large, one can look to accumulated ground water reserves.

In the Kitt Peak mass, the ready percolation of water in the fissured structure is such that little in the way of accumulated water is likely. At the foot of the mountain, however, the occurrence of ground water in the alluvium deposits is more likely. Borings by the U. S. Geological Service for the Bureau of Indian Affairs found that moderate supplies of ground water could be developed adjacent to mountain masses. They also found that the depth of ground water rapidly approached 1,000 feet at a couple of miles from the mountain mass.

The possibility of developing ground water in the alluvium at the foot of Kitt Peak should not be neglected. The lift of approximately 3,500 feet that would be involved could be solved by a double or triple lift system. If the pipes are laid near the temporary access road, some three miles of pipe would be involved. Since the power line parallels this route, adequate power could be available as needed for the pumping operation.

Again, it must be emphasized that the development of ground water near the foot of the mountain mass is highly uncertain. The possibility of a long-termed water source from wells near Pan Tak or San Vincente, providing a permissive agreement with the Papago Tribe, should be studied.

III. Paved Collection Areas

The method of paved collection areas is based upon improving the collection efficiency from 2 to 3 percent to 60 to 80 percent. The factor of 20 to 30 is enough to render the method of paving a

collection basin one of economic feasibility. This procedure was elected because of the certainty of collecting some water, although it was estimated that years of rainfall as low as one third of normal would occur. The fact that small pumping lifts are involved enchances this method.

The collection of rainfall poses a problem in the purity of the collected water. While ground water or percolated water is free of organic matter, it frequently will contain significant quantities of dissolved inorganic matter, such as salts. While rather hard water can be tolerated for human consumption, the presence of these ions can cause problems with photographic processing. In this regard, collected rain water will have a low ion content and be highly satisfactory for scientific requirements as well as human consumption. The presence of a higher concentration of Sr90 in natural rainfall over ground water should be noted, but no problem should develop from this radioactive micro-contamination in the foreseeable future.

There is one important problem connected with the use of rainfall gathered from a collection area. The water can be contaminated by organic surface deposits. Photographic materials are susceptible to hydrocarbon compounds and the quality of fundamental photographic material could be accidentally jeopardized from these compounds. Since photographic records have usefulness measured in centuries, astronomers are cautious in any regard that could lead to the deterioration of these records. We, therefore, must carefully examine the hazard present in this respect.

Recent examination of water seeping up through seeps in the present water collection area show the taste and interference colors of oil. Water that promptly runs off the surface of the asphalt area does not show interference colors. We have concluded that continued contact with the asphalt, particularly with the sealer beneath the asphalt, will result in the leaching of hydrocarbons. It is hoped that the sealing of these seeps will confine the dissolved hydrocarbons to the sub-surface drainage placed beneath the dam.

A more serious hazard from organic contamination is presented by the exposure of the surface to human activities. It is, therefore, strongly recommended that the entire area be fenced and no access by persons or vehicles onto the collection area be permitted except under the strictest surveillance.

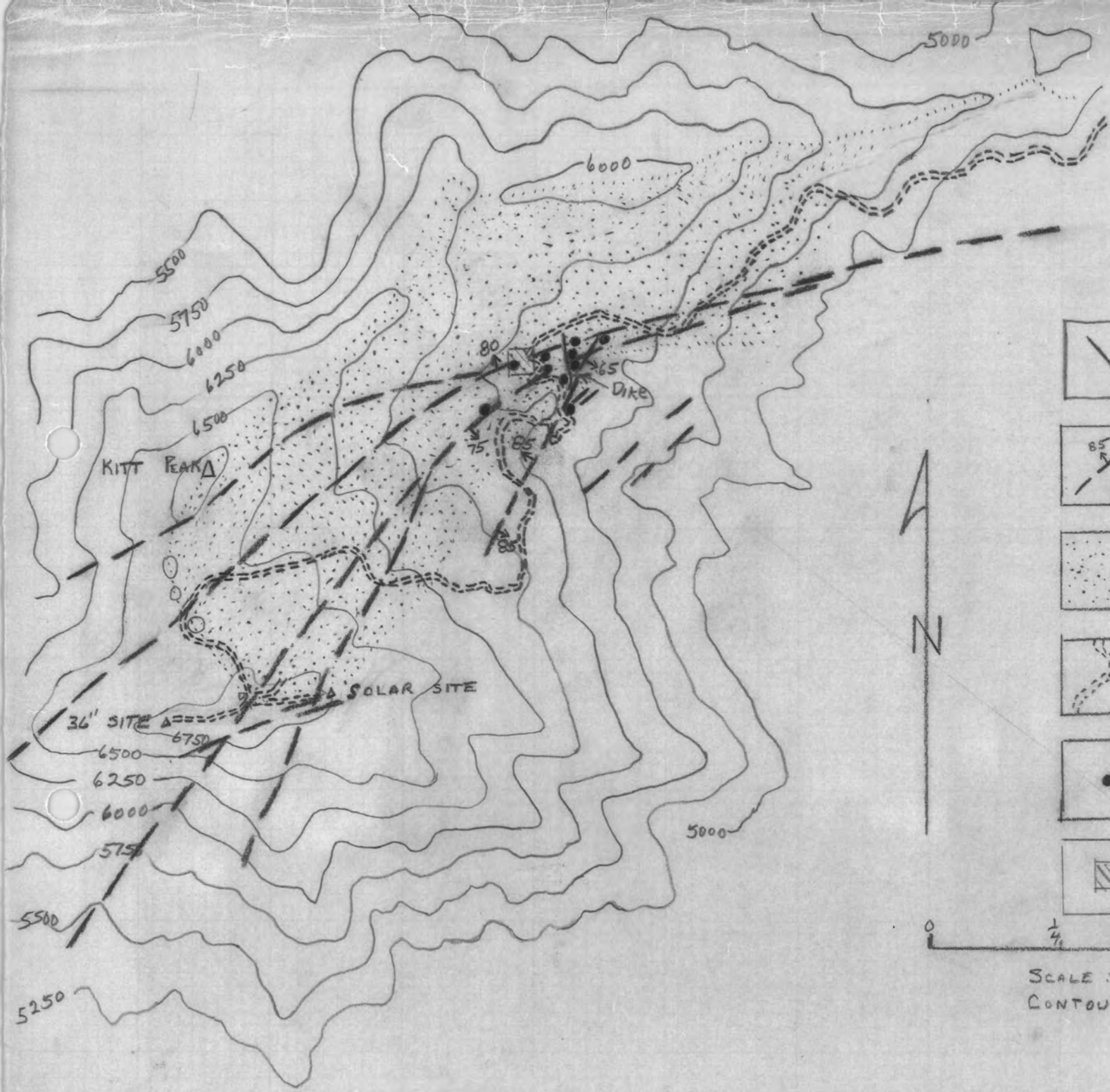
We have for some time considered the expansion of the water collection area by the inclusion of water collected from the onsite roads. At first glance this approach is appealing, but upon reflection, the hazards become apparent. The travel and parking of vehicles over these roads will present a source of hydrocarbon compounds, often in uncontrolled or unpredicted amounts. The risk of poisoning the entire water supply for exacting uses would indicate that adding roads to the collection areas is poor economy. Rather than risk consequences that might not be readily apparent either from bacterial infections or hydrocarbons, it is strongly recommended that water from the onsite roads be rejected as a source for domestic and scientific use. I know of no installation in civilian or military use that collects runoff of roads or airstrips because

of the hazard of unpredictable contamination.

The utilization of water from the onsite roads is desirable if the above danger can be avoided. It is recommended that the onsite road runoff be collected in a separate area and kept in separate and unsophisticated storage for industrial usage. The best way to accomplish this use is to direct the water past the collection area to a catchment dam. It has been found that a large catchment area (about 300,000-gallon) can be developed in a rock neck below the present access road, about 300 yards downslope northeast of the present catchment area. Ready access by the tank truck to this area would be possible from the present road. The area is situated below the secondary catchment area proposed for expansion of the domestic and scientific supply.

I, therefore, wish to make the following recommendations in resume:

1. That the possible development of wells and springs on Kitt Peak be deferred for the present until more is known of the areas to be traversed by the new road.
2. That development of ground water at the foot of Kitt Peak be considered.
3. That access to the collection area at the summit be restricted and the area fenced and locked.
4. That water from onsite roads, if collected, be maintained separate from the domestic and scientific supply.



KITT PEAK

WATER INVESTIGATION

9/17/59

DIKE

85 FRACTURE ZONE

DRAINAGE BASIN (STIPPLED)

MAIN ROAD

SPRING

DRILL HOLE SITE

N

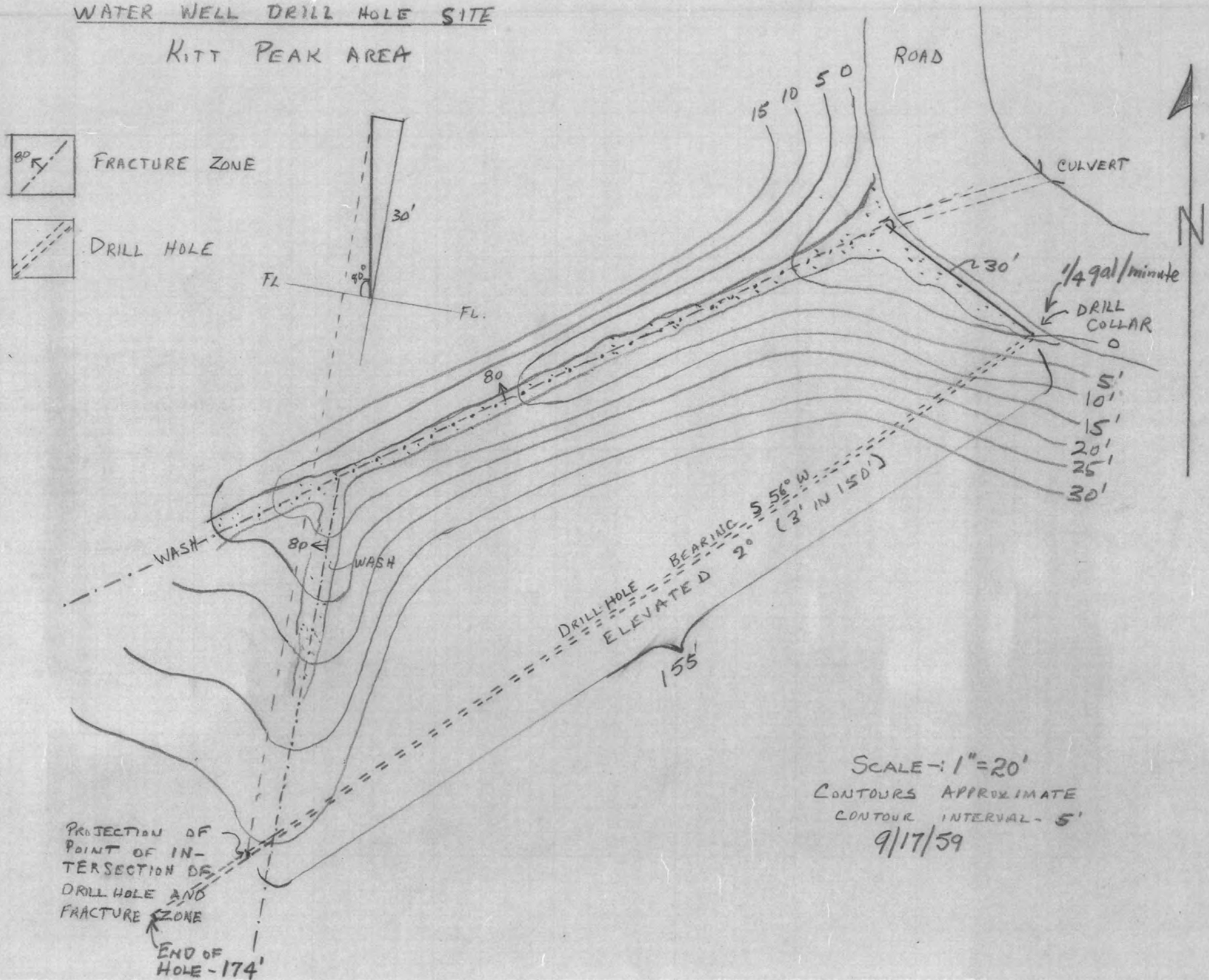
0 1/4 1/2 3/4 1

SCALE: 4" = 1 MILE

CONTOUR INTERVAL = 250'

WATER WELL DRILL HOLE SITE

KITT PEAK AREA



SCALE - 1" = 20'

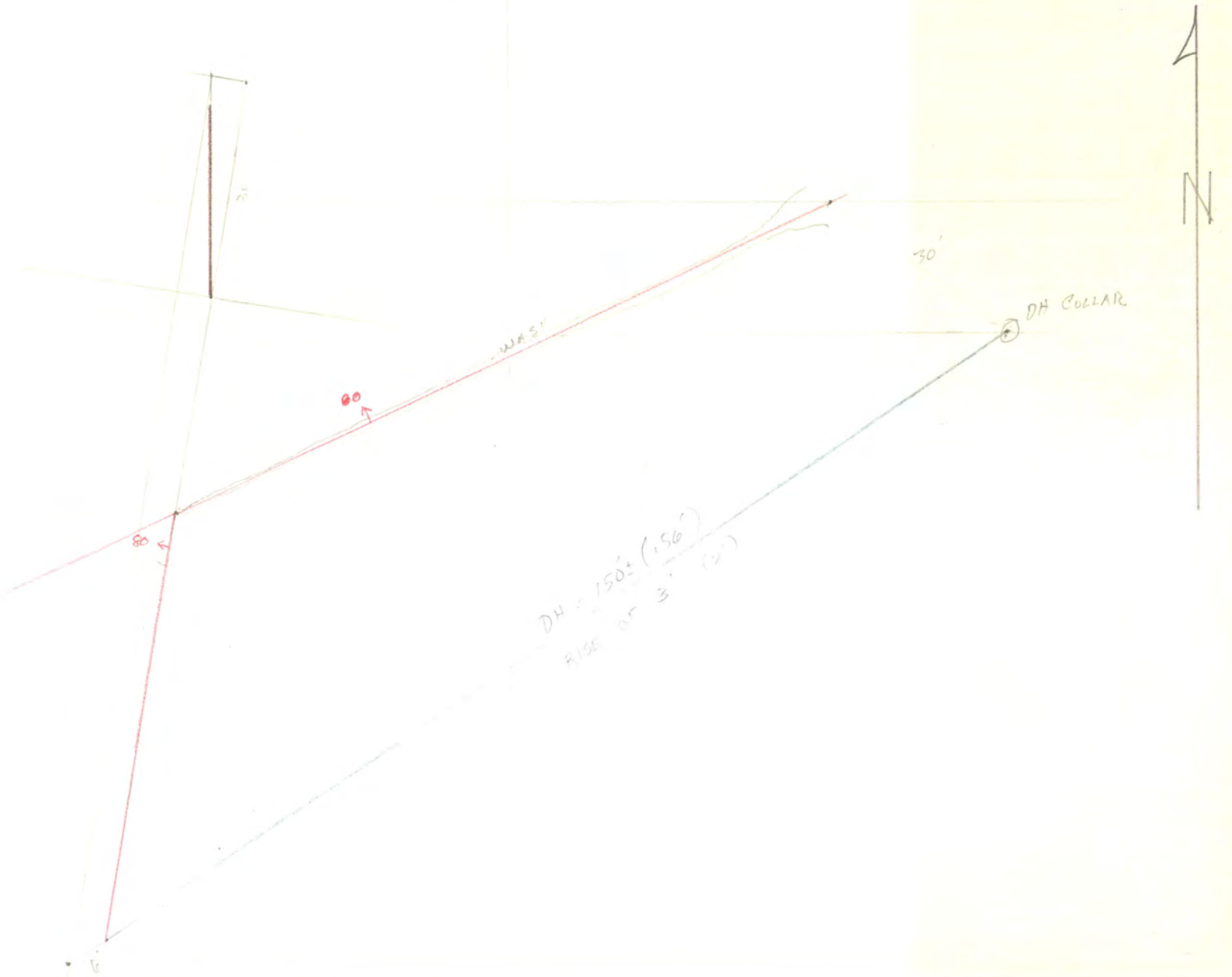
CONTOURS APPROXIMATE

CONTOUR INTERVAL - 5'

9/17/59

WATER DRILL HOLE
KITT PEAR

1" = 20'



September 18, 1959

Dr. A. K. Pierce
AURA, Incorporated
1033 N. Park Avenue
Tucson, Arizona

Re: Kitt Peak Water Development

Dear Kieth:

Enclosed herewith in duplicate, together with my indicated approval, is statement for Metler Brothers Drilling Company for the one water well hole. If possible, an extra effort to expedite remittance would be very much appreciated as I understand, they are still awaiting balance on last statement to Michigan for previous work.

Log on this hole is as follows: West side of road near culvert at first main draw on SE slope of main Kitt Peak Ridge, 2° up from horizontal at S56°W.

Date	Set-up	
9/10/59	0-8' soil and overburden.	Inside threaded 8 threads/inch, BX casing. Set & cemented at 9'.
9/11/59	8'-35' Bedrock (granite) Hole dry.	
9/12/59	35'-112' Medium hard to soft granite. Hole dry.	
9/14/58	112'-124' Medium hard to soft granite - dry? 124'-130' Red oxfdized fracture zone-fault? - wet. 130'-157' Medium hard to soft granite--wet?	
9/15/59	157'-174' Hard "blue" granite. Hole caving from 100' to 135' - wet? Might require perforated casing to hold open permanently.	

Estimated yield, 1/4 gal.per minute.

Since my letter of 28 August 1959 on this same subject, additional time has been spent on the ground and study made of the SE slopes of Kitt Peak. Several sites with good potential were revealed but none were easy to get to for a short hole with maximum elevation difference between collar or set-up and target. Either the elevation ifference was too small or the target distance too great or considerable dozing was required or a combination of these.

The hole drilled, therefore, was the best immediate compromise, and although, quantity results seem small, I believe the technical feasibility of the approach has been demonstrated. This hole tested mainly a major drainage fault-fracture zone. If other tests are made the next should check a different type of feature, for example the seeps behind the dike which crosses the old cat-jeep trail just above the present road on the SE side of the 2nd main Kitt Peak drain to the SE. This would require considerable dozing off the old cat-jeep trail below the present road, (maybe 2 or 3 days worth,) but would give between 100' and 200' elevation difference for a hole only 200' - 300' long and in addition to the dike may also cut a favorable zone of fracturing and possibly some seep from the 2nd main Kitt Peak drain. This set-up and dozer trail to it have been flagged with red flagging.

Other otential sites are: 1. longer holes at or just below the old spring with the pipe and tank by the road. 2. Fracture zones at the confluence of the two main drains just above the powder magazine near the "Marylin Monroe" stump. One set up and trail to it has been flagged with white and orange flags, but it would be better to get closer to the drainage "Y" and this is possible with a little more cat work. 3. Just below the high-bold-bare outcrop between the first and second main drains on the SE slope of Kitt on the WW side of the 2nd drain. This would require a fairly long, but not too difficult dozer trail across the 2nd drain from the old cat-jeep trail. It has not been inspected closely on the ground, but looks favorable from the aerial photos. 4. Just below some of the flatter "bog" type areas further up the mountain. 5. A 200'- plus hole southerly from the just completed setup would also cut the 2nd main drain to the SE and its associated fracturing.

Sincerely,

[illegible] GEOEXPLORATION COMPANY

Walter E. Heinrichs, Jr.
President & General Manager

mmwjh
cc: 2 extras enclosed (w/o Encl.)

August 28, 1959

AURA, Incorporated
1033 North Park Avenue
Tucson, Arizona

Attn: Dr. A. K. Pierce

Re: Kitt Peak Ground Water Potential

Gentlemen:

Pursuant to our various discussions relative to the above and verbal requests this week from Messers Baustian and Patey, this will serve as written comment, supplementing material included in our original report of May 1959 which still applies, but comment more appropriate to the present considerations.

There is a definite technical possibility for developing a small permanent, or at least semi-permanent, underground water supply. This can only be proven by a certain amount of preliminary test development work. Results of such work will help to indicate how much effort might logically be spent on further ground water investigation and testing. Among the various possibilities, there is sufficient probability for success to certainly justify attempts in several areas in a cautious and limited manner. This is particularly true in view of the relative expense of buying and hauling water from more distant sources and the present uncertainties of the immediate usefulness, as well as long range feasibility of the collection basin systems and the current and continual need for water. Even if only periodic and limited quantities are attained, the costs should be more than recovered as a valuable long range supplementary source.

In our May report, we dealt with the overall broader aspects of ground water investigation from a long range standpoint. More specifically, the present known possibilities may be summarized as follows:

1. Known and relatively accessible seeps along present road.
2. Mapped spring and heavier growth below SW ridge from site 36"--(Not presently accessible).

3. Spring on NW slope(?) reported by surveyors (Not presently accessible)?
4. Seeps likely may be uncovered during construction of the permanent access road.
5. Seeps or springs located by specific reconnaissance search on foot as evidenced by geology and growth observed on the ground and from aerial photographs.

Of these five possibilities, only #1 is immediately feasible. It has good potential, and for both long and short range, may be as good as any of the others. Actually there are 3 separate and distinct places involved here:

1. Main (1st) ravine immediately south east of main Kitt Peak ridge, larger catchment and runoff.
2. 2nd ravine (slightly smaller) south east of main Kitt Peak ridge, less catchment and runoff.
3. 3rd ravine (much smaller) southeast of main Kitt Peak ridge, least catchment and runoff. Partially developed by jackhammer holes.

The first two were apparently dry on the surface in May of this year, but are now running about 20 and 5 gallons per minute respectively and could both be perennial at depth. Number 3 has apparently seeped ever since being cut by the road and has not increased much since the recent rains. Its storage source is the smallest-least apparent of the three, but may be accounted for by the small flat area above and/or faulting.

In order to properly test each of these locations, it would be desirable to drill at least 2 holes and possibly 3 in each place. Desired length of each hole will depend on conditions and results encountered, but they probably should be no less than 50' and might advantageously be as long as 200' to 300'. Setups should be as low as convenient below each area tested, yet as close as possible for minimum footage for maximum back and penetration of the zone of interest. All holes should be slightly up, 2° to 5° for gravity flow. A threaded surface pipe should be cemented and tightly sealed to firm rock, in order when completed, to be able to attach a valve to control and conserve the flow. If sufficient flow is encountered, it may be necessary and/or advisable to set some perforated and/or unperforated casing to preserve the hole.

Costs are estimated at about $6.00 per foot, plus casing at about $2.30 per foot unperforated and $3.80 per foot perforated, plus valves and fittings at $15.00 per successful hole, or on an average of about $6.00 per foot of unsuccessful hole and $8.00 to $10.00 per foot of successful hole.

Before spotting the setups and directions the holes should be oriented, it would be advisable for a geologist to spend one more day in detail examination of the immediate areas around the three sites. At this stage, there is evidence both for and against each of the three sites and it is difficult to relatively evaluate which one might be the best.

Sincerely yours,

HEINRICHS GEOEXPLORATION CO.

by:_____

Walter E. Heinrichs, Jr.
President & General Manager

WEH:jh

cc: 2 extras enclosed

4
27
70
18.90

6900'
3000
3900'

2

6 G.P.M. x 2" pipe

1.4' friction loss.

10,000 hrs.
6¢ (600,000

25000'
1.4
0000

25
1.4
100
25
35.0

7.5 KWH
7.5,000 KWH
3,750.00

24,000
10,000
600,000
6 (3,000,000

4000' left
6
24,000 = 6

10,000
$ 5.000 power.

4000
3960

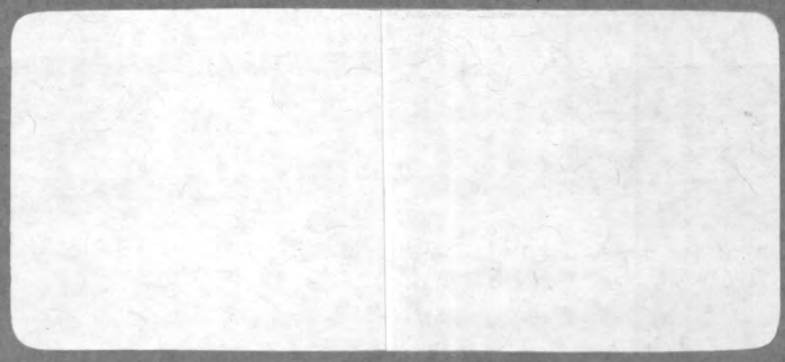
10 hp ±

6 PM x TDH
3960 x .7
HP

Pipe & ditch @ 3.00/foot. = $75,000
pumpsets 20,000
$100,000 while job.

8 KWh/hr.

200



HEINRICHS
GEOEX

GEOPHYSICAL ENGINEERS
TUCSON, ARIZONA

January 25, 1965

Associated Universities, Inc.
N. R. A. O.
Foundation Study, Proposed Site, 36 ft. Radio-Scope
Re: Map #51D00557
Kitt Peak, Arizona

DRILL HOLE LOGS:

HOLE #1

1'-3' -- sticky clay
3' - 30' -- gravel to coarse sand and small boulders
30' - 31'--granite solid with one fracture
31' - 34'--decomposed granite
34' - 35'--badly fractured granite
35' - 39½' -- solid granite
39½ - 49½' -- solid granite
49½ - 50' -- altered decomposed granite & bottom of hole
HOLE #2

1' - 3' -- clay and top soil
3' - 10'-- gravel and decomposed granite
10' - 11½'--solid granite
11½' - 22' -- fractured granite with vertical fractures and joints.
22' - 26½' -- badly fractured, decomposed granite
26½ - 27' -- decomposed granite
27' - 28' -- fractured granite
28' - 30' -- badly fractured granite
30' - 32' -- solid granite with core sections from 2" - 7" long.

HOLE #3

1' - 3' -- top soil - clay
3' - 7' -- gravel and small boulders 3" to 6".
7' - 29½'-- decomposed granite
29½' - 30' -- broken, badly fractured granite.
30' - 35½' -- decomposed granite
35½' - 42' -- soft silt, decomposed mafic rock containing roots.
42' - 57' -- decomposed granite
57' - 58' -- fractured granite
58' - 60' -- soft seam of schist-like material, decomposed ferromag material
60' - 64½' -- solid granite.

Registered Professional Engineer (Mining) CERTIFICATE EXPIRES WALTER E. HEINRICHS, JR. DEC. 31, 19 65 ARIZONA, U. S. A.

Walter E. Heinrichs Jr.

HEINRICHS GEOEXPLORATION COMPANY

Drill Hole Logs (Continued)

HOLE #4

1' - 3' -- clay top soil
3' - 30' -- gravel and decomposed granite
30' - 33½'-- soft decomposed and fractured granite
33½ - 34½-- very soft, badly altered ferro mag. material
34½ - 39½ -- solid granite

NOTE: Granite may actually be a quartz monzonite. Thin section work would be required to determine which it is.

Consolidated rock depth accurate to +/- 6".
Unconsolidated rock depth accurate to +/- 1'.

Holes are located relative to a circle of 50 ft. radius, with #1 at the center and the other three spaced symmetrically 120° apart on the circumference of the circle, 150 ft. from Hole #1 on bearings of N20°W for #2 hole, S80°E for #3 hole and S40°W for #4 hole. Hole #4 is on the jeep road, Hole #1 about 5 ft. east of the jeep road and Hole #2 about 15 ft. west of the jeep road.

January 5, 1965

COPY

G. S. Thatcher, Diamond Core Drilling
315 W. Pennsylvania Drive
Tucson, Arizona 85714

Re: Core Drilling, Proposed Site
Radio Telescope, Kitt Peak, Ariz.

