GEOTECHNICAL INVESTIGATION REPORT
for
Proposed Array of Six 40-Meter Diameter Antennas
PIONEER SITE, DSS 11
GOLDSTONE, CALIFORNIA
TRACKING COMPLEX

Prepared for

JET PROPULSION LABORATORY

(NASA-CR-158715) GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED ARRAY OF SIX 40-METER DIAMETER ANTENNAS, PIONEER SITE, DSS 11, GOLDSTONE, CALIFORNIA TRACKING COMPLEX (Pacific Soils Engineering, Inc.) 211 p   N79-25603

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Attn: Mr. A. A. Riewe, Bldg. 138/310

Subject: JPL Contract No. 955295
Geological and Geophysical Studies and a Foundation Investigation - DSS 11, Goldstone, California.

Gentlemen:

Transmitted herewith are 20 copies of our report entitled:

"Geotechnical Investigation Report for Six (6) 40-Meter Diameter Antennas, Pioneer Site, DSS 11, Goldstone, Tracking Complex".

This report includes a resume of our field investigation, laboratory testing and calculations utilized in preparation of our recommendations for the foundation construction of the six antennas.

Also included are a summary of the geologic and geophysical studies and findings, including the shear wave velocity determination which was utilized in analyzing the soil structure interaction to dynamic forces.

The investigation was conducted in cooperation with Mr. A. A. Riewe, JPL Cognizant Engineer and Mr. Bert Sweetser.

Mr. Edwin Browne provided geophysical consultant services to Pacific Soils Engineering. All other phases of the project were performed by PSE personnel.

Respectfully submitted,
PACIFIC SOILS ENGINEERING, INC.

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I. SUMMARY

Presented herein are the results of a Geological, Geophysical and Foundation Engineering Investigation for proposed design and construction of an array of six 40-meter diameter antennas for the Pioneer Site, DSS 11, at JPL's Goldstone, California Tracking Complex.

The geotechnical investigation was conducted in three disciplines:

1) Geological field reconnaissance of the general area of proposed construction.

2) Geophysical seismic refraction survey of the localized area surrounding the six proposed antenna sites, including shear wave velocity determination.

3) Detailed foundation engineering investigation of each of the six sites.

During the foundation engineering phase of the project, each of the six antenna sites was investigated and analyzed as a separate individual foundation problem. For simplicity of design the results from the six separate analyses were combined, where possible, into a single set of recommendations applicable to more than one antenna site.

The geological and geotechnical investigations indicate that the six sites selected are relatively free from geologic hazards which would inhibit the proposed construction or future antenna operations.

Data obtained from the shear wave velocity determination, coupled with laboratory test results, provided information for evaluating the response of the structure-soil system to dynamic loading.

Our investigation revealed that the existing soil foundation conditions at the proposed antenna sites 1 through 3 are of considerably lower quality than those encountered at proposed sites 4 through 6. Utilization of the original JPL design criteria limitations of 0.25 inch maximum total settlement and 0.125 inch maximum differential settlement indicates that sites 1 through 3 would require foundations of greater depth and width than at the other three sites. In order to reduce the potential for maximum settlement at these sites, analyses were made concerning the use of both cast-in-place friction piles and the removal and recompaction of the upper soils. The latter proposed corrective method appears to be more feasible.

Because of the massive footings obtained based on the 1/4 inch settlement criteria at sites 1 through 3 JPL later indicated that total settlement is not the governing criterion for design, as long as an 0.125 inch maximum differential settlement (as stated above) is not exceeded. Using this information, our analyses indicate that the foundations at sites 1 and 3 could be constructed to the same design as sites 4 through 6. Site 2 would require a slightly wider foundation in order to keep within the required tolerances.

In summary, the required foundations for sites 1, 3, 4, 5, and 6 must be founded at a depth of 5 feet below finished grade, and must be 5 feet in width. At site 2, the depth of penetration must be 5 feet, but the width must be 8 feet.

Because of a sensitivity of site soils to hydroconsolidation it is important to provide positive site drainage, to limit on-site irrigation, and to carry sewage effluent to a reasonable distance from any of the antenna sites.

II. AUTHORIZATION

This investigation and report were authorized under Jet Propulsion Laboratory (JPL) Contract No. 955295, dated November 22, 1978. All work under this contract has been performed under the technical cognizance of Mr. A. A. Riewe, Project Engineer, of the Jet Propulsion Laboratory.

III. SCOPE OF INVESTIGATION

The geotechnical investigation for the proposed array of six antennas was made in accordance with the "Statement of Work (Doc. Control No. 355-SW-714) for Geological and Geophysical Studies and a Foundation Investigation, DSS 11, Goldstone, Califomia", dated September 1, 1978, as modified in a meeting among Messrs A. A. Riewe, Bert Sweetser, and R. M. Reid, of JPL, and S. S. Neblett and L. S. Deutsch, of Pacific Soils Engineering, Inc. on October 31, 1978.

The investigation was made up of the following phases: geophysical analysis; geological reconnaissance; foundation investigation; shear wave velocity determination; laboratory testing; and engineering analyses.

The geophysical analysis involved refraction lines through each of the sites. Methods used and results obtained are presented in Appendix A.

The shear wave velocity determination was made in a borehole at site 3. The determination used a method developed by Mr. Edwin Browne, our consulting geophysicist. Results obtained from this phase were used in engineering analyses to determine dynamic responses. The report on this phase of our investigation is in Appendix B.

Eighteen test borings, three at each antenna site, were drilled to depths ranging from 30 to 51 feet. The predominant material encountered in the borings was a gravelly, silty sand containing various amounts of cobble-sized rocks. Relatively undisturbed samples were taken at frequent depth intervals in each of the borings. These and bulk samples were taken to our laboratory for testing. Test procedures are described in Appendix D; the results were used to determine soil reactions to the proposed loadings. The Logs of Borings (Appendix C, Plates A-1 through A-53) contain not only the field classification and a graphical representation of materials encountered, but also present a portion of the laboratory test data.

Engineering analyses were completed in order to formulate conclusions and recommendations for foundation depths and widths, anticipated total and differential settlement under dead- and live-load application, excavation, construction and backfilling methods and site paving recommendations.

The geological reconnaissance made for this investigation is essentially an elaboration of that which was performed for our 1974 reports. The previously obtained data has been combined with additional information for our latest evaluation of site geological conditions.

IV. DETAILED DISCUSSION

A. CONSTRUCTION SITE

1. General Site Characteristics

The proposed array of six 40-meter diameter antennas is to be located at the Pioneer Site within the Goldstone complex. The area consists of a northerly-draining, relatively flat basin which contains the existing 26-meter diameter Pioneer Antenna and service buildings. The basin is approximately 1 mile long and 0.5 mile wide; it drains to an existing playa at the north end. Gradients within the areas of proposed construction vary somewhat to an estimated maximum of seven to eight percent in the vicinity of site 4. On-site vegetation is relatively sparse, consisting of low-growing California high desert plants.

The six proposed antenna sites are located within an area which has approximate dimensions of 1400 feet in the north-south direction and 1600 feet in the east-west direction. The approximate distances between adjacent antennas range from 625 feet to 950 feet. The selected locations are all outside of anticipated zones of influence of known fault traces.

IV. A. 2. Geology and Geophysics

a) Geology

Geological features of these sites and the surrounding area, extending roughly a mile in all directions, were investigated during the 1974 study. In the current investigation only the area shown on Plate 1 was considered, inasmuch as geological background data on the region are assumed to be adequate.

The bulk of the study area is covered by alluvial sediments, hence the only bedrock outcrops are on the fringes. All such exposures are volcanic. Tertiary dark andesite, the major type, is a dark gray to black, blocky, and essentially unweathered. Undoubtedly this formation underlies the alluvium-covered sites and has engineering characteristics which are favorable for the proposed use.

Rock classified as Tertiary tuff, a medium gray pyroclastic rock displaying poor bedding, occurs as a small area in the northeast corner of the mapped terrain. It is of limited extent, so it probably has no influence on the geologic suitability of the sites.

IV. A. 2. a) Alluvium exposed at the surface consists of unconsolidated, locally derived debris containing blocks large enough to interfere with drilling.

Geophysical evidence, reported in the 1974 study, indicates a denser, more consolidated (perhaps slightly cemented) older alluvium underlying the surficial sediments. However, borings did not confirm this, probably because they were not deep enough.

No additional geological structural data were acquired during the current investigation. Regional study and local geophysical work delineated faults cutting bedrock, and locally older alluvium, near the sites. The most distinct, and probably most important, of these faults, the Pioneer Fault, strikes north-south, cutting the older alluvium but not the younger sediments. It is our opinion, expressed in the 1974 report (p. 29) that this faulting will not be hazardous in terms of surface rupture, ground acceleration, or ground shaking. A set-back of 100 feet from the vertical projection of the bedrock/alluvium contact of the fault is recommended.

IV. A. 2. a) No zones which are saturated with ground water (below water table) were found in the borings or suggested by geophysical data. Hence the water table is believed to be too deep to be of concern regarding damage from liquefaction, settlement, etc.

b) Geophysics Field work

A network of five basic lines was devised in order to augment previous seismic studies by this firm to complete geophysical coverage within the confines of the new antenna array. The pattern consisted of two N-S lines, two lines striking roughly N15W, and one E-W crosstie between antenna sites 5 and 6. The line lengths are based on increments of 400 feet, the longest is 1600 feet.

The antenna network was located and staked by members of the JPL supervisory group for the project. Each antenna location had at least one seismic line passing through its location so that all lines could be precisely tied together without undue effort. The areal layout of the network of seismic lines, including location of the shot points is shown on Plate 1.

IV. A. 2. b) An SIE P-T 100 (Southwest Instrument Engineering) seismic system was utilized. Line spreads of 400 feet were used, with a geophone spacing of 20 feet. Data was obtained in both directions along each array by shifting the instrument and shot point from one end to the other. Energy from these shots was received at the geophones in the array; the output of each geophone was recorded on a separate channel of the recording unit. The time of explosion, termed time break, is also recorded on one channel as a reference to calculate travel times to each geophone. Primacord (50 grain) is the explosive charge that was employed. Variable lengths of up to 25 feet were used (depending on specific line requirements) to provide an energy source. Each charge was placed in a pit at an average depth of 2 feet. Shots were made at intervals of 200 feet.

Communications and remote-shot-point cables were necessary because the shot distances were up to 1200 feet long. A total of 4,800 feet of seismic line was evaluated.

1) Operational Considerations

The wave energy received as first arrivals at the geophones decreases in strength with respect to distance traveled.

IV. A. 2. b) 1) Compensation for this can be made by increasing the size of the explosive charge (by increasing the length of the primacord). Extraneous noise recorded on the channel during the shot can increase the problem of recognizing reduced first-arrival signals. Noise can be caused by the instrument, by motion of personnel during shooting, by the wind, by equipment vibration, and by nearby electrical lines. A full shutdown of the Pioneer Station was not possible during the survey. In effect, partial shutdown was obtained by performing the seismic operations during non-tracking periods during this investigation. Noise was not a critical factor in limiting data collection; the data collection proved to be excellent.

c) Data Analysis

1) Introduction

The seismic refraction survey consisted of introducing energy into the subsurface by exploding charges of primacord at the end of a linear array of gephones and sequentially recording the arrival of energy at each geophone as the wave front

IV. A. 2. c) 1) expands downward and outward, away from the shot point. In this investigation there is no interest in the wave form (compression, shear, or Rayleigh) the energy takes, or in the reflected energy. Analysis is restricted to direct arrivals traveling through the surface medium, and to arrivals refracted along deeper horizons. The relationship of interest on the recordings is the time of arrival of direct or refracted energy, which is plotted against distance in diagrams known as T-D (time-distance) curves (see Appendix A). The slopes of these curves represent the apparent velocities in certain materials underlying those phones. If the subsurface materials are assumed to be horizontal beds which increase in density with depth and have no lateral inhomogeneities, the recorded velocities would be the true velocities of the various horizons. This type of situation is not common, so interpretative approximations and corrections are required.

2) <u>T-D Curves</u>

Of the multiplicity of paths the wave energy from a shot point can take to arrive at a given geophone, the first perturbation in the recorded traces represents the fastest path. This first

IV. A. 2. c) 2) arrival energy may have traveled directly to the geophone through the surface layer, or (depending on the distance of the geophone from the shot point) it may represent a composite of refracted paths through one or more subsurface layers. The direct arrival energy (traveling through the surface layer) reaches the first geophones in the array almost immediately following the shot. As the shot energy progresses down the array, a point is reached at which energy following a composite ray path travels the fastest. Such a composite path may consist of a downward-refracted ray path which passes through the surface material, a critically refracted ray path along the first velocity horizon, and an upward-refracted ray path to the array. On the T-D curve, a sharp change in slope denotes a change in velocity. At greater distances from the shot point (depending on the length of the line and the depth of the various refracting horizons) these changes in velocity are repeated. Because velocity is assumed to increase with depth, the geophones most distant from the shot point read the highest velocities, and see the deepest horizon. By extending the line length we obtain deeper infomation.

IV. A. 2. c) 3) Reduction Technique

Data from each line (or composite lines) were plotted on individual T-D curves. In order to produce a subsurface profile of the various velocity horizons (see Appendix A), depths were calculated on both directions of shooting, using variations of the Barthelmes and Wyrobecks procedures (references 2 and 3). These depths were offset laterally, as determined by the appropriate procedure, and were then plotted under the T-D curve. A graphical method was used to determine the best fit of a surface through the two sets of points, one set from the forward shot and one from the reverse shot of each line. Time checks were made along the various ray paths fixed by the locus of velocity horizons (as drawn), the relative position of the geophones and the shot point, and the anomalies within the slope of the T-D curves. These horizons were then shifted to assure that the time traveled along these paths matched the velocities and distances associated with the ray paths.

4) Refraction Phenomena

Because of the path wave energy must take to be critically

IV. A. 2. c) 4) refracted along subsurface velocity interfaces, the point at which the critically refracted wave energy enters or leaves the interface is not directly below either the shot point or the receiver. The basic formulas to calculate the amount of displacement are derivable from Snell's law. This phenomena creates a shadow zone (adjacent to the shot point and the last geophone receivers) that is as large as several hundred feet for the deepest velocity horizon. Thus an array (or line) could be 1,600 feet in length, but the deepest velocity horizon may be detectable for only the middle portion, even using both forward and reverse shooting. Therefore, where different lines intersect there may be velocity horizon matching problems. Also discontinuities may exist in the shadow zone, and may not be recorded, although they appear in the middle of an adjacent line. The profiles derived from the data on this survey clearly illustrate this shadow effect because the deepest high-velocity horizons never extend to either end of the lines.

Another concept which is important to bear in mind when analyzing such data for discontinuities is the scale of the

IV. A. 2. c) 4) feature with respect to the resolution capability of the array. Excluding a number of other pertinent parameters, the closer the geophones are to one another, the better able the system is to resolve small time discrepancies which might represent minor faults. Typically, with a 100 foot geophone spacing the interpreter is not able to discern small features which have only a few milliseconds delay. With closer geophone spacing (hence more data points over the same interval) such features may be resolved as faults or other anomalous phenomena.

Many of the T-D curves show quite different velocities on forward and reverse shots over a region which, it would seem, should have the same velocity. A major reason for this difference is that dipping velocity horizons are involved. The apparent velocity recorded when the shot is directed up-dip is faster because the initial path through the low velocity material is longer. Conversely, when shooting down-dip the apparent velocity recorded is slower than it seems it should be, because of a shorter initial path through lower velocity material. The dip of a horizon can be calculated from the two apparent velocities for the same horizon.

IV. A. 2. c) 5) Fault Discrimination

Various criteria were used to identify anomalies in the slopes of the T-D curves. Features on the order of a few milliseconds were ascribed to singular characteristics of the travel path, rather than to indicating small faults. If a feature or anomaly was found within the shallow horizon, but not within deeper horizons, it was not labeled a fault. Additionally, it was required that features be observable in both opposite-directed shootings of the lines, i.e., the travel path of the energy must be affected in traveling both directions. The sense of displacement (whether up or down) was taken to match. This means that if a fault should intersect two parallel seismic lines, that it should also displace both lines in the same sense. A strike slip fault can shift a velocity horizon so that apparent vertical separation at two different locations might have the opposite vertical sense of apparent displacement. It is assumed that this situation does not exist in the basin, thus faults are placed only where the sense of vertical displacement correlates.

The best- discriminated faults were assumed to be where two

IV. A. 2. c) 5) broken different velocity horizons were recorded in the same location by both the longer shots and the shorter refraction lines. This occurs typically with more recent faults. Some of the faults were found to cut only the deepest high velocity horizons. Small anomalies in the T-D curves were used only where dictated by the overall geometry to align with either a firmly discriminated fault or a series of minor ones. It is our opinion that the major structural features within the surveyed area have been previously identified in the geophysical report of January 2, 1974, by this firm. Data obtained during the current investigation clearly supports this premise.

6) Interlensing Velocity Horizons

In some of the profiles derived from the survey the deep velocity horizons do not necessarily have the same values on the forward and reverse shots of a given line. In cases where this occurs an apparent interfingering of lenses of differing density alluvium probably exists. To determine the exact nature of the change (and possible interlensing) would require a number of additional overlapping layouts.

IV. A. 2. c) 6) This was considered unnecessary, and to have little bearing on recognition of the major geologic structures underlying the site. Thus a given low-velocity horizon may have different velocities at either end that are not explained by a dipping surface, but there was no attempt to show interlensing on the profiles. In some cases a definite pinching out of a specific horizon is observable, and is defined on the profiles.

d) Evaluation

Subsurface profiles (Plate 1 and Appendix A) show the various velocity horizons and structural features interpreted from the data. Each line is discussed briefly, and the overall geometry of the various features derived from the lines are discussed separately. Each seismic line develops a slightly different character, thus a certain flexibility must be maintained for correlation between lines.

1) Refraction Line (Site 1)

The westernmost N-S line (1200 feet long) lies west of the Pioneer access road; it has no apparent structural breaks at depth. This line indicates site 1 is mantled by a variable

IV. A. 2. d) 1) thickness of alluvial material increasing in depth to the north (toward Goldstone playa). Immediately beneath the antenna site these surficial deposits attain a velocity of 3850 feet per second, and a depth of approximately 60 feet.

2) Refraction Line (Site 2)

Line 2 is a short 400-foot line displaying moderately firm alluvial materials nearly 120 feet thick. Three alluvial profiles reflect velocities of 1100 feet per second, 3200 feet per second, and 3850 feet per second as the depth increases to bedrock. No discordancy was observed in any of these profiles. Deeper velocity horizons of 6600 feet per second and 10,200 feet per second were transposed from an earlier study submitted by this firm in December of 1973.

3) Refraction Line (Sites 3 through 5)

Refraction lines 3 through 5 is 1600 feet long; it strikes diagonally across the basin at N 15W. This profile displays no major discontinuity in any of the five velocity horizons, with the exception of a small discordancy 150 feet north of antenna site 3. This feature appears only on the deep horizon between the 5300 feet per second and 11,300 feet per second velocity horizons. The alluvial cover is undulatory. It

IV. A. 2. d) 3) appears to be less thick along this section, where it attains a depth of approximately 70 feet. The seismic profile matches a typical geomorphic regimen for the basin and range province of the desert.

4) Refraction Line (Sites 4 through 6)

Refraction lines 4 through 6 is 1600 feet long; it is 900 feet east of, and strikes parallel to, companion lines 3 through 5. The seismic profile is very similar to lines 3 through 5, depicting no abrupt discontinuity in any horizon. Some interlensing is present. As noted in previous profiles all velocities throughout the survey area are consistent for alluvial materials. Variable high velocities (6300 feet per second to 12,000 feet per second) are present in this section, reflecting seismic profiles of typical volcanic flow structure.

5) Refraction Line (Sites 5 through 6 - Crosstie Line)

The east-west crosstie line between antenna sites 5 and 6 indicates that a fault transects the deep 10,000 foot per second velocity horizon (bedrock) apparently 100 feet east of site 5, but does not affect the superjacent horizon of 5300 feet per second material (alluvium).

IV. A. 2. d) 5) There is a discrepancy between velocity values and depths between the intersection of sections 3 through 5 and 5 through 6 which relates to typical sedimentation patterns in the desert, random channeling and deposition. However, the deep geometric-geologic seismic relationships are good.

3. Field Investigation and Subsurface Soils

The subsurface soils exploration was conducted between the 8th and 30th of January, 1979. During this period 18 soil borings were drilled, utilizing a truck-mounted drill rig equipped with a 24-inch diameter rotary bucket auger. At each of the six antenna locations one 50-foot deep and two 30-foot deep borings were drilled and sampled. The borings were located about JPL-placed center stakes at 120-degree intervals at a 60-foot radius from the stake for antenna sites 1 through 5. At site 6 the antenna center had been moved 50 feet easterly of the center stake. The borings were thus located about the new antenna center at the 120-degree interval and 60-foot radius. The approximate location of each boring is shown on the accompanying copy of the site topographic map, Plate 1.

Each boring was logged during the drilling operation, and the soils

IV. A. 3. encountered were classified by visual and tactile methods. Soil classifications are based on the Unified Soils Classification System. Classification of the native soils encountered in the borings varied from silty clay to well-graded sandy gravel with gravelly, silty sand being the most predominunt soil type. These soils varied from light tan to medium red-brown in color, and dry to damp in moisture. The amount of gravel and cobble sized rocks encountered varied from site to site, and with depth in each boring. In general the gravel and cobble content increased with depth below ground surface. Antenna sites 4, 5, and 6 contain significantly higher amounts of gravel and cobbles than the other three sites. With the exception of the near-surface materials, which were considered loose at all sites, the tightness of the subsurface soils also varied from site to site. The material at antenna sites 4, 5, and 6 were generally tighter and denser than at the other three sites.

No unusual soil conditions were found in any of the borings, nor were ground water or bedrock encountered. The rocky and predominantly coarse grain characteristics of the native soils caused caving of the boring side walls to a varying degree in most of the borings.

Where possible, undisturbed samples of the native material were

IV. A. 3. obtained, using a split barrel drive sampler containing 2.5-inch inside diameter brass rings. Cobbles prevented the recovery of undisturbed samples at certain locations, as noted on the Log of Borings (Appendix C). Bulk samples were also collected from each boring for laboratory testing.

Upon completion of logging and sampling, all borings (with the exception of Boring No. 3-3) were immediately backfilled. Boring No. 3-3 was covered with plywood for later use in determining the in situ shear wave velocity. It was later backfilled, following completion of the shear wave velocity determination.

Logs of test borings made during the course of the field investigation are provided on Plates A-1 through A-53. These logs present descriptions of the materials encountered, as well as a partial summary of laboratory test data. The laboratory data presented in the Logs of Borings include in situ moisture content, and dry unit weight and shear strength. The blow counts and hammer weights given in the logs are those required to drive a Pacific Soils Engineering, Inc. split barrel drive sampler 12 inches into undisturbed material. Where a full 12 inch penetration was not possible, due to rocks in the soil, the length of penetration is also given. No attempt has been made to convert

IV. A. 3. the blow counts for different hammer weights to those required when using a standard or uniform hammer weight. This was not done because of the poor correlation between driving energy and penetration for large-weight hammers.

For determination of the in situ dynamic properties of the foundation soils an uphole seismic survey was conducted by Mr. Edwin R. Browne, Consulting Geophysicist. Boring No. 3-3 was used for the in situ dynamic testing, as it best represented the foundation soils at all six antenna sites, while having a minimum amount of caving.

This procedure uses an impact source mounted in the bore hole to create s and p seismic waves. Using geophones at the top of the bore hole, the velocities of both types of waves in the material between the impact source and the geophones can be determined. By repeating the test at a regular interval over the entire depth of the boring, a velocity profile of the foundation soils can be compiled. Using the theories of elastic wave propagation and the mass density, ρ, of the material, the elastic parameters such as the Shear or Rigidity Modulus, G, Young's Modulus, E, and Poisson's Ratio, ν, can be obtained from the velocity profile.

IV. A. 3. Mr. Browne's report, containing a method diagram, seismic wave velocities, and calculated elastic parameters, is presented in Appendix B.

The level of shearing strain produced during the tests were very low. At higher levels of dynamic shearing strain during moderate or large earthquakes, the modulus values for the same material will generally be smaller.

IV. B. FOUNDATION ANALYSIS

1. Preliminary Design Parameters

The following preliminary foundation loading and design information, on which the foundation engineering analysis is based, was furnished to our office verbally by Mr. B. M. Sweetser on February 5, 1979, and was confirmed by JPL Interoffice Memo dated February 7, 1979. The maximum amount of total allowable settlement was subsequently revised during a telephone conversation between Messrs. Riewe and Sweetser of JPL and personnel from our office.

Preliminary design information states that each of the proposed 40-meter diameter antennas will be supported by a square-based steel frame. Each corner of the frame will be supported by a single 24-inch-diameter wheel riding on a circular steel track. This track will be approximately 2 feet above finished grade. Horizontal forces due to wind and seismic loading will be resisted by a pintle bearing located at the center of antenna horizontal rotation. The 10-foot-diameter pintle bearing will be connected to the 90-foot-diameter ring footing by grade beams.

The estimated dead load from the antenna and frame will be in the range of 200 kips per wheel (800 kips total). Maximum design vertical live loading due to wind will be on the order of 95 kips for one wheel,

IV. B. 1. with a corresponding unloading on the diagonally opposite wheel. Maximum design horizontal forces at the pintle bearing will be on the order of 190 kips for wind loading and 240 kips for seismic loading.

Originally the allowable total settlement due to dead load was given as 1/4 inch maximum, with a maximum allowable differential settlement of 1/8 inch across the 90-foot-diameter footing ring. After discussion with JPL personnel concerning the large size of ring footing that would be required at sites 1, 2, and 3 because of the stringent total settlement allowance, it was agreed that the governing criterion for footing size design would be the 1/8 inch allowable differential settlement and that a larger, unspecified, amount of total settlement could be tolerated.

2. Theoretical Foundation Behavior

a) Settlement Due to Dead Load

As the weight of the antenna and steel frame is added to the antenna ring footing, the underlying foundation soils will undergo initial settlement. Due to the large spacing between loading points on the ring footing and the assumed flexibility of the footing, the initial settlement is not expected to be uniform around the entire ring. However, by rotating the antenna structure horizontally

IV. B. 2. a) around the ring, the foundation soils below the entire ring will be loaded and allowed to undergo initial settlement. Considering the generally granular nature of the native soils encountered during exploration, the initial settlement due to dead load should occur over a relatively short period of time after the load is applied.

Once the initial settlement has been completed around the entire footing, the foundation soils will continue to undergo a small amount of rebound and resettlement with each unloading and loading caused by the horizontal rotation of the antenna.

As stated under the preliminary design parameters above, the dead load from the antenna will be evenly distributed among the four wheels, thus differential settlement from this source between the four loading points will be negligible, inasmuch as consolidation characteristics at any one site are similar between borings at that site.

b) Movement Due to Wind Load

When a lateral wind load is applied to an antenna superstructure the resulting forces tend to have a two fold effect on the ring footing. First, an applied lateral (wind) load will tend to move

IV. B. 2. b) the antenna laterally in the direction the load is applied. Second, when a lateral (wind) load is applied to the antenna superstructure, the antenna and ring footing will tend to rotate about a horizontal axis perpendicular to the direction of rotation.

In the first case, the antenna will tend to move laterally away from the wind force. This movement is resisted by the soil below the ring footing and the soil on the downwind side of the footing. The soil below the footing will resist movement through friction between the concrete footing and the soil, while the soil on the down wind side of the footing will develop a passive earth pressure that acts on the side of the footing to resist movement. The pressure will be developed by the soil inside the ring footing on the windward half of the footing, as well as the soil outside the ring footing on the leeward half of the footing. An example is shown on Sheet 1 of Appendix E. In this example the wind direction is from left to right, thus the antenna tends to move toward the right. The soil on the inside of the left half of the ring and on the outside of the right half will develop passive earth pressure to resist the movement. Also shown is the frictional resistance between the soil and the bottom of the footing that works with the passive earth pressure to resist the movement.

IV. B. 2. b) Because the wind force acts on the antenna structure while the soil resists the lateral movement of the footing, and thus the two forces are not applied in the same horizontal plane, a net overturning moment is created. This overturning moment tends to rotate (tip over) the antenna structure. The effect of the rotational movement on the footing and foundation soil is that the vertical stresses beneath a section of the ring footing increases while the vertical stresses beneath a corresponding section on the other side of the footing decreases. For instance, if the wind is from left to right, as indicated on Sheet 1 of Appendix E, the antenna structure tends to overturn (rotate) in a clockwise direction. The overturning moment is resisted by an increase in the vertical stress beneath the right-hand section of the footing ring. This is accompanied by a corresponding stress decrease beneath the left-hand side of the footing ring. The soil subject to the increased stress undergoes additional settlement, while the soil subjected to the decrease in stresses rebounds. Thus a differential settlement condition is created.

If the footing ring were truly rigid (without flexing), the increase and decrease of the vertical stresses would be distributed over the

IV. B. 2. b) entire ring in proportion to the distance from the axis of rotation. In the case of the flexible footing that is assumed to exist in this instance, the increase and decrease in vertical stresses depend on the orientation of the steel frame in relationship to the direction of the wind load applied to the antenna structure. The assumed worst case would be where the maximum wind load is applied diagonally across the square base of the steel frame. In this case the wind load is resisted by only the wheel diagonally opposite the corner from which the wind load is applied. The wheel at the corner from which the wind load is applied experiences stress unloading, while the two remaining corners are located on the axis of rotation and thus have no change in vertical loading. This is the case shown on Sheet 1 of Appendix E.

c) Movement Due to Seismic Loading

With the present state of the art of seismic analysis, seismic loading is generally treated as a static horizontal force applied at the center of gravity of the structure. The effect on the footing is similar to that for an equivalent wind loading. That is, the structure tends to undergo both rotational and lateral movement, as described in paragraph b, above.

IV. B. 3. Settlement

a) Methods of Analysis

With the present state of the art of soil mechanics and foundation engineering it is often necessary to make certain simplifying assumptions and approximations to obtain reasonable solutions. When such assumptions and approximations are used herein, the method of analysis selected is considered either to closely approximate actural field conditions, or to be on the conservative side.

For determining the amount of total initial settlement that could be expected beneath the ring footing for each antenna, a simple and conservative method of analysis was used during this investigation. The primary reason for using this method is that it was concluded that the relatively moderate vertical loads placed on the footing by each wheel, coupled with the relatively large spacing between loading points, would produce a negligible overlap of influence within the soil from adjacent loading points. This basic conclusion allows the distribution of stresses, and thus settlement, below each loading point to be determined independently of the stresses produced by adjacent loading points.

IV. B. 3. a) Using the basic conclusion described above the vertical stress distribution and settlement below each wheel was treated as a point load acting on an equivalent rectangular footing. As shown on Sheet 2 of Appendix E, the width of the equivalent footing is the actual width of the ring footing. The length of the equivalent footing was determined, based on the assumption that a point load would be dissipated uniformly with depth at a slope of 1:1 (45 degrees from horizontal). Within the soils below the foundation it was assumed that the load would dissipate uniformly with depth at a slope of 1/2:1 (approximately 63 degrees from horizontal) in both directions.

In actuality the stresses produced below each wheel of the antenna frame will not be evenly distributed in the concrete or in the foundation soils. The actual effective footing size and distribution of stresses induced upon the soils immediately below the footing depend upon the rigidity of the ring footing. In all probability the actual load will be distributed over a greater portion of the ring footing than was assumed in the settlement calculations; if so, the average stress actually induced into the foundation material will be less than calculated. This, in turn, will produce less settlement.

IV. B. 3. a) Differential vertical loading due to the rotational effect of wind loading on the antenna structure produces a small amount of additional settlement under the loaded wheel or wheels. Under the wheel (or wheels) that have a decreased load, the soil will rebound slightly. The rebound will probably be elastic movement, but the small increase in settlement due to wind loading has also been treated as an elastic-type deformation. Thus the amount of expected settlement, as well as rebound, can be analyzed by using the theory of elasticity and the Young's Modulus derived from the consolidation testing. The maximum differential loading between any two of the legs of the antenna would thus cause the maximum differential settlement.

b) Estimates of Settlement

The foundation materials encountered at all six antenna sites would normally be considered acceptable for conventional structural developments. However, the extremely small tolerances, originally presented, for settlement of the antenna ring footings due to dead load would reduce antenna sites 1, 2, and 3 to marginal, at best, in regard to settlement. As shown on the

IV. B. 3. b) summary of calculated settlements, Table I, the required footing size for these three sites is relatively large when initial settlement due to dead load must remain below 1/4 inch. Several methods were considered for limiting the total settlement due to dead load, including preloading of the antenna site, short pile foundation, and replacement of the in situ native soils immediately below the footing with compacted fill.

