DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

CATALOG OF ALINEMENT ARRAY MEASUREMENTS IN CENTRAL AND SOUTHERN CALIFORNIA FROM 1983 THROUGH 1986

by

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U.S. Geological Survey

Menlo Park, California 94025

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INTRODUCTION

The U.S. Geological Survey (USGS) is engaged in a program to monitor fault creep in California. As a part of this effort, frequent measurements of special survey lines called alinement arrays are made using a Wild T-3 precision theodolite with Wild precision traverse targets, in a fashion similar to traversing but using a methodology developed at the USGS.

Currently 37 alinement arrays along 5 active faults in California are being surveyed (Table 1, Figures 1 a, b, c). Each array consists of from 5 to 35 survey monuments placed at intervals in a line across an active fault. The lines range in length from 30 to 300 meters, and wing, or orientation, stations are used for control (Figure 2). The theodolite is centered and leveled over a fixed point designated the "instrument station" (IS) on one side of the fault. Traverse targets are centered and leveled over two fixed points: an orientation station (OS) on the same side of the fault as the IS, and an end station (ES), the last monument in line on the opposite side of the fault. These stations are emplaced such that the IS to ES line is as close to perpendicular to the fault trend as local topography will allow. On some arrays there will be more than one OS and/or an additional ES. Occasionally, when it is impractical to use an OS or ES that can be occupied with a traverse target, a distant cultural feature such as a powerline structure on the same side of the fault as the IS is used. Fault slip is determined by the formula

$$s = d \tan \Delta / h$$

where s is slip, Δ is change in angle ϕ (angle between original IS-ES azimuth and the IS-ES azimuth at some later time), d is distance from theodolite to the end station target (ES), and h is the correction factor (cosine of the angle between the IS to ES azimuth and a line perpendicular to the fault azimuth). Distribution of movement within the fault zone is further defined by using a specially fabricated target and tripod to measure deflection values at monuments along the line between the IS and ES. The measurements presented herein were collected using surveying procedures described by Burford and Harsh (1980), with additional techniques from Galehouse and others (1982).

ANGLE MEASUREMENT PROCEDURE

In the following descriptions the "Party Chief" is the person operating the theodolite. "Assistant" refers to the person operating the targets.

The Party Chief and one assistant occupy the alinement array site and set up the theodolite by centering and leveling over an instrument monument (IS). The theodolite is enclosed in a special tent for protection from the elements. Traverse targets are centered and leveled over their respective orientation and end station monuments (OS and ES). Initial placement of targets is such that optical plummets of each target and one leg of each tripod face toward instrument station. Initial placement of the T-3 is such that the optical plummet and one tripod leg face toward the ES1. This aids in standardization.

The Party Chief begins Round 1 of measurements by placing the theodolite in a face-left orientation and focussing the telescope on the end station (ES1) target across the fault. The micrometer knob is turned until the micrometer reading against the index is 30". The cover of the circle setting drive knob is opened and circle is turned to 0°0'. The cover is then closed

to prevent any accidental movement of the circle. The starting value is now 0°0'30". The pointing is carefully checked before reading the micrometer scale to the nearest 0.1". The assistant records this pointing value on the data sheet. The alidade is turned clockwise to sight on Orientation Station 1 (OS1). This is done by loosening the horizontal clamp, sighting on OS1, retightening the clamp and using the horizontal drive to complete fine tuning. The circle reading is recorded. The second End Station (ES) and remaining Orientation Stations (OS), if any, are observed in the same manner and, finally, the ES1 and OS1 are re-observed for closure values. After each pointing the micrometer is read to within the nearest 0.1" and these values are recorded. If the second reading on the ES1 differs by more than 3" from the first reading, the entire procedure is repeated until the closure value is 3" or less. The Party Chief reads the first OS target a second time similar to the ES1 procedure, and a closure of 3" must also be achieved before going on to next round. This eliminates any significant OS reading errors. All rounds are recorded on the data sheet, including any rounds repeated due to non-closure on the ES1 or OS1. The angle between the initial ES1 and OS1 pointings and second ES1 and OS1 readings are calculated, thereby providing two of the twelve angles used in calculating the average angle for this measurement day.

After completion of Round 1, Party Chief begins Round 2 by plunging the theodolite telescope over into the reversed position (face-right), and following the same reading procedure as Round 1, except that the theodolite is rotated counterclockwise between readings. After completion of Round 2, measurements are made to each deflection monument (if any). Normally, there will be anywhere from 3 to 35 deflection monuments in an array. After completion of deflection measurements, the theodolite and each of the ES and OS

targets are rotated 120° in a clockwise manner upon their respective tripods. The theodolite and targets are again leveled and centered over their respective stations. The 120° rotation reduces any instrumental errors that could occur due to slight eccentricity in the optical plummets or misadjustments of the levels. Rounds 3 and 4 are completed, using the same procedure as for Rounds 1 and 2, and deflection measurements are repeated. After completion of the second set of deflection measurements, theodolite and targets are again rotated 120° clockwise. The theodolite and targets are again leveled and centered, pointings read, and the third and final set of deflection measurements made for Rounds 5 and 6. This completes measurements at an array for a single day. The results are 6 rounds comprised of 12 IS to ES pointings and 12 IS to OS pointings, resulting in 12 ES1-OS1 angle measurements which are averaged (mean is determined). In addition, the 3 sets of deflection monument measurements are averaged to produce plots showing the pattern of fault zone movement over time. These plots are essential in the accurate placement of fault-crossing instruments such as creepmeters.

DATA PROCESSING

Alinement array data are processed on the VAX 785 computer at Menlo Park, using a programs written by Gerald R. Mavko and Sandra Schulz, substantially modified by F. Brett Baker. The program output is used by a program written by Baker that produces Versatek plots of movement over time at the arrays.

RESOLUTION

The resolution of alinement array measurements is dependent in part on line of sight between the instrument and targets, and thus temperature fluctuations produced by clouds, wind, and topography affect survey results.

Resolution is also affected by length of array. Surveys of a shorter array (<80 m) contain larger standard deviations because targets appear larger, making judgment of exact crosshair center more difficult. Longer arrays (>160 m) are affected more intensely by heat waves, and errors in judgment of target center occur because the target appears much smaller through the T-3 telescope.

The T-3 can be read to ±0.1 second, which would produce an error of ±0.05 mm on a 100-meter array. In practice, resolution of this nature is impossible. Measurements presented in this report have a range of standard deviations of the mean of ±0.21 to ±1.45 seconds. The mean array length is 108.64 meters, giving a ±0.11 to ±0.76 mm resolution for the measurements.

Procedures to increase resolution include surveying in early morning or late evening to avoid midday heat, protecting the T-3 with a tent, requiring 3.0-second repeatability within a round, surveying only when temperatures are within the range of 30° to 100°F, and repeating the IS-OS angle measurement at the end of each round to provide 12 angles for the mean angle used to calculate movements between surveys. Also, as mentioned in the section on field procedure, any misadjustment of or eccentricity in the opitcal plummets that could affect resolution is effectively cancelled out by rotating the T-3 and all targets 120° on their tripods after rounds 2 and 4.

CATALOG FORMAT

Array data herein are arranged roughly north to south according to fault as follows: Hayward, Calaveras, Paicines, San Andreas, Nunez, and Imperial. For each array with more than one survey, the following are presented:

1. Site description with map, including directions for reaching site and locating all monuments.

2. Site layout diagram, showing spacing between monuments and local landmarks to help in recovering buried monuments.
3. Table of cumulative slip (after application of correction factor h) between the IS and ES, with an entry at the time of each survey.
4. Plot of cumulative movement of deflection monuments between the original and the most recent survey, expressed in mm on the horizontal axis. The vertical axis represents location of the monument along the line in meters from the IS. Unless otherwise noted, the IS is the bottommost monument and the ES is the topmost monument. The straight plot line on the left of the page represents monument alinement at the original survey; the plot line on the right represents alinement at the time of the most recent survey. Survey dates are given by year, month, and day, i.e., 860616 = June 16, 1986.

NOTE: Sites were originally designated with a 4 as the last part of their code, i.e., XUB4. Sites that have had enough change in their geometry that they are essentially "new" arrays show a number higher than 4. For example, RCW6 has had 2 substantial changes in site geometry due to relocation of an end or orientation station.

ACKNOWLEDGEMENTS

Collection and interpretation of the data would not have been possible without the continued patience and cooperation of the landowners, ranchers, and civic officials on whose property the survey lines are located, and we offer them our kindest thanks.

We particularly wish to express our appreciation to Richard Liechti for his cheerful help and his skill with the drill rig during installation of many of the Parkfield arrays. We also wish to thank Ronald Jenkins, without whose assistance much of the early data collection would not have been possible. We also thank Kay L. Schulz, our volunteer surveying assistant.

Special gratitude is due Beth D. Brown, who organized the current Alinement Array project during 1982-83, set up the field routines, and supervised all aspects of data collection (including performing the surveying), until her departure in 1985. Her skill in organization and record-keeping provided the foundation for this catalog.

REFERENCES

Burford, R.O., and Harsh, P.W., 1980, Slip on the San Andreas fault in central California from alinement array surveys: Bulletin of the Seismological Society of America, v. 70, no. 4, p. 1233-1261.

Galehouse, Jon S., Brown, Beth D., Pierce, Brian, and Thordsen, James J., 1982, Changes in movement rates on certain East Bay faults, in Proceedings Conference on Earthquake Hazards in the Eastern San Francisco Bay Area: California Division of Mines and Geology Special Publication 62.

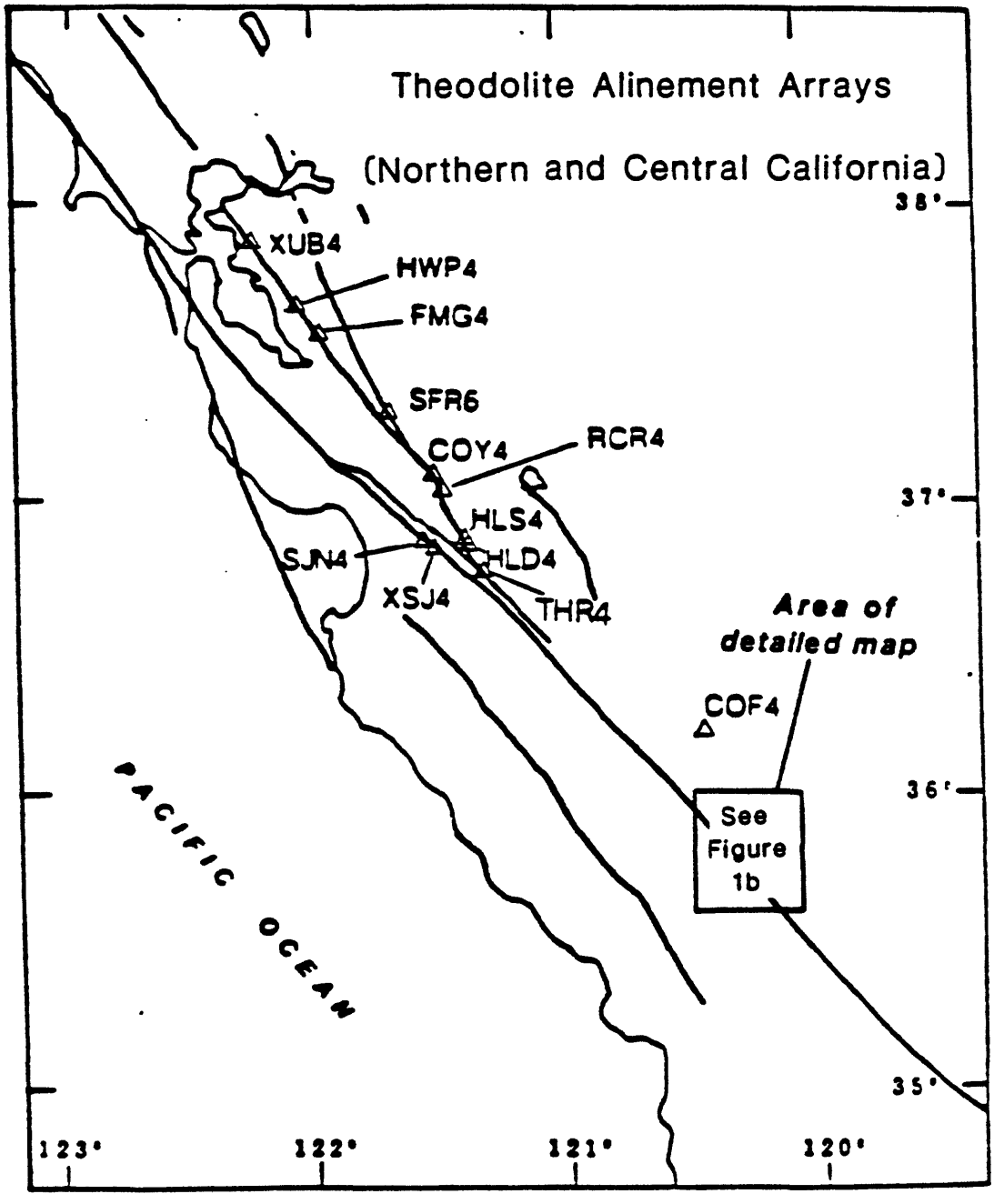

Theodolite Alinement Arrays
(Northern and Central California)
XUB4
HWP4
FMG4
SFR6
COY4
RCR4
HLS4
HLD4
SJN4
XSJ4
THR4
COF4
Area of detailed map
See Figure 1b
PACIFIC OCEAN
38°
37°
36°
35°
123°
122°
121°
120°

Figure 1a

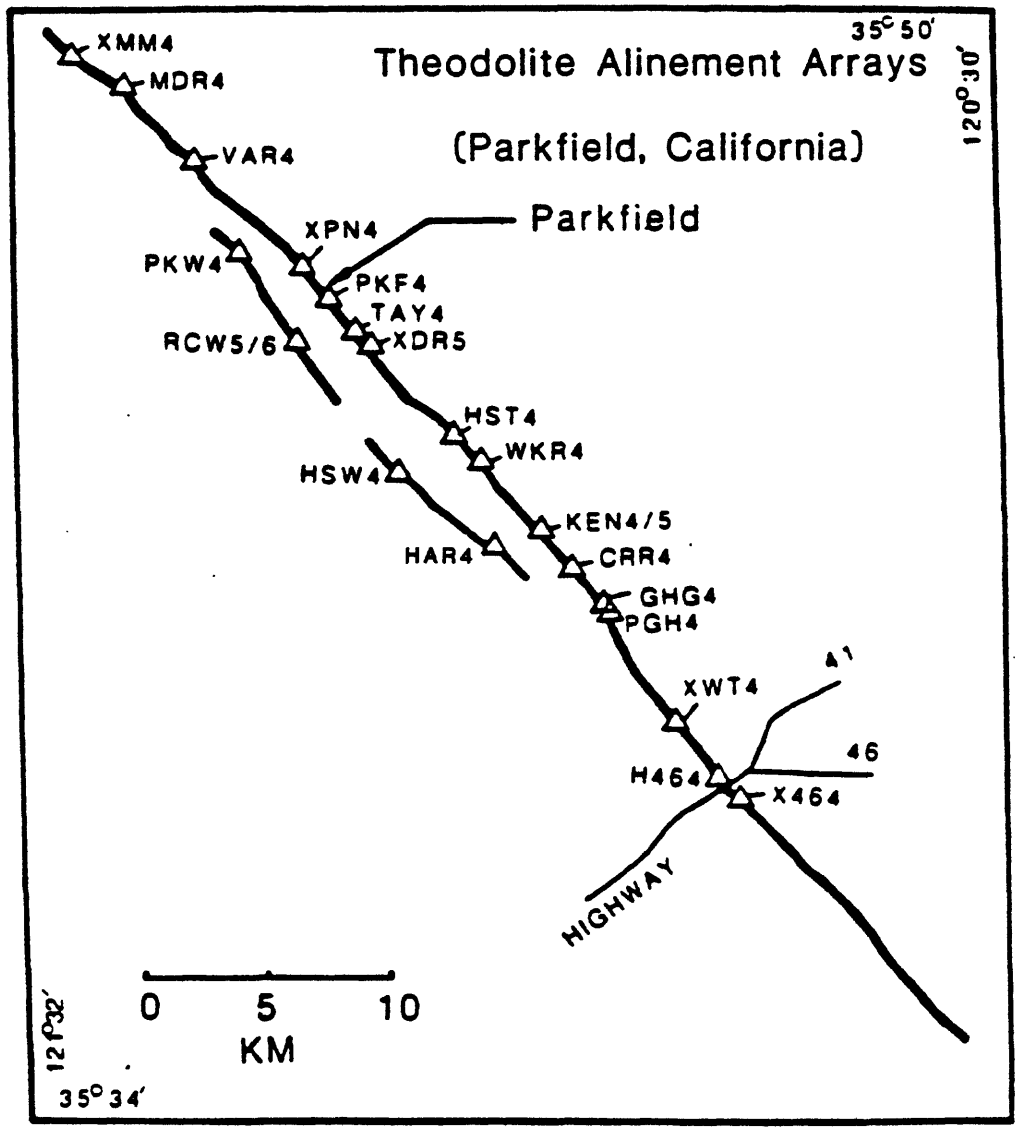

Theodolite Alinement Arrays
(Parkfield, California)
Parkfield
35°50'
120°30'
XMM4
MDR4
VAR4
XPN4
PKW4
PKF4
TAY4
XDR5
RCW5/6
HST4
WKR4
HSW4
KEN4/5
HAR4
CRR4
GHG4
PGH4
XWT4
41
46
H464
X464
HIGHWAY
0 5 10
KM
120°32'
35°34'

Figure 1b

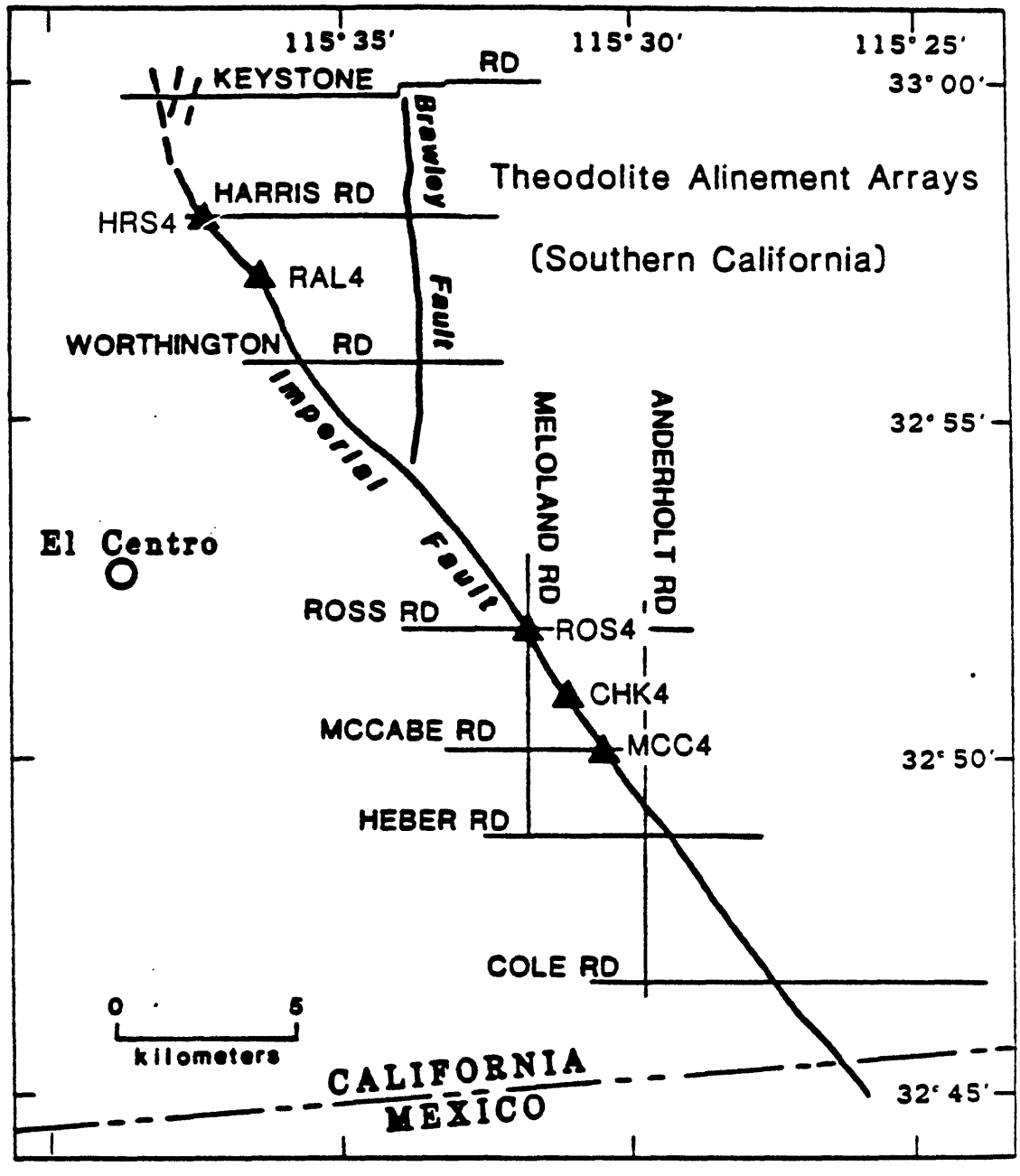

115° 35'
115° 30'
115° 25'
33° 00'
KEYSTONE
RD
Brawley
Fault
Theodolite Alinement Arrays
(Southern California)
HARRIS RD
HRS4
RAL4
WORTHINGTON
RD
Imperial
Fault
MELOLAND RD
ANDERHOLT RD
32° 55'
El Centro
ROSS RD
ROS4
CHK4
MCCABE RD
MCC4
32° 50'
HEBER RD
COLE RD
0
5
kilometers
CALIFORNIA
MEXICO
32° 45'

Figure 1c

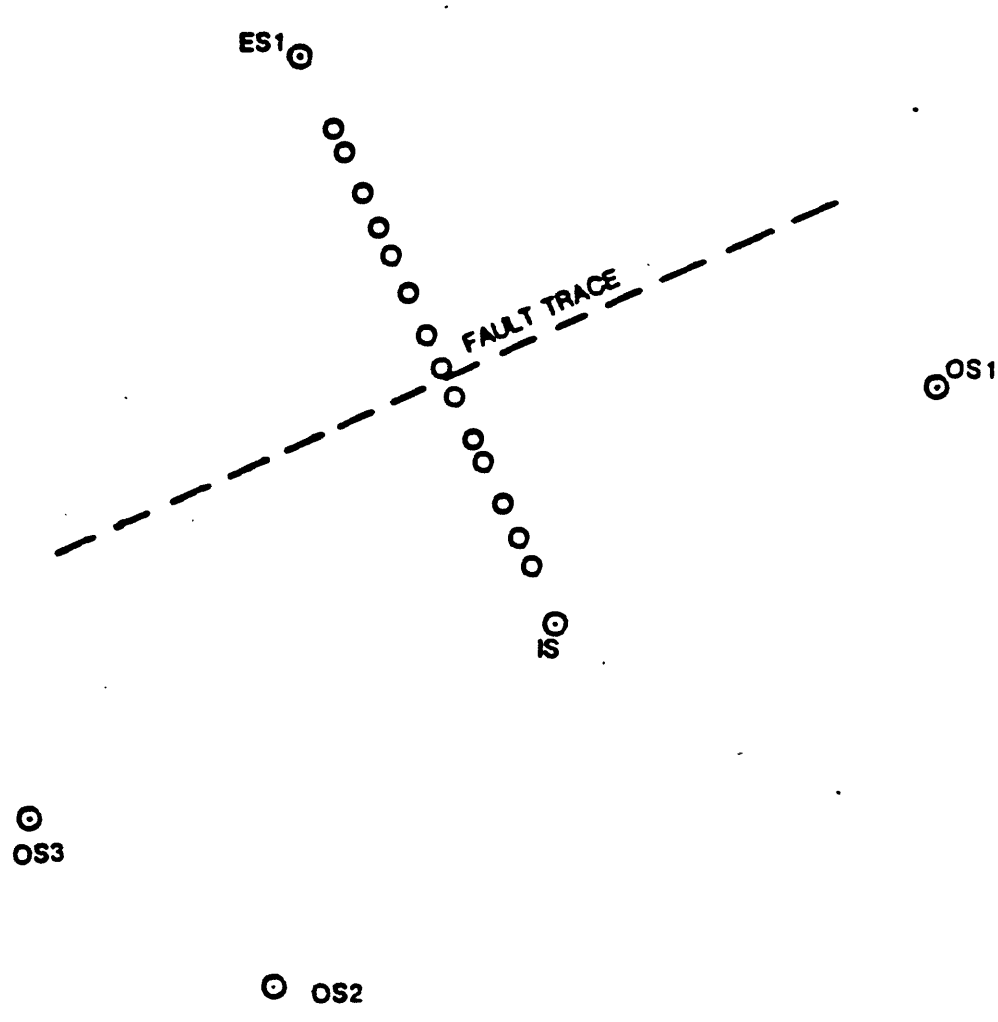


Figure 2. Typical alinement array configuration

Site Code	Site Name	Lat.	Long.	Date First Survey	Date Current Survey	Cumulative Movement mm
Hayward Fault						
XUB4	U.C. Berkeley	37°52.4	122°15.1	830927	860616	4.77
HWP4	Hayward Palisade	37°39.8	122° 4.5	830717	860620	2.53
FMG4	Fremont Gilbert	37°34.0	121°58.9	831004	860620	14.58
Calaveras Fault						
SFR6	San Felipe Ranch	37°16.8	121°40.9	690729	860605	-15.91
COY4	Coyote Reservoir	37° 4.1	121°31.4	680503	860703	323.16
RCR4	Ruby Canyon Road	37° 2.9	121°30.6	840720	860801	59.84
HLS4	Hollister 7th St.	36°51.1	121°24.2	841212	860804	18.89
HLD4	Hollister D St.	36°50.5	121°24.2	831129	860807	22.01
Paicines Fault						
THR4	Thomas Road	36°45.7	121°19.4	730411*	860702	80.51
San Andreas Fault						
SJN4	Nyland Road	36°51.3	121°32.7	840816*	860806	10.93
XSJ4	San Juan Bautista	36°50.2	121°31.2	830923	860805	17.29
XMM4	Middle Mountain	35°57.5	120°30.1	840429*	860918	47.55
MDR4	Middle Ridge	35°56.6	120°29.1	860610*	861217	3.73
VAR4	Varian Ranch	35°55.3	120°27.7	860515	861212	10.69
PKW4	Parkfield Kester	35°54.4	120°27.6	850207	861212	4.56
XPN4	Parkfield North	35°54.0	120°26.5	841227*	861105	18.41
PKF4	Parkfield Bridge	35°53.7	120°26.0	830519	861017	26.99
RCW6	Ranchita Canyon Rd	35°53.1	120°26.5	850730	861010	13.66
TAY4	Taylor Ranch	35°53.4	120°25.6	840828	861031	22.23
XDR5	Durham Ranch	35°53.1	120°25.3	840607	861018	29.07
HST4	Hearst North	35°52.4	120°24.1	861122*		
HSW4	Hearst Southwest	35°51.8	120°25.3	861110*		
WKR4	Work Ranch	35°51.6	120°23.8	840606*	861003	18.47
KEN4/5	Kennedy Ranch	35°50.7	120°22.6	861120*	861210	0.45
HAR4	Harlan Ranch	35°50.4	120°22.9	861124*		
CRR4	Carr Ranch	35°50.1	120°21.8	840105*	860814	7.15
GHG4	Gold Hill Gilman	35°49.2	120°21.0	830823*	861113	4.69
PGH4	Gold Hill	35°49.2	120°21.0	831108	861016	14.81
XWT4	Water Tank	35°45.4	120°18.4	840511	861105	- 1.21
H464	Highway 46	35°44.1	120°17.2	830824*	860127	1.24
X464	Highway 46 South	35°43.3	120°16.7	860612*	861016	1.78
Nunez Fault						
COF4	Coalinga Floodplain	36°12.6	120°27.4	830810*	850807	10.94
Imperial Fault						
HRS4	Harris Road	32°53.0	115°32.5	850106	860219	4.00
RAL4	Ralph Road	32°52.2	115°31.4	850108	860219	1.73
ROS4	Ross Road	32°46.9	115°26.8	840112	860220	33.02
CHK4	Chick Road	32°46.0	115°26.3	840105	860218	17.78
MCC4	McCabe Road	32°45.1	115°25.5	840111	860220	34.41

*also date of installation

NOTE: Alinement Array sites are originally designated with a 4 as the last number of their code. Sites that have had some change in their layout are recognized by an increase in this last number; an example is RCW6, which has been changed twice.

Alinement Array sites measured with an Electronic Distance Measurer (EDM-Nikkon NTD-2) are indicated on site layout maps by measurements with 3 decimal (1 mm) precision.

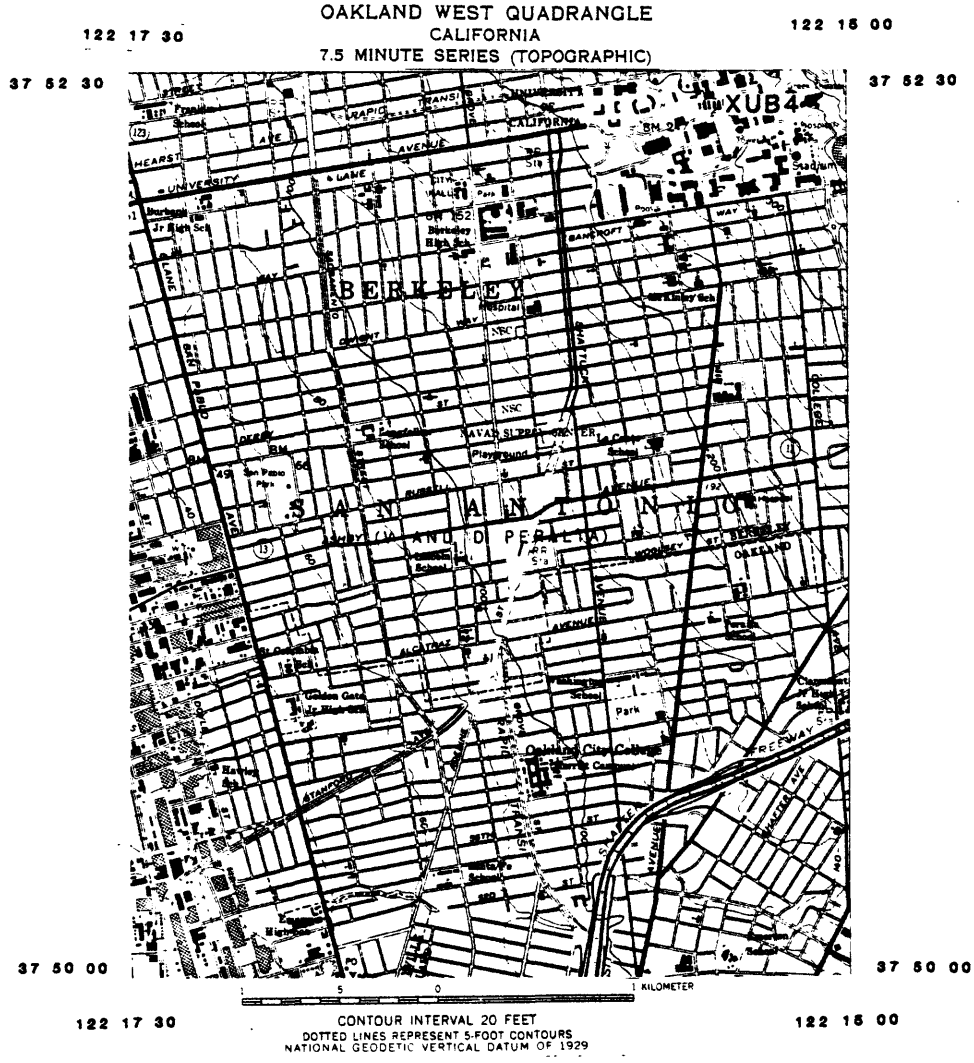
SITE DESCRIPTION

STATION CODE XUB4 NAME BERKELEY COUNTY ALAMEDA

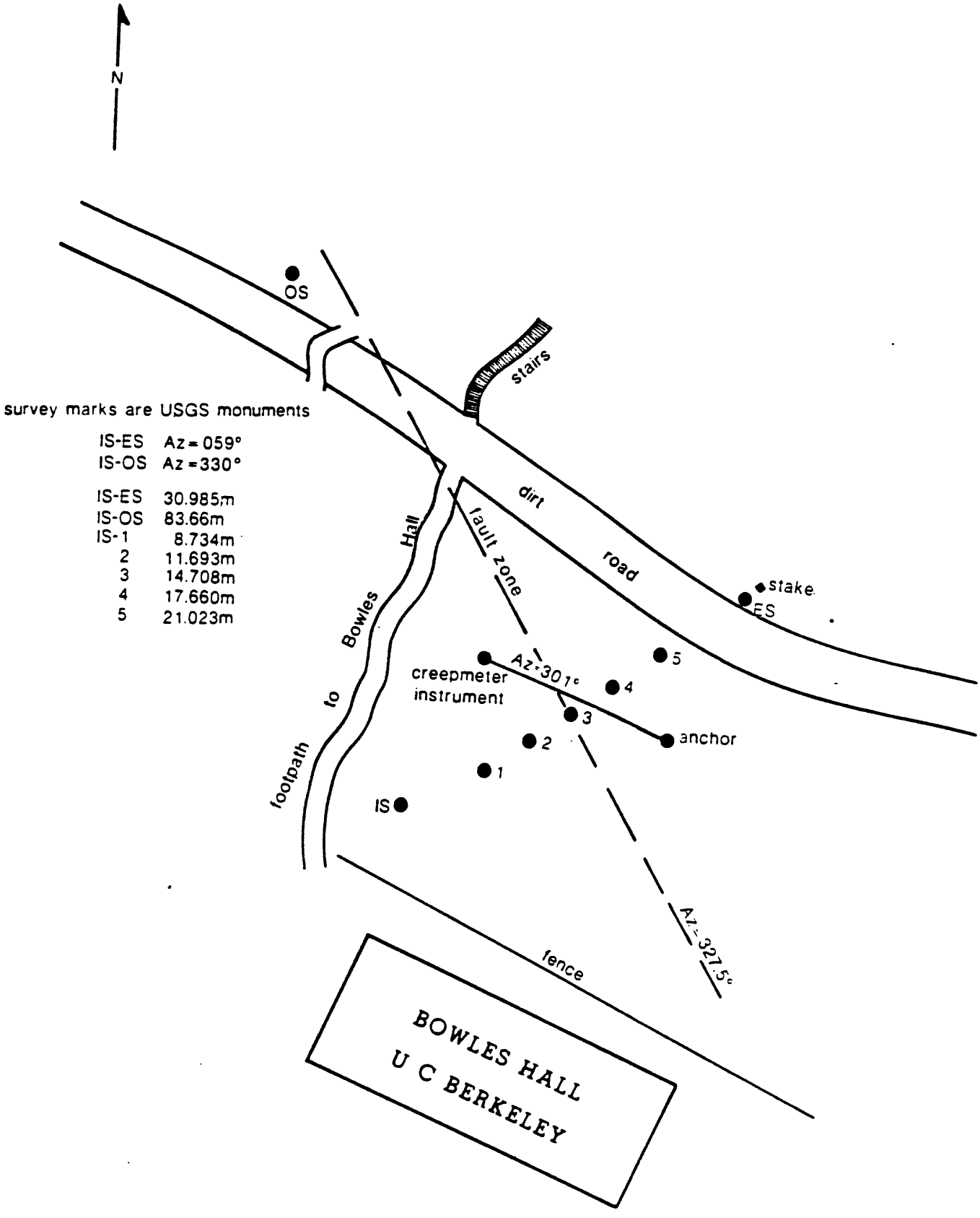
QUAD OAKLAND WEST 7.5' LATITUDE 37°52.4' LONGITUDE 122°15.1'

TO REACH: Turn east onto University Avenue from Interstate 80, then north on Oxford Street, then east on Hearst Avenue. Pass Highland Place on the north and a parking lot on the south. Take first right (a fire trail) east of parking lot. Alinement array crosses trail approximately 30 meters past pedestrian stairway behind Greek Theatre.

GENERAL DESCRIPTION: The array crosses between creepmeter vaults. IS is to west and ES is approximately one meter east of trail. OS is on east side of trail and north of stairway. Stations are subsurface monuments within p.v.c. pipes. Monuments were installed by USGS in 1983.



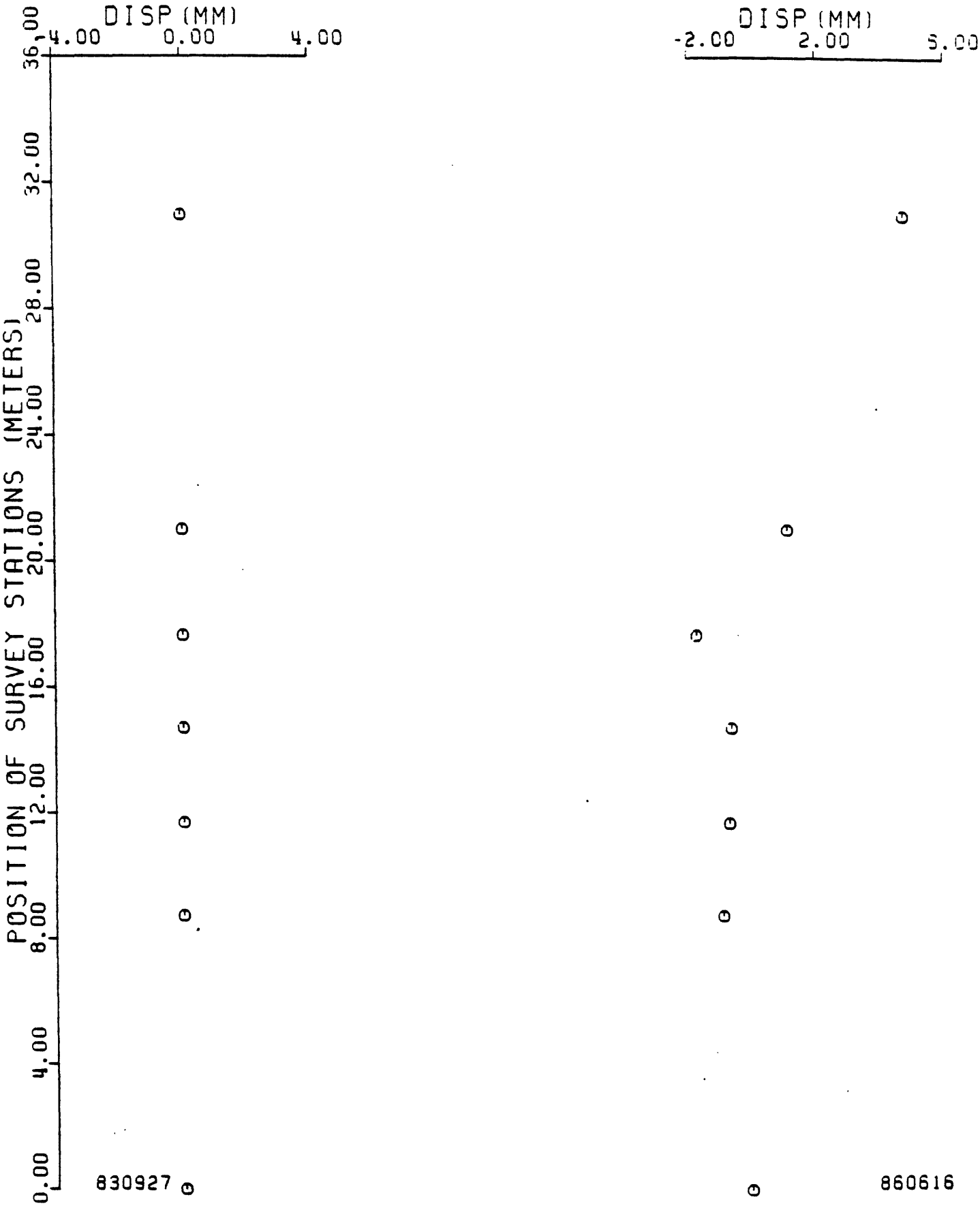
USGS : UC BERKELEY ALINEMENT ARRAY
(XUB4) installed 3/10/83



XUB4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 1.5°	
Sep 27	0.00	30.99	0.9996	0.00
1984				
Apr 6	3.60			3.60
1985				
Jan 14	0.87			4.47
Jul 17	0.08			4.55
1986				
Jun 16	0.22			4.77

XUB4 SURVEY LINE



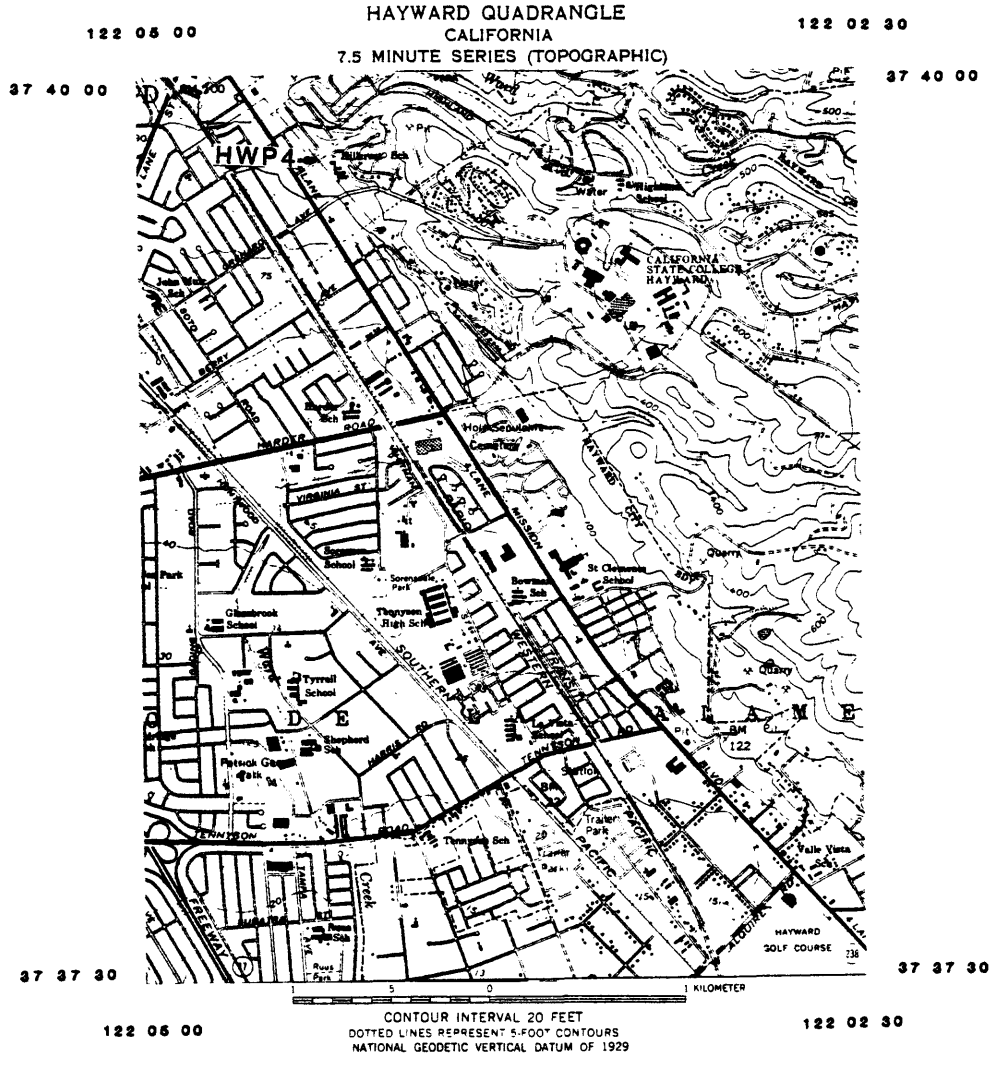
SITE DESCRIPTION

STATION CODE HWP4 NAME HAYWARD PALISADE COUNTY ALAMEDA

QUAD HAYWARD 7.5' LATITUDE 37°39.8' LONGITUDE 122°04.5'

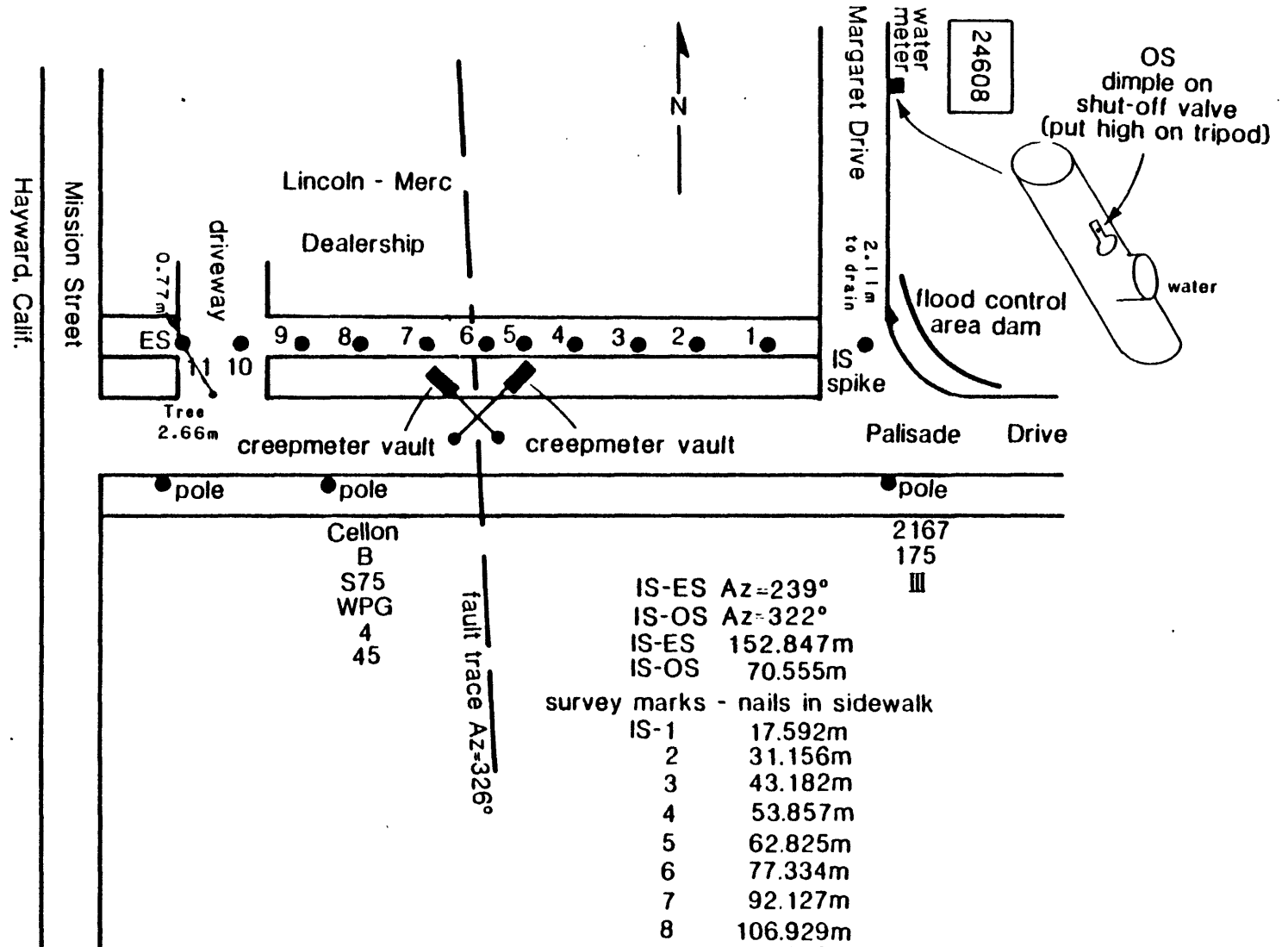
TO REACH: Proceed 3.5 blocks south on Mission Blvd. from intersection with Jackson Street near downtown Hayward. Turn east onto Palisade Drive. ES is on northeast corner of intersection of Mission and Palisade. IS is in intersection of Palisade and Margaret Drive near northeast corner of curb. OS is on east sidewalk of Margaret Drive.

GENERAL DESCRIPTION: IS is a spike in line with sidewalk north of Palisade Drive. OS is a dimple on shut off valve on water meter in front of 24608 Margaret Drive. ES and deflection stations are nails in sidewalk next to Lincoln-Mercury dealership. Monuments were installed by City of Hayward (date unknown).



USGS: HAYWARD-PALISADE STREET ALINEMENT ARRAY

HWP5 2/11/83

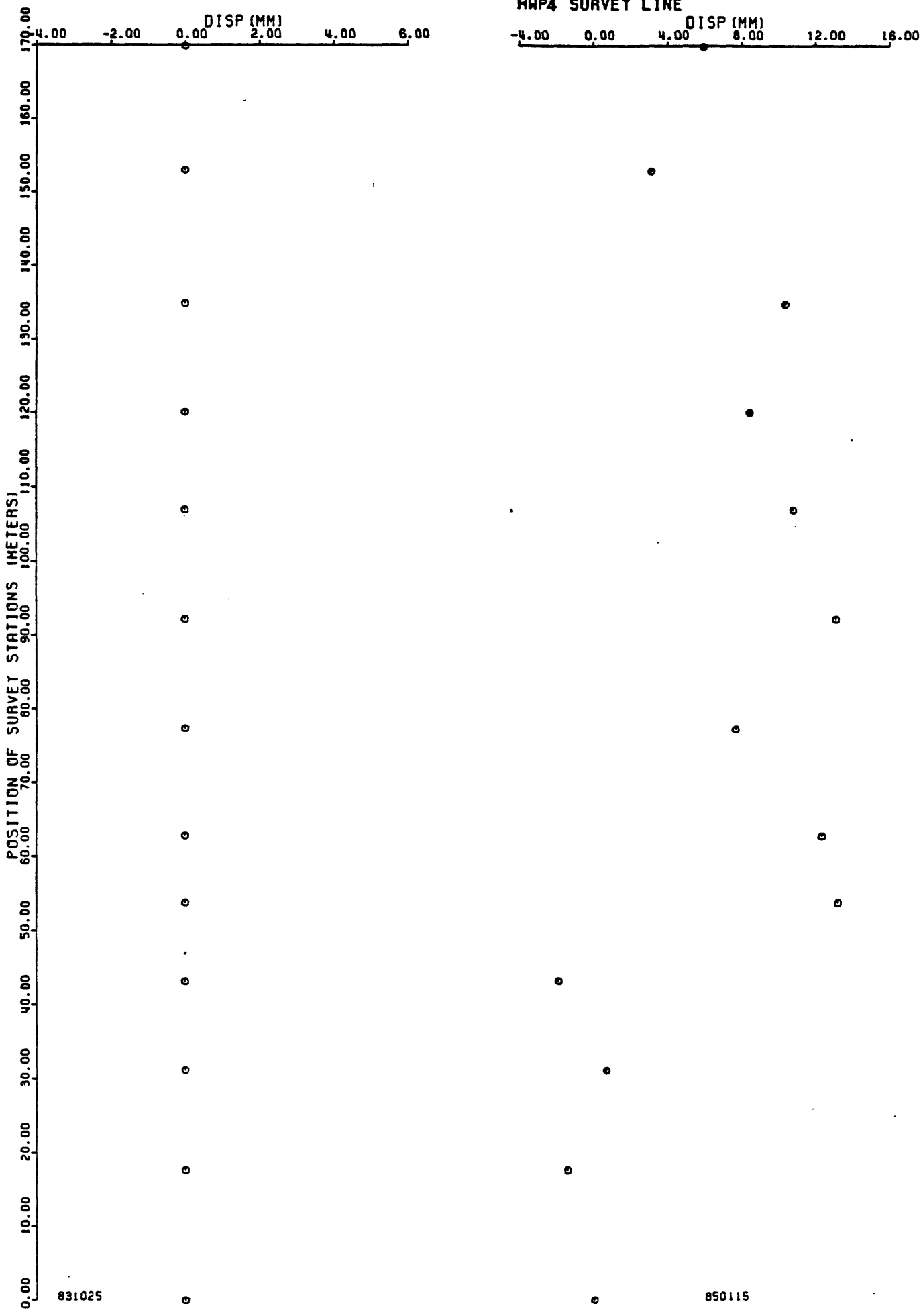


HWP4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 3.0°	
Oct 25	0.00	169.90	0.9986	0.00
1984				
Jun 12	1.68			1.68
1985				
Jan 15	0.85			2.53

BWP5 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
			Cos 3.0°	
1985				
Jul 18	0.00	152.85	0.9986	0.00
1986				
Jun 18	5.27			5.27


HWP4 SURVEY LINE
DISP (MM)
-4.00
-2.00
0.00
2.00
4.00
6.00
DISP (MM)
-4.00
0.00
4.00
8.00
12.00
16.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
170.00
831025
850115

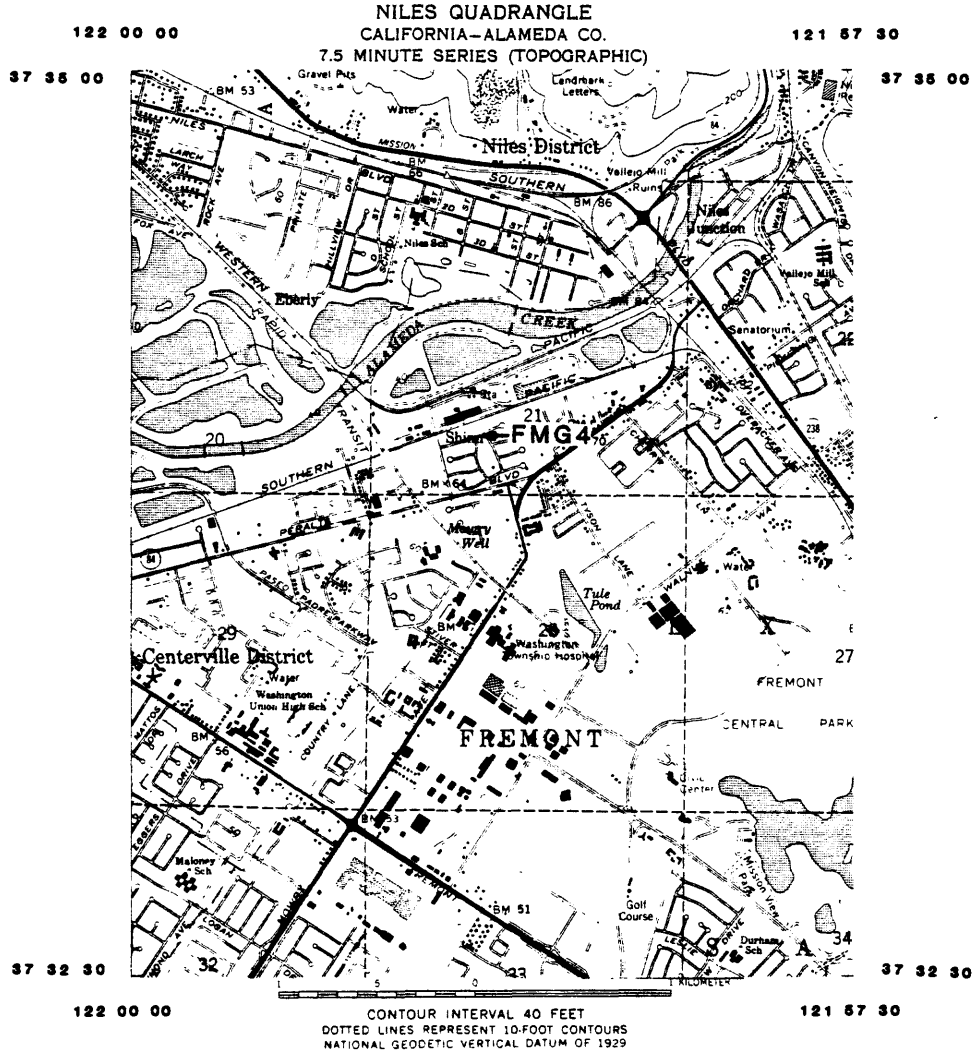
SITE DESCRIPTION

STATION CODE FMG **NAME** FREMONT GILBERT **COUNTY** ALAMEDA

QUAD NILES 7.5' **LATITUDE** 37°34.0' **LONGITUDE** 121°58.9'

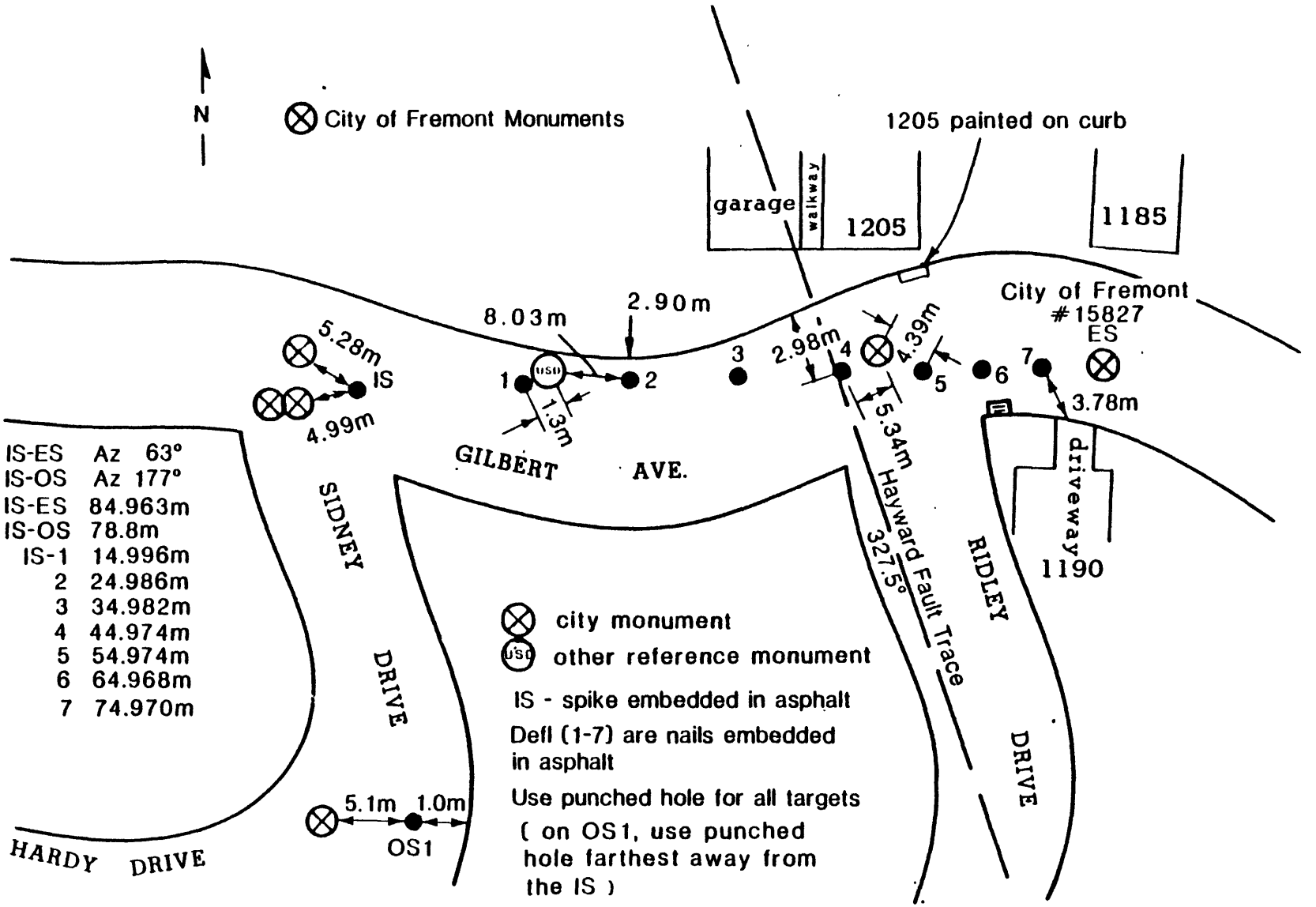
TO REACH: Go east on State Highway 84 (Thornton) from intersection with State Highway 17 in Fremont. Turn right on Fremont Blvd. and left on Peralta. Turn left on Shinn and then right onto Gilbert. IS is in intersection of Gilbert and Sidney Drive.

