University of Hawai'i at Hilo
CENTER FOR MAUNAKEA STEWARDSHIP

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UNIVERSITY of HAWAI'I HILO

MEMORANDUM

January 8, 2026

- Proposal rec'd: 10/24/2025
- Type (A) / B / C
- CMS MIP #362
- ED review: 12/11/2025
- EC review: 12/11/2025
- KKM review: N/A
- MKMB review: 1/6/2026
- MKSOA review: 1/8/2026

TO: Mauna Kea Stewardship and Oversight Authority

FROM: Greg Chun, Executive Director, CMS

SUBJECT: Informational, Request for Concurrence, Upgrade Subaru Environmental Monitoring

I. Project Description

The Subaru Telescope requests to replace existing monitoring instruments with upgraded units including a fog monitor and camera, ice monitor, and a wind gauge. These will enable safe, remote operation of the telescope. The request identifies the applicable land use as HAR §13-5-22, P-8, Structures and Land Uses, Existing (A-1) *Minor repair, maintenance, and operation to an existing structure, facility, use, land, and equipment… that involves mostly cosmetic work or like-to-like replacement of component parts, and that results in negligible change to or impact to land, or a natural and cultural resource.* In-house staff and contractors expect to complete the work by spring 2026. The action addresses various maintenance concerns and is expected to have negligible impact on any resources.

II. Resources Identified

The project area is located within the following identified historic properties:

- Kūkahau'ula Traditional Cultural Property, State Inventory of Historic Places (SIHP) Site #50-10-23-21438.
- Mauna Kea Summit Region Historic District, SIHP Site #26869;
- Mauna A Wākea Traditional Cultural Property and District, SIHP Site #31382; and

The site geology is composed of varying depths of volcanic ash, cinder, and clinkers over native Hawaiite flows. Lake Waiau, the nearest freshwater body, is over one mile from the project site, over porous and hilly terrain. Sparse lichen and/or moss may occur at the project site. No rare, threatened, or endangered plant, arthropod, or animal species have been documented at the site. Recreational visitors stop by the site, primarily at sunset for sightseeing.

III. Impacts Identified

The proposed work is limited to existing infrastructure and will not enlarge Subaru's footprint, nor change or extend the permitted use of the facility. The applicant does not anticipate any impacts to

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any identified historic properties or cultural resources, nor to any natural (geological and hydrological), biological, recreational, or scientific resources.

IV. Recommended Mitigation

Pending review by the Mauna Kea Stewardship and Oversight Authority, a request for concurrence will be sought from the Office of Coastal and Conservation Lands (OCCL). The project will not proceed unless all applicable reviews are completed and approvals obtained. Standard Best Management Conditions and approval conditions will be complied with.

V. Compliance with Maunakea Comprehensive Management Plan

The request is consistent with the 2022 Comprehensive Management Plan (CMP), approved by the Board of Land and Natural Resources. In fulfillment of the CMP's community review requirements:

- The project was reviewed by the Environment Committee on December 11, 2025, which questioned whether the proposed ultrasonic anemometer would impact the Hawaiian hoary bat (*Lasiurus cinereus semotus)*, a federally endangered species. CMS staff replied there have been no documented observations of the species on or near the summit, which offers neither good foraging nor roosting habitat. Further, Subaru's new anemometer would operate at 4.5 kHz. This would be below the 10-70 kHz range used by Pinzari et al (2019) to detect for bats' feeding calls. CMS concludes no impact to bats, should any be in the vicinity.
- Project is scheduled for Maunakea Management Board review during its January 6, 2026 meeting.