If the allowable total settlement due to dead load must remain at or near 1/4 inch, the replacement of in situ soil with compacted fill appears to be the most feasible method. The foundation soils immediately below the footing contain the most significant increase in vertical stresses. By replacing the compressible foundation soils immediately below the footing with significantly less compressible compacted fill the amount of total settlement anticipated is greatly reduced. As shown in Table I, replacing the first 5 feet of soil below the ring footing at the three marginal sites reduces the total settlement by approximately 30 percent.

Once the initial dead load settlement in the in situ native soils below the entire ring footing is completed, additional movement

IV. B. 3. b) of the ring footing due to loading and unloading or differential loading will be very small. Thus, if the estimated differential settlement is the criterion used to determine the size of the ring footings, the footing size required for antenna sites 1, 2, and 3 is greatly reduced. As shown on Table I, only site 2 requires a slightly larger footing than the minimum recommended footing size.

IV. B. 3. c) Table I - Summary of Calculated Settlements and Foundation Recommendations

Site No.	Footing Depth (feet)	Footing Width (feet)	Estimated Total Settlement (inches)	Estimated Differential Settlement (inches)
1	5.0	5.0	0.67	0.05
1*	5.0	5.0	0.46 1/	0.05
1*	10.0	8.0	0.30	0.02
1*	12.0	6.0	0.30	0.02
2	5.0	8.0	0.68	0.13
2*	5.0	8.0	0.45 1/	0.13
2*	10.0	14.0	0.30	0.06
2*	12.0	12.0	0.27	0.06
3	5.0	5.0	0.64	0.12
3*	5.0	5.0	0.48 1/	0.12
3*	10.0	10.0	0.26	0.05
4	5.0	5.0	0.29	0.05
5	5.0	5.0	0.34	0.04
6	5.0	5.0	0.22	0.05

*Alternate Foundation Size

1/ Based on the assumption that the strata between 5.0 foot and 10.0 foot depth has been over-excavated and replaced with fill compacted to 95 percent of the laboratory maximum density.

IV. B. 4. Bearing Capacity

Bearing capacity for the in situ soils were calculated for each site using the Terzaghi bearing capacity equation for continuous footings. The calculated bearing capacity for the minimum-sized footing at each site was then checked against the bearing capacity required for the equivalent rectangular footing used in the settlement calculations. The lowest factor of safety between the assumed required bearing capacity and the calculated bearing capacity of the foundation soils is 4.8 for site 6. Calculations for the minimum-sized footings at each site are given on Sheets 28 through 33 of Appendix E.

5. Lateral Resistance

For determining the resistance to lateral movement due to wind or seismic loading, it was assumed that all the lateral loading would be transmitted from the pintle bearing to the ring footing. No credit has been given to the ability of the pintle bearing or the grade beam to resist lateral movement. For determining the frictional resistance between the soil and the bottom of the footing, it was assumed that the antenna dead load would be transmitted to the same equivalent rectangular footing that was used to determine initial dead load

IV. B. 5. settlement. Only the weight of the antenna structure was used in friction calculations. The weight of the footing and the soil has been neglected. Lateral bearing was determined, using the entire ring footing for development of passive earth pressure. The minimum factor of safety for lateral loading at any of the sites is 9.2 for the maximum horizontal wind load and 7.3 for the maximum horizontal seismic loading. Calculations for lateral bearing and friction for the minimum-sized footing at each site are presented on Sheets 34 through 39 of Appendix E.

IV. C. GRADING AND PAVING

1. Cut and Fill Slopes

Although the finished grade is not expected to be significantly different from the existing grade, some grading is required for control of surface water. Specific recommendations for control of water are presented in paragraph 2, below. For this grading, and for any other grading that is required in the vicinity of the subject antenna sites, it is recommended that all permanent cut or fill slopes be no steeper than 2-horizontal to 1-vertical. Temporary excavation cut slopes for construction purposes could not be constructed steeper than 1-horizontal to 1-vertical. Vertical cuts must not be allowed.

2. Control of Surface Water

The on-site native soils are somewhat sensitive to the addition of moisture. To minimize the possibility of undesirable conditions caused by partial saturation or inundation of the foundation materials, certain protective measures for the control of surface water must be implemented during the design and construction of the antennas.

As stated above, it is not expected that the finished grade will be significantly different from the existing grade; final gradients that

IV. C. 2. provide positive drainage away from each site are necessary. For the circular area inside the ring footing final gradients are required that will drain surface water away from the footing, into a drainage system. The drainage system should be designed to pick up all of the surface water inside the ring footing and discharge it outside the footing. As an additional moisture protection measure, suitable paving should be provided inside the footing ring and for a minimum of 50 feet beyond the outside of the footing rings.

The period of October 15 to April 15 is generally considered to be the rainy season; however, in the high desert rains of short duration and high intensity are often experienced through the year. Thus, provisions for control of surface water during construction, should be provided regardless of the time of year. As a protective measure, the area adjacent to the construction area should be graded at all times to drain away from foundation excavations and/or any temporary cut slopes. Also, any storm runoff ponding in the foundation excavations should immediately be pumped out.

These measures for the control of water are required (and will become critical during a storm) for two reasons. An increase in the moisture

IV. C. 2. content of the foundation soils could lead to substantial increase in the amount of settlement that will occur when the weight of the antenna is applied to the ring foundation. Also, an increase in moisture in the soils (especially saturation) would greatly reduce the stability of temporary excavation cut slopes.

3. Compacted Fill and Backfill

Surface areas that are to receive compacted fill must be stripped of organic material, construction debris, and loose surface soils. The surface areas must then be thoroughly scarified to a minimum depth of 12 inches, watered or dried to near-optimum moisture content, and then rolled and compacted to 95 percent of the laboratory maximum density, as determined in accordance with ASTM Designation D1557-70 (Methods A or C, 5 layers).

On-site soils may be utilized for compacted fill and backfill, provided all trash, vegetation, and other deleterious substances are removed prior to placement. Oversized material in excess of 6 inches maximum dimension must be broken down or removed and wasted from the site. Fill material must be placed at or near optimum moisture content in thin lifts (not to exceed 8 inches in thickness prior to rolling), and

IV. C. 3. mechanically compacted to a minimum of 95 percent of the laboratory maximum density, as determined in accordance with ASTM Designation D1557-70 (Methods A or C). There must be no jetting or flooding allowed. Backfill placed against temporary excavation cut slopes should be thoroughly benched into the slopes as it is placed.

All of the above site preparation, grading, and earthwork should be performed under the continuous inspection and testing of a qualified soils engineer. All fill and backfill should be tested at the time of placement to ascertain that the required compaction is achieved. The minimum number of tests performed should be one test per 2 feet of fill or backfill depth, or per each 500 cubic yards of fill or backfill placed, whichever is greater.

A soils engineering report should be prepared at the completion of the required site preparation and earthwork. The report should contain the basic quality control test data pertaining to the on-site earthwork.

4. Paving

Asphaltic concrete pavement may be used for paving around each of the antenna sites that will be subjected to vehicle loading, and for

IV. C. 4. service roads connecting the sites, provided the native soils used as subgrade are properly prepared. Such preparation requires the removal of all material over 4 inches in maximum dimension, and thorough preparation of the upper 2 feet of subgrade material by rolling and compacting to 95 percent of the laboratory maximum density, as determined by ASTM Designation D1557-70 (Method C, 5 layers).

The minimum thickness of the asphaltic concrete pavement should be 3 inches. This thickness is based on the results of one California Bearing Ratio test performed on soils typical of the on-site near-surface material, and an estimate that vehicle traffic will be comparable to that in a light industrial area.

5. Underground Fluid Carrying Lines

Special care must be taken in the location and design of subsurface fluid-carrying lines. Lines should not be closer than 50 feet to an antenna. Provisions must be made to allow periodic inspection.

Discharge systems for the disposal of sewage effluent must be located not less than 300 feet from the center of any of the antennas.

Backfill for utility lines that are within the footing ring, or are outside the ring, but within a 45-degree plane subtended from the bottom

IV. C. 5. of the footing, should be compacted by mechanical means to a minimum of 95 percent of the laboratory maximum density as determined by ASTM Designation D1557-70 (Methods A or C).

6. Landscaping

Any plantings must be restricted to native vegetation that can survive without the need for irrigation.

7. Ease of Excavation

Blasting will not be required for excavation during grading on the sites. However, the large amount of oversized material present will require the use of large-sized equipment ("D-8" tractor or larger).

The granular nature of the native soils and presence of oversized material will require that no vertical cuts be allowed. Thus, forming of footings will be necessary.

APPENDIX A

REFRACTION SEISMIC SURVEY
PIONEER STATION DSS 11

JET PROPULSION LABORATORY
GOLDSTONE, CALIFORNIA

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FINAL REPORT

INTERPRETIVE REPORT ON THE REFRACTION SEISMIC SURVEY CONDUCTED AT THE PIONEER SITE FOR SIX PROPOSED ANTENNA LOCATIONS

Prepared For:

Pacific Soils Engineering Inc.
1402 W. 240th Street
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Prepared By:

Edwin R. Browne
Registered Geophysicist
California Registration GP 620

Pacific Soils Engineering Work Order N. 200827

December 13, 1978

Sierra Madre Exploration Services
2038 Desire Avenue
Rowland Heights, Ca. 91748

Edwin R Browne

Edwin R. Browne

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF CROSS-SECTIONS

CONCLUSIONS

The seismic refraction survey exhibited no velocity discontinuities at Sites 2, 3, 4, and 5. At Site 1 there appears a slight displacement in the apparent velocity of bedrock at a depth of 60 feet. This is believed to be erosional. At Site 6 there is a velocity inversion. Approximately three feet of very low velocity material is sandwiched between two higher velocity layers. This is typical of a lag deposit and since it could cause lateral instability should be thoroughly investigated by the drill.

The shallow shot holes in the vicinity of Sites 4, 5, and 6 could not be drilled with the portable auger. The near surface soil is a mixture of pebbles ranging to eight inches in diameter and very fine sand. An Abundance of boulders and surface caving can be expected during the drilling program.

INTERPRETIVE RESULTS

The location of lines is shown on the Location Plat, Figure 1. A summary of the velocities recorded is presented on Figure 2 for quick reference.

Refraction Line, Site 1:

The velocity of the weathering varies considerably on this line, from a low of 800 ft/sec to a high of 1200 ft/sec. It appears to consist of soft sand and occasional thin layers of gravel. The older alluvium varies from 3450 ft/sec to 4100 ft/sec and thickens from 20 feet at the south end of the line to 100 feet at the north. Small deviations in the time-distance plots are believed to be caused by changes in the weathering velocity and minor erosional channels within the velocity layer. A major change is shown on the 6400 ft/sec apparent velocity plot shot from S.P. G. This is also believed to be caused by erosion since no sharp displacement denoting a fault is recorded on the corresponding 7600 ft/sec plot north shot from S.P. C. The presence of a high velocity horizon is indicated by a 12,000 ft/sec velocity and a 9600 ft/sec velocity recorded on the long shots. The data is not sufficient to directly correlate and plot the horizon but it can be assumed that a true velocity in excess of 10,000 ft/sec is present at approximately 300 feet beneath Site 1.

Refraction Line, Site 2:

The 400 foot line shot across Site 2 provided more definition on the shallow velocity horizons. No significant discontinuities were found. The 6600 ft/sec and 10,200 ft/sec horizons were transposed from a previous survey done in December, 1973.

INTERPRETIVE RESULTS (Cont.)

Refraction Line, Sites 3 and 5:

No velocity discontinuities were found in the vicinity of these sites. There appears to be a fault in the high velocity interface 150 feet north of Site 3, however there is no evidence that this fault is present in the shallower horizons.

Refraction Line, Sites 5 and 6:

There is no evidence of faulting in the 3600 or 4425 ft/sec horizons at Site 5. There is quite a discrepancy in velocity values and depths between the two sections intersecting at Site 5. This is not unusual in refraction, especially in relatively confined valleys which has undergone flow-type deposition. A fault is indicated 100 feet east of Site 5 in the high velocity horizon but there is no sign of any faulting in the shallower horizons.

At Site 6 we see a velocity discontinuity in the 4250 ft/sec apparent velocity. This is not a fault and the same discontinuity is evident on the cross line and will be discussed separately. There are no discontinuities in the other velocity horizons.

Refraction Line, Sites 4 and 6:

Site 4 is clear of faults or discontinuities. Between S.P. E and S.P. H there are several examples of a shallow velocity discontinuity caused by a velocity inversion where a layer of very low velocity material lies between two higher velocity layers. This is evident on the east-west line also. Refer to Figure 3 for sample calculations with respect to this anomaly. The thickness of this "stringer" is probably two or three feet.

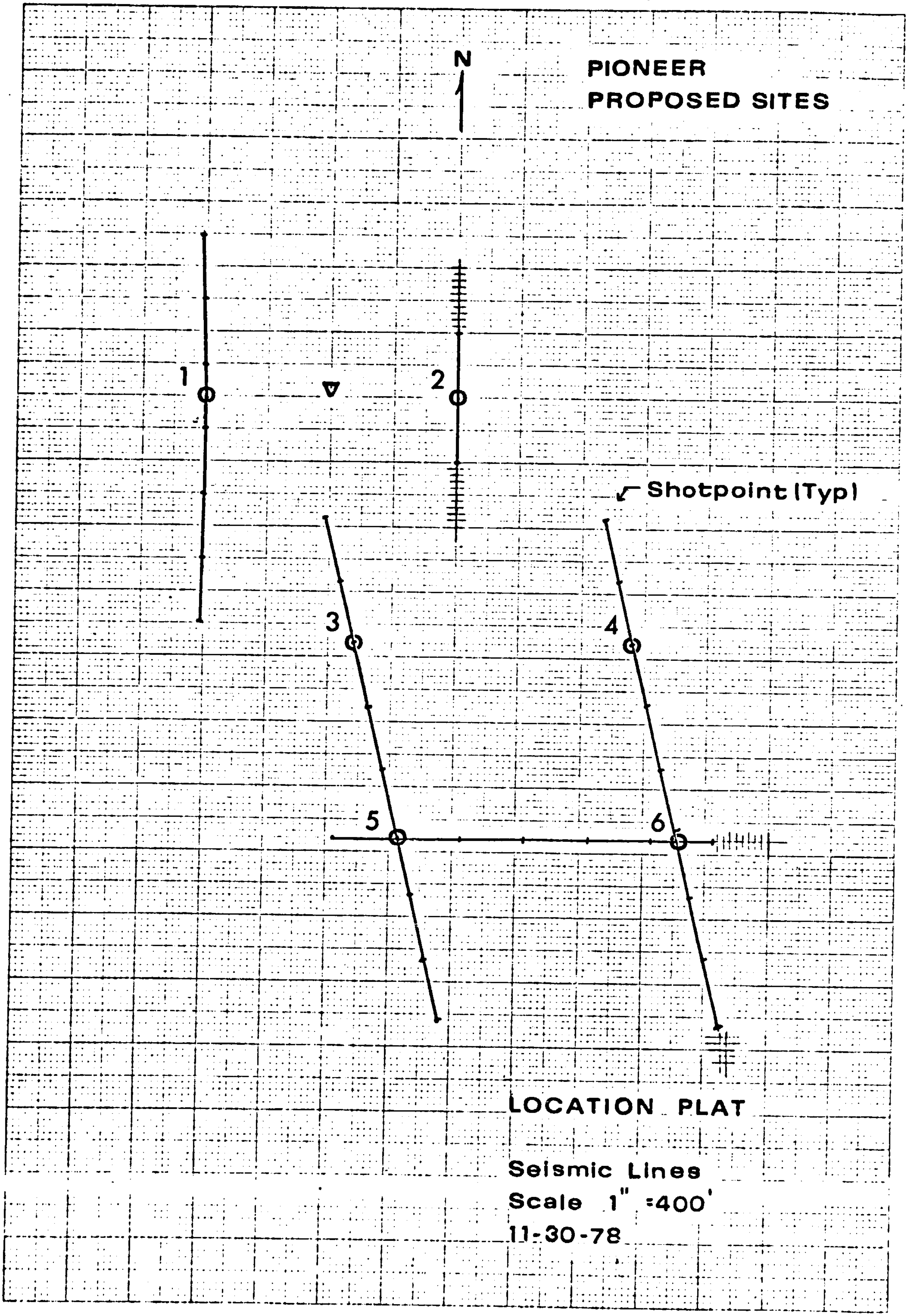
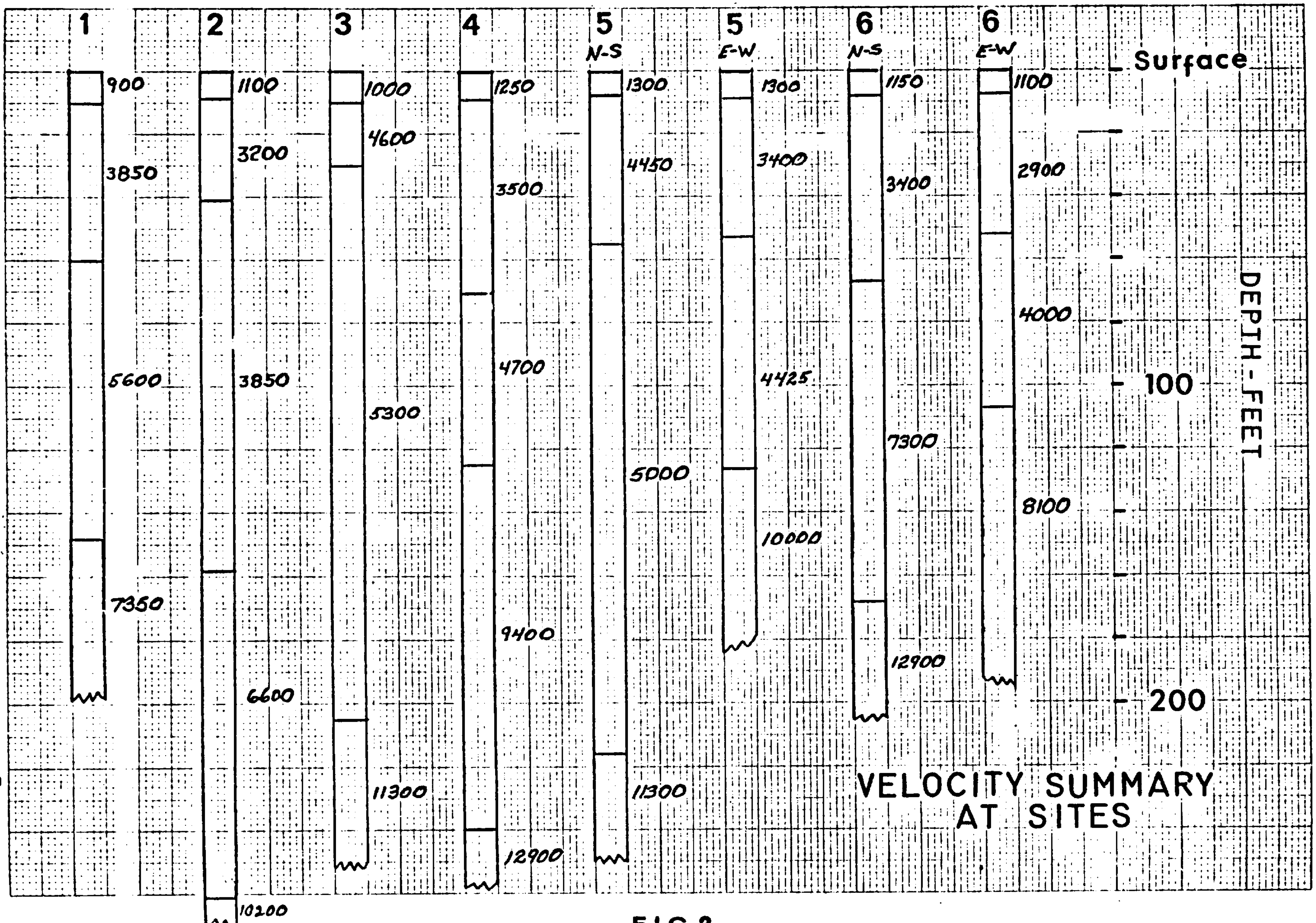

N
PIONEER
PROPOSED SITES
1
2
Shotpoint (Typ)
3
4
5
6
LOCATION PLAT
Seismic Lines
Scale 1" =400'
11-30-78

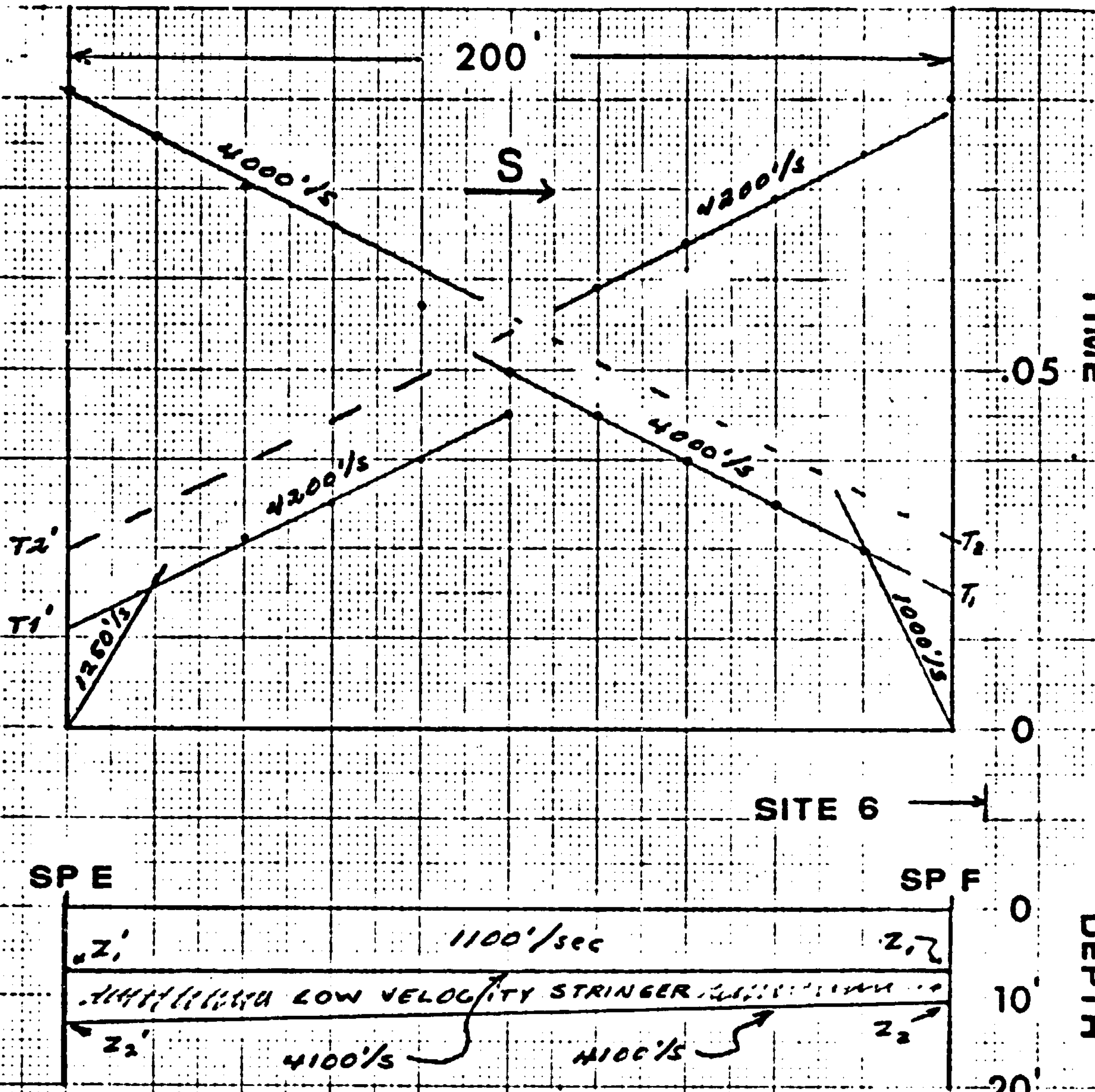
FIG 1



1
900
3850
5600
7350
2
1100
3200
3850
6600
10200
3
1000
4600
5300
11300
4
1250
3500
4700
9400
12900
5 N-S
1300
4450
5000
11300
5 E-W
1300
3400
4425
10000
6 N-S
1150
3400
7300
12900
6 E-W
1100
2900
4000
8100
Surface
100
200
DEPTH - FEET
VELOCITY SUMMARY AT SITES

FIG 2

p.5



$$Z_1 = \frac{T_1 V_0}{2 \cos \phi} \quad \text{where } \phi = \sin^{-1} \frac{V_0}{V_1} = 14.5^\circ$$

$$Z_1 = \frac{.015 \times 1000}{2(.97)} = 7.73'$$

$$Z_2 = \frac{.021 \times 1000}{2(.97)} = 10.8'$$

$$Z_1' = \frac{.011 \times 1250}{2(.955)} = 7.2'$$

$$Z_2' = \frac{.020 \times 1250}{2(.955)} = 13.1'$$

VELOCITY ANOMALY AT SITE 6

FIG 3

INTERPRETIVE PROCEDURES

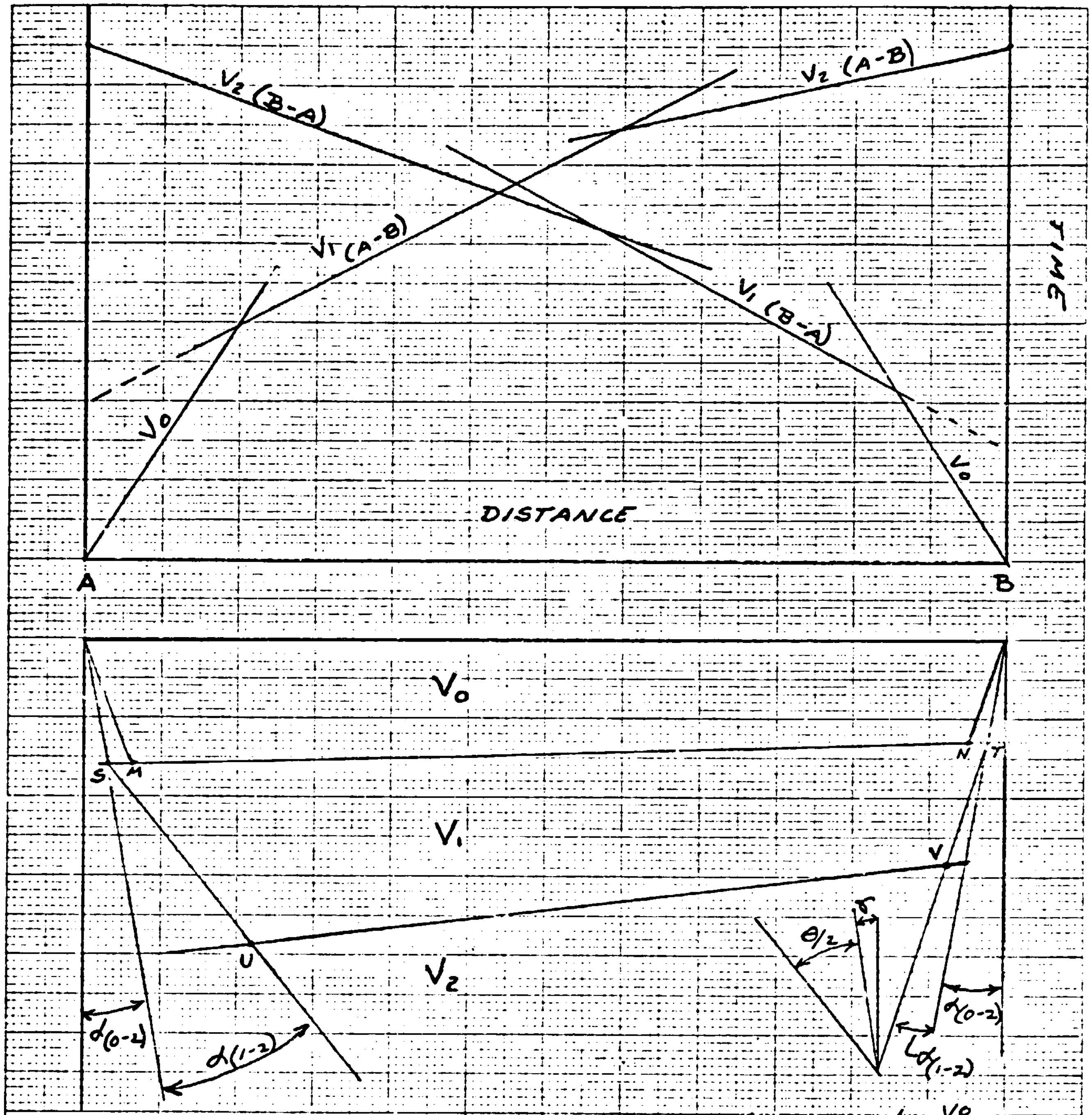
The thickness of the weathering layer can be measured only at the shot points. This is normally done with the Intercept Method. This method is used on Figure 3. In multi-layer cases the Graphical Method is used (see Figure 4). When ray paths are constructed from all apparent velocities the interpreter can tell which apparent velocity in one direction matches its counterpart in the other direction. The dip of each horizon segment can be calculated. Time checks of total travel paths must be made for each layer. A certain amount of smoothing is done on the final presentation.

FIELD OPERATIONS

The field crew was mobilized on November 27, 1978, and the field work carried out on November 28, 29, and 30. The energy sourceused was 50 grain primacord buried at an average of two feet. Where possible a portable auger rig was used to drill the shot holes. About half the holes, those on the southeast part of the prospect, had to be dug by hand as the near surface soil was a fine grained sand mixed with loose rock and boulders. Shots were fired with a SIE blaster and the time break transmitted by a built-in electronic telephone.

Spreads of 400 feet were used and a geophone separation of 20 feet. Shots were taken every 200 feet to give good shallow control. The seismic system was a SIE PT-100 system. The operation enjoyed excellent weather with practically no wind. Data quality was excellent.

A four man crew was used the first day, and a three man crew thereafter. Besides the instrument and cable vehicle a utility vehicle was used for shooting and drilling.



$$\alpha_{(0-2)} = \sin^{-1}\frac{V_0}{V_2\,(A-B)} \qquad \alpha_{(0-2)} = \sin^{-1}\frac{V_0}{V_2\,(B-A)}$$

$$\alpha_{(1-2)} = \sin^{-1}\frac{V_1\,(A-B)}{V_2\,(A-B)} \qquad \alpha_{(1-2)} = \sin^{-1}\frac{V_1\,(B-A)}{V_2\,(B-A)}$$

Total time A to B and B to A should be practically the same.

Measure angles α_{1-2} with respect to $\overline{MN}$.

Extend SU and TV and measure θ and $\theta/2$ with protractor.

Dip of interface is γ.

With dividers take time check: $\frac{\overline{AS}}{V_0} + \frac{\overline{SU}}{V_1} + \frac{\overline{UV}}{V_2\,AV} + \frac{\overline{VT}}{V_1} + \frac{\overline{TB}}{V_0}$ = Total Time

Use apparent velocities for time check.

Vo-V1 interface usually calcutated by intercept method.

