Appendix B. Construction Plan

This Construction Plan covers the three Project components to be built within the Conservation District: (1) the Access Way, (2) the TMT Observatory, and (3) utility extensions and upgrades. It outlines the anticipated construction schedule and the methods to be employed to complete the work are also described.

The contractor(s) selected to build the TMT Observatory and Access Way will be required, in its contract documents, to comply with the mitigation measures outlined in the Final EIS. This will entail complying with (and in some cases preparing) the following:

- Reporting Plan. A Reporting Plan will be developed by TMT and their contactor and implemented in coordination with OMKM to provide information from construction activities to OMKM. This plan and its implementation will comply with CMP Management Action C-4.
- Project-specific Safety and Accident Prevention Plan. TMT‟s contractor will prepare this plan.
- Cultural and Archaeological Monitoring Plan. A draft of this plan is provided as a component of the Draft Historic Preservation Mitigation Plan (Appendix A of the TMT Project Management Plan). This plan will be refined as the design and schedule for TMT construction is finalized; the plan will then be submitted to SHPD for review and approval. The plan requires an independent construction monitor who will have oversight and authority to insure that all aspects of ground based work comply with protocols and permit requirements. This plan and its implementation will comply with CMP Management Actions C-1, C-5, and C-6 plus HAR section 13-279.
- Cultural and Natural Resources Training Program. This program will be developed by OMKM in coordination with TMT and other stakeholders. Construction workers will be required to receive annual cultural and natural resources training in compliance with CMP Management Actions C-7 and C-8.
- Invasive Species Prevention and Control Program. This program is described in Section 1.6 below and will be further refined by TMT and their selected contractor in coordination with OMKM. This plan will comply with CMP Management Action C-9.
- Waste Minimization Plan. TMT‟s contractor will prepare this plan as it relates to the construction phase of the Project.
- Ride-Sharing Program. TMT‟s contractor will prepare the construction phase part of this plan based on the framework provided in Section 3.15.2 of the Final EIS.
- Fire Prevention and Response Plan. TMT‟s contractor will prepare this plan based on the framework provided in Section 3.15.2 of the Final EIS, if applicable.
- Rock Movement Plan. TMT and their contractor will prepare this plan in coordination with OMKM based on the framework provided in Section 1.2.1 below. This plan will comply with CMP Management Action C-3.

- National Pollutant Discharge Elimination System (NPDES) permit. The Project will obtain a Notice of General Permit Coverage (NGPC) for general construction activities. The contractor will prepare a Site-Specific Best Management Practice (BMP) plan and submit it to the State of Hawai„i Department of Health (HDOH) for review prior to construction. The BMP plan will include a Materials Storage/Waste Management Plan and Spill Prevention and Response Plan; the plan will include measures outlined in Sections 3.15.1 and 3.15.2 of the Final EIS, including measures related to Erosion and Water Quality, Solid and Hazardous Materials and Waste, Air Quality and Lighting, and Additional Disturbance and Encroachment. This permit and component plans will comply with CMP Management Action C-2.
- Noise permit and noise variance. TMT"s contractor will obtain and comply with both a noise permit and a noise variance, as applicable.
- Oversize and Overweight Vehicles Permit (OOVP). TMT"s contractor will obtain and comply with an OOVP, as applicable.

1.1 Schedule

The conceptual Project construction schedule is presented in Table B-1. Project construction could begin as early as 2011 and take approximately seven years to complete.

Table B-1: Anticipated Construction Timeline

Phase	Start	End
Grading and foundation	2011	2013
Access Way	2011	2012
TMT Observatory 13N Site grading	2011	2012
TMT Observatory foundation	2012	2013
Electrical upgrades	2012	2012
Observatory construction	2012	2017
Dome assembly (exterior cranes active)	2013	2015
Internal telescope assembly	2015	2017
Support building construction (including foundation)	2015	2017
Observatory finish	2015	2017
Batch Plant Staging Area restoration/naturalization	2017	2017
Telescope/instrument testing	2017	2018

Source: TMT Observatory Corporation, July 17, 2010.

Drawings illustrating the construction phasing are provided in Attachment A.

Construction activities will take place 12-15 hours a day, seven days a week; however, work times will vary depending on activities and some special operations or construction phases will require longer work hours. Winter weather conditions at the TMT Observatory site will interrupt construction at times, until the dome is completed.

1.2 Grading, Underground Utilities, and Foundation

This section discusses ground level and underground construction activities. The grading of the Access Way and TMT Observatory will take place first, followed by TMT Observatory foundation work. Plans, which illustrate proposed changes in contours, are included in Attachment B.

1.2.1 Rock Movement Plan

Project construction will require the excavation of rock from the TMT Observatory site and along the Access Way. Along the Access Way, the need to excavate rock is primarily governed by the need to generate a smoothly sloping road and the need to bury utilities within the Access Way. At the TMT Observatory site, excavation is necessary to prepare a level work surface plus place a foundation for the telescope and the observatory dome. TMT and their contractor will prepare a Rock Movement Plan prior to construction in compliance with CMP Management Action C-3 and submit it to the Office of Mauna Kea Management (OMKM) for review and approval. The Rock Movement Plan will detail excavation and grading activities.

Preliminary engineering plans indicate that the total volume of excavated material ("cut" material) will be 64,000 cubic yards. These preliminary engineering plans, which illustrate proposed changes in contours, are included in Attachment B. The estimated cut and fill volumes are based on geotechnical assumptions concerning the subsurface in the area and could change following the completion of geotechnical borings. As summarized in Table B-2, roughly 32,000 cubic yards of the cut material will be reused at the TMT Observatory site or Access Way. An estimated 32,000 cubic yards of material will be excess cut and will be used to provide some restoration of the Batch Plant Staging Area and a portion of which will be stored at a location designated by OMKM for use as determined by OMKM. By using most of the material on the TMT Observatory site and Access Way, that material will be available for later use to restore the TMT Observatory site and the portion of the Access Way exclusively used by TMT during decommissioning.

Table B-2: Estimated Cut and Fill Volumes

Site	Cut (cubic yards)	Fill (cubic yards)
TMT Observatory 13N site	34,000	29,000
Access Way	30,000	3,000
Batch Plant Staging Area	None	30,000
Saved for OMKM Use	NA	2,000

Source: TMT Observatory Corporation, July 17, 2010.

No soil or cinder that originates off the mountain used as fill within the Conservation District. Some courser material from on-island quarries will be transported to the TMT Observatory site and used under concrete foundation slabs as "base course". Aggregate from on-island quarries will also be used to make the foundation concrete.

1.2.2 Batch Plant

TMT will re-establish a temporary concrete batch plant at the previously utilized "Batch Plant Staging Area". Prior to utilizing the Batch Plan Staging Area, the site will be cleared of invasive species to the extent practicable, if any are observed by a biologist inspecting the area prior to use. Best management practices (BMPs) will also be installed to (a) limit the potential for the later establishment of invasive species; (b) limit the production of dust and mud; (c) limit and control stormwater run-on, runoff, and quality; and (d) prevent disturbance of undisturbed areas beyond the previously disturbed batch plant area.

The batch plant will be required to produce roughly 5,900 cubic yards of concrete for the TMT Observatory foundations. As discussed above, this volume is an estimate based on geotechnical assumptions concerning the subsurface in the area and could change following the completion of geotechnical borings.

No mass grading of the Batch Plant Staging Area is planned prior to use of the site as a batch plant other than the storage of excess material from the TMT Observatory site and Access Way within the area. The stored material will be placed such that the entire Batch Plant Staging Area can be utilized (i.e., it will be graded and compacted after placement so that it can be driven over rather than left in a pile). The Project will utilize the area using a layout similar to that used by previous projects that utilized the area as a batch plant. During the Project‟s use of the Batch Plant Staging Area there will be temporary stockpiles of soil and rock, a concrete batch plant, and construction materials staged within the area.

Once the Project‟s use of the Batch Plant Staging Area is complete, the stored excess material will be regraded. The excess material will be utilized to restore/naturalize the Batch Plant Staging Area to the degree practicable. A portion or all of the excess material will be spread over a portion of the Batch Plant Staging Area in such a way as to create a rough, more natural surface that could not be driven over. Some of the excess material may be left in a stockpile within the Batch Plant Staging Area depending on OMKM‟s desires. This restoration of the Batch Plant Staging Area would reduce the size of the Batch Plant Staging Area that could be used for parking and other uses following the construction of the TMT Observatory; however, the restored area could be temporarily reclaimed as a staging area by future projects, if needed.

1.2.3 Access Way

The Access Way has two distinct sections (1) the southernmost portion where the Access Way will follow existing roads on cinder, and (2) the rest of the Access Way where it will primarily follow existing roads on lava flows. These two sections are discussed below.

Southernmost Cinder Section

Generally, grading along the Access Way will be performed to achieve a smooth and level travel surface. In the cinder section, the existing 4-wheel drive road (the "jeep trail") travel surface has degraded over the years and no longer provides a level travel surface. Where the Access Way occurs on the cinder lower slope of Pu„u Hau„oki, the Access Way features will be as illustrated in Figure B-1 – a 12 foot wide paved travel way (1 lane), a four foot paved shoulder with drainage channel and guardrail, and slope graded to 2.5:1.

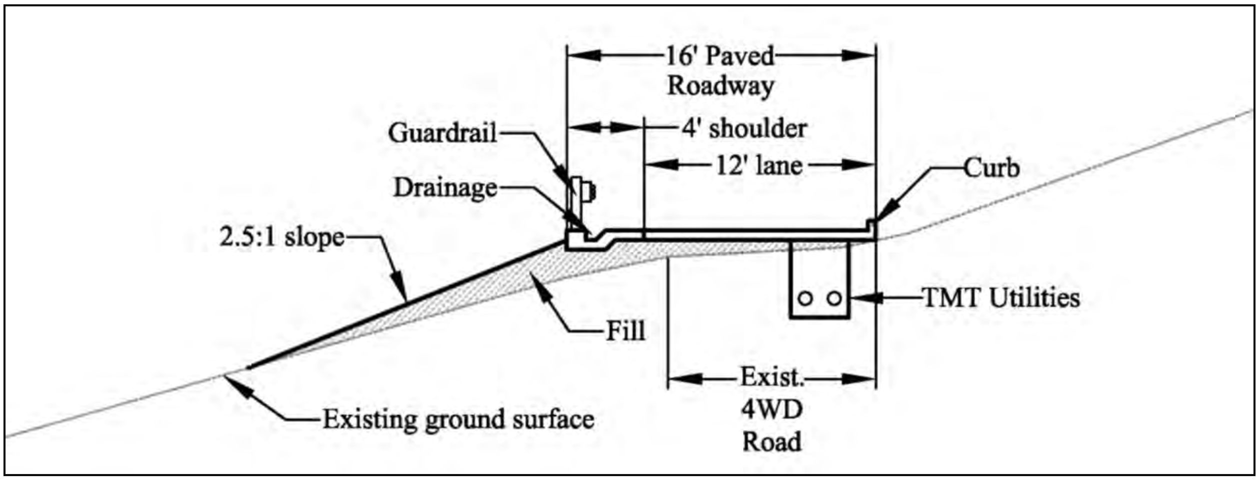


Figure B-1: Cross Section of Access Way in Southernmost Cinder Section Overlapping 4-Wheel Drive Road

Lava Flow Section

Generally, grading along the Access Way will be performed to achieve a smooth travel surface. In the lava flow section the Access Way will follow an existing SMA road and the 4-wheel drive road through Area E. Although the SMA road already provides a smooth travel surface, grading will be done to raise the grade of the travel surface in order to protect the SMA utilities under the roadway, as illustrated in Figure B-2. During early construction activities when sufficient material has not been cut to install the 18-inch cushion over the SMA utilities as shown in the figure, steel plates will be used to cover and protect the SMA utilities until sufficient material is available.

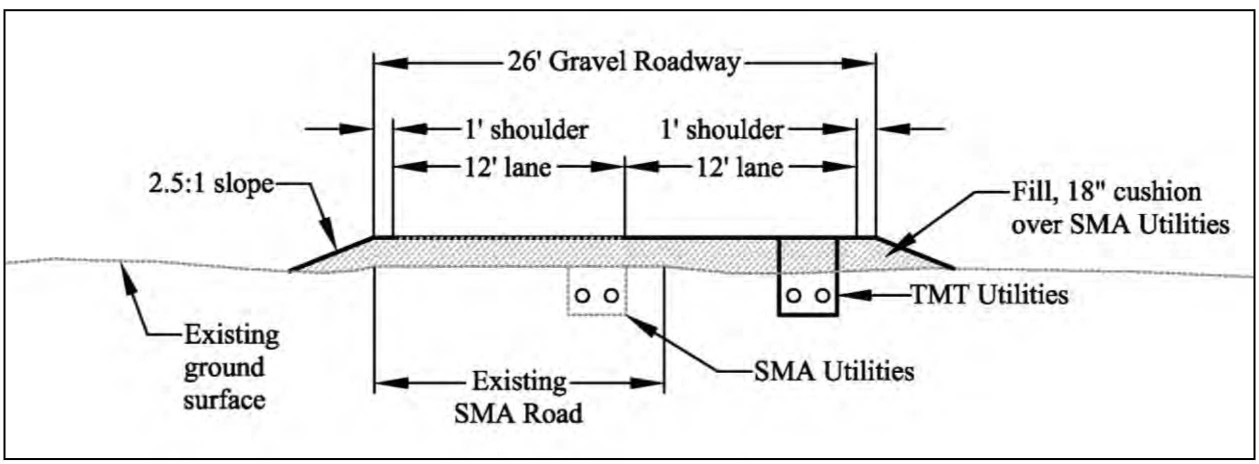


Figure B-2: General Cross Section of Access Way in Lava Flow Section Overlapping SMA Road

In addition to the steps discussed above to protect the SMA utilities where the SMA utilities and TMT utilities run parallel to each other, additional measures will be taken where they cross. They will cross at two points – (1) where the SMA road branches to a SMA pad on the east side of the SMA Area near where the Access Way comes off the cinder cone, and (2) where the SMA road and the 4-wheel drive road split. At those locations additional measures will be taken to protect the SMA utilities, including the use of steel plates and additional cushion so that the TMT utilities can cross over the SMA utilities but still provide the necessary cover over the TMT utilities.

The 4-wheel drive road portion in the cinder cone section will have to be graded to a greater extent because it is not straight and the slope changes dramatically. Throughout the lava flow section, the Access Way features will be as illustrated in Figure B-3 – a 24 foot wide gravel travel way (two lanes), one foot shoulders, and slopes graded to 2.5:1. The slopes beyond the shoulder of the Access Way will vary depending on the topography and steeper embankment slopes may be used depending on geotechnical conditions encountered.

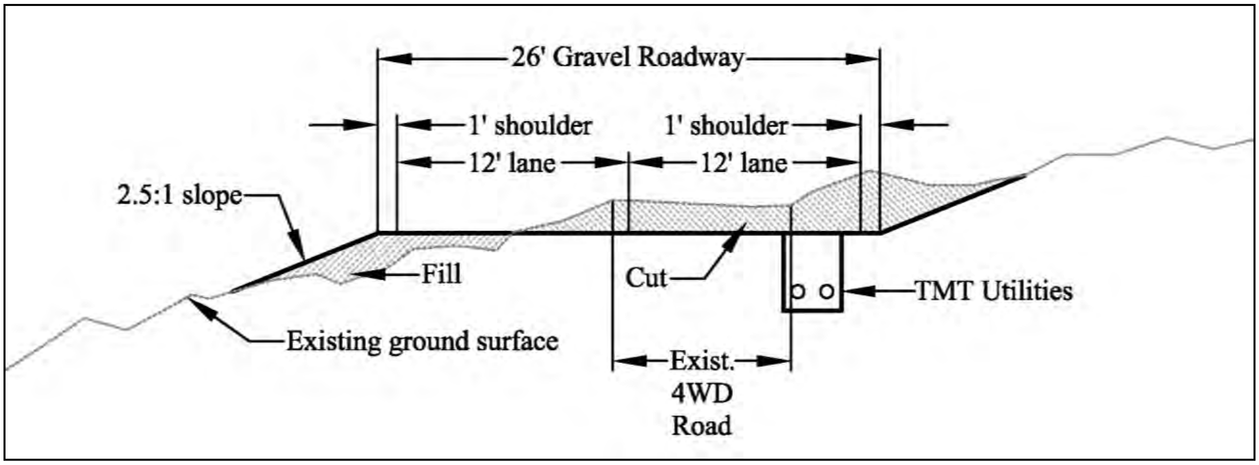


Figure B-3: General Cross Section of Access Way in Lava Flow Section Overlapping 4-Wheel Drive Road

Utilities

A trench for electrical and communications lines will be excavated along the Access Way on one side of the road as illustrated in Figure B-1, Figure B-2, and Figure B-3. The conduits will be encased in concrete per governing code requirements. Excavated material will be used to raise the Access Way road surface where required to improve grades on the road and to provide a smooth and level driving surface where a rough surface from excavation will otherwise be exposed.

1.2.4 TMT Observatory

The limits of grading activities (the area that will be affected by the cut and fill), the existing contours, and proposed contours at the TMT Observatory 13N site are shown in Figure B-4. Grading and foundation details are illustrated on preliminary plans included in Attachment A and B.

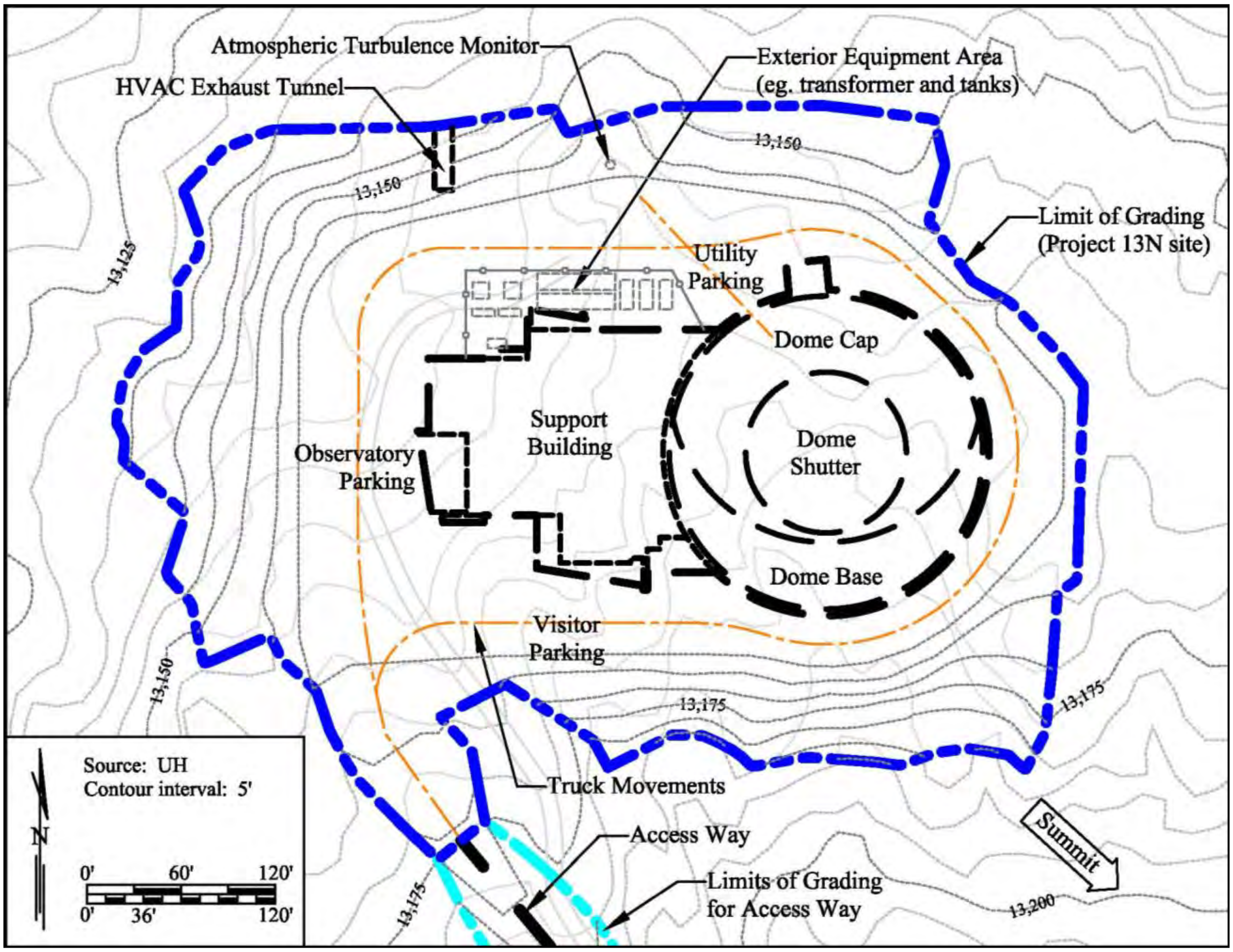


Figure B-4: TMT Observatory 13N Site Grading Plan

The construction at the TMT Observatory site will start with the rough grading of the 13N site, followed by the excavation for foundations, as depicted in the construction sequence drawings provided in Attachment A.

The TMT pier foundation will consist of a continuous, circular outer wall shallow concrete spread footing that will bear on the soil at a depth of approximately 20 feet below the finished floor grade. There will be a central shallow concrete pad for a pintle bearing, used to hold the center of rotation of the telescope in place when at rest, that will bear on the soil at a depth of 16 feet below finished floor grade. The central shallow concrete pad will be connected to the telescope pier outer wall and footing with six radial concrete spokes. A utility tunnel bearing on the soil at a depth of 21.5 feet below the finished floor elevation will connect the telescope pier with the mechanical equipment room on the utility level of the support building. A utility tunnel for venting warm air from the mechanical room out to the north side of the site will bear on the soil at a depth of 21.5 feet below the finished floor elevation.

The dome foundation will be shallow continuous spread footings bearing at a varying depth of 6 to 10 feet below finished floor grade, depending on the depth of original rock. Floors will be concrete slabs-on-grade bearing on a six-inch layer of material obtained from excavated (cut) material. Some utility piping and conduit will be located below the concrete floor slabs.

The support building foundation will consist of shallow spread footings bearing at approximately 6 feet below the finished floor grade. Floors will be concrete slabs-on-grade bearing on a six-inch layer of material obtained from excavated (cut) material.

An electrical grounding system will be installed in the excavations for the dome and support building foundation footings. Beneath the dome footings, the grounding system will consist of a grid of #3/0 cables (10 feet by 10 feet cable grid spacing) will be placed prior to pouring the concrete. Beneath the support building footings, the ground system will consist of #3/0 cables placed at the bottom of the excavations prior to pouring concrete.

1.2.5 Utilities

As discussed in Section 1.2.3, electrical and communication utilities exclusively for TMT will be located under the roadway in the Access Way. Underground utilities from the HELCO electrical substation to the switch boxes near the SMA building (which are shared with other uses in the summit region), will also be upgraded. This activity will include the replacement of existing conductors in existing conduits. In order to avoid interruption of services to current observatories and uses in the summit region, this work will be performed using the following steps:

- Transition all existing electrical loads to one of the two existing transformers and conductors.
- Remove and properly dispose/recycle the unused transformer and conductor.
- Install a new, larger-capacity transformer within the HELCO compound and conductor in the recently vacated conduit.
- Transition all electrical loads to the new transformer and conductor.
- Remove and properly dispose/recycle the unused transformer and conductor.
- Install a new, larger-capacity transformer within the HELCO compound and conductor in the recently vacated conduit.
- Allocate the electrical loads between the two transformers and conductors as appropriate.

The removal and replacement of the transformers is discussed in Section 1.3.4. The removal and replacement of the conductor will be done by accessing the handholds along the conduit, which is within a 20-foot wide HELCO electrical easement within the Mauna Kea Forest Reserve, Mauna Kea Ice Age NAR, and MKSR. The handholds are spaced roughly 300 feet apart for the length of the conduit and will be accessed only by driving along the utility easement.

1.3 Above Ground Construction

Following foundation work, the dome, telescope, and support building will be built. All buildings and structures with indicated use, including floor plans, are illustrated on preliminary design plans in Attachment B. Table F-3 summarizes the buildings to be constructed at the TMT Observatory 13N site.

Table F-3: Summary of Buildings

Project Component	Gross Floor Area (square feet)	Net Floor Area (square feet)	Height (feet above finished grade)
Observatory Dome	34,304	31,400	26.5 (fixed enclosure) 183.7 (top of dome)
Support Building	18,376	15,961	26

Source: TMT Observatory Corporation, July 17, 2010.

1.3.1 Dome Construction

Crane Selection Process

Prior to determining how the dome would be built, the equipment that would be used to build it had to be selected. The biggest consideration is what type of crane will be used. Three crane options were considered: gantry type, tower type, and crawler type cranes.

The pros and cons of each viable option are outlined in Table B-4. Based on the review performed, a 300-ton crawler crane, in combination with a 200-ton assisting crawler crane, was selected to be used to erect the dome.

Table B-4: Crane Option Pros and Cons

Crane Option	Pros	Cons
Gantry Crane	• Can be custom-designed to take construction loads and wind loads and meet project specific needs with additional built-in safety redundancy. • Possibility with variation to lower crane when storms are forecast.	• Requires track and foundations be installed, which would be complex as it would have to be circular due to site restrictions. • Requires assist crane to erect and dismantle. • Need additional clearance around enclosure so there is space between gantry rail and the dome to transport large pieces. This would require a larger flat area around the dome and, therefore, result in a larger area of impact to the environment. • Serious safety issues with lifting large pieces right next to the crane supports, as these could collide with the crane during windy conditions. This could be mitigated by using widely spread columns; however, this would increase the impact to the environment.

Crane Option	Pros	Cons
Tower Crane	• Quick set up and erection time for this option. • Has the option of one tower crane in the center in order to perform all lifting operations from one point. • Has the option of having the crane on a track around the enclosure so the crane can maneuver. • Some tower cranes have been rated to work at 45 mile-per-hour winds. These are readily available.	• Additional cost and labor impacts for having an assist crane with enough boom and capacity to erect and dismantle the tower crane. • Cannot erect the whole enclosure using this option. An assist mobile crane with enough boom and capacity has to be used to install the shutter plug. • Has to be set up permanently and cannot be lowered during ice storms. • May not be safe during ice storms with the 40-meter boom hanging out over the enclosure at all times. • Possibility of frequent break downs and seize up of mechanical parts at higher altitudes due to ice storms.
Crawler Crane	• Can be assembled and disassembled without the aid of another crane. • Can maneuver around to perform lifts. • Boom can be readily lowered at the end of every shift and during heavy winds to reduce the risk of tipping due to heavy wind loads. • Main boom and jib can be assembled in various lengths; the boom can be lengthened at various stages to reach higher areas as the job progresses. • Easy access to mechanical parts as most are located near ground behind the operator cab. • Wind charts are available for most crawler cranes to use as guidelines.	• Susceptible to tipping during high wind loads. • Requires ground preparation around the enclosure to take the required bearing load.

