APPENDIX M

U. S. FISH AND WILDLIFE SERVICE,
SECTION 7, INFORMAL CONSULTATION DOCUMENT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

TAKE PRIDE IN AMERICA

In Reply Refer To:
1-2-2007-I-0133

MAR 28 2007

Dr. Craig B. Foltz
Advanced Technology Solar Telescope Program Officer
Division of Astronomical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Subject: Informal Consultation on the Construction and Operation of the Advanced Technology Solar Telescope at the Haleakala High Altitude Observatories Site on Maui, Hawaii

Dear Dr. Foltz:

On June 15, 2006, you requested initiation of formal consultation for the construction and use of the National Science Foundation's (NSF) proposed Advanced Technology Solar Telescope (ATST) at the Haleakala High Altitude Observatories site on Maui, Hawaii, pursuant to section 7 of the Federal Endangered Species Act of 1973, as amended (16 USC 1531, et seq.). At that time you determined the construction of the ATST could adversely affect the federally endangered Hawaiian petrel (*Pterodroma phaeopygia sandwichensis*) and you included a no effect determination for the following federally endangered species: Hawaiian goose (*Branta sandvicensis* or nene); Hawaiian hoary bat (*Lasiurus cinereus semotus*); and Haleakala silversword (*Argyroxiphium sandwicense* ssp. *macrocephalum*). During the pre-consultation and formal consultation process, the U.S. Fish and Wildlife Service (Service) and the NSF worked cooperatively to develop avoidance and minimization measures to reduce impacts to listed species, specifically for the Hawaiian petrels occupying the 33 known nest chambers in the vicinity of the proposed telescope. The following issues were addressed during our initial consultation process:

- Excessive noise and vibration from construction equipment
- Ground vibration that could collapse Hawaiian petrel burrows
- Flight obstacles
- Increased rat population
- Spread of invasive species from construction equipment and vehicles
- Increased vehicular traffic

Your designated consultant, Dr. Fein from KC Environmental, worked with us for several months to develop avoidance and minimization measures to reduce project impacts to the Hawaiian petrel and Hawaiian goose. These measures include: (1) modification of the construction schedule to avoid the peak petrel nesting period; (2) reduction in vehicular traffic; (3) monitoring of noise and reduction of decibel levels; (4) rat removal by baiting; (5) elimination of weed and invasive species transport to Haleakala, and (6) extensive petrel monitoring and research.

On February 27, 2007, our office participated in a conference call to discuss the aforementioned minimization measures. Dawn Greenlee and Patrice Ashfield, of my staff, yourself and your solicitor, Bijan Gilanshah participated. We concurred with your determination that the inclusion of extensive avoidance and minimization measures had reduced project impacts to a level of insignificance. Although not anticipated, we also discussed that if a Hawaiian petrel or Hawaiian goose was harmed or killed as a result of the ATST construction activities that the Service would be contacted immediately and that work action would cease until we have formally addressed the cause for the take. You also extended our consultation deadline to March 28, 2007, due to the new information and measures to be considered in our consultation process.

Enclosed is a description of the proposed action along with detailed information outlining the avoidance and minimization measures you agreed to implement. We have also included our analysis that led to our concurrence with your determination that this project is not likely to adversely affect the Hawaiian petrel and the Hawaiian goose. Information and documents used in our analysis include: (1) the NSF's September 2006, Draft Environmental Impact Statement for the Advanced Technology Solar Telescope, Haleakala, Maui, Hawaii (NSF 2006a); (2) three risk analysis documents prepared in response to requests by the Service, entitled: a.) Acoustic Evaluation of the ATST Mechanical Equipment Building (Phelps, unpublished); b.) Effect of Lightning Upon Burrowing and Tunneling Birds and Mammals Near ATST (Kithil, National Lightning Safety Institute, unpublished); and c.) Technical Response to Vibration Issues (Barr, unpublished 2006), (3) peer-reviewed journal articles and unpublished literature; (4) information in our files; and (5) meeting notes and correspondence associated with this consultation. A complete administrative record of this consultation is on file in the Service's Pacific Islands Fish and Wildlife Office.

We concur with your determination that the proposed ATST project is not likely to adversely affect the Hawaiian petrel and the Hawaiian goose. You made a no effect determination for the Hawaiian hoary bat, Haleakala silversword, and critical habitat for the Haleakala silversword and the *Geranium multiflorum*. You requested our concurrence on these determinations and you will find this information in the enclosed document.

We thank you for your support and coordination throughout the consultation process. It was a pleasure working with a Federal partner that took additional steps to avoid and minimize project impacts to endangered species. Your efforts reduced potentially adverse effects for the

Hawaiian petrel and Hawaiian goose to a level of discountable effects for these species. We also appreciate the additional measures you incorporated into this consultation such as video nest monitoring that will enhance our understanding of the breeding ecology of Hawaiian petrels. The data gathered from the video monitoring will assist us in our management and recovery efforts of petrel colonies in the future. If you have questions or would like additional information regarding these comments, please contact Dawn Greenlee, Fish and Wildlife Biologist (phone: 808/792-9400; fax: 808/792-9581).

Sincerely,

for Patrick Leonard
Field Supervisor

Enclosure

Enclosure for PIFWO Log Number 1-2-2007-I-0133 (March 2007)

Informal Section 7 Consultation on the Construction and Operation of the Advanced Technology Solar Telescope at the Haleakala High Altitude Observatories Site on Maui, Hawaii.

This section 7 informal consultation document provides our U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office (Service) understanding of the proposed action, including all avoidance and minimization measures that will be implemented, and our analysis of the effects to listed species and designated critical habitats occurring within the Action Area.

The National Science Foundation (NSF) is proposing to fund the construction and use of the ATST within the 7.4 hectare (ha) (18.2 acre (ac)) University of Hawaii Institute for Astronomy, Haleakala High Altitude Observatories site, Maui, Hawaii. Near the peak of a large shield volcano, at an elevation of 3,042 m (9,982 ft), the proposed telescope site is one of the prime sites in the world for astronomical and space surveillance activities (Figure 1). The Haleakala High Altitude Observatories site houses seven existing observatories, including astronomical facilities and the Air Force Maui Space Surveillance Complex. Two small adjacent properties host facilities of the U.S. Department of Energy, U.S. Coast Guard, the Federal Aviation Administration, the Maui Police Department, Federal Bureau of Investigation, and other agencies. Haleakala was selected as the preferred location for the ATST project after evaluating 72 sites around the world. As the largest and most capable solar telescope, the ATST will provide researchers with four-kilometer (km) (2.5 mile (mi)) resolution images of the Sun's surface. This high-resolution data will enable scientists to pursue an understanding of the solar magnetic variability that drives space weather and resolutions to fundamental length and time scale questions about the basic physical processes governing variations in solar activity associated with climate changes on Earth.

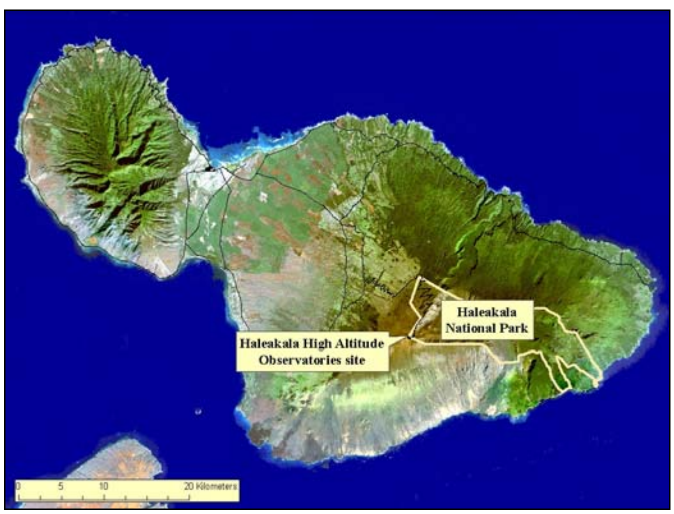

Figure 1. Haleakala High Altitude Observatories site location near the summit of and adjacent to Haleakala National Park, Maui, Hawaii.

The new facility is proposed for construction on an approximately 0.3 ha (0.7 ac) site consisting of cinder, lava, and ash deposits. The completed observatory enclosure will be a maximum of 43.5 meters (142.7 feet) high and 25.6 meters (84 feet) in diameter (Figure 2). The attached Support and Operations Building will be several stories high in order to accommodate a large receiving bay, large platform lift, offices, and laboratories. The Utility Building will provide space for mechanical and electrical equipment including a generator, very-low-temperature chiller, ice storage tanks, a 10-ton heat pump condenser unit and uninterruptible power supply units. There will be a utility and ventilation tunnel connecting the Utility Building to the Support and Operations Building. Additional support structures will include a subsurface grounding field for observatory equipment that also includes lightning protection, a wastewater treatment plant and infiltration well, and a storm water management system designed to provide potable water to the facility (NSF 2006).

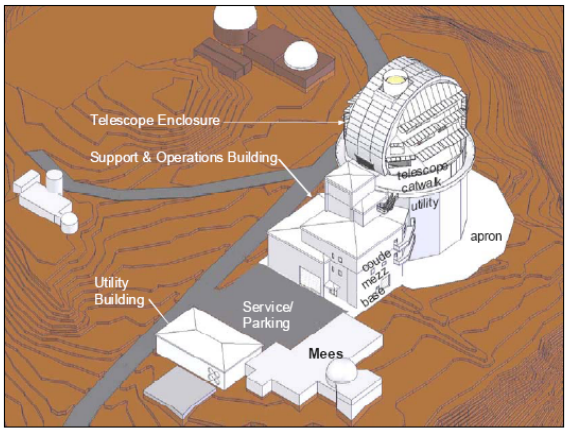

Figure 2. Artist’s rendering of proposed ATST telescope enclosure, Support and Operations Building, and Utility Building as they will appear adjacent to several of the existing observatory buildings including the Mees and AEOS facilities. (NSF, 2006).

Project Schedule

Construction is scheduled to begin after October 1, 2008 and will occur in various phases including site preparation and foundation work. It is anticipated that construction of the exteriors of the buildings will be completed within two years. Interior work and telescope integration, testing, and commissioning will then be completed within approximately three to four years. The telescope is then scheduled for operation and use through the year 2039.

Demolition: The existing Mees Solar Observatory driveway, parking area and rock wall borders, the underground cesspool, and other selected items at the Mees Solar Observatory utility area will be demolished and removed. Demolition will be staged and will occur throughout the construction period. Demolition will require the use of bulldozers, dump trucks, bobcats, and other heavy machinery. Demolition work will occur during about 60 total days throughout the duration of the construction project.

Grading and Leveling: The construction will require the creation of a level pad at least 20 feet wider, in all directions, than the footprint of the telescope enclosure and the Support and Operations Building. The grade cut will be made at approximately the 3,042 m (9,980 ft) contour elevation, the removal of a maximum of approximately three meters (10 ft) of material from the highest portions of the site. This will be done using a bulldozer, backhoe, trencher, hoe ram, dump trucks, and other heavy equipment. An estimated eight vehicles will travel to and from the site on a daily basis during a one month period to complete this activity.

