APPENDIX C. EXISTING ASTRONOMY FACILITIES

UH 2.2-meter Telescope
This decade of activity started with the first operations of the UH 2.2-meter Telescope in 1970. This optical/infrared telescope was one of the first in the world to be fully computer-controlled. This telescope is used for a wide range of observing programs and is an essential component in the Institute's graduate teaching program. Observations on the telescope are typically conducted by principal investigators associated with the University of Hawai'i.

Canada-France-Hawaii Telescope
In 1972, the French national agency responsible for research in astronomy chose Mauna Kea as the site for their nation's major telescope. An agreement was reached between UH and government agencies in Canada and France to cooperate in a joint venture to develop a 3.6-meter optical/infrared telescope. The Canada-France-Hawai'i Telescope (CFHT) became operational in 1979. Headquarters for the CFHT were developed in Waimea.

Infrared Telescope Facility
In 1973, NASA applied to the State to construct an infrared telescope on Mauna Kea. The 3-meter Infrared Telescope Facility (IRTF) was completed in 1979 to provide infrared observations in support of NASA's programs. It is the only U.S. national observatory dedicated to infrared astronomy and half of the observing time is reserved for studies of solar system objects. The IRTF is managed and operated by the UH Institute for Astronomy under contract to NASA.

United Kingdom Infrared Telescope
Like the IRTF, the United Kingdom Infrared Telescope (UKIRT) is designed for studies of cooler celestial objects such as planets and developing stars. With a 3.8-meter mirror, UKIRT is the world's largest telescope dedicated solely to infrared astronomy. Since it was first developed, several upgrades have been made on the telescope instrumentation to improve observation performance. Funded by the British government, UKIRT is operated, along with the James Clerk Maxwell Telescope, by the Joint Astronomy Centre (JAC), headquartered in Hilo.

Caltech Submillimeter Observatory
The Caltech Submillimeter Observatory (CSO), identified in the 1983 Plan as the California Institute of Technology 10.4-meter Telescope for Millimeter and Submillimeter Astronomy, was assembled and tested in Pasadena, California before being shipped and reassembled on Mauna Kea. At the time, submillimeter wavelength astronomy was an emerging field which promised to greatly complement traditional optical/infrared astronomy. The 10.4 meter telescope, dedicated in the Fall of 1986, is one of the easiest to use submillimeter telescopes and has been a leading edge facility for instrumentation development. It is located in "Millimeter Valley" near the James Clerk

Maxwell Telescope (JCMT) and sometimes participates in short baseline interferometry with the JCMT. The telescope is operated by Caltech under a contract from the National Science Foundation. Headquarters for the CSO are located in Hilo.

James Clerk Maxwell Telescope
The James Clerk Maxwell Telescope (JCMT) is a 15-meter submillimeter telescope operated by the Joint Astronomy Centre (JAC) for science organizations in the United Kingdom, Canada, and the Netherlands. This facility was identified as the United Kingdom/Netherlands 15-meter Millimeter Wave Telescope in the 1983 Plan. One of the goals of this instrument, as explained in the 1983 plan, is to understand the way galaxies have evolved to reach their present condition. The JAC also operates the UKIRT from its headquarters in Hilo. The JCMT is the largest of a new generation of radio telescopes designed to work at submillimeter wavelengths. During observations, the doors to the JCMT are opened and the viewing aperture is covered with a membrane that transmits 80 percent of the incident submillimeter radiation but reflects most of the incident Solar heat. Because of this, the telescope can be used during the day and may even look directly at the Sun.

The JCMT began operations in 1987 and has been used to study the Sun, comets, planets, molecular clouds, galaxies, quasars and cosmic background radiation. The telescope has been successful in mapping many star-forming complexes.

