Summary of TMT Mitigation Measures

#	Primary Topic	Secondary Topic	Mitigation Measure	Compliance
1	• Land Use	• All	**Comprehensive Management Plan and Sub Plans** The TMT Project will comply with the BLNR approved: • Comprehensive Management Plan (CMP) • CMP Sub Plans - Cultural Resources Management Plan (CRMP) - Natural Resources Management Plan (NRMP) - Public Access Plan (PAP) - Decommissioning Plan (DP); decommissioning of the TMT Observatory and the portion of the Access Way exclusively used by TMT will occur at the appropriate time	X (State BLNR condition of approval of CMP)
2	• Land Use	• Socioeconomic	**Sublease Rent** All sublease rents including the rent to be negotiated with TMT shall be deposited into the Mauna Kea lands management fund and used for the purposes set forth in Section 3.4A-2170, Hawai'i Revised Statutes, to manage Mauna Kea lands within the UH Management Area, including maintenance, administrative expenses, salaries and benefits of employees, contractor services, supplies, security, equipment, janitorial services, insurance, utilities, and other operational expenses; and enforcing administrative rules that may be promulgated by UH related to its management of the Mauna Kea lands within the UH Management Area and the implementation of the CMP.	
3	• Land Use		**Hale Pōhaku** TMT will only utilize existing developed areas at Hale Pōhaku. TMT Project activities at Hale Pōhaku will not displace existing uses, including star-gazing tours.	

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4	• Land Use • Culture • Historic • Natural Resources • Visual	• Noise	**TMT Observatory Location** The TMT Observatory has been sited at the 13N site, within Area E, north of and below the summit. Therefore the TMT Observatory: • Will not be visible from culturally sensitive locations, such as the summit of Kūkahau'ula, Lake Waiau, and Pu'u Līlīnoe; • Is more than 200 feet from known historic properties; • Will not be visible from Hilo and the southern portion of the island; and • Is outside of the wēkiu bug's preferred habitat.	
5	• Land Use • Culture • Historic • Natural Resources	• Visual • Air Quality	**TMT Access Way Design** Access Way physical and visual impacts have been mitigated by: • Designing Access Way to reduce the potential for both physical and visual impacts to the historic properties and potential impacts to natural resources known to be in the vicinity. • Limiting the southern 750 foot long portion of the Access Way to a single-lane even though such a configuration is not desirable from an operational standpoint. • Aligning the bulk of the Access Way to follow an existing single-lane, 4-wheel drive road that was built in the 1960s for access and testing of the 13N site. • Paving the portion of the Access Way within the boundaries of Kūkahau'ula on the flank of Pu'u Hau'oki, and, therefore, within the alpine cinder cone habitat, in order to reduce dust. • Coloring the pavement and guardrail a reddish color that blends with the surrounding area. • Placing the utilities to the TMT Observatory within the Access Way and beneath the paved roadway instead of on a different or parallel alignment that would cause more ground disturbance.	

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6	• Culture • Historic • Natural Resources		**Cultural and Natural Resources Training Program** Institute a Cultural and Natural Resources Training Program. The content of the training program will be determined by OMKM. All TMT staff and all construction workers will be trained annually regarding: • Potential impacts to cultural practices and archaeological/historic resources and the measures to prevent such impacts. • Potential impacts to natural resources and the measures to prevent such impacts. • Understanding of Mauna Kea's cultural landscape, including cultural practices, historic properties and their sensitivity to damage, and the rules and regulations regarding the protection of historic properties. • Guidance and information as to what constitutes respectful and sensitive behavior while in the summit area.	X (CMP CR-3; NRMP 4.4; CRMP 4.3.3; PAP 4.2, 5.2, 6.1)
7	• Culture • Historic • Natural Resources		**Development of Exhibits** TMT will support, through financial contributions and utilization of its outreach office, the development of educational exhibits related to Mauna Kea. The exhibits will be: • Developed in coordination with OMKM and "Imiloa. • Address the following subjects: cultural, natural, and historic resources. • Developed for use at the Visitor Information Station (VIS), 'Imiloa, TMT facilities, and other appropriate locations. • Include informational materials that explore the connection between Hawaiian culture and astronomy.	
8	• Culture • Historic	• Land Use • Natural Resources • Visual	**Restoration of Pu'u Poliahu** TMT will fund the restoration of the closed access road on Pu'u Poli'ahu per a plan submitted by the Institute for Astronomy and approved by DLNR (SPA HA-10-04).	

