



UNM-TAOS CAMPUS OBSERVATORY FEASIBILITY STUDY

January 2023

PROJECT TEAM

OWNER / CLIENT - **UNM** | UNIVERSITY OF NEW MEXICO

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1.0 Executive Summary

With the intent to strengthen the overall campus experience, community, and culture of the campus and northern New Mexico, UNM-Taos is presented with a unique opportunity to expand and improve outreach, presentation, study, and preservation of one of the world's most precious natural resources: the night sky.

In its current location on UNM-Taos' campus, the Science department conducts its astronomical observations out of a temporary pre-fabricated metal storage shed with a small area of concrete pavers. Makeshift light shielding is ineffective at blocking transient light sources from campus and nearby roads from reaching telescope lenses. ADA access to the site is inadequate.

UNM-Taos' current facilities require the following:

- Infrastructure to support a large-aperture telescope and equipment with tracking capability
- Meet or exceed minimum observational conditions by effectively controlling/shielding light pollution
- Provide sufficient storage for the UNM-Taos campus telescope collection which now includes northern New Mexico's largest telescope¹; a 36-inch diameter, 12-foot tall operable Dobsonian telescope recently donated to the University by a local resident.

The purpose and value of the campus observatory is to:

- Provide engaging, hands-on experience to students and community members of all ages.
- Create a space to carry out observational studies and outreach activities.
- Educate students and the local community on the natural resource that is the night sky, and "put discoveries made both near and far into a larger historical and societal context."²

A dedicated observatory facility at UNM-Taos campus will allow for proper housing and storage of the UNM-Taos campus telescope collection, more adequate light shielding, and a flexible, multi-use classroom for UNM students, community members, and local K-12 students.

View of UNM-Taos campus from proposed site (looking East).



"The new observatory will be a center to educate and inspire students, residents, and visitors of Northern New Mexico."

-Colin Nicholls, UNM-Taos Science Department Chair

¹ Nicholls, C. (2020, November). "36" Telescope Donation Briefing Document". UNM Department of Math & Science.

² De Pree, C., & Scoles, S. (2022, April). "The Past, Present, and Future of College Observatories". Sky & Telescope.

1.1 The Vision

UNM-Taos proposes to build an Astronomy Center on its campus. The goal of this center will be to offer regional K-12 students and residents, as well as visitors to this very rural area, an opportunity to experience and connect to Astronomy as well as other scientific fields relevant to Northern New Mexico.

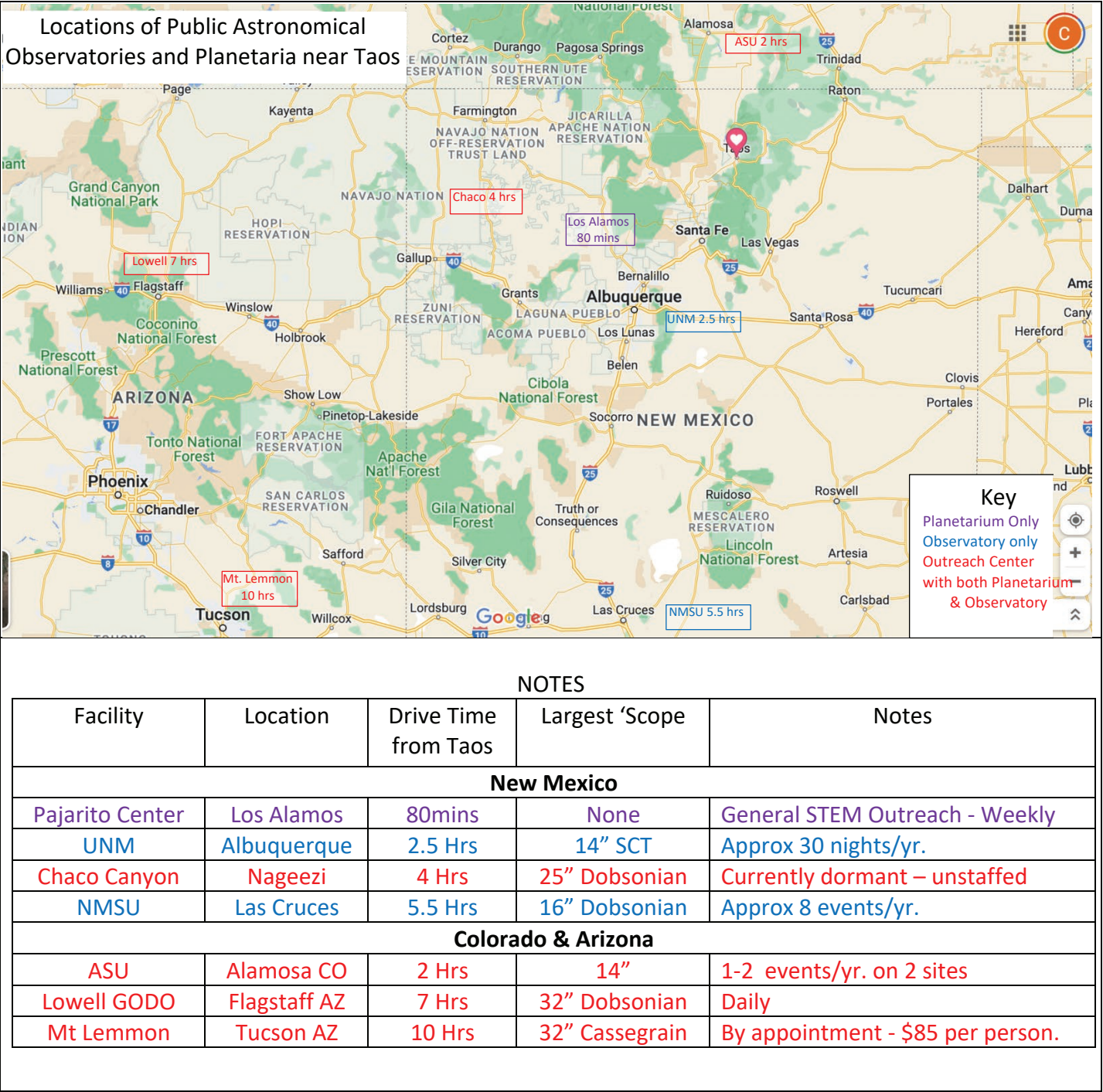
The center will be unique in New Mexico in that it is in a dark sky location, has the largest public telescope in the state, offers an observatory and a planetarium, which allows students and visitors to enjoy hands-on learning experiences and operate some of the college’s telescopes. The closest comparable facility is in Flagstaff AZ, which is a 7 hour drive from Taos (See map to the right).

The heart of the center will be the astronomical observatory, which will house a large telescope (36- inch diameter mirror, 12-foot tall) recently donated to the college by a local resident. This telescope will be the largest telescope in New Mexico accessible to the public. It will be used to take advantage of the area’s dark skies to show planets, nebulae, star clusters and distant galaxies to students in STEM classes as well as to local students and visitors in regularly scheduled public viewing events. The college’s smaller telescopes and binoculars will be stored at the center and will be made available for use by visitors on the open nights. Local astronomy clubs will also have access to the facilities. There will be an outdoor planetarium-where visitors will be shown images and details of celestial objects, which will then be pointed out to them in the night sky. The last major component of the center will be a multi-use classroom/exhibition hall/learning space that will be used for classes, public meetings, lectures & other activities.

The area around the UNM-Taos has excellent dark skies very suitable for astronomical observations using telescopes, binoculars or even just un-aided eyesight. Less than 1% of the population of the US and Europe are able to experience dark skies, so the campus’s dark skies, where you can see the Andromeda Galaxy (2.5 Million light years away) with your un-aided eye, is a precious resource. These dark skies will not only be used to show students and visitors some of the wonders of the universe, but also be used to educate them on the consequences of light pollution, such as wasted energy, the enforced disconnection of people from their cultural heritage and the disruption to wildlife and the ecosystem caused by light pollution.

It is anticipated that the proposed center will house activities to educate and inspire students and visitors, be used on a regular basis for exhibitions and astronomical observing sessions and will become an attraction for visitors and tourists coming into the region.

While the center will primarily focus on Astronomy, it could also host activities and exhibitions in Natural Resource Management (e.g. Forestry, Wildlife Biology, Ecology, Water Resources) and Geology. Since the UNM-Taos campus has a 500 KW Solar panel array and houses the Cisneros Acequia Archives, activities and exhibitions in cultural water resources and renewable energy sources could also be displayed.



A new observatory at UNM-Taos will house the largest operable telescope in Northern New Mexico¹

A Dobsonian telescope that is:

- Altazimuth-mounted
- 36-inch diameter
- 12-foot, 6-inch tall
- Large aperture and long focal length

This allows college and K-12 students, community members and visitors to the region to observe thousands of celestial objects across the northern New Mexico sky.

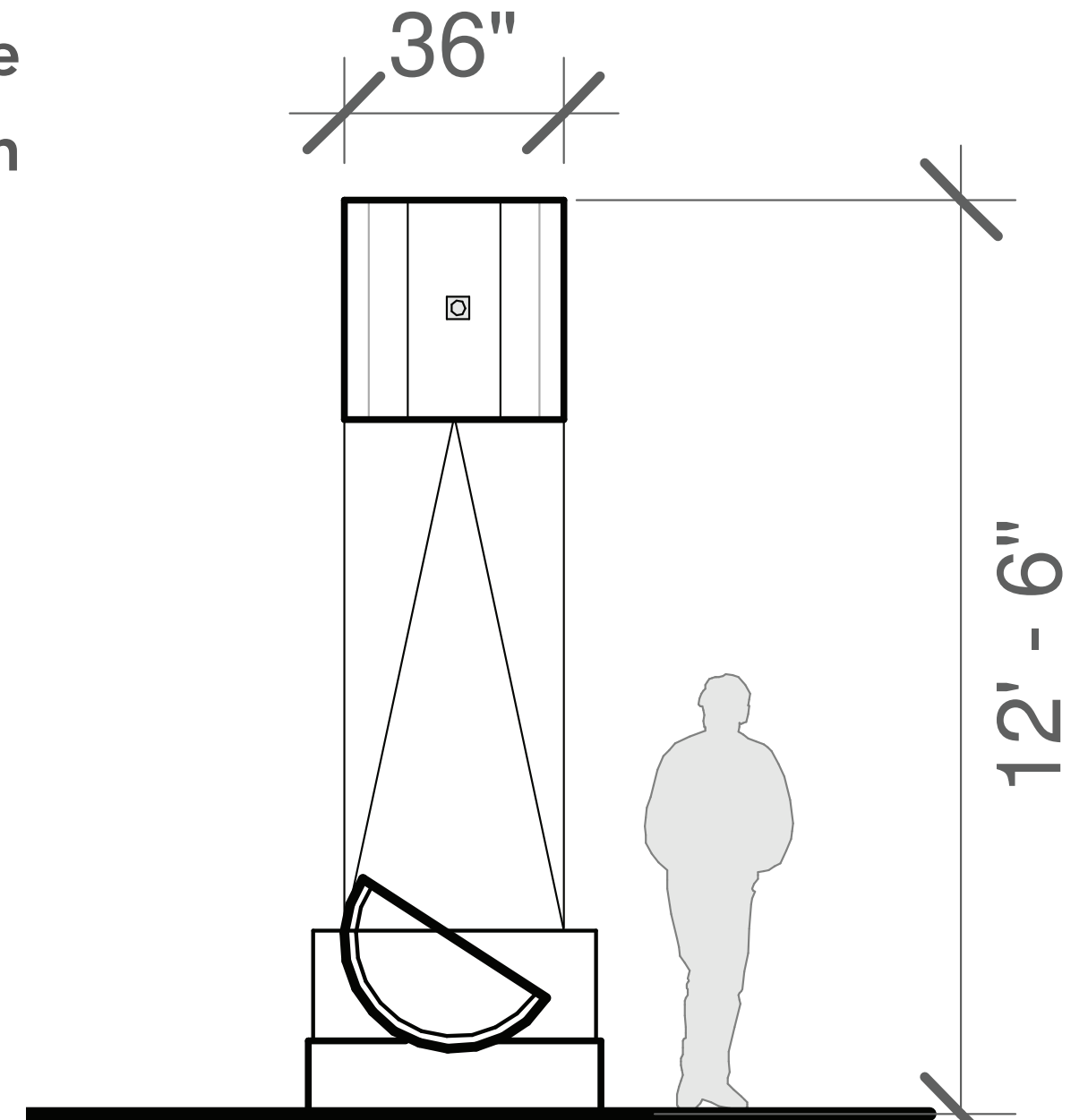


Diagram to illustrate telescope size relative to silhouette of 6' average height individual

¹ Nicholls, C. (2020, November). "36" Telescope Donation Briefing Document". UNM Department of Math & Science.
SSA | UNM-Taos Campus Observatory Feasibility Study

2.0 Site Analysis & Existing Conditions

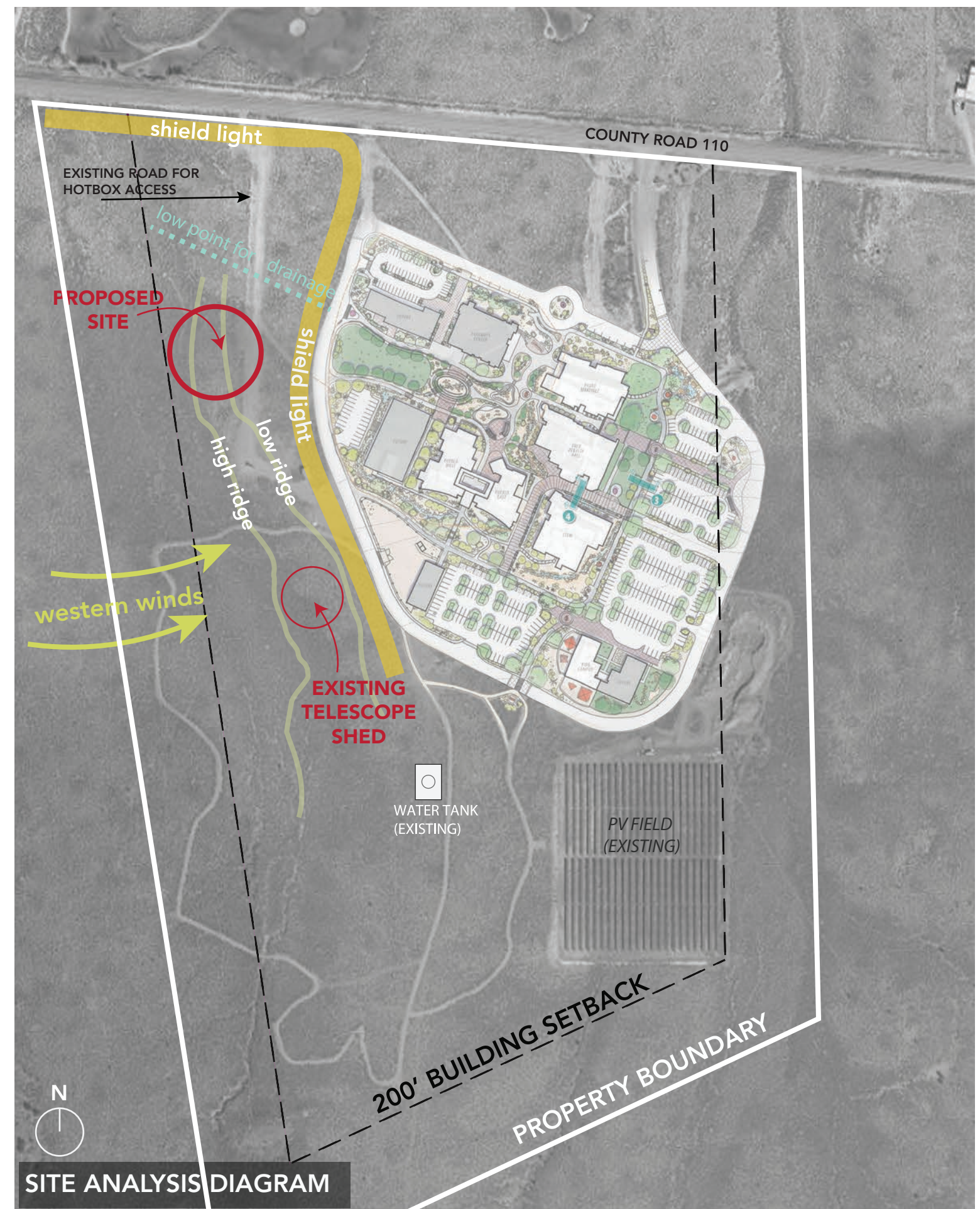
The UNM-Taos campus sits atop a ridge off of NM State Road 58 and County Road 110. The area is exceptionally valuable for its access to dark skies which are ideal for astronomical observations.

The campus' access to dark skies is a precious resource which can be used to show students and visitors some of the wonders of the universe.

The proposed site includes the following assets to the campus observatory:

- Access to dark skies
- Proximity to existing utilities
- Coordination with new developments per the Infrastructure Improvements Framework Plan³
- An unparalleled observatory experience in Northern New Mexico

The site analysis diagram on the right shows an aerial photo of the UNM-Taos campus superimposed with the Campus Infrastructure Improvements Framework Plan's³ site plan and proposed site located between high and low ridge lines. The current issues of high western winds and light pollution from the campus and roads call for shielding methods to protect the observatory's functionality and visitors experience. Watershed drainage from mountains to the South (Picuris Mountains) suggests locating the new facility on the high side of the ridge as opposed to the possible drainage way, further West.



³ MRWM Landscape Architects. (November, 2022) "UNM Taos Klauer Campus Infrastructure Improvements Framework Plan".

2.1 Existing Telescope Storage & Use Conditions

UNM-Taos’ existing telescope storage and observation area operates out of a pre-fabricated metal storage shed. Currently, the campus telescopes are wheeled out onto a brick paver pad.

The current storage shed (roughly 150 square feet) has room to house the UNM-Taos campus collection of around 15 small to medium telescopes; however, the campus’ new **36-inch Dobsonian telescope requires disassembly and reassembly to be stored due to its 12 foot height.**

The current site employs a makeshift shielding method to attempt to block light interference from vehicular headlights and campus lighting.

The current facility sits atop a ridge that is difficult to access from campus and adjacent parking lots. Existing trails, landscape, and topography make the current site a challenge to access. **Additionally, the 36-inch Dobsonian telescope, has an eyepiece height of 11 feet 4 inches from the ground, which requires a lift, projection camera, or extended eyepiece for full accessible (ADA) use.**

- 3 methods to achieve ADA accessibility to use the 36-inch Dobsonian telescope:**
- Chair lift and assistant platform
 - Computer projection
 - Extended eye piece (requires custom development)

For the purpose of this study, the chair lift and assistant platform will be included in the overall cost estimate. This method could also be supplemented with a computer projector for larger crowd viewings.