Very Long Baseline Array
The Very Long Baseline Array (VLBA) consists of ten identical radio telescopes, each 25 meters in diameter, spread across the United States from Hawai‘i to the U.S. Virgin Islands. A small staff of technicians operate Hawai‘i facility. The Operations Center for the entire array is located in Socorro, New Mexico. The Mauna Kea component of the VLBA was completed in 1992. Located far below the identified telescope siting areas, the VLBA was not a component of the 1983 Complex Development Plan. An amendment to the 1983 Plan was prepared in 1988 to allow development of this facility. The radio telescope is located east of the Access Road at approximately the 12,200 foot elevation level. The site, located between two *pu‘u*, was selected because it is shielded from radio-frequency interference (RFI) in most directions. It was also placed at the lower elevation because there was no scientific advantage to having it much higher than the tropical inversion layer and snow loading at the summit would be problematic. The VLBA is used to observe galaxies, quasars, and gravitational lenses, and can be combined with other telescopes around the world. The antenna is operated remotely 24 hours a day by the national Radio Astronomy Observatory and is funded by the National Science Foundation. Support staff on island work on day-to-day technical issues at the antenna.

W.M. Keck Observatory
Envisioned in the 1983 Plan as the University of California 10-meter Telescope, the W. M. Keck Observatory (Keck I) was completed in 1993. Beyond specifically-defined facilities, the 1983 Plan anticipated proposals for two additional 10-meter class

telescopes. Subsequently, NASA joined the Keck team and a second10-meter telescope, Keck II, was constructed. The second of the twin telescopes began operations in 1996. The largest optical and infrared telescopes in the world, each mirror is composed of 36 hexagonal segments that work together as a single piece of reflective glass. The observatory is operated by the California Institute of Technology, the University of California, and NASA. Astronomers perform much of their research, including remote observing during the night, and sleep at the Keck headquarters in Waimea. Electronics and adaptive optics laboratories and maintenance facilities are also included in the Waimea complex.

The large size of the telescope's mirror is significant in that it allows more light to be collected. This makes it possible to observe faint objects far away, allowing scientists to look farther back to the beginning of time. The Keck telescopes are also used in with the Hubble Space Telescope for detailed exploration of the deep images taken from. This collaboration between ground-based and space-based telescopes will continue as both types of astronomy serve distinct scientific purposes and together can be more powerful than each alone.

Gemini North

Gemini Northern, an 8-meter optical/infrared telescope, will see its first light in 1999. What ultimately has become Gemini North was first identified in the 1983 Plan as the National New Technology Telescope (NNTT). The NNTT was originally conceived as a 15-meter telescope funded by the US federal government. Over time the project evolved to comprise two smaller telescopes funded and operated by an international partnership which includes the United States, United Kingdom, Canada, Argentina, Australia, Brazil, and Chile. The Gemini North telescope on Mauna Kea is complemented by an 8-meter Gemini telescope in Chile in the Southern Hemisphere. Headquarters for the international project have recently opened in Hilo. Complete sky coverage will be available from the two telescopes. The telescopes are designed to exploit the best image quality allowed by the Earth's atmosphere at these sites.

Subaru

Site work for the Japanese National Large Telescope began on Mauna Kea in 1992. This telescope was generally described in the 1983 Plan as a 10-meter class optical/infrared that had not been specifically identified. It is the first large Japanese scientific instrument to be located at an overseas site. The optical/infrared telescope, called Subaru after the Japanese word for the star cluster Pleiades, has a 8.3-meter diameter mirror made from a single piece of glass. Subaru telescope gathered its first light in 1999 and will be in full operation in the year 2000. Scientists plan to use Subaru to study immensely bright but distant quasars and to image individual planets around other stars. While recent observations at other telescopes have indicated the presence of far away planets, no planet outside of our solar system has been imaged directly.

Submillimeter Array

The Submillimeter Array (SMA) is a collaborative project between the Smithsonian Astrophysical Observatory and the Institute of Astronomy and Astrophysics in Taiwan. The SMA is an instrument designed for high resolution observations at submillimeter wavelengths. The SMA will improve angular resolution by a factor of ten over single facilities such as CSO and JCMT. The SMA's four primary areas of research will be star formation, structure of galaxies, quasars and active galactic nuclei, and solar system studies. Twenty-four antenna pads will host varying configurations of up to 12 antennas. The antennas are transportable using a specially designed carrier. The SMA will begin operations in 2000. The SMA represents the major radio facility foreseen in the 1983 plan. As that time, this was expected to be a 25 m single-dish facility somewhat smaller than the VLBA antenna. Because of technological advances in radio astronomy in the late 1980's, the focus for submillimeter astronomy switched from single-dish instruments to interferometer arrays.