GRAPHICAL METHOD

FIG 4

EQUIPMENT

SIE PT-100 Refraction Seismograph w/Filter Unit
SIE Capacitance Blaster w/Electronic Telephone
Geospace HS-1 Refraction Geophones, 14 HZ
Refraction Cables and Telephone Line
SIE PRO-11 Recording Oscillograph
Portable Shothole Auger Drill

PERSONNEL

Edwin R. Browne
Paul Mairesse
Robert B. Dicken
Patrick F. Fehr

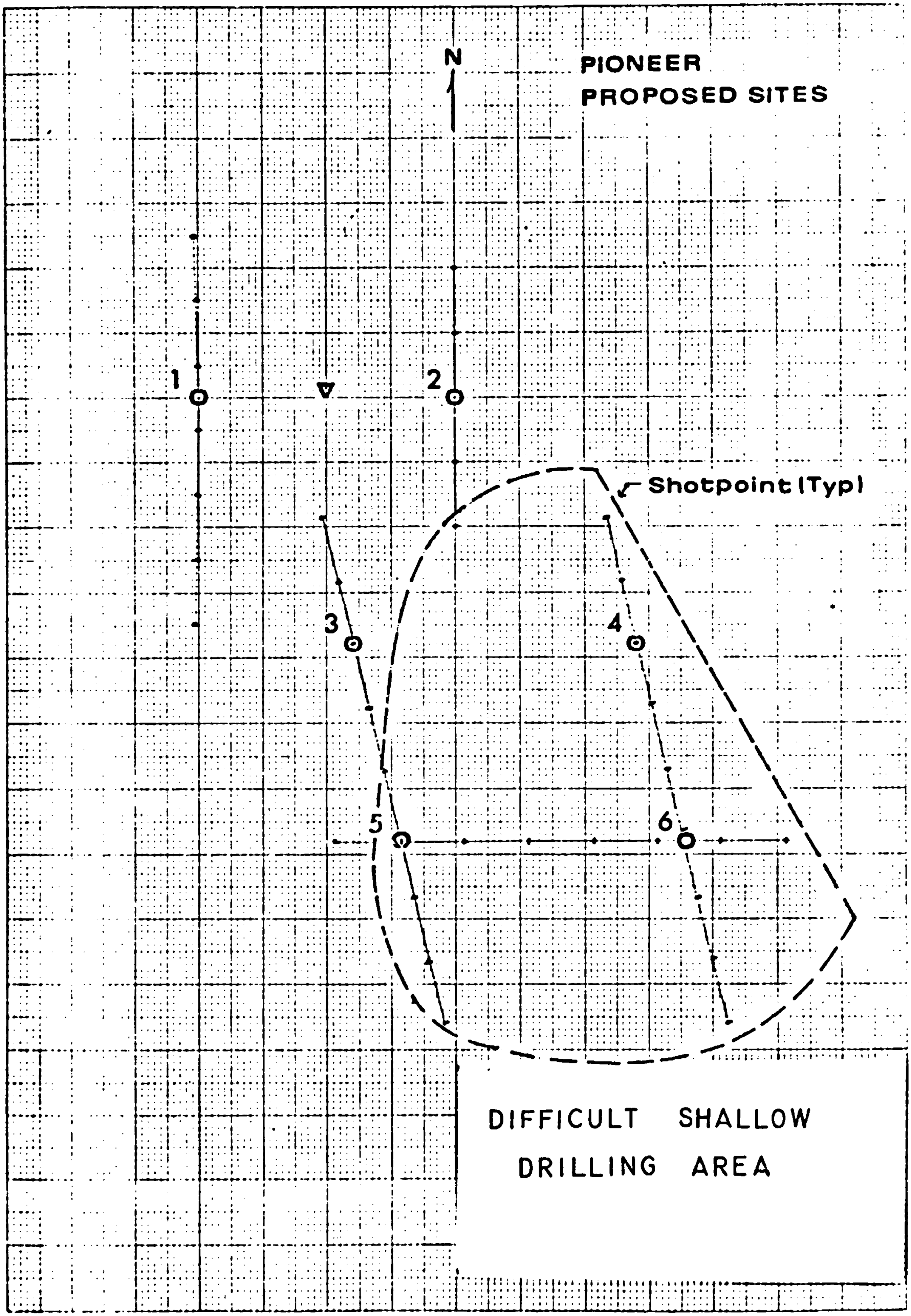
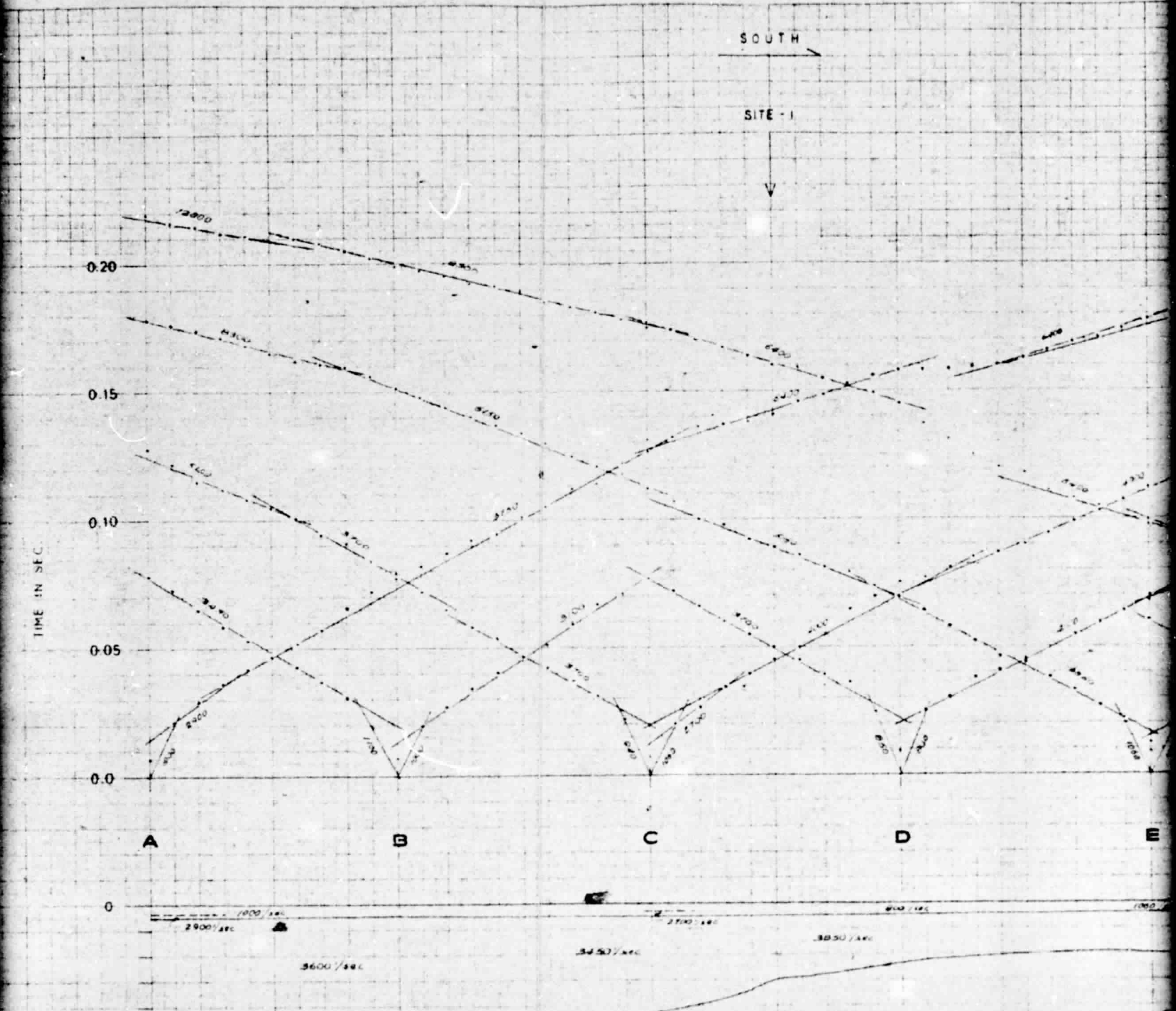
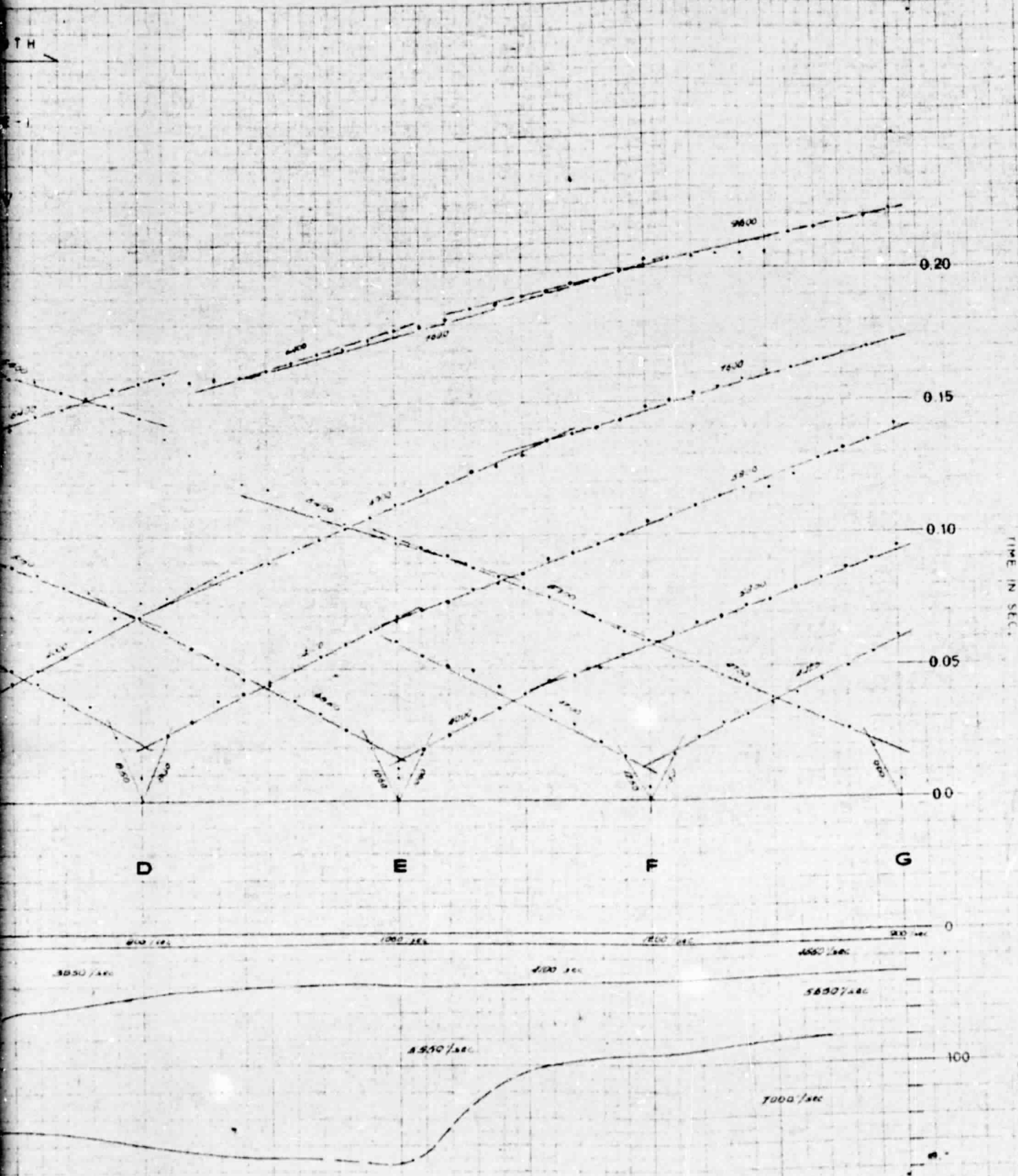

N
PIONEER
PROPOSED SITES
1
2
3
4
5
6
Shotpoint (Typ)
DIFFICULT SHALLOW
DRILLING AREA

FIG 5


SOUTH
SITE - I
TIME IN SEC.
0.20
0.15
0.10
0.05
0.0
A
B
C
D
E
DEPTH IN FEET
0
100
200
1000'/sec
2900'/sec
2700'/sec
800'/sec
3600'/sec
3450'/sec
3850'/sec
5775'/sec
7350'/sec



SIERRA MADRE
EXPLORATION

CLIENT
PACIFIC SOIL

TITLE
REFRACTION

JOBSITE
PIONEER

INTERPRETATION BY
EK Brown

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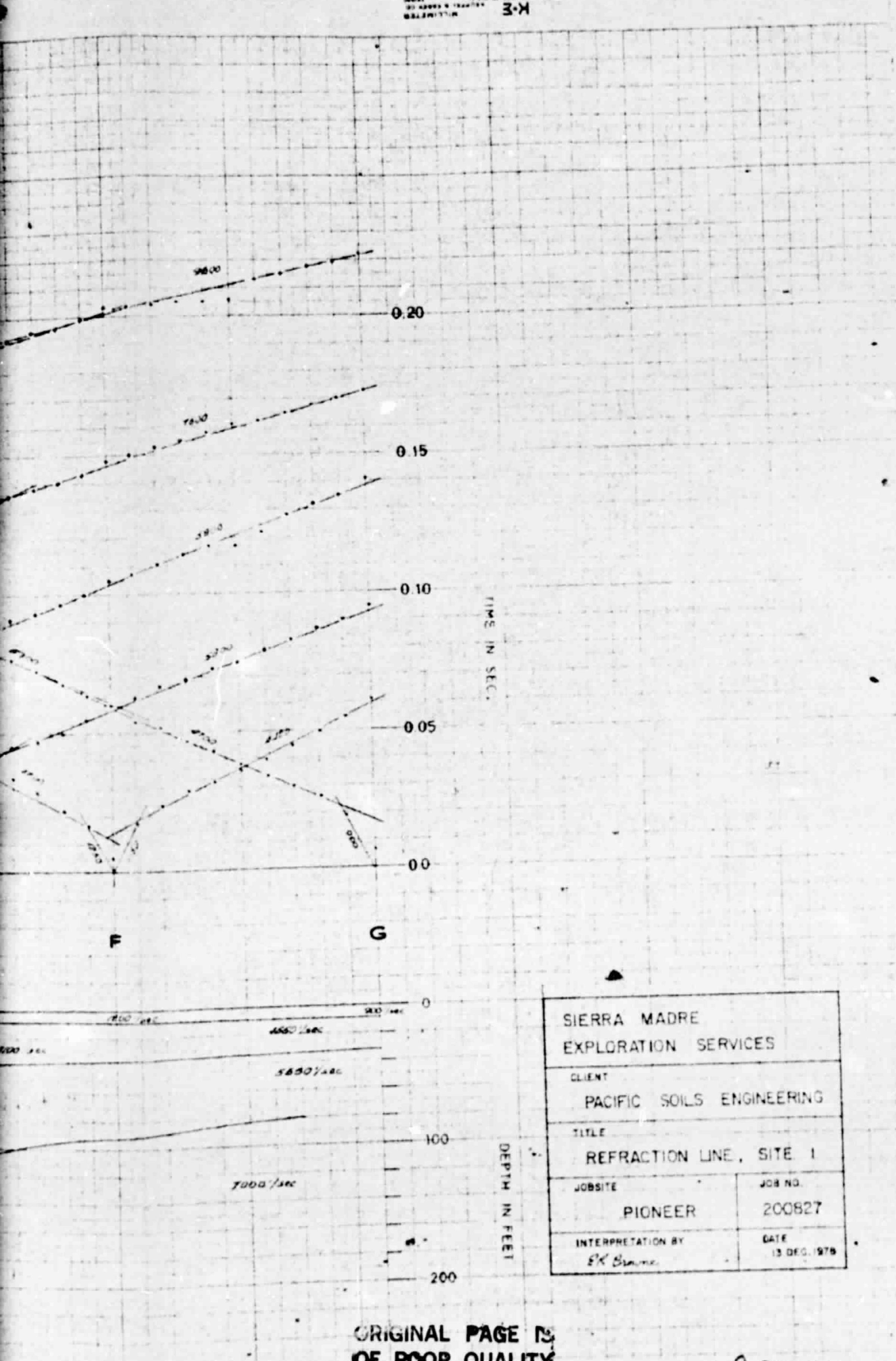

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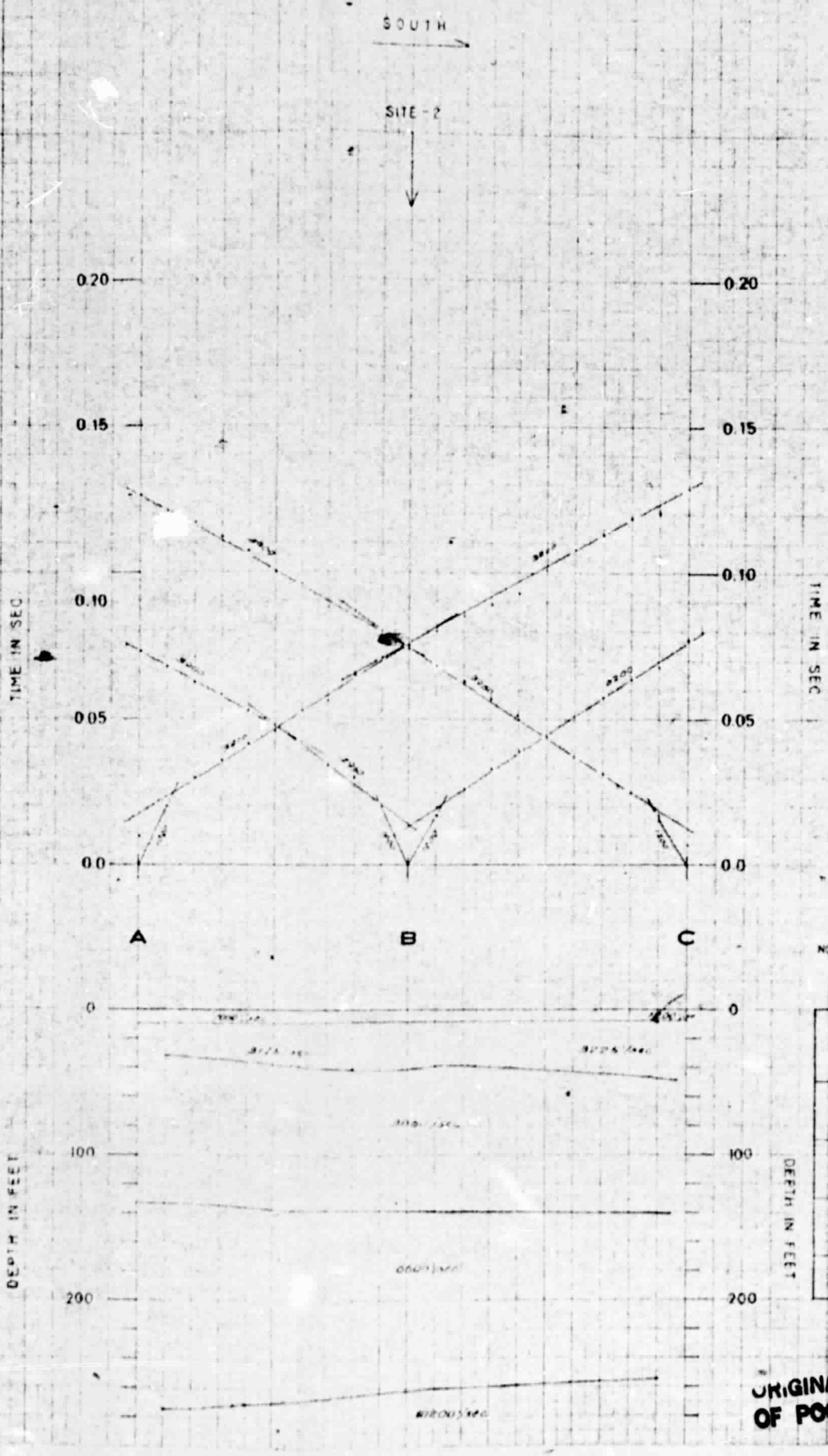

NOTE: 6500 AND 10200 VELOCITIES TAKEN FROM FIGURES 4 & 5, PIONEER SITE REFRACTION SURVEY OF 19 DEC 1973

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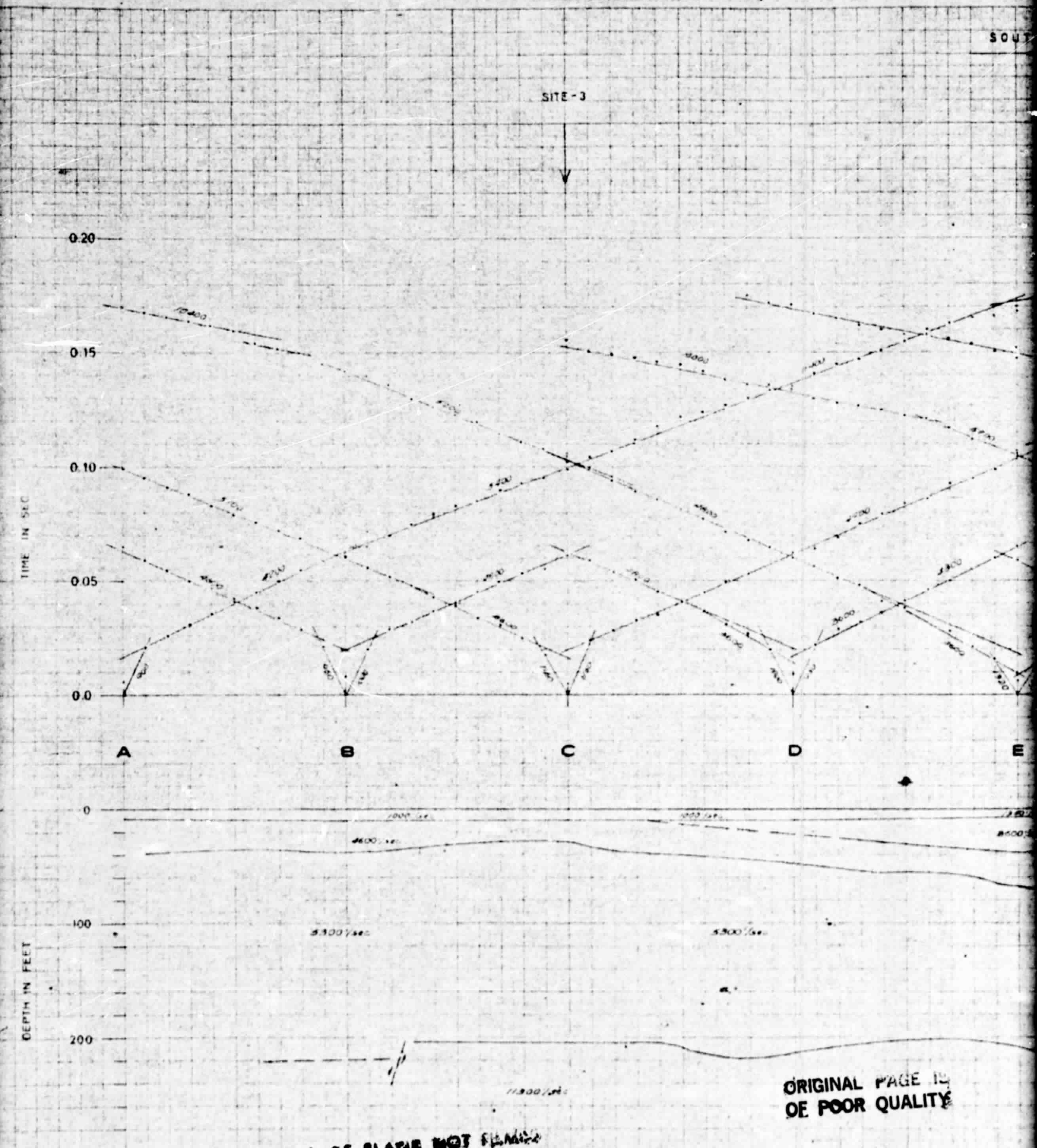
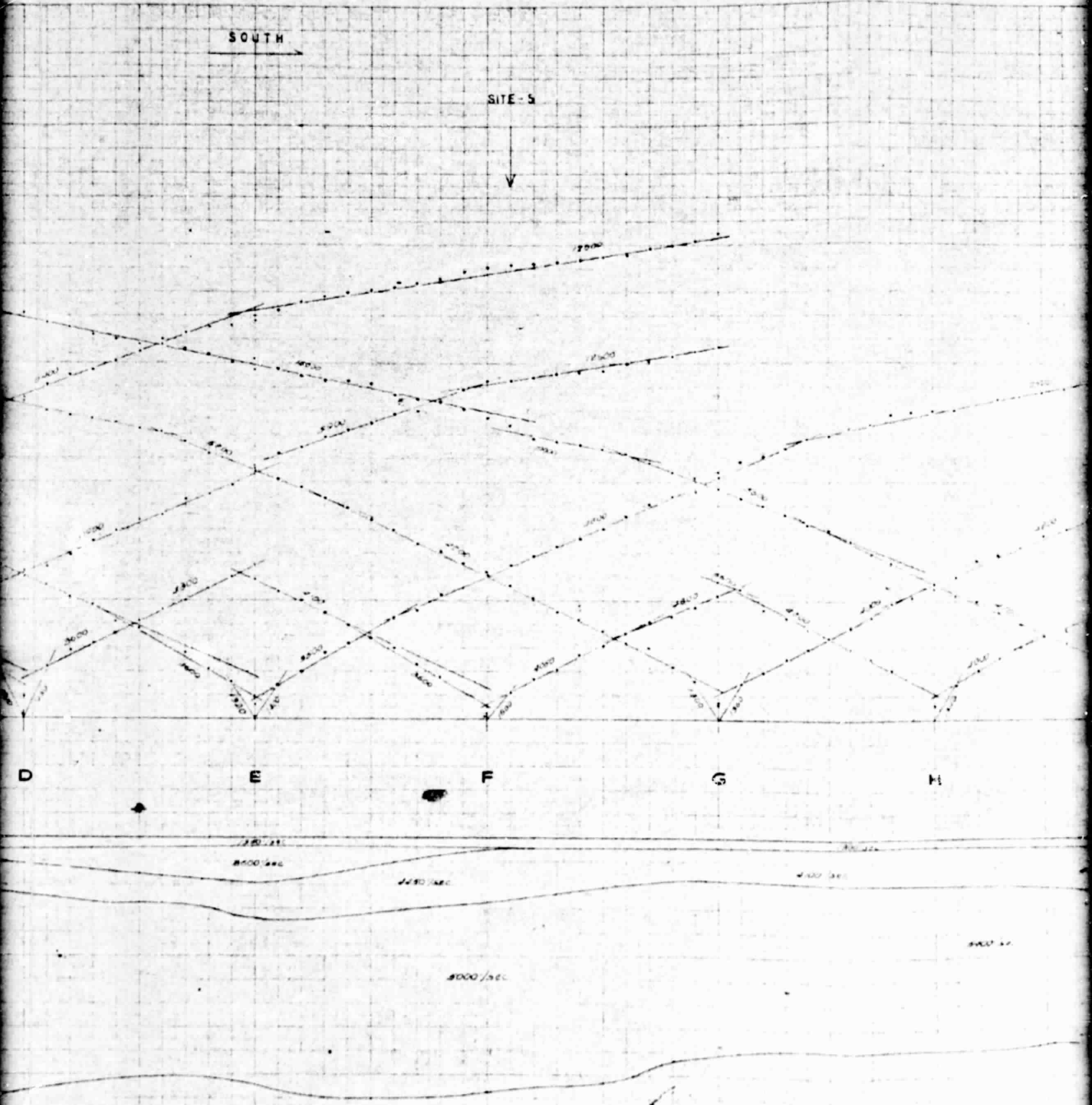
TITLE: REFRACTION LINE, SITE 2	
JOBSITE: PIONEER	JOB NO: 200827
INTERPRETATION BY: E.R. Brune	DATE: 13 DEC 1978


SITE - 3
TIME IN SEC
0.20
0.15
0.10
0.05
0.0
A
B
C
D
E
DEPTH IN FEET
0
100
200
1000'/sec
4600'/sec
5300'/sec
11300'/sec



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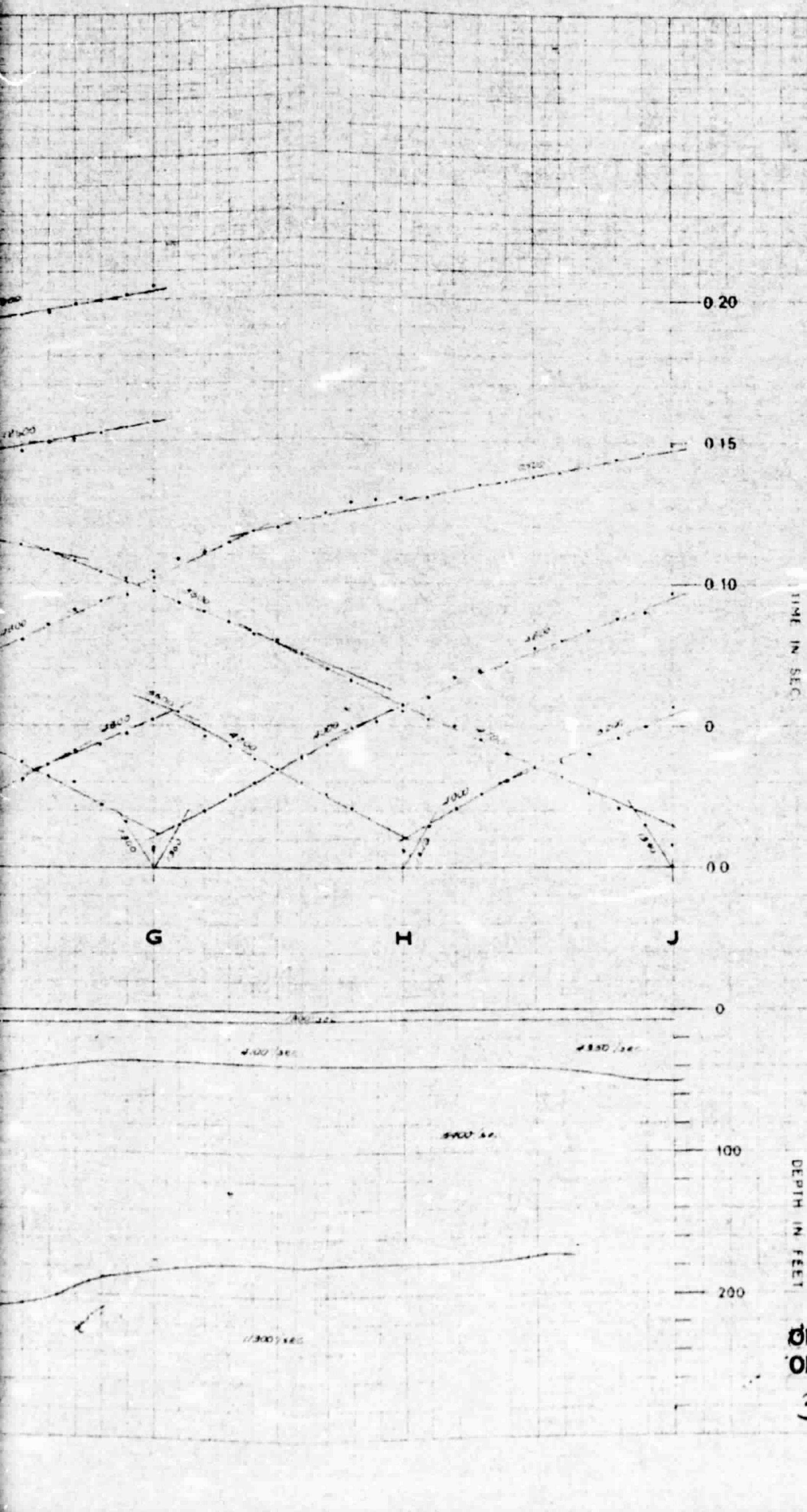

SIERRA MADRE
EXPLORATION SERVICES

CLIENT
PACIFIC SOILS ENGINEERING

TITLE
REFRACTION LINE, SITE 3-5

JOBSITE	JOB NO.
PIONEER	200827
INTERPRETATION BY	DATE 13 DEC 1978

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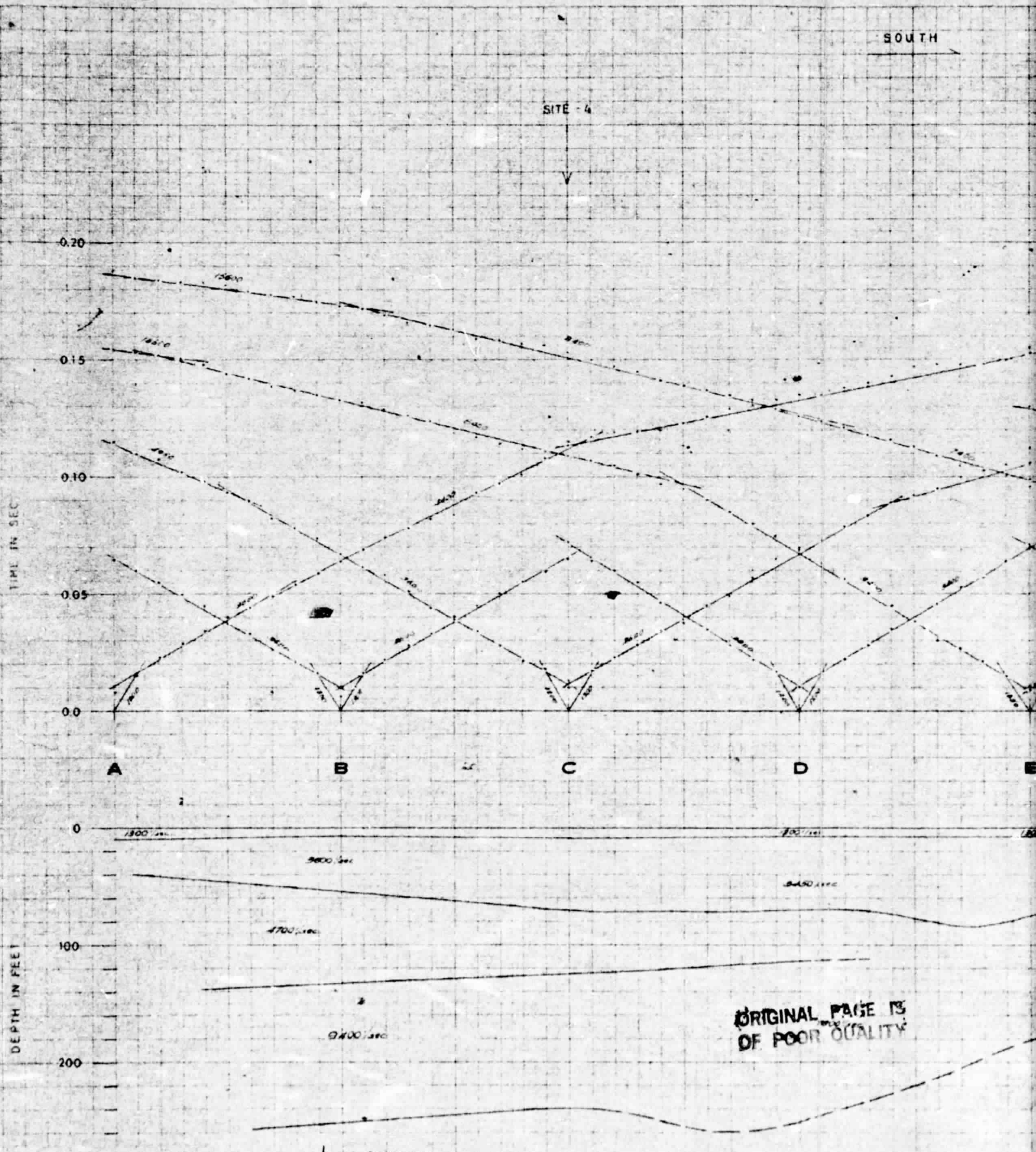