After a thorough review, it was concluded that an assist crane with considerable boom reach would be required to erect and dismantle both of the tower crane options. Also, the tower crane option does not provide any advantage in terms of wind safety; the tower crane could be considered even less safe than the crawler crane option since it cannot be lowered during strong winds. This is particularly important at Mauna Kea where strong winds are frequently combined with ice storms, which greatly increases both the weight on the crane structure and the wind cross section. The gantry crane option does not provide any advantage over the crawler crane option, and would require a larger area to be disturbed, increasing the Project impacts to the environment. This leaves the crawler crane option as the preferred crane option for construction of the TMT Observatory at the 13N Site.

Crawler Crane Construction Plan

A Manitowoc 2250 crane with 300 ton lifting capacity in combination with a 200 ton hydraulic assist crane, or similar, will be used to erect the enclosure and telescope structures. The following subsections discuss the construction plan for the crawler crane option at the 13N site, including topics such as site layout and crane maneuvering.

Site Layout and Crane Access

It is envisioned that the crawler crane would be transported to the 13N site via transport trailers and assembled on site. An advantage of this type of crane is that is can be assembled without assistance from a second crane.

The width of the 300-ton crane is approximately 27 feet. The required minimum crane access width is roughly 33 feet around the whole enclosure, and about 40 feet where the crane will be setup for lifting; this yields a minimum clearance of approximately 11 feet between the boom and the enclosure.

Ground preparations must be made to take the full bearing load of the crane out to the 40-foot width in the specified setup areas. The crawler crane has a pressure on the ground of 3,400 psf with no load. With a 45 ton load (the likely maximum during this project), the pressure on the ground is 5,600 psf. Ground preparations to handle this load can be achieved by (1) preparing the soil, but this may not be possible and will only be known once the geotechnical studies have been completed, (2) temporary foundations, or (3) crane mats that spread the load further than the track widths.

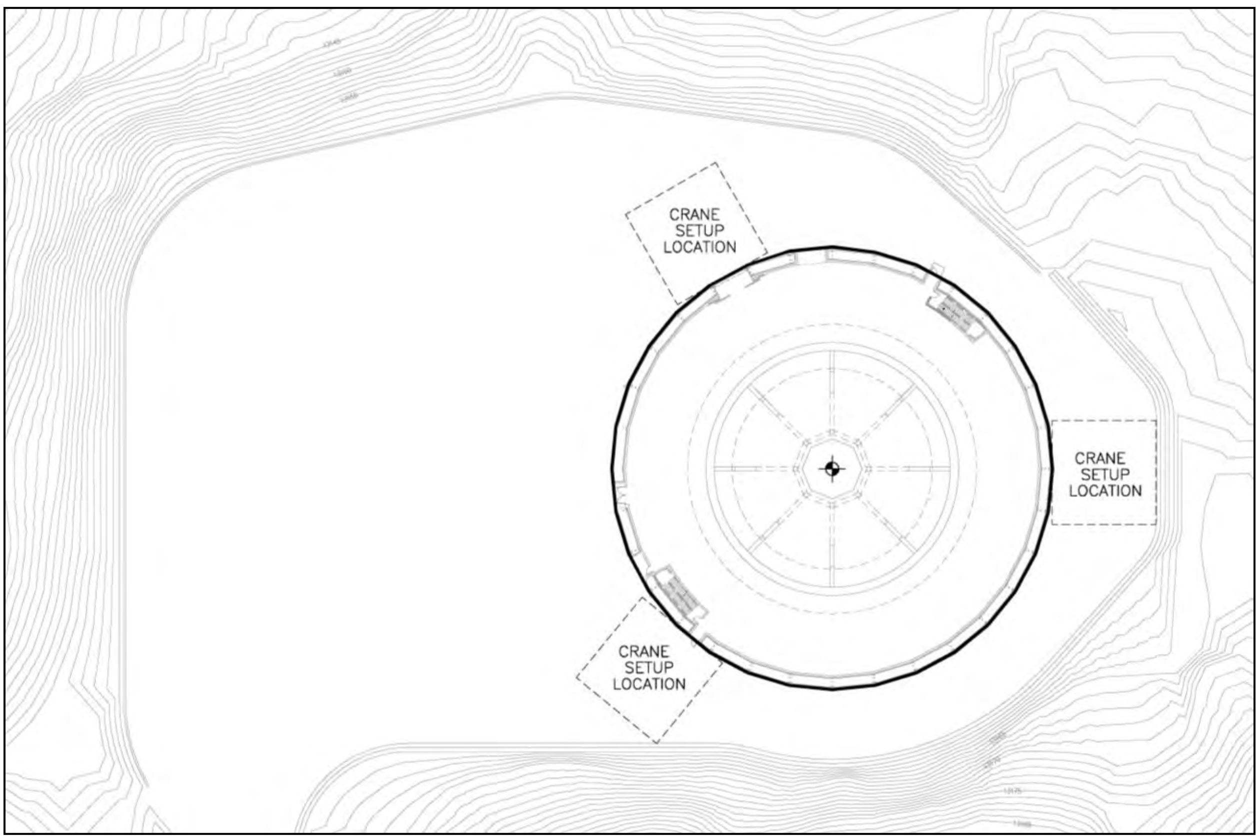


Figure B–5: 13N Site Crane Layout Plan View

As shown in Figure B–5 , the crane will sit at three strategic positions to cover all areas around the enclosure. A good crane layout results in the least number of moves or crane repositions to complete all lifts. Figure B–6 below shows an elevation view layout with the crane next to the enclosure.

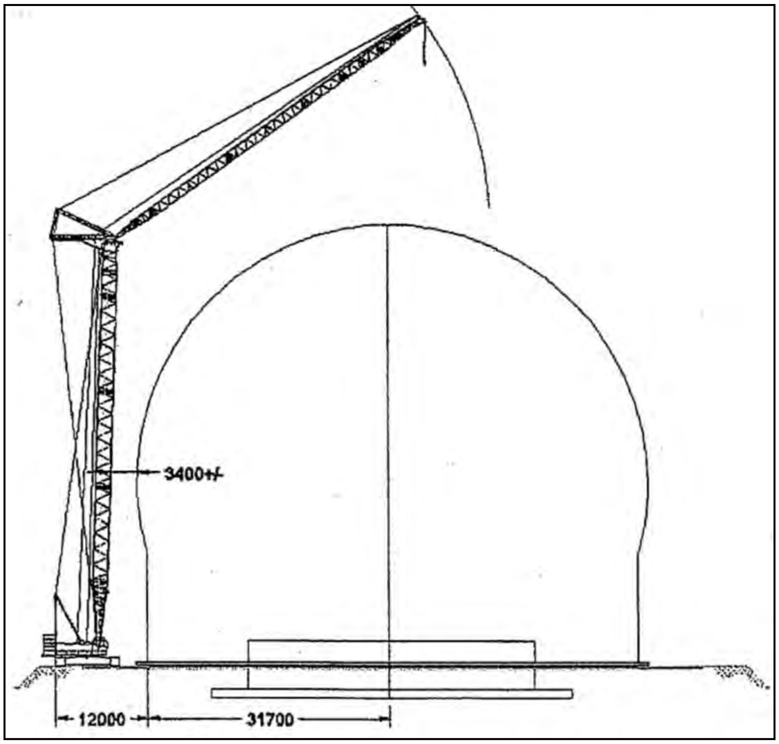


Figure B–6: 13N Site Crane Layout Elevation View
Dimensions in millimeters; 304.8 millimeters = 1 foot.

Figure B–7 below shows the boom lay down scenarios for the crawler crane at the 13N Site.

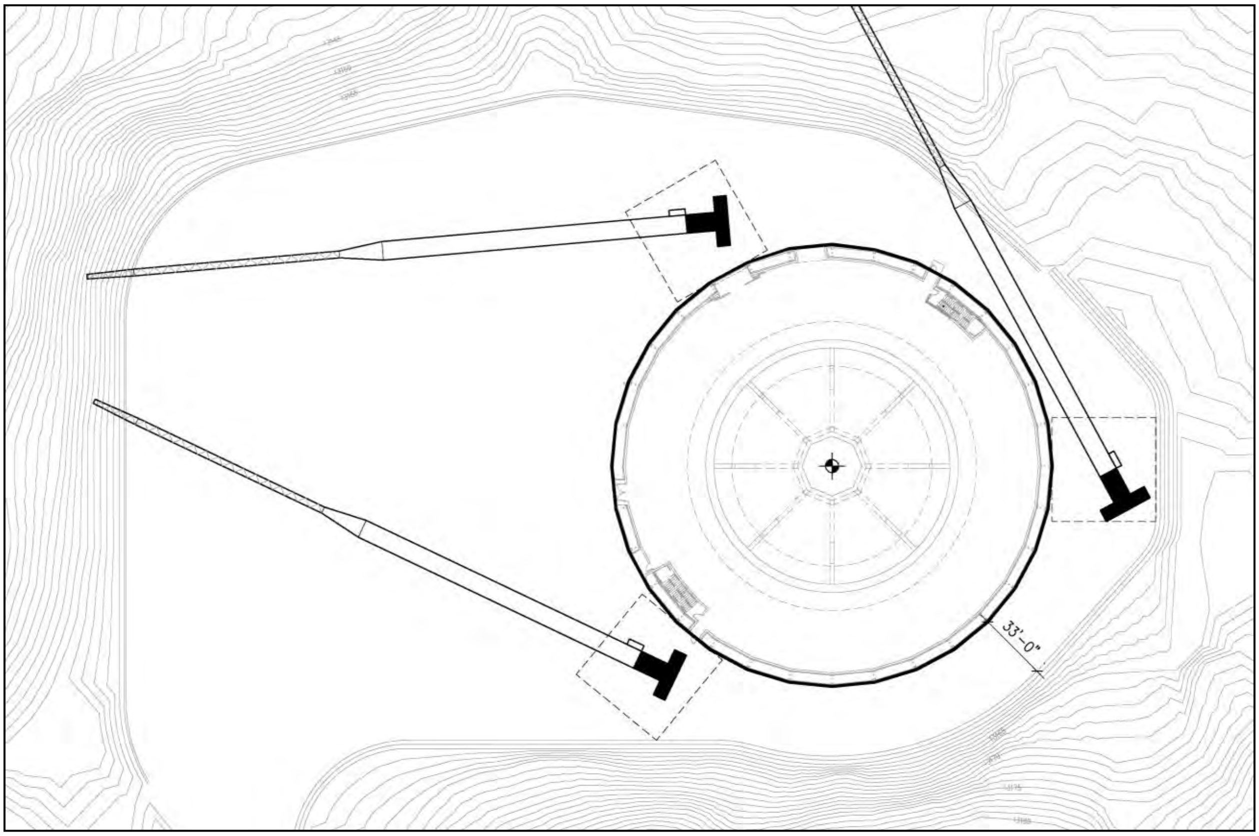


Figure B–7: Crawler Crane Boom Lay Down Scenarios

The enclosure structure will be built in two phases. The first phase involves building the enclosure structure to the point where the enclosure is fully enclosed. The second phase involves all work with regards to the mechanical setup, electrical install, insulation install, commissioning, and testing. Materials staging will be performed in the flat graded areas around the work area; during dome construction this is primarily the area west of the dome.

Crane Maneuvering

The crawler crane can readily maneuver around the site with minimum effort. Repositioning of the crane does not require it to boom down or be dismantled. To move the crane, all that needs to be done is to boom up and move to the desired location. That it requires minimum effort to reposition is another advantage of having a mobile crane onsite.

Observatory Dome Specifications

The dome will be a Calotte type enclosure with the following dimensions:

- Exterior radius: 108 feet (33.0 meters)
- Interior stay-clear radius: 95 feet (29.0 meters)
- Aperture (a.k.a. shutter, door, etc) diameter: 102 feet 6 inches (31.25 meters)
- Aperture pointing: 0 to 65 degrees zenith

- Height of dome center: 75 feet 5-1/2 inches (23.0 meters) above observatory floor elevation

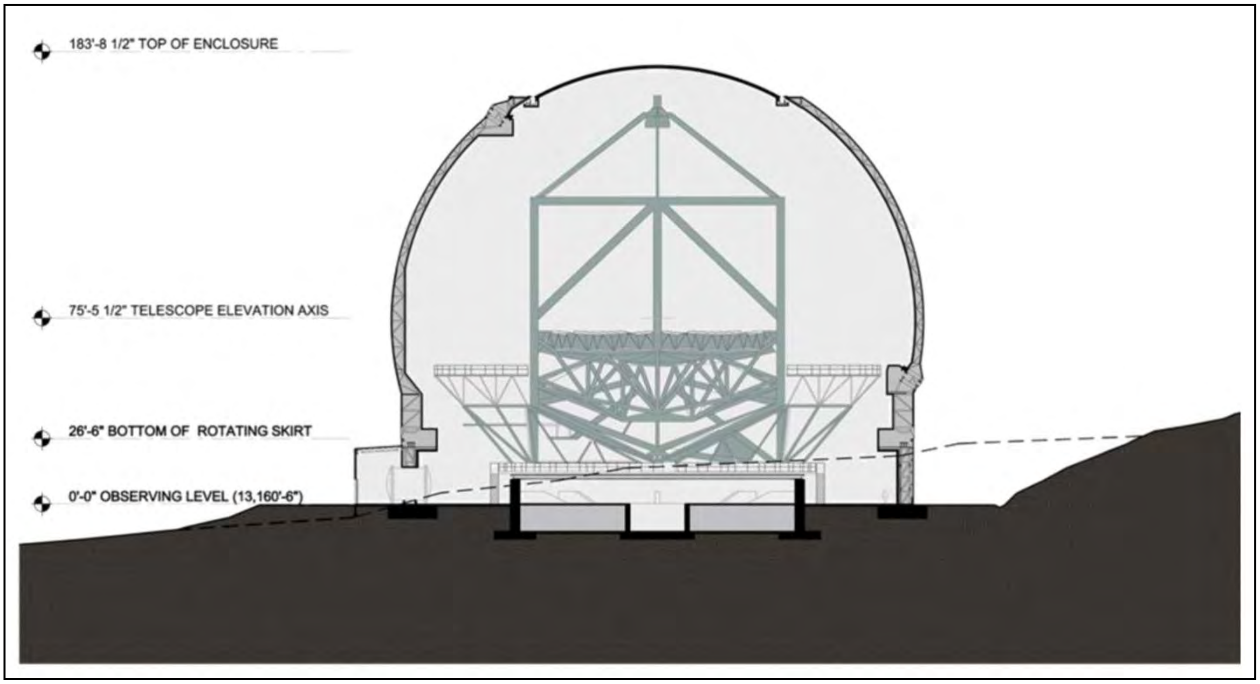


Figure B-8: Rotating Enclosure and Telescope Overview

1.3.2 Telescope Construction

Once the dome has been assembled, the telescope will be built within the dome. The construction will be accomplished by delivering telescope components directly into the dome on trucks and then assembling them using a hydraulic crane working inside the enclosure. The entire telescope structure will have been assembled where it is fabricated to ensure that the pieces fit together properly and will achieve the required tolerances. The telescope structure will then be disassembled and transported to the site in pieces.

The actual mirror surfaces will not be delivered to the site until the support building described in the following section has been completed.

1.3.3 Support Building Construction

Once the large structural components of the telescope have been delivered to the dome and assembled, the construction of the support building will begin. The support building is a relatively standard building and no special construction equipment will be required to build it. All building details with indicated use, including floor plans, are illustrated on preliminary design plans in Attachment B.

Table B-5 summarizes the support building use areas and their respective floor area and Figure B-9 provides a general illustration of the support building floor plan.

Table B-5: Summary of Support Building Areas

Use	Net Floor Area (square feet)
Utility and Mechanical Rooms	9,939
Mirror Cleaning, Coating, Staging	2,072
Computer Room and Laboratory	1,485
Office, Control, Conference, Kitchen Rooms	1,986
Restrooms	276
Visitors Lobby	203
Total	**15,961**

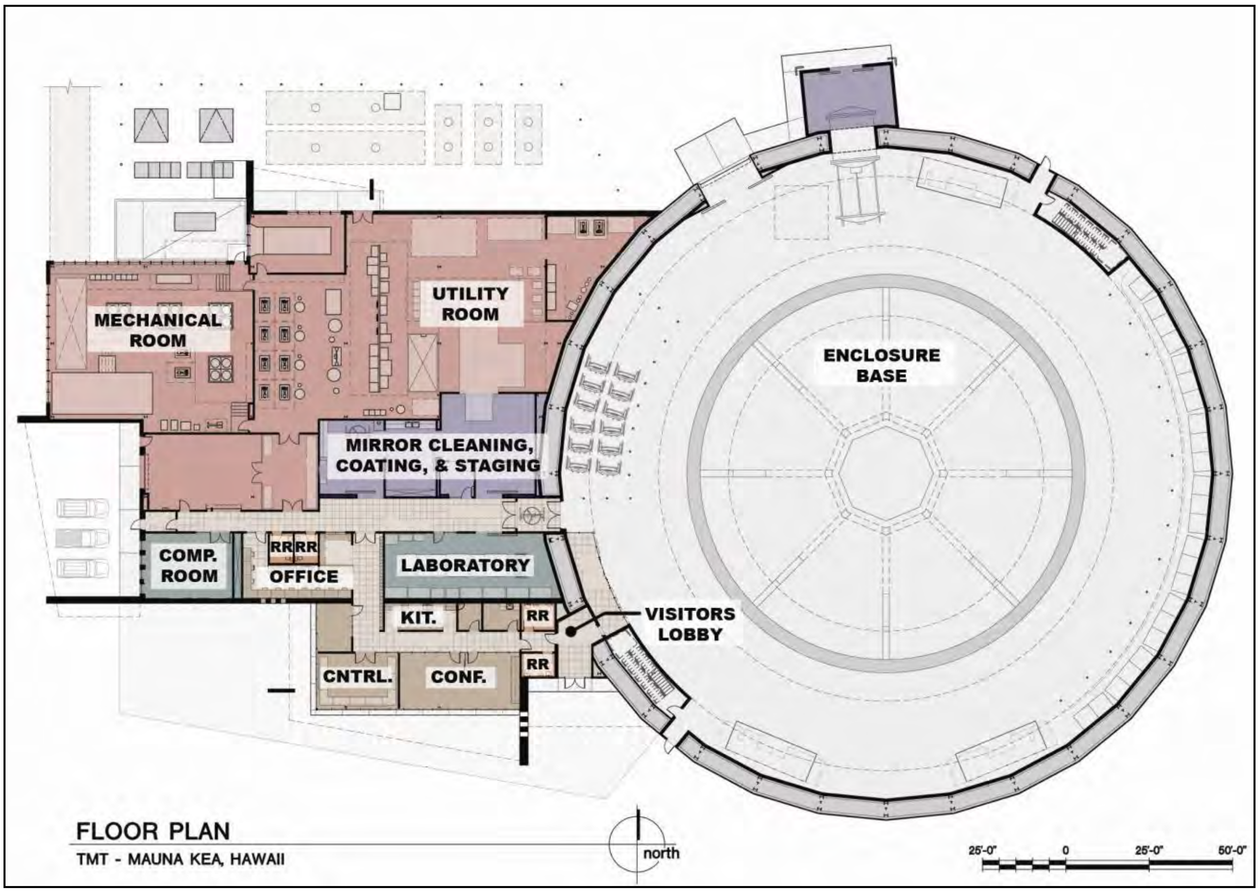


Figure B-9: Support Building Floor Plan

1.3.4 Transformer Replacement

As discussed in Section 1.2.5, the two transformers in the HELCO compound near Hale Pōhaku will be upgraded. The existing transformers will be removed and disposed of properly and new, higher-capacity transformers installed in their former location. This work will be achieved using truck-mounted cranes to position the equipment. The crane will be positioned on the existing roadway just outside the compound fence. Flat-bed trucks will be used to deliver and remove the equipment and will travel on existing roadways.

1.4 Port Staging Area and Transportation to Summit Area

Outside of the Conservation District near the port where materials are received on-island TMT will lease a “Port Staging Area”. The Port Staging Area has not been selected yet. Figure B-10 illustrates a potential Port Staging Area layout. This layout would be modified to fit the site selected but the figure provides an overview of the types of activities that would take place at the Port Staging Area. Prior to utilizing the Port Staging Area, the site would be cleared of invasive species to the extent possible and best management practices (BMPs) installed to (a) limit the potential for the later establishment of invasive species; (b) limit the production of dust and mud; and (c) limit and control stormwater run-on, runoff, and quality.

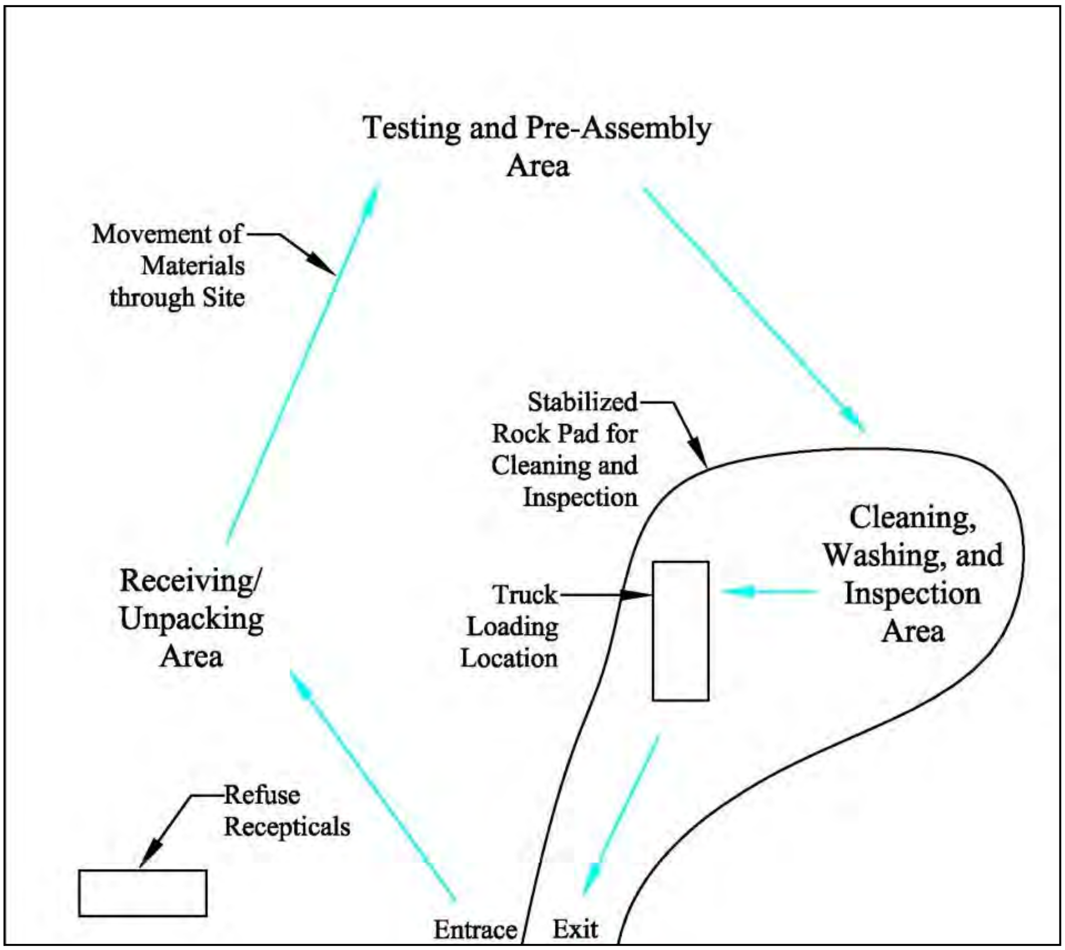


Figure B-10: Potential Port Staging Area Layout

Activities conducted at the Port Staging Area will include:

- Receiving/unpacking area. In this area materials received will be unpacked and excess packaging disposed of.
- Testing and pre-assembly area. In this are materials will be tested for use on the construction site and assembled to the extent possible prior to being transported to the summit region.

- Cleaning, washing, and inspection area. In this area materials and equipment will be cleaned and prepared for transportation to the summit region. Both the materials being transported and the vehicles transporting them will be cleaned and inspected, per the discussion in Section 1.6. Only minimal packing materials will be used.

Materials and equipment transport between the Port Staging Area or other area outside of the Conservation District to the summit region will follow a set route established using the Oversized and Overweight Vehicles Permit (OOVP) process administered by the State of Hawai„i Department of Transportation (HDOT). Transport will be along established paved roads only. Drivers will not be allowed to divert from the route or stop for an extended period or time once cleared to transport materials and/or equipment to the summit region.

1.5 Construction Monitoring in the Conservation District

During all construction related activities in the Conservation District, TMT will comply with CMP Management Action C-1, which calls for an on-site construction monitor who will have authority to order any and all construction activity cease if and when, in the construction monitor‟s judgment, (a) there has been a violation of the permit that warrants cessation of construction activities, or (b) that continued construction activity would unduly harm cultural resources; provided that the construction monitor‟s order to cease construction activities be for a period not to exceed seventy two (72) hours for each incident. A separate draft Cultural and Archaeological Monitoring Plan presented as section of the Draft Historic Preservation Mitigation Plan (Appendix A of the TMT Project Management Plan) spells out the details of monitoring related to cultural resources. These details will be refined as the design and schedule for TMT construction is finalized; the monitoring plan will then be submitted for approval to SHPD. Components of the monitoring plan include:

- Monitors, such as archaeologists, will have the appropriate training and experience, be selected by OMKM and approved by DLNR.
- A trained archaeologist and cultural specialist will be on site to monitor any impacts, real or potential, of construction activities on archaeological and historical resources.
- The trained archaeological cultural specialist will be funded by TMT.

All orders to cease construction issued by the construction monitor will immediately be reported to OMKM and DLNR. The monitoring provisions are consistent with the CMP and previous conditions on CDUPs approved by BLNR.