Dear Mr. Thatcher:

This is notification that fifty (50) additional feel of core drilling has been authorized by Dr. Findlay, Deputy Director of the National Radio Astronomical Observatory.

Very truly yours,

HEINRICHS GEOEXPLORATION COMPANY

E. Grover Heinrichs
Vice President

cc: Mr. Vick, So. Ariz. Testing Lab.

pr

January 5, 1965

National Radio Astronomical Observatory
P. O. Box 2
Green Bank, West Virginia

Attn: Dr. John F. Findlay, Deputy Director

Re: Foundation Study, Proposed Site
36' Radio Telescope, Kitt Peak, Ariz.

Gentlemen:

This will confirm our telephone conversation of yesterday, January 4, 1965.

Due to slightly greater depth to solid granite than expected, we request fifty (50) additional feet of drilling, over and above the 140 feet in our quotation of November 5, 1964.

This will necessitate an increase in the core drilling cost of $500.00, or a revised total drilling cost of $1,900.00. Drilling supervision and laboratory test costs will be increased proportionately by $160.00, a total lab test and supervision cost of $610.00. All other costs will remain per our quote of November 5, 1964.

If the foregoing meets with your approval, please so indicate by signing and returning the enclosed copy of this letter.

Very truly yours,
HEINRICHS GEOEXPLORATION COMPANY

E. Grover Heinrichs, Vice President

APPROVED:
NATIONAL RADIO ASTRONOMY OBSERVATORY

BY_____
Title_____
Date_____

PR

COPY

December 17, 1964

G.S. Thatcher, Diamond Core Drilling
315 W. Pennsylvania Dr.
Tucson, Arizona 85714

Re: Bid on core drilling Radio Telescope
Proposed Site, Kitt Peak, Arizona

Gentlemen:

This is to inform you that the bid you submitted on December 14, 1964 for a total of 140 ft., approximately, and at the rate of $9.00 per foot, including move costs and hauling water is hereby awarded to your company.

Please let us know as much in advance as possible when you can be on the ground and when you will begin drilling.

Very truly yours,

HEINRICHS GEOEXPLORATION CO.

Walter E. Heinrichs, Jr.
President & General Manager

WEH:lb
CC: National Radio Astronomical Observatory
P.O. Box 2, Green Bank, West Virginia

COPY

HEINRICHS GEOEXPLORATION COMPANY

806 WEST GRANT ROAD. TUCSON, ARIZONA 85703. P.O. BOX 5964. PHONE: (602) 623-0578

April 8, 1975

I hereby acknowledge receipt of the following:

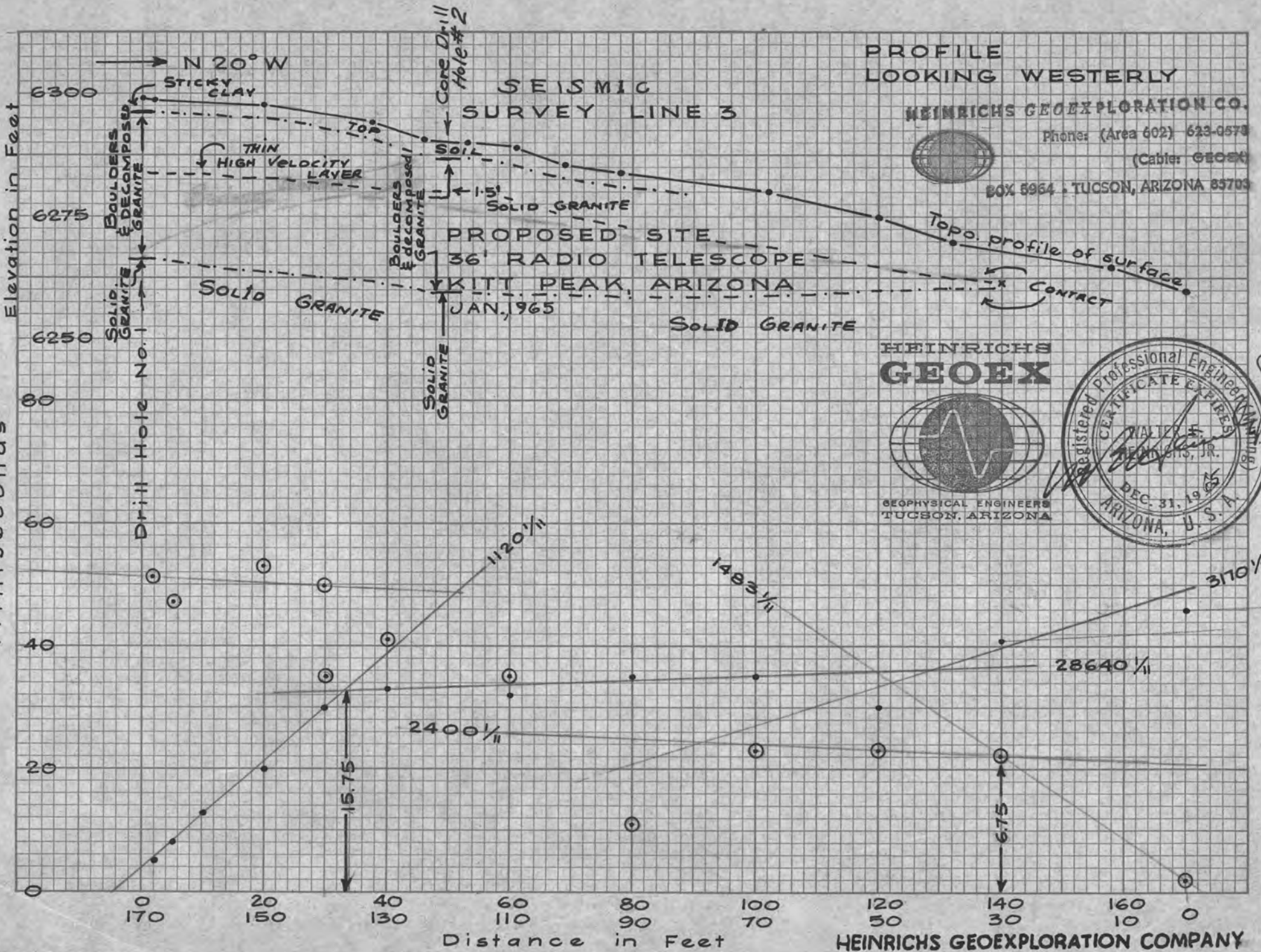
1 Report "Kitt Peak, Arizona - Foundation Investigations Proposed Radioscope Site"

1 Map "Topo 36' Millimeter Wave Telescope Site"

7 Original illustrations accompanying part of report.

Dale Webb
National Radio Astronomical Observatory

K+E 10 X 10 TO THE INCH 359-5DG
KEUFFEL & ESSER CO. MADE IN U.S.A.



HEINRICHS GEOEXPLORATION CO.
Phone: (Area 602) 623-0573
(Cable: GEOEX)
BOX 5964 . TUCSON, ARIZONA 85703

HEINRICHS
GEOEX
GEOPHYSICAL ENGINEERS
TUCSON, ARIZONA

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
WALTER [illegible], JR.
DEC. 31, 19[illegible]
ARIZONA, U.S.A.

K+E 10 X 10 TO THE INCH 359-5DG KEUFFEL & ESSER CO. MADE IN U.S.A.

HEINRICHS GEOEXPLORATION CO.
Phone: (Area 602) 623-0573
(Cable: GEOEX)
BOX 5964 · TUCSON, ARIZONA 85703

PROFILE LOOKING NORTHERLY

S80° E

Core #3 Drill Hole

Sticky Clay

Top Soil

Topo. profile of surface

Boulders & Decomposed Granite

Solid Granite

*SEISMIC SURVEY LINE 2

Thin higher velocity layer

Boulders & Decomposed Granite

Solid Granite

Contact

Solid Granite

Core Drill Hole No. 1

PROPOSED SITE
36' RADIO TELESCOPE
KITT PEAK, ARIZONA
JAN., 1965

Elevation in Feet: 6300, 6275, 6250

Milliseconds: 0, 20, 40, 60, 80

0900 1/11

2902 1/11

28640 1/11

19080

2605 1/11

11.6

55.7

49.8

Distance in Feet

0	20	40	60	80	100	120	140	160		180
170	150	130	110	90	70	50	30	10	0	

Registered Professional Engineer (Wyoming)
CERTIFICATE EXPIRES
WINTER H. HEINRICHS, JR.
DEC. 31, 1965
ARIZONA, U.S.A.

HEINRICHS GEOEX
GEOPHYSICAL ENGINEERS
TUCSON, ARIZONA

HEINRICHS GEOEXPLORATION COMPANY

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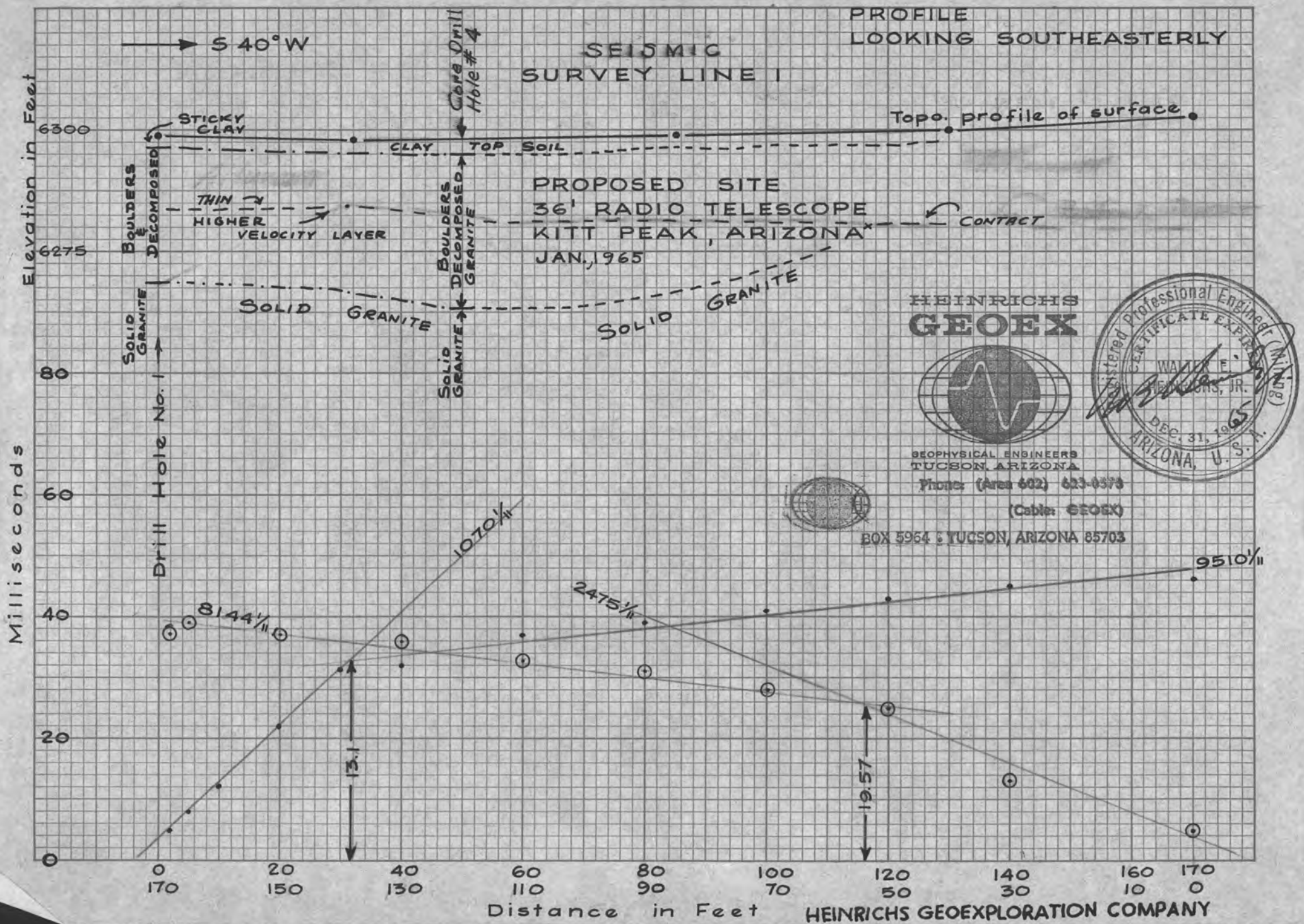

HEINRICHS
GEOEX
GEOPHYSICAL ENGINEERS
TUCSON, ARIZONA
Phone: (Area 602) 623-0578
(Cable: GEOEX)
BOX 5964 : TUCSON, ARIZONA 85703

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
WALTER F. HEINRICHS, JR.
DEC. 31, 19[illegible]
ARIZONA, U.S.A.

RECORD OF SEISMIC SURVEY

Job No. N.R.A.O.

Location Kitt Peak 36' Radio Telescope

Date 12-10-64

Purpose Foundation Study

Engineer P.M.S. F.N.

Local Geology Granite

Survey Line No. 3 Direction N20°W Page 4 of 4

Survey Line Location Same as

GEOPHONE LOC. N. #1 R	#2 L	IMPACT DISTANCE	R TRAVEL-TIMES Geophone #1						Geophone #2 L						
		2	168	5	5	5			5	51	51	50				51
		5	165	6	8	8	8	3	8	53	47	47	47	1	3	47
				5	8	3				30	10	8	55	46		
		10	160	13	13	13	13		13	46	46	47	1	46		46
		20	150	20	21	20			20	53	53	36	53	53		53
		30	140	30	30	30			30	12	10	50	50	50	17	50
										36	47	35	35	36	35	35
		40	130	33	33	33	33		33	34	41	41	41	40	33	41
										33	42					
		60	110	32	32	32	33	33	32	29	28	55	28	35	55	35
FENCE POST →										29						
		80	90	35	35	35	35		35	27	11	33	10	23	11	11
										10	8					
		100	70	35	35	35	36	35	35	23	4	30	24	30	23	23
										31	30	10				
		120	50	30	31	31	30	30	30	22	23	5	25	23	15	23
										22						
		140	30	66	41	51	41	43	41	21	22	28	28	27	27	22
				42	41					22	27	18				
		170	0	52	52	45	44	43	44	2	1	2	2	2		2
				44	44											

REMARKS:

808 W. Grant Road • P. O. Box 5964
Tucson, Arizona 85703
Phone: (Area 602) 623-0578

Registered Professional Engineer (Mining) CERTIFICATE EXPIRES WALTER E. HEINRICHS, JR. DEC. 31, 19[illegible] ARIZONA, U.S.A.

HEINRICHS GEOEXPLORATION COMPANY

RECORD OF SEISMIC SURVEY

Job No. NRAO,

Location Kitt Peak Radio Telescope

Date 12/10/64

Purpose Foundation Study

Engineer

Local Geology

Survey Line No. 1 Direction S40°W Page 1 of 4

Survey Line Location Instrument @ Hole center; #1 @ center R #2 @ 170' S40°W over hole #4

GEOPHONE LOC. N. #1 R	#2 L	IMPACT DISTANCE		R TRAVEL-TIMES L Geophone #1					Ave	Geophone #2							Ave
		2	168	2	8	7	8	8	5.1	5.2	5.2						5.2
		5	165	8	6	8	8	8	11.5	6.2	5.0	5.0	5.1				5.1
		10	160	10	13	12	12	12	4.9	4.9	4.9						4.9
		20	150	20	21	21		21	4.6	4.7	4.6						4.6
		30	140	30	15	29	31	30	4.9	3.6	5.2	4.8	3.4	48 48			4.8
		40	130	32	33	33		33	4.4	3.7	4.5	4.5	4.4	4.7			4.5
		50	120	34	34	34		34	3.4	3.4	3.4						3.4
		60	110	37	37	36	43	37	3.4	3.4	3.4						3.4
		80	90	37	36	40	48 43	41	3.1	3.9	3.0	3.0	3.1	27 25			
									4.0	4.4	3.2	4.0					4.0
		100	70	43	41	44	47 47	44	3.4	3.8	3.3	3.7	3.7				3.7
				43	42								3.6				
		120	50	36	36	36		36	1.9	1.9	1.9						1.9
		140	30	44	42	46	45		4	13	9	20	28				
									12	12	9	5	9	4			
							43		28	2	19						
		140	30	44	14 31	15 43	44 22	43	19	20	18	19					19
		170	0	16	45	44	45	45	2	2	1	2					2
				45													

REMARKS:

808 W. Grant Road • P. O. Box 5964
Tucson, Arizona 85703
Phone: (Area 602) 623-0578

Registered Professional Engineer CERTIFICATE EXPIRES DEC. 31, 19 WALTER E. HEINRICHS, JR. ARIZONA, U. S. A.

65

RECORD OF SEISMIC SURVEY

Job No. N.RAO.1

Location KITT PEAK

Date 12/10/64

Purpose 36' Radio Scope

Engineer P.M. & F.J.

Local Geology Granite

Survey Line No. 1 REPEAT Direction S46°W Page 2 of 4

Survey Line Location

USING STEEL PLATE
REPEAT OF PAGE 1

GEOPHONE LOC. N. #1 R	#2 L	IMPACT DISTANCE L	R	TRAVEL-TIMES R Geophone #1						L Geophone #2						
		170	0	47	46	44	45	45	46	2	5	5	5	5		5
		140	30	45	45	44			45	12	18	18	1	1	16	
										4	13	14	6	12	13	13
		120	50	18	42	24	4	43	43	25	26	25				25
				48	17	14	36	35								
				36												
		100	70	41	41	41			41	28	28	28				28
		80	90	34	39	39			39	31	50	31				31
		60	110	37	37	37			37	33	33	33				33
		40	130	28	32	32	32		32	36	35	36				36
		30	140	31	31	31			31	37	37	37				37
		20	150	22	18	22	22		22	40	37	38	36	37		37
		10	160	12	12	12	12		12	38	38	39				38
		5	165	8	4	8	8		8	39	39	39				39
		2	168	5	5	5			5	8	37	37	38	42	38	37
										47	35	37	36	36		

REMARKS: 120-50 near big tree root?

808 W. Grant Road • P. O. Box 5564
Tucson, Arizona 85703
Phone: (Area 602) 623-0578

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
WALTER J. HEINRICHS, JR.
DEC. 31, 1965
ARIZONA, U.S.A.

RECORD OF SEISMIC SURVEY

Job No. N.R.A.O.

Location KITT PEAK 36' RADIO TELESCOPE

Date 12/10/64

Purpose FOUNDATION SURVEY

Engineer PM. F.J.

Local Geology Granite

Survey Line No. 2 Direction S80°E Page 3 of 4

Survey Line Location Instrument @ center
#1 @ center hole #2 over hole #3

	R GEOPHONE #1	L LOC. N. #2	IMPACT DISTANCE		R TRAVEL-TIMES L Geophone #1					Avg.	Geophone #2						Avg.
			2	168	1	4	4	4		4	62	53	53	52			53
			5	165	1	3	7	4	7,2 2,6	7	53	52	52				52
			10	160	10	10	4/5	5/10		10	52	53	64/55	53			53
			20	150	3	20	14/20	9/20		20	73	72	73				73
			30	140	24	36	35	36		36	53	54	53				53
			40	130	43	30	43	43		43	51	51	51				51
			70	100	48	12 18	23 48	48		48	48	43	42	43			43
R.R.	54 55 53		90	80	18	54	54	26 22	38 13	54	37	36	37				37
RR.	64 63 63		110	70	64	64	50	62		64	29	29	29				29
Rep.	53 54 54	19	130	50	55	54	37 48	34		54	18	18	18				18
			150	30	60	76	59	57		59	11	12	11				11
			170	0	59	57	56	57		57	2	2					2
			60	110	44	44	44			44	44	44	44				44

REMARKS:

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Tucson, Arizona 85703
Phone: (Area 602) 623-0578

Registered Professional Engineer (Civil Engr.) CERTIFICATE EXPIRES WALTER E. HEINRICHS, JR. DEC. 31, 1965 ARIZONA, U.S.A.

HEINRICHS GEOEXPLORATION COMPANY

KITT PEAK, ARIZONA

FOUNDATION INVESTIGATIONS

PROPOSED RADIOSCOPE SITE

for

NATIONAL RADIO ASTRONOMICAL OBSERVATORY

P. O. Box 2

Green Bank, W. Virginia

December 1964

-

January 1965

HEINRICHS GEOEXPLORATION COMPANY
P. O. Box 5964 Tucson, Arizona

HEINRICHS GEOEXPLORATION COMPANY

806 WEST GRANT ROAD, TUCSON, ARIZONA, 85703. P.O. BOX 5964. PHONE: (AREA CODE 602) 623-0578

February 2, 1965

National Radio Astronomical Observatory
P. O. Box 2
Green Bank, W. Virginia

Attn: Dr. John F. Findlay, Dep. Director.

Re: Kitt Peak, Arizona Foundation Investigations Proposed Radioscope Site.

LETTER REPORT

Gentlemen:

In response to inquiry by Dr. John F. Findlay on Oct. 9, 1964 and visit to our office by Mr. Sidney C. Smith in October, we submitted a letter proposal dated 5 November 1964 which was accepted by Dr. Findlay effective on November 10, 1964.

Accordingly, invitation to bid on the drilling went to three firms: Joy Mfg. Co., Metler Bros. Drilling Co. and G. S. Thatcher. Thatcher was the low bid and he was awarded the job on December 17, moving his equipment to the site to start drilling on December 28.

Per phone conversation with Mr. E. Grover Heinrichs and Dr. Findlay on January 4, 1965, confirmed in our letter of January 5, an added 50 ft. of drilling was authorized by Dr. Findlay on January 7, 1965. Drilling was completed January 8. Results are summarized on the attached two pages of drill logs of the four holes. Holes were located as originally planned and shown on map No. 51D00557.

Seismic field work was first initiated on December 2, 1964 and completed on December 10. Three profiles were run out 120° apart radially from drill hole 1 across each of holes 2, 3 and 4 as shown on the plan map, copy attached.

Results are tabulated on four data sheets and shown, together with interpretation, on three graphical plots, copies of all are attached.

Report of tests on drill core and foundation samples made by Southern Arizona Testing Laboratory is also attached.

Conclusions are that the near surface weathered and decomposed granite is of marginal competency for any permanent structure requiring high stability, regardless of bearing load involved, unless it were very light and almost completely floated or padded. And especially since the depth to the more or less unweathered or fresh and more competent "bedrock" granite is not excessively deep, it is recommended that it be used as the foundation bearing material. This would be adequate for all but the most severe design requirements. The deeper variable zones of soft material encountered in the drilling are fairly common on Kitt Peak. They apparently extend indefinitely but probably somewhat interrupted over most of the mountain and seem to represent later dikes which have intruded fractures in the cooling or cooled main granite mass or segregations of different material within it. Without expensive long range study, their precise effect is unpredictable because such large masses of unknown shape and complexity are involved. However, it is believed they will only prove adverse under long range erosional or seismic conditions, or in case of strong earth tremors. Otherwise, the granite is considered quite stable and well "keyed".

Respectfully submitted,

HEINRICHS GEOEXPLORATION CO.

Registered Professional Engineer (Mining) CERTIFICATE EXPIRES DECEMBER 31, 1965 ARIZONA WALTER E. HEINRICHS, JR.

Walter E. Heinrichs, Jr., Geol. Engr.
President & General Manager

WEH:jh
cc: Extra Encl
[redacted]. Rohr Corp. - Tom Collard
S. Ariz. Testing Lab.

January 25, 1965

Associated Universities, Inc.
N. R. A. O.
Foundation Study, Proposed Site, 36 ft. Radio-Scope
Re: Map #51D00557
Kitt Peak, Arizona

DRILL HOLE LOGS:

HOLE #1

1'-3' -- sticky clay
3' - 30' -- gravel to coarse sand and small boulders
30' - 31'--granite solid with one fracture
31' - 34'--decomposed granite
34' - 35'--badly fractured granite
35' - 39½' -- solid granite
39½' - 49½' Solid GRANITE 49½' - 50' - Altered decomposed Granite & bottom of hole.

HOLE #2

1' - 3' -- clay and top soil
3' - 10'-- gravel and decomposed granite
10' - 11½'--solid granite
11½' - 22' -- fractured granite with vertical fractures and joints.
22' - 26½' -- badly fractured, decomposed granite
26½ - 27' -- decomposed granite
27' - 28' -- fractured granite
28' - 30' -- badly fractured granite
30' - 32' -- solid granite with core sections from 2" - 7" long.
Bottom of Hole

HOLE #3

1' - 3' -- top soil - clay
3' - 7' -- gravel and small boulders 3" to 6".
7' - 29½'-- decomposed granite
29½' - 30' -- broken, badly fractured granite.
30' - 35½' -- decomposed granite
35½' - 42' -- soft silt, decomposed mafic rock containing roots.
42' - 57' -- decomposed granite
57' - 58' -- fractured granite
58' - 60' -- soft seam of schist-like material, decomposed ferromag material
60' - 64½' -- solid granite.
Bottom of hole

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Drill Hole Logs (Continued)

HOLE #4

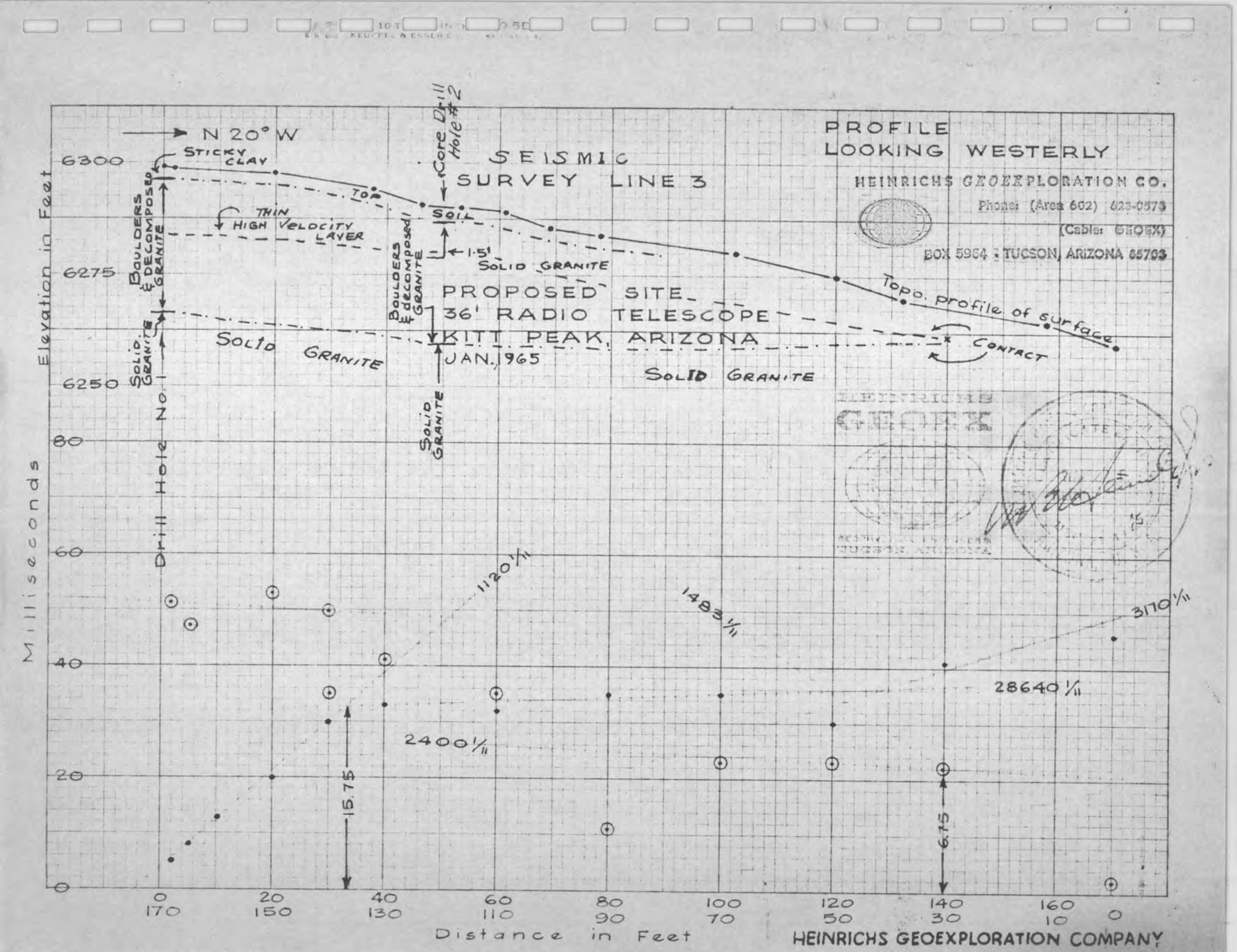
1' - 3' -- clay top soil
3' - 30' -- gravel and decomposed granite
30' - 33½' -- soft decomposed and fractured granite
33½' - 34½' -- very soft, badly altered ferro mag. material
34½' - 39½' -- solid granite

Bottom of Hole.