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9	• Culture • Historic	• Visual	**Camouflage Utility Boxes** TMT will camouflage utility boxes that are visually distracting or intrusive at the summit of Mauna Kea and other key locations visible from other portions of Kūkahau'ula. The method of camouflage will be determined through consultation with Kahu Kū Mauna and may include one of the following options: • Painting the lids to match the surrounding natural colors. • Affixing stones and cinders from nearby to the exposed utility box.	
10	• Culture • Historic	• Land Use • Natural Resources • Visual	**Restoration of the Batch Plant Staging Area** TMT will partially restore the Batch Plant Staging Area after completion of TMT construction activities.	
11	• Culture		**Sense of Place** • TMT facilities will be furnished with items to provide a sense of place and acknowledge the cultural sensitivity and spiritual attributes of Mauna Kea. • Will be a constant reminder of the lessons learned during the required annual cultural training to respect, honor, and not restrict or interfere with cultural or religious practices.	
12	• Culture	• Historic	**Cultural History** TMT will support, through financial contributions and utilization of its outreach office: • The translation of chants and mele and use their teachings; the focus here will include both (a) translation, and (b) developing programs that go to schools to spread what is learned about Hawaiian science and genealogy. • The hosting of an annual cultural event or training. Examples of how this measure will be implemented include activities such as a star-gazing program at the annual Makahiki festival, workshops of stone adze-making, and workshops on how to recognize archaeological sites and to assess their importance. • The translation of modern astronomy lessons into Hawaiian language for use at Hawaiian language charter schools.	

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13	• Culture		**Cultural Outreach** TMT will: • Develop an outreach office (two full time staff) that will work with 'Imiloa and Native Hawaiian groups to support/fund programs specific to Hawaiian culture and archaeological resources. • Have an open door policy so that TMT's outreach management can be contacted by the Native Hawaiian community to discuss various issues. • Provide initial and then annual or as-needed tours of the TMT Observatory, with the Native Hawaiian community invited at least two weeks prior to the tour. Insofar as practicable, these tours will be scheduled on the days (up to four each year) on which cultural events are scheduled. • Request permission to attend meetings of the Kahu Kū Mauna council on a quarterly basis. A TMT representative will be available on an ongoing basis to review cultural impact issues, should there be any related to the TMT Project. By attending the meetings the TMT representative would become aware of other cultural resource issues on the mountain and then implement any necessary changes in TMT policies to address potential similar issues at the TMT Observatory.	
14	• Culture		**Cultural Observance** On up to four days per year, to be identified by Kahu Kū Mauna, the Project will minimize daytime activities in observance of Native Hawaiian cultural practices. While the observatory will be operated during these periods, this measure will involve having only a skeleton crew at the observatory, minimizing vehicle traffic reducing noise, and prohibiting visitors to the TMT Observatory.	
15	• Historic	• Culture	**Cultural Protocols** Continue consultation with SHPD and Kahu Kū Mauna Council regarding the appropriate protocols for the relocation of the modern shrine at the 13N site. The Project will also perform archaeological data recovery for the modern shrine and the other "find spot" in the area of the 13N site, which is a site that initially appeared to be a temporary habitation.	
16	• Natural Resources (biology)		**Arthropod Monitoring** Arthropod monitoring will be performed prior to, during, and for two years following construction in the area of the Access Way on the alpine cinder cone habitat (the flank of Pu'u Hau'oki).	