GENERAL DESCRIPTION: IS is a spike in asphalt. OS is a nail in asphalt one meter from east curb of intersection of Sidney Drive and Hardy Drive. Deflection stations are nails on Gilbert Avenue. ES is a City of Fremont survey monument, number 15827; installation date is unknown.



USGS : FREMONT GILBERT ALINEMENT ARRAY
(FMG4) 9/26/83

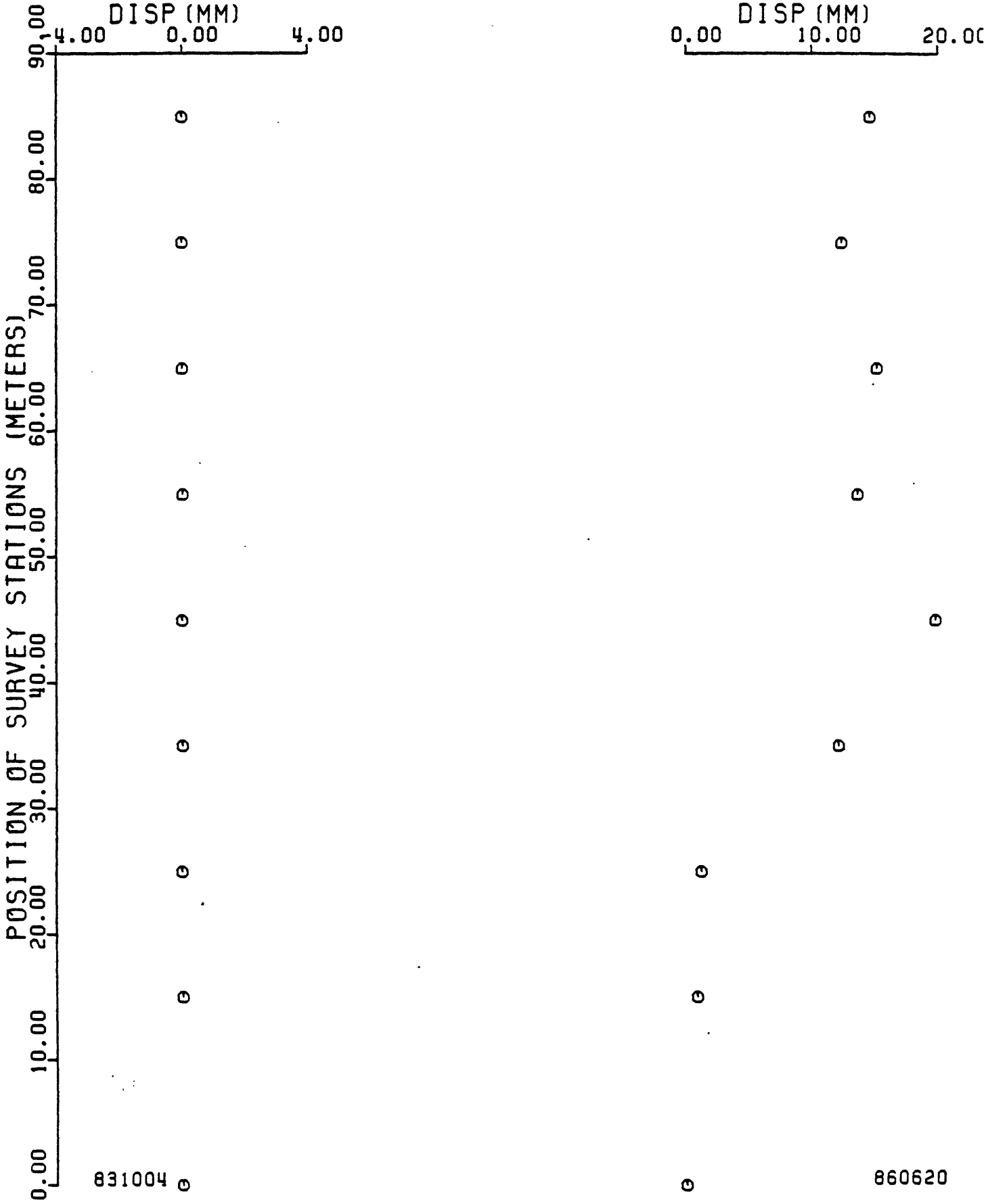
CAUTION : School buses travel through in afternoons – make sure sufficient amount of marker cones are displayed in work area



FMG4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 6.0°	
Oct 4	0.00	84.96	0.9945	0.00
Oct 27	0.33			0.33
1984				
Mar 23	0.20			0.53
Mar 26	0.46			0.99
Mar 30	-1.14			-0.15
Aug 14	-0.32			-0.47
1985				
Jan 29	0.66			0.20
Jul 12	0.98			1.18
1986				
Jun 20	13.40			14.58

FMG4 SURVEY LINE



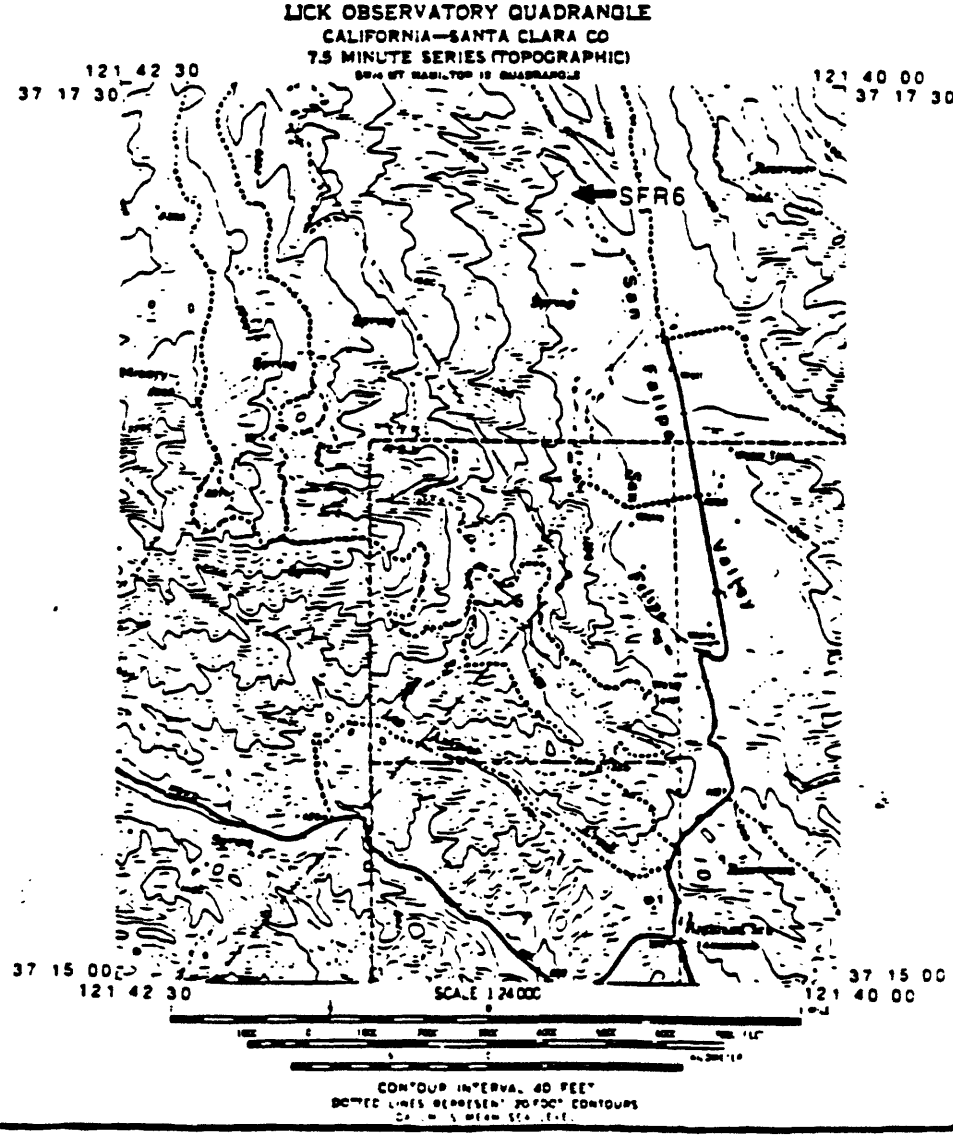
SITE DESCRIPTION

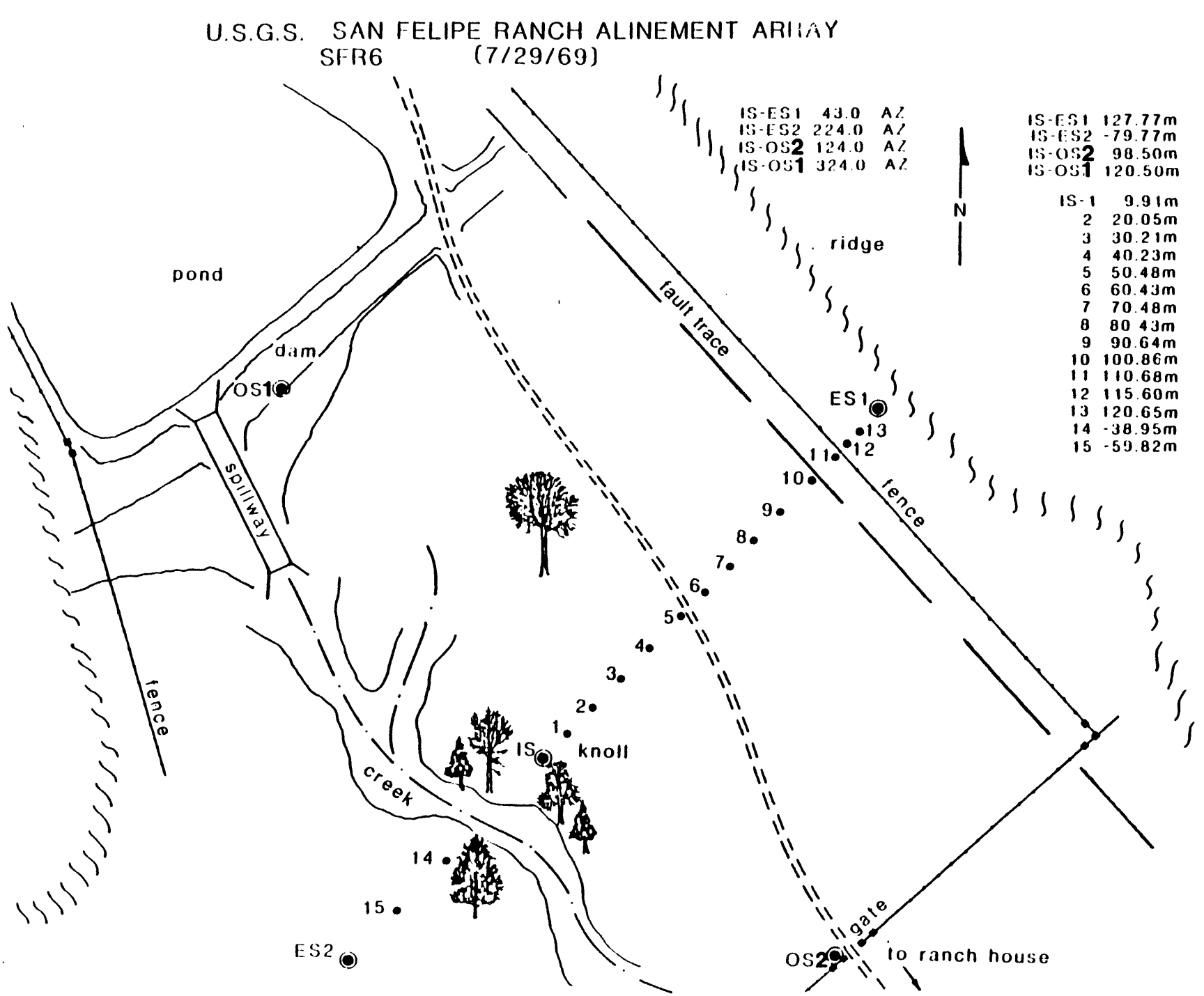
STATION CODE SFR6 **NAME** SAN FELIPE RANCH **COUNTY** SANTA CLARA

QUAD LICK OBSERVATORY **LATITUDE** 37°16.8' **LONGITUDE** 121°40.9'

TO REACH: From Highway 101 in South San Jose, take Capital Expressway to Aborn Road and turn right. Travel to San Felipe Road and turn right. Travel 8.8 mi to where road forks into Las Animas Road on right and San Felipe on left. Turn left and drive 1.5 miles to gravel road, turn left to Hewlett Ranch headquarters and fill out sign-in sheet in mailbox. Continue past headquarters, turn right just after houses, bear right at fork, cross creek, turn left when road ends. Go left at fork, recross creek, and go through barbed wire gate.

GENERAL DESCRIPTION: OS2 (monument #3) is just inside gate, approximately 2 meters to left of road. OS1 is at top edge of dam spillway. ES1 is just right of a large fence post, 5 metal posts north of an oak tree. Monuments are copper weld rods driven inside cement asbestos pipe sections. ES2 is 78.7 m from IS.
Ranch Foreman: Bob Andrade, 408/274-5303, wife Nicky.

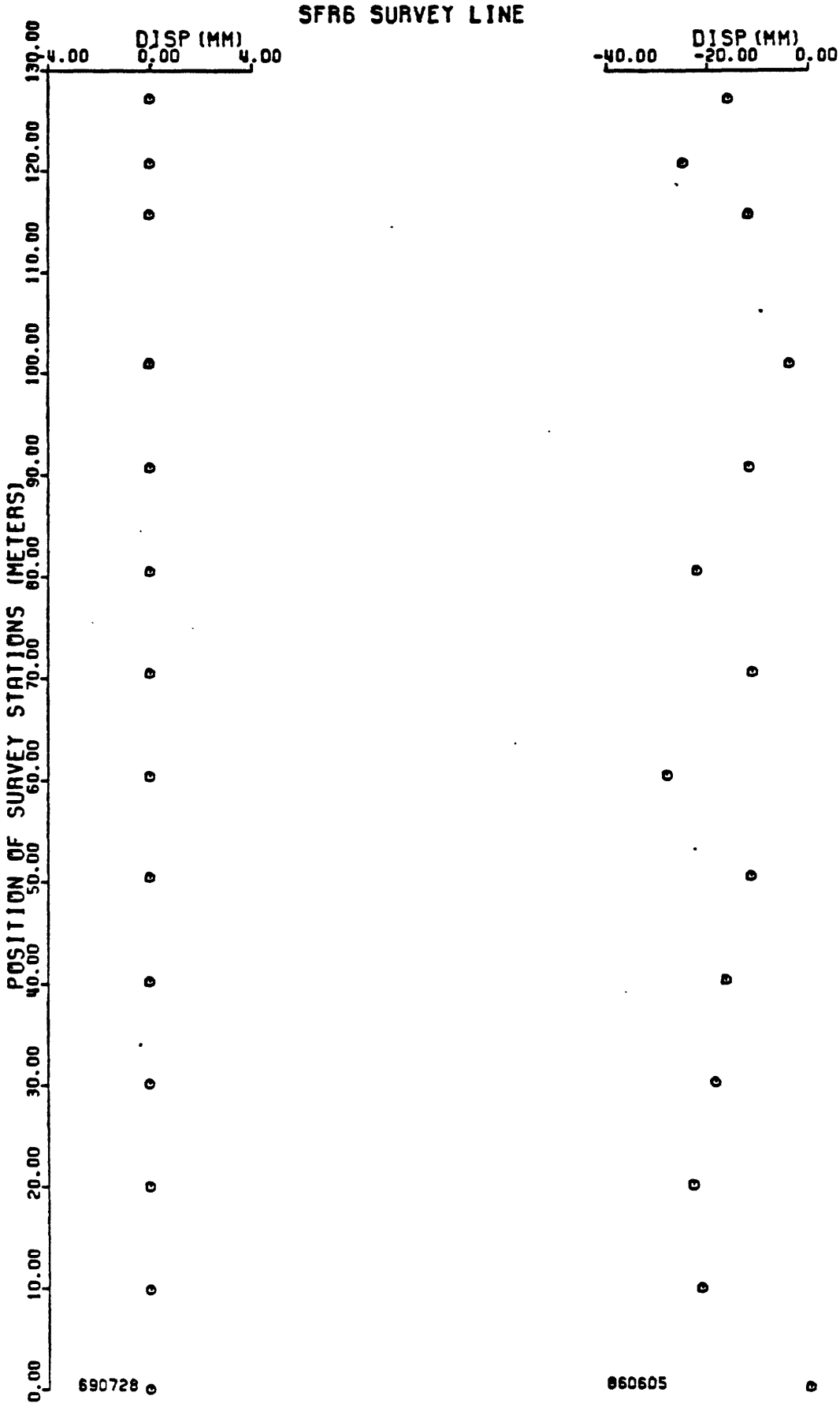



U.S.G.S. SAN FELIPE RANCH ALINEMENT ARRAY
SFR6 (7/29/69)
IS-ES1 43.0 AZ
IS-ES2 224.0 AZ
IS-OS2 124.0 AZ
IS-OS1 324.0 AZ
IS-ES1 127.77m
IS-ES2 -79.77m
IS-OS2 98.50m
IS-OS1 120.50m
IS-1 9.91m
2 20.05m
3 30.21m
4 40.23m
5 50.48m
6 60.43m
7 70.48m
8 80.43m
9 90.64m
10 100.86m
11 110.68m
12 115.60m
13 120.65m
14 -38.95m
15 -59.82m
N
ridge
pond
dam
OS1
spillway
fence
fault trace
ES1
13
12
11
10
9
8
7
6
5
4
3
2
1
IS
knoll
creek
14
15
ES2
fence
gate
OS2
to ranch house

SFR6 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1969				
Jul 29	0.00	127.71		0.00
1970				
Feb 5	2.25			2.25
1972				
Sep 12	-10.66			- 8.41
1986				
Jun 5	- 7.50			-15.91

NOTE: Alinement Array sites were originally designated with a 4 as the last number of their code. Sites that have had some change in their layout are recognized by an increase in this last number; an example is SFR6, which has been changed twice.


SFR6 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-40.00
-20.00
0.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
690728
860605

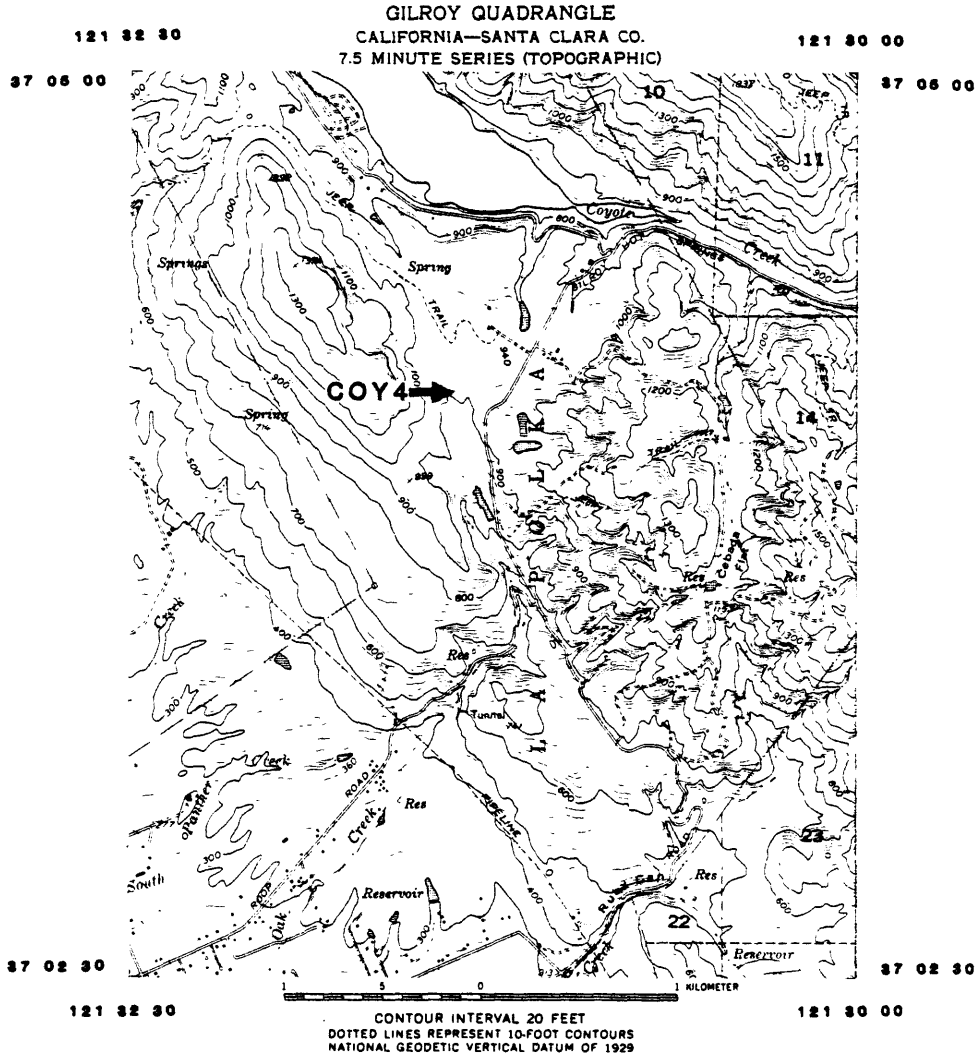
SITE DESCRIPTION

STATION CODE COY4 NAME COYOTE RESERVOIR COUNTY SANTA CLARA

QUAD GILROY 7.5' LATITUDE 37°04.1' LONGITUDE 121°31.4'

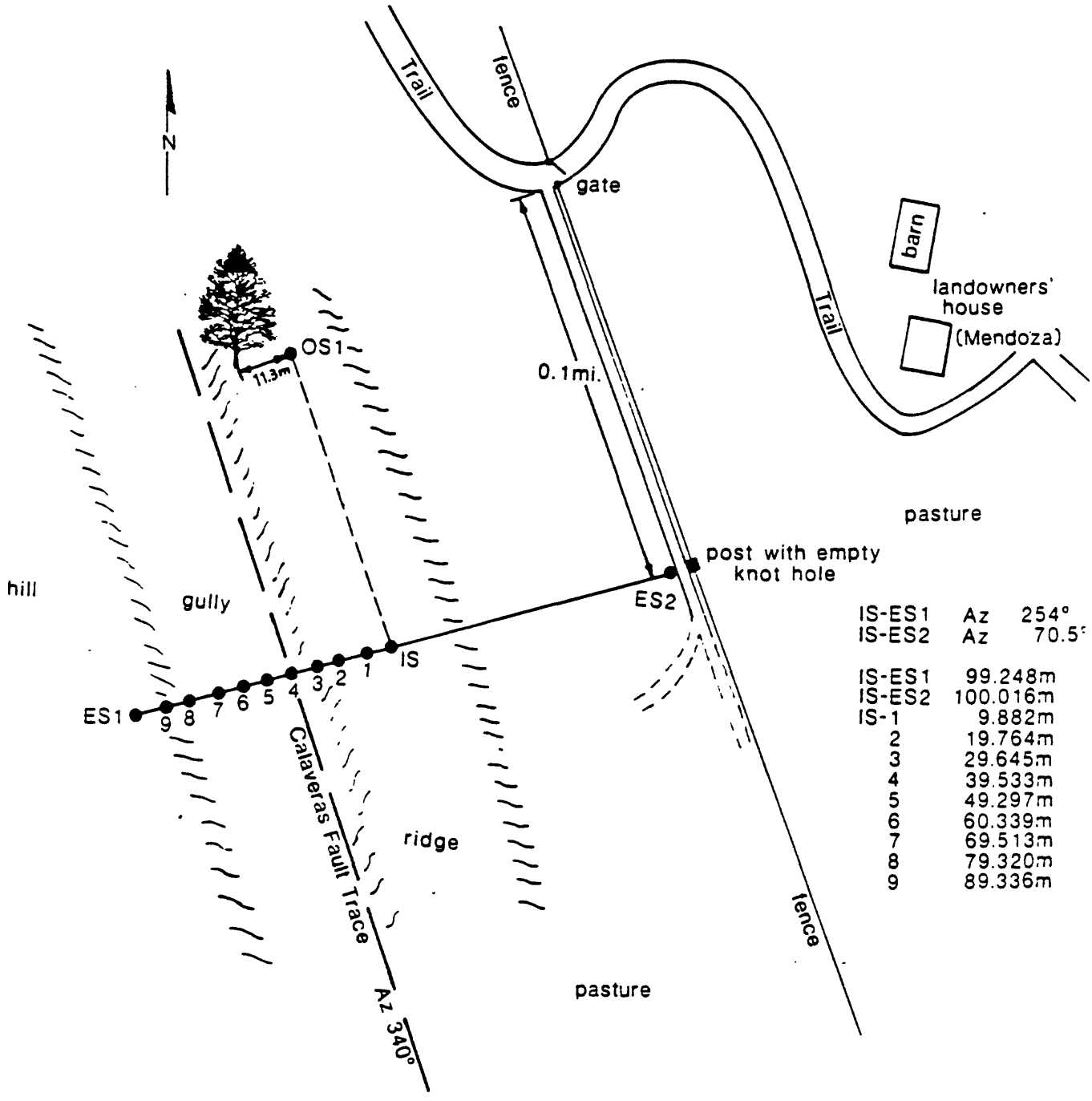
TO REACH: North of Gilroy, take Leavesley Road exit east from Highway 101. Turn onto New Avenue and right onto Prop Road. Turn left at junction of Prop and Gilroy Hot Springs Road, go 0.9 miles, turn left, drive to ranch house, and notify landowner of your presence.

GENERAL DESCRIPTION: Deflection monument 3 is approximately 12 meters south of easternmost vault of abandoned creepmeter. From deflection monument 3, deflection monuments 2, 1, and IS are at an azimuth of 74°. From IS, ES2 is at an azimuth of 70.5° and 100 meters distant, and OS is at an azimuth of 344° and is 12 paces from a tree. Monuments were installed by USGS (date unknown).



USGS : COYOTE RESERVOIR ALINEMENT ARRAY

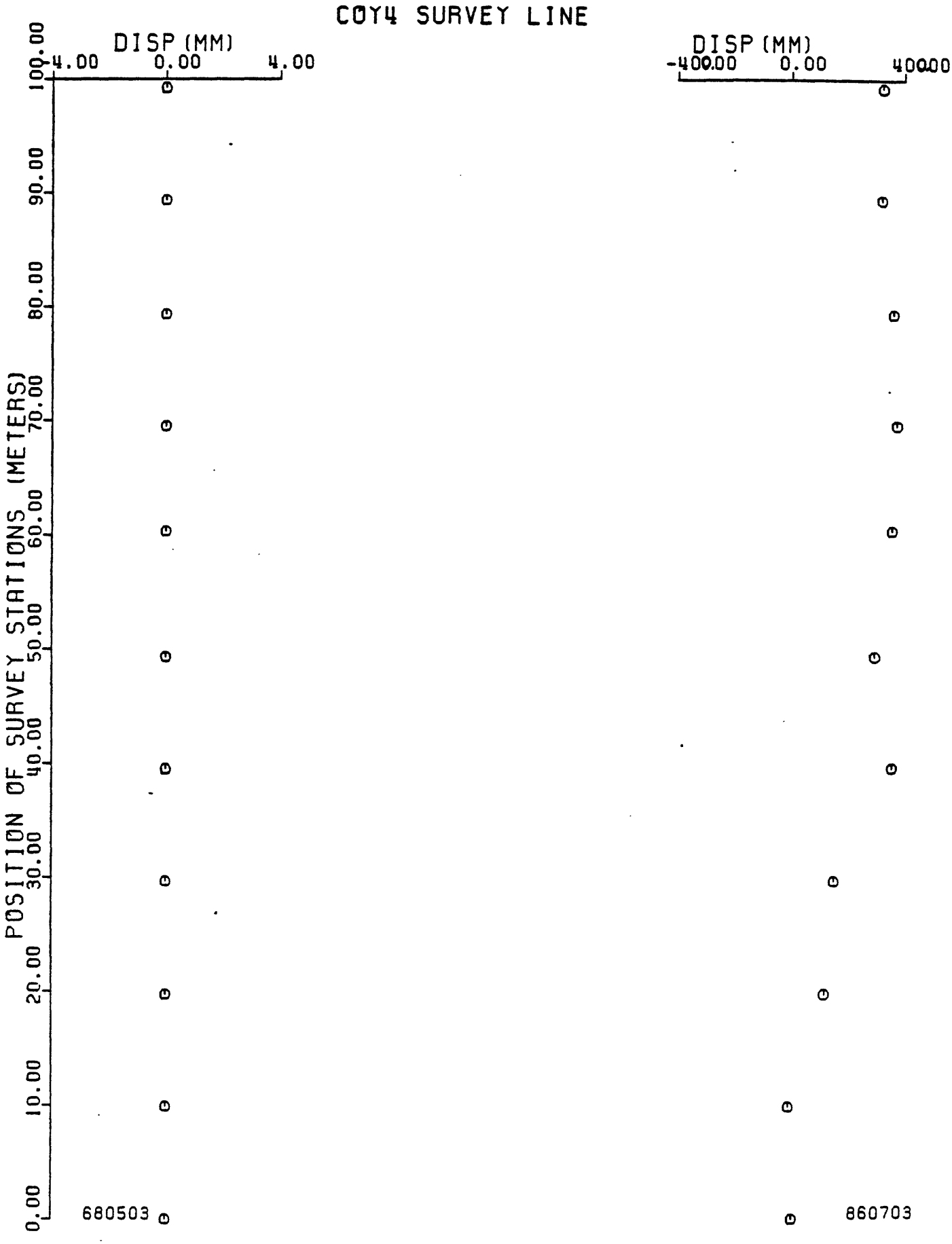
(COY4) 7/16/84



IS-ES1	Az	254°
IS-ES2	Az	70.5°
IS-ES1		99.248m
IS-ES2		100.016m
IS-1		9.882m
2		19.764m
3		29.645m
4		39.533m
5		49.297m
6		60.339m
7		69.513m
8		79.320m
9		89.336m

COY4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1968			Cos 4.0°	
May 3	0.00	99.25	0.9976	0.00
1986				
July 3	323.16			323.16


COY4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-400.00
0.00
400.00
POSITION OF SURVEY STATIONS (METERS)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
680503
860703

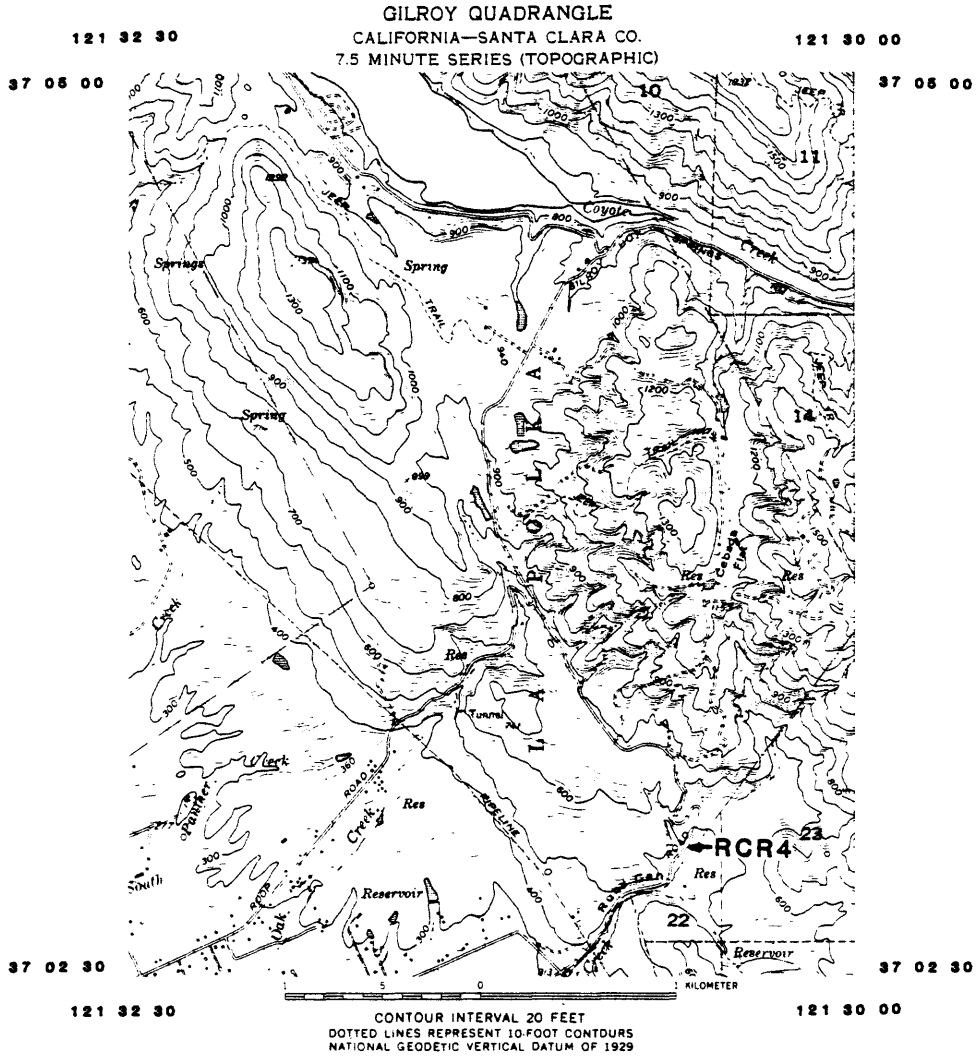
SITE DESCRIPTION

STATION CODE RCR4 NAME RUBY CANYON ROAD COUNTY SANTA CLARA

QUAD GILROY 7.5' LATITUDE 37°02.9' LONGITUDE 121°30.6'

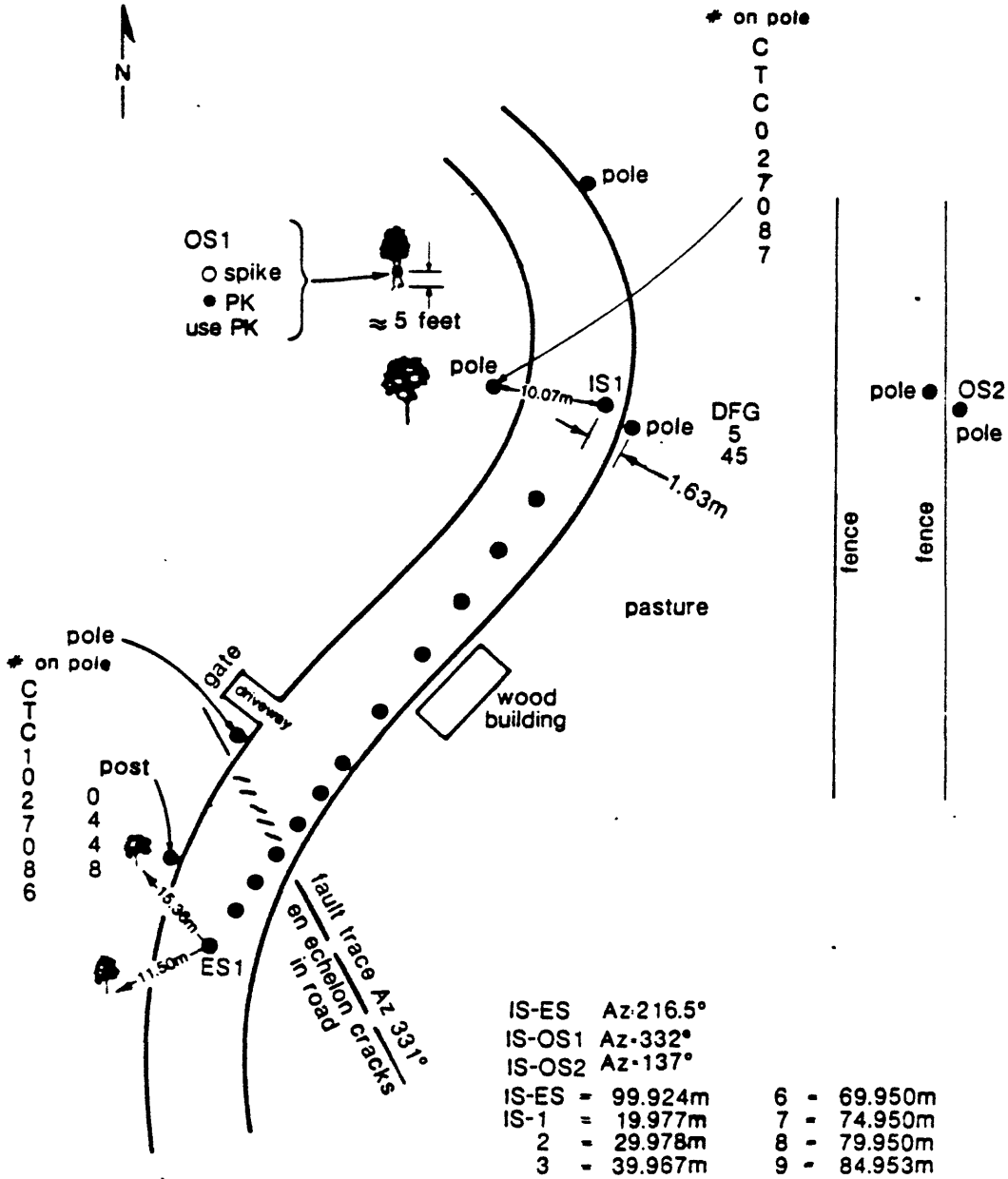
TO REACH: North of Gilroy, take Leavesley Road exit east from Highway 101. Turn onto New Avenue and turn right at first intersection. Turn left 0.2 miles past sharp curve onto Ruby Canyon Road. Alinement array is 0.6 miles ahead.

GENERAL DESCRIPTION: The array consists of nails along the south edge of road. The IS is 1.63 meters from a pole with markings "DFG 5 45"; 10 meters across the road is another pole with markings "CTC 1027087". Past IS, road curves to left and winds up hill. ES and deflection stations are at an azimuth of 216 degrees. OS1 is a spike in a tree at an azimuth of 332 degrees, and OS2 is a telephone pole at an azimuth of 137 degrees. Installer and date of installation are unknown.



USGS : RUBY CANYON ROAD ALINEMENT ARRAY

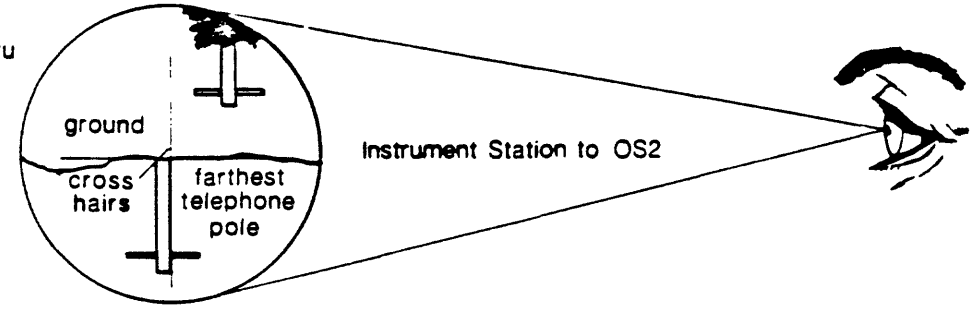
(RCR4) 7/16/84



IS-ES Az 216.5°
IS-OS1 Az 332°
IS-OS2 Az 137°

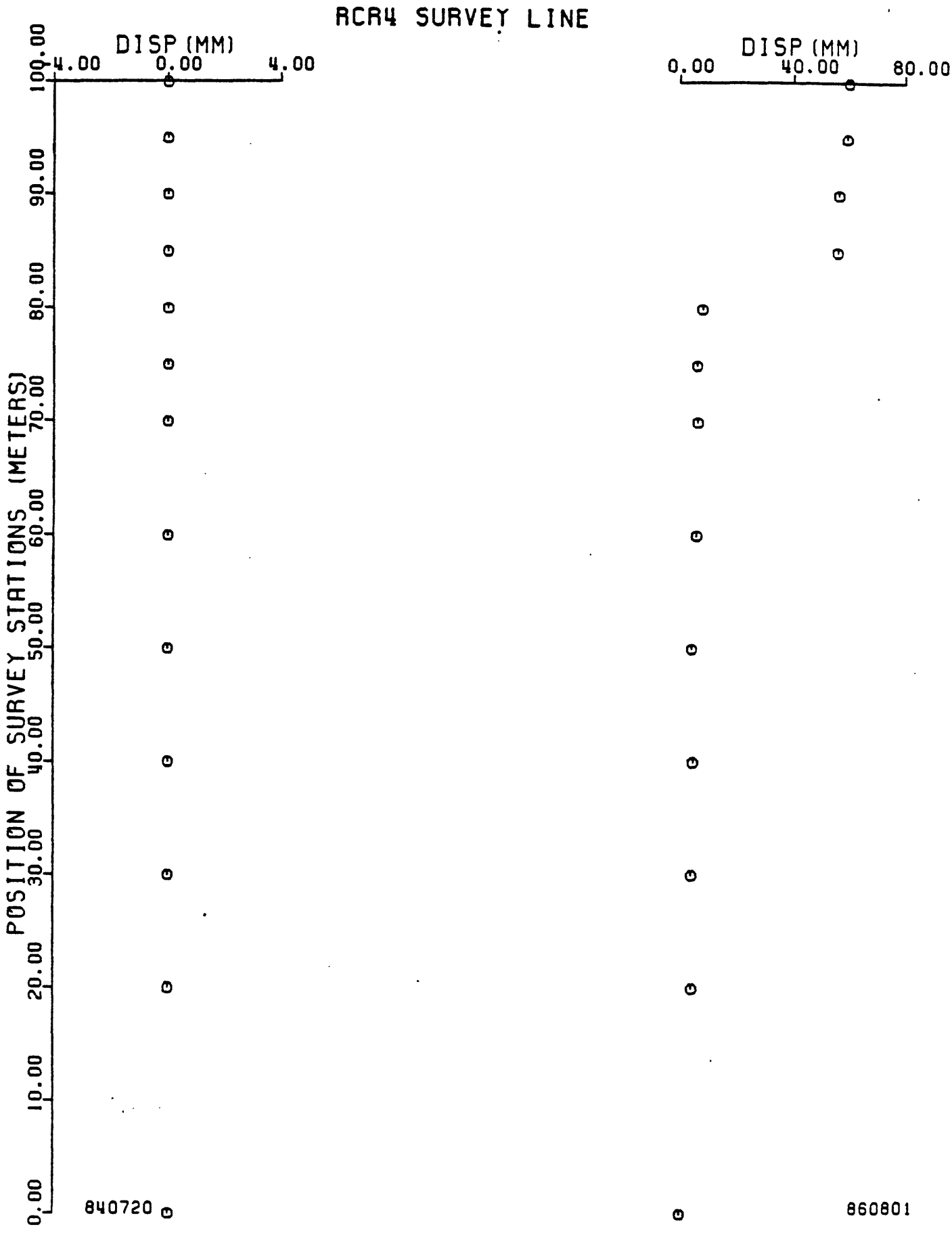
IS-ES	99.924m	6	69.950m
IS-1	19.977m	7	74.950m
2	29.978m	8	79.950m
3	39.967m	9	84.953m
4	49.962m	10	89.940m
5	59.957m	11	94.930m

RCR4
OS
as seen thru
instrument
7/20/84



RCR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
			Cos 24.5°	
1984				
Jul 20	0.00	99.92	0.9099	0.00
1985				
Aug 14	33.13			33.13
1986				
Aug 1	26.71			59.84


RCR4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
0.00
40.00
80.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
840720
860801

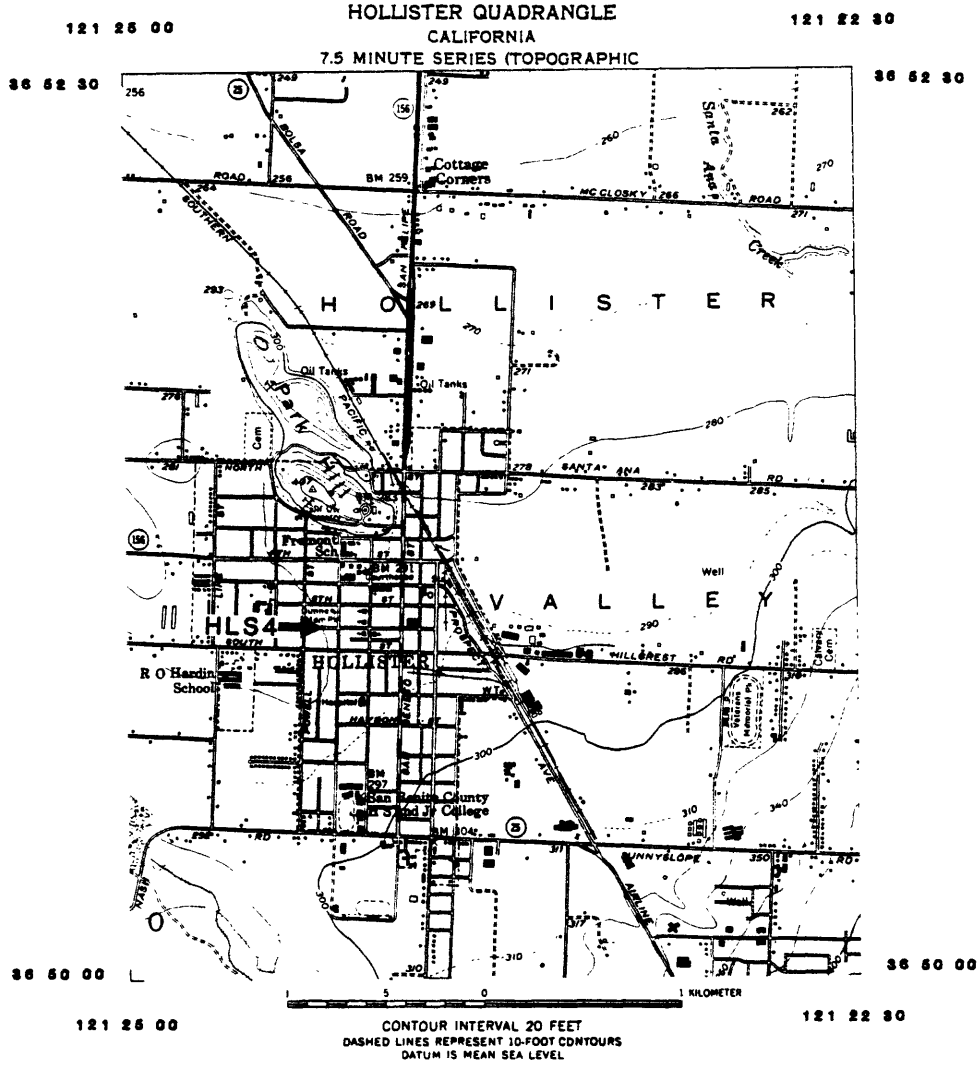
SITE DESCRIPTION

STATION CODE HLS4 **NAME** 7TH STREET HOLLISTER **COUNTY** SAN BENITO

QUAD HOLLISTER 7.5' **LATITUDE** 36°51.1' **LONGITUDE** 121°24.2'

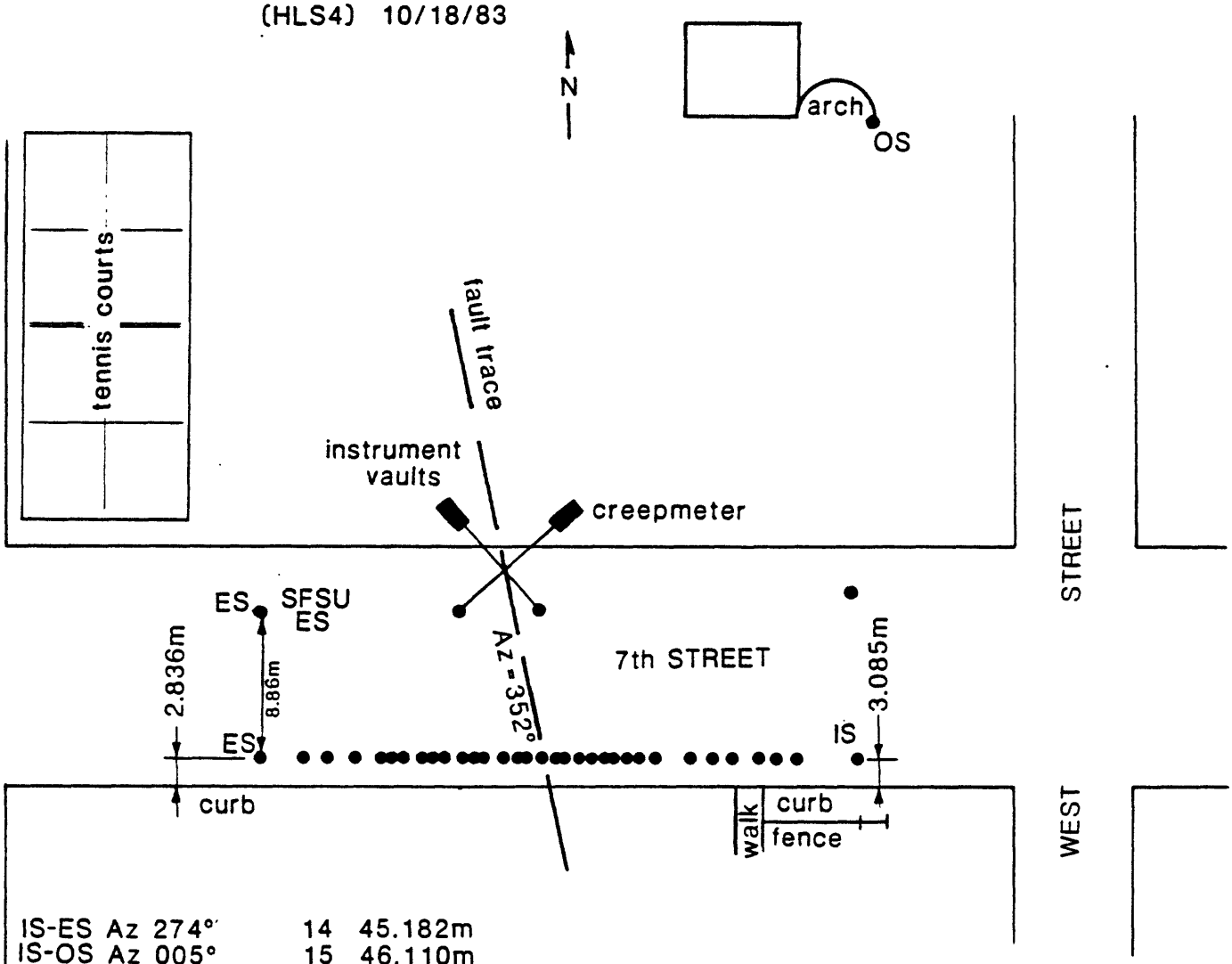
TO REACH: Two miles south of Gilroy, take Highway 25 turnoff from Highway 101 12 miles to Hollister. Proceed through Hollister on Highway 152-156 to intersection with 7th Street and turn right. Look for array on left side of street across from park (see diagram).

GENERAL DESCRIPTION: OS is a point on roof of park building at corner of 6th Street and Monterey (see diagram). Nail line was installed by NOAA-EML personnel (date unknown).