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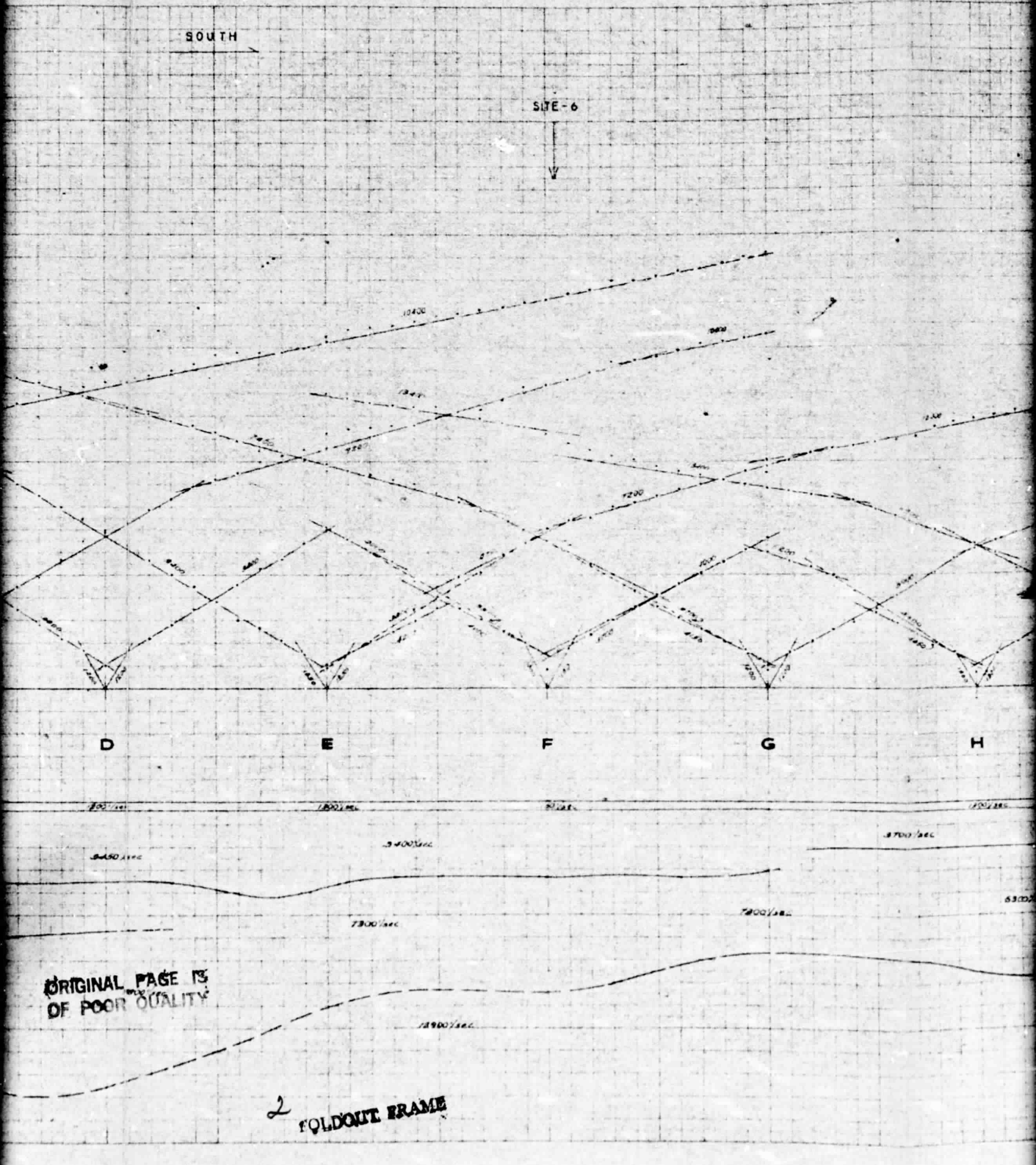

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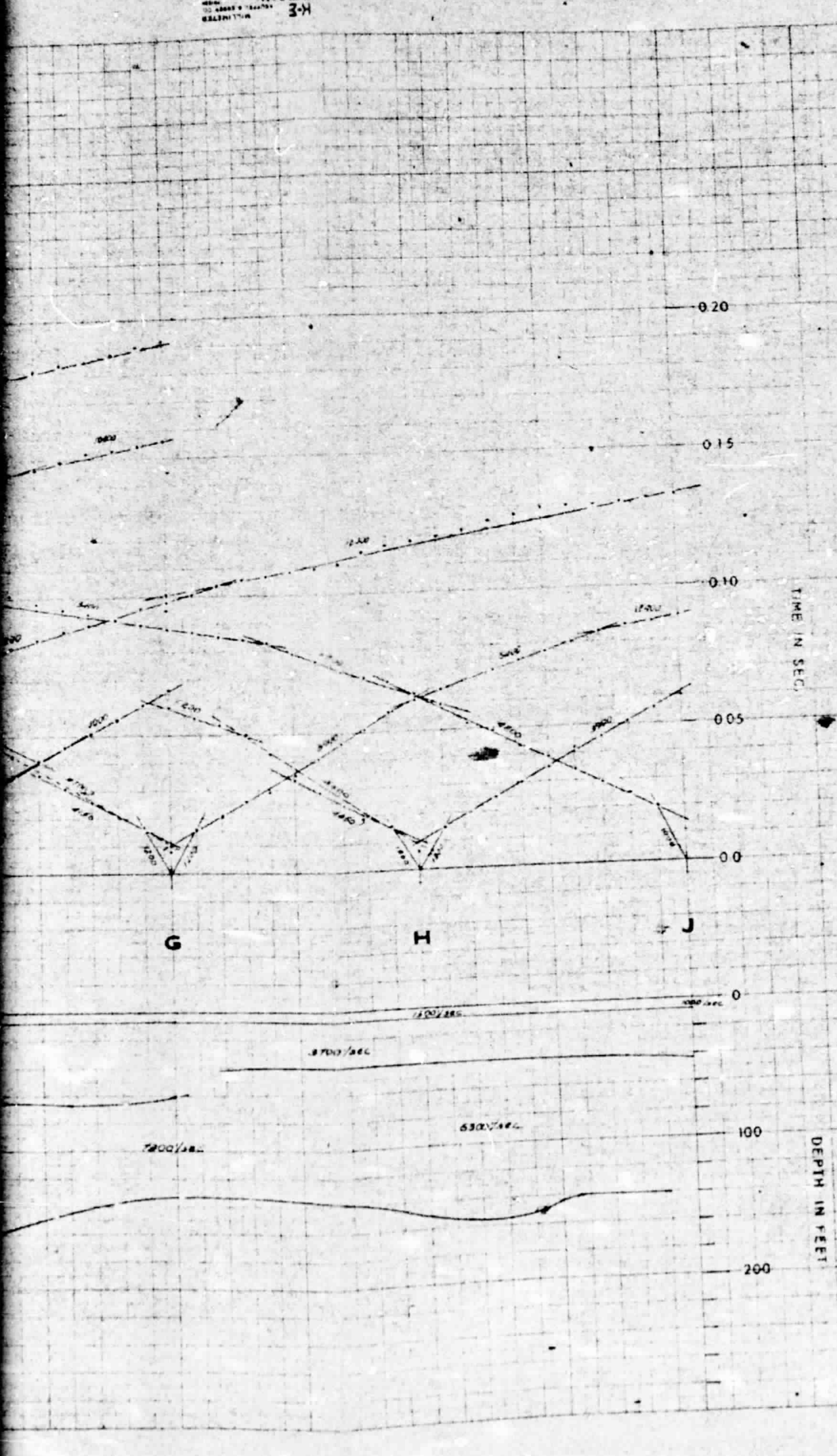

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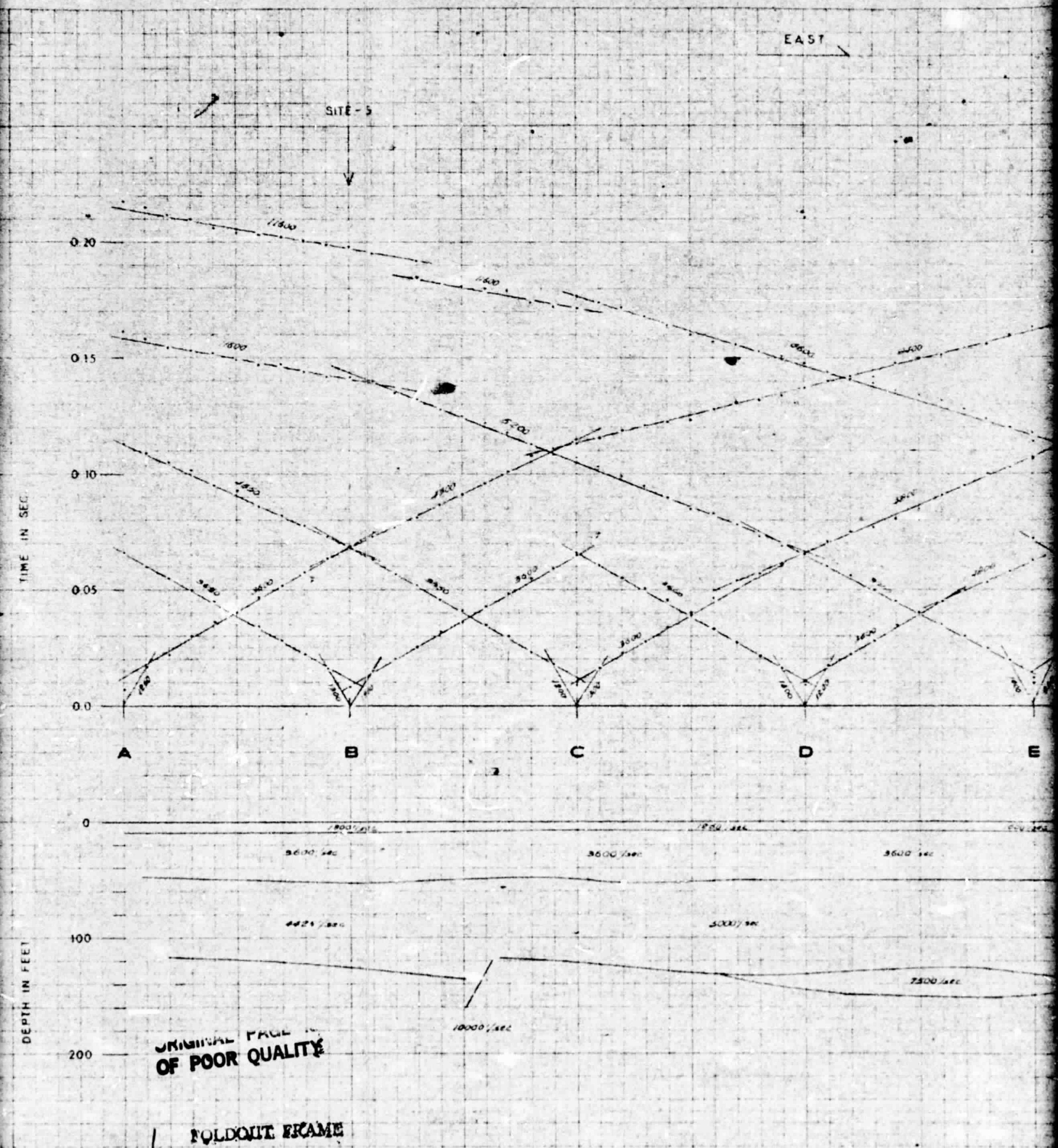
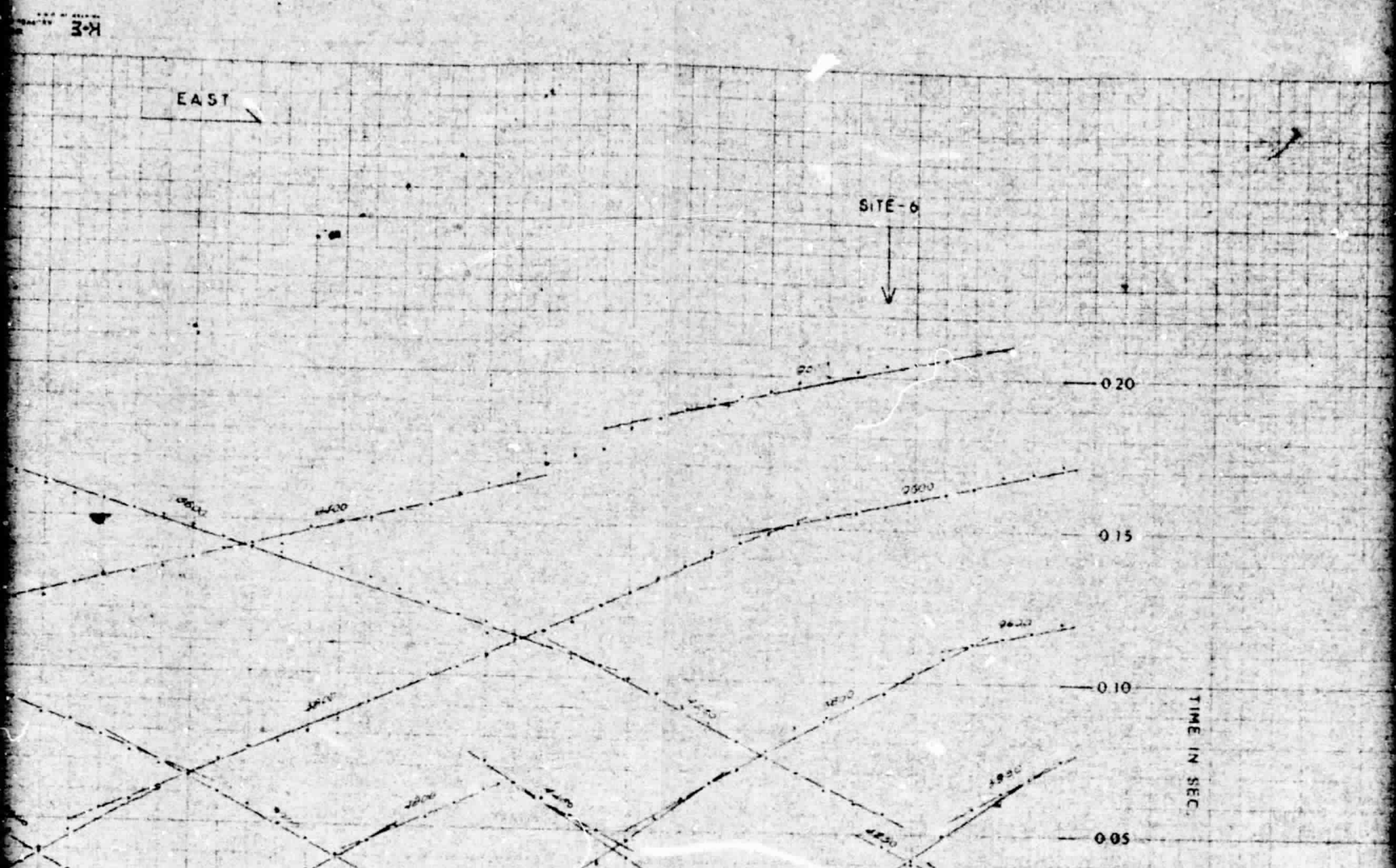
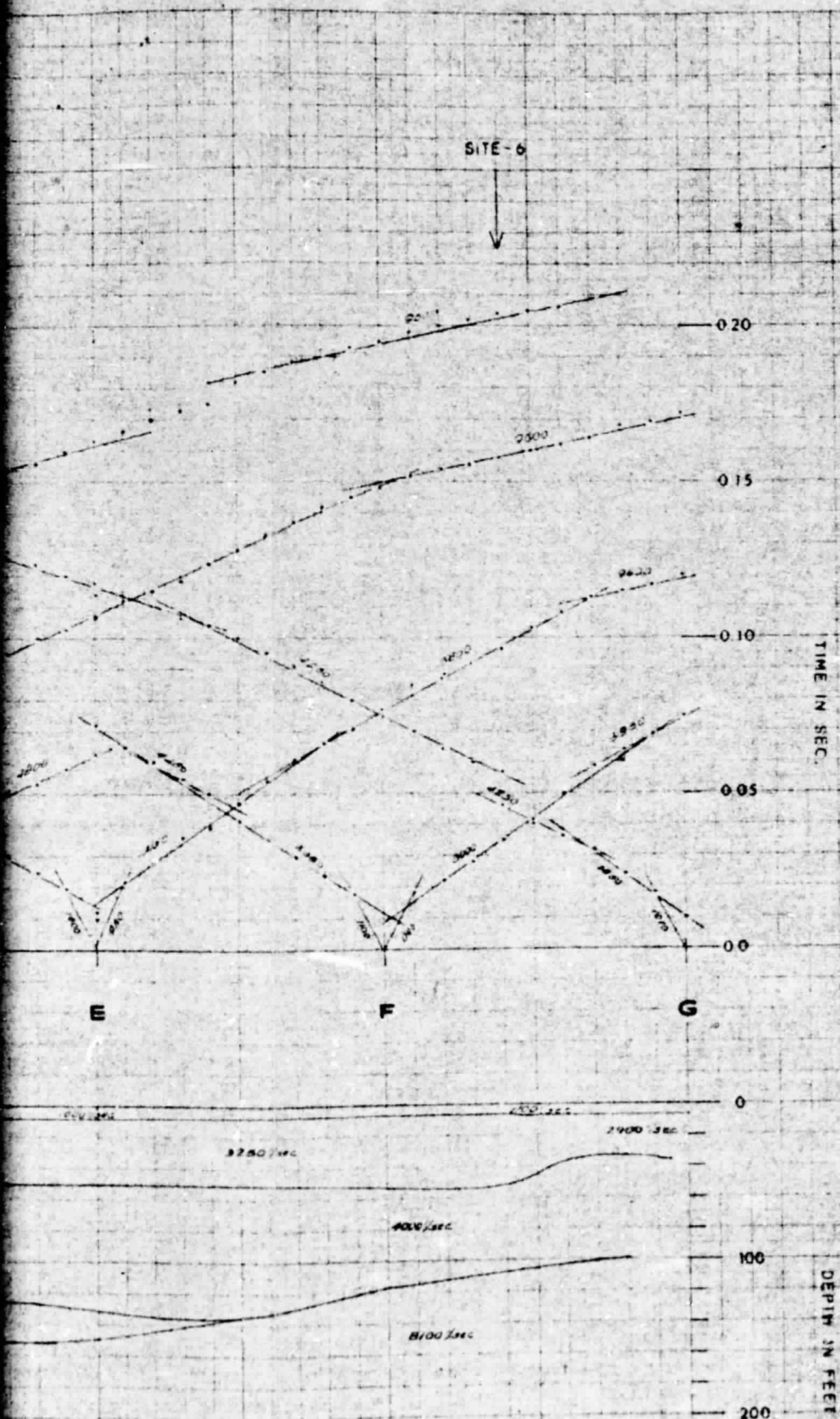
SIERRA MADRE EXPLORATION SERVICES	
CLIENT: PACIFIC SOILS ENGINEERING	
TITLE: REFRACTION LINE, SITE 4-6	
JOBSITE: PIONEER	JOB NO. 200827
INTERPRETATION BY:	DATE 13 DEC 1978

3 FOLDOUT FRAME



EAST
SITE - 5
11600
TIME IN SEC
0.20
0.15
0.10
0.05
0.0
A
B
C
D
E
DEPTH IN FEET
0
100
200
3600/sec
3600/sec
3600 sec
5000/sec
7500/sec
10000/sec


EAST
SITE-6
0.20
0.15
0.10
0.05
0.0
TIME IN SEC.
D
E
F
G
0
100
200
DEPTH IN FEET
3600 /sec
3250/sec
2900 /sec
5000/sec
4000/sec
7500/sec
8100/sec
SIERRA MADRE
EXPLORATION
CLIENT
PACIFIC SOIL
TITLE
REFRACTION
JOBSITE
PIONEE
INTERPRETATION BY



SIERRA MADRE EXPLORATION SERVICES	
CLIENT: PACIFIC SOILS ENGINEERING	
TITLE: REFRACTION LINE, SITE 5-6	
JOBSITE: PIONEER	JOB NO. 200827
INTERPRETATION BY: E.K. Paine	DATE: 13 DEC. 1978

APPENDIX B

SHEAR WAVE VELOCITY DETERMINATIONS
PROPOSED ANTENNA SITE THREE
BORE HOLE 3-3
PIONEER STATION DSS 11

JET PROPULSION LABORATORY
GOLDSTONE, CALIFORNIA

REPORT OF P-WAVE AND S-WAVE DETERMINATIONS, PIONEER SITE, BORE-HOLE 3-3

Prepared For:

Pacific Soils Engineering Inc.
1402 W. 240th Street
Harbor City, Ca. 90710

Prepared By:

Edwin R. Browne
Registered Geophysicist
California Registration GP 620

Pacific Soils Engineering Work Order 200827

February 2, 1979

Edwin R. Browne
Edwin R. Browne
Consultant Geophysicist

FIELD OPERATIONS

The seismic survey to determine P-Wave and S-Wave velocities at Bore-hole 3-3, Pioneer Site, was undertaken on January 30, 1979. The temperature was near freezing and the wind brisk.

Recording instrumentation was the same as that used on the previous refraction study described in the report dated December 13, 1978.

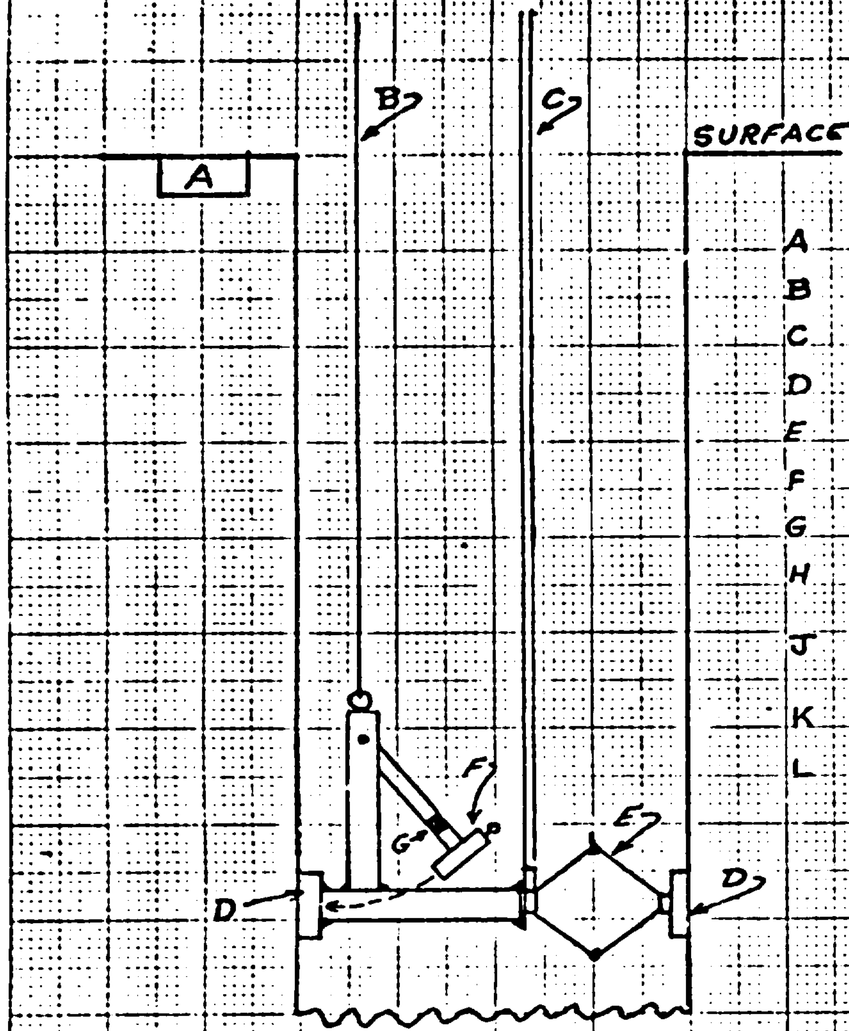
The downhole energy source is described in the attached "Method Diagram". We wish to thank the personnel of Pacific Soils, JPL, and Tri-Valley Drilling for their assistance in handling the downhole equipment.

P & S waves were recorded every two feet from 10 feet to 30 feet. Below this the hole had belled out considerably.

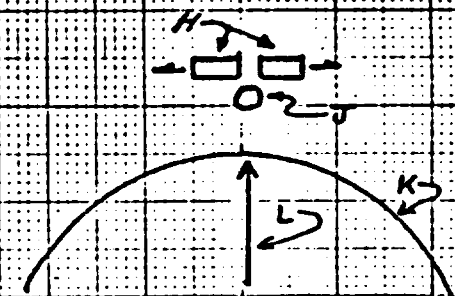
RESULTS

There was a marked break in velocities for both the P and S Waves at approximately 19 feet. The readings at 14 feet were discarded as the time break for that depth was in error.

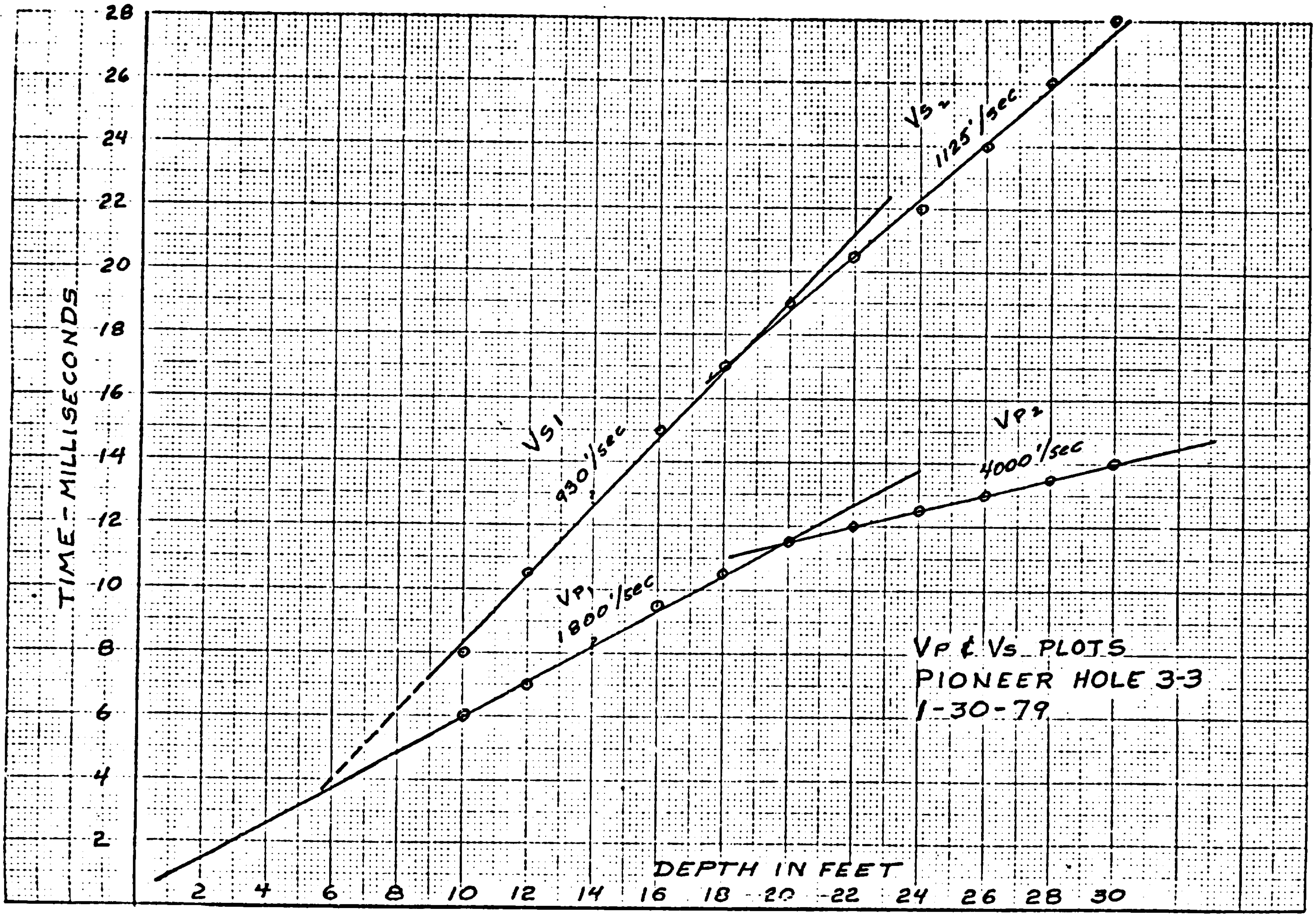
The time-distance plots of P-Waves and S-Waves are attached as are the computed results using an average density of 119 lbs/cu.ft. as supplied by Pacific Soils. These results were calculated with a slide rule and should be rechecked with a floating point calculator.



A GEOPHONE ARRAY
B MANILA ROPE
C ALUMINUM RODS
D STEEL PLATES
E SCISSOR JACK
F 8 lb. HAMMER
G IMPACT SWITCH
H HORIZONTAL GEOPHONES 14 HZ, MARK PRODUCTS
J VERTICAL GEOPHONE 14 HZ, GEOSPACE
K WALL OF BOREHOLE
L DIRECTION OF IMPACT



METHOD DIAGRAM


VP & VS PLOTS
PIONEER HOLE 3-3
1-30-79
TIME - MILLISECONDS
DEPTH IN FEET
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
VS1
930'/sec
VS2
1125'/sec
VP1
1800'/sec
VP2
4000'/sec

COMPUTED RESULTS

	ZONE 1 6 Ft. to 19 Ft.	ZONE 2 19 Ft. to 30 Ft.
Average P Wave Velocity, Ft/Sec.	1800	4000
Average S Wave Velocity, Ft/Sec.	930	1125
Average Unit Weight, γ lbs/cu. ft.	119	119
Poisson's Ratio, ν	.317	.457
Bulk Modulus, K $\times 10^6$ lbs/in^2	.0537	.368
Rigidity Modulus, G $\times 10^6$ lbs/in^2	.0228	.0324
Young's Modulus, E $\times 10^6$ lbs/in^2	.060	.0945

$$\nu = \frac{V_p^2 - 2V_s^2}{2(V_p^2 - V_s^2)}$$

$$K = C\gamma(V_p^2 - 4/3\, V_s^2)$$

$$G = C\gamma V_s^2$$

$$E = 2G(1 + \nu)$$

WHERE $C = 2.16 \times 10^{-4}$

APPENDIX C

LOGS OF BORINGS
PIONEER STATION, DSS 11

JET PROPULSION LABORATORY
GOLDSTONE, CALIFORNIA

MAJOR DIVISIONS				TYPICAL NAMES
COARSE-GRAINED SOILS (more than 50% of material is LARGER than 200 sieve size)	GRAVELS (more than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (appreciable amt. of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly-graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (appreciable amt. of fines)	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than 50% of material is SMALLER than 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays.
	SILTS AND CLAYS (liquid limit more than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

UNIFIED SOIL CLASSIFICATION SYSTEM: R - Undisturbed Sample
B - Bulk Sample
▼ Groundwater Table or Groundwater Seepage

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953: (revised April, 1960).