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17	• Natural Resources (biology)		**Wēkiu Bug** TMT will work closely with OMKM to develop and implement a wēkiu bug habitat restoration study.	
18	• Natural Resources (biology)		**Invasive Species Prevention and Control** Develop and implement invasive species prevention and control program that will include: • Materials control and reduction • Washing/cleaning • Inspections • Monitoring • Control, and • Education/training	X (CMP NR-2)
19	• Natural Resources (geology)		**Seismic Risk** • The Project will comply with all applicable seismic safety regulations and standards. • Minimize the seismic risk to the telescope and equipment through extra design measures. • Additional mitigation may include identifying, through interpretive signs, noteworthy examples of glacial features near the Access Way. The placement of interpretive signs is consistent with CMP Management Action EO-4.	X (CMP EO-4)
20	• Visual	• Culture	**Visual Impact** The TMT Observatory has been designed to mitigate its visual impact by: • Reducing the size of the dome through the use of a Calotte type dome. • Designing the telescope to be much shorter than usual using a focal ration of f/1.0. • Designing the dome to fit very tightly around the telescope. • Finishing the dome with a reflective aluminum-like surface similar to that on the Subaru Observatory, which during the day reflects the sky and reduces the visibility of the structure. • Finishing the support building and fixed structure exterior with a lava color.	

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21	• Socioeconomic		**Workforce Pipeline, Employment Opportunities, and Additional Measures** • Employment opportunities will be filled locally to the greatest extent possible. • In addition to its Public Information and Education Office, the TMT Project will create a separate Community Outreach Office with at least one full-time position dedicated to establishing and implementing the Workforce Pipeline Program and various mentoring and scholarship programs to maximize job opportunities for local residents. • Project operations budget will have funds specifically earmarked to provide financial support to workforce development programs, including curriculum and program development. • At least three full-time positions will be established for community outreach. One of these positions will focus on the WPP and the others will perform general outreach activities. General outreach activities will include scientific and technical outreach to the local community and educational institutions to further the Project objectives to develop general science and technology education and allied employment opportunities. • Support of, and active participation in, ongoing efforts to strengthen STEM education in Hawai'i Island K-12 schools and informal learning organizations. Examples include the Science and Engineering Fair, FIRST robotics competitions, and 'Imiloa Astronomy Center of Hawai'i. • A mentoring program for children will be developed to provide support for those interested in astronomy, technology, engineering, and math during the entire elementary school-to-university graduate school educational path, with an ultimate goal of strengthening STEM skills throughout Hawai'i Island. • Scholarship programs for students interested in careers in astronomy, engineering, science, and technology will be established.	
22	• Socioeconomic	• Culture	**Community Benefits Package (CBP)** The TMT Observatory Corporation will fund a CBP of $1 million per year, to be administered via The Hawai'i Island New Knowledge (THINK) Fund Board of Advisors. THINK Fund purposes could include scholarships and mini-grants; college awards; educational programs in general and specific to Hawaiian culture, astronomy, math, and science; and community outreach activities.	

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23	• Water	• Culture	**Wastewater Treatment** A zero-discharge wastewater system will be installed at the TMT Observatory. All wastewater generated at the Observatory will be transported to an approved treatment facility for treatment and disposal. The discharge of wastewater within the summit region has been identified as an impact on cultural resources and is one of the reasons for this measure.	X (CMP FLU-7)
24	• Water		**Water** • The Project will use storm water dry wells and perform grading to maximize groundwater recharge. • The Project will install water efficient fixtures and implement water saving practices to reduce the demand for freshwater resources.	
25	• Waste	• Water • Power	**Waste Minimization and Recycling** • The Project will implement a Waste Minimization Plan (WMP) and institute an annual WMP audit, which will include an examination of: - Waste produced by the Project and how that waste could be reduced, reused, or recycled. - Water use by the Project and how that use could be reduced. - Energy use by the Project and how that could be reduced. • The Project will recycle solid and non-hazardous waste material and reuse them to the extent possible.	
26	• Waste	• Culture • Water	**Materials Storage/Waste Management and Spill Prevention and Response Plan** The Project will implement a Materials Storage/Waste Management Plan, including a Spill Prevention and Response Plan. The plan will require: • Daily inspections of equipment handling hazardous materials. • Mandatory training of all personnel handling hazardous materials and wastes. • Regular inspections by a Safety and Health Officer. • That all solid waste be collected in secured and covered storage containers. • Storing a minimal amount of hazardous materials on site. • That all wastes be transported down the mountain for proper disposal at an off-site disposal facility. • Recycling solid and non-hazardous waste materials and reusing them to the extent possible.	X (Portions are compliance with HDOH rules)