USGS: HOLLISTER-7th STREET ALINEMENT ARRAY

(HLS4) 10/18/83

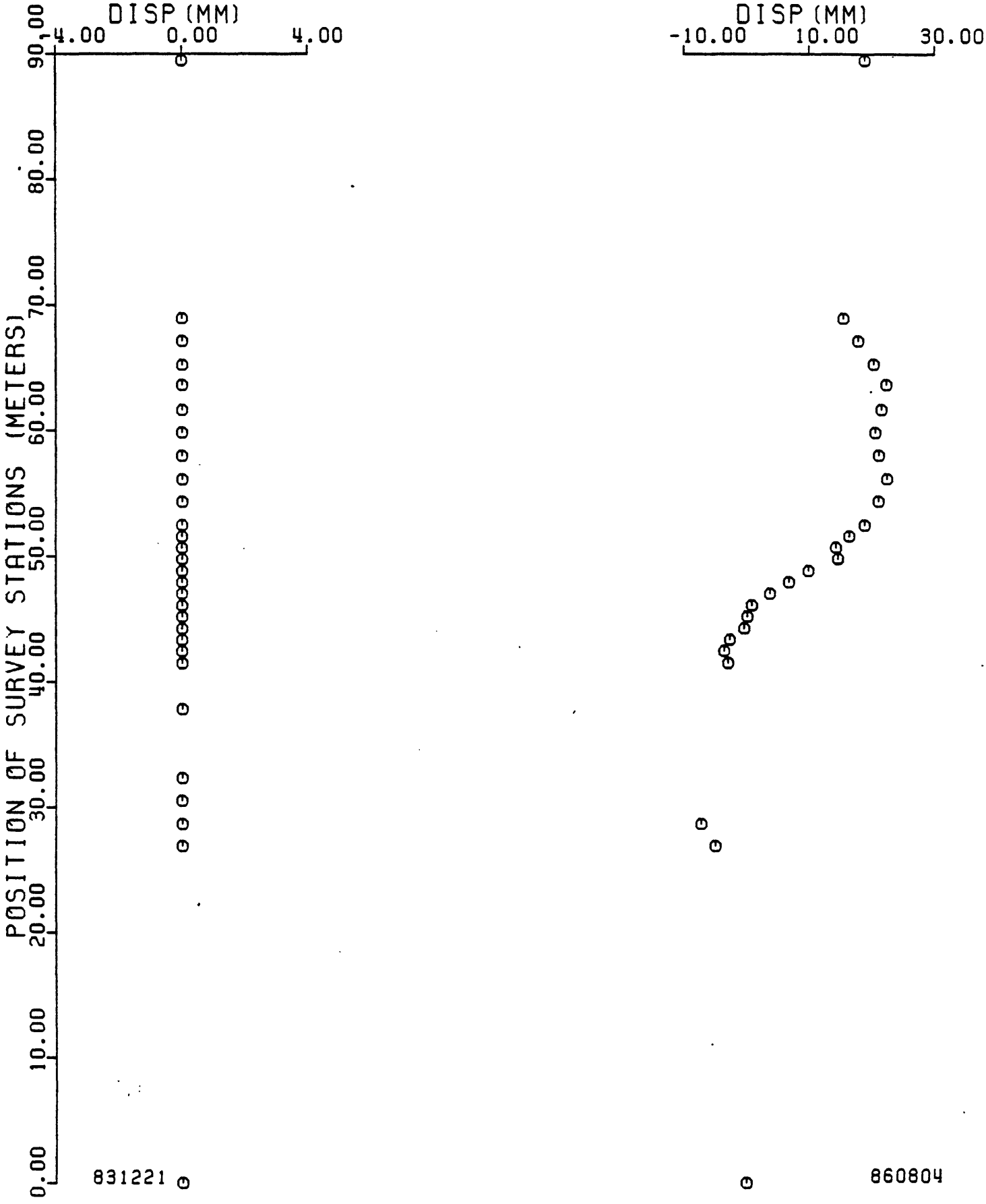


IS-ES	Az 274°	14	45.182m
IS-OS	Az 005°	15	46.110m
IS-ES	89.508m	16	47.030m
IS-1	21.407m	17	47.952m
2	23.235m	18	48.862m
3	25.071m	19	49.778m
4	26.888m	20	50.691m
5	28.713m	21	51.614m
6	30.534m	22	52.514m
7	32.371m	23	54.347m
8	37.852m	24	56.173m
9	39.668m	25	58.001m
10	41.509m	26	59.843m
11	42.429m	27	61.67m
12	43.352m	28	63.65m
13	44.267m	29	65.31m
		30	67.13m
		31	68.96m

HLS4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 12.0°	
Dec 12	0.00	89.59	0.9781	0.00
1984				
Jul 6	11.18			11.18
1985				
Jul 10	1.39			12.57
1986				
Aug 4	6.32			18.89

HLS4 SURVEY LINE



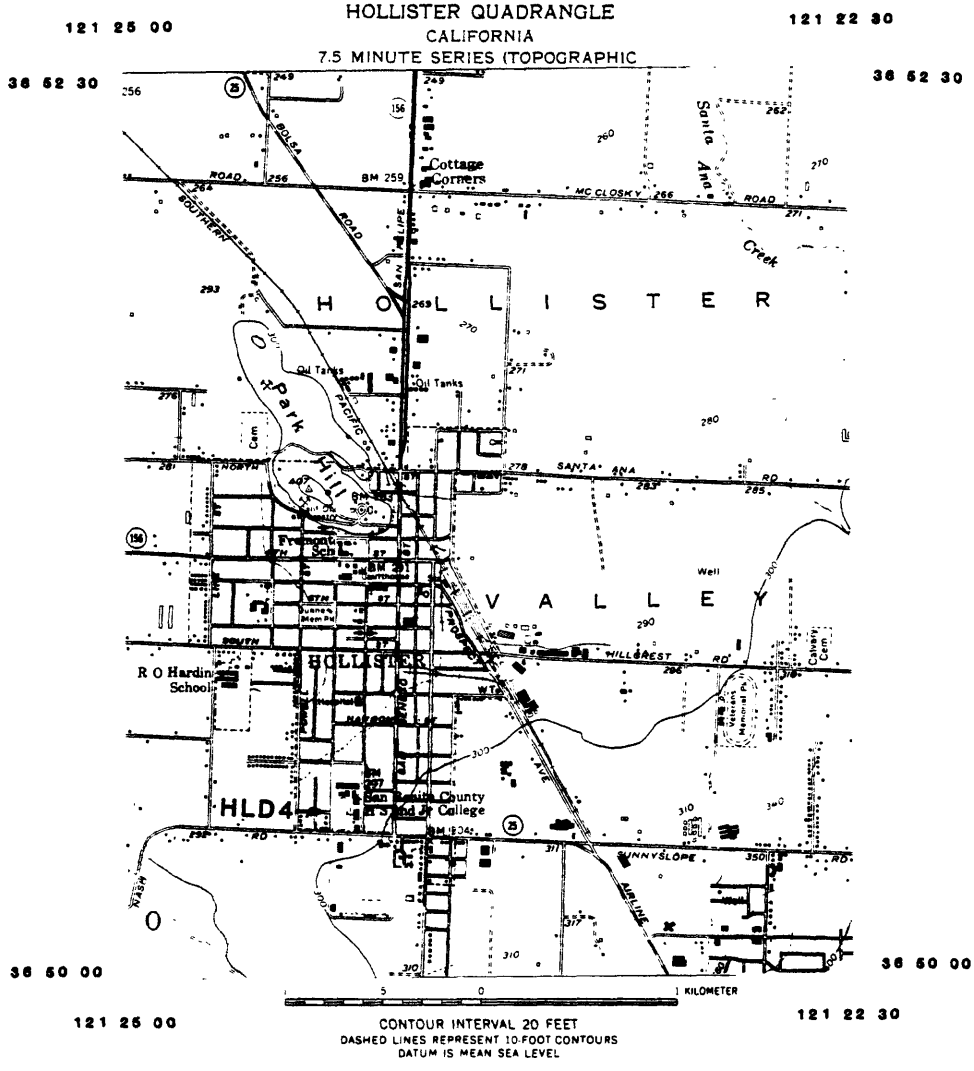
SITE DESCRIPTION

STATION CODE HLD4 **NAME** HOLLISTER D STREET **COUNTY** SAN BENITO

QUAD HOLLISTER 7.5' **LATITUDE** 36°50.5' **LONGITUDE** 121°24.2'

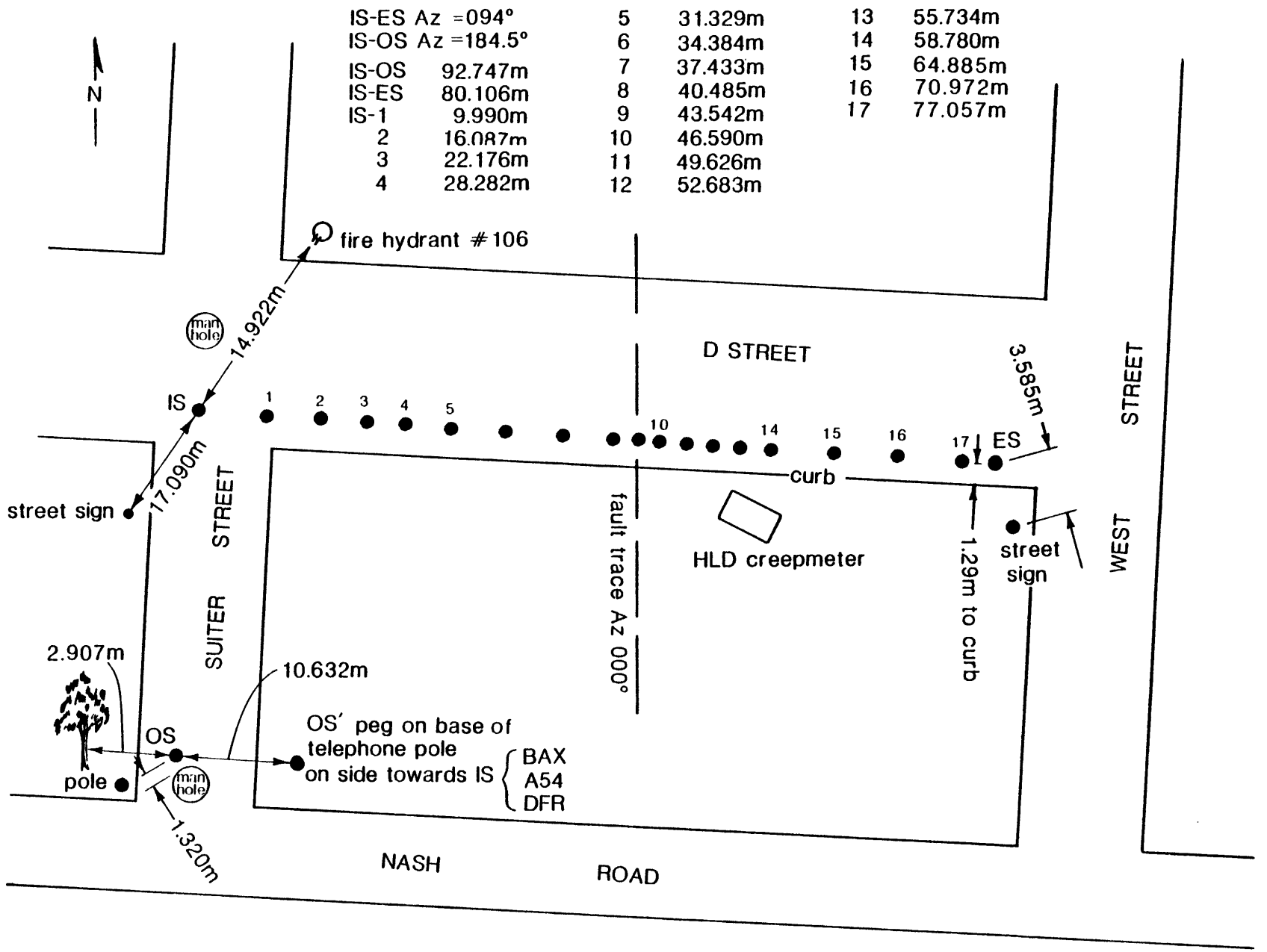
TO REACH: Two miles south of Gilroy, take the Highway 25 turnoff from Highway 101 12 miles to Hollister. Proceed through Hollister on Highway 152-156 to intersection with Nash Road. Turn right on Nash Road, right on West Street, and left on D Street.

GENERAL DESCRIPTION: IS is in southwest quadrant of D Street-Suiter Street intersection. OS is located south on Suiter Street (see diagram). Nails were installed by NOAA-EML personnel (date unknown).



USGS: HOLLISTER D STREET ALINEMENT ARRAY

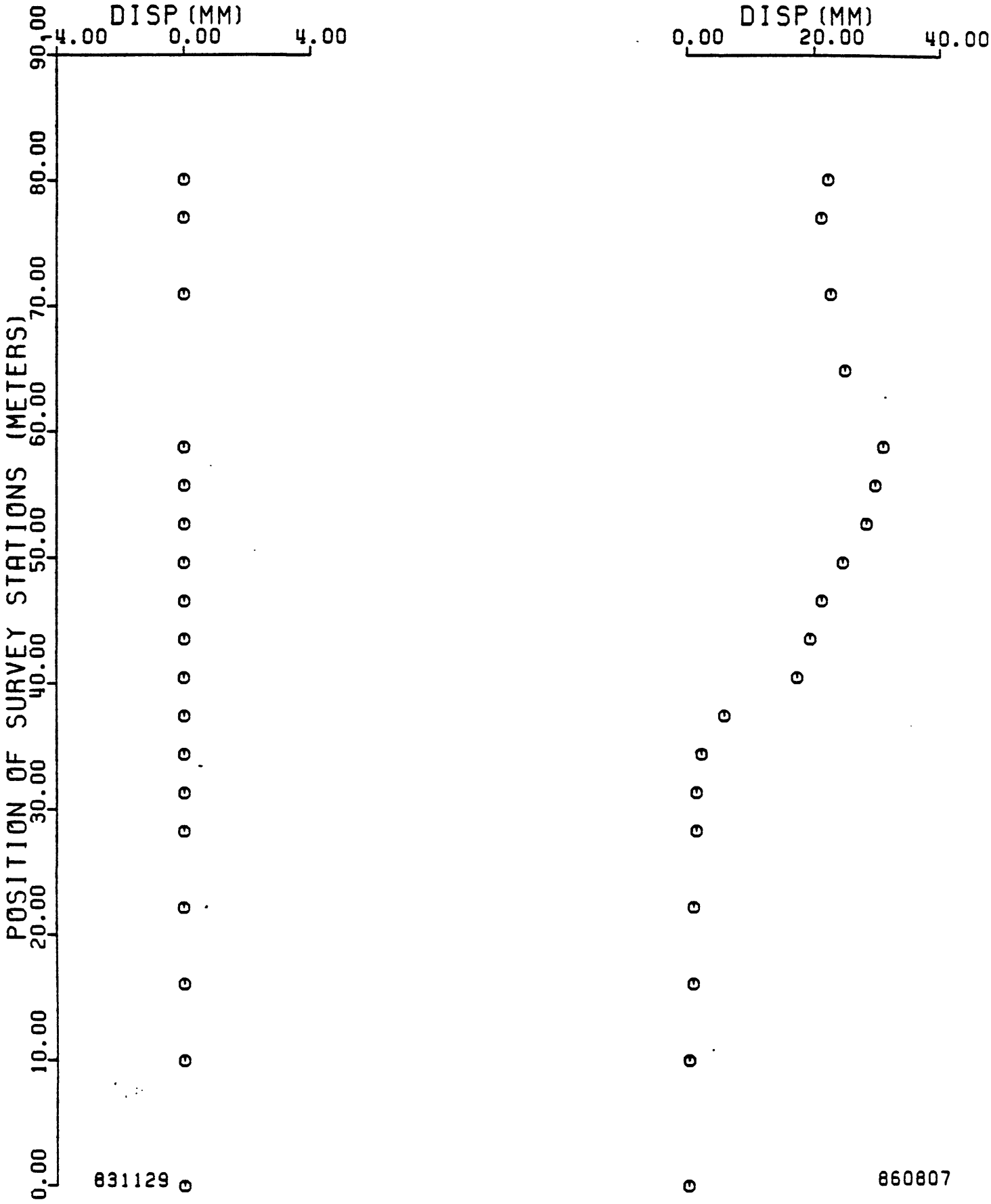
(HLD4) 10/18/83



HLD4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 4.0°	
Nov 29	0.00	80.11	0.9976	0.00
1984				
Jul 5	12.89			12.89
1985				
Jul 16	9.22			22.11
1986				
Aug 7	-0.10			22.01

HLD4 SURVEY LINE



SITE DESCRIPTION

STATION CODE THR4 NAME THOMAS ROAD COUNTY SAN BENITO

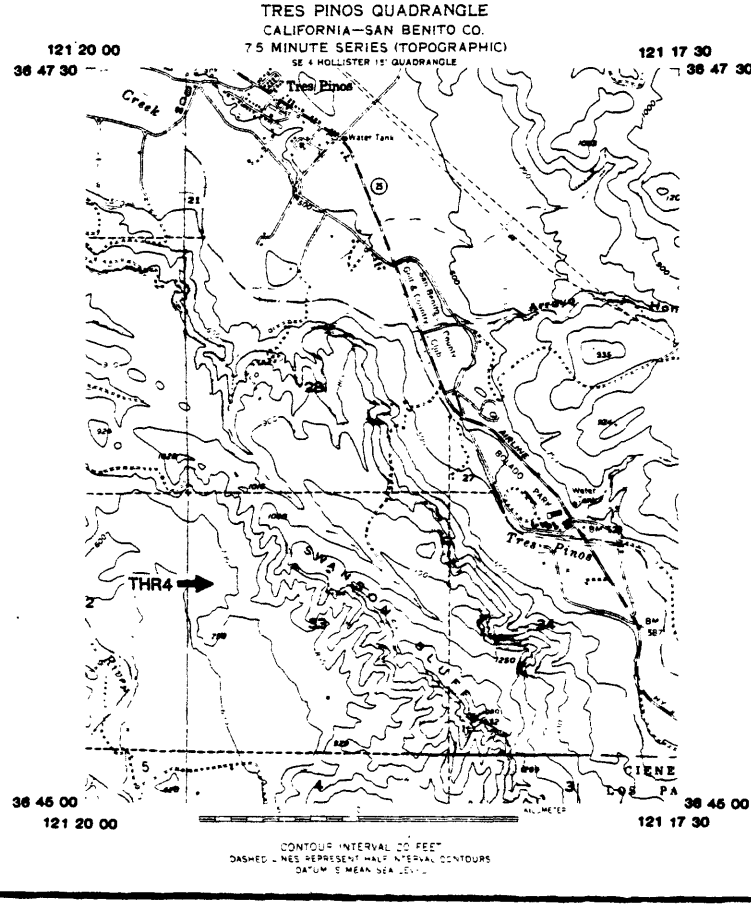
QUAD TRES PINOS LATITUDE $36^{o}45.7'$ LONGITUDE $121^{o}19.4'$

TO REACH: From Hollister, take California State Highway 25 south 5.9 miles to Tres Pinos. Turn west on Southside Road, travel 2.1 miles to Thomas Road, and turn right. Follow Thomas Road to end of pavement, pass through iron gate by sign "Country Road Ends" onto dirt road. Cross cattle guard and small stream, turn left at fork, travel parallel to stream, and pass another cattle guard. Bear right at next fork, pass old houses, then drive left alongside a young orchard. Continue straight to boundary between young and old orchards, take left fork into old orchard, pass shed on your right. Turn left at fence line and proceed to corner of orchard. Pass through wire gate on left and follow jeep trail to hay shed. Array lies to southeast of shed.

GENERAL DESCRIPTION: Instrument station (#9) is located approximately 10 meters south of jeep trail at a bearing of 140 degrees from the hay shed. End and orientation stations are located by standing at IS and measuring azimuths and distances from IS as follows:

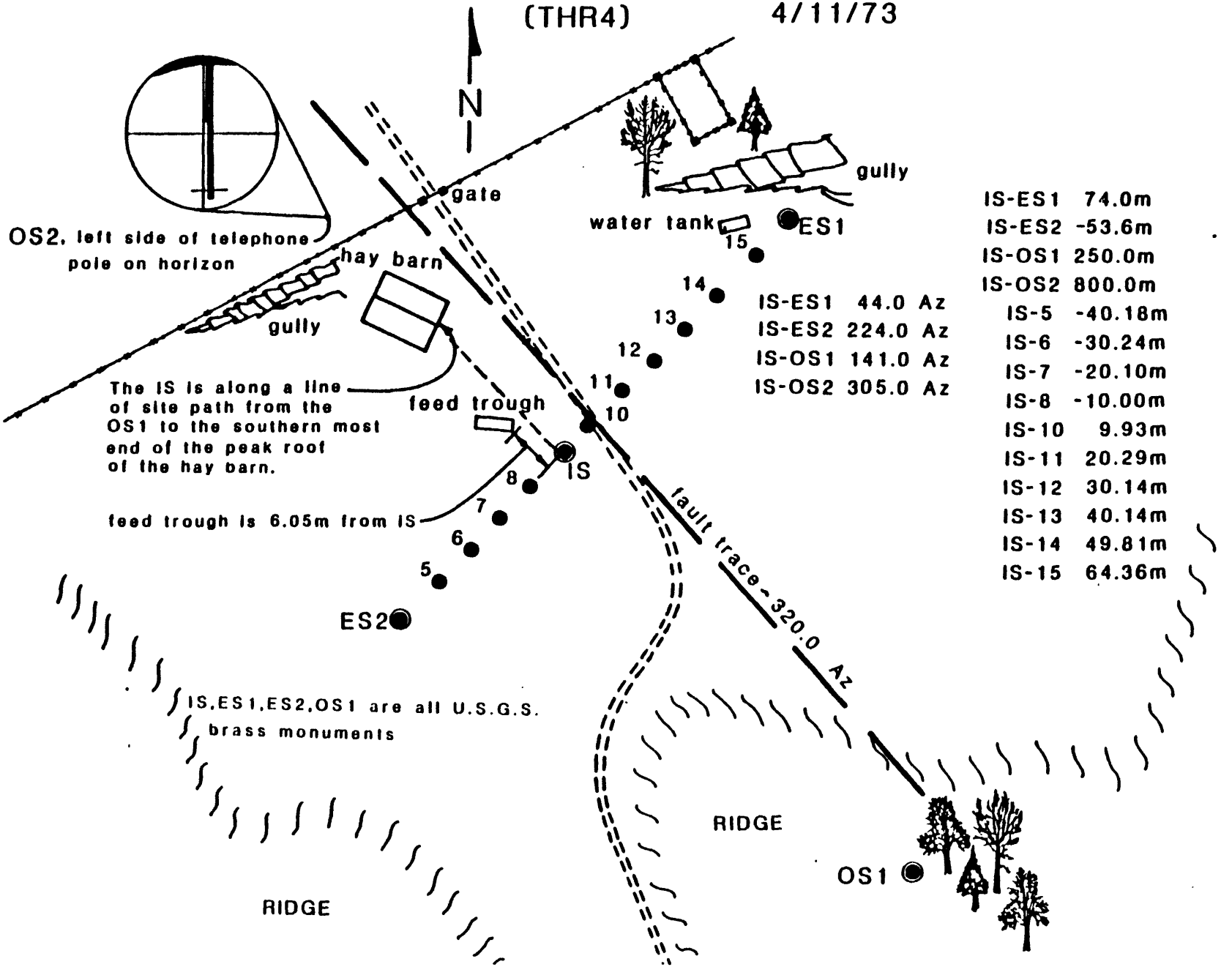
ES1	44 degrees	74 m
ES2	224 degrees	53 m
OS1	141 degrees	250 m
OS2	315 degrees	800 m

IS, ES1, ES2, OS1, and OS2 are subsurface brass tablets; deflection monuments are surveyor's plugs. Array was installed by USGS in 1973.



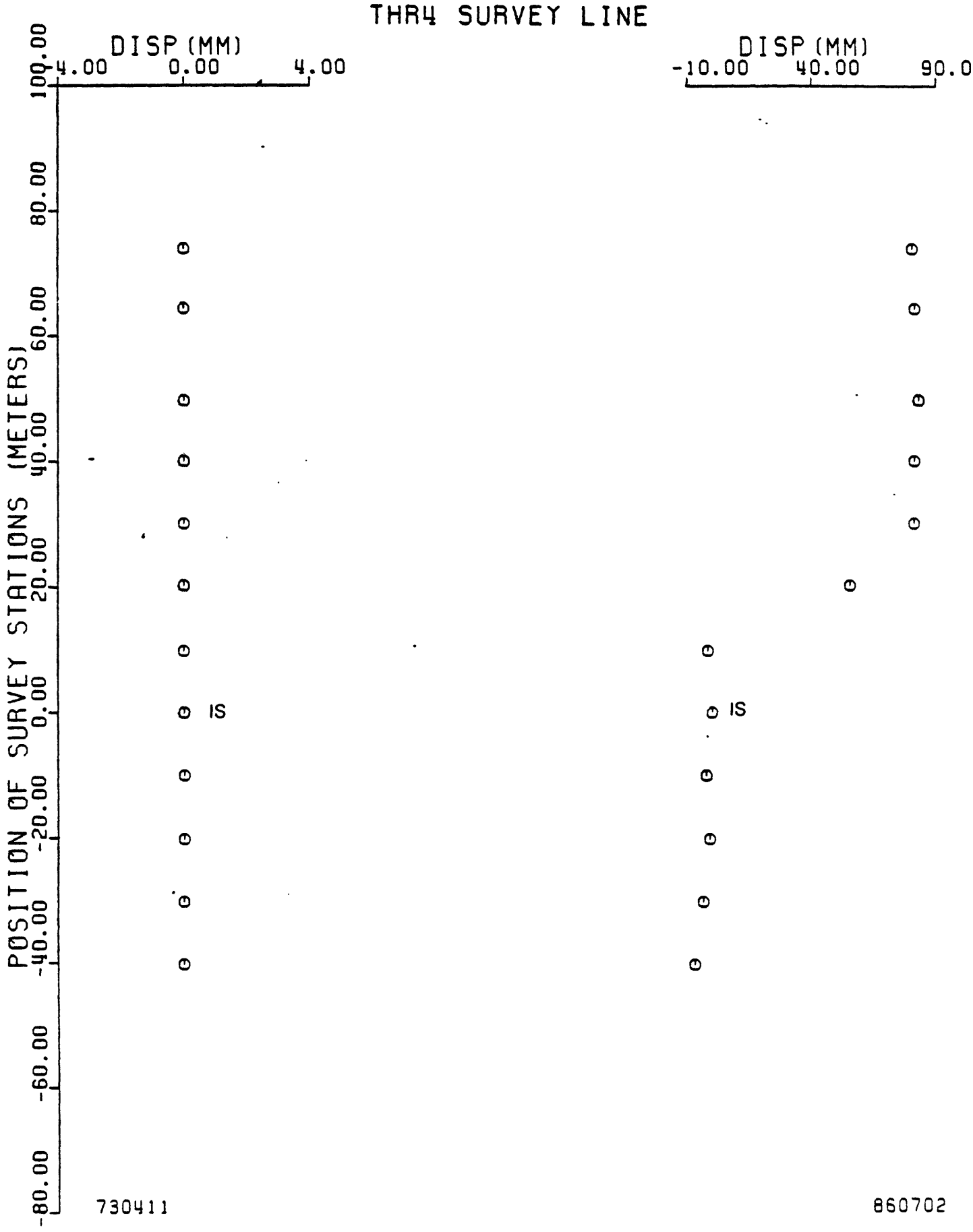
U.S.G.S. : THOMAS ROAD ALINEMENT ARRAY

(THR4) 4/11/73



THR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1973			Cos 4.0°	
Apr 11	0.00	74.00	0.9976	0.00
1985				
Jul 10	75.70			75.70
Aug 8	1.96			77.66
1986				
Jul 2	2.85			80.51


THR4 SURVEY LINE
DISP (MM)
4.00
0.00
4.00
DISP (MM)
-10.00
40.00
90.0
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
POSITION OF SURVEY STATIONS (METERS)
IS
IS
730411
860702

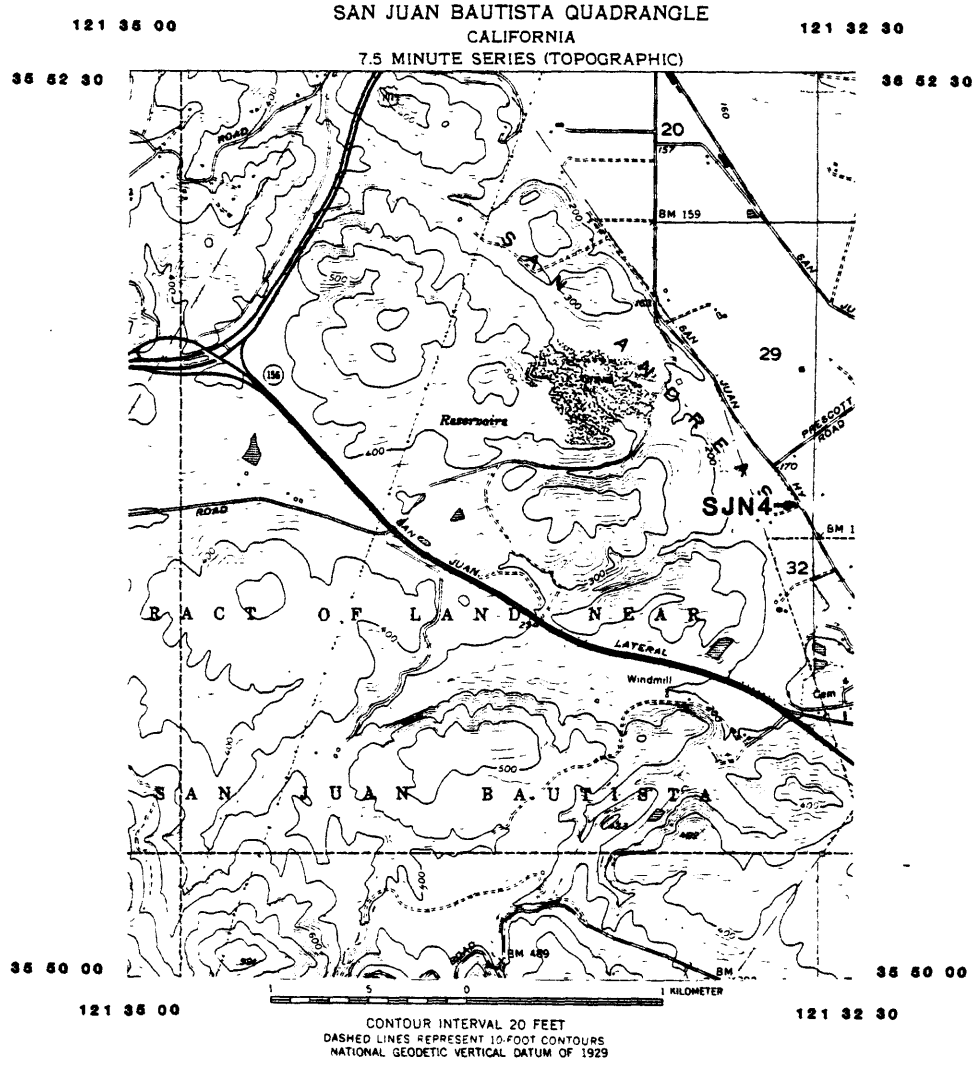
SITE DESCRIPTION

STATION CODE SJN4 NAME NYLAND RANCH COUNTY SAN BENITO

QUAD SAN JUAN BAUTISTA 7.5' LATITUDE 36°51.3' LONGITUDE 121°32.7'

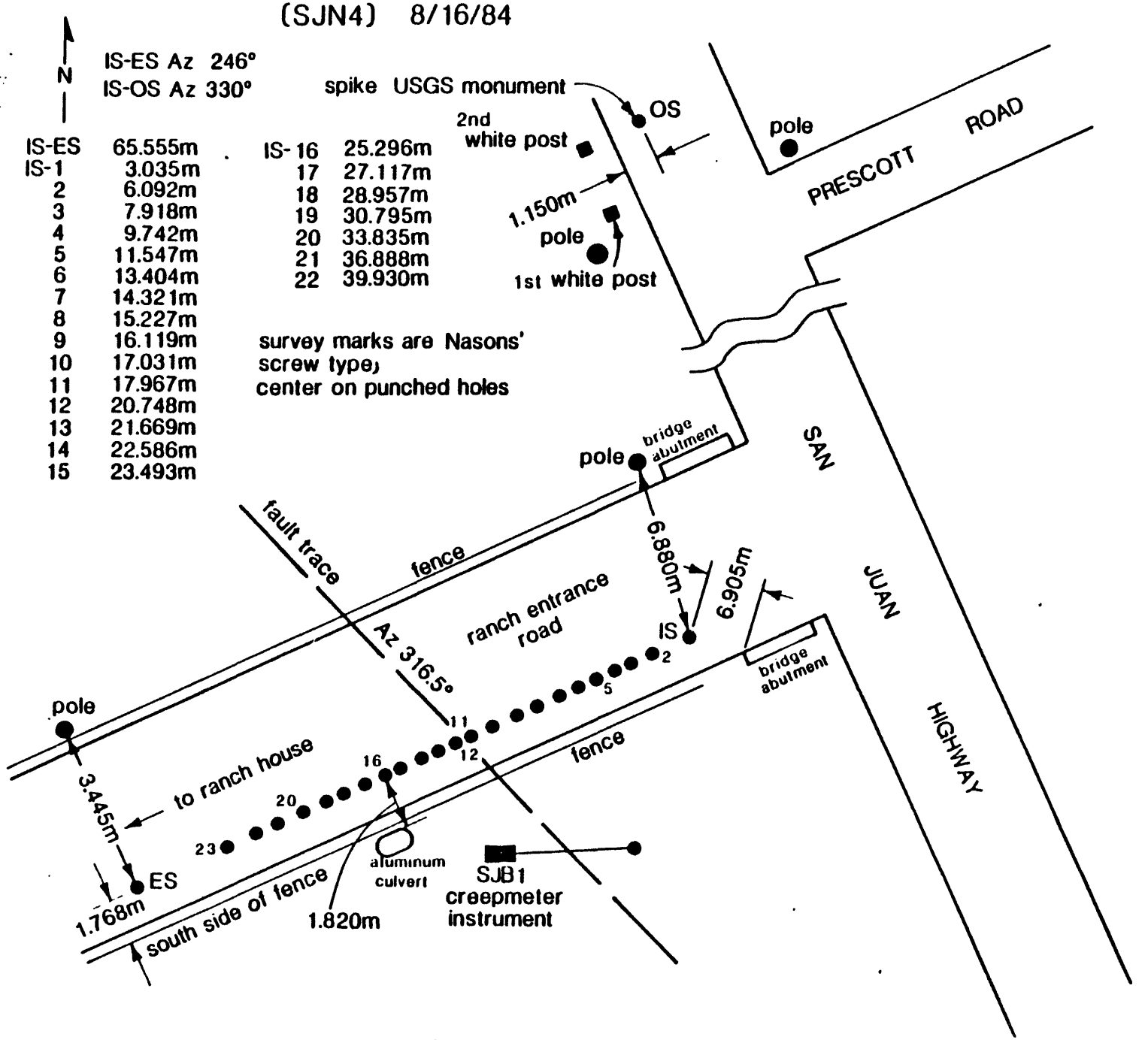
TO REACH: Approximately 7.6 miles south of Gilroy, take Highway 129 (old San Juan Highway) turnoff from Highway 101 south to San Juan Bautista. Approximately 2 miles from Highway 101, look for Nyland Ranch driveway, bordered by white board fences. Call Mrs. Avila a day or two before survey for permission to occupy array, as it is located in her private driveway.

GENERAL DESCRIPTION: IS is nail closest to bridge abutment at driveway entrance. OS is located just north of Prescott Road (see diagram). San Juan Nyland nail line was installed by NOAA-EML personnel in September 1967.



USGS : NYLAND RANCH ALINEMENT ARRAY

(SJN4) 8/16/84

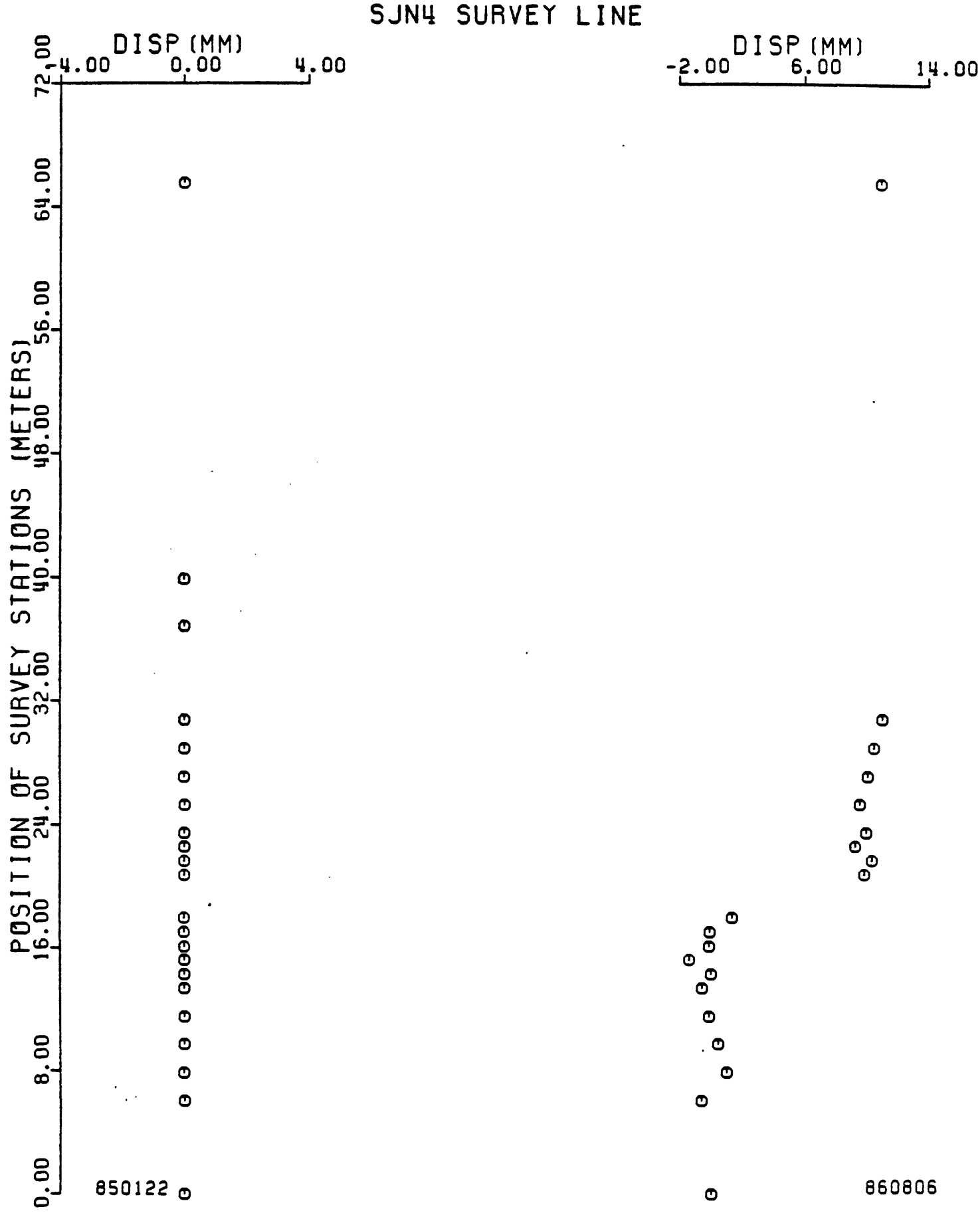


IS-ES	65.555m	IS-16	25.296m
IS-1	3.035m	17	27.117m
2	6.092m	18	28.957m
3	7.918m	19	30.795m
4	9.742m	20	33.835m
5	11.547m	21	36.888m
6	13.404m	22	39.930m
7	14.321m		
8	15.227m		
9	16.119m		
10	17.031m		
11	17.967m		
12	20.748m		
13	21.669m		
14	22.586m		
15	23.493m		

survey marks are Nasons' screw type, center on punched holes

SJN4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 19.5°	
Aug 16	0.00	65.55	0.9426	0.00
1985				
Jan 22	4.07			4.07
Jul 11	1.53			5.60
1986				
Aug 6	5.33			10.93


SJN4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-2.00
6.00
14.00
POSITION OF SURVEY STATIONS (METERS)
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0.00
850122
860806

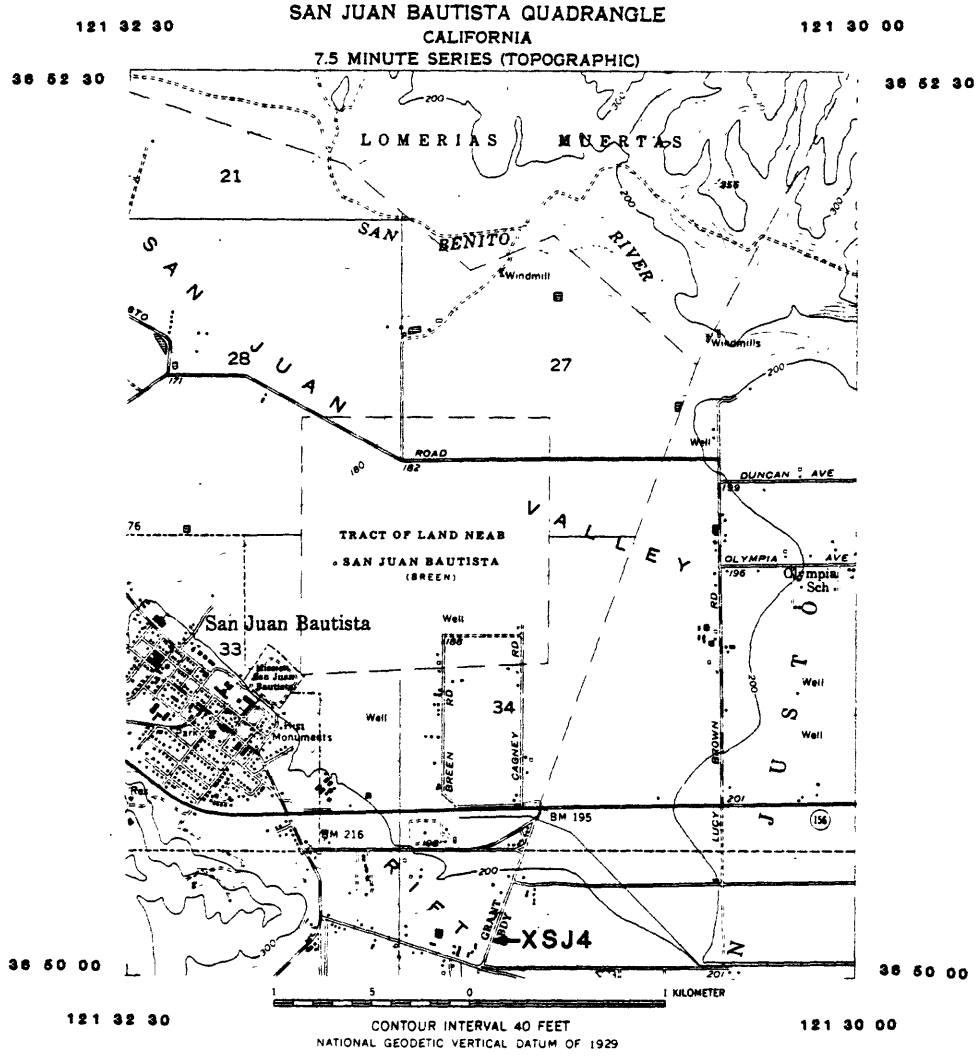
SITE DESCRIPTION

STATION CODE XSJ4 NAME SAN JUAN BAUTISTA COUNTY SAN BENITO

QUAD SAN JUAN BAUTISTA 7.5' LATITUDE 36°50.2' LONGITUDE 121°31.2'

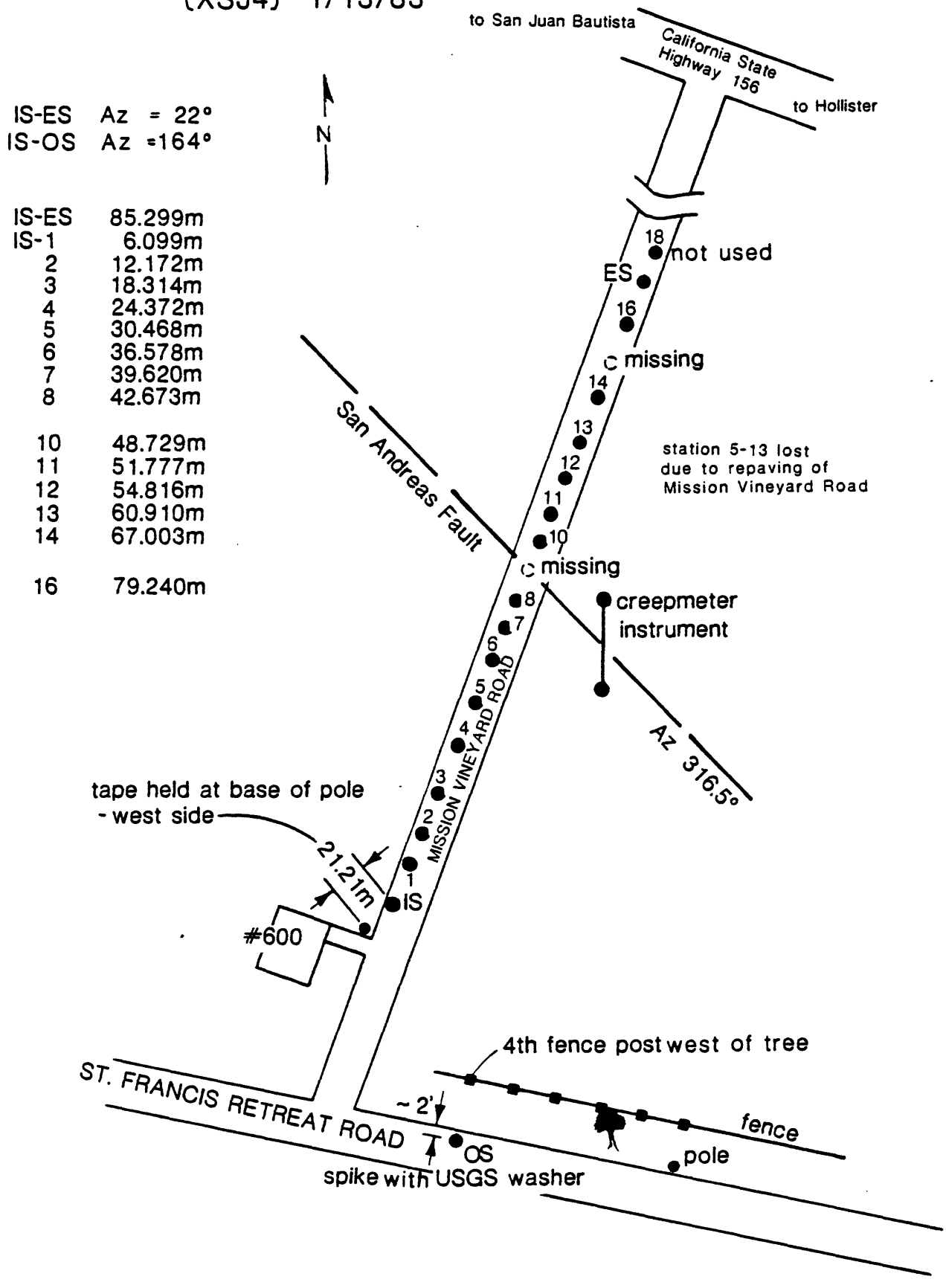
TO REACH: Eight miles south of Gilroy, take San Juan Bautista (Highway 156) turnoff from Highway 101 and travel three miles to intersection with San Juan Highway (flashing yellow light). Continue on Highway 156 0.8 miles to Mission Vineyard Road. Turn right and travel approximately 0.5 miles. Look for creepmeter vault lid located in field on left, next to turnstile in fence.

GENERAL DESCRIPTION: Survey marks are nails with washers in street surface. IS is located adjacent to a telephone pole at the driveway to 600 Mission Vineyard Road. OS is a spike with a USGS washer in surface of St. Francis Retreat Road approximately 2 feet from side of road (see map). Nail line was installed by USGS in 1968; OS was installed by USGS in 1984.



USGS : SAN JUAN BAUTISTA ALINEMENT ARRAY

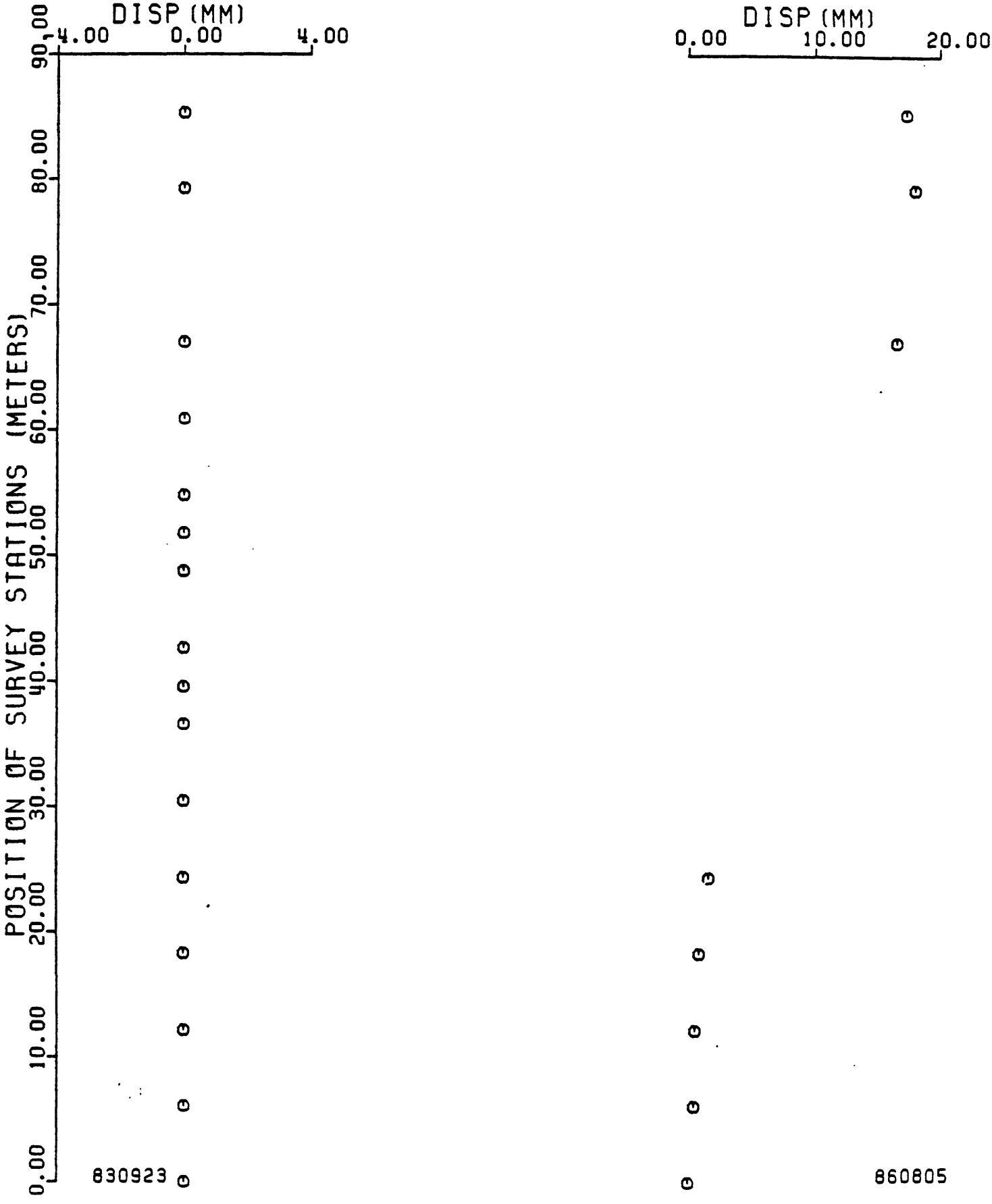
(XSJ4) 1/13/83



XSJ4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 23.0°	
Sep 23	0.00	85.30	0.9205	0.00
1984				
Jun 14	4.89			4.89
Aug 13	1.86			6.75
1985				
Jan 30	-2.51			4.24
1986				
Aug 5	13.05			17.29

XSJ4 SURVEY LINE



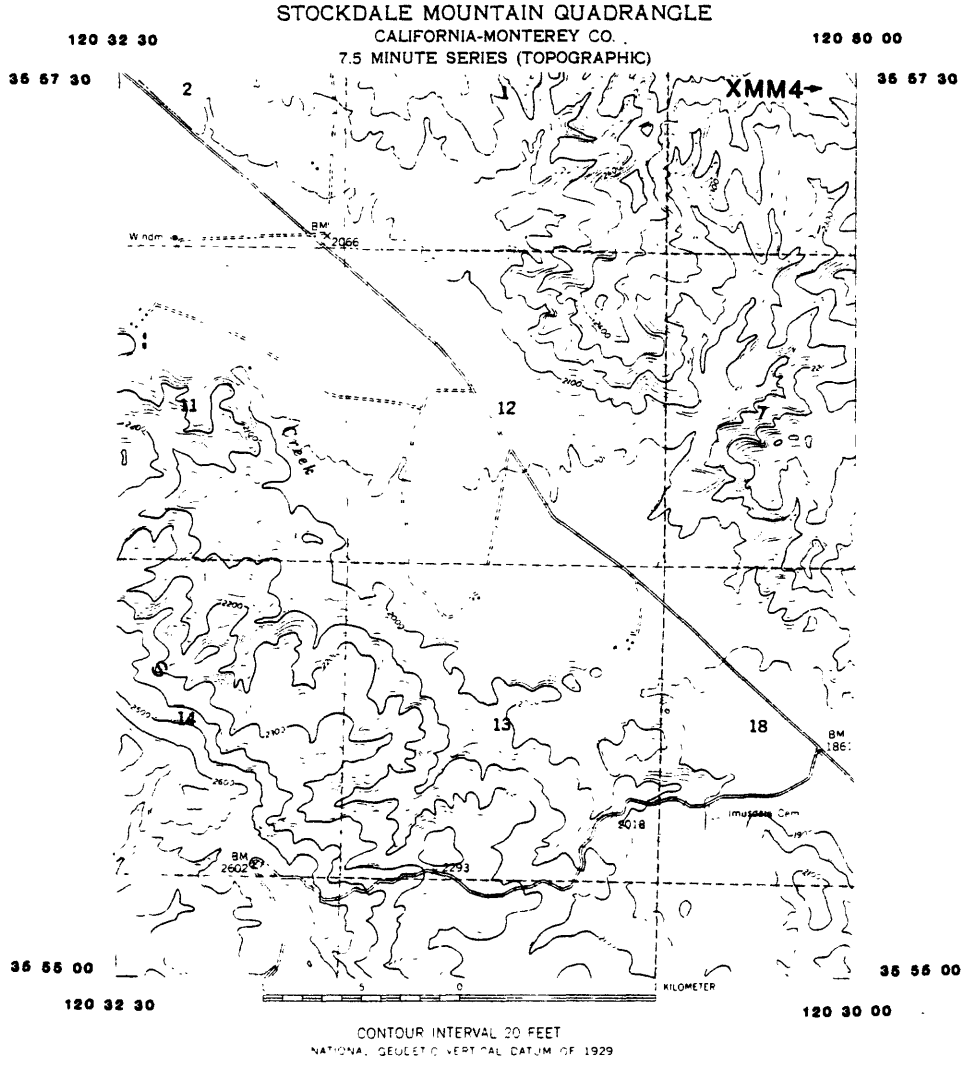
SITE DESCRIPTION

STATION CODE XMM4 **NAME** MIDDLE MOUNTAIN **COUNTY** MONTEREY

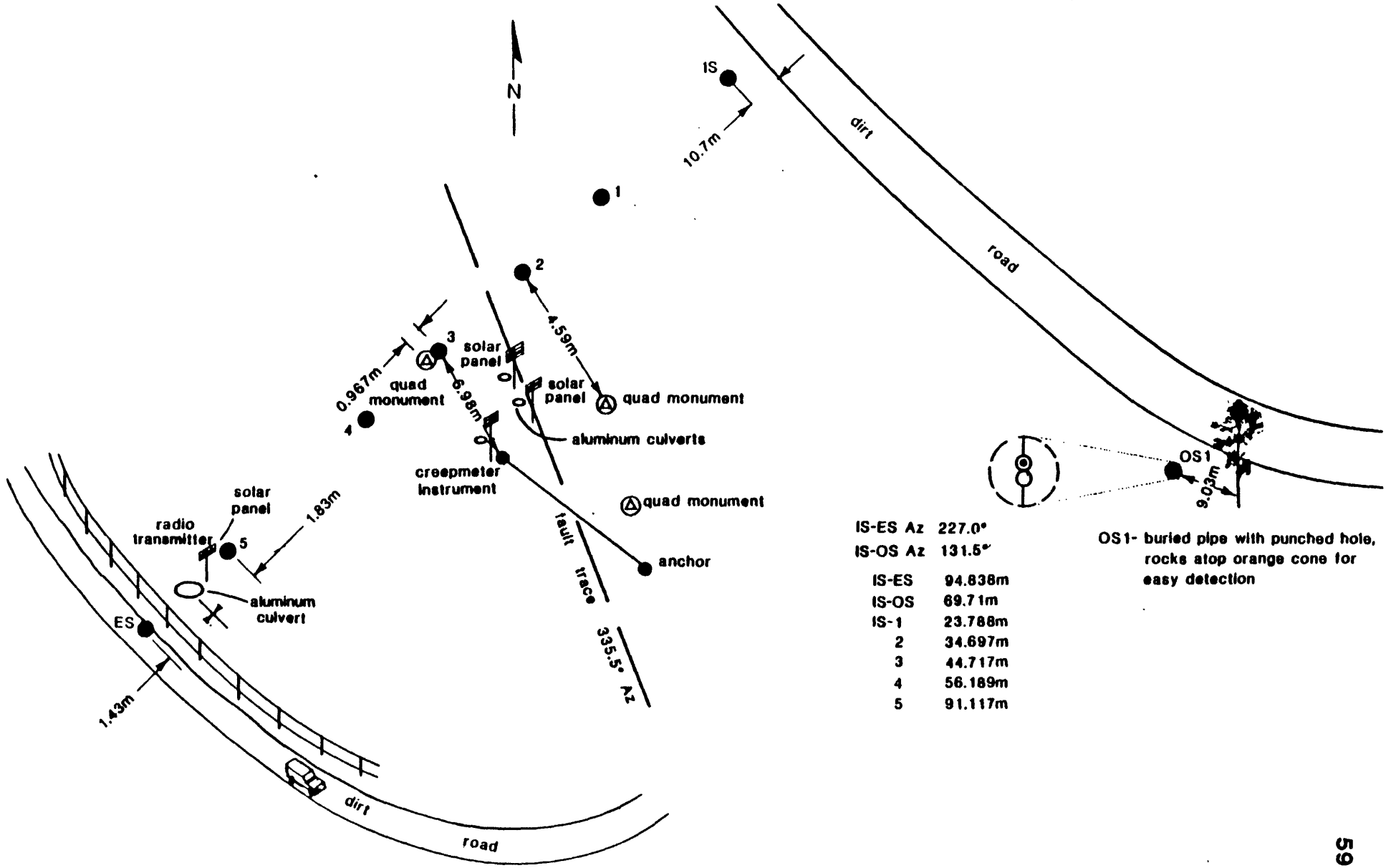
QUAD STOCKDALE MOUNTAIN 7.5' **LATITUDE** 35°57.5' **LONGITUDE** 120°30.1'

TO REACH: From San Miguel, take Vineyard Canyon Road 19 miles to dead-end at road to Parkfield, and turn south. Proceed 4 miles to Parkfield turnoff, turn left, cross bridge, pass through town, and proceed 5 miles to Varian Ranch. Immediately past ranch entrance, turn left on dirt track, cross field, and follow trail, which alternately parallels or runs on top of ridge, and travel approximately 2 miles. Creepmeter will be visible to west in a swale. Alinement array runs east-west near creepmeter instrument end.

GENERAL DESCRIPTION: Survey monuments are covered by rocks. Array passes just north of creepmeter and solar panels. ES is located on top of ridge in center of dirt road, beyond fence near radio transmitter and battery culvert. IS used for measurements in this catalog is sixth marker to northeast of ES and closest monument to road on array side of fence. OS is 9.03 meters northwest from a large tree which lies southeast of IS. Monuments were installed by USGS in 1979.