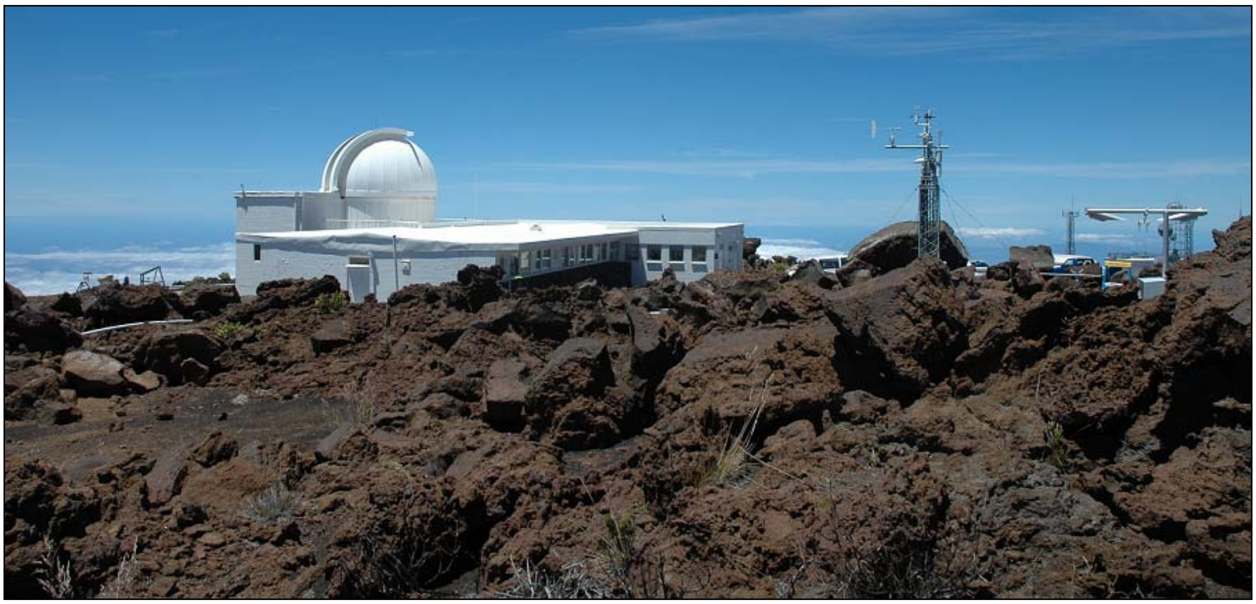

Figure 3. ATST construction site.

Excavation and Soil Retention: Initial major excavation will include a total removal of approximately 3,555 cubic meters (4,650 cubic yards) of rock and soil to accommodate the foundation systems for the proposed structures. This work will be done using bulldozers, backhoe, trencher, a truck-mounted auger for drilling down to bedrock, and a hydraulic hammer or jackhammers to break up large rock formations. A relatively undisturbed rocky site will be graded and leveled to approximately 0.6 m (2 ft) above the floor elevation of the Mees building (in the background in Figure 3) to accommodate construction of the ATST enclosure and concrete apron. Additional excavation will be needed in order to trench for utility lines, all of which will be installed underground. The major structural excavation is expected to follow the leveling work and take approximately two months to complete. The rock and soil removed from the construction site will be deposited in designated soil placement areas which are both previously disturbed sites (Figures 4, 5, and 6).

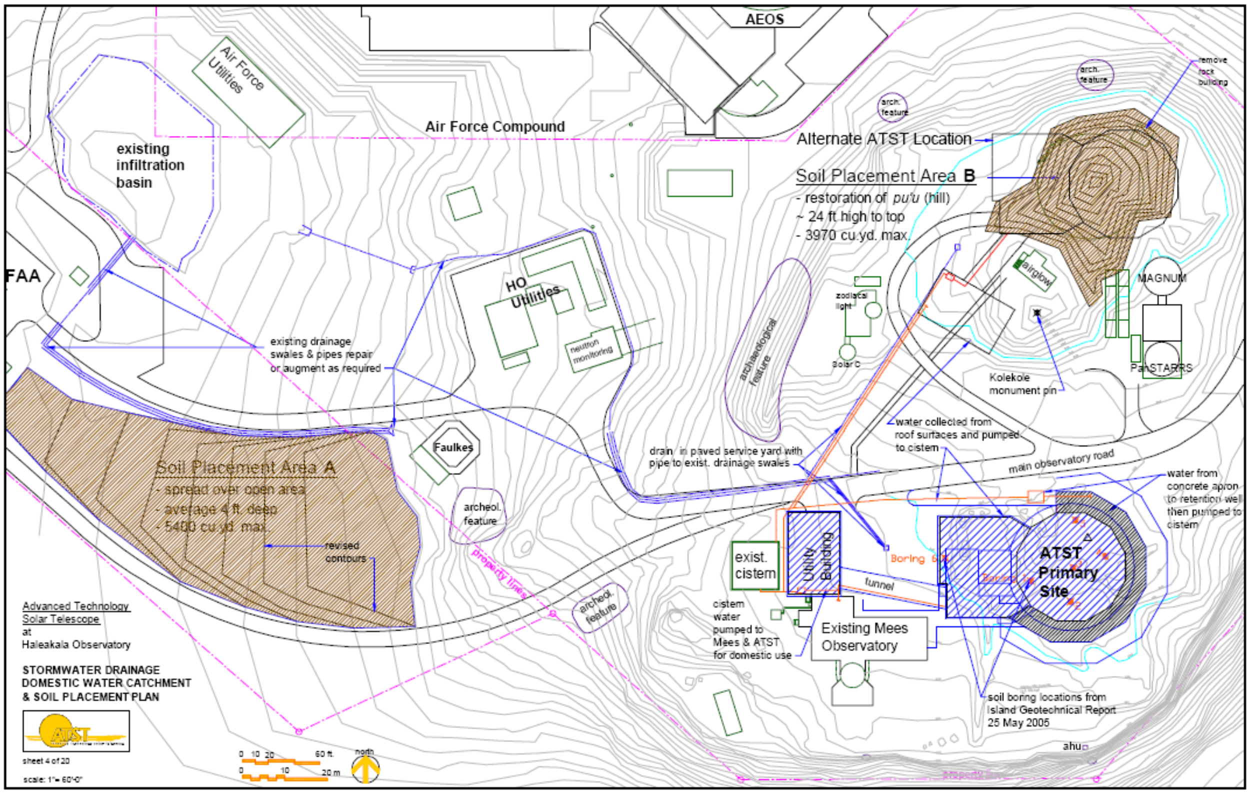

Figure 4. Soil placement areas, totaling 0.3 ha (0.9 ac).

Figure 5. Soil Placement Area A, which will also serve as the equipment staging area - where the truck is parked in this photograph - is a previously disturbed site.

Figure 6. Soil Placement Area B is a previously disturbed site.

Caisson Drilling: Approximately 21 holes will be drilled to a maximum depth of 6 m (20 ft) to reach basalt bedrock so that caissons (support structures) can be poured to support concrete mat foundations below the telescope and enclosure. The Support and Operations and utility buildings, by contrast, will be built on simple concrete pads laid on top of the volcanic rock and gravel of the upper site strata.

Vehicular Activities: It is estimated that during the first two years of construction, eight vehicles will make one round-trip drive to the construction site an average of six days per week. During later construction and integration (approximately a three year period), an average of seven round-trips per day will be necessary. Then during the 30-year operational life of the project approximately five trips per day, seven days per week will be made. A total of 66,294 vehicle round-trips will be made during the entire life of the project. During the construction and integration phases of the project, vehicles will consist primarily of heavy trucks, while during the operational life of the ATST, vehicles will consist primarily of passenger vehicles. Truck traffic will be limited, during all years of the project, between April 20 and July 15, to no more than two truck round-trips per day.

Conservation Measures and Effects Analysis

During the pre-consultation and consultation process, the Service and NSF worked cooperatively to develop avoidance and minimization measures to reduce impacts of the project to listed species, specifically to the endangered Hawaiian petrel. NSF incorporated conservation measures into the proposed action to minimize the impacts of the project and to avoid incidental take of Hawaiian petrel. Avoidance and minimization measures include equipment visibility marking, construction scheduling, Hawaiian petrel monitoring and research, predator control and invasive species interdiction and control (Table 1).

Table 1. Summary of effects of the project which were addressed during the section 7 consultation process.

Possible Effects	Avoidance and Minimization Measures Adopted
Collision of Hawaiian petrels with equipment and buildings	Construction crane will be lowered at night and marked with white visibility polytape. All structures will be painted white. No outdoor lighting will be associated with the project.
Burrow collapse from construction vibration	Engineers set ground vibration threshold for burrow collapse. Vibration will be monitored to ensure that the burrow collapse threshold is not reached.
Noise concerns and incubating Hawaiian petrels	Construction noise will not be louder than ambient wind noise at nest during incubation period (April 20 - July 15). Only two truck round-trips per day will be taken to the construction site during the incubation period.
Predator population increase	Trash will be contained. Rat predation at the Haleakala Observatories Hawaiian petrel colony will decrease as a result of project's predator control efforts.
Transport of invasive species to Haleakala	Cargo will be thoroughly inspected for introduced non-native species. All ATST facilities and grounds with 100 feet of the buildings will be thoroughly inspected for introduced species on an annual basis and any introduced species found will be erradicated.
Driver education	All drivers will receive a briefing and a breeding season refresher to further reduce the chance that a vehicle associated with the project will hit a Hawaiian goose.

Definition of the Action Area

The ATST Action Area (Figure 7) was dictated by the area impacted by the noise associated with the loudest vehicles scheduled to drive the road and the loudest pieces of equipment scheduled for use at the ATST construction site. Pursuant to a thorough literature search (Awbrey and Hunsaker 1997, Mock and Tavares 1997, Delaney *et al*. 1999, South San Francisco Ferry Terminal Project EA 2003), 60 dBA was selected to be a reasonable threshold of avian disturbance. Sound energy level at various frequencies is measured in decibels (dB). The A-weighted decibel scale was developed to represent the response of the human ear to sound.

The loudest truck noise permitted by EPA standards is 83 dBA (when measured at 50 feet), and the loudest equipment proposed for use at the ATST construction site are rock hammers and rock drills, which produce up to 113 dBA (measured at 10 feet). Sound attenuation was assumed to be only 6 dBA per doubling of distance, with no additional attenuation assumed to occur for either atmosphere or vegetation (NSF 2006). The outer edge of the Action Area corresponds with a sound pressure level of 65 dBA out in the open, where there is a clear line of sight to the road or construction site within the burrow during the periods of maximum noise production. Because no specific burrow depth or orientation information was available for the burrows along the road, a burrow attenuation rate of only five dBA was applied to each burrow for the creation of the Action Area: therefore, all nest chambers which would be exposed to a 60 dBA sound as a result of the proposed action were considered to be within the Action Area. Along a 1.5 km (0.9 mile) portion of the Haleakala National Park Road, the Action Area follows a cliff edge, where the terrain serves as a barrier to road noise. Based on these conservative attenuation rates, the Action Area perimeter is 122 m (400 ft) from the road and 780 m (2,560 ft) from the outer edges of the construction site. The total area encompassed by the Action Area is approximately 574 ha (1,418 ac).

Construction was scheduled to further limit the frequency and extent of noise generation at various times of year, in order to minimize impacts to the Hawaiian petrel within the Action Area, particularly to those occupying burrows immediately adjacent to the construction site (Figure 8). Please refer to pages 15 through 25 for a thorough discussion and analysis of noise impacts.