NOTE: Granite may actually be a quartz monzonite. Thin section work would be required to determine which it is.

Consolidated rock depth accurate to +/- 6".
Unconsolidated rock depth accurate to +/- 1'.

Holes are located relative to a circle of 50 ft. radius, with #1 at the center and the other three spaced symmetrically 120° apart on the circumference of the circle, 150 ft. from Hole #1 on bearings of N20°W for #2 hole, S80°E for #3 hole and S40°W for #4 hole. Hole #4 is on the jeep road, Hole #1 about 5 ft. east of the jeep road and Hole #2 about 15 ft. west of the jeep road.


PROFILE
LOOKING WESTERLY
SEISMIC
SURVEY LINE 3
HEINRICHS GEOEXPLORATION CO.
Phone: (Area 602) 623-0573
(Cable: GEOEX)
BOX 5964 : TUCSON, ARIZONA 85703
N 20° W
STICKY CLAY
Core Drill Hole #2
TOP
SOIL
1.5'
SOLID GRANITE
BOULDERS & DECOMPOSED GRANITE
THIN HIGH VELOCITY LAYER
PROPOSED SITE
36' RADIO TELESCOPE
KITT PEAK, ARIZONA
JAN., 1965
Topo. profile of surface
CONTACT
SOLID GRANITE
Drill Hole No. 1
1120 1/11
1483 1/11
3170 1/11
28640 1/11
2400 1/11
15.75
6.75
Milliseconds
Elevation in Feet
6300
6275
6250
80
60
40
20
0
0 170
20 150
40 130
60 110
80 90
100 70
120 50
140 30
160 10
0
Distance in Feet
HEINRICHS GEOEXPLORATION COMPANY

K+E 10 X 10 TO THE INCH 359-5DG
KEUFFEL & ESSER CO. MADE IN U.S.A.

HEINRICHS GEOEXPLORATION CO.
Phone: (Area 602) 623-0578
(Cable: GEOEX)
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PROFILE LOOKING NORTHERLY

S80°E

Core #3 Drill Hole

STICKY CLAY

TOP SOIL

Topo. profile of surface

SEISMIC SURVEY LINE 2

THIN HIGHER VELOCITY LAYER

BOULDERS & DECOMPOSED GRANITE

SOLID GRANITE

Core Drill Hole No. 1

PROPOSED SITE
36' RADIO TELESCOPE
KITT PEAK, ARIZONA
JAN., 1965

CONTACT

SOLID GRANITE

0900 1/11

2902 1/11

2860 1/11

28640 1/11

19080

11.6

55.7

49.8

Elevation in Feet

6300
6275
6250

Milliseconds

80
60
40
20
0

0 20 40 60 80 100 120 140 160 180
170 150 130 110 90 70 50 30 10 0

Distance in Feet

HEINRICHS GEOEXPLORATION COMPANY

KEUFFEL & ESSER CO. MADE IN U.S.A.

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PROFILE LOOKING SOUTHEASTERLY
SEISMIC SURVEY LINE I

S 40° W

Core Drill Hole #4

Topo. profile of surface

STICKY CLAY

CLAY

TOP SOIL

BOULDERS DECOMPOSED GRANITE

THIN HIGHER VELOCITY LAYER

CONTACT

SOLID GRANITE

Drill Hole No. 1

PROPOSED SITE
36' RADIO TELESCOPE
KITT PEAK, ARIZONA
JAN., 1965

HEINRICHS GEOEX GEOPHYSICAL ENGINEERS TUCSON, ARIZONA

10701/11

8144'/11

2475'/11

9510'/11

13.1

19.57

Elevation in Feet: 6300, 6275

Milliseconds: 0, 20, 40, 60, 80

Distance in Feet

0	20	40	60	80	100	120	140	160	170
170	150	130	110	90	70	50	30	10	0

HEINRICHS GEOEXPLORATION COMPANY

RECORD OF SEISMIC SURVEY

Job No. NRAO.

Location Kitt Peak No. Radio Telescope

Date 12/10/64

Purpose Foundation Study

Engineer

Local Geology

Survey Line No. 1 Direction S40°W Page 1 of 4

Survey Line Location Instrument @ Hole center, #1 @ center R #2 @ 170' S40°W over hole #4

GEOPHONE LOC. N. #1 R	#2 L	IMPACT DISTANCE		R TRAVEL-TIMES L Geophone #1	Geophone #2	
		2	168	2 8 7 8 8 51 52 52		52
		5	165	8 6 8 8 8 115 62 50 50 51		51
		10	160	10 13 12 12 12 49 49 49		49
		20	150	20 21 21 21 46 47 46		46
		30	140	30 15 29 31 30 49 36 52 48 34 48 48		48
		40	130	32 33 33 33 44 37 45 45 49 47		45
		50	120	31 34 34 34 34 34 34		34
		60	110	31 37 36 37 34 34 34		34
		80	90	37 36 40 45 41 31 39 30 30 31 37 35		
				40 44 32 40		40
		100	70	43 41 44 47 44 39 38 33 37 37		37
				43 42 47 36		
		120	50	36 36 36 36 19 19 19		19
		140	30	44 42 46 45 4 13 9 20 28		
				12 12 9 5 9 4		
				43 28 2 19		
		140	30	44 14 31 15 43 44 22 43 19 20 18 19		19
		170	0	16 45 44 45 45 2 2 1 2		2
				48		

REMARKS:

HEINRICHS GEOEXPLORATION CO.

Phone: (Area 602) 623-0573

(Cable: GEOEX)

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Registered Professional Engineer (Mining) CERTIFICATE EXPIRES DEC. 31, 19 65 WALTER E. HEINRICHS, JR. ARIZONA, U.S.A.

RECORD OF SEISMIC SURVEY

Job No N.R.A.O.

Location Kitt Peak

Date 12/10/64

Purpose 36' Radio Scope

Engineer P.M.S & F.N.

Local Geology Granite

Survey Line No. 1 REPEAT Direction S46°W Page 2 of 4

Survey Line Location

USING STEEL PLATE
REPEAT OF PAGE 1

GEOPHONE LOC. N. #1 R	#2 L	IMPACT DISTANCE L	R	TRAVEL-TIMES R Geophone #1	L Geophone #2
		170	0	47 46 44 45 45	46 25 25 25 25 25 5
		140	30	45 45 44 45	12 18 18 1 1 16
					4 13 14 6 12 13 13
		120	50	18 42 24 4 43 43	25 25 25 25
				48 17 14 36 35	
				36	
		100	70	41 41 41 41	28 28 28 28
		80	90	34 34 34 39	31 30 31 31
		60	110	37 37 37 37	33 33 33 33
		40	130	28 32 32 32	36 35 36 36
		30	140	31 31 31 31	37 37 37 37
		20	150	22 18 22 22	22 40 37 38 36 37 37
		10	160	2 12 12 12	38 38 39 38
		5	165	8 4 8 8	39 37 39 37
		2	168	5 5 5 5	8 37 37 38 42 38 37
					47 35 37 36 36

REMARKS: 120-50 near big tree not?

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Registered Professional Engineer (Mining) CERTIFICATE EXPIRES DEC. 31, 19 65 WALTER E. HEINRICHS, JR. ARIZONA, U.S.A.

RECORD OF SEISMIC SURVEY

Job No. NRAO

Location KITT PEAK 36' RADIO TELESCOPE

Date 12/10/64

Purpose FOUNDATION SURVEY

Engineer PM F.J.

Local Geology Granite

Survey Line No. 2 Direction S80°E Page 3 of 4

Survey Line Location Instrument @ center
#1 @ centerhole #2 over hole #3

GEOPHONE LOC. N. #1	#2	IMPACT DISTANCE		R TRAVEL-TIMES L Geophone #1	Avg.	Geophone #2	Avg.
		2	168	1 4 4 4	4	6 2 5 3 5 3 5 2	53
		5	165	1 3 7 4 7 7	7	5 3 5 2 5 2	52
		10	160	10 10 4/5 5/10	10	5 1 5 3 4/5 5/10 5 3	53
		20	150	3 20 14/20 9/20	20	7 3 7 2 7 3	73
		30	140	24 36 35/36 36	36	5 3 5 4 5 3	53
		40	130	48 30 43 43	43	5 1 5 1 5 1	51
		70	100	48 12/18 23/48 48	48	4 8 4 8 4 3 4 2 4 3	43
R.R. 54 55 53		90	80	18 54 54 16/22 36/13	54	3 7 3 6 3 1	37
R.R. 64 63 63		110	70	64 64 50 62	64	2 9 2 9 2 9	29
Rep. 53 54 54	R	130	50	55 54 37/48 34	54	1 8 1 8 1 8	18
		150	30	60 76 64 57	59	11 12 11	11
		170	0	59 57 R 57	57	2 2	2
		∞	110	44 44 44	44	44 44 44	44

REMARKS:

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Registered Professional Engineer
CERTIFICATE EXPIRES
WALTER F. HEINRICHS, JR.
DEC. 31, 19 65
ARIZONA, U.S.A.

RECORD OF SEISMIC SURVEY

Job No. NKA.0.

Location Kitt Peak 36' Radio Telescope

Date 12-10-64

Purpose Foundation Study

Engineer PM & FJ.

Local Geology Granite

Survey Line No. 3 Direction N20°W

Page 4 of 4

Survey Line Location Same as

GEOPHONE LOC. N. #1	#2	IMPACT DISTANCE	R TRAVEL-TIMES Geophone #1						L Geophone #2						
		2 | 168	5	5	5			5	51	51	50				51
		5 | 165	6	8	8	8	3	8	53	47	47	47	1	3	47
			5	8	3				30	10	8	55	46		
		10 | 160	13	13	13	13		13	46	46	47	1	46		46
		20 | 150	20	21	20			20	53	53	36	53	53		53
		30 | 140	30	30	30			30	12	10	50	50	50	17	50
									36	47	35	35	36	35	36
		40 | 130	33	33	33	33		33	34	41	41	41	40	33	41
									33	42					
		60 | 110	32	32	32	33	33	32	29	28	35	28	35	36	35
									29						
		80 | 90	35	36	35	35		35	27	11	33	10	23	11	11
									10	8					
		100 | 70	35	35	36	36	35	35	23	4	30	24	30	23	23
									31	30	10				
		120 | 50	30	31	31	30	30	30	22	23	5	23	23	15	23
									22						
		190 | 30	66	41	51	41	43	41	21	22	28	28	27	27	22
			42	41					22	27	18				
		170 | 0	52	52	45	44	43	44	2	1	2	2	2		2
			44	44											

REMARKS:

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Registered Professional Engineer (Civil) CERTIFICATE EXPIRES WALTER E. HEINRICHS, JR. DEC. 31, 1965 ARIZONA, U.S.A.

SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

for

NATIONAL RADIO ASTRONOMICAL OBSERVATORY

Project: Foundation Study, Proposed Site
36 Ft. Radio-Scope, Kitt Peak, Arizona

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Shear vs Unit Load	Graph #2
VOIDS RATIO CURVE Long Footings 3' Deep	Graph No. 3
VOIDS RATIO CURVE Long Footings 5 Ft. Deep	Graph No. 4
Shear Diagram	Graph No. 5
STANDARD PROCTOR	Data Sheet No. 1
ATTERBERG LIMITS	Data Sheet No. 2 & 3

SOUTHERN ARIZONA TESTING LABORATORY
P. O. Box 2508 1516 East 20th St.
Tucson, Arizona

SOILS INVESTIGATION January 26, 1965

for
N. R. A. O.
KITT PEAK NATIONAL OBSERVATORY

Project: Foundation Study, Proposed Site, 36 ft. Radio-Scope

SCOPE

This investigation is for structures having foundations placed on a firm bearing or bedrock, capable of supporting heavy loads without objectionable settlement.

INVESTIGATION

Test borings were made at the locations shown on the site sketch. Representative samples were taken and rock cores were obtained where recovery was possible. Undisturbed samples were recovered from Boring No. 1, at the 3 and 6 foot levels, shear and consolidation tests were run and the voids ratio and shear diagram are presented in this report. The Atterbergs Limits test of the surface soil is also included.

SITE DESCRIPTION

The site is an undisturbed mountain top covered with medium size oak trees. The surface is very irrigular, with occasional out-crop of granite boulders, and the top 1 to 3 feet of soil is mostly clay, which becomes very soft when wet.

CONCLUSIONS AND RECOMMENDATIONS

1) Design curves have been prepared showing the relationship of shear and settlement to unit loads for long footings 3 feet deep. These curves should only be used with shallow foundations which will tolerate .75 inch settlement, and which have unit loads of

2500 pounds per square foot or less, and not more than 3000 pounds per linear foot. No structure should be placed on the clayey top-soil in this area.

2) The four borings were advanced into solid granite. Samples were taken for the folowing compressive strength tests.

Boring No.	Depth of Sample	Compressive strength psi
1	38'	7770
2	25½'	7350
3	59½'	8370
4	36'	7270

Pile Foundations

When a pile foundation is used, the pile should be keyed into the bedrock. Consult the Log of Borings for the depths of the solid granite, and change in the soil conditions.

DISCUSSION

This report assums reasonable variations in the conditions of the site from those represented by the samples. If, however, unusual materials are encountered during excavation, the soils engineer should be notified immediately. This report is issued with the understanding that it is the responsibility of the Architect or Engineer to see that its provisions are carried out or brought to the attention of these concerned.

Registered Professional Engineer (Civil) CERTIFICATE No. 5932 E. L. VICK Date Signed 1-29-69 Arizona U. S. A.

Respectfully submitted,

Southern Arizona Testing Laboratory

Certified by E L Vick

E. L. Vick, PE
Arizona Reg. No. 5932

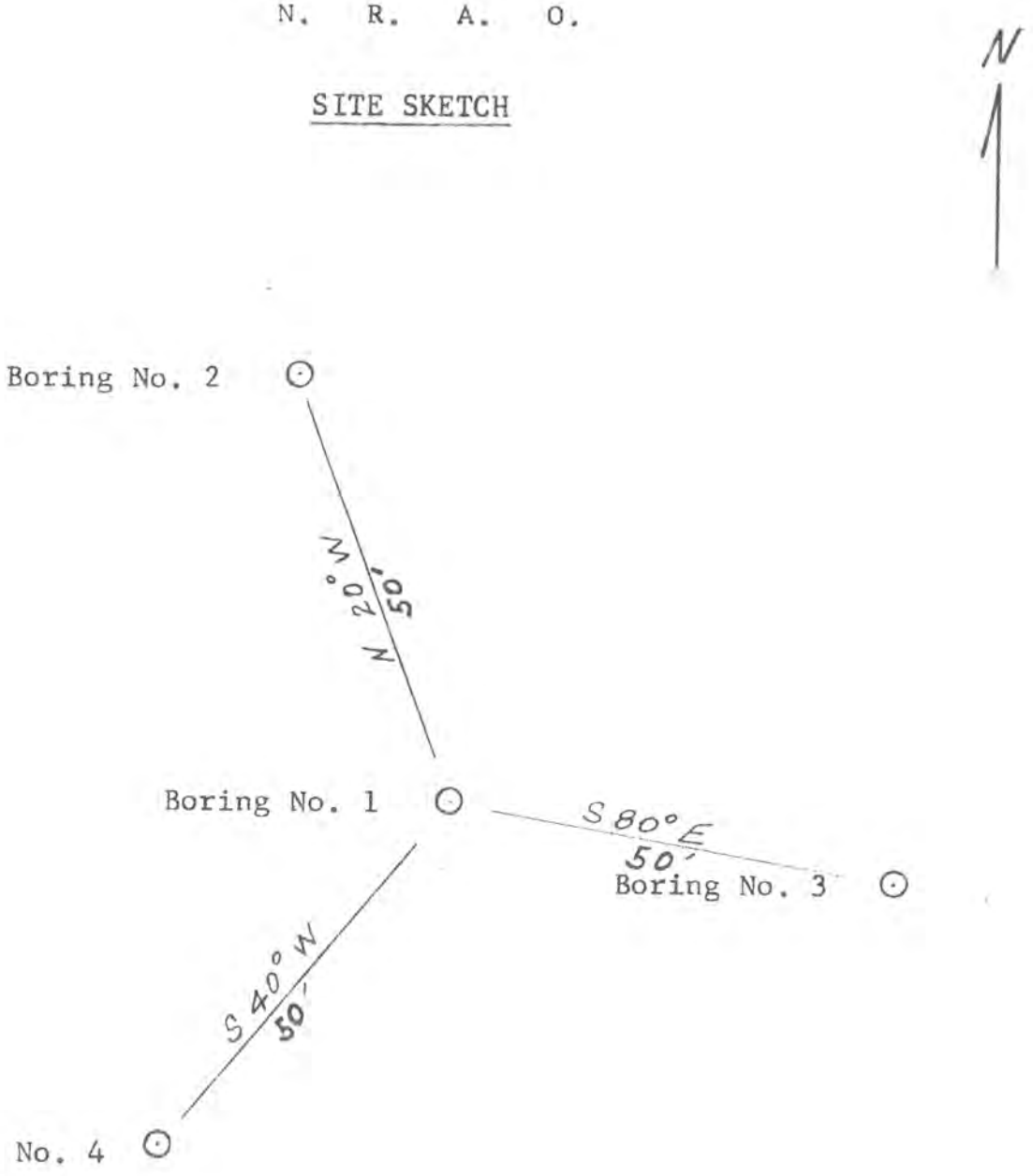
SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

for

N. R. A. O.

SITE SKETCH



Project: Foundation Study, Proposed Site,
36 ft. Radio-Scope

Plate No. 1

SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

for

N. R. A. O.

LOG OF BORINGS

Boring No. 1

1' - 3'	stickey clay
3' - 30'	gravel to coarse sand and small boulders
30' - 31'	granite solid with one fracture
31' - 34'	decomposed granite
34' - 35'	badly fractured granite
35' -39½'	solid granite
39½-49½	SOLID GRANITE 49½ -50 Altered decomposed GRANITE & Bottom of Hole

Boring No. 2

1' - 3'	clayey top soil
3' - 10'	gravel 7 decomposed granite
10' -11½'	solid granite
11½ - 22'	fractured granite with vertical fractures and joints
22' -26½'	badly fractured, decomposed granite
26½ - 27'	decomposed granite
27' - 28'	fractured granite
28' - 30'	badly fractured granite
30' - 32'	solid granite with core sections from 2" - 7" long.

Boring No. 3

1' - 3'	clayey top soil
3' - 7'	gravel and small boulders 3" to 6"
7' -29½'	decomposed granite
29½ - 30'	broken, badly fractured granite.
30' -35½'	decomposed granite
35½ - 42'	soft silt, decomposed mafic rock containing roots.
42' - 57'	decomposed granite
57' - 58'	fractured granite
58' - 60'	soft seam of schist-like material, decomposed ferromag material
60' - 64½	solid granite

SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

For

N. R. A. O.

LOG OF BORINGS Sheet: 2 of 2

Boring No. 4

1' - 3'	clayey top soil
3' - 30'	gravel & decomposed granite
30' -33½'	soft decomposed and fractured granite
33½ -34½'	very soft, badly altered ferromag. material
34½ -39½'	solid granite

Note: Granite may actually be a quartz monzonite. Thin section work would be required to determine which it is.

Comsolidated rock depth accurate to + or - 6"
Unconsolidated rock depth accurate to + or - 1'

Borings are located relative to a circle of 50 ft. radius, with Boring No. 1 at the center and the other three spaced symetrically 120° apart on the circumference of the circle, 50 ft. from Boring No. 1 on bearings of N 20° W for Boring No. 2, S 80° E for Boring No. 3 and S 40° W for Boring No. 4. Boring No. 4 is on the Jeep road, Boring No. 1 about 5 ft. East of the Jeep road and Boring No. 2 about 15 ft. West of the Jeep road.

SOUTHERN ARIZONA TESTING LABORATORY

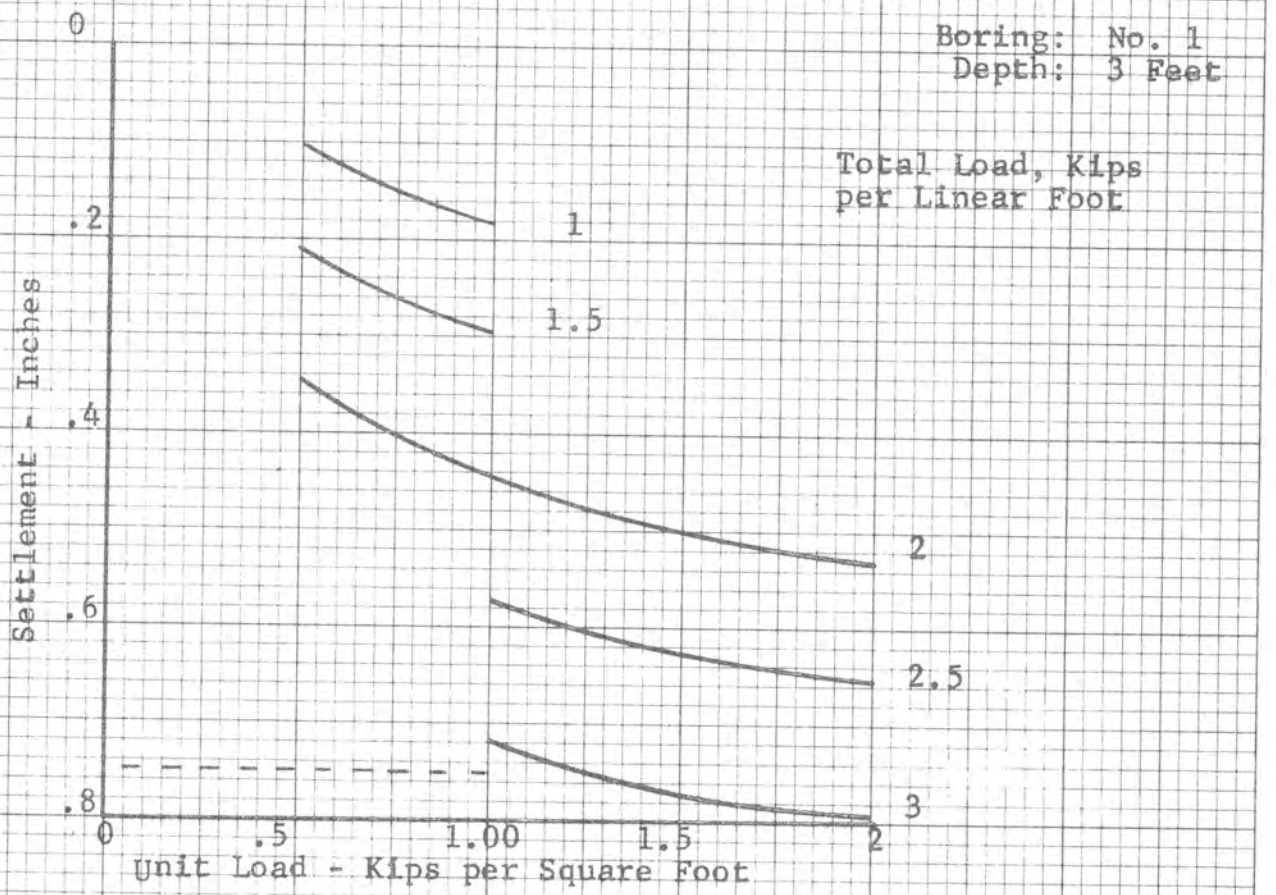
SOILS INVESTIGATION

for

N. R. A. O.

SETTLEMENT vs UNIT LOAD

Long footings 3 Feet Deep



Project: 36' Radio-Scope
Kitt Peak Arizona

Graph No. 1

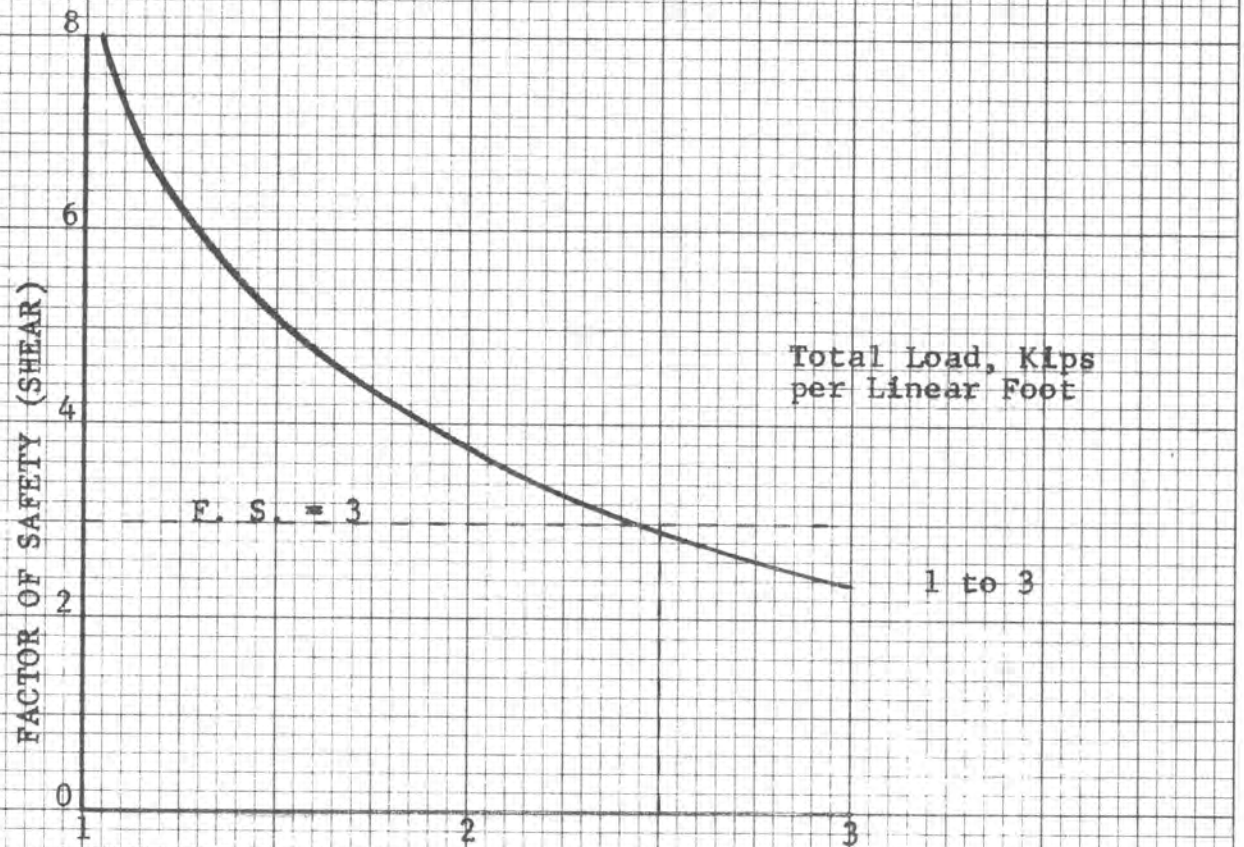
SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