USGS : MIDDLE MOUNTAIN ALINEMENT ARRAY
(XMM4) 4/29/84
(STOP AT RANCH HOUSE PRIOR TO ENTRY)

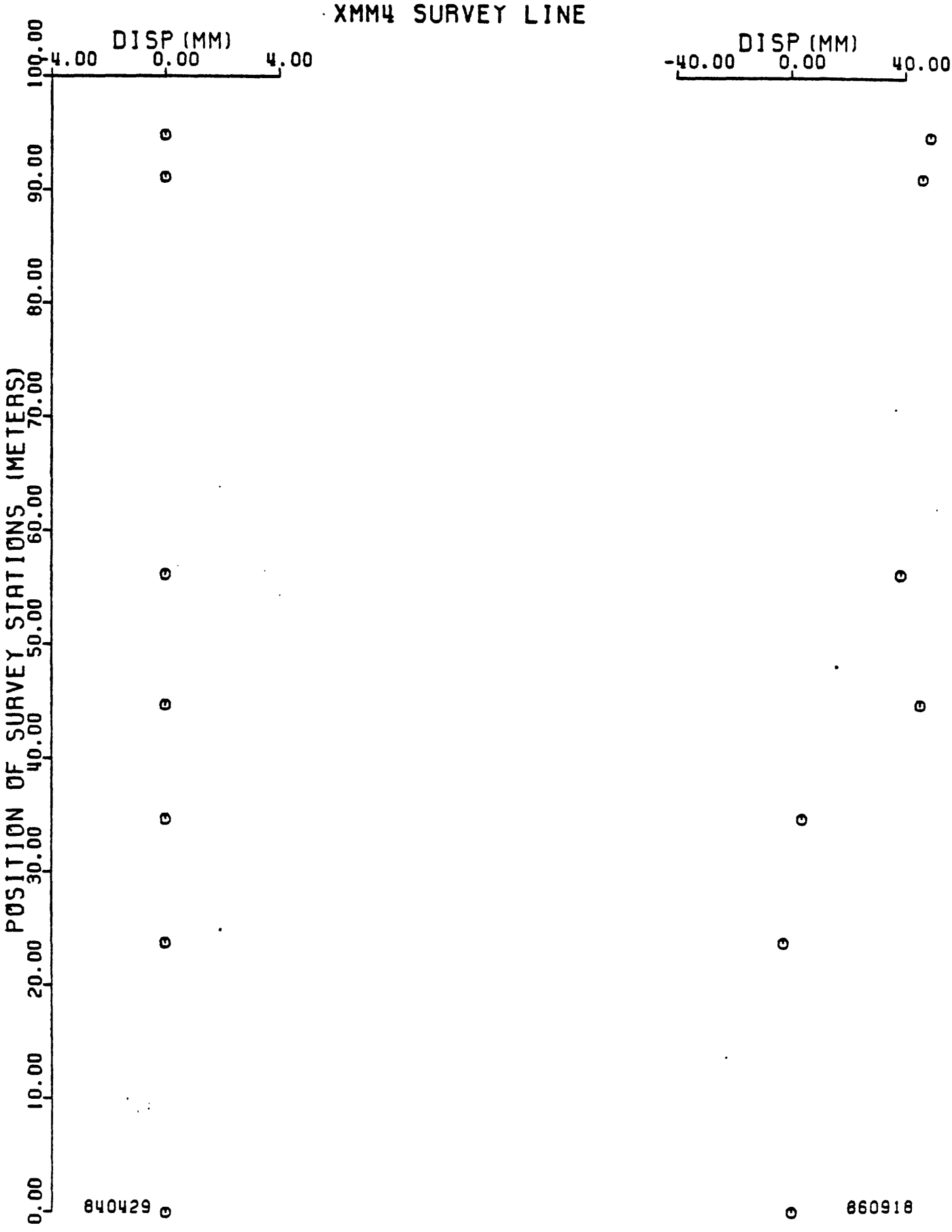


IS-ES Az	227.0°
IS-OS Az	131.5°
IS-ES	94.838m
IS-OS	69.71m
IS-1	23.788m
2	34.697m
3	44.717m
4	56.189m
5	91.117m

OS1- buried pipe with punched hole, rocks atop orange cone for easy detection

XMM4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 18.5°	
Apr 29	0.00	94.84	0.9483	0.00
May 10	-1.03			-1.03
Jun 19	1.71			0.68
Aug 7	4.60			5.28
1985				
Jun 11	7.69			12.97
1986				
Jun 24	30.10			43.07
Sep 18	4.48			47.55


XMM4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-40.00
0.00
40.00
POSITION OF SURVEY STATIONS (METERS)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
840429
860918

SITE DESCRIPTION

STATION CODE MDR4 **NAME** MIDDLE RIDGE **COUNTY** MONTEREY

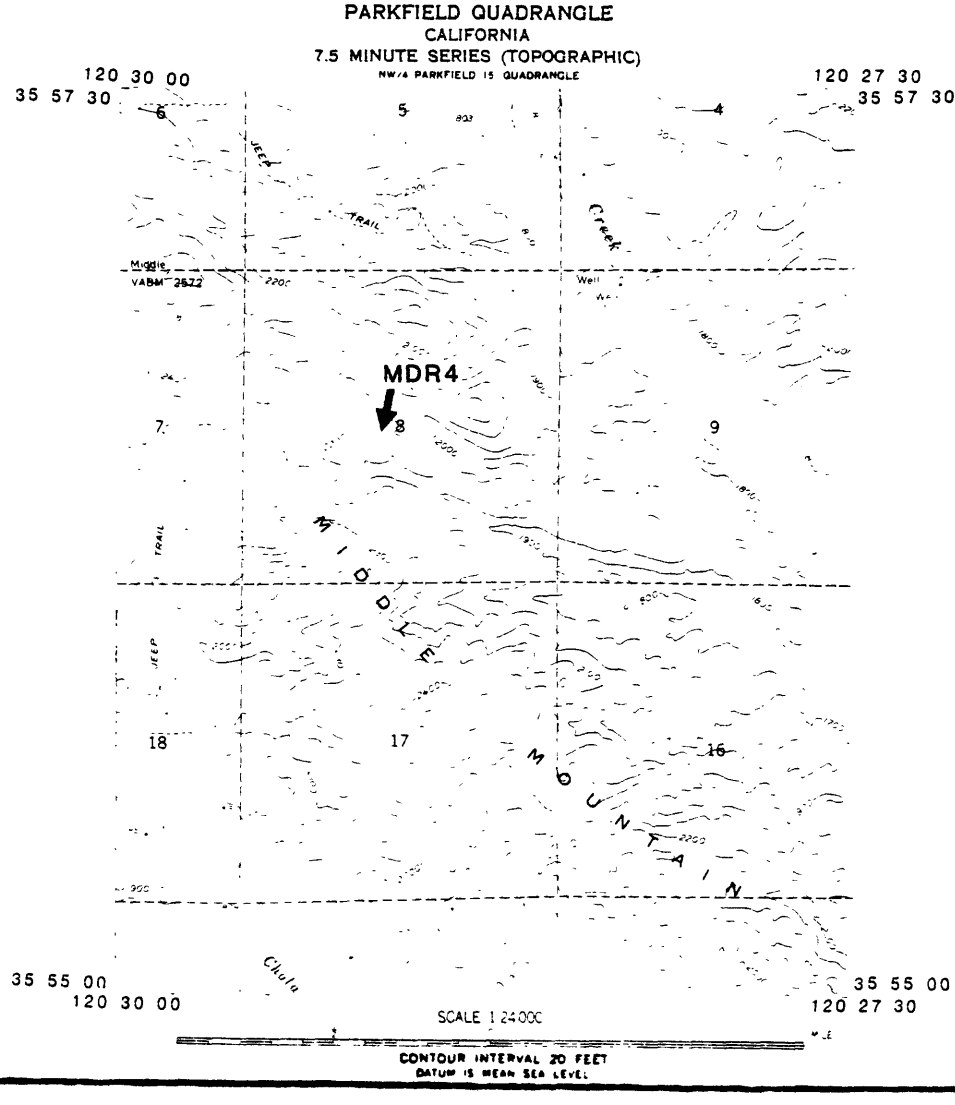
QUAD PARKFIELD 7.5' **LATITUDE** 35°56.6' **LONGITUDE** 120°29.1'

TO REACH: From San Miguel, take Vineyard Canyon Road northeast 19 miles to dead-end at road to Parkfield. Turn right and travel 0.6 mi to gate on left near two mailboxes, one marked "Roden", 3405, and the other "Focht", 3406. Turn in, drive beside fence and after 0.17 miles, take left fork. Follow road for 0.6 m, through gate, go right at fork, and then observe following directions:

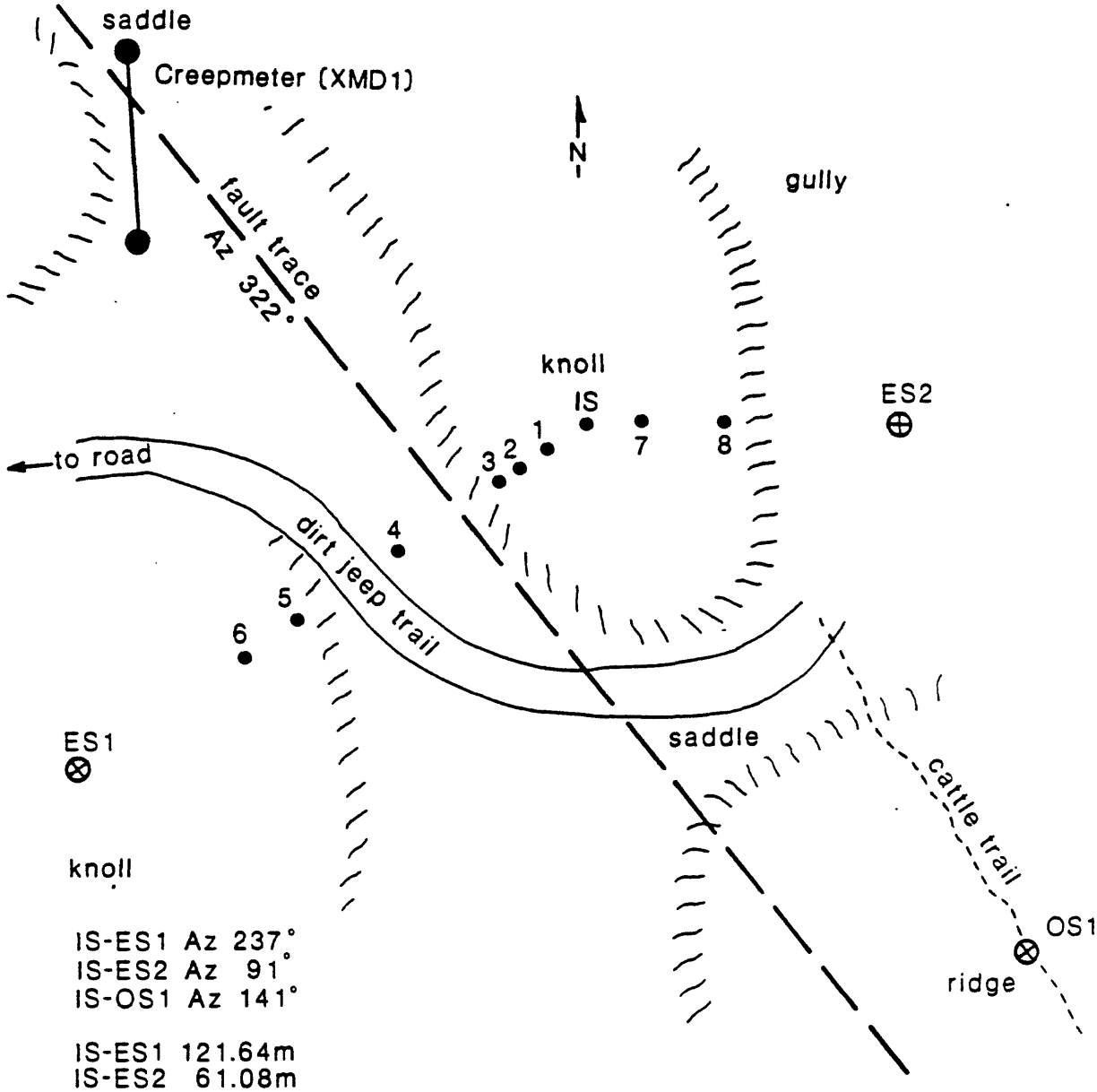
Travel: 0.3 mi, turn left at fork,
0.25 mi, go through gate,
0.22 mi, turn left at fork,
0.36 mi, at windmill, veer left around broken-down corral, taking road to left up steep grade,
0.57 mi, turn right at fork and go through gap in fence,
0.35 mi, turn left at fork,
0.10 mi, turn left at fork,
0.33 mi, you are at site.

GENERAL DESCRIPTION:

IS is on top of small ridge to left. ES1 is 121.6 m from IS at an azimuth of 237°. ES2 is 61 m from IS at an azimuth of 91°. OS1 is on knoll 136.7 m southwest of IS, right beside cow path and before you reach base of small slope on knoll. IS, both ES's, and OS are brass monuments marked with station numbers. Deflection monuments are yellow survey plugs with numbers stamped on them.



USGS : MIDDLE RIDGE ALINEMENT ARRAY
(MDR4) 6/10/86

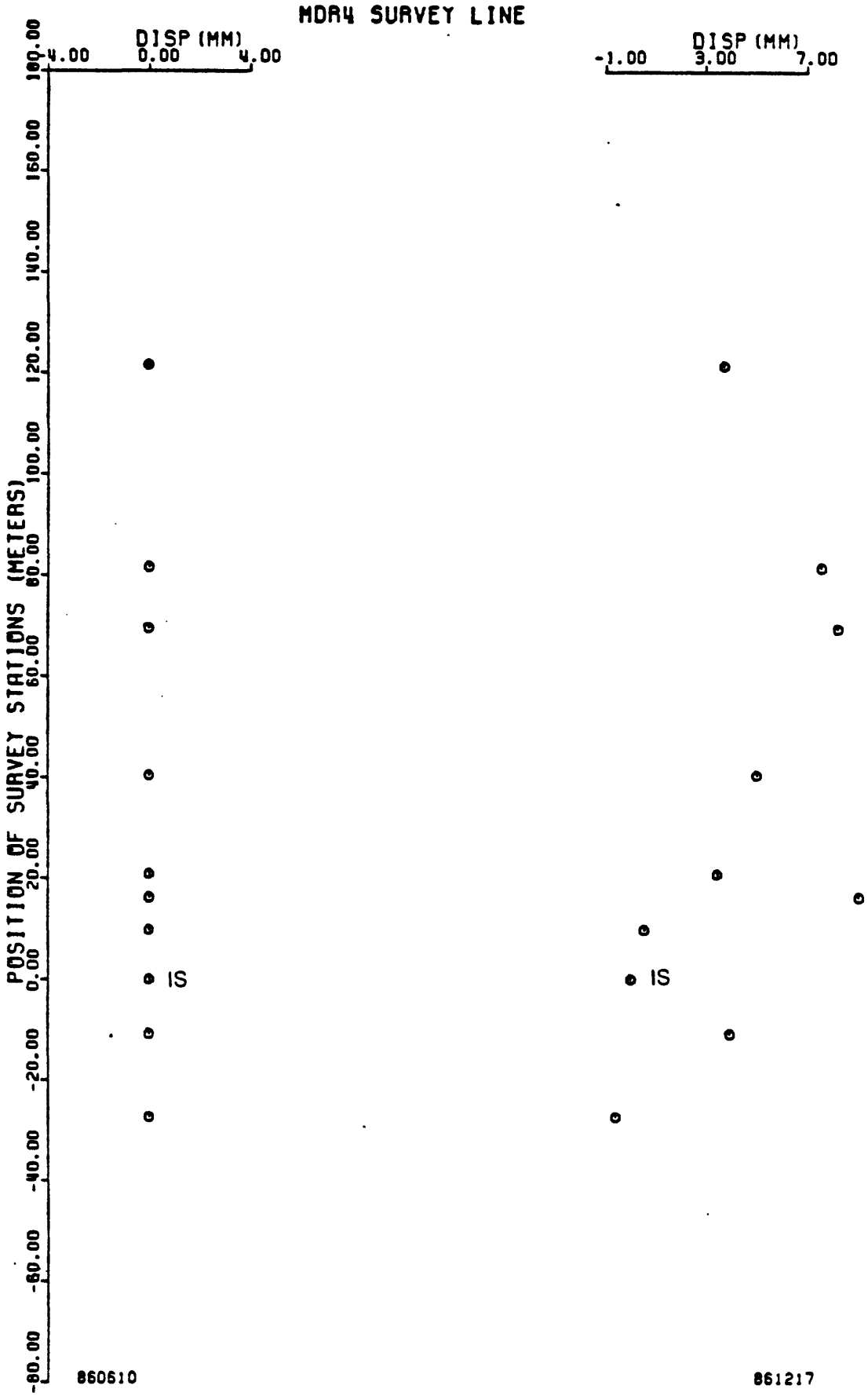


IS-ES1 Az 237°
IS-ES2 Az 91°
IS-OS1 Az 141°

IS-ES1	121.64m
IS-ES2	61.08m
IS-OS1	136.67m
IS-1	9.82m
2	16.31m
3	20.95m
4	40.48m
5	69.60m
6	81.47m
7	10.7 m
8	27.2 m

MDR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 5.0°	
Jun 10	0.00	121.64	0.9962	0.00
Dec 17	3.73			3.73


MDR4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-1.00
3.00
7.00
POSITION OF SURVEY STATIONS (METERS)
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
IS
IS
860610
861217

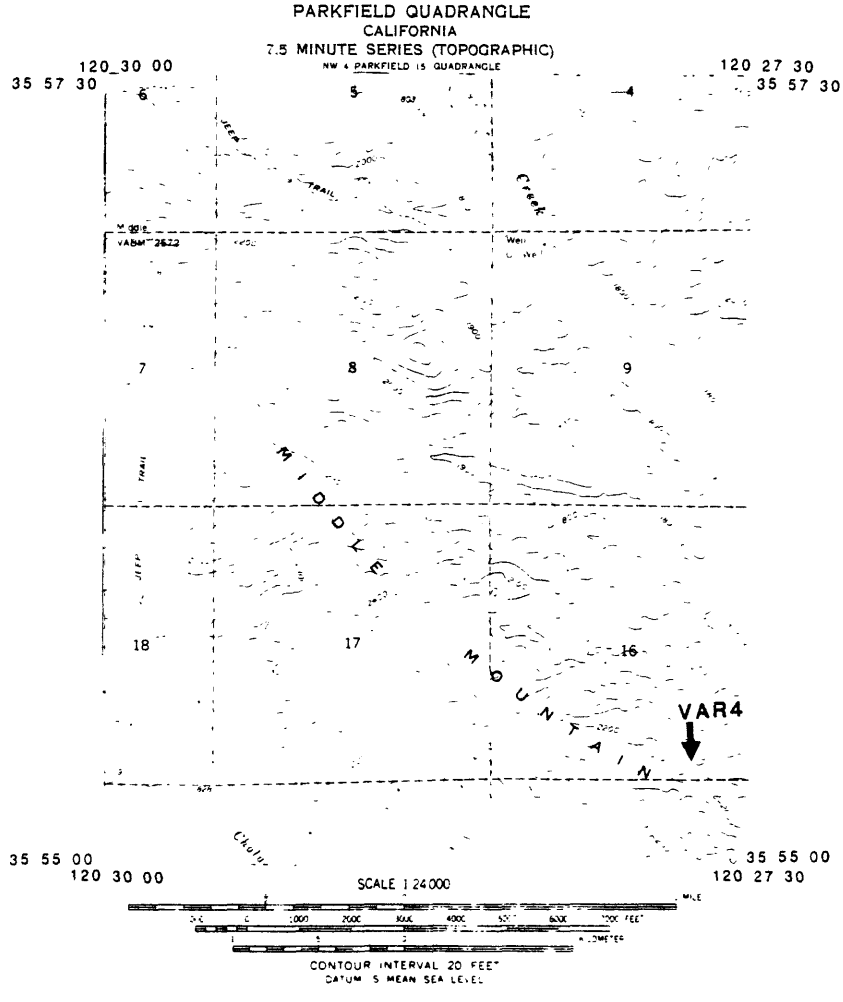
SITE DESCRIPTION

STATION CODE VAR4 **NAME** VARIAN RANCH **COUNTY** MONTEREY

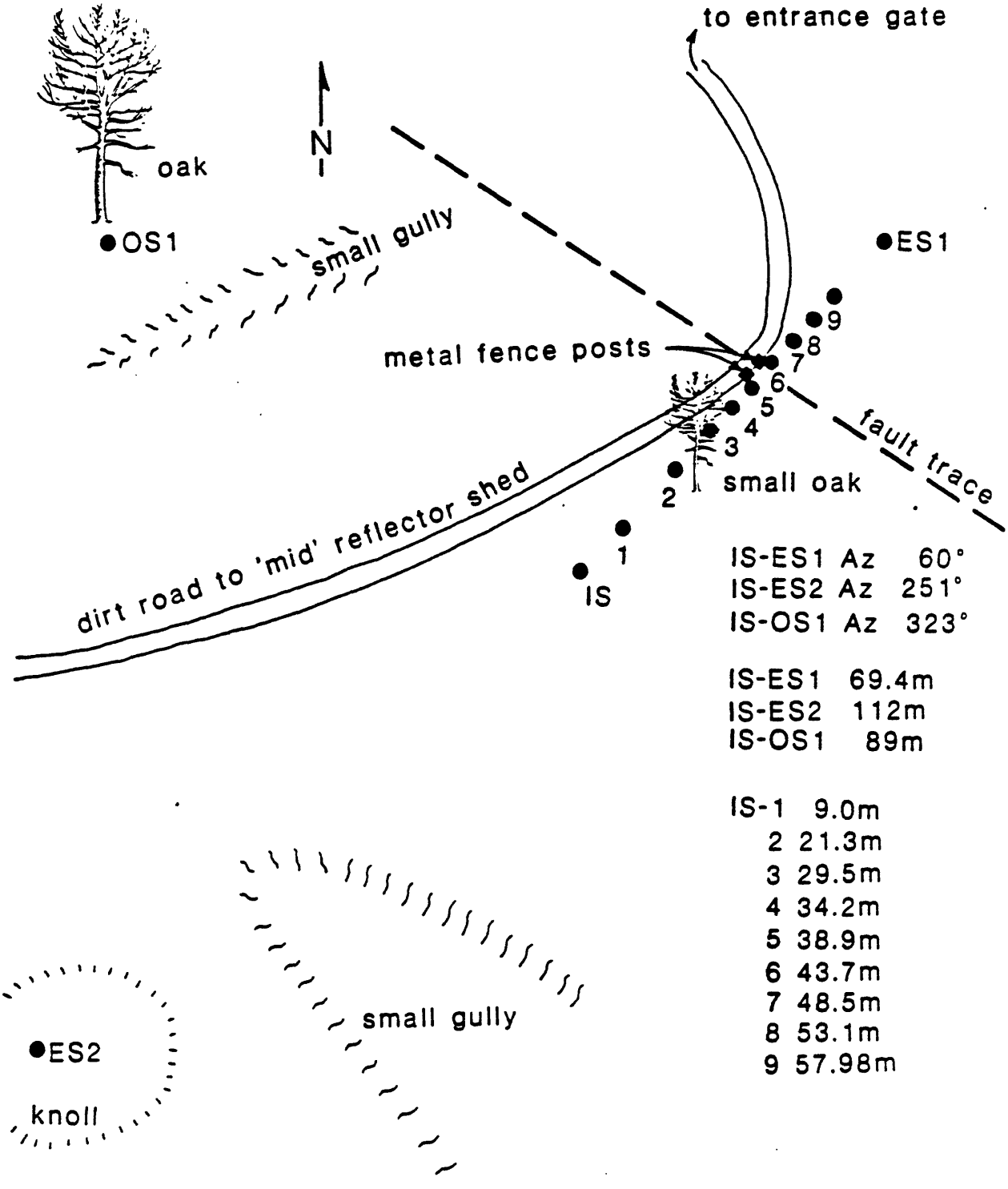
QUAD PARKFIELD 7.5' **LATITUDE** 35°55.3' **LONGITUDE** 120°27.7'

TO REACH: From San Miguel, take Vineyard Canyon Road 19 miles to dead-end at road to Parkfield, and turn south. Proceed 4 miles to Parkfield turnoff, turn left, cross bridge, pass through town and proceed 3.3 miles to home of Blaine and Katy Santos (sign over gate). Turn in at barbed wire gate at north side of house. Combination to the USGS lock is 2364 (May 1986). Cross field to hill and follow track for 0.7 miles, taking right-hand road at fork, and travel to where road crosses the fault gulley. Two metal fenceposts beside road protect deflection monuments 5 and 6 from traffic.

GENERAL DESCRIPTION: All monuments are subsurface, are covered with aluminum lids with dirt on top, and are either brass tablets marked with "1986" or yellow survey plugs stamped with the monument number. ES1 is on ridge to left as road descends toward fault zone. IS is near middle of hill southwest of metal posts. ES2 is on knoll visible from IS, and can be reached by continuing on road then turning left. OS1 is beside an oak 89 meters northwest from IS. Monuments were installed by USGS in 1986.
NOTE: BEFORE EACH VISIT, CALL BLAINE SANTOS, 805-463-2354, FOR PERMISSION TO ENTER PROPERTY.

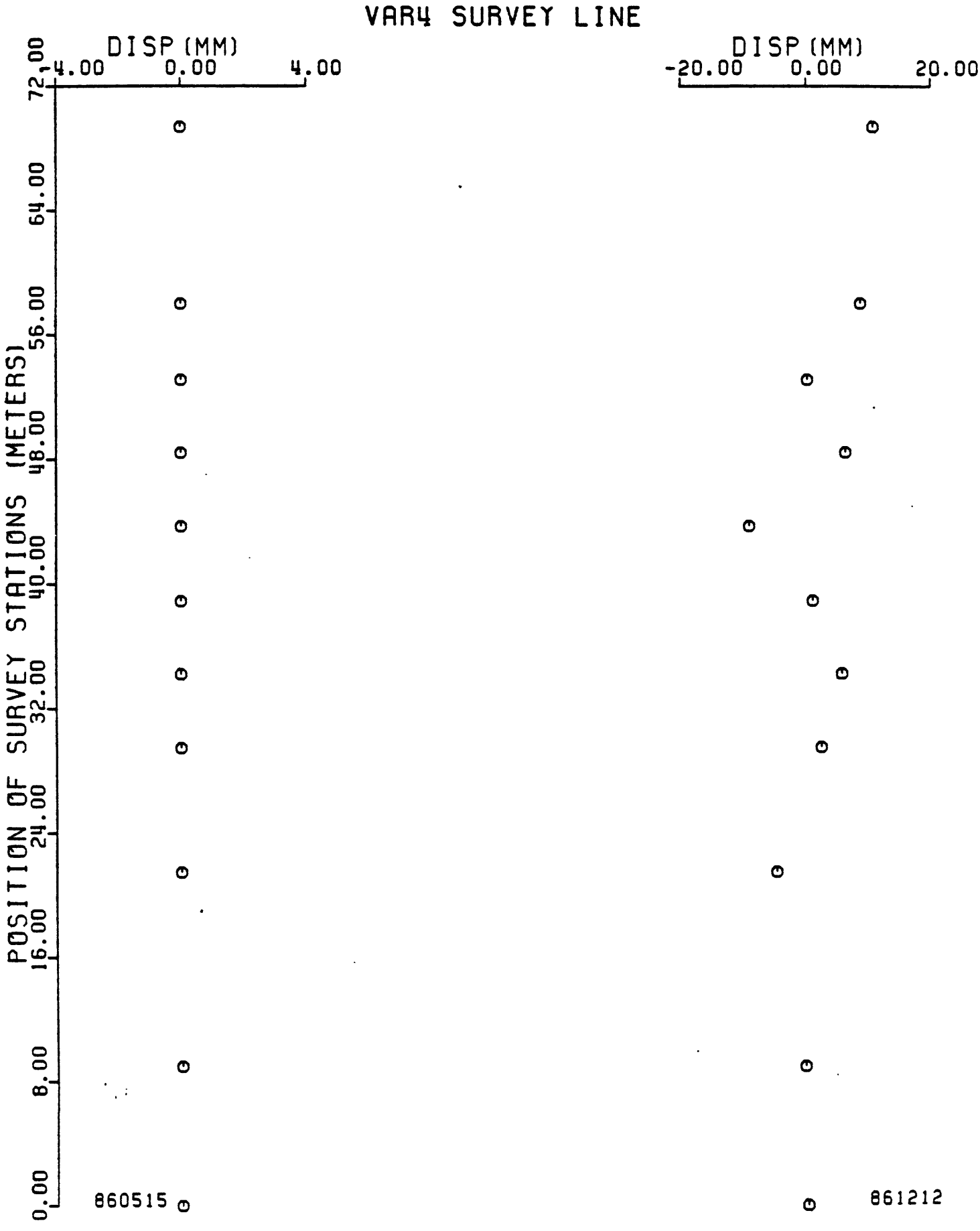


USGS : VARIAN RANCH ALINEMENT ARRAY
(VAR4) 4/23/86



VAR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 10.0°	
May 15	0.00	69.40	0.9848	0.00
Jun 25	3.85			3.85
Jul 24	2.85			6.70
Aug 13	-2.13			4.57
Oct 10	3.24			7.81
Dec 12	2.87			10.69


VAR4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-20.00
0.00
20.00
POSITION OF SURVEY STATIONS (METERS)
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0.00
860515
861212

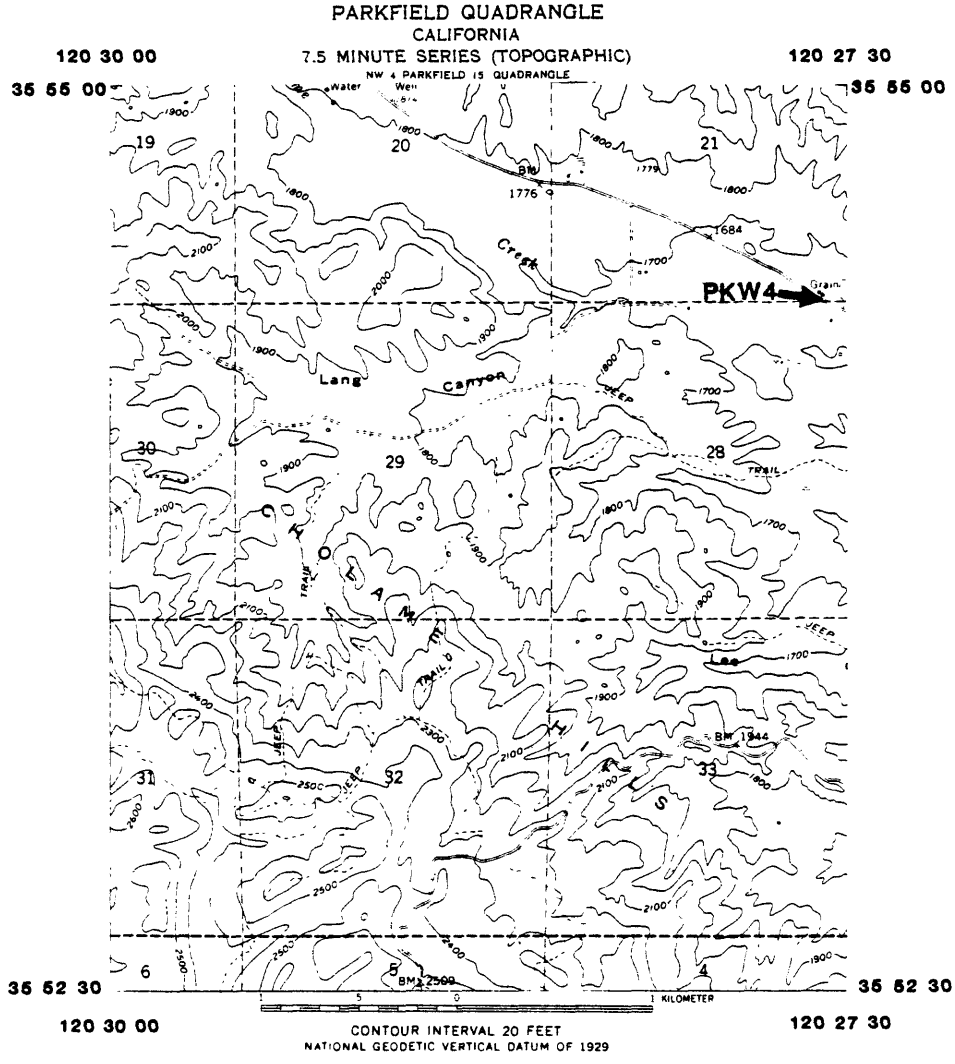
SITE DESCRIPTION

STATION CODE PKW4 NAME PARKFIELD KESTER COUNTY MONTEREY

QUAD PARKFIELD 7.5' LATITUDE 35°54.4' LONGITUDE 120°27.6'

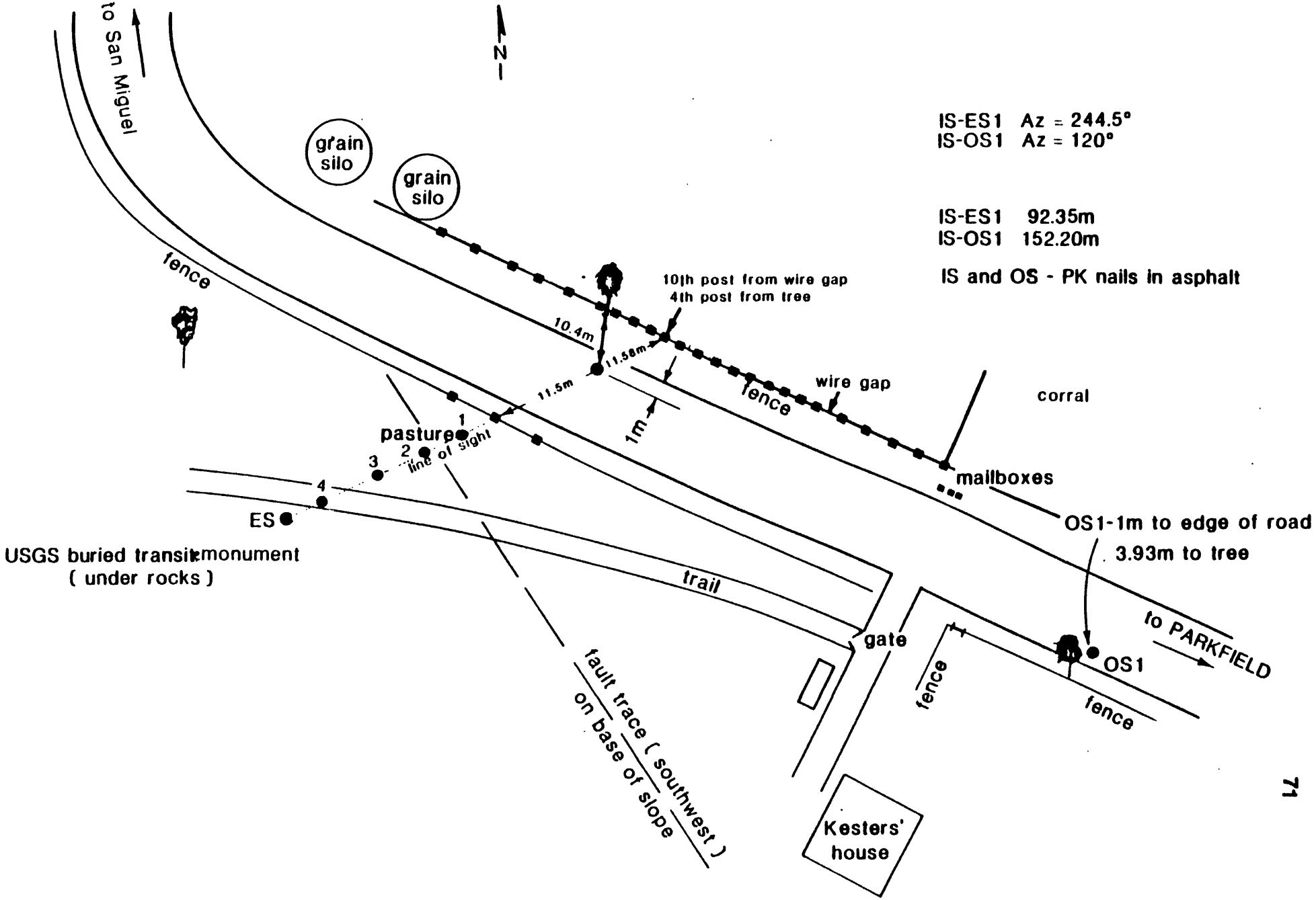
TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to deadend at road to Parkfield. Turn right and travel approximately 2.75 miles south to Kester Ranch driveway.

GENERAL DESCRIPTION: Parkfield Kester alinement array is about 50 meters north of Kester Ranch house. IS is a P&K nail in asphalt one meter from east side of road and 10.4 meters from tree just south of two grain silos. ES1 is reached via driveway and is just west of a dirt jeep trail on ridge west of road. OS is just south of ranch entrance, 3.93 meters from first tree and one meter from east edge of road. Monuments were installed by USGS in 1985.



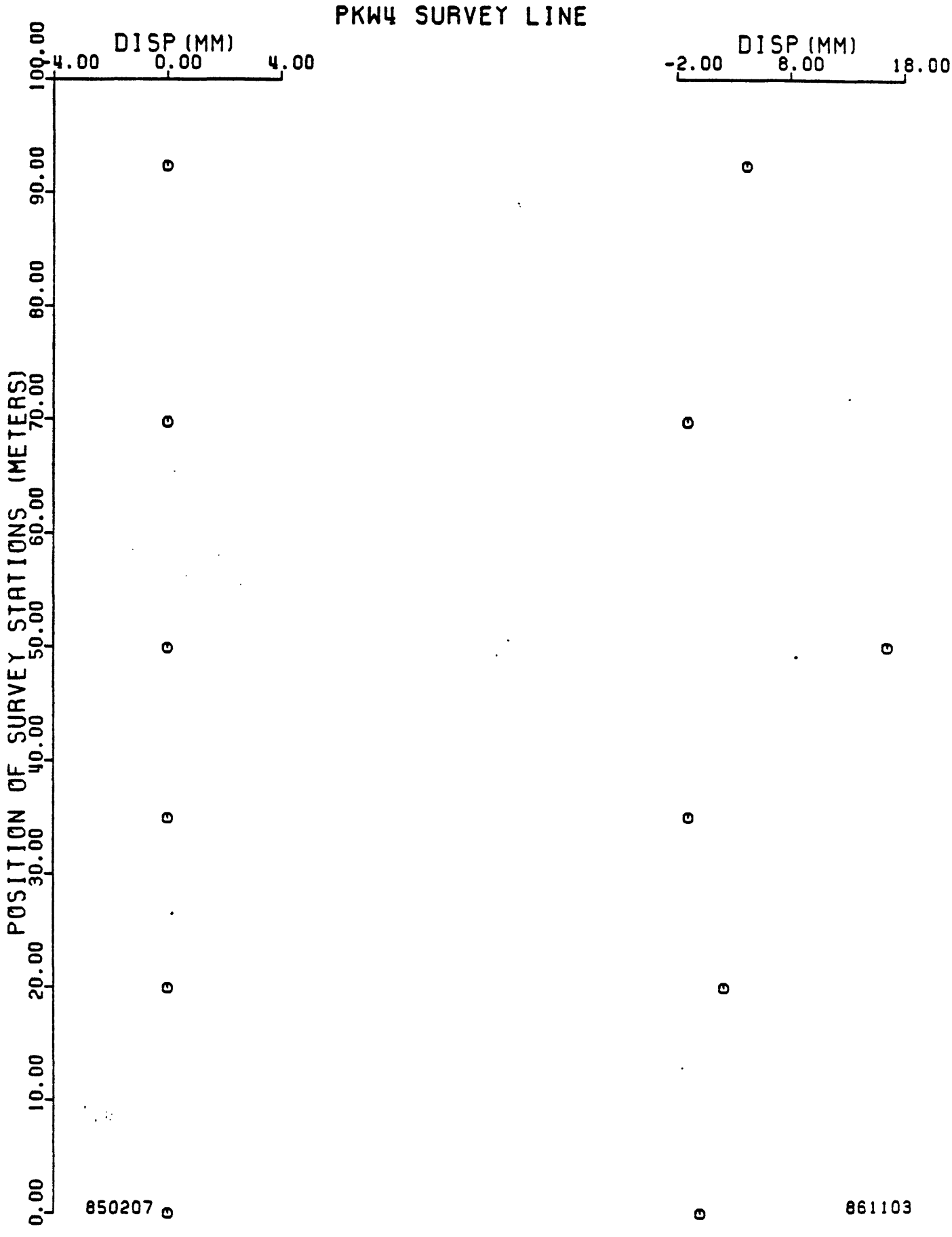
USGS : PARKFIELD KESTER WEST ALINEMENT ARRAY

(PKW4) 2/6/85



PKW4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1985			Cos 21.5°	
Feb 7	0.00	92.35	0.9304	0.00
Apr 4	0.45			0.45
Jul 31	-3.90			-3.45
Nov 15	0.14			-3.31
1986				
Jul 17	9.84			6.53
Nov 3	-2.41			4.12
Dec 12	0.44			4.56


PKW4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-2.00
8.00
18.00
POSITION OF SURVEY STATIONS (METERS)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
850207
861103

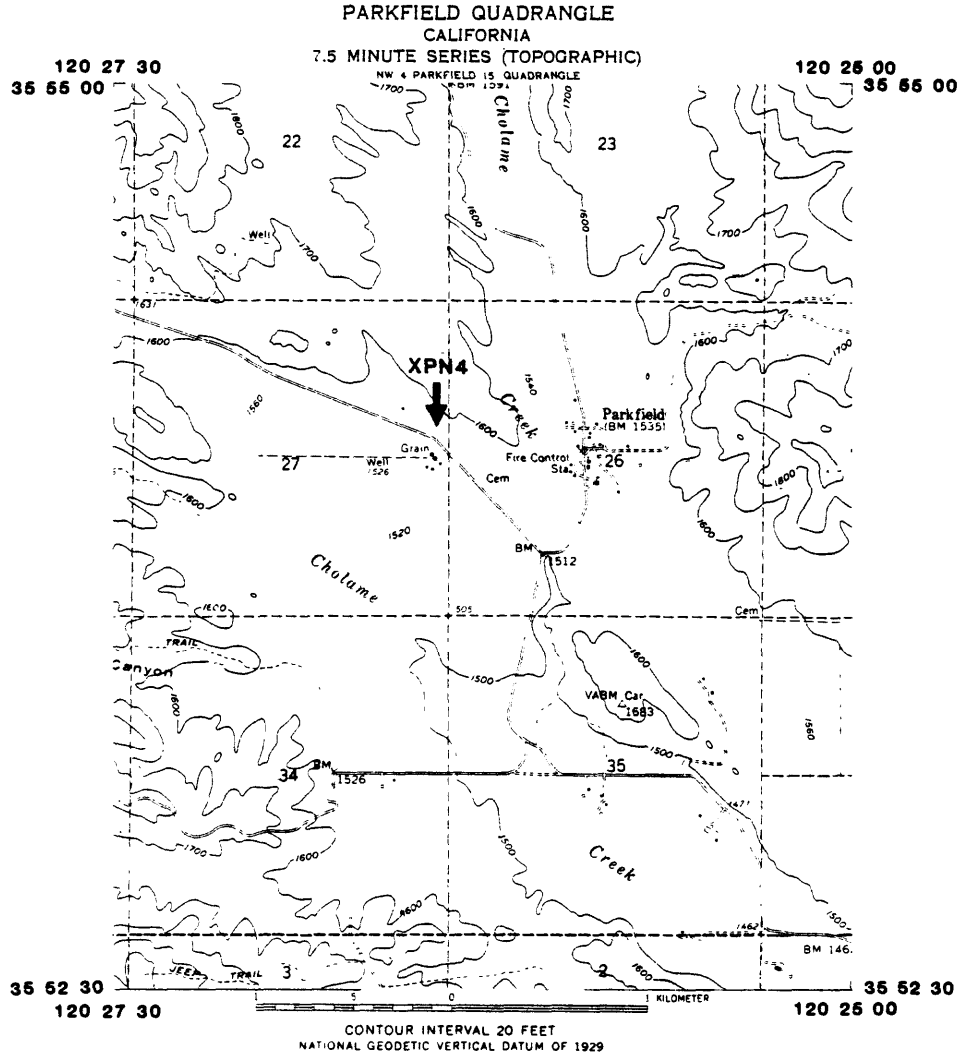
SITE DESCRIPTION

STATION CODE XPN4 NAME PARKFIELD NORTH COUNTY MONTEREY

QUAD PARKFIELD 7.5' LATITUDE 35°54.0' LONGITUDE 120°18.5'

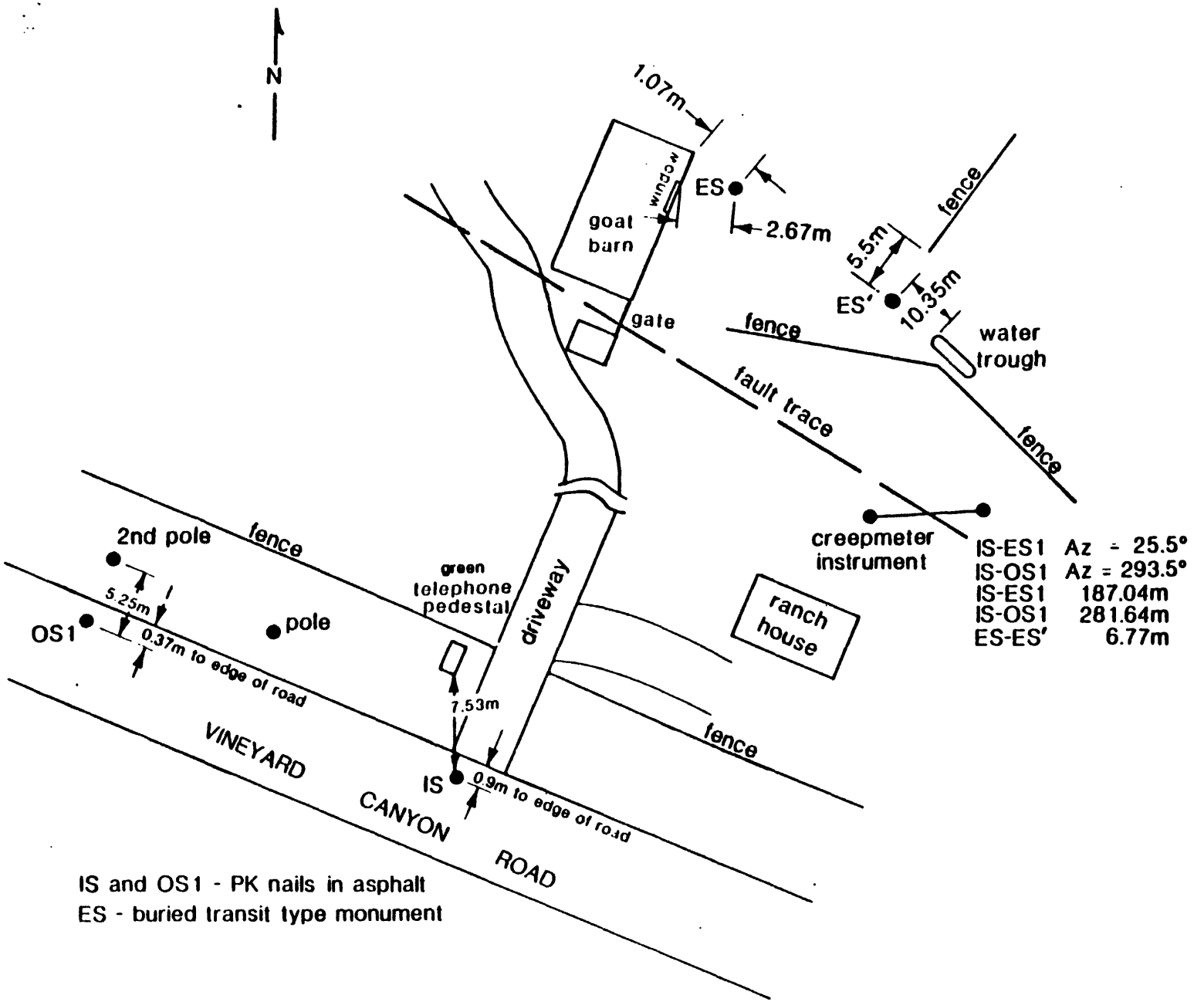
TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to deadend at road to Parkfield and turn south. Parkfield North alinement array is 3.83 miles from intersection.

GENERAL DESCRIPTION: IS and OS are P&K nails. IS is 0.9 meters from edge of asphalt in front of driveway into Roberson ranch. OS is 0.37 meters north from edge of asphalt and 5.25 meters from second telephone pole from IS. ES is at end of driveway near northwest corner of goat barn at base of slope. ES1 is buried pipe with yellow survey marker in it. Monuments were installed by USGS in 1984.



USGS : PARKFIELD NORTH ALINEMENT ARRAY

(XPN4) 12/27/84



XPN4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 18.5°	
Dec 27	0.00	187.04	0.9483	0.00
1985				
Jan 16	0.49			0.49
Apr 4	-0.09			0.40
Jul 31	2.04			2.44
Sep 30	3.01			5.45
Nov 13	1.86			7.31
1986				
Jun 26	3.50			10.81
Nov 5	7.60			18.41

NOTE: This was was established as an end-point-only survey. Thus it has no deflection target readings and therefore no plot.

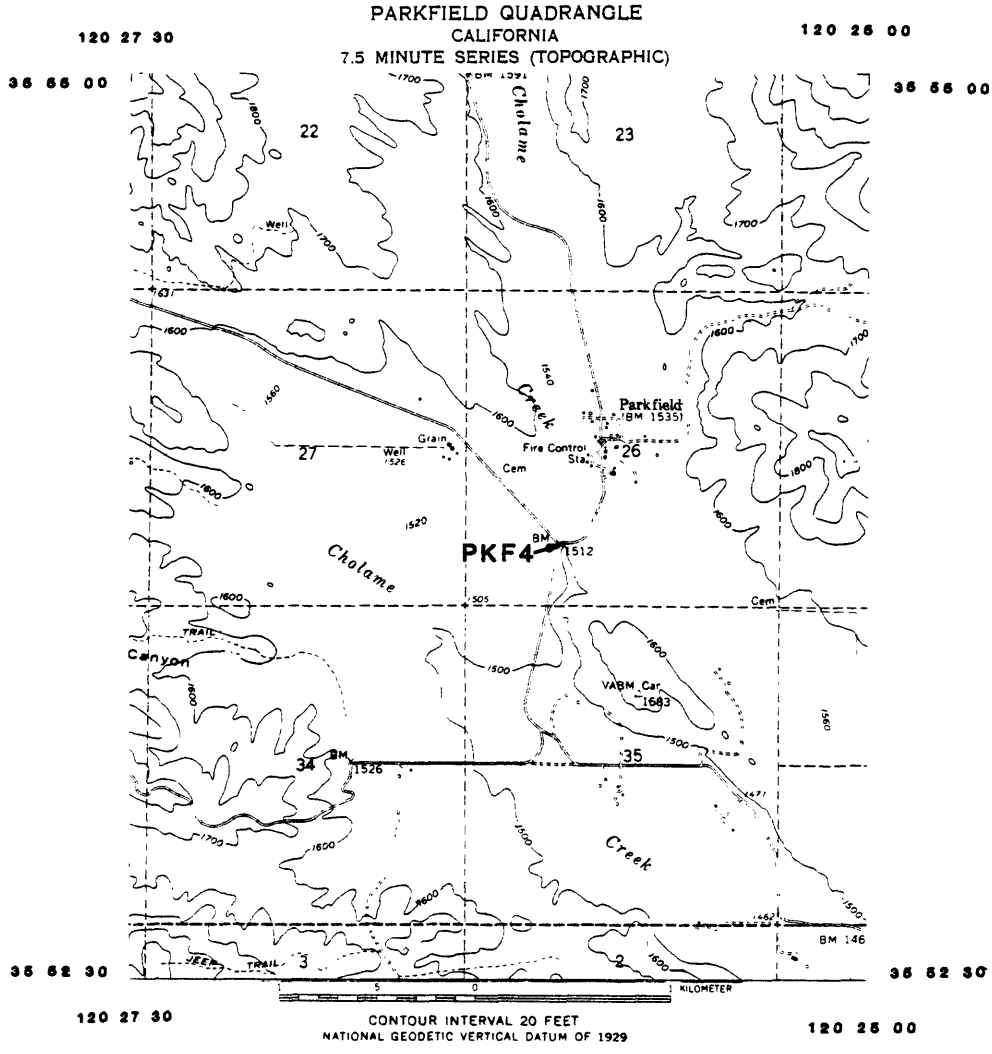
SITE DESCRIPTION

STATION CODE PKF4 NAME PARKFIELD BRIDGE COUNTY MONTEREY

QUAD PARKFIELD 7.5' LATITUDE 35°53.7' LONGITUDE 120°26.0'

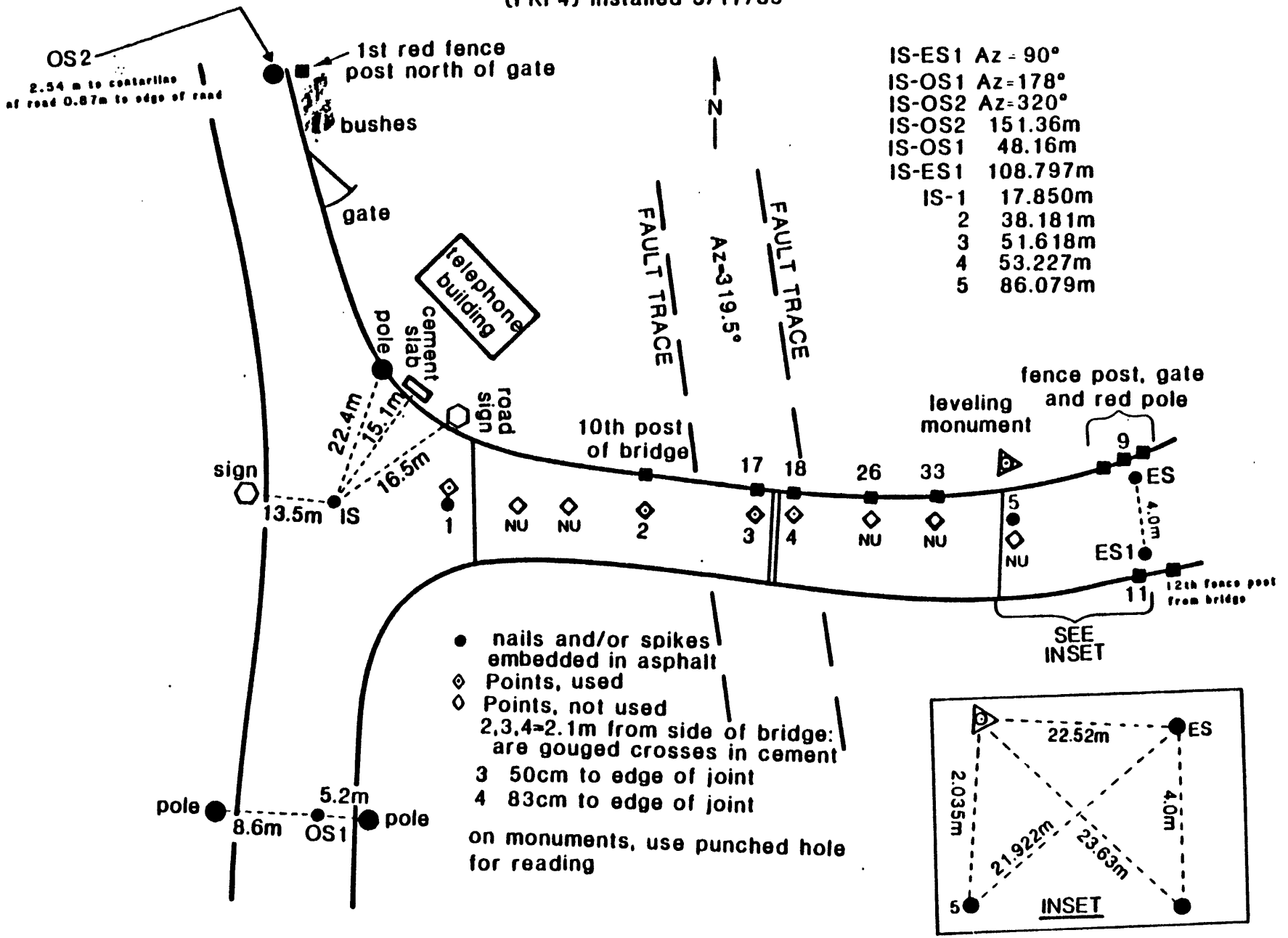
TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to dead-end at road to Parkfield, turn right and proceed 4 miles to Parkfield turnoff. Array is located directly atop bridge into Parkfield.

GENERAL DESCRIPTION: One set of survey marks are spikes and nails in asphalt on either side of bridge. Another set are crosses chiseled in cement roadway of bridge. There are two orientation stations, one south and one north of IS. OS and ES monuments used to produce data for this catalog were installed by USGS in 1983. It is not known when other marks were installed, or by whom.