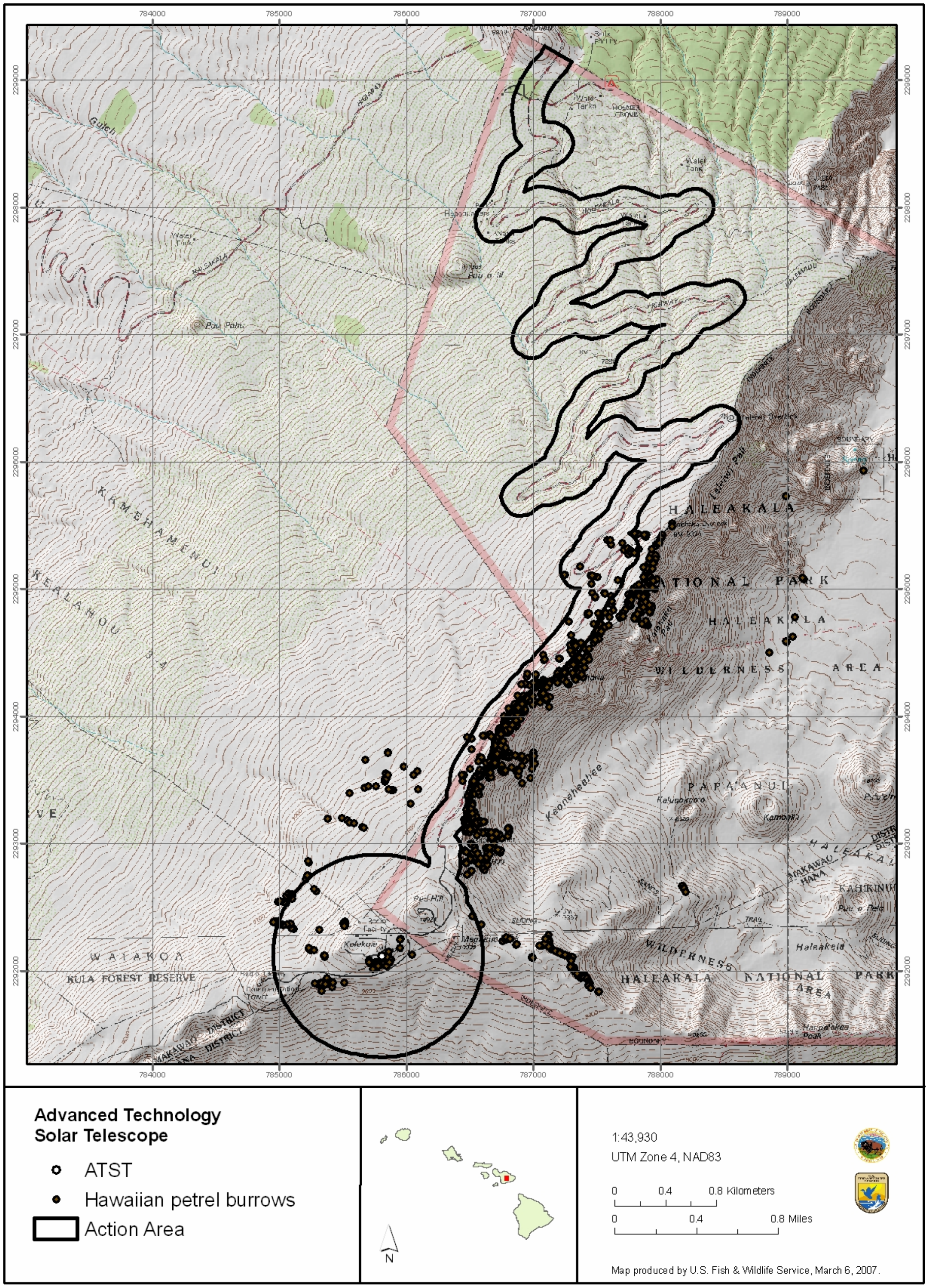

Figure 7. Delineation of the ATST Action Area.

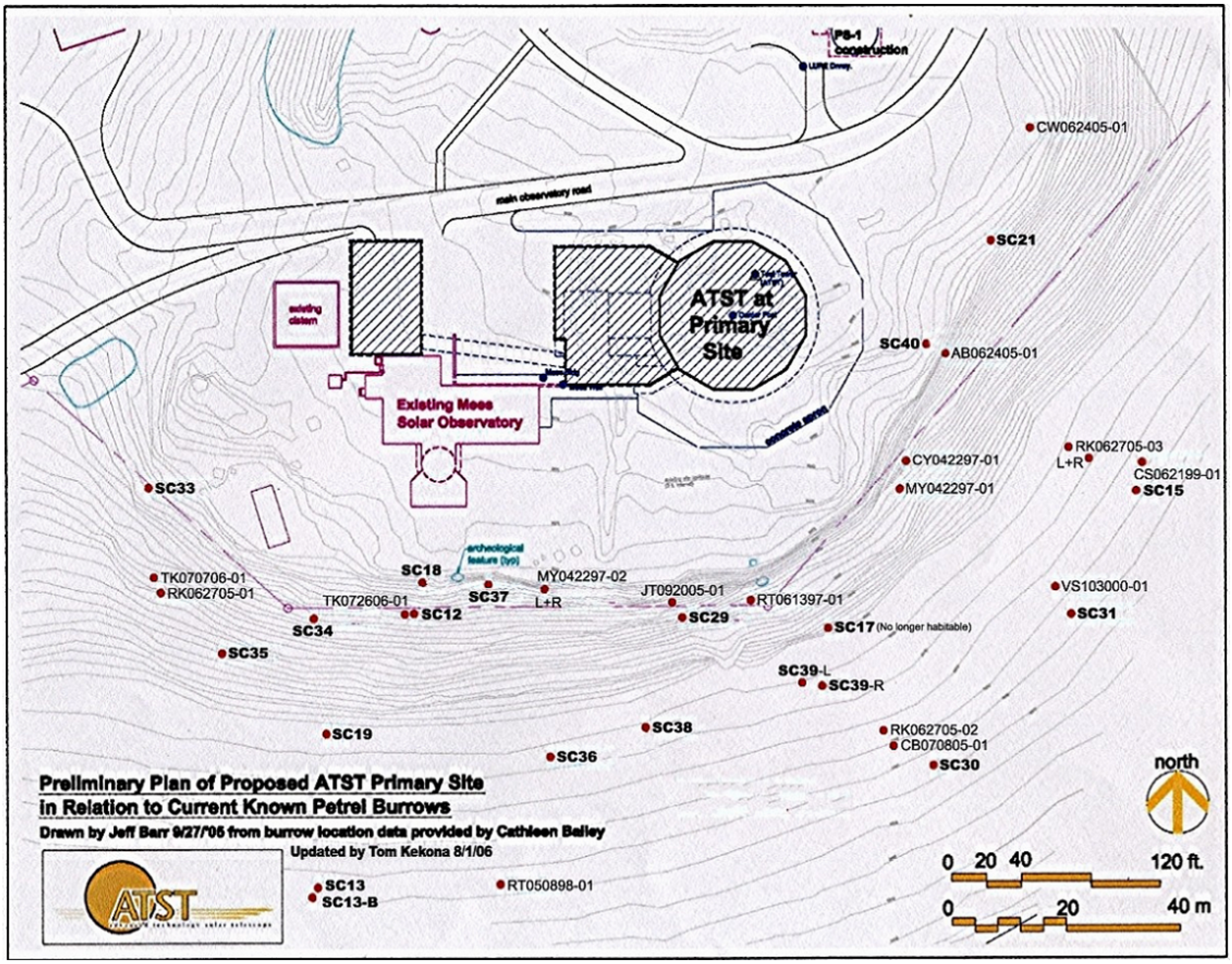

Figure 8. The Hawaiian petrel colony adjacent to the ATST construction site.

Collision with Buildings and Equipment

There is a risk that Hawaiian petrel injury or mortality can occur due to collision with man-made objects. For example, collision with structures such as poles, buildings, vehicles, and lights, accounted for the death of 37 Hawaiian petrels (accounting for 26 percent of all Hawaiian petrel mortality, and the death of an average of 1.1 bird/year), in the vicinity of Haleakala National Park and the Haleakala Observatories site between 1964 and 1996 (Hodges and Nagata 2001). Bailey (pers. comm. 2006b) attributes the death of 26 of those birds to fences containing barbed wire, constructed to exclude ungulates from the Haleakala National Park in the 1980s. After two years, the barbed wire was removed from the fences and Bailey (pers. comm. 2006b) estimates that an average of one Hawaiian petrel per year is lost due to striking the Park's ungulate exclusion fences. A petrel struck a small utility building in the saddle southwest of the ATST site (Bailey pers. comm. 2006b), in an area that is heavily used by birds (Day and Cooper 2004). Additional petrel mortality results during the fledging period, when fledglings collide with structures and rock outcroppings on their first flight to sea (Bailey pers. comm. 2006b).

A construction crane, which will be at the construction site for approximately three and a half years, could pose a flight obstacle to the fast-flying Hawaiian petrels during breeding season. The crane will be located just north of the telescope enclosure, between the enclosure and the access road (Fein pers. comm. 2006c). In order to minimize and avoid the flight risk to birds, the crane's lattice structure will be lowered each night, to a height of 14 feet or less, and the boom will be marked with visible white electric fence polytape, at night, between February 1 and November 30. White, non-reflective electric fencing polytape will be secured in some way to the all sides of the entire boom portion of the crane each night. The polytape strips will form a grid, with vertical and horizontal strips of polytape running a minimum of every 30.5 centimeters (12 inches). The specific method of attachment will be finalized after consultation with the crane contractor. The polytape grid might be sewn to a canvas fabric to be thrown over the crane boom at night, a sewn matrix of tape might be pulled over the boom, or another method may be employed to secure the grid of polytape to the crane.

Ornithological radar and visual data collected during 2004 and 2005 (Day and Cooper 2004a, Day and Cooper 2004b, and Day *et al* 2005) indicate that the ATST construction site does not lie within a heavily used Hawaiian petrel flight path. The ornithological radar data does indicate that birds tend to fly along the sides of the cliffs and through saddles on either side of the proposed construction site, rather than flying over the top of the peak, where the ATST is proposed for construction (Figure 9).

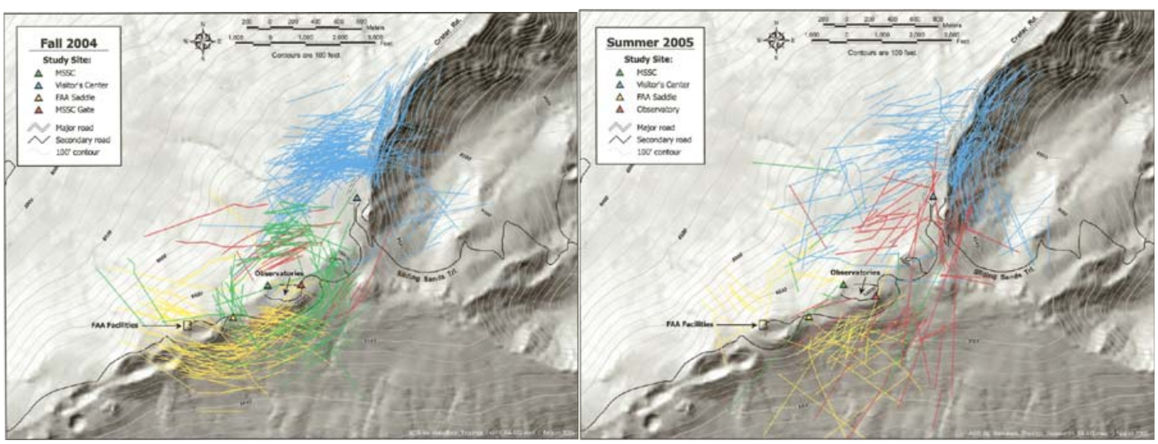

Figure 9. Diagrams from Day *et al*. 2005 indicating all Hawaiian petrel flight paths documented in the vicinity of the observatories site.