The proposed land is also consistent with UH's General Lease for the Science Reserve (S-4191) and Subaru's sublease. Further, CMS' review of project requests like this complies with the following CMP Actions:

- Natural Resources (NR)-1: Limit threats to natural resources through management of permitted activities and uses.
- Education and Outreach (EO)-2: Require orientation of users
- EO-7: Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Maunakea, to ensure systematic input regarding planning, management, and operational decisions that affect natural resources, sacred materials or places, or other ethnographic resources with which they are associated.
- Astronomical Resources (AR)-1: Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.
- Permitting and Enforcement (P)-1: Comply with all applicable federal, state, and local laws, regulations, and permit conditions related to activities in the UH Management Areas.
- P-1: Strengthen CMP implementation by recommending to the BLNR that the CMP conditions be included in any Conservation District Use Permit or other permit.

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- P-4: Educate management staff and users of the mountain about all applicable rules and permit regulations.

VI. Center for Maunakea Stewardship Recommendation

CMS recommends the project proceed to MKSOA and OCCL for concurrence review and approval with the standard project conditions in the attached list, should the project be approved.

Facility Project Proposal for the UH-Managed Lands

for projects anticipated to be classified as having "Minimal Impact"

Proposals due by the 15th monthly

Please mark all that apply to your project

_Y_ Project was reviewed in a 3-Year Plan
_Y_ Project is a CMP, lease, or sublease compliance measure (e.g., keeps the site in safe working order)
_No_ Project involves heavy machinery
_No_ Project requires ground disturbance such as digging or trenching
_No_ Project will result in a change to the facility footprint

Facility Name

Subaru Telescope

Brief Descriptive Title of Project

Upgrade of Subaru's Environment Monitoring Function toward Remote Night Operation

Project Description

As an upgrade of existing monitoring instruments, we install the following environmental monitors on Subaru Telescope Dome: 1) Fog Monitor, 2) Dome Ice Monitor, 3) Ultrasonic Anemometer.

Proposed Commencement Date

February 2026, pending any necessary approval (anytime after approval)

Proposed Completion Date

May 2026

Estimated Project Cost

$ 1k or less (all devices and parts are already available. We only need a cost for the actual installation).

Total size / area of proposed use

Less than 3 m^2

Project Purpose and Need

Following the request to reduce observatory personnel activity in the summit area of Maunakea, we are working toward remote nighttime summit operations. To safely conduct remote operations of a large telescope during the night, Subaru must upgrade its environmental monitoring capabilities by replacing outdated weather instruments and cameras to the best tools currently available.

In this proposal, we outline three upgrades to the existing system:

a. **Fog monitoring system to work in tandem with Subaru's existing webcams consisting of (a1) an illuminator and (a2) cloudcam, similar to cloudcams on CFHT and Gemini North.**
b. **Illuminator to monitor ice formation on the dome.**
c. **Ultrasonic anemometer for accurate wind monitoring. This single anemometer will replace the existing mechanical gauges**.

Has professional peer-review occurred

These proposed upgrades have not been reviewed by any outside staff, but have been thoroughly internally vetted at Subaru.

Are there any related ongoing, pending, or planned projects associated with this submission?

No.

Description of the Project

Location

These upgrades will occur to the existing instruments that are currently installed on the exterior of the Subaru Telescope Enclosure . The cloudcam, Item a2, will be a new addition among several other cameras already on the Subaru catwalk. The location of the Subaru Telescope is denoted by the red box in Figure 1.

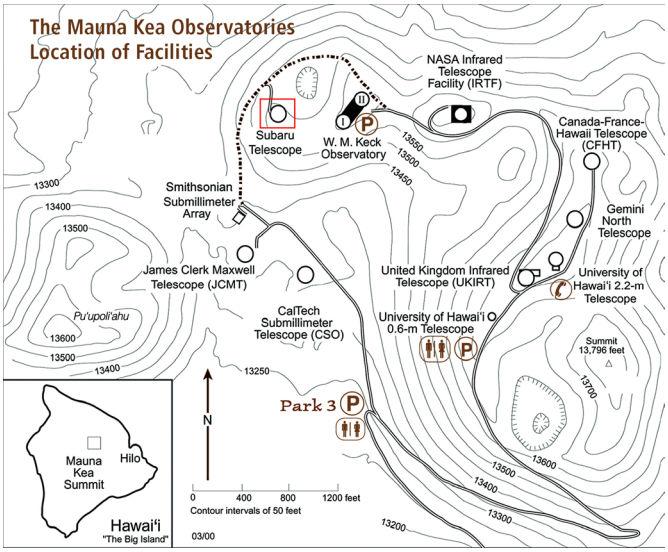

Figure 1: the Location of Subaru Telescope Summit Facility

The location of webcams and illuminators for (a1) and (b) are shown in the arrow on Figure 2 below.. The location of the dome-top anemometer for (c) is also labelled.