TELESCOPE STORAGE



12’ tall Dobsonian telescope currently needs to be disassembled for proper storage. A larger storage space would allow the telescope to be stored fully assembled.



The existing telescope storage shed which holds approximately 15 telescopes of various sizes



The existing shed is faced with OSB/flake board, exposed wood studs and exposed plywood floors, and exterior metal cladding.

SHIELDING METHOD



View to the proposed site as seen from UNM-Taos Campus. An addition of a berm would shield light from campus and roads.



View of UNM-Taos campus from proposed site. Locating the classroom building on the west side of site would block strong western wind.



Down-lighting on campus buildings and parking lots at sunset.

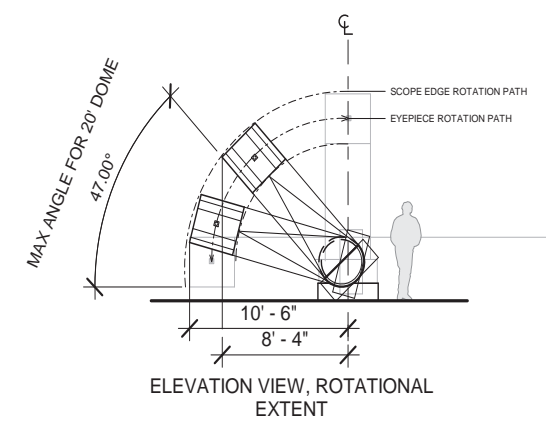
ACCESSIBILITY CHALLENGES



The existing trail loop that provides access to the telescope shed.



New pedestrian paths will need to be developed to have proper ADA access to the proposed site with the addition of path lighting that complies with the Night Sky Protection Act.



The eyepiece location on the Dobsonian telescope requires a ladder or lift for use. A solution would need to be further studied to allow full accessibility to use the telescope in a safe manner.

3.1 Space List and Diagrams

The following programmatic requirements and square footages are necessary to create the UNM-Taos Campus Observatory based on the desired use of the 36 inch Starsplitter-style Dobsonian telescope:

Space List

- Telescope storage space must be double that of the current existing space (minimum 300 square feet)
- A mechanical room no larger than 150 square feet to house any electrical, mechanical, or technological equipment required for the operation of the observatory
- A 30-foot diameter observatory dome, manufactured by AshDome or similar to allow for operation and housing of UNM-Taos’ 36-inch Dobsonian telescope
- 12 foot tall CMU base with two external access doors for dome to rest atop
- 1,000 square feet of classroom space to be used for astronomy programs
- Singular unisex ADA accessible restroom
- Janitor closet with mopsink
- Entry vestibule (225 square feet)
- Space accounting for corridors, interior, and exterior walls (22%)
- 1,700 square foot exterior observation pad
- Outdoor planetarium / amphitheater and seating to accommodate 50 people
- 20 parking spaces per future development identified in the UNM-Taos Infrastructure Improvement Plan

UNM-Taos Campus Observatory Feasibility Study Space List

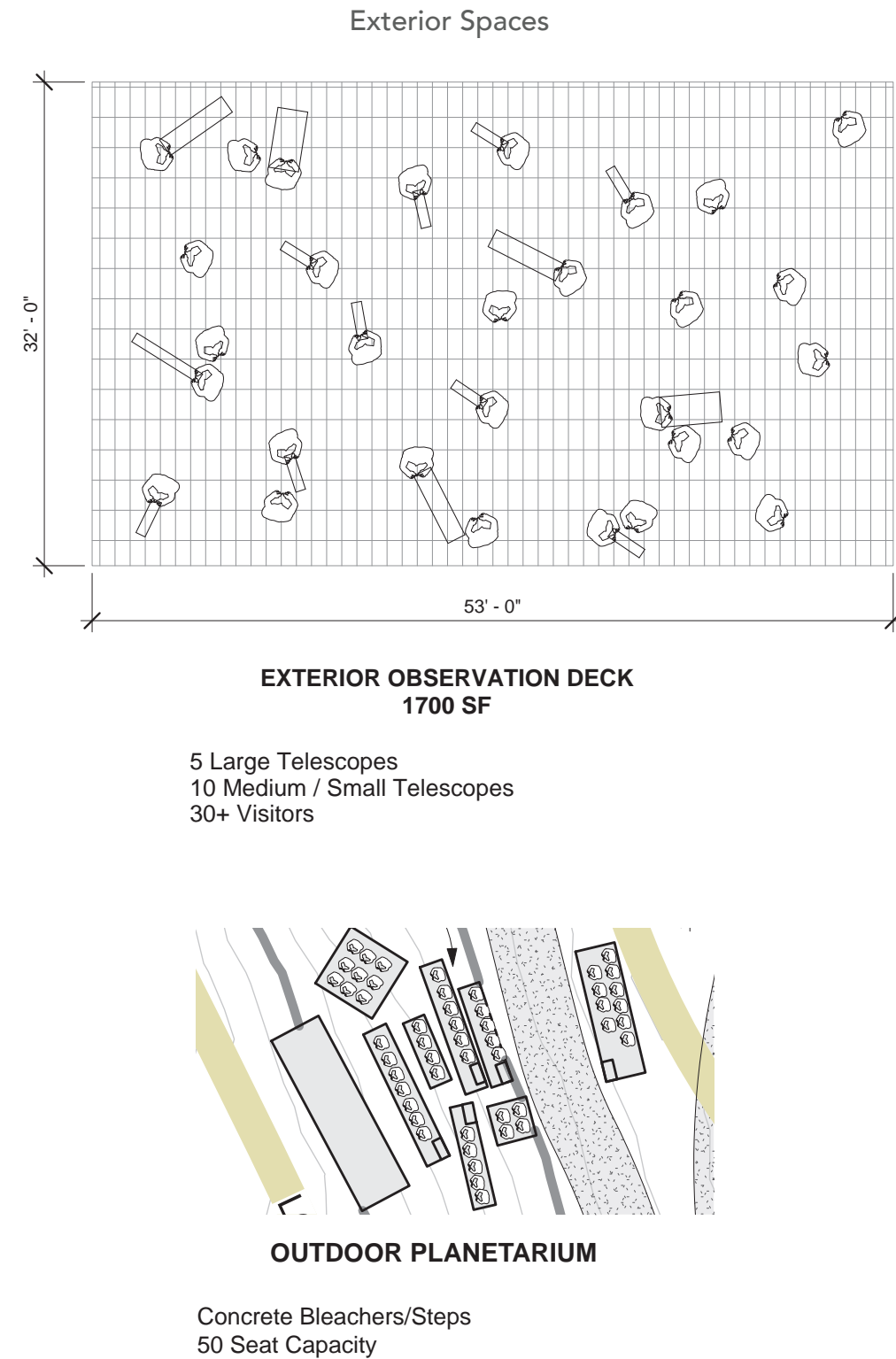
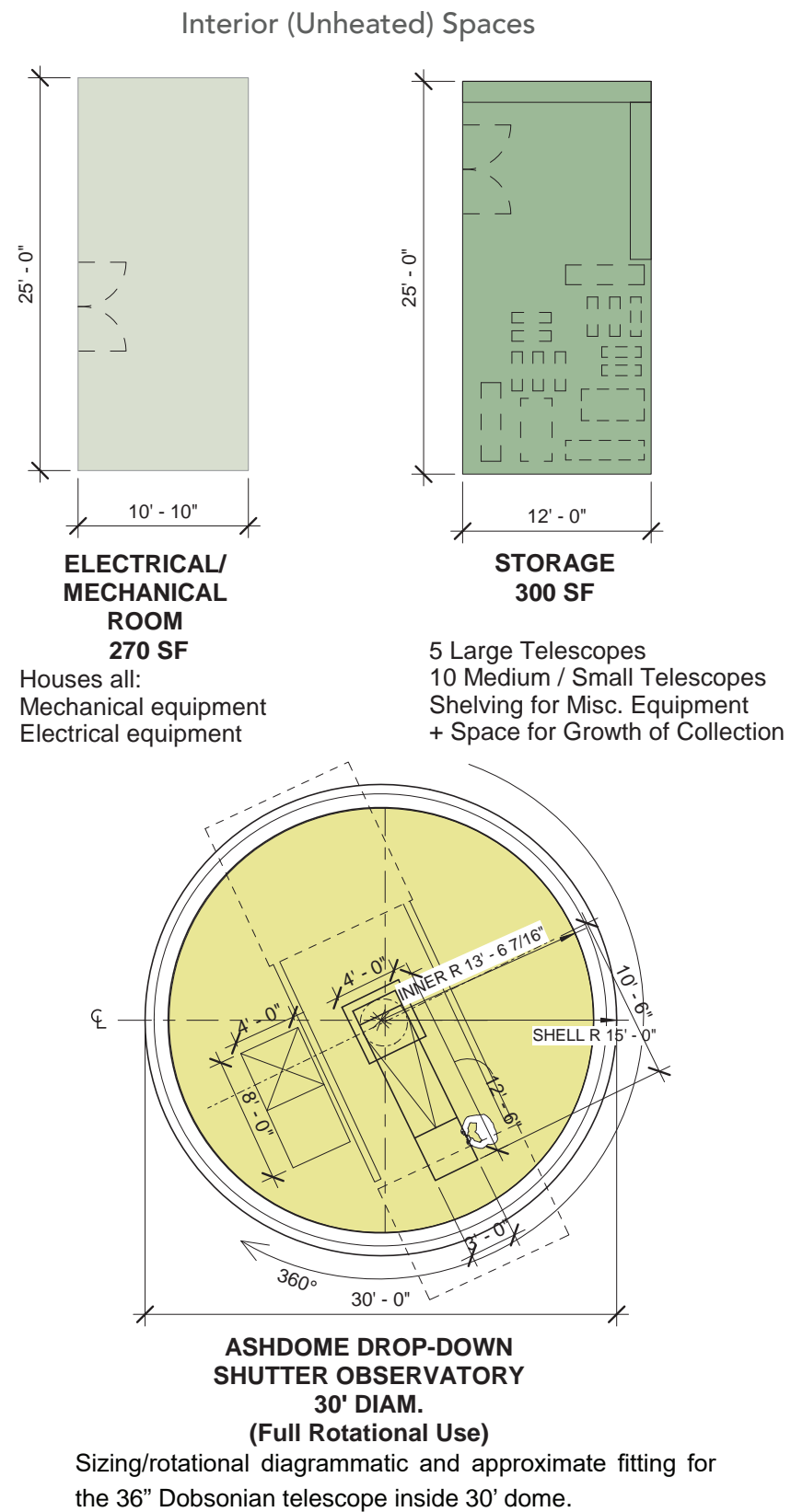
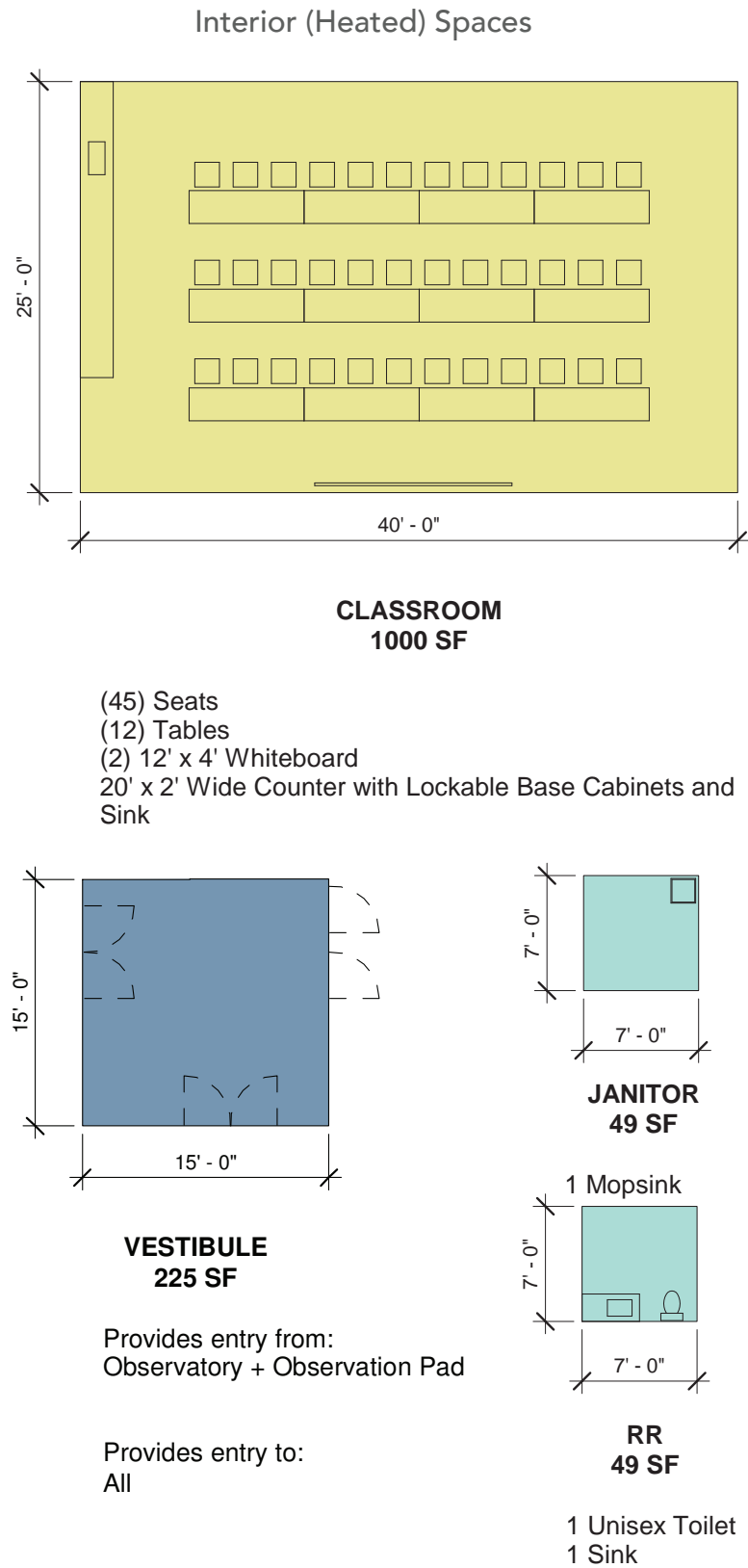
PROGRAM SPACES		PROPOSED AREA
Description		Total Area (SF)
1	Storage	300
1a	Telescope Storage	300
2	Accessory Spaces	150
2a	Mechanical Room	150
3	Education	1,730
3a	Classroom	1,000
3b	Observation Floor (30' 6" Dome)	730
4	Restrooms / Utility	98
4a	Unisex Restroom	49
4b	Janitor Room	49
5	Circulation	400
5a	Vestibule	225
5b	Corridors (10%)	175
Subtotal Building Area		2,678
Mechanical / Electrical Room (10%)		270
Interior and Exterior Walls (12%)		320
Total Building Area		3,268

EXTERIOR PROGRAM ELEMENTS

Trail (from parking lot to proposed site)	300 lf
Trail (from proposed site to existing trail loop)	450 lf
Observation Pad	1700 sf
Outdoor Planetarium (Amphitheater)	50 seats
Parking Lot (future work per MRWM 2022 Infrastructure Improvement Plan)	20 spaces
Total Exterior Program Area	1700 SF

3.1 Space List and Diagrams

The following diagrams describe the layout and size of the program spaces for the observatory, classroom, support spaces, exterior observation deck and outdoor planetarium.

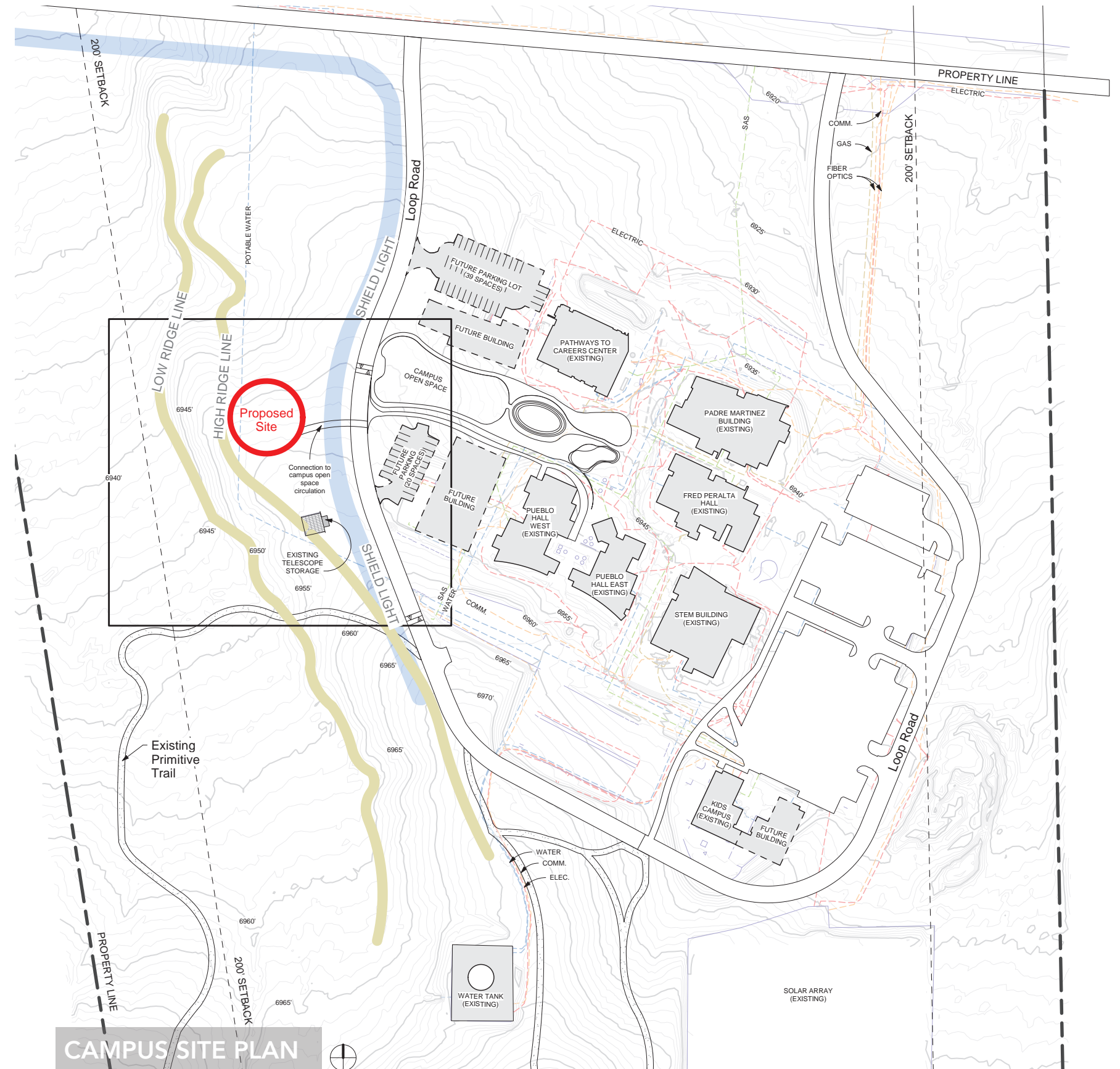


3.2 Site Plan

Though the process, multiple sites for the proposed UNM-Taos Campus Observatory were assessed. Taking into consideration site conditions such as winds, drainage, utility locations, and the Campus Infrastructure Improvements Plan, the proposed site is identified on the site plan just above the high ridge on the west side of campus, adjacent to future parking and landscape developments.