PACIFIC SOILS ENGINEERING, INC.
1402 W. 240TH STREET, HARBOR CITY, CALIFORNIA 90710, TEL (213) 325-7272 OR 775-6771

W.O. 200827 DATE 4-1-79

DATE 1-11-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 3

BORING NO. 1-1

SURFACE ELEV. 3350

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 1

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, light brown, dry, loose, 5 to 10% angular to subrounded gravel to 1-1/2 inches.
					CL		Fine Sandy Clay, light red-brown, dry to damp, stiff, scattered angular to subrounded gravel to 1 inch.
5	○ □	108	9.5		SM	9-2550#	Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, medium dense, 5 to 10% angular to subrounded gravel to 1-1/2 inches. The sand is predominantly in the fine range.
10	○	109	8.0	1.46	SM	9-2550#	Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, medium dense, 15 to 20% angular to subrounded gravel to 1-1/2 inches. Below 13 ft. 30% ± angular to subrounded gravel scattered subangular to subrounded cobbles to 5 inches.

PLATE A-1

DATE 1-11-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET

HARBOR CITY, CALIFORNIA 90710 SHEET NO. 2 OF 3

SUBJECT Pioneer Site; Goldstone, California BORING NO. 1-1

Antenna No. 1 SURFACE ELEV.

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	112	5.0		SM	10-2550#	Gravelly Silty Fine to Coarse Sand, as above.
20	○	109	6.5	2.08		12-2550#	Dense below 20 ft.
25	○	121	3.0			12-2550#	Below 25 ft. the fines are cohesionless.

DATE 1-11-79

BY F.D.

SUBJECT Pioneer Site; Goldstone, California

Antenna No. 1

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 3 OF 3

BORING NO. 1-1

SURFACE ELEV.

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	⊛				SM		Silty Fine to Coarse Sand, gravelly.
							END OF BORING AT 31 ft. NO WATER SLIGHT SLOUGHING ABOVE 3.5 ft.

DATE 1-11 thru 12-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

BY F.D.

SHEET NO. 1 OF 3

SUBJECT Pioneer Site; Goldstone, California

Antenna No. 1

BORING NO. 1-2

SURFACE ELEV. 3352

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, light brown, dry, loose, scattered angular to subrounded gravel to 1 inch.
5	○	103	14.5		CL	12-2550#	Gravelly Silty Clay, light red-brown, dry to slightly moist, stiff, 15% ± angular to subrounded gravel to 1-inch.
					SM		Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, dense, 20% ± angular to subrounded gravel to 1-1/2 inches. The sand is predominately in the fine range.
10	○	117	4.0	1.24		11-2550#	
							Below 14 ± ft. 35% to 40% angular to subrounded gravel.

DATE 1-11 thru 12-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 2 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 1

BORING NO. 1-2

SURFACE ELEV. 3352

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	116	4.5		SM	11-2550#	15% ± subangular to subrounded cobbles to 5 inches.
20	○ □	112	4.0	2.7		8-2550#	
25	○	121	4.0		GW-GM	30-1700#	Fine to Coarse Sandy Gravel, slightly silty, light brown, dry, dense to very dense, 60% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 5 inches.
							Below 29 ± ft. light red-brown, dry, very dense.

PLATE A-5

DATE 1-11 thru 12-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 3 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 1

BORING NO. 1-2

SURFACE ELEV. 3352.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○		6.0		GW-GM	45/10 1700#	Fine to Coarse Sandy Gravel.

END OF BORING AT 31 ft.

NO WATER

SLIGHT SLOUGHING ABOVE 4.3 ft.

DATE 1-11-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 1 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 1-3

Antenna No. 1 SURFACE ELEV. 3350

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, light brown, dry, loose. 5 to 10% angular to subrounded gravel, scattered subangular to subrounded cobbles to 5-inch size.
5	○	108	10.0	.54	CL	6/6" 2550#	Gravelly Silty Clay, light red-brown, dry, stiff to hard, 12% ± angular to subrounded gravel.
					SM		Gravelly Silty Fine to Medium Sand, light brown, dry, medium dense to dense, 25% ± angular to subrounded gravel, 20 %± subangular to subrounded cobbles to 6 inches.
10	○	107	10.5	1.20	CL	13-2550#	Gravelly Silty Clay, light red-brown, dry, stiff to hard, 10% to 15% angular to subrounded gravel to 1 inch.
					SM		Gravelly Silty Fine to Coarse Sand, light red-brown, dry to slightly moist, medium dense, 25 % ± angular to subrounded gravel to 2 inches. The sand is predominantly in the fine range.
15							

DATE 1-11-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 2 OF 4

BORING NO. 1-3

SURFACE ELEV. 3350

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 1

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	110	7.5	1.26	SM	10-2550#	Moisture content increasing slightly with depth.
20	○	109	7.0	2.12		10-2550#	
25	□ ○	111	6.5	3.57		10-2550#	
					SM		Gravelly Silty Fine Sand, red-brown, damp to slightly moist, 50 % ± subangular to subrounded cobbles to 12 inches.
					SM		Gravelly Silty Fine to Coarse Sand, red-brown, slightly moist to moist, dense, 25% ± angular to subrounded gravel, 20% ± sub-angular to subrounded cobbles to 6 inches. The sand is predominantly in the fine range.
30							

PLATE A-8

DATE 1-11-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 3 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 1-3

Antenna No. 1 SURFACE ELEV. 3350

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✳ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○	112	8.5	3.04	SM	26 - 1700#	Gravelly Silty Fine to Coarse Sand, as above.
							Below 34 ft. 35 % ± angular to subrounded gravel.
35							
							At 37 ft. 1.5 ft. ± lens of gravel with many ccbbles to 10 inches.
40							
	○	118	7.0	6.73		21 - 1700#	
					ML		Fine Sandy Silt, red-brown, damp to slightly moist, firm to stiff, 10 % ± angular to subrounded gravel to 1-1/2 inches.
					SM		Gravelly Silty Fine Sand, red-brown, slightly moist to moist, medium dense to dense, 15% ± angular to subrounded gravel to 1 inch.
45							

PLATE A-9

DATE 1-11-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 4 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 1-3

Antenna No. 1 SURFACE ELEV. 3350

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					SM		Graveily Silty Fine Sand At 46 ft. 1 ft. ± lense of cobbles.
50	○	106	6.5	4.20		31/8" 850#	
							END OF BORING AT 50.5 ft. NO WATER SLIGHT SLOUGHING ABOVE 3.5 ft.

DATE 1-12-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 4

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

BORING NO. 2-1

SURFACE ELEV. 3362.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, light brown, dry, loose, scattered angular to subrounded gravel to 1 inch.
5	○	103	6.0	0.73		4-2550#	
					SC		Clayey Fine Sand, light red-brown, dry, stiff, scattered angular to subrounded gravel to 1-1/2 inches.
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry, medium dense, 25% ± angular to subrounded gravel to 2 inches.
10	○	109	6.0	1.00		10-2550#	
					SM		Gravelly Silty Fine Sand, slightly clayey, light red-brown, dry, very dense, 20% ±

DATE 1-12-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

1402 WEST 240th STREET

HARBOR CITY, CALIFORNIA 90710

BY F.D.

SHEET NO. 2 OF 4

SUBJECT Pioneer Site; Goldstone, California

Antenna No. 2

BORING NO. 2-1

SURFACE ELEV. 3362.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	111	8.0		SM	30-2550#	angular to subrounded gravel to 1-1/2 inches. Scattered subangular to subrounded cobbles to 5 inches.
20							
	○	112	9.0		SM	30-2550#	
25	○	113	4.0		SM	32-1700#	Gravelly Silty Fine to Coarse Sand, light red-brown, dry, dense to very dense, 25% ± angular to subrounded gravel, 15% ± subangular to subrounded cobbles to 8 inches.
					SM		

PLATE A-12

DATE 1-15-79 | PACIFIC SOILS ENGINEERING, INC. | WORK ORDER 200827

BY F.D.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 3 OF 4

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

BORING NO. 2-1

SURFACE ELEV. 3362.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○	118	3.0	3.82	SM	15-1700#	Gravelly Silty Fine to Coarse Sand, as above.
35							
40	○	115	4.0		SM	28-1700#	
	□						

DATE 1-15-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827
SHEET NO. 4 OF 4
BORING NO. 2-1
SURFACE ELEV. 3362.0

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					SM		Below 45 ft. 20% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
50	○	103	6.0			30-850#	
							END OF BORING AT 51 ft. NO WATER SLIGHT SLOUGHING ABOVE 6 ft.

PLATE A-14

DATE 1-15-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 1 OF 2

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 2 - 2

Antenna No. 2 SURFACE ELEV. 3365.5

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0	□				SM		Silty Fine Sand, light brown, dry, loose, less than 10% angular to subrounded gravel to 1-1/2 inches.
5	○	106	9.0	1.78	SM	8-2550#	Silty Fine Sand, slightly clayey, light red-brown, dry, medium dense, less than 10% angular to subrounded gravel to 1-1/2 inches.
10	○	104	5.0	0.88	SM	3-2550#	Gravelly Silty Fine to Coarse Sand, light brown, dry, loose to medium dense, 20% to 25% angular to subrounded gravel, scattered cobbles to 4 inches.
					SC		Clayey Fine Sand, light red-brown, dry, medium dense, scattered angular to sub-rounded gravel.

PLATE A-15

DATE 1-15-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 2 OF 2

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

BORING NO. 2 - 2

SURFACE ELEV. ____

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	108	10.0		SC	14-2550#	Dense below 15 ft.
					SM		Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, medium dense to dense, 25% ± angular to subrounded gravel to 2 inches.
20	○	116	5.0	2.85		18-2550#	
25	○	117	3.0			14-2550#	
					GP-GM		Sandy, Poorly Graded Gravel, slightly silty light brown, dry, dense, 55 % + angular to subrounded gravel, scattered subangular to subrounded cobbles to 4 inches.
							END OF BORING AT 30 ft. NO WATER SLIGHT SLOUGHING ABOVE 4 ft.
	○	112	4.0			26-1700#	

PLATE A-16

DATE 1-15-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 1 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

BORING NO. 2 - 3

SURFACE ELEV. 3362.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine Sand, light brown, dry, loose, 15 % to 20% angular to subrounded gravel to 1-1/2 inches.
							Medium dense below 3 ft.
5	○	114	6.0		SM	4/8" 2550#	Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, medium dense to dense, 25% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 4 inches.
	□						
10	○	113	6.0	1.00		10-2550#	

PLATE A-17

DATE 1-16-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 2 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

BORING NO. 2 - 3

SURFACE ELEV. 3362.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	107	10.0		SM	28 - 2550#	Gravelly Silty Fine to Coarse Sand.
					GP		Poorly Graded Gravel, dry, dense, cobbles to 12 inches.
					SM		Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry, dense, 20% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
20	○	115	6.0			19-2550#	
25	○	112	5.0	1.90		18-2550#	

DATE 1-16-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827
SHEET NO. 3 OF 3
BORING NO. 2 - 3
SURFACE ELEV. 3362.0

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 2

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○	116	3.0	2.56	SM	25-1700#	Gravelly Silty Fine to Coarse Sand.

END OF BORING AT 30.5 ft.

NO WATER

SLIGHT SLOUGHING ABOVE 4 ft.

DATE 1/26/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 3

SUBJECT Pioneer Site: Goldstone, California
Antenna No. 3

BORING NO. 3 - 1

SURFACE ELEV. 3363

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, brown, moist, loose, 5% ± angular to subrounded gravel to 1 inch.
					SM		Gravelly Silty Fine to Coarse Sand, light red-brown, dry to damp, loose, 30% ± angular t subrounded gravel to 3 inches.
5					CL		Silty Clay, red-brown, damp to slightly moist, stiff, 5% ± gravel.
	○	115	7.0	1.40	SM	11-2550#	Gravelly Silty Fine to Coarse Sand, slightly clayey, light brown, dry to damp, medium dense, 25% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches. The predominate sand size is in the fine range.
10	○	124	5.5	1.25		9-2550#	
					SC		Clayey Fine to Coarse Sand, red-brown, damp to slightly moist, dense, 5% ± gravel.

DATE 1/26/79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 2 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 3

BORING NO. 3 - 1

SURFACE ELEV. 3363

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	116	8.5		SM	23-2550#	Gravelly Silty Fine to Coarse Sand, light red-brown, dry to damp, very dense, 30% ± angular to subrounded gravel, scattered cobbles to 6 inches.
20	○	115	4.1	2.08		17-2550#	
	□				GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light pink-tan, dry to damp, dense to very dense, 55% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 6 inches.
25	○	111	7.0			15-2550#	

PLATE A-21

DATE 1/26/79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 3 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 3

BORING NO. 3 - 1

SURFACE ELEV. 3363

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○	118	3.5		GP/GM		Fine to Coarse Sandy Gravel.

END OF BORING AT 30.5 ft.

NO WATER

NO CAVING

PLATE A-22

DATE 1/23/79

BY F.D.

SUBJECT Pioneer Site; Goldstone, California

Antenna No. 3

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 2

BORING NO. 3 - 2

SURFACE ELEV.

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, light brown, moist, loose, 8% ± subangular to subrounded gravel. Below 1 ft. dry to damp, loose.
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose to medium dense, 15% ± angular to subrounded gravel, scattered cobbles to 6 inches.
5							
	○	110	5.0	0.71		6-2550#	Below 6 ft. 25% ± gravel, scattered cobbles to 10 inches.
10							
	○	118	4.0			9-2550#	Below 12.5 ft., light red-brown.
	□						

DATE 1/23/79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 2 OF 2

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 3 - 2

Antenna No. 3 SURFACE ELEV. 3364

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	115	4.5	2.01	SM	10-2550#	Gravelly Silty Fine to Coarse Sand, as above. Below 16 ft. dense, 45% ± angular to sub-rounded gravel, 15% ± cobbles to 8 inches.
20	○	108	5.0			26/9" 2550#	At 21 ft. 1 ± ft. lens of very hard cobbles and boulders.
25	○	119	5.0	2.43		20/11" 2550#	At 26.5 ft. 1 ± ft. lens of very hard cobbles and boulders.
					GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, dense, 55% ± angular to subangular gravel, 15% ± subangul[ar] to subrounded cobbles.
	○	108	4.0			15-1700#	END OF BORING AT 30 ft. NO WATER SLIGHT CAVING, 7 to 10 ft.

PLATE A-24

DATE 1/24-1/26/79 | PAC[illegible] SOILS ENGINEERING, INC. | WORK ORDER 200827

BY F.D. | 1402 WEST 240th STREET, HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 1 OF 4

SUBJECT Pioneer Site: Goldstone, California | BORING NO. 3 - 3

Antenna No. 3 | SURFACE ELEV. 3362

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, brown, moist, loose 5% ± angular gravel to 1 inch.
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose to medium dense, 25% ± angular to subangular gravel to 2-1/2 inches. Below 2.5 ft. light red-brown.
5	○	113	4.5	0.76		6-2550#	Below 5.5 ft. light brown, medium dense to dense with scattered angular to subrounded cobbles to 6 inches.
10	○ □	125	4.0	1.10		12-2550#	Below 11 ft., 35% ± angular to subrounded gravel, scattered cobbles to 8 inches.
							Below 13 ft., light red-brown.

PLATE A-25

DATE 1/24-1/26/79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 2 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 3 - 3

Antenna No. 3 SURFACE ELEV. 3362

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	119	4.5	1.41	SM	19-2550#	Gravelly Silty Fine to Coarse Sand, as above.
							Below 19 ft. 45% ± subangular to subrounded gravel, 15% ± subangular to subrounded cobbles to 6 inches.
20							
	(*)					18/8" 2550#	
					GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light red-brown, dry to damp, dense, 55% ± subangular to subrounded gravel, 20% ± subangular to subrounded cobbles to 10 inches.
25							
	(*)					11/5" 2550#	
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, medium dense to dense, 45% ± subangular to subrounded gravel, 20% ± subangular to subrounded cobbles to 6 inches.

DATE 1/24-1/26/79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY .D.

SHEET NO. 3 OF 4

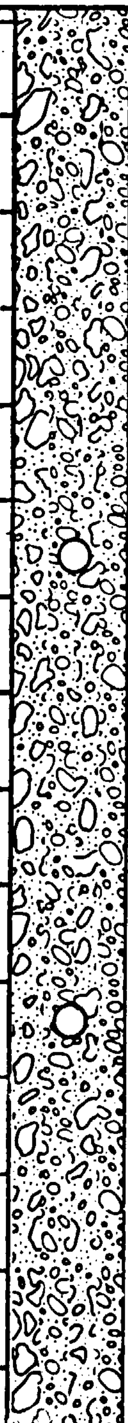
SUBJECT Pioneer Site; Goldstone, California
Antenna No. 3

BORING NO. 3 - 3

SURFACE ELEV. 3362

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✳ SAMPLE NOT RECOVERED



DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30					GP/ GM		Fine to Coarse Sandy Gravel, slightly silty, light red-brown, dry to damp, dense, 60% ± angular to subrounded gravel, 20% ± subangular to subrounded cobbles to 12 inches.
35	○		4.0			35- 1700#	
40	○		3.5			35- 1700#	Below 41 ft., red-brown, damp to slightly moist. Between 41.5 and 46.5 ft., 75% ± very hard cobbles and boulders in a matrix of fine to coarse sandy gravel.

PLATE A-27

DATE 1/24-1/26/79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 4 OF 4

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 3

BORING NO. 3 - 3

SURFACE ELEV. 3362

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					GP/GM		Sandy Gravel, as above.
					SC		Gravelly Clayey Fine to Coarse Sand, red-brown, damp to slightly moist, dense to very dense, 45% ± angular to subrounded gravel, 15% ± subangular to subrounded cobbles to 6 inches.
50							END OF BORING AT 49.5 ft. NO WATER SLIGHT CAVING BELOW 8 ft.

PLATE A-28

DATE 1/16-1/22/79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

BY F.D. SHEET NO. 1 OF 4

SUBJECT Pioneer Site; Goldstone, California BORING NO. 4 - 1

Antenna No. 4 SURFACE ELEV. 3392

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose, 45% ± angular to subrounded gravel, 15% ± cobbles to 8 inches.
5	□, ⊛				GP/GM		Fine to Coarse Sandy Gravel, slightly silty, dry to damp, dense, 55% ± angular to subrounded gravel, 15% ± subangular to subrounded cobbles.
10	○	126	3.0	2.18		15-2550#	Gravelly Silty Fine to Coarse Sand, light red-brown, dry to damp, dense, 45% ± angular to subrounded gravel, 8% ± subangular to subrounded cobbles to 8 inches.
					SM		

PLATE A-29

DATE 1/16-1/22/79

PAC. IC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 2 OF 4

SUBJECT Pioneer Site: Goldstone, California
Antenna No. 4

BORING NO. 4 - 1

SURFACE ELEV. 3392

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✳ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT	FIELD SOIL CLASSIFICATION
15	○	122	3.5	2.69	SM	23-2550#	Gravelly Silty Fine to Coarse Sand, as above.
20	○ □	87	5.0		GP-GM	20-2550#	Fine to Coarse Sandy Gravel, slightly silty, light red-brown, dry to damp, dense, 65% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 6 inches.
25	○	98	8.0			13/8" 2550#	

DATE 1/16-1/22/79 PACIFIC SOILS ENGINEERING, INC. WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 3 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 4 - 1

Antenna No. 4 SURFACE ELEV. 3392

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	△		6.0		GP/GM	40-1700#	Fine to Coarse Sandy Gravel, as above.
35	○		5.0			28/8" 1700#	
							At 37 ft. 6 ± inch lens of very hard cobbles.
					SM		Gravelly Silty Fine to Coarse Sand, pink-tan, dry to damp, very dense, 45% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 10 inches.
40	(*)						
						32-1700#	
	○	113	5.0	5.29		38-1700#	

PLATE A-31

DATE 1/16-1/22/79 PAC[illegible]IC SOILS ENGINEERING, INC. WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 4 OF 4

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 4 - 1

Antenna No. 4 SURFACE ELEV. 3392

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					SM		Gravelly Silty Fine to Coarse Sand, pink-tan, dry to damp, very dense.
							At 47 ft. 1 ± ft. lens of very hard cobbles.
50	*					60-850#	
							END OF BORING AT 50.5 ft. NO WATER SLIGHT CAVING ABOVE 5 ft.

PLATE A-32

DATE 1/24/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 2

BORING NO. 4 - 2

SURFACE ELEV. 3396

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 4

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Silty Fine Sand, brown, moist, loose, scattered angular gravel to 1 inch.
					GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, medium dense 60% ± angular to subangular gravel, 15% ± angular to subrounded cobbles to 10 inches.
					SM		Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry to damp, medium dense, 10% ± angular to subrounded gravel to 1 inch.
5							
	○	109	7.2	1.11	GP/GM	13- 2550#	Fine to Coarse Sandy Gravel, slightly silty, light pink-tan, dry to damp, dense, 60% ± angular to subangular gravel, scattered angular to subangular cobbles to 6 inches.
	□						
							Very dense below 9 ft.
10	○	120	3.4	2.01		25 2550#	At 11 ft. 1.5 ± ft. lens of very hard cobbles and boulders.
					SM		Gravelly Silty Fine to Coarse Sand, light pink-tan, dry to damp, medium dense to dense, 35% ± angular to subangular gravel, scattered angular to subrounded cobbles to 6 inches.

PLATE A-33

DATE 1/24/79 — **PACIFIC SOILS ENGINEERING, INC.** — WORK ORDER 200827

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

BY F.D. — SHEET NO. 2 OF 2

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 4

BORING NO. 4 - 2

SURFACE ELEV. 3396

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	116	4.8		SM	9-2550#	Gravelly Silty Fine to Coarse Sand, as above.
20							
	○	118	4.5	3.12		13-2550#	Below 22 ft., 45% ± angular to subangular gravel.
25	○	112	5.4			20-2550#	
	○		4.3			40-1700#	END OF BORING AT 30 ft. NO WATER. SLIGHT CAVING ABOVE 5 ft, and BETWEEN 10 and 12.5 ft.
30							

PLATE A-34

DATE 1/23/79

BY F.D.

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 4

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 2

BORING NO. 4 - 3

SURFACE ELEV. 3389

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
					SM		Silty Fine to Coarse Sand, brown, moist, loose, 8% ± angular to subrounded gravel.
					SM		Gravelly Silty Fine to Coarse Sand, light red-brown, dry to damp, medium dense, 20% ± angular to subrounded gravel, scattered subangular to subrounded gravel to 6 inches.
5	⊛						
	○	118	5.8	1.65		12-2550#	Below 6 ft. light pink-tan, 45% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 8 inches.
	□						
10	○	118	3.1	1.60		12/9" 2550#	
					GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light pink-tan, dry to damp, medium dense to dense, 60% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.

DATE 1/23/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 2 OF 2

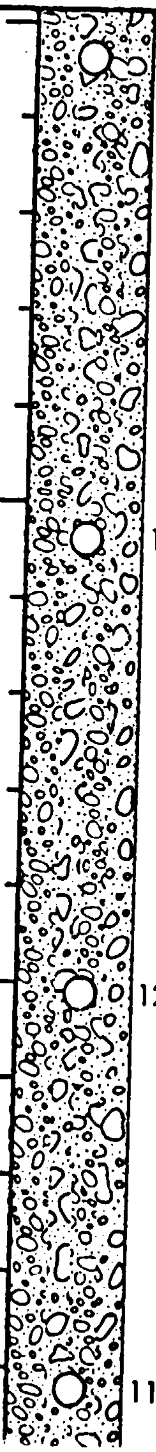
BORING NO. 4 - 3

SURFACE ELEV. 3389

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 4

LOG OF BORINGS

UNDISTURBED SAMPLE (○) · BULK SAMPLE (□) · PLASTIC BAG SAMPLE (△) · SAMPLE NOT RECOVERED (*)



DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	116	4.3	2.32	GP/GM	18-2550#	Fine to Coarse Sandy Gravel, as above.
20	○	116	5.5	1.98		21-2550#	
							At 22 ft., 1 ± ft. lens of very hard cobbles.
25	○	128	3.3	2.88		15-2550#	
30	○	114	5.9	2.84		25-1700#	

END OF BORING AT 30 ft.

NO WATER

SLIGHT CAVING ABOVE 4 ft. and BELOW 23 ft.

DATE 1/8-1/10/79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

BY F.D.

WORK ORDER 200827

SHEET NO. 1 OF 4

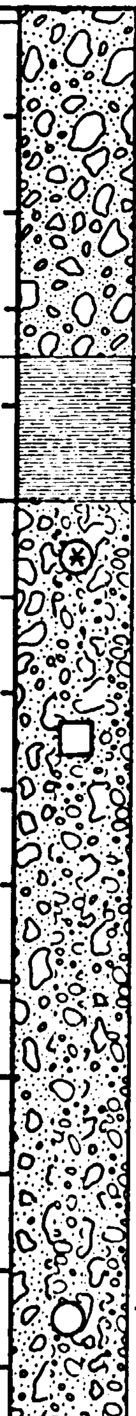
SUBJECT Pioneer Site; Goldstone, California
Antenna No. 5

BORING NO. 5 - 1

SURFACE ELEV.

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED



DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					GP		Fine Sandy Gravel, slightly silty, tan, dry, medium dense, 60% ± angular to subrounded gravel, 20% ± angular to subrounded cobbles to 10 inches.
					CL		Gravelly Silty Clay, light red-brown, slightly moist, firm to stiff, 40% ± angular to subrounded gravel, scattered angular to sub-rounded cobbles to 8 inches.
5					GP/GM		Fine to Coarse Sandy Gravel, slightly silty, light pink-tan, dry, medium dense, 50% ± angular to subrounded gravel, scattered angular to subrounded cobbles to 8 inches.
10							
		114	5.0	1.43		23-2550#	

DATE 1/8 - 1/10/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 2 OF 4

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 5

BORING NO. 5 - 1

SURFACE ELEV. 3373.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15					GP/ GM		Fine to Coarse Sandy Gravel. Below 17 ft. gravel and cobble content increases slightly.
20	○	110	4.8		SM	13-2550#	Gravelly Silty Fine to Coarse Sand, light pink-tan, dry to damp, dense, 20% ± angular to subrounded gravel to 1 inch.
25	○	115	8.0	3.12	GP		Fine to Coarse Sandy Gravel, light pink-tan, dry to damp, dense, 60% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
					SW		Gravelly Well-Graded Sand, slightly silty, light tan, dry, dense, 45% ± angular to subrounded gravel, 20% ± subangular to subrounded cobbles to 6 inches. The sand fraction is angular.

PLATE A-38

DATE 1/8 - 1/10/79 | **PACIFIC SOILS ENGINEERING, INC.** | WORK ORDER 200827

BY F.D. | 1402 WEST 240th STREET, HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 3 OF 4

SUBJECT Pioneer Site; Goldstone, California | BORING NO. 5 - 1

Antenna No. 5 | SURFACE ELEV. 3373.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✳ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○	113	3.3	3.35	SW	24-1700#	Gravelly Well-Graded Sand.
35							At 34.5 ft. ±, 6 inch lens of hard rock or nested cobbles.
40	○		3.1			30-1700#	At 41 ft. ±, 6 inch lens of hard rock or nested cobbles.
	□				GW-GM		Sandy Well-Graded Gravel, slightly silty, light tan, dry, very dense, 60% ± angular to subrounded cobbles to 8 inches. Below 44 ft. light red-brown, dry to damp, very dense, slightly more silt.

DATE 1/8 - 1/10/79

BY F.D.

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 5

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 4 OF 4

BORING NO. 5 - 1

SURFACE ELEV. 3373.0

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					GW-GM		Sandy Well-Graded Gravel, slightly silty. At 47 ft. 6 ± inch lens of hard rock or nested cobbles.
	○	109	4.2	3.53	GM	30/6" 850#	Silty Poorly Graded Gravel, red-brown, damp to slightly moist, dense, 55% ± angular to subrounded gravel, 20% ± subangular to subrounded cobbles to 8 inches.
50							END OF BORING AT 50 ft. NO WATER SLIGHT CAVING ABOVE 3.5 ft. and BELOW 5 ft.; SEVERE CAVING BELOW 47.5 ft.

DATE 1/29/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 2

BORING NO. 5-2

SURFACE ELEV.

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 5

LOG OF BORINGS

○ UNDISTURBED SAMPLE
☐ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine Sand, brown, moist, loose, 45% ± angular to subrounded gravel, 20 % ± angular to subrounded cobbles to 8 inches.
					GP		Fine to Coarse Sandy Gravel, tan, dry to damp, medium dense, 60% angular to subrounded gravel, 20 % ± subangular to subrounded cobbles to 8 inches.
					CL		Silty Clay, light red-brown, dry to damp, firm, 10 % ± gravel.
5	✱ ☐				GP/GM	3/10" 2550#	Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, 55% ± angular to subrounded gravel, 20 % ± subangular to subrounded cobbles to 8 inches.
10	○	125	3.6	1.86		22-2550#	

PLATE A-41

DATE 1/29/79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 2 OF 2

SUBJECT Pioneer Site - Goldstone, California
Antenna No. 5

BORING NO. 5 - 2

SURFACE ELEV. 3376

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	110	7.8	1.84	GP/GM		Fine to Coarse Sandy Gravel, slightly silty.
					SM		Gravelly Silty Fine to Coarse Sand, light pink-tan, dry to damp, medium dense to dense, 40% ± angular to subrounded gravel.
20	○	116	4.2			10-2550#	
							Very dense below 23 ft.
25	○	117	5.7	3.02		25/10" 2550#	
							At 27 ft., 2 ± ft. lens of very hard rock (nested cobbles and boulders)
	○	115	4.9	2.76		40-1700#	END OF BORING AT 30 ft. NO WATER. SLIGHT CAVING ABOVE 3.5 ft.

PLATE A-42

DATE 1/30/79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

BY F.D. SHEET NO. 1 OF 2

SUBJECT Pioneer Site; Goldstone, California BORING NO. 5 - 3

Antenna No. 5 SURFACE ELEV. 3374

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✳ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine Sand, brown, moist, loose, 10 to 15% angular to subrounded gravel, scattered angular to subangular cobbles to 6 inches.
					GP-GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp.
					SC		Gravelly Clayey Sand, light red-brown, damp to slightly moist, medium dense, 15% ± angular to subangular gravel to 1 inch.
5					SM		Gravelly Silty Fine to Coarse Sand, slightly clayey, light pink-tank, dry to damp, dense, 45 % ± angular to subrounded gravel, 20 % ± subangular to subrounded cobbles to 6 inches.
	○	119	4.2	1.28		16-2550#	
	□						
10							
	○	117	4.4			13-2550#	
							At 13 ft. 2 ft. ± lens of very hard cobbles and boulders.

PLATE A-43

DATE 1/30/79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 2 OF 2

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 5-3

Antenna No. 5 SURFACE ELEV. 3374

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	102	7.1	1.44	SM	11/6" 2550#	Gravelly Silty Fine to Coarse Sand. Between 16 and 21 ft., 50 % + cobbles and boulders in a matrix of gravelly silty fine to coarse sand, dry to damp, dense.
20							
	○	120	3.5	2.29		23- 2550#	
25	○	121	2.9	3.25		20- 2550#	
					GW/ GM		Fine to Coarse Sandy Gravel, slightly silty, light red-brown, dry to damp, dense, 60 %± angular to subrounded gravel to 3 inches.
	○	3.5				30- 1700#	END OF BORING AT 30 ft. NO WATER SLIGHT CAVING ABOVE 3.5 ft.

PLATE A-44

DATE 1-29-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 1 OF 3

BORING NO. 6 - 1

SURFACE ELEV. 3402

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 6

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine Sand, brown, moist, loose, 15% ± angular to subangular gravel.
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose to medium dense, 45% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 5 inches.
					SC		Clayey Fine to Coarse Sand, red-brown, dry to damp, medium dense, 8% ± angular to subangular gravel.
5					SM		Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry to damp, medium dense to dense, 45% ± angular to subrounded gravel to 2-1/2 inches.
	○	125	4.7			10-2550#	
10							
	○	128	3.3	1.21		14-2550#	
	□						

DATE 1-29-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 2 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 6

BORING NO. 6 - 1

SURFACE ELEV. 3402

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	125	3.9	2.09	SM	7- 2550#	Gravelly Silty Fine to Coarse Sand, as above.
					GP-GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, medium dense to dense, 55% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 8 inches.
20					SM		Gravelly Silty Fine to Coarse Sand, light pink-tan, dry to damp, very dense, 35% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
	○	130	7.0	2.12		20- 2550#	
25	○	117	4.3			20/10" 2550#	Below 26 ft. 45% ± gravel.
							At 29 ft. 1 ± ft. lens of very hard cobbles and boulders.