Existing Haleakala Observatories telescopes, some in existence for several decades, have not documented any bird strike or petrel mortality associated with the buildings. In addition, there is no outdoor lighting associated with the ATST project which might confuse or attract the seabirds.

Research conducted by Swift (2004) and unpublished observations by Penniman and Duvall 2006 and Penniman (pers. comm.) indicate that Hawaiian petrels avoid collision when objects are visible. Both the Swift (2004) and Penniman and Duvall (2006) applications of visibility marking found that the incorporation of strips of white, non-reflective electric fence polytape or similar material into fences reduced the risk of Hawaiian petrel collision. Before the installation of white visibility tape, birds were heard colliding with a new ungulate exclusion fence in the vicinity of a Hawaiian petrel colony on Lanai on two occasions. Since the white electric fence polytape was installed (Figure 10), no bird collisions with the fence have been heard (Penniman pers. comm.). Swift (2004) noted that birds appear to exhibit late avoidance behaviors when approaching marked fences, which they did not display when approaching unmarked fences, indicating that the apparent 100 percent successful collision avoidance marked fences is due to the birds' visual detection of the white tape. The polytape visibility flagging which will be draped over the ATST construction crane at night between February 1 and November 30 will contain a five times greater density of flagging than the flagging used in the fences studied by Swift (2004) and Penniman (unpublished). Therefore, we anticipate that the crane will be visible to petrels flying in the area.

Figure 10. White electric fence polytape improves visibility of lattice structures (Photograph by Jay Penniman, Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, 2006).

Because the ATST structures and construction crane will not be located within a heavily used Hawaiian petrel flight paths, and because the petrels have demonstrated that they are able to avoid collision with the large white existing telescope dome structures as well as structures marked with white polytape visibility flagging, we do not anticipate the fatality of petrels associated with collision with the construction equipment or telescope buildings associated with this project.

Potential Burrowing Habitat Modification

GIS assessment of the locations of the proposed activities indicates that 0.31 ha (0.77 ac) of unoccupied, potential burrowing habitat would be lost due the construction of the ATST facilities. Burrowing habitat quality varies throughout the ATST project site, but stable rocks with loose material suitable for burrow excavation are available for future petrel colony expansion within the area which will be disturbed by the proposed project. The ATST project activities will make the site unsuitable for burrowing due to changes in soil structure or access. Impact areas include the telescope enclosure, apron, support and operations building; the portion of utility building and new wastewater treatment plant and infiltration well which will be constructed on ground not previously developed; areas disturbed for the radial field of grounding conductors; and the areas to be excavated for staging areas and equipment use. No storm water or grey water erosion is expected to be associated with the project. The two soil deposition areas were previously disturbed; therefore, no potential burrowing habitat loss will occur in these areas.

Burrow Collapse Due to Vibration

ATST project engineers conducted inspections of the burrows adjacent to the ATST project site to determine probability of burrow collapse due to vibration. They determined that the angular interlocking of separate rock segments which has allowed the borrows to survive seismic events, erosion and other potentially damaging forces over many years would enable them to withstand vibrations with peak particle velocities (PPV) of 0.12 in/sec without damage (Barr, unpublished 2006). PPV is the measure of the strength of ground vibration which is the most often used to gauge the stress experienced by structures. Seismographs are used to measure PPV (Figure 11). The most fragile historic structures can be exposed to PPV of 0.12 in/sec without being damaged (U.S. Department of Transportation Federal Transportation Administration 2006a).

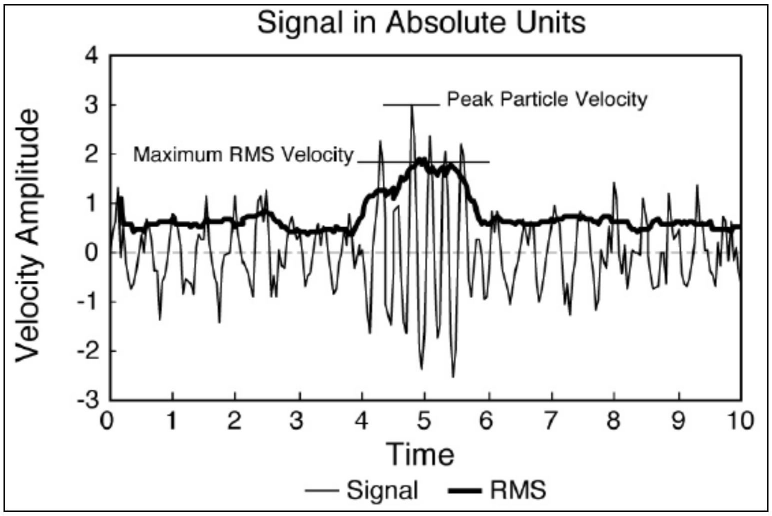

Figure 11. Peak Particle Velocity example (Excerpt from U.S. Department of Transportation Federal Transit Administration 2006a).

Vibration is transmitted through the soil or rock as earth particles are moved as a wave front radiating out from a source of excitation similar to water ripples initiated by a point disturbance. These waves encounter an increasingly larger circumferential surface area as they radiate outward. Therefore, the energy within each wave decreases with the distance from the source of vibration. This decrease, with distance, is called geometric damping, and it is inversely proportional to the square of the distance away from the source (Attewell and Farmer 1973) (Figure 12).

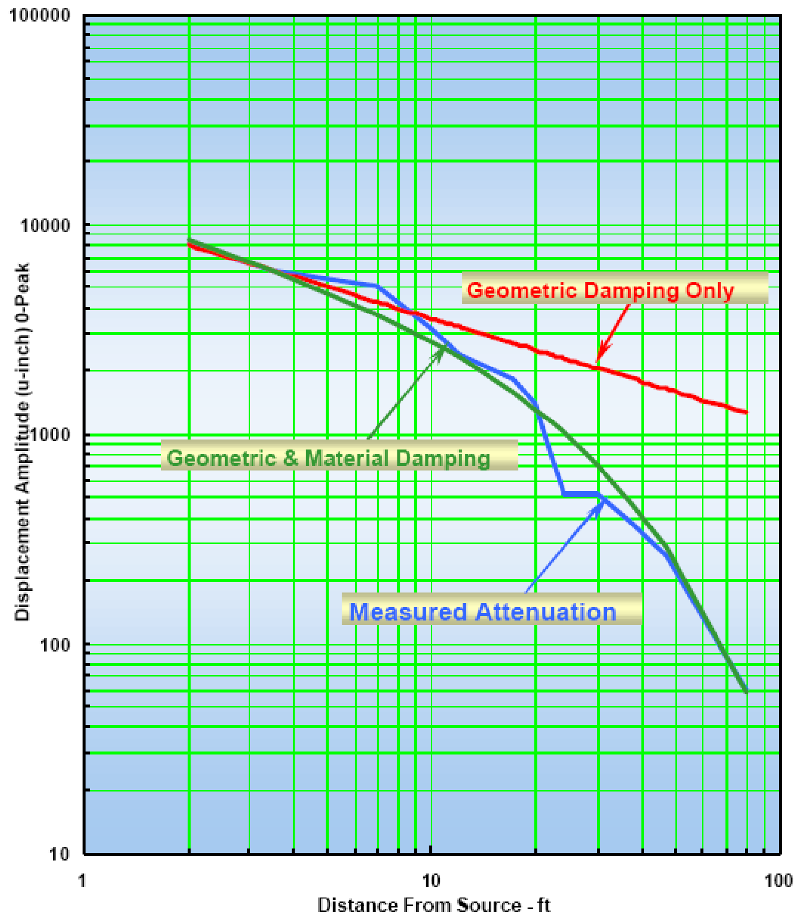

Figure 12. Comparison of geometric and material damping of vibration with distance from source (from ESI Engineering, Inc. unpublished).

Even though the most conservative estimates (Table 2) indicate that caisson drilling would produce vibrations which are less than one twentieth the strength of the engineer's burrow collapse threshold, ATST engineers agreed to relegate all use of rock drill equipment to the December through mid-February season when the Hawaiian petrels are absent from the site. Rock drills are the equipment used to drill holes for caisson pouring. Barr (unpublished, January 31, 2007) produced a map (Figure 13) which indicates the locations of the caissons in relation to the closest Hawaiian petrel burrows. No digging, trenching, or other type of earth removal work, associated with the lightning protection system, will be done within 12 meters (40 feet) of any occupied Hawaiian petrel burrow.

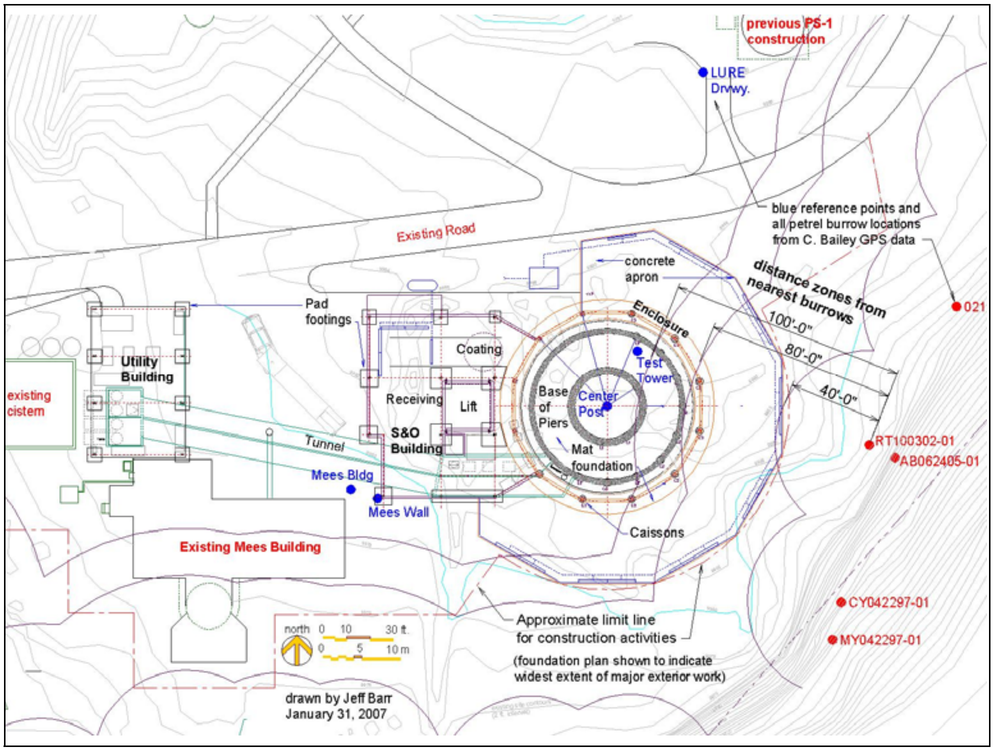

Figure 13. Hawaiian petrel burrows (bright red dots) in relation to the ATST construction site, including caisson drilling locations.