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27	• Waste	• Culture • Water	**Chemical, Fuel and Waste Storage** The TMT Observatory will include engineered systems designed to provide proper chemical and fuel storage and waste collection and storage, including: • Double-walled piping and tanks for fuel and mirror washing wastewater. • Automatic leak detection systems installed on double-walled storage tanks and piping. • Designs that include specialized space and a contained system to collect chemical waste from the mirror stripping, coating, and washing area floor drain and laboratory.	X (Portions are compliant with HDOH fuel storage requirements.)
28	• Traffic	• Culture • Historic • Natural Resources • Noise • Air Quality	**Ride Sharing** The Project will institute mandatory participation in a Ride-Sharing Program using Project vehicles for TMT Observatory employees traveling beyond Hale Pōhaku. This step will reduce the Project's impact to the spiritual and sacred quality of Mauna Kea by reducing dust, transient noise, and general movements in the summit region. Construction workers will also be required to participate in this program. The observatory vehicles used for the Ride-Sharing Program will be selected based on balancing the needs for fuel efficiency, low emissions, and safety for transportation to the summit.	
29	• Power		**Energy Saving** • As part of TMT's design work, there is an active program to analyze the environmental heat loads and energy usage in the telescope enclosure and supporting facilities. • Appropriate energy saving designs will be incorporated into TMT Project facilities including high R-rated insulation panels, radiant exterior barriers, high performance window glazing, and air infiltration sealing. • Energy saving devices will be incorporated including energy efficient lighting, solar hot water systems, and Energy Star rated electrical appliances. • Although outside of the conservation district, plans at the Headquarters include a photo voltaic power system.	

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30	• Noise		**Noise Reduction** Noise generated by the operation of the TMT Observatory will be mitigated by: • Placing heating, ventilation, and air conditioning (HVAC) equipment and other noise generating equipment indoors, significantly reducing noise in the outside environment. • Directing the exhaust of the HVAC equipment through a tunnel duct that exits on the northwest side of the graded area, which faces away from noise sensitive areas. • Placing façade acoustical louvers, tunnel duct wall treatments, and duct silencers in air ducts to further reduce the level of HVAC-associated noise outside the TMT Observatory. • Furnishing other openings between the interior of the observatory and outdoors, such as air intake locations, with measures to reduce noise discharging outside of the observatory, such as acoustical louvers.	
31	• Air Quality	• Land Use	**Air Traffic Safety** The TMT Observatory will coordinate the use of its AO laser guide stars with other observatories on Mauna Kea using the existing Laser Traffic Control software system to minimize the interference between the various guide star systems in use, as well as their impact on other astronomical observations.	
32	• Construction • Culture • Historic • Natural Resources • Land Use • Water • Noise • Air Quality		**Construction Best Management Practices (BMP)** The Construction BMP Plan will be implemented with measures to: • Minimize land disturbance by flagging of the planned limits of disturbance, surveying nearby property boundaries, flagging nearby property boundaries to ensure the limits of disturbance do not encroach on neighboring parcels (the NAR in the case of the Batch Plant Staging Area). • Appropriately manage materials and wastes, and respond to spills. • Measures to endeavor to reduce noise in the vicinity of cultural practices. • Measures to connect to HELCO-supplied power early in the construction process to eliminate the need for generators, except for limited emergency use. • Other measures to limit impacts to storm water. • Prevent and respond to fire.	X (Portions are compliance with rules and regulations such as NPDES permit requirements.)
33	• Construction • Culture • Historic		**Cultural and Archaeological Monitoring** Plan will be prepared and implemented during construction within the conservation district.	

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34	• Construction		**Access Road Maintenance** Due to the expected increase in heavy traffic during construction there is a chance for more rapid deterioration of the unpaved portions of the Mauna Kea Access Road surface; TMT will arrange for the more frequent grading of the unpaved roadway.	
35	• Construction		**Contractors** The contractor(s) selected to build the TMT Observatory and Access Way will be required to comply with the mitigation measures outlined in the Project's Final Environmental Impact Statement and the TMT Conservation District Use Application. Specific provisions regarding this will be included in contract documents.	