DATE 1/29/79

PACIFIC SOILS ENGINEERING, INC.
1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 3 OF 3

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 6

BORING NO. 6 - 1

SURFACE ELEV. 3402

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	○		3.0		SM	23/10" 1700#	Gravelly Silty Fine to Coarse Sand, as above.
							END OF BORING AT 32 ft. NO WATER SLIGHT CAVING ABOVE 3 ft. and BETWEEN 17 and 20 ft.

PLATE A-47

DATE 1-26-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY F.D.

SHEET NO. 1 OF 4

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 6

BORING NO. 6 - 2

SURFACE ELEV. 3406

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
					SM		Gravelly Silty Fine Sand, brown, moist, loose, 15% ± angular to subangular gravel, scattered angular to subangular cobbles to 4".
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose to medium dense, 45% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
5	○	114	6.3	0.69	CL		Silty Clay, red-brown, damp to slightly moist, firm to stiff.
					SM	10-2550#	Gravelly Silty Fine to Coarse Sand, slightly clayey, light red-brown, dry to damp, medium dense, 45% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6"
					GW-GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, dense, 60% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 5 inches.
	□						
10	○	117	4.1	0.88		11-2550#	

DATE 1-26-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 2 OF 4

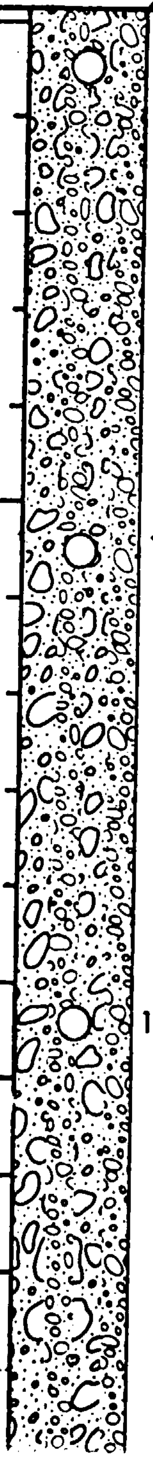
HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 6 - 2

Antenna No. 6 SURFACE ELEV. 3406

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED



DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	130	2.8	1.29	GW-GM	12-2550#	Fine to Coarse Sandy Gravel, as above.
20	○	124	2.8	1.72		9-2550#	
							Below 22 ft. pink-tan, dense to very dense, 55% ± angular to subrounded gravel, scattered subangular to subrounded cobbles to 6 inches.
25	○	123	3.6	1.88		17-2550#	

PLATE A-49

DATE 1-26-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET

HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

SHEET NO. 3 OF 4

SUBJECT Pioneer Site; Goldstone, California

Antenna No. 6

BORING NO. 6 - 2

SURFACE ELEV. 3406

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
30	△		3.1		GW-GM	35/10" 1700#	Fine to Coarse Sandy Gravel, as above.
							At 32 ft. 8 ± inch lens of very hard cobbles.
35							At 35 ft. 6 ± inch lens of very hard cobbles.
							At 37.5 ft. 1 ± ft. lens of very hard cobbles.
40	○	121	3.6			25/8" 1700#	
					GP/GM		Fine to Coarse Sand, gravel, slightly silty, pink-tan, dry, very dense 65% ± angular to subrounded gravel, 10% ± subangular to subrounded cobbles to 6 inches.

DATE 1-26-79

BY F.D.

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240th STREET
HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California
Antenna No. 6

WORK ORDER 200827
SHEET NO. 4 OF 4
BORING NO. 6 - 2
SURFACE ELEV. 3406

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
45					GP/ GM		Fine to Coarse Sandy Gravel, as above.
50	(*)					35/2" 850#	END OF BORING AT 49.7 ft. NO WATER SLIGHT CAVING ABOVE 4.5 ft. and BETWEEN 19 and 21 ft.

PLATE A-51

DATE 1-27-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 1 OF 2

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 6 - 3

Antenna No. 6 SURFACE ELEV. 3402

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
✱ SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ. FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
0					SM		Gravelly Silty Fine Sand, brown, moist, loose, 15% + angular to subangular gravel, scattered angular to subrounded cobbles to 4 inches.
					SM		Gravelly Silty Fine to Coarse Sand, light brown, dry to damp, loose to medium dense, 45% ± angular to subrounded gravel, scattered angular to subangular cobbles to 4 inches.
					SC		Clayey Fine to Coarse Sand, light red-brown, dry to damp, firm to stiff, 5% ± angular to subangular gravel.
5	○ □	119	6.2	0.78	SM	18-2550#	Gravelly Silty Fine to Coarse Sand, slightly clayey, red-brown, damp, dense, 35% ± angular to subrounded gravel.
					GW-GM		Fine to Coarse Sandy Gravel, slightly silty, light brown, dry to damp, medium dense to dense, 60% ± angular to subrounded gravel, scattered angular to subrounded cobbles to 5 inches.
10	○	119	5.0	1.42		11-2550#	

PLATE A-52

DATE 1-27-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY F.D. 1402 WEST 240th STREET SHEET NO. 2 OF 2

HARBOR CITY, CALIFORNIA 90710

SUBJECT Pioneer Site; Goldstone, California BORING NO. 6 - 3

Antenna No. 6 SURFACE ELEV. 3402

LOG OF BORINGS

○ UNDISTURBED SAMPLE
□ BULK SAMPLE
△ PLASTIC BAG SAMPLE
* SAMPLE NOT RECOVERED

DEPTH	SAMPLE NO.	DRY DENSITY LBS./CU.FT.	MOISTURE CONTENT, %	SHEAR STRENGTH KIPS/SQ.FT.	U.S.C.S. GROUP SYMBOL	BLOW COUNT PER FT. - DRIVING WT.	FIELD SOIL CLASSIFICATION
15	○	120	5.7	1.24	GW-GM	10-2550#	Fine to Coarse Sandy Gravel, as above.
							Below 17 ft. occasional subangular cobbles to 8 inches.
20	○	120	6.6			11/7" 2550#	
					SM		Gravelly Silty Fine to Coarse Sand, light pink-tan, dry to damp, very dense, 35% ± angular to subangular gravel to 2 inches.
25	○	116	7.1			37-2550#	Fine to Coarse Sandy Gravel, slightly silty, light pink-tan, dry to damp, very dense, 55% ± angular to sub-rounded gravel, scattered suban subangular to subrounded cobbles to 6 inches. At 29 ft. 1 ± ft. lens of very hard cobbles.
					GW/GM		END OF BORING AT 30 ft. NO WATER SLIGHT CAVING ABOVE 4 ft.
	(*)					49/9" 1700#	

PLATE A-53

APPENDIX D

LABORATORY TESTING
PIONEER STATION, DSS 11

JET PROPULSION LABORATORY
GOLDSTONE, CALIFORNIA

APPENDIX D

LABORATORY TESTING

Following completion of drilling and sampling for each boring, all samples were transported to our office for laboratory testing. As stated before, the laboratory program for each antenna site was set up so it could be analyzed later as an individual foundation problem.

The critical factor in the foundation system selection and analysis was the response of subsurface materials under dead load, as well as during the loading and unloading cycles, caused by wind or seismic loading. Lateral loading from wind or seismic forces are the basic factors affecting rotational stability and, in turn, differential settlement. In order to analyze each antenna foundation under these loading conditions, a detailed testing program was carried out in order to establish both the shear strength and the consolidation characteristics of the in situ materials.

For each site, representative samples were chosen for consolidation testing. Where possible, testing was performed on undisturbed samples. Where the undisturbed sample contained enough gravel-sized material to significantly affect the results of the test, the sample was screened to remove the oversized material, and then remolded to approximate field density. The samples were carefully placed in the consolidation test apparatus and loaded incrementally at their natural moisture content from near 0 to 4 tons per square foot. At the 4-ton load, water was introduced and the sample was allowed to saturate for 24 hours. Loading was then continued to 8 tons per square foot, after which rebound characteristics were determined.

To determine the effects of repetitive loading due to wind forces, certain consolidation tests were continued by incrementally loading and unloading the samples between 4 and 8 tons per square foot loading. The loading-unloading cycle was continued until the recorded deformation stabilized for two cycles. Assuming that the majority of recorded deformation during the rebound portion of a repetitive loading cycle is primarily elastic deformation, the static constraint modulus (D) can be calculated for each sample subjected to repetitive loading. Using the Poisson's Ration, ν , obtained from the in situ testing, the constraint modulus can be converted to Young's modulus, E.

The most appropriate stress range for calculating D, and thus E, would be that range over which the stress range is most likely to occur for the actual installations. However, due to limitations in sample size and testing apparatus the expected actural stress range was not used. In order to minimize the effect of sample size and equipment limitations, the stress range from 8 tons to 1 ton per square foot was used for the analysis. The modulus values obtained from using this range of stresses are considered realistic, or somewhat conservative.

Load-deflection relations for samples subject to conventional consolidation testing have been plotted on Plates D-1 through D-3, while those for samples subject to the additional modulus testing are plotted on Plates E-1 through E-15. All plots have been corrected for machine deflection and deflection of the sample caps. Also included on the load-deflection plots for the samples tested under repetitive loading are the calculations for D and E.

Triaxial compression and direct shear tests were performed to determine shear strength parameters needed for bearing.

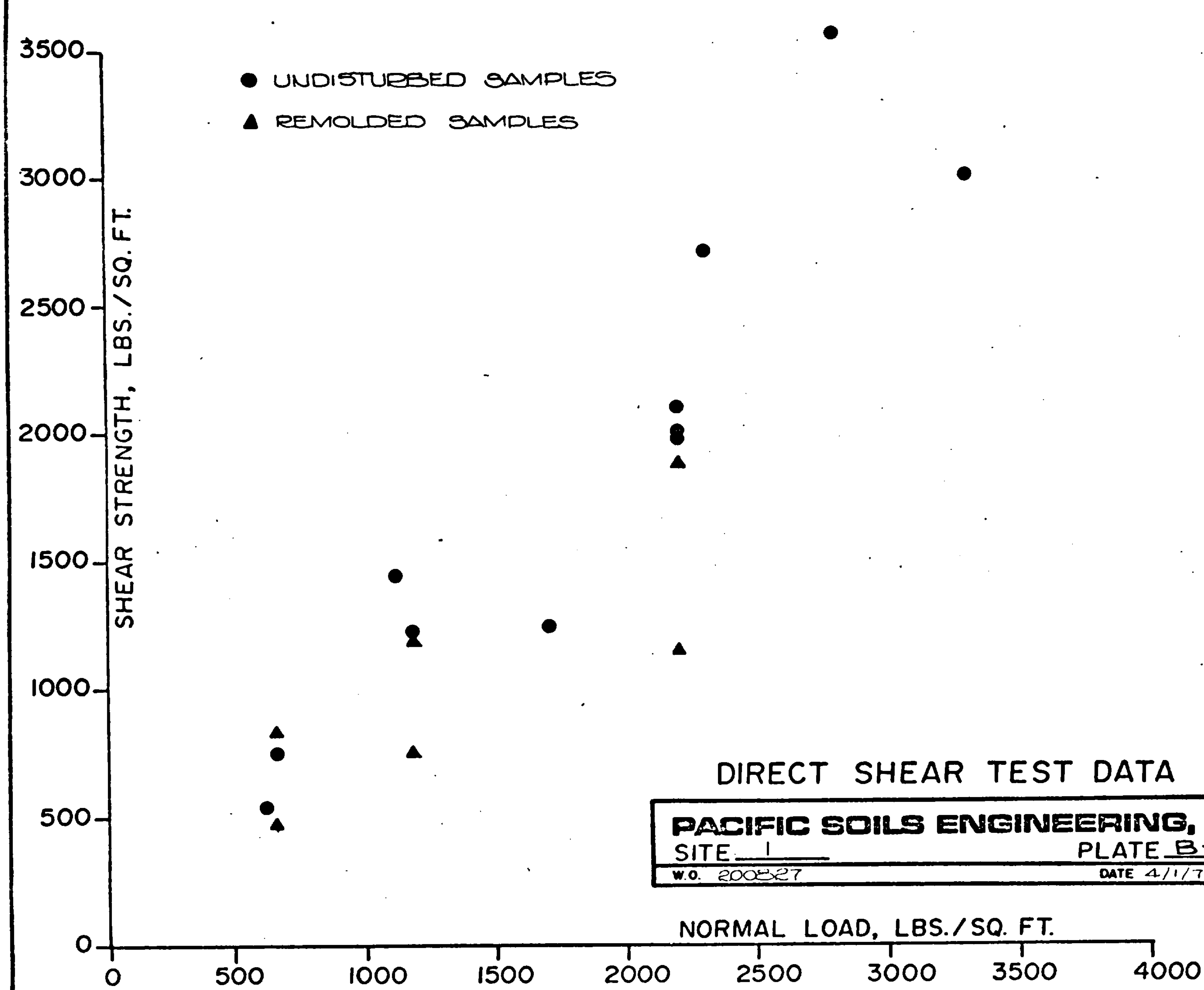
For the triaxial compression tests, three bulk samples were screened to remove all oversized material (+ 1/4 inch size) and then remolded to the approximate field density. The remolded sample was then placed in the triaxial test chamber and allowed to saturate. Upon reaching saturation the samples were then tested under the consolidated drained condition at a minimum of three confining pressures. Loading rate was 0.004 inch per minute. The results of the triaxial compression tests are given on Plates C-1 through C-3.

As with the consolidation tests, direct shear tests were made on undisturbed ring samples, where possible. Where the undisturbed samples contained significant amounts of oversized material that could substantially effect the tests results, the sample was remolded to the approximate field density. Selected remolded samples and undisturbed samples were tested at three different confining pressures. The remaining undisturbed samples were tested at a confining pressure corresponding to the existing overburden pressures in the field. Samples were allowed to saturate for a minimum of 24 hours and then tested at a shearing rate of 0.05 inch per minute. Results of the direct shear tests, grouped by antenna site, are located on Plates B-1 through B-6.

The in situ unit dry weight and moisture content, as shown on the Logs of Borings (Plates A-1 through A-53), were obtained for each undisturbed drive sample. No adjustment for rock content has been made.

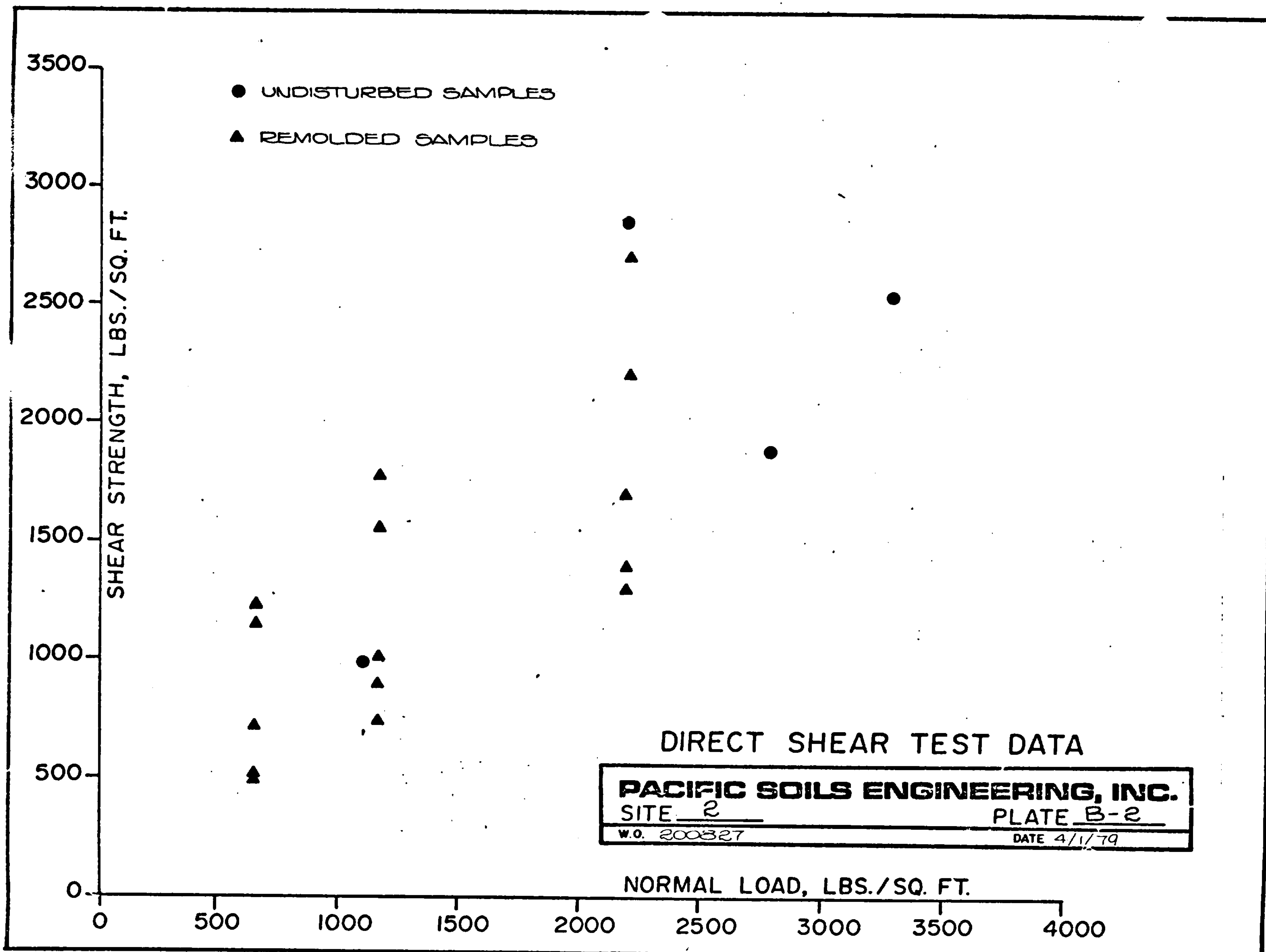
Laboratory maximum unit weight determinations and full gradation analyses were performed on selected bulk samples from each site as an aid in soil classification and in determining the compactability of the native soils.

As an aid in determining extent of subgrade preparation and pavement thickness required for the proposed service roads, a California Bearing Ratio Test was performed on a selected sample. This is an empirical test that compares the load carrying ability of the road subgrade material to that of standard crushed rock. The test results can then be correlated with pavement performance records to determine the required pavement thickness, and subgrade preparation.

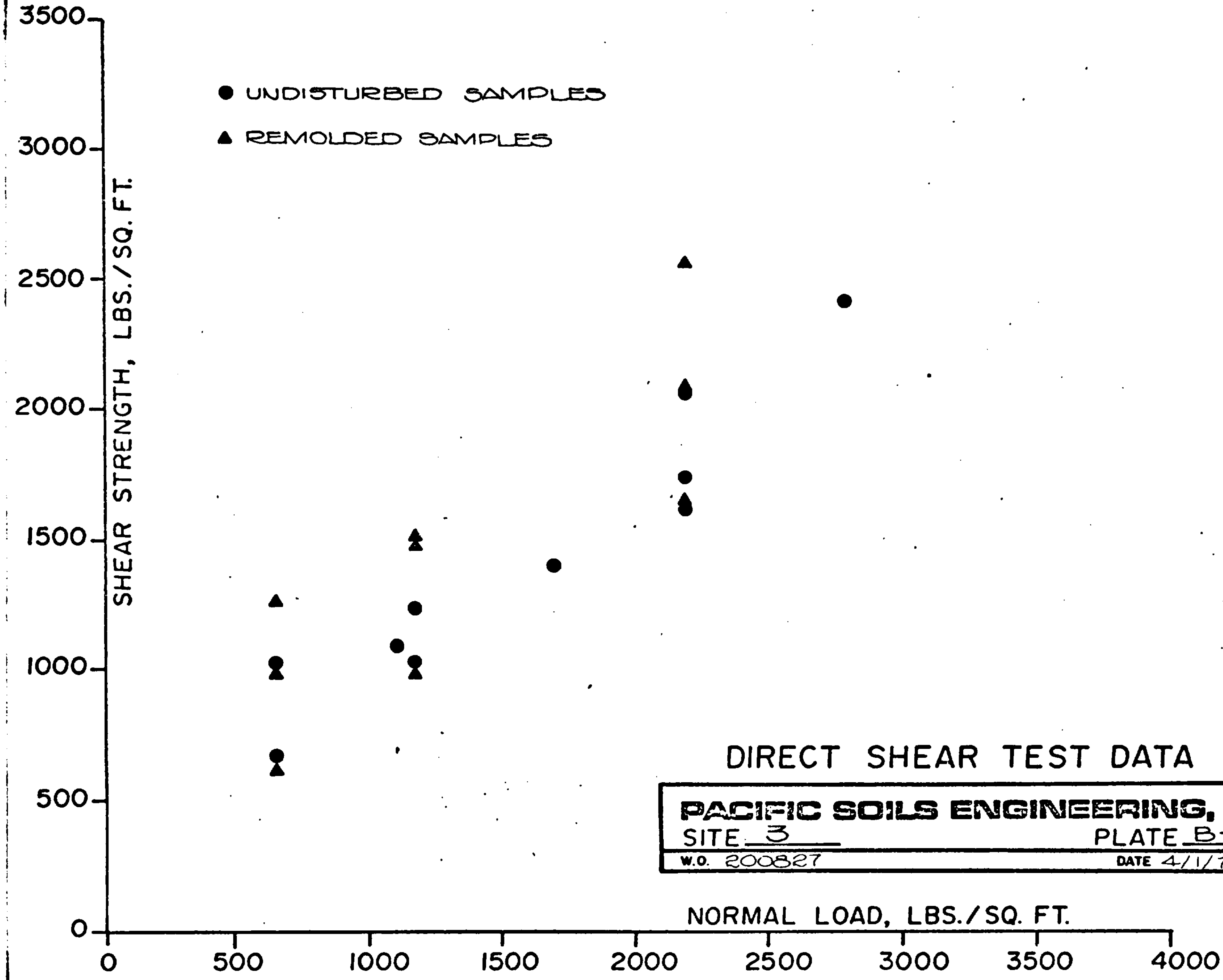


DIRECT SHEAR TEST DATA

PACIFIC SOILS ENGINEERING, INC.	
SITE 1	PLATE B-1
W.O. 200827	DATE 4/1/79



UNDISTURBED SAMPLES
REMOLDED SAMPLES
SHEAR STRENGTH, LBS./SQ. FT.
NORMAL LOAD, LBS./SQ. FT.
0
500
1000
1500
2000
2500
3000
3500
4000
DIRECT SHEAR TEST DATA
PACIFIC SOILS ENGINEERING, INC.
SITE 2
PLATE B-2
W.O. 200827
DATE 4/1/79

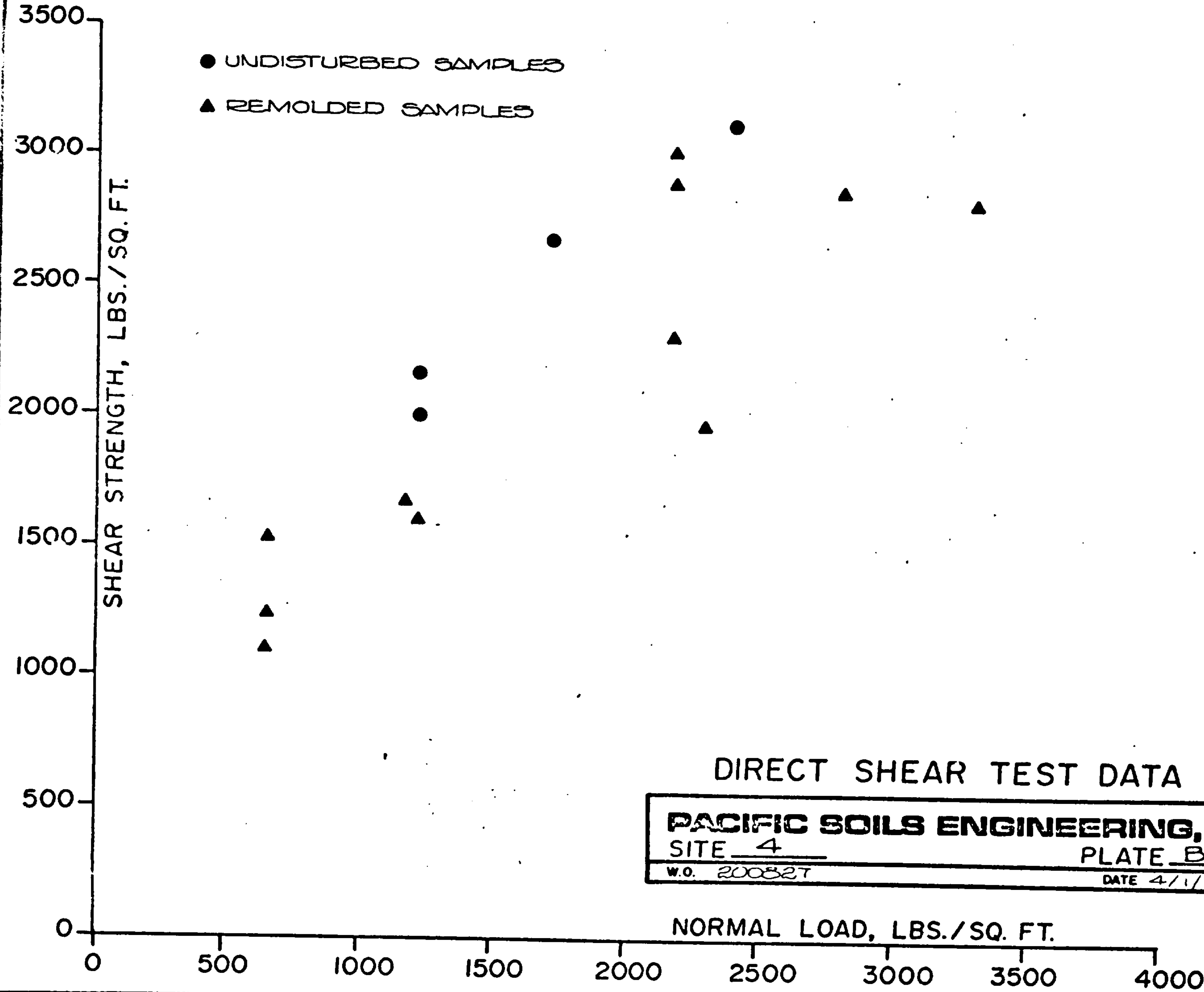


DIRECT SHEAR TEST DATA

PACIFIC SOILS ENGINEERING, INC.