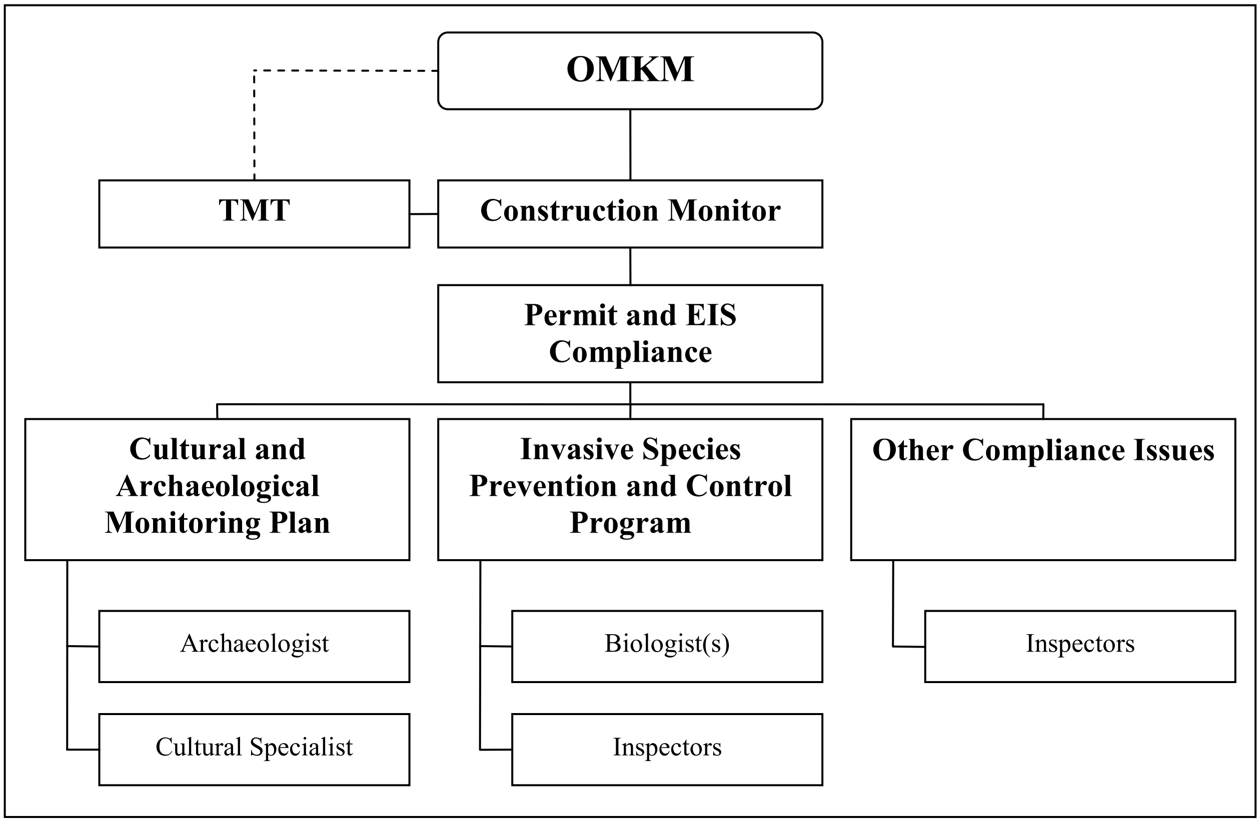


Figure B-11: Construction Monitoring Organization Chart

Likewise, prior to leaving the Port Staging Area or other location outside of the UH Management Area, all construction materials, equipment, crates, and containers carrying materials and equipment which are of substantial size and capable of harboring invasive flora and fauna will be inspected by a trained biologist, selected by OMKM and approved by DLNR, who will certify that such materials, equipment, and containers are free of any and all flora and fauna that may potentially have an impact on the Mauna Kea summit ecosystem. This provision is consistent with the CMP and previous conditions on CDUPs approved by BLNR.

1.6 Invasive Species Prevention and Control Program

This program is described below and will be further refined by TMT and their selected contractor in coordination with OMKM.

Movement of construction materials, earthmoving equipment, and vehicles to the construction areas may introduce non-indigenous weedy flora or invasive fauna pests to the Mauna Kea summit region or Hale Pōhaku. These alien species can out-compete and displace native species and thereby reduce their populations. The CMP requires this potential impact be addressed by new developments. Packaging material will be redone at the Port Staging Area prior to continuing up the mountain. To comply, the Project has developed and will implement an Invasive Species Prevention and Control Program to address this potential impact. Components of the program regarding materials movement during the construction phase include:

- Materials Control and Reduction. All shipments will be repacked at the Port Staging Area so that only essential packing material is used for the final transportation to the construction site. This will reduce the volume of material potentially harboring invasive species, aid inspection, and minimize the waste generated at the construction sites. In addition:
    - Contractors will be required to inspect shipping crates, containers, and packing materials before shipment to Hawai„i.
    - Pallet wood will be free of bark and treated to prevent the transport of alien species.
    - Items that could serve as a food source for invasive species, such as food waste and food wrappers, will be collected separately from other debris and removed from the Mauna Kea summit region construction sites at the end of each day.
- Washing/Cleaning. Materials and clothing will be washed or otherwise cleaned prior to proceeding above Saddle Road. This will be done at lower elevation baseyards, such as the Port Staging Area, and will include:
    - A requirement that everyone brushes down their clothes and shoes to remove invasive plant seeds and invertebrates.
    - A requirement that waste containers be regularly pressure-washed using steam and/or soap to reduce odors that may attract bugs. This will include containers at the Port Staging Area.
    - A requirement for pressure wash-down of all construction vehicles and heavy equipment.
- Inspections. Prior to proceeding to the summit region from the Port Staging Area or other location, all construction materials, equipment, crates, and containers carrying materials and equipment which are of substantial size and capable of harboring invasive flora and fauna will be inspected and certified free of invasive species by a trained biologist, selected by OMKM and approved by the DLNR.

The Invasive Species Prevention and Control Program will be part of project plans and specifications for construction bidding. The implementation of this plan will reduce the potential for accidental introduction of non-indigenous species and reduce the likelihood of adverse impacts associated with invasive species.

1.7 Other Plan Components

There will be no designated open space and recreations areas created as part of the Project.

Landscaping will be restricted to the graded slopes and rock features near the entrance to the TMT Observatory, as illustrated in Figure B-12. There will be no re-vegetation or plantings as part of the Project due to the natural conditions of the site being well above the tree line.

Figure B-12: Proposed Landscaping

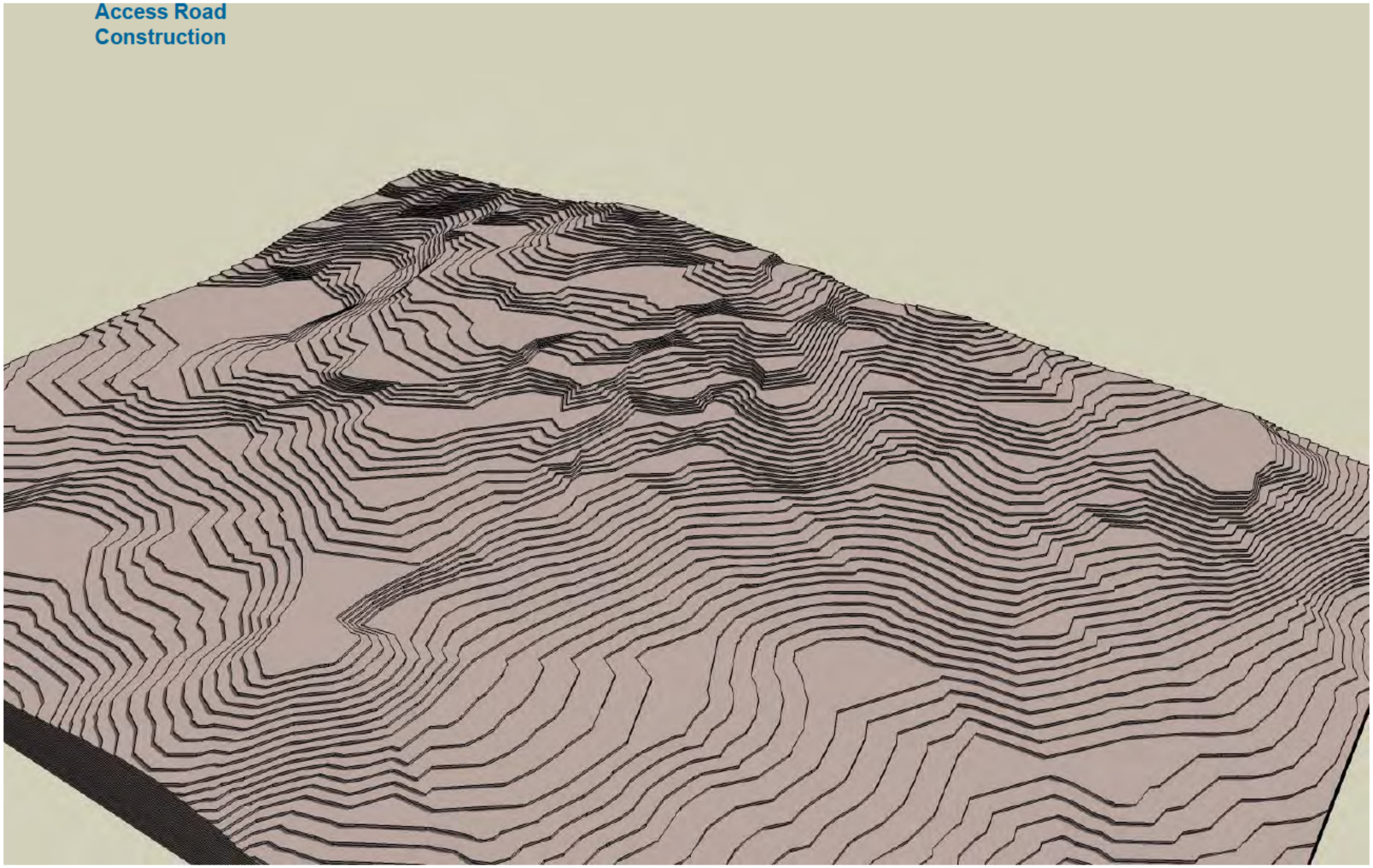
All parking, workers and visitors, will occur within the TMT Observatory 13N site graded area as illustrated on Figure B-4.

As rainfall in the summit region is infrequent and not extreme, no underground drainage systems will be constructed. Above-ground drainage facilities will be restricted to the drainage swale on the cinder section of the Access Way (the only paved portion of the Access Way) as illustrated in Figure B-1. Generally, water will flow from the impervious surfaces (the paved portion of the Access Way and the TMT Observatory dome and support building) to the surrounding graded parking areas, roadways, embankments and slopes, plus the surrounding natural area which consists of very permeable lava flows.

Attachment A: Construction Sequence

Construction Sequence
Summit (Pre-Construction)

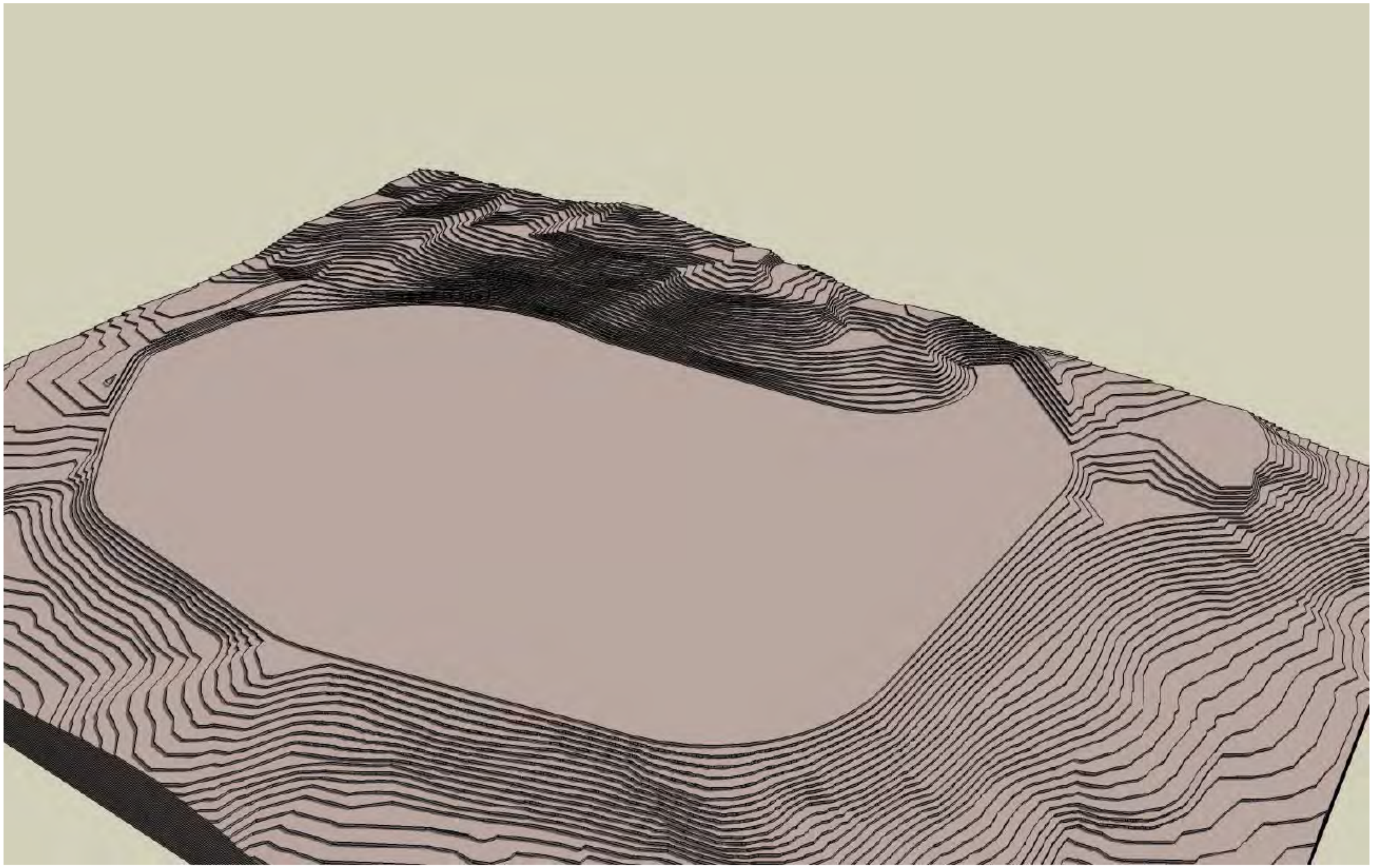
2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



THIRTY METER TELESCOPE

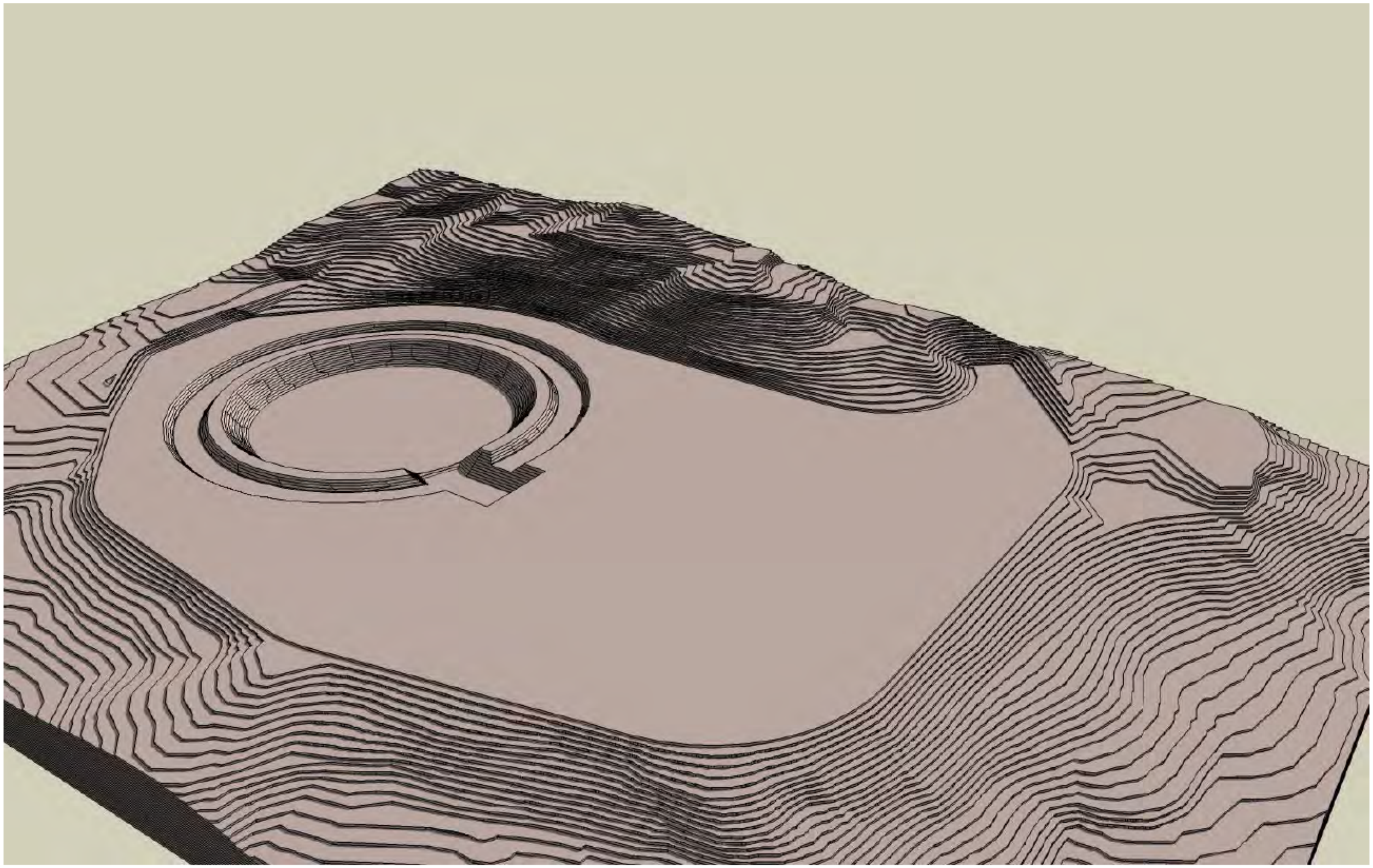
Construction Sequence
Rough Grading

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



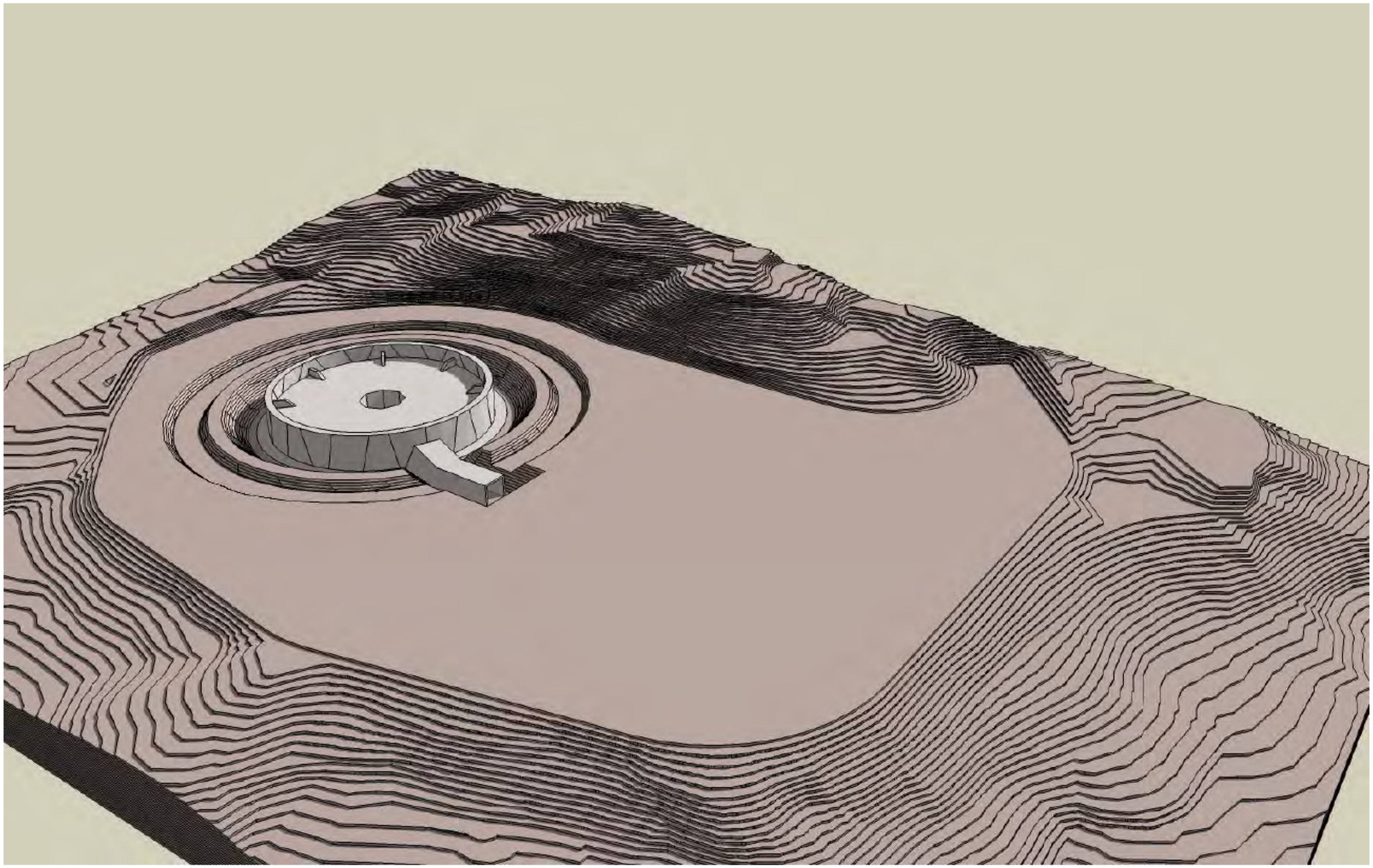
Construction Sequence
Pier / Foundation _xcavation

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



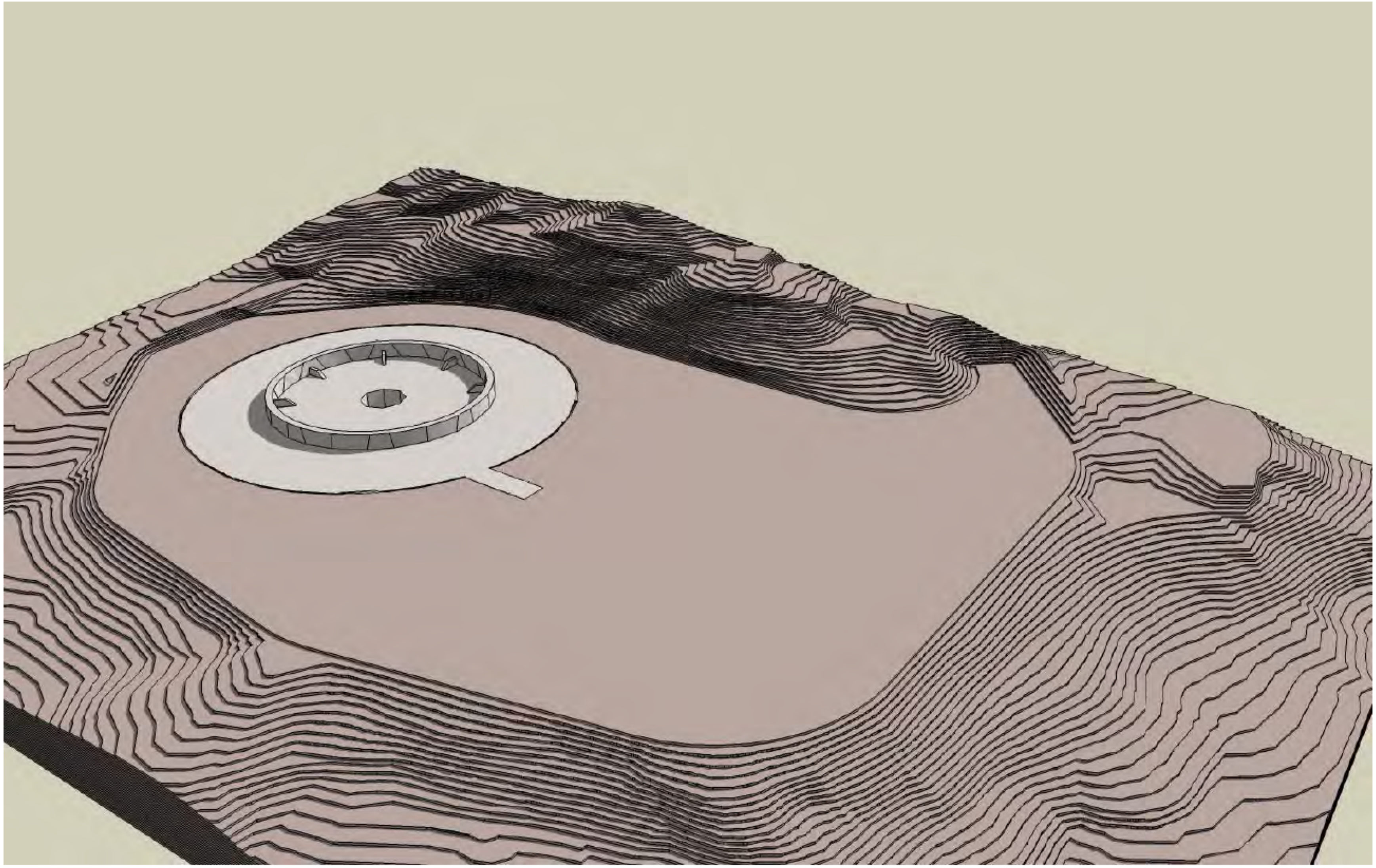
Construction Sequence
Pier and Tunnel Concrete

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Construction Sequence
Fixed Enclosure Foundation ... ete