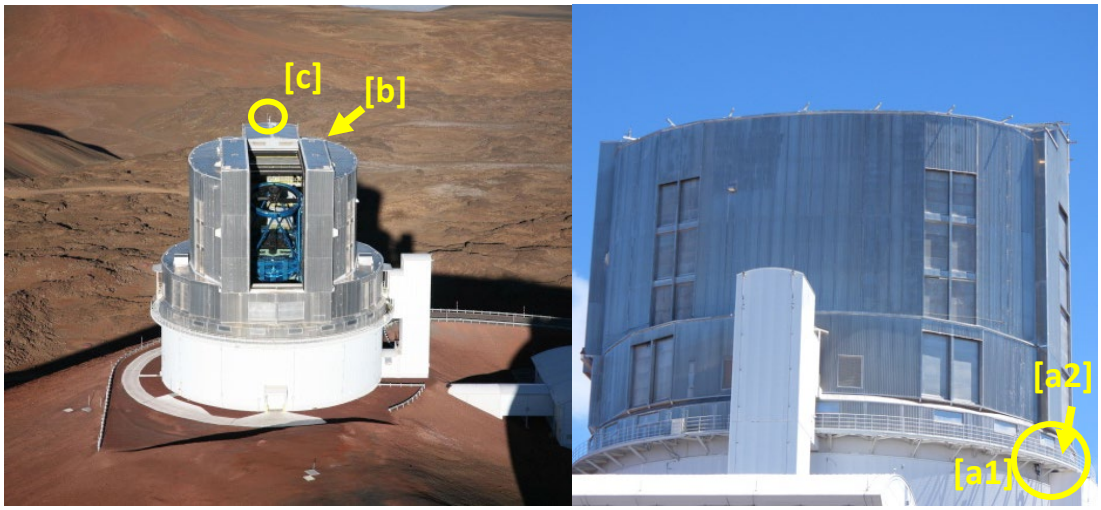

Figure 2. Proposed installation sites for [a1] and [b] the illuminators ; [a2] Subaru cloudcam; and[c] new anemometer.

The detail of each project

(a) Fog monitoring

Fog poses a serious threat to telescopes and observation instruments, requiring its rapid detection and immediate dome closure. To enable effective fog monitoring, we propose [a1] adding an illuminator to the webcam currently installed and in operation on the catwalk of the Subaru Telescope Enclosure, and [a2] adding a high-sensitivity camera that is similar to existing "CloudCams[(1)]" on Gemini Observatory and CFHT observatory.

The [a1] linked webcam is equipped with infrared imaging capability. The infrared illuminator is an official accessory for this camera model. The manufacturer guarantees its safety and use (Figure 3).

Operation of this item will be unnoticeable to visitors , as infrared light is invisible to the human eye (Figure 4). The illuminator will only be activated during periods of high humidity, when fog formation is likely. The device is software-controlled and will automatically switch off after less than one minute.

The webcam to which the illuminator will be attached is currently installed on the north side of the Subaru Dome catwalk and is used to monitor the parking area. This location is not visible from other telescopes (figure 5), ensuring that no light reaches other observatories. Combined with the fact that the illuminator emits infrared light, the impact on the surrounding environment will be negligible.

Figure 3. the Webcam and the proposed Illuminator

Figure 4. the view of the test illumination. The right and middle panels show the visibility of the IR light with the IR_Level=30 (medium) and 90 (maximum). For the actual use, the IR_level less than 10 is enough for the fog detection (based on our on-site test during 2020-2021). For comparison, we show the view of the regular white light that has similar brightness to the small pen light. It demonstrates the effectiveness of the IR light for no-impact operation.