Table 2. Maximum calculated ground vibration expected at various distances from construction equipment.

Equipment or Activity	Maximum Vibration Expected (PPV inches/second) Assuming Geometric Damping Only (Soil Attenuation Not Included)			
	25 ft* (7.6 m)	50 ft (15.2 m)	100 ft (30.5 m)	200 ft (61 m)
Caisson drilling, large bulldozer, hoe ram	0.089	0.022	0.006	0.001
Loaded trucks	0.076	0.019	0.005	0.001
Jackhammer	0.035	0.009	0.002	0.001
Small bulldozer	0.003	0.001	0.000	0.000
* Federal Transit Administration, 2006				

Ground vibration estimates in Table 2 were calculated based on the attenuation of ground vibration resulting from geometric damping alone. As the energy wave moves through the soil, vibration energy is transferred to kinetic energy of soil particles, and additional attenuation occurs (Attewell and Farmer 1973). Jenson (1993) measured vibration of between 0.0009 in/sec and 0.0025 in/sec, 23 meters (75 ft) from large trucks and tour buses driving on a road on Haleakala, approximately four times lower than the vibration values listed in Table 2. The lower observed vibration is likely due to soil attenuation. Given the combination of geometric damping, and additional attenuation of vibration as it moves through the soil, vibration levels at all burrows are expected to remain well below the 0.12 in/sec damage threshold throughout all stages of ATST construction. The incorporation of the noise standard, limiting maximum equipment noise to 83 dBA (at five feet), will eliminate the use of any equipment at the construction site, which would cause a vibration greater than 0.0019 in/sec at any of the closest burrows during the incubation period. Fewer than 20 percent of people can perceive a vibration with a PPV of 0.0019 in/sec (Turunen-Rise *et al* 2003, Klaeboe *et al* 2003).

Vibration Monitoring: Ground vibration will be monitored with seismographic equipment that utilizes either accelerometers or geophones appropriate to detect vibration between 0.001 in/sec and the 0.12 in/sec peak particle velocity burrow safety threshold. The exact equipment has not yet been selected, but it would be similar to the Mini-Seis units manufactured by White Industrial Seismology (http://www.whiteseis.com/Seismographs.html), which are appropriate for monitoring vibration from heavy construction equipment. At least two units will be deployed adjacent to the entrances to the Hawaiian petrel burrows nearest to the source of the vibration. The units will be operational and archiving data during all periods of construction when ground disturbance work is being done, including caisson drilling and excavation. When only concrete pouring and fabrication of the telescope buildings is being done, vibration would not be monitored. Sensors will be equipped with an auto-call feature for reporting events that meet or exceed a defined trigger level. The auto-call feature would send an alert by cell phone or telephone, and e-mail to the ATST Project Site Manager if the sensors register a vibration of 0.08 in/sec. This would provide the Project Site Manager with an early warning that the on-site activity was causing vibration which would warrant close monitoring of the vibration sensor data. A vibration of 0.12 in/sec or greater is not expected to occur at any Hawaiian petrel burrow as a result of ATST construction activity. Any vibration of 0.12 in/sec or greater, measured at a Hawaiian petrel burrow would be reported to the Service by telephone within one hour, and in a follow-up letter.

An ATST biological technician has measured the depths of all 41 of the Hawaiian petrel burrows, leading to 33 nest chambers, located within 80 meters of the ATST construction site. Each winter following any periods of construction, the burrow tunnels will be re-measured and a report will be submitted to the Service summarizing any changes in burrow configuration.

None of the 27 Hawaiian petrel burrow entrances which were being monitored by burrow cameras during the October 15, 2006, 6.8 magnitude earthquake (which had a measured PPV of 3.4 in/sec at a seismograph located adjacent to the Haleakala Observatories site) collapsed or showed any signs of instability. The stronger vibration lasted for 15 to 20 seconds and reduced vibration lasted one minute (U.S. Geological Survey unpublished). Since burrow and tunnel entrances are more susceptible to collapse than the interior tunnel walls and ceilings, this demonstrates that the burrows can withstand a substantial amount of vibration for one minute without collapsing. Many buildings and bridges were damaged by the earthquake (Honolulu Advertiser, 2007). Peak particle velocities produced by earthquakes often exceed 3.0 in/sec (U.S. Geological Survey unpublished). We know of no Hawaiian petrel burrows that have historically been collapsed as a result of any type of local construction project or earthquake (Bailey pers. comm. 2007 and Fein pers. comm. 2006b). Based on our review of the engineering report by ATST engineers, our review of the evidence provided, and our review of vibration physics in current literature, we believe that it is reasonable to conclude that Hawaiian petrel burrow collapse is not likely to occur as a result of proposed ATST construction activities. We believe that the camera and physical measuring monitoring protocols in the proposed project description are adequate to identify any collapse of any portion of the burrows adjacent to the ATST construction site, where exposure vibration above background levels is expected to occur.

Noise and Vibration Disturbance to Hawaiian Petrels

Effect of the proposed construction noise on Hawaiian petrels can be inferred based on our knowledge about petrels, and from studies that addressed the effects of noise to other avian species. The birds' sensitivity to the sounds generated by the proposed project are likely to be associated with factors including the energy level and duration of the sound, how it reacts with topography and burrows, ambient sound levels and individual bird tolerance to sounds due to habituation. Construction and maintenance of the ATST will require use of equipment and large vehicles which introduce increased levels of noise into the environment. We were concerned with sound levels that would result in disturbance to the Hawaiian petrels. We split our analysis of the effects of the project on the petrels into the egg incubation period (April 20 – July 15) and the nestling period (July 1 through the end of November) (Simons 1985), based on the activity that will occur within the Hawaiian petrel burrows during the day, when construction activity will be occurring. Within each period, we further refined our analysis to address differences between the noise impacts to birds occupying burrows along the road portion of the Action Area, and those occupying burrows adjacent to the construction site.

Sound energy level at various frequencies is measured in decibels (dB). For many purposes, sound measurements are A-weighted (dBA) to emphasize the middle portion of the entire sound frequency range, where humans and birds have the greatest sensitivity. The Hawaiian petrel vocalizations are sharp squeaks and nasal clucks (Simons 1985) which are within the central frequency range expressed by dBA sound measurements. This species is not known to use particularly high or low frequency hearing to search for prey or for other life history functions. Because Hawaiian petrels vocalize to each within the human hearing frequencies, the A-weighted dBA scale was appropriate for application to the petrel. Therefore the dBA sound estimates presented in the DEIS (NSF 2006) were considered adequate for our analysis of the effect of construction noise on the Hawaiian petrel. It is important to note that sound (dBA) measurements are always associated with a distance from the source. Two of the standard distances for sound measurements, referred to in this document, are five feet and 50 feet from the source.

Table 3. Noise levels of ATST construction equipment and vehicles (at 50 feet), compared with familiar noise levels.

Noise Source	Decibel (dBA) at 50 feet from source	Reference
Limit to human hearing	0 dBA	US DOT FHA 2006
Closed audiometric booth / bottom of Haleakala Crater	10 dBA	US DOT FHA 2006, NPS unpublished
Rustling leaves, tall grass in a light to moderate wind, and typical daytime urban residential area away from major streets	35 to 55 dBA	Resource Systems Group, Inc. 2006
Ambient noise in front of Hawaiian petrel burrow at Haleakala Observatories Hawaiian petrel colony with 5 mph wind	55 to 68 dBA	Fein, unpublished 2007 data
Office, Restaurant, Library, toilet refilling its tank, air conditioning unit	60 dBA	Wikipedia
Passenger car, traveling at 30 mph	65 dBA	Resource Systems Group, Inc. 2006
Large barking dog	70 dBA	Acoustical Solutions unpuslished
Passenger car, van, jeep at Haleakala	71 to 75 dBA	Fein, unpublished 2007 data
Tour busses at Yosemite National Park	58 to 77 dBA	NPS unpublished
City Bus	80 dBA	FTA 1995
Tour buses at Haleakala	77 to 91 dBA	Fein, unpublished 2007 data
Backhoe, Earth movers	80 dBA	FTA 1995, NSF 2006
Crane	82 dBA	NSF 2006
EPA maximum permissable truck noise level	83 dBA	Bearden 2000
Bulldozer	82 to 85 dBA	FTA 1995, NSF 2006
Jackhammer	97 dBA	NSF 2006
Rock hammers/drills	99 dBA	NSF 2006

Birds habituate to noises and may not respond to stimuli when they do not perceive a direct threat. American black ducks (*Anas rubripes*) reacted to 39 percent of military aircraft overflights on their first day of exposure, but after two weeks they responded only six percent of the time. However, wood ducks (*Aix sponsa*) in the same study, did not habituate to the aircraft noise (Conomy *et al* 1998). Incubating herring gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*) habituated to the continual presence of humans by modifying their responses, but would continue to be disturbed when they perceived direct approach by a human walking directly toward their nest (Burger and Gochfeld 1981).

Construction Site: From April 20 through July 15, when any of the burrows within 80 meters of the ATST construction site is occupied by an incubating Hawaiian petrel, no noise greater than 83 dBA (measured at five feet from the source) will be generated at the construction site. The noise standard will preclude the use of vehicle reverse signal alarms, loud shouting, and a wide range of power tools (see examples Figure 14), at the construction site. From April 20 through

July 15, during construction the generation of noise, other than vehicle noise, will be restricted to the area bounded by orange in Figure 15.

Noise Monitoring: For equipment and hand tools without published noise levels, field testing will be done to confirm that noise production of all equipment meets the 83 dBA standard. Sound levels will be recorded with a sound meter and datalogger, five feet from the equipment or hand tool, during a continuous thirty minute period of operation, on three different days. Sound measurements will be taken downwind of the equipment, and will be taken on the loudest exposed side of the equipment (for instance, closest to the engine or exhaust). The equipment will be operated in the same manner during the test as it will be during actual construction operations. All documentation from the three thirty minute tests, for each piece of equipment will be archived by the ATST Project Site Manager. Equipment which produces any sound greater than 83 dBA (at five feet) during any period of testing will not be permitted for use at the construction site between April 20 and July 15.

A minimum of two microphones or other type of sound level (dBA) meters will be installed adjacent to Hawaiian petrel burrow SC40. One will be installed within five meters of burrow SC40 at a location where it has a direct line of sight view of the ATST construction site. The other will be installed at the opening to burrow number SC40. The noise monitoring equipment will archive sound data during all years of ATST construction, for confirmation of sound attenuation estimates and for comparison with Hawaiian petrel behavior data.

Tasks (*Trade*)	**Average noise level (dBA)**	**Maximum noise level (dBA)**	**Tools**	**Average noise level (dBA)**	**Maximum noise level (dBA)**
Installing Trench Conduit (*Electricians*)	95.8	118.6	Welding, Cutting Equipment	94.9	122.8
Operating Work Vehicle (*Bricklayers*)	98.0	116.7	Other Hand Power Tool	95.4	118.3
Operating Manlift (*Operating Engineers*)	98.1	117.6	Hand Power Saw	97.2	114.0
Welding, Burning (*Ironworkers*)	98.4	119.7	Screw Gun, Drill Motor	97.7	123.7
Operating Scraper (*Oper. Engineers*)	99.1	108.6	Rotohammer	97.8	113.5
Demolition (*Laborers*)	99.3	112.1	Chopsaw	98.4	117.7
Laying Metal Deck (*Ironworkers*)	99.6	119.9	Rattle Gun	98.4	131.1
Grinding (*Masonry Trades*)	99.7	118.6	Stationary Power Tool	101.8	119.8
Operating Bulldozer (*Oper. Engineers*)	100.2	112.5	Powder Actuated Tool	103.0	112.8
Chipping Concrete (*Laborers*)	102.9	120.3	Chipping Gun	103.0	119.2

Figure 14. Examples of construction activities producing noise levels greater than 83 dBA (at five feet).