for

N. R. A. O.

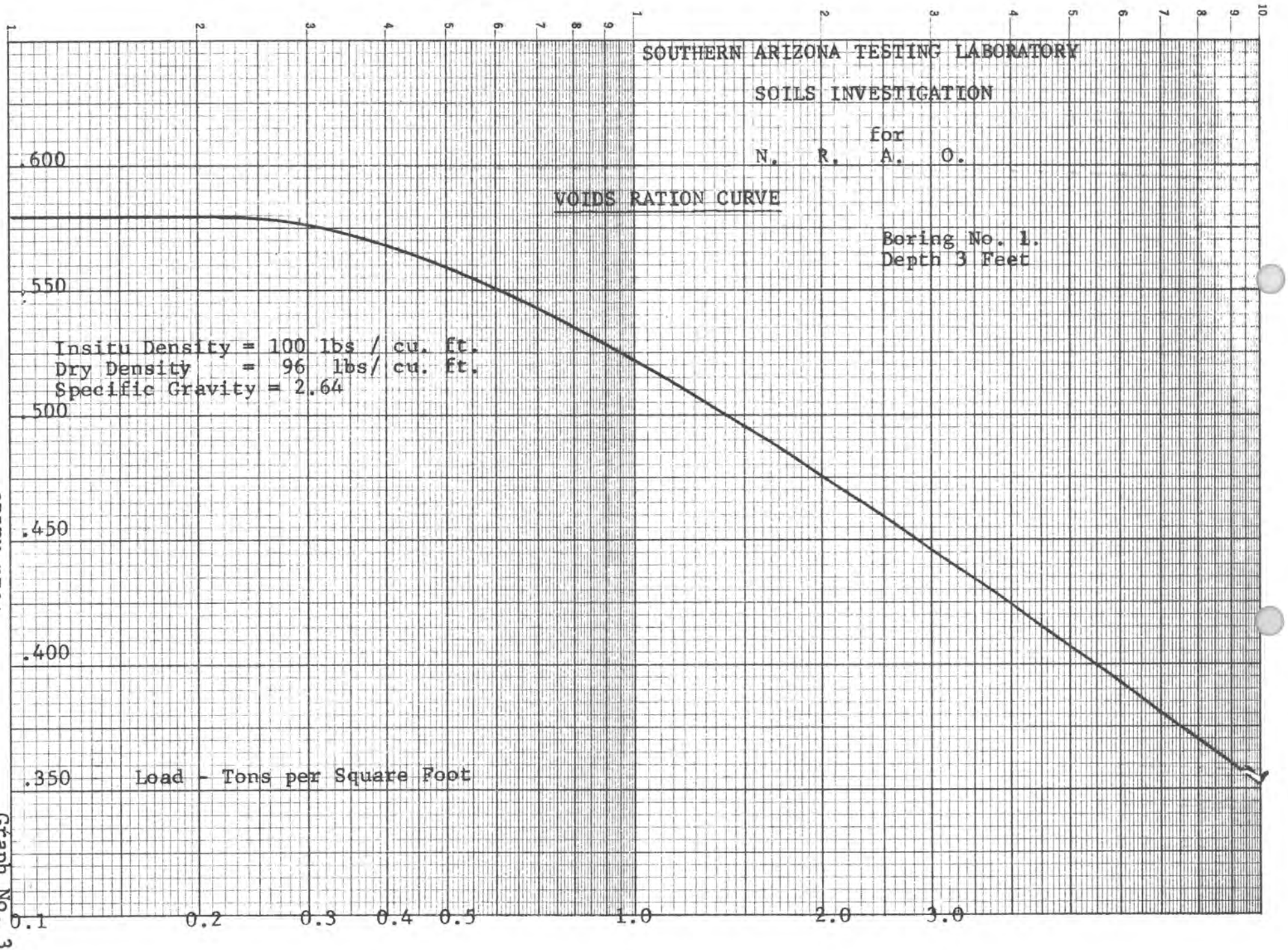
SHEAR vs UNIT LOAD
Long Footings 3 Feet Deep



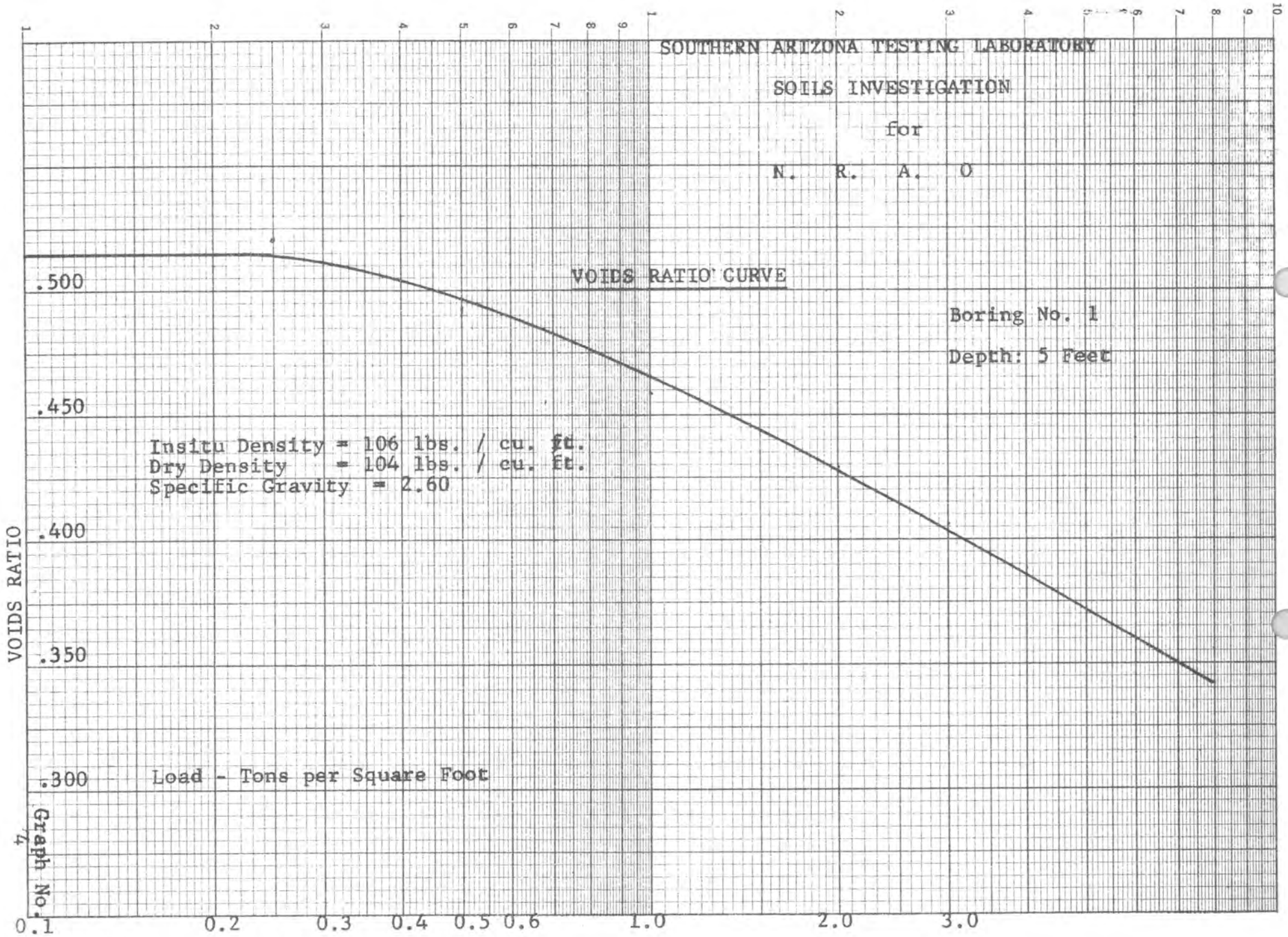
Project: 36" Radio-Scope
Kitt Peak, Arizona

Graph No. 2

KEUFFEL & ESSER CO. MADE IN U.S.A.
2 CYCLES X 70 DIVISIONS



Graph No. 3


SOUTHERN ARIZONA TESTING LABORATORY
SOILS INVESTIGATION
for
N. R. A. O
VOIDS RATIO CURVE
Boring No. 1
Depth: 5 Feet
Insitu Density = 106 lbs. / cu. ft.
Dry Density = 104 lbs. / cu. ft.
Specific Gravity = 2.60
Load - Tons per Square Foot
VOIDS RATIO
.500
.450
.400
.350
.300
0.1
0.2
0.3
0.4
0.5
0.6
1.0
2.0
3.0

Graph No. 4

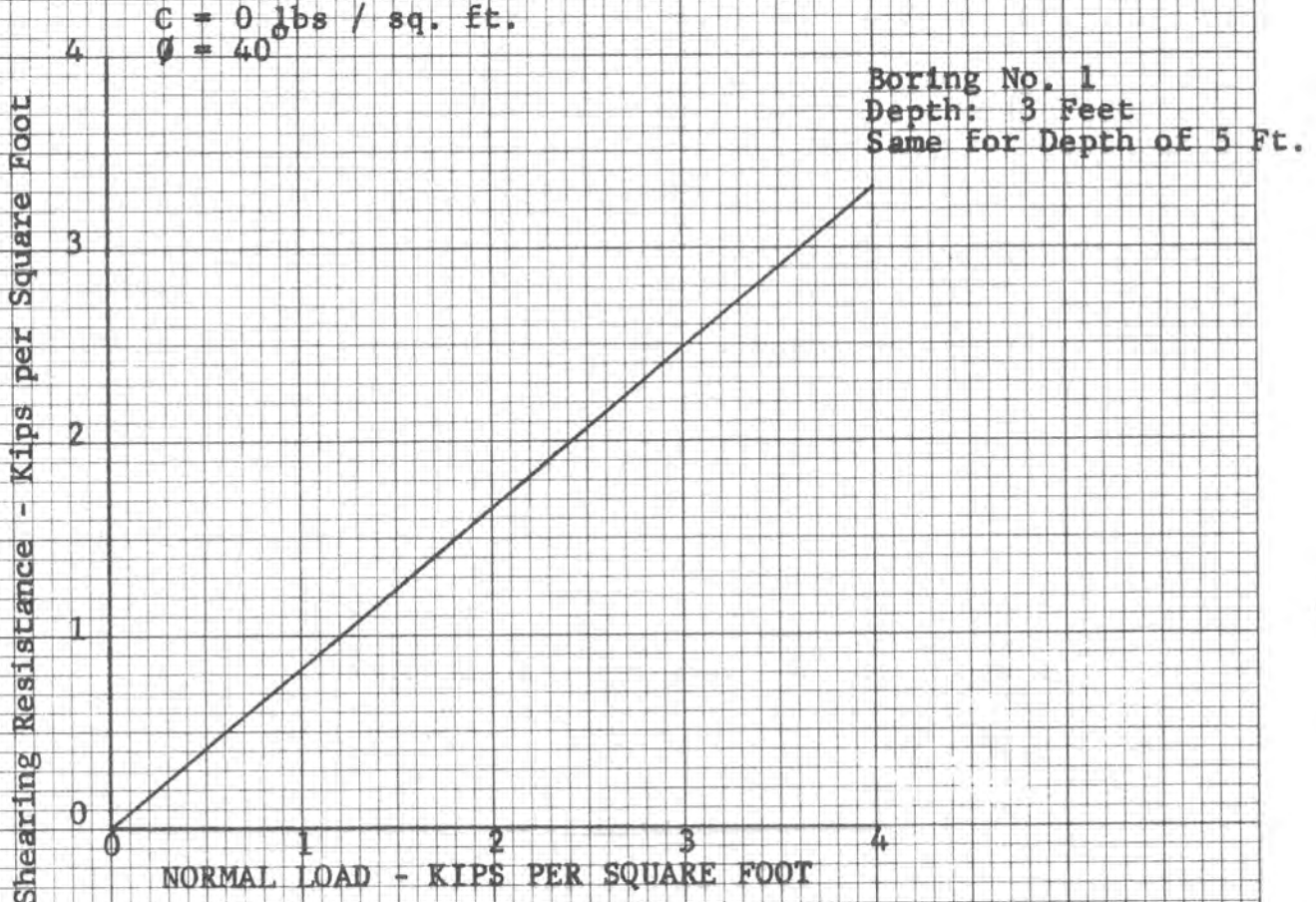
SOUTHERN ARIZONA TESTING LABORATORY

SOILS INVESTIGATION

for

N. R. A. O

SHEAR DIAGRAM



Project: Foundation Study, Proposed Site
36' Radio-Scope

Graph No. 5

EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340R-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

SOUTHERN ARIZONA TESTING LABORATORY
P. O. Box 2508 1516 East 20th St.
Tucson, Arizona

SOILS INVESTIGATION

for

A. R. A. O

Report of Laboratory Tests

STANDARD PROCTOR

Maximum Dry Density	109.2
Optimum Moisture	16.6

Dat Sheet No. 1

SOUTHERN ARIZONA TESTING LABORATORY

PHONE 623-3331 P. O. BOX 2508 1516 EAST 20th STREET TUCSON, ARIZONA 85702

For: National Radio Astronomical Observatory
Post Office Box 2
Green Bank W. Va.

Date: January 29, 1965

Lab. No. 38705

Received: 1-8-65

Marked: Boring No. 1 Top Soil

Report of Laboratory Tests
SA & PI

Mechanical Analysis:

Sieve Size	% Retained (Indiv.)	% Passing (Cumul.)	
6"			
4			
3			
2			
1½			
1			
¾			
½			
⅜			
¼	0	100	
#4	1	99	
#8	2	97	
10	1	96	
16	2	94	
30	4	90	
40	2	88	
50	2	86	
100	4	82	
200	4	78	
-200	78		

Liquid Limit	43	%
Plastic Limit	23	%
Plasticity Index	20	%
Soil Classification		
Bitumen Content		%
Specific Gravity		
Moisture		%
Absorption		%
Weight/Cu. Ft. Rodded	lbs., Loose	lbs.
Fineness Modulus		
Organic Impurities		
Abrasion (L. A.) % wear 100 rev.		%
% wear 500 rev.		%
Soundness (Sodium Sulphate) 5 cycles		%
(Magnesium Sulphate) 5 cycles		%
Potential Reactivity		
Sc		mm/l
Rc		mm/l

Respectfully submitted,
SOUTHERN ARIZONA TESTING LABORATORY

Certified by E L Vick
E. L. Vick, PE
Arizona Reg. No. 5932

Data Sheet No. 2

SOUTHERN ARIZONA TESTING LABORATORY

PHONE 623-3331 P. O. BOX 2508 1516 EAST 20th STREET TUCSON, ARIZONA 85702

For: National Radio Astronomical Observatory
Post Office Box 2
Green Bank, W. Va.

Date: January 29, 1965

Lab. No. 38757

Received: 1-8-65

Marked: Boring No. 1 Depth 3 Feet

Report of Laboratory Tests

SA - PI

Mechanical Analysis:

Sieve Size	% Retained (Indiv.)	% Passing (Cumul.)	
6"			
4			
3			
2			
1½			
1			
¾			
½	0	100	
⅜	1	99	
¼	3	96	
#4	4	92	
#8	16	76	
10	5	71	
16	13	58	
30	16	42	
40	7	35	
50	5	30	
100	9	21	
200	6	15	
-200	15		

Liquid Limit		%
Plastic Limit		%
Plasticity Index	NON PLASTIC	%
Soil Classification		
Bitumen Content		%
Specific Gravity		
Moisture		%
Absorption		%
Weight/Cu. Ft. Rodded	lbs., Loose	lbs.
Fineness Modulus		
Organic Impurities		
Abrasion (L. A.) % wear 100 rev.		%
% wear 500 rev.		%
Soundness (Sodium Sulphate) 5 cycles		%
(Magnesium Sulphate) 5 cycles		%
Potential Reactivity		
Sc		mm/l
Rc		mm/l

Respectfully submitted,
SOUTHERN ARIZONA TESTING LABORATORY

Certified by E. L. Vick, PE
Arizona Reg. No. 5932

Data Sheet No. 3

REPORT OF SUPPLEMENTARY CORE DRILL RESULTS

at

SOLAR SITE, KITT PEAK, ARIZONA

11 February 1960

for

AURA, INCORPORATED

Tucson, Arizona

by

Heinrichs GEOEXploration Company

P. O. Box 5671 Tucson, Arizona

CONTENTS

	Page Number
Introduction	1
Results, Interpretation & Conclusions	2
Daily progress Log of Drilling	4
Logs of Holes #8, #9, #10 and #11	6

MAPS — IN BACK POCKET

#3 Vertical Sections of Diamond Drill Holes
Scale 1" = 20'

#4 Plan Map as submitted by Skidmore, Owings & Merrill

REPORT OF SUPPLEMENTARY CORE DRILL RESULTS

at

SOLAR SITE, KITT PEAK, ARIZONA

INTRODUCTION

This report summarizes the results of additional diamond drilling completed at the Solar Site Area of the Kitt Peak Project of AURA, Inc. and is in accordance with Purchase Order No. 1931 dated 30 December 1959 issued by AURA to Heinrichs GEOEXploration Company of Tucson, Arizona. An original employment contract between AURA and Heinrichs GEOEXploration Company was executed on 5 May 1959.

During July and August 1959 seven diamond drill holes were completed along the proposed Solar axis and a report of the results was submitted on 1 September 1959 by Heinrichs GEOEX. After further study, discussion and planning, and inspection of the core by personnel of AURA and Skidmore, Owings and Merrill, it was decided to drill an additional two holes each at the areas of the foundation for the proposed heliostat support tower and the observing rooms at the point of emergence for the inclined and vertical shafts.

After receipt of a sketch from Skidmore, Owings & Merrill showing the locations they had selected for further drilling (copies of which are enclosed in the report map pocket) the first hole was started on 30 December 1959 and the final hole completed on 5 February 1960. All holes penetrated to at least the 6670 foot elevation, as specified. A total of 382 feet of hole was drilled at an average cost of $7.77 per ft. All coring was done with an NX barrel and over all average core recovery was 78.6%. The drillers spent 24 working days on the job which was delayed because of considerable adverse cold and wet weather and resulting occasional impassable road conditions.

RESULTS, INTERPRETATION AND CONCLUSIONS

The results of the additional drilling showed nothing to warrant any change from the conclusions as stated in the previous report. In summary: the rock type is basically a biotite quartz monzonite, every where altered to varying degrees, usually to apoint of rottenness near the surface, but rapidly becoming hard and competent at depth. It is quite fractured and there have been numerous slips that are usually healed with epidote. Where the biotite is in heavier concentration the rock is somewhat less competent than where it is a minor fraction. These are the usual and common conditions in granitic type rocks and there are no apparent reasons why excavations in or installations on this rock should require anything more than application of the usual, careful engineering principles which should be used on this type of design and construction.

Holes #8 and #11 show nothing new of significance. Hole #9 has a long intersection of very hard, nearly white monzonite with a low biotite content. It is probable that the interval in the bottom of hole #3 logged previously as aplite is a facies change that would grade into similar rock if the hole were extended downward. Both rock facies are found on the surface and were so plotted on the original geology map, and in this case probably tie to the similar surface exposures to the west. This is good rock and will make good foundation.

Probably the most significant things of note found in the new drilling are the somewhat larger fault zones found toward the bottoms of holes #9 and #10. The one in hole #9 lies at a depth of 89 feet below the surface with plenty of good back over it and should cause no trouble. The one in hole #10 lies at a depth of 59 feet and possibly will be reached during some of the excavating over and around it. This may necessitate some additional reinforcing where it is encountered. Without positive evidence to the

contrary, and for the sake of conservative safe planning, it should be assumed that these two zones may actually be one fault which would probably strike west of north and dip to the east. No definite surface projection of such a zone is evident. This indicates it either weakens or frays out toward the surface and that it does not represent a fracture of any major consequence. For example, it could be explained as an old contraction joint caused during some phase of solidification or cooling of the rocks masses involved.

HEINRICHS GEOEXPLORATION COMPANY

by:_____
Walter E. Heinrichs, Jr.
President & General Manager

11 February 1960
P. O. Box 5671
Tucson, Arizona

DAILY PROGRESS LOG OF DRILLING

DATE		DAILY COSTS	CUMULATIVE TOTALS
December 1959 29	Moved rig up mountain and started set up on hole #8	$60.00	$60.00
30	Completed set up and drilled 12'	60.00 48.00	$168.00
January 1960 6	Drilled to 27' depth	60.00 60.00	288.00
7	" " 49' "	60.00 88.00	436.00
8	" " 73.5' "	60.00 98.00	594.00
9	" " 92' " and started moving rig. Hole #8 completed at 92'	60.00 74.00	728.00
12	Finished set up on Hole #9	60.00	788.00
14	Drilled to 18' depth	60.00 72.00	920.00
19	" " 33' "	60.00 60.00	1040.00
20	" " 45' "	60.00 48.00	1148.00
21	" " 64.25' "	60.00 77.00	1285.00
22	" " 75.5' "	60.00 45.00	1390.00
25	" " 96' "	60.00 82.00	1532.00
26	" " 106' " and started moving rig. Hole #9 completed at 106'	60.00 40.00	1632.00
27	Finished set up on Hole #10	60.00	1692.00
28	Drilled to 38' depth	60.00 152.00	1904.00

DAILY PROGRESS LOG OF DRILLING (continued)

DATE		DAILY COSTS	CUMULATIVE TOTALS
January			
29	Drilled to 68' depth	$60.00	
		120.00	$2084.00
30	" " 92' " and		
	started moving rig. Hole #10	60.00	
	completed at 92'	96.00	2240.00
February			
1	Finished set up on Hole #11	60.00	2300.00
3	Drilled to 35' depth	60.00	
		140.00	2500.00
4	" " 92' " Hole #11	60.00	
	completed at 92'	228.00	2788.00
5	Started to tear down rig	60.00	2848.00
6	Pulling casing & loading up	60.00	2908.00
7	Moved off mountain	60.00	2968.00

SOLAR SITE - KITT PEAK

Drill Contractor: Metler Bros.

Supervision & Logging:
Heinrichs Geoexploration Co.

Hole #: 8
Started: 12/30/59
Completed: 1/9/60
Location: 85' north & 30' east of Solar Control Point
Depth: 92'
Inclination: Vertical
Direction: Vertical
Elevation: 6758 ±

Drilled Interval	Core	% Recovery	LOG
0' - 12'	2.4'	20%	Hole started near east edge of a bulldosed road, some fill and boulders. A rock bit was used until solid bedrock was definitely penetrated. First core is a piece of aplite boulder, then highly altered biotite quartz monzonite between 3' and 12'. Most of this was soft enough to disintegrate and be washed out as sludge by the drill water.
12' - 24'	10.9'	90%	Series "C" Nx core barrel used. Recovery good. Biotite quartz monzonite quite altered at first but becoming fresher and harder at increasing depth. Some minor diorite clotting about 19' - 22'. Not much fracturing.
24' - 42.5'	16.8'	91%	Nx core. Same rock type--hard but showing some fracturing at about a 45 degree angle especially at 29.5', 30.5', 38.5' and 40'. The fracture at 30.5' has had fault slip movement along it and shows a little gouge and epidotization.
42.5' -56.5'	9.8'	70%	Nx core and same rock type. Little change to about 48' except the fracturing is at a shallow angle of about 20 degrees to 25 degrees from horizontal. From 48' to 51' there are only a few fragments of altered and drill-water eroded core, some showing fault evidence so the zone is presumed to be a fault area with soft rock material. Below 51' the rock freshens and hardens again but the major fracturing is 70 - 75 degrees from horizontal, and alteration with consequent weakness is pronounced along the fractures.
56.5' - 73'	16.9	102%	Nx core. Some monzonite rock type. This is a zone of rehealed fractures and slips. The rehealing is fine grained and greenish from epidotization and usually strong and competent with fracturing across them

HEINRICHS GEOEXPLORATION COMPANY

Drilled Interval	Core	Recovery	Log
			rather than in or adjacent. Fracture angles include all those noted above with the majority being low angle. A couple of dioritic clots are present.
73½ - 92'	18.1'	95%	NX core. Same monzonite. From 73' to 84' is the best (hardest, least fractured and least altered) rock penetrated in this hole. From 84' to 92' is almost as good but there is a nearly vertical fracture that split the core in half at 85' - 87'. Hole completed at 92' in hard competent rock.

SOLAR SITE - KITT PEAK

Drill Contractor: Metier Bros.

Supervision & Logging
Heinrichs Geoexploration Co.

Hole #: 9
Started: 1/9/60
Completed: 1/25/60
Location: 85' north and 30' westof solar control point.
Depth: 106'
Inclination: Vertical
Direction: Vertical
Elevation: 6766 + or -

Drilled Interval	Core	% Recovery	LOG
0' - 3.5'	0.3	8.5%	Overburden
3.5' - 22'	13.5	73 %	Biotite quartz monzonite as seen in other holes. Fairly rich in biotite, little fracturing, a dioritic blot at 18'.
22' - 29'	7.5'	107%	A little harder and more siliceous with considerable decrease in biotite.
29' - 31'	1.0'	50%	Fault zone with epidotization.
31' - 32'	1.0'	100%	Like the interval 22' - 29'.
32' - 35.5'	3.8'	109%	Abrupt gradation into light colored and more aphanitic monzonite. Biotite quite minor. Small healed fault about 35'.
35.5' - 65'	29.3'	100%	Light colored, hard, quartz rich, low in biotite, quite fractured rock. This is probably another more acidic phase of monzonite and likely is the aplite, mapped on the surface a little to the west. It is not quite the same rock in appearance, but the surface exposure having been subjected to bleaching and alteration probably has any biotite formerly present all removed. Altered pyrite crystals are scattered through portions of this rock.
65' - 70'	4.4'	88%	Very broken, biotite rich, feldspars altered. Red spots of hematite & limonite.
70' - 89'	13.5'	70%	The hard, light colored rock as inninterval 35.5 - 65'. Also has red spots of iron alteration.
89' - 102'	2.8'	15%	Fault--practically no recovery in core so some sludge taken.

More

Drilled Interval	Core	Recovery	LOG
89' - 102'			(continued) - 89' - 95', red gouge; 95 - 100' tan-white; 100' - 102' dark biotite gouge.
102' - 106'	3.0'	75%	Hard solid rock again: biotite quartz monzonite quite rich in biotite.
END			

SOLAR SITE - KITT PEAK

Drill contractor: Metler Bros.

Supervision & Logging:
HEINRICHS GEOEXPLORATION CO.

Hole #: 10
Started: 1/26/60
Completed: 1/30/60
Location: 75' South & 30' West of Solar Control Point
Depth: 92'
Inclination: Vertical
Direction: Vertical
Elevation: 6762 ±

Drilled Interval	core	% Recovery	LOG
0' - 1'	0'	0%	Overburden
1' - 18	11'	65%	Biotite quartz monzonite altered to the point where it is somewhat eroded by drill water.
18' - 22'	1'	25%	Fault
22' - 41.5'	18'	92%	Increasingly harder and more competent rock. Small slips healed with epidote at 24' and 41'. Occasional dioritic clots at 22' through 32'. Small fault 35'-36'. Some fractures.
41.5' - 59'	17.2'	98%	Biotite quartz monzonite as above. Somewhat fractured for first 2 ft: A small healed fault at 44', some clotting at 50' and upper contact of large fault zone at bottom.
59' - 76'	4'	23%	Fault zone. A little fragmental core recovered. Sludge from the top and bottom is high in ground biotite.
76' - 92'	16.6'	104%	Good fresher, and competent biotite quartz monzonite.