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



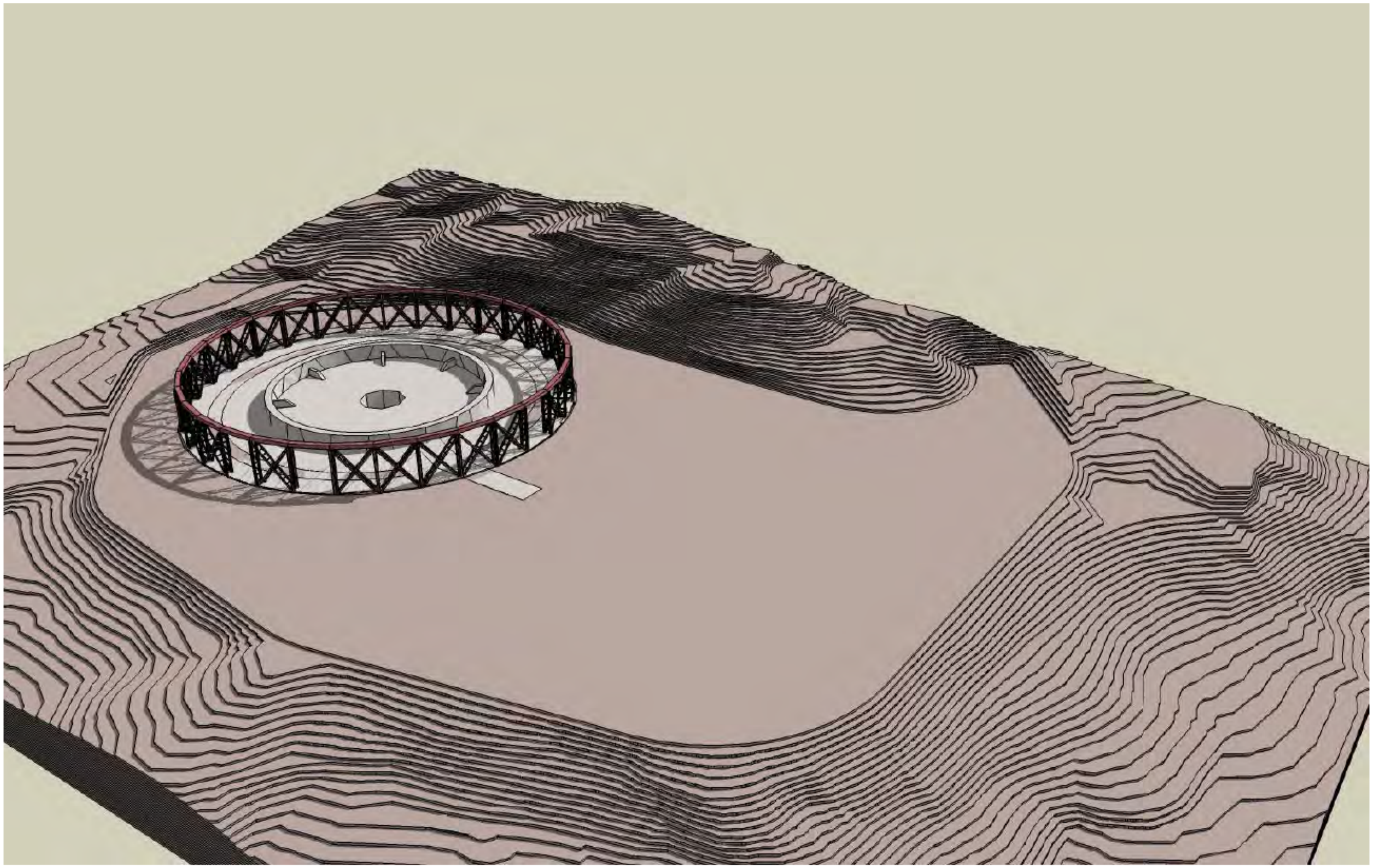
TMT

THIRTY METER TELESCOPE

Construction Sequence
Fixed Enclosure Structural

m3

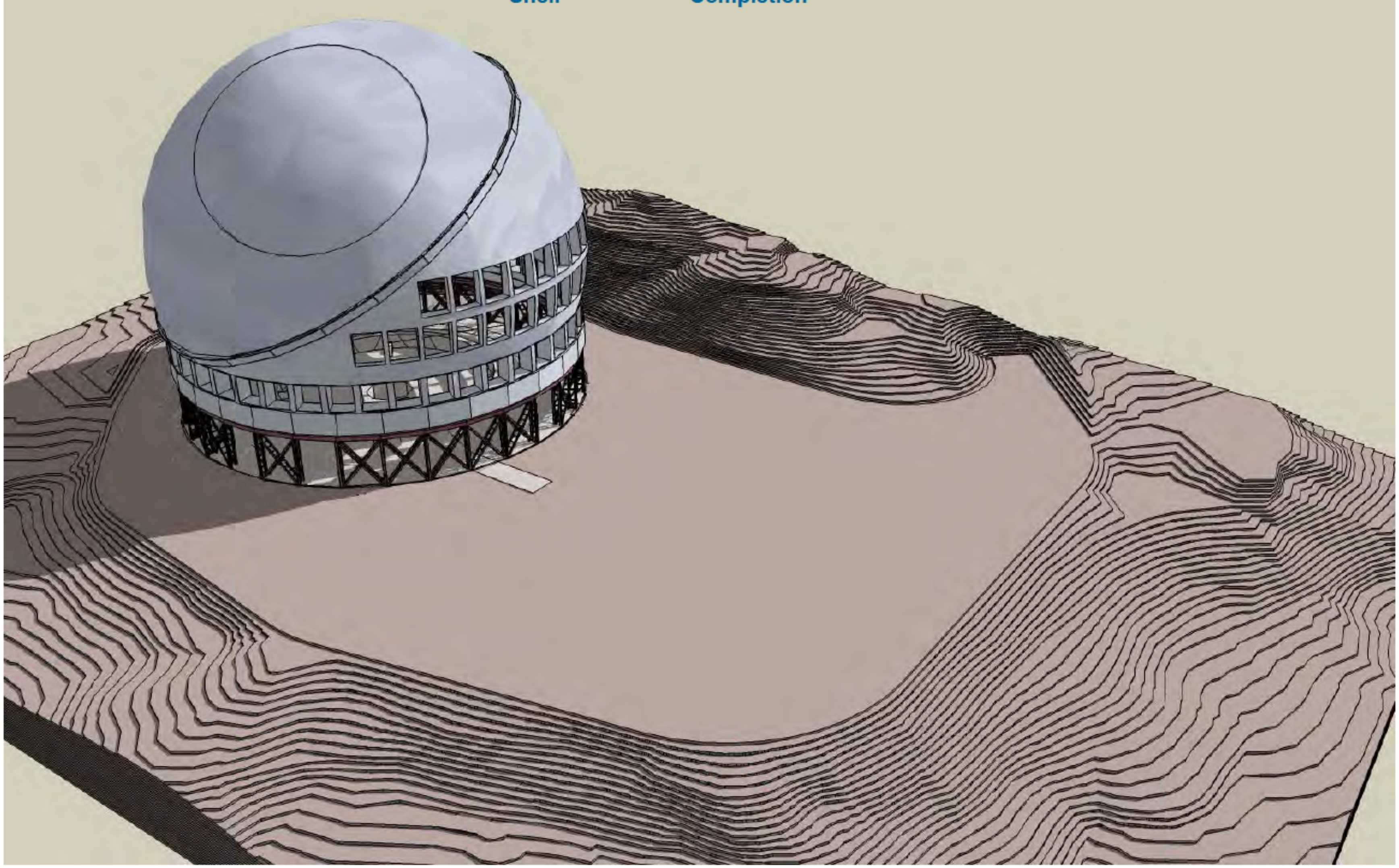
2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Construction Sequence
Rotating Enclosure Erection

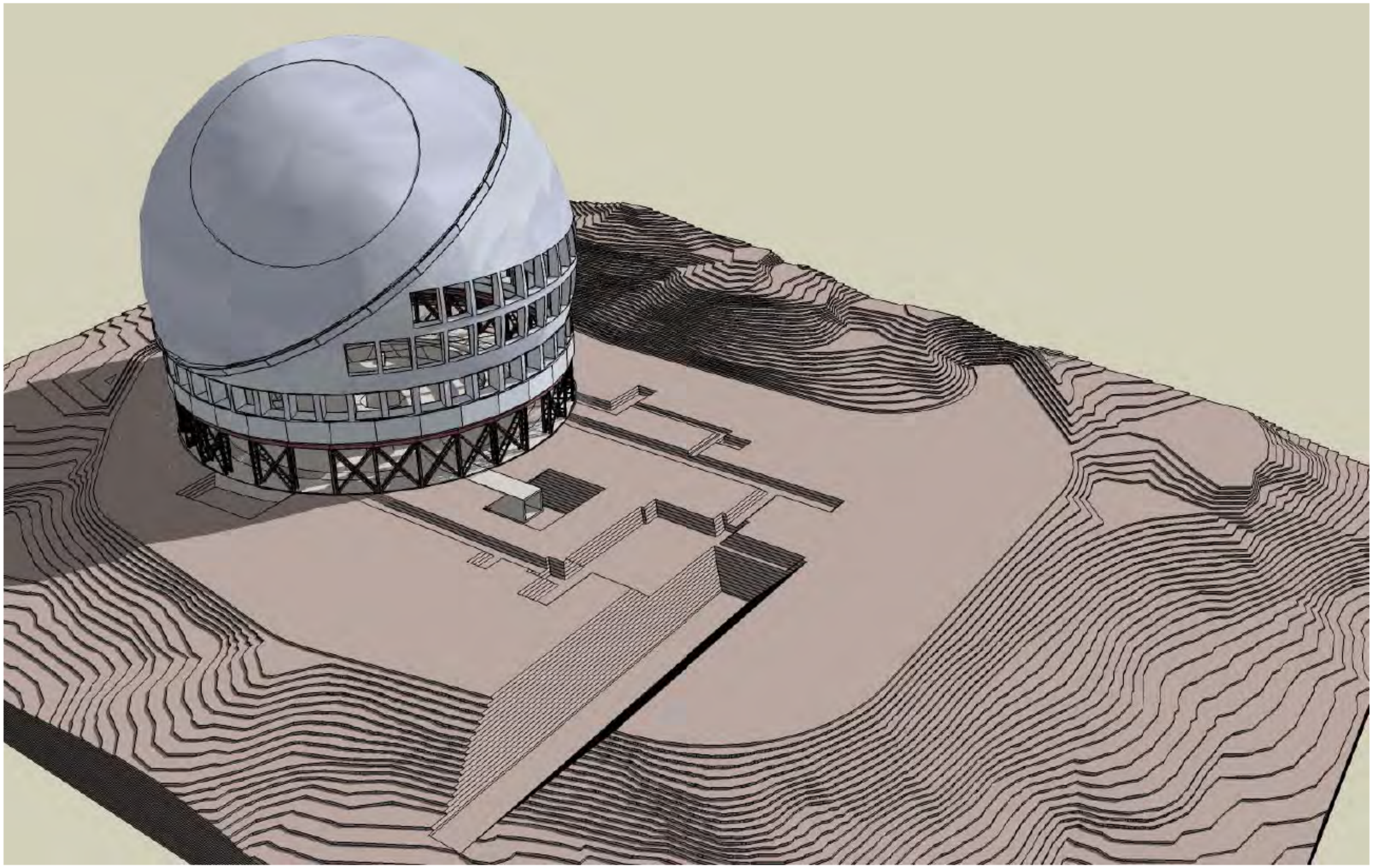
2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

Shell Completion



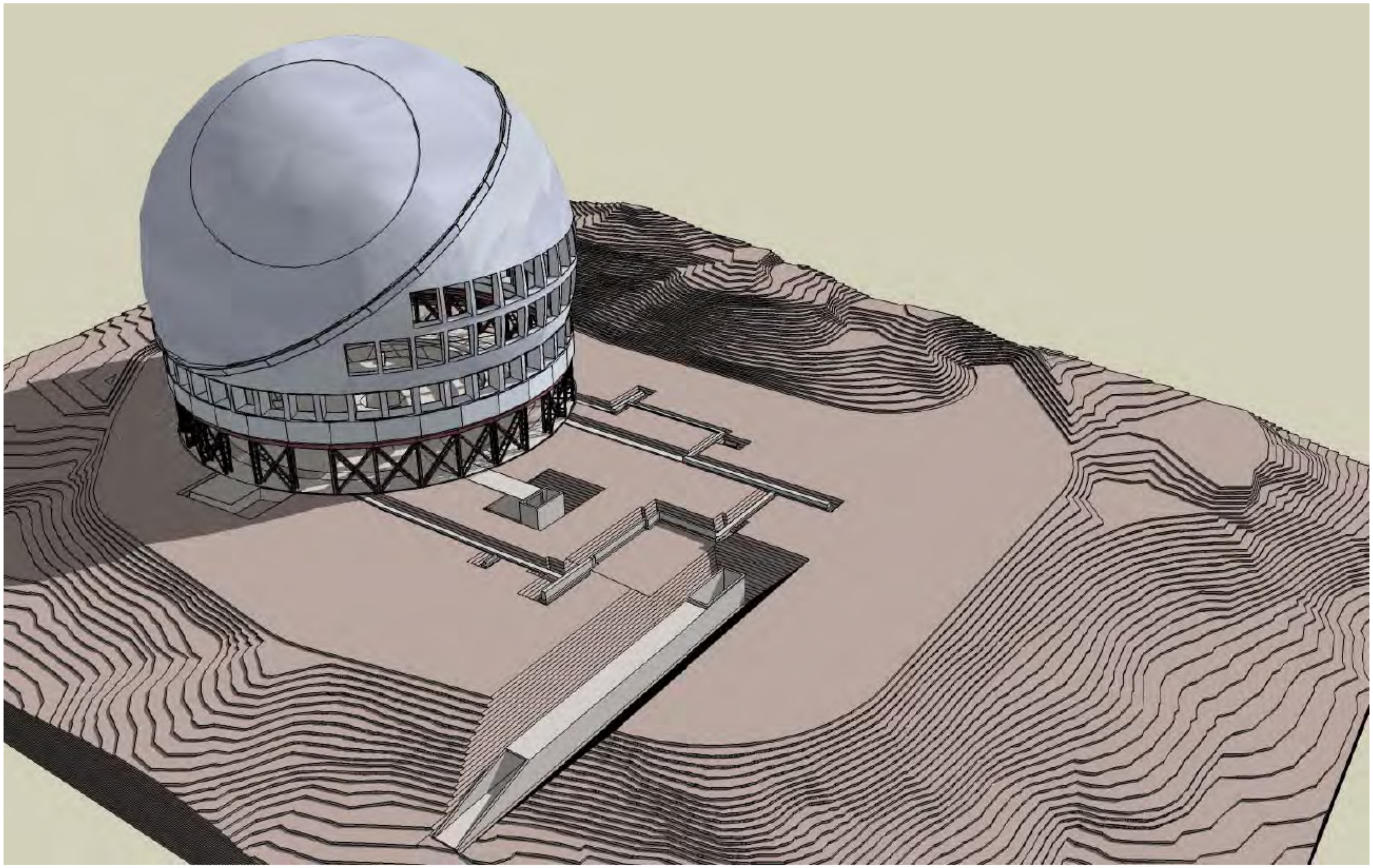
Construction Sequence
Summit Facility Rough Grading & Excavation

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Construction Sequence
Summit Facility Foundation Tunnel

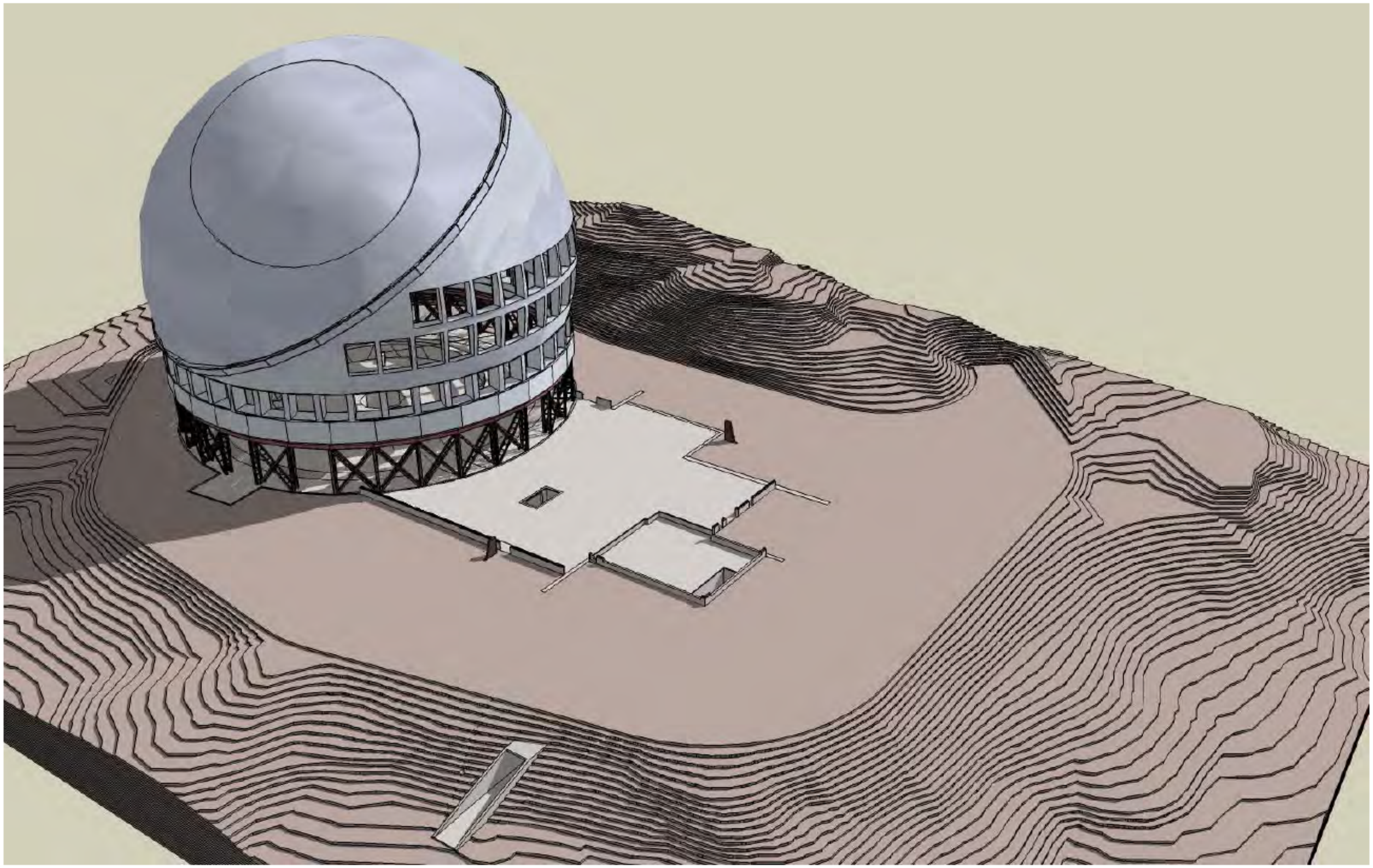
2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



TMT
THIRTY METER TELESCOPE

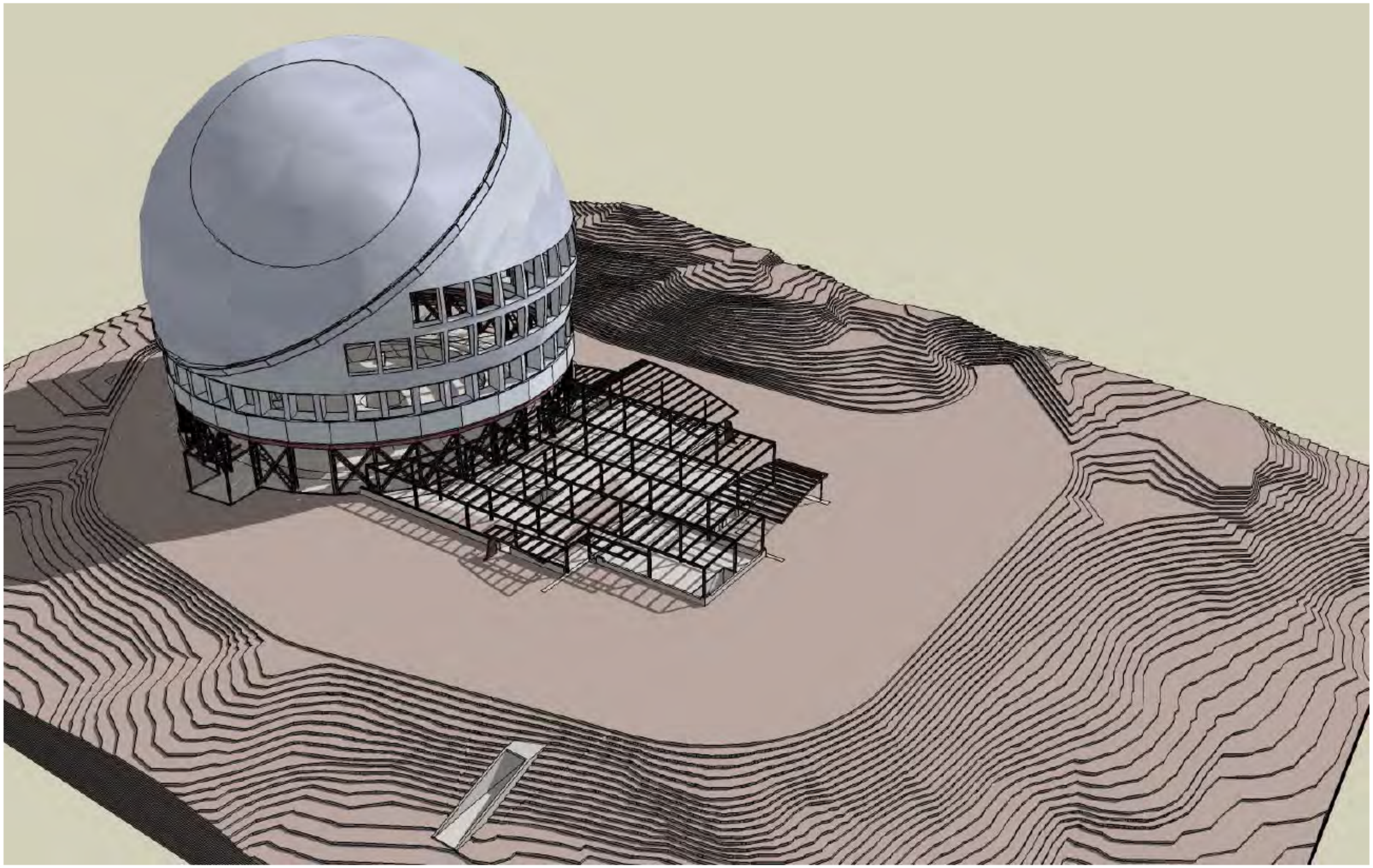
Construction Sequence
Summit Facility Concrete Slab ... a

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



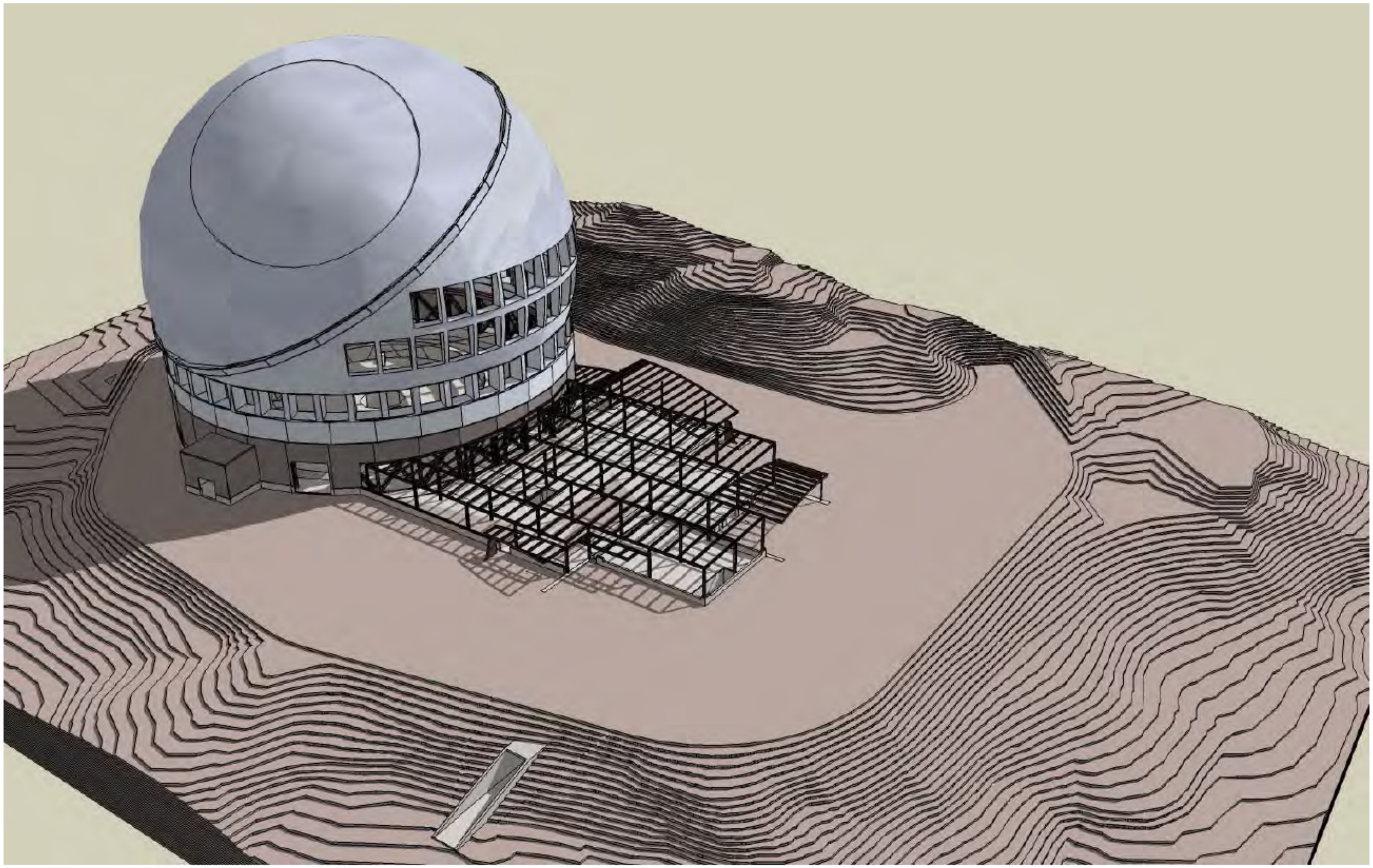
Construction Sequence
Summit Facility Steel

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



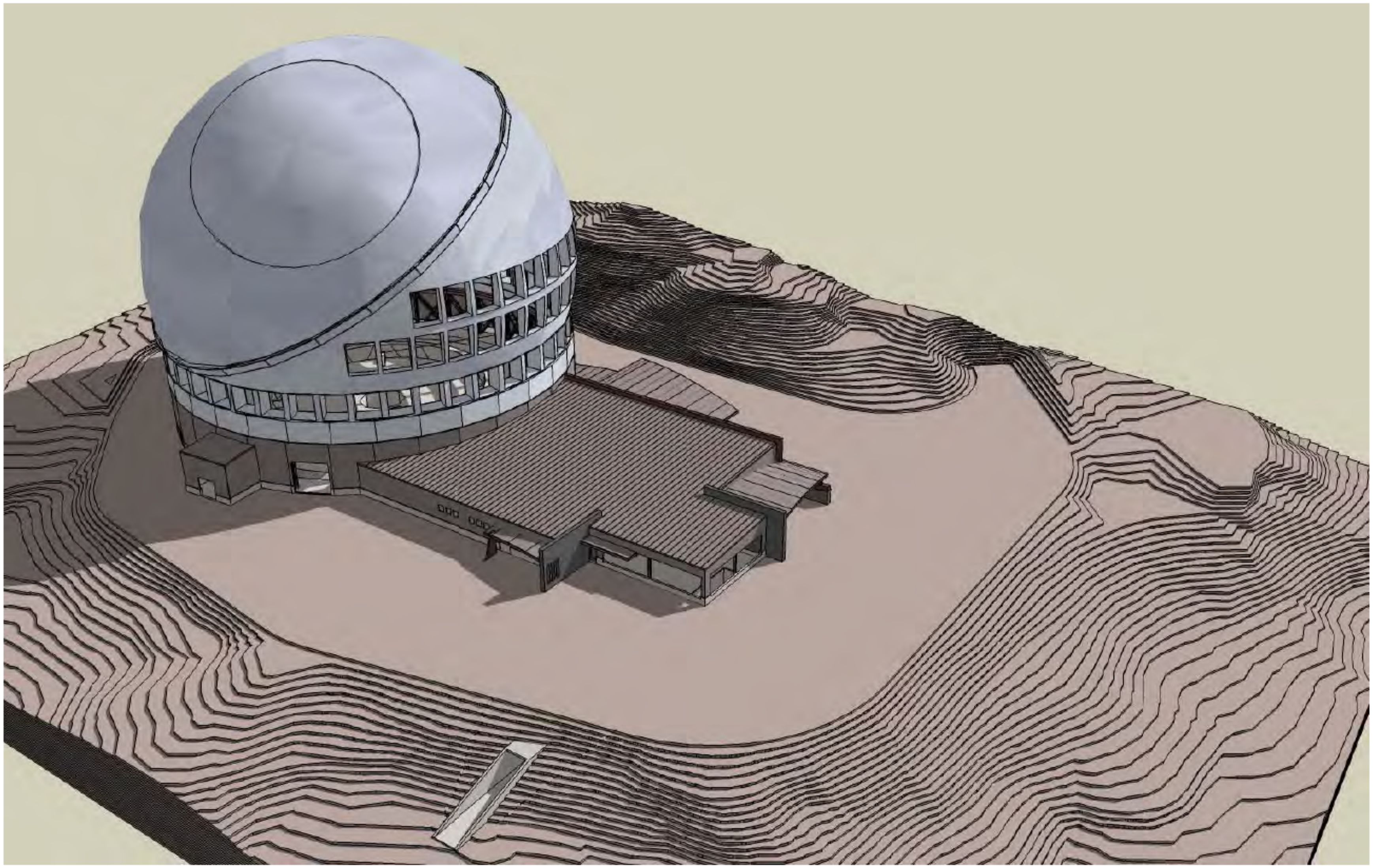
Construction Sequence
Fixed Enclosure Wall Panels