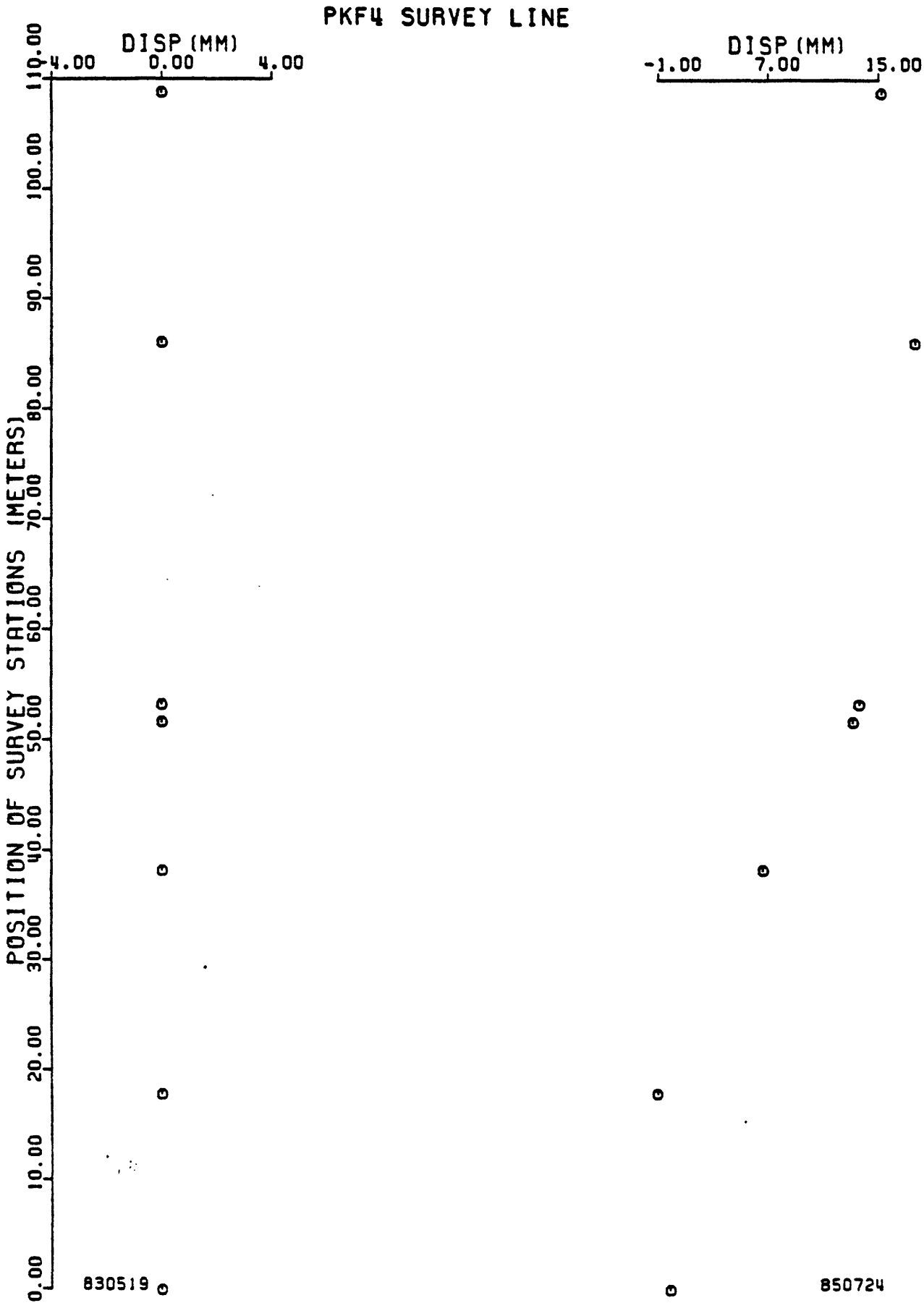
USGS: PARKFIELD BRIDGE ALINEMENT ARRAY

(PKF4) installed 5/17/83



PKF4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 40.5°	
May 19	0.00	108.70	0.7604	0.00
Aug 2	2.86			2.86
1984				
Jan 5	-3.98			-1.12
Jun 5	1.29			0.17
Aug 7	5.73			5.90
1985				
Jan 17	-3.82			2.08
Apr 25	4.50			6.58
Jul 24	8.65			15.23
Nov 7	6.12			21.35
1986				
Jan 27	-5.08			16.27
Jul 22	5.10			21.37
Oct 17	5.62			26.99


PKF4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-1.00
7.00
15.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
830519
850724

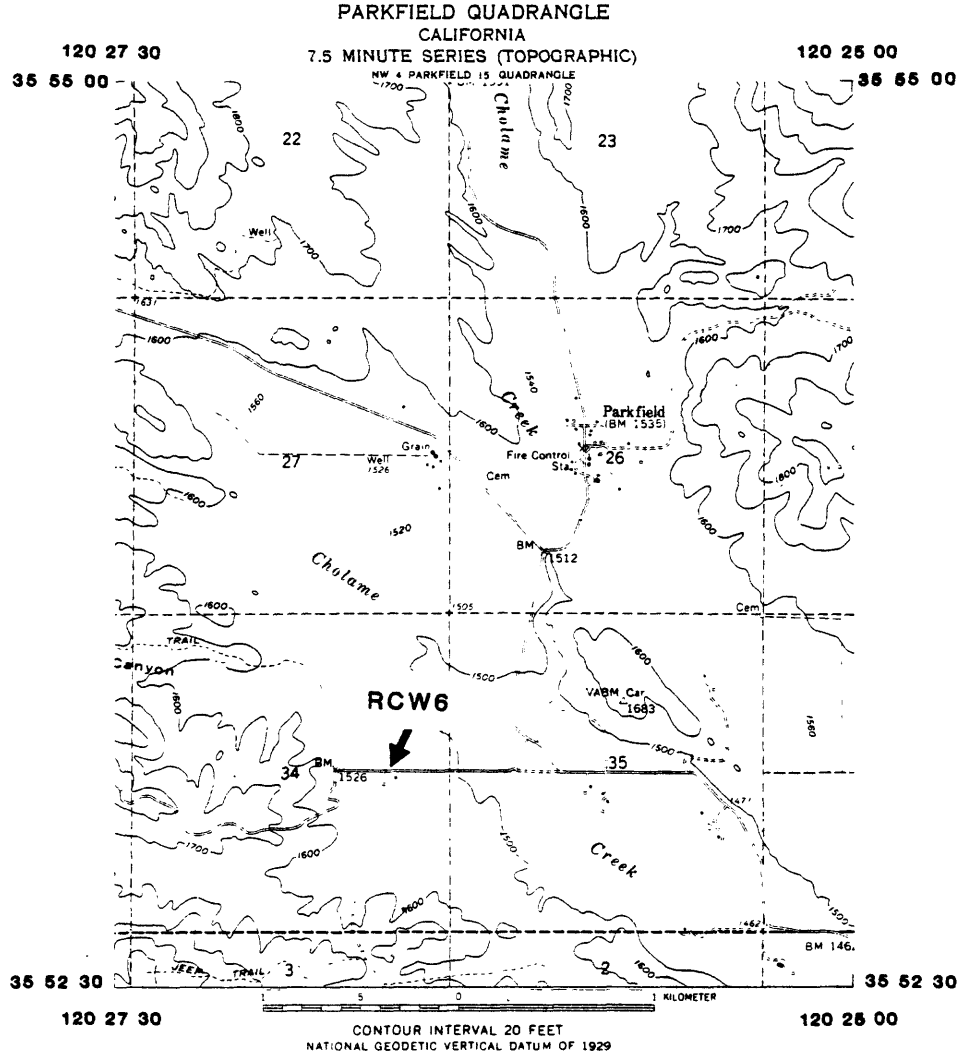
SITE DESCRIPTION

STATION CODE RCW5, RCW6 NAME RANCHITA CANYON WEST COUNTY MONTEREY

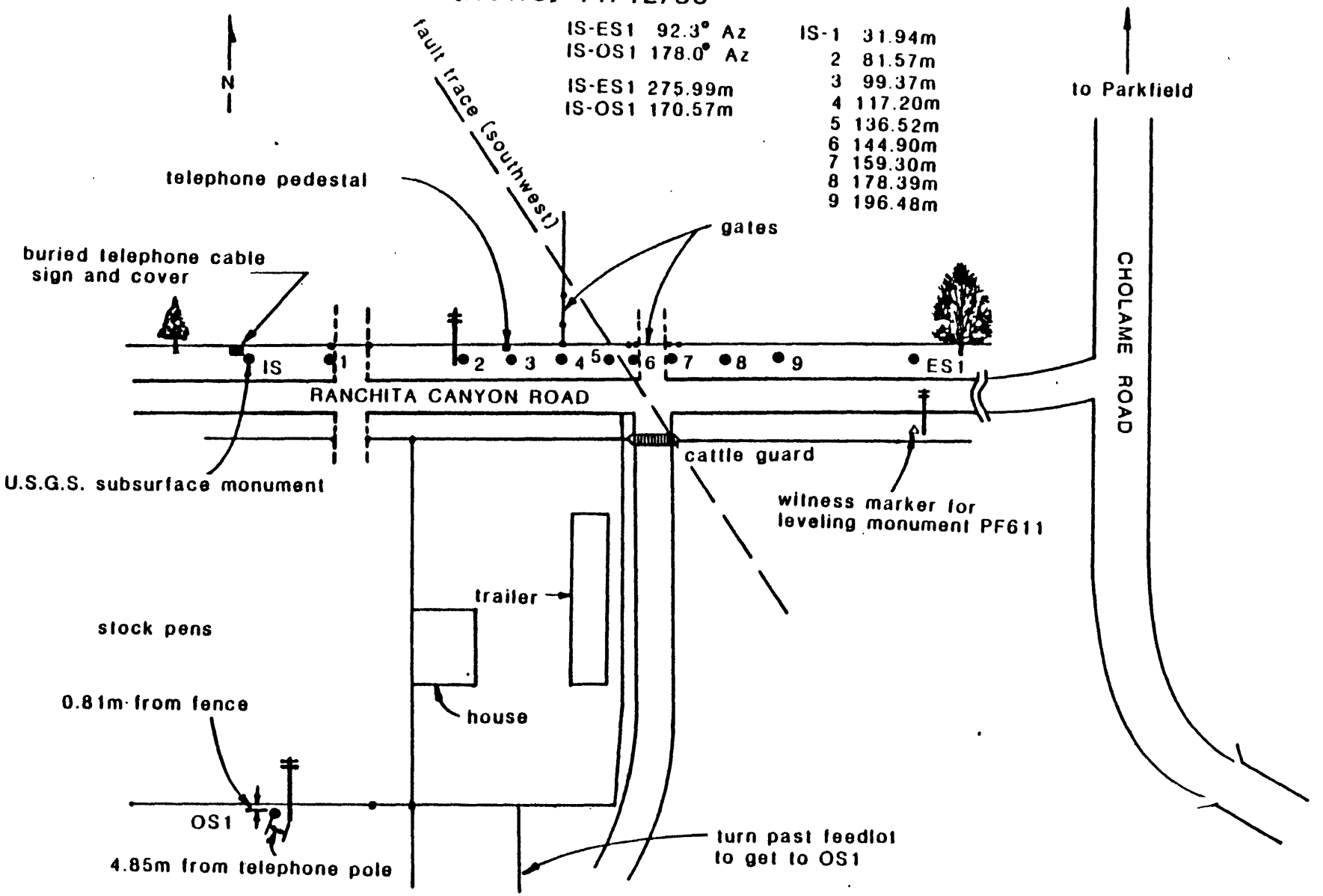
QUAD PARKFIELD 7.5' LATITUDE 35°53.1' LONGITUDE 120°26.5'

TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to deadend at road to Parkfield, and turn south. Drive past turnoff to Parkfield and continue 0.62 miles to Ranchita Canyon Road, just before a green trestle bridge. Alinement array is 0.52 miles west of Ranchita Canyon Road.

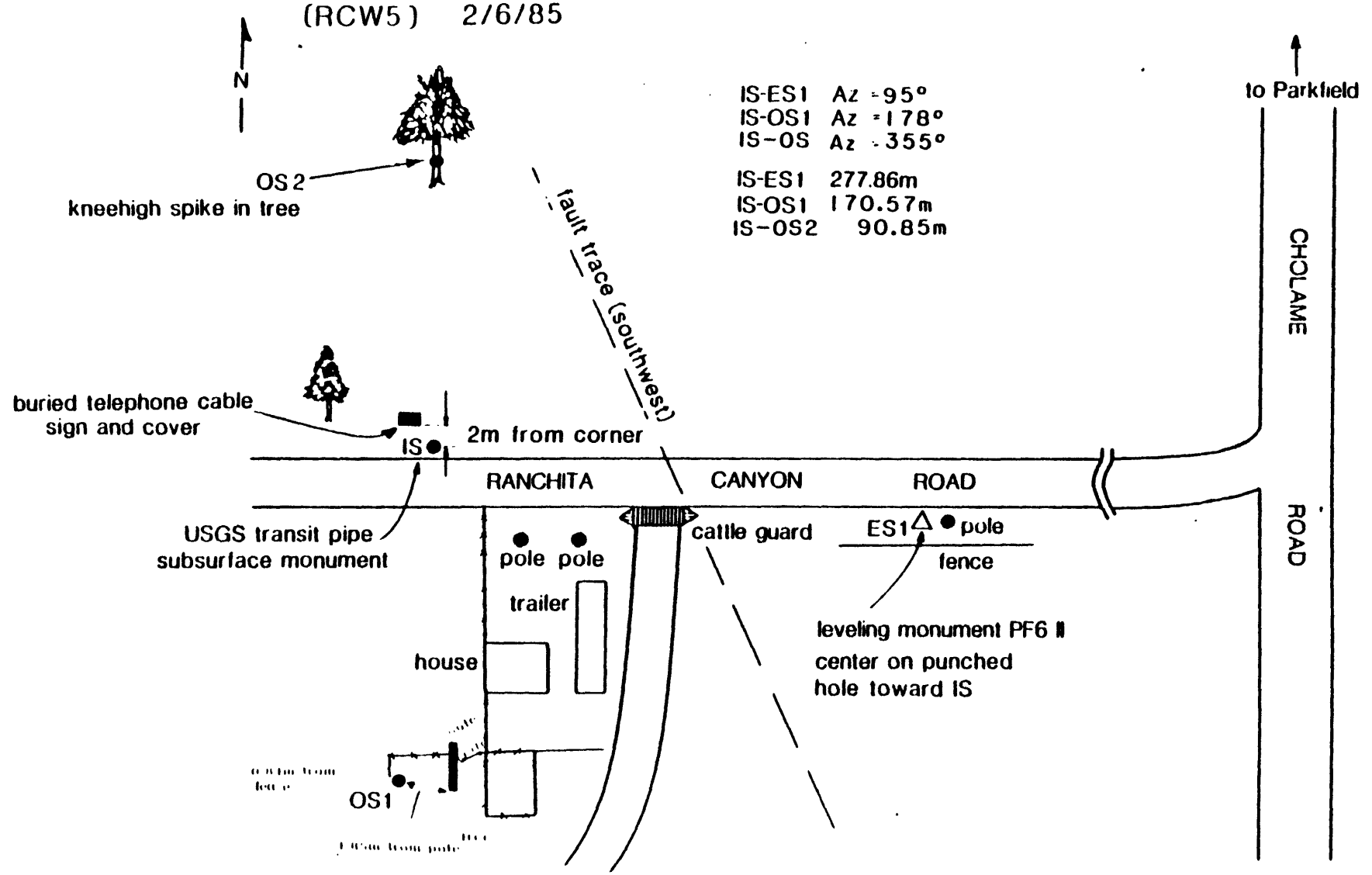
GENERAL DESCRIPTION: IS is past house and trailer on south side of road and near a telephone company 'buried cable' sign on north side of road. OS2 is near southeast gate of pasture south of IS. Original OS1 is a spike kneehigh in a tree north of IS, and is no longer used due to seasonal tall grass. ES1 is a punched hole on leveling monument PFS 11 east of fault scarp on south side of road. IS and OS2 are subsurface pipes with yellow marker caps on them. With exception of PFS 11, monuments were installed by USGS in 1985.



U.S.G.S. : RANCHITA CANYON ROAD ALINEMENT ARRAY (RCW6) 11/12/86



USGS : RANCHITA CANYON ROAD ALINEMENT ARRAY
(RCW5) 2/6/85



RCW5 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1985			Cos 46.5°	
Jul 30	0.00	277.86	0.6883	0.00
Aug 20	1.17			1.17
Nov 14	6.85			8.02
1986				
Mar 26	5.48			13.50
Jun 25	2.54			16.04
Aug 12	-5.75			10.29
Oct 10	3.37			13.66

NOTE: This site was established as an end-point-only survey. Thus there are no deflection readings or plot included for it. Deflection monuments were installed in November, 1986, and a table and plot will be made from future survey data.

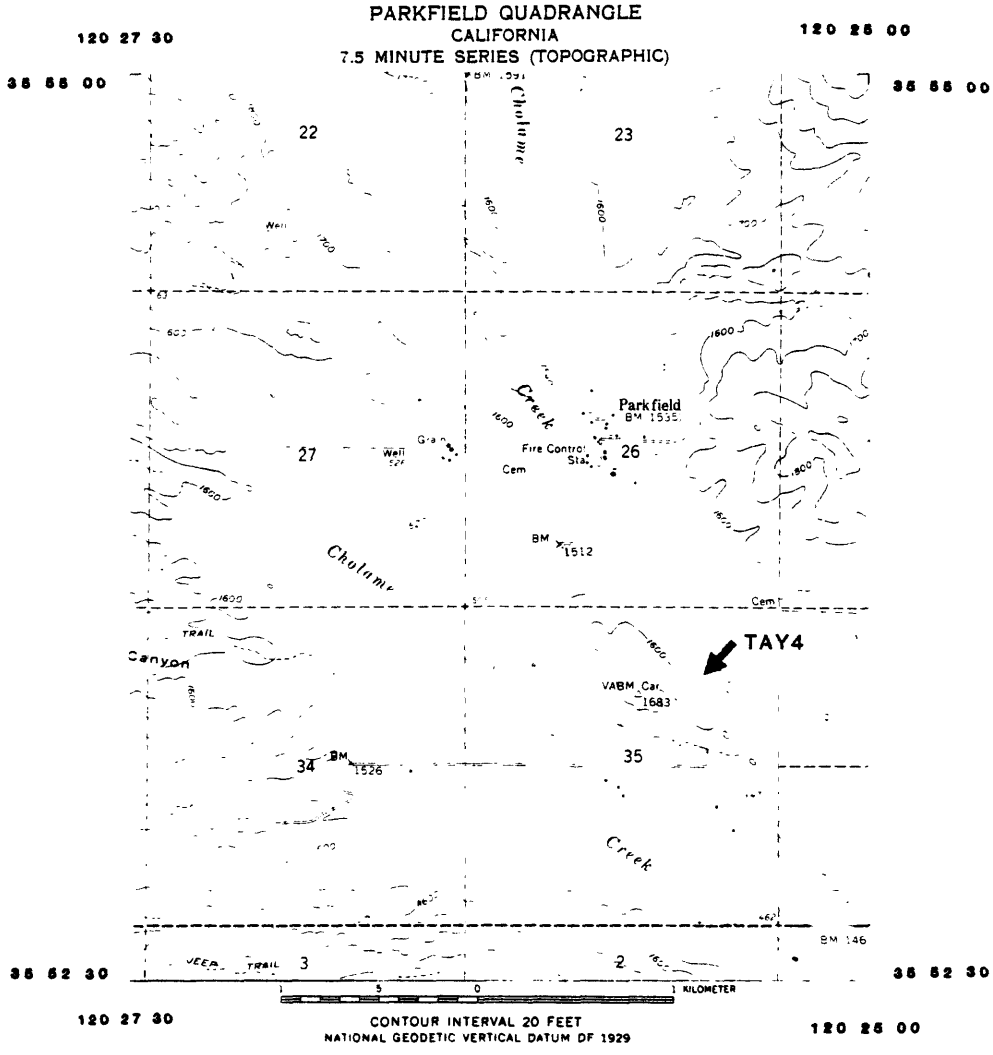
SITE DESCRIPTION

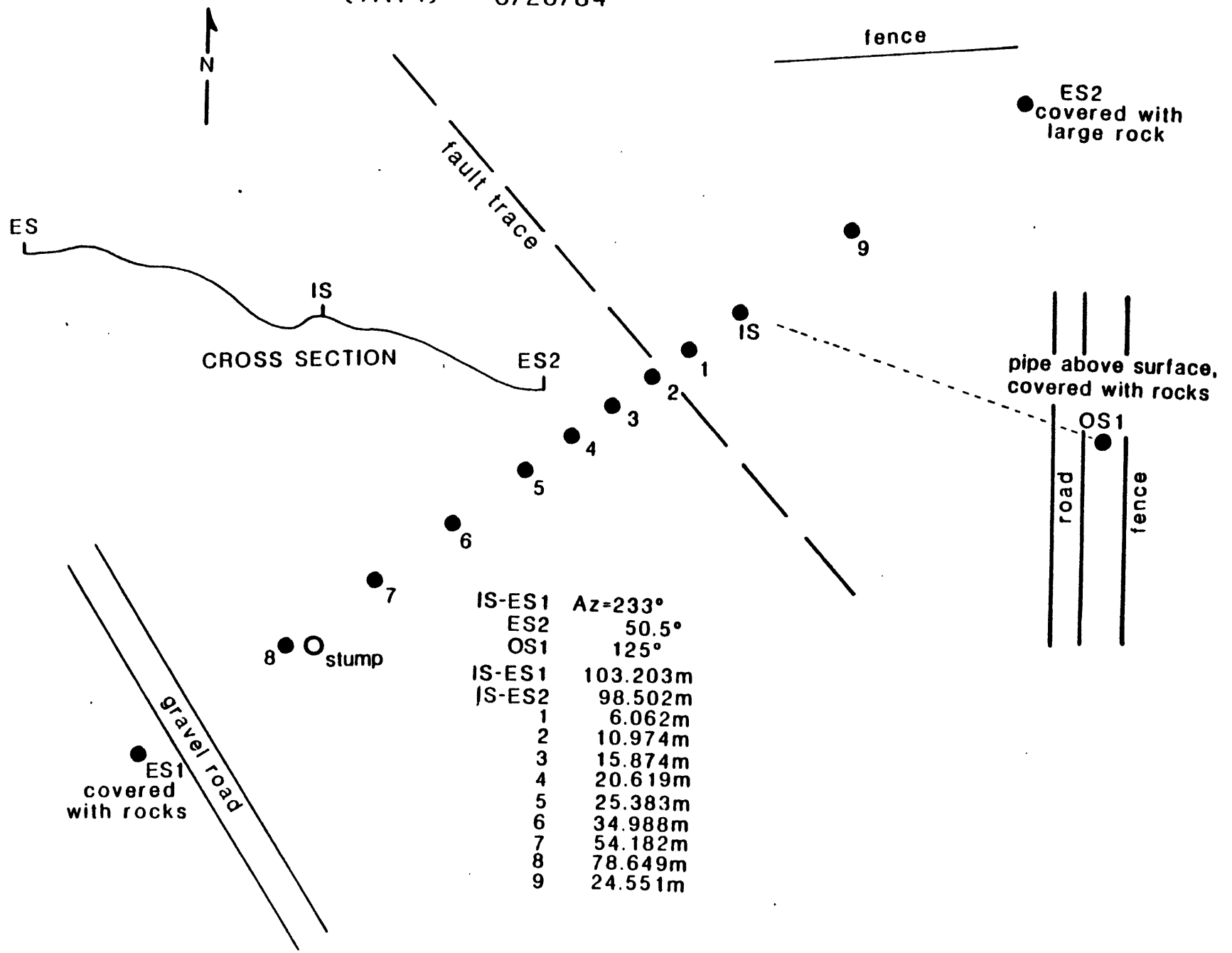
STATION CODE TAY4 NAME TAYLOR RANCH COUNTY MONTEREY

QUAD PARKFIELD 7.5' LATITUDE 35°53.4' LONGITUDE 120°25.6'

TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to dead-end at road to Parkfield, and turn south. Travel approximately 4.5 miles, past Parkfield turnoff and over trestle bridge, to green gate on left. Use combination to enter, then continue east on gravel road to fork, take road to right, and follow road up slope past OS and abandoned buildings to site.

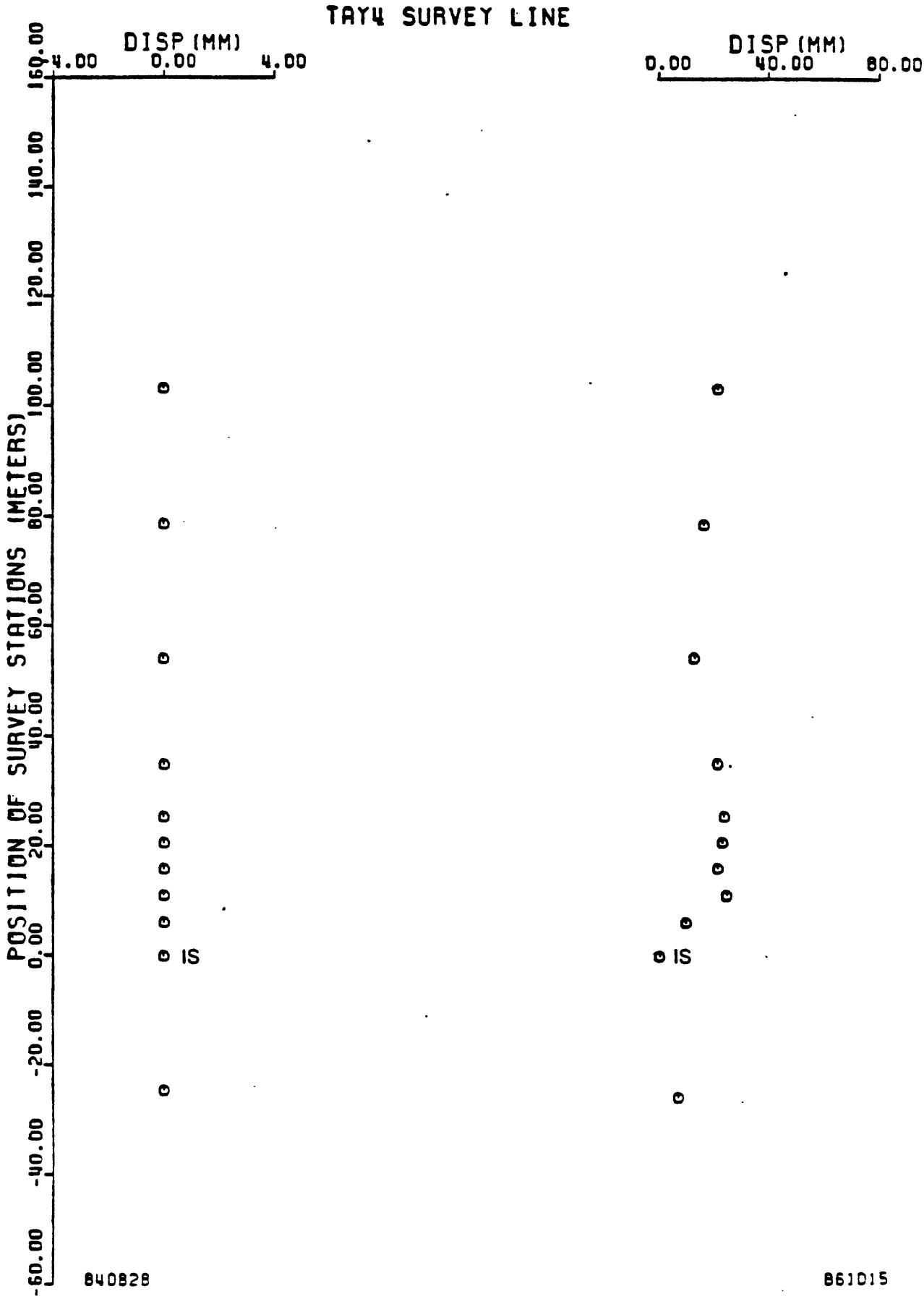
GENERAL DESCRIPTION: Survey monuments have rocks piled on them. ES is located west of road to laser shed; OS is beside road between fork in road and abandoned buildings. IS is on knoll near creepmeter and battery vaults, and between two solar panel poles.




USGS : TAYLOR RANCH ALINEMENT ARRAY
(TAY4) 6/20/84
N
fence
ES2
covered with
large rock
fault trace
ES
IS
CROSS SECTION
ES2
9
IS
1
2
3
4
5
6
7
8
Ostump
pipe above surface,
covered with rocks
OS1
road
fence
gravel road
ES1
covered
with rocks
IS-ES1 Az=233°
ES2 50.5°
OS1 125°
IS-ES1 103.203m
IS-ES2 98.502m
1 6.062m
2 10.974m
3 15.874m
4 20.619m
5 25.383m
6 34.988m
7 54.182m
8 78.649m
9 24.551m

TAY4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 2.5°	
Aug 28	0.00	103.20	0.9990	0.00
1985				
Jan 19	4.73			4.73
Apr 24	1.28			6.01
Jul 23	4.69			10.70
Nov 7	3.47			14.17
1986				
Jan 28	-2.78			11.39
Mar 27	7.38			18.77
Jul 23	3.54			22.31
Oct 15	-0.69			21.62
Oct 31	0.61			22.23


TAY4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
0.00
40.00
80.00
POSITION OF SURVEY STATIONS (METERS)
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
IS
IS
840828
861015

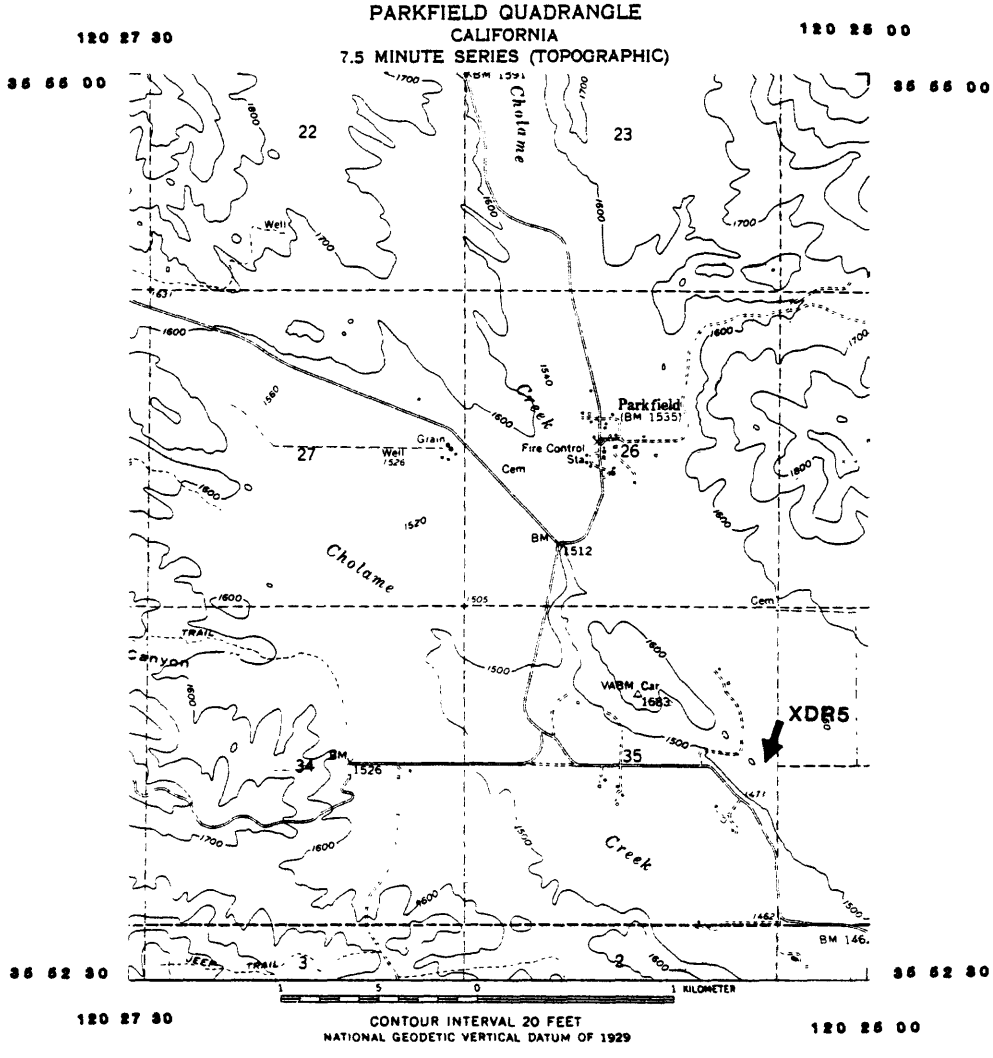
SITE DESCRIPTION

STATION CODE XDR5 NAME DURHAM RANCH COUNTY MONTEREY

QUAD PARKFIELD 7.5' LATITUDE 35°53.1' LONGITUDE 120°25.3'

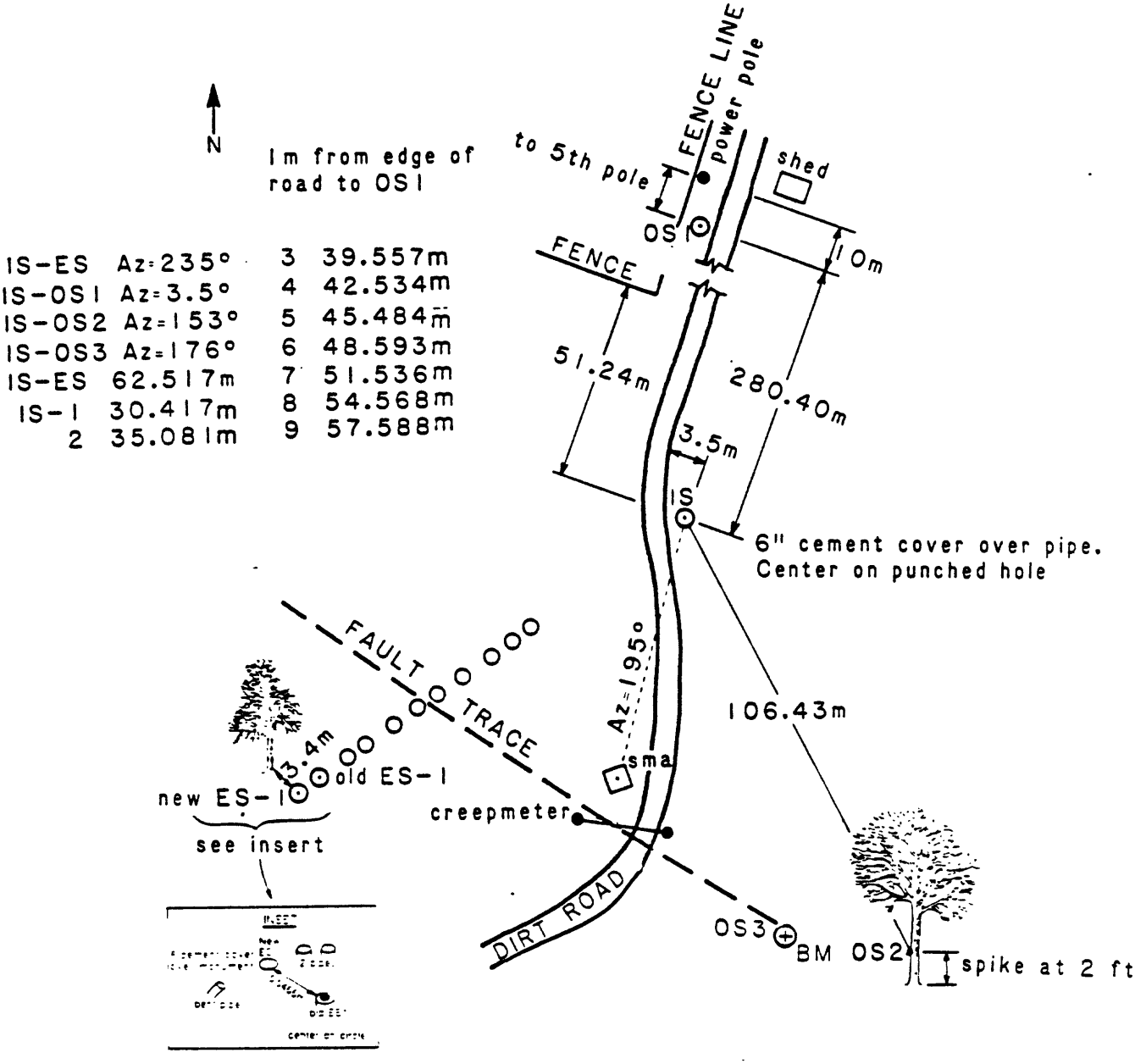
TO REACH: From San Miguel, take Vineyard Canyon Road east 19 miles to deadend at road to Parkfield. Turn south and travel approximately five miles to Turkey Flat Road. Turn east and travel approximately 1/4 mile, then turn north through first gate on left (Eade Ranch). Follow road to ranch house and ask permission for entry. Continue west on dirt road, cross airfield and pass through barbed wire gate. Travel west on trail to first left, then right at water trough, right at feeder, and west past oak to fence. Array is approximately 51 m south of fence. Creepmeter solar panel and Strong Motion housing are visible just past array.

GENERAL DESCRIPTION: Instrument station is about 6 feet east of dirt road. ES1 is atop ridge where creepmeter vault is located. OS2 is a spike about 2 feet above base of an oak tree south of ES1. Deflection monuments are embedded in cement on surface of ground; OS1 and IS are subsurface monuments. Most of the monuments were installed by USGS in 1968; IS, OS1, and OS2 were installed by USGS in 1984.



USGS: DURHAM RANCH ALINEMENT ARRAY

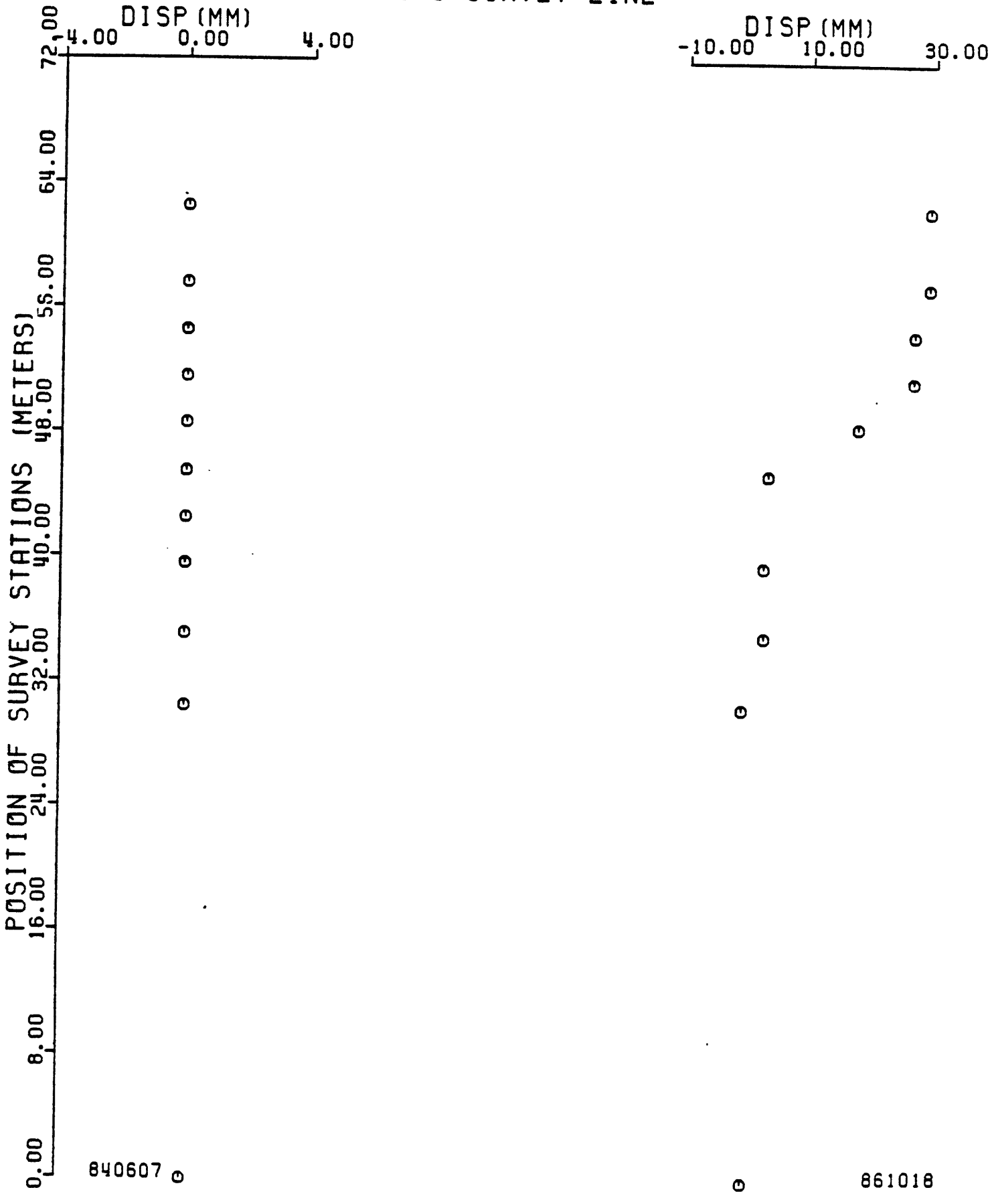
(XDR5) 11/7/83



XDR5 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 6.0°	
Jun 7	0.00	62.517	0.9945	0.00
Aug 8	0.52			0.52
1985				
Apr 25	14.95			15.47
Jul 23	1.45			16.92
Nov 6	4.30			21.22
1986				
Jan 28	6.39			27.61
Jul 23	2.44			30.05
Oct 18	-0.98			29.07

XDR5 SURVEY LINE



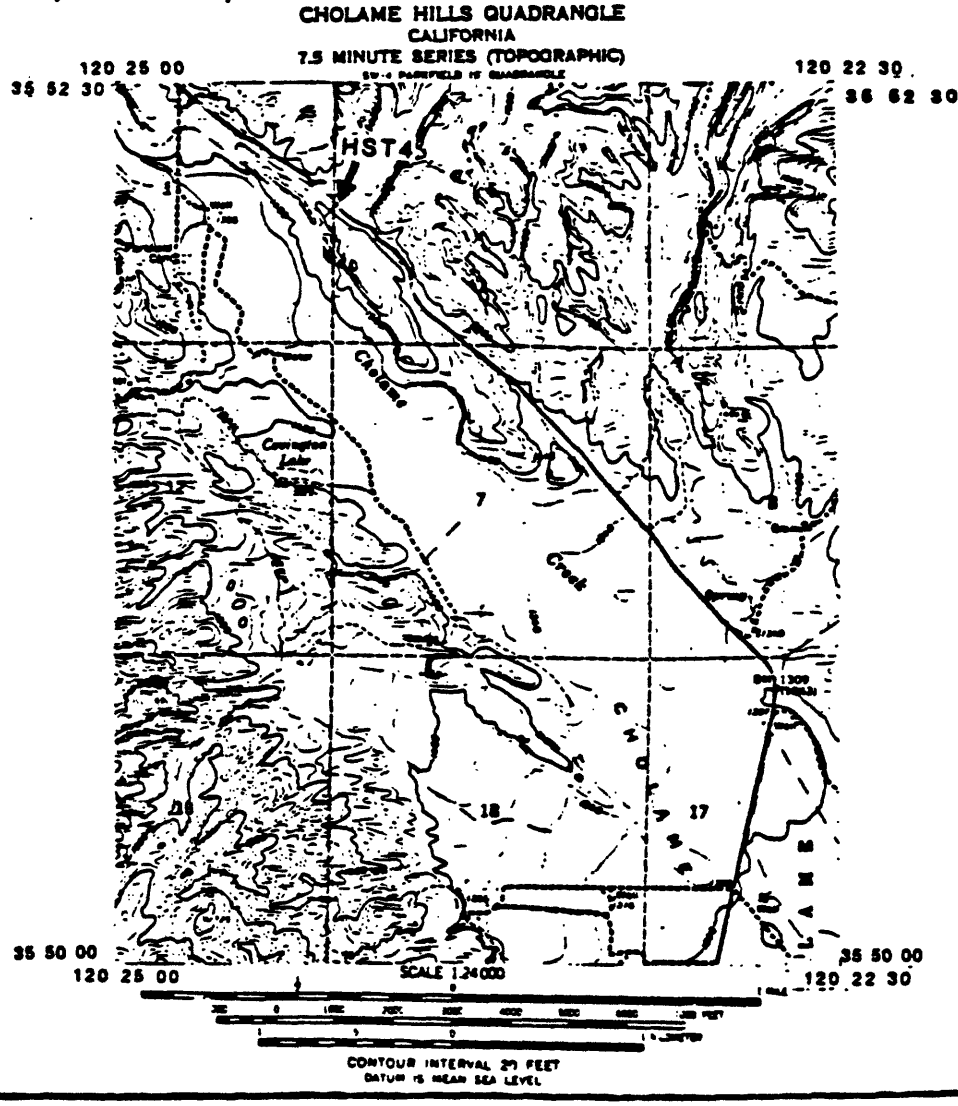
SITE DESCRIPTION

STATION CODE HST4 **NAME** HEARST NORTH **COUNTY** MONTEREY

QUAD CHOLAME HILLS **LATITUDE** 35° 52.4' **LONGITUDE** 120°24.1'

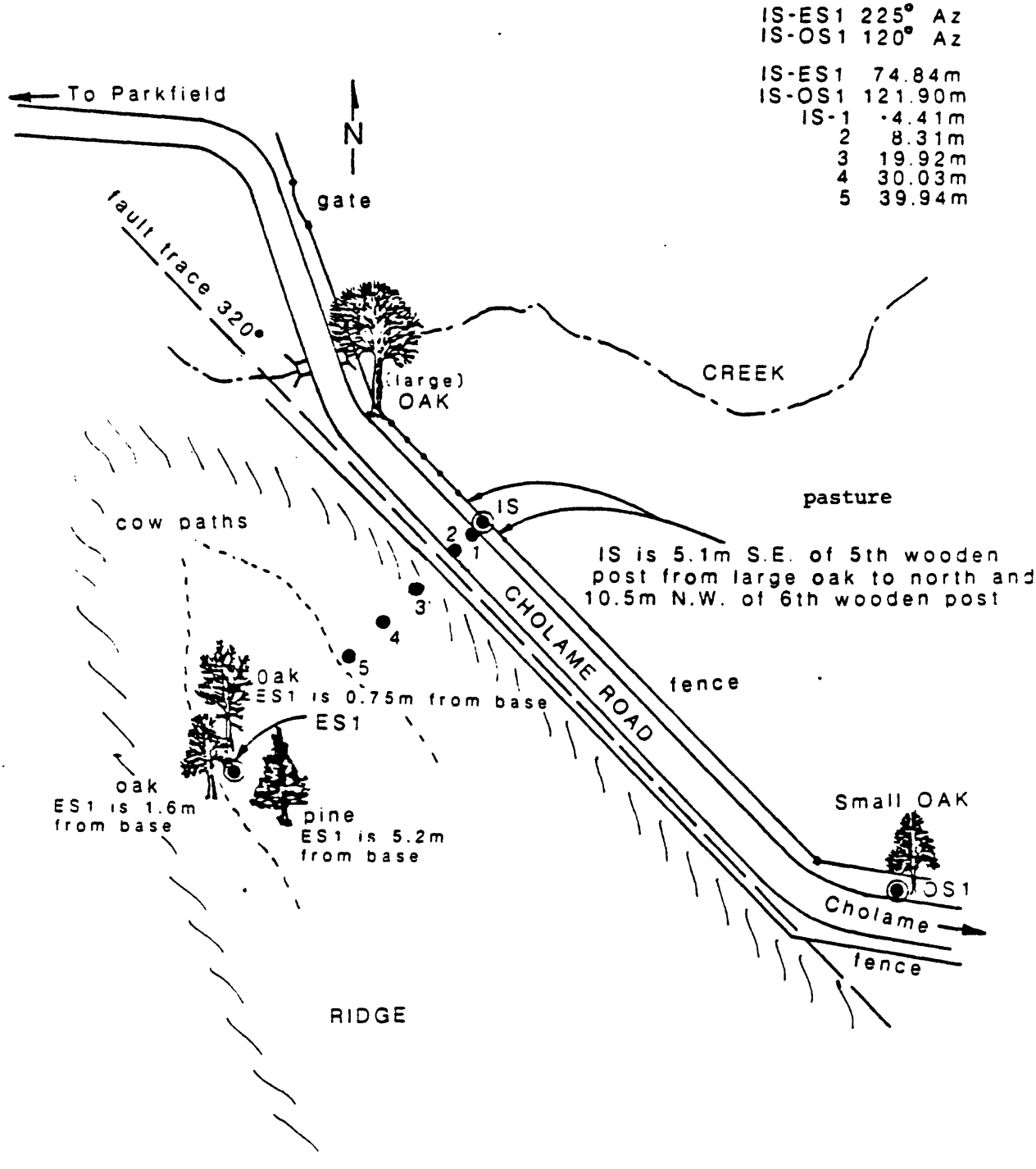
TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame, 1 mile past Cholame turn north on Parkfield-Cholame Valley Road. Travel 11.6 miles, crossing into Monterey County and passing Work and Carr Ranch Alinement Array sites and U.S.G.S. Work Ranch Creepmeter. The array is in the small valley where the creek is offset by the fault, approximately 0.9 mile east of Turkey Flat Road.

GENERAL DESCRIPTION: IS is located on the east side of the road -60 meters south of large oak tree in the same fenceline. The oak tree is near the culvert where the creek passes beneath the road. Deflection stations 1 and 2 are P-K nails driven into the pavement approximately 1 meter from the roadside. Stations 3-5, and the ES1 continue west up to the crest of the ridge. The ES1 lies just to the north of a large "digger" pine. (Site installed November, 1986, Wilmesher)



U.S.G.S. : HEARST NORTH ALINEMENT ARRAY

(HST4) 11/22/86



HST4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 0.0°	
Nov 22	0.00	74.84	1.000	0.00

NOTE: This site was established in November, 1986 and therefore has only initial data on file. A table and plot of deflections will be made from future survey data.

SITE DESCRIPTION

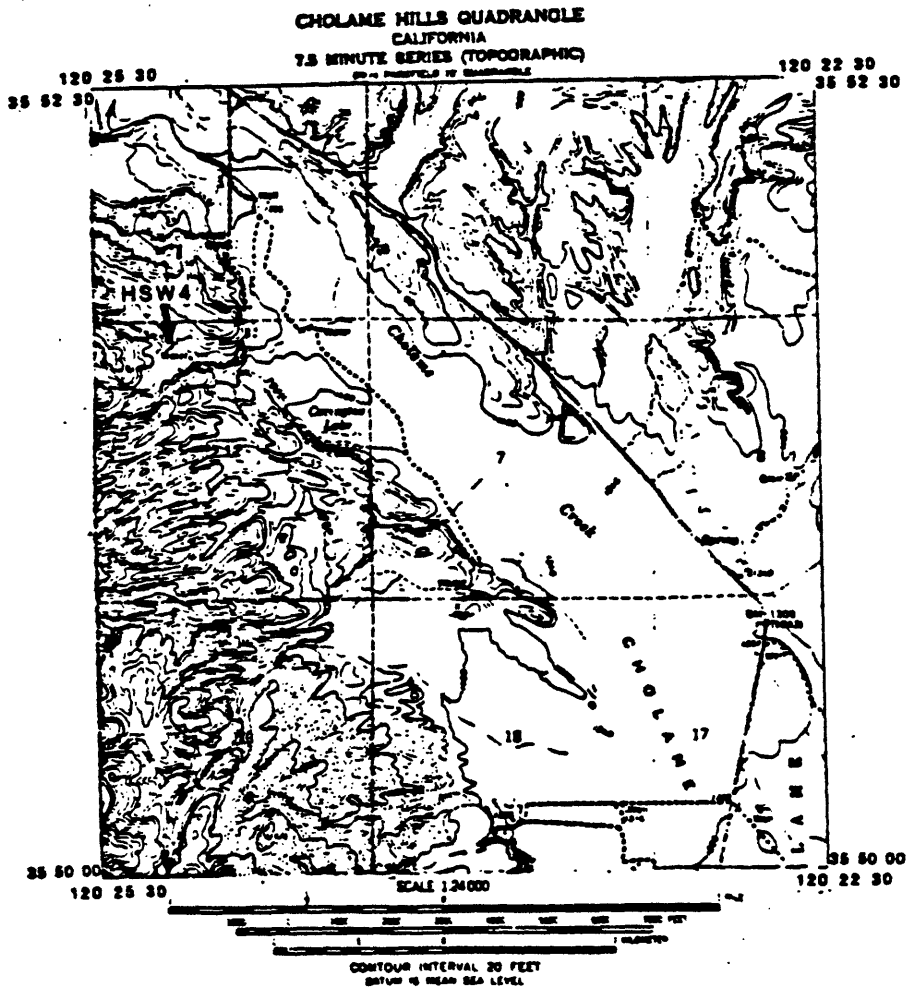
STATION CODE HSW4 **NAME** HEARST SOUTHWEST **COUNTY** MONTEREY

QUAD CHOLAME HILLS **LATITUDE** 35°51.8' **LONGITUDE** 120°25.3'

TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame. Approximately 1 mile east of Cholame, turn north on the Parkfield-Cholame Road. Travel 12.4 miles to Parkfield Cemeterey Road. It is a gravel road that turns west approximately 0.2 mile south of Turkey Flat Road. Once on the cemeterey road, cross Cholame creek, pass Parkfield Ranch, and turn left just before the stock corral. The gravel road passes next to a small ranch house and through a gate. Proceed through the gate and bear right, drive south 0.25 mile to next intersection. Turn right at gate, the trailer is left, cross creek, proceed to "Y" in road (0.15 mile), bear right. Cross creek, travel ~0.15 mile to next "Y" in road, the OS1 is ~50 meters down left fork, bear right into pasture. Station 3 is ~200 meters up the road and is on the right edge of the road, it should be covered with rocks.

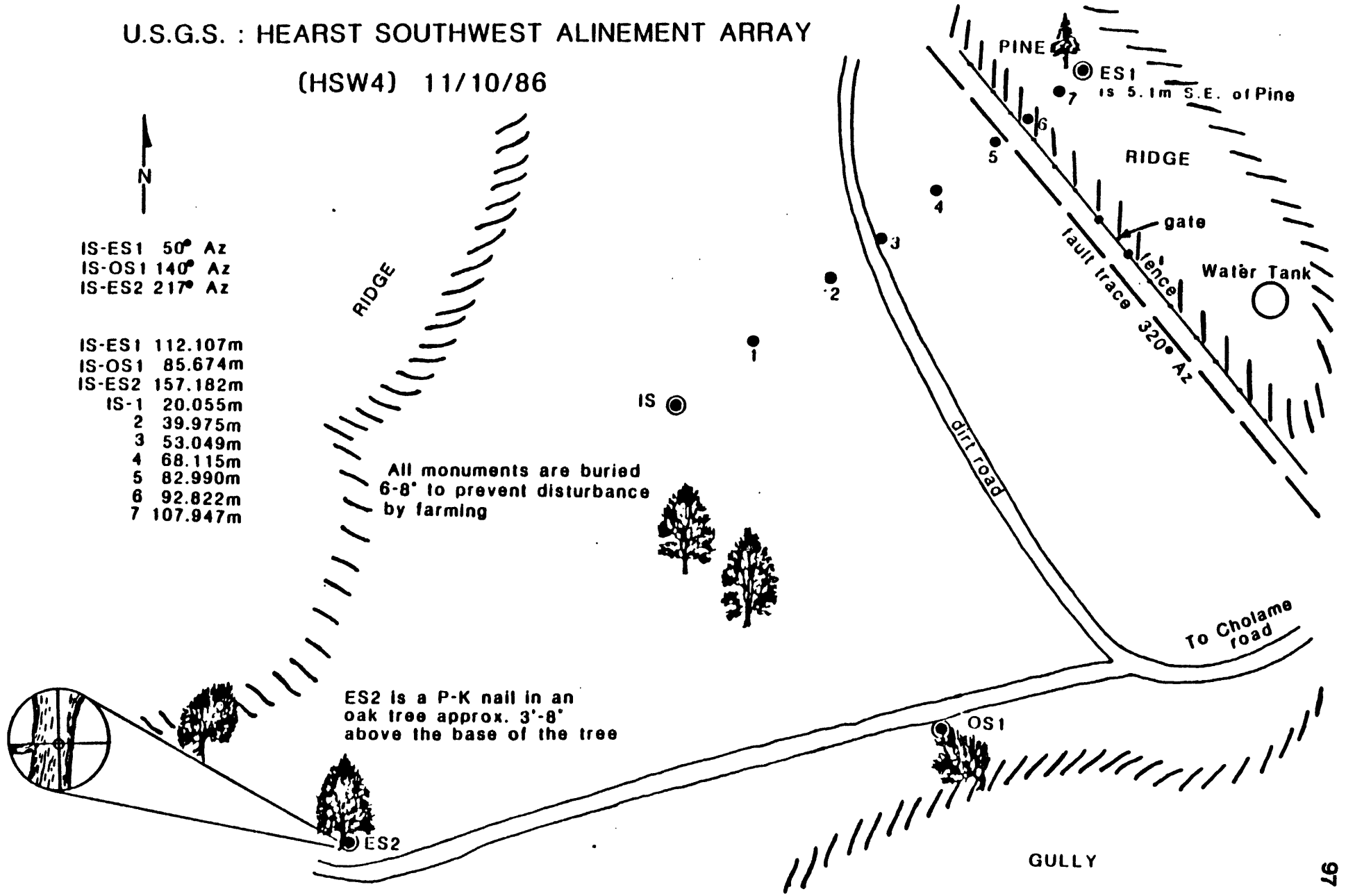
GENERAL DESCRIPTION:

The IS is ~50 meters off the road to the SW of station 3. The OS1 is off the left side in the road (the road to the site), ~50 meters from the "Y". The stations run to the NE towards a "digger" pine on a small ridge. The pine is ~125 meters to the NW of the water tank on the same ridge line. The ES1 is ~5 meters to the SE of the base of the pine tree. All stations are covered by rocks. (Site installed November, 1986, Wilmesher)



U.S.G.S. : HEARST SOUTHWEST ALINEMENT ARRAY

(HSW4) 11/10/86



BSW4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 0.0°	
Nov 10	0.00	112.11	1.000	0.00

NOTE: This site was established in November, 1986 and therefore has only initial data on file. A table and plot of deflections will be made from future survey data.

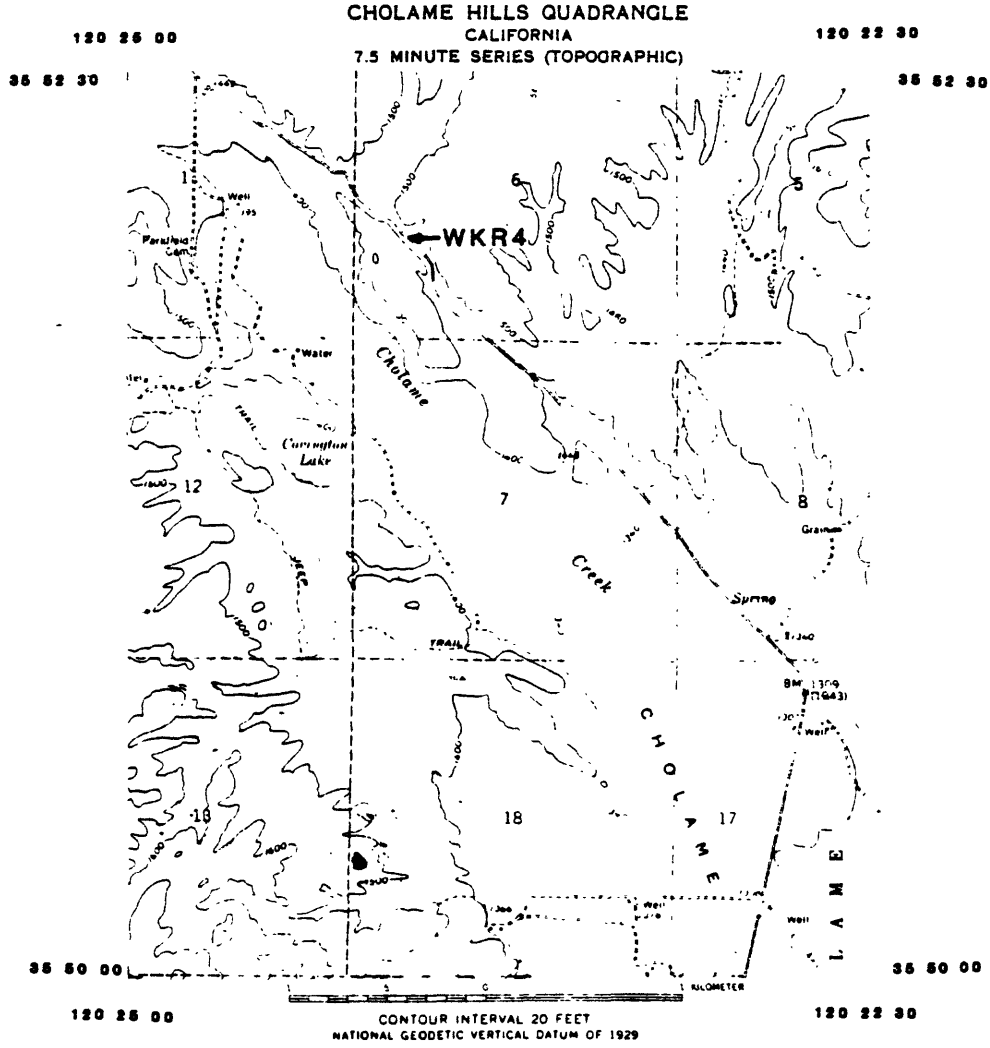
SITE DESCRIPTION

STATION CODE WKR4 **NAME** WORK RANCH **COUNTY** MONTEREY

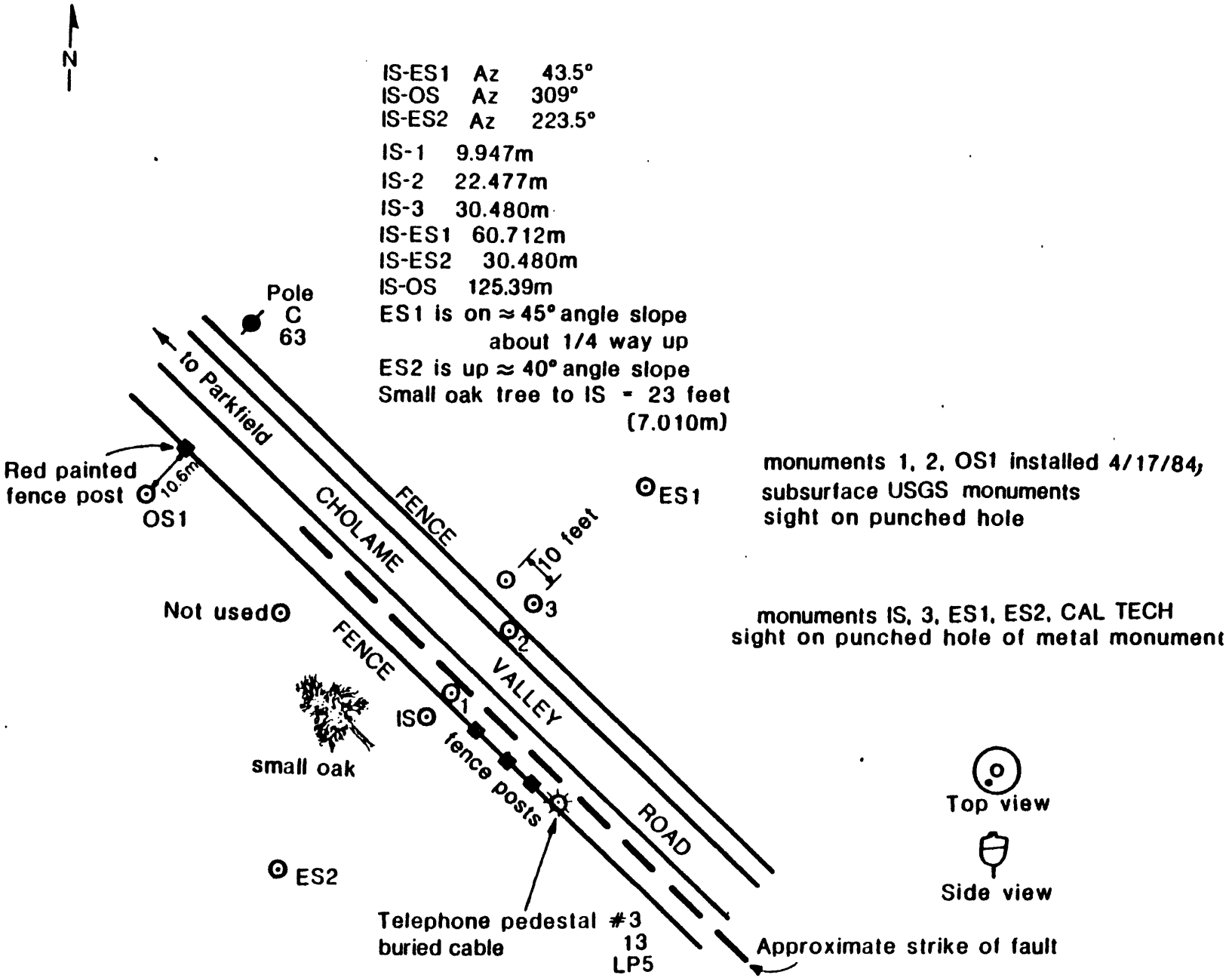
QUAD CHOLAME HILLS 7.5' **LATITUDE** 35°51.8' **LONGITUDE** 120°23.8'

TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame. Approximately one mile past Cholame, turn north onto Cholame-Parkfield road. Travel 11 miles, crossing into Monterey County and passing Jack and Carr Ranch alinement array turnoffs and USGS Work Ranch creepmeter. Array is on west side of road about 1/4 mile north of Work Ranch creepmeter and 100 feet north of pedestal for creepmeter telephone drop.