END

SOLAR SITE - KITT PEAK

Drill Contractor: Metler Bros.

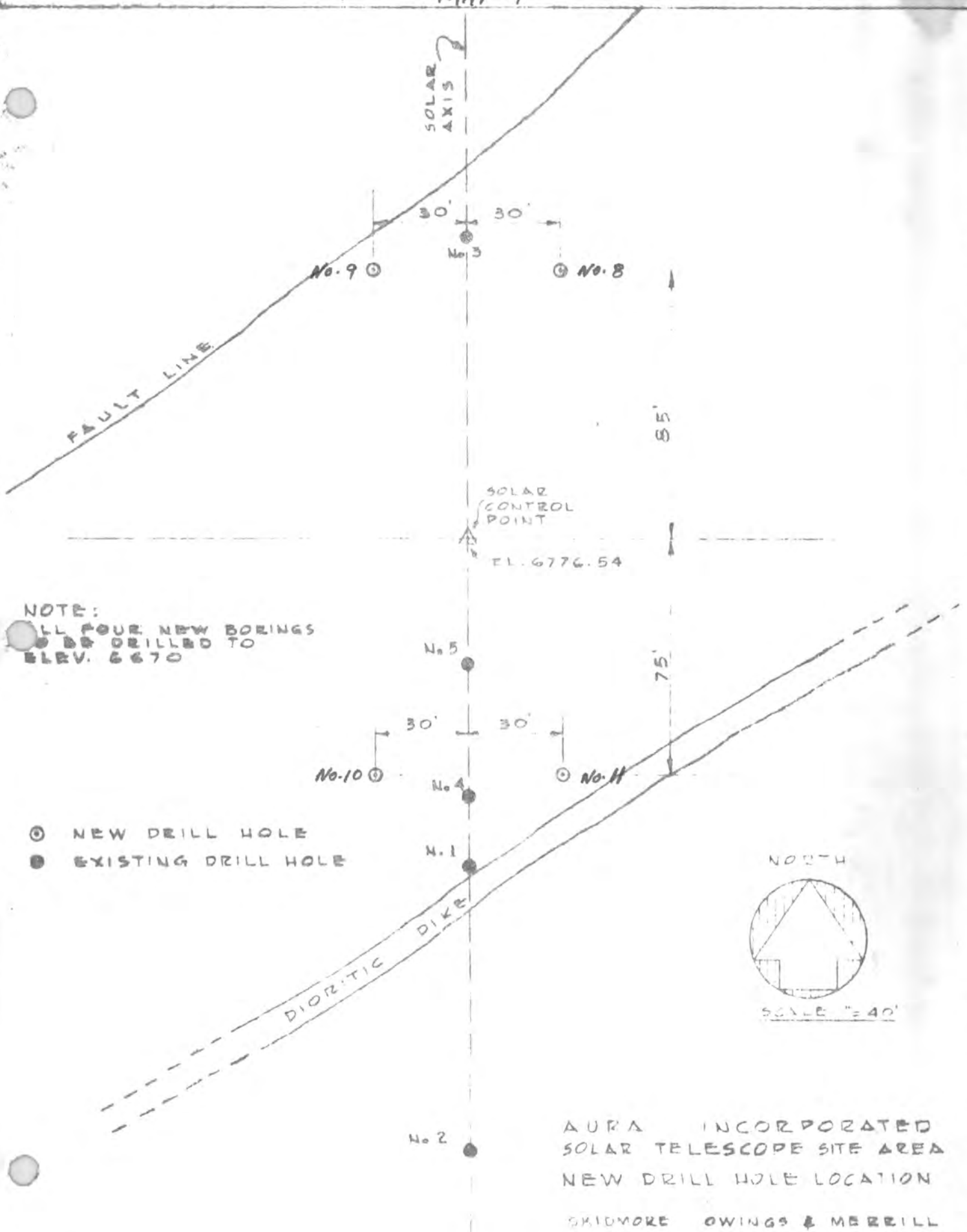
Supervision & Logging
HEINRICHS GEOEXPLORATION CO.

Hole #: 11
Started: 2/1/60
Completed: 2/4/60
Location: 75' South & 30' E. of Solar Control Pt.
Depth: 92'
Inclination: Vertical
Direction: Vertical
Elevation: 6758 ±

Drilled Interval	Core	% Recovery	LOG
0' - 3'	0'	0%	Overburden & bulldozer filling
3' - 16'	5.4'	41%	Biotite Quartz monzonite, [illegible] decomposed and eroded by the drill water.
16' - 69'	50.7'	96%	Biotite quartz monzonite, similar to what is found at depth in most of the holes. Hard and competent with fracture pattern as found in all the drill holes. A few diorite clots in the zone 31' - 42'. A series of small slips healed with epidote at 56' - 59'
69-77'	7.8'	97%	The more siliceous, less biotitic phase of the monzonite. Hard & competent.
77' - 92'	14.3'	95%	Biotitic phase again. Hard but slightly more fractured with minor clotting at 91'.

END

MAP #4

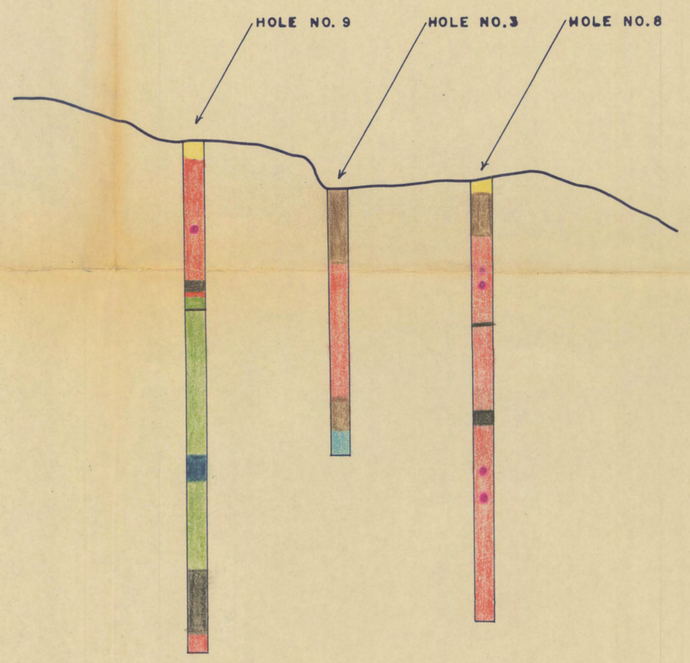


NOTE:
ALL FOUR NEW BORINGS TO BE DRILLED TO ELEV. 6670

⊙ NEW DRILL HOLE
● EXISTING DRILL HOLE

AURA INCORPORATED
SOLAR TELESCOPE SITE AREA
NEW DRILL HOLE LOCATION

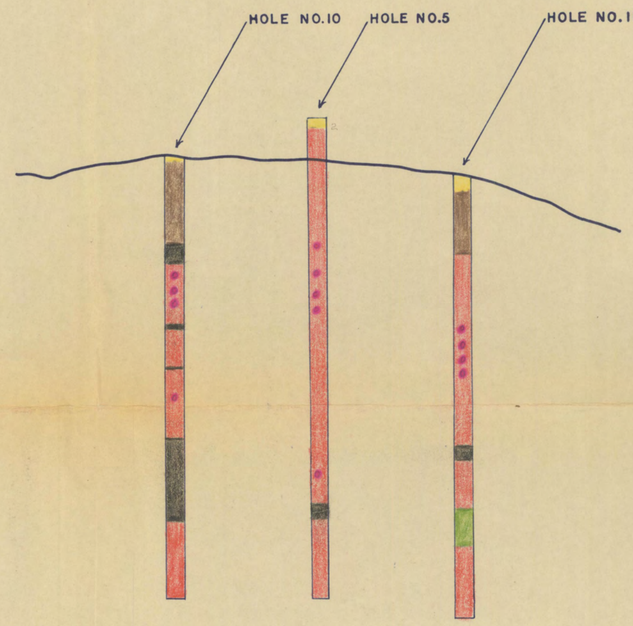
SKIDMORE OWINGS & MERRILL
CHICAGO DEC. 10, 1959



N

EAST-WEST PROFILES LOOKING NORTH

SCALE
10 0 10 20 FEET



SOIL, SAND, OVERBURDEN
MONZONITE, SOMEWHAT ALTERED
" FRESHEST & LEAST ALTERED
" HIGH BIOTITE CONTENT
" LOW " "
" WITH DIORITIC CLOTS
APLITE OR ALASKITE
FAULTS

MAP #3

AURA INCORPORATED

KITT PEAK PROJECT, PIMA COUNTY, ARIZONA
SOLAR SITE

VERTICAL SECTIONS OF DIAMOND DRILL HOLES

BY

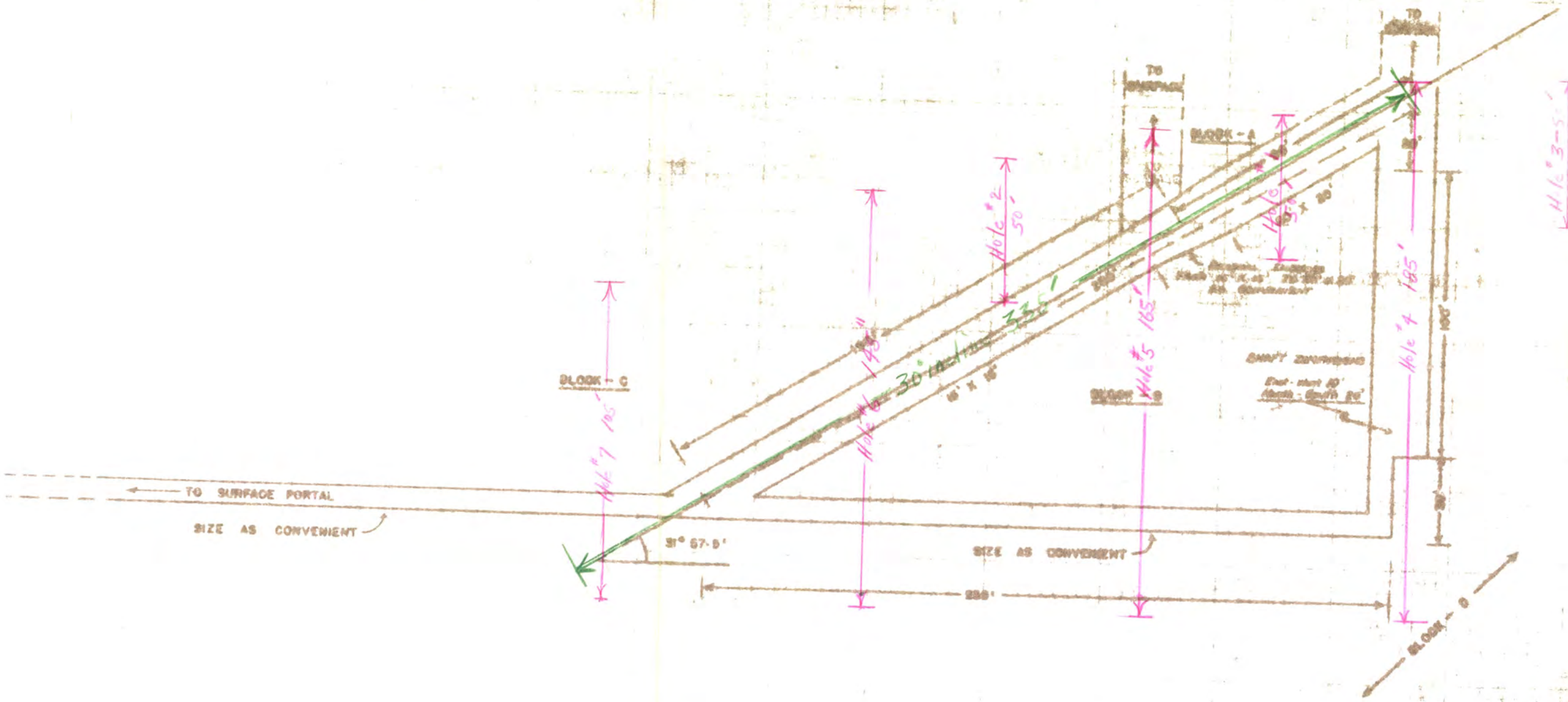
HEINRICHS GEOEXPLORATION COMPANY
P.O. BOX 5671 TUCSON, ARIZONA

FEBRUARY, 1960

CROSS SECTION
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE — 1" = 40'

SHOWING PROPOSED SOLAR TELESCOPE AND

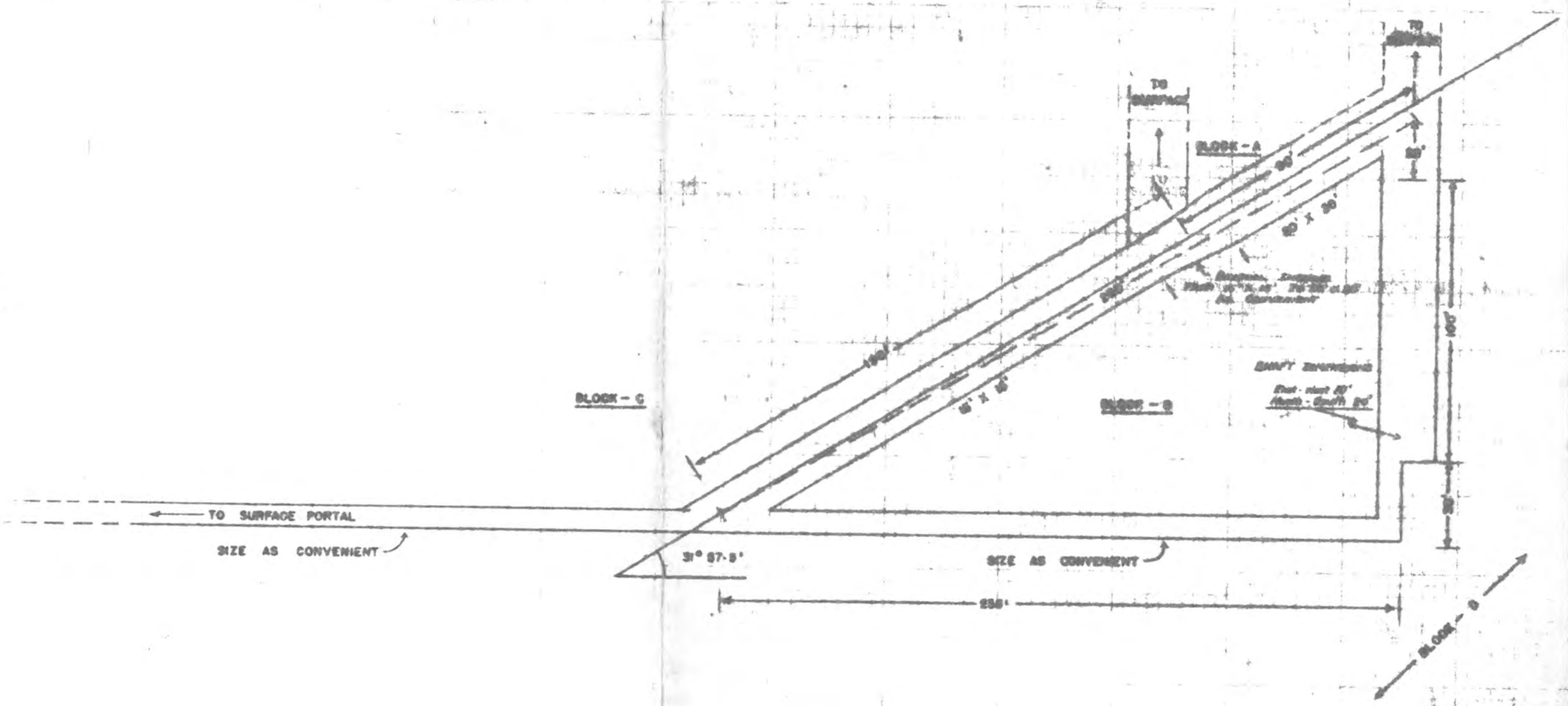


MAP 5

CROSS SECTION
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE – 1" = 40'

ALSO PROPOSED SOLAR TELESCOPE SITE

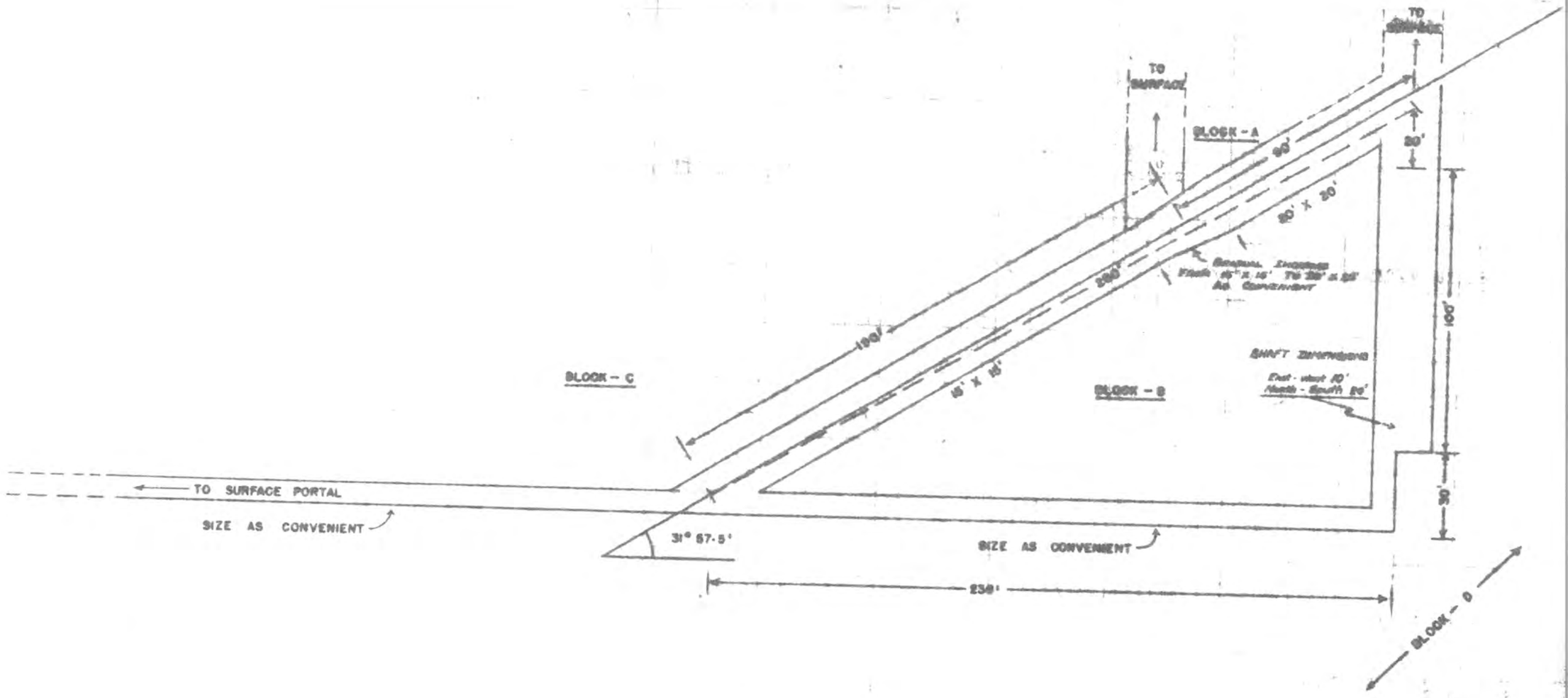


MAP 5

CROSS SECTION
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE — 1" = 40

ALONG PROPOSED SOLAR TELESCOPE AXIS



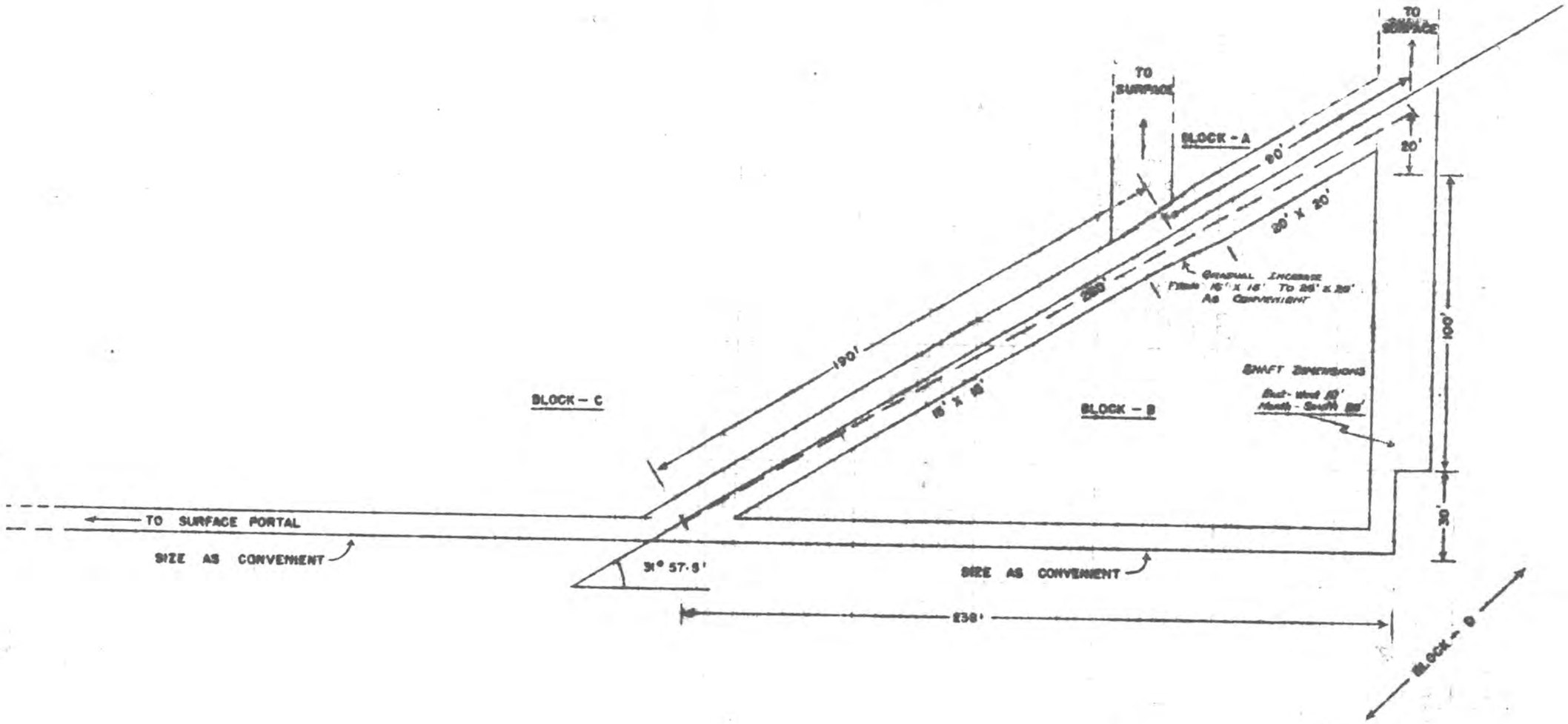
MAP 5

CROSS SECTION

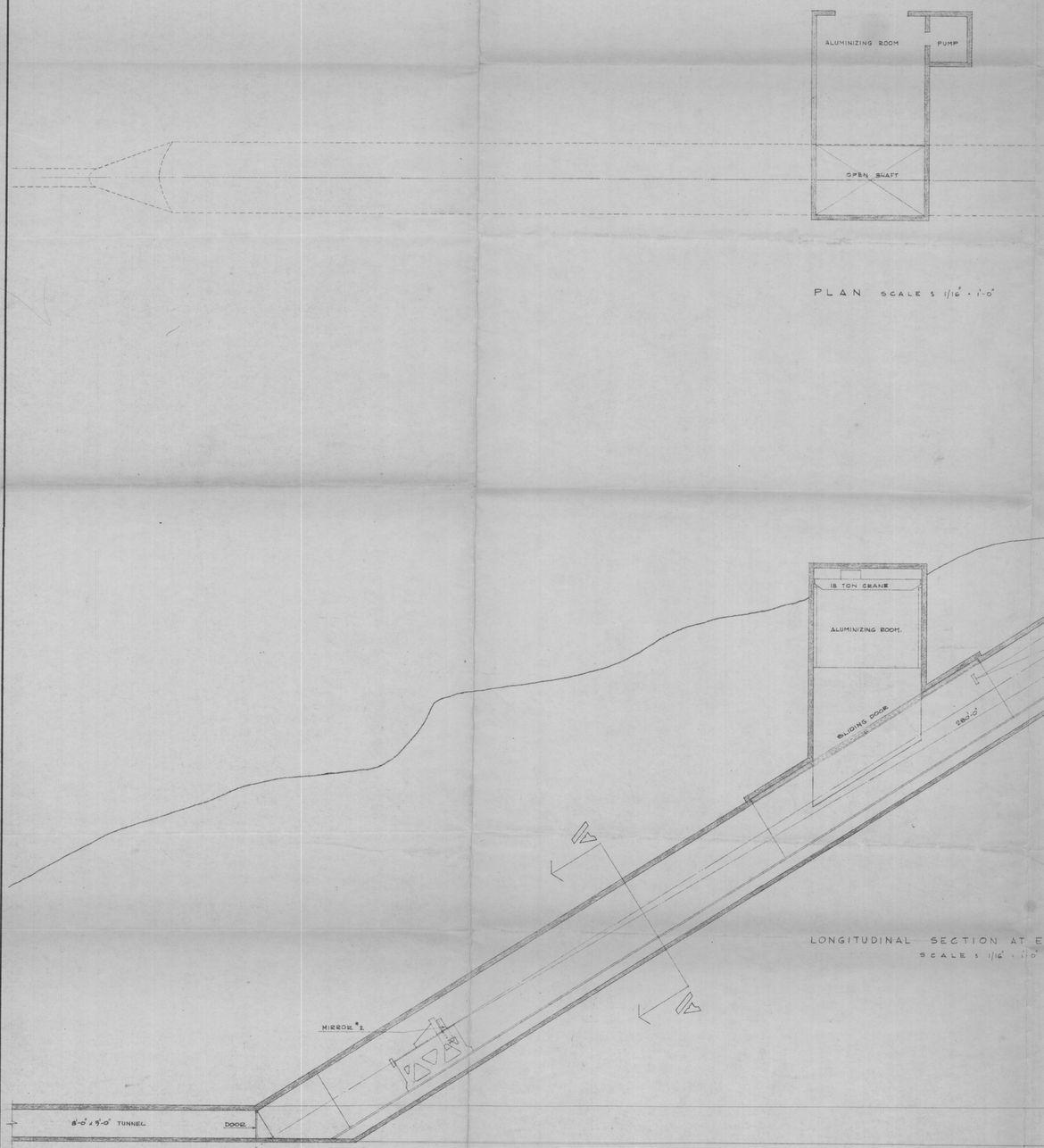
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE — 1" = 40'