UNM-Taos' identified design goals:

- Screening/blocking light pollution
- Prioritizing proximity to utility lines
- Providing ADA compliant access to all buildings and site developments
- Connection and coordination with the 2022 Campus Infrastructure Improvements Framework Plan



3.3 Proposed Observatory Site Plan

The proposed site development utilizes a new parking lot and path additions from the Campus Infrastructure Plan, allowing visitors ease of access from campus while being unaffected by the overall campus and watershed drainage.

The method of using berms at the north-eastern portions of the site to block light penetration from campus is intended to provide natural screening, unobstructive of the site's precious night skies while working with campus landscape and allowing the observatory and its accompanying spaces (observation deck, telescope storage) to be placed in the optimal position for observational studies.

Trails connecting the site to parking and the existing campus loop branch off to create access to the outdoor planetarium, which staggers across the ridge contours to create a natural space where indoor and outdoor classes can be held to observe the night sky.

A concrete amphitheater is fitted to the natural topography and supports campus and community events.

The trails and associated wayfinding should be incorporated into the observatory, classroom, and planetarium site design and used to enforce the educational, ecological, and recreational aspects of the site.



4.0 Cost Estimate Summary

The total estimated cost for a new observatory facility at UNM-Taos campus is \$3,081,212.

The observatory facility includes a new observatory to house the donated 36-inch Dobsonian telescope, a multi-use classroom, exterior observation pad, an outdoor planetarium with a 50 person capacity, and new ADA trails that connect to the new observatory, the parking lot and existing primitive trail loop.

The space diagrams and information gathered throughout this study conclude that the most viable option providing adequate space to store and use the new 36-inch Dobsonian telescope would be the 30-foot, 6-inch Ash, Hydraulic Drop-Down dome.

The facilities for UNM-Taos’ new observatory can be implemented into two phases to utilize various funding sources as they become available. Phase 1 includes all the necessary features to house the recently donated 36-inch Dobsonian telescope, a new larger telescope storage shed to allow for growth, an observation deck for multiple telescopes to be used at a time, and an outdoor planetarium/auditorium for larger events and gatherings. Phase 2 includes a new multi-use classroom building with an outdoor classroom deck for community events and student classes.

There were multiple domes and roll-off roof options of various sizes and costs researched, which can be found in the Appendix section of this study.

TOTAL ESTIMATED COST\$ 3,081,212

Phase 1	Observatory Facilities (Observatory, storage shed, observation/overlook deck, outdoor planetarium/auditorium and trails)	\$ 1,792,896
Phase 2	Classroom Building (Multi-use classroom, support spaces, outdoor classroom deck)	\$ 1,288,316

See appendix for detailed cost breakdown.

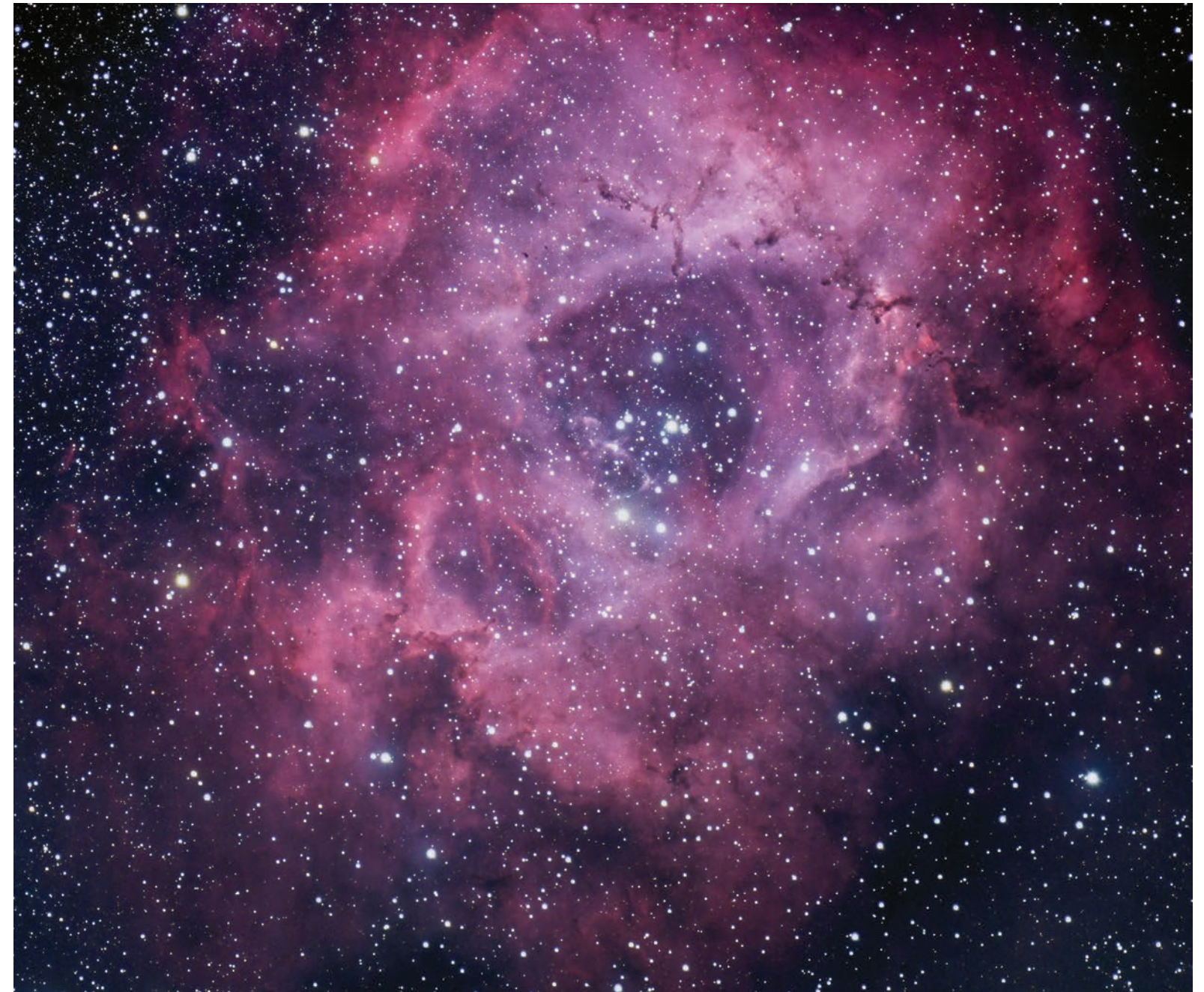


UNM-Taos campus view from proposed area, west of campus. ⁹

⁹ (2016). [UNM-Taos Klauer Campus] [Photograph]. Taos News. https://www.taosnews.com/news/thieves-steal-telescopes-from-unm-taos-astronomy-program/article_e6dbb618-05de-595f-9026-88c4ffebe585.html

5.0 Conclusion

A new observatory at UNM-Taos campus can enhance campus activities and provide a destination for STEM outreach to the wider community. The incorporation of outdoor features and new ADA-accessible connection trails to the existing primitive trails are part of a larger UNM-Taos initiative to be a site for outdoor education, using the campus and trail system as a K-12 field trip destination and teaching tool for science, art, and culture.



Post-processed photo of the Rosette Nebulae (NCG 2237-39) in embedded open star cluster as observed from the Rabbit Valley Observatory near Taos, NM.

¹⁰ Greiner, W. (2022). [Rosette Nebulae (NGC 2237-39) and embedded open star cluster (NGC 2244).] [Photograph]. The Taos Astronomer. <http://taosastronomer.com/>

6.0 References

¹ Nicholls, C. (2020, November). *“36” Telescope Donation Briefing Document*”. UNM Department of Math & Science.

² De Pree, C., & Scoles, S. (April, 2022) *“The Past, Present, and Future of College Observatories”*. Sky & Telescope.

³ MRWM Landscape Architects. (November, 2022) *“UNM Taos Klauer Campus Infrastructure Improvements Framework Plan”*.

⁴ WE+A Architects. (Month, 2019) *“University of North Georgia Observatory Study”*.

⁵ Night Sky Protection Act, NM STAT. ANN § 74.12. (1999) <https://lawlibrary.nmcourts.gov/general/>

⁶ Taos County, NM Code of Ordinances 2006-9. (2006) <https://www.taoscounty.org/207/Ordinances-and-Resolutions>

⁷ International Dark Sky Association. (June, 2018) *“Urban Night Sky Place Program Guidelines”*. <https://www.darksky.org/our-work/conservation/idsp/unsp/>

⁸ University of Texas at Austin. *“McDonald Observatory Dark Skies Initiative”*. <https://mcdonaldobservatory.org/darkskies>

⁹ (2016). [UNM-Taos Klauer Campus] [Photograph]. Taos News. https://www.taosnews.com/news/thieves-steal-telescopes-from-unm-taos-astronomy-program/article_e6dbb618-05de-595f-9026-88c4ffebe585.html

¹⁰ Greiner, W. (2022). [Rosette Nebulae (NGC 2237-39) and embedded open star cluster (NGC 2244).] [Photograph]. The Taos Astronomer. <http://taosastronomer.com/>

7.1 Cost Estimate

UNM TAOS - KLAUER CAMPUS
OBSERVATORY FEASIBILITY STUDY
January 6, 2023

Project name	23002 - UNM Taos - Klawer Campus Observatory
Architect	SAM STERLING ARCHITECTURE
Notes	Deductive Alternate - Classrom and Associated Sitework - (\$1,288,316)
Report format	Sorted by 'Group phase/Phase' 'Detail' summary Print item notes Print sort level notes




UNM TAOS - KLAUER CAMPUS
OBSERVATORY FEASIBILITY STUDY
January 6, 2023

SSA
SAM STERLING ARCHITECTURE, LLC
924 2nd St NW Suite C, Albuquerque, NM 87102
505.232.2520 samsterlingarchitecture.com

				Total	
Item	Description	Takeoff Qty	Unit Cost	Amount	
<hr/>					
020000	EXISTING CONDITIONS				
<hr/>					
024100	Demolition				
05	Remove existing storage building	150.00	sf	14.00 /sf	2,100
05	Remove existing pavers	900.00	sf	5.00 /sf	4,500
	Demolition				<hr/> 6,600
EXISTING CONDITIONS					6,600
<hr/>					
030000	CONCRETE				
<hr/>					
033100	Structural Concrete				
290	Foundation	730.00	sf	22.00 /sf	16,060
300	5" slab on grade	730.00	sf	10.80 /sf	7,884
	Structural Concrete				<hr/> 23,944
CONCRETE					23,944
<hr/>					
040000	MASONRY				
<hr/>					
042200	Concrete Unit Masonry				
170	8x8x16 cmu, building exterior	1,152.00	sf	40.00 /sf	46,080
	Concrete Unit Masonry				<hr/> 46,080
MASONRY					46,080
<hr/>					
070000	THERMAL AND MOISTURE PROTECTION				
<hr/>					
079500	Expansion Control				
50	Expansion control	1.00	ls	2,500.00 /ls	2,500
	Expansion Control				<hr/> 2,500
THERMAL AND MOISTURE PROTECTION					2,500
<hr/>					
080000	OPENINGS				
<hr/>					
081100	Metal Doors and Frames				
300	Single door/frame/hw, exterior	2.00	ea	2,625.00 /ea	5,250
	Metal Doors and Frames				<hr/> 5,250
OPENINGS					5,250
<hr/>					
130000	SPECIAL CONSTRUCTION				
<hr/>					
132300	Observation Domes				
----	30'-6" observation dome, quote by Ash Manufacturing Co. Inc.	1.00	ea	334,408.00 /ea	334,408
<hr/>					
1/6/2023					

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BALIS & COMPANY

PROJECT CONTROL AND COST ESTIMATING

UNM TAOS - KLAUER CAMPUS

OBSERVATORY FEASIBILITY STUDY

January 6, 2023


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				Total	
Item	Description	Takeoff Qty		Unit Cost	Amount
132300	Observation Domes				
----	Labor/installation of dome	1.00	ls	50,000.00 /ls	50,000
	Observation Domes				384,408
133100	Pre-Fabricated Structures				
----	Metal storage building/slab	300.00	sf	75.00 /sf	22,500
	Pre-Fabricated Structures				22,500
134200	Classroom Building				
----	Classroom, mechanical, electrical and restroom building	1,362.00	sf	450.00 /sf	612,900
----	Crusher fine outdoor classroom	400.00	sf	4.00 /sf	1,600
----	Domestic water line	300.00	lf	80.00 /lf	24,000
----	Fire protection line	300.00	lf	100.00 /lf	30,000
----	Fire hydrant/valve/bollards	1.00	ea	5,000.00 /ea	5,000
----	Sanitary sewer line	300.00	lf	110.00 /lf	33,000
	Classroom Building				706,500
SPECIAL CONSTRUCTION					1,113,408
140000	CONVEYING EQUIPMENT				
144200	Wheelchair Lifts				
10	ADA accessible wheelchair lift/platform	1.00	ea	30,000.00 /ea	30,000
	Wheelchair Lifts				30,000
CONVEYING EQUIPMENT					30,000
260000	ELECTRICAL				
260099	Electrical Systems				
----	Extend electrical and new transformer	1.00	ls	200,000.000 /ls	200,000
----	Power/data to ampphitheater	1.00	ls	10,000.00 /ls	10,000
----	Electrical sytems	1.00	ls	15,000.00 /ls	15,000
----	Path lighting	1.00	ls	10,000.00 /ls	10,000
	Electrical Systems				235,000
ELECTRICAL					235,000
310000	EARTHWORK				
312200	Grading				
11	Site grade	7,500.00	sf	2.00 /sf	15,000
	Grading				15,000
312300	Excavation and Fill				
60	Excavate foundation	240.00	cy	16.00 /cy	3,840
150	Backfill /compact foundations	210.00	cy	20.00 /cy	4,200
380	Site cuts & fills	1,000.00	cy	18.00 /cy	18,000
390	Site 5' tall berms (light blocking)	2,000.00	cy	18.00 /cy	36,000

1/6/2023

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UNM TAOS - KLAUER CAMPUS

OBSERVATORY FEASIBILITY STUDY

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				Total	
Item	Description	Takeoff Qty	Unit Cost	Amount	
	Excavation and Fill				62,040
EARTHWORK					77,040
320000	EXTERIOR IMPROVEMENTS				
321100	Base Courses				
40	ADA compliant stabilized crusher fines	7,500.00 sf	4.00 /sf		30,000
	Base Courses				30,000
321200	Site Concrete Paving, Retaining Walls				
80	Concrete observation deck	4,550.00 sf	10.00 /sf		45,500
80	Retaining wall/ftg at observation deck (3' avg)	84.00 lf	120.00 /lf		10,080
80	Guard rails at deck	84.00 lf	250.00 /lf		21,000
80	18" tall x 2' wide concrete benches/steps	120.00 lf	225.00 /lf		27,000
80	Outdoor stage slab	200.00 sf	10.00 /sf		2,000
	Site Concrete Paving, Retaining Walls				105,580
329300	Plants				
10	Landscaping & Irrigation at berms	5,000.00 sf	4.00 /sf		20,000
	Plants				20,000
EXTERIOR IMPROVEMENTS					155,580

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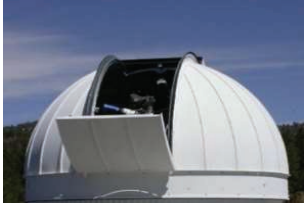



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Estimate Totals

Description	Amount	Totals	Rate	Cost per Unit
Labor	10,324			
Material	18,870			
Subcontract	1,666,208			
Equipment				
Other				
	1,695,402	1,695,402		
General Requirements	271,264		16.000	%
General Contractor OH&P	98,333		5.000	%
Bonds and Insurance	51,625		2.500	%
	421,222	2,116,624		
Contingency	423,325		20.000	%
	423,325	2,539,949		
NMGRT	211,133		8.313	%
	211,133	2,751,082		
Escalation (Every 2 years)	330,130		12.000	%
	330,130	3,081,212		
Total		3,081,212		

7.2 Dome Manufacturer Quotes
Quote Comparison Chart

	Manufacturer	Type	Dome Size	2022 Cost	2023 Cost (10% per year escalation)	Comments
	Ash Manufacturing	Hydraulic Drop-Down Dome	20' 6" diameter	\$180,441	\$198,485	12' tall CMU block walls, (2) exterior doors, LED downlighting w/ red filter, general lighting fixtures, and electrical capacity for telescope equipment and hydraulics need to be included in pricing on Ash Dome models.
		Hydraulic Drop-Down Dome	30' 6" diameter	\$276,371	\$304,008	
	Astrohaven	Belt-Driven Legacy Hybrid Clamshell Dome	20' diameter	\$186,700	\$205,370	12' tall CMU block, (2) exterior doors, LED downlighting w/ red filter, general lighting fixtures, and electrical capacity for telescope equipment and opening mechanisms need to be included in pricing for Astrohaven models
		X' Clamshell Dome	27' diameter	\$693,500	\$762,850	
	Observadome	Single Skin Dome w/ Electronic Shutters (lead time of 12-14 months)	19' 8"	\$460,952	\$507,047	12' tall CMU block walls, (2) exterior doors, LED downlighting w/ red filter, general lighting fixtures, and electrical capacity for telescope equipment and shutter operation need be included in pricing on Observadome observatory.
	PierTech	Dual Roll Off Roof w/ Control System	12 1/2' x 20' rectangle	\$64,650*	\$71,115	electrical capacity for telescope equipment and LED downlighting w/ red filter and general wall mounted lighting fixtures need be included in pricing along with shipping/assembly.