GENERAL DESCRIPTION: IS is located on west side of road at base of a low hill. Array is perpendicular to the strike of fault and roadway. All monuments are covered by rocks. Monuments were installed by California Institute of Technology personnel (Peacock Array) in 1976.

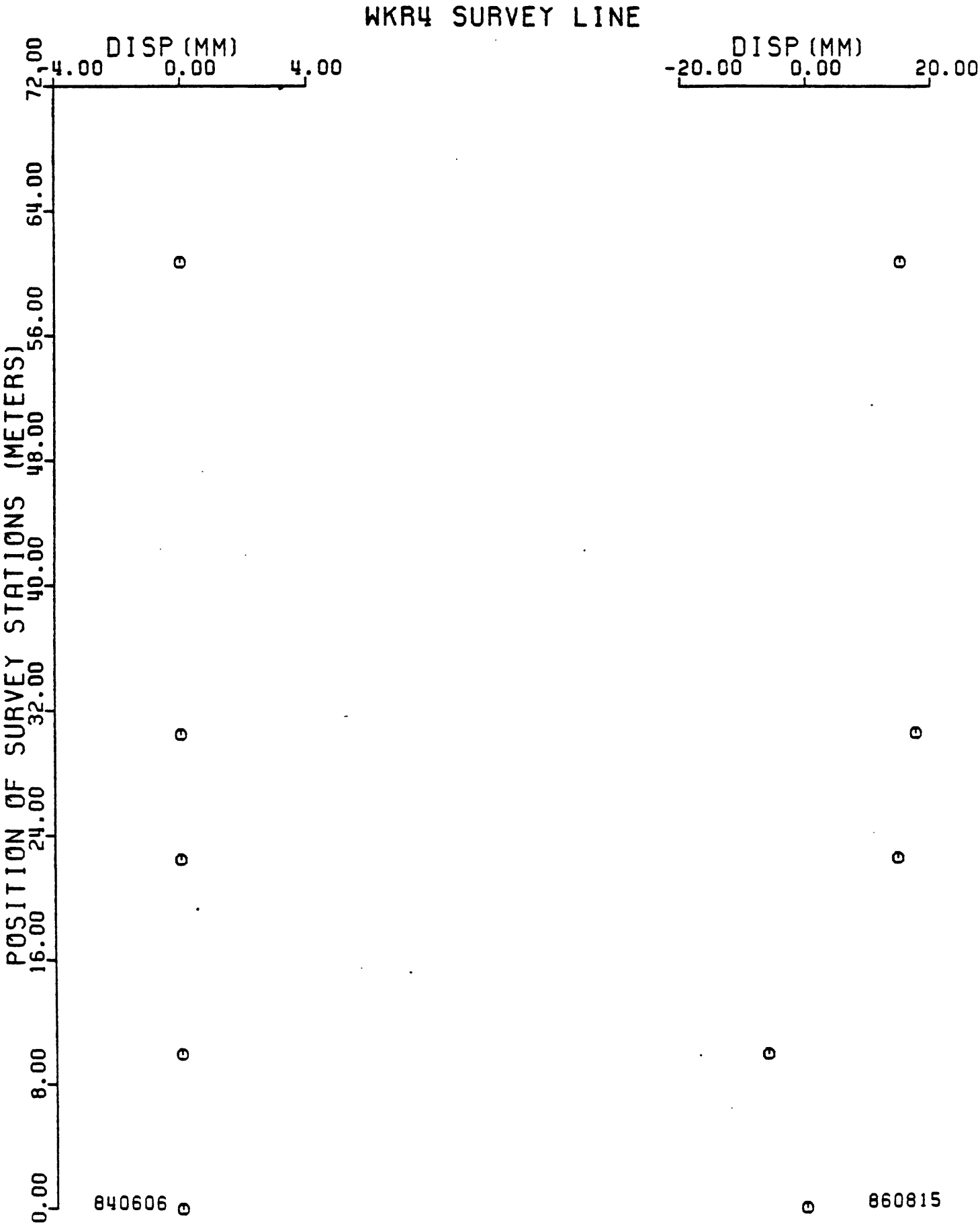


USGS : WORK RANCH ALINEMENT ARRAY
(WKR4) 6/6/84



WKR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 3.0°	
Jun 6	0.00	60.71	0.9986	0.00
1985				
Apr 23	2.40			2.40
Jul 24	4.56			6.96
Nov 6	2.03			8.99
1986				
Jan 27	-2.00			6.99
Aug 15	8.08			15.07
Oct 3	3.40			18.47


WKR4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-20.00
0.00
20.00
POSITION OF SURVEY STATIONS (METERS)
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0.00
840606
860815

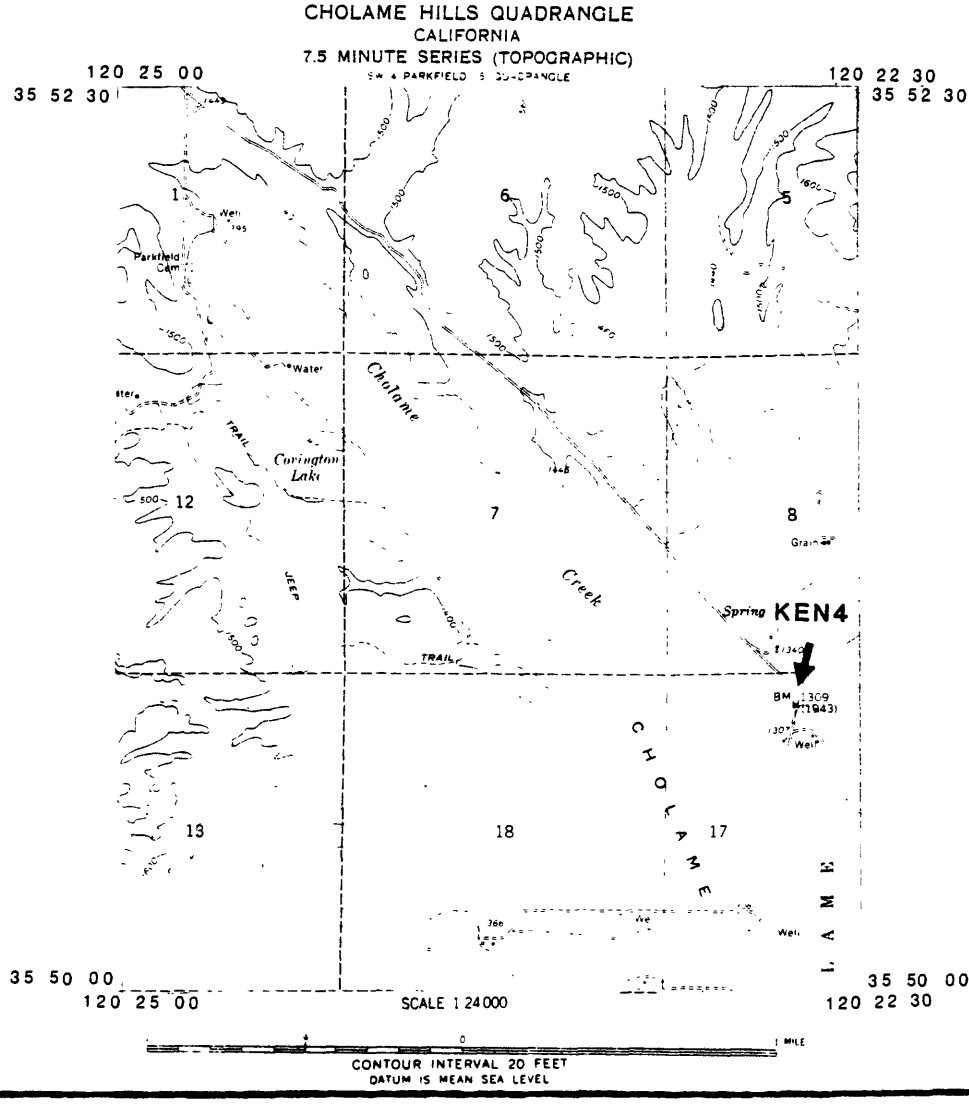
SITE DESCRIPTION

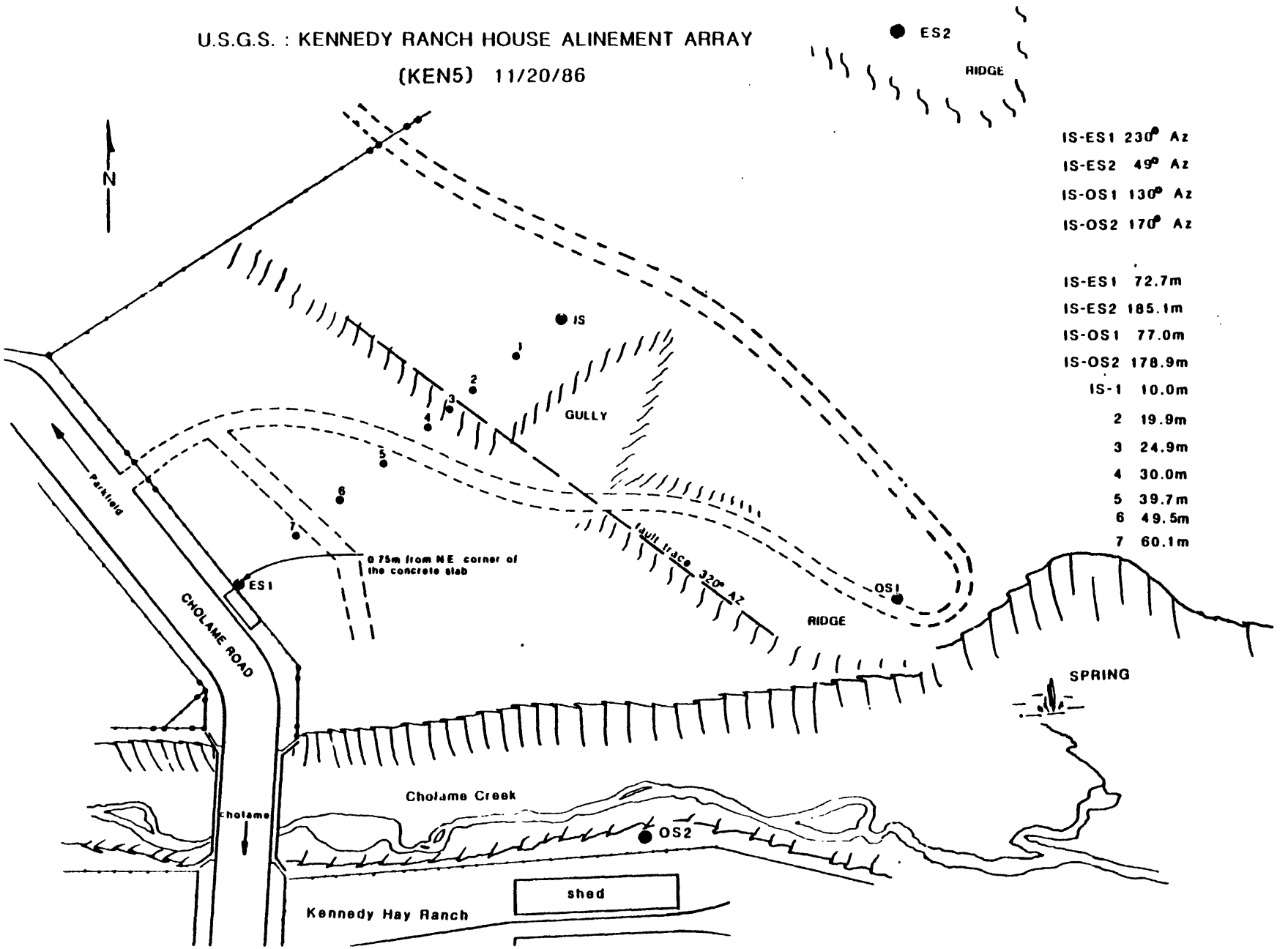
STATION CODE KEN4/5 **NAME** KENNEDY RANCH **COUNTY** MONTEREY

QUAD CHOLAME HILLS **LATITUDE** 35°50.7' **LONGITUDE** 120°22.6'

TO REACH: From Paso Robles, take Highway 46 east 24 miles to Cholame. Proceed through Cholame on 46, then approximately 1 mile east turn north onto Parkfield-Cholame Valley Road. Travel 10.36 miles, cross bridge just past Kennedy Hay Ranch, stop at gate approximately 175 meters north of bridge. Enter through gate and proceed to top of escarpment. Turn back to the north and travel approximately 100 meters along escarpment, passing the gully, to the ES1. Array crosses down the escarpment and SW toward the bridge.

GENERAL DESCRIPTION: ES1 is near the fenceline approximately 2 feet NW of old concrete slab near road. IS is at the crest of the scarp approximately 15 meters from the edge, deflection station 1 is at or near the edge. OS2 is across the creek near a large cottonwood tree. The OS2 is on the creek side of the fence and may need metal detector due to changes in the creek topography. ES2 is located NE of IS on first small ridge. (Site installed November, 1986, Wilmesher)




U.S.G.S. : KENNEDY RANCH HOUSE ALINEMENT ARRAY
(KEN5) 11/20/86
ES2
RIDGE
N
IS-ES1 230° Az
IS-ES2 49° Az
IS-OS1 130° Az
IS-OS2 170° Az
IS-ES1 72.7m
IS-ES2 185.1m
IS-OS1 77.0m
IS-OS2 178.9m
IS-1 10.0m
2 19.9m
3 24.9m
4 30.0m
5 39.7m
6 49.5m
7 60.1m
IS
GULLY
Parkfield
0.75m from N.E. corner of the concrete slab
ES1
fault trace 320° Az
OS1
RIDGE
CHOLAME ROAD
SPRING
Cholame Creek
cholame
OS2
shed
Kennedy Hay Ranch

KEN5 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 0.0°	
Nov 20	0.00	72.72	1.000	0.00
Dec 10	2.70			2.70

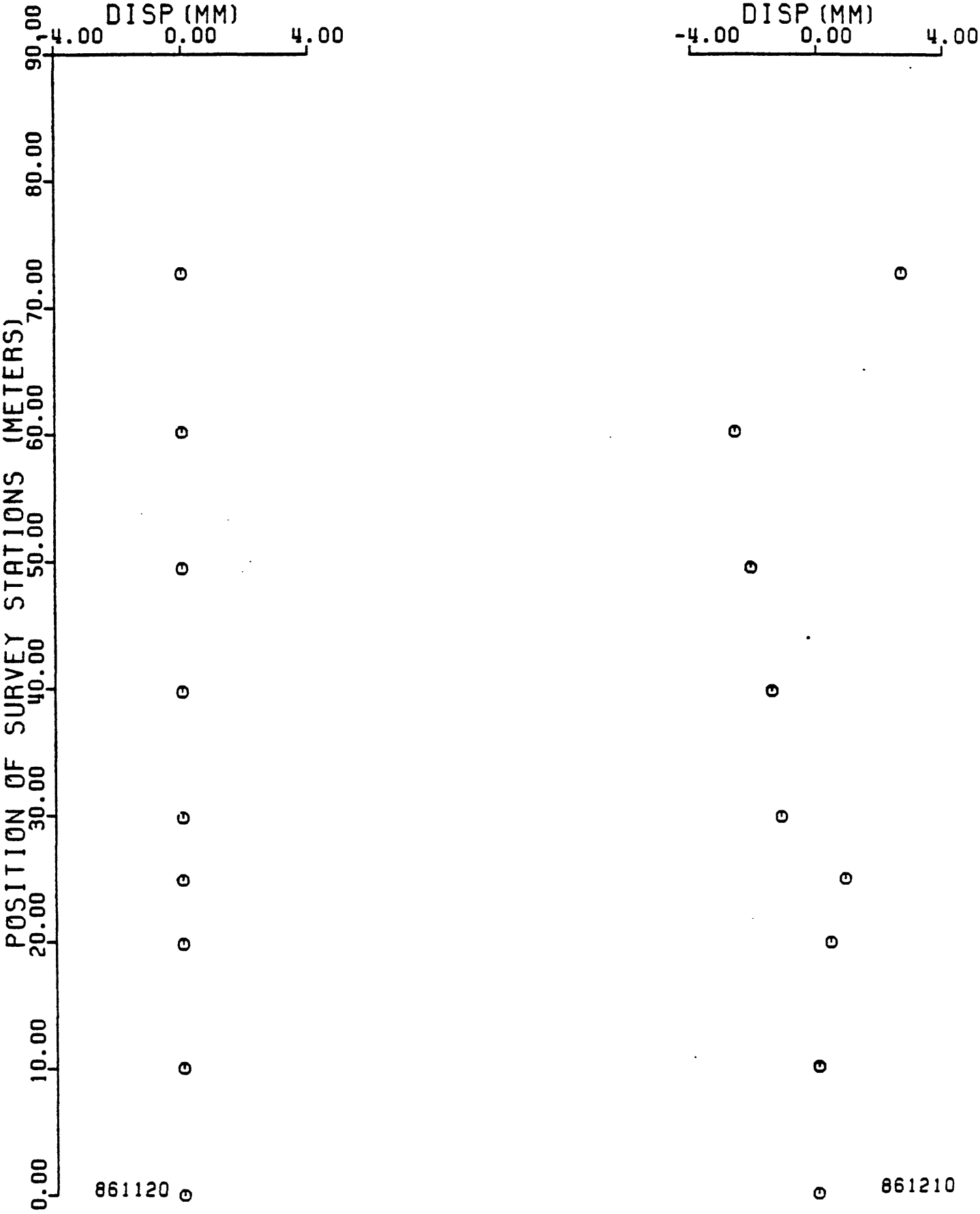
On December 10, alinement array site KEN4 (Kennedy Ranchhouse) was surveyed for the second time (see Figure 1b for location). This site is a few hundred yards southeast of the pipeline that broke prior to the 1966 earthquake. Through the first two sets of deflection measurements, the monuments remained steady and the readings were relatively equal. However, during the third set, deflection monuments 4 through 7 were found to have moved significantly (up to 3 mm), leaving monuments 1 through 3 in their original positions (see site layout). The end station (ES1) moved, but in an unexpected way. Because of the extraordinary changes, another set of deflection readings and angles was made.

Data from the four sets were split by the "event", two sets prior and two after. The first two sets were averaged to create a third set for Survey #2 for KEN4, and the last two sets were averaged to create a third set for Survey #2 for KEN5. The plot for KEN5 illustrates the apparent movement of the deflection monuments during the second half of the survey. Note they appear to have moved left-lateral. However, by the geometry of the site, the angle ES1-OS1 grew larger, indicating right-lateral movement at the ES1.

KEN4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 0.0°	
Nov 20	0.00	72.72	1.000	0.00
Dec 10	-2.25			-2.25

KEN5 SURVEY LINE



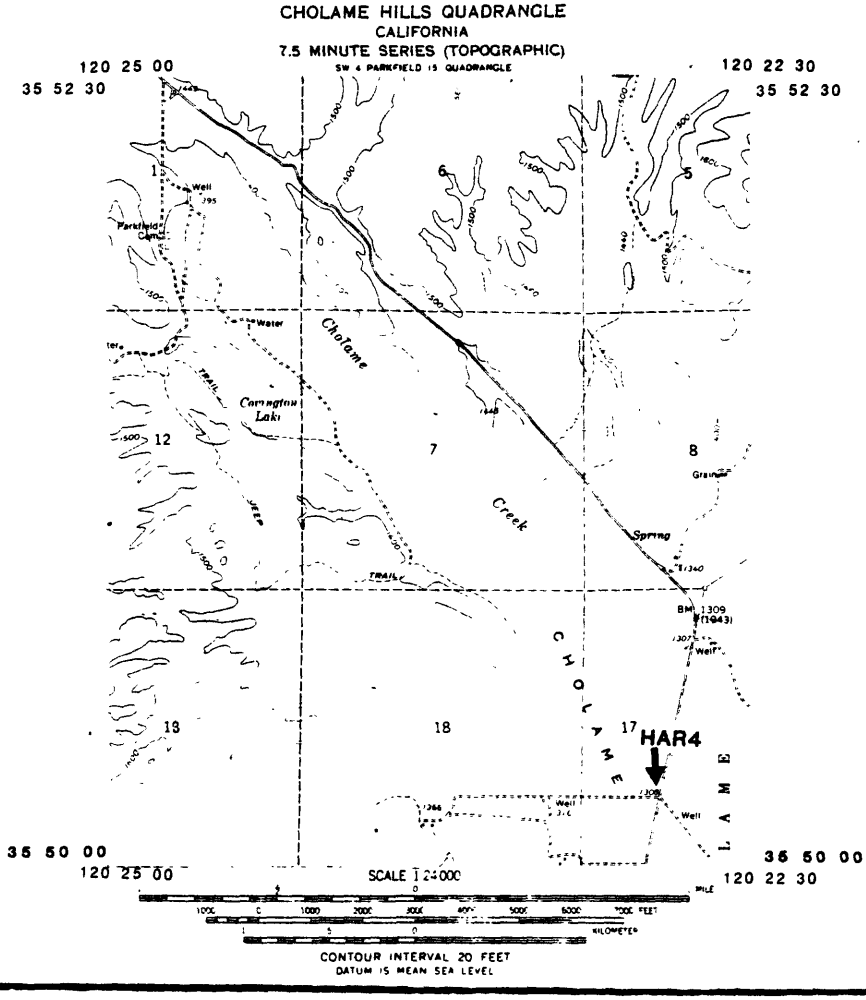
SITE DESCRIPTION

STATION CODE HAR4 **NAME** HARLAN RANCH **COUNTY** MONTEREY

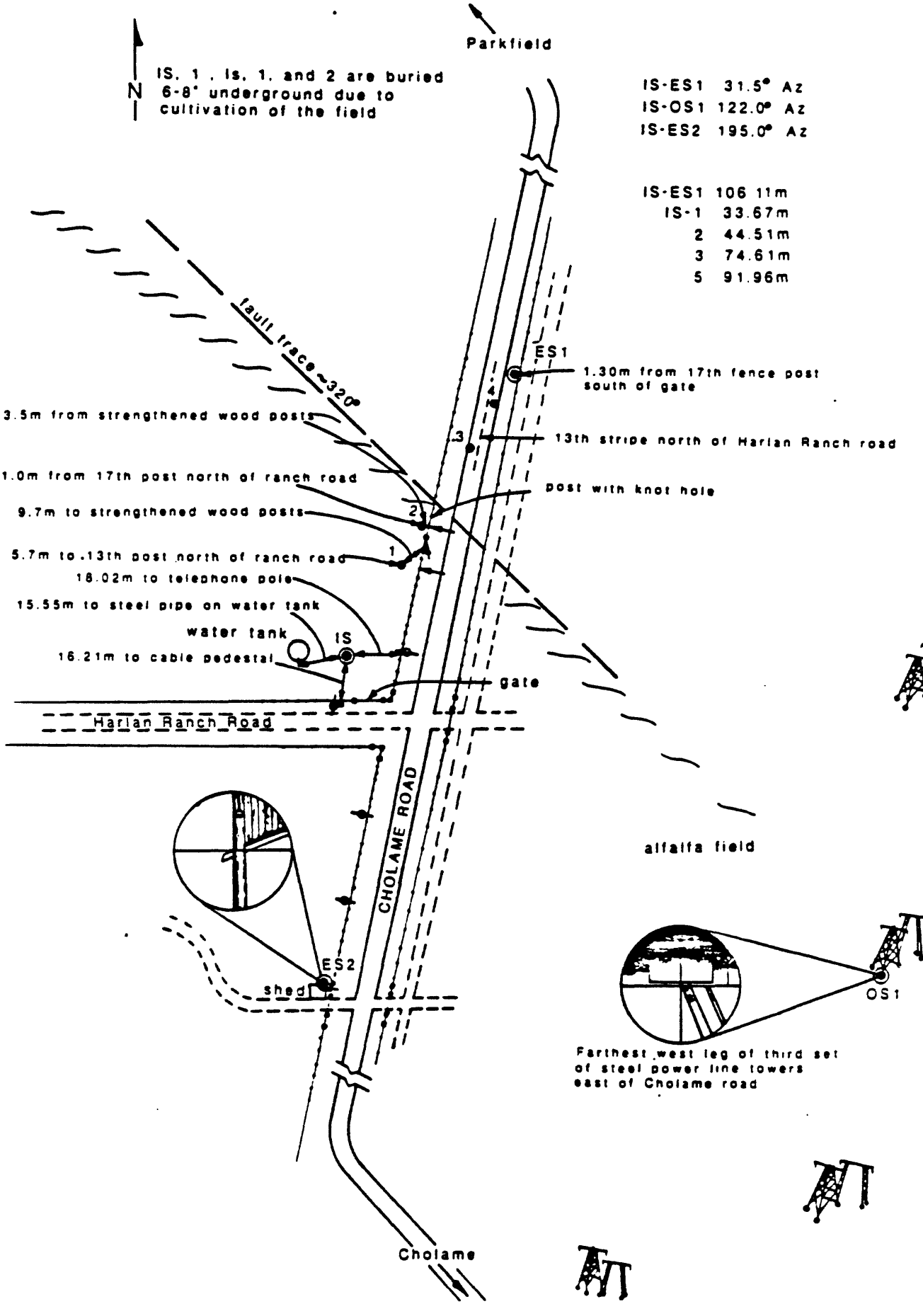
QUAD CHOLAME HILLS **LATITUDE** 35°50.4' **LONGITUDE** 120° 22.9'

TO REACH: From Paso Robles, take State Highway 46 east 24 miles to Cholame. Approximately 1 mile past Cholame turn north on Parkfield-Cholame Valley Road. Travel 10.3 miles to Harlan Ranch Road or the Harlan Ranch entrance road. Array runs from the SW corner of the field that lies to the NW of the intersection, across the field and the Parkfield-Cholame Road to the NE.

GENERAL DESCRIPTION: The IS is in the field located approximately equidistant from the telephone pedestal, the telephone pole to the east in the fenceline, and the water tank. Two deflection stations 1 and 2 are buried ~1 foot deep in the field. Stations 3-5 are P-K nails dirven into the pavement of the Parkfield-Cholame Road. Station 3 and 5 are each approximately 1 meter from the roadside. Station 3 is in the middle of the road between two yellow center lines. The ES1 is on the south side of the road on a small knoll. The OS1 is the farthest west leg of the third set of steel power poles west of the fault. ES2 is in line-of-sight with last telephone pole to the south next to the small shed. (Site installed November, 1986, Wilmesher)



(HAR4) 11/24/86


Parkfield
N
IS, 1 , Is, 1, and 2 are buried 6-8' underground due to cultivation of the field
IS-ES1 31.5° Az
IS-OS1 122.0° Az
IS-ES2 195.0° Az
IS-ES1 106 11m
IS-1 33.67m
2 44.51m
3 74.61m
5 91.96m
fault trace ~320°
ES1
1.30m from 17th fence post south of gate
3.5m from strengthened wood posts
13th stripe north of Harlan Ranch road
1.0m from 17th post north of ranch road
post with knot hole
9.7m to strengthened wood posts
5.7m to 13th post north of ranch road
18.02m to telephone pole
15.55m to steel pipe on water tank
water tank
IS
16.21m to cable pedestal
gate
Harlan Ranch Road
CHOLAME ROAD
alfalfa field
ES2
shed
OS1
Farthest west leg of third set of steel power line towers east of Cholame road
Cholame

HAR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos	
Nov 24	0.00	106.11	0.	0.00

NOTE: This site was established in November, 1986 and therefore has only initial data on file. A table and plot of deflections will be made from future survey data.

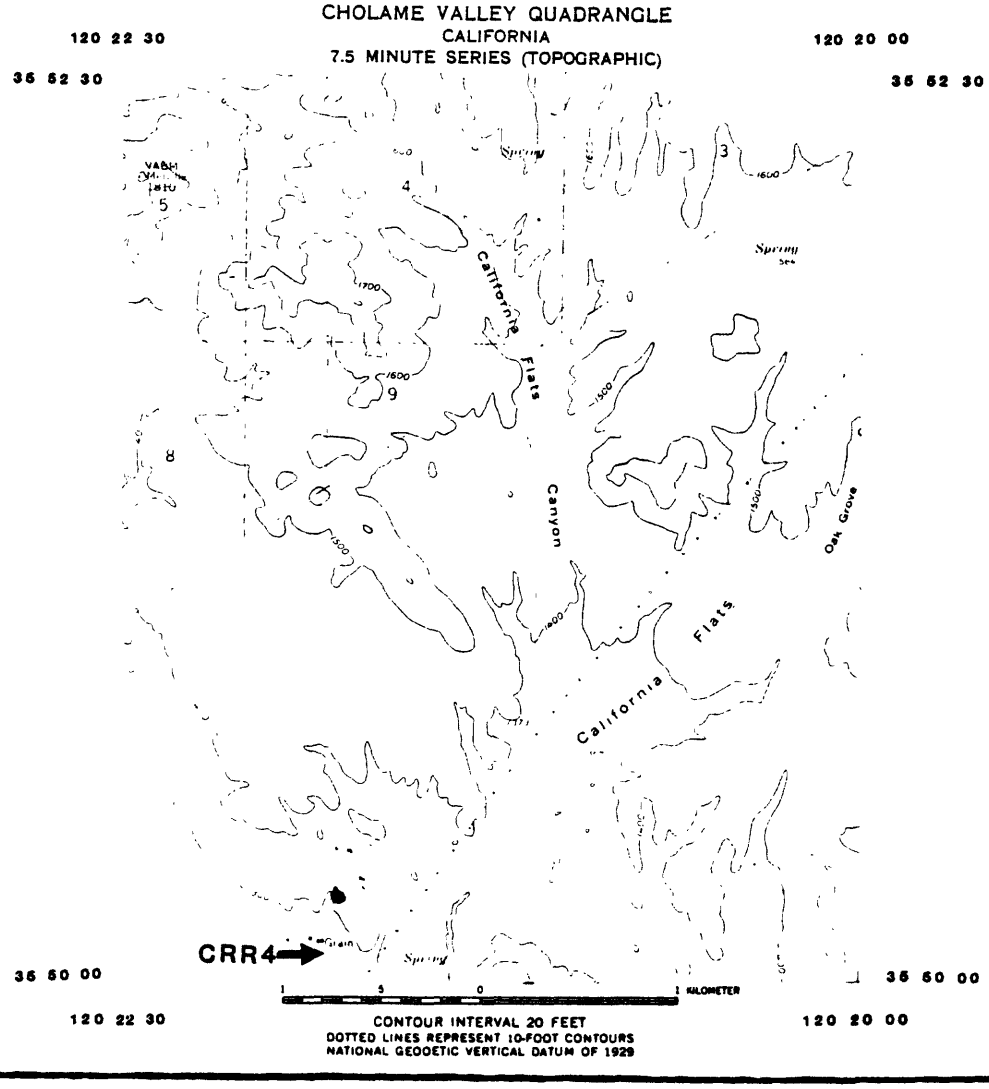
SITE DESCRIPTION

STATION CODE CRR4 NAME CARR RANCH COUNTY MONTEREY

QUAD CHOLAME VALLEY 7.5' LATITUDE 35°50.1' LONGITUDE 120°21.9'

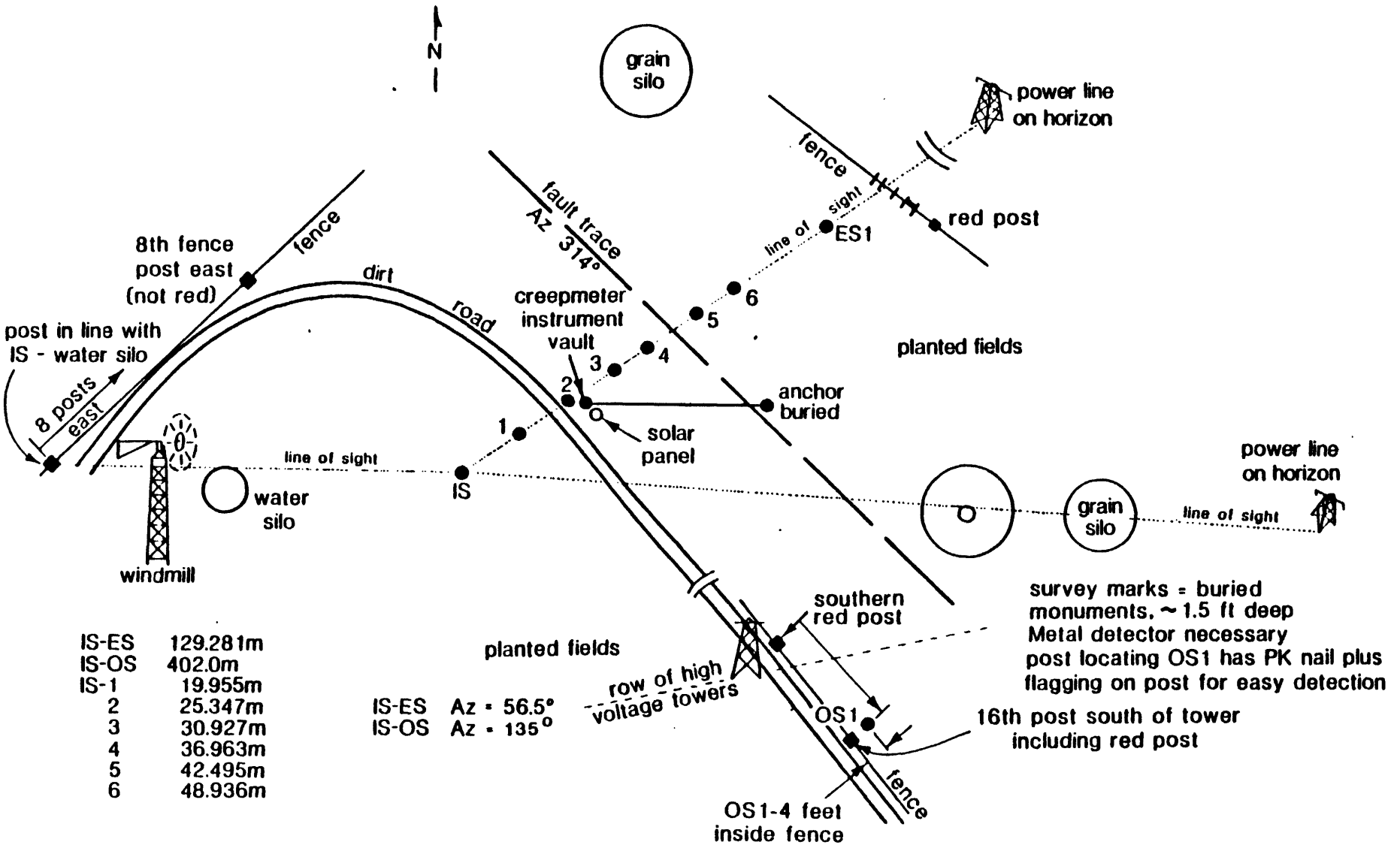
TO REACH: From Pasa Robles, take State Highway 46 east 24 miles to Cholame; approximately 1 mile past Cholame turn north onto Parkfield-Cholame Valley Road. Travel 10.35 miles, turn right at Jack Ranch Hay Headquarters sign, and go past ranch house and barns. Drive east on road along fenceline for 1.1 miles, turn left down track leading toward two grain silos. Before reaching silos, take first turn to right. Array crosses road just north of creepmeter and solar panel.

GENERAL DESCRIPTION: Deflection station 2 is approximately 2 feet northwest from creepmeter vault. ES is near fenceline at an azimuth of 56.5 degrees from station 2. IS is 25 meters in opposite direction from station 2. Deflection stations 3, 4, 5, and 6 are buried 1.5 feet below surface and use of a metal detector is necessary to find them. OS1 is 402 meters southeast of IS, and 4 feet to east of 16th fencepost south of high voltage tower. Monuments were installed by USGS in late 1970's.



USGS : CARR RANCH ALINEMENT ARRAY (CRR4) 1/5/84

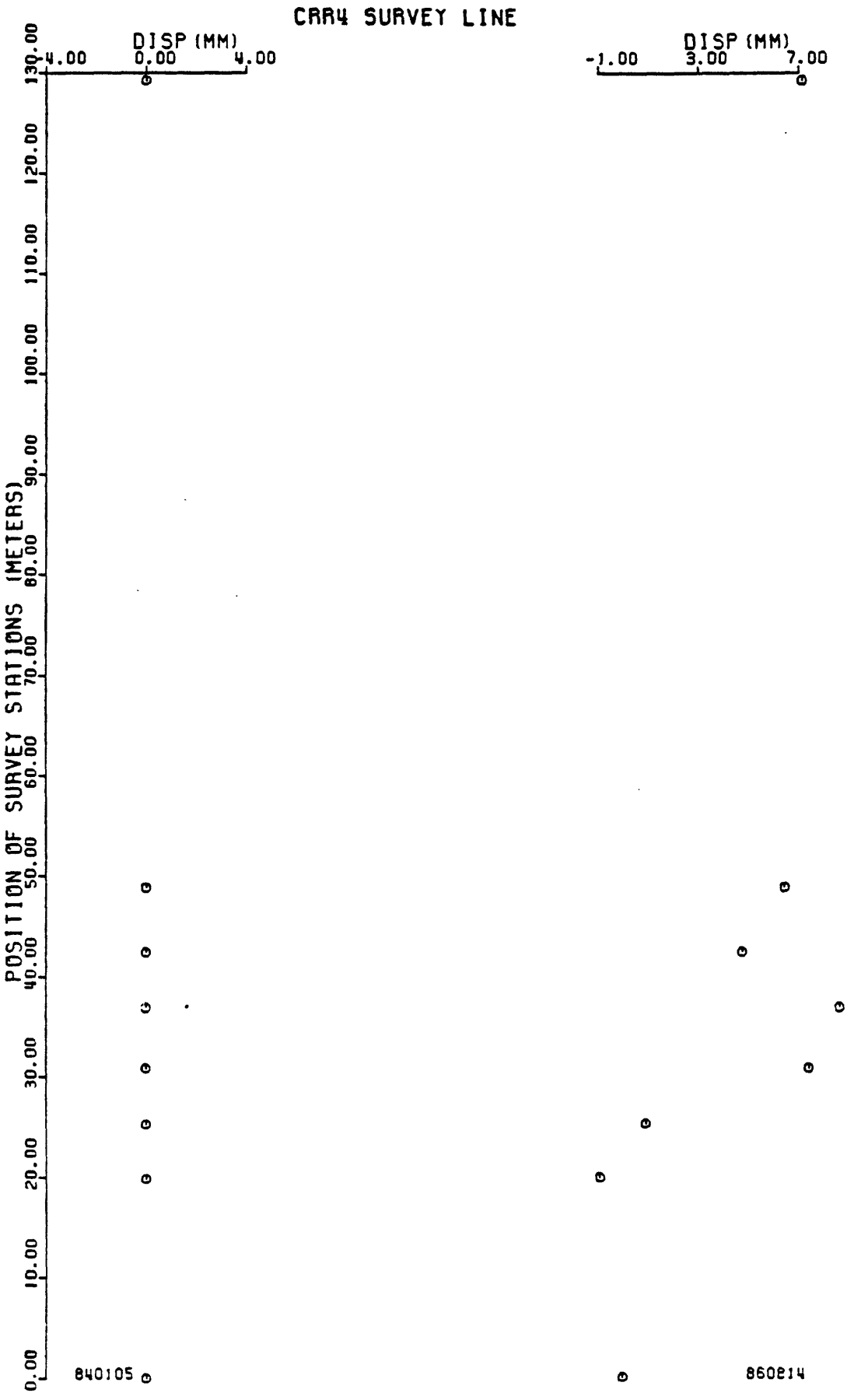
(STOP AT RANCH HOUSE PRIOR TO ENTRY)



IS-ES	129.281m
IS-OS	402.0m
IS-1	19.955m
2	25.347m
3	30.927m
4	36.963m
5	42.495m
6	48.936m

CRR4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 12.5°	
Jan 5	0.00	129.28	0.9763	0.00
Jun 21	-0.16			-0.16
Aug 8	-.64			-0.80
1985				
Jul 31	4.79			3.99
1986				
Aug 14	3.16			7.15


CRR4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-1.00
3.00
7.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
840105
860814

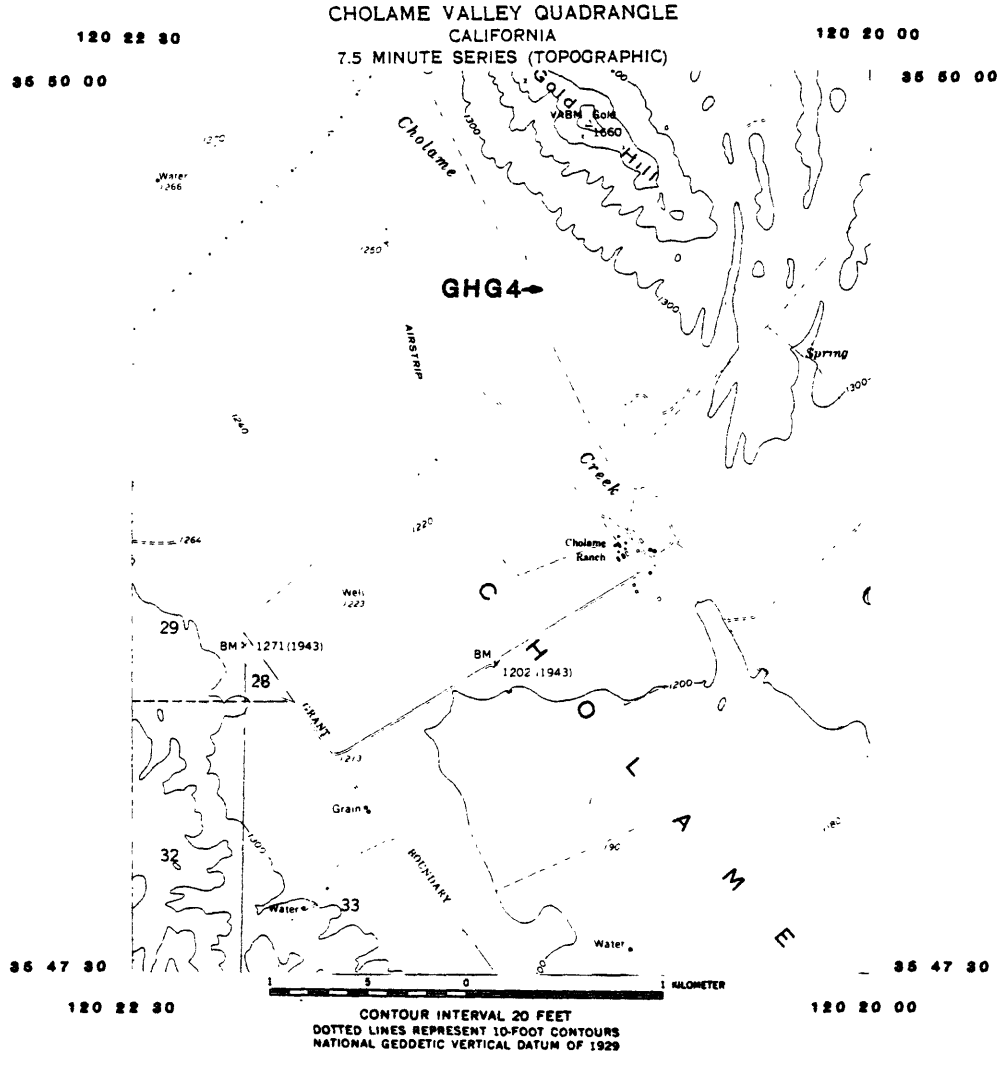
SITE DESCRIPTION

STATION CODE GHG4 NAME GOLD HILL GILMAN COUNTY MONTEREY

QUAD CHOLAME HILLS 7.5' LATITUDE 35°49.1' LONGITUDE 120°21.0'

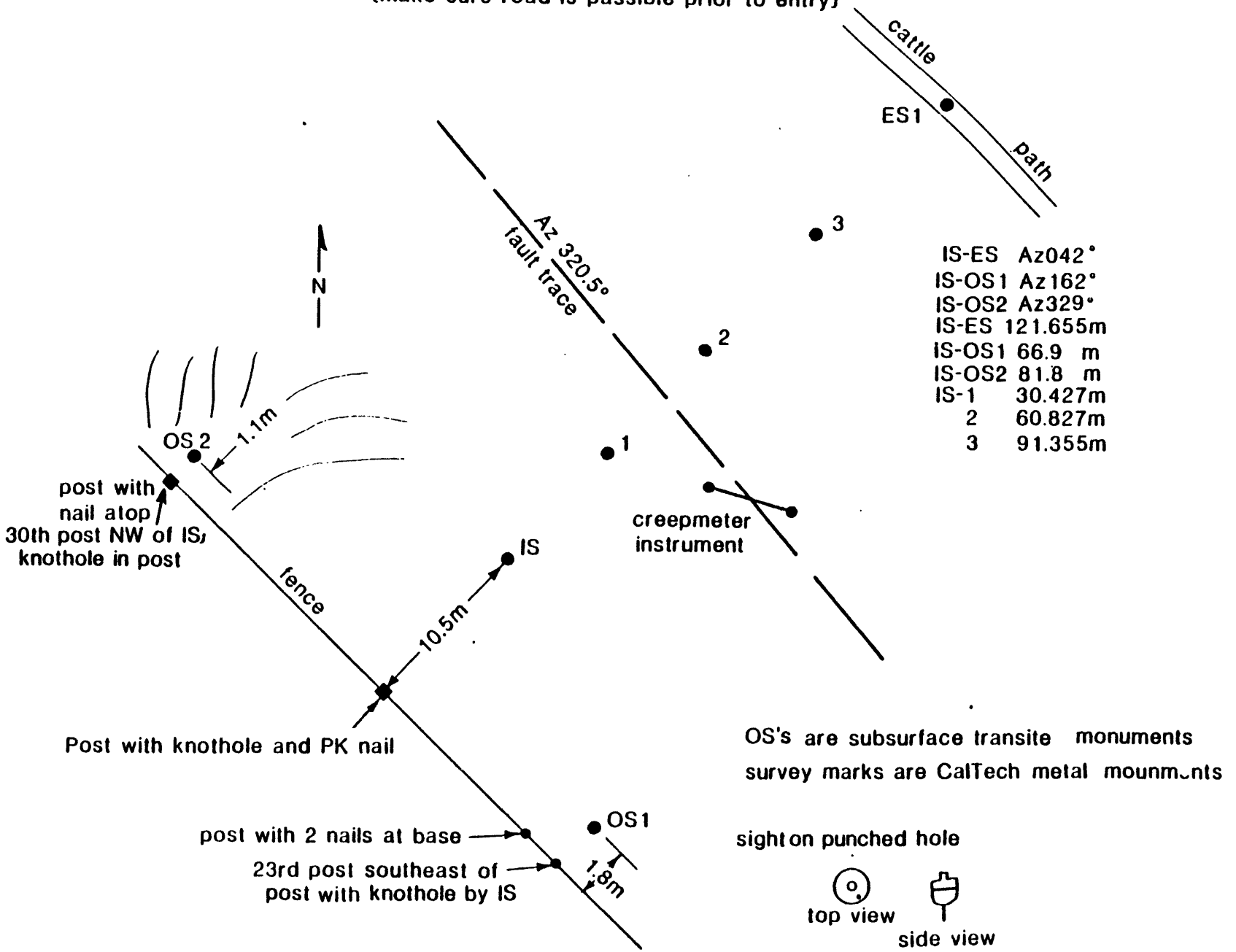
TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame. Approximately 1 mile past Cholame, turn north onto Parkfield-Cholame Valley Road and proceed 6.35 miles to Jack Ranch. Go past ranch house to northeast gate at horse barn. Go through gate, cross stream, pass through middle gate into northeast pasture and follow road along western base of Gold Hill for 0.3 mile. Look for white fiberglass creepmeter vault lid approximately 100 yards to left of road. Alinement array is located just north of creepmeter.

GENERAL DESCRIPTION: OS1 and OS2 are USGS monuments inside pipes, and the other markers are small metal monuments. All are covered with rocks. IS is located 10.5 meters from fence line. OS2 is northwest of IS and 1.1 meters from a post with a nail in its top. OS1 is southeast of IS and 19 posts south of the brief emergence of an underground cable. ES lies along a cow trail, across fault from IS. With exception of OS1 and OS2, monuments were installed by California Institute of Technology personnel in 1979.



USGS : GILMANS GOLD HILL ALINEMENT ARRAY
(GHG4) 8/23/83

(make sure road is passible prior to entry)



GHG4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 8.5°	
Aug 23	0.00	121.65	0.9890	0.00
1984				
Mar 27	0.10			0.10
Aug 27	-0.35			0.25
1985				
Feb 13	0.60			0.35
Jun 12	-1.96			-1.61
1986				
Nov 13	6.30			4.69

NOTE: This site has been measured as an end-point-only survey. Thus it has no deflection target readings and therefore no plot.

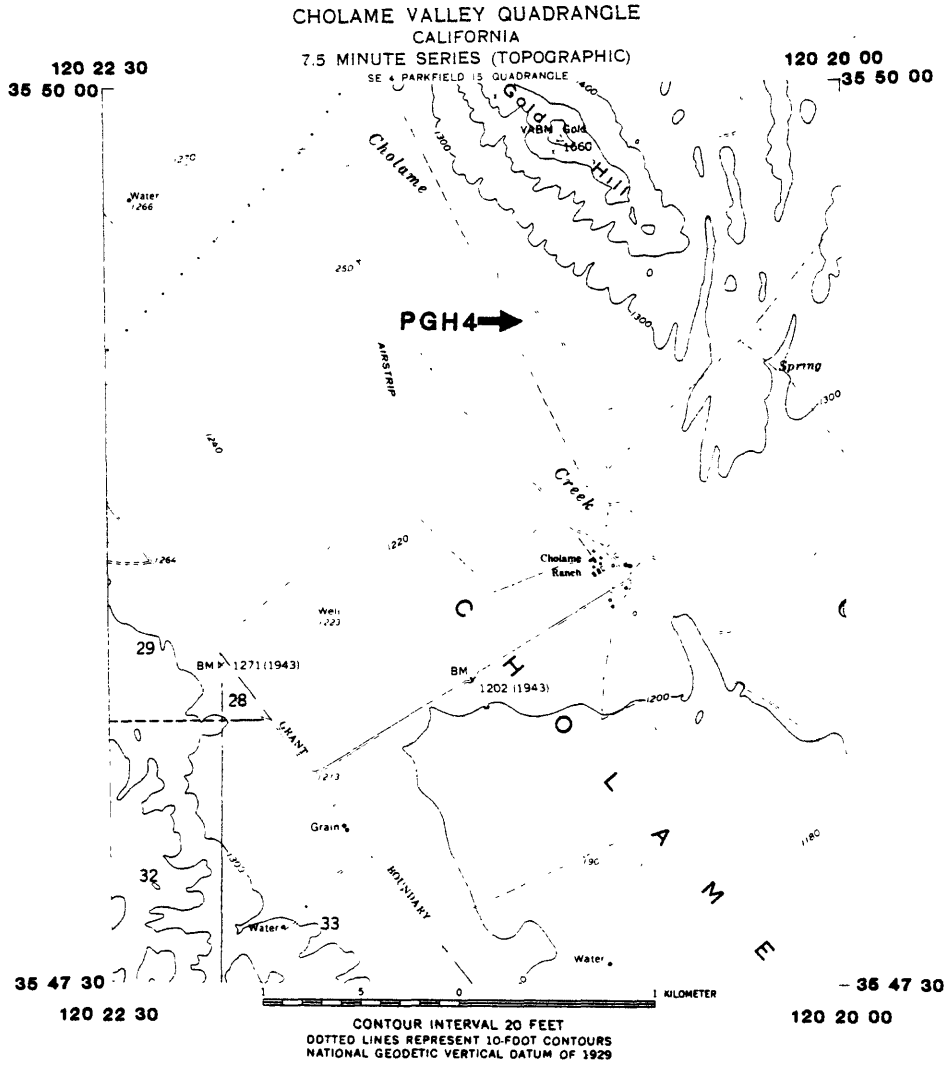
SITE DESCRIPTION

STATION CODE PGH4 NAME GOLD HILL COUNTY MONTEREY

QUAD CHOLAME HILLS 7.5' LATITUDE 35°49.1' LONGITUDE 120°21.0'

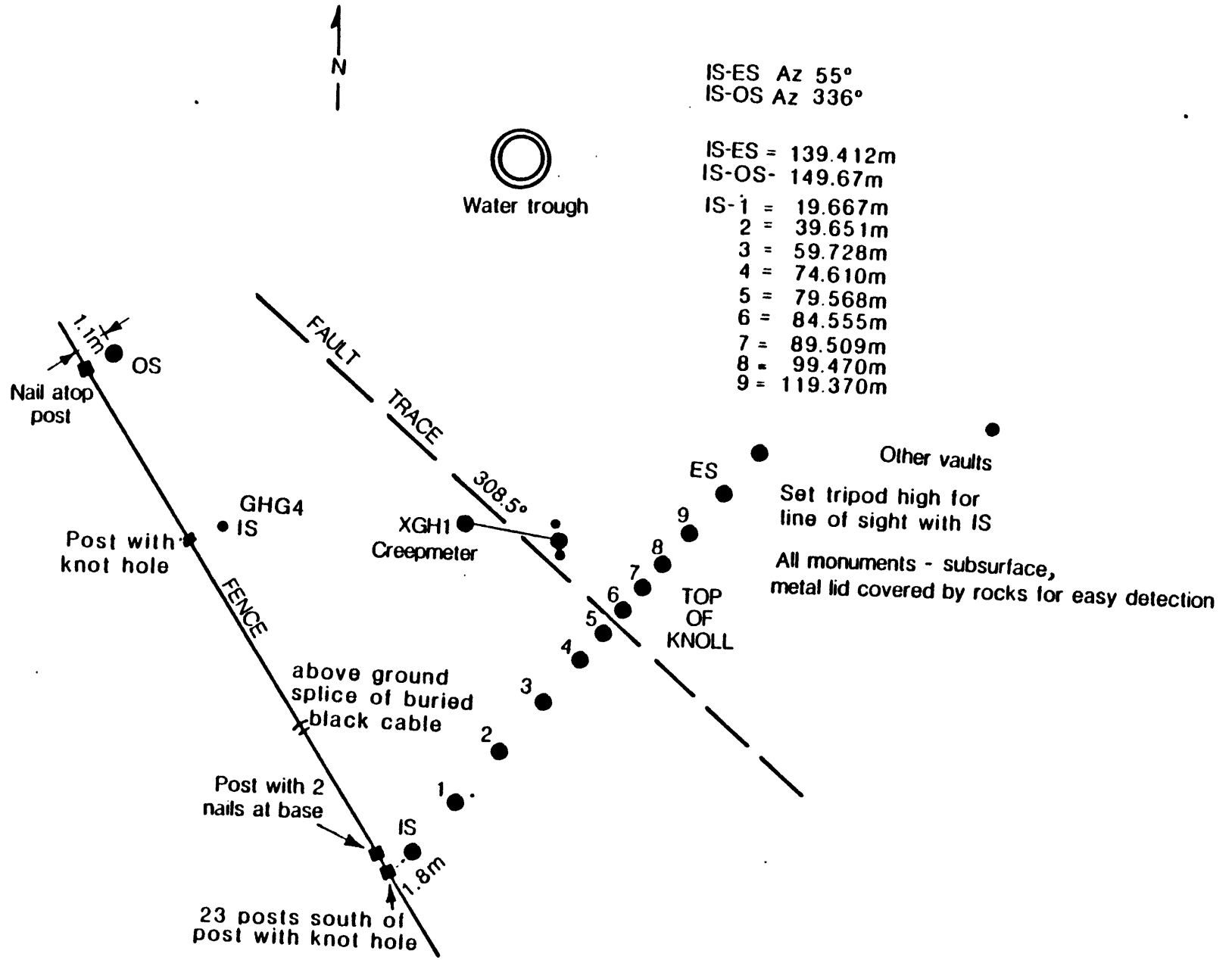
TO REACH: From Paso Robles, take State Highway 46 east 24 miles to Cholame. Approximately 1 mile past Cholame turn north on Cholame-Parkfield Valley Road, and proceed 6.35 miles to Jack Ranch. Go past ranch house to northeast gate at horse barn, go through gate, cross river, pass through middle gate into northeast pasture, and follow road north along western base of Gold Hill for 0.3 mile. Look for white fiberglass creepmeter vault lid approximately 100 yards to left of road. Alinement array is located on south side of creepmeter.