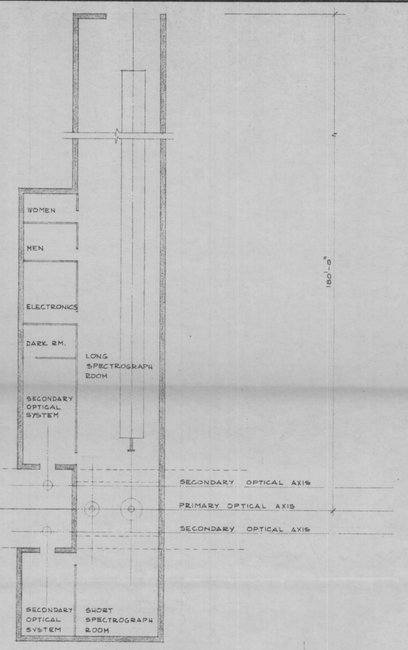
ALONG PROPOSED SOLAR TELESCOPE AXIS

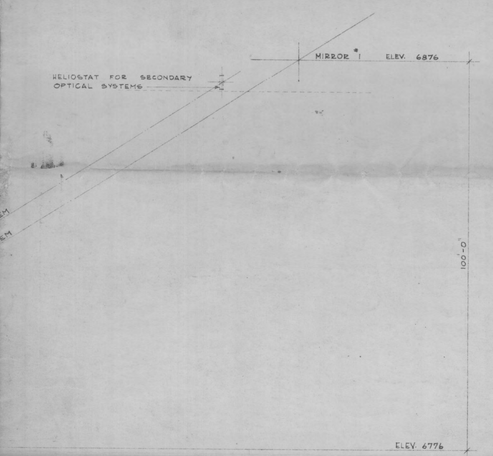


MAP 5

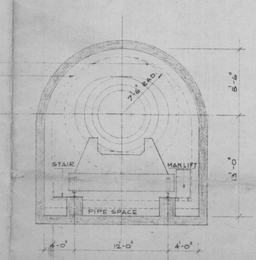


PLAN SCALE : 1/16" = 1'-0"





LONGITUDINAL SECTION AT E. 599 859
SCALE : 1/16" = 1'-0"



SECTION A-A
SCALE : 1/8" = 1'-0"

Skidmore Owings & Merrill
30 West Monroe Str
Chicago 3 Ill

Scheme #5 SK-17

AURA

PLAN & SECTIONS

SCALE : 1/8" & 1/16" = 1'-0" DATE : 5-15-59

SKIDMORE, OWINGS & MERRILL

ARCHITECTS ENGINEERS

CHICAGO SAN FRANCISCO NEW YORK

SCALE: 1" = 20'

AURA

PROPOSED ARRANGEMENT AND LOCATION

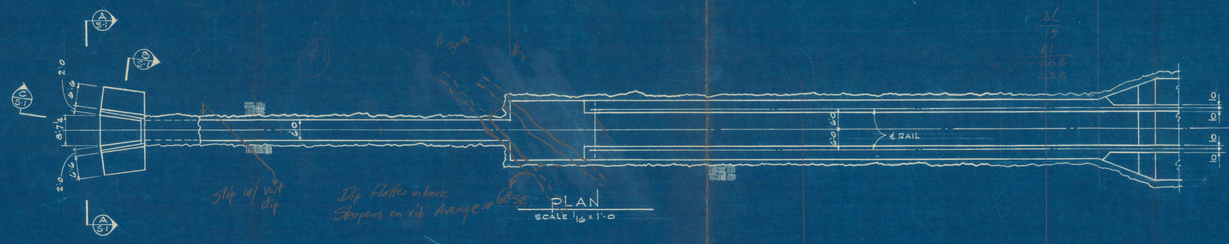
D.E.A. 7-9-59

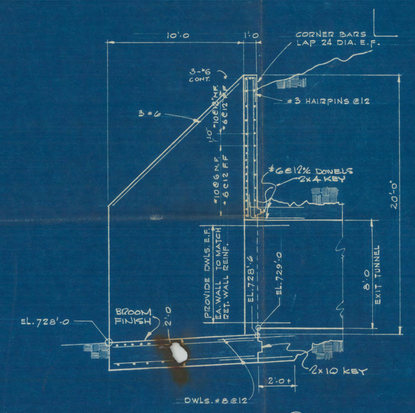
SK-26

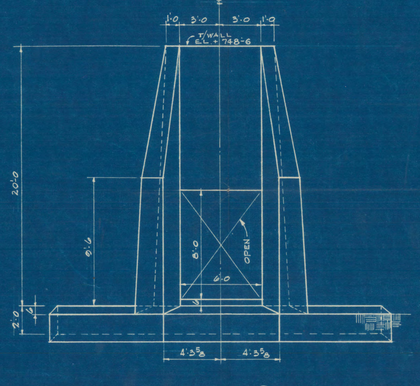
SKIDMORE, OWINGS & MERRILL
ARCHITECTS ENGINEERS
CHICAGO SAN FRANCISCO NEW YORK

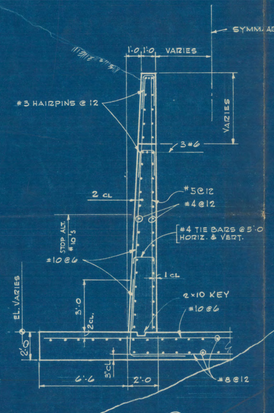
G.W. 890—3-58—250

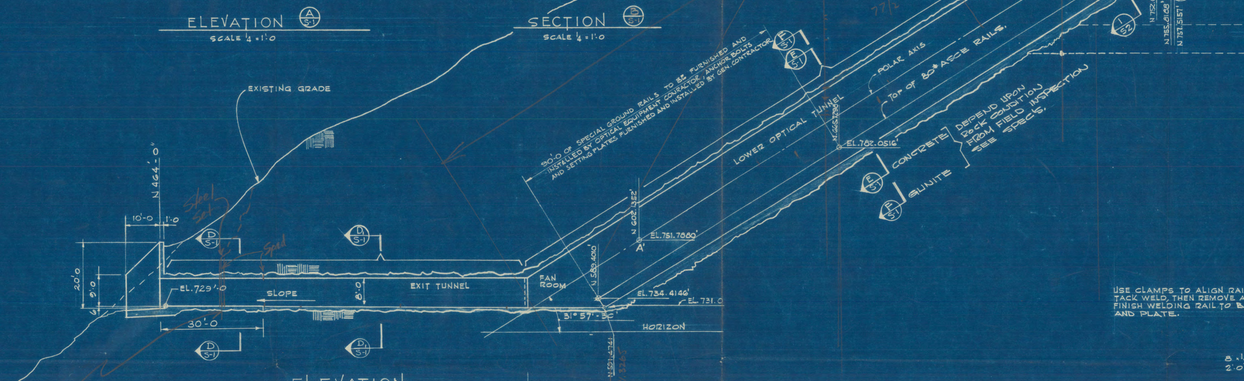
PRINTED
JUL 9 1959
SKIDMORE, OWINGS & MERRILL

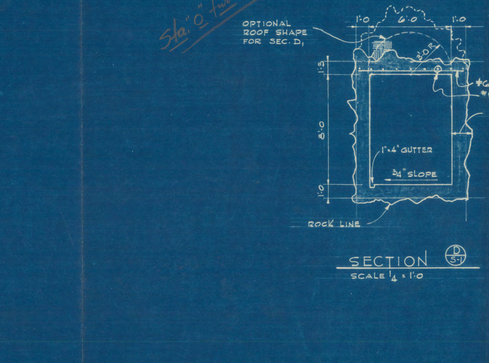


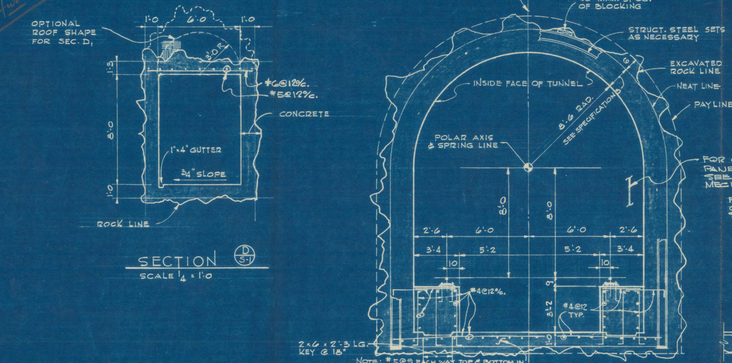


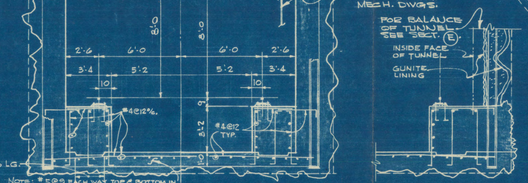


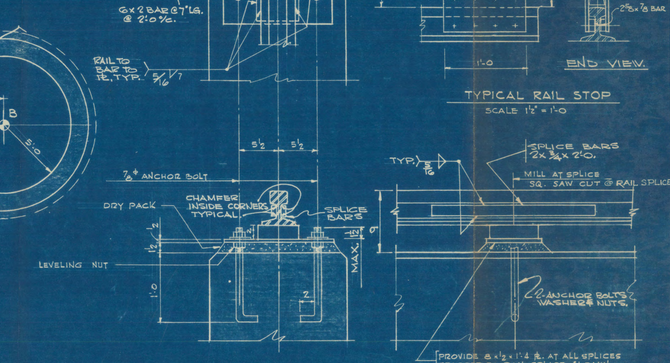


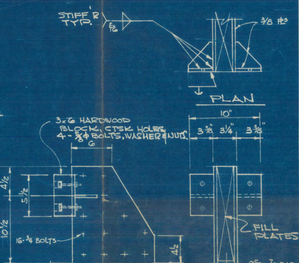












NOTES

FOR "GENERAL NOTES" OF CONCRETE CONSTRUCTION SEE DWG. S-3

REFERENCES

WORK THIS DRAWING WITH S-2 & S-7

CORRECTIONS FOR BIDDING — MAY 23, 1960

REVISIONS

60 INCH SOLAR TELESCOPE

KITT PEAK, PIMA COUNTY, ARIZONA

FOR ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.

UNDER CONTRACT WITH NATIONAL SCIENCE FOUNDATION

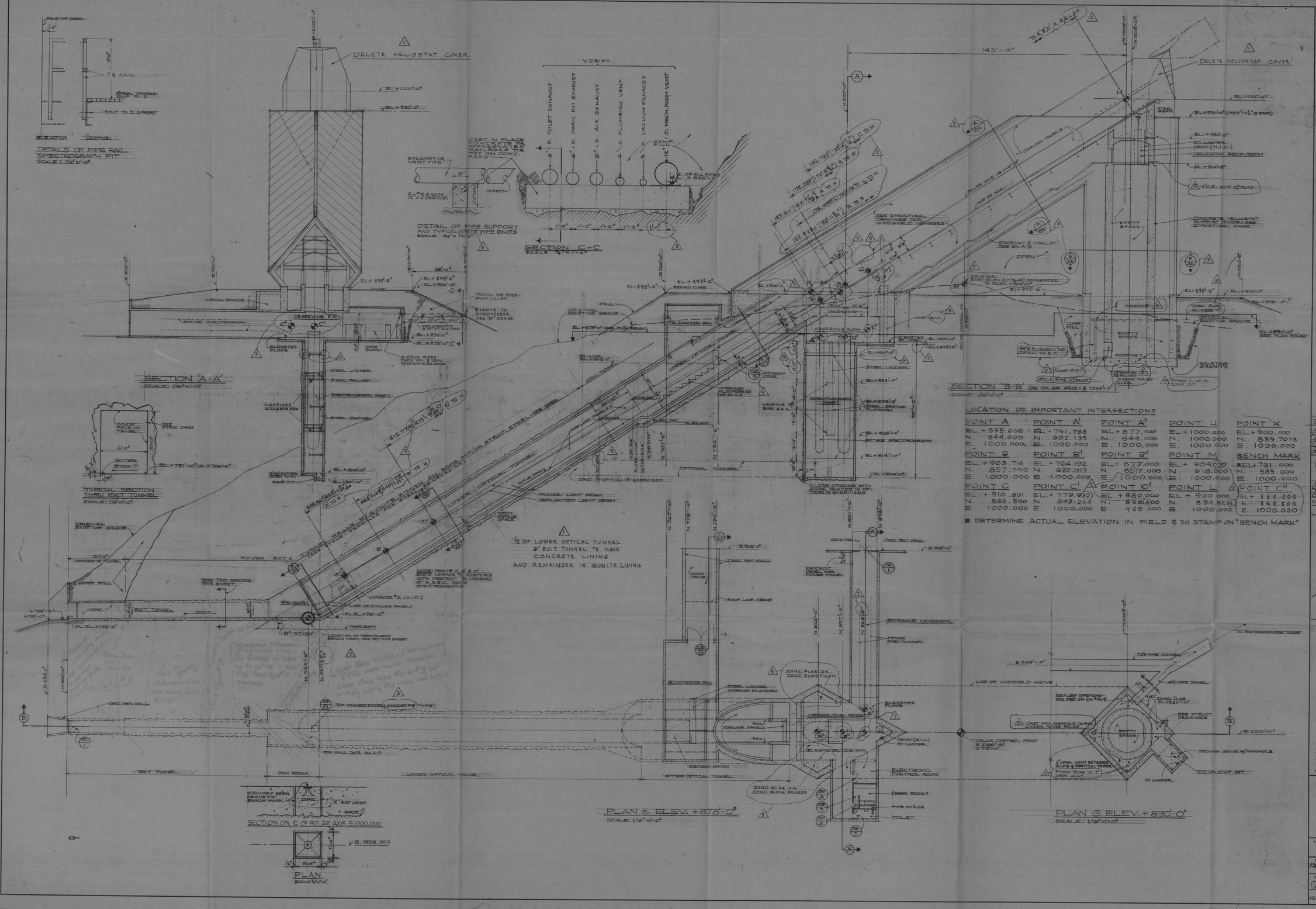
SKIDMORE OWINGS & MERRILL
ARCHITECTS ENGINEERS
30 WEST MONROE STREET, CHICAGO
NEW YORK SAN FRANCISCO PORTLAND

OPTICAL & EXIT TUNNEL PLAN & SECTIONS

APPROVED

DRAWN	APPROVED	APPROVED	APPROVED	DRAWING NUMBER
M.P.	DEPT. HD.	JOB CAPT.	PROJ. MGR.	S-1

SCALE	DATE	JOB NUMBER
AS NOTED	MAY 2, 60	5749



LOCATION OF IMPORTANT INTERSECTIONS

POINT A	POINT A'	POINT A''	POINT H	POINT K
EL. +895.606	EL. +751.788	EL. +877.000	EL. +1000.000	EL. +900.000
N. 844.000	N. 602.135	N. 844.000	N. 1000.000	N. 839.7073
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT B	**POINT B'**	**POINT B''**	**POINT M**	**BENCH MARK**
EL. +903.716	EL. +764.192	EL. +877.000	EL. +904.000	■ EL. +731.000
N. 857.000	N. 622.017	N. 857.000	N. 918.000	N. 585.000
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT C	**POINT C'**	**POINT C''**	**POINT L**	**POINT C'''**
EL. +910.891	EL. +779.930	EL. +880.000	EL. +900.000	EL. +880.000
N. 868.500	N. 647.244	N. 868.500	N. 854.824	N. 868.500
E. 1000.000	E. 1000.000	E. 988.000	E. 1000.000	E. 1000.000

■ DETERMINE ACTUAL ELEVATION IN FIELD & SO STAMP ON "BENCH MARK"

NOTES:

DOOR NUMBER / HARDWARE SET — DOOR SYMBOL

DETAIL OF SECTION NUMBER — DETAILED ON SHEET AS NOTED ON CROSS REFERENCED SHEET

TOLERANCES:

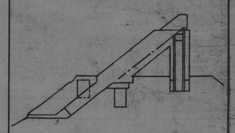
THE ORDINATES AND ABSISSAS OF POINTS ON THE RAILS IN A LOCATION PERPENDICULAR TO THE POLAR AXIS AT POINTS H, A, B, C, A', B' & C' SHALL NOT VARY FROM DIMENSIONS SHOWN ON DRAWING BY MORE THAN ± 1/8"

6	CHANGES	NOV. 22, 60 RFK
5	CHANGES	OCT. 7, 60 RFK
4	CHANGES	SEPT. 23-60 cdj
3	CORRECTIONS	AUG. 29-60 cdj

ISSUED FOR CONSTR.
AUGUST 1, 1960

2	DIMENSION CORRECTIONS 7-27-60 cdj
1	CORRECTIONS PER ADDENDUM NO. 1-2-3 & 4 6-14-60 cdj
	CORRECTIONS FOR BIDDING - MAY 23, 1960

REVISIONS



KEY SECTION

60 INCH SOLAR TELESCOPE

KITT PEAK, PIMA COUNTY, ARIZONA

FOR
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.

UNDER CONTRACT WITH
NATIONAL SCIENCE FOUNDATION

SKIDMORE OWINGS & MERRILL
ARCHITECTS ENGINEERS
30 WEST MONROE STREET, CHICAGO
NEW YORK SAN FRANCISCO PORTLAND

ENGINEERING GEOLOGY
by
SECTIONS

RECEIVED DEC 1 1960
HEINRICHS GEOEXPLORATION COMPANY
P. O. BOX 9671 TUCSON, ARIZONA

APPROVED

DRAWN	APPROVED	APPROVED	APPROVED	DRAWING NUMBER
Kehen	Kea	Seaborg	W. Lundy	A-3
CHECKED	DEPT. HD.	JOB CAPT.	PROJ. MGR.	
SCALE AS NOTED	DATE MAY 2, 60	JOB NUMBER 5749		

DETAIL OF PIPE RAIL
SPECTROGRAPH PIT
SCALE: 1/4"=1'-0"

DELETE HELIOSTAT COVER

EXHAUSTOR VENT PIPE

DETAIL OF PIPE SUPPORT AND TYPICAL PIPE ENDS

CAST IN PLACE CONCRETE OR IMPREGNATED ASBESTOS ADAPTER SET ON CONC. PIER

VERIFY

8'-0" I.D. TOILET EXHAUST
6'-0" I.D. DARK RM EXHAUST
6'-0" I.D. AIR EXHAUST
4'-0" I.D. PLUMBING VENT
3'-0" I.D. VACUUM EXHAUST
EXPAN. FILL
2'-6" I.D. MECH. ROOM VENT

SECTION C-C

SECTION 'A-A'

TYPICAL SECTION TUNNEL EXIT TUNNEL

Massive, moderately jointed, but weathered from 1'+ to 4' joints

Rock Type #3

Small Slid N45°E Vert Dip

Rock Type #4
Moderately blocky and seamy. Joints 18"-3".

Rock Type #3

Average Thickness 3' = Diorite Dike - Dip flatter in back up to 60° SE in east rib, Rock Type #5 steel sets in.

Only Back Visible - floor & ribs under muck - transition zone Rock type #4 to #3 but probably mostly #3 - some rock bolts in.

12/9/60

SECTION ON ℄ OF POLAR AXIS E1000.000

PLAN

½ OF LOWER OPTICAL TUNNEL & EXIT TUNNEL TO HAVE CONCRETE LINING AND REMAINDER IS GUNITE LINING

PLAN @ ELEV. +878'-0"
SCALE: 1/16"=1'-0"

DELETE HELIOSTAT COVER

SECTION 'B-B' (ON POLAR AXIS = E1000.000)
SCALE: 1/16"=1'-0"

PLAN @ ELEV. +890'-0"
SCALE: 1/16"=1'-0"

LOCATION OF IMPORTANT INTERSECTIONS

POINT A	POINT A'	POINT A''	POINT J	POINT K
EL. +895.606	EL. +751.788	EL. +877.000	EL. +1000.000	EL. +900.000
N. 844.000	N. 602.135	N. 844.000	N. 1000.000	N. 859.7075
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT B	POINT B'	POINT B''	POINT I	BENCH MARK
EL. +903.716	EL. +764.192	EL. +877.000	EL. +904.000	EL. +731.000
N. 857.000	N. 622.017	N. 857.000	N. 918.000	N. 585.000
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT C	POINT C'	POINT C''	POINT I	POINT C'''
EL. +910.891	EL. +779.930	EL. +880.000	EL. +900.000	EL. +880.006
N. 868.500	N. 647.244	N. 868.500	N. 854.824	N. 868.560
E. 1000.000	E. 1000.000	E. 988.000	E. 1000.000	E. 1000.000

■ DETERMINE ACTUAL ELEVATION IN FIELD FROM STAMP ON "BENCH MARK"

NOTES:

- DOOR NUMBER, HARDWARE SET
- DETAIL OR SHEET NUMBER
- DETAILED SOLIDLY AS NOTED ON CROSS REFERENCED SHEET

TOLERANCES:

THE ORDINATES AND ABSCISSAS OF POINTS ON THE RAILS IN A LOCATION PERPENDICULAR TO THE POLAR AXIS AT POINTS A, A', B, C, B' & C' SHALL NOT VARY FROM DIMENSIONS SHOWN ON DRAWING BY MORE THAN 1/8".

1	CHANGES	NOV. 22 '60	EPK
2	CHANGES	OCT. 7 '60	EPK
3	CHANGES	SEPT. 28 '60	CRT
4	CORRECTIONS	AUG. 24 '60	CRT

ISSUED FOR CONSTR.
AUGUST 1, 1960

5	DIMENSION CORRECTIONS	SEPT. 30 '60
6	CORRECTIONS FOR ASSEMBLY ERRORS	NOV. 21 '60

CORRECTIONS FOR BUILDING - PARTS, 1960

REVISIONS

KEY SECTION

60 INCH SOLAR TELESCOPE

KITT PEAK, PIMA COUNTY, ARIZONA

FOR
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.

UNDER CONTRACT WITH
NATIONAL SCIENCE FOUNDATION

SKIDMORE OWINGS & MERRILL
ARCHITECTS ENGINEERS
20 WEST MONROE STREET, CHICAGO
NEW YORK SAN FRANCISCO PORTLAND

ENGINEERING GEOLOGY BY
SECTIONS
RECEIVED DEC 1 1960
HEINRICHS GEOEXPLORATION COMPANY
P. O. BOX 5671 TUCSON, ARIZONA

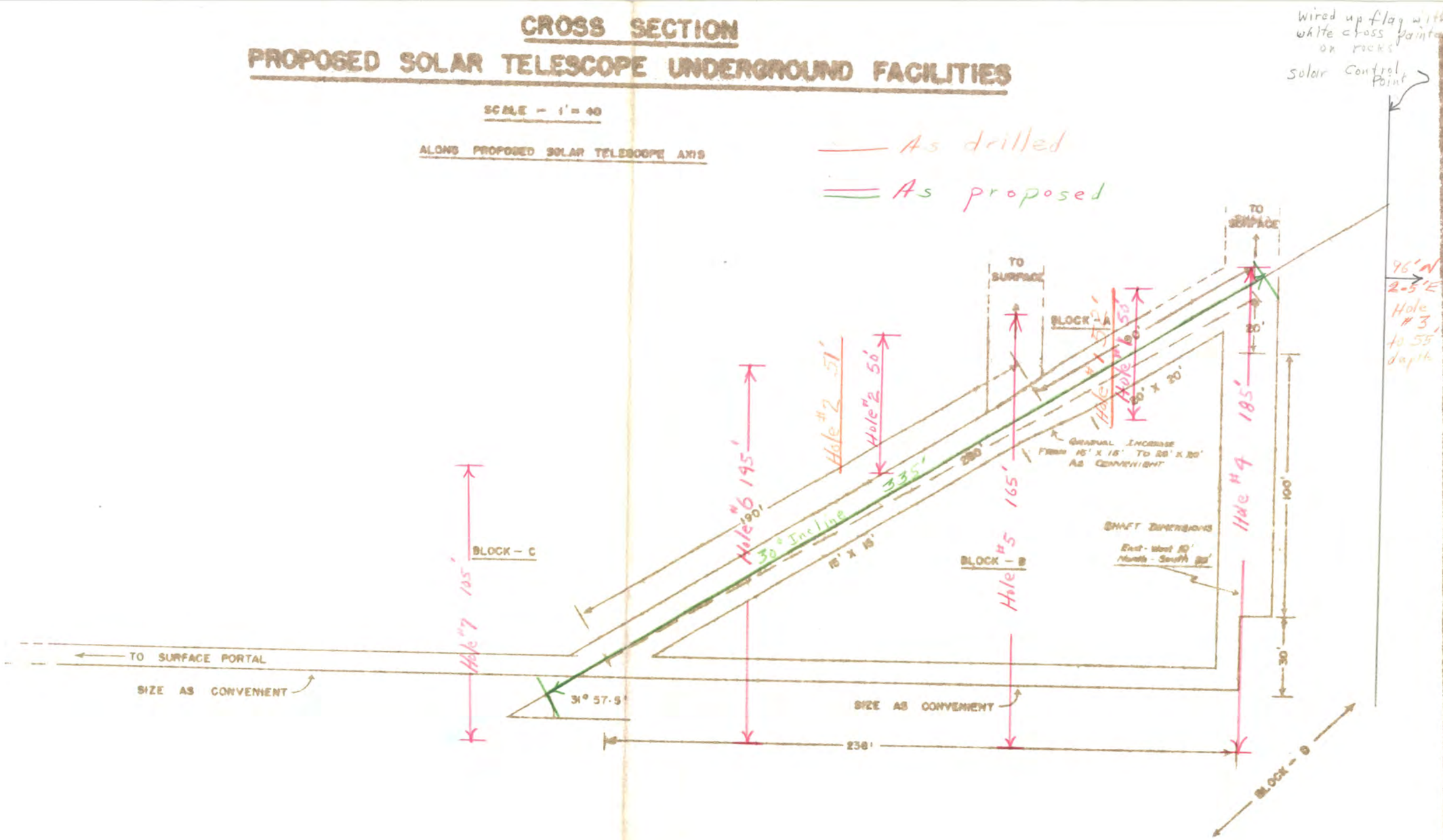
APPROVED

DRAWN	APPROVED	APPROVED	APPROVED	DRAWING NUMBER
CHECKED	DEPT. HD.	JOB CAPT.	PROJ. ENGR.	A-3
ISSUED	DATE	JOB NUMBER		
ACCEPTED	MAY 2, 60	5749		