* cost does not include assembly/shipping
** all dome quotes are for dome portion only (no walls, doors, or floor included)

7.2 Dome Manufacturer Quotes
AshDome



December 16, 2022

ASH MANUFACTURING COMPANY INC.
P.O. Box 312 • Plainfield, IL 60544

Raquel Alexis Pacheco
Sam Sterling Architecture
24 2nd Street NW Suite C
Albuquerque NM 87102

Dear Raquel,

In accord with your request, we submit the following quotation for our 30’6” diameter, Model MEBH Ash-Dome with Automation. We have also included the packing and estimated shipping charges to Taos, NM.

1.

We shall provide our 30’6” diameter, Model MEBH, Ash-Dome electrically operated upper shutter and azimuth with hydraulic lower Type ‘B drop-out and set of 4 contactor bars to carry continuous power to the shutter drives. The dome will be computer controlled with Astrometrics DomePro U system for the sum of

Total Materials

*Deposit required with order

\$237,960.00

\$237,960.00

\$118,980.00
2.

We shall pack and ship the disassembled unit to Taos, NM – via commercial carrier for the estimated sum of

\$9,135.00
- *Note: Pricing based on today’s rate and is subject to change at the time of shipment.
3.

We shall provide supervision for the reassembly for an estimated 9 to 10 working days, for the sum of

\$29,276.00
- *Note: You will be required to provide 4 to 5 semi-skilled laborers during the reassembly plus any misc. scaffolding, ladders, hand tools, electrical supply, and a crane for lifting the dome materials if necessary. We will require a minimum of 4 weeks prior notification to schedule our supervisor and make travel arrangements. When a firm date has been chosen, the charges of the supervision will become due. You are required to provide an authorized person to sign off on the work completed.
- Total PO

\$276,371.00

Option: We shall increase the aperture of the dome from 71” to 90” for the sum of \$5,750.00

Presently, we are able to make our Model ‘M’ dome available for delivery within 180 to 210 days after the receipt of a purchase order and nonrefundable deposit in the amount of 50% materials cost. The policy of this company is not to start the fabrication of any observatory dome unit without a deposit. Even though the dome is a standard size it is still a custom item. The final balance due materials will be invoiced when the fabrication is completed, and the unit is ready for shipment. The materials will not be shipped until this balance has been paid. Finished materials held for a period longer than 30 days will have a storage charge added to the balance due. Any state or local taxes, local building codes, engineering fees or permits, zoning permits are the responsibility of the purchaser.

The above quotation will be honored for 30 days after which costs are subject to change. Should you have any questions please contact this office.

Yours truly,
Riley Brannen
Riley Brannen / Ash Mfg. Co.

Phone: 815.436.9403 • Fax: 815.436.1032 • www.ashdome.com • info@ashdome.com

7.3 Dome Manufacturer Specifications
AshDome 30-foot 6-inch MBEH Model

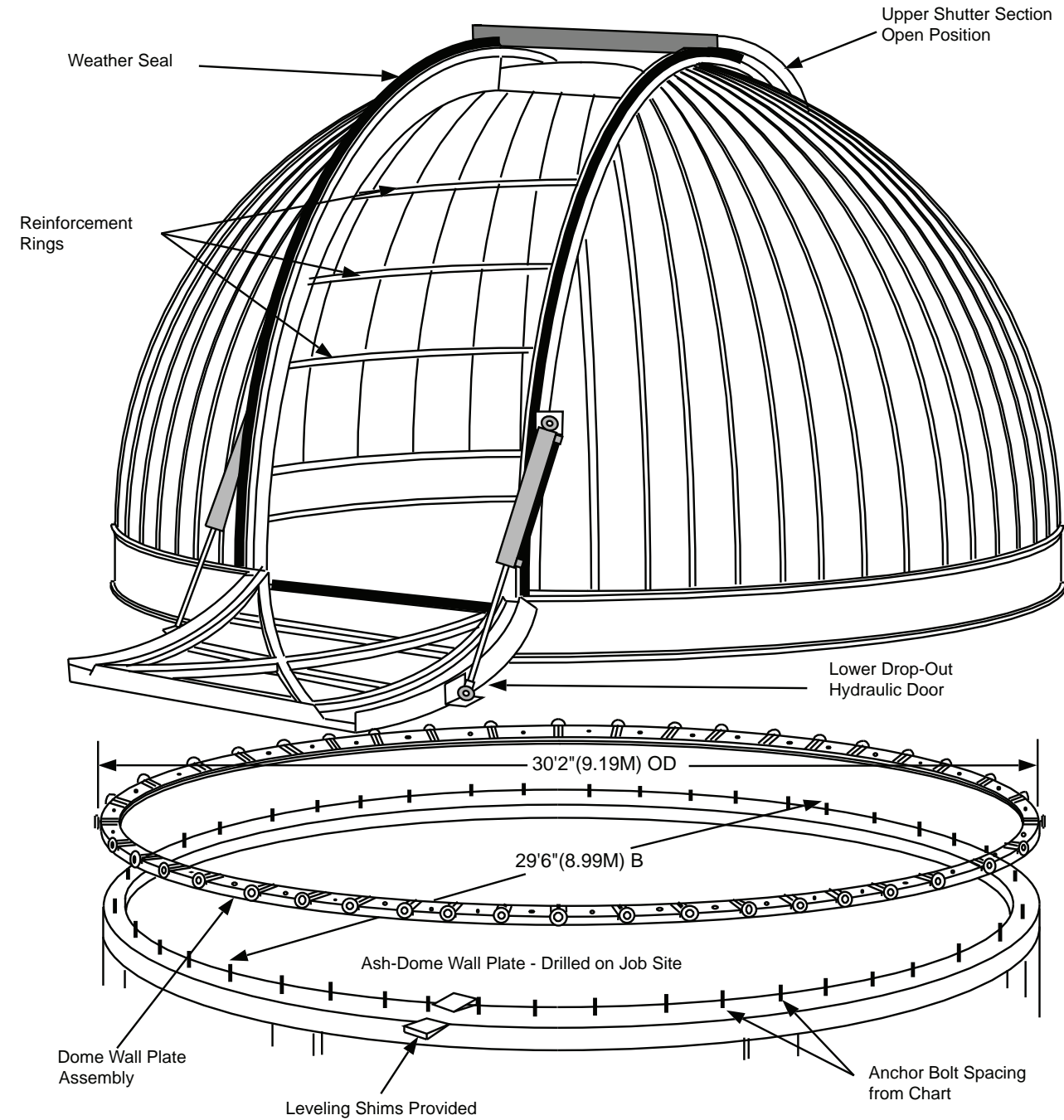
Ash-Dome

MEBH 100.30

MEBH 101.30

Ash-Dome

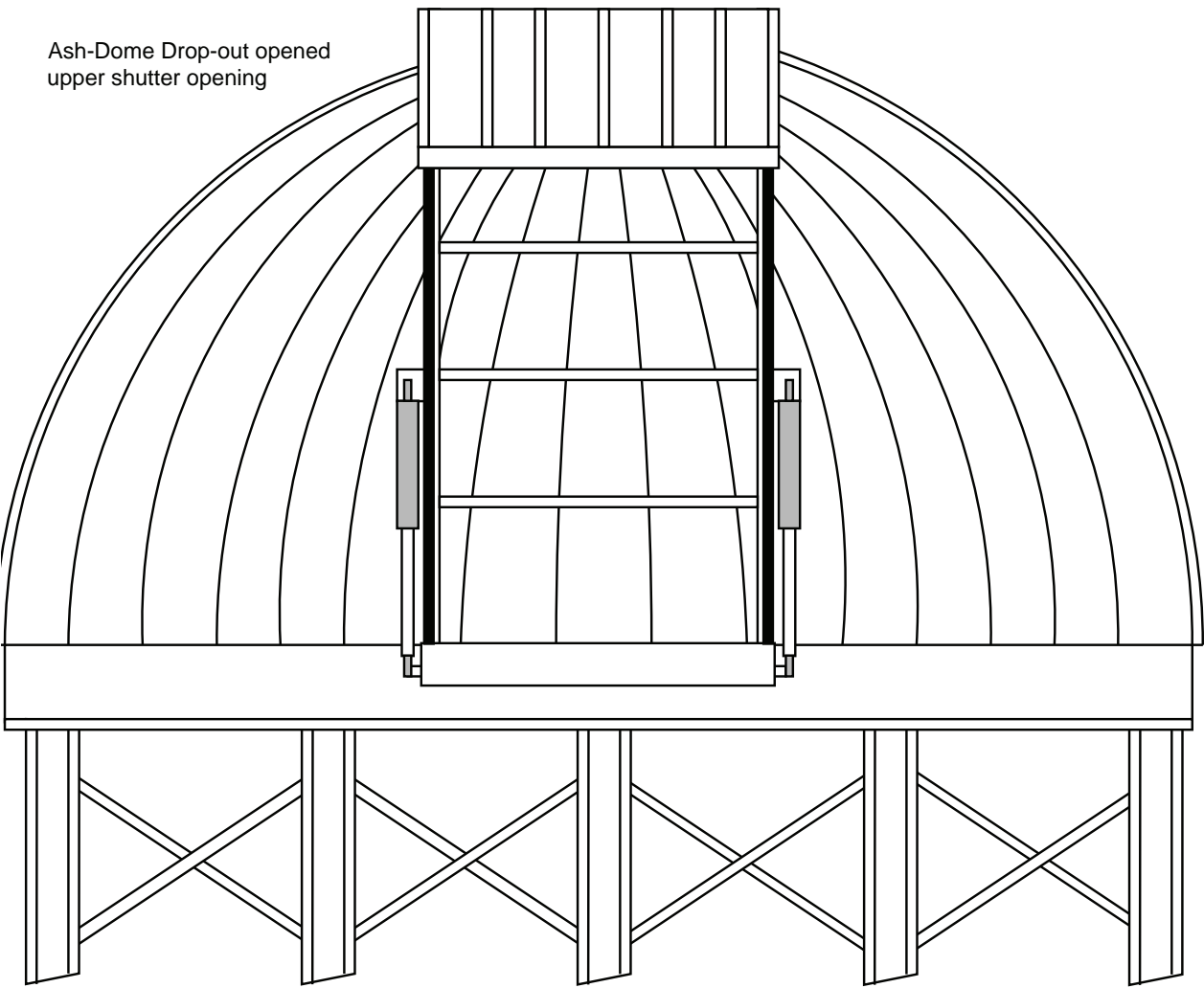
Ash-Dome 30'6" - 9.2M Observatory Dome



no scale

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

Ash-Dome 30'6" - 9.2M Observatory Dome



Dome Diameter	'A' Outside Wall Plate Diameter	'B' Anchor Bolt Diameter	'C' Closest Obstruction	'D' Minimum Outside Clearance	Aperture Width
30'6" (9.2M)	30'2" (9.19M)	29'6" (8.99M)	14'2" (4.31M)	8'7" (2.62M)	108" (2.74m)