GENERAL DESCRIPTION: Monuments are subsurface type, covered with rocks; array was installed by USGS in late 1970's.



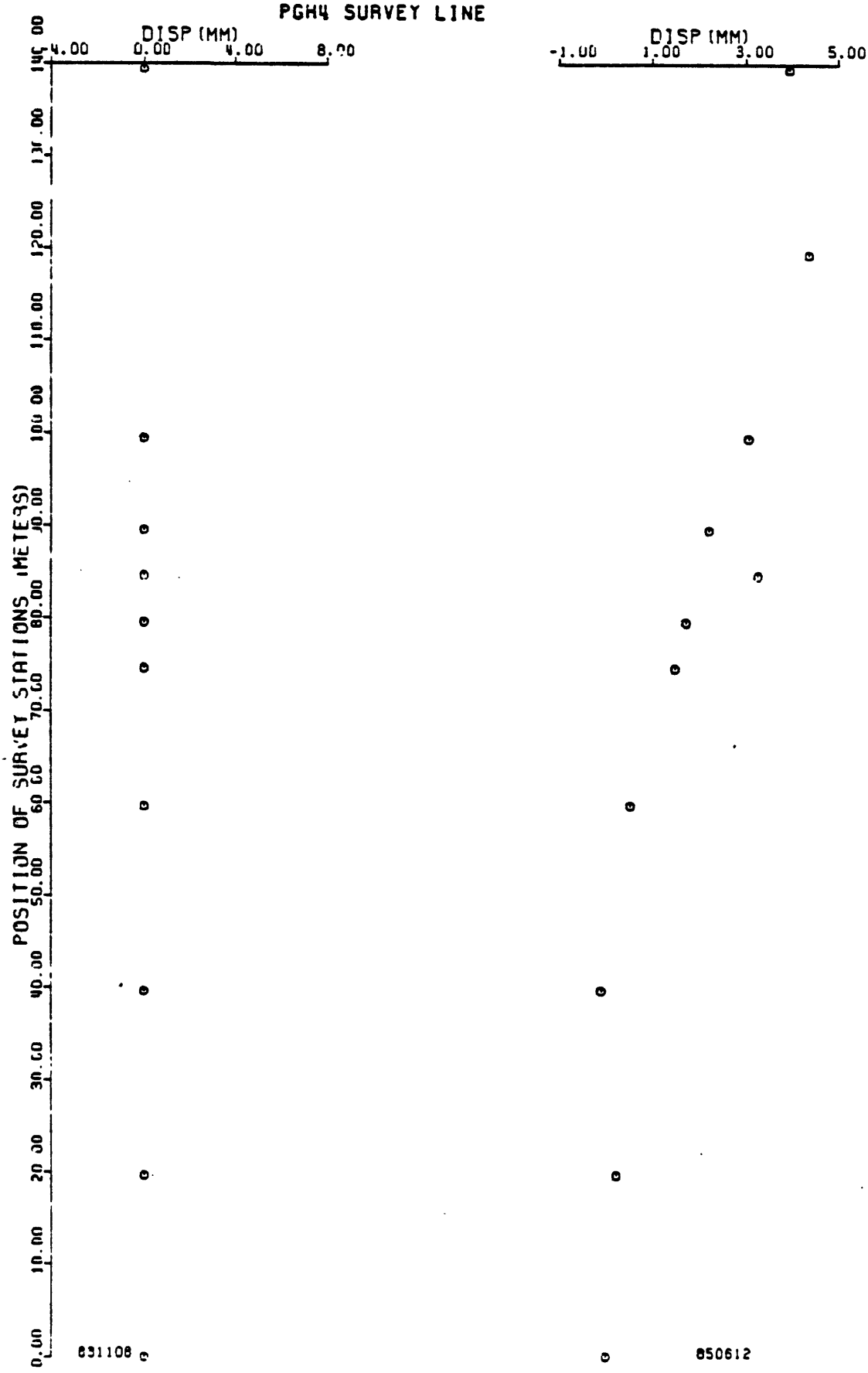
USGS : GOLD HILL ALINEMENT ARRAY

(PGH4) 11/8/83



PGH4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 18.5°	
Nov 8	0.00	139.41	0.9483	0.00
1984				
Mar 28	1.09			1.09
Jun 22	0.87			1.96
1985				
Jun 12	1.98			3.94
1986				
Oct 16	10.87			14.81


PGH4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
8.00
DISP (MM)
-1.00
1.00
3.00
5.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
831108
850612

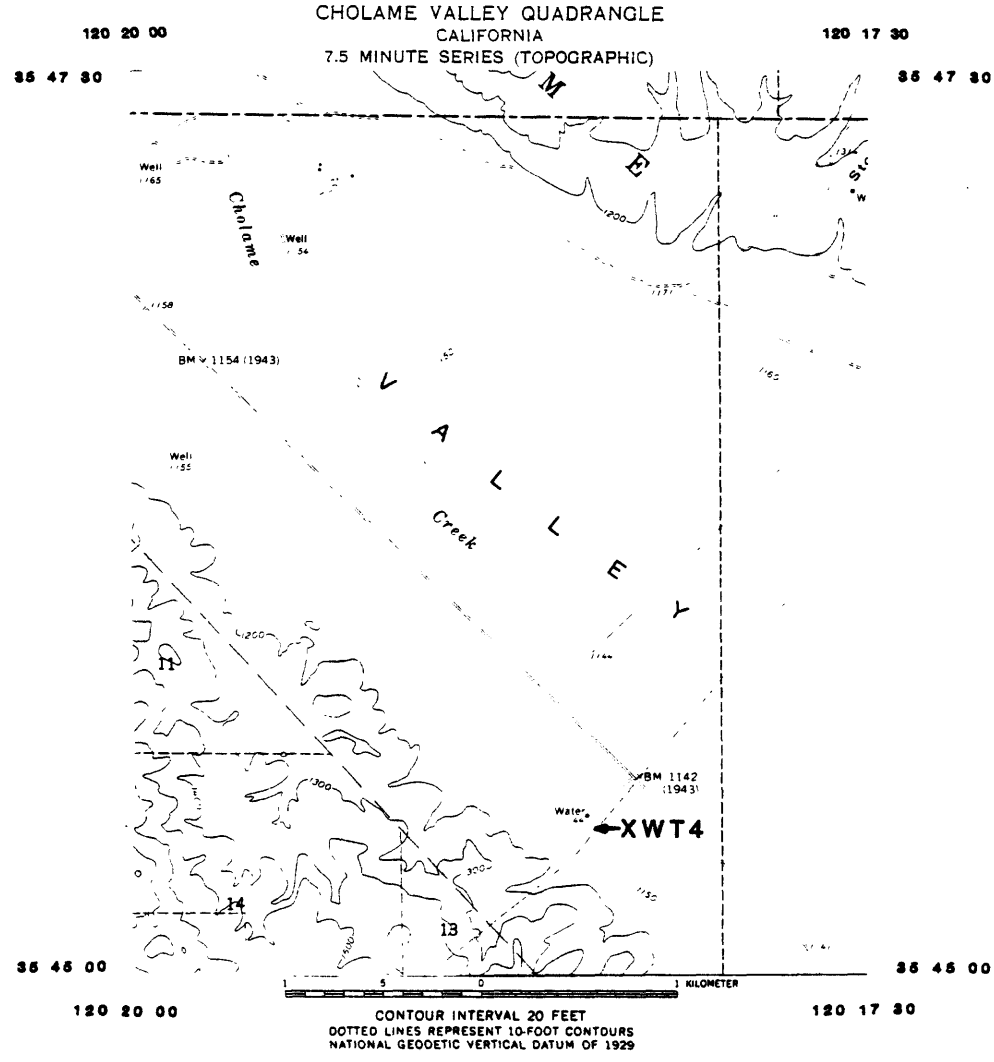
SITE DESCRIPTION

STATION CODE XWT4 NAME WATER TANK COUNTY SAN LUIS OBISPO

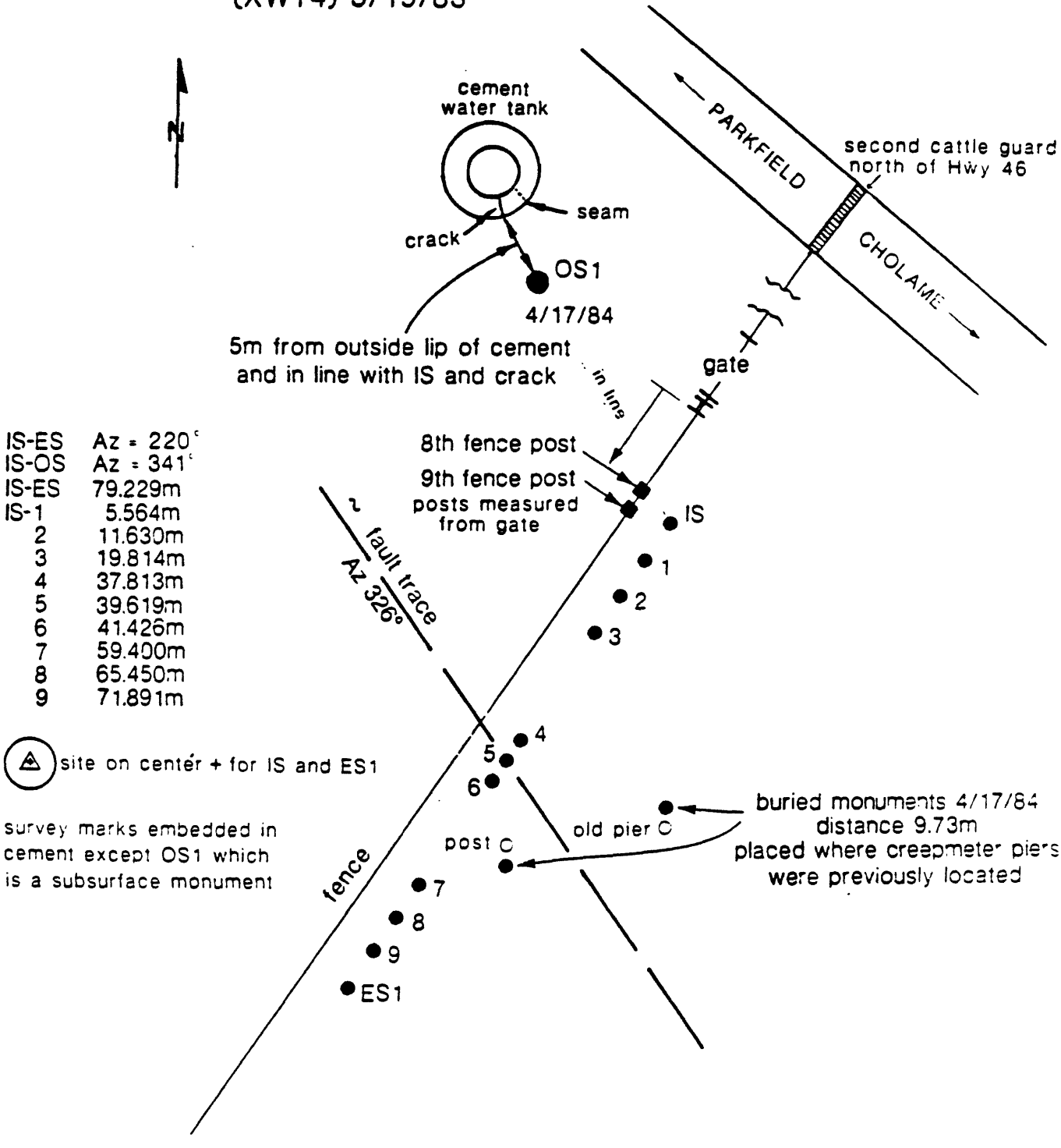
QUAD CHOLAME VALLEY 7.5' LATITUDE 35°45.4' LONGITUDE 120°18.5'

TO REACH: From Paso Robles, take State Highway 46 east 24 miles to Cholame; approximately 1 mile past Cholame turn north onto Parkfield-Cholame Valley Road. Travel 1.3 miles and, just north of fence, turn west. Cross fenceline at water tank. Array starts 8 fence posts west of gate and runs along fenceline.

GENERAL DESCRIPTION: IS is between 8th and 9th fence posts west of gate and is covered by rocks. OS is 5 meters toward IS from outside lip of water tank north of fence. All monuments except current OS are brass caps embedded in cement; OS is a subsurface monument. Old brass cap OS1 is 100m southeast of IS at an azimuth of 125°. Monuments (except OS) were installed by USGS in 1966; OS was installed by USGS in 1983.

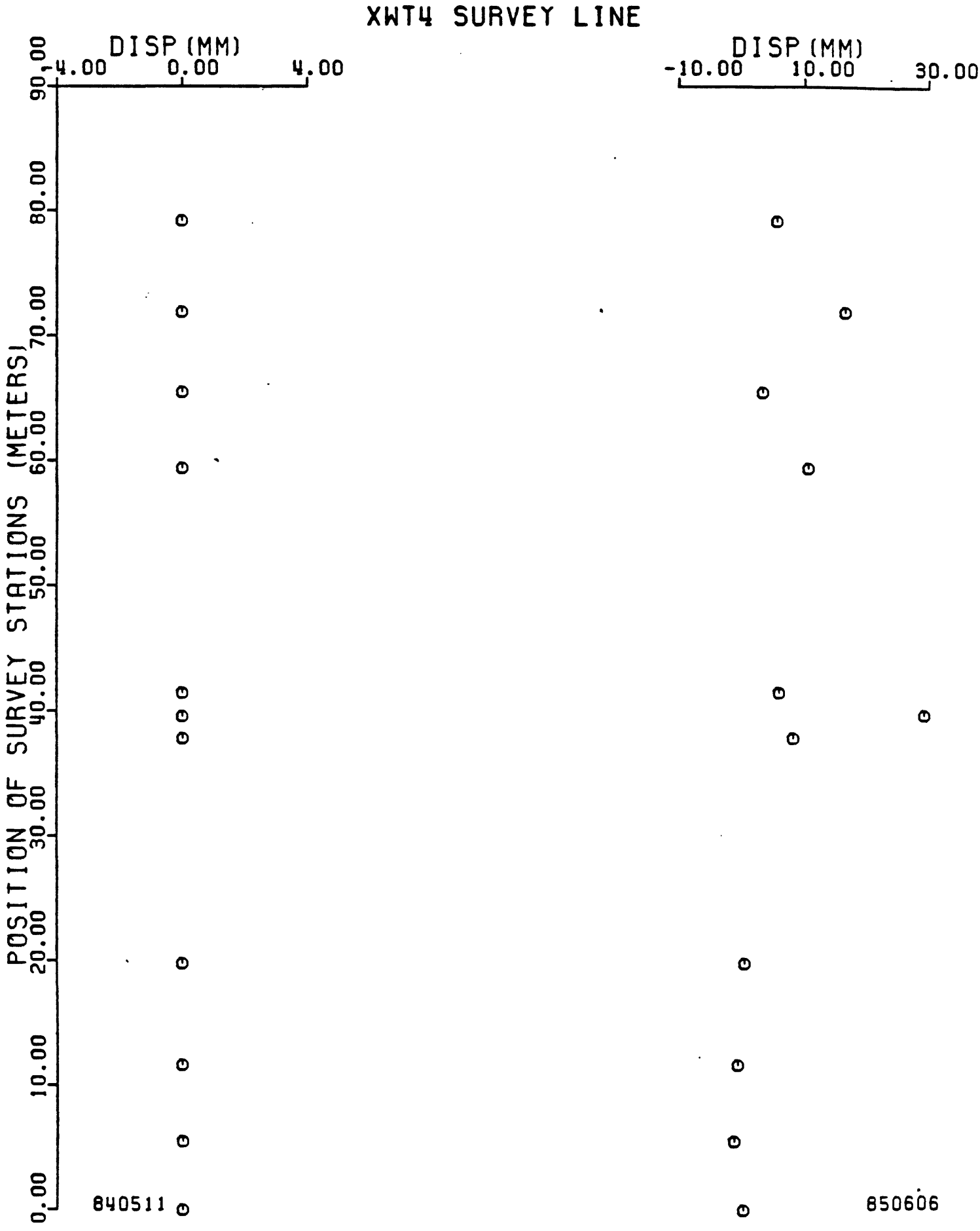


USGS : WATER TANK ALINEMENT ARRAY (XWT4) 5/19/83



XWT4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos	
May 11	0.00	79.23	0.9613	0.00
Aug 6	2.75			2.75
1985				
Jun 6	2.67			5.42


XWT4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-10.00
10.00
30.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
840511
850606

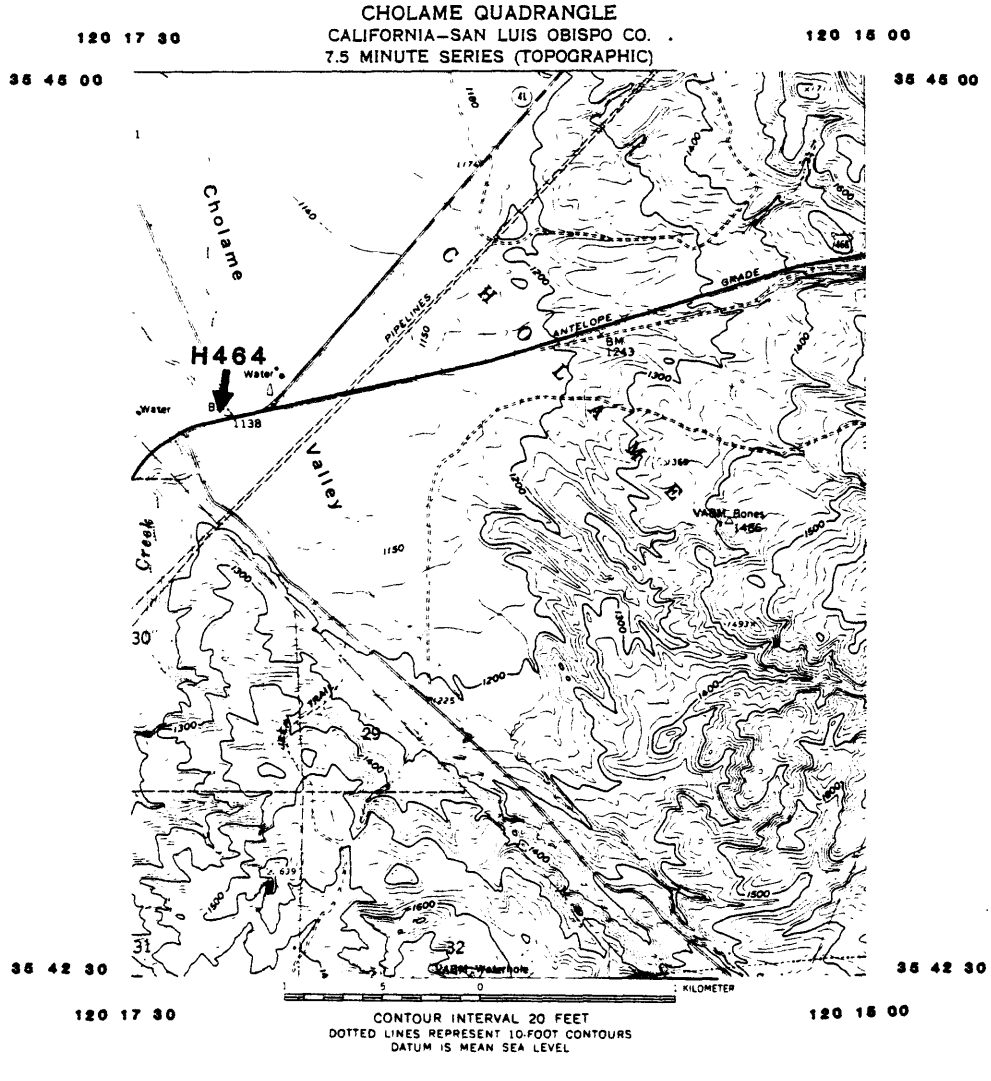
SITE DESCRIPTION

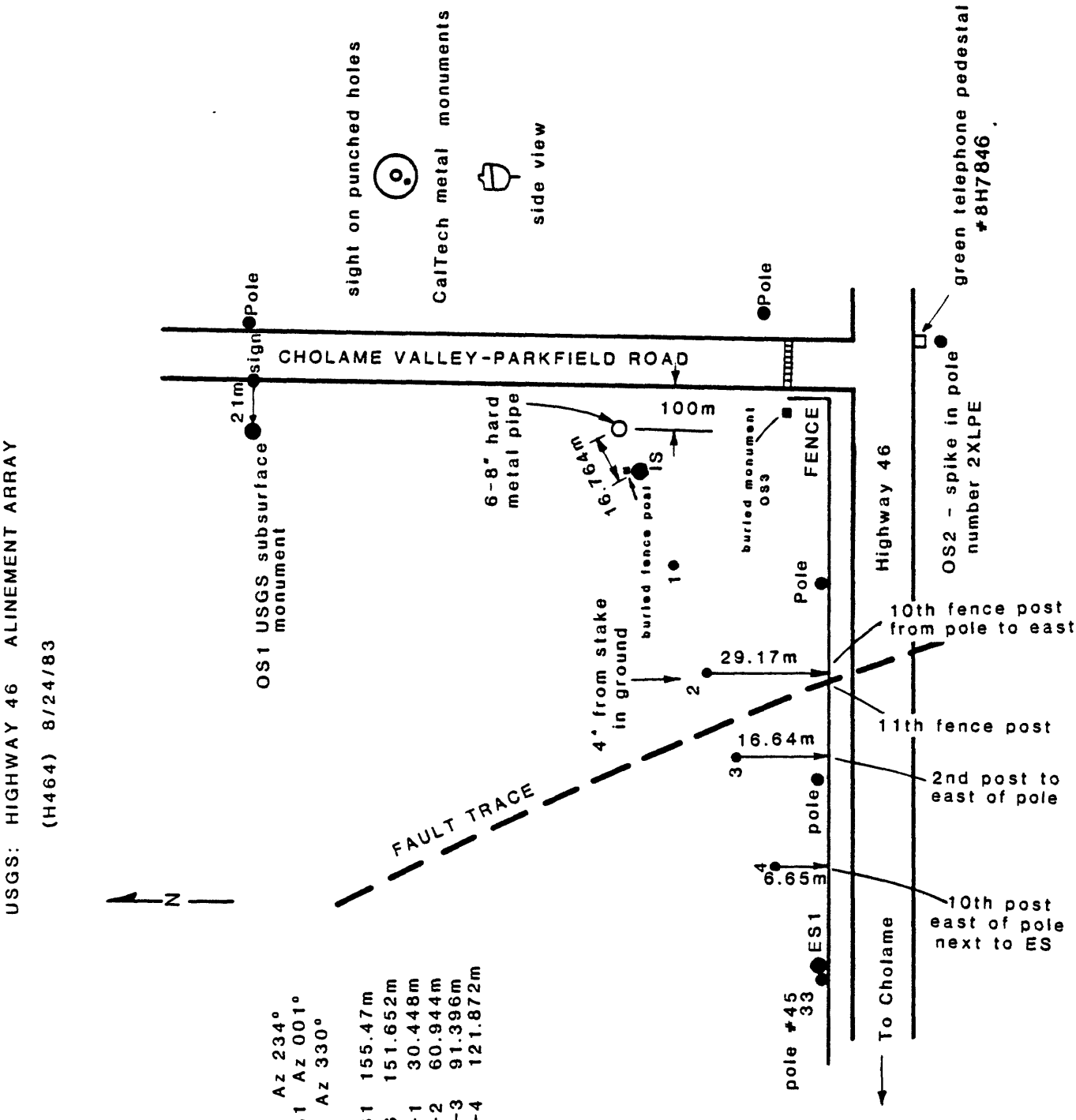
STATION CODE H464 **NAME** HIGHWAY 46 **COUNTY** SAN LUIS OBISPO

QUAD CHOLAME HILLS 7.5' **LATITUDE** 35°44.1' **LONGITUDE** 120°17.2'

TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame. Approximately 1 mile past Cholame, turn north on Cholame-Parkfield Valley Road and drive about 100 ft. Array is located west of road.

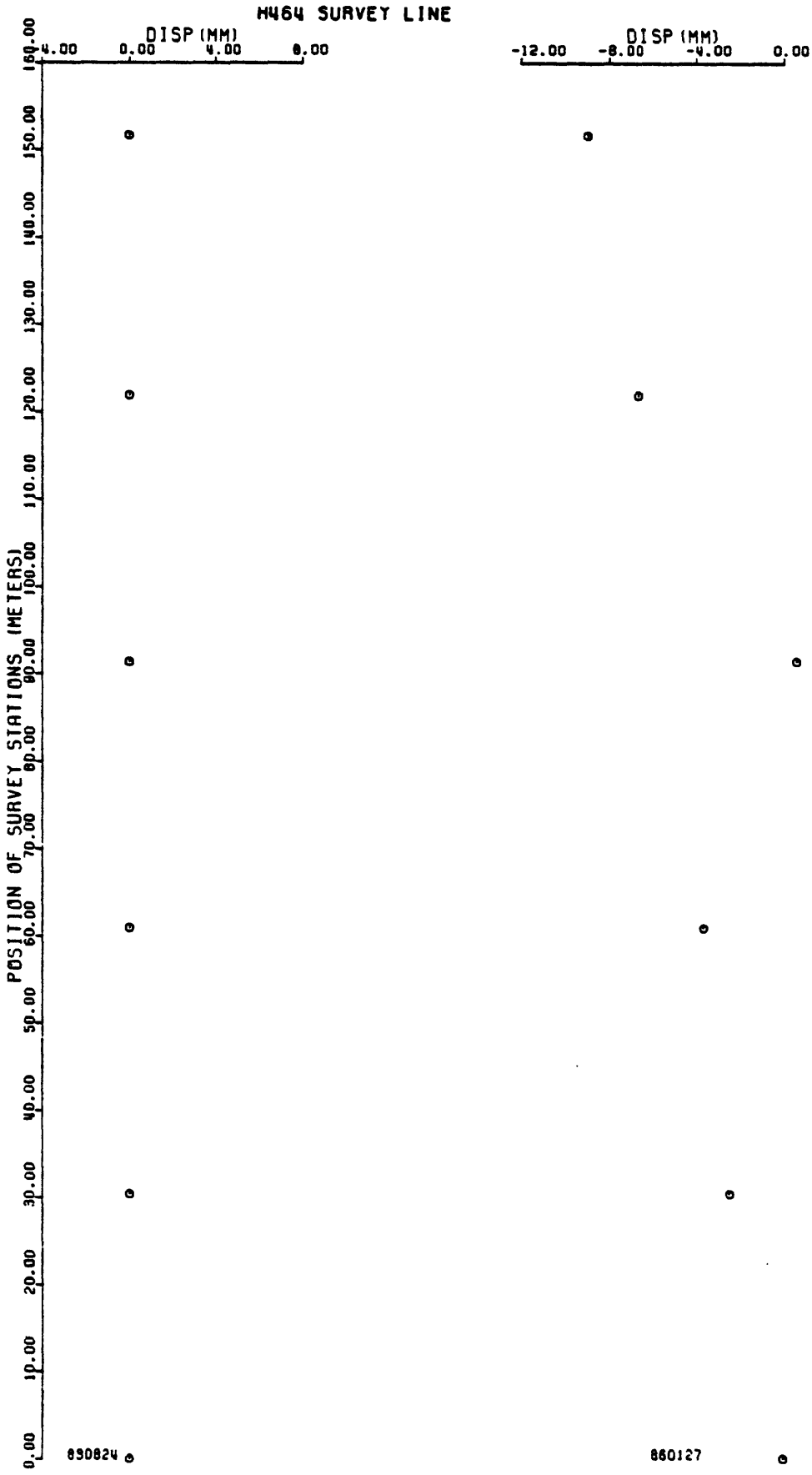
GENERAL DESCRIPTION: OS1 is a USGS subsurface monument; the other monuments are small metal plugs with hexagonal openings on top. OS2 is located on a telephone pole south of Highway 46 near its intersection with Cholame Valley Road. With exception of OS1 (installed in 1983), monuments were installed by California Institute of Technology personnel in 1977.




USGS: HIGHWAY 46 ALINEMENT ARRAY
(H464) 8/24/83
sight on punched holes
CalTech metal monuments
side view
green telephone pedestal
#8H7846
Pole
sign
21m
OS1 USGS subsurface monument
CHOLAME VALLEY-PARKFIELD ROAD
Pole
6-8" hard metal pipe
100m
16.64m
IS
buried fence post
1
buried monument OS3
FENCE
Highway 46
OS2 - spike in pole number 2XLPE
4' from stake in ground
Pole
10th fence post from pole to east
29.17m
2
11th fence post
16.64m
3
2nd post to east of pole
pole
4
6.65m
10th post east of pole next to ES
ES1
33
pole #45
To Cholame
FAULT TRACE
N
IS-ES Az 234°
IS-OS1 Az 001°
Fault Az 330°
IS-OS1 155.47m
IS-ES 151.652m
IS-1 30.448m
IS-2 60.944m
IS-3 91.396m
IS-4 121.872m

H464 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos 6.0°	
Aug 24	0.00	151.65	0.9945	0.00
1984				
Mar 29	6.95			6.95
Dec 28	7.39			14.34
1985				
Apr 23	-4.12			10.22
Jul 22	-9.57			0.65
Nov 5	-1.38			-0.73
1986				
Jan 27	1.97			1.24


H464 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
8.00
DISP (MM)
-12.00
-8.00
-4.00
0.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
830824
860127

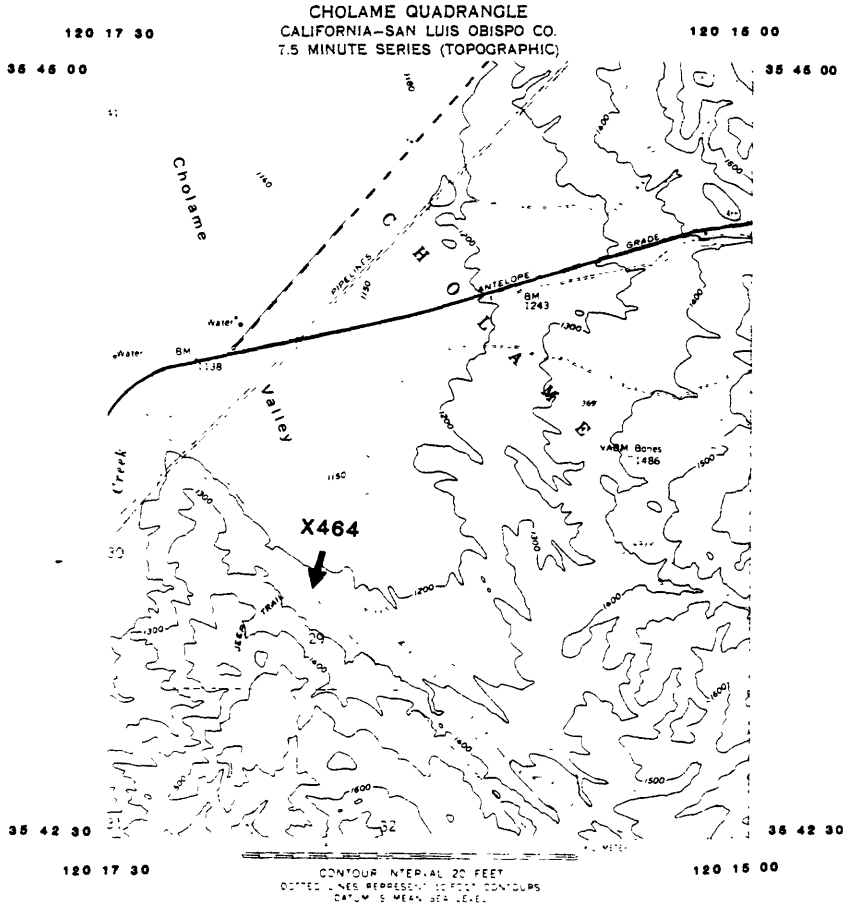
SITE DESCRIPTION

STATION CODE X464 **NAME** HIGHWAY 46 SOUTH **COUNTY** SAN LUIS OBISPO

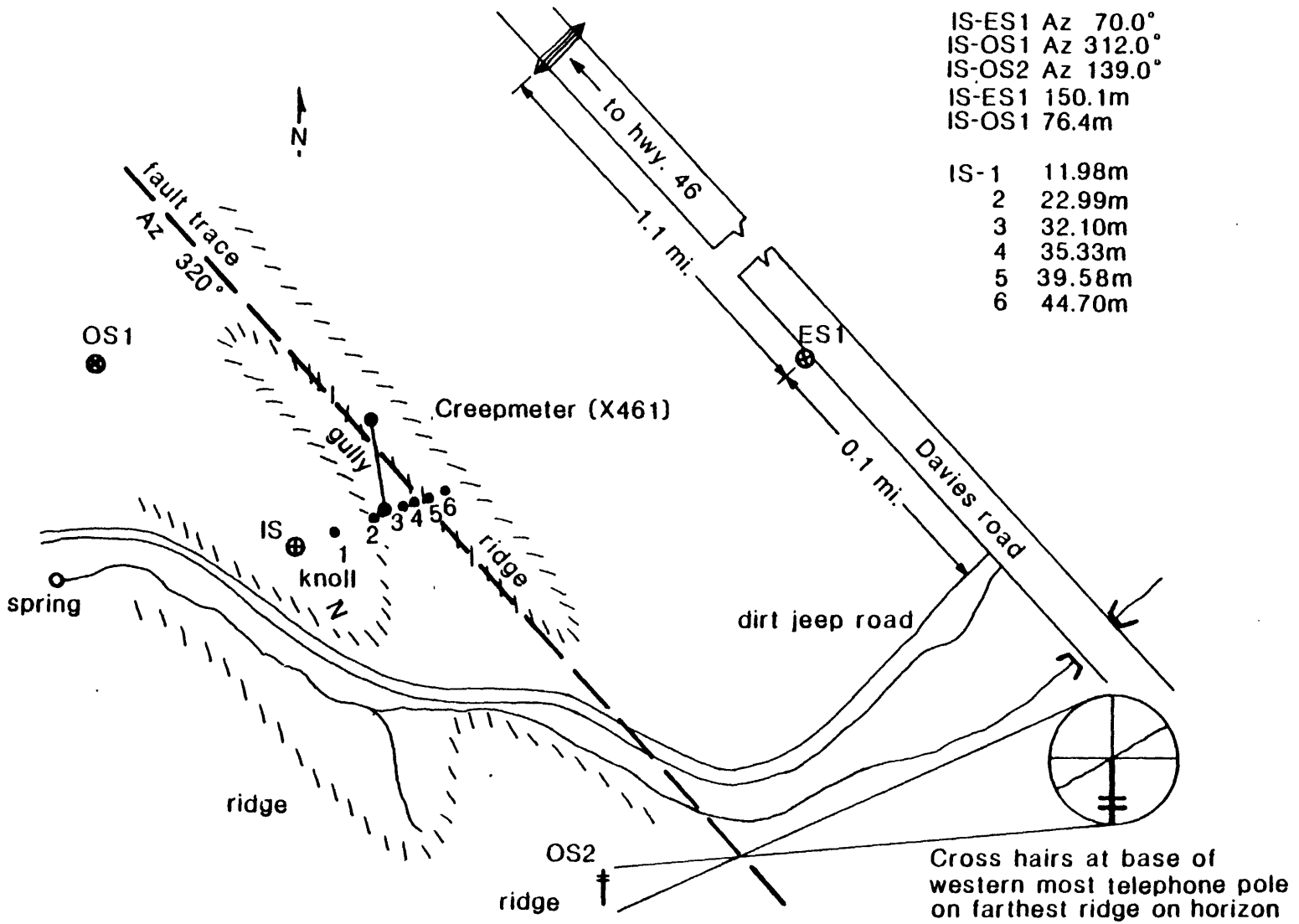
QUAD CHOLAME 7.5' **LATITUDE** 34°43.3' **LONGITUDE** 120°16.7'

TO REACH: From Paso Robles, take California State Highway 46 east 24 miles to Cholame. Approximately 0.8 mile past Cholame, turn right on Davies Road and travel 1.2 miles to a jeep trail on right side of road. Trail is approximately 10 m north of culvert marked by a red San Luis Obispo road marker. Follow trail about 1/4 mile to top of small ridge just past fault gulley.

GENERAL DESCRIPTION: IS is approximately 3 m north of trail and below top of ridge on fault side. ES1 is 8.5 m from centerline of Davies Road, approximately 140 m north of culvert described above. At installation (1986), ES1 was encircled by 3 stakes driven nearly flush with ground. OS1 is 76.4 m northwest of IS, at an azimuth of 312°. All monuments are subsurface and are yellow survey plugs in 5'-lengths of water pipe inside 6" PVC pipe collars with aluminum lids. All plugs except OS1 are numbered. An alternate ES1, to be used only if original ES is lost, is P&K nail inside two washers, located near west edge of Davies Road beyond original ES1. At installation, average angle between ES1 and alternate ES1 was 6'21.4" with alternate to southeast.

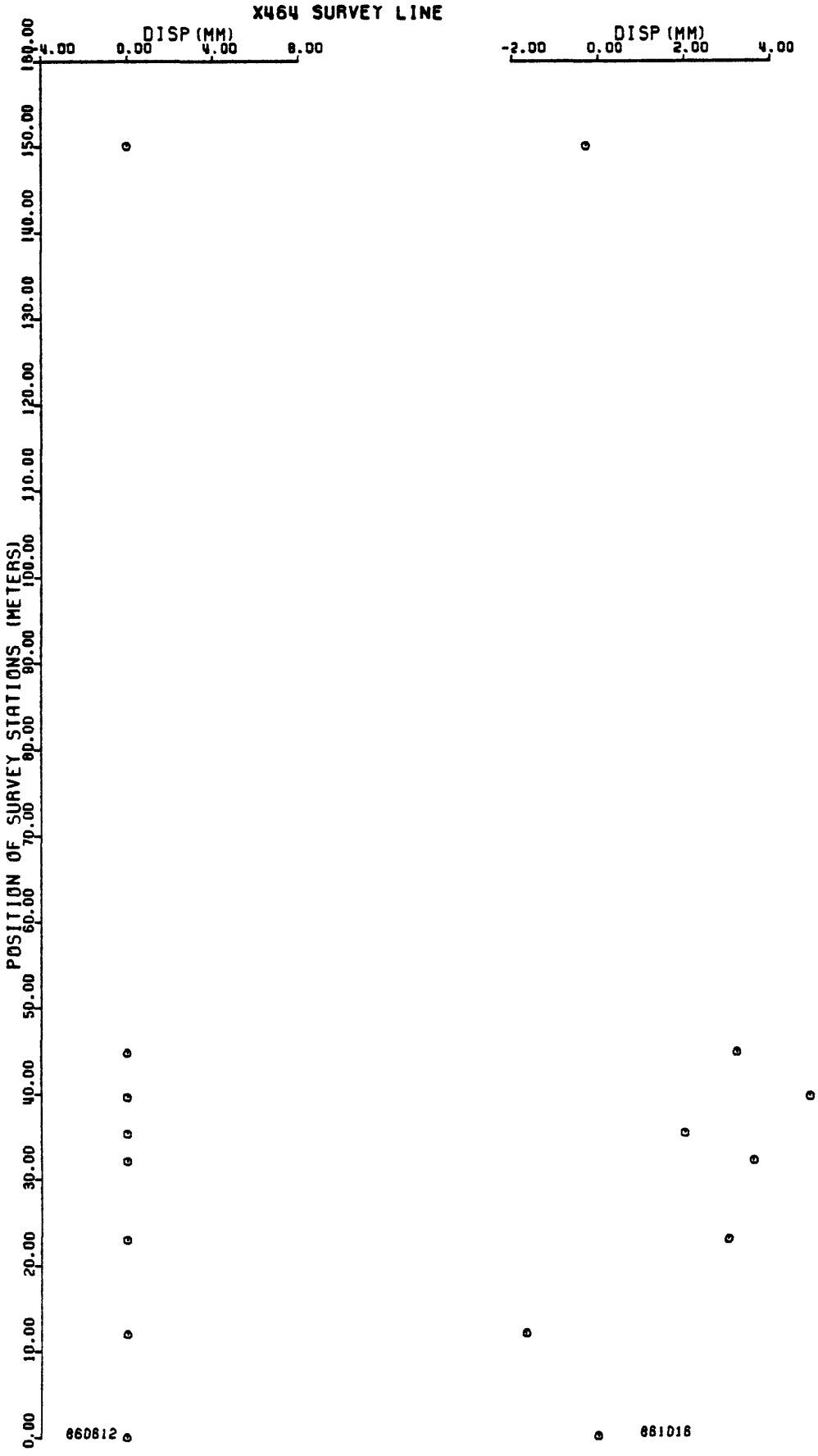


USGS : HIGHWAY 46 SOUTH ALINEMENT ARRAY
(X464) 6/12/86



X464 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1986			Cos 10.0°	
Jun 12	0.00	150.10	0.9848	0.00
Jul 20	-0.28			-0.28
Oct 16	1.50			1.78


X464 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
8.00
DISP (MM)
-2.00
0.00
2.00
4.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
860812
881018

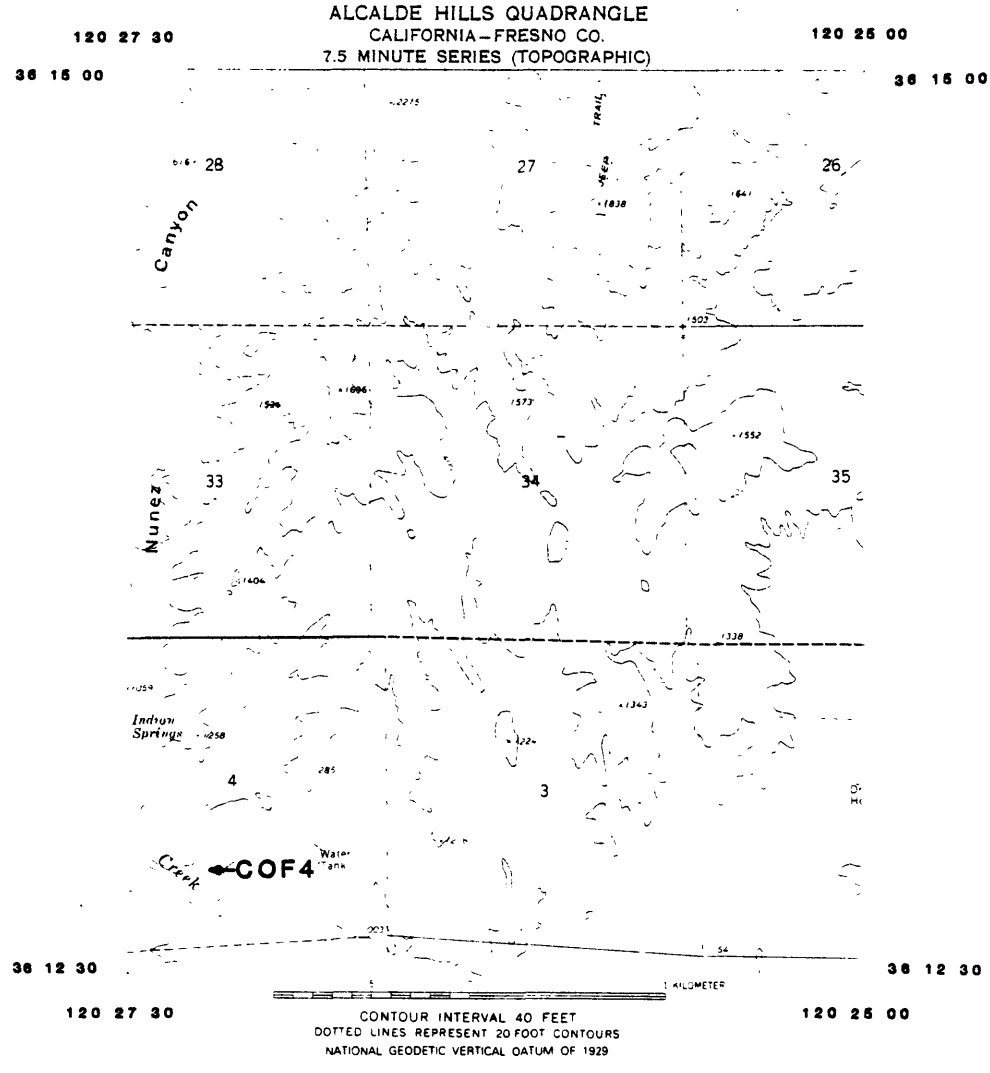
SITE DESCRIPTION

STATION CODE COF4 **NAME** COALINGA-FLOODPLAIN **COUNTY** FRESNO

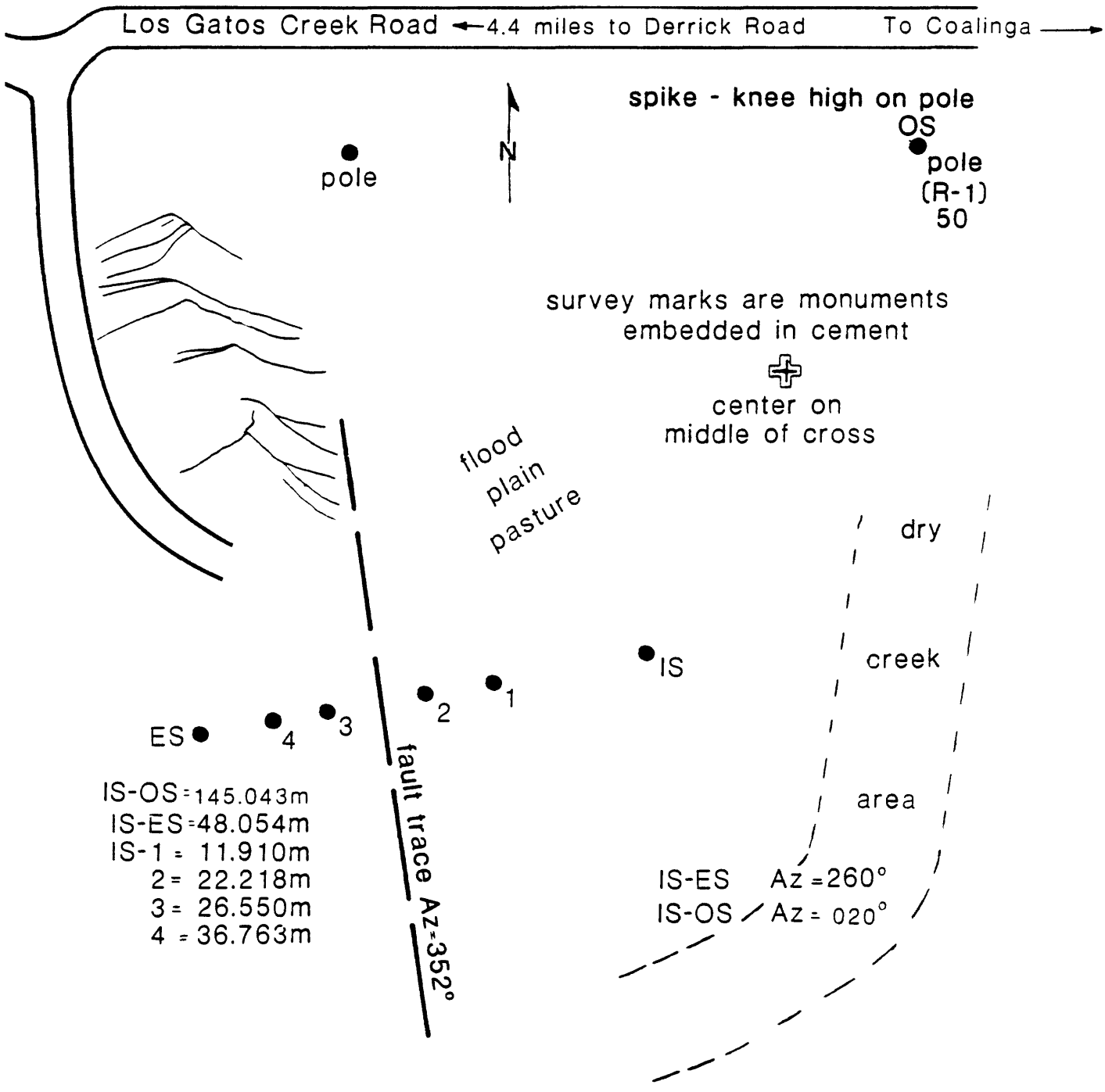
QUAD ALCALDE HILLS **LATITUDE** 36°12.6' **LONGITUDE** 120°27.4'

TO REACH: From Coalinga, southwest on State Highway 198, turn west on Jayne Avenue. Travel 0.8 mile to the west and turn north on Derrick Avenue. Travel 4.0 miles to the intersection of Derrick and Los Gatos Creek Road. Turn west on Los Gatos Creek Road and travel 4.6 miles to a dirt road on left (no fence). Dirt road is approximately 0.2 mile east of Indian Springs. Travel south on dirt road approximately 0.2 mile, site lies in valley. ES is closest.

GENERAL DESCRIPTION: The ES is at the end of the road at the bottom of the hill. The IS is approximately 50 meters to the east. The IS is ~50 meters west of the dry creek bed. The OS1 is a knee-high spike in a pole up the incline toward Los Gatos Creek Road. There are 4 deflection stations.

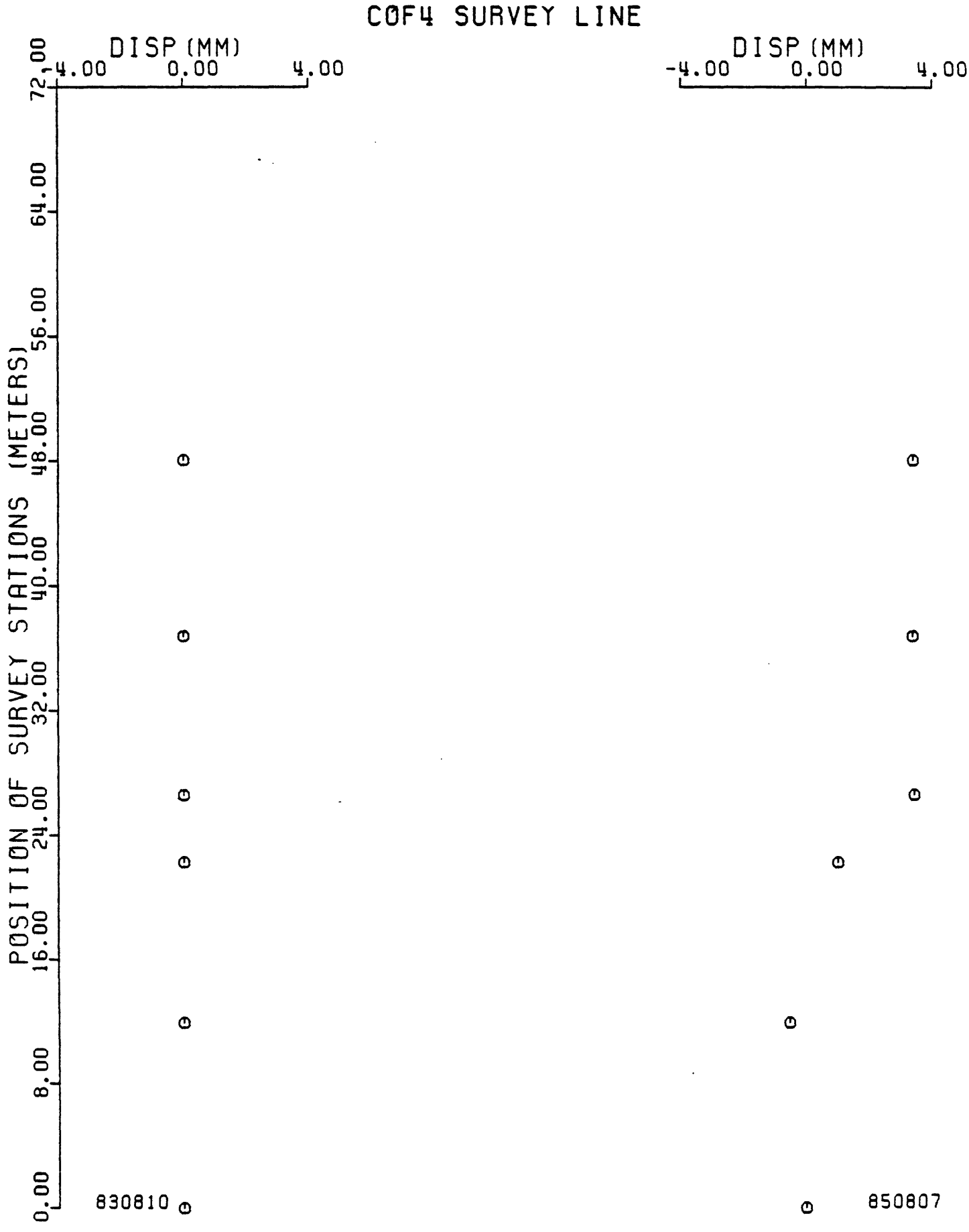


USGS : COALINGA FLOODPLAIN ALINEMENT ARRAY (COF4) 8/10/83



COF4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1983			Cos	
Aug 10	0.00	48.04		0.00
Nov 14	4.35			4.35
1984				
Apr 28	3.50			7.85
Jun 18	0.56			8.41
Nov 23	0.94			9.35
1985				
Feb 12	0.47			9.82
Jun 7	1.11			10.93
Aug 7	0.01			10.94


COF4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
DISP (MM)
-4.00
0.00
4.00
POSITION OF SURVEY STATIONS (METERS)
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0.00
830810
850807

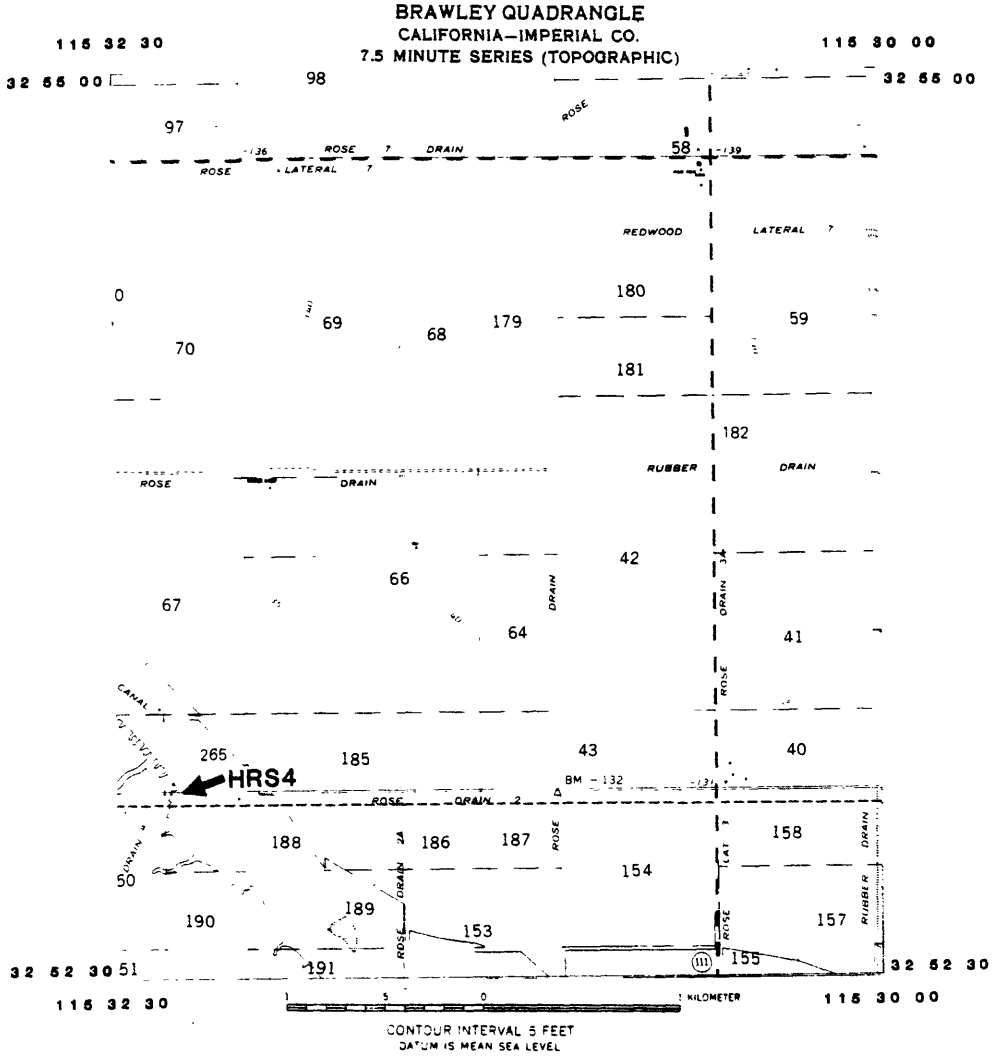
SITE DESCRIPTION

STATION CODE HRS4 NAME HARRIS ROAD COUNTY IMPERIAL

QUAD BRAWLEY 7.5' LATITUDE 32°53.0' LONGITUDE 115°32.3'

TO REACH: From El Centro, take S31 (Dogwood Road) north and turn west on Harris Road.

GENERAL DESCRIPTION: Array crosses highest vertical expression of Imperial fault, and en echelon cracks are evident along the northeast-facing scarp. Monuments are nails in surface of north side of Harris Road. OS1 is buried under guy wire of utility pole approximately 100 meters north of IS. Monuments were installed by USGS in 1976 and 1979.