CROSS SECTION
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE – 1" = 40

ALONG PROPOSED SOLAR TELESCOPE AXIS



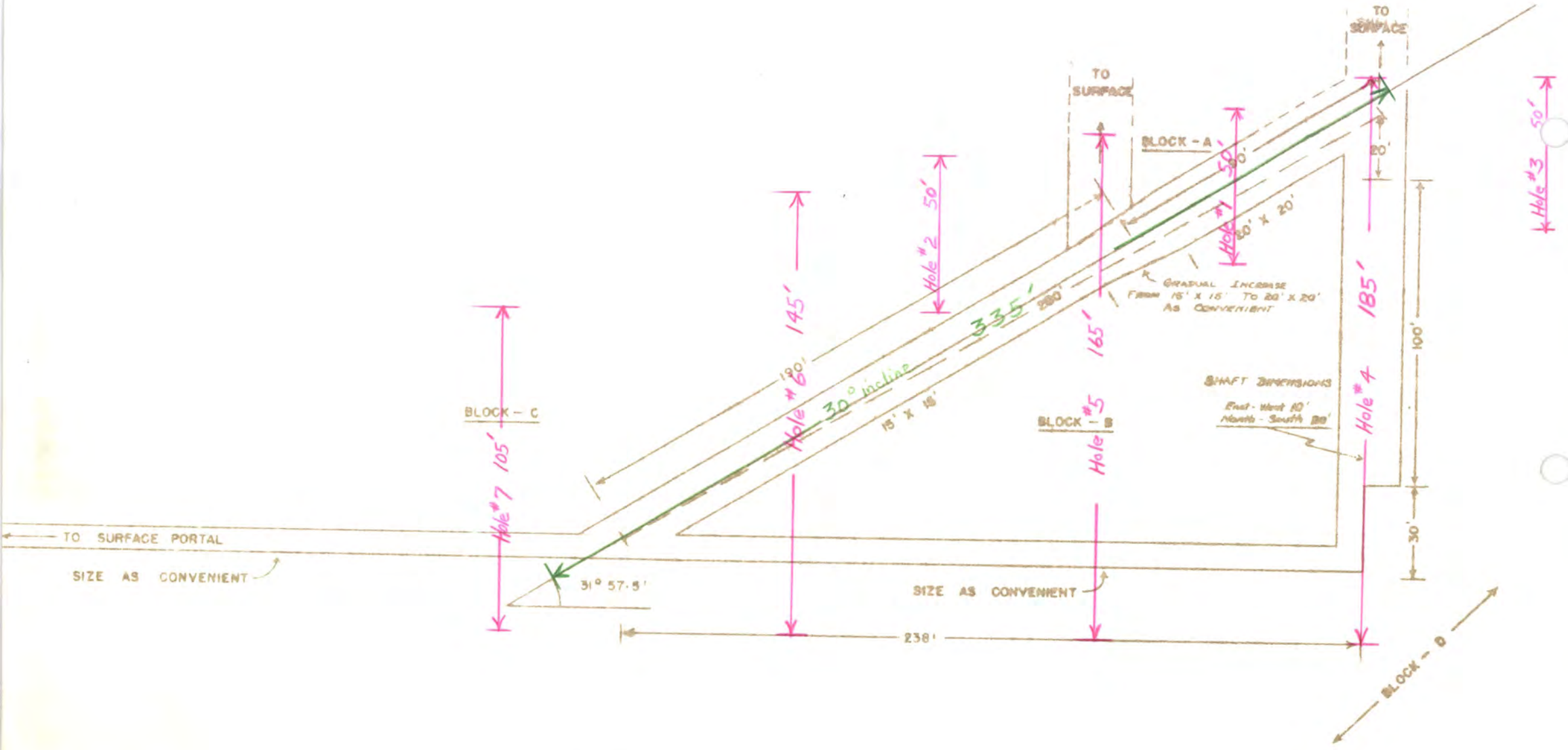
MAP 5

CROSS SECTION

PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

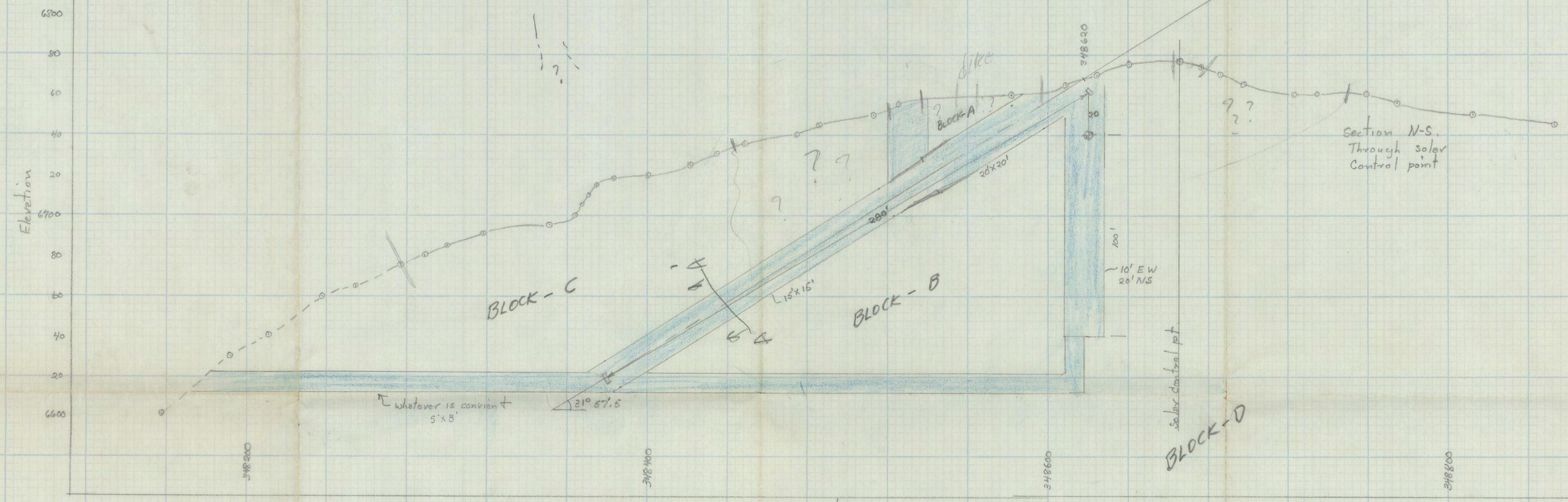
SCALE – 1" = 40'

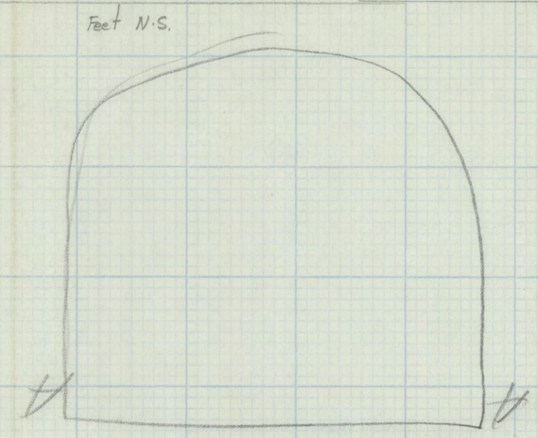
ALONG PROPOSED SOLAR TELESCOPE AXIS



MAP 5

SCALE: 1" = 40'±





40.00 CY
80.00 CY
1.45 SF

11,111 CY
7407 CY shafts

Excav 40.00 CY
Conc 80.00 CY
Gunite 1.50 SF

Gunite per SF
Concrete per LF or CY

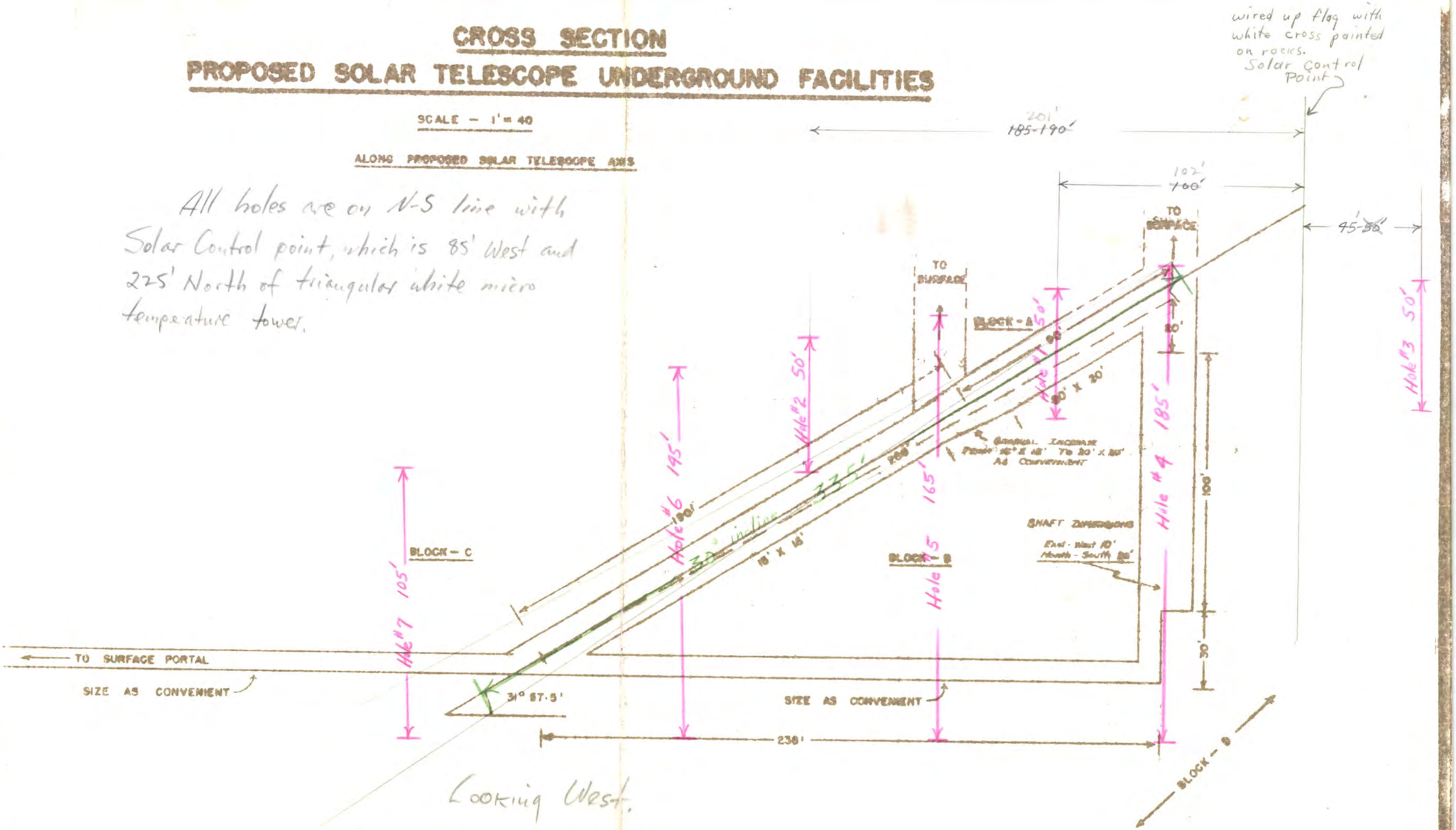
Walt Heindricks MA 2-4202

CROSS SECTION
PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE — 1" = 40

ALONG PROPOSED SOLAR TELESCOPE AXIS

All holes are on N-S line with Solar Control point, which is 85' West and 225' North of triangular white micro temperature tower.



Looking West.

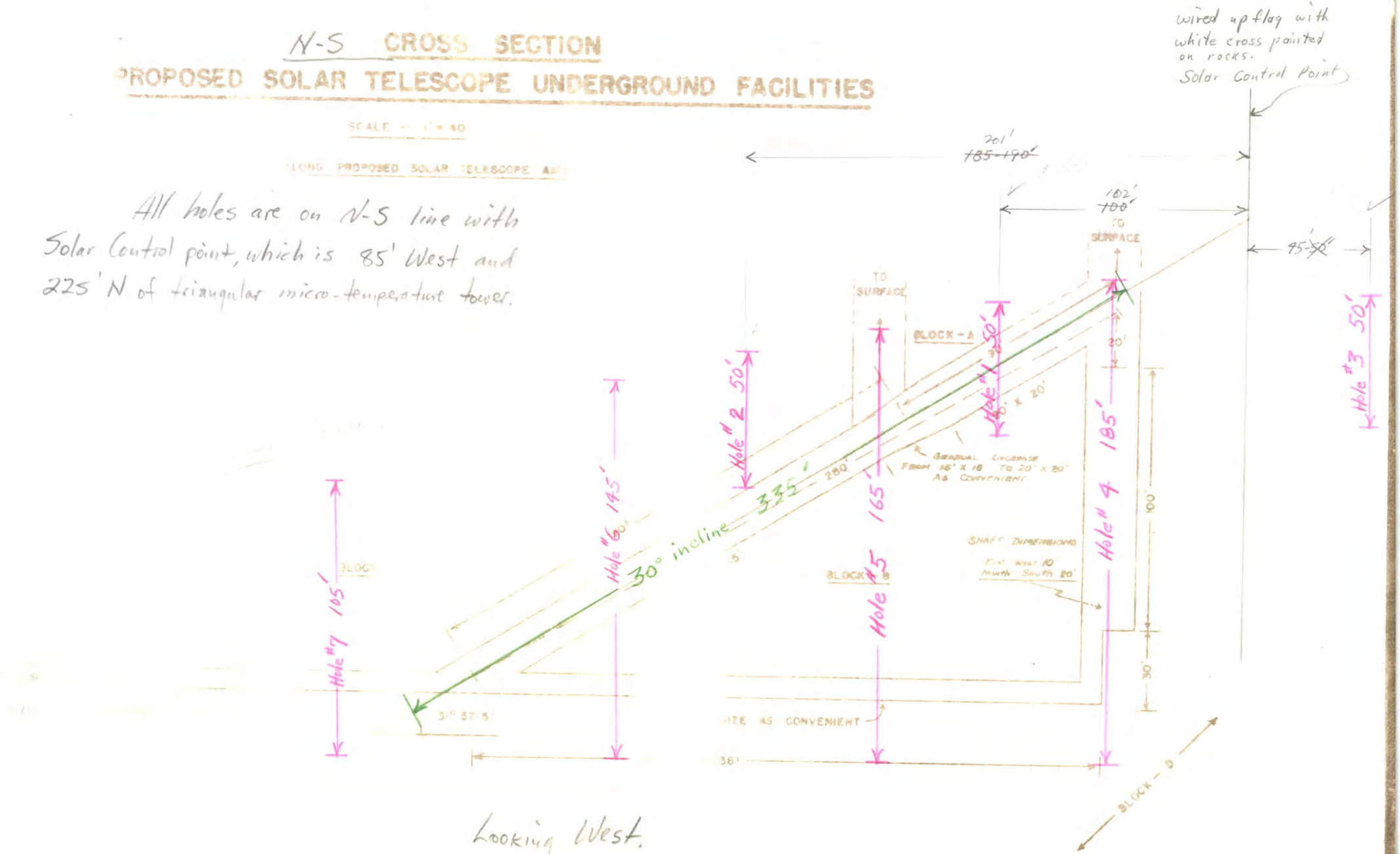
N-S CROSS SECTION

PROPOSED SOLAR TELESCOPE UNDERGROUND FACILITIES

SCALE — 1" = 40'

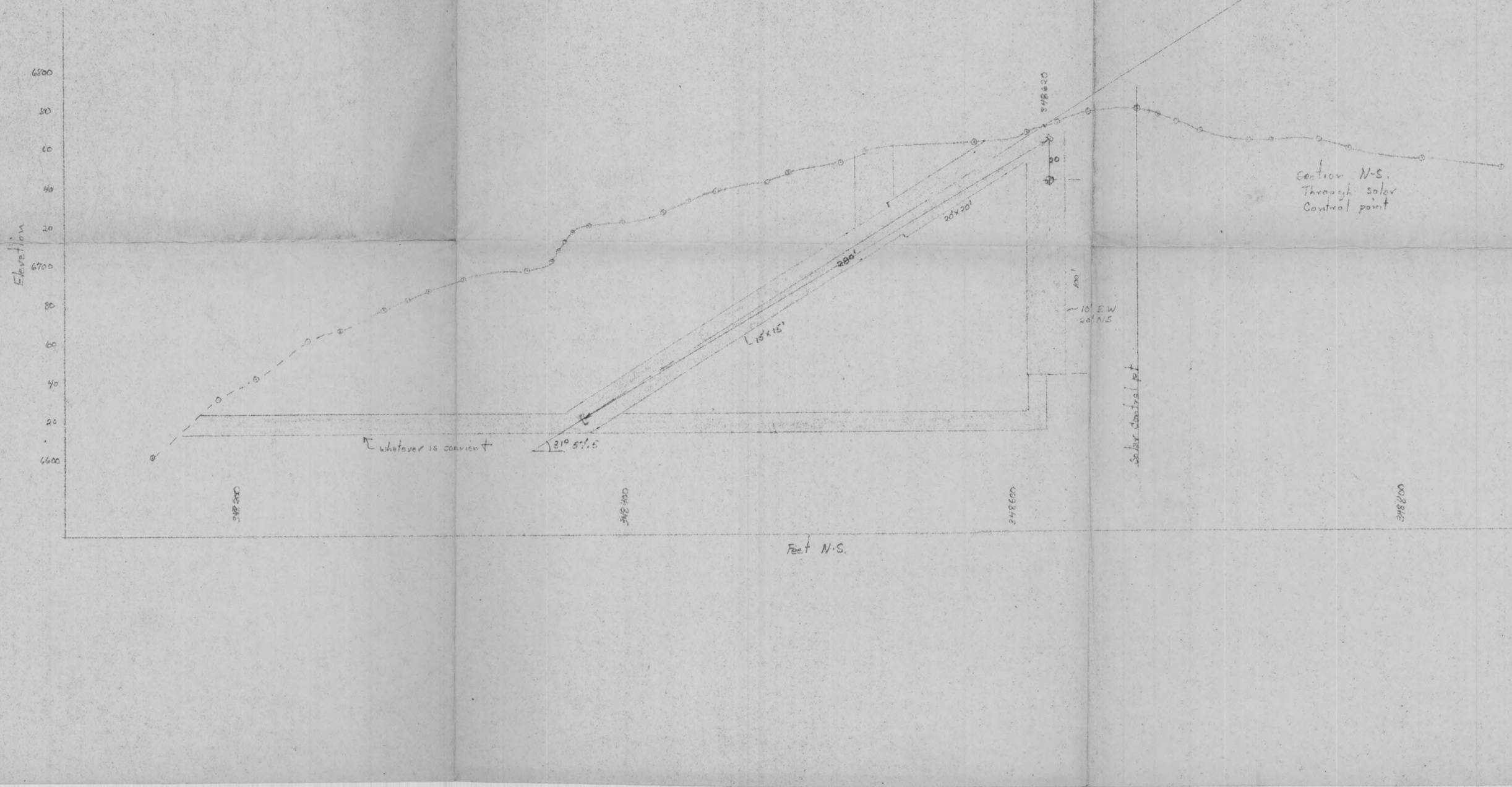
ALONG PROPOSED SOLAR TELESCOPE AXIS

All holes are on N-S line with Solar Control point, which is 85' West and 225' N of triangular micro-temperature tower.



Looking West.

Proposed Solar Site
SCALE: 1" = 40' ±



SOLAR TELESCOPE SITE

Scale 1" = 10'

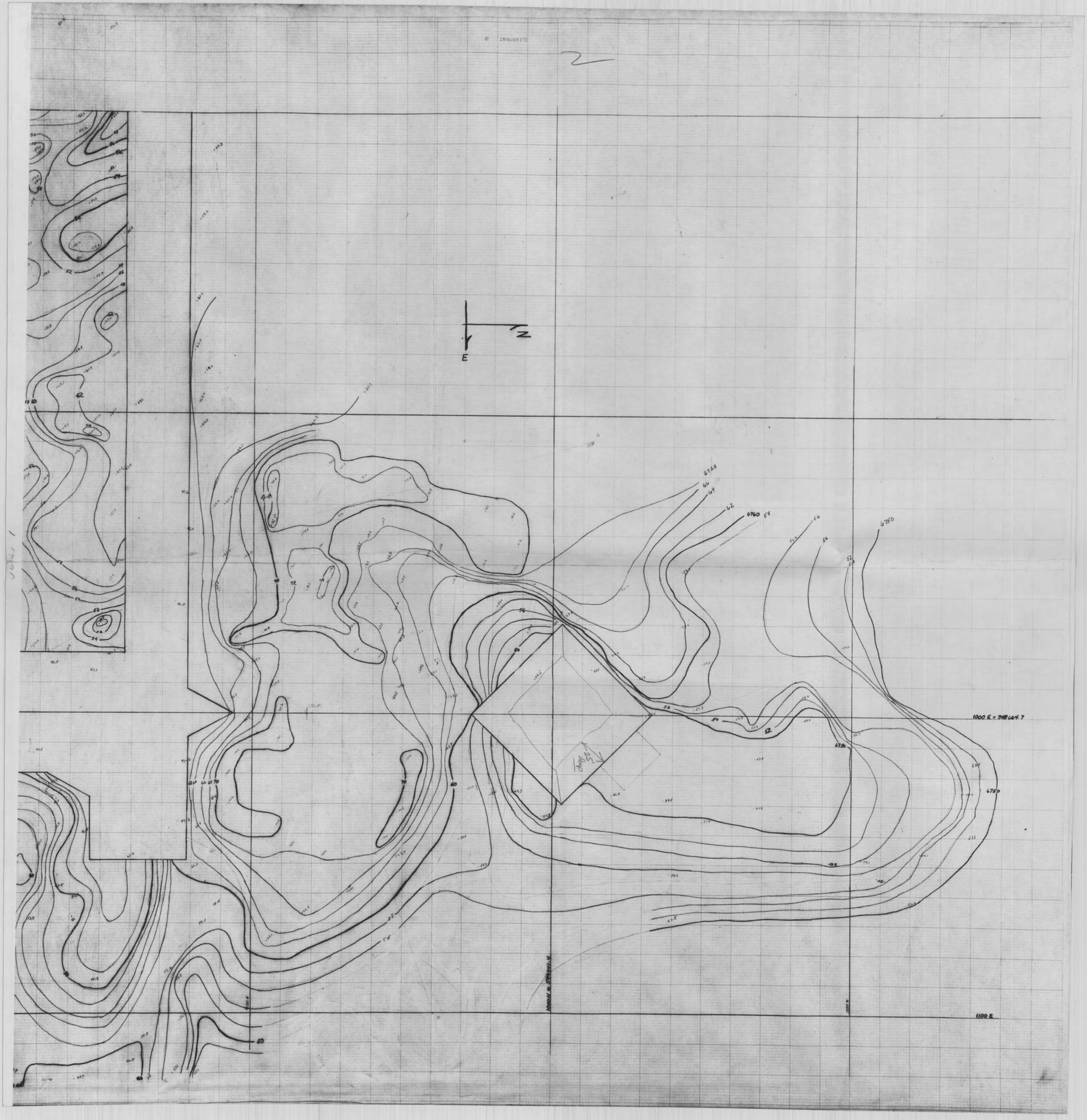
June 7, 1960

Map No. 9055 R

Co-ordinate System

S

Site Elevation Subtract 6872' from Survey Elevations



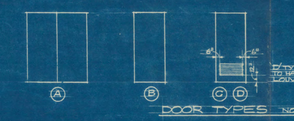
N
E
1000 E = 348664.7
1100 E
6750
6760
6768

DOOR SCHEDULE

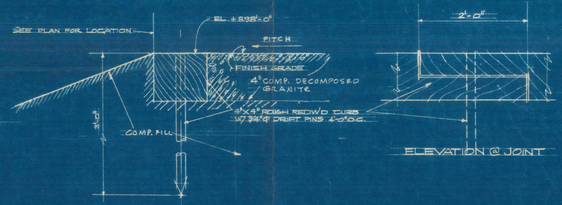
DOOR NO.	LOCATION ELEV.	LOCATION SHEET	TYPE	SIZE WIDTH	SIZE HT.	SIZE THICK.	MATERIAL DR.	MATERIAL FR.	HEAD	JAMB	JAMB	SILL	LOUVER GROSS SQ. IN.	HDW.	REMARKS
01	730'-0"	A-3	A	PAIR 2'-0"	7'-10"	1¾"	MET	MET	1	1	1	8		1	THRESHOLD *
02	SEE SEC.	A-4	E	2'-4½"	4'-4½"	1¼"	MET	MET	1	1	1	8		7	THRESHOLD
03	732'-0"	A-3	B	3'-0"	7'-0"	3⅜"	ST	ST.	A_{29}	A_{29}	A_{29}	8		6	JALOUSIE TYPE - SEE SH. A-9
04	802'-0"	A-3,4	B	3'-0½"	7'-0⅝"	1⅜"	MET	—	A_{28}	A_{28}	A_{28}	8		3	SEE SH. A-3 FOR DETAILS
05	802'-0"	A-3,4	A	PAIR 2'-10"	15'-9½"	2¼"	ST	ST.	A_{28}	A_{28}	A_{28}	8		6	SEE SH. A-8 FOR DETAILS *
06	874'-0"	A-3,4	C	2'-8"	7'-11"	1¾"	MET	MET	3	3	4	A_{29}		5	SEE DETAIL (5)
07	874'-0"	A-3,4	D	2'-8"	7'-11"	1¾"	MET	MET	3	2	3A	A_{29}		6	DOOR HEIGHT 1" LESS THAN FRAME HT.
08	874'-0"	A-3,4	D	2'-8"	7'-11"	1¾"	MET	MET	3	3A	3A	8		5	" " " " " "
09	874'-0"	A-3,4	A	PAIR 2'-0"	7'-11"	1¾"	MET	MET	3	3	3	—		8	" " " " " "
10	874'-0"	A-3,4	A	PAIR 3'-0"	7'-3"	1¾"	MET	MET	2	2	2	8		1	THRESHOLD *
11	902'-0"	A-5	B	3'-0"	7'-0"	1¾"	MET	ST.	9	9	9	8		7	THRESHOLD
12	902'-8"	A-4	B	3'-0"	7'-0"	1¾"	MET	NET	1	1	1	8		6	THRESHOLD
13	877'-6"	A-10	A	5'-4½"	7'-0"	1¾"	MET	MET	A_{17}	A_{17}	A_{17}	8	A17	1	TRANSOM HOL. MET. PANEL FIXED A_{17}

* AIRTIGHT ASTRAGAL. SEE DET. 7

(5) HARDWARE IS PART OF DOOR CONST.

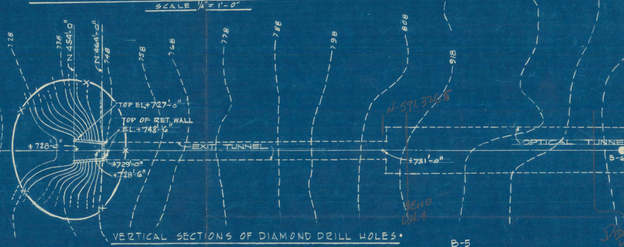


DOOR TYPES NO SCALE

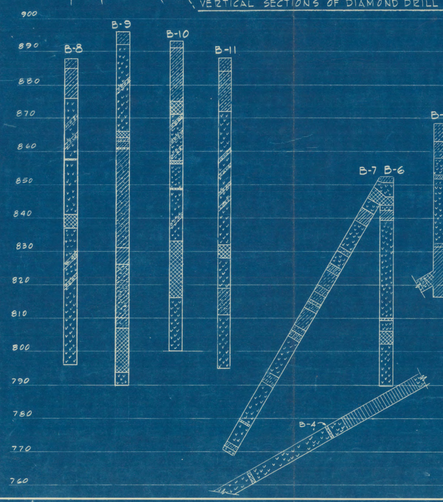


DETAIL I REDWOOD CURB
SCALE: 3"=1'-0"

TYPICAL SECTION OF PROPOSED ROAD (N.I.C)
SCALE ¼"=1'-0"



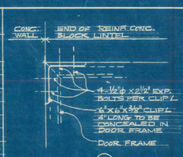
VERTICAL SECTIONS OF DIAMOND DRILL HOLES.



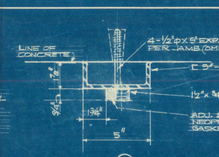
NOTES

1.- ALL GEOLOGICAL DATA SHOWN ON THIS DRAWING IS TAKEN FROM MAPS #1, 2 & 3 PREPARED BY HEINRICHS GEOEXPLORATION COMPANY, DATED MAY 4 & AUGUST 1959 & FEB. 1960.

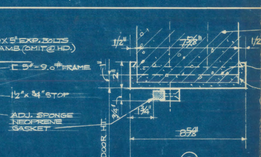
2.- CONTRACTOR TO VERIFY ALL GEOLOGICAL DATA.