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

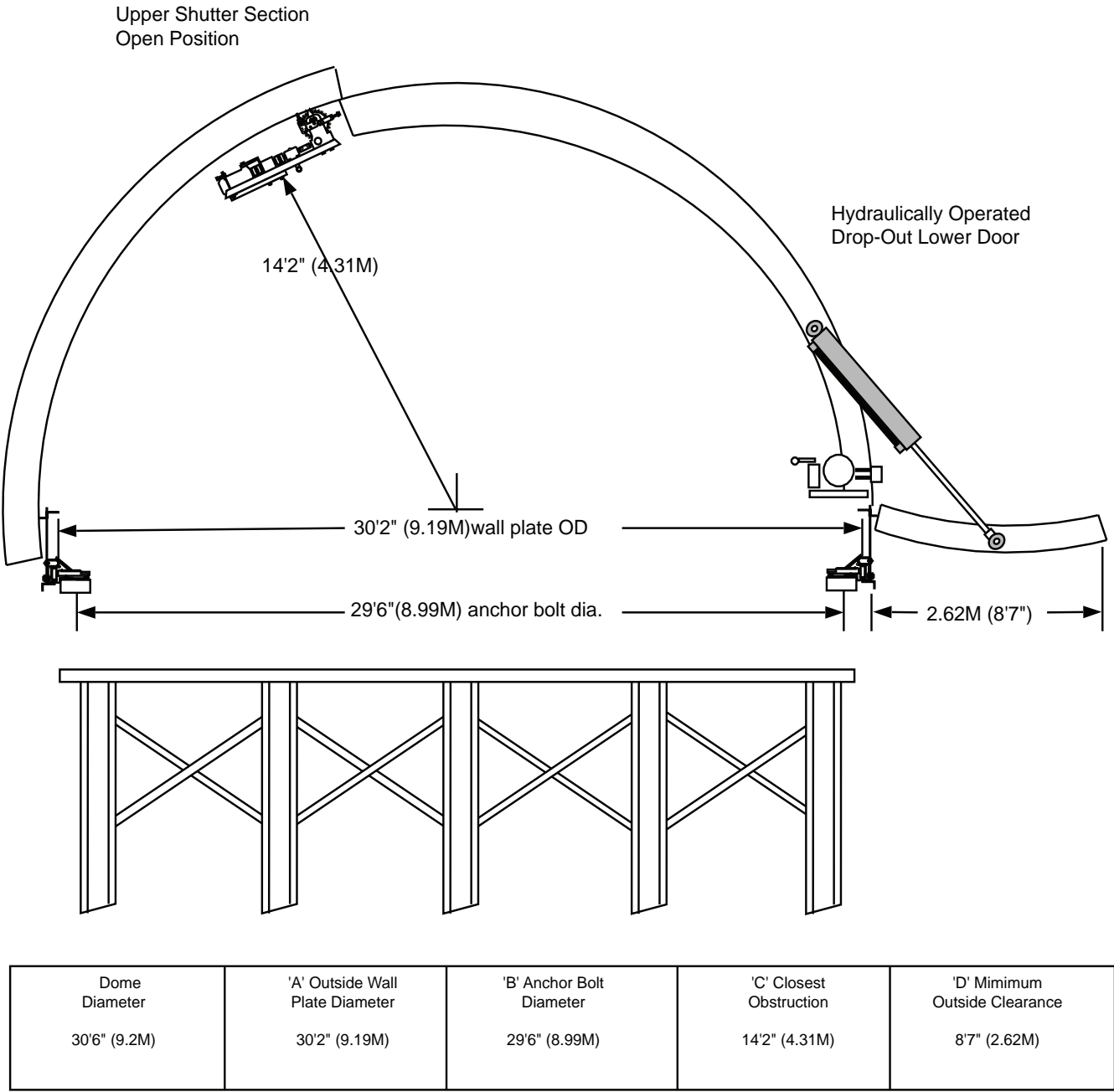
Ash-Dome

MEBH 102.30

MEBH 103.30

Ash-Dome

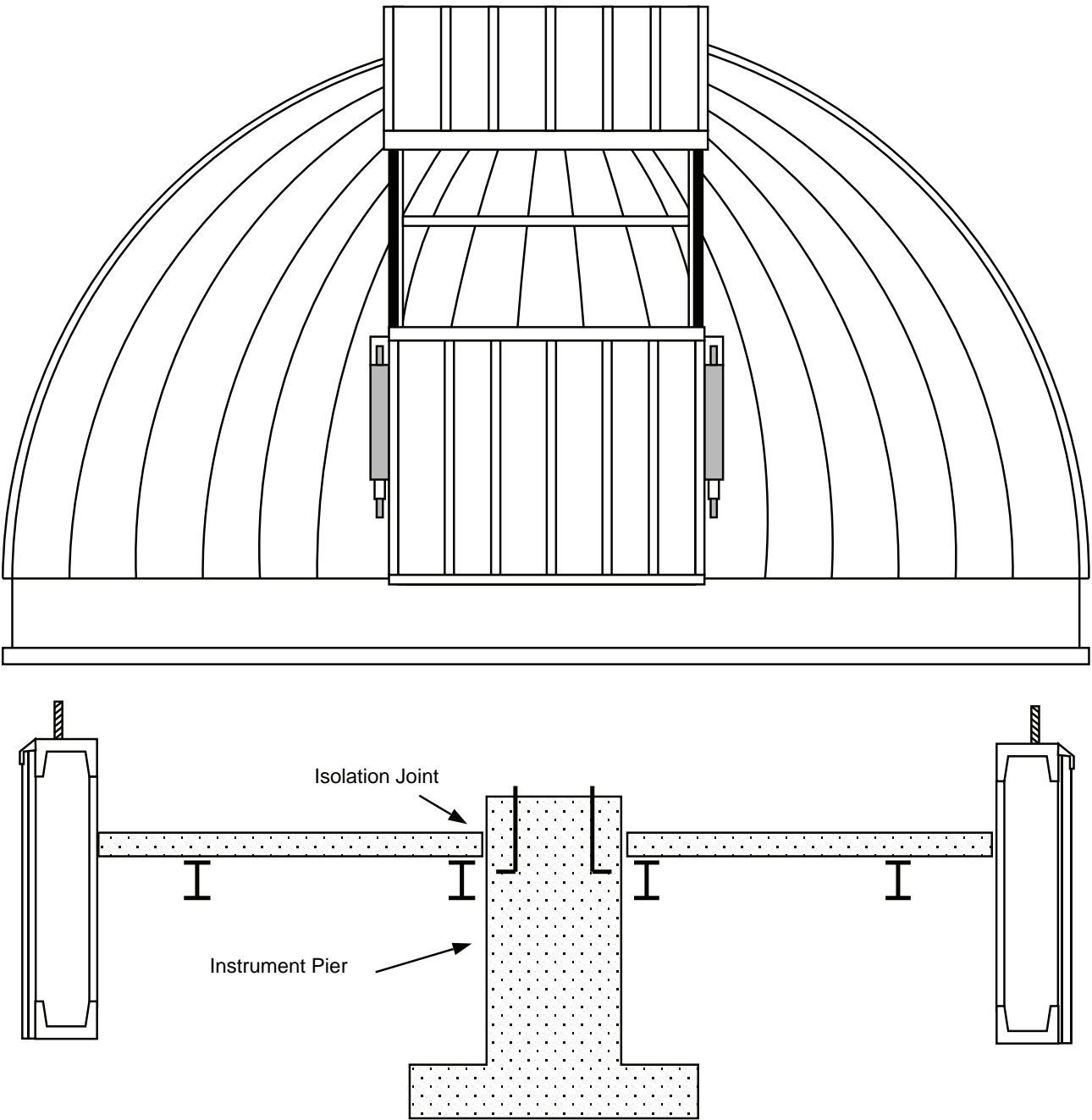
Ash-Dome 30'6" - 9.2M Observatory Dome



no scale

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

Ash-Dome 30'6" - 9.2M Observatory Dome



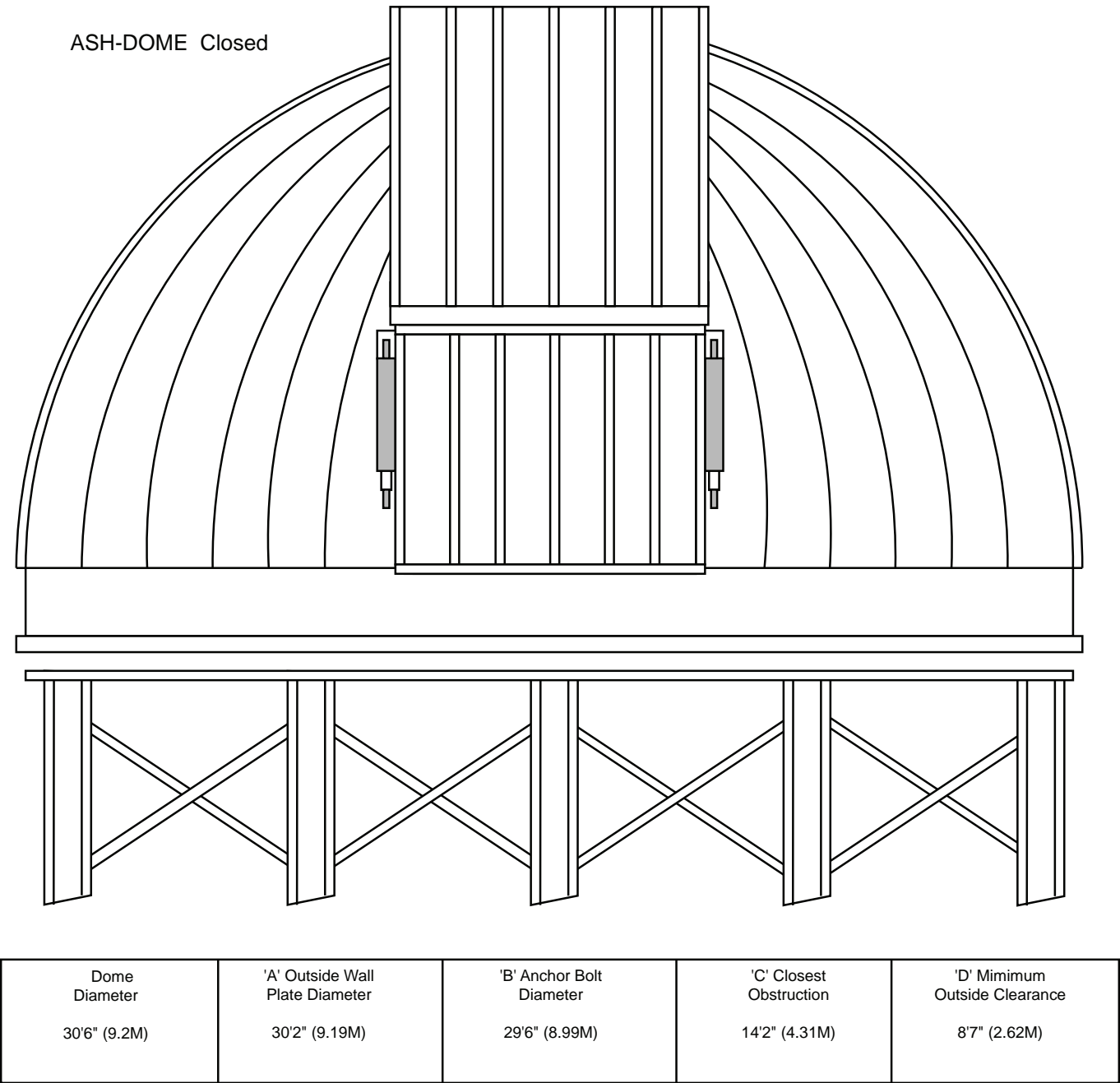
property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

Ash-Dome

MEBH 104.30

Ash-Dome 30'6" - 9.2M Observatory Dome



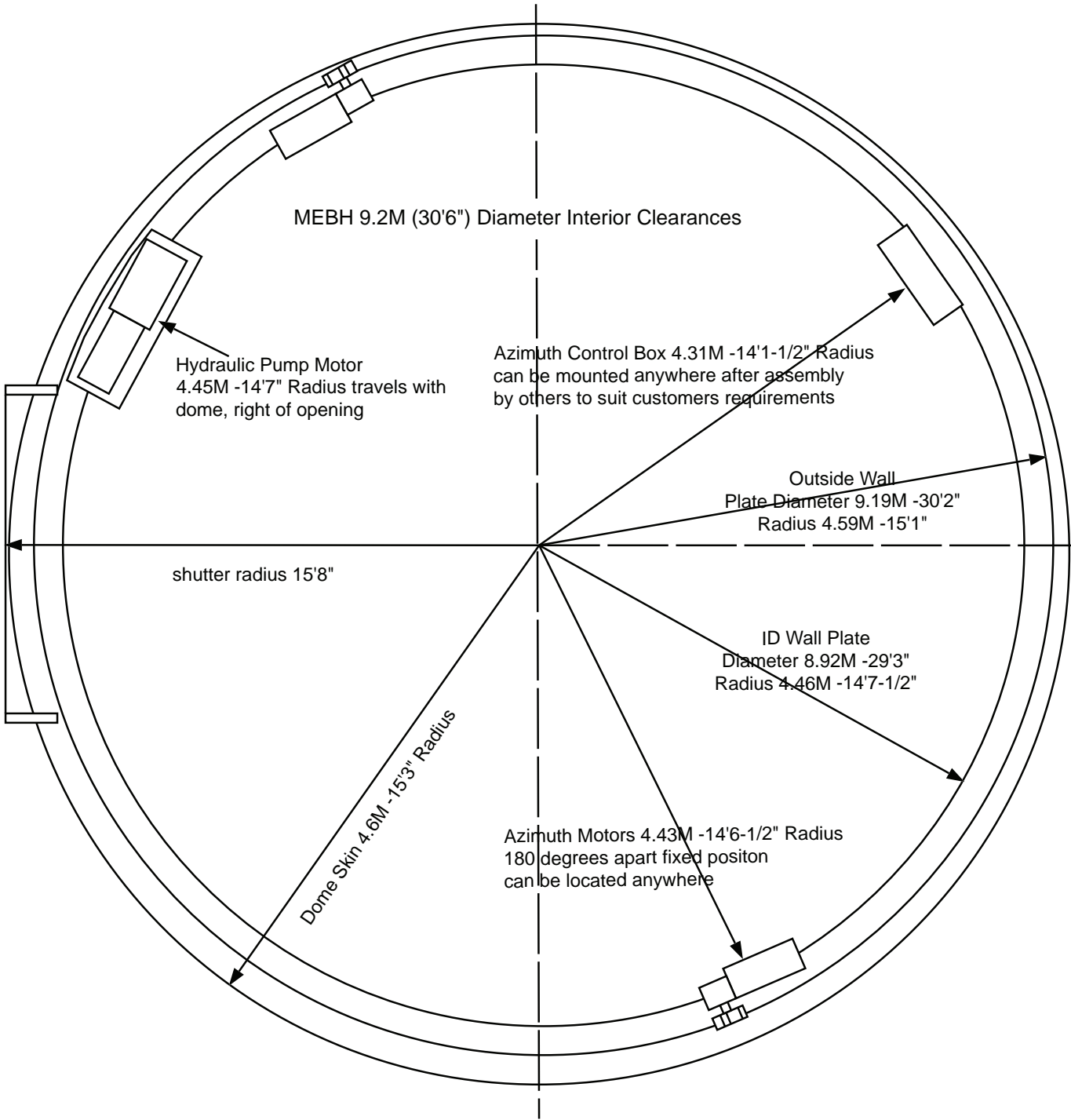
no scale

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

MEBH 105.30

Ash-Dome

Ash-Dome 30'6" - 9.2M Observatory Dome



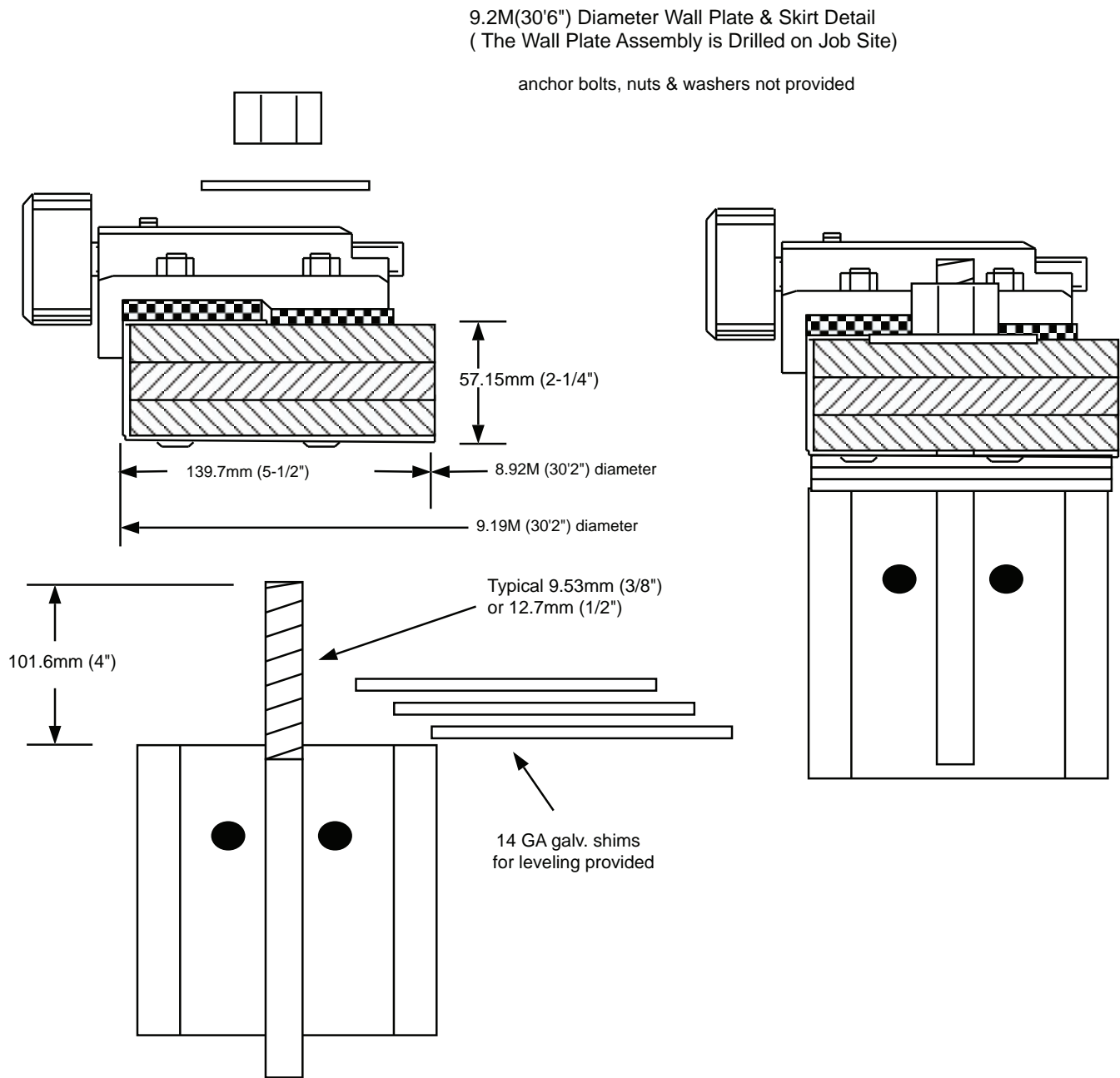
property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

Ash-Dome

MEBH 106.30

Ash-Dome 30'6" - 9.2M Observatory Dome



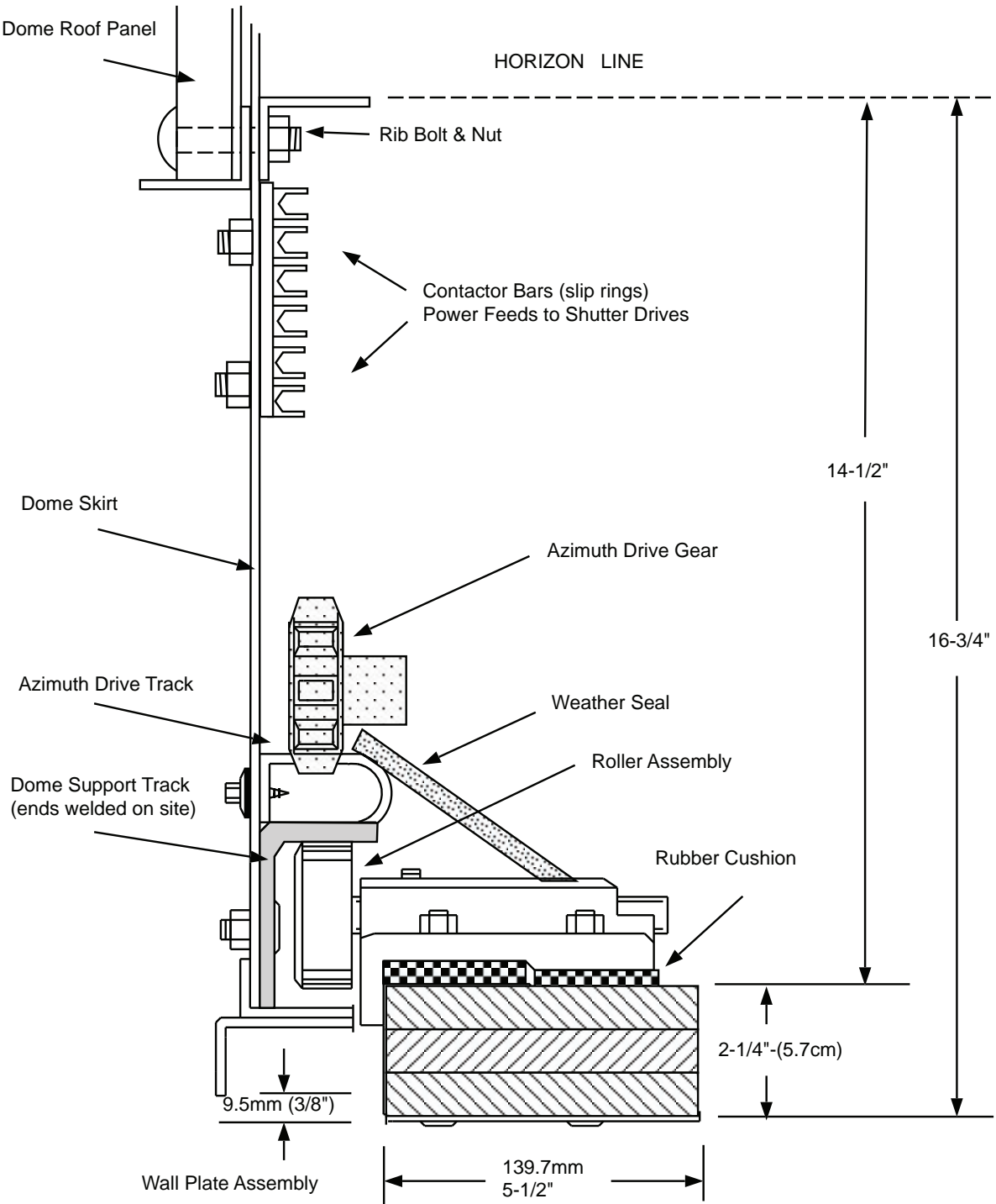
property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

MEBH 107.30

Ash-Dome

Ash-Dome 30'6" - 9.2M Observatory Dome

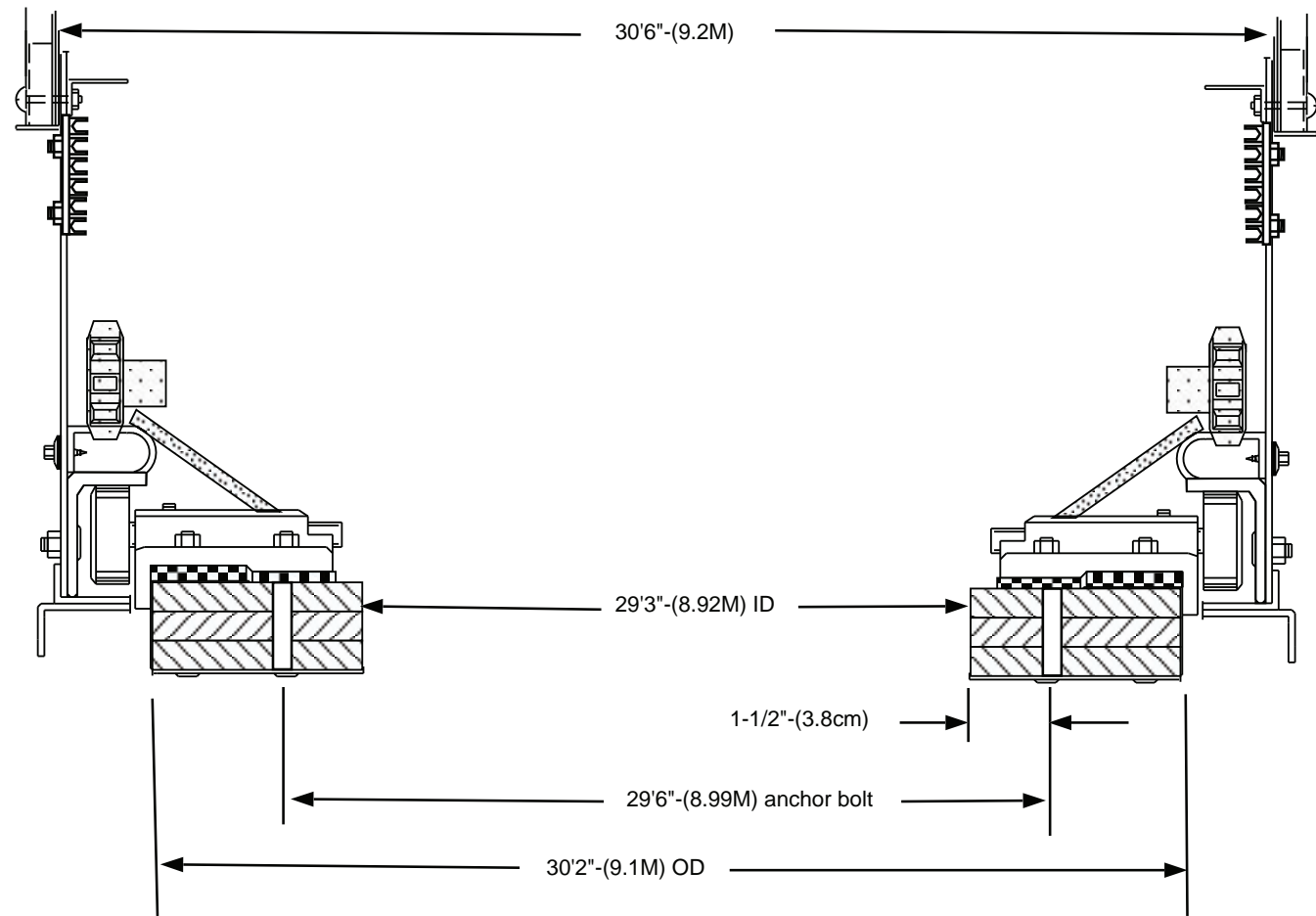


property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

Ash-Dome 30'6" - 9.2M Observatory Dome

30'6"-(9.2M) Wall Plate & Skirt Detail
(Wall Plate Assembly is Drilled on Job Site, Anchor Bolts, Nuts and Washers not furnished)