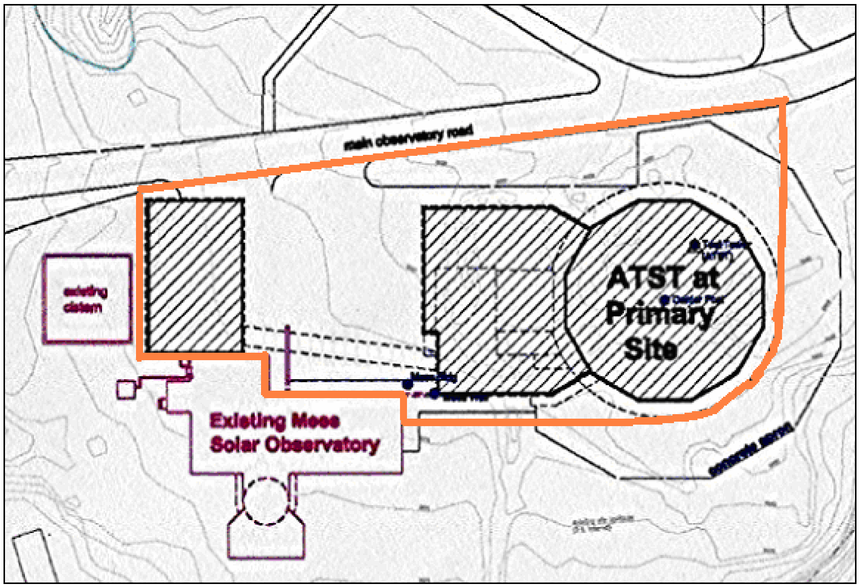

Figure 15. Between April 20 and July 15, construction noise, other than vehicle transportation noise, will not be generated outside the area bounded by orange.

Transportation: From April 20 through July 15, a maximum of two trucks, with maximum sound production of 83 dBA (measured at 50 feet) (pursuant to EPA standards) will make one round trip each, to the ATST site, per day, during any year of the project. These trucks will produce sound louder than 65 dBA at the petrel burrow entrances closest to the road. No truck traffic within the National Park and no construction activities at the ATST site will occur prior to 6:00 am or later than 8:00 pm during late April, May and June. Passenger vehicle access to the site will not be restricted during the incubation period.

Noise and Vibration During Incubation Period: The egg incubation period (April 20 through July 15 (Simons 1985) is the only time of year when adult petrels are at the Haleakala colonies during the day. Adult birds incubate their egg for an uninterrupted shift of one to three weeks, during which time the petrel maintains a low metabolic rate, conserving energy by sleeping 95 percent of the time (Simons 1985). Incubating petrels would be more sensitive to noise and vibration disturbance during this period. Undisturbed birds can lose substantial percentages of body weight during their incubation periods. Sleeping bird metabolism is approximately half that of awake, resting birds (Simons 1985). If birds are frequently awakened by noise or vibration from construction activities during incubation, they could lose enough weight that they would be forced to leave on a foraging trip prior to their mate's return. They would be more likely to leave an egg unattended, for a longer period, due to asynchronous parental incubation, than undisturbed birds. To avoid this problem, ATST project engineers developed a construction schedule to eliminate any equipment which would generate sound greater than 83 dBA (measured at five feet) or vibration greater than 0.0019 in/sec (at the closest burrows) between April 20 and July 15 during all years of construction. Although sound levels of 83 dBA would be produced at five feet from the source, noise attenuation due to distance, terrain shielding, and noise attenuation within the burrow would result in damping of the construction noise. Geometric damping will result in a minimum decrease of 6 dBA for every doubling of distance (10 feet, 20 feet, etc.) for the 83 dBA sound (originally measured at five feet) (NSF 2006, U.S. Department of Transportation Federal Highway Administration Highway 2006 and Fein unpublished). Therefore, burrows closer to the construction site would be exposed to louder sound. All of the nest chambers adjacent to the construction site are shielded from the construction noise by terrain barriers. Burrow entrances face down and away from the construction site, which is on the mountain slope above them. The noise generated at the construction site will reach the nest chamber after it is diffracted around the terrain barriers which include the slopes and the burrow cavities themselves. Fein (unpublished) found that the difference in noise level between line of sight and the burrow entrance was 9 dBA and that the burrow corridor attenuated noise at an average rate of 0.625 dBA per inch of burrow depth. Each burrow's distance from the main area of the ATST construction site, outside which no construction work will occur during the incubation period, was measured. Table 4 shows the maximum calculated noise levels anticipated to occur at the burrow entrances and within the nest chambers of the Hawaiian petrel burrows adjacent to the ATST construction site between April 20 and July 15, given an 83 dBA sound at the outer edge of the construction site.

Table 4. April 20 through July 15 approximate noise levels (dBA) expected in the vicinity of ATST construction site and within Hawaiian petrel burrows.

Hawaiian Petrel Burrow Number	Distance from Construction Site	Burrow Depth (m)	Construction Site Noise (dBA at 5 ft from Source)	Noise Level Expected at the Point Above Burrow Entrance with Line of Sight View of Construction Site (Based on 6 dBA attenuation per doubling of distance) (dBA)	Noise Level Expected at the Burrow Entrance (Based on 9 dBA Sound Attenuation due to Terrain Noise Barrier Characteristics (Fein, unpublished)) (dBA)	Noise Level Expected at the Nest (Based on 0.625 dBA Noise Attenuation per Inch of Burrow Depth (Fein, unpublished)) (dBA)
SC40 - R	20 m	0.914	83	63	54	39
- L	20 m	0.609	83	63	54	47
AB-062405-01	22 m	1.829	83	60	51	21
CY-042297-01	25 m	0.762	83	59	50	46
MY-042297-01	28 m	1.219	83	59	50	35
SC21	32 m	1.524	83	58	49	27
RT-061397-01	35 m	0.457	83	57	48	48
JT-092005-01	37 m	0.914	83	56	47	40
SC37	38 m	0.457	83	56	47	47
SC29	39 m	0.700	83	56	47	47
SC33	43 m	0.305	83	55	46	46
MY-042297-02	44 m	1.524	83	55	46	24
SC18 - R	44 m	0.700	83	55	46	46
- L	44 m	1.524	83	55	46	24
SC 34	46 m	0.305	83	55	46	46
CW-062405-01	48 m	0.762	83	54	45	41
SC12	49 m	0.914	83	53	44	37
TK072606-01	49 m	0.305	83	53	44	44
SC39 - R	50 m	0.762	83	53	44	40
- L	51 m	0.305	83	53	44	44
RK-062705-02 - R	52 m	0.700	83	53	44	44
- L	52 m	0.700	83	53	44	44
SC35	57 m	0.305	83	53	44	44
SC38 - R	58 m	0.305	83	53	44	44
- L	58 m	0.700	83	53	44	44
VS-103000-01	60 m	0.305	83	52	43	43
SC062199-01	61 m	0.305	83	52	43	43
SC15	63 m	0.700	83	52	43	36
SC36	65 m	0.305	83	52	43	43
CB-070805-01	66 m	0.305	83	51	42	42
SC31 - R	66 m	0.305	83	51	42	42
- L	66 m	0.762	83	51	42	38
SC19	67 m	0.305	83	51	42	42
SC30	73 m	0.305	83	51	42	42
TK070706-01	78 m	0.305	83	51	42	42
RK-062705-03 - R	80 m	0.457	83	50	41	41
- L	80 m	0.457	83	50	41	41
RT050898-01	87 m	0.305	83	50	41	41
SC13	92 m	0.305	83	50	41	41
SC13B	93 m	0.305	83	50	41	41

Construction Site Noise Impacts to Incubating Adult Petrels: The maximum construction site noise which is expected to reach the nest chamber of the four closest, shallowest Hawaiian petrel burrows if construction equipment producing the maximum permissible incubation period noise level of 83 dBA is used at the outer perimeter of the ATST construction site would be 47 to 48 dBA (Table 4). During this period, 23 nest chambers would be exposed to maximum noise levels between 40 and 46 dBA, and the remaining six nest chambers would be exposed to maximum construction noise levels between 21 dBA and 37 dBA. No studies of the sensitivity of sleeping Hawaiian petrel to noise have been conducted. Human sensitivity to being awakened from sleep varies among individuals, as shown in Figure 16 (Federal Interagency Committee on Noise 1992, Finegold *et al* 1993, Finegold *et al* 1994, Finegold pers. comm. 2007). Based on this dose response curve, 5.34 percent of sleeping humans would be awakened by a noise event of 48 dBA. Because ambient wind noise levels range from 55 to 68 dBA on Haleakala (Fein, unpublished), ambient noise levels at the burrow entrances and within the nest chambers are expected to be equal to or greater than those originating from the construction site during the incubation period. These factors indicate that the incubating birds that occupy the burrows adjacent to the ATST construction site are not likely to be affected by the telescope construction activities.

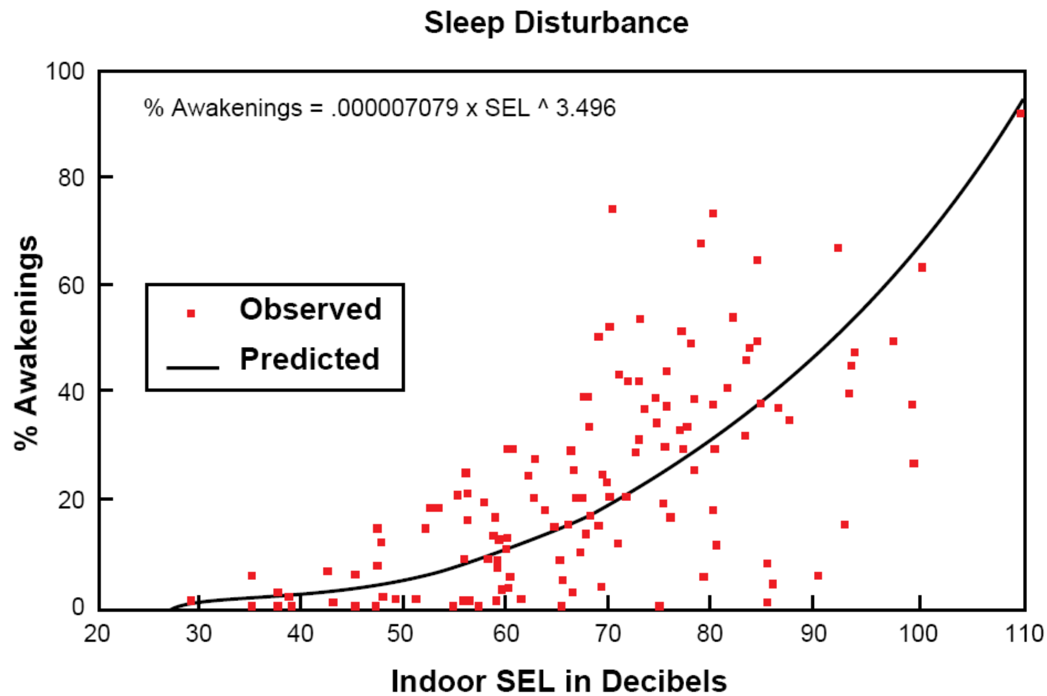

Figure 16. Percent of human awakenings at various dBA single event noise exposure levels (SEL) (Finegold *et al* 1993, Finegold *et al* 1994, Federal Interagency Committee on Aviation Noise 1997).