(5) SUPPORT DET. END OF REINF. CONC. BLK. LINTEL AT CONC. WALL
SCALE 1½"=1'-0"



(1) JAMB & HEAD

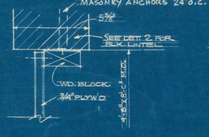

1½"
2½"
1½"
8⅝"
DOOR FRAME
(2) JAMB & HEAD

NOTE TYPICAL PRECAST CONC. BLK. LINTEL: FILL W/ CONC., USE 2 ¾ø RODS FOR C7"-9.0" OR LESS; 4 ¾ø RODS FOR C9"-5" OVER 2'-0"
LINE OF CONC. BLOCK @ HEAD
3 COURSES T' ANCHORS PER JAMB (TYPICAL)
ANCHORS FOR DET 3A
LINE OF CONC. BLK @ DETAIL 3A
DOOR FRAME
(3) JAMB & HEAD

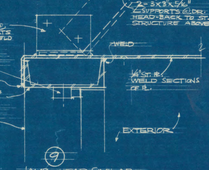
EDGE OF CONCRETE
4 - 4"ø x 2" EXP. BOLTS PER JAMB
SPACER
GROUT
REMOVABLE STOP
(4) JAMB

(7) ASTRAGAL DETAIL NO SCALE

(8) MECH. RETRACTING DOOR SEALING GASKET NO SCALE

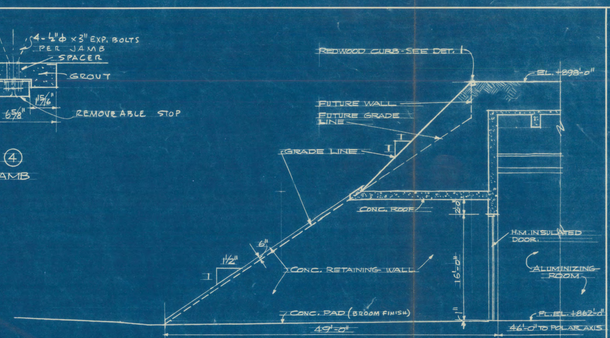


(6) JAMB, HEAD & SILL

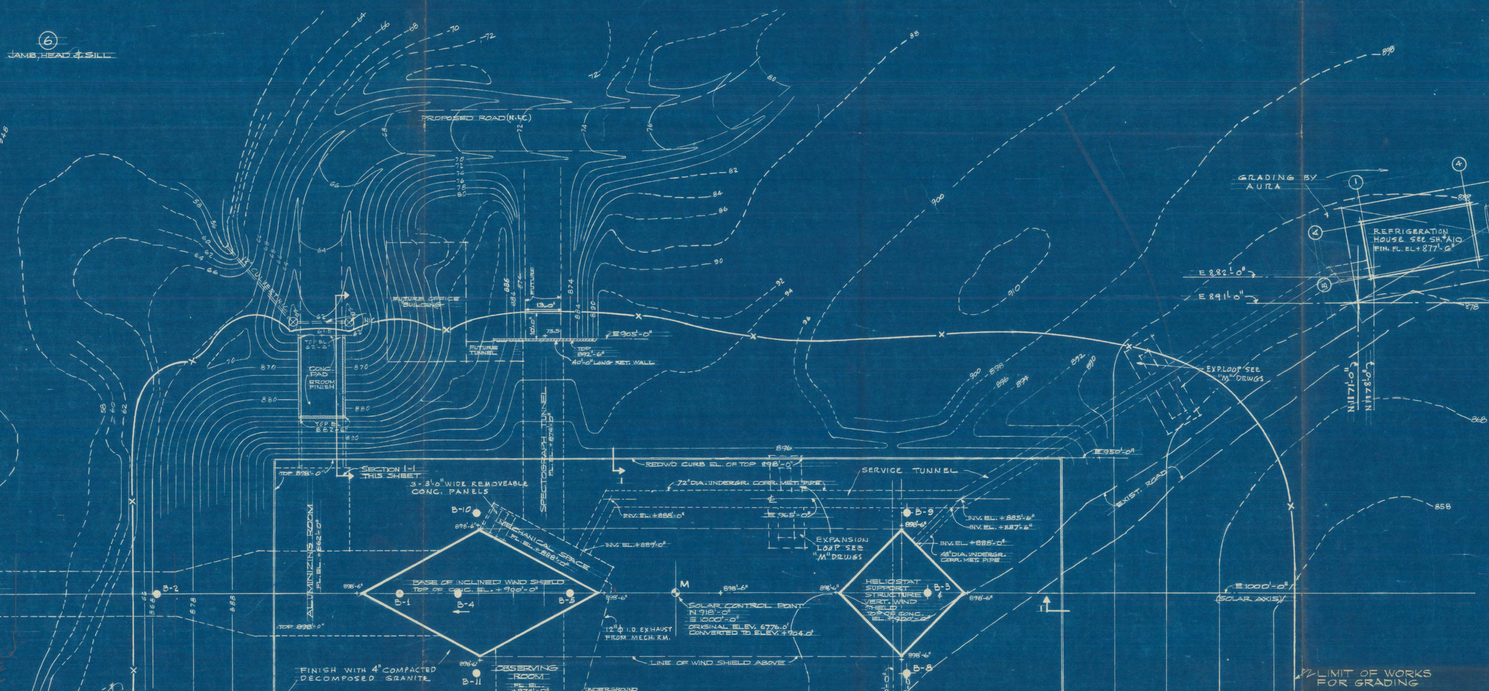


(7) JAMB - HEAD SIMILAR

DOOR DETAILS
SCALE: 3"=1'-0" UNLESS NOTED OTHERWISE



SECTION I-I
SCALE: ½"=1'-0"



SITE PLAN
SCALE: 1"=20'-0"

NOTE: LEGEND APPLIES FOR TRUE POSITION OF BORING B-4

LEGEND

- SOIL & SAND FROM VERY HIGHLY ALTERED MONZONITE - POOR OR NO CORE RECOVERY, ALSO INFERRED TALUS ON SLOPE SURFACE
- MONZONITE ALTERED TO THE POINT WHERE IT IS RECORD SOMEWHAT BY THE DRILL WATER.
- MONZONITE WITH GREATER CONCENTRATION OF BIOTITE - BREAKS MORE READILY INTO FRAGMENTS.
- MONZONITE WITH SLOTS OF DIORITIC SEGREGATION.
- FRESHEST AND LEAST ALTERED MONZONITE
- DIORITIC DIKE
- SMALL FAULTS
- SILICEOUS DIKE - APLITE OR ALASKITE.
- MONZONITE WITH LOW BIOTITE CONTENT

GENERAL NOTES

1. COORDINATE E - 598857.44' CONVERTED TO E +1000'-0"
2. COORDINATE N - 348,747.70' CONVERTED TO N +1000'-0"
3. ELEVATION 6872.0' CONVERTED TO +1000'-0"
4. TO ATTAIN CORRECT DATUM ELEV. ADD 5872 TO ELEV. NOTED.
5. CONTOURS INDICATED ARE FROM ORIGINAL TOPOGRAPHY BY PAUSE & EASTMOORE, OF AURA, INC. DATED APRIL 24 1959 AND CERTAIN EXCAVATION WORK HAS BEEN PERFORMED - VERIFY CONDITIONS

GRID NORTH

LEGEND

- RETAINING WALL
- FINISHED GRADE
- EXISTING GRADE
- UNDERGROUND BLDG. LINE

CORRECTIONS FOR BIDDING - MAY 23, 1960

REVISIONS

KEY SECTION

60 INCH SOLAR TELESCOPE

KITT PEAK, PIMA COUNTY, ARIZONA

FOR ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.

UNDER CONTRACT WITH NATIONAL SCIENCE FOUNDATION

SKIDMORE OWINGS & MERRILL
ARCHITECTS ENGINEERS
30 WEST MONROE STREET, CHICAGO
NEW YORK SAN FRANCISCO PORTLAND

SITE PLAN

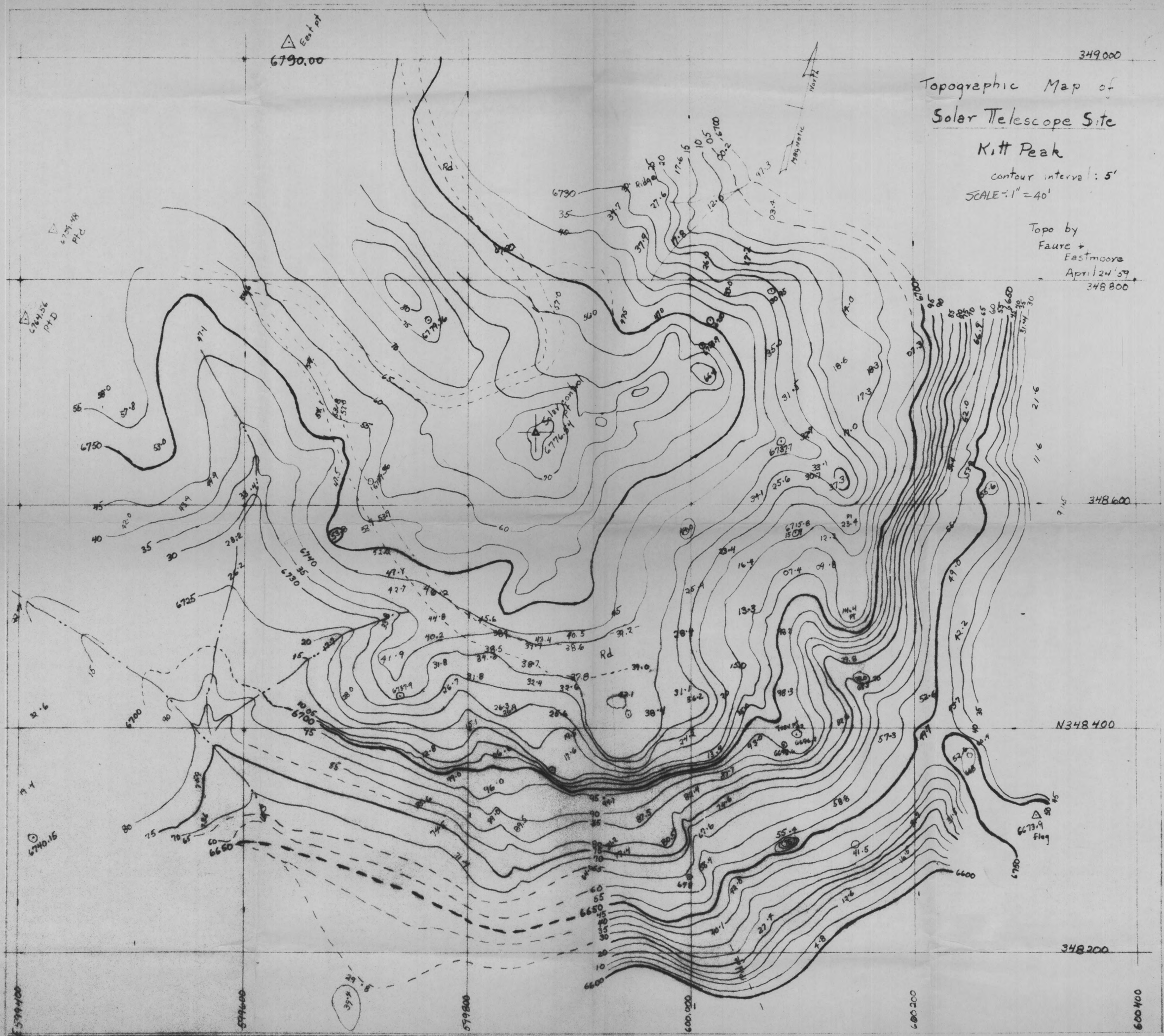
APPROVED

DRAWN	APPROVED	APPROVED	APPROVED	DRAWING NUMBER
Kitchen	K.L.A.	Skidmore	W. Merrill	A-1
CHECKED WSW	DEPT. HD.	JOB CAPT.	PROJ. MGR.	
SCALE AS NOTED	DATE MAY 2,60	JOB NUMBER 5749		

NATIONAL ASTRONOMICAL OBSERVATORY
UNIVERSITY OF MICHIGAN

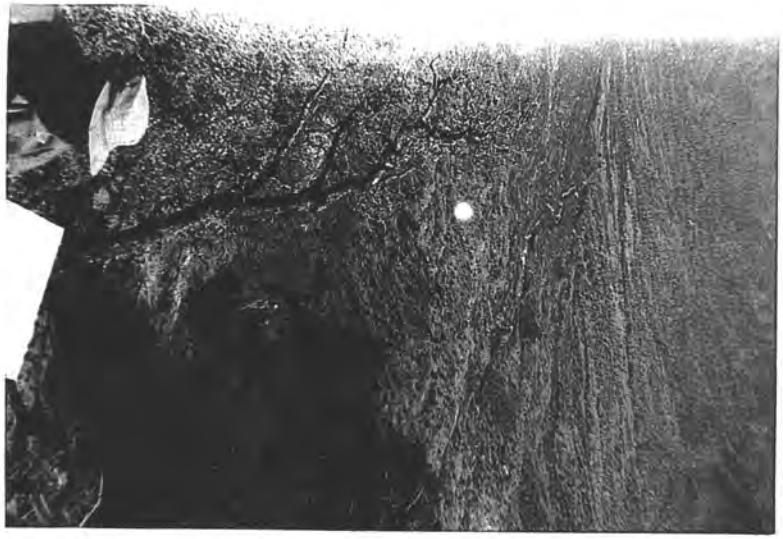
MATERIAL	TOLERANCES UNLESS NOTED:	DRAWN BY	DATE
FINISH	DECIMAL 00.00 ±.010; 00.000 ±.003; 00.0000 AS MARKED	APPROVED BY	DATE
HEAT TREAT	FRACTIONAL ± 1/8 ± 1/16 ± 1/64	SCALE	QUANTITY
NAME		PART NUMBER	

DIETZGEN 199M AGEPROOF


Topographic Map of
Solar Telescope Site
Kitt Peak
contour interval: 5'
SCALE: 1" = 40'
Topo by
Faure + Eastmoore
April 24 '59
349000
348800
348600
N348400
348200
6790.00
East pt
Magnetic North
Ridge
Rd
Solar control pt
6776.54
6673.9 Flag
6740.15
6750
6725
6700
6650
6600
599400
599600
599800
600000
600200
600400

APR • 59

APR • 59



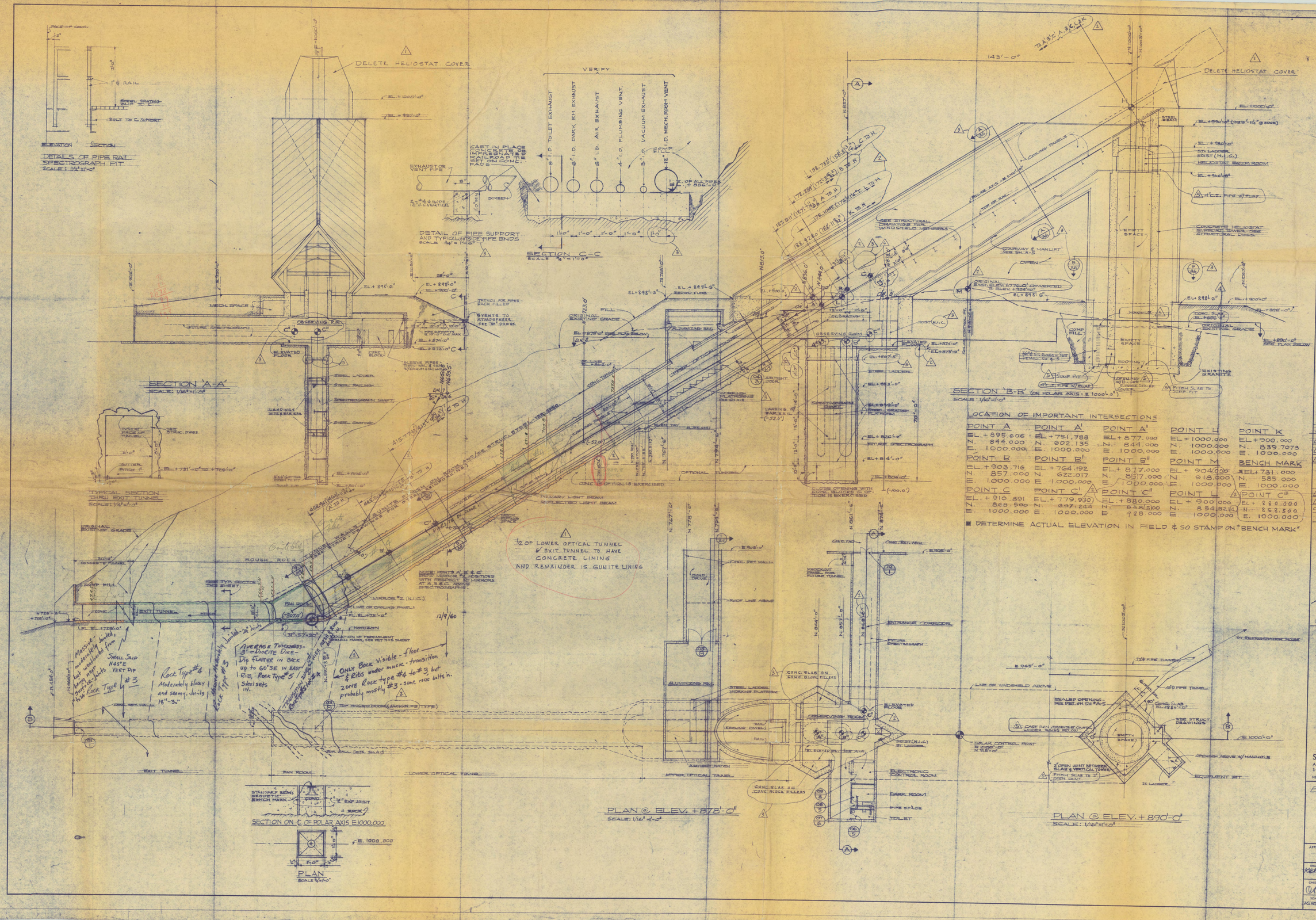
APR • 59

APR • 59

MAY • 59

MAY • 59

MAY • 59



LOCATION OF IMPORTANT INTERSECTIONS

POINT A	POINT A'	POINT A''	POINT L	POINT K
EL. + 895.606	EL. + 751.788	EL. + 877.000	EL. + 1000.000	EL. + 900.000
N. 844.000	N. 602.135	N. 844.000	N. 1000.000	N. 839.7073
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT B	**POINT B'**	**POINT B''**	**POINT M**	**BENCH MARK**
EL. + 903.716	EL. + 764.192	EL. + 877.000	EL. + 904.000	■ EL. + 731.000
N. 857.000	N. 622.017	N. 857.000	N. 918.000	N. 585.000
E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000	E. 1000.000
POINT C	**POINT C'**	**POINT C''**	**POINT L**	**POINT C'''**
EL. + 910.891	EL. + 779.930	EL. + 880.000	EL. + 900.000	EL. + 880.000
N. 868.500	N. 647.244	N. 858.500	N. 854.824	N. 868.500
E. 1000.000	E. 1000.000	E. 988.000	E. 1000.000	E. 1000.000

■ DETERMINE ACTUAL ELEVATION IN FIELD & SO STAMP ON "BENCH MARK"

NOTES:

- DOOR NUMBER / HARDWARE SET — DOOR SYMBOL
- DETAIL OR SECTION NUMBER — DETAILED ON SHEET AS NOTED ON CROSS REFERENCED SHEET

TOLERANCES:

THE ORDINATES AND ABSISSAS OF POINTS ON THE RAILS IN A LOCATION PERPENDICULAR TO THE POLAR AXIS AT POINTS H, A, B, C, A', B' & C' SHALL NOT VARY FROM DIMENSIONS SHOWN ON DRAWING BY MORE THAN ± 1/8"

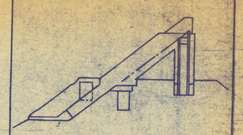
6	CHANGES	NOV. 22, 60 RFK
5	CHANGES	OCT. 7, 60 RFK
4	CHANGES	SEPT. 23-60 CAJ
3	CORRECTIONS	AUG. 29-60 CAJ

ISSUED FOR CONSTR.
AUGUST 1, 1960

2	DIMENSION CORRECTIONS 7-27-60 CAJ
1	CORRECTIONS PER ADDENDUM'S NO. 1-2-3 & 3a 6-14-60 CAJ

CORRECTIONS FOR BIDDING - MAY 23, 1960

REVISIONS



KEY SECTION

60 INCH SOLAR TELESCOPE

KITT PEAK, PIMA COUNTY, ARIZONA

FOR
ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.

UNDER CONTRACT WITH
NATIONAL SCIENCE FOUNDATION

SKIDMORE OWINGS & MERRILL
ARCHITECTS ENGINEERS
30 WEST MONROE STREET, CHICAGO
NEW YORK SAN FRANCISCO PORTLAND

ENGINEERING GEOLOGY by

SECTIONS

RECEIVED DEC 1 1960
HEINRICHS GEOEXPLORATION COMPANY
P. O. BOX 5671 TUCSON, ARIZONA

APPROVED

DRAWN	APPROVED	APPROVED	APPROVED	DRAWING NUMBER
Kehm	Rea	Seaborg	W. Hunter	A-3
CHECKED	DEPT. HD.	JOB CAPT.	PROJ. MGR.	
SCALE AS NOTED	DATE MAY 2, 60	JOB NUMBER 5749		

Kitt Peak Solar Scope To Go Underground

SOIL & SAND FROM VERY HIGHLY ALTERED MONZONITE

MONZONITE ALTERED TO THE POINT WHERE IT IS ERODED SOMEWHAT BY THE DRILL WATER

MONZONITE WITH GREATER CONCENTRATION OF BIOTITE — BREAKS MORE READILY INTO FRAGMENTS

MONZONITE WITH CLOTS OF DIORITIC SEGREGATION

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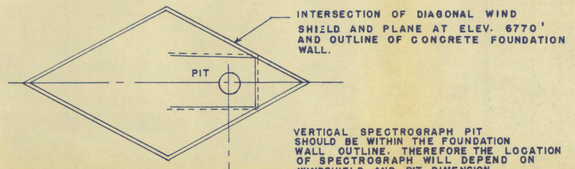

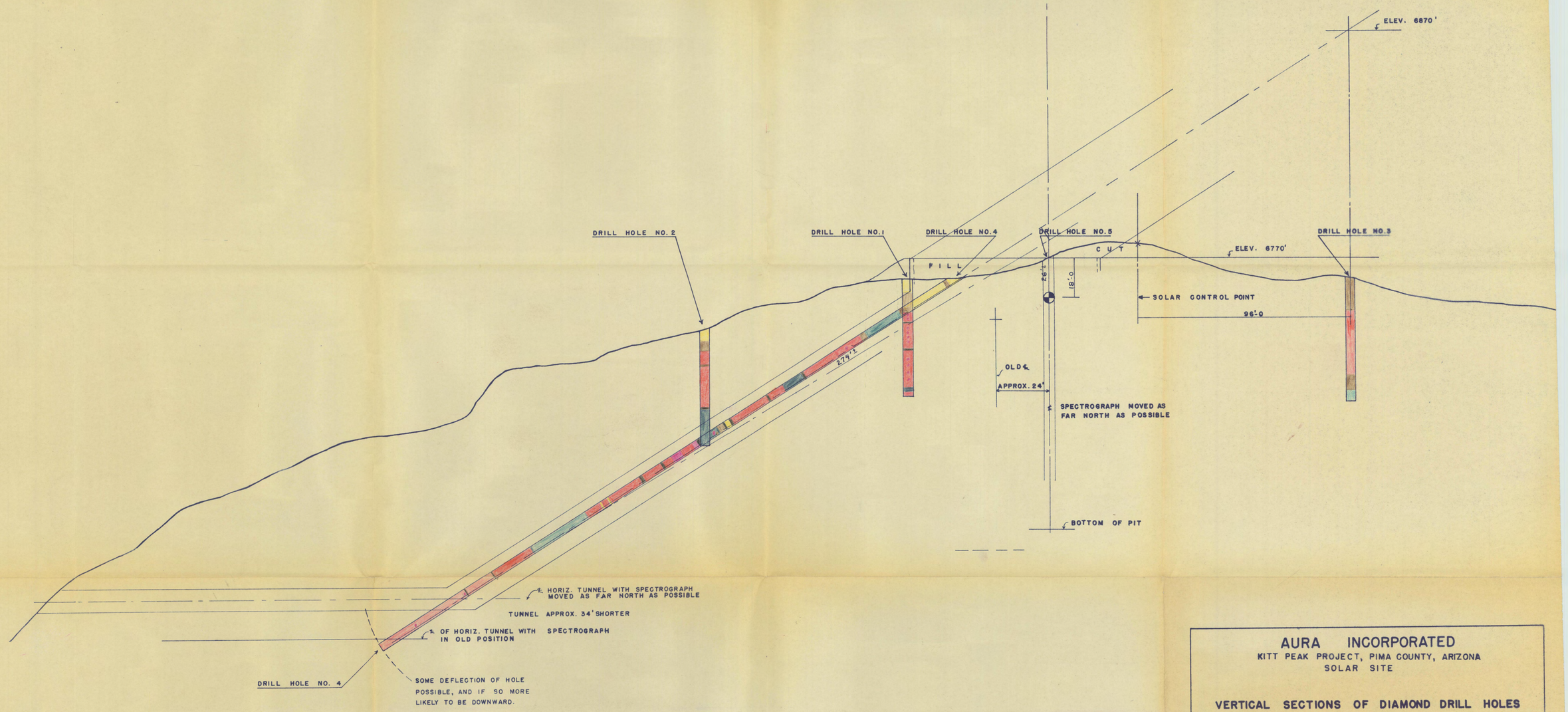

SOUTH–NORTH PROFILE LOOKING WEST

SCALE
10 0 10 20 FEET

AURA INCORPORATED

KITT PEAK PROJECT, PIMA COUNTY, ARIZONA
SOLAR SITE

VERTICAL SECTIONS OF DIAMOND DRILL HOLES

BY

HEINRICHS GEOEXPLORATION COMPANY
P.O. BOX 5671 TUCSON, ARIZONA

SEPTEMBER, 1959

PROFILE & PROPOSED ARRANGEMENT FROM SKIDMORE, OWINGS & MERRILL (SK-26 7/9/59)

BILL OF MATERIAL				
ITEM	DWG. NO.	QTY.	DESCRIPTION	WEIGHT

348,200 348,300 348,400 348,500 348,600 348,700 348,800 348,900 349,000

599,600 599,700 599,800 599,900 600,000 600,100

EAST POINT
PIN ELEV. 6730.00
N 349,013.09
E 599,640.18

B11 "X" On Rock ELEV. 6742.08

B12 "X" On Rock ELEV. 6752.86

B10 ½" I.P. ELEV. 6746.42

B9 ½" I.P. ELEV. 6738.14

B8 NOT SET

B7 NOT SET

B6 "X" On Rock ELEV. 6749.80

B5 "X" On Rock ELEV. 6739.52

B4 ½" I.P. ELEV. 6767.66

B3 "X" On Rock ELEV. 6767.21

B2 "X" On Rock ELEV. 6761.53

B1 ½" I.P. ELEV. 6761.25

B18 ½" I.P. ELEV. 6768.69

N348664.70
E599859.44
SOLAR O.P.
ELEV. 6776.54

DRILL HOLE #1
DRILL HOLE #2
DRILL HOLE #3
DRILL HOLE #4
DRILL HOLE #5
DRILL HOLE #6
DRILL HOLE #7

12' TEST TOWER

60' TEST TOWER

TOPOGRAPHIC SURVEY OF SOLAR SITE

CENTRAL AREA ON 2 Ft. CONTOUR SURVEYED AND MAPPED BY BRAATZ AND HOUSHOLDER 8-13-59.

SURROUNDING AREA FROM SURVEY BY FAURE AND EASTMOORE 4-24-59.

SCALE: 1" = 20.0'

NATIONAL ASTRONOMICAL OBSERVATORY
AURA

SOLAR TELESCOPE SITE

MATERIAL	TOLERANCES UNLESS NOTED: DECIMAL .00 ± .010, .000 ± .005, .0000 AS MARKED; FRACTIONAL ± 0 ± 1/64 ± 1/16	DRAWN BY Ken Kirk	DATE 1/11/60
FINISH		APPROVED BY	DATE
HEAT TREAT		SCALE 1" = 20.0'	QUANTITY
NAME Topographic Survey		PART NUMBER 9055	

NO.	REVISION	DATE	BY

DIETZGEN POST CLEARPRINT 10001