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



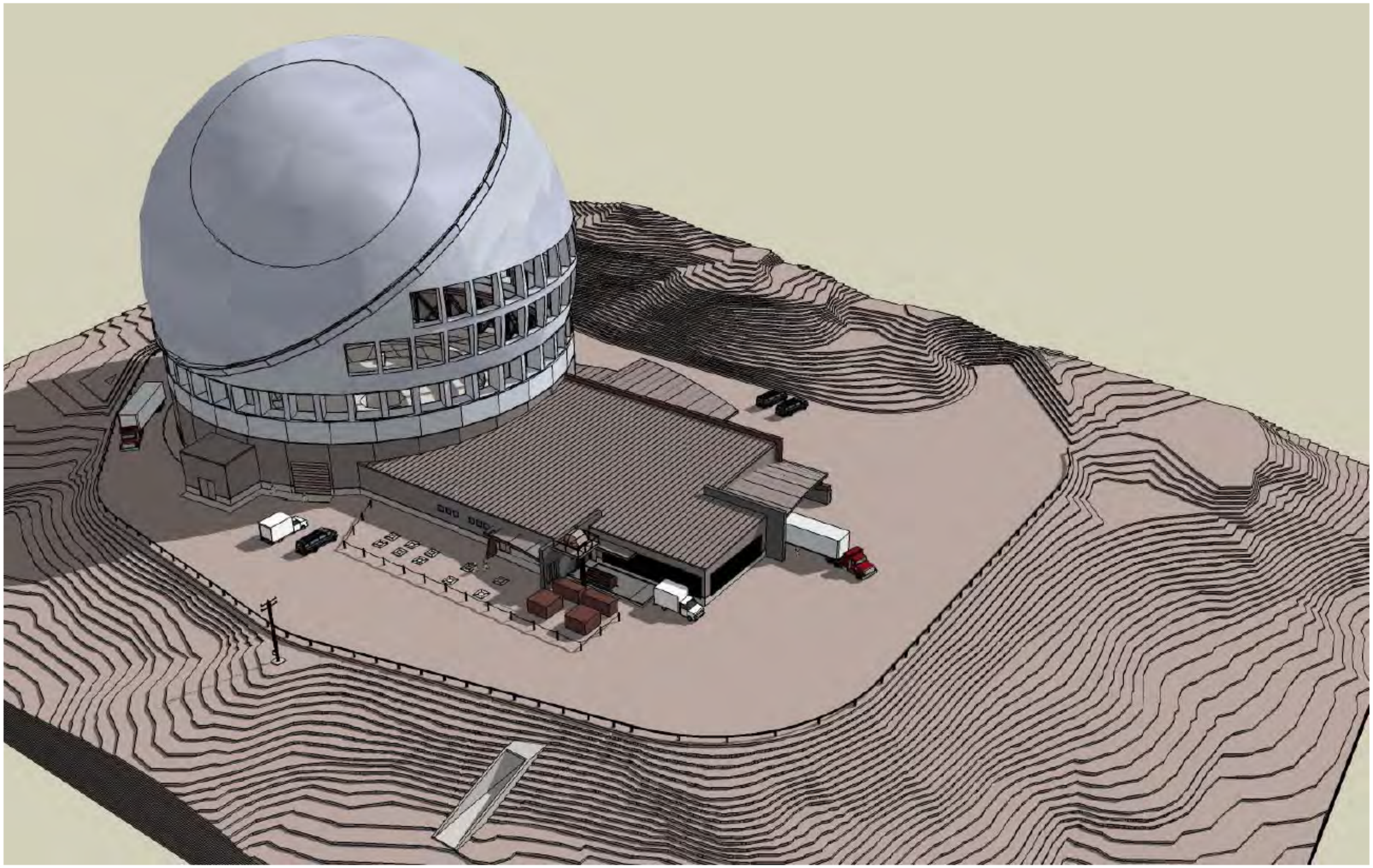
Construction Sequence
Summit Facility Shell, Utilities, & Site Work

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Construction Sequence Completion

2011				2012				2013				2014				2015				2016				2017				2018				2019			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Attachment B: Grading and Foundation Plans

THIRTY METER TELESCOPE

PHASE III - DESIGN DEVELOPMENT SUBMITTAL FOR THE OFFICE OF MAUNA KEA MANAGEMENT

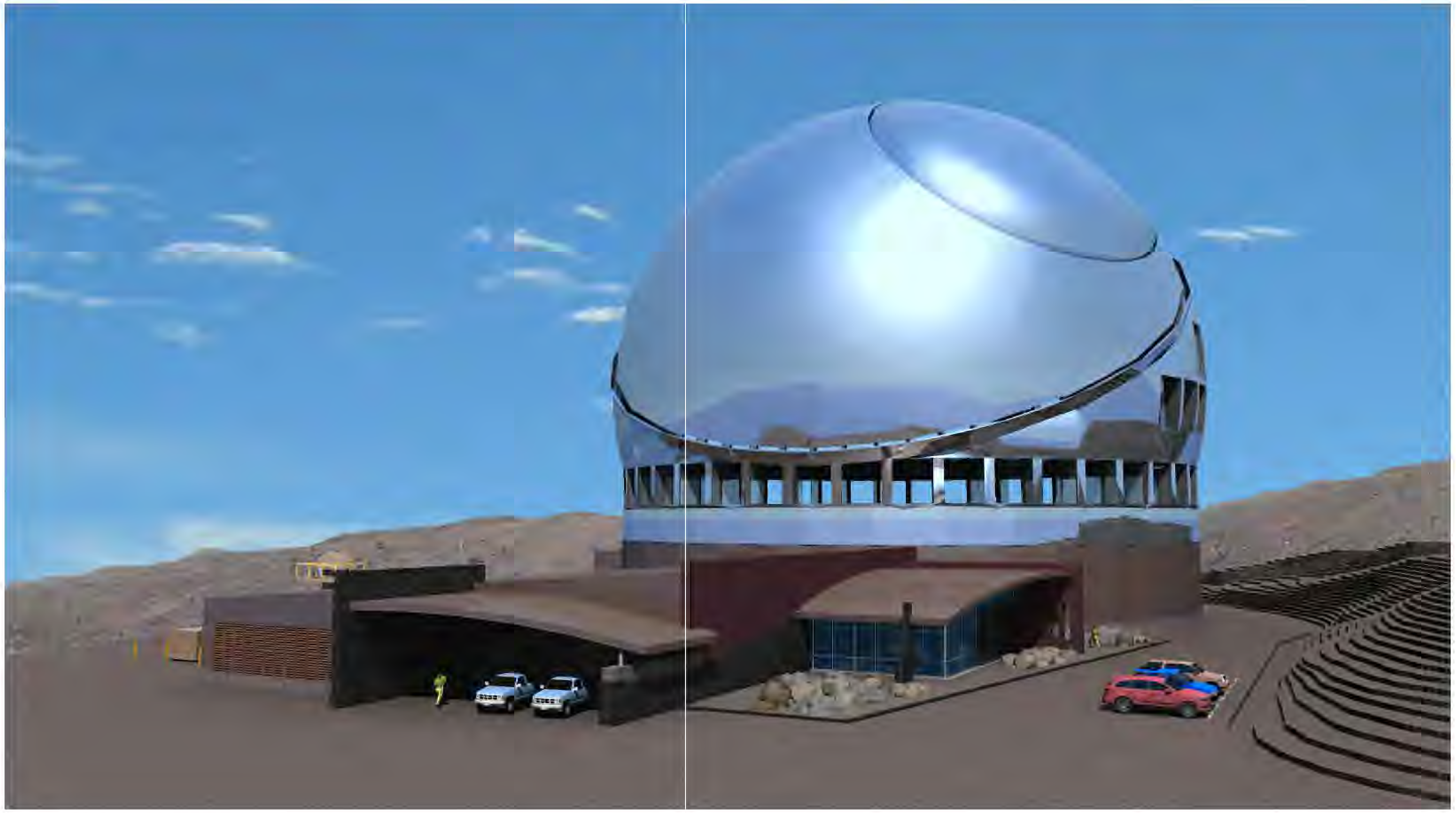
TMT

ASSOCIATION OF CANADIAN UNIVERSITIES FOR RESEARCH IN ASTRONOMY - CALIFORNIA INSTITUTE OF TECHNOLOGY - UNIVERSITY OF CALIFORNIA

MAUNA KEA, HAWAII

APRIL 5, 2010

TMT.SUM.PDD.10.009.DRF01



THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

Revisions

Description	Date
1	
2	
3	
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5	
6	

Drawn: E.J.S.
Checked: -
Issue Date: 4-5-10

Drawing Title

COVER SHEET

Sheet Number

GI001

PRELIMINARY
NOT FOR CONSTRUCTION

Last Update: 3.26.2010

ABBREVIATIONS (NOT ALL ABBREVIATIONS SHOWN BELOW ARE USED IN THIS SET OF DRAWINGS)

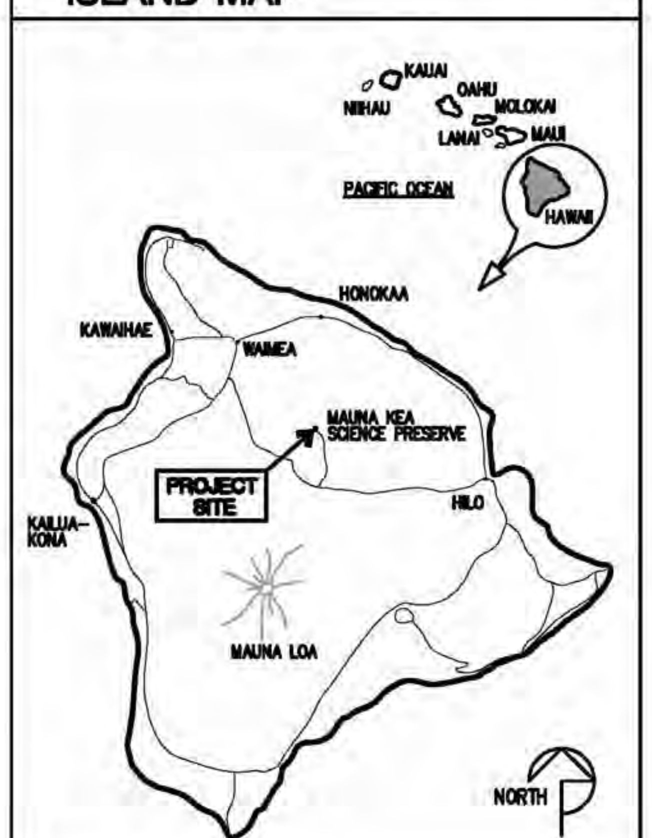
&	AND
A.B.	ANCHOR BOLT
ABUT	ABUTMENT
ABC	AGGREGATE BASE COURSE
ABV	ABOVE
AC	ACOUSTICAL SPRAY ON CEILING
ACI	AMERICAN CONCRETE INSTITUTE
L	ANGLE (STRUCTURAL)
AFF	ABOVE FINISHED FLOOR
ALT	ALTERNATE
ALUM	ALUMINUM
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AP	ACOUSTICAL WALL PANEL
APPROX	APPROXIMATE
ARCH	ARCHITECT(URAL)
ARS	ARIZONA REVISED STATUTES
ASPH	ASPHALT
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
AVG	AVERAGE
AWG	AMERICAN WIRE GAGE
AZ	AZIMUTH
B	BRICK
B.BD	BULLETIN BOARD
BD	BOARD
B.L.	BUILDING LINE
BLDG	BUILDING
BLK(G)	BLOCK(ING)
BLT	BOLT
BLW	BELOW
BM	BEAM
B.M.	BENCH MARK
BOF	BOTTOM OF FOOTING
BOT	BOTTOM
BRG	BEARING
BUR	BUILT UP ROOFING
CAB	CABINET
C/C	CENTER TO CENTER
CF	CUBIC FOOT
CFCI	CONTRACTOR FURNISHED/ CONTRACTOR INSTALLED
CFM	CUBIC FEET PER MINUTE
CIP	CAST-IN-PLACE
CJ	CONTROL JOINT
CL	CENTER LINE
CLG	CEILING
CLOS	CLOSET
CLR	CLEAR(ANCE)
CO	CLEAN OUT
COL	COLUMN
CONC	CONCRETE
CONF	CONFERENCE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
CONTR	CONTRACT(OR)
COT	CITY OF TUCSON
CP	CARPET
CR	STAGE CURTAIN
CT	CERAMIC TILE
CTR	CENTER
CW	COLD WATER
d	PENNY (NAIL SIZE)
DBL	DOUBLE
DEG	DEGREE
DEM	DEMOLISH, DEMOLITION
DESC.	DESCRIPTION
D.F.	DRINKING FOUNTAIN
DIAG	DIAGONAL
DIA.	DIAMETER
DIM	DIMENSION
DISP	DISPENSER
DL	DEAD LOAD
DN	DOWN
DO	DITTO
DR	DOOR
D.S.	DOWNSPOUT
DTR	DUCT THROUGH ROOF
DTW	DUCT THROUGH WALL
DWG(S)	DRAWING(S)
E, (E)	EXISTING TO REMAIN
EA	EACH
ELEV	ELEVATION
EIFS	EXTERIOR INSULATION FINISH SYSTEM
EOM	EDGE OF MASONRY
EOS	EDGE OF STEM WALL
EP	EPOXY PAINT
EQ	EQUAL
EQUIP	EQUIPMENT
ESMT	EASEMENT
EWC	ELECTRIC WATER COOLER
EXIST	EXISTING
EXP	EXPANSION, EXPOSED
EXT	EXTERIOR
F	FAHRENHEIT
FD	FLOOR DRAIN
FDN	FOUNDATION
F.E.	FIRE EXTINGUISHER
FF	FINISH FLOOR
FFE	FINISH FLOOR ELEVATION
F.G.	FINISHED GRADE
FIN	FINISH(ED)
FLR	FLOOR
FLUOR	FLUORESCENT
FLG	FLANGE
FLASH	FLASHING
FOS	FACE OF STUD
FT	FOOT, FEET
FTG	FOOTING
FTR	FLUE THROUGH ROOF
FURN	FURNITURE
G	GYPSUM BOARD
GALV	GALVANIZED
G.B.	GRAB BAR
G.I.	GALVANIZED IRON
GL	GLASS, GLAZING
GWB	GYPSUM WALL BOARD
GYP	GYPSUM
H	HEIGHT
H.B.	HOSE BIBB
HC	HANDICAPPED
HGT	HEIGHT
H.M.	HOLLOW METAL
HORIZ	HORIZONTAL
H.P.S.	HIGH PRESSURE SODIUM
HVAC	HEATING/VENTILATING/ AIR CONDITIONING
I.D.	INSIDE DIAMETER
INCL	INCLUDE(D, ING)
INFO	INFORMATION
INV. EL.	INVERT ELEVATION
INSUL	INSULATION
INT	INTERIOR
IRRIG	IRRIGATION
JB	JUNCTION BOX
JCT	JUNCTION
JT	JOINT
L	LENGTH
LAM	LAMINATE(D)
LAV	LAVATORY
LB	POUND
LH	LEFT HAND
LT(G)	LIGHT(ING)
LT.WT	LIGHT WEIGHT
LVR	LOUVER
M	MOVABLE PARTITION
MACH	MACHINE
MAINT	MAINTENANCE
MAS	MASONRY, MASON
MATL	MATERIAL(S)
MAX	MAXIMUM
MB	MACHINE BOLTS
MCJ	MASONRY CONTROL JOINT
MEAS	MEASURE
MECH	MECHANICAL
MED	MEDIUM
MEMB	MEMBRANE
MFD	MANUFACTURED
MFG	MANUFACTURING
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM, MINUTES
MIR	MIRROR
MISC	MISCELLANEOUS
M.O.	MASONRY OPENING
MT	MOSAIC TILE
MTL	METAL
#	NUMBER
N	NEW
N/A	NOT APPLICABLE
NAT	NATURAL
NEC	NATIONAL ELECTRIC CODE
NEUT	NEUTRAL
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
N.I.C.	NOT IN CONTRACT
NOM	NOMINAL
NTS	NOT TO SCALE
OA	OVERALL
O.C.	ON CENTER(S)
O.D.	OUTSIDE DIAMETER
OFCI	OWNER FURNISHED/ CONTRACTOR INSTALLED
OFOI	OWNER FURNISHED/ OWNER INSTALLED
OH	OVERHEAD
OPNG	OPENING
OPP	OPPOSITE
ORN	ORNAMENTAL
PL	PLATE
P.L., P	PROPERTY LINE
PLF	POUNDS PER LINEAL FOOT
PLMB	PLUMBING
PLS.LAM	PLASTIC LAMINATE
PLYWD	PLYWOOD
PM	PRESSED METAL
PNL	PANEL
POLYISO	POLYISOCYANURATE
REQ'D	REQUIRED
REQMENT	REQUIREMENT
R	RESILIENT BASE
RA	REPAIR
R	RADIUS
RE	REPLACE
RR	RESTROOM(S)
ROW	RIGHT OF WAY
S	STUCCO
SC	SOLID CORE
SCHD	SCHEDULE
S.D.	SOAP DISPENSER
SECT	SECTION
SF	SQUARE FOOT (FEET)
SHT	SHEET
SIM	SIMILAR
SND	SANITARY NAPKIN DISPOSER
SNV	SANITARY NAPKIN VENDOR
SOV	SHUT OFF VALVE
SPECS	SPECIFICATIONS
SQ.	SQUARE
S.S.	SERVICE SINK
STA	STATION
STD	STANDARD
STR	STORAGE
STL	STEEL
STRUC	STRUCTURAL
SURF	SURFACE
SUSP	SUSPEND(ED)
SYM	SYMMETRY(ICAL)
SYS	SYSTEM
SW	SWITCH
T&B	TOP AND BOTTOM
TEL	TELEPHONE
T.O.	TOP OF
T.O.BM.	TOP OF BEAM
T.O.FTG	TOP OF FOOTING
T.O.M.	TOP OF MASONRY
T.O.P.	TOP OF PARAPET
T.O.S.	TOP OF STEEL
T.O.W.	TOP OF WALL
TPD	TOILET PAPER DISPENSER
TS	TUBE STEEL
TV	TELEVISION
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UG	UNDERGROUND
UMC	UNIFORM MECHANICAL CODE
UNF	UNFINISHED
UNG	UNDERGROUNDED
UNO	UNLESS NOTED OTHERWISE
UPC	UNIFORM PLUMBING CODE
UR	URINAL
UTIL	UTILITY(IES)
VAR	VARIES
VGB	VERTICAL GRAB BAR
VCR	VIDEO CASSETTE RECORDER
VCT	VINYL COMPOSITION TILE
VER	VERIFY
VERT	VERTICAL
VOL	VOLUME
VTR	VENT THROUGH ROOF
W	WIDTH
W/	WITH
WD	WOOD
WH	WALL HUNG
W/O	WITHOUT
WSCT	WAINSCOT
WS	WAFFLE SLAB
W/W	WALL TO WALL
WWF	WELDED WIRE FABRIC
YD	YARD
Z	GLAZING

SCOPE OF WORK

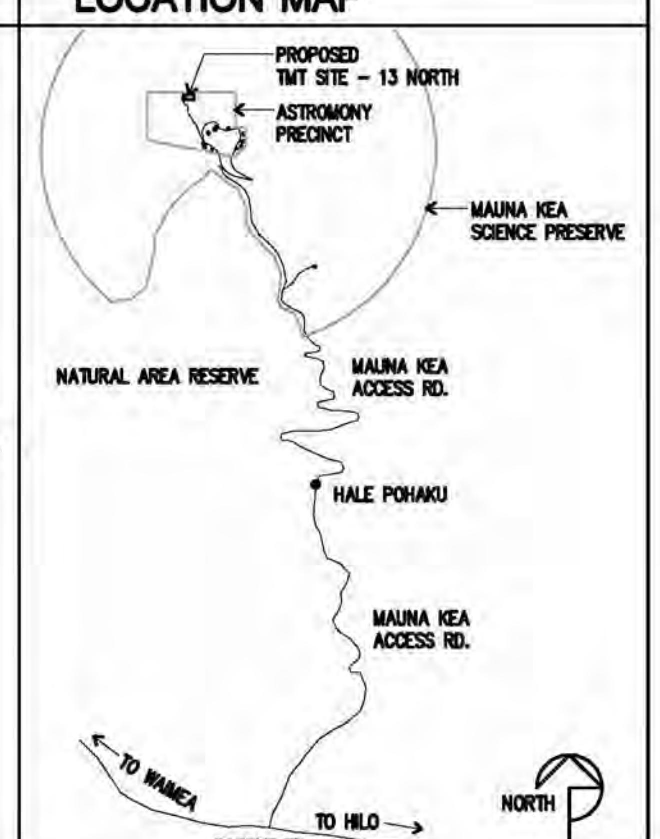
THE SCOPE OF WORK CONSISTS OF, BUT NOT LIMITED TO, THE CONSTRUCTION OF THE THIRTY METER TELESCOPE FIXED ENCLOSURE AND SUMMIT FACILITY WHICH INCLUDES ALL SITE WORK, ARCHITECTURAL, STRUCTURAL, PLUMBING, MECHANICAL, AND ELECTRICAL SYSTEMS AS NOTED IN THE DRAWINGS AND WRITTEN SPECIFICATIONS.

GENERAL NOTES

ISLAND MAP



LOCATION MAP



MATERIAL SYMBOLS (NOT ALL SYMBOLS ARE USED IN THIS SET OF DRAWINGS)

- POURED CONCRETE
- EARTH
- GRAVEL
- BATT INSULATION
- WOOD (ROUGH)
- WOOD (FINISHED)
- PLYWOOD
- METAL (LARGE SCALE)
- GYPSUM WALL BOARD
- RIGID INSULATION

KEYING SYMBOLS

- 101A — DOOR SYMBOL REFER TO DOOR SCHEDULE
- WOMEN'S SHOWER 133 — ROOM SYMBOL REFER TO ROOM FINISH SCHEDULE
- A — COLUMN LINE
- A / AR302 — DETAIL NUMBER; GENERAL BUILDING SECTION; SHEET NUMBER
- 4 / AR501 — DETAIL
- 4 — KEYNOTE

DRAWING INDEX

OUTLINE OF WRITTEN SPECIFICATIONS

AIA MASTERSPEC – 16 DIVISION FORMAT

Division 1 – General Requirements
01000 – Special Provisions
01002 – Fire Plan
01010 – Summary of Work
01027 – Applications for Payment
01035 – Modification Procedures
01040 – Coordination
01045 – Cutting and Patching
01200 – Project Meetings
01300 – Submittals
01400 – Quality Control
01421 – Reference Standards and Definitions
01500 – Construction Facilities and Temporary Controls
01600 – Materials and Equipment
01631 – Substitutions
01700 – Contract Closeout
01740 – Warranties

Division 2 – Site Construction
02080 – Piped Utilities
02230 – Site Clearing
02300 – Earthwork
02361 – Termite Control
02510 – Water Distribution

Division 3 – Concrete
03300 – Cast-In-Place Concrete

Division 4 – Masonry
04200 – Unit Masonry

Division 5 – Metals
05120 – Structural Steel
05310 – Steel Deck
05400 – Cold-Formed Metal Framing
05510 – Metals Stairs and Handrails
05530 – Gratings
05550 – Corrugated Metal Pipe Exhaust Ducts

Division 6 – Woods & Plastics
06402 – Interior Architectural Woodwork

Division 7 – Thermal & Moisture Protection
07210 – Building Insulation
07412 – Manufactured Wall, Roof, and Soffit Systems
07620 – Sheet Metal Flashing and Trim
07841 – Through Penetration Firestop Systems
07920 – Joint Sealants

Division 8 – Doors and Windows
08110 – Steel Doors and Frames
08163 – Sliding Aluminum – Framed Glass Door
08211 – Flush Wood Doors
08305 – Access Doors
08331 – Overhead Coiling Doors
08410 – Aluminum Entrances
08420 – Aluminum Windows
08711 – Door Hardware
08800 – Glazing
08920 – Glazed Aluminum Curtain Walls

Division 9 – Finishes
09255 – Gypsum Board Assemblies
09511 – Acoustical Panel Ceilings
09651 – Resilient Tile Flooring
09652 – Sheet Vinyl Floor Coverings
09653 – Resilient Wall Base and Accessories
09680 – Carpet
09900 – Painting

Division 10 – Specialties
10155 – Toilet Compartments
10200 – Louvers and Vents
10505 – Metal Lockers
10520 – Fire-Protection Specialties
10521 – Fire Suppression Systems
10523 – Fire Extinguishers
10801 – Toilet and Bath Accessories

Division 11 – Equipment
11160 – Loading Dock Equipment

Division 12 – Furnishings
12500 – Block-Out Shades

Division 13 – Special Construction
13100 – Lightning Protection
13852 – Fire Alarm Systems
13963 – Gaseous Fire Suppression Systems

Division 14 – Conveying Systems
14605 – Crane Rail
14620 – Trolley Hoist
14630 – Bridge Cranes
14650 – Jib Cranes

Division 15 – Mechanical
15010 – General Provisions
15050 – Basic Mechanical Materials and Methods
15060 – Hangers and Supports
15081 – Duct Insulation
15100 – Valves
15122 – Meters and Gages
15170 – Motors
15185 – Hydronic Pumps
15241 – Mechanical Vibration Controls and Seismic Restraints
15411 – Water Distribution Piping
15420 – Drainage and Vent Piping
15440 – Plumbing Fixtures
15450 – Fire Protection Water Storage Tanks
15461 – Electric Water Heaters
15465 – Compressed-Air Equipment
15545 – Chemical Water Treatment
15815 – Metal Ducts
15851 – Centrifugal Fans
15985 – Sequence of Operations
15590 – Testing, Adjusting, and Balancing

