Written Direct Testimony of Tom Nance

My name is Tom Nance. I am president of Tom Nance Water Resource Engineering which is located at 560 N. Nimitz Highway, Suite 213, Honolulu, Hawai'i 96817. My company specializes in water resource development, well and water system design, and most aspects of hydrologic analyses. I received my B.S. in Mechanical Engineering from Stanford University in 1966 and a B.S. in Economics from Claremont Men's College in 1966. I received a master of science in Civil Engineering with a specialty in hydrology from Stanford University in 1970. Since receiving my masters, I have done graduate work in physical oceanography at the University of Hawai'i and also graduate work in hydrology at the University of California at Berkeley. I have been working in the field of hydrology and water resource engineering for 44 years. The first 17 years of my career in the field of hydrology and water resource engineering were spent with Belt Collins & Associates. My curriculum vitae was submitted as Exhibit A-43.

I started my own company in 1989. I have been qualified as an expert in hydrology and water resource engineering on a number of occasions. I reviewed the sections on water, wastewater, and drainage of the Final Environmental Impact Statement ("**FEIS**") for the Thirty Meter Telescope ("**TMT**") Project. *See* Exhibits A-3 & A-5 (FEIS Vols. 1 & 3). Previously, I did work on the Keck Outrigger Telescopes project which involved research and water sampling of Lake Waiau and the perched springs which supply the Pohakuloa Training Area ("**PTA**"). I have also reviewed and discussed with Don Thomas the results of his geophysical work and test borehole at PTA.

Water Resources and Wastewater

For the reasons described in detail below, it is my opinion that the TMT Project will have no significant or adverse impact on water resources.

I. Surface Runoff

Paved areas and buildings are impervious surfaces that prevent rainwater from directly percolating into the subsurface. The TMT Project will create a total of approximately 1.3 acres of impervious surfaces at the TMT Observatory (about 0.5 acres) and paved portions of the Access Way (about 0.8 acres). The parking areas will not be paved and will remain pervious, allowing rain water to percolate naturally.

The impact due to new impervious surfaces will be limited by the high permeability of the surrounding ground surface and the area down slope of the TMT Observatory and Access Way. The existing landforms attest to the high permeability of the area — there are no developed water channels or evidence of overland water flow. As such, the impact associated with localized runoff from new impervious surfaces created by the Project will not be significant. Runoff will dissipate via percolation into surrounding permeable areas.

Lake Waiau, which is located within Pu'u Waiau, is one of the highest alpine lakes in the United States. The lake is about 300 feet in diameter and reaches approximately 7.5 feet in depth at full capacity. It sits at an elevation of 13,020 feet on the southern flank of Mauna Kea. The lake's water is derived primarily from snow melt and precipitation within its directly tributary watershed. Due to the topography of Pu'u Waiau, only surface runoff from within the crater rim can enter the lake. As confirmed by my field observations, this area is about 30 to 35 acres. Lake Waiau is 1.5 miles south of the TMT Observatory site. The TMT Observatory will be on the opposite flank of Mauna Kea from Lake Waiau and will not be in the lake's tributary watershed. In the event that surface runoff during an extreme storm event were to flow off the TMT site, it would move in an opposite direction from the lake. It is not physically possible for such surface runoff to flow to and over the Pu'u Waiau crater rim to enter the lake.

The TMT Project's Batch Plant Staging Area, roughly 3,000 feet upslope of Lake Waiau, is also not located in the lake's watershed. Lake Waiau is approximately 3,000 feet south of the Batch Plant and 285 feet lower in elevation. There is no possibility of such contamination for the reasons explained in the paragraphs below.

Lake Waiau sits in the central depression of Pu'u Waiau, one of a number of eruptive vents near the summit of Mauna Kea. It is surrounded by the ridges of the pu'u which define an enclosed area of about 32 acres. This topographic enclosure makes it physically impossible for surface runoff from other areas, even areas at higher elevation such as the Batch Plant, from entering the lake. The only water that can enter the lake as surface flow is direct precipitation on the two-acre lake itself and runoff from the surrounding and enclosing 30-acre area which comprises the interior of the pu'u.

Additionally, the subsurface volcanic intrusives (dikes) which created Pu'u Waiau form an impermeable base that enables Lake Waiau to be the perennial water feature that it is. On a more permeable base, accumulated rainfall-runoff on the 32-acre interior area of the pu'u would simply drain downward, and no perennial water feature would exist. These near vertical and impermeable intrusives complete its hydrologic isolation. Perched subsurface water from upslope areas, possibly including local runoff from the Batch Plant which has percolated downward, would also be prevented from entering the lake.

Given the physical terrain, there would be no effect of surface runoff from the TMT Observatory site or the TMT Batch Plant on Lake Waiau.

II. Wastewater

I am informed that, in compliance with Comprehensive Management Plan ("**CMP**"), Management Action FLU-7, TMT will install a zero-discharge wastewater system at the

Observatory. *See* Exhibit A- 9. A zero-discharge system means there will be no discharge of any wastewater from the TMT Observatory, including domestic wastewater and mirror washing wastewater, in the summit region. Instead, all wastewater would be collected and transported off the mountain for proper treatment and disposal. Given that no wastewater from the TMT Observatory will be released into the environment at the summit, wastewater would not be an environmental issue for the TMT Project.

III. Groundwater Occurrence

The occurrence of groundwater beneath the summit area is what is referred to in Hawai'i as "high-level," which means that the groundwater is impounded by subsurface geologic structures, such as intrusive dikes, which compartmentalize the groundwater. Although groundwater is the primary source of drinking water in Hawai'i, there are no wells extracting groundwater near the summit. The nearest wells are located approximately 12 miles away in Waiki'i Ranch along Saddle Road. *See* Exhibit A-44 (Demonstratives). Ground elevation at these wells is 4,260 feet above mean sea level (MSL) and the static water level is about 1,280 feet above MSL. The TMT Project's use of a zero-discharge wastewater system means that wastewater will not be released from the TMT Project into the environment and therefore will not percolate into the groundwater at depth below the TMT Observatory.

Furthermore, the composition of Mauna Kea consists of very porous lavas that naturally treat and filter water percolating downward. Any discharge on the summit would be naturally treated and filtered through thousands of feet of the porous lavas, thereby removing any contamination in that discharge by the time it reaches groundwater. Accordingly, contamination of groundwater is very unlikely.

A good example of the effectiveness of this natural filtering phenomenon is the Kahalu'u Shaft in Kona on Hawai'i Island. *See* Exhibit A-44. The horizontal tunnel from which water is derived from the Kahalu'u Shaft sits approximately 800 to 1400 feet below the more than 30 residences that are upgradient of the Shaft. Wastewater from these homes is disposed of in cesspools and septic system leach fields. As the wastewater percolates downward through the unsaturated lavas to finally reach the basal lens below, a natural treatment process occurs such that there is no evidence of wastewater contamination in the drinking water pumped from the basal lens by the Kahalu'u Shaft.

As such, there is no reasonable prospect of the TMT Project adversely impacting groundwater.

IV. Level of Impact

In light of the foregoing, the TMT Project will not have a significant or adverse impact on water resources, including Lake Waiau and the underlying groundwater.

[*Remainder of page intentionally left blank. Signature page follows.*]

DATED: Honolulu, Hawai'i, October 11, 2016

Tom Nance
President, Tom Nance Water Resource Engineering