Road Noise Impacts to Incubating Adults: From April 20 through July 15, only two trucks, with maximum sound production of 83 dBA (measured at 50 feet, pursuant to EPA standards) will make one round trip each to the ATST site, per day throughout the construction period of the project. Approximately 11 Hawaiian petrel burrow entrances, located closer than 15 meters (50 feet) to the road may be exposed to sound levels higher than 83 dBA, resulting from ATST construction trucks, four times per day. Approximately 149 additional Hawaiian petrel burrow entrances are located within the road corridor of the Action Area, where they may be exposed to truck noise levels, at burrow entrances, of 65 dBA or greater. An estimated 600 to 900 vehicles, including buses and touring vans access the Haleakala National Park road per day (Bailey pers. comm. 2006c), in addition to the two trucks and seven to eight passenger vehicles scheduled to visit the ATST construction site during the Hawaiian petrel incubation period. Although Bailey's (pers. comm. 2006a) data analysis is not yet complete, preliminary reports suggest that egg neglect has not resulted in Hawaiian petrel mortality at Haleakala, due to noise disturbance or otherwise. The birds occupying burrows close to the road may be habituated to the vehicle noise. In 2002 and 2003, Bailey (NPS 2003) documented two egg mortalities which were both attributed to infertility.

Periods of egg neglect occur naturally and are usually associated with intermittent incubation resulting from asynchronous mate shift in inexperienced breeders, or in the general population during years of variable oceanic conditions which affect feeding success (Warham 1990). Therefore, eggs may be able to survive exposure for some period. In fork-tailed storm-petrels, chicks have been observed to hatch successfully from eggs that were left unattended for as long as seven consecutive days (Boersma *et al* 1980). Simons (1985) documented a Hawaiian petrel egg which was left unattended for three days during its incubation, and successfully hatched a healthy chick.

Summary of Noise Impacts to Incubating Petrels: Because construction is not expected to produce noise which is louder than ambient wind noise at the burrow entrance or at the nest chamber between April 20 and July 15, disturbance of incubating adult birds by construction site noise is not anticipated. Because birds occupying burrows adjacent to the Haleakala National Park road appear to be habituated to traffic noise caused by the 600 to 900 vehicles that access the Park each day, and because only two truck round trips will be associated with the ATST project during the incubation period, we believe that the ATST construction project is not likely to result in any Hawaiian petrel egg loss. The monitoring protocols developed to document egg neglect will yield additional information regarding petrel incubation behavior.

Summary of Vibration Impacts to Incubating Petrels: The incorporation of the noise standard between April 20 and July 15, limiting maximum equipment noise to 83 dBA (at five feet), will eliminate the use of any equipment at the construction site which would cause a vibration greater than 0.0019 in/sec at any of the closest burrows during this period. Fewer than 20 percent of people can perceive a vibration with a PPV of 0.0019 in/sec (Turunen-Rise *et al* 2003, Klaeboe *et al* 2003). The two round-trips taken by trucks per day during this period may produce noticeable vibration at the burrow sites along the road. Because the duration of the vibration would be limited, and because the birds are exposed to vibration from 600 to 900 vehicles, including buses, which produce vibration amplitudes which are identical to trucks (Jensen 1993), we do not believe that the effects of these two vehicles on the incubating birds will be measurable.

Nestling Period: Construction activities that will produce daily prolonged loud noises and vibration are scheduled to coincide with the nestling period (July 1 through the end of November). Hawaiian petrel nestlings have been observed on their nests, in their burrows, and near their burrow entrances during this period. Adults visit the burrows at night to feed the nestlings and would presumably be unaware of any noise disturbance. The noise generated by construction equipment and vehicles are expected to increase startle, alarm, and alert behavior and disturb the day time sleep of nestlings occupying burrows within 780 meters (2,560 feet) of the construction site and within 122 meters (400 feet) of the Haleakala Park Road. The closest burrow entrance is 12 meters (40 feet) from the outer edge of the construction site. The noise level at a point 12 meters (40 feet) away from an operating crane is 84 dBA when the crane is operating, and 101 dBA when the rock hammer is in use. Topographical shielding between the line of sight view of the construction site, and the burrow entrance, cuts 9 dBA off of the noise level (Fein, unpublished) so that the maximum noise level at any burrow entrance will be 92 dBA. Sound attenuation of 0.625 dBA per inch of burrow depth (Fein, unpublished) would result in a maximum noise level of 85 dBA within the nest chamber of the burrow closest to the construction site.

Potential consequences of construction noise and vibration could include increased metabolism, nest abandonment, and temporary damage to auditory cells. Juvenile Hawaiian petrels in close proximity to the construction site are expected to respond to loud noises and vibration with increased activity and decreased incidence of sleep, therefore their food demands are expected to increase. Rat pups exposed to 80 dBA and 100 dBA noises for 3 hours per day for 30 days were found to have increased incidence of grooming, play, locomotion behavior, and decreased incidence of sleep. No indication of a noise-induced stress reaction, such as changes in adrenal gland weight or stomach ulceration were found in the 15 to 45 day old rats, compared to the control groups (Smiley and Wilbanks 1982). Forty percent of people would be awakened by a sound of 85 dBA. The people who would not be awakened by such a loud sound are those who have habituated to the loud sound (Finegold *et al* 1994). Adult Hawaiian petrels feed chicks at night, when construction activity will not be occurring. Parents continue to feed chicks, driven primarily by the chick's demands for food (Simons 1985). If a chick has an increased need for food resulting from increased daytime activity, it is not anticipated that this would result in reduced chick survival rates. A potential consequence of increased noise and vibration could be nest abandonment by juvenile Hawaiian petrels. No references to chick abandonment of their nests due to noise or vibration disturbance were found in a thorough literature review (CSAMultiSearch 2007). We do not expect Hawaiian petrel chicks to abandon their nest, where they are fed, due to the noise and vibration associated with the ATST construction activities. Hawaiian petrel chicks, exposed to noise and vibration associated with the Haleakala Park Road and past construction projects on Haleakala have not resulted in a documented decrease in chick survival or in chick nest abandonment. In 2001, excavation for a telescope began in September and continued through the months when the birds were absent from the colony. Although the closest petrel burrow to this telescope was 100 feet, the 2001 project did not appear to have a negative impact on the nestlings (NPS 2003). The monitoring protocols incorporated into the project description appear to be sufficient to capture new information which would indicate any risks to the chicks, associated with noise, which were not anticipated at the time of this analysis.

We were concerned the nestlings may be exposed to sound levels which are known to cause permanent hearing loss in mammals. Sound levels over 85 dB are considered harmful to inner ear hair cells, 95 dB is considered unsafe for prolonged periods (Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, unpublished). Nestlings may be outside the burrows closest to the loud construction equipment (66 feet) during the day and exposed to 101 dBA sounds which may be loud enough to damage ear hairs. A review of avian hearing loss was conducted and it was determined that hearing loss in birds is difficult to characterize because birds, unlike mammals, regenerate inner ear hair cells, even after substantial loss (Corwin and Cotanche 1988, Stone and Rubel 2000). Therefore, we do not expect permanent hearing loss in Hawaiian petrels to result from the proposed action.

Monitoring and research: Real-time monitoring of Hawaiian petrels, noise, and vibration will be continuously conducted at the Haleakala Observatories petrel colony in order to detect any effects of construction on the birds at this site. Motion-triggered digital infrared and visible spectrum cameras have been mounted at the entrances to the burrows in the Haleakala Observatories colony, adjacent to the ATST construction site. Most of the burrow cameras are mounted outside the burrow entrances so that the bird is visible only when it is at the burrow entrance. Several of the cameras are mounted in the burrows, so that the nesting activity of the birds can be monitored. Pre-construction data was gathered in 2006 and additional pre-construction data will be gathered and archived in 2007. A control site, with burrow cameras monitoring petrels which are not as directly impacted by construction activities, will be identified and monitored. During construction, a minimum of two noise sensors and two ground vibration sensors will be installed in the vicinity of the burrow(s) closest to the construction activity. Noise and ground vibration will be monitored and data will be archived for statistical comparisons with behavior data. NSF will fund a research biologist and, for less technical aspects of monitoring, a biological technician, to be based with a university, National Park Service, or private contractor, in order to ensure that any changes in behavior associated with the ATST construction project, and any petrel mortality associated with the project, are monitored and reported to the Service. Several university and contract research biologists are expressing interest in participating in the burrow camera noise disturbance study. NSF will select and fund a principal investigator to complete this work.

Construction site noise and vibration will be minimized to such a low level during the incubation period that the project is not expected to result in egg neglect or nest failure. Intensive real-time monitoring will be conducted during the incubation period to confirm that birds are not being disturbed. During the incubation period, a researcher will observe and document all burrow entry and exit events by the petrels occupying the 33 nest chambers within 80 meters of the ATST construction site. If a bird exits a burrow between April 20 and July 15 during any year of early construction, (when there has been any excavation or exterior construction work done on any ATST building between April 20 and July 15), and a bird does not enter that burrow within 24 hours, a burrow-scope would be used, (by a trained technician, within 36 hours of the bird's exit) to view the nest chamber of the burrow that was exited, to document the contents of the nest chamber. If an unattended egg is found, NSF would contact the Service by phone or email within six hours. A follow-up letter would be sent to the Service, documenting the egg neglect incident. The Service would review the incident to determine if initiation of formal consultation would be recommended. After June 1, daily burrow exit data for any burrows confirmed to be occupied by non-breeding pairs of birds, (with no egg) would no longer be tracked by the researcher in real time. Egg neglect incidences at the control site would be documented and studied, but would not be reported immediately to the Service.

During the year(s) of heavy excavation and external building construction, the fledglings will be monitored in real-time for mortality and fledging date. A monthly status report of all fledglings, including their most recent activity, and the date of the activity, will be provided to the Service. The behaviors of the chicks occupying burrows at the colony adjacent to the construction site will be compared to the behaviors of the birds from the control site. NSF will fund a researcher who would be expected to produce a Masters Thesis or peer-reviewed journal article summarizing the impacts of construction related noise and vibration on the behavior of the Hawaiian petrel adults and chicks.

The construction site and completed telescope structures will be systematically checked every week for downed birds from February 1 through November 30 of each year. Any dead bird found will be secured, labeled, placed in a freezer, and the Service will be contacted within 48 hours. NSF may utilize on-site personnel or local National Park Service personnel for this weekly monitoring work. The construction crew could be taught to look for downed birds during construction. NSF may also consider an agreement with the National Park Service to fund a petrel management and research intern position for 16 weeks/year, in exchange for a weekly downed petrel surveys by National Park Service staff. Weekly searches will begin when construction begins, and will run through the first year after the enclosure is completed, after which the timing of the searches may be modified, with the concurrence of the Service, based on the results obtained. The results of all weekly searches will be documented and submitted in an annual report to the Service.