Division 16 – Electrical
16000 – General Requirements for Electrical Work
16100 – Raceways, Boxes, and Cabinets
16114 – Cable Trays
16124 – Medium Voltage Cable – Single Conductor Cable
16140 – Wiring Devices
16170 – Motor and Circuit Disconnects
16180 – Overcurrent Protective Devices
16230 – Generator Assemblies
16425 – Distribution Switchboards
16450 – Electrical Grounding System
16460 – Dry Type Transformers
16470 – Panelboards
16473 – Transient Voltage Surge Protection
16481 – Motor Starters and Control Centers
16483 – Adjustable Frequency Motor Controller
16500 – Lighting Fixtures
16610 – Uninterruptable Power Supply (UPS)
16670 – Lighting Protection System
16720 – Fire Alarm System
16990 – Testing

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

2051 W. SUNSET ROAD SUITE NO. 101 TUCSON, ARIZONA

M3 ARCHITECTURE CONSTRUCTION MANAGEMENT

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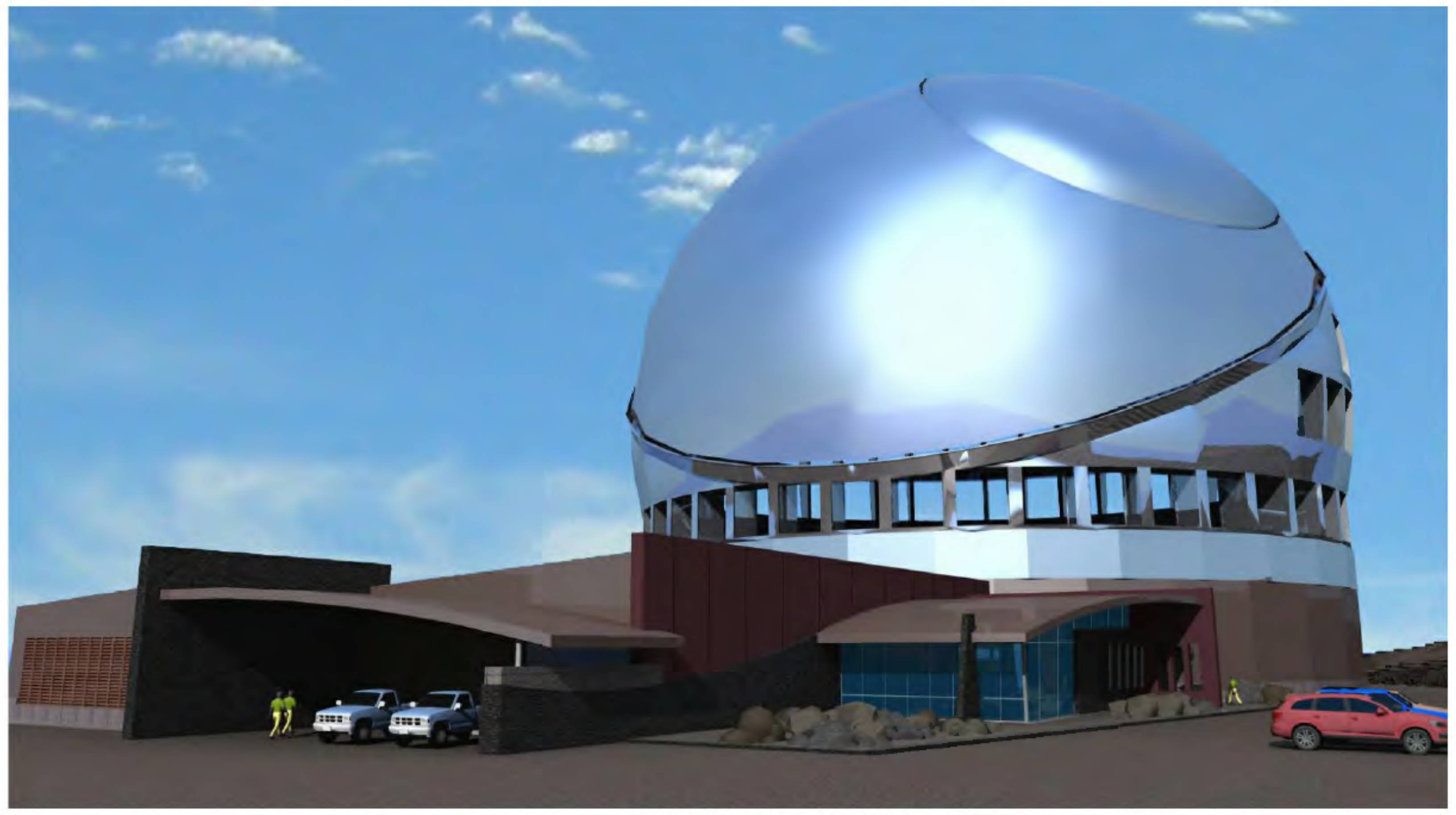
Drawn: EJG
Checked: –
Issue Date: 4-5-10

Drawing Title
DRAWING INDEX, ABBREVIATIONS, AND SYMBOLS

Sheet Number
GI002

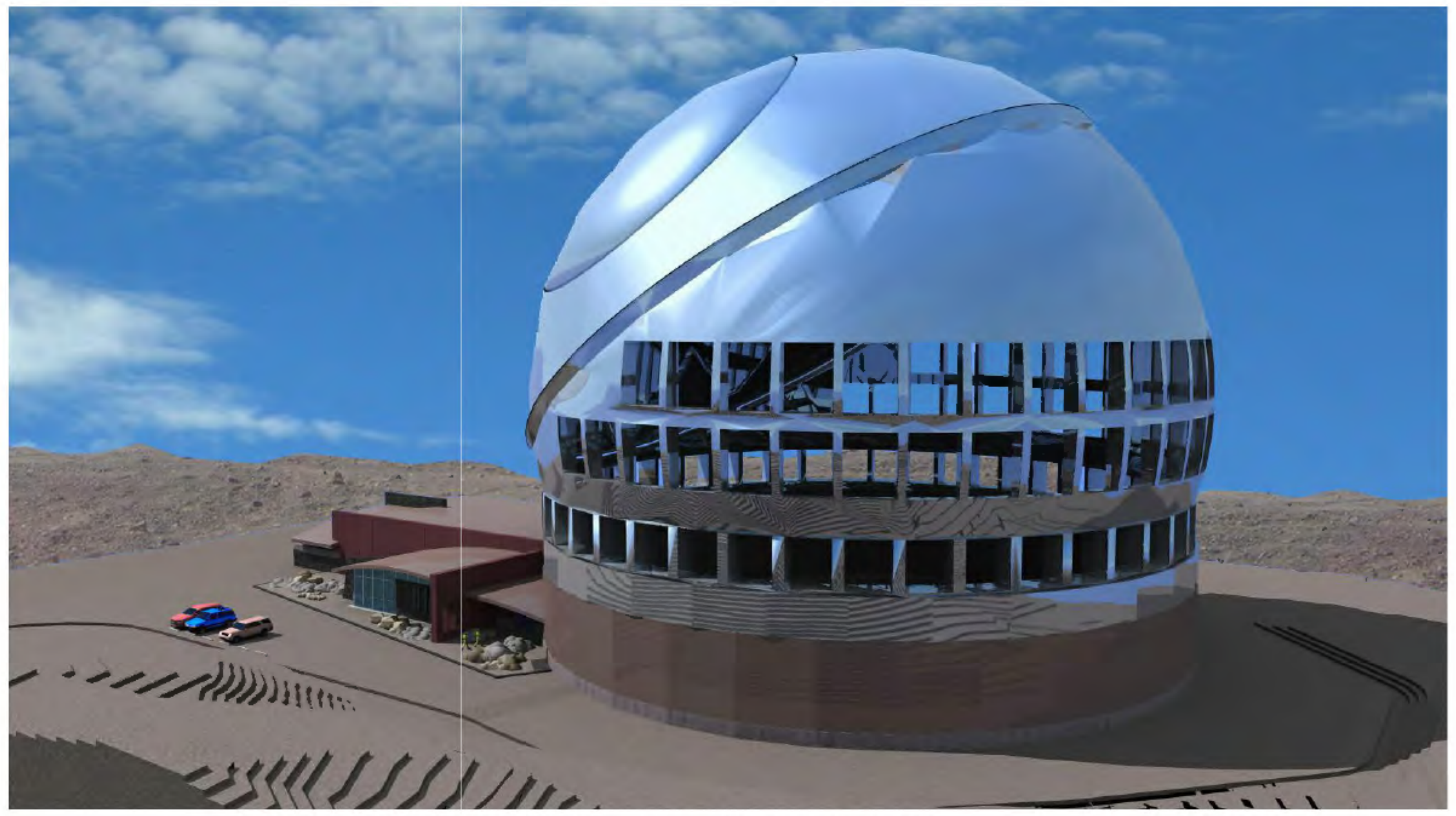
M3PN 07131

Last Update: 3.28.2010

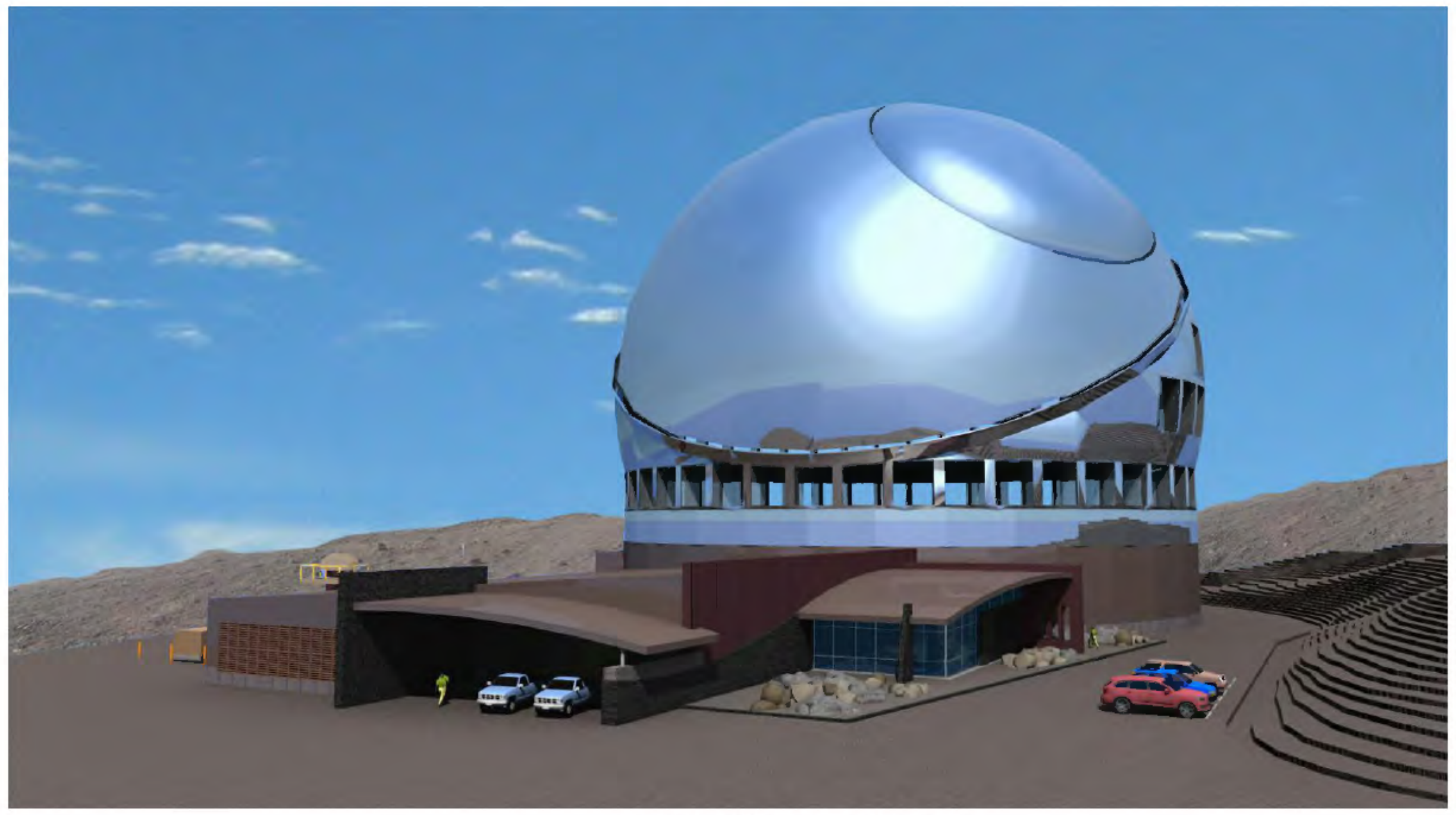


PERSPECTIVE NO. 1

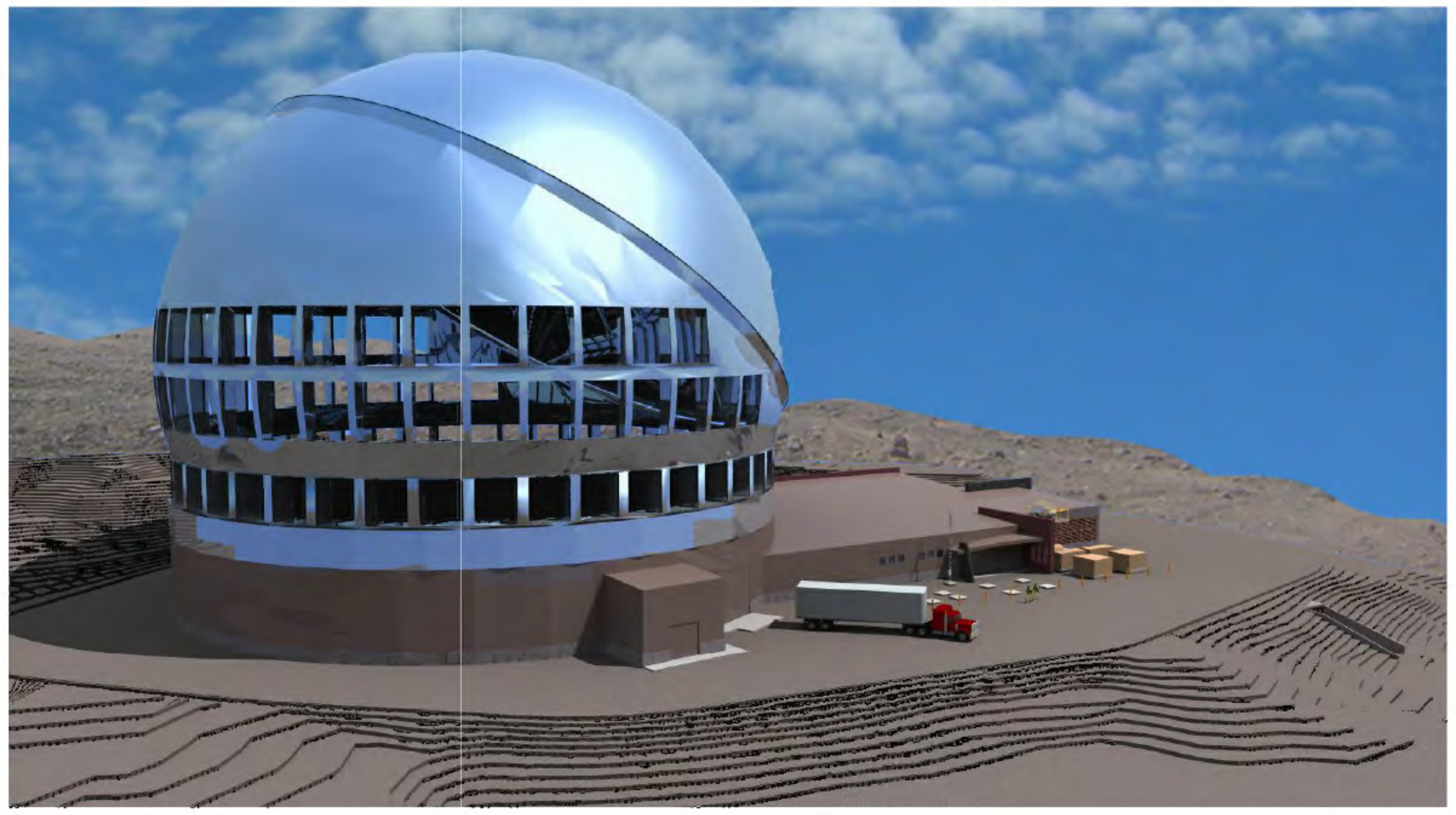
PERSPECTIVE NO. 2



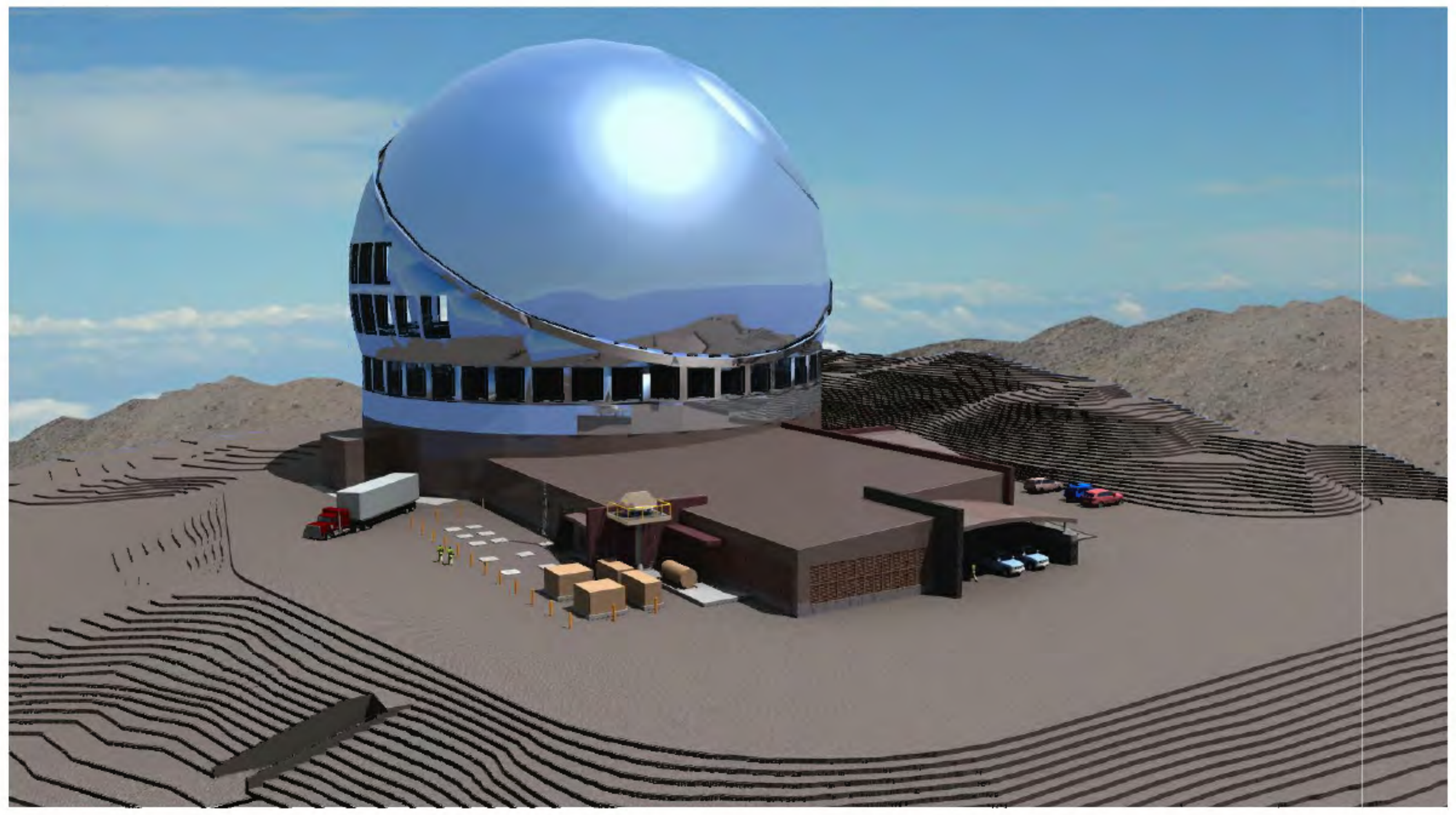
SOUTHEAST VIEW



SOUTHWEST VIEW



NORTHEAST VIEW



NORTHWEST VIEW

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

CONSTRUCTION MANAGEMENT

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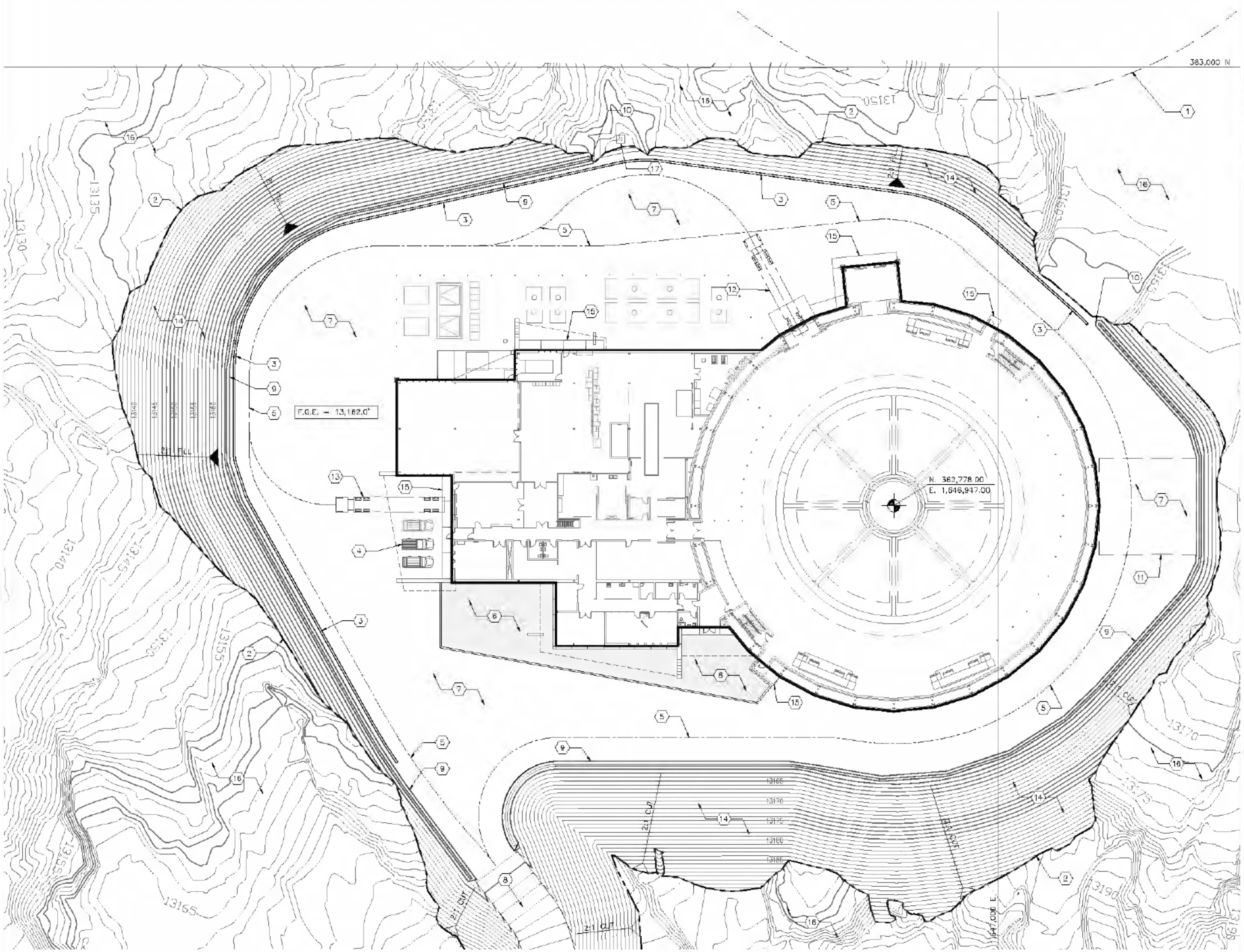
3-D MODEL RENDERINGS

Sheet Number

GI003

Last Update: 3.26.2010



ARCHITECTURAL SITE PLAN

1" = 20'-0"

NORTH

KEY NOTES

1. 200'-0" ENVIRONMENTAL AREA RADIUS
2. PROPOSED DISTURBED SITE AREA LIMITS
3. VEHICULAR GUARDRAIL
4. TMT STAFF PARKING
5. CIRCULATION PATH (CENTERLINE)
6. NATURAL LANDSCAPING
7. 2" DECOMPOSED GRANITE OR CRUSHED BASALT
8. TMT ACCESS ROAD
9. SITE DRAINAGE SWALE
10. SITE DRAINAGE SWALE OUTLET
11. 49'-0" x 49'-0" DOME CRANE ACCESS
12. TRUCK ACCESS TO FIXED ENCLOSURE & DOME
13. TRUCK ACCESS TO SUMMIT FACILITIES
14. DISTURBED AREA TO BE GRADED SIMILAR TO THE EXISTING SITE CONTOURS TO CREATE A MORE NATURAL SURFACE
15. CONCRETE WALK
16. UNDISTURBED AREA
17. WEATHER STATION TOWER (TMT)

GENERAL INFORMATION

PROPOSED LOCATION:
MAUNA KEA SCIENCE PRESERVE
ASTRONOMY PRECINCT
AREA 'E' – 13 NORTH

PROPOSED SITE ELEVATION
F.G.E. 13,162.0'

PROPOSED DISTURBED SITE AREA
AREA: APPROX. 4.5 ACRES
(3.9 ACRES BEFORE 'RE-CONTOURING')

PROPOSED SITE GRADING
CUT: 36,881 CUBIC YARDS
FILL: 22,356 CUBIC YARDS

PROPOSED BUILDING SIZE:
52,579 GROSS SQUARE FEET
SINGLE LEVEL FACILITY
(OVERALL FOOTPRINT OF THE FIXED ENCLOSURE AND SUMMIT FACILITY)

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE
SCHEMATIC DESIGN PACKAGE
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
ENGINEERING
CONSTRUCTION MANAGEMENT