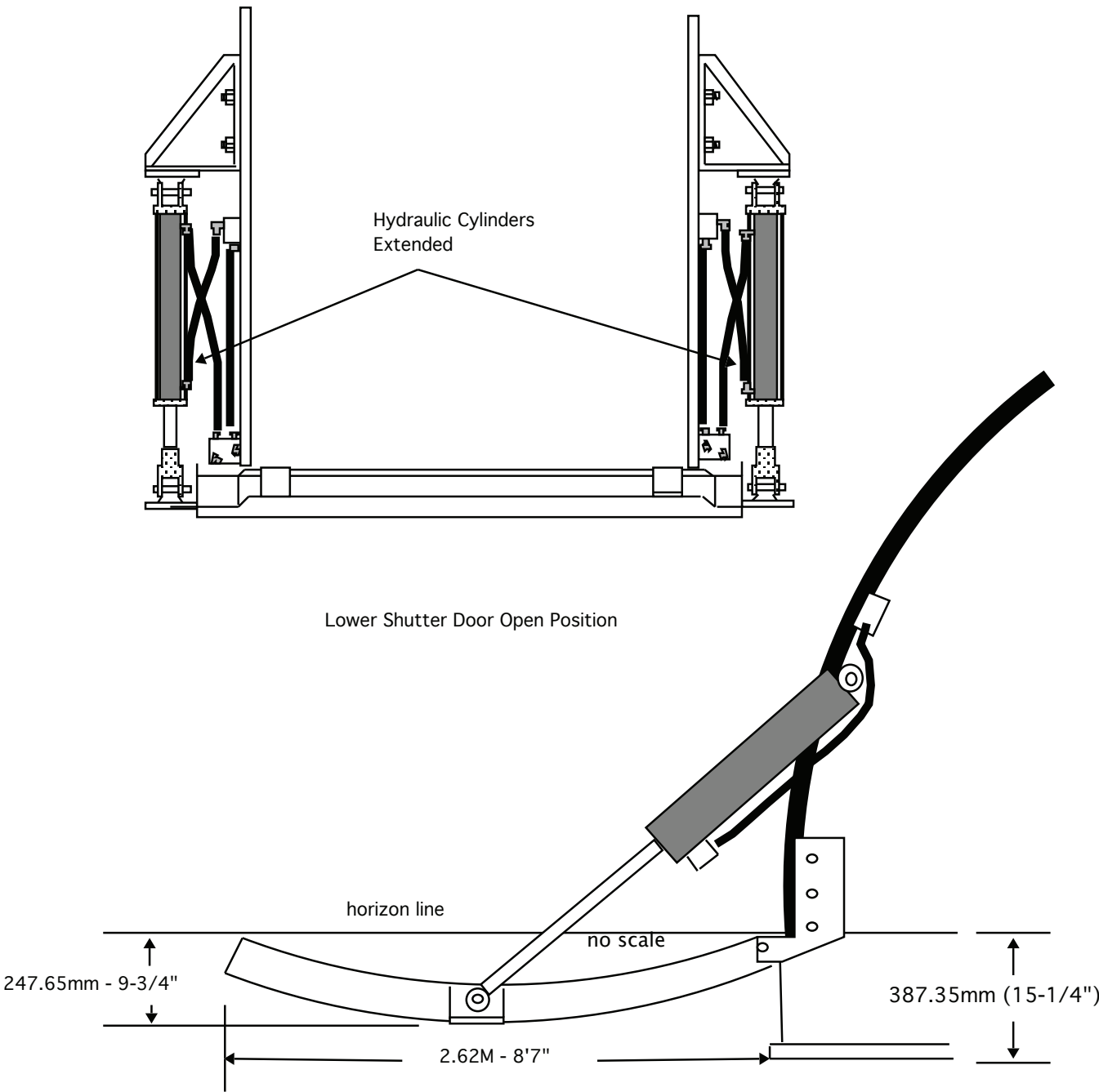


property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

Ash-Dome 30'6" - 9.2M Observatory Dome

MEBH Lower Door Hydraulic Cylinder Locations



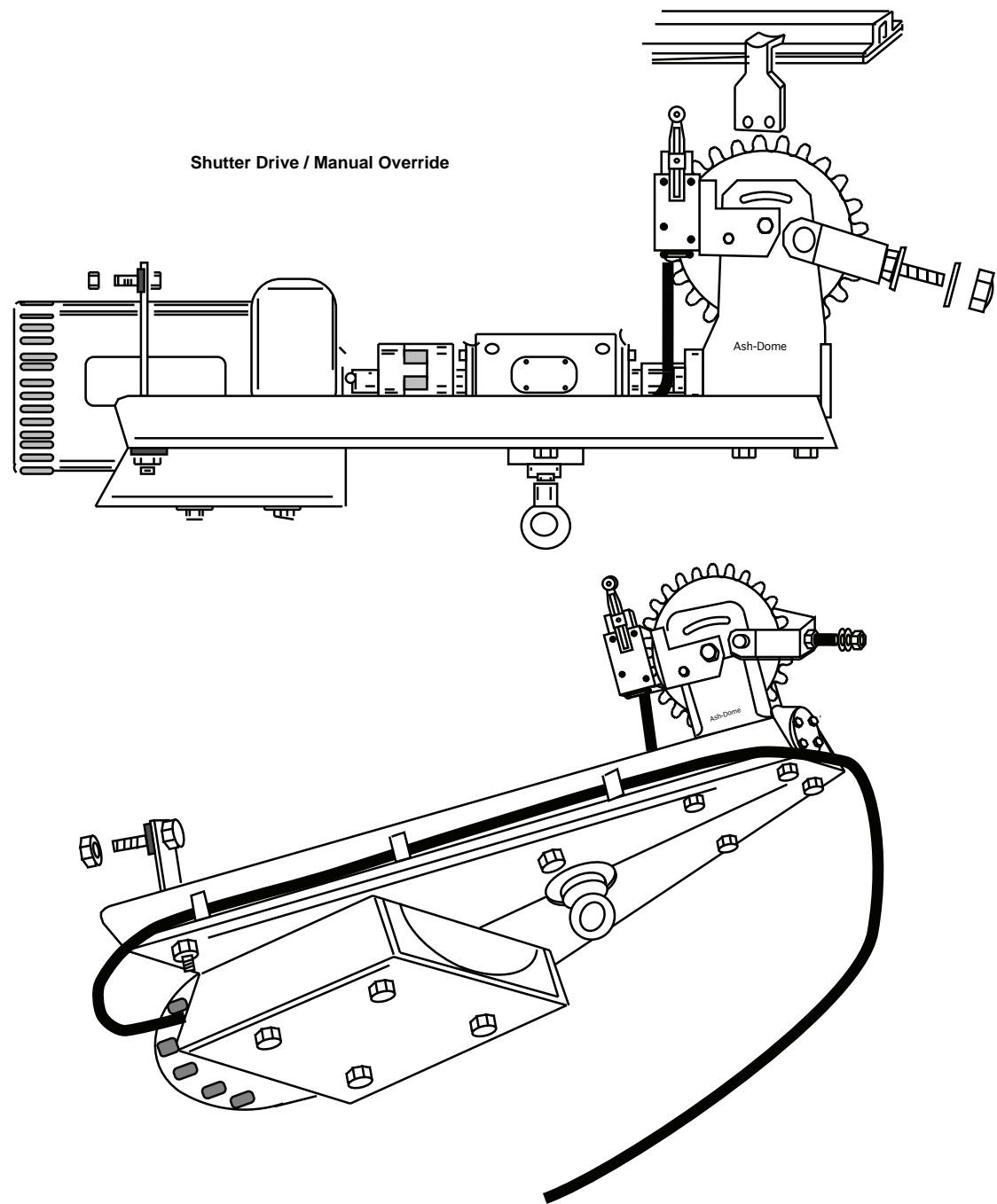
no scale

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

Ash-Dome

MEBH 110.30

Ash-Dome 30'6" - 9.2M Observatory Dome



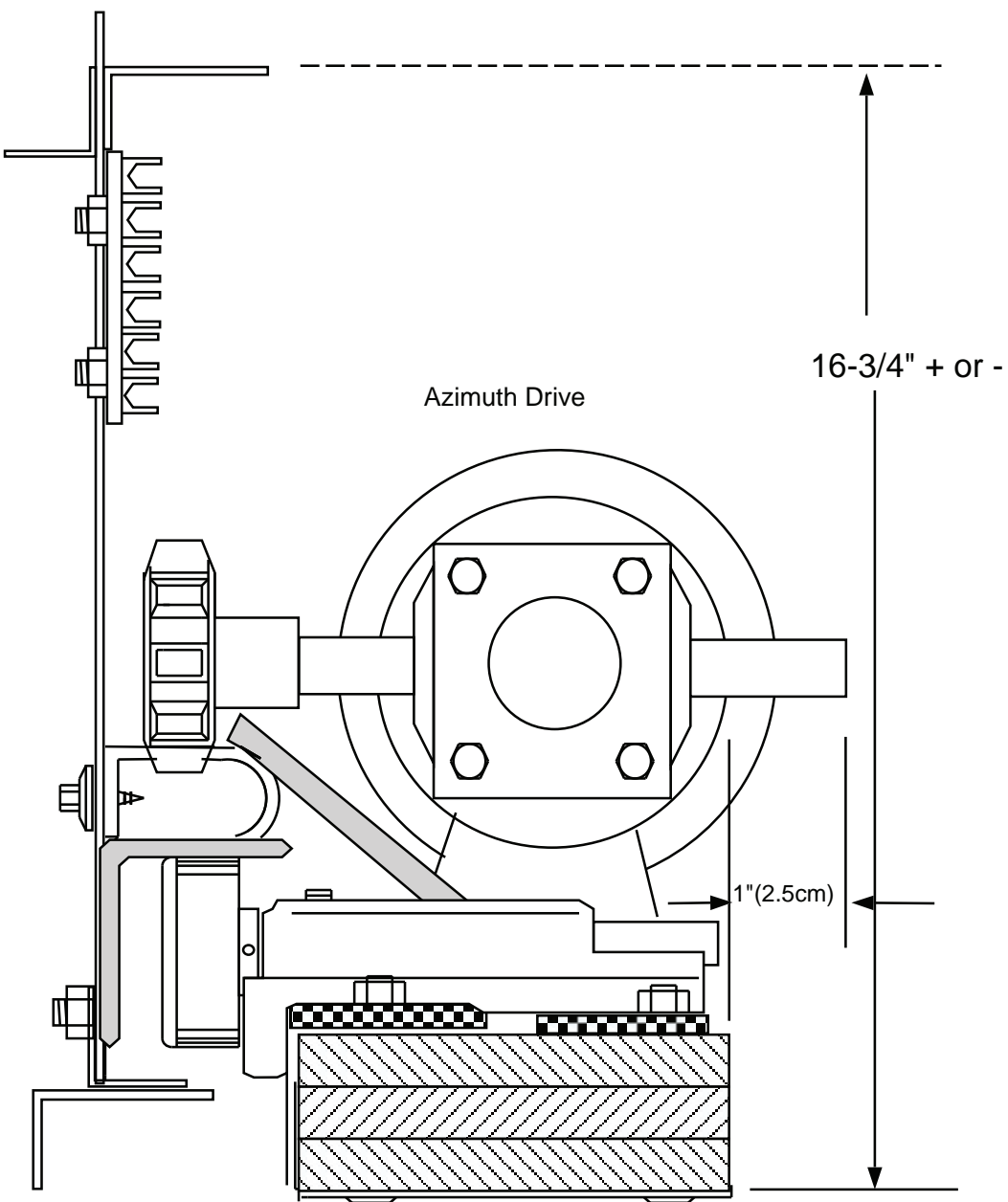
property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

no scale

MEBH 111.30

Ash-Dome

Ash-Dome 30'6" - 9.2M Observatory Dome



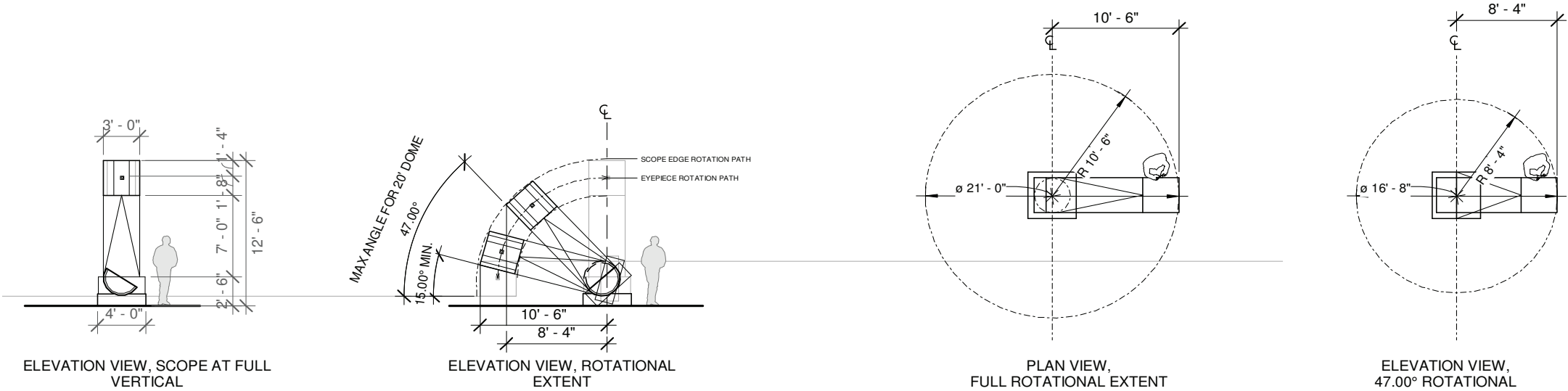
no scale

property of the Ash Manufacturing Company
Plainfield, Illinois, U.S.A.

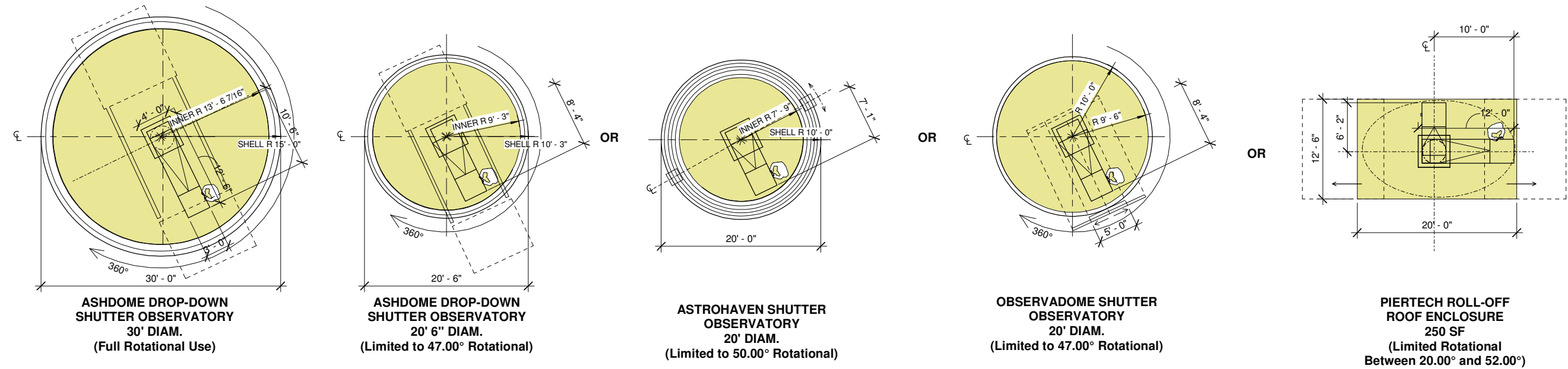
7.4 UNM-Taos Observatory Telescope Fitting Diagrams
Telescope Sizing Diagrams

TELESCOPE TYPE:

36-INCH STARSPLITTER STYLE
DOBSONIAN TELESCOPE



Telescope Fitting Diagrams



7.5 Observatory Case Studies

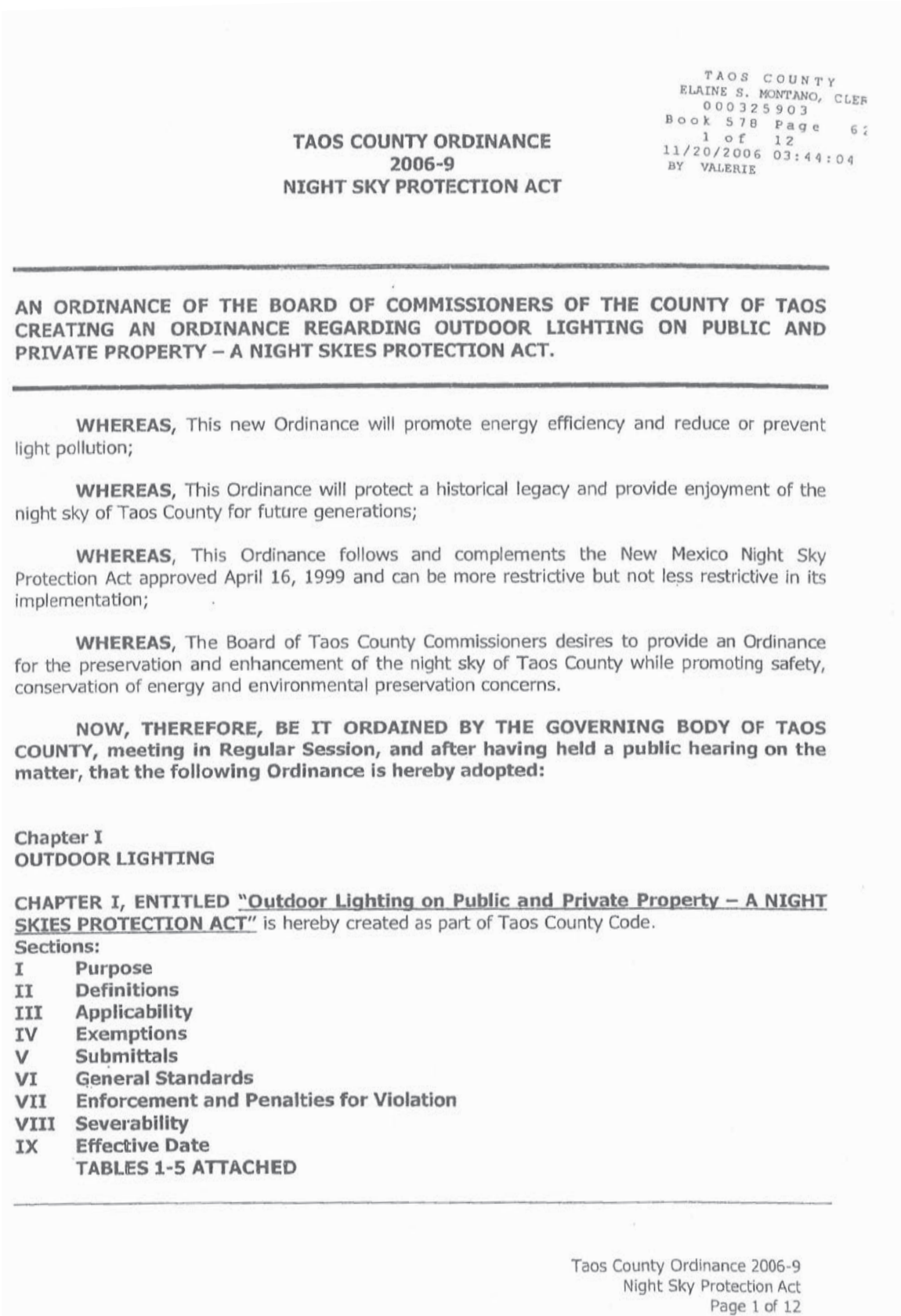


McDonald Observatory - Ft. Worth, Texas



New Mexico Natural History Museum Observatory - Albuquerque, New Mexico

7.6 Night Sky Protection Act



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BY VALERIE

I Purpose.