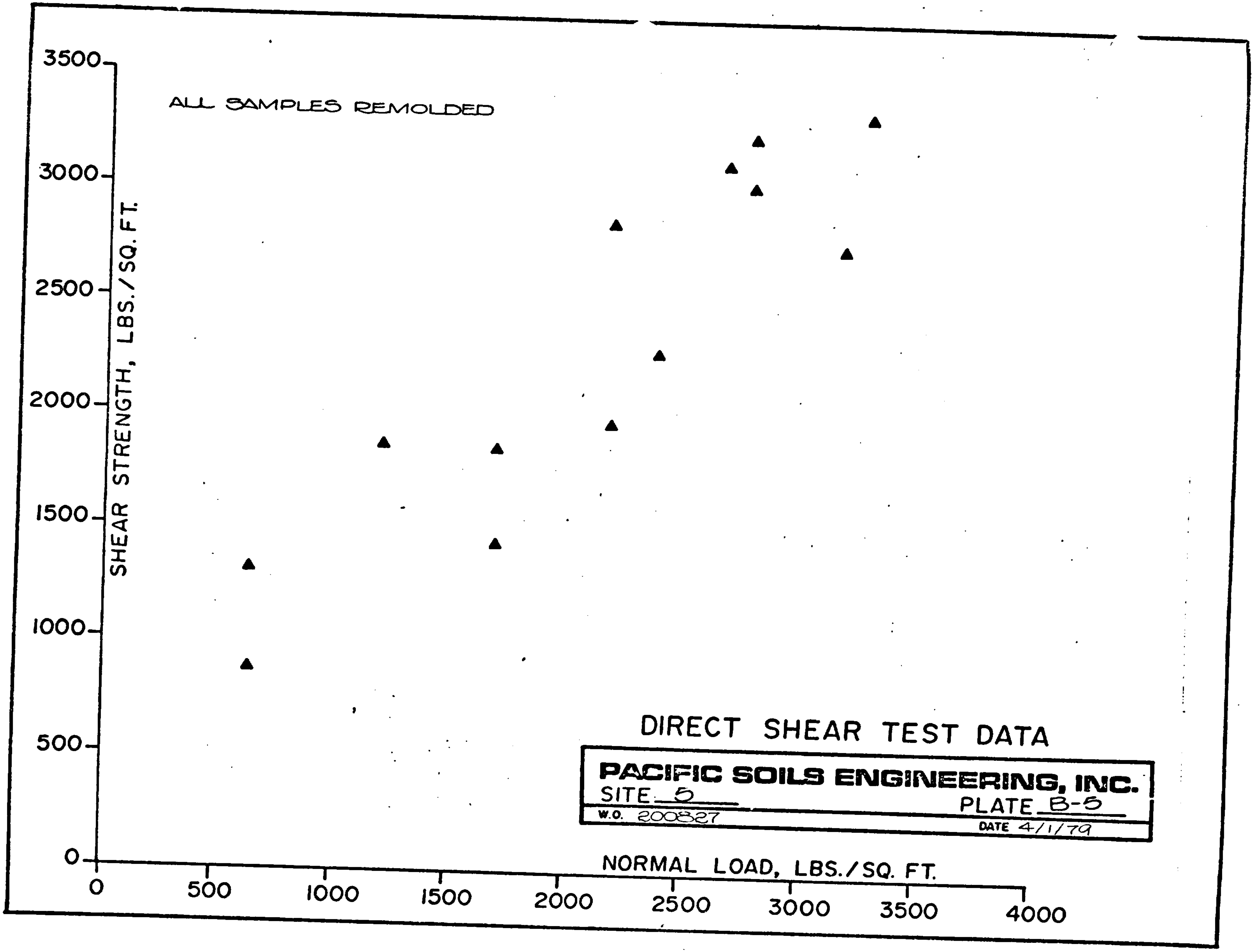
SITE 3 PLATE B-3

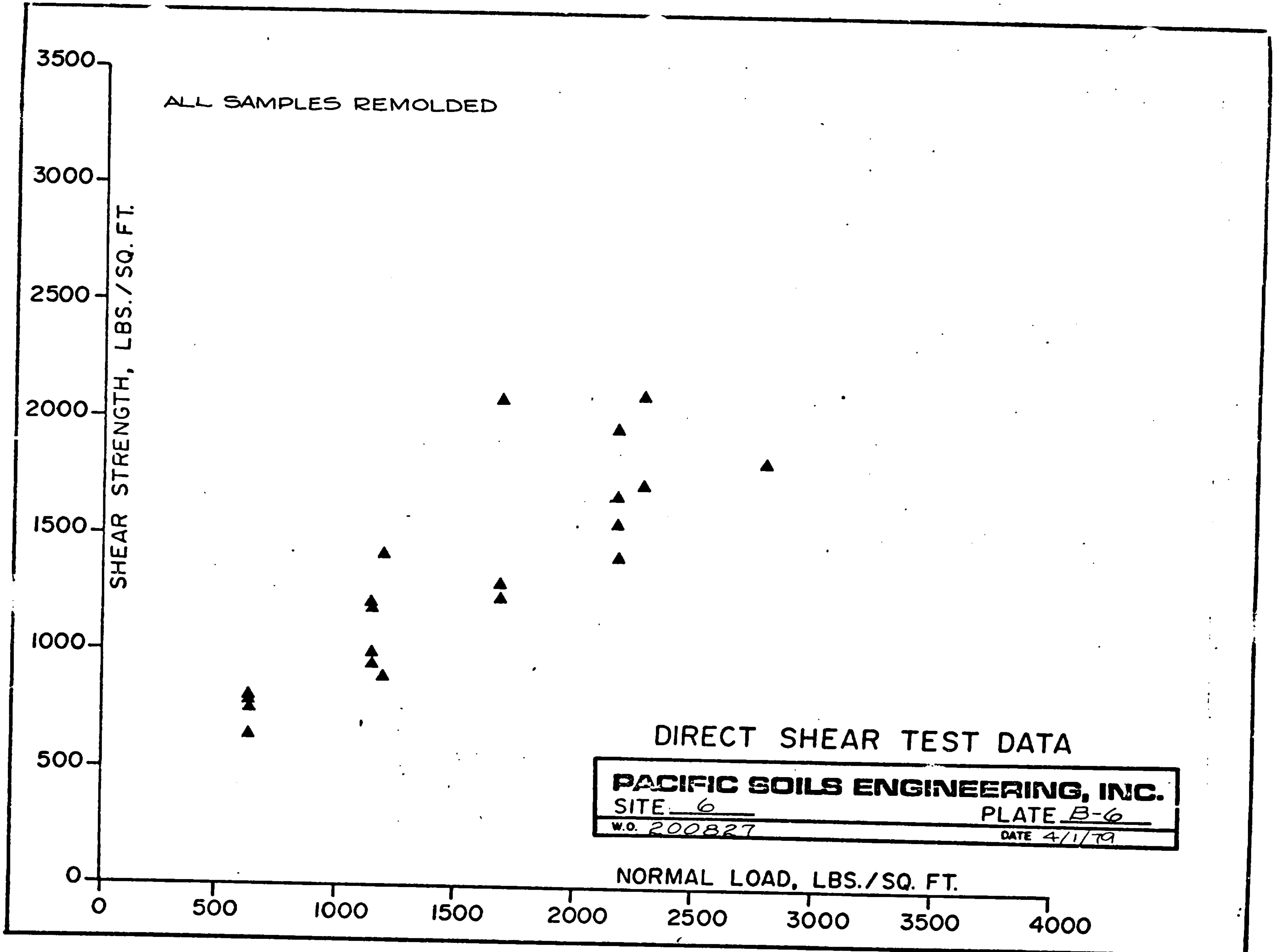
W.O. 200827 DATE 4/1/79

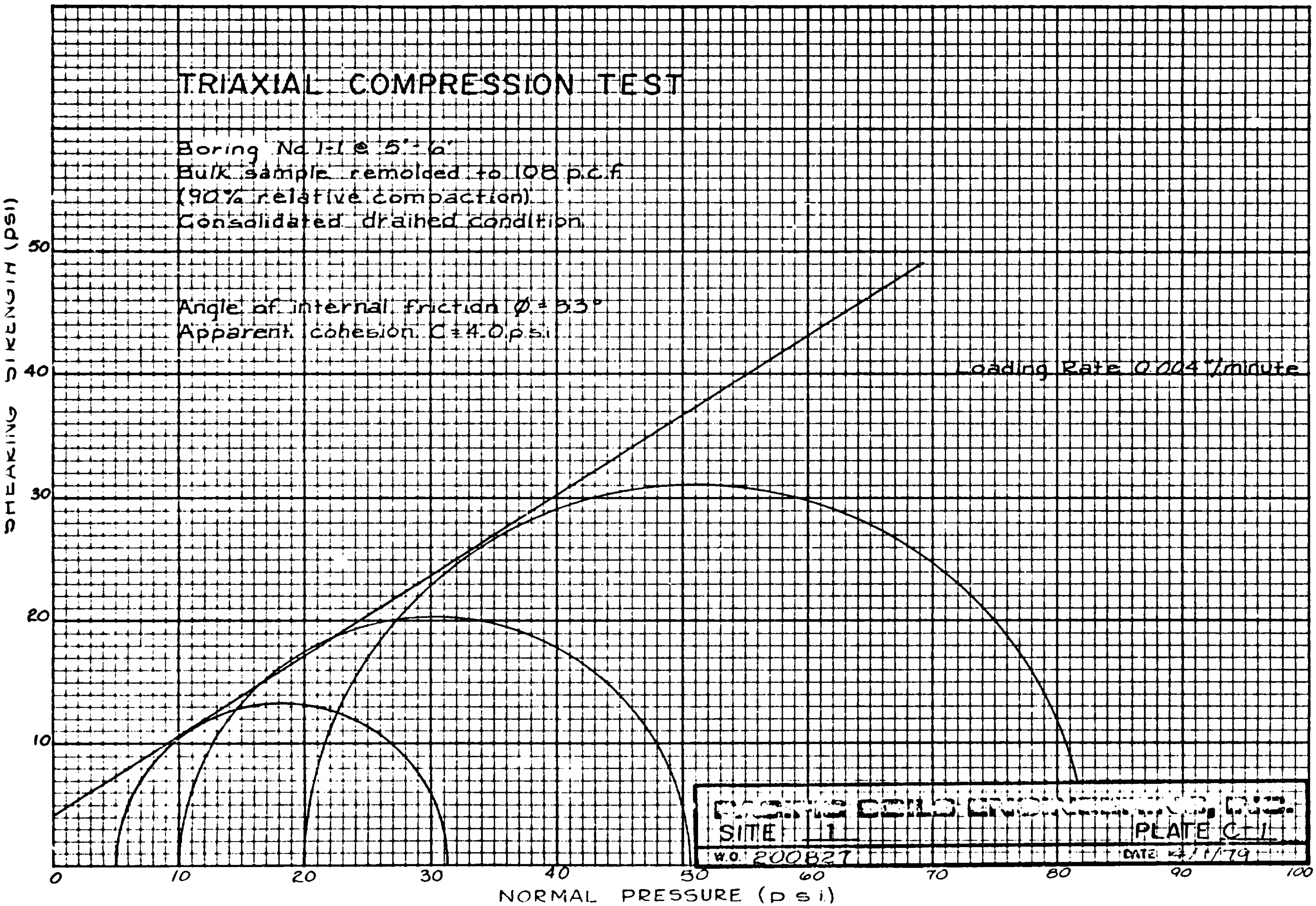


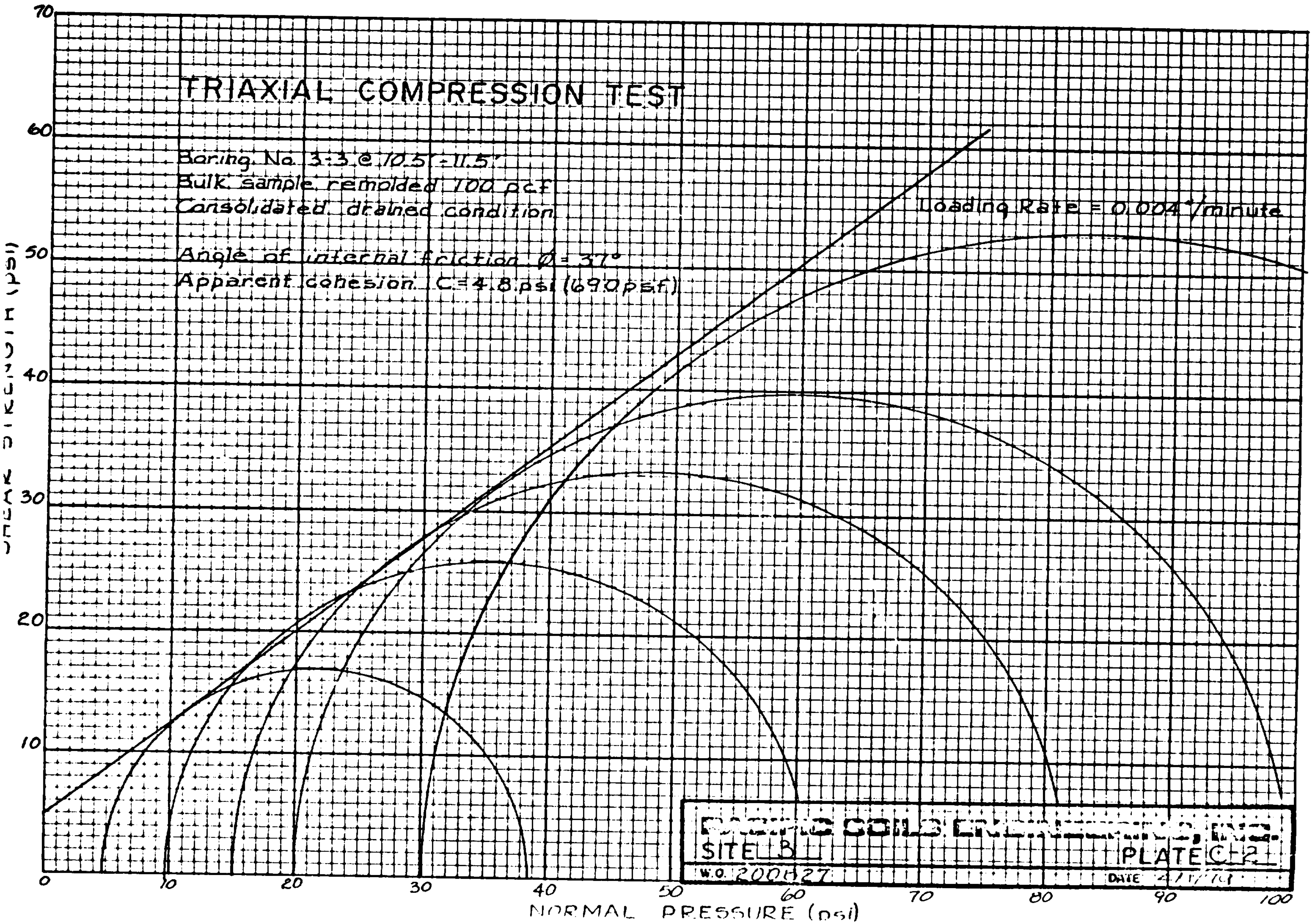
DIRECT SHEAR TEST DATA

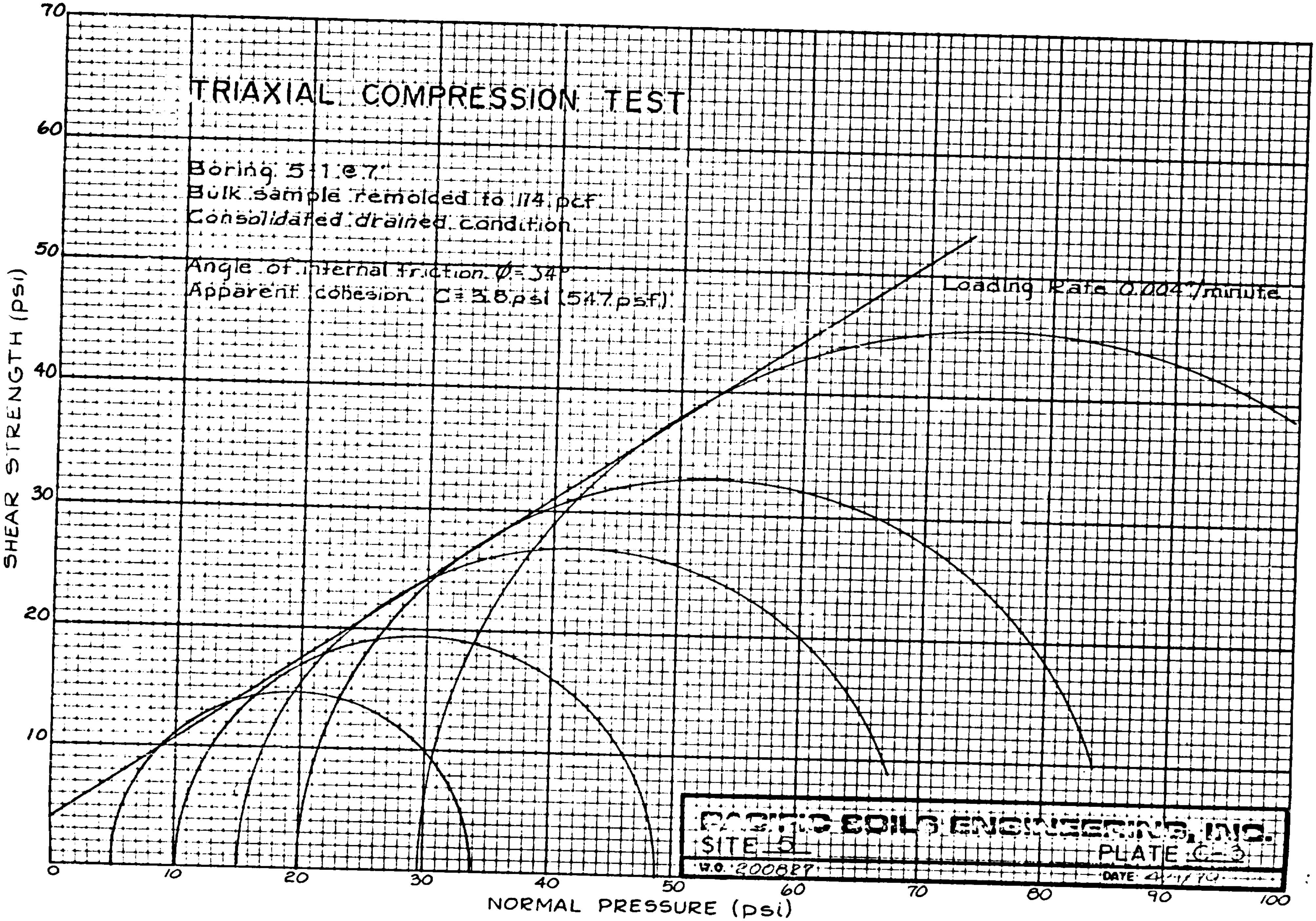
PACIFIC SOILS ENGINEERING, INC.	
SITE 4	PLATE B-4
W.O. 200827	DATE 4/1/79

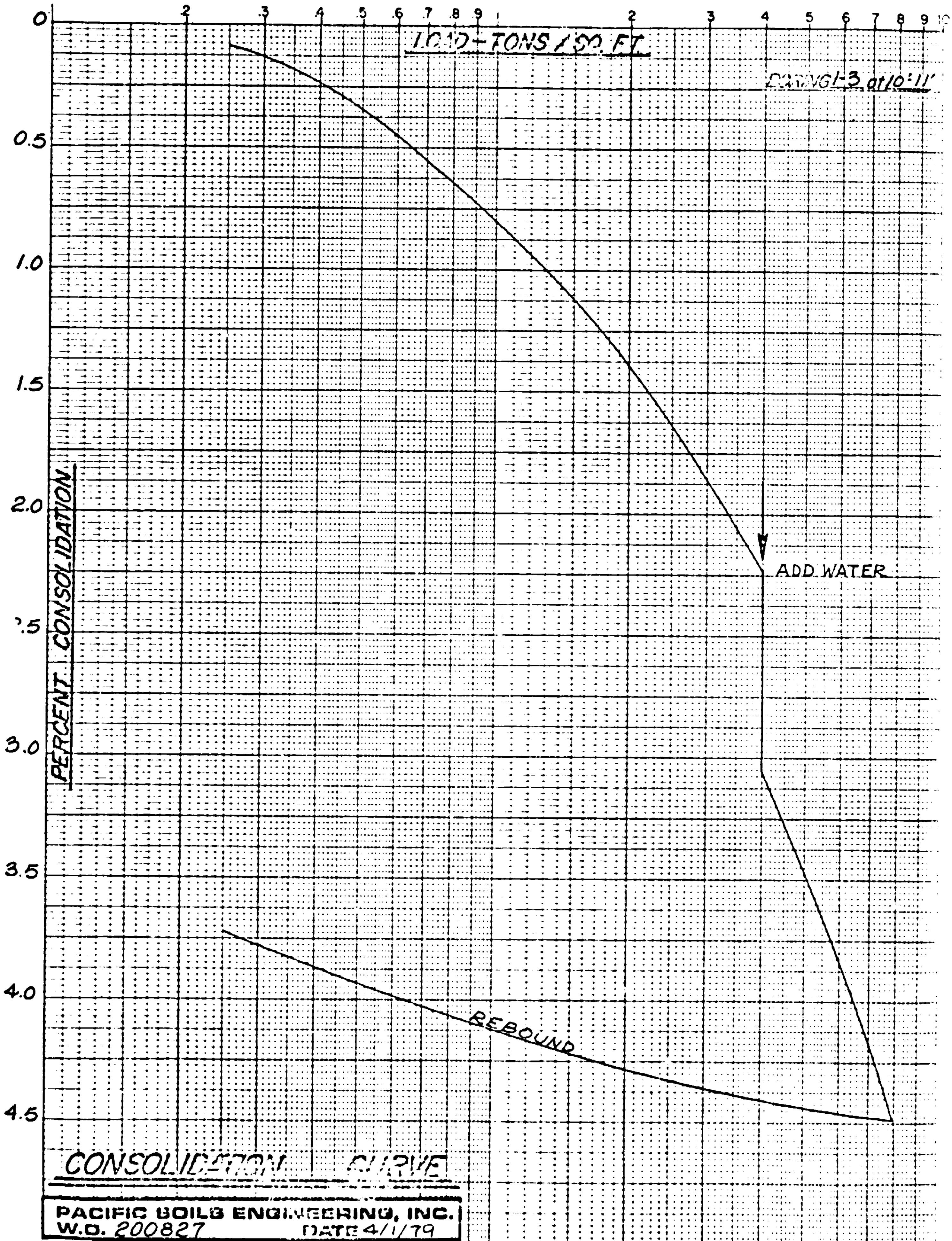

ALL SAMPLES REMOLDED
SHEAR STRENGTH, LBS./SQ. FT.
3500
3000
2500
2000
1500
1000
500
0
NORMAL LOAD, LBS./SQ. FT.
0
500
1000
1500
2000
2500
3000
3500
4000
DIRECT SHEAR TEST DATA
PACIFIC SOILS ENGINEERING, INC.
SITE 5
PLATE B-5
W.O. 200827
DATE 4/1/79


ALL SAMPLES REMOLDED
SHEAR STRENGTH, LBS./SQ. FT.
3500
3000
2500
2000
1500
1000
500
0
NORMAL LOAD, LBS./SQ. FT.
0
500
1000
1500
2000
2500
3000
3500
4000
DIRECT SHEAR TEST DATA
PACIFIC SOILS ENGINEERING, INC.
SITE 6
PLATE B-6
W.O. 200827
DATE 4/1/79


TRIAXIAL COMPRESSION TEST
Boring No. 1-1 @ 5'-6'
Bulk sample remolded to 108 p.c.f.
(90% relative compaction)
Consolidated drained condition
Angle of internal friction Ø = 33°
Apparent cohesion C = 4.0 p.s.i.
Loading Rate 0.004"/minute
SHEARING STRENGTH (psi)
10
20
30
40
50
0
10
20
30
40
50
60
70
80
90
100
NORMAL PRESSURE (psi)
SITE 1
PLATE C-1
W.O. 200827


TRIAXIAL COMPRESSION TEST
Boring No. 3-3 @ 10.5'-11.5'
Bulk sample remolded 100 pcf
Consolidated drained condition
Angle of internal friction Ø = 37°
Apparent cohesion C = 4.8 psi (690 psf)
Loading Rate = 0.004"/minute
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
NORMAL PRESSURE (psi)
SOILS
INC.
SITE B
PLATE C-2
W.O.
DATE


TRIAXIAL COMPRESSION TEST
Boring 5-1 @ 7'
Bulk sample remolded to 114 pcf
Consolidated drained condition
Angle of internal friction Ø = 34°
Apparent cohesion C = 3.8 psi (547 psf)
Loading Rate 0.004"/minute
SHEAR STRENGTH (psi)
NORMAL PRESSURE (psi)
0
10
20
30
40
50
60
70
80
90
100
ENGINEERING, INC.
SITE 5
PLATE
W.O. 200827
DATE

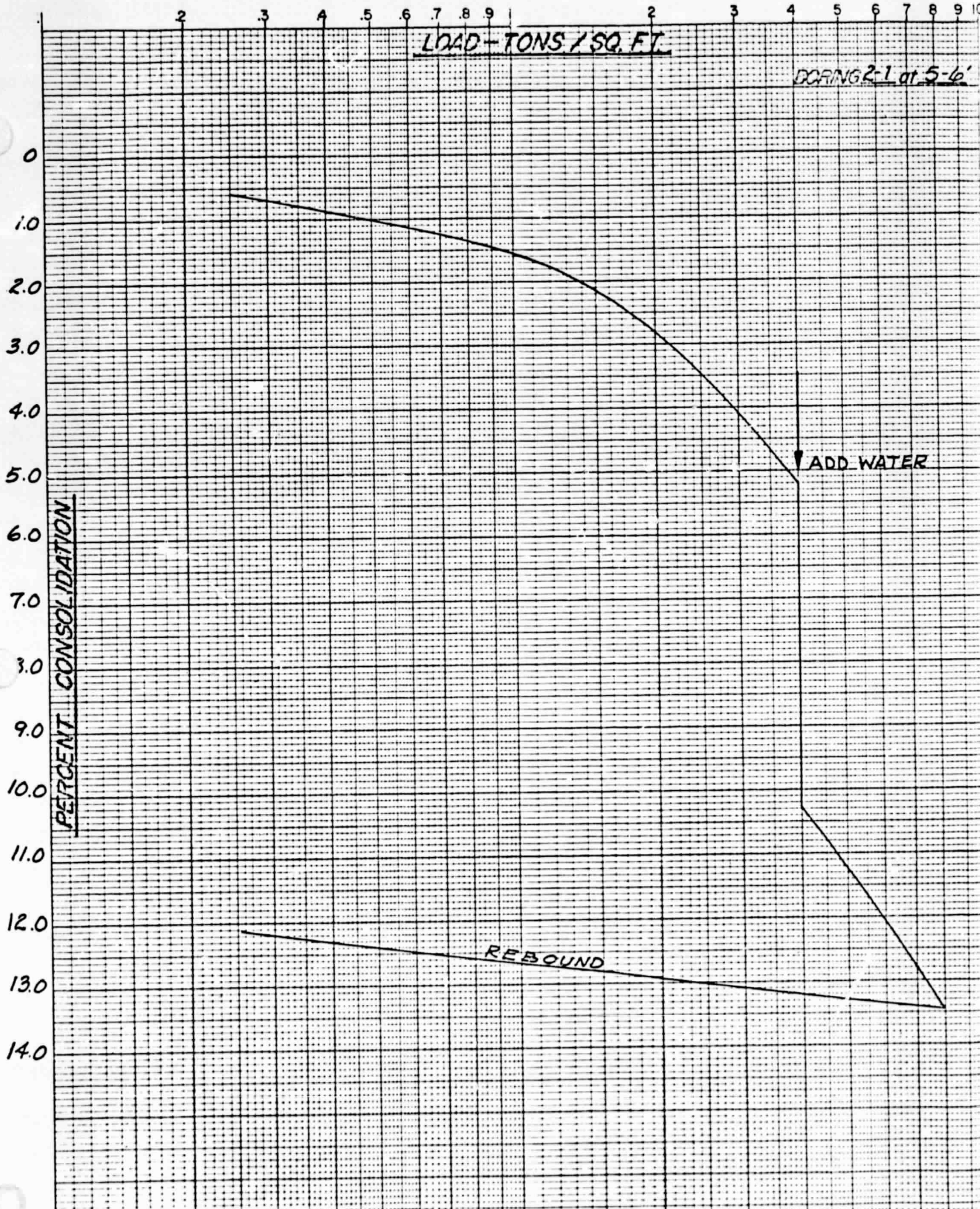


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE D-1

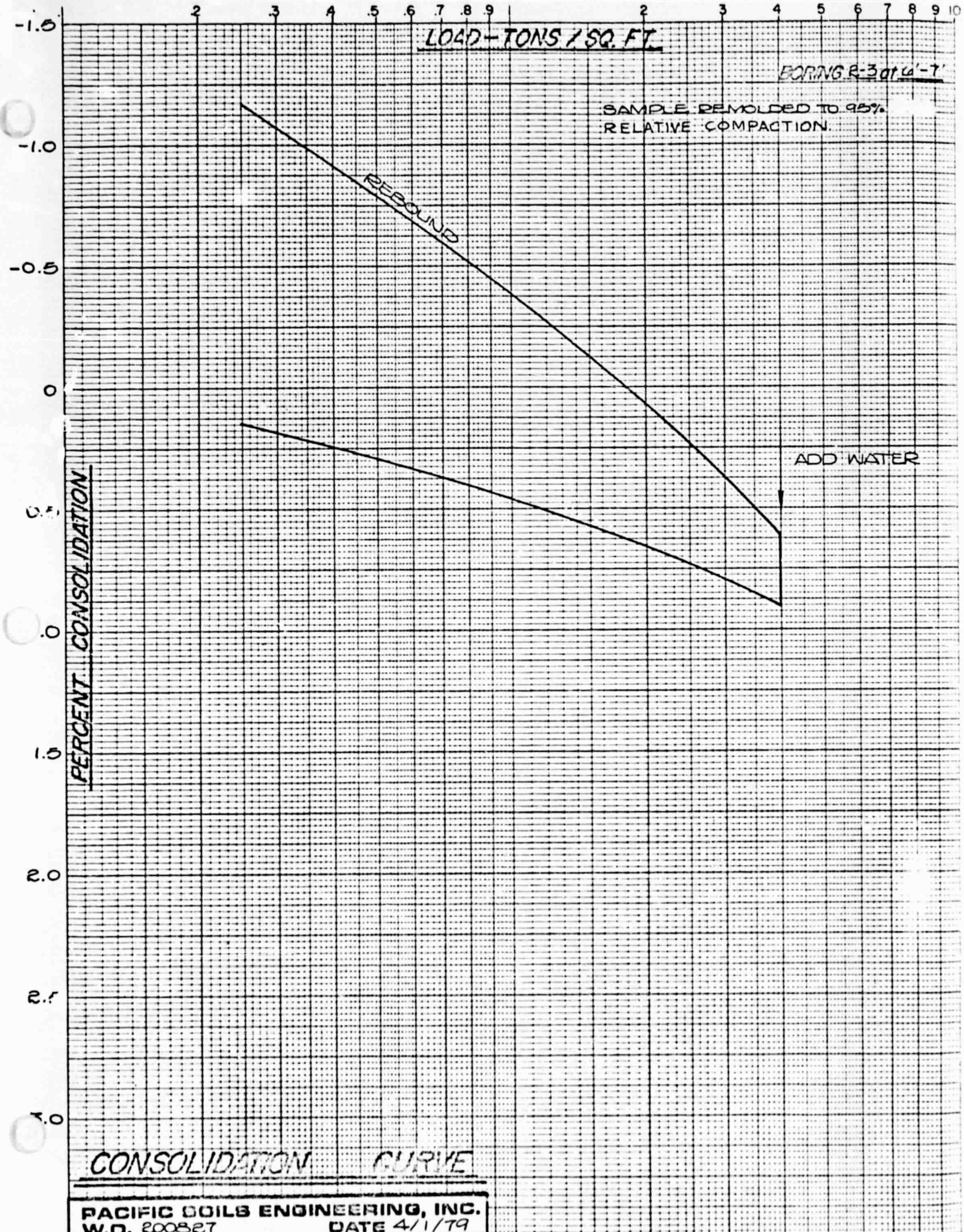


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE D-2

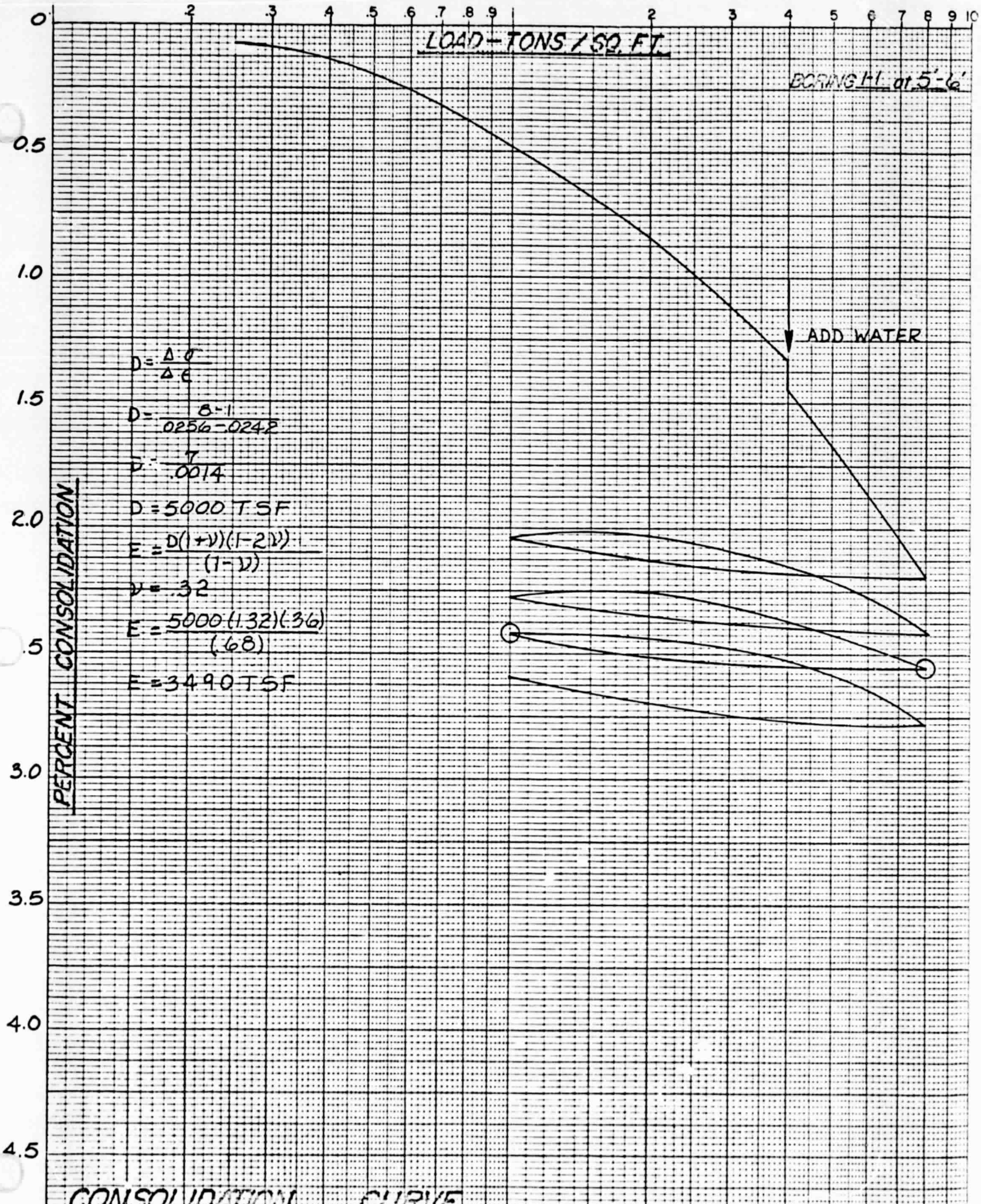


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE D-3

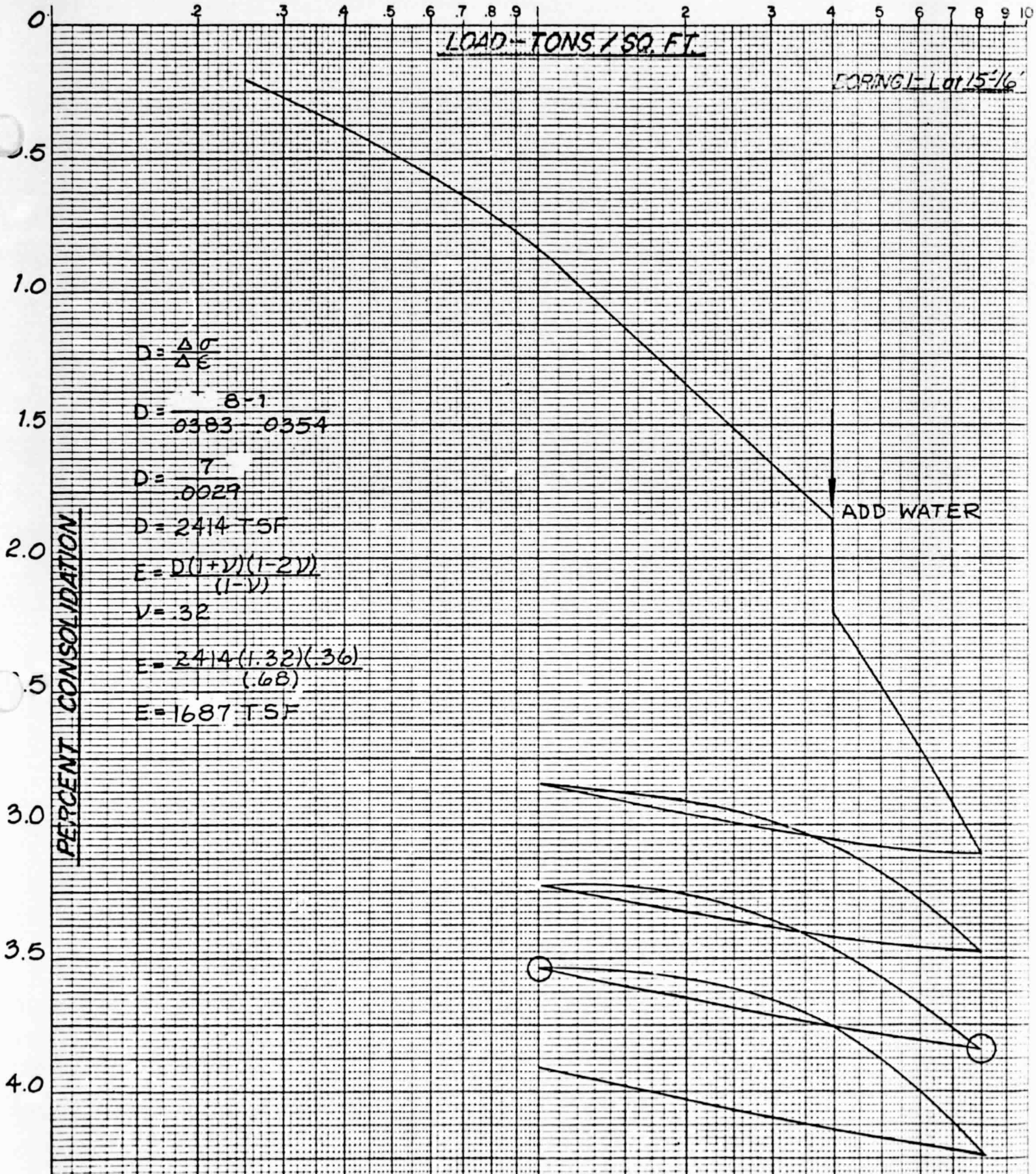


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

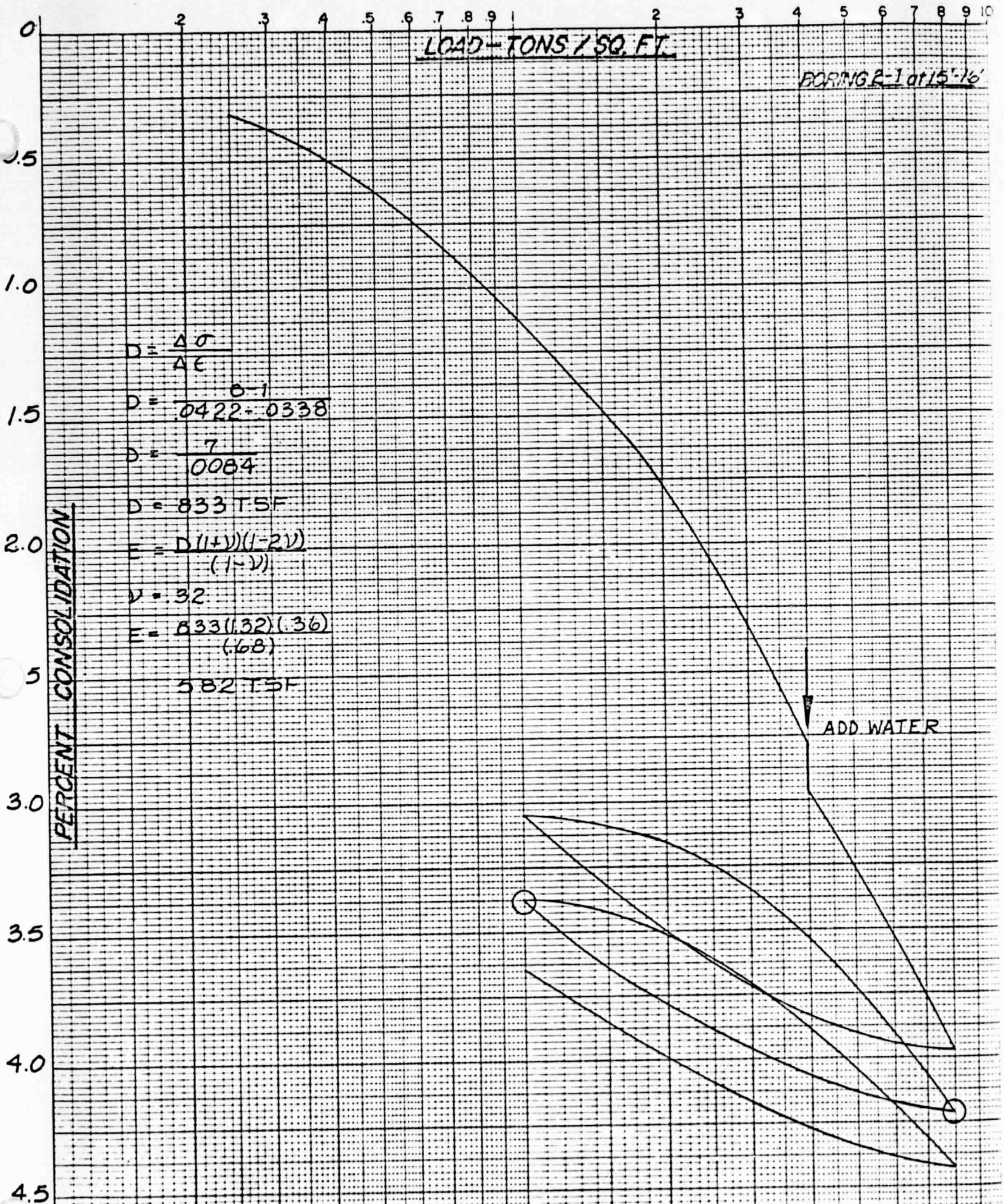
PLATE E-1



PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE E-2



$$D = \frac{\Delta \sigma}{\Delta \epsilon}$$

$$D = \frac{8-1}{.0422 - .0338}$$

$$D = \frac{7}{.0084}$$

$$D = 833 \text{ TSF}$$

$$E = \frac{D(1+\nu)(1-2\nu)}{(1-\nu)}$$

$$\nu = .32$$

$$E = \frac{833(1.32)(.36)}{(.68)}$$

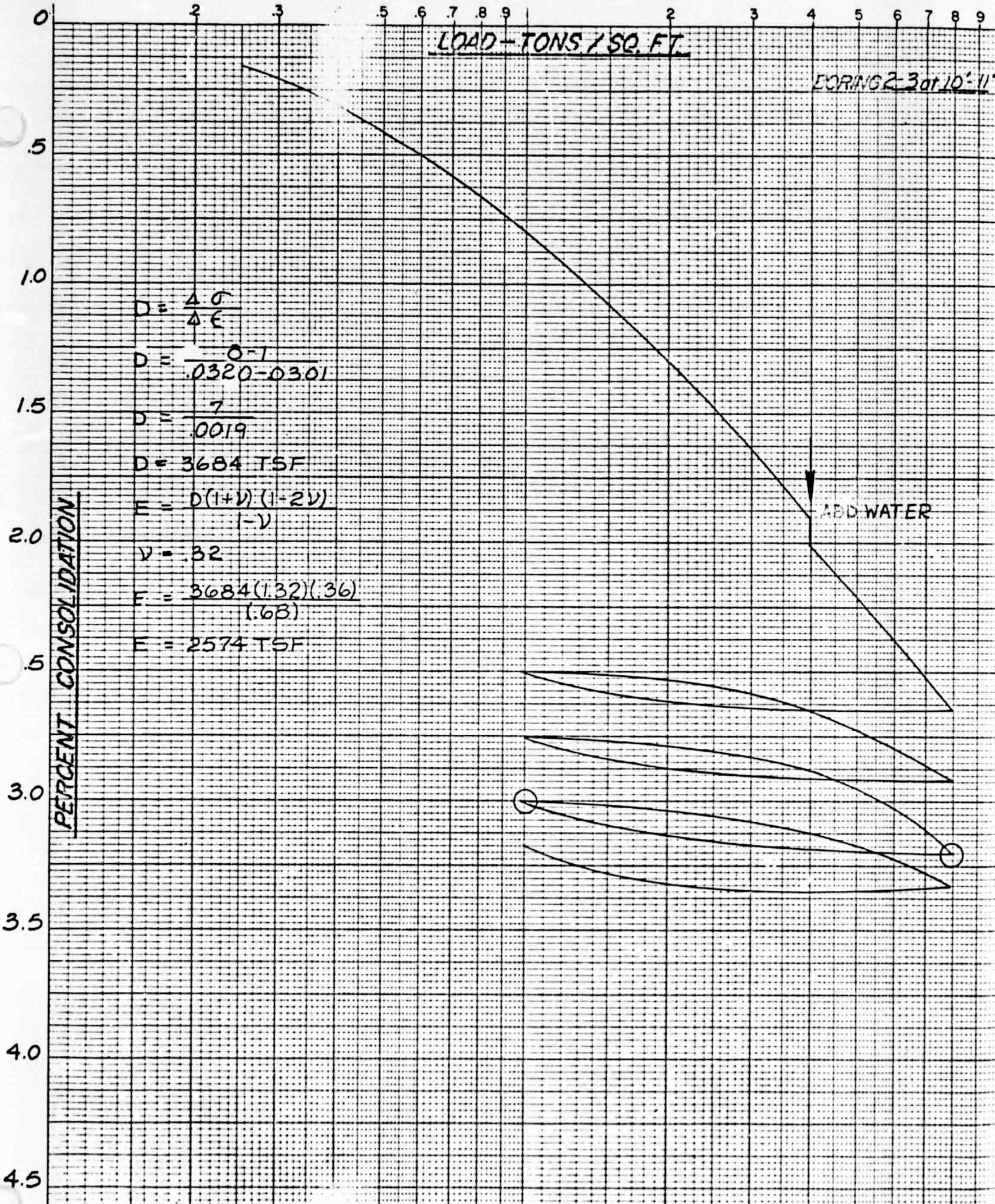
582 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE E-3

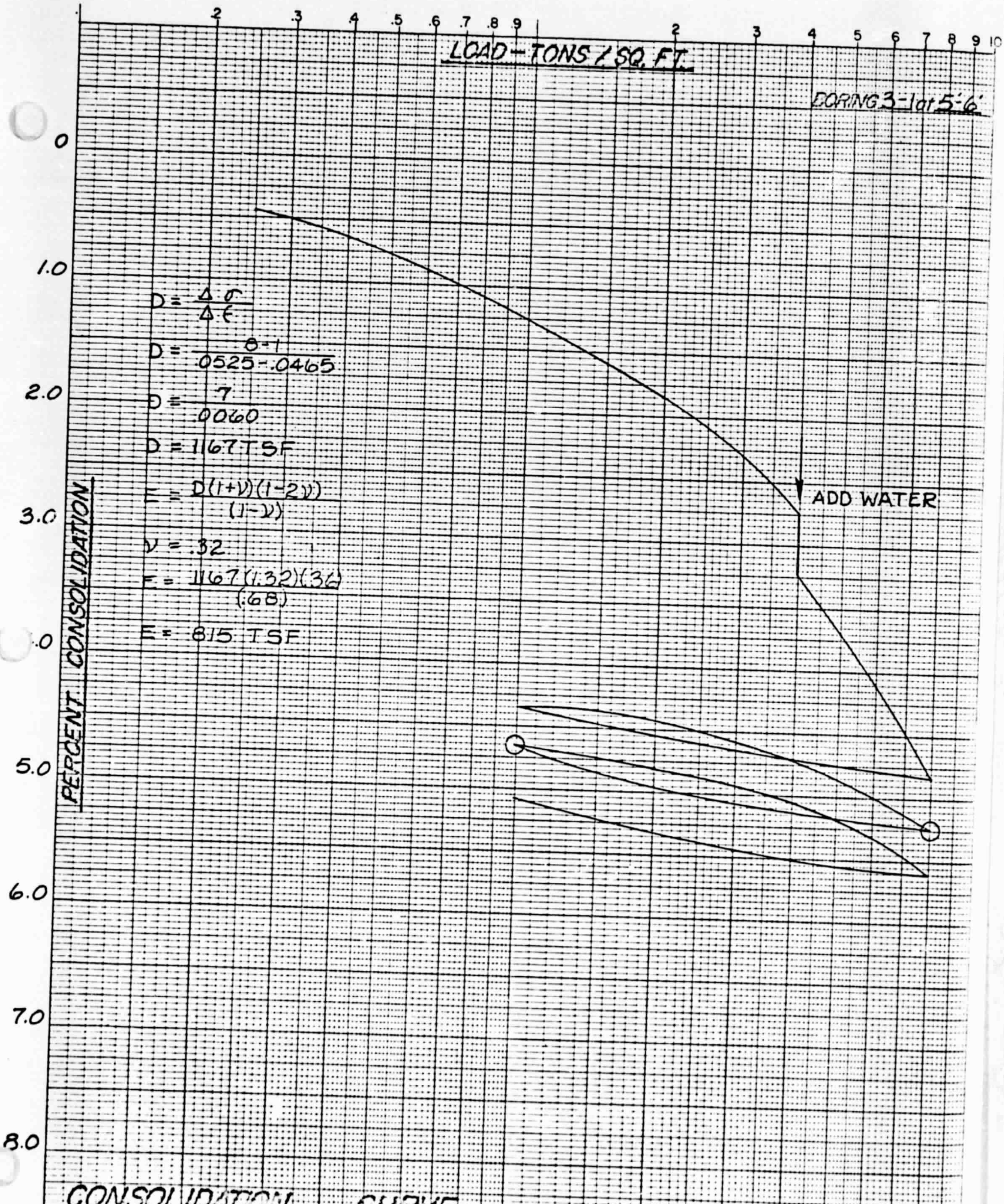


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 4/1/79

Form CC2

PLATE E-4



$D = \frac{\Delta \sigma}{\Delta \epsilon}$

$D = \frac{8-1}{.0525-.0465}$

$D = \frac{7}{.0060}$

$D = 1167 \text{ TSF}$

$E = \frac{D(1+\nu)(1-2\nu)}{(1-\nu)}$

$\nu = .32$

$E = \frac{1167(1.32)(.36)}{(.68)}$

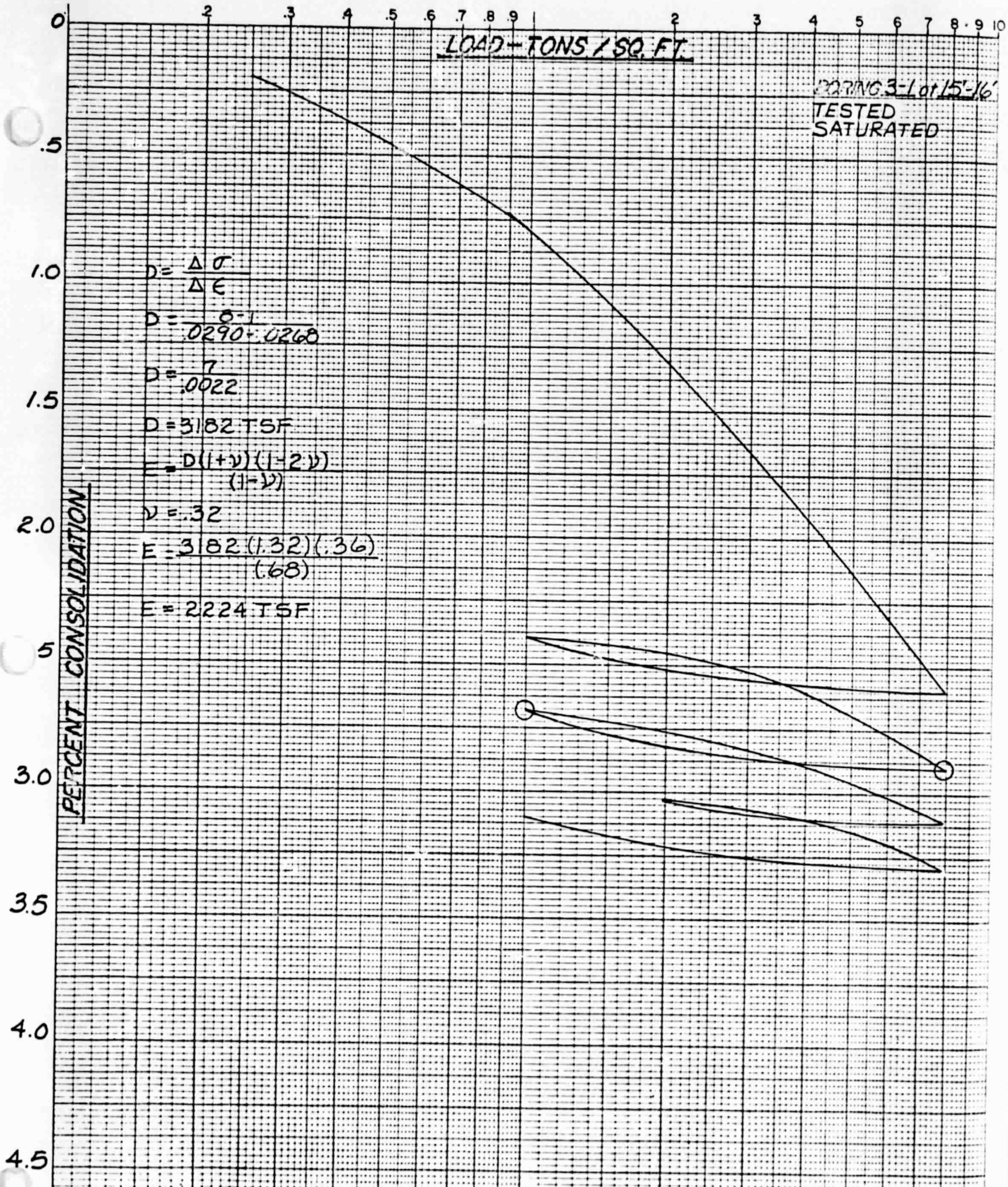
$E = 815 \text{ TSF}$

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-5

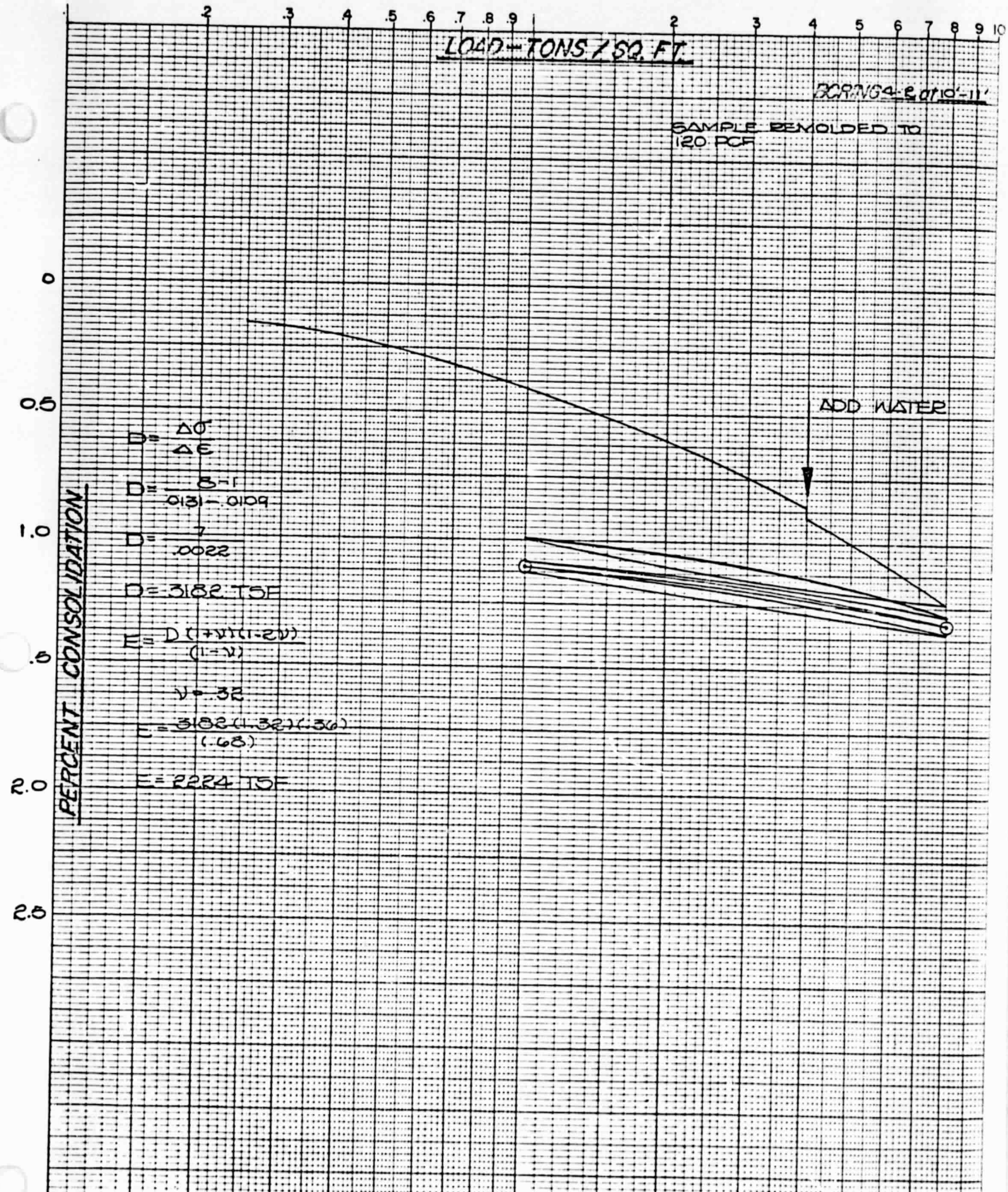


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE E-6

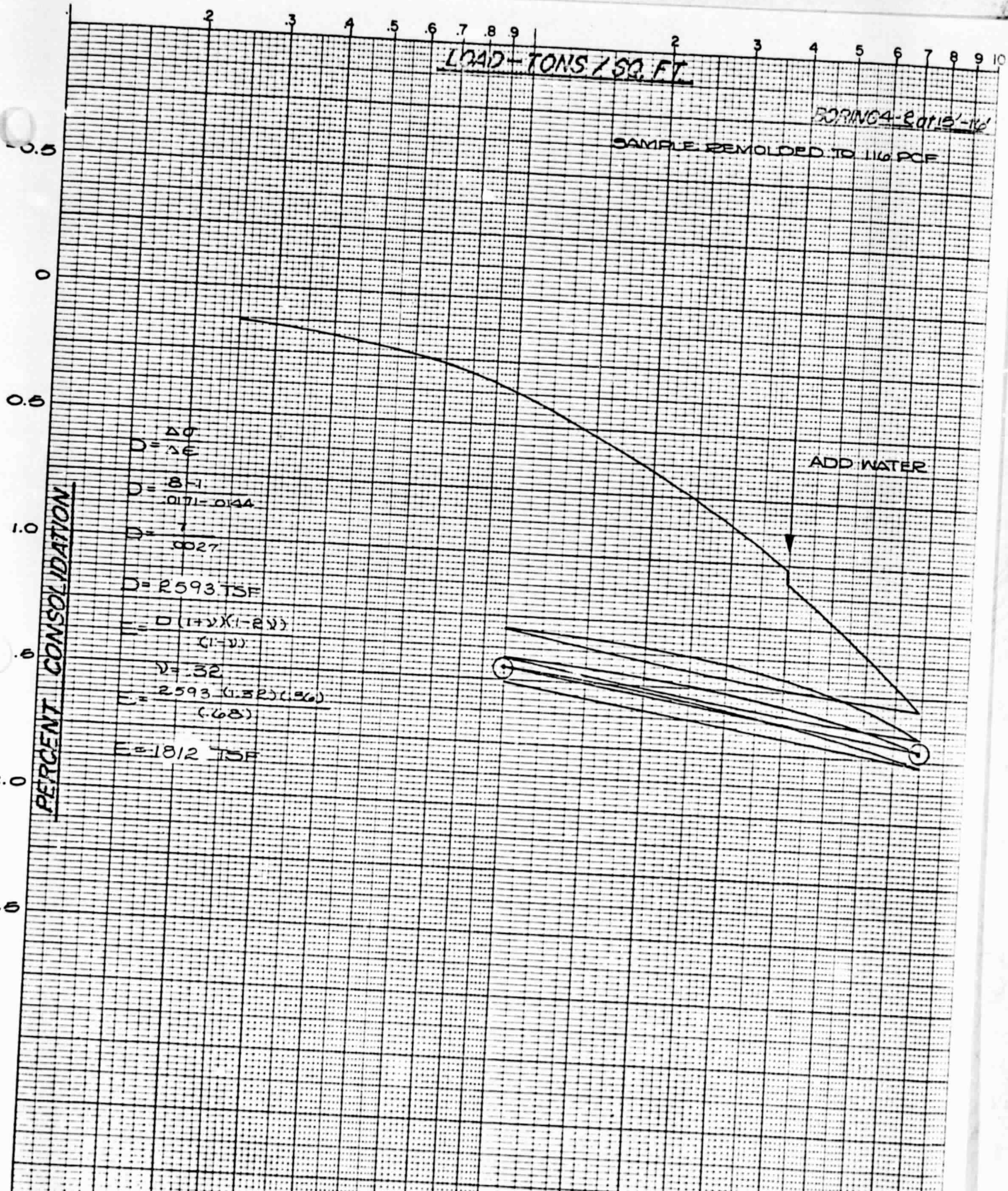


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-7

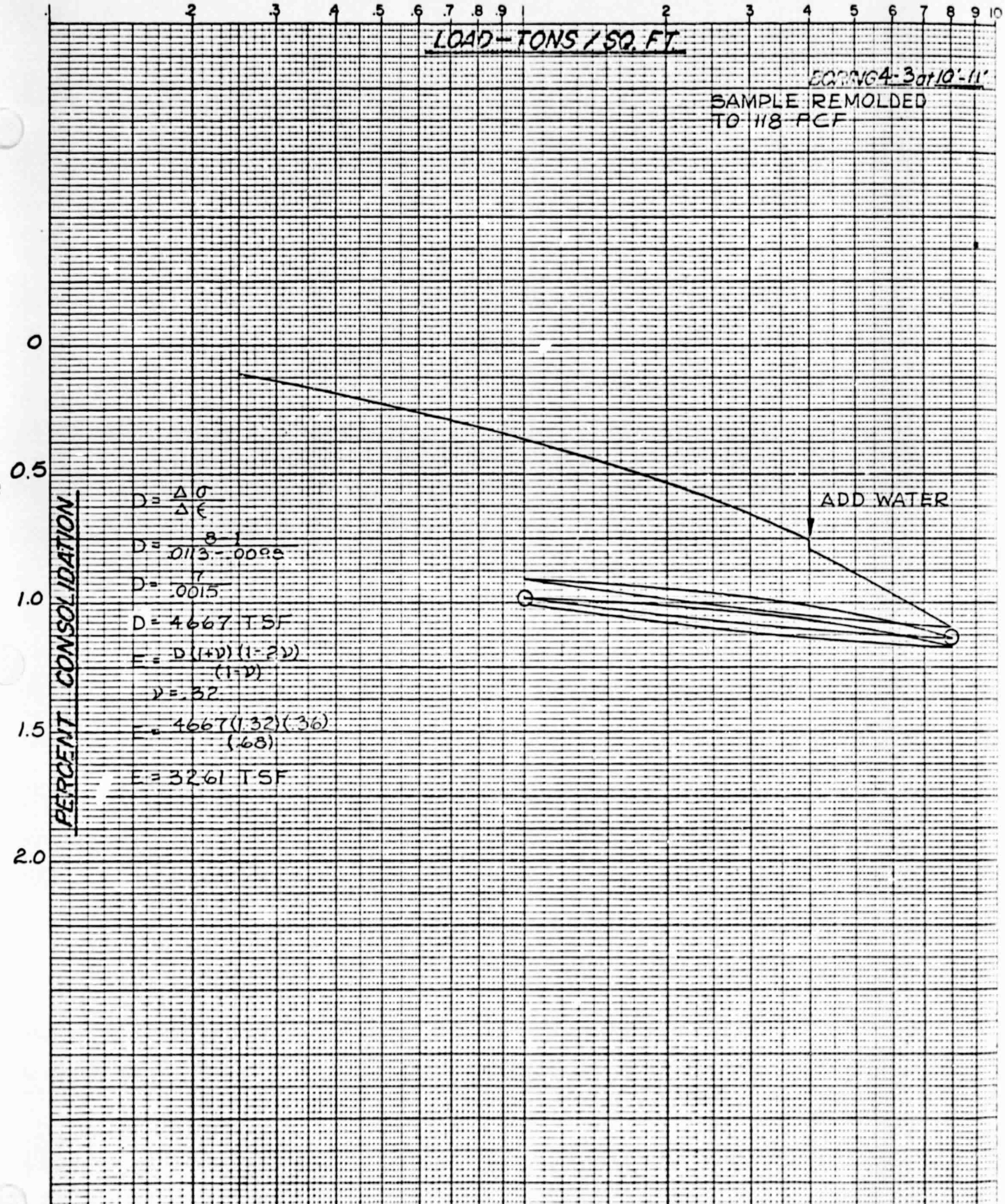


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/77

Form CC2

PLATE E-8

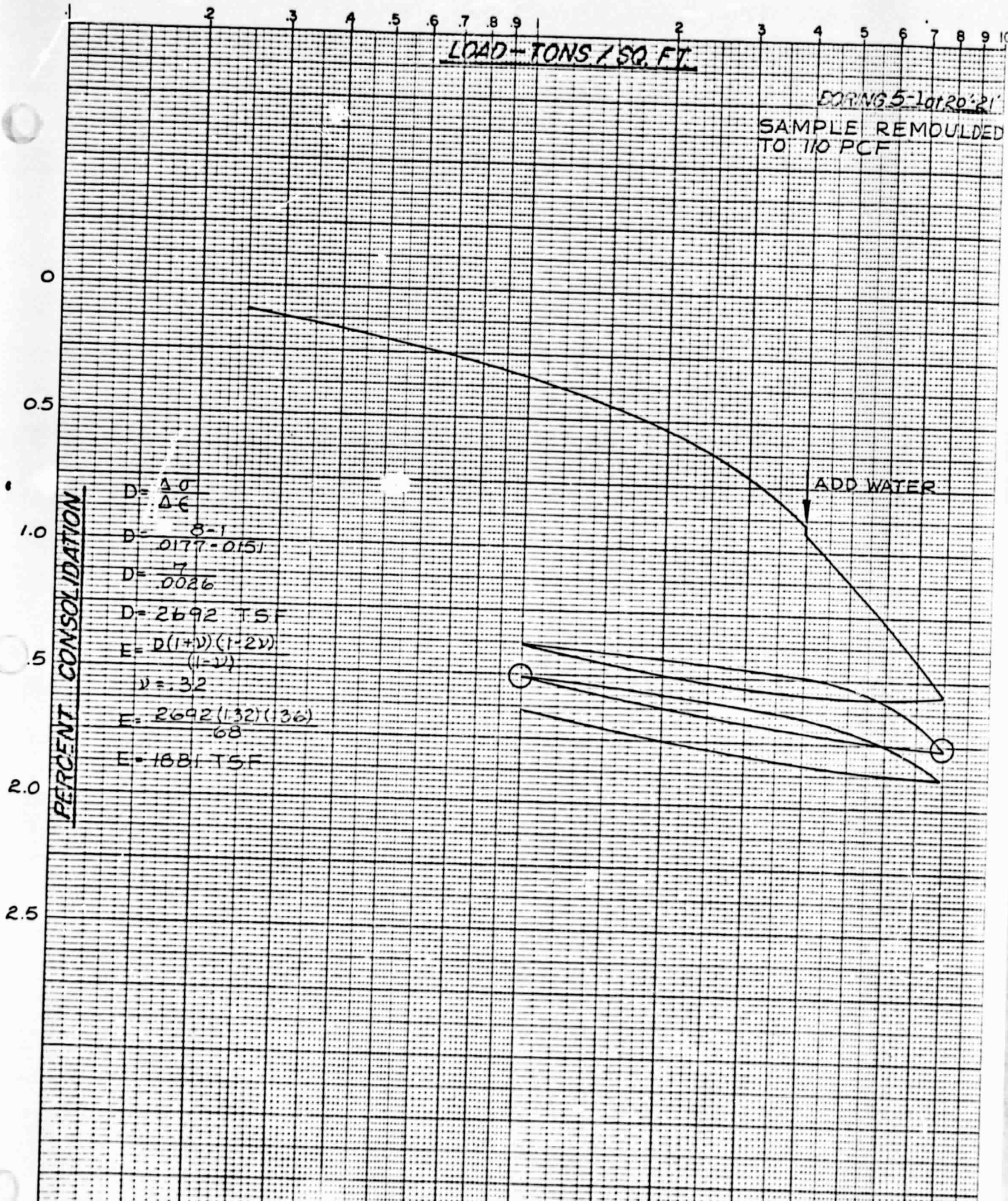


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-9