2031 W. SUNSET ROAD
SUITE NO. 101
TUCSON, ARIZONA

Revisions

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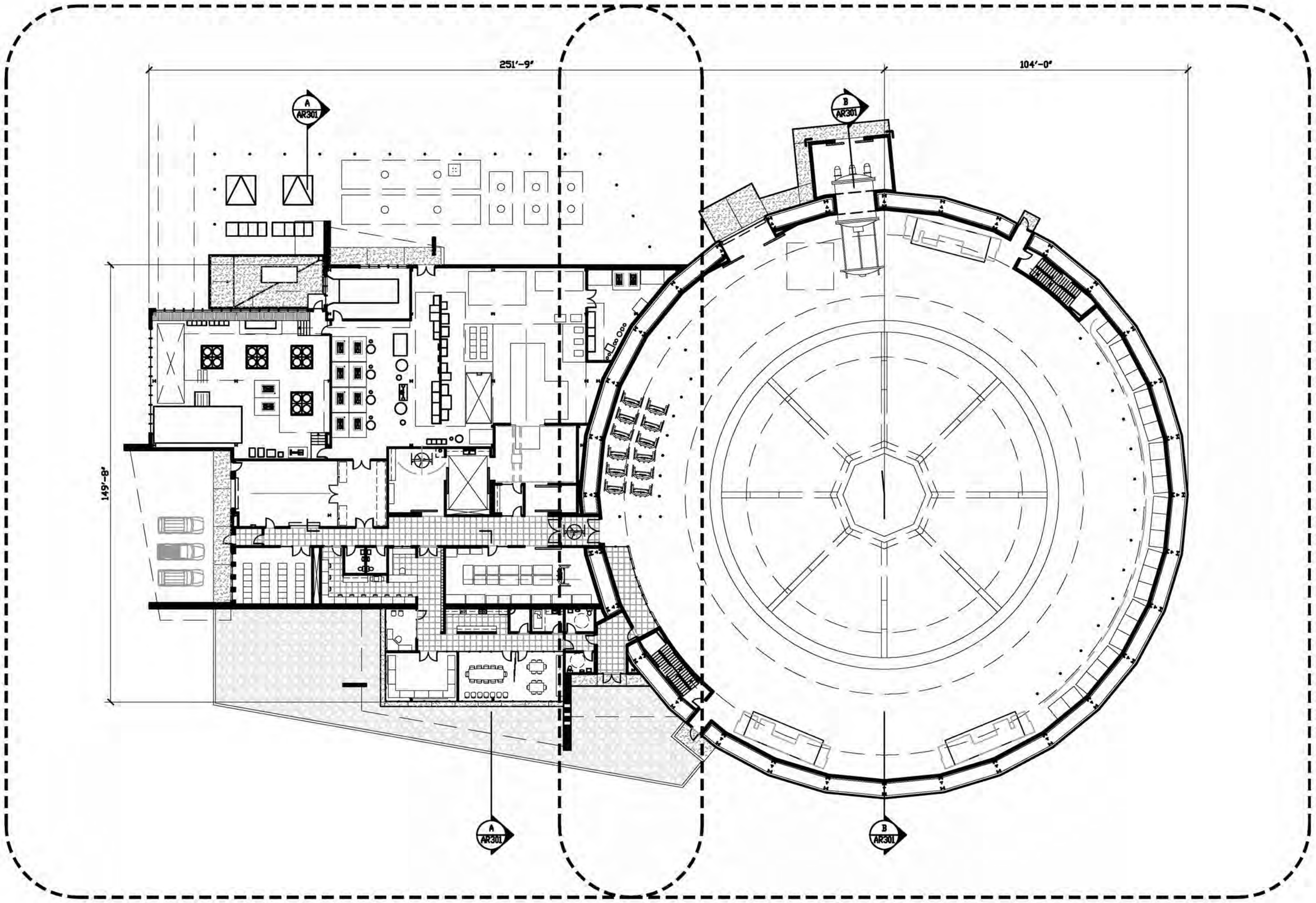
Drawing Title
ARCHITECTURAL SITE PLAN

Sheet Number
AS101

M3PN 07131

Last Update: 8.19.2010

KEY NOTES



SEE SHEET AR103 FOR
FLOOR PLAN OF THIS AREA

SEE SHEET AR102 FOR
FLOOR PLAN OF THIS AREA

OVERALL FLOOR PLAN

1/16"=1'-0"

NORTH

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

2601 W. SUNSET ROAD
SUITE NO. 101
TUCSON, ARIZONA

ARCHITECTURE
ENGINEERING
CONSTRUCTION MANAGEMENT

M3

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OVERALL
FLOOR PLAN

Sheet Number

AR101

PRELIMINARY
NOT FOR CONSTRUCTION

M3PN 07131

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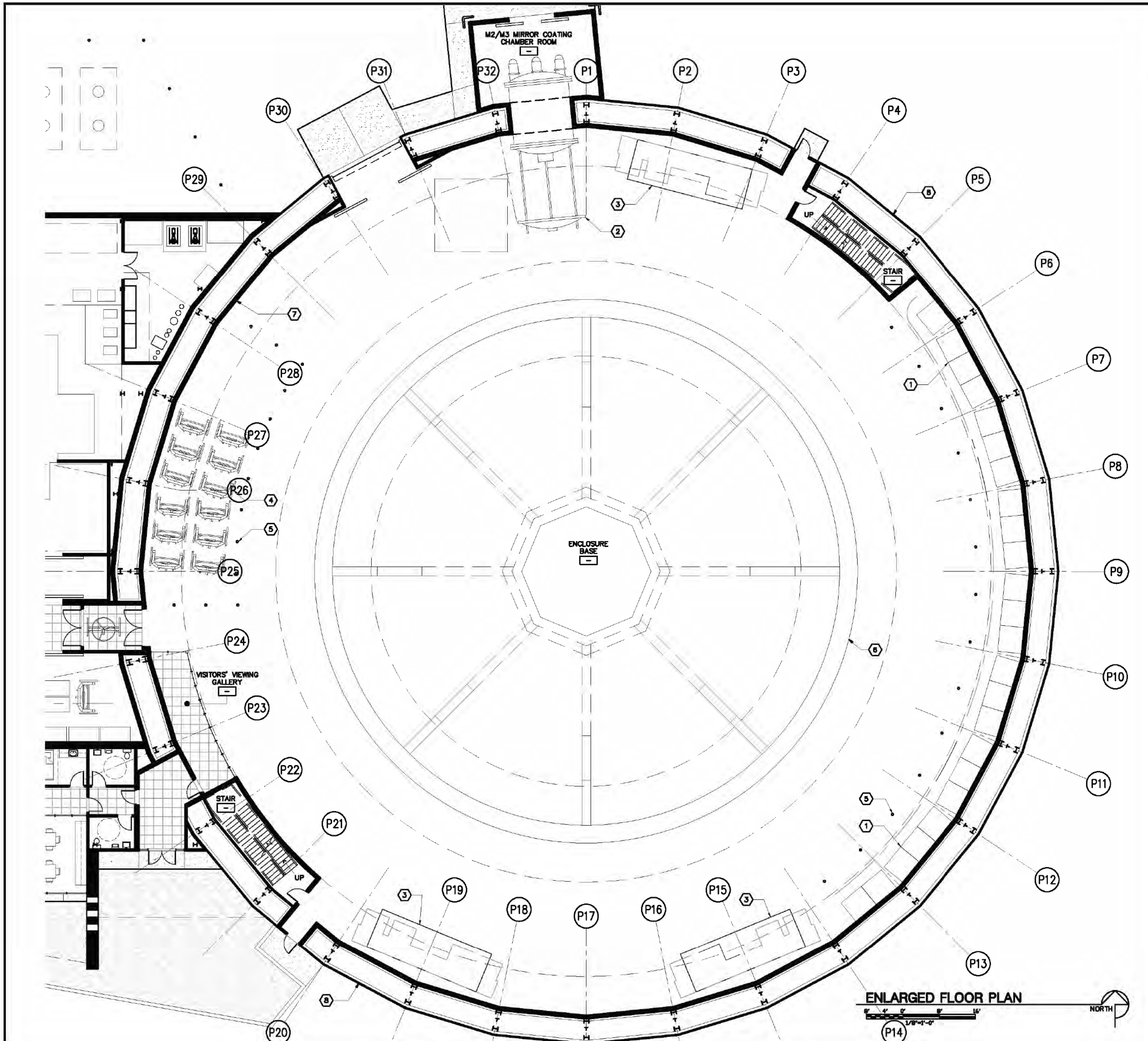

KEY NOTES

1. M1 MIRROR STORAGE CABINETS
2. M2/M3 COATING CHAMBER
3. DOME COOLING AIR HANDLER UNITS (TYPICAL OF 3)
4. M1 SEGMENT STAGING AREA
5. BOLLARD, TYP.
6. CONCRETE PIER
7. 10" INSULATED METAL WALL PANEL
8. EXTERIOR METAL PANEL

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

CONSTRUCTION MANAGEMENT

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Issue Date: 4-5-10

Drawing Title

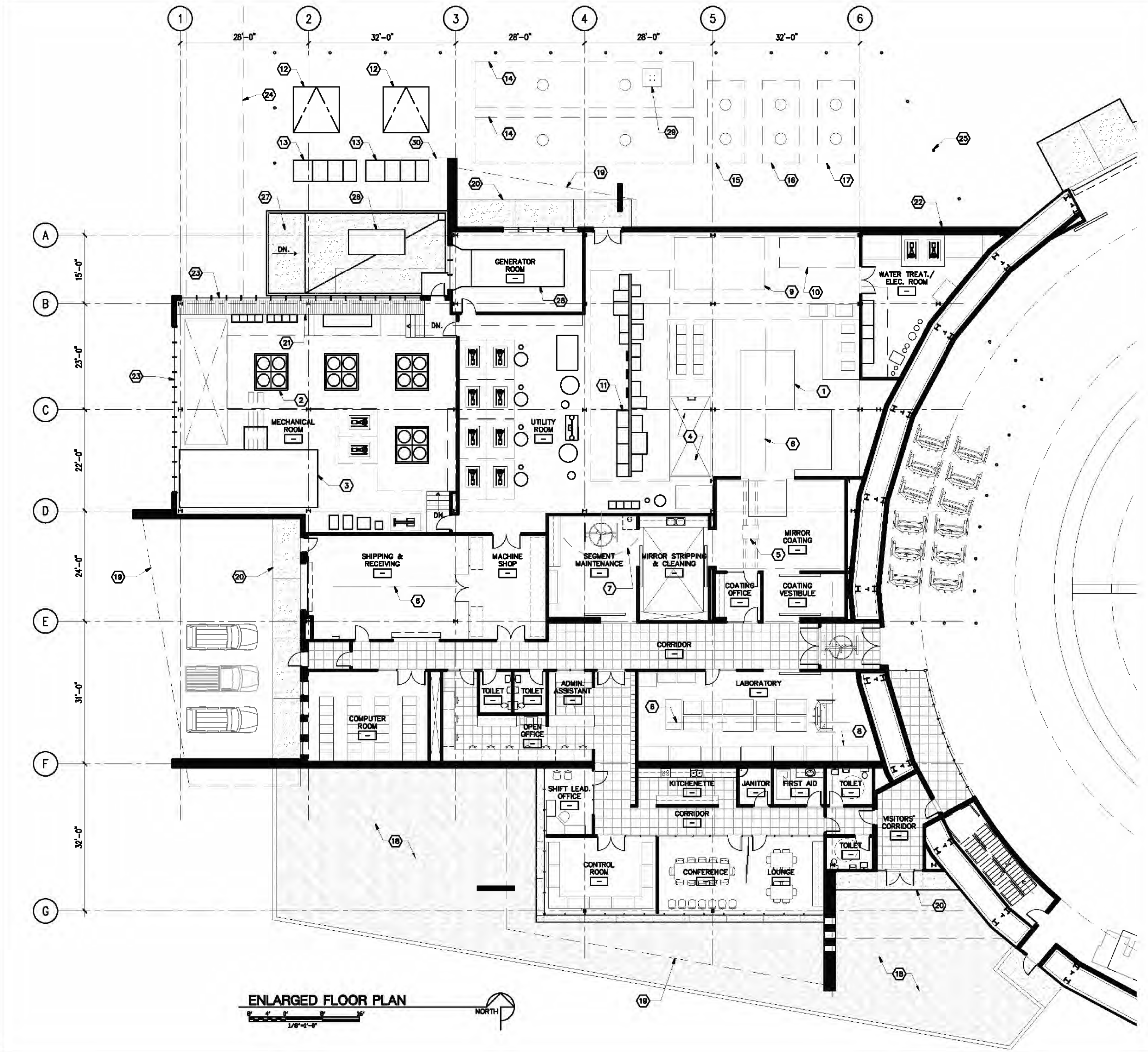
ENLARGED FLOOR PLAN

Sheet Number

AR102

PRELIMINARY
NOT FOR CONSTRUCTION

Last Update: 3.24.2010



KEY NOTES

1. M1 COATING CHAMBER
2. MECHANICAL CHILLERS (TYPICAL OF 4)
3. AIR ECONOMIZER
4. UTILITY CHASE
5. BRIDGE CRANE ABOVE
6. MONORAIL CRANE ABOVE
7. JIB CRANE
8. LABORATORY EQUIPMENT
9. HYDROSTATIC OIL EQUIPMENT
10. HYDROSTATIC OIL TANK
11. ELECTRICAL EQUIPMENT
12. HELCO SERVICE TRANSFORMER
13. ELECTRICAL SERVICE ENTRANCE SWITCHBOARD
14. UNDERGROUND FIRE WATER STORAGE TANK
15. UNDERGROUND 5,000 GALLON WATER STORAGE TANK
16. UNDERGROUND 5,000 GALLON WASTE STORAGE TANK
17. UNDERGROUND 5,000 GALLON DOUBLE CONTAINED CHEMICAL WASTE STORAGE TANK
18. NATIVE LANDSCAPING
19. ROOF ABOVE
20. CONCRETE WALK
21. DUCT SILENCER
22. EXTERIOR METAL PANEL
23. ACOUSTICAL LOUVER
24. UNDERGROUND EXHAUST TUNNEL
25. BOLLARD, TYP.
26. 2,000 GALLON ABOVE-GROUND DIESEL FUEL TANK
27. CONCRETE CONTAINMENT PAD AND FILL STATION
28. EMERGENCY GENERATOR
29. WEATHER STATION TOWER
30. ATMOSPHERIC TURBULENCE MONITOR ABOVE

THIRTY METER TELESCOPE

DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

CONSTRUCTION MANAGEMENT

Revisions

Description	Date

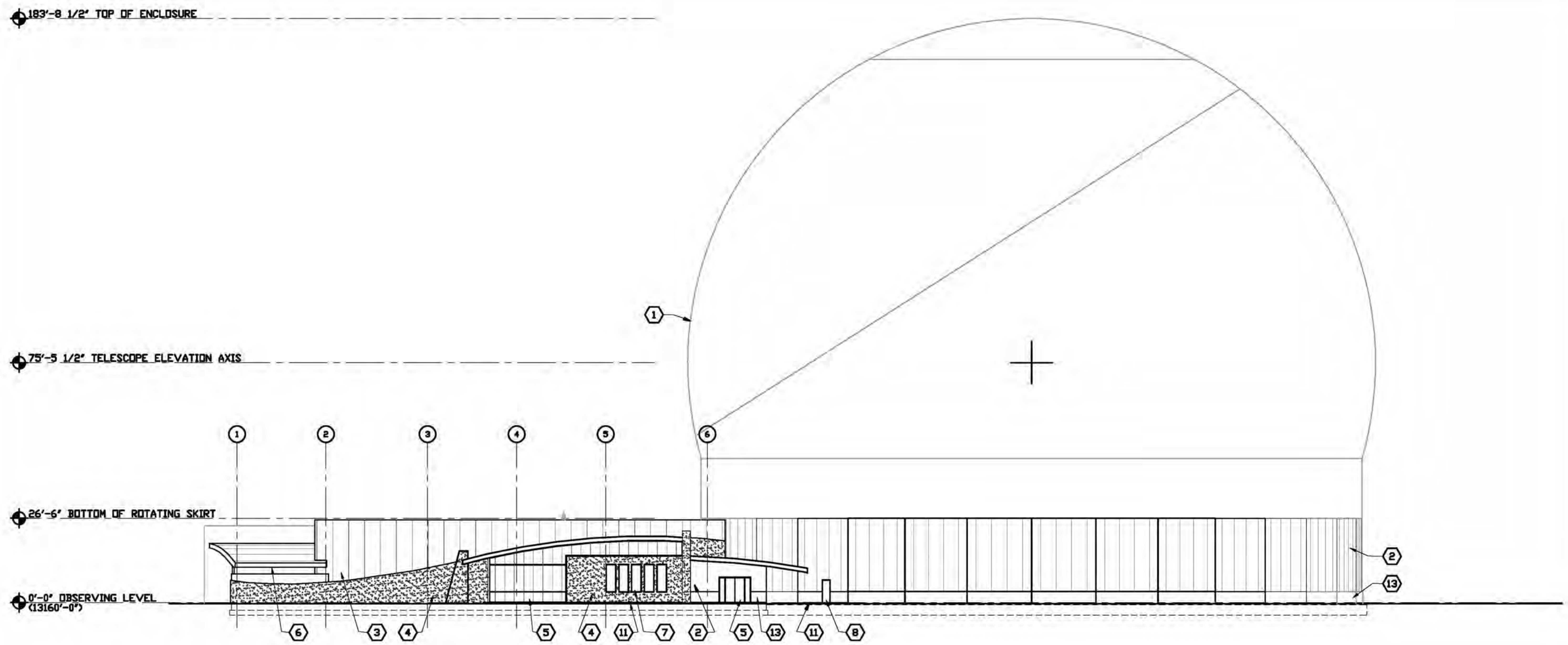
Drawn: E.J.S.
Checked: -
Issue Date: 4-5-10

Drawing Title
ENLARGED FLOOR PLAN

Sheet Number
AR103

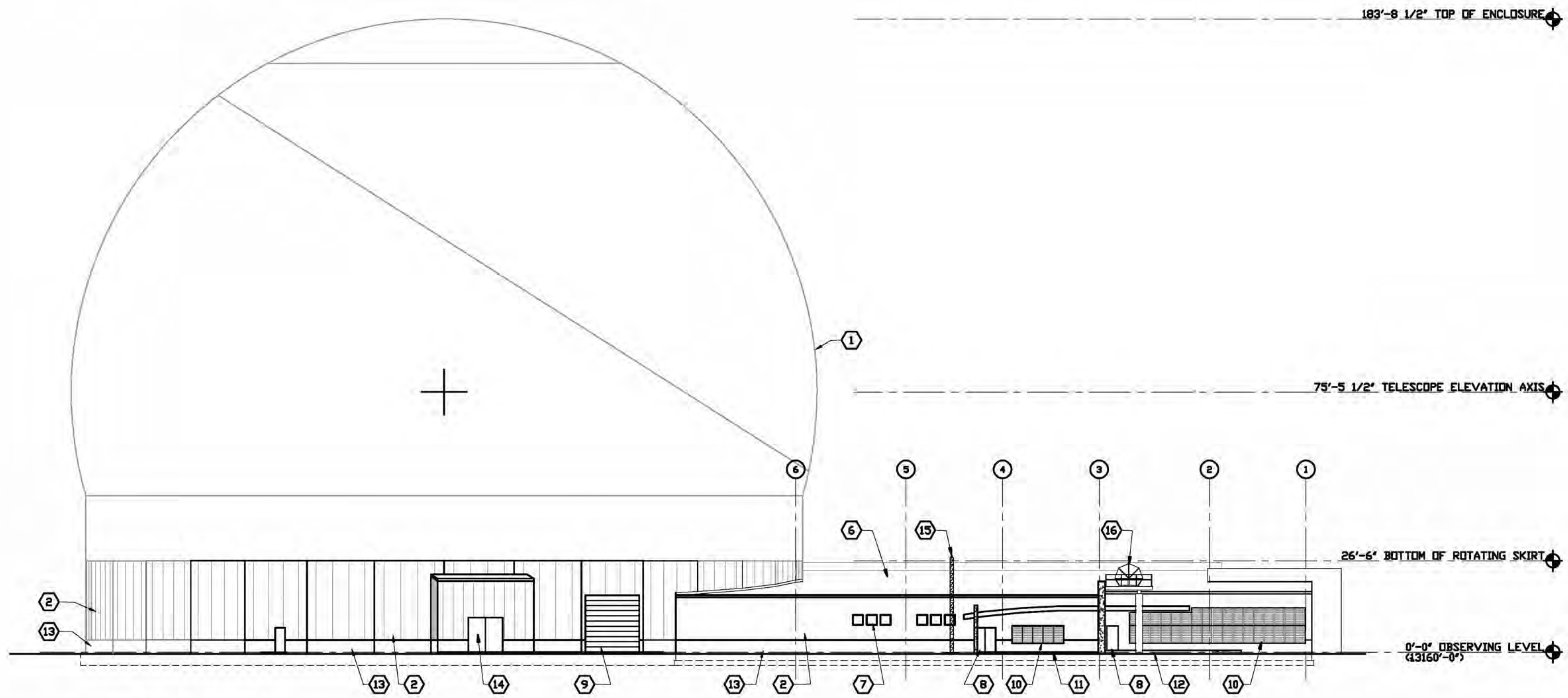
PRELIMINARY
NOT FOR CONSTRUCTION

Last Update: 3.26.2010



SOUTH ELEVATION

16' 8' 0' 16' 32'
1/16"=1'-0"



NORTH ELEVATION

16' 8' 0' 16' 32'
1/16"=1'-0"

KEY NOTES

1. DOME STRUCTURE N.I.C.
2. METAL SIDING
3. SMOOTH METAL SIDING
4. LAVA ROCK VENEER
5. ALUMINUM STOREFRONT WITH INSULATED GLAZING
6. METAL ROOF
7. ALUMINUM WINDOWS WITH INSULATED GLAZING
8. HOLLOW METAL DOORS AND FRAME (PAINT)
9. INSULATED COILING ROLL UP DOOR
10. ACOUSTICAL LOUVER
11. CONCRETE WALK OR STOOP
12. CONCRETE UTILITY PAD
13. CONCRETE WAINSCOT
14. INSULATED SLIDING DOOR
15. WEATHER STATION TOWER
16. ATMOSPHERIC TURBULENCE MONITOR

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

2601 W. SUNSET ROAD
SUITE NO. 101
TUCSON, ARIZONA

m3
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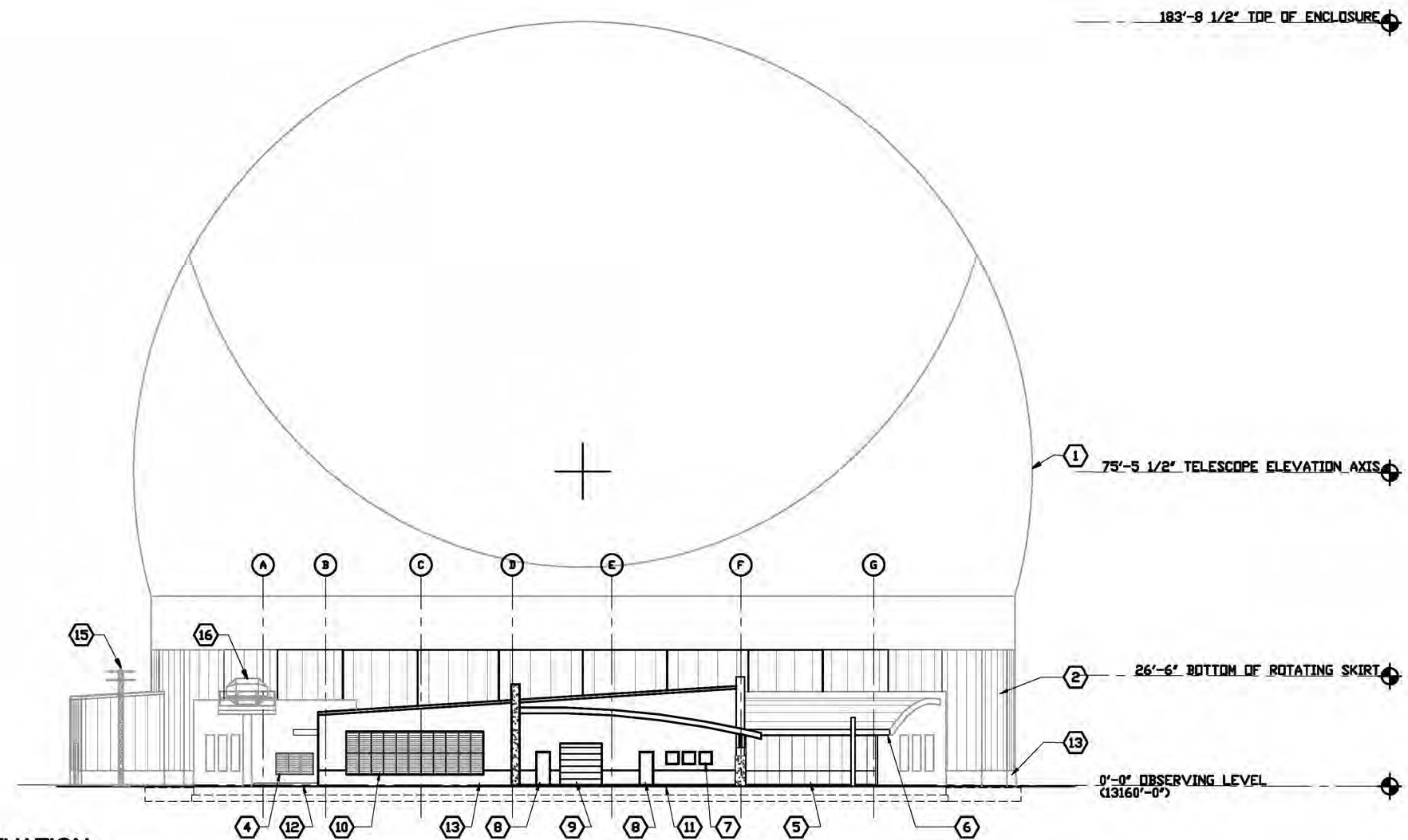
Drawn: E.I.G.
Checked: -
Issue Date: 4-5-10