The purpose of the Night Skies Protection Act is to regulate outdoor lighting in order to reduce or prevent light pollution. This means, to the extent reasonably possible, the reduction or prevention of glare and light trespass, the conservation of energy, and promotion of safety and security. This Ordinance will ensure aesthetically appropriate outdoor lighting in keeping with the historic character and night-sky beauty of Taos County.

II Definitions. As used in this section:

- Lamp or Bulb** means the light-producing source installed in the socket portion of a luminaire.
- Luminaire or Fixture** means a complete lighting unit including the lamps or bulbs, together with the parts required to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.
- Light pollution** means general sky glow caused by the scattering of artificial light in the atmosphere resulting in decreased ability to see the natural night sky.
- Glare** means the brightness of a light source that causes eye discomfort.
- Disabling glare** means lighting that impairs visibility and creates a potentially hazardous situation for either pedestrians or motorists.
- Light trespass** means light emitted by a luminaire that shines beyond the property on which the luminaire is installed.
- Shielding** means that no light rays are emitted by a fixture above the horizontal plane running through the lowest point of the fixture where light is emitted.
- Accent lighting** means any directional lighting which emphasizes a particular object or draws attention to a particular area.
- Spotlight or Floodlight** means any lamp that incorporates a reflector or a refractor to concentrate the light output into a directed beam in a particular direction

III Applicability

- This Ordinance is in addition to and supplements the State Night Sky Protection Act which, among other things, outlawed the sale and/or use of mercury vapor outdoor lighting and required shielding of outdoor lighting fixtures installed after January 1, 2000, (except specified low wattage lighting that is to be shielded with this Ordinance for Taos County).
- All outdoor lighting fixtures installed on private and public property in Taos County after the effective date of this Ordinance shall be shielded. This Ordinance does not apply to interior lighting.
- All outdoor lighting fixtures existing and legally installed and operative before the effective date of this Ordinance are exempt from these requirements. When existing lighting luminaires or fixtures become inoperable, their replacements are

Taos County Ordinance 2006-9
Night Sky Protection Act
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subject to all the provisions of this Ordinance and the State Night Sky Protection Act.

- D. When an existing fixture is replaced, the replacement fixture shall meet the requirements of this article. More stringent modifications to nonconforming fixtures in historic districts shall also apply where mandated.
- E. Compliance with this Ordinance shall be administered by the County Planning Department.
- F. In the event of a conflict with any other section of this article, the more stringent requirement shall apply.
- G. All governmental agencies, federal, state or county – including their security facilities – which operate within the limits of Taos County should experience no difficulty meeting the requirements of this Ordinance and are encouraged by the County to comply with its provisions.

V Exemptions.

The following lights that exceed the brightness limitations contained herein are exempt from the provisions of this Ordinance:

- A. All existing lights as of the date of this Ordinance.
- B. Traffic control signals and devices.
- C. Street and road lights installed prior to the effective date of this Ordinance.
- D. Temporary emergency lighting (i.e. fire, police, repair workers).
- E. Moving vehicle lights.
- F. Navigation lights (i.e. airports, heliports, radio/television towers).
- G. Seasonal decorations with individual lights in place no longer than 60 days.
- H. Sports-field outdoor lighting sites existing at the date of passage of this Ordinance (i.e. ball fields, football, soccer, ice rink, etc.). Any new County sports lighting installations (or any over-all, complete replacement of *luminaires or fixtures*¹ at existing sites) are to be shielded or hooded within the spirit of this Ordinance.
- I. Other special situations approved by the County for temporary or periodic events (i.e. rodeos, revivals, fairs, fiestas, carnivals, night-time construction).
- J. Security lights of any wattage that are controlled by a motion-sensor switch and which do not remain on longer than 12 minutes after activation.

¹ See definitions section on page 2 of Ordinance Draft

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- K. Existing industrial, mining or rural agricultural compounds that require adequate lighting for safety, security or to discourage theft of property. They should be hooded or shielded when possible.
- L. State highway high-mast tower lighting should adhere to the same standards identified in paragraph A of **General Standards** Section VI.

V. Submittals

- A. Applications for building permits or applications for review by the County Planning Department, which includes the installation of outdoor lighting fixtures for new construction, shall provide evidence of compliance with the requirements of this Ordinance. The submittal shall contain the following information and be provided as part of the site plan to the County Planning Department for approval:
 - (1) Plans indicating the location, type, and height of luminaires including both building and ground-mounted fixtures,
 - (2) A description of luminaires, including lamps, poles or other supports and shielding devices, which may be provided as catalogue illustrations from the manufacturer,
 - (3) Ganging of individual luminaires to achieve more than allowed lumens in a specific area is prohibited. They may be ganged on a single standard only if focused downward on different surfaces,
 - (4) Fixture photometric data, such as that furnished by the manufacturer, showing the downward angle of light emission,
 - (5) Additional information as may be required by the County Planning Department in order to determine compliance with this Ordinance.

To help assure compliance with this Ordinance the following Certification will be executed on submittals to the County Planning Department for all commercial, residential, and multi-family projects:

Engineer's, Architect's or Licensed Contractor's Certification, Date _____

I, _____, a Registered Professional Engineer, Architect or Licensed Contractor, number _____ under the Laws of The State of New Mexico, hereby certify that the Outdoor Lighting Plan on this drawing was prepared under my direction and conforms to the County of Taos Lighting Ordinance _____ and is true and correct to the best of my knowledge and belief.

Signed by Registered Professional Engineer, Architect, Licensed Contractor or individual Home Builder.

- B. Requests for any lighting deviation from the requirements of this Ordinance are to be submitted in writing to the Taos County Planning Department. It shall be approved only when it is determined that a deviation is warranted in order to provide even more security for personal property, business inventory, agricultural produce or livestock.
 - (1) The lighting deviation application shall contain a detailed site plan showing the location and type of lighting fixtures and the lumens/wattage deviations for each fixture sought by the applicant. In addition, the site plan shall show the

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locations of all buildings, public streets and roadways and other structures located within two hundred (200) feet of the property.

(2) The requested deviation shall be reviewed by the Planning Director. The Planning Director may grant the application, with or without conditions, if the Director determines that the General Standards of Section VI, are met. Determinations of the Planning Director may be appealed by the applicant to the Planning Commission by written notice of appeal filed with the Planning Director within ten (10) calendar days following written notification to the applicant of the Director's determination. Appeals from determinations of the Planning Commission shall follow the appeal procedure of the County's Zoning Ordinance as amended from time to time.

(3) On change of use of the property, any permitted deviations are automatically terminated.

VI. General Standards.

The following general standards shall apply to all outdoor lighting installed after the effective date of this Ordinance, which are not exempted in Section IV above:

- A. Outdoor lighting must be hooded, shielded and aimed downward. Examples of acceptable and unacceptable light shielding and hooding are shown in Tables 1-5, attached.
- B. The hood or shield must mask the direct horizontal surface of the light source. The light must be aimed to insure that the illumination is only pointing downward onto the ground surface, with no escaping light permitted to contribute to sky glow by shining upward into the sky.
- C. Any bright light shining onto adjacent property or streets which would result in a disabling glare shall not be permitted. Light trespass beyond property boundaries or above the horizontal plane shall be considered non-compliant.
- D. Existing fixtures may be adapted to comply with this Ordinance by adding a properly designed hood or shield, or by pointing any upward-mounted, shielded fixture downward toward the ground surface.
- E. All outdoor lighting fixtures shall be designed, installed, located and maintained such that glare onto adjacent properties or streets shall be minimized and all direct illumination kept within the boundaries of the fixture owner's property.
- F. Accent lighting, when so approved, shall be directed downward onto the building or object and not toward the sky or onto adjacent properties. Direct light emissions shall not be visible above the roof line or beyond the building edge.
- G. Agricultural or government installation light fixtures are limited to 50,000 lumens and must be hooded or shielded from dispersing upward rays.
- H. Lumen/wattage limitations by light-source type are shown on Table 5, attached.

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VII. Enforcement and Penalties for Violation.

This Ordinance will be enforced when any citizen complains in writing to the County Manager or Planning Director and the complaint is determined to be legitimate within the spirit of this Ordinance. The County Code Enforcement Officer will contact the offender.

- A. For the first offense, the offender maybe issued a warming with 30 days to correct the offense.
- B. Penalties for Commercial and Non-Residential Lighting Violations
Any further violations of the provisions of this Ordinance shall constitute a petty misdemeanor, and upon conviction thereof, shall be punishable by a fine not to exceed one hundred dollars (\$100.00) for the first violation; three hundred dollars (\$300.00) for the second violation; and five hundred dollars (\$500.00) for the third violation.
- C. Penalties for Residential Violations
Any further violations of the provisions of this Ordinance shall constitute a petty misdemeanor, and upon conviction thereof, shall be punishable by a fine not to exceed twenty-five dollars (\$25.00) for the first violation; seventy-five dollars (\$75.00) for the second violation; and one hundred twenty-five dollars (\$125.00) for the third violation.

VIII. Severability

The provisions of this Ordinance are severable and if any paragraph, section, subsection, or part of this Ordinance is held to be invalid, unenforceable, unconstitutional, or inapplicable to any person or circumstance, such illegality, invalidity, unconstitutionality, or inapplicability shall not affect or impair the remainder of this Ordinance.

IX. Effective date

The provisions of this Ordinance shall become effective thirty (30) days after published unless otherwise provided by law.

After passage and at least annually thereafter, presentations of this Ordinance will be made through Kit Carson Electric to registered County electricians, builders, architects, developers, Neighborhood Associations and ranching industry, and any other groups that should be interested in the preservation of Taos County's dark skies beauty.

TABLES 1 – 5, ATTACHED

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PASSED, ADOPTED AND APPROVED THIS 20th DAY OF November, 2006.

BOARD OF COUNTY COMMISSIONERS
OF TAOS COUNTY, NEW MEXICO

Emanuel B. Pacheco, MSW
Emanuel B. Pacheco MSW, Chairman

Nicklos Jaramillo, Vice Chairman

Gabriel Romero, Commissioner

Don Francisco R. Trujillo II, Commissioner

Virgil Martinez, Commissioner

ATTEST:

Elaine Montano, Taos County Clerk

Christine Anaya Esq., Robles, Rael & Anaya, P.C.

Vote Record:

E. Pacheco	<input checked="" type="radio"/> yes	<input type="radio"/> no	<input type="radio"/> abstain	<input type="radio"/> absent
N. Jaramillo	<input checked="" type="radio"/> yes	<input type="radio"/> no	<input type="radio"/> abstain	<input type="radio"/> absent
G. Romero	<input checked="" type="radio"/> yes	<input type="radio"/> no	<input type="radio"/> abstain	<input type="radio"/> absent
DF Trujillo II	<input checked="" type="radio"/> yes	<input type="radio"/> no	<input type="radio"/> abstain	<input type="radio"/> absent
V. Martinez	<input checked="" type="radio"/> yes	<input type="radio"/> no	<input type="radio"/> abstain	<input type="radio"/> absent

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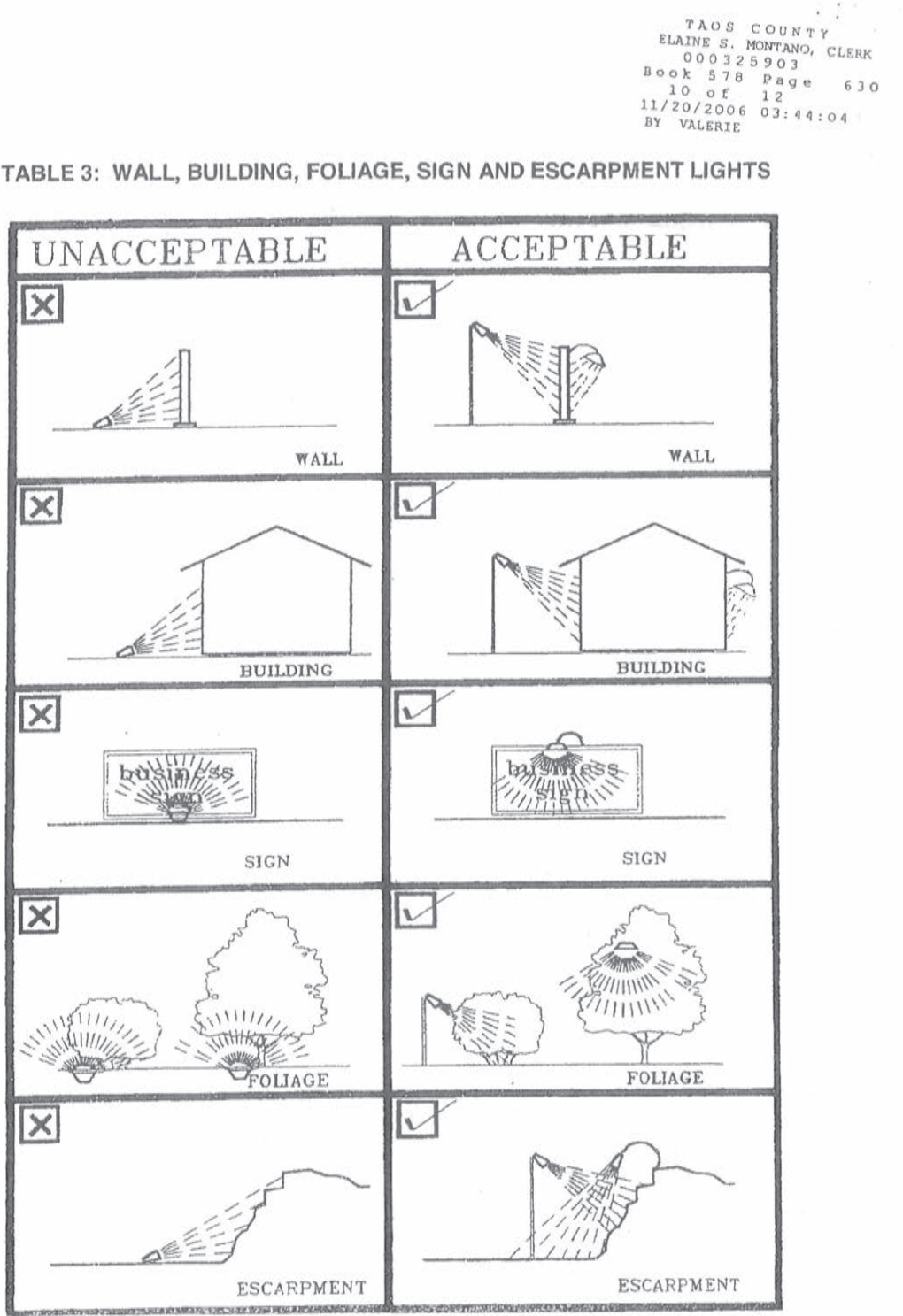
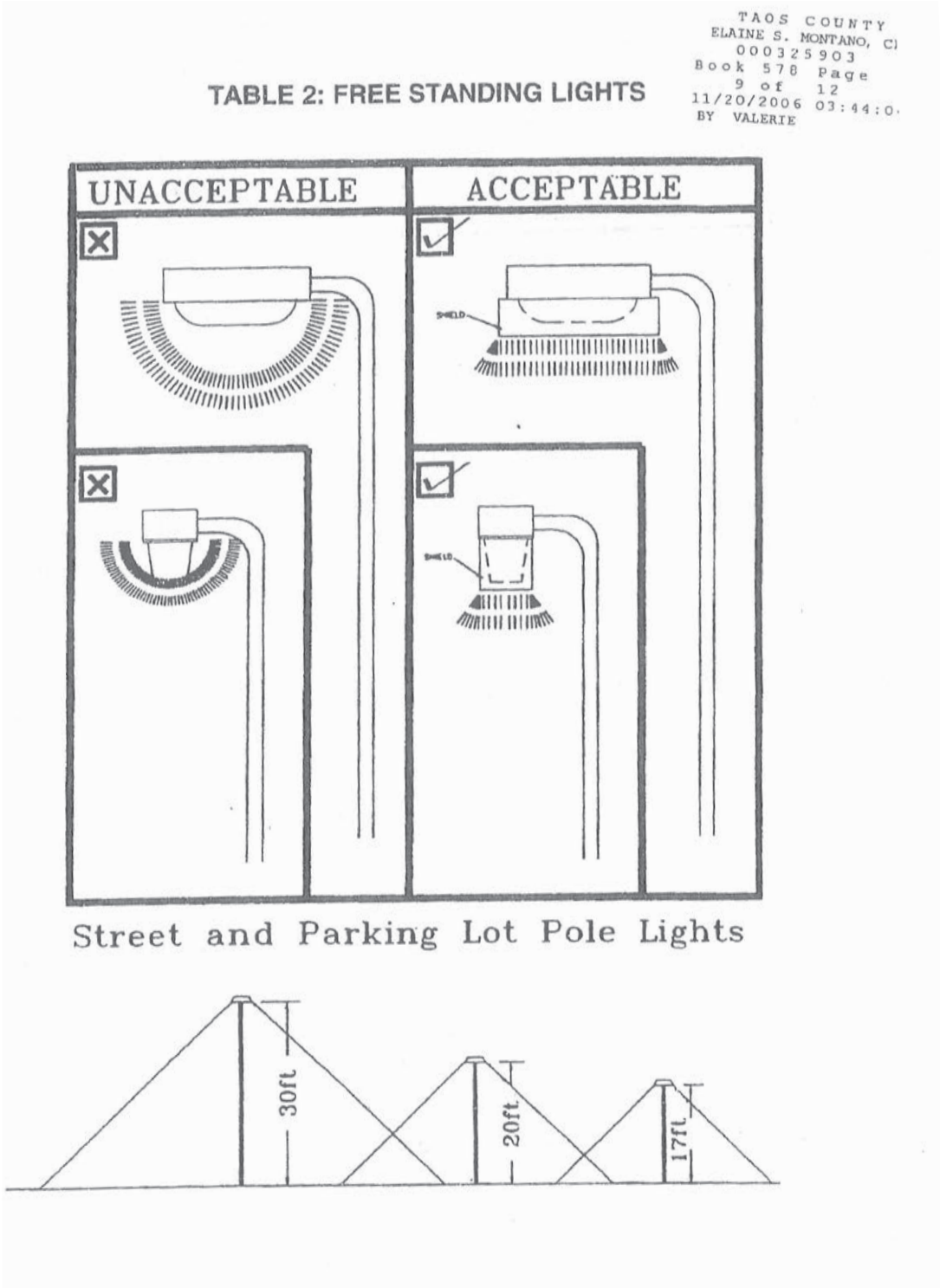
TABLES 1 - 5
ACCEPTABLE SHIELDING, HOODING AND AIMING OF OUTDOOR LIGHT
FIXTURES

The following 5 tables of schematics show what is acceptable and what is unacceptable in the County of Taos.