USGS : HARRIS ROAD ALINEMENT ARRAY

(HRS4) 12/14/83

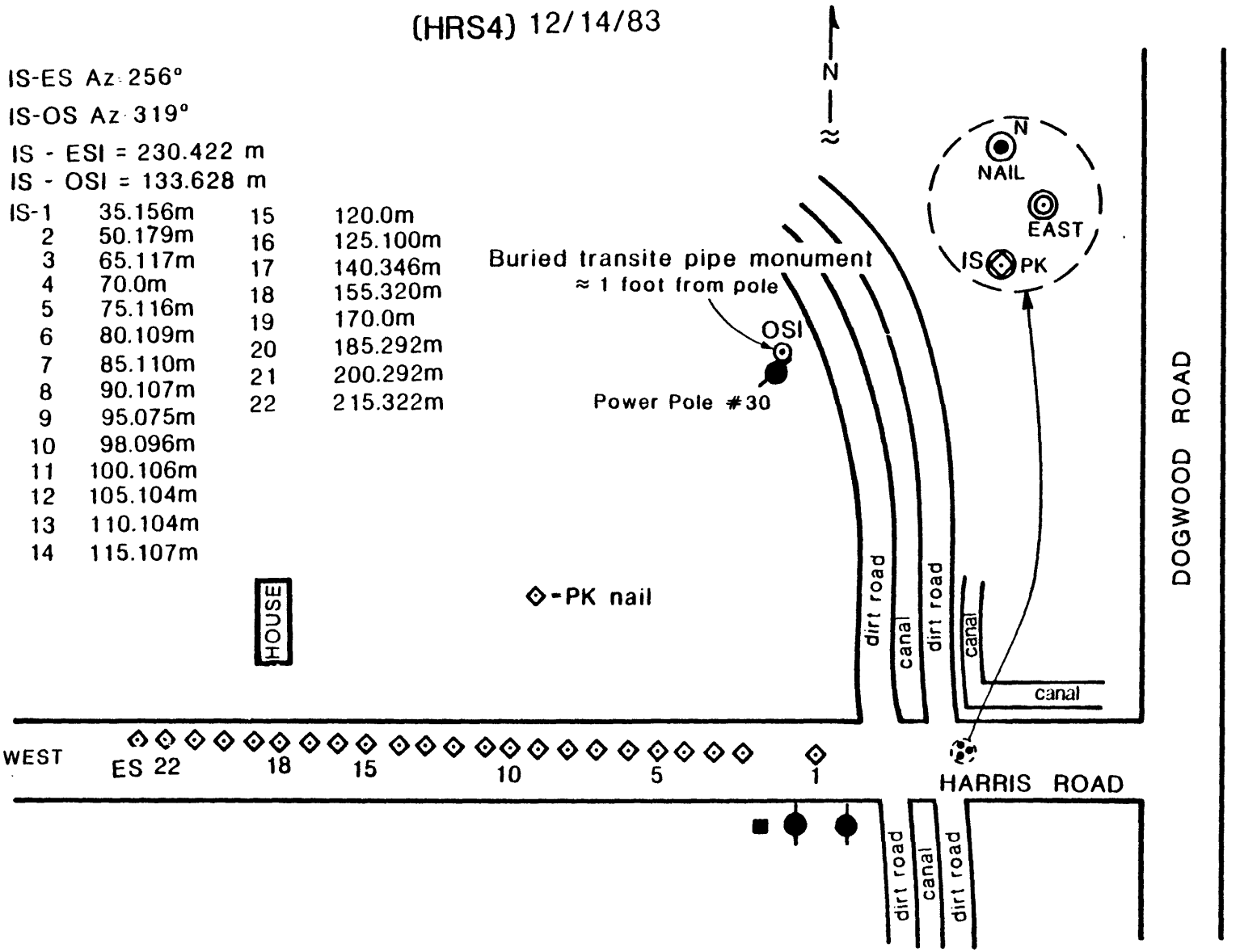
IS-ES Az 256°

IS-OS Az 319°

IS - ESI = 230.422 m

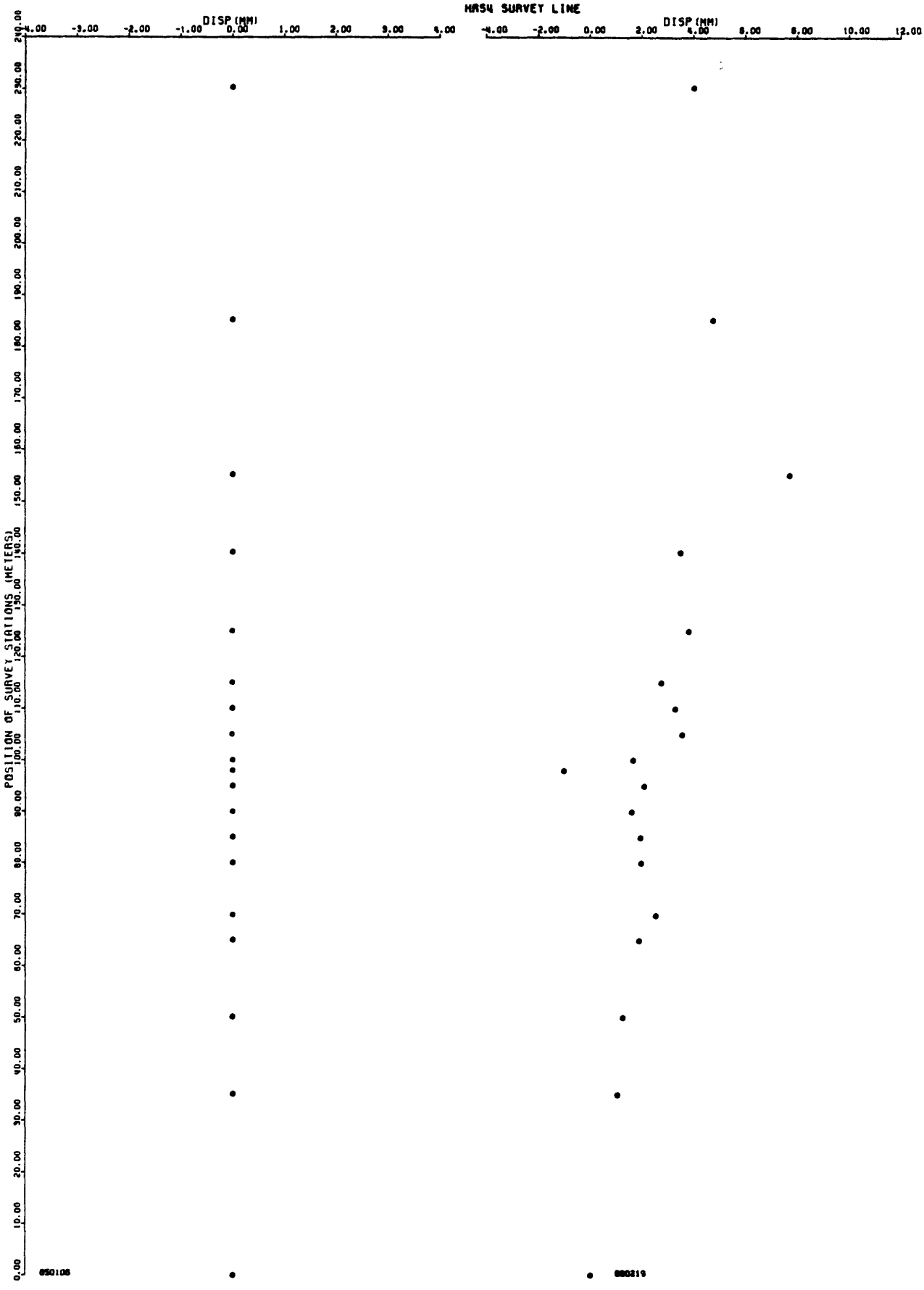
IS - OSI = 133.628 m

IS-1	35.156m	15	120.0m
2	50.179m	16	125.100m
3	65.117m	17	140.346m
4	70.0m	18	155.320m
5	75.116m	19	170.0m
6	80.109m	20	185.292m
7	85.110m	21	200.292m
8	90.107m	22	215.322m
9	95.075m		
10	98.096m		
11	100.106m		
12	105.104m		
13	110.104m		
14	115.107m		



HRS4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1985			Cos 29.0°	
Jan 6	0.00	230.42	0.8746	0.00
Aug 13	4.87			4.87
Nov 13	-1.96			2.91
1986				
Feb 19	1.09			4.00


HAS4 SURVEY LINE
DISP (MM)
-4.00 -3.00 -2.00 -1.00 0.00 1.00 2.00 3.00 4.00
DISP (MM)
-4.00 -2.00 0.00 2.00 4.00 6.00 8.00 10.00 12.00
POSITION OF SURVEY STATIONS (METERS)
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00 110.00 120.00 130.00 140.00 150.00 160.00 170.00 180.00 190.00 200.00 210.00 220.00 230.00 240.00
850108
850219

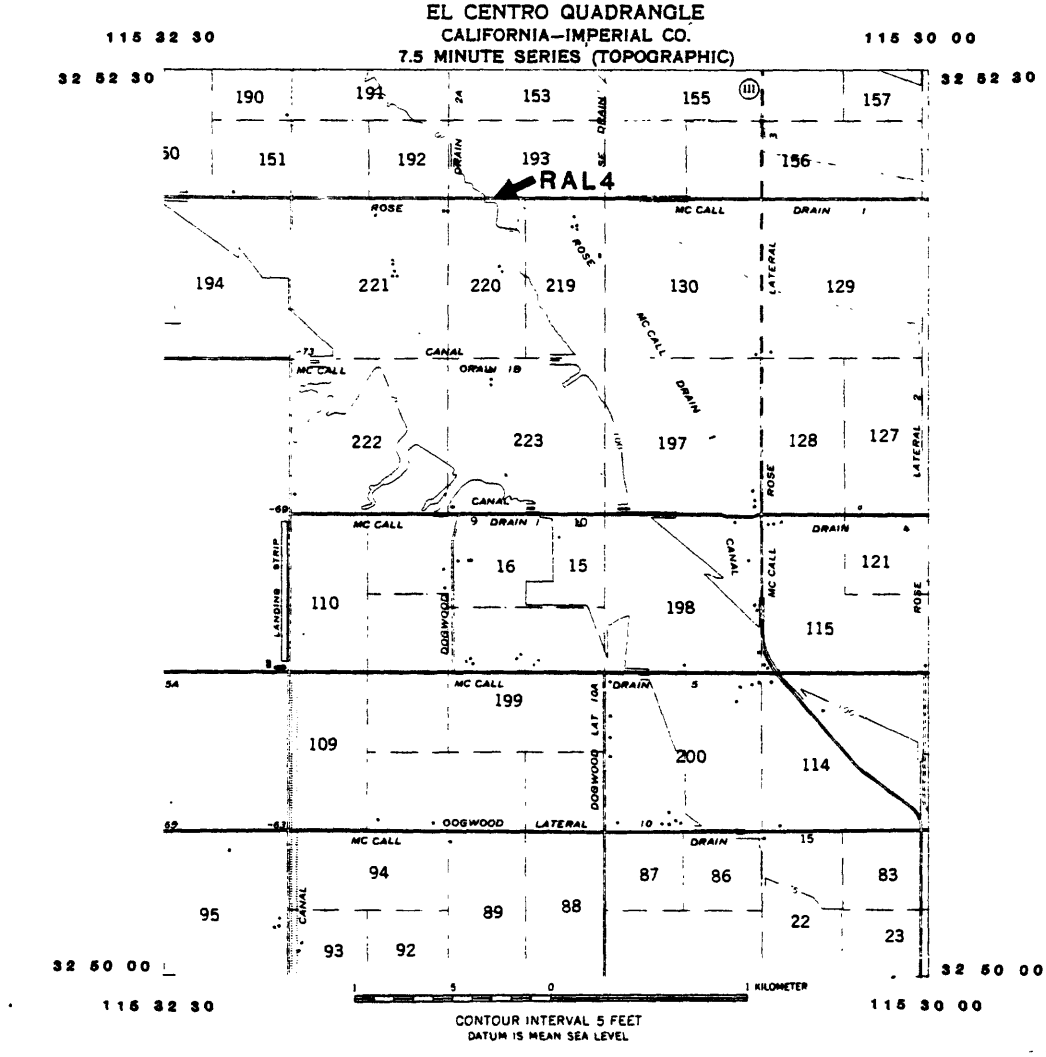
SITE DESCRIPTION

STATION CODE RAL4 **NAME** RALPH ROAD **COUNTY** IMPERIAL

QUAD EL CENTRO 7.5' **LATITUDE** 32°52.2' **LONGITUDE** 115°31.4'

TO REACH: From El Centro, take S31 (Dogwood Road) north, and turn east on Ralph Road.

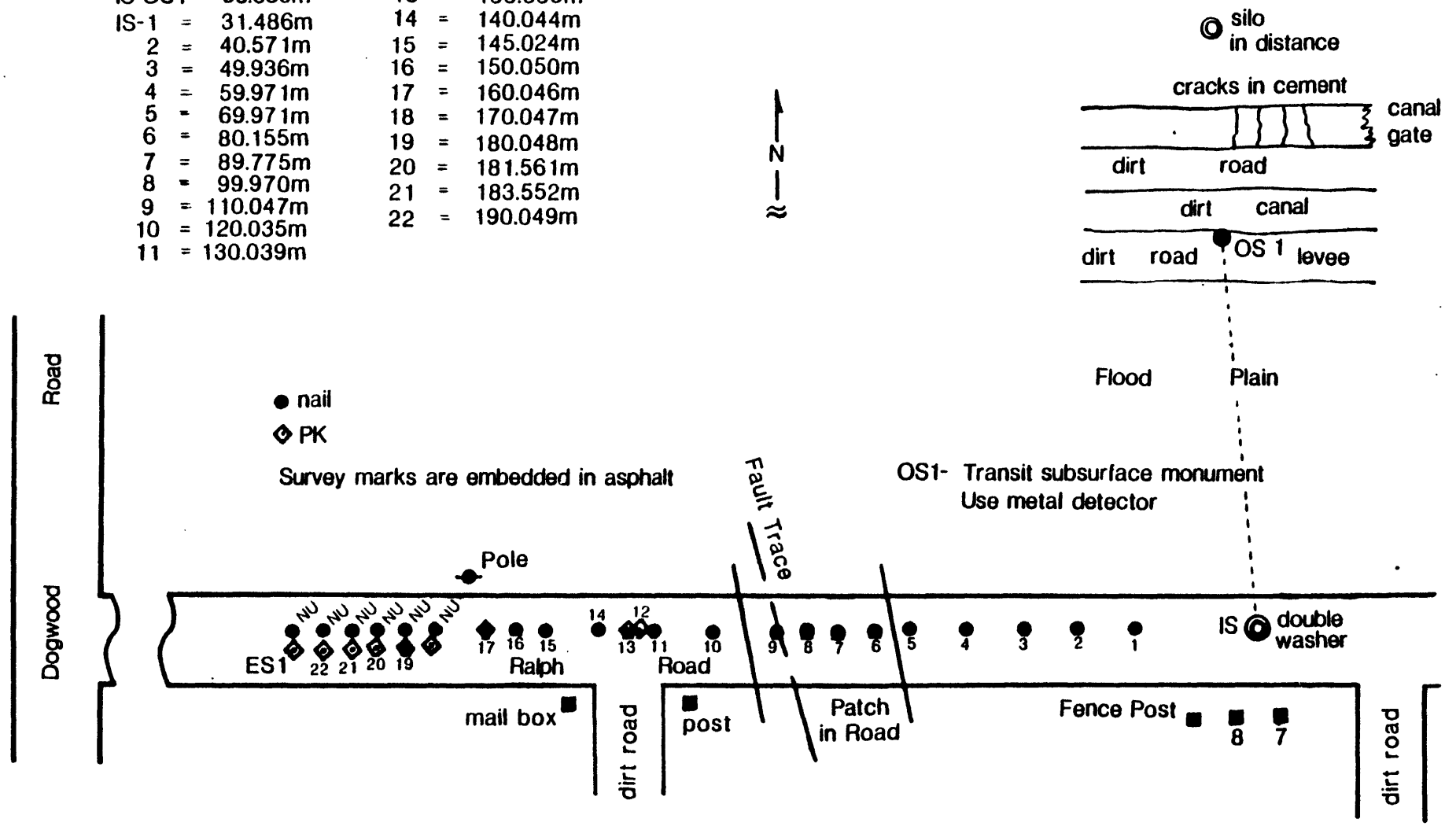
GENERAL DESCRIPTION: As of January, 1984, the Imperial fault trace at Ralph Road was marked by vertical displacement and en echelon cracks in the patched asphalt. Width of fault zone is not yet obvious. Monuments are regular and P&K nails in surface of north side of Ralph Road. OS2 is on a silo several miles north of IS. Monuments were installed by USGS in 1979.



USGS : RALPH ROAD ALINEMENT ARRAY

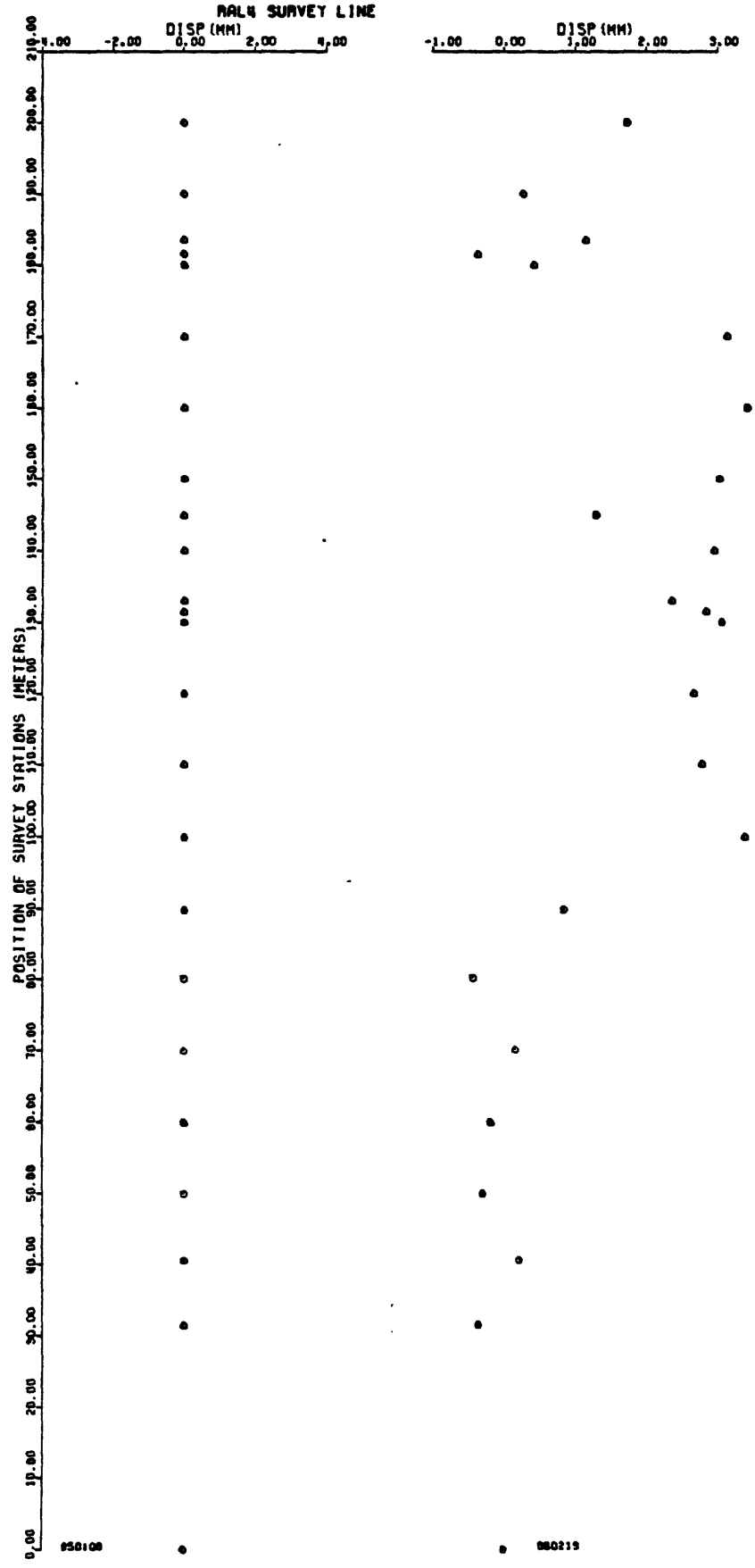
(RAL4) 12/14/83

IS-ES1 = 200.046m
IS-OS1 = 93.380m
IS-1 = 31.486m
2 = 40.571m
3 = 49.936m
4 = 59.971m
5 = 69.971m
6 = 80.155m
7 = 89.775m
8 = 99.970m
9 = 110.047m
10 = 120.035m
11 = 130.039m
12 = 131.542m
13 = 133.035m
14 = 140.044m
15 = 145.024m
16 = 150.050m
17 = 160.046m
18 = 170.047m
19 = 180.048m
20 = 181.561m
21 = 183.552m
22 = 190.049m



RAL4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1985			Cos 28.0°	
Jan 8	0.00	200.05	0.8829	0.00
May 19	-0.05			-0.05
Aug 14	1.97			1.92
Nov 13	-0.98			0.94
1986				
Feb 19	0.79			1.73


RAL4 SURVEY LINE
DISP (MM)
-4.00
-2.00
0.00
2.00
4.00
DISP (MM)
-1.00
0.00
1.00
2.00
3.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
170.00
180.00
190.00
200.00
210.00
850108
880219

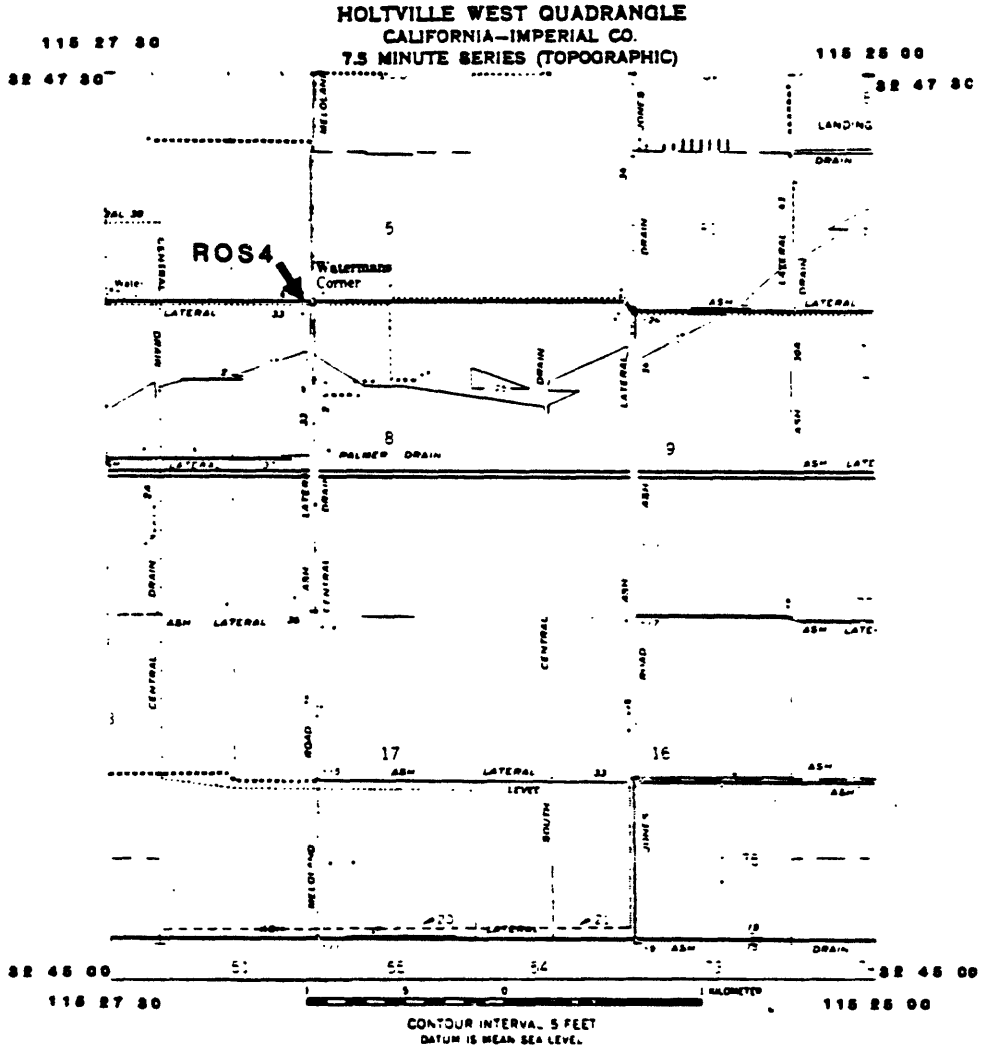
SITE DESCRIPTION

STATION CODE ROS4 NAME ROSS ROAD COUNTY IMPERIAL

QUAD HOLTVILLE WEST 7.5' LATITUDE 32°46.9' LONGITUDE 115°26.8'

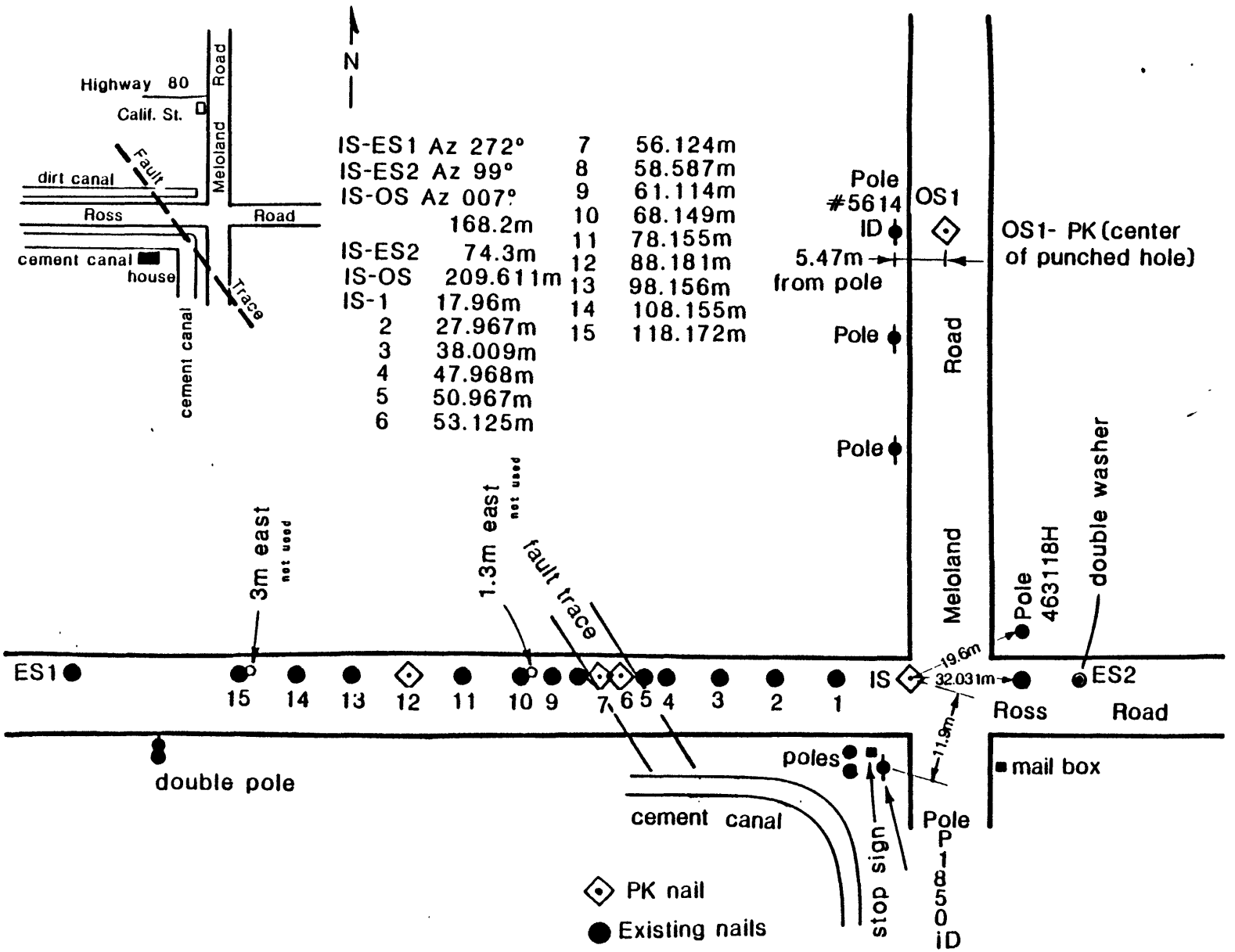
TO REACH: From El Centro, take S31 (Dogwood Road) south, turn east on Ross Road, and travel to Meloland Road. Array is at intersection.

GENERAL DESCRIPTION: The Imperial fault trace is marked by en echelon cracks across patched asphalt of Ross Road west of Meloland Road. Viewed along array's strike, center line of Ross Road shows an offset at fault trace. Monuments are regular and P&K nails in surface of north side of Ross Road. OS1 is a spike in Meloland Road north of intersection and east of third utility pole. Monuments were installed by USGS in 1979.



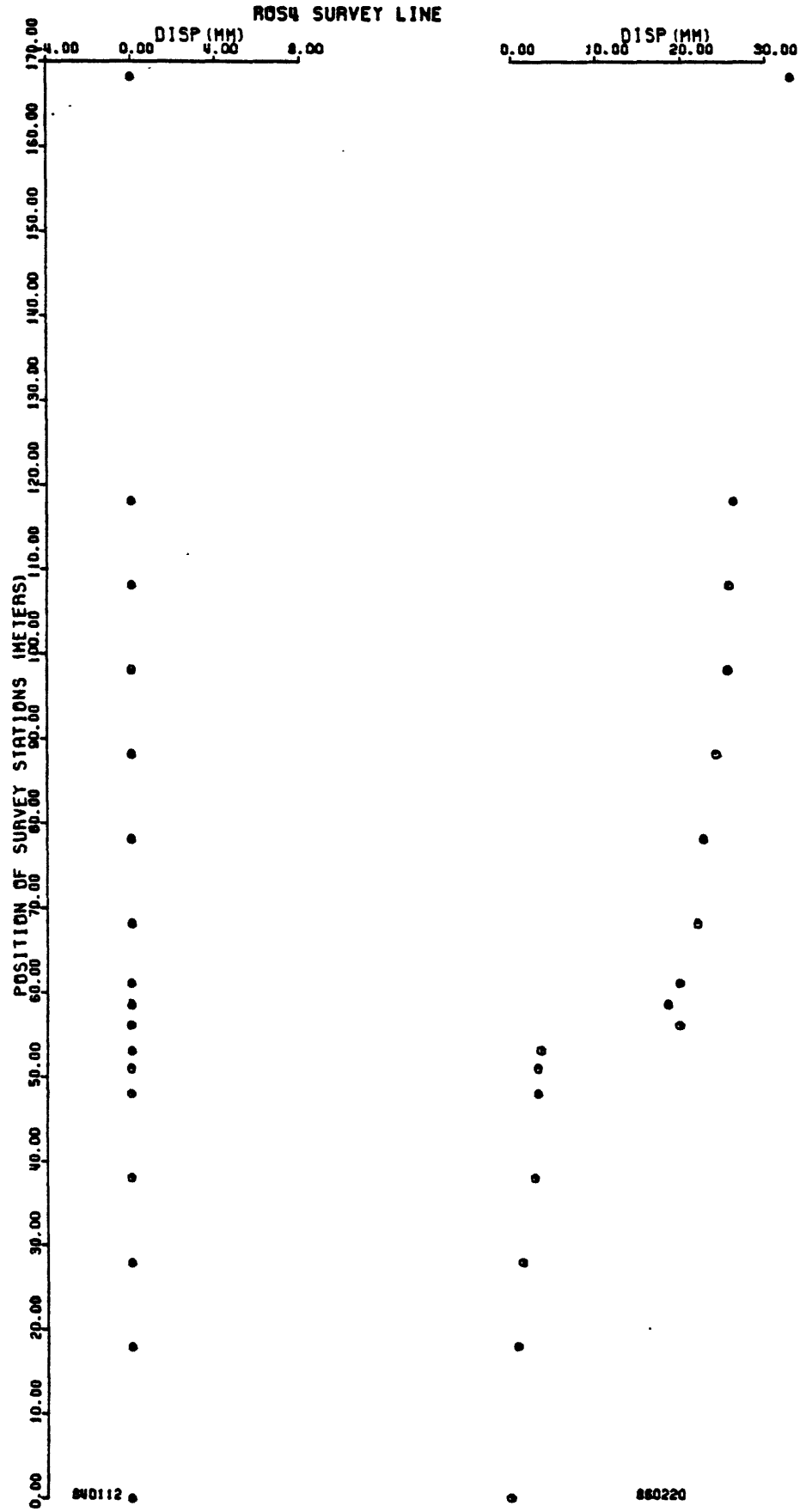
USGS : ROSS ROAD ALINEMENT ARRAY

(ROS4) 12/14/83



ROS4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 38.5°	
Jan 12	0.00	168.20	0.7826	0.00
1985				
May 7	23.16			23.16
Aug 13	-2.46			20.70
Nov 14	2.87			23.57
1986				
Feb 20	9.45			33.02


ROS4 SURVEY LINE
DISP (MM)
-4.00
0.00
4.00
8.00
DISP (MM)
0.00
10.00
20.00
30.00
POSITION OF SURVEY STATIONS (METERS)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
170.00
840112
860220

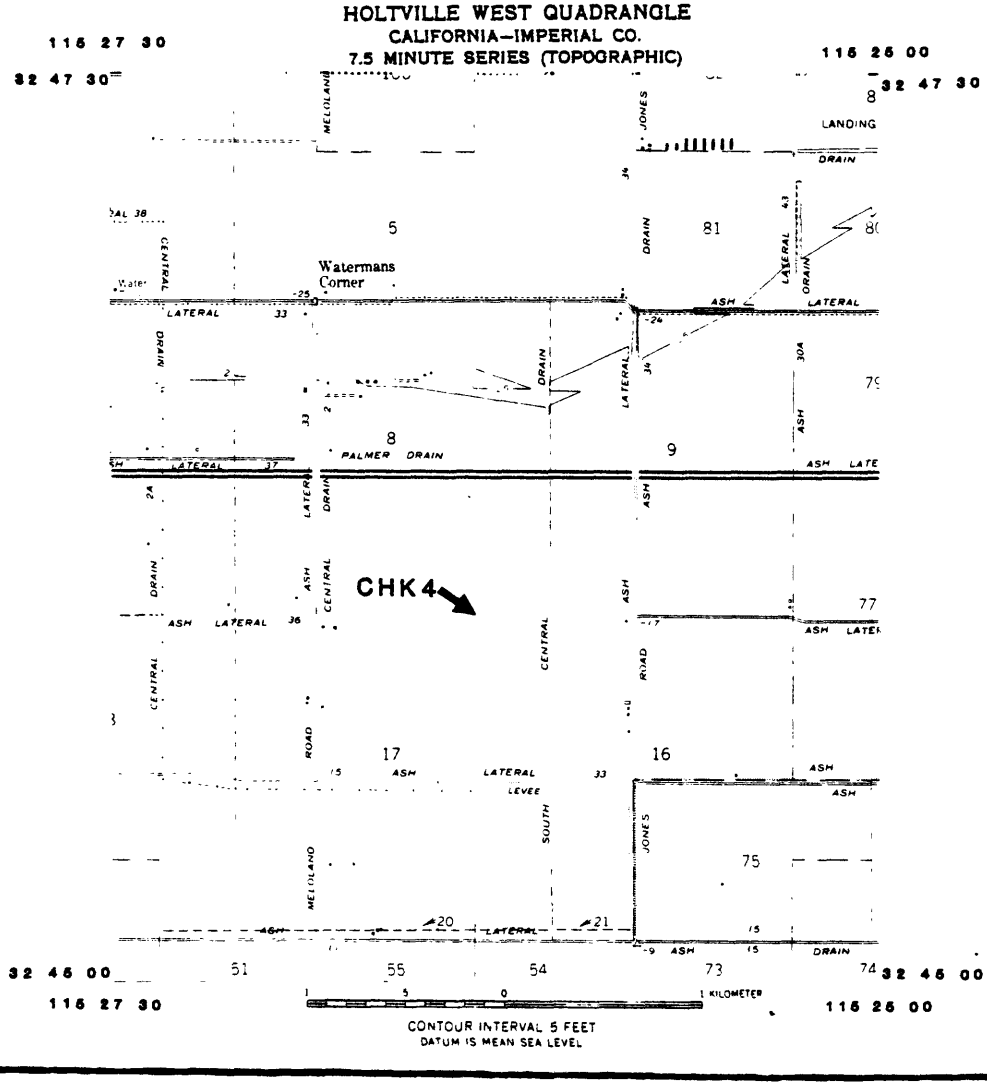
SITE DESCRIPTION

STATION CODE CHK4 NAME CHICK ROAD COUNTY IMPERIAL

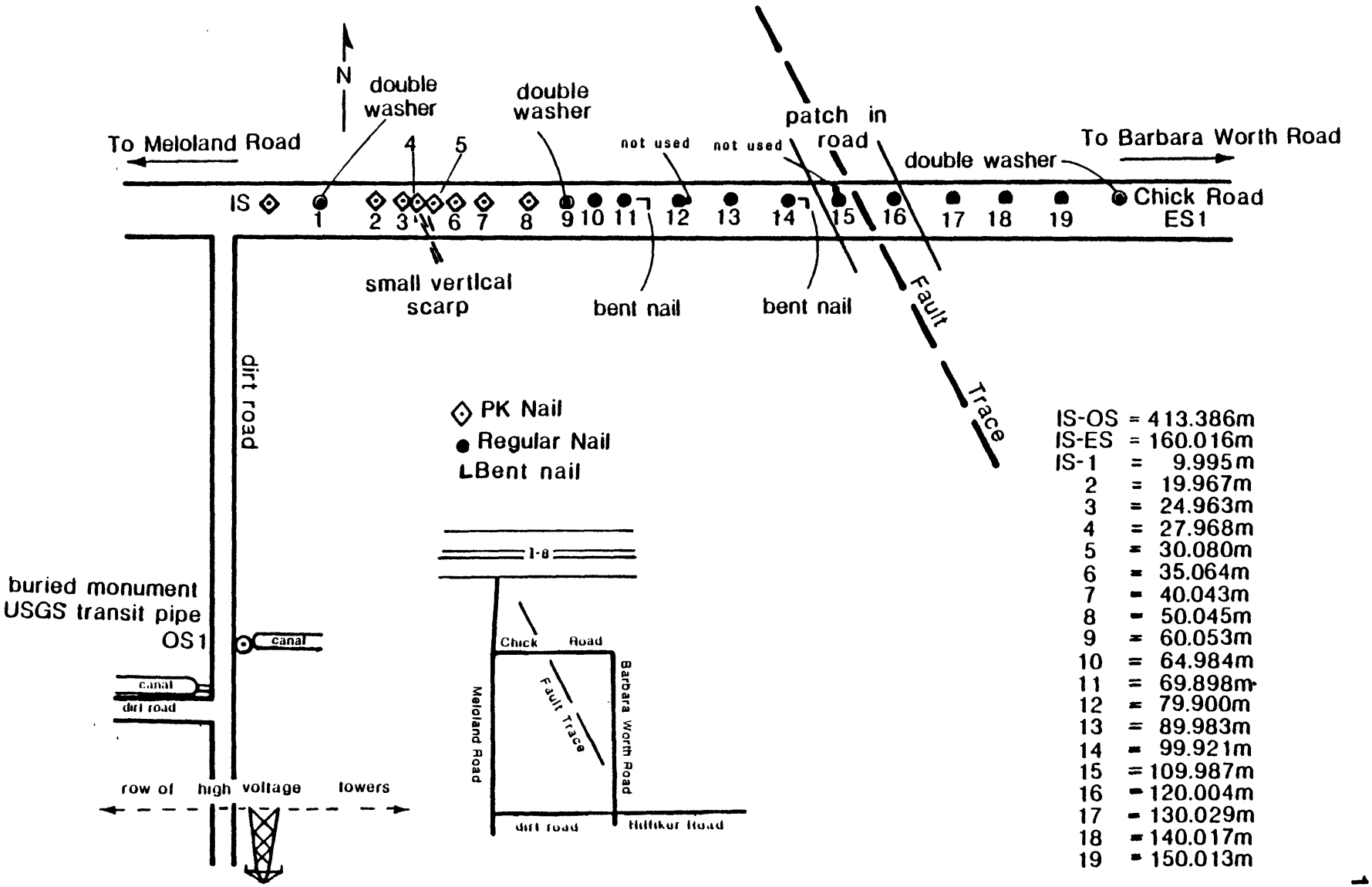
QUAD HOLTVILLE WEST 7.5' LATITUDE 32°46.0' LONGITUDE 115°26.3'

TO REACH: From El Centro, take S31 (Dogwood Road) south and turn east on Chick Road. Array is approximately 1/4 to 1/2 mile east of intersection of Chick and Meloland Roads.

GENERAL DESCRIPTION: Array was extended to 160 meters to cover two traces of Imperial fault. One trace is set of en echelon cracks and other trace is a vertical scarp approximately 90 meters to west. Cement liner of an adjacent canal parallel to Chick Road shows horizontal displacement. Monuments are regular and P&K nails in surface of north side of Chick Road. OS1 is buried monument approximately 500 meters south of the IS. Monuments were installed by USGS in 1979.



USGS : CHICK ROAD ALINEMENT ARRAY
(CHK4) 12/14/83

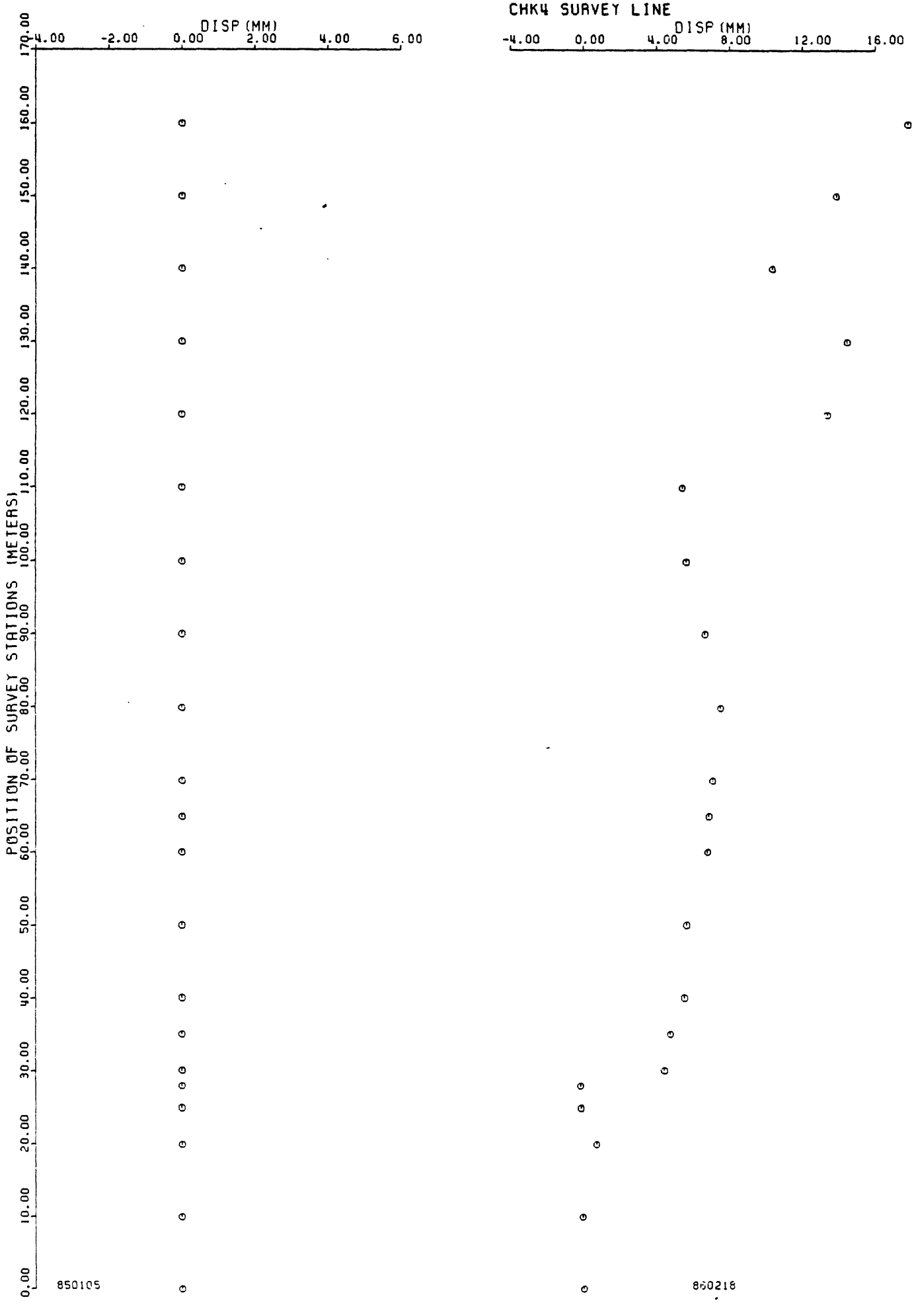


IS-OS	=	413.386m
IS-ES	=	160.016m
IS-1	=	9.995m
2	=	19.967m
3	=	24.963m
4	=	27.968m
5	=	30.080m
6	=	35.064m
7	=	40.043m
8	=	50.045m
9	=	60.053m
10	=	64.984m
11	=	69.898m
12	=	79.900m
13	=	89.983m
14	=	99.921m
15	=	109.987m
16	=	120.004m
17	=	130.029m
18	=	140.017m
19	=	150.013m

CHK4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1985			Cos 36.0°	
Jan 5	0.00	160.02	0.8090	0.00
May 7	7.57			7.57
Aug 14	1.70			9.27
Nov 14	0.63			9.90
1986				
Feb 18	7.88			17.78

CHK4 SURVEY LINE



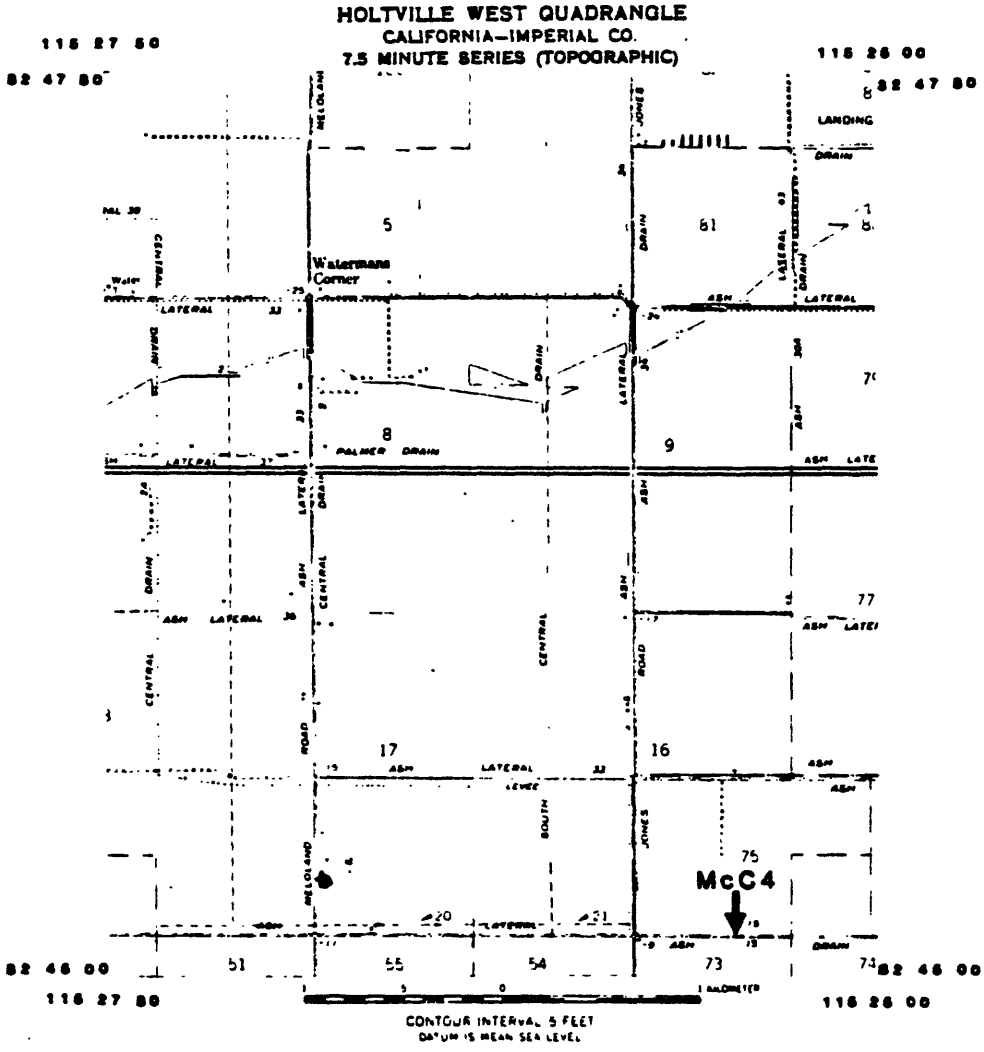
SITE DESCRIPTION

STATION CODE MCC4 NAME MCCABE ROAD COUNTY IMPERIAL

QUAD HOLTVILLE WEST 7.5' LATITUDE 32°45.1' LONGITUDE 115°25.5'

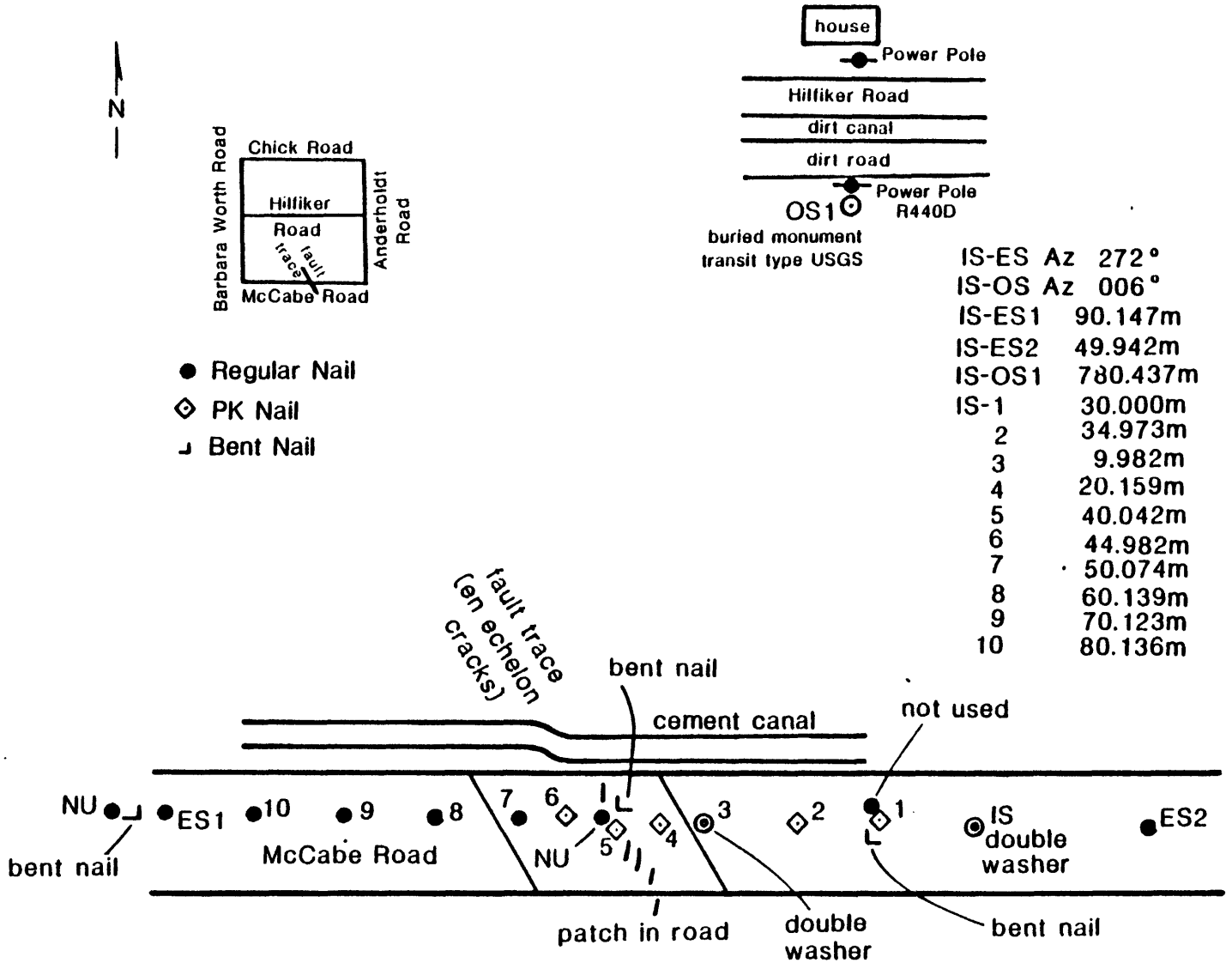
TO REACH: From El Centro, take S31 (Dogwood Road) south, turn east on McCabe Road, and travel to Barbara Worth Road. Array is about 1/4 mile past intersection of McCabe and Barbara Worth Roads.

GENERAL DESCRIPTION: Large right-lateral surface displacement was observed near here following the 1979 earthquake. Only one fault trace is visible as en echelon cracks in a patched section of McCabe Road. Cement liner of an adjacent canal parallel to McCabe Road shows horizontal displacement. Monuments are regular and P&K nails in surface of north side of road. OS1 is a buried monument 800 meters due north of IS, in front of utility pole #R440D across from a house on Hilfiker Road. Monuments were installed by USGS in 1979.



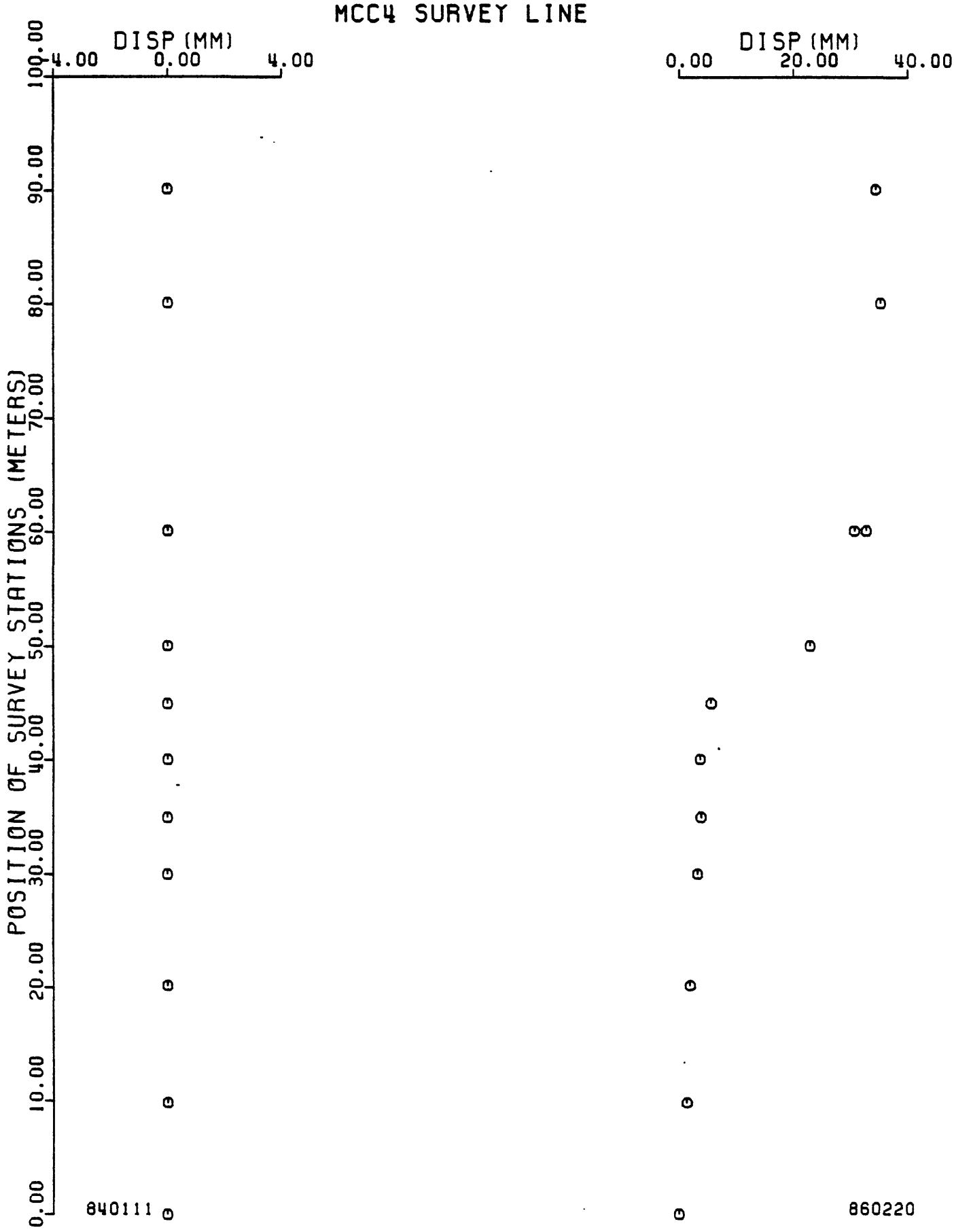
USGS : McCABE ROAD ALINEMENT ARRAY

(McC4) 12/14/83



MCC4 CORRECTED ALINEMENT ARRAY READINGS

Date	Movement since last survey, mm	IS-ES distance, m	Correction factor	Cumulative movement, mm
1984			Cos 33.6°	
Jan 11	0.00	90.15	0.8329	0.00
1985				
Jan 9	25.32			25.32
May 8	0.18			25.50
Aug 12	-1.66			23.84
Nov 12	0.46			24.30
1986				
Feb 20	10.11			34.41


MCC4 SURVEY LINE
DISP (MM)
4.00
0.00
4.00
DISP (MM)
0.00
20.00
40.00
POSITION OF SURVEY STATIONS (METERS)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
840111
860220