Drawing Title
BUILDING ELEVATIONS

Sheet Number
AR201

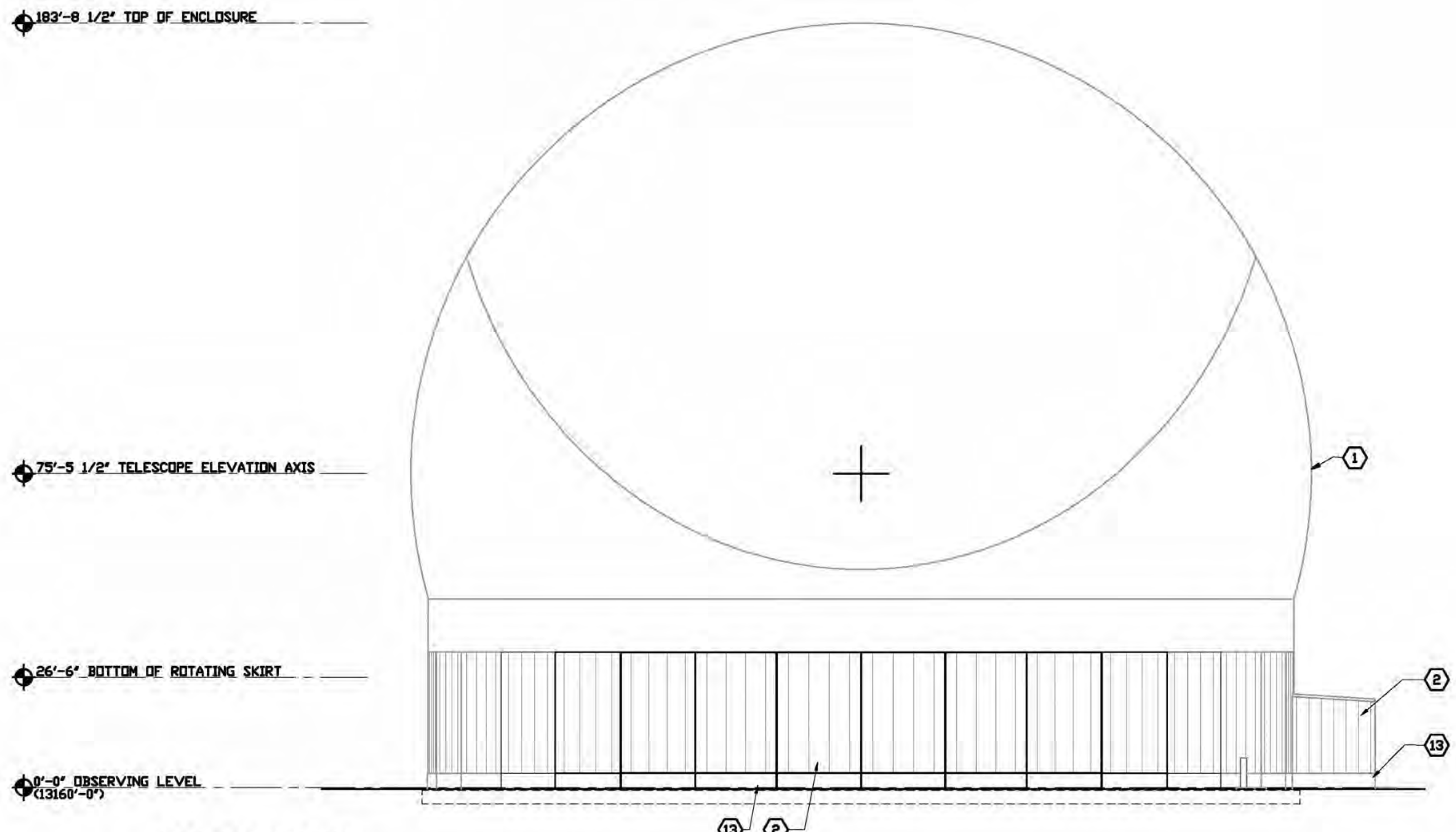
M3PN 07131

Last Update: 3.28.2010



WEST ELEVATION

1/16"=1'-0"



EAST ELEVATION

1/16"=1'-0"

KEY NOTES

1. DOME STRUCTURE N.I.C.
2. METAL SIDING
3. SMOOTH METAL SIDING
4. LAVA ROCK VENEER
5. ALUMINUM STOREFRONT WITH INSULATED GLAZING
6. METAL ROOF
7. ALUMINUM WINDOWS WITH INSULATED GLAZING
8. HOLLOW METAL DOORS AND FRAME (PAINT)
9. INSULATED COILING ROLL UP DOOR
10. ACOUSTICAL LOUVER
11. CONCRETE WALK OR STOOP
12. CONCRETE UTILITY PAD
13. CONCRETE WAINSCOT
14. INSULATED SLIDING DOOR
15. WEATHER STATION TOWER
16. ATMOSPHERIC TURBULENCE MONITOR

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

ARCHITECTURE ENGINEERING CONSTRUCTION MANAGEMENT

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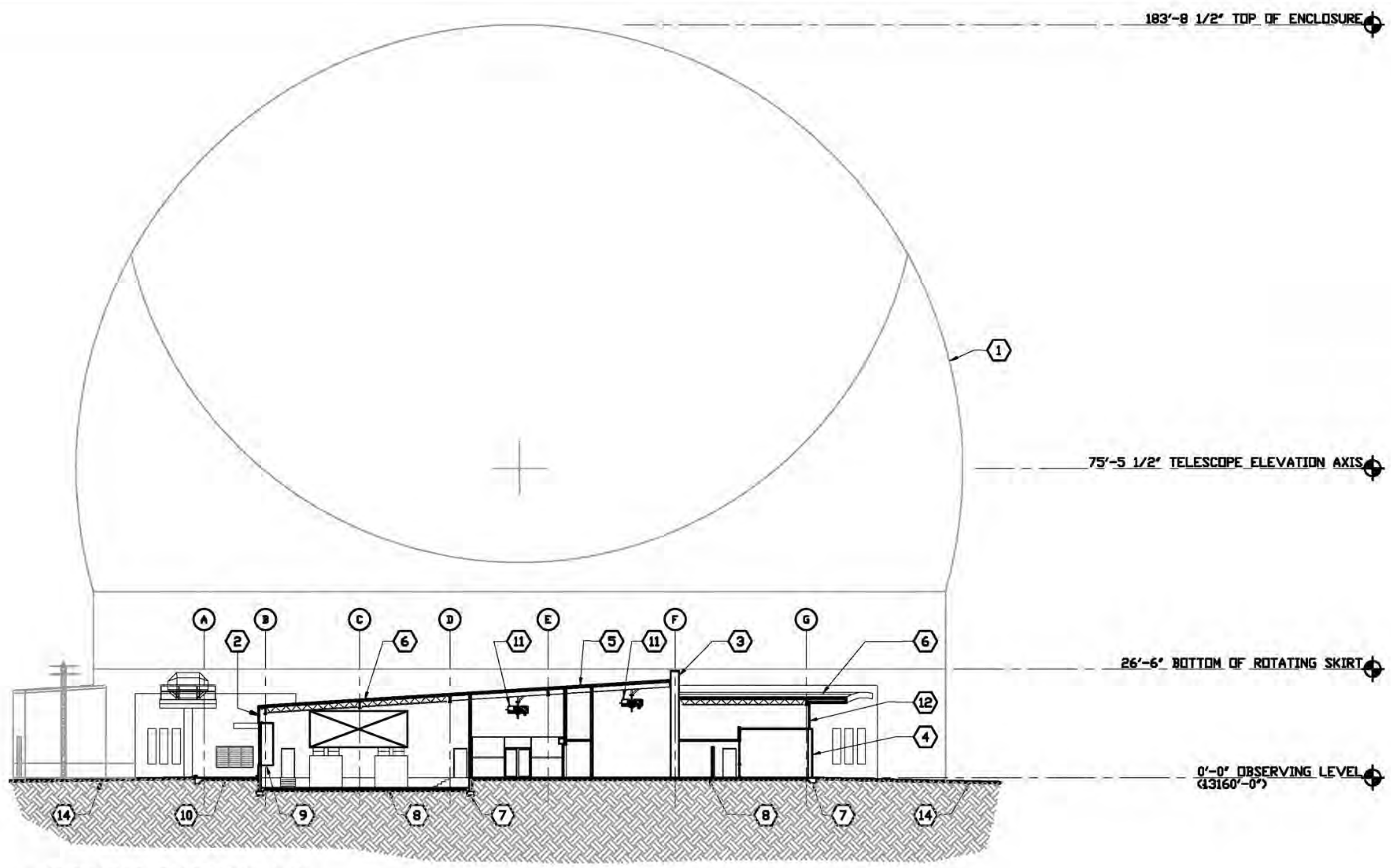
Drawing Title
BUILDING ELEVATIONS

Sheet Number
AR202

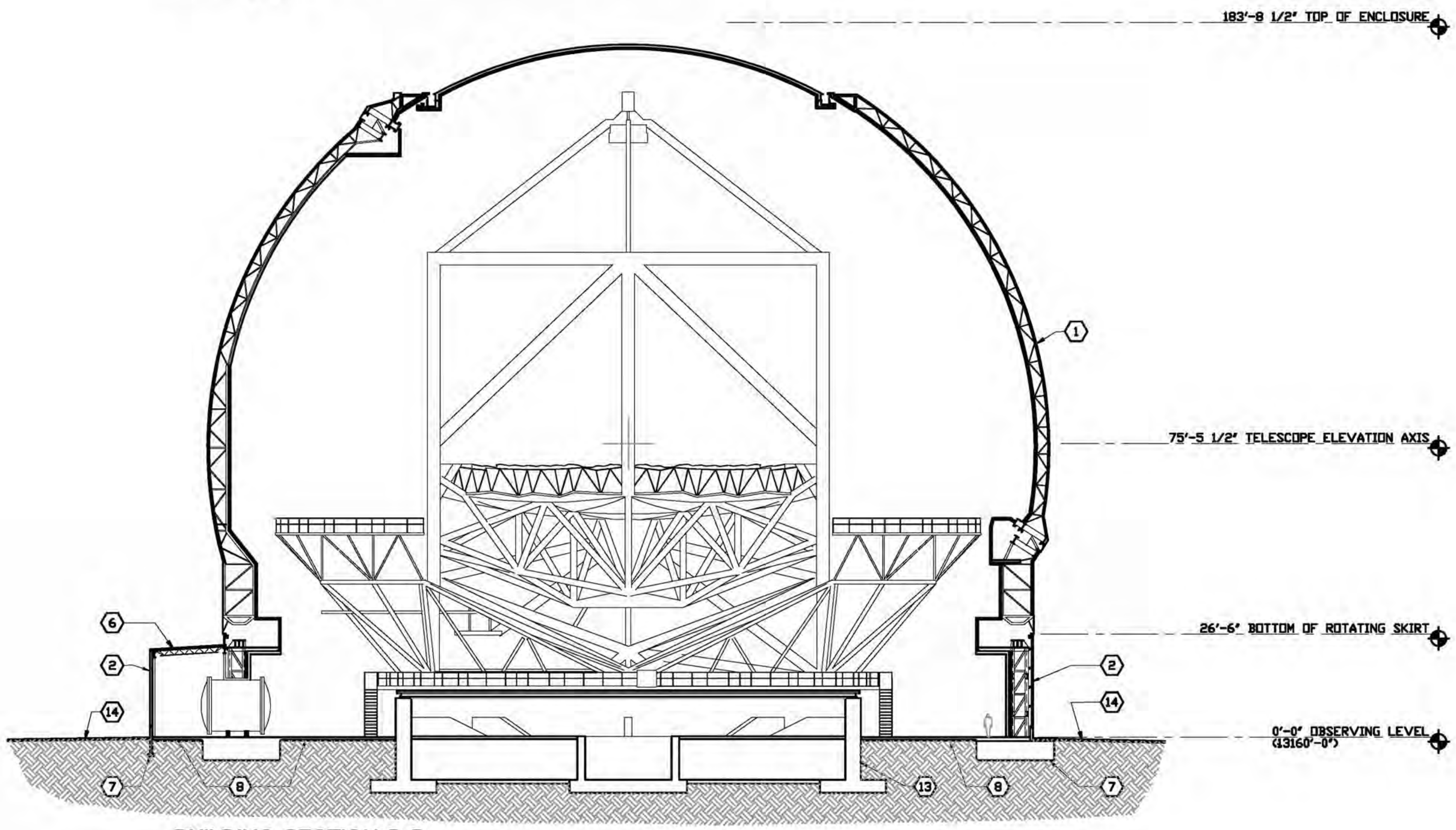
M3PN 07131

Last Update: 3.26.2010



BUILDING SECTION A-A

1/16"=1'-0"



BUILDING SECTION B-B

1/16"=1'-0"

KEY NOTES

1. DOME STRUCTURE N.I.C.
2. METAL SIDING ON GIRTS
3. SMOOTH METAL SIDING ON GIRTS
4. LAVA ROCK VENEER ON STRUCTURAL STEEL STUDS
5. METAL ROOF ON METAL DECK OVER STEEL BEAMS
6. METAL ROOF ON METAL DECK OVER METAL JOISTS
7. CONCRETE FOOTING – SEE STRUCTURAL DRAWINGS
8. CONCRETE FLOOR – SEE STRUCTURAL DRAWINGS
9. ACOUSTICAL LOUVER AND DUCT SILENCER
10. CONCRETE UTILITY PAD
11. MONORAIL HOIST
12. ALUMINUM STOREFRONT WITH INSULATED GLAZING
13. CONCRETE PIER – SEE STRUCTURAL DRAWINGS
14. FINISH GRADE

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
DESIGN DEVELOPMENT SUBMITTAL
FOR THE OFFICE OF MAUNA KEA MANAGEMENT
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
ENGINEERING
CONSTRUCTION MANAGEMENT
2051 W. SUNSET ROAD
SUITE NO. 101
TUCSON, ARIZONA
WWW.M3ENG.COM

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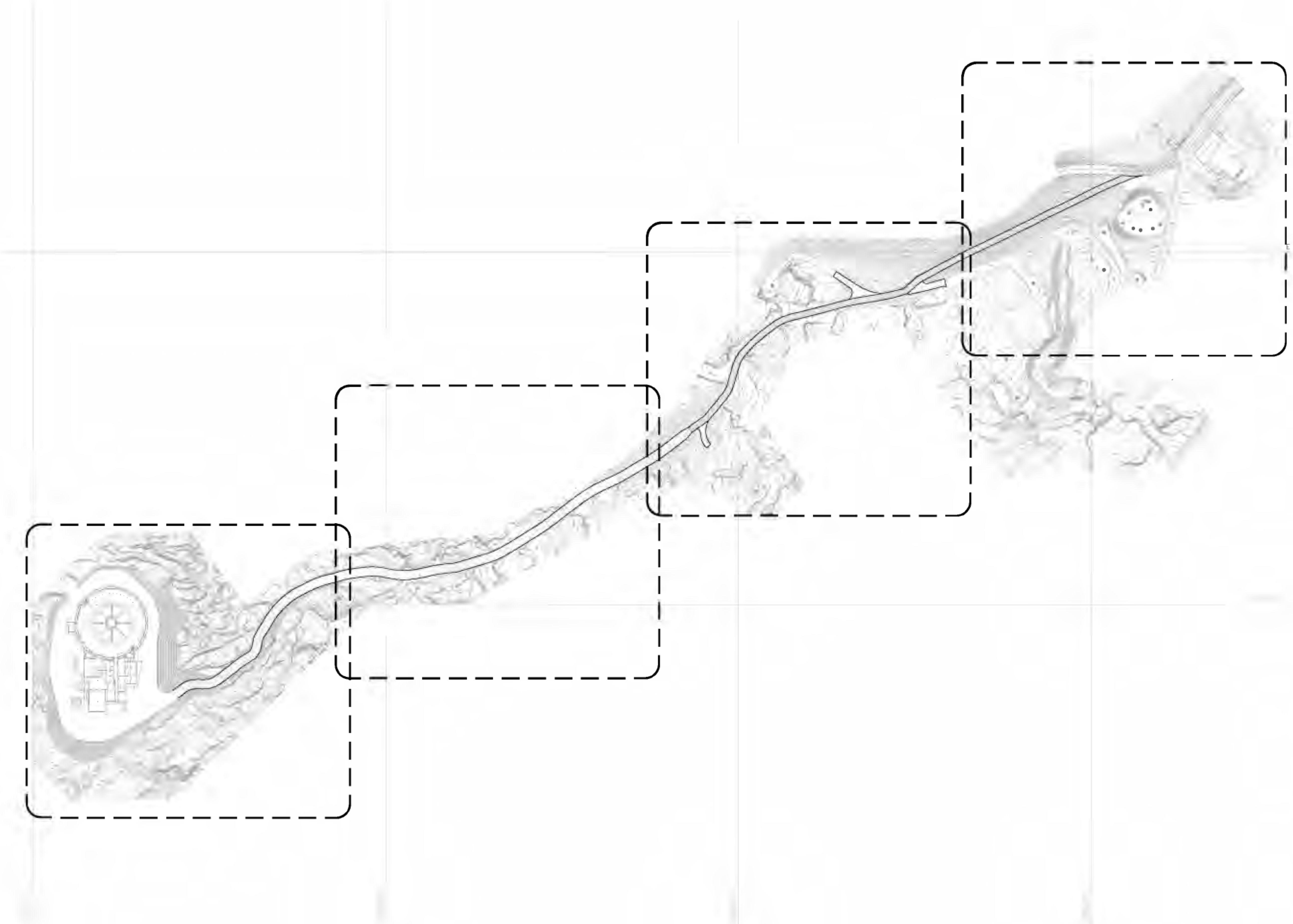
Drawing Title
BUILDING SECTIONS

Sheet Number
AR301

M3PN 07131

Last Update: 3.26.2010



CIVIL OVERALL SITE PLAN

100' 50' 0' 100' 200'

1" = 100'

NORTH

PRELIMINARY

NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE

CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE

SCHEMATIC DESIGN PACKAGE

MAUNA KEA, HAWAII

TMT

2051 W. SUNSET ROAD
SUITE NO. 101
TUCSON, ARIZONA 85704

ARCHITECTURE
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Issue Date: 9–1–10

Drawing Title

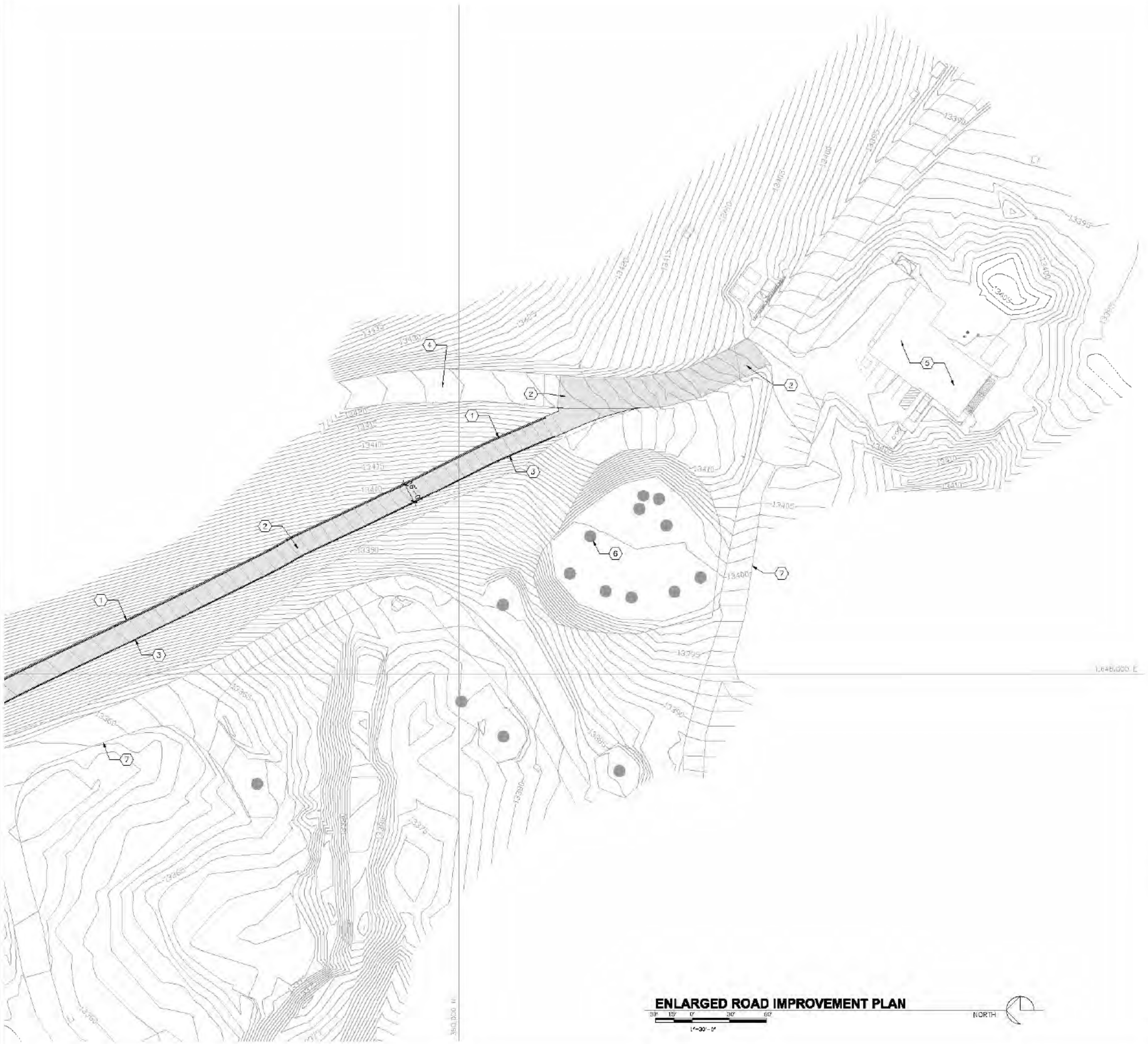
CIVIL OVERALL SITE PLAN

Sheet Number

CS101

M3PN 07131

Last Update: 8.30.2010

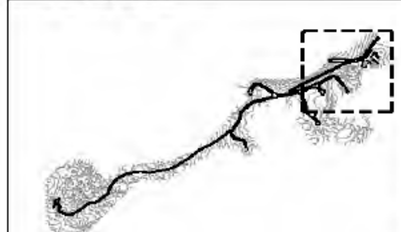


ENLARGED ROAD IMPROVEMENT PLAN

KEY NOTES

1. 6" VERTICAL CONCRETE CURB
2. 3" ASPHALT OVER 4" ABC
3. VEHICULAR GUARDRAIL
4. EXISTING MAUNA KEA LOOP ROAD (DIRT)
5. SMA ARRAY FACILITY
6. SMA CONCRETE ANTENNA PAD, TYP.
7. EXISTING SMA ACCESS ROAD (DIRT)

KEY PLAN



PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE
SCHEMATIC DESIGN PACKAGE
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
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Drawn: EJG
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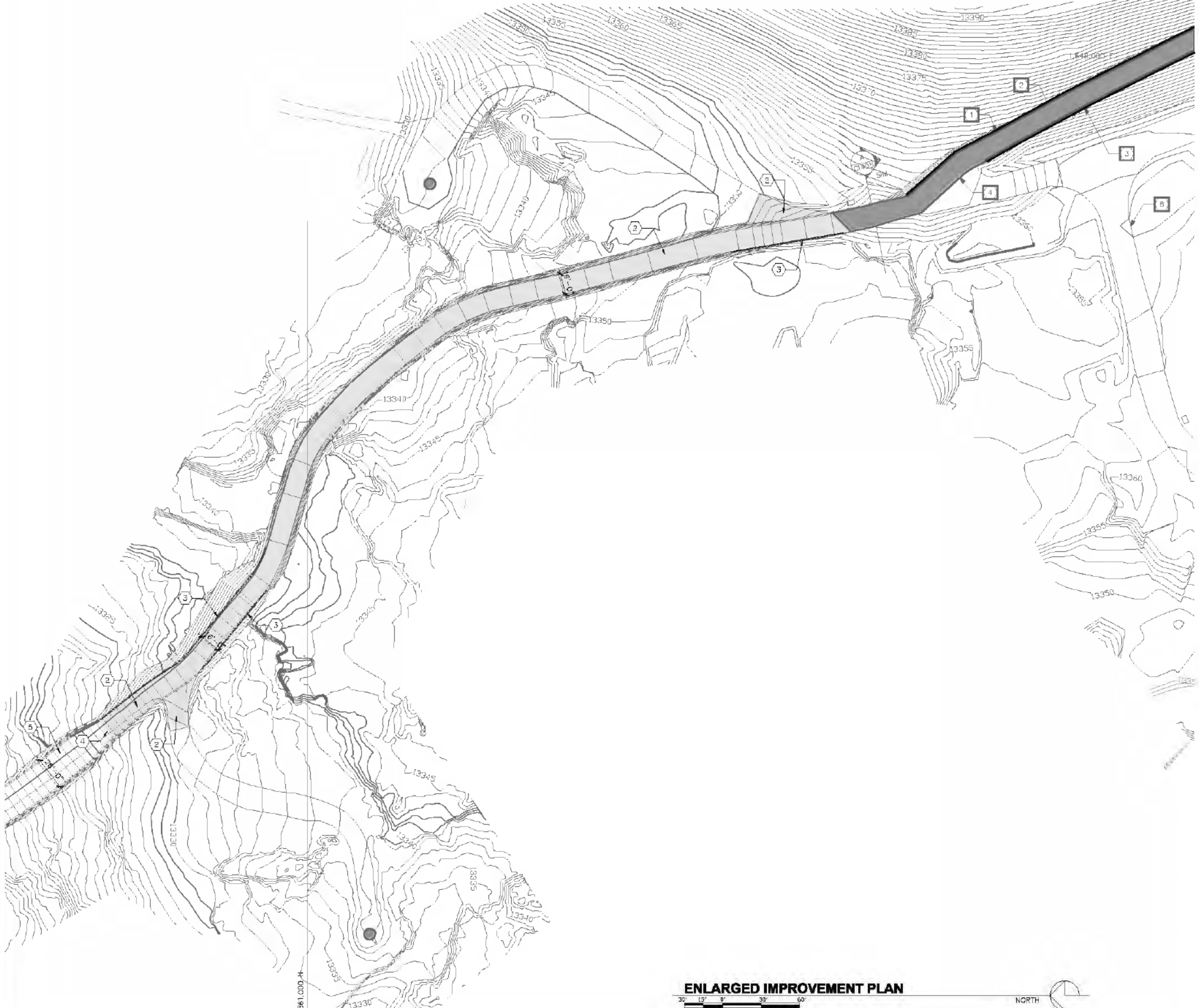
Issue Date: 9-1-10

Drawing Title
ENLARGED ROAD IMPROVEMENT PLAN

Sheet Number
CI401

MSPN 07131

Last Update: 8.30.2010



ENLARGED IMPROVEMENT PLAN

1"=30'-0"

NORTH

KEY NOTES

1. 6" VERTICAL CONCRETE CURB
2. 3" ASPHALT OVER 4" ABC
3. VEHICULAR GUARDRAIL
4. EDGE OF ASPHALT
5. TMT ACCESS ROAD – DIRT
6. –

KEY PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE

CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE
SCHEMATIC DESIGN PACKAGE
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
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Drawn: EJG
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Issue Date: 9–1–10

Drawing Title
ENLARGED IMPROVEMENT PLAN

Sheet Number
CI402

M3PN 07131

Last Update: 8.17.2010

KEY NOTES

1. TMT ACCESS ROAD – DIRT
2. –

ENLARGED IMPROVEMENT PLAN

30' 15' 0' 30' 60'

1"=30'-0"

NORTH

KEY PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE
SCHEMATIC DESIGN PACKAGE
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
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ENLARGED IMPROVEMENT PLAN

Sheet Number

CI403

M3PN 07131

Last Update: 8.17.2010

ENLARGED IMPROVEMENT PLAN

30' 15' 0' 30' 60'
1"=30'-0"
NORTH

KEY NOTES

1. VEHICULAR GUARDRAIL
2. SITE DRAINAGE SWALE
3. 2" DECOMPOSED GRANITE
4. —
5. —
6. —

KEY PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

THIRTY METER TELESCOPE
CIVIL, SUMMIT FACILITIES, AND FIXED ENCLOSURE
SCHEMATIC DESIGN PACKAGE
MAUNA KEA, HAWAII

TMT

ARCHITECTURE
ENGINEERING
CONSTRUCTION MANAGEMENT

2601 W. SUNSET ROAD
SUITE NO. 151
TUCSON, ARIZONA 85704

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Drawn: EJG
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Issue Date: 9–1–10

Drawing Title
ENLARGED IMPROVEMENT PLAN

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CI404

M3PN 07131

Last Update: 8.17.2010