A report summarizing the effects of the first year of construction disturbance on the Hawaiian petrels will be prepared and submitted to the Service. The report will summarize all behavioral events associated with construction. The report will provide any new information which will enable the Service to determine whether there is a need to modify the minimization measures for subsequent years. The report will include recommendations regarding revisions to monitoring protocols for future years. In subsequent years, if more or less intensive monitoring measures are agreed to by the Service and the NSF, monitoring could consist of a greater or reduced level of effort.

Predator Control

In order to contribute to the ongoing effort to control rat predation on Haleakala, the NSF proposes to install and maintain a permanent 24c State Conservation Label rat bait station grid around the Haleakala Observatories Hawaiian petrel colony. Forty-nine bait stations will be installed and maintained approximately 50 meters apart (Figure 17). Bait stations will be placed on previously disturbed areas along edges of buildings, roads, and trails, throughout the Haleakala Observatories petrel colony area. The rat bait station grid extends 200 meters around the petrel colony in all directions except to the southeast and directly to the west, where access would damage natural resources. In order to prevent predation of petrel eggs, rat bait stations will be stocked with fresh rodenticide as needed, in accordance with label requirements, from April 1 through July 15, during the 31 years of the ATST project. The ATST project would not result in any increase in rat population on the site. Sanitation practices would tightly control trash containment. In addition, thorough rat control would be maintained throughout all ATST structures.

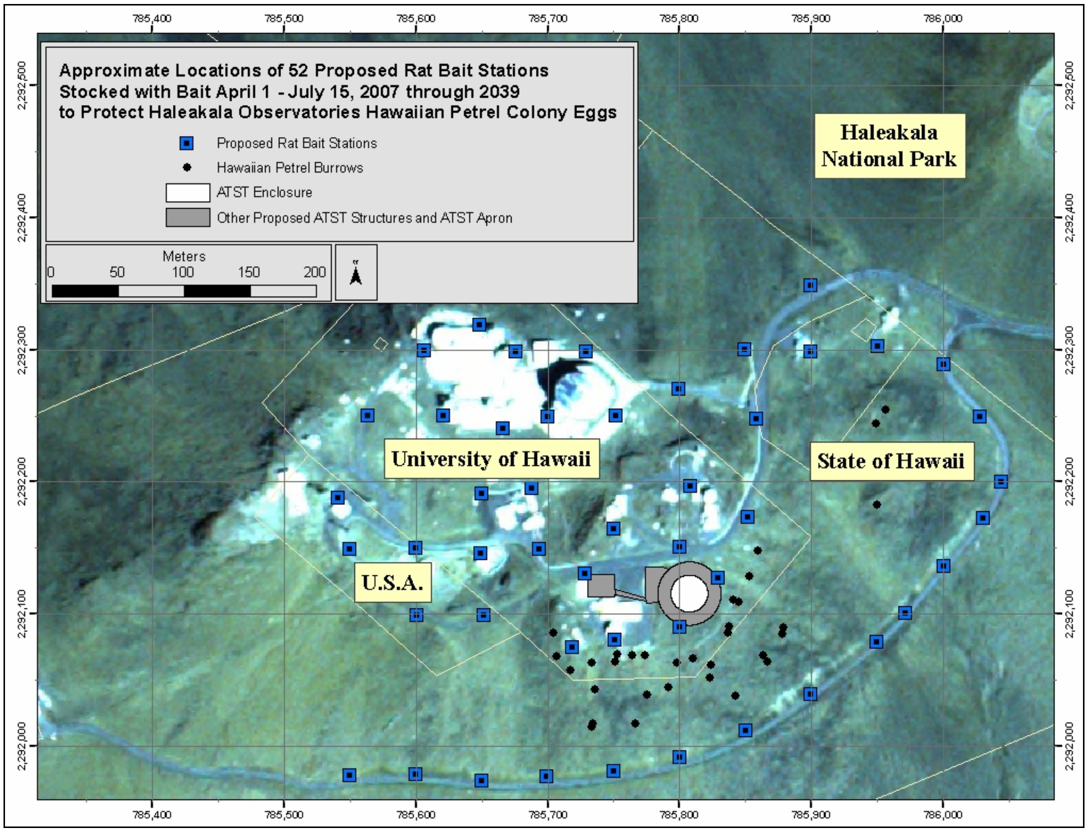

Figure 17. Approximate locations of rat bait stations to be maintained to protect the Haleakala Observatories Hawaiian petrel colony burrows.

We reviewed published data and unpublished sources of information to assess the effect the proposed rat control program would have on the Hawaiian petrel population at the Haleakala Observatories site (Simons and Hodges 1998, Hodges and Hagata 2001, Seto 1994, Seto and Conana 1996, Bailey pers. comm. 2006d, Fein pers. comm. 2006a). There are currently 33 known Hawaiian petrel nests which will benefit from rat baiting over the 31-year life of the ATST project. Although we do not expect complete control of rats because rat bait station placement will be limited to disturbed areas to minimize impacts to habitat, we do expect that the petrels at the Haleakala Observatories colony will benefit from the rat baiting program.

Invasive Species Interdiction and Control

To reduce the risk of transporting non-native species or seeds to the project site, NSF has proposed the following measures. The Haleakala Observatories Long Range Development Plan for the prevention of introduction of invasive exotic weed species will be followed during the construction, maintenance, and use of the ATST. In order to ensure that destructive, non-native species are not introduced to the Haleakala National Park or Haleakala High Altitude Observatories site, the Advanced Technology Solar Telescope Project Site Manager would cooperate with the National Park Service in developing and implementing a construction worker education program that informs workers of the damage that can be done by unwanted introductions. Satisfactory fulfillment of this requirement would be evidenced by successful completion of a test approved by the National Park Service and administered by the contractor under Institute for Astronomy supervision. All workers bringing vehicles into Haleakala Observatories would be required to complete the training and pass the test before beginning work on the site. In addition, all construction vehicles will be steam cleaned to remove all organic matter and insects before they are transported into Haleakala National Park. Any equipment, supplies, and containers with construction materials originating from outer islands, the mainland, or an international port, will be checked for infestation by unwanted species by a qualified biologist or agricultural inspector prior to departure from that port and again prior to unloading at Kahului Harbor or Airport (University of Hawaii 2005).

The following measures will also be taken to prevent introductions of invasive exotic species to the project area: Documentation of all inspections, including the name and contact information for the inspector will be maintained with each load. The Advanced Technology Solar Telescope Project Site Manager will ensure that the National Park Service is provided with advance notice about the arrival of each load in order to facilitate load inspections prior to vehicles reaching the park entrance. In addition, ATST facilities and grounds within 100 feet of the buildings will be thoroughly inspected on an annual basis for introduced species that may have eluded the cargo inspection processes. This annual inspection will be conducted by a qualified biologist. Any newly-discovered non-native, invasive plant or animal will be photo documented, mapped, and described. Any introduced species found inside or within 100 feet of the ATST buildings will be exterminated within six months of detection. Appropriate control methods include the use of available herbicides and pesticides, in accordance with the Long Range Development Plan (University of Hawaii 2005) and pursuant to label requirements.

Hawaiian Goose

NSF requested Service concurrence with their determination that the ATST project is not likely to adversely affect the Hawaiian goose. Based on vehicle use and Hawaiian goose fatality estimates provided by Bailey (pers. comm. 2006c), one Hawaiian goose is killed on the road at Haleakala National Park, for every 224,454 round-trips taken by vehicles through the Park. We calculated that during the 31-year life of the ATST project, a total of 66,294 vehicle round-trips will be taken to the project site (11,544 during construction and 54,750 during operation and use). By combining the average Hawaiian goose fatality rates due to vehicles driving the Haleakala National Park Road and the ATST vehicle use data, we calculated that there would be a collision with 0.3 Hawaiian goose during the 31-year live of the project. To further reduce the chance of a collision with a Hawaiian goose, all drivers accessing the ATST site during the life of the project will receive a Hawaiian goose briefing from the Institute for Astronomy. Drivers will receive a refresher briefing regarding the Hawaiian goose at the beginning of this species' breeding season approximately November 1 of each year. These measures will further reduce the probability of affecting this endangered species within the action area. Therefore, we concur with NSF's determination that the project is not likely to adversely affect the Hawaiian goose.

Hawaiian Hoary Bat

NSF requested that we review their determination that the ATST project would have no effect on the Hawaiian hoary bat. Hawaiian hoary bats are not likely to be in the vicinity of the construction site during the day because there are no roost trees in the vicinity of the site. At night, bats may transit the site, commuting through the area or foraging for local insects. Because the telescope buildings will not have external lighting, they will not attract insects which would attract foraging bats to the vicinity of the buildings. When they are commuting they navigate entirely by sight. However, the telescope buildings will be painted white and will therefore be more visible than their surroundings. Therefore a bat collision with the telescope structures is very unlikely. The Service does not have any information that would indicate that the Hawaiian hoary bat would be affected by the ATST project.

Endangered Plants and Plant Critical Habitats

There are a number of Haleakala silversword plants, 382 hectares (ha) (944 acres (ac)) of designated Haleakala silversword critical habitat, and one ha (2 ac) of *Geranium multiflorum* designated critical habitat, within the action area of the ATST project. NSF determined that the proposed project will have no effect on the Haleakala silversword, Haleakala silversword critical habitat, and *Geranium multiflorum* critical habitat, and requested that the Service review their determination. The Service does not have any information which would indicate that the Haleakala silversword plants or any of the Haleakala silversword and *Geranium multiflorum* critical habitat within the Action Area, would be affected by the proposed action. In providing for vehicle steam cleaning, invasive species inspections, and rapid response to on-site discoveries of introduced species, this project is providing the best available level of protection against habitat-modifying invasive insects, plants, and other pests.

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Bailey, C. pers. comm. 2006b. Gina Shultz, Patrice Ashfield, Holly Freifeld, Dawn Greenlee, from the Service met with NPS Hawaiian Petrel Biologist Cathleen Bailey to discuss various aspects of the proposed ATST project and measures which will minimize the impacts of the project to the Hawaiian petrel and Hawaiian goose. October 25, 2006.

Bailey, C. pers. comm. 2006c. NPS Hawaiian Petrel Biologist Cathleen Bailey Emailed Service Fish and Wildlife Biologist Dawn Greenlee with information regarding vehicle use of the Park and Hawaiian goose mortality on the road. November 21, 2006.

Bailey, C. pers. comm. 2006d. Bailey, C. pers. comm. 2006c. NPS Hawaiian Petrel Biologist Cathleen Bailey provided Service Fish and Wildlife Biologist Dawn Greenlee with information regarding the number of active Hawaiian petrel burrows on Haleakala. November 22, 2006.

Bailey, C. pers. comm. 2007. NPS Hawaiian Petrel Biologist Cathleen Bailey told Service Fish and Wildlife Biologist Dawn Greenlee that in her 20 years at Haleakala, she had not seen a Hawaiian petrel burrow collapse as a result of an earthquake. March 20, 2007.

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Fein, C. pers. comm. 2006b. Via email, Dr. Fein provided the Service with the results of video monitoring of burrows during the October 15, 2006, earthquake, which indicated that none of the burrows were damaged and none of the petrel chicks appeared to respond to the strong ground vibration. October 26, 2006.

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