Maui. The HO site is an 18.166-acre parcel of land set aside for the University of Hawai‘i in 1961 through State of Hawai‘i Executive Order 1987. HO is located within the General Subzone of the Conservation District and the IfA is responsible for managing the site. MSSC comprises approximately 4.4 acres of land leased by the United States Army Corps of Engineers and owned by the University of Hawai‘i. The current lease between USA CE and UH commenced on 14 May 2006 and has a term of 25 years. Initial construction at the MSSC site occurred in 1963, and it is currently operated by the AFRL/DET 15.

Another major part of the MSSC is the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) System, which is operated for the Air Force Space Command, Detachment 3. The GEODSS at HO is one of three operational sites in the world performing ground-based optical tracking of space objects. The GEODSS site performs its mission using three powerful telescopes; low light level, electro-optical cameras; and high-speed computers. Detachment 3 uses three, 1-meter telescopes with a 1.68-degree field of view. GEODSS telescopes primarily operate between civil sunset and civil sunrise, just before all ambient light is out of the atmosphere. The telescopes are able to see objects 10,000 times dimmer than the human eye can detect.

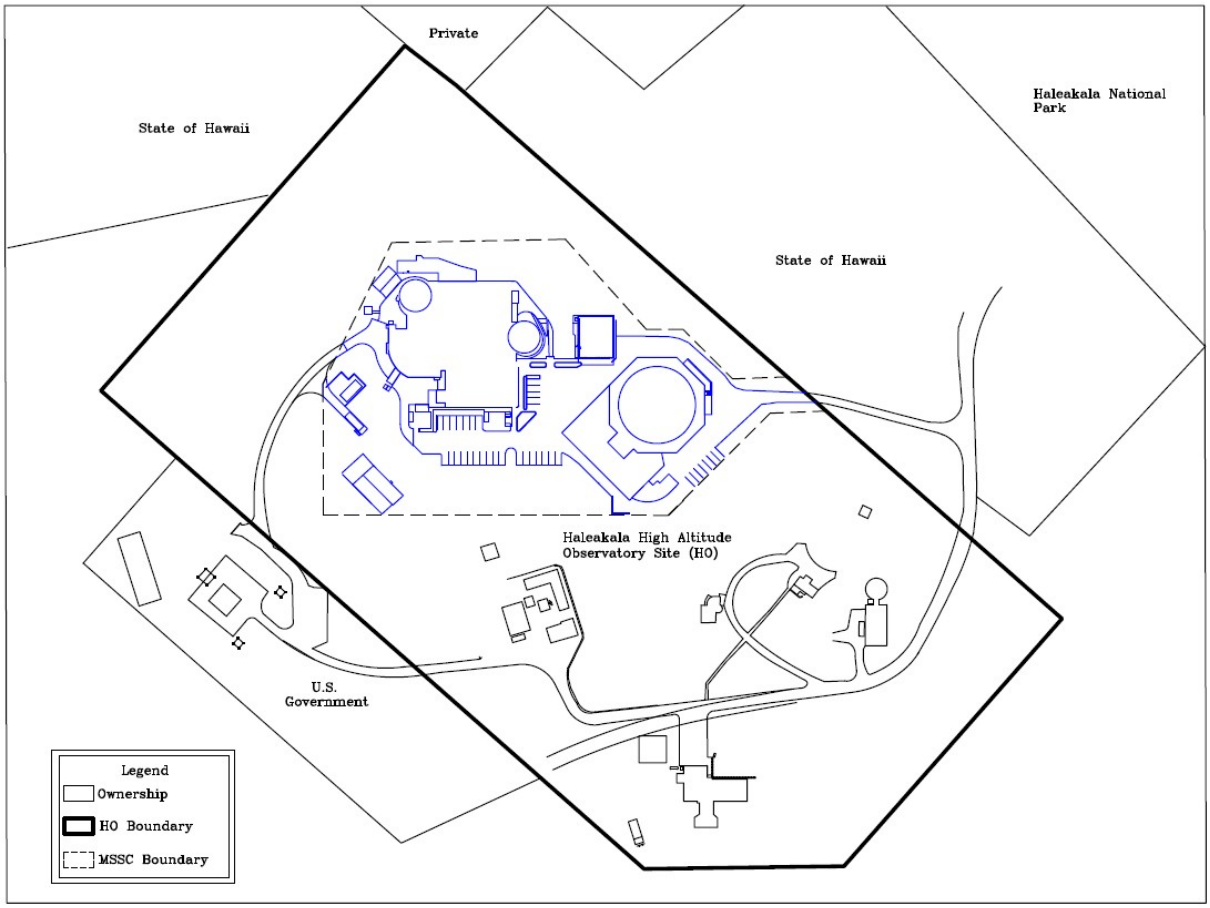


Figure 2: The US Air Force operates the MSSC which is located within the Haleakalā High Altitude Observatory Site (HO).

1.4 Purpose and Need for the Proposed Action

The purpose of this action is for AFRL/DET 15 to modernize research equipment in order to continue meeting its DoD operational requirements and emerging research objectives. The MSSC mission is required for the space monitoring network of the U.S. Air Force serving a dual role: 1) Providing electro-optical facilities for the collection of data from suborbital, near earth, and deep–space objects; and 2) Serving as a test site for sensor/laser research.

1.5 Relevant Resources and Issues

This EA focuses on the following environmental resources and issues of concern:

- Land Use
- Biological Resources
- Cultural Resources
- Safety
- Cumulative Impacts

Impacts on Water Quality, Socioeconomics, Hazardous Materials/Waste, Traffic and Roads, Noise, Geology and Soils Resources are deemed to be negligible; as the modernization of research equipment will take place within existing structures, no digging or soil would be removed; no new facilities would be constructed; no changes to site drainage would be made; there would be no changes in the size of the workforce at MSSC; and all activities would meet the requirements defined in the University of Hawai‘i *Haleakalā High Altitude Observatory Site Management Plan* (HOMP). The primary environmental impact of this action will be increased visible laser beam activities from the AEOS telescope due to installation of the FASOR Sodium Guide Star instrument. Impacts of modernization of MSSC research equipment on all other environmental resources would be minimal as all upgrades would be contained within the existing buildings and would not exceed current structure dimensions.

1.6 Objectives of the Proposed Action

The objective of this modernization and upgrade of equipment and sensors at MSSC is to accomplish state-of-the-art space observation, illumination, and ranging capabilities. This proposed action is the installation of improved cameras and lasers to support operational requirements. One of the primary lasers to be installed would be the FASOR Sodium Guide Star laser.

The goal of this modernization is to improve the site's ability to maintain awareness of deep space objects; to characterize objects and search for closely spaced objects in proximity to objects of interest; to discover dim objects; to improve fast-search capabilities; to perform tactical indications and warnings; and continue to provide space object identification (SOI) data products on Low Earth Orbit (LEO) and Geosynchronous Earth Orbit (GEO) objects. Mount Haleakalā, located at 3,050 meters (10,010 feet) in altitude, is above one third of the Earth's atmosphere and provides excellent conditions for astronomical observation. This combined with its remoteness from light pollution sources and high number of non-cloudy days makes it one of the best locations in the world for ground-based telescope observations. Haleakalā is an optimal location for obtaining the highest quality space object imagery required by the Air Force mission.

1.7 Purpose of this Document

This revised draft Environmental Assessment (EA) was prepared in accordance with NEPA, as amended (42 USC §§4321 *et seq.*); CEQ regulations, as amended (40 CFR Chapter V Parts 1500 *et seq.*; Department of the Air Force Environmental Impact Analysis Process (32 CFR Part 989) This EA identifies the purpose and need for the proposed action, reasonable alternatives, existing environmental conditions, environmental consequences, and measures to avoid or minimize potential impacts.

1.8 Decision(s) to be Made

The decision to be made by AFRL is whether or not to pursue the modernization of equipment within existing facilities with a Finding of No Significant impact (FONSI), determine if an Environmental Impact Statement (EIS) needs to be prepared, or to do nothing and continue current operations with existing technologies and equipment.

1.9 Required Permits/approvals

All activities proposed under this action include upgrades to research equipment only and do not involve construction or facility modification. The repair, maintenance and replacement of existing research equipment would stay within the footprint and facility dimensions of current structures; no federal or state permits or approvals will be required for this action. This action does not trigger compliance with Hawai‘i Revised Statutes (“HRS”) Chapter 343, the Hawai‘i Environmental Policy Act, because the action does not require an approval, defined under Hawai‘i law as a discretionary consent required from a state or county agency prior to actual implementation of the action, HRS §-343-2, 343-5(e).

1.10 Regulatory Overview

National Environmental Policy Act (NEPA):

NEPA establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and requires all Federal government agencies to assess the environmental impacts of proposed federal agency actions prior to their execution. To determine if a proposed Federal action would have significant environmental impacts, NEPA requires that a document be prepared to assess the potential impacts and examine alternative actions. As indicated in the introduction of this chapter, this EA document is intended to comply with NEPA.

National Historic Preservation Act:

The National Historic Preservation Act (NHPA) of 1966, as amended (16 USC §470), recognizes the nation’s historic heritage and establishes a national policy for the preservation of historic properties as well as the National Register of Historic Places (NRHP). Section 106 of the NHPA requires Federal agencies to take into account the effects of Federal undertakings on historic properties, and affords the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. The NHPA Section 106 process, as defined in 36 CFR Part 800, provides for the identification and evaluation of historic properties for determining the effects of undertakings on such properties and for developing ways to resolve adverse effects in consultation with consulting parties.

Native American Graves Protection and Repatriation Act:

The Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC§3011, 1990) provides for the protection and repatriation of Native American and Native Hawaiian human remains and cultural items discovered on Federal lands. NAGPRA provides a process for Federal agencies to return certain cultural items (i.e., human remains, funerary objects, sacred objects, or objects of cultural patrimony) to lineal descendants and culturally affiliated Native Hawaiian organizations. NAGPRA includes provisions for unclaimed and culturally unidentifiable cultural items, intentional and inadvertent discovery of cultural items on Federal lands, and penalties for noncompliance and illegal trafficking.

Endangered Species Act:

The Federal Endangered Species Act (ESA) of 1973 (16 USC §1531 et seq., 1973) establishes a process for identifying and listing threatened and endangered species. It requires Federal agencies to carry out programs for the conservation of federally listed endangered and threatened plants, wildlife, and designated critical habitats for such species, and prohibits actions by Federal agencies that would likely jeopardize the continued existence of those species or result in the destruction or adverse modification of designated critical habitat. Section 7 of the ESA requires consultations with Federal wildlife management agencies on actions that may affect species or designated critical habitat. Section 9 of the ESA prohibits the "taking" (through harm or harassment) of endangered species without an agency-issued permit.

For this Proposed Action, it is anticipated that no rare, threatened, or endangered species (or their habitat) that occur in the area will be affected.

Migratory Bird Treaty Act (MBTA):

The Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712, 1918) implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Unless permitted by regulations, the MBTA prohibits the pursuit, hunting, taking, capture or killing; attempted taking, capture or killing; possession, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not. Subject to limitations in the MBTA, the Secretary of the Interior (Secretary) may adopt regulations determining the extent to which, if at all, hunting, taking, capturing, killing, possessing, selling, purchasing, shipping, transporting or exporting of any migratory bird, part, nest or egg will be allowed, having regard for temperature zones, distribution, abundance, economic value, breeding habits and migratory flight patterns. Regulations are effective upon Presidential approval. Currently there are over 800 bird species covered by the MBTA. The USFWS is currently responsible for overseeing and enforcing the MBTA.

Clean Air Act:

The Clean Air Act (CAA) and amendments (42 USC §7401 et seq.) are comprehensive Federal laws that regulate air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. Pursuant to the CAA and amendments, State operated permit programs serve to control emissions. In Hawai‘i, the State operating permit program is implemented by the State of Hawai‘i Department of Health (DOH) and emissions of regulated air pollutants within the state may be subject to permitting as required under Hawai‘i Administrative Rules (HAR) Chapter 11-60.1.

Other environmental regulatory requirements relevant to the Proposed Action include, but are not limited to:

Occupational Safety and Health Act (OSHA):

Congress enacted the Occupational Safety and Health Act of 1970, which created the Occupational Safety and Health Administration (OSHA). Its mission is to help employers and employees reduce on the job injuries, illnesses and deaths. OSHA directs national compliance initiatives in occupational safety and health.

Chemical Hazard Communication Program:

The Chemical Hazard Communication Program requires that chemical hazard identification, information and training be available to employees using hazardous materials and institutes safety data sheets (SDS) which provide this information.

Air Force Instruction 91-203, Air Force Consolidated Occupational Safety Instruction, 15 June 2012:

AFI 91-203 identifies occupational safety, fire prevention, and health regulations governing Air Force activities in the workplace. In conjunction with the USAF Mishap Prevention Program, these standards ensure all USAF workplaces meet Federal safety and health requirements.

AFI 91-202, USAF Mishap Prevention Program:

AFI 91-202 implements AFPD 91-2, Safety Programs. It establishes mishap prevention program requirements and assigns responsibilities for program elements, and contains program management information.

Resource Conservation and Recovery Act (RCRA) of 1976:

An amendment to the Solid Waste Disposal Act, RCRA authorizes USEPA to provide for “cradle-to-grave” management of hazardous waste and sets a framework for the management of nonhazardous municipal solid waste. Under RCRA, hazardous waste is controlled from generation to disposal through tracking and permitting systems, and restrictions and controls on the placement of waste on or into the land. Under RCRA, a waste is defined as hazardous if it is ignitable, corrosive, reactive, toxic, or listed by USEPA as being hazardous. With the Hazardous and Solid Waste Amendments (HSWA) of 1984, Congress targeted stricter standards for waste disposal and encouraged pollution prevention by prohibiting the land disposal of particular wastes. The HSWA strengthens control of both hazardous and nonhazardous waste and emphasizes the prevention of pollution of groundwater.

Coastal Zone Management:

15 CFR 930.39 requires federal agencies to assess their proposed activity and make a consistency determination. The assessment reviews the activity and its effects on any coastal use or resource, associated facilities (e.g., proposed siting and construction of access road, connecting pipeline, support buildings, and the effects of the associated facilities (e.g., erosion, wetlands, beach access

impacts), must all be consistent to the maximum extent practicable with the enforceable policies of the management program. The State of Hawai‘i CZM program states “Because there is no point of land more than 30 miles from the ocean, a definite land-sea connection exists throughout the state. So, designating the entire state as the CZM area was logical. What occurs on land, even on the mountains, will impact and influence the quality of the coastal waters and marine resources. The CZM area also extends seaward to the limit of the State’s police power and management authority, to include the territorial sea. This legal seaward boundary definition is consistent with Hawaii’s historic claims over the Hawaiian archipelagic waters based on ancient transportation routes and submerged lands.” The proposed action does not require a coastal zone consistency determination because all activities occur inside existing infrastructure.

Air Force Instruction 32-7086, Hazardous Materials Management, 11 April 2014:

AFI 32-7086 establishes procedures and standards that govern management of hazardous materials (HAZMAT) throughout the Air Force. It applies to all Air Force personnel (at classified and unclassified operations) who authorize, procure, issue, use, or dispose of HAZMAT in the course of their official duties; and to those who manage, monitor, or track any of the preceding processes, whether the processes are performed by government or contractor personnel.

Air Force Instruction 32-7042, Waste Management, 31 March 2010:

AFI 32-7042 identifies compliance requirements for all solid waste (SW), including hazardous waste (HW), but excludes radioactive waste (except mixed waste) and medical waste. It applies to individuals at all levels who handle and/or manage waste.

Air Force Pamphlet (AFPAM) 32-7043 Hazardous Waste Management Guide, and AFI 32-7086 Hazardous Materials Management:

This document describes the actions and procedures necessary to ensure compliance with all applicable federal, state, and local laws and regulations; executive orders; and DoD and Air Force policies.

1.11 Related Documents

Previous EAs prepared for activities at AF facilities in Maui that may have relevance to this proposed action are:

Programmatic Environmental Assessment for Maui Space Surveillance Site (MSSS), Haleakalā, Maui, FONSI dated 5 July 1991. This EA discuss the AF desire to expand the MSSS within HO to increase the boundary and to add a pre-engineered metal maintenance shop warehouse. Additionally, this EA proposed activities to upgrade fuel storage, improve site access, enhance heat exchanger capability, expand utility capability, and demonstrate lasers.

Environmental Assessment for *Advanced Electro-optical System (AEOS) Telescope and Related*

Improvements at the Maui Space Surveillance Site (MSSS), Haleakalā, Maui, Hawai‘i, FONSI dated 24 July 1994. In this EA, the Air Force proposed the construction and operation of the Advanced Electro-Optical System (AEOS) telescope to provide greater light gathering ability than any existing telescope at MSSS and enhance MSSS's infrared capabilities. This telescope was needed to increase research capabilities to improve resolution and allow more extensive work on object characterization.

Environmental Assessment for *Proposed Advanced Electro Optical System Completion at the Maui Space Surveillance Complex (MSSC)* Haleakalā, Maui, Hawai‘i. In this EA, the AF proposed the completion of the Advanced Electro-Optical System (AEOS) telescope building by adding a mirror coating shop (MCS) at the Maui Space Surveillance Complex (MSSC) to accommodate the 3.67 meter mirror within the existing AF MSSC footprint atop Haleakalā, Maui, Hawai‘i. The Proposed Action was previously identified in the 1994 Environmental Assessment for AEOS construction; however, the mirror coating shop was not completed due to a funding shortfall. The FONSI for this action was signed on September 13, 2005.

Final Environmental Assessment for the Haleakalā High Altitude Observatory Site, Maui, Hawai‘i Management Plan University of Hawai‘i Institute for Astronomy, 25 October 2010. This EA evaluates the implementation of a Management Plan for appropriate and reasonable activities that would be undertaken by the University of Hawai‘i Institute for Astronomy (IfA) at the Haleakalā High Altitude Observatory Site (HO) in support of ongoing and future astronomical research activities.

CHAPTER 2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

This chapter describes the Proposed Action and reasonable alternative actions that would meet the following objectives:

Modernization and upgrade of equipment at MSSC to accomplish state-of-the-art space observation, illumination, and ranging capabilities. The proposed action is the installation of improved cameras, sensors, and adaptive optics, to support operational requirements. One of the primary items to be installed would be the FASOR Sodium Guide Star laser. All upgrades would be contained within the existing buildings and would not exceed current structure dimensions.

In accordance with CEQ regulations implementing NEPA (40CFR 1500-1508), the No-Action Alternative represents two common meanings: (1) Continue present management activities, but do not do the proposed project, and (2) don't do anything. For this AF Draft EA the DET 15 would continue performing research at MSSC Haleakalā with existing equipment and improvements with improved sensors would not occur. The No-Action will be analyzed to provide the baseline against which the environmental impacts of implementing the range of alternatives addressed can be compared. While the no action alternative would not satisfy the purpose of or need for the proposed action, it is analyzed in detail in the remainder of this document.

The alternatives considered to this proposed action are to perform the required AF mission requirements at another suitable location. The only other AF facility with a telescope similar in size and with high altitude viewing is the Star Fire Optical Range (SOR) at Kirtland AFB. SOR has been considered but eliminated due to the AF mission requirements/operations tempo currently accomplished at SOR and due to the foreseeable future activities required at this site as SOR would not be able to accommodate or incorporate the Det 15, MSSC mission.

2.2 Description of Proposed Action

The Air Force is proposing to continue space object viewing, data collection, and site operations at MSSC on Haleakalā with the following improvements: (1) replacement of sensors and instrumentation, (2) operation of a sodium laser known as FASOR propagated from the existing AEOS 3.6m telescope, and (3) installation and operation of an improved adaptive optics system which would be used throughout the year for the observation of stars and satellites. All of the equipment would be installed by qualified scientists, engineers, technicians and electricians within the existing buildings previously constructed at the MSSC, on Haleakalā in Maui, Hawai‘i. When activities require the integration with facility electrical power, licensed electricians would follow National Electric Code requirements. The instrumentation sensors, cameras, and other research equipment are relatively small and can be installed by one to two individuals and will not alter the existing structure dimensions.

An improved Adaptive Optics (AO) system in the AEOS facility would be installed to improve sensor and camera focus. This AO system would be used to sense atmospheric induced irregularities along the path from an object to the primary aperture so that the deformable mirror can

compensate for those aberrations. This can be achieved by sensing the light from an object, if the object is bright enough and sky background is dim enough. However, when the object is dim, either due to its intrinsic reflectance or in earth shadow, or when the sky is quite bright in the daytime, the use of an artificial sodium guide star is an alternative source of reference light for sensing. This is accomplished by using a laser to excite the naturally occurring sodium layer in the atmosphere, located 80-105 km above the earth's surface making it emit light or “glow”. This provides a moveable guide star reference point anywhere in the sky to allow adaptive optical compensation of images. Optical compensation greatly enhances image quality. This laser guide star technology is currently in use at observatories around the world, including the Keck Observatory on Mauna Kea, HI; the Lick and Palomar Observatories in California; the European Southern Observatory in Northern Chile; and the Air Force Starfire Optical Range, Albuquerque, NM.

The FASOR, a Class IV, 589-nm wavelength (orange color), 50 watt continuous wave laser propagated from the azimuthal base of the AEOS 3.67m telescope would be used to excite the sodium layer in the mesosphere to create a guide star. This laser, mounted on the existing AEOS telescope, would not change the dome or structure that houses the telescope. The laser equipment would occupy less than 13 square feet of space on the existing telescope mount and would not require heavy equipment for installation, operation or removal. Once installed, the FASOR guide star system would be integrated into MSSC operations and become a standard instrument for collecting space object imagery in support of its mission. The FASOR would be added to the list of existing devices at the MSSC, and operated in accordance with American National Standards for the Safe Use of Lasers, ANSI Z136.1, U.S. Air Force, AFOSH Standard 48-139 and Federal Aviation Administration 7400.2 Outdoor Laser Operation requirements. Light emissions from FASOR would occur primarily at night, approximately 80 nights per year. The duration of testing is dependent on weather conditions, cloud cover and targets approved for imaging (4-6 hours estimated per night). A typical operation would consist of 5 to 10 minutes of propagation; laser OFF during computer selection of next object; confirmation of next object; and then ON 5 to10 minutes for tracking and laser light emission. This would be done for nominally 2-5 objects per nightly operation. Laser beam pointing elevation is limited to 30-90 degrees above the horizon; and 0-360 degrees in azimuth. This ensures the beam does not interfere with personnel on the ground or other structures adjacent to AFRL facilities.

The improved instrumentation would be operated and supported by the existing staff, so no increase in MSSC personnel would occur and no additional Anti-Terrorism/Force Protection standoff would be required. The installation of instrumentation will be installed within existing buildings and is not expected to have any environmental effects.

2.3 No-Action Alternative

Under the No-Action Alternative, modernization of the equipment would not occur, and operations with improved equipment/sensors to include the FASOR sodium guide star laser would not be propagated outdoors at the MSSC. The objective to modernize current equipment at MSSC necessary to accomplish state-of-the-art space observation, illumination, and ranging capabilities will not be met. Critical operational mission data collection, and research and development pertaining to improved image resolution would not occur. The MSSC capabilities would fall behind in its ability to provide relevant, high quality data to support Air Force mission needs and eventually become obsolete.

2.4 Alternatives Considered But Eliminated From Further Analysis

Alternative sites were considered for research activities that require the proposed modernization of equipment for state-of-the-art research at MSSC. Modernization includes installation and operation of a sodium laser known as FASOR and the installation of improved sensors and instrumentation. The Starfire Optical Range (SOR) at Kirtland AFB, New Mexico could be a potential location to perform the AFRL/DET 15 MSSC research activities. Operations at SOR consist of optical research and advanced imaging R&D experiments. These research efforts and associated experiments utilize similar equipment in the form of 3.5 m and 1.5 m telescopes and various lasers to obtain optical images. The facility is operated primarily from dusk to dawn including infrequent daylight operational experiments that do not require totally dark conditions.

SOR operates 5 days a week for 42 weeks out of the year. A typical night of testing encompasses approximately 10-12 hours per night with 6-8 hours being scheduled test hours. The SOR facility is shut down for approximately 8 weeks for engineering/maintenance and there is a 2 week shutdown during the holidays. Additionally, the SOR desert climate and seeing conditions are greatly impacted by Mie scattering caused by constituents and particles in the atmosphere, see details in section 4.3.2.

The SOR was eliminated as an alternative to the proposed action due to its current and projected future operations tempo, which is heavily programmed and scheduled for its current R&D mission. Additionally, SOR does not have the same climate and atmospheric conditions available at the MSSC. As MSSC is located at 3,050 meters (10,010 feet) in altitude, above one third of the Earth’s atmosphere, it provides excellent conditions for astronomical and space surveillance observations. This combined with its remoteness from light pollution sources and high number of non-cloudy days makes it one of the best locations in the world for ground-based telescope observations. Haleakalā is an optimal location for obtaining the highest quality space object imagery required by the Air Force mission. Additionally, SOR cannot provide the AF Space Command with operational data and information for the on-going DoD operational mission that is available from the MSSC.

No other telescopes, the size of the AEOS 3.6 m telescope, are available to the AF to conduct this ongoing mission.

CHAPTER 3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Area of Potential Effect (APE) for determining the affected environment for the proposed action includes the 4.4 acres of land leased by the United States Air Force and owned by the University of Hawai‘i where MSSC is located within the HO on Haleakalā. Additionally, based upon experimental testing at Kirtland AFB, Albuquerque, NM the APE would include visual perception of the FASOR at a maximum distance of 1200m.

The following resources were not evaluated in the EA since it was determined that the nature of the proposed action will no impact or negligible impact on the environment. These resources are:

Air Quality

Water Quality

Hazardous Materials/Waste

Geology and Soils

Socioeconomics

Resources that may be impacted are as follows:

3.1 Land Use

State Land Use District designations, established by the State Land Use Commission, categorize all land in one of four districts: Urban, Agriculture, Conservation, or Rural. Conservation District subzone designations, regulated by the State Department of Land and Natural Resources (DLNR), are Protective, Limited, Resource, General, and Special.

Astronomical research activities occur within the Haleakalā Observatories (HO) complex at the summit of Haleakalā. A repeater station that is part of the Federal Aviation Administration’s (FAA) air traffic control system and a U. S. Department of Energy (DOE) research facility are situated immediately to the west of HO. Also bordering the HO parcel is an area owned by the State of Hawai‘i, which is controlled by the State Department of Land and Natural Resources.

The HO complex is situated in the General subzone of the State Conservation District (Figure 3) in accordance with Hawai‘i Administrative Rules (HAR) Chapter 13-5, which regulates land use in the Conservation District for conserving, protecting, and preserving the important natural resources of the state through appropriate management and use to promote their long-term sustainability and the public health, safety and welfare. Astronomy is a permitted use in the General subzone. Other nearby conservation areas include the National Park Service’s Haleakalā National Park and four state forest reserves (Kula, Makawao, Ko‘olau and Kahikinui) that function as watersheds and biological preserves. The forest reserves are also used for tourism and recreational purposes such as hiking, hunting and camping. Ranch lands used for cattle grazing border these conservation lands. Physical development (e.g., roads, buildings and water catchment projects) is minimal

throughout these conservation and agricultural areas.

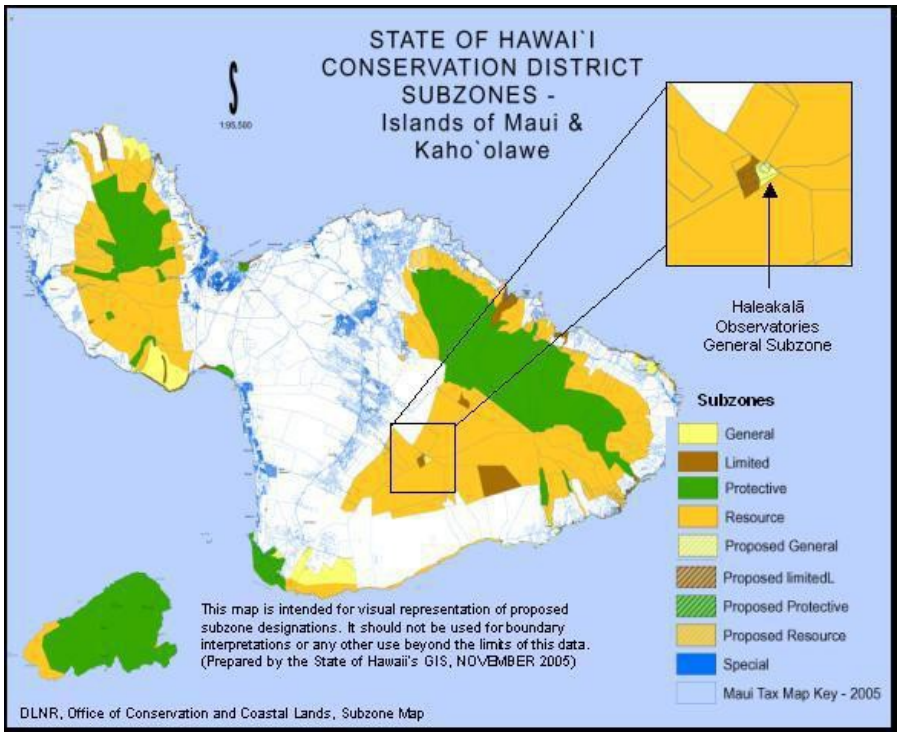


Figure 3: State of Hawai‘i Conservation District Subzones.

The Air Force Research Laboratory (AFRL) has the responsibility of host command for the MSSC. One part of the MSSC is the Maui Space Surveillance System (MSSS), an electro-optical facility combining operational satellite tracking facilities with a research and development facility. The MSSC houses the largest telescope in the Department of Defense (DoD) inventory, the 3.67m (12 ft.), the Advanced Electro-Optical System (AEOS). Conservation District Use Permit number MA-2705 was issued for AOES on 8/26/1994. AEOS is the primary telescope used by the AF at MSSC. Additional telescopes ranging from 0.4 to 1.6 m (1.3 to 5.2 ft.) with in the MSSS facility also support the AF mission. The MSSC also supports the Ground-Based Electro-Optical Deep Space Surveillance System (GEODSS), which is operated for the AF Space Command. The GEODSS is one of four operational sites in the world performing ground-based optical tracking of space objects. The main telescope (3.3ft.) aperture and 2 degree field of view is used to search the deep sky for faint slow-moving objects. The GEODSS telescopes are able to see objects 10,000 times dimmer than the human eye can detect.

Over the past 45 years, HO has experienced managed growth of astronomy and space surveillance facilities within its boundaries. The first major UH facility at HO was the C.E.K. Mees Solar Observatory (MSO) that has operated since 1964. The scientific programs at the MSO facility emphasize studies of the solar corona and chromosphere. The LURE Observatory was operated by IfA under contract to the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center from 1972 until 1993, to conduct highly accurate measurements of the distance between LURE and the Moon, as well as measurements of the distance between LURE and satellites in orbit about the Earth. From 1993 to 2004 LURE was operated for the NASA Space

Geodesy and Altimetry Projects, providing NASA with highly accurate range measurements between LURE and satellites. The facility was also involved in the NASA Crustal Dynamics Project. Other space programs have been pursued by UH using telescopes to discover and characterize space objects and to monitor for approaching asteroids and comets that might pose a danger to our planet. Additional UH telescope facilities include:

The Daniel K. Inouye Solar Telescope (DKIST,) formerly the Advanced Technology Solar Telescope (ATST,) represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The DKIST represents the next generation ground-based solar telescope and is currently under construction, and is expected to become operational in 2017.

The Faulkes Telescope North (FTN) was originally built by the Dill Faulkes Educational Trust and became operational in 2004; the Zodiacal Light Observatory; and the IfA has dedicated a small building for the Haleakalā Amateur Astronomers to organize and host programs for professors and students at Maui Community College (MCC), K-12, Boy Scout groups, Akamai students, community members and others to conduct astronomy observations at HO.

Vehicular traffic to and from Haleakalā Observatories is via Haleakalā Crater Road, a two-lane roadway through Haleakalā National Park. This road is owned and maintained by the National Park Service from its intersection with Haleakalā Highway to the park boundary nearest to the Haleakalā Observatories.

Visitors to the Park generate most of the vehicle traffic on the Park road, with the highest traffic volumes occurring during peak recreation hours. The high elevations combined with relatively steep grades and numerous switchback curves on the road limit vehicle speeds, particularly speeds of trucks and tour buses.

3.2 Safety and Occupational Health

All USAF-related operations are required to comply with the AF Occupational Safety and Health Program. Program requirements are specified in AFI 91-301, AFI 91-202, AFI 91-204 as Supplemented by AF Material Command and AFRL, *Air Force Occupational and Environmental Safety, Fire Prevention, and Health (AFOSH) Program*. The AFRL Safety Office has oversight of all ground and test safety activities performed at AFRL/Det 15 on Maui. Det 15 obtains support for government personnel to ensure occupational health requirements are met from the AF located at Hickam AFB, Aerospace Medical Squadron. The primary directive governing the AFOSH Program is USAF Policy Directive 48-1, *Aerospace Medical Program*. Outdoor laser operations are conducted in accordance with American National Standards for the Safe Use of Lasers, ANSI Z136.6 and U.S. Air Force, AFOSH Standard 48-139.

The proposed action at the MSSC would comply with the above program requirements under the supervision of the AFRL/safety office. Mitigation to reduce risks associated with the installation and operation of the improved equipment would be implemented to ensure hazards to human and biological resources are at the lowest level. The safety requirements for the proposed action are consistent with those currently required for mission activities at MSSC. Contractor personnel

involved in AFRL mission activities are required to comply with the AFOSH Program in addition to the requirements for contractors under the OSHA.

3.3 Biological Resources

MSSC is on University of Hawai'i land within the Conservation district on Pu‘u Kolekole, approximately 0.3 mile from the highest point, Pu‘u ‘Ula‘ula. Mountain summits are typically Aeolian (windy) deserts populated by a few mosses, lichens, and grasses. The predominant vegetation type at HO is alpine drawf-shrubland at the summit, 10,053 ft. Alpine ecosystems exist at elevations from 9,842 to 11,155 feet above mean sea level and can be extremely dry. The wet trade winds frequently do not rise above 6,233 ft. in elevation, being suppressed by the tropical inversion layer, leaving upper slopes too dry to support wet vegetation. Great daily variations in temperature occur, with frost most common at night. Cinder and ash soils underlie this area. At HO, shrubs consist of interspersed ‘*ahinahina* (Silversword) *and na‘ena ‘e* (Dubautia). Vegetation cover is relatively small, 10% of the surface area or less due to the harsh climate and soil conditions.

Approximately 44 plant species have been observed in the HO area of which 14 are native species and 30 are non-native species. The MSSC currently has over 100 threatened ‘ahinahina (Silverswords), thriving in planter bays and around the non-paved areas surrounding the MSSC facilities.

The MSSC and HO sites have been surveyed for biological resources (Movements of Hawaiian Petrels near USAF Facilities, Fall 2004 and Spring 2005 ABR, Inc.; ATST botanical survey, December 2005 and July 2009 Starr and Starr; Biological Opinion USFWS for ATST June 15, 2011). These surveys have included several botanical and arthropod surveys, a radar and visual survey of the movements of Hawaiian dark-rumped petrels *(Pterodroma phaeopygia sandwichensis*), and annual monitoring of Haleakalā Silverswords (*Argyroxiphium sandwicense* var. *macrocephalum*) within the MSSC site since 1998. All federally listed species at or near the site have been identified.

The diversity of insect fauna (arthropods) at the HO site is less than what has been reported for adjacent, undisturbed habitat. This is due in part to the harsh climate, but it is also a result of ground disturbance that has occurred at the overall site. (HOMP, October 2010). Arthropod surveys have occurred on numerous occasions within the vicinity of the MSSC site (Medeiros and Loope 1994, Pacific Analytics, L.L.C., 2003, 2005, 2007, 2010, 2011 and 2012).

Habitat for three Threatened and Endangered (Federal and State) species and one threatened (Federal) species lies within the vicinity of the summit area of Haleakalā. The three endangered species include: the Hawaiian dark-rumped petrel, which nests in burrows located just outside the 18-acre HO parcel; the Hawaiian goose (*Branta sandvicensis*), which nests at lower altitudes but over-flies the summit; and the Hawaiian hoary bat (*Lasiurus cinereus semotus*), which has been sighted near the summit. The threatened Haleakalā Silversword (*Argyroxiphium sandwicense* var. *macrocephalum)* is the only federally listed plant species found within the MSSC site.

Haleakalā Silversword (*Argyroxiphium sandwicense* var. *macrocephalum*)

The Silversword is the only federally listed plant species found within the MSSC site that is (Threatened - Federal). The Haleakalā Silversword is adapted to the intense, ultraviolet-light and cold, dry atmosphere indicative of the summit environment. The Haleakalā Silversword generally flowers from June to September, with annual numbers of flowering plants varying dramatically from year to year. In 2011, which was an average flowering year, there were approximately 565 blooms out of the tens of thousands of plants found on Haleakalā. The largest flowering year was 1991, with over 6,000 blooms, and the lowest year was 1970 with no blooms (Starr and Starr 2011). The Haleakalā Silversword has a highly restricted distribution. It is only found growing at elevations above 6,900 feet on Haleakalā within the crater and outer slopes around the rim. It is a distinctive, globe-shaped rosette plant, with a dense covering of silver hairs that completely hide the leaf surface. Usually single-stemmed, with its sword-like, rigid, and succulent leaves are 5.9-15.8 inches long, 0.2-0.6 inches wide at the middle, and usually three-angled in cross section. The flowering stalk grows 1.6-9.8 feet tall and contains numerous flowering heads. Plants mature from seed to its final growth stage in approximately 15-50 years. The plant remains a compact rosette until it sends up an erect, central flowering stalk, sets seed, and dies. The Silversword comes from the Asteraceae (Asters) family. In the late 80s two plants existed on the MSSC property. Recent surveys conducted by the AF, Oct 2013 and Jun 2014were completed with 128 plants in 2013 and 127 plants in 2014.

‘ua‘u (Hawaiian Dark-rumped petrel)

The Hawaiian petrel (*Pterodroma sandwichensis*) or ‘u‘au was listed as endangered on March 11, 1967 (32 FR 4001). The endangered ‘ua‘u, is known to nest and fly around the Haleakalā summit. The Haleakalā population was estimated to number 450-650 breeding pairs and 1,800 individuals in the 1980-1990s (Simons T. , 1985) (Simons & Hodges, 1998), and the West Maui populations may number around 100 (International, 2009), although radar observations suggest that this island-wide estimate may be low (Cooper, 2003), and it may be increasing due to increased reproductive success in response to predator-control in the colony areas (Hodges & Nagata, 2001) (International, 2009). The largest known nesting colony of Hawaiian petrels is located in and around the Haleakalā National Park (Simons and Hodges, 1998). In 2003, approximately 30 known burrows were located along the southeastern perimeter of HO, several burrows were northwest of HO, and additional burrows have been found northeast of the DKIST Project site (NPS, 2003).

The Hawaiian petrel or ‘ua‘u nests on Haleakalā in high elevation burrows located beneath rock outcrops, under boulders and cliff faces, along talus slopes or along edges of lava flows where there is suitable soil underlying rock substrate for excavation of tunnels. Most of the nests on Haleakalā are in rock crevices in sparsely vegetated, xeric habitat (Simons & Hodges, 1998). ‘Ua‘u can be found in deep burrows inside and outside Haleakalā Crater from late February to early November. They spend the remainder of the year at sea. Although historically the species may have nested at lower elevations, the current nesting habitat of Hawaiian Petrels on Maui is at elevations above 7,200 ft. (2,195 m). The majority of known Hawaiian petrel burrows are located along the western rim of the Haleakalā Crater, approximately 3,200 feet northeast of HO, where this habitat is most abundant and also where predator control is afforded. In 2004 and 2005, Hawaiian Petrel passage rates, collected using ornithological radar, were 4 to 7 times greater during summer and fall at the Visitor’s Center (Western rim), when compared to the Haleakalā Observatory complex, suggesting bird numbers are lower in areas encompassing the HO. Importantly, the population trend at

Haleakalā is increasing, which suggests that additional recruitment into this site is possible (Holmes, 2010).

Beginning in mid-February to early March, after a winter absence from Hawai‘i, breeding and non-breeding birds visit their nests regularly at night, for a period of social activity and burrow maintenance work. Pairs are site tenacious, returning to the same burrow year after year. From mid-March to mid-April, birds visit their burrows briefly at night on several occasions. Then breeding birds return to sea until late April or early May, when they return to lay and incubate their eggs. The eggs are incubated until July when hatching occurs. Adults that did not breed or whose eggs failed to hatch usually depart during August. Male and female parents share in feeding their young until the chicks double in size. ‘Ua‘u chicks are fed at approximately two- to three-day intervals for their first three months (July to September). The parents abandon the young around September of each year and leave the nesting colony until the next season. Fledgling occurs between mid-October and mid-November. ‘Ua‘u fly to and from their nests just after dark. Scientists believe the birds approach the crater from the west and leave through the Ko‘olau Gap to the north, where rim elevations are less than 9,500 feet.

‘Ua‘u is prone to colliding with protruding foreign obstacles. Overhead power lines are of concern. Primary predators of the ‘ua‘u are thought to be rats, dogs and mongoose. Other principal threats to the birds are collapsing of burrows by feral goats, collision with artificial light sources, and disease (U.S Fish and Wildlife Service, 1983). To help protect the petrels from feral goats, rats and dogs, UH installed a fence around the summit as part of the DKIST project.

nēnē (Hawaiian Goose)

Another federally listed endangered species, the nēnē , Hawaiian goose, or nēnē *Branta sandvicensis*, is Hawaii’s state bird and is a medium-sized goose. The nēnē was re-introduced on the islands of Maui, Kaua‘i and Hawai‘i and recently on Moloka‘i. The nēnē is found in a variety of habitats and elevations. On the island of Maui (at Haleakalā) the nēnē population is located between 5500-8000 feet and on the West Maui Mountains between 3000 and 4000 feet. There are approximately 250-300 nēnē on Haleakalā within the National Park. Most nēnē feed on leaves and seeds of grasses and sedges, leaves and flowers of composites, and various fruits. The breeding season is from October through March. Nests are built on the ground and the females lay 2-5 eggs per next. The female incubates (approximately 30 days) the eggs while the male guards the nest. Fledging occurs at 10-12 weeks after hatch. Adults molt following breeding season at such time they do not fly for about 5 weeks. Predators to the nēnē are dogs, cats, mongooses, rats and pigs.

Hawaiian Hoary Bat

The Hawaiian hoary bat (*Lasiurus cinereus semotus*), is a federal-listed endangered species that resides on the lower slopes of Haleakalā. The Hawaiian hoary bat is found on Hawai‘i, Maui, O‘ahu, Kaua‘i and Moloka‘i. On the island of Hawai‘i, most observations have been from between sea level and 7,500 feet ASL, although individuals have been recorded at elevations as high as 13,000 feet. On Maui, the bat resides in the lowlands of the Haleakalā slopes. According to the “Roadside Faunal Survey, Haleakalā National Park Fall 2014,” bats are present in low numbers at Haleakalā National Park (Starr Environmental, Roadside Faunal Survey National Park, 2014). The

highest numbers of bat pulses have been recorded at the 8500 ft. Eucalyptus grove. This grove may also be a roost site for the bats, as bats were detected just after sunset on multiple nights. This is in contrast to most other places in the Park, where bats show up many hours after sunset, suggesting they have roosts relatively far away. The second most active bat area is along the entrance road to Hosmer's Grove, in a protected area near the FAA Road. The numbers aren't large, but the bats are present and appear to possibly be foraging for short periods of time. The only place bats were not detected while having a detector out over multiple nights was near HO. A detector was left out for a week in the cinder parking lot by HO, facing HO and the front gate to the Air Force property, where an Air Force security guard had reported viewing a bat at dusk. No bats were detected. (Starr Environmental, Roadside Faunal Survey National Park, 2014)

Invertebrate Fauna

On Haleakalā, there is an Aeolian ecosystem extending up the summit from about the 7,550 feet elevation. It is characterized by relatively low precipitation, porous lava substrates that retain relatively little moisture, little plant cover, and high solar radiation. The dark, heat-absorbing cinder provides only slight protection from the extreme temperatures, and thermal regulation and moisture conservation are critical adaptations of arthropods occurring in this unusual habitat.

Due to the harsh environment, fewer insects are present at upper elevations on Haleakalā than are found in the warm, moist lowlands. A survey and inventory of arthropod fauna was conducted for the 18 acres of HO in 2003 for the UH Long Range Development Plan and HOMP. In this study, several species were added to the previous inventory site records. An additional survey including arthropod collection and analysis was conducted in 2005 at the MEES and Reber Circle sites for the proposed DKIST Project (Pacific Analytical, 2005). The arthropod species that were collected in this study were typical of what had been found during previous studies. Although the study was conducted during the fall months, no species were found that are locally unique to the site, nor were there any species found whose habitat is threatened by normal observatory operations.

An arthropod survey was conducted in June 2009 (Pacific Analytics, 2009). The results of this arthropod survey indicate there are no special concerns or legal constraints related to invertebrate resources in the project areas. No invertebrate species listed as endangered, threatened, or that are currently proposed for listing under either federal or State of Hawai‘i endangered species statutes were found at the project site (DLNR 1997, Federal Register 1999, 2005).

3.4 Cultural Resources

The cultural resources of Maui encompass pre-contact to present time, span legends and religious beliefs, and include activities ranging from spiritual use and hunting to tourism and high technology science. The cultural significance of Haleakalā has connections to the legends of Pele, who died at Haleakalā during a battle with her rival sister, and the demi-god Maui, who lassoed the sun to slow it down. (CKM Cultural Resources, Traditional Practices Assessment for the Summitt of Haleakalā, 2002) Historical uses of Haleakalā included meditation and prayers by kahuna (priest, clergyman) and their students, who sometimes lived at Haleakalā. An order of priesthood, called Paliku, conducted ceremonies during the Makahiki (ancient annual festivals beginning around the middle of October and lasting about four months). Haleakalā has been and continues to be a source

of spiritual guidance; it is considered a temple, a graveyard, and a focal point for mana (supernatural or divine power). The entire summit area, which includes Kolekole, is considered wahi-pana (a legendary place). (CKM Cultural Resources, Cultural Resources Evaluation For the Summit of Haleakalā, 2003) The summit area has been used to train kahuna in the arts of healing and navigating with the stars and constellations. Given its religious significance, access to the summit area was limited to Ali‘i (royalty) and kahuna, while commoners were only allowed here to gather stone in the quarry or to bury their dead Ali‘i. The remains of Ali‘i were buried in caves throughout the summit, crater, and adjoining areas. Those who brought the deceased to their final resting place were sacrificed and buried along with the royalty in a secret location.

Remnants of the physical and spiritual culture have survived. Several cultural resources of importance, such as wind shelters, petroglyph images, and burial and ceremonial sites are still found on Kolekole. Connections to the spiritual sensitivity remain as the summit is still the highest point overlooking Maui and there is still a connection to ancient gods and goddesses and the past traditions. Modern uses of the Kolekole area include the gathering of flora and fauna for medicinal purposes and for adornments by Kumu Hula (hula teachers).

In 2007, Cultural Surveys Hawai‘i, Inc. (CSH) was commissioned to conduct a Supplemental Cultural Impact Assessment (SCIA). The SCIA was performed in accordance with the guidelines for assessing cultural impacts, as set forth by the Office of Environmental Quality Control (OEQC) (OEQC 1997) and was intended to supplement the initial Cultural Resource Evaluation (CKM 2006) for the proposed DKIST Project. The primary purposes of the SCIA were to widen community outreach and to gather additional information on the Traditional Cultural Property of Haleakalā as an additional means to assess the potential effects of that particular proposed undertaking on Native Hawaiian traditional cultural practices and beliefs. Although the SCIA was conducted for a specific project, the preparers of the SCIA made an additional effort to gather supplementary information, community input, and knowledge of the summit area, and therefore the information is relevant to this proposed action. The SCIA contains considerable additional historical perspective on Haleakalā. It discusses in great detail the symbology of the mountain, its role in the history of Maui as a living entity, as well as the archeological record.

Haleakalā Summit as a Traditional Cultural Property

The summit of Haleakalā is considered a significant cultural resource in and of itself. It is eligible for listing on the NRHP as a Traditional Cultural Property (TCP) through consultation with the State Historic Preservation Office (SHPO) under Criterion “A” for its association with the cultural landscape of Maui and this is reflected in the number of known uses, oral history, mele and legends surrounding Haleakalā. The term “Traditional Cultural Property” is used in the NRHP to identify a property “that is eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that, (a) are rooted in that community’s history, and (b) are important in maintaining the continuing cultural identity of the community” (DOI 1994). The summit is also eligible under NRHP Criterion “C” because it is an example of a resource type, a natural summit, and a source for both traditional materials and sacred uses. The value ascribed to Haleakalā as a TCP can be expressed in five distinct attributes, solidifying the role of the summit as a place of value.

1. Haleakalā summit is considered by Kanaka Maoli, as well as more recent arrivals to Hawai‘i, as a place exhibiting spiritual power.
2. The summit of Haleakalā is significant as a traditional cultural place because of traditional cultural practices conducted there. For both Hawaiians and non-Hawaiians who live and visit here, the summit is a place of reflection and rejuvenation.
3. The mo‘olelo and oli surrounding the summit present a collection of stories suggesting the significance of Haleakalā as a TCP.
4. Some believe that the summit possesses therapeutic qualities.
5. The summit provides an “experience of place” that is remarkable.

As mentioned previously, in recognition of the traditional cultural importance of Haleakalā, Native Hawaiian stonemasons erected the West and East *ahu* (altar or shrine) for ceremonial use by Kanaka Maoli at HO in 2005 and 2006, respectively. Native Hawaiians practicing cultural traditions are welcome to use these sites, with the understanding that such use will not interfere with other uses and activities within HO.

The archaeological resources at Haleakalā Observatories are described in several studies conducted at the summit. No archaeological features have been identified within the boundaries of the MSSC; however, archaeological features at Haleakalā Observatories include four sites identified near the MSSC. The State Inventory of Historic Places (SIHP) lists several sites that consist of individual wind shelters and partial enclosures for temporary habitation, complexes of wind shelters, and one site that includes two petroglyph images and a possible burial location. Other sites, identified at Haleakalā Observatories, included wind shelters, a historic radio telescope foundation, and a probable trail segment.

There have been three archaeological surveys that had been conducted in the 18.166-acre HO parcel. The first of these archaeological studies was carried out in 1990 and consisted of a reconnaissance survey (Chatters, 1991). Cultural Surveys Hawaii, Inc. conducted the second study, an archaeological inventory survey, in 1998 (April 2000). In the third study Xamanek Researches carried out an archaeological inventory survey in the fall of 2002.

The first study, which consisted of an archaeological reconnaissance survey, was carried out by Pacific Northwest Laboratory on behalf of the U.S. Air Force for the expansion of the Maui Space Surveillance Site or MSSS (Chatters, 1991). During the course of this walkover, four archaeological sites were identified, primarily along the western side of Kolekole Hill. These features included 23 temporary shelters and a short, low wall. These wind shelters were typically constructed against the existing rock outcrop of the hill. The sites were designated No. 50-50-11-2805 through 2808. One sling stone was found on the floor of Feature J at Site 2807. In addition, one *opihi* (Cellana spp.) shell was noted on the surface of the Feature B floor of Site 2808. There was no subsurface investigation carried out, and only Site 2805 was mapped (Ibid.)

The second study was carried out by Cultural Surveys Hawaii, Inc., in conjunction with the planned construction of the Faulkes Telescope North. This study located two previously unidentified sites—4835 and 4836. Both of these sites were constructed against an exposed rock outcrop. Site 4835 consists of 2 features—both historic rock enclosures filled with burned remnants of modern refuse—obviously historic trash burning pits. These may have been used initially by the U.S. Army

during the war, and later by University of Hawai‘i workers. Site 4836 consists of 3 terraces, a rock enclosure, 2 leveled areas and a rock wall—all constructed against an exposed rock outcrop. Five of the features are interpreted as temporary shelters, while the 2 leveled areas were of indeterminate usage.

Xamanek Researches carried out an inventory survey of the entire 18.166 acre parcel in 2002-2003 (Fredericksen and Fredericksen, April 2003). A total of six previously unrecorded sites (50-50-11-5438 through 5443) were located during the course of this inventory survey. These sites consist of wind shelters, two petroglyph images, a possible burial feature, and an historic foundation—Reber Circle. In addition, a trail segment was recorded at Site 4836 and designated as Feature F. Several isolated pieces of coral were noted in the southeastern portion of the study area, but not assigned a formal site number, because the coral pieces were not weathered.

No archaeological features were identified within the boundaries of the MSSC from these surveys.

Visual Resources

The terrain around HO is rugged, sparsely vegetated, and covered with an abundance of lava rock. The summit area’s appearance is a sharp contrast to the lower slopes of Haleakalā and the more tropical environment at sea level. Near the HO, the cinder cones of Haleakalā’s summit dominate the panorama. The summit of Haleakalā is an important visual resource for Native Hawaiians, Maui residents, and tourists.

The Haleakalā Observatories are visible from the Pa Ka‘oao (White Hill) Visitor Center and the Pu‘u Ula‘ula (Red Hill) Overlook (Figure3). Additionally, when there is no cloud cover, the reflection of sunlight off the AEOS dome can be seen from Central Maui during the early morning and late afternoon hours. The visibility of the HO facilities varies depending upon one’s vantage point. Several HO facilities are visible from Pu‘u Ula‘ula. Some HO facilities are partially visible from the Park entrance station to about the first mile of the Park road, the Park Headquarters Visitor Center, portions of the Park road corridor (particularly the last one-third of the Park road closest to the summit), and near the summit from the Haleakalā Visitor Center (Pa Ka‘oao or White Hill).

Figure 3: View of HO from Pulu Ula ula.

Approximately 785,000 visitors annually (HALE 2010) are attracted to Haleakalā‘s various lookouts and vantage points for its spectacular vistas. Looking down the slopes to the northwest, a majestic view of Maui’s isthmus and West Maui Mountains is afforded, while to the east are the richly colored scenes of the crater and, on minimal cloud-cover days, the slopes of Mauna Kea, Mauna Loa and Hualālai.

Overall, visibility of the HO facilities is highly variable depending on a combination of factors. These include locations from where one views them on the island, atmospheric conditions (e.g., dust content, humidity), time of day, cloud cover, and human activity (e.g., cane burning). For example, on a clear, low-humidity day, some of the facilities would be distinguishable as very small man-made objects from as far away as Ma‘alaea Bay, which is a distance of approximately 17 linear miles. However, in humid and/or dusty conditions, they may not be visible at all from Ma‘alaea Bay or even from locations in Upcountry Maui at half that distance.

Visibility of the summit area would be more likely in the early morning before the daytime cloud inversion layer builds up, and in the late afternoon after the inversion layer dissipates. When mid- and upper-level cloud cover is absent, a few of the existing structures at HO are visible. depending on one’s vantage point they are visible from miles away. Some of the facilities can also be seen from public viewpoints and highways that climb the slopes of the mountain (UH IfA, 2010).

CHAPTER 4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Land Use

The Proposed Action is to modernize AF research equipment at existing MSSC facilities, including the installation of a FASOR laser on the AEOS telescope, the installation improved sensors and instrumentation, an improved adaptive optics system, and other related supporting equipment located internal to the facility. This action would not significantly change the operational tempo or manning of the MSSC. The AEOS is situated in the HO complex within the General subzone of the State Conservation District (Figure 3) in accordance with Hawai‘i Administrative Rules (HAR) Title 13-5. Astronomy is a permitted use within the General subzone. The AF AEOS facility and operation was approved under CDUP MA2705 issued by DLNR 8/26/1994 following the Environmental Assessment for *Advanced Electro-optical System (AEOS) Telescope and Related Improvements at the Maui Space Surveillance Site (MSSS)*, Haleakalā, Maui, Hawai‘i, FONSI dated 24 July 1994. The installation and operation of the FASOR laser at AEOS and the installation improved sensors and instrumentation, an improved adaptive optics system, and other related supporting equipment will not result in a change in land use, nor would there be a significant impact on land use. Adding the FASOR laser to the AEOS telescope and adding improved research equipment at MSSC existing facilities would improve the quality of the data collected at the site. The proposed project is consistent with the goals and objectives of the following state, county, community, and University of Hawai‘i, Institute for Astronomy (UH IfA), Haleakalā Observatories plans:

- Similar research activities are performed at HO by the AF, UH IfA, NSF, TU, and NASA.
- AFRL’s practices of handling MSSC’s cultural and biological resources, is consistent with UH IfA Haleakalā High Altitude Observatory Site Management Plan (HOMP), USFWS and Haleakalā National Park Service plans
- Astronomy is a permitted use in the Conservation District General Subzone.

Implementation of the Proposed Action would not restrict access to any areas that are currently open to the general public. In accordance with the lease agreement, AFRL contributes financially to maintenance of the road through HO only and does not apply to the federal highway through Haleakalā National Park. All activities performed for the proposed action do not require any special use equipment, nor will traffic along this highway increase. MSSC buildings are considered secured military facilities and will continue to have restricted access. The 4.4 acres managed by the AF is not fenced and does not have any archeological sites. Access for native Hawaiians to cultural areas would not change from current practices as the ahu are outside the AF property.

No-Action Alternative

There would be no impacts to Land Use under the No-Action Alternative as the proposed MSSC modernization efforts would not be implemented. Current research activities would continue.

4.2 Safety and Occupational Health

AFRL Det 15 manages all laser projections by analyzing the hazards for each proposed test, determines the safest way to accomplish mission objectives and implements mitigation to reduce the risk to the lowest level. Standard best practices are implemented such as: coordination with FAA and adjacent users; establishing a laser exclusion zone; limiting pointing angles; implementing operator situational awareness; designing safety interlock devices for equipment associated with the laser projection; and developing emergency stop procedures. The outdoor laser propagation at MSSC is controlled using a tiered safety approach providing space asset protection via Predictive Avoidance (PA) for satellites; aircraft asset protection via a Federal Aviation Administration (FAA) radar feed to monitor aircraft in and around the MSSC; and the use of outdoor spotter(s). All of the lasers at MSSC have shutters that block the laser (light emission) beam from propagating inside and outside the facility. First, the FAA radar feed is linked with the mount/laser beam software to provide aircraft position information in relation to the telescope mount orientation and beam projection angle; second, the outdoor spotter visually monitors air traffic in relation to the telescope mount orientation and beam projection angle; and third, specific coordinates and times of satellite passes are entered into the mount software to prohibit laser projections to protect against inadvertent satellite illumination. All of these processes and procedures are used to ensure personnel at the summit, air and space assets are protected from laser operations.

The FAA Radar feed is a direct link into the control room at MSSC and provides real-time data on the location of all private and commercial aircraft in the area. If an aircraft enters the exclusion zone of the proposed laser projection, an automatic shutter is engaged. Additionally, the person monitoring this feed has the ability to shutter the laser photon emission if an aircraft approaches too close to the beam affected airspace.

The Safety Spotter stationed outside the facility is continually evaluating outdoor conditions to ensure propagation of laser light will not cause any hazards to aircraft, biological resources and personnel on or off the site. This will include but is not limited to an observation of the cloud cover and weather in the area, observation of personnel or equipment at outlying facilities, and evaluating the beam proximity to aircraft. Any time the spotter recognizes an unsafe condition, the propagation is terminated. By the ANSI Z136.6 ‘Safe Use of Lasers Outdoors Standard’ safety spotters “shall have the responsibility, capability, and authority to terminate laser beams immediately when an aircraft approaches, and before a potential hazard occurs.” The Safety Spotters have a headset for communicating with the test laser safety officer, and a dead-man switch that allows the Plane Watch control over the Laser shutter.

To ensure the light emissions do not cause hazards for personnel, AFRL strictly adheres to OSHA, Air Force, and ANSI laser safety Standards and imposes strict safety protocols for all of its laser operations. For example, AFRL imposes a 30-degree above the horizon minimum pointing angle for all laser operations—resulting in the elimination of laser hazards to the Public on the ground. The MSSC incorporates this multi-tiered safety system to address inadvertent lasing of personnel on aircraft and space optical assets, by incorporating human outdoor safety spotters, monitoring Federal Aviation Administration (FAA) radar feed, and a space asset Predictive Avoidance (PA) system during all outdoor laser operations. Implementation of these safe guards has allowed MSSC to operate without incident for over twenty years.

No adverse or significant safety impacts are anticipated from the implementation of the proposed action to modernize MSSC equipment within existing facilities.

The FASOR Laser emits light at a wavelength of 589.2 nm. This causes sodium atoms, which are naturally occurring in the mesosphere at an altitude of 80-105 km, to absorb laser light and fluoresce ("glow") at the same wavelength. This glowing is not a chemical reaction, green-house gas or an air emission; it is caused by the sodium ions in the mesosphere absorbing the light from the FASOR, becoming excited, and reemitting the light omnidirectional like a lamp. Once the FASOR laser stops illuminating, the sodium ions will no longer be excited and will stop glowing. This process does not change the chemical make-up of the sodium ions and does not cause any off-gassing. No significant impacts on safety or human health would occur from the proposed project, including the operation of the FASOR laser.

No-Action Alternative

There would be no impacts to public safety under the No-Action Alternative as the proposed MSSC modernization efforts would not be implemented. There would be no impacts to safety or human health under the No Action Alternative as the proposed MSSC modernization efforts would not be implemented.

4.3 Biological Resources

The proposed modernization of the MSSC equipment within existing facilities would have no significant impact on biological resources. The potential threat to fauna from the installation and operation of the FASOR laser is from the visible light (589nm orange color) that would be propagated from the AFRL, MSSC 3.6 m AEOS telescope. As mentioned above, past and existing visible laser have been used at the MSSC and HO, however these lasers have been in the blue and green visible spectrum. Since the FASOR is in the orange spectrum, the spectrum visible to avifauna and possibly a source of distraction to these species, additional analysis was performed. To determine the impact on fauna, specifically the ‘ua‘u, nēnē and hoary bat, an analysis of proposed operations and behavioral information for these species was analyzed with consideration for: 1) Direct laser illumination where the animal would be exposed by flying through the laser beam; and/or 2) distraction or disorientation by back scattered laser light.

4.3.1 Direct Laser Illumination

The theoretical worst case hazard to birds or bats directly exposed to the FASOR laser beam is retinal damage due to the species looking directly into the beam while simultaneously being illuminated. There is no surface or skin hazard due to the beam size, power, and notional exposure duration. The Avifauna retinal exposure hazard is expected to be very low because of laser tracking an object in space, the relatively short times during which such beams would be on (5-10 min), the relatively small diameters of the beam, the species flight speed, and low flight activity over the MSSC. A bird or bat flying at 48 km/h (30 mph) would pass through a 20cm (7.874 in.) diameter beam in less than 0.015 s. While an avian retinal damage event is possible, the combination of: the laser beam tracking an object in space; propagation path above 30 degrees; limited lasing times; relatively sparse bird activity over the MSSC; narrow laser beam parameters; and bird flight speed

makes it a highly unlikely event. Additionally, the bird or bat would need to focus on the beam, directly in-line with the beam projection in the very short time during which it flew through the beam further reducing the probability of a direct illumination blinding event.

The bird species of particular concern at the MSSC are the ‘ua‘u, or Hawaiian Petrel, which flies to and from nest sites at night; and the Nēnē, which has been re-introduced on Haleakalā. Although experiments using lasers could occur during the ‘ua‘u breeding season, impacts are expected to be unlikely because of the predominant flight path which takes the birds over the Haleakalā NPS Visitor Center and not over the MSSC. Laser projections at MSSC are primarily directly overhead where the beam is blocked from propagating below 30 degrees. However, on rare occasions the AF has received past missions that required night projections below this 30-degree limit. The probability still remains very low that a species would be impacted due to safety protocols implemented and positive laser controls. Typically, these sensors/communications lasers are invisible to both humans and birds thereby reducing the potential species will be disoriented. The Visitor’s Center is approximately 965 m (3168 feet) from the AEOS telescope/FASOR laser would be located. At this laser projection limitation (30 degrees above horizon) the beam would be 557 m (1,827 feet) above the Visitor’s Center. This would indicate that it is highly unlikely petrels would intercept the beam at this location, since the majority of petrels fly below 15m (49 feet) AGL.

According to representatives at the Daniel K. Inouye Solar Telescope (DKIST) less than 17 petrel incidents have been observed near, but not on the Haleakalā Observatory site, from 1988 to 2014.

It is highly unlikely that the Nēnē population would be affected as very few have been observed at the summit, and none have been observed at AFRL 4.4 acres; there is sparse vegetation and food supplies are very limited; consequently Nēnē are not known to reside near MSSC facilities. Although the hoary bat could potentially be in the MSSC area, it is not expected due to the cooler temperatures at night and therefore would not be adversely impacted.

4.3.2 Scattered Laser Light

It is well documented that petrel fledglings are attracted to and disoriented by sources of anthropogenic light on their post-natal nocturnal flights to the ocean (Troy, Holmes, & Green, 2011). One explanation for this behavior is that petrels use moonlight to navigate to their burrows. It is believed that the petrel focuses on other bright light sources that emanate omni-directionally causing disorientation. This disorientation can cause them to fall to the ground following exhaustion and/or crashing into manmade structures and vegetation in a phenomena termed “fallout.” Once grounded, the birds become vulnerable to dehydration, starvation, and predation (Troy, Holmes, & Green, 2011). While it is unknown what threshold of light intensity is required to attract or disorient birds, experiments have been performed that demonstrated a 40% decreased attraction of fledgling Procellariiform birds, which is an order of seabirds that include Newell’s Shearwater, Dark-rumped Petrel, and Band-rumped Storm-Petrels, by shielding upward radiation of lights at the largest resorts on Kauai (Reed, Sincock, & Hailman, 1985). This shows that limiting light viewing angles and direct intensity significantly reduces the attraction potential of artificial lights. These results can be extrapolated to the FASOR case, where all but a very small angle of light is shielded from view (i.e. the main beam) and the backscattered light consisting of a low

intensity cone of light would have minimal attraction to birds.

Due to a laser's directionality and coherence properties, the on-axis (in-beam direct view) is very bright (i.e. when the beam is pointed directly at the viewer); while the off-axis visibility is very dim. In a vacuum, when the viewer is off-axis to the beam, the laser beam itself is invisible because the photons are all going in the same direction, and none are impacting the receptors in the viewer's eye. When propagating through an atmosphere, the laser photons are scattered when they hit air molecules (primarily nitrogen and oxygen)--Rayleigh scattering; and larger particles (dust and water vapor)--Mie scattering. When there are enough photons received in the eye, it resolves it as a beam in the sky. The angular distribution of scattered light is complex; however, it can be simplified by imagining the photons as balls all travelling in a single direction and bouncing off of molecules that they encounter. The distribution of the bounced photons would vary, with more bouncing back towards the source and fewer bouncing to the angle normal to the original direction of the source. The result is a cone of intensity, so the apparent brightness will change depending upon the viewer's angle relative to the beam—the backscattered light is brightest when standing near the laser source and gets dimmer as the viewer moves laterally away. Also, the density of molecules in the air will change the number of photon collisions and therefore the off-axis apparent brightness (Prilutsky & Fomenkova, 1990). For Rayleigh scattering the atmospheric nitrogen and oxygen concentrations can be considered pretty constant; however the Mie scattering can vary wildly due to ambient conditions such as clouds and dust storms. For this reason, MSSC operations are suspended during cloudy or extreme weather conditions.

The easiest way to explain the off-axis visibility of the laser beam is to compare its apparent brightness compared to stars observed in the night sky. Astronomers use an "apparent magnitude scale" to measure the brightness of objects in the night sky. The brighter an object appears, the lower the value of its magnitude. A star that is one magnitude number lower than another star is about two-and-a-half times brighter. Table 1 is a list of some common apparent magnitudes.

Direct View Object	Apparent Magnitude	Number of stars brighter than apparent magnitude
Sun	**-26.74**	**0**
Full-Moon	**-12.92**	**0**
International Space Station (when fully illuminated by the	**-5.9**	**0**
10 watt incandescent bulb (5%	**-2**	**0**
Sirius (brightest star in	**-1.46**	**0**
Vega	**0**	**4**
Calculated FASOR brightness directly below the	**2.5**	**between 48 and 171**
Faintest star visible to Human	**6.5**	**9096**
Calculated FASOR brightness at 1.5 km with source	**6.5**	**9096**
Source: Wikipedia		

Table 1: The calculated brightness of the FASOR backscatter is less than many stars and diminishes as the viewer travels away from the laser source.

To compare the FASOR laser brightness in the night sky AFRL/RDMT and AFRL/RDS conducted a test involving a Sodium Laser at Kirtland AFB, NM; using a 10 watt light bulb to provide a reference light source, Figure 4. The apparent brightness of this laser was much less than a 10 watt light bulb and no brighter than the average star in the sky.

The photo was taken on a clear night, so the majority of the laser light seen Figure 4 is caused by Rayleigh scattering. A 10W incandescent light bulb viewed from 500 m (1,640 ft.) has an apparent magnitude of around -2.00, assuming that the bulb is 5% efficient; and the Sodium Laser has a magnitude of around 2.5 when viewed from directly under the beam pointed at zenith (Hackett, 2014).

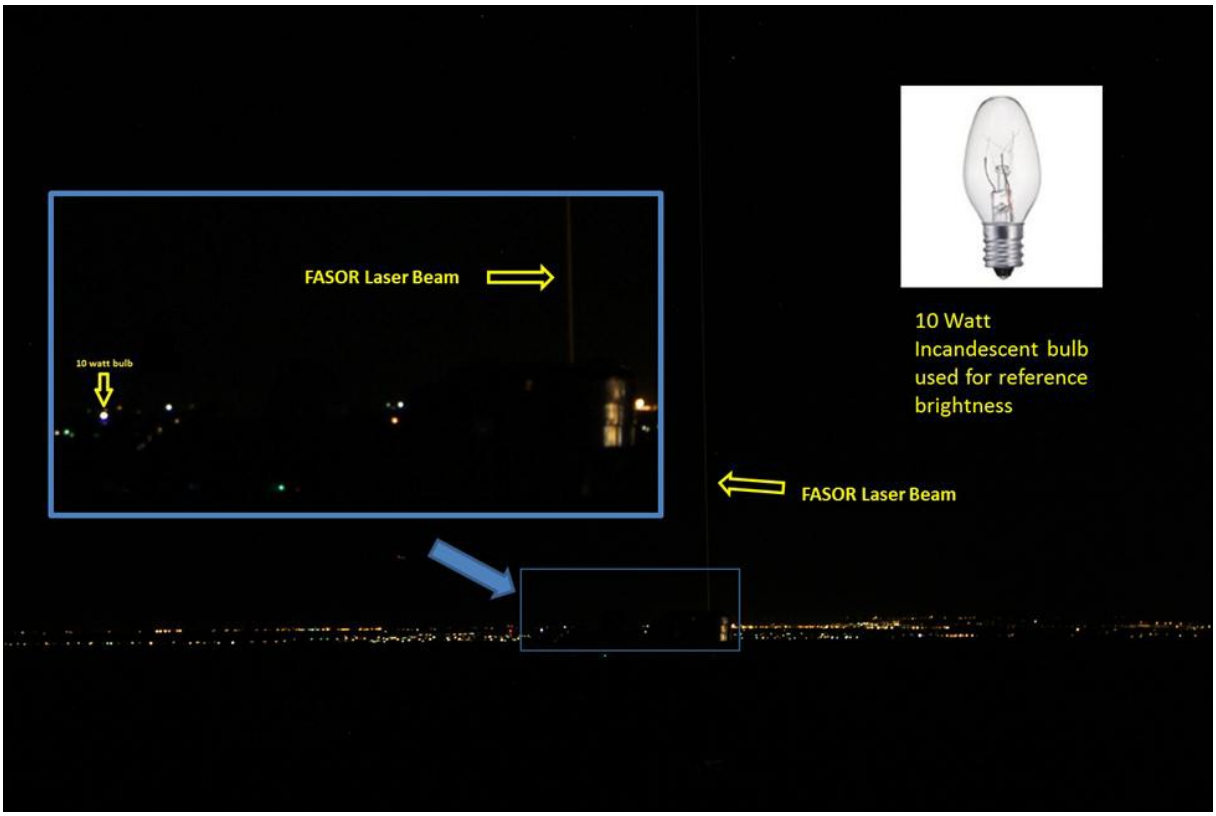


Figure 4: A 10 watt light bulb provides a relative brightness to the laser beam in this photo of the Sodium Guidestar laser at the Starfire Optical Range located on Kirtland Air Force Base, NM taken at a distance of 0.6 miles away.

Based upon this experiment and subsequent analysis, the operation of the FASOR laser at MSSC is highly unlikely to adversely affect the wellbeing or flying behavior of any threatened or endangered species. Leading factors for this conclusion are:

- The FASOR laser poses no surface or skin hazard due to the beam size, power, and notional exposure duration.
- The AFRL's MSSC has been performing outdoor laser and optical system testing since 2000 with negligible impact on environmental resources and no recorded impacts on any ‘u‘au or other wildlife form.
- While possible, it is extremely unlikely that a bird inflight near the laser projection (beam diameter 20 cm (7.874 in.)) would intersect resulting in retinal injury or surface injury, due to tracking and slewing of the laser beam, short exposure time to the beam, relative low bird activity over the MSSC, 30 degree laser elevation pointing limitation, and typical flight altitude (15m) of the petrel – below normal beam height above the ground.
- The backscattered sodium laser light will be 6.25 times dimmer than the brightest star in the sky, thus not constituting a bright light source. It is unlikely that a relatively dim, directional light would have the equivalent disorientation effects on petrels, as observed with bright omni-directional light sources.
- The FASOR laser would only be used intermittently and the duration of the laser beam

projection is typically short (5-10 minutes in duration). If a bird were to become distracted or disoriented by the laser light, the light would be extinguished before the bird becomes exhausted, allowing it to recover and reorient its flight path.

Consultation under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.) was completed with the U.S. Fish and Wildlife Service on 3 Jan 2015. Based on AFRL's avoidance and minimizing measures, USFWS has concurred with our determination that the proposed project may affect, but is not likely to adversely affect the Hawaiian petrel, Haleakalā Silversword, Hawaiian goose, and Hawaiian hoary bat. For these reasons, and the established practices designed to prevent impacts to flora and fauna, no significant impacts on biological resources are anticipated from the Proposed Action.

No-Action Alternative

There would be no impacts to biological resources under the No-Action Alternative as the proposed MSSC modernization efforts would not be implemented.

4.4 Cultural and Visual Resources

Views of the summit are considered in this section as Haleakalā is considered by many to be a sacred place. The existing MSSC facilities can be seen faintly from Maui's central valley when clouds are absent and the air is clear. As the sun is going down the sunlight reflect off of the AEOS aluminum siding and is potentially seen at different Island locations. As the sunlight continues to diminish the potential glint or "sparkle" off of the AEOS dome disappears. Daylight visibility of the MSSC facilities would not change with the proposed projects described in this EA. With the proposed project, the existing relationships between the natural and man-made environments would be maintained. The Area of Potential Effect (APE) for determining the affected environment for the proposed action includes the 4.4 acres of land leased by the United States Air Force and owned by the University of Hawai‘i where MSSC is located within the HO on Haleakalā. Additionally, based upon experimental testing at Kirtland AFB, Albuquerque, NM the APE would include visual perception of the FASOR at a maximum distance of 1200m. Based upon the analysis in 4.3, the proposed action would not affect visual resources and view planes from distances greater than 1200 m.

The primary impact on visual resources and view planes that would result from the operation of the FASOR laser is the visible light (589 nm orange color) propagated from the AFRL MSSC AEOS telescope. The FASOR laser would be visible from a few locations on the summit; mainly the Visitor's Center and the Summit Overlook starting at dusk. The summit area is open to the public 24 hours a day, with the vast majority of people visiting during daylight hours. The beam becomes faintly visible at dusk and more apparent as the night sky darkens. The visibility of the beam becomes faint as the sky lightens and dawn approaches. As mentioned above, past and existing visible lasers have been used at the MSSC and HO, currently UH (TLRS4/NASA GSFC) conducts operation using a visible green (532 nm) laser almost continuously 10-hours a day. They will operate their laser during day and nighttime hours.

Visitors to these areas will be able to see the FASOR laser as it is propagated during nighttime hours. Although a photo is difficult to communicate the actual visibility of the FASOR laser beam,

the image below was taken at SOR Kirtland AFB, NM with a long exposure to relate the potential visibility depending on seeing conditions and background light. The photo is a reasonable facsimile of the FASOR appearance from the visitor center. The FASOR laser would only be used intermittently and the duration of the laser beam projection is typically would be short (5-10 minutes in duration). During daylight activities, the FASOR would not be visible to the naked eye.

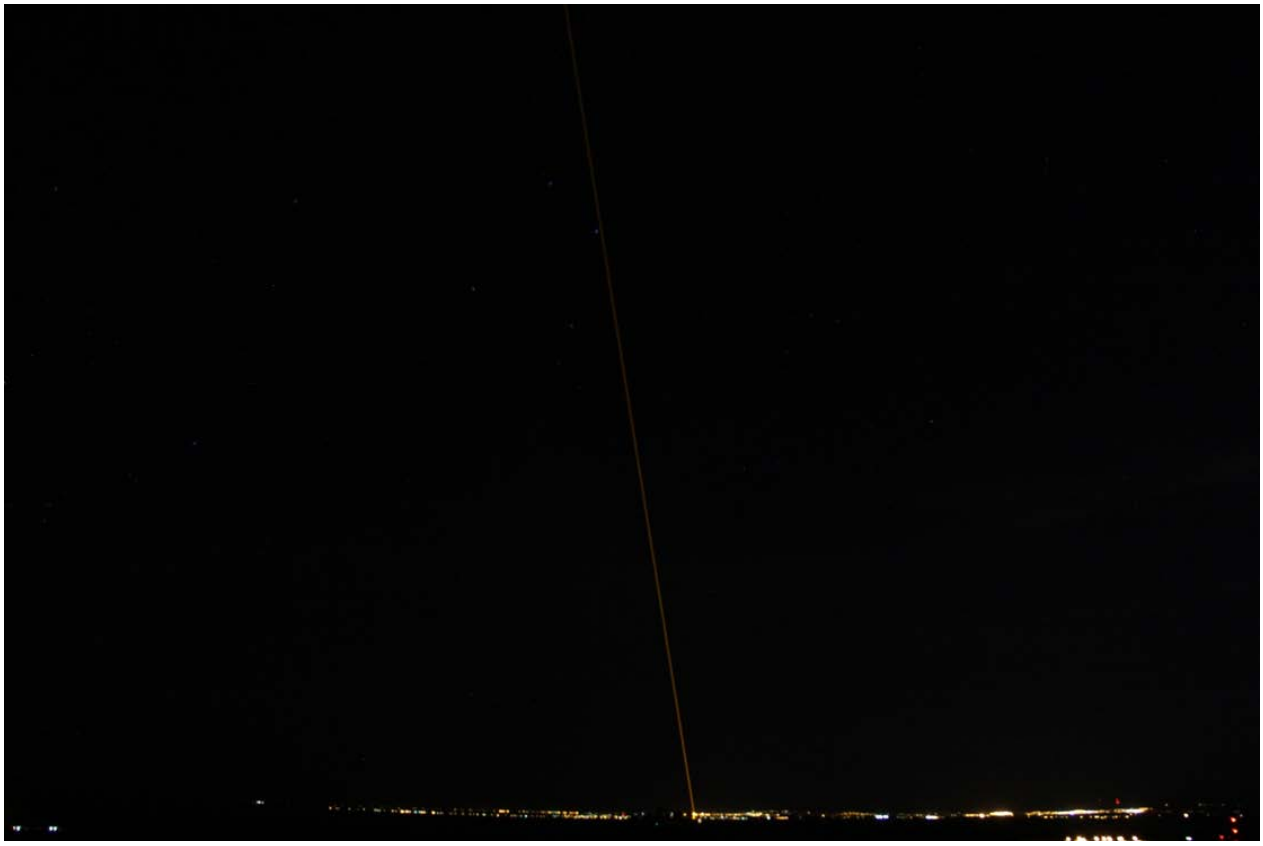


Figure 5: The SOR Sodium Guidestar Laser, located South-East of the Albuquerque, NM metropolitan area, using a long exposure camera.

Initial consultation with the State of Hawai‘i, State Historic Preservation Office in accordance with Title 36, Code of Federal Regulations, Part 800.3(c) and National Historic Preservation Act, Section 106 was performed February of 2015. The AF also briefed the Maui Lana’i Burial Council, April 2015 explaining the AF proposed action. The AF has incorporated SHPO and community requests regarding cultural resources and the removal of construction activities in this DRAFT EA. The AF submitted a revised Draft EA to the SHPO on 31 Dec 2015 for consultation. The AF has determined the proposed action will have No Adverse Effect on Cultural or Visual Resources within the defined APE and is awaiting concurrence from Hawai‘i SHPO in accordance with Title 36, Code of Federal Regulations, Part 800.3(c) and National Historic Preservation Act, Section 106. Preliminary response from the Hawai‘i SHPO indicates concurrence with the AF No Adverse Effect determination and that the archaeological resources are outside the APE defined in this revised EA.

No-Action Alternative

There would be no impacts to cultural or visual resources under the No-Action Alternative as the proposed MSSC modernization efforts would not be implemented. However visible laser activities conducted by other HO organizations would continue to occur.

CHAPTER 5.0 CUMULATIVE IMPACTS

A cumulative impact is the effect on the environment that could result from the incremental impact of a Proposed Action when added to other past, present, or reasonably foreseeable future actions. Cumulative impacts may result from individually minor but collectively significant actions that can take place over time. The projects listed below occur within the same geographical region of influence and have the potential to be implemented within a 20-year period. Table 2 lists Past, Present, and Reasonably Forseeable Future Actions Associated with HO and Adjacent Neighbors. This analysis identifies likely impact on the environment, including short- and long-term impacts, and direct, indirect, and cumulative impacts. The analysis focuses only on those environmental issues that have potential impact and are associated with the MSSC Modernization of Equipment activity. Table 3 is a brief description of the impact intensity rating and definitions used for the analysis.

Facility	Status	Reasonably Foreseeable Future Actions
Mees Solar Observatory	1966, currently used	Remain as-is, or be replaced by the proposed ATST Project
Atmospheric Airglow	1961, currently used	Remain as-is, or be replaced by Pan-STARRS or the proposed ATST Project
Zodiacal Light	1961, currently used	Remain as-is
Cosmic Ray Neutron Monitor Station	1961, currently inactive	To Be Determined
Baker-Nunn Site	1957, currently used	Remain as-is
Faulkes Telescope Facility	2003, currently used	Remain as-is
Pan-STARRS, PS-1 South	June 2007, currently used	Remain as-is (was formerly Lunar Ranging Experiment facility)
PS-2 North, 2nd Facility	2009, currently used	Remain as-is
Maui Space Surveillance Complex	Construction occurred over several years since 1963, currently used	Remain as-is
SLR 2000	Proposed	Reuse of site behind Mees facility for Laser Ranging
Haleakalā Visitor Center Comfort Station	Renovations in 2002	Upgrades to water and wastewater treatment system
HALE road cattle guards	Built 2006	HALE project. Edge of HALE road. Installed cattle guard to prevent feral goats from entering Park summit area from State land
FAA site adjacent to HO, Homeland Security tower	Constructed in 2006	Remain as-is
Maui Electric Co., Inc.	Proposed upgrades	Replace transformers, voltage regulators, upgrade and relocate substation for proposed ATST Project. Combined with the proposed ATST Project for **impacts.**
Hawaiian Telcom	2007	Repair to damaged/exposed conduits
(Roadway)	Early 2009	Repair to 0.3 miles of Saddle access road
HALE road cattle guard	Early 2009	Installed cattle guard to prevent feral goats from entering Park summit area from State land.
HALE road chip sealing	January 2009	HALE road surfacing on upper **two miles, canceled due to potential adverse impact on ‘ua‘u burrows.**
Advanced Technology Solar Telescope	Feb-12	Construction continuing through 2015, initial operations 2017
HALE road slurry sealing	2011	**Hale road surfacing on upper two miles.**
Hale road rehabilitation	**Within the next 5 years**	**Rehabilitation of road segment in FHWA study reaching end-of-life cycle.**

Table 2: Past, Present, and Reasonably Foreseeable Future Actions Associated with HO and Adjacent Neighbors. (Source: Final Environmental Impact Statement-Advanced Technology Solar Telescope.)

Impact Intensity	Intensity Description
Negligible	Effect is at the lowest levels of detection with neither adverse nor beneficial consequences and would not alter resource conditions.
Minor	Adverse impact — impact(s) result(s) in little, if any, loss of integrity and would be slight but noticeable, but would not appreciably alter resource conditions.
Moderate	Adverse impact — disturbance of a site(s) results in loss of integrity and impact(s) would be apparent and would alter resource conditions or significantly interfere with the resource.
Major	Adverse impact — disturbance of a site(s) results in loss of integrity and impact(s) would alter resource conditions and would severely jeopardize the resource .

Table 3: Definitions of Impact Intensity.

5.1 Cultural and Visible Resources

Installation of instrumentation, cameras and other research equipment within existing facilities would have no cumulative impact on the environment. Cumulative impacts associated with this Proposed Action were evaluated for the operation of the FASOR laser as it would be visible to a maximum distance of 1200m from the AEOS telescope on Haleakalā. There is a potential for visitors to the summit during nighttime hours to see the visible beam. The FASOR sodium guide star laser would only be used intermittently and the duration of the laser beam projection would be short (5-10 minutes in duration) but would occur multiple times per hour over a 6-8 hour period. Laser usage has been in place at HO for decades. Currently lasers are being used for outdoor propagation by numerous entities on HO. The proposed visible FASOR laser is an addition to existing and previously used lasers in the HO. Visible lasers in the green spectrum are currently used by the AF and the University of Hawai‘i. The only difference is that the FASOR laser will be a different color (orange) than is currently being used. Overall, AFRL/Det 15 has significantly reduced the number of lasers used at the MSSC. Adding the FASOR does not increase the operations tempo, but does create an intermittent new visual image that visitors to the summit during nighttime hours would potentially see.

5.2 Biological

Based upon our experiment at SOR and subsequent analysis, the operation of the FASOR laser at MSSC is highly unlikely to adversely affect the wellbeing or flying behavior of any threatened or endangered species. Consultation under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.) was completed with the U.S. Fish and Wildlife Service on 3 Jan 2015. Based on AFRL’s avoidance and minimizing measures, USFWS has concurred with our determination that the proposed project may affect, but is not likely to adversely affect the Hawaiian petrel, Haleakalā Silversword, Hawaiian goose, and Hawaiian hoary bat.

Cumulative impacts on cultural resources as a result of the FASOR laser operation (visible beam propagation) would only occur during night operations when the sky is very dark and individuals are at the summit performing cultural practices as the laser is not visible during the day.

Impact Category	Baseline of Impacts for Past, Present, & Reasonably Foreseeable Future Actions Other Than the Proposed MSSC Equipment Modernization Project *(Source: Final EIS--Advanced Technology Solar Telescope, 2009)*	Proposed MSSC Equipment Modernization Project
Land Use and Exist Activities	Mi-A-L	N
Cultural, Historic, Arch Resources	Mo-A-L	N
Biologic Resources	Ma-A-L	N-A-L*
Topography, Geology, Soils	Mi-A-L	N
Visual Resources and View Planes	Mi-A-L	N-A-L*
Visitor Use and Experience	Mi-A-L	N-A-L*
Water Resources	Mi-A-L	N
HazMat and Solid Waste	Mi-A-L	N
Infrastructure and Utilities	Mi-A-L	N
Noise	Mi-A-L	N
Air Quality	N-A-L	N
Socioecon. and Env. Justice	Mi-B-L	N
Public Services and Utilities	Mi-A-L	N
Natural Hazards	N-A-L	N

Notes: For simplicity, where there are multiple impacts for any of the 14 aspects of affected environment, for past actions, only the highest intensity is displayed in each box, whether it is adverse or beneficial. It should not be assumed that only one adverse or beneficial impact has occurred or would occur for the 14 aspects of affected environment.

*** The negative effect would only occur when the laser is being projected at night. Expected duration is 5-10 minutes, up to 5 times per night**

LEGEND: A-Adverse B-Beneficial L-Long term S-Short term
N-Negligible Mi-Minor Mo-Moderate Ma-Major

Table 4: Relative and Cumulative impacts of the MSSC Equipment Modernization Project

Table 4 lists a summary of the highest intensity impacts for each of 14 categories of past, current, and foreseeable actions and the expected impacts associated with this action. The proposed action would result in negligible, adverse, long term impacts on Visual resources and View Planes, Visitor Use and Experience, and Biological resources. The impacts would only exist when the laser is actively being projected into the sky, 5-10 minutes duration and up to 5 times per night. This action would not significantly increase the cumulative impact on the HO and surrounding areas.

CHAPTER 6.0 LIST OF ORGANIZATIONS AND INDIVIDUALS CONTACTED, REVIEWERS, AND PREPARERS

Person and Agency	Subject/Role
Michelle Hedrick, AFRL/RD, Lead Test and Environmental Engineer	Preparer
Joseph Volza, AFRL/RD, Test and Environmental Office	Preparer
Stephen Yan, AFRL/RD, Test and Environmental Office	Preparer
Sarah Loney, AFRL/RDS/Det 15, Safety and Environmental Contractor	MSSC Site Operations Safety and History
Capt. Shawn Hackett, AFRL/RDSS, FASOR Laser Operations Specialist	FASOR Laser visibility calculations
Dr. Skip Williams, AFRL/RDSM/Det 15, Technical Advisor	MSSC & FASOR Operations

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