Figure 5. Visibility plot of the illuminator. It is effectively blocked by the elevator tower and the door structure on the dome. The illumination angle is roughly 90 degrees.

As for the sub-project [a2], we will add a camera box that contains a still-camera and related electronics on the south-eastern side of the Subaru's catwalk (Figures 2 and 6). Sometimes the fog hits the summit observatories from the West . Adding the ability to monitor the western area during the nighttime will enable quick detection of any fog. Note that, if the budget allows, we have a plan to add another camera box to the eastern side of catwalk to monitor the summit ridge. We will submit the proposal once the budget is secured. No light will be emitted from this setup.

Figure 6: Subaru "Cloudcam" under testing. The size is 30cm x 22cm x 15cm.

(b) Ice monitoring on the dome.

The Ice Monitoring System is designed to visually observe the conditions of ice and snow accumulation on the dome using the existing roof-top webcam. The enclosure of the Subaru Telescope has a flat upper surface, which makes it prone to the buildup of snow and ice. In addition, when opening or closing the main shutter during nighttime operations, it is essential that the amount of ice or snow on the rail, where the shutter guide rollers pass, remains below the allowable limit.

In the current operation, whenever icing is suspected, an operator must climb to the top floor of the dome, lean out of a small window beside the main shutter, and estimate the amount of ice using a flashlight. This method is inaccurate, places a heavy physical burden on the operator, and carries the risk of accidents.

To address this issue, we propose, similar to case (a), installing an infrared illuminator on the surveillance camera located on the upper part of the dome. In addition, markers serving as reference scales will be drawn with weatherproof ink at several points along the guide rail (the area for drawing marks is a few inches at most: see figures 7 and 8). When weather conditions improve at night, the camera and illuminator will be used to observe icing and snow accumulation, and to determine whether the ice/snow conditions meet the safety requirements for dome operation. The camera is equipped with powerful zoom as well as pan–tilt functions, and with the infrared illuminator, it will enable detailed inspection of the rail area remotely.

By combining an infrared-capable webcam with an infrared illuminator, icing and snow accumulation can be monitored in a manner almost unnoticeable to visitors at the summit, since infrared light is invisible to the human eye. The infrared illuminator is an official accessory for this camera model, and its safety in installation and use is guaranteed by the manufacturer.

Furthermore, during operation, the illuminator will be software-controlled so that each activation lasts less than one minute and automatically switches off. Activation will occur only during adverse winter weather conditions when icing or snow accumulation is expected, and it is not anticipated that the system will be used while other observatories are conducting observations.

The camera to which the illuminator will be attached is located on top of the Subaru Dome and points in the direction of the summit ridge where other telescopes are situated (Figure 9). However, because the light is very faint and propagates horizontally relative to the other telescopes, there is virtually no possibility of infrared light entering their instruments or causing adverse effects. As an additional precaution, whenever the illuminator is used, the dome will be oriented northward to ensure that no light is directed toward other telescopes.

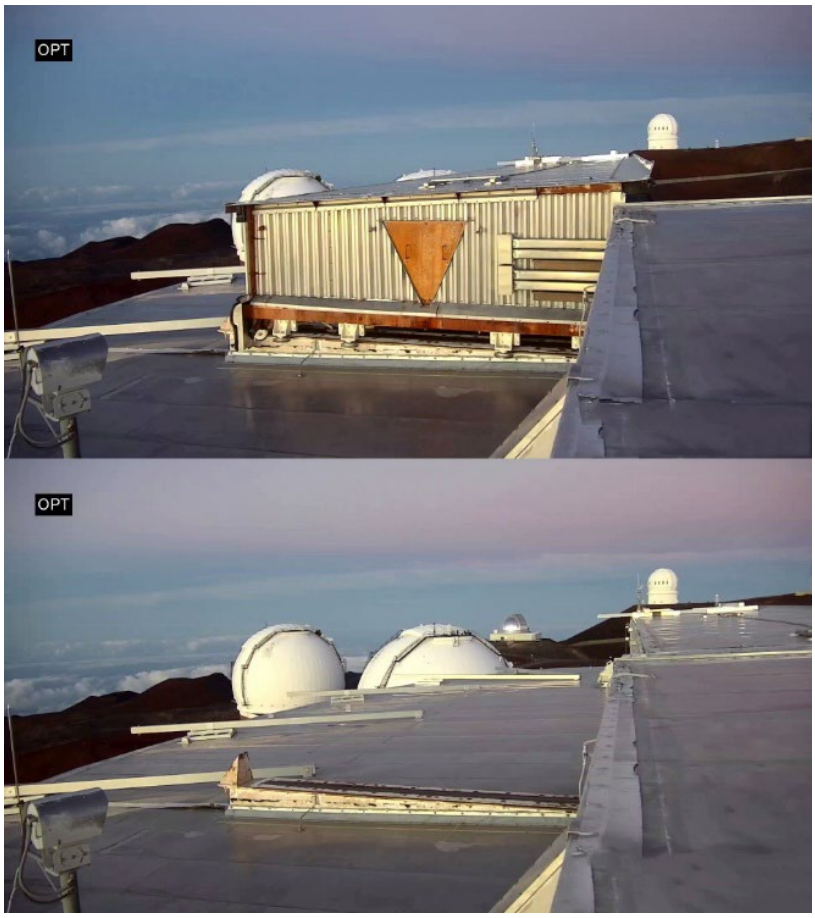

Figure 7. Main Shutter: Dome Open (Up) and Close (Down). The rail we check the condition is visible under the shutter.

Figure 8: [Left] zoom-in view of the guide rail under the Open state. Our webcam can zoom-in five times closer than this. [Right] The proposed markers on the rail. We put black lines every 0.25 inches.

Figure 9: the position of the webcam which we propose to put the IR illuminator. This is a zoom-in view of the Subaru Telescope Enclosure.

(c) Reliable wind monitoring

The anemometer currently used by Subaru ([c] in Figure 1 and Figure 10) is a traditional type that calculates wind speed based on the physical rotation of a propeller. Under the harsh winter conditions of Maunakea, the instrument frequently becomes covered with ice, causing it to freeze entirely and making wind-speed monitoring impossible. To overcome this limitation, we propose to introduce an ultrasonic anemometer, which measures both wind direction and wind speed using ultrasonic signals.

Figure 10: [Left] current (blue circle) and proposed location (shown in red lines, see also Figure 11) of the existing anemometer at the top of the Subaru Telescope enclosure. The inset picture is the new ultrasonic anemometer. [Right] Current anemometer sometimes freezes up by harsh environment of the summit area, like the picture here. The new anemometer does not have any movable parts with heater, so we expect it is much more tough even under such condition.

The planned installation site is near the current anemometer site but closer to the center (Figure 11). The device consists of a three-arm structure on a pole approximately one to

three meter high. The pole will be securely mounted to the building to withstand strong winds. The cables will enter the enclosure through an existing hole just below the foot of the pole.

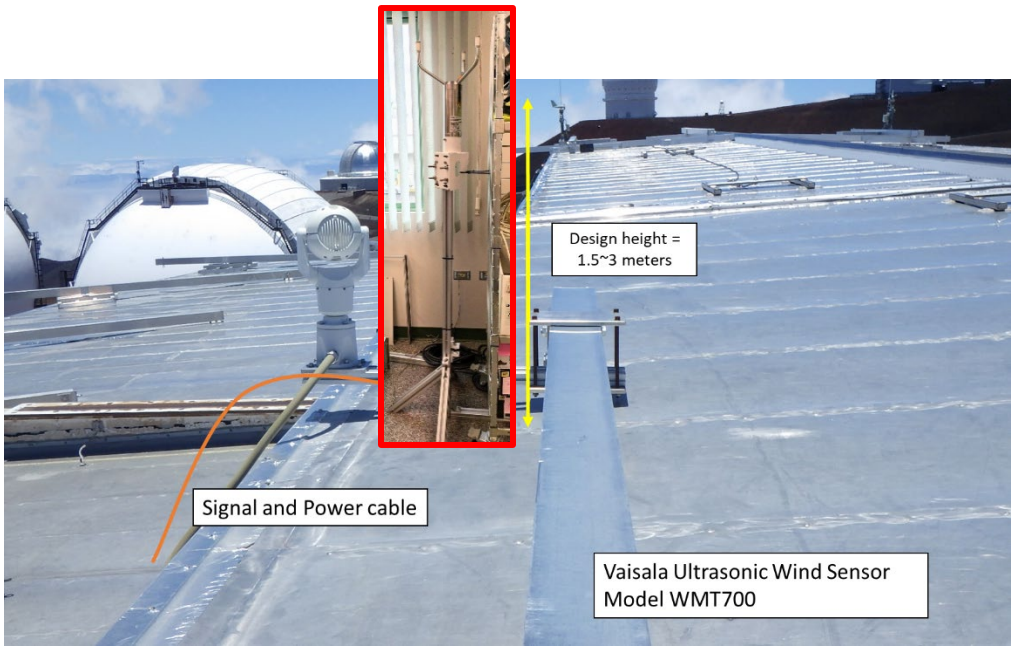

Figure 11. Proposed installation for ultrasonic anemometer.

Description of the process of completing the project

For the item [a1], installation involves simply attaching the commercially available illuminator (an option of the current camera) to the existing webcam using screws. Since the location is under the catwalk at a height of approximately 10 meters, the work will be carried out by personnel certified for high-altitude operations, accessing the site with a cherry picker. The installation will be conducted on a calm day with good weather conditions, and a safety officer will be assigned to ensure secure operations. After installation, software integration will be performed to enable control of the illuminator. Neighboring observatories will be notified regarding the possible activation of the infrared light during adverse weather conditions.
The item [a2] is planned to install on the handrail of the catwalk. The cable will run through the inner rim of the catwalk floor, so it is easy to install. We note that the cable is hidden behind the floor so is invisible from people outside. We protect the lines with an inch-width conduit.

For [b], installation similarly involves attaching the commercially available illuminator to the existing webcam with screws, along with marking scales on the rail using weather-resistant ink. Because the installation site is on top of the dome, the work will be carried out by personnel certified for high-altitude operations, using safety harnesses to access the camera. The installation will be conducted on a calm day with favorable weather. After installation, software integration will be performed to enable control of the illuminator. Neighboring observatories

will be notified regarding the possible activation of the infrared light during adverse weather conditions.

For [c], the new ultrasonic anemometer will be installed adjacent to the existing anemometer. It will be secured with bolts, with additional locking measures applied to prevent loosening. Power and network connections will be supplied from existing lines already extended to the vicinity. Because the installation site is on top of the dome, the work will be carried out by personnel certified for high-altitude operations, using safety harnesses, and performed on a calm day with favorable weather.

Who will do the work?

Two to four in-house employees will be required to install these devices. For [a] the additional safety officer will be assigned to ensure secure operations.

Equipment & Transportation

No heavy equipment nor oversized vehicles will be required for this project.

Measures to protect the environment and/or mitigate impacts

Impacts

No impact to environment.

Compliance with Lease, Sublease, or Comprehensive Management Plan (CMP)

We enclose a draft of the CMP matrix as a separate excel file.

Identify other required or associated permits

N/A

Community Benefits

Benefits to other Maunakea entities and/or global astronomy community

We will make the measurement data available to public and all the MKO facilities via the Subaru and Mauna Kea Weather Center (MKWC) public websites. As the purpose of the sensors (fog/ice/reliable windspeed) are common needs among all observatories, Subaru's fellow observatories can utilize these data directly for safe operations.

Benefits to the Hawaii Island community

Reducing the need for summit workers to access the summit under hazardous icing conditions will lower the risk of traffic accidents involving vehicles traveling to the summit, and will contribute positively to the well-being of the summit workforce, who are valued members of the community. The same applies to fog detection, as safe operation without accidents on this sacred mountain is itself a significant benefit.

Furthermore, the introduction of the ultrasonic anemometer will provide valuable information on the most extreme weather conditions at the summit of Maunakea. Such data hold scientific

and educational significance for the broader community. By more accurately measuring and learning about the severity of the summit environment, we can also be truly astonished and moved by the monumental feat of the ancient Hawaiians who survived in this setting and carried out the great undertaking of collecting and processing valuable adze. A proper scientific measurement of the summit environment allows us to reflect upon the skill requirements possessed by the people who survived in that environment, and the reason why this place was later declared kapu.

Will data, publications, or other products be free and available to the public?

Yes, via Subaru telemetry portal and the MKWC website.

For internal use only by CMS

Review checklist
_Y_ Staff review and report
_n/a__ Outside agency review or approval required
_Y__ Environment committee, if environmental impacts are anticipated
_3YP_ Kahu Ku Mauna, if cultural impacts are anticipated and KKM requested consultation, or the project was not included in a 5YP or 3YP
_Y__ Maunakea Management Board
_Y_ Mauna Kea Stewardship and Oversight Authority

Project approval conditions

Prepare to Start the Project

- Identify and comply with other permit requirements, such as County of Hawai'i building permits or Department of Land & Natural Resources permits (see *both*/any applicable DLNR permit and HAR §13-5-42 Standard conditions).
- Use of real-time GPS during any surveying or equipment operation requires advance written approval from CMS and the Institute for Astronomy. GPS use should be requested at least four (4) weeks prior to the proposed activity.
- Any required Best Management Practices, Communication Plans, contract scope questions, etc. must be finalized and approved by CMS prior to final approval.
- CMS will provide a final, written notice explicitly stating whether the project is approved to commence (i.e., issue a "Notice to Proceed"). The Notice to Proceed will include any additional, project-specific conditions. **No project work may commence before this time.**
- Project approval may not be transferred or assigned without prior authorization. A copy of the approval/permit must be present on-site and available for review at all times while working on UH-managed lands.
- Applicant shall comply with all actions and measures described in the proposal, including (community) benefits, CMP compliance list, and mitigation measures.

Notifications

- Applicant may request to arrange a pre-construction meeting with CMS before work commences. These meetings review orientation content, implications of project non-compliance, project-specific concerns regarding resource protection, health and safety, visitor and/or traffic impacts, etc. Meetings may be held in person or via phone, webinar, or other means.
- Notify CMS in writing via email to cmshilo@hawaii.edu at least five (5) days prior to beginning field work on UH-managed lands (Halepōhaku, Road Corridor, Maunakea Science Reserve, or Astronomy Precinct) with the following:
    - Identify the date that onsite work will commence.
    - Identify by name-of-entity all observatories, contractors, vendors, suppliers, etc. anticipated to be associated with and substantively present on UH-managed lands for the project.
    - Identify the individual(s) who will be coordinating all invasive species inspections.
    - Attest that the observatory or relevant entity will ensure compliance with all permit conditions and communicate with CMS if there is any uncertainty.
    - Notify CMS in writing of any other entities responsible for elements of compliance.
    - Attest that all individuals anticipated to be associated with the project have completed the Maunakea User Orientation.
    - CMS is not liable or responsible for delays due to inadequate or late submissions or submissions requiring verification.

Onsite Activity

General

- Use of lighting from sunset to sunrise is prohibited unless described in the project proposal and approved.
- Use of cell-phones, other than in airplane mode, is prohibited except in case of emergency.
- Placement of permanent markers, monuments, mag nails, or survey pins, etc. is not allowed without explicit prior approval from CMS (and the State if required). ALL surveyors' work must be shared with CMS in digital format with coordinate info stored in and using a common, transferrable coordinate reference system such as “State Plane Coordinates (NAD83), Hawai‘i Zone 1”.
- Allow CMS Rangers to visit and monitor activities.

Transportation and Motorized Equipment

- No use of mechanized equipment is allowed unless authorized by this permit.
- 4-wheel-drive required for travel above Halepōhaku.
- Large, heavy, non-4-wheel-drive or oversized loads must submit notification to the Maunakea Road Conditions listserv, MK-ROAD-CONDITIONS@lists.hawaii.edu, at least one day prior to transit. Loads requiring an escort on public roadways must have this escort accompany them to the final destination. Projects failing to submit notification or arrange for escort to the summit may be denied entry to Halepōhaku or above.
- During public closures of the Summit Access Road, vehicle access above Halepōhaku is limited to explicitly-marked observatory, CMS, federal, or state of Hawaii vehicles. Vehicles must be operated by approved employees or representatives on official business and possessing requisite orientation, training, safety, and rescue supplies.
- Motorized equipment, when stationary, must have a drain-pan in place suitable for catching fuel or fluid leaks.

Debris Prevention and Severe Weather Concerns

- Ensure that any debris, tools and equipment are secured to avoid becoming windblown and are properly stored at the end of each day.
- Projects occurring in the summit region must verify that temporary and permanent infrastructure and improvements can sustain 120 MPH winds and severe weather.

Environmental Concerns

- All perishable items including food, food wrappers, and containers must be removed from the site daily and properly disposed of.
- Remove and properly dispose of all waste material.
- Nēnē (*Branta sandvicensis*) may be present. If a nēnē appears within 100 feet (30.5 meters) of ongoing work, all activity shall be temporarily suspended until the animal leaves the area of its own accord. Federal law prohibits feeding or any “taking” (e.g., harassing, harming, killing) of nēnē.
- Best Management Practices for seabirds, including the endangered Hawaiian petrel (*Pterodroma sandwichensis)*
    - Use red light bulbs outside to the maximum practicable extent.
    - Fully shield outdoor bulbs so the light is only visible from below.
    - Install motion sensors or turn off lights when human activity is not occurring in the area.

    - September-December: Avoid nighttime construction.
- Best Management Practices for the endangered Hawaiian Hoary Bat *(Lasiurus cinereus semotus)*
    - No barbed-wire fencing allowed.
    - June-November: Do not trim, remove, or disturb trees over 15 feet tall.

Invasive Species Prevention

- Employ invasive species prevention best practices, including inspections of materials by a DLNR-approved biologist, as identified in the Maunakea Invasive Species Management Plan prior to entering UH-managed lands.
    - Inspections can only occur at locations where landowners have given permission (i.e. facilities, baseyards, and vendor locations).
    - Inspections shall not occur on UH-managed lands on Maunakea, at State or County parks, along public roadsides, or on Department of Hawaiian Homelands lands.

Upon Project Completion

- The project must be completed within the time frame specified in the proposal and, when applicable, as specified by DLNR. Projects that cannot be completed within this timeframe are not allowed to continue (or commence) without explicit prior written approval from CMS.
- Notify CMS in writing when field activity associated with the project is completed.
- Unless otherwise stated in the proposal, copies of all data, field notes, photos, log books, collected specimens, and other forms of documentation will be shared with CMS for future, unrestricted use by CMS or its designee. All geospatial data, metadata or applications must be in a format compatible with CMS GIS software or other industry standard identified in advance.
- Collected specimens that are not consumed in analysis will be returned to CMS unless otherwise specified.
- Provide CMS with electronic and paper copies of all publications resulting from the work. When applicable, annual, final reports must be submitted to CMS.
- When applicable, a brief, approximately 1-page, non-technical summary suitable for public outreach (school groups, community meetings, newsletter articles, etc.) must be provided to CMS within 90 days of project completion or publication. Photos and illustrations are encouraged.