TABLE 1: WALL-MOUNTED LIGHTS

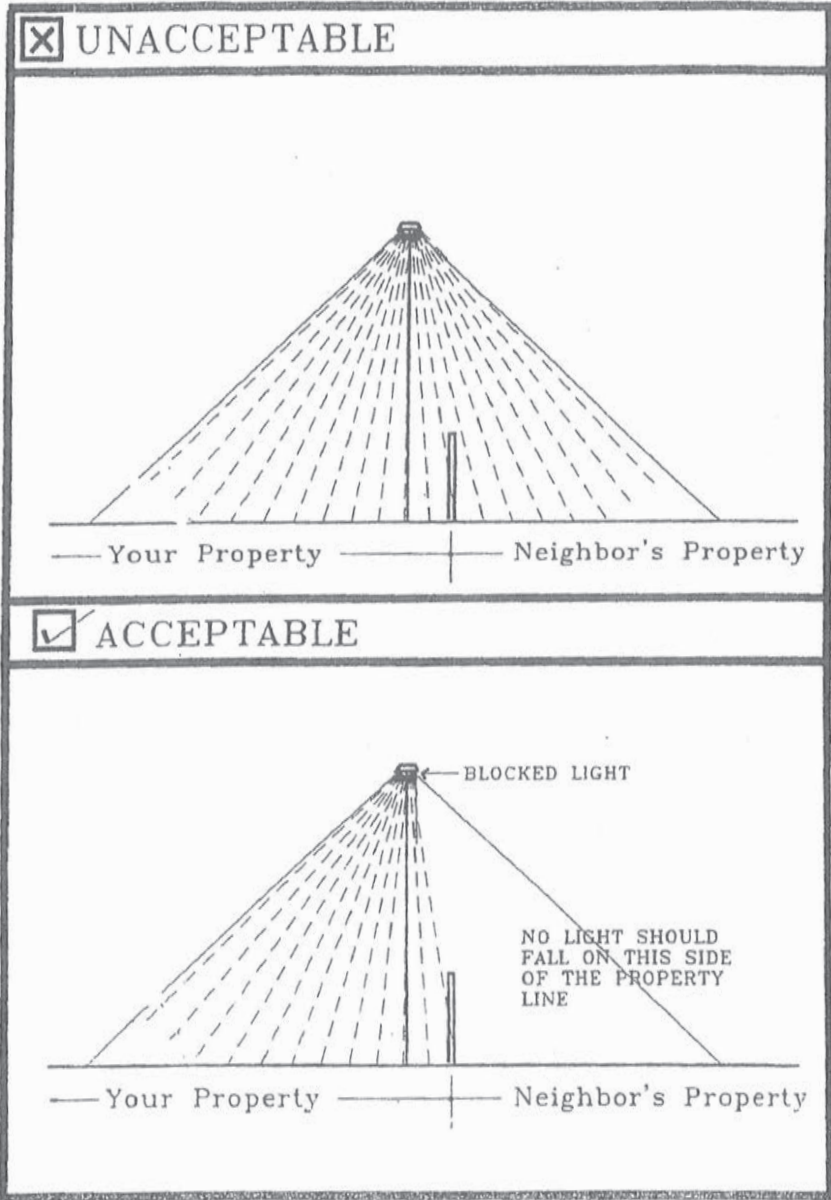
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TABLE 4: STREET AND LOT LIGHT CUT-OFF AT PROPERTY LINE



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BY VALERIE

TABLE 5: LIGHT-TYPE WATTAGE COMPARISONS

Bulbs Lawful Outdoors In Taos County	Wattage of Bulb Allowed (At or Below the 2,200 Lumens Limit for Residential and Commercial Lights)*
Incandescent	150 watts
High Pressure Sodium	35 watts
Low Pressure Sodium	18 watts
Metal Halide	39 watts
Halogen	100 watts
Quartz	100 watts
Florescent	30 watts

Bulbs Unlawful Outdoors
In State of
New Mexico

Mercury Vapor**

* Agricultural and Government lights are limited to 50,000 lumens.

** Grandfathered in New Mexico until the bulb/luminare must be replaced. See
State of New Mexico, 44th Legislature, 1st Session, Laws 1999, Chapter 197, House
Bill 39, as amended, Signed April 6, 1999.
Bill 39, as amended, Signed April 6, 1999.

Unannotated New Mexico Statutes
Chapter 74 Environmental Improvement
Article 12 Night Sky Protection

74-12-1. Short title.
This act may be cited as the "Night Sky Protection Act".

74-12-2. Purpose.
The purpose of the Night Sky Protection Act is to regulate outdoor night lighting fixtures to preserve and enhance the state's dark sky while promoting safety, conserving energy and preserving the environment for astronomy.

74-12-3. Definitions.
As used in the Night Sky Protection Act:
A. "outdoor lighting fixture" means an outdoor artificial illuminating device, whether permanent or portable, used for illumination or advertisement, including searchlights, spotlights and floodlights, whether for architectural lighting, parking lot lighting, landscape lighting, billboards or street lighting; and
B. "shielded" means a fixture that is shielded in such a manner that light rays emitted by the fixture, either directly from the lamp or indirectly from the fixture, are projected below a horizontal plane running through the lowest point on the fixture where light is emitted.

74-12-4. Shielding of outdoor light fixtures.
All outdoor lighting fixtures installed after January 1, 2000 shall be shielded, except incandescent fixtures of one hundred fifty watts or less and other sources of seventy watts or less.

74-12-5. Nonconforming light fixtures.
A. In addition to other exemptions provided in the Night Sky Protection Act, an outdoor lighting fixture not meeting these provisions shall be allowed, if the fixture is extinguished by an automatic shutoff device between the hours of 11:00 p.m. and sunrise.
B. No outdoor recreational facility, whether public or private, shall be illuminated after 11:00 p.m. except for a national or international tournament or to conclude any recreational or sporting event or other activity conducted, which is in progress prior to 11:00 p.m. at a ballpark, outdoor amphitheater, arena or similar facility.

74-12-6. Use of mercury vapor lighting fixtures.
No new mercury vapor outdoor lighting fixtures shall be sold or installed after January 1, 2000.

74-12-7. Exemptions.
A. The following are exempt from the requirements of the Night Sky Protection Act:
(1) outdoor lighting fixtures on advertisement signs on interstates and federal primary highways;

(2) outdoor lighting fixtures existing and legally installed prior to the effective date of the Night Sky Protection Act; however, when existing lighting fixtures become unrepairable, their replacements are subject to all the provisions of the Night Sky Protection Act;
(3) navigational lighting systems at airports and other lighting necessary for aircraft safety; and
(4) outdoor lighting fixtures that are necessary for worker safety at farms, ranches, dairies, feedlots or industrial, mining or oil and gas facilities.
B. The provisions of the Night Sky Protection Act are cumulative and supplemental and shall not apply within any county or municipality that, by ordinance or resolution, has adopted provisions restricting light pollution that are equal to or more stringent than the provisions of the Night Sky Protection Act.

74-12-8. Construction industries division; duties.
The construction industries division of the regulation and licensing department shall review the outdoor lighting provisions in the uniform building codes used in New Mexico and make recommendations for appropriate changes to comply with the provisions of the Night Sky Protection Act and shall permit and inspect, to the standards set forth in the Night Sky Protection Act, all construction of and on state-owned buildings that is subject to permit and inspection under the Construction Industries Licensing Act [Chapter 60, Article 13 NMSA 1978].

74-12-9. Costs of replacement; recovery.
If public utilities are required pursuant to the provisions of the Night Sky Protection Act or by local government ordinances to accelerate replacement of lighting fixtures, the cost of such replacement shall be included in rates approved by the public regulation commission.

74-12-10. Violations; penalty.
Any person, firm or corporation violating the provisions of the Night Sky Protection Act shall be punished as follows:
A. for a first offense, the offender may be issued a warning; and
B. for a second offense or offense that continues for thirty days from the date of the warning, twenty-five dollars (\$25.00) minus the replacement cost for each offending fixture.

74-12-11. Enforcement.
In order to promote the purposes of the Night Sky Protection Act and to provide uniform minimum outdoor lighting standards throughout the state, the construction industries division of the regulation and licensing department shall enforce the Night Sky Protection Act as it pertains to public buildings subject to permit and inspection under the Construction Industries Licensing Act [Chapter 60, Article 13 NMSA 1978] and each political subdivision of the state shall fully enforce the provisions of the Night Sky Protection Act.

New Mexico Night Sky Protection Act

In 1999, New Mexico enacted the Night Sky Protection Act [74-12-1 to 74-12-10 NMSA 1978]; *its purpose is to regulate outdoor night lighting fixtures to preserve and enhance the state’s dark sky while promoting safety, conserving energy and preserving the environment for astronomy*. One of the first of its kind in the U.S., the Night Sky Protection Act makes dark skies a priority in New Mexico for the health of its people, wildlife, and economy.

The act requires that outdoor lighting be fitted with shielding that directs light downward, rather than upward or laterally. The act allows present lighting to remain throughout its useful life, but requires the installation of conforming lights whenever replacement would normally occur, so that any economic burden is limited or avoided altogether. The law also allows local communities to enact more stringent local ordinances. The New Mexico Night Sky Protection Act takes important steps to stop continued increase in light pollution while the bright stars are still among the things that make New Mexico the “Land of Enchantment.”

The Monument’s Lighting Management Plan

Introduction

A natural lightscape is one that is free of light pollution. Spilled light or wasted light are phrases that describe the misuse of outdoor lighting, especially in a natural or protected environment such as a national park. The term light pollution has commonly been used to emphasize the concept that anthropogenic light in the naturally dark environment is indeed a pollutant with undesirable ecological consequences, not just a nuisance. There are many good reasons to eliminate light pollution in national parks, including:

- The preservation of natural lightscapes (the intensity and distribution of light on the landscape at night) will maintain the nocturnal scotopic (vision under low light conditions) environment within the range of natural variability. Excursions outside this natural range may result in a modification to natural ecosystem function, especially to systems involving the behavior and survival of nocturnal animals. The natural night sky is therefore one of the physical resources under which natural ecosystems have evolved.
- The scenery of national park areas does not just include the daytime hours. A natural starry sky absent of anthropogenic light is a key scenic resource, especially in parts of the Southwest.
- The history and culture of many civilizations are steeped in interpretations of night sky observations, whether for scientific, religious, or time-keeping purposes. As such, the natural night sky is an important cultural resource, especially in areas where evidence of aboriginal cultures is present.

The remote location of Salinas Pueblo Missions National Monument within the high desert of central New Mexico allows for pristine night skies that are relatively free of light pollution. The Monument believes that preserving the natural night sky is an integral part of the resource protection performed at this park unit, and is committed to the ongoing conservation of this important cultural, natural, and scientific resource. Through responsible lighting management and night sky interpretation and public education, the Monument will continue to preserve natural night skies for this and future generations.

Purpose and Goal

The purpose of this Lighting Management Plan (LMP) is to provide guiding principles, lighting guidelines, and standards and best practices for the use of artificial outdoor lighting in the Monument in order to preserve the fundamental resources and visitor experience of this special place. The LMP was developed to conform to the goals and requirements of NPS Management Policy 4.10— Natural Lightscapes. This LMP is the official outdoor lighting policy of the Monument. It has been codified as a park Standard Operating Procedure (SOP) and was approved by the park Superintendent on August 31, 2016.

The goal of this LMP is to provide for the safety of NPS staff and the security of NPS facilities without any significant impact on the night skies of the Monument.

Guiding Principles

The following principles will be followed:

- Providing light for visitor and staff safety in commonly used developed areas, as well as for building security purposes, will be achieved while protecting the natural environment from light pollution. Decisions on lighting necessary for employee and visitor safety must be made by considering factors such as the expectation of permanent artificial lighting, existing safety hazards (such as tripping, falling, criminal activity, and wildlife), type of tasks performed, frequency of those tasks or use level, and available alternatives.
- Energy efficiency should be a goal for all outdoor lighting, as it lessens the Monument’s carbon footprint. An important distinction here, however, is that – especially with new LED technology - an energy efficient light is not necessarily a night-friendly light.
- Long term sustainability in the operation and maintenance of outdoor lighting solutions should be maximized. The total lifecycle cost should be weighed in a sustainability assessment. In many cases, the lower wattage requirements of a lighting installation designed to preserve night skies makes that installation more economical than the traditional alternatives over the life of the products.
- Outdoor lighting will be sensitive to the impact upon wildlife. The addition of artificial light into a park setting will alter nocturnal habitat, and the impact may reach beyond the bounds of the developed area. Parameters of direct light intensity, scattered light intensity, light color, light timing and duration are all important considerations for wildlife.
- External threats to the natural lightscape within the parks will be addressed, primarily by setting a leadership example for surrounding communities. NPS management policies put a positive responsibility upon superintendents to partner, to the extent possible, with these communities to protect the natural environment of parks. Part of this effort is to provide examples of outdoor lighting Best Practices for the public. This requires that outdoor lighting in parks be held to a high standard, that the existing lights incorporate these principles, and that park facility lighting is interpreted to visitors and the surrounding community.

Lighting Guidelines

The guiding principles can be distilled into four main lighting guidelines:

1. Artificial light should exist only where deemed necessary.

- 2. Artificial light should exist at a minimum practical level.
- 3. The area of illumination should be restrained to the area judged necessary.
- 4. Duration of illumination should be similarly restrained to a practical and required area.

Lighting Standards and Best Practices

All exterior lighting in the Monument shall be designed to eliminate light trespass, minimize glare, and use an intensity, color, and duration that will preserve the natural darkness as much as possible.

NPS Management Policies direct parks to use artificial light on an “only as needed” basis and to minimize impact whenever possible. Merely shielding a light does not necessarily constitute lightscape, wildlife, or night-sky friendliness; especially if that light is unnecessary in the first place. Even when a light is necessary, the incorporation of a timer, motion sensor, or switch can greatly reduce its impact. The mitigation of outdoor lighting impacts upon the environment is best accomplished by addressing six parameters of lighting.

- 1) **Warranting- Light only WHERE you need it**
 - a. Lighting installations should be placed only where uses dictate.
- 2) **Controls- Light only WHEN you need it**
 - a. Rather than defaulting to a dusk-till-dawn operational cycle, lighting controls should be designed to minimize the amount of time the light is on while still fulfilling the need met by installing the light at that spot in the first place.
- 3) **Shielding- Direct light DOWNWARD**
 - a. No fixture should emit light above the horizontal. In most cases, beams of light should be restricted even further. Lights should be directed downward and shielded.
- 4) **Spectrum- Select LAMPS that minimize negative impacts**
 - a. Humans and many other animals are most sensitive to blue/white light. Most evening lighting goals can be achieved using warmer temperature lighting, which decreases the disruption to wildlife (including insects), maintains the human ability to adapt to low light conditions, and decreases sky glow. Amber or yellow light sources are preferable, both to limit attraction by insects and to reduce sky glow. Light sources should be chosen for energy efficiency, long life and low maintenance.
 - b. The color tint (correlated color temperature, or CCT) of white light is measured in Kelvins (K), a scale in which warm-toned white light has smaller values (1800-3000K) and cold-toned light has larger values (5000K and higher). Between 3000 and 5000K, light is said to be “neutral” in tone. The common incandescent lamp is 2700K. Lights should be selected with warm colors, such as amber (not to exceed 3000K). Any fixtures that exceed 3000K must be limited in duration of operation and utilize motion sensors to activate the light only when needed.
- 5) **Intensity- Use the minimum AMOUNT of light necessary**
 - a. Lights should only exist in the minimum amount necessary. Any fixtures used in continuous overnight operation that exceed 500 lumens should be fully shielded.
- 6) **Efficiency- Select the most energy EFFICACIOUS lamp and fixture**
 - a. Energy efficiency should be considered when choosing lighting. Standard bulbs should be compact fluorescent (CFL), which are low-wattage, or light-emitting diodes (LED).

- 7) **Monitoring- Make sure lights are WORKING PROPERLY**
 - a. Evaluate and monitor lighting performance to ensure that fixtures are calibrated and working properly. Utilize the Monument’s maintenance work order system to annually inspect and adjust lighting as needed.

Fortunately, due to the small scale of facilities in the three units, both extant and planned, the LMP for Salinas Pueblo Missions is generally simple. In its simplest form, the main components are:

- Lighting used to secure the Monument property should be restricted to motion sensor lights wherever possible; and these lights should be fully-shielded and use low wattage, warm-colored bulbs.
- Any light that does not have a motion sensor should be on a timer or day-time light sensor so that they operate not to exceed dusk to dawn nighttime hours; the wattage should be as minimal as practical and warm-colored bulbs should be used.
- Any light used for safety purposes (including at the employee housing area) should adhere to the standards and best practices presented on the previous page.

All future outdoor lighting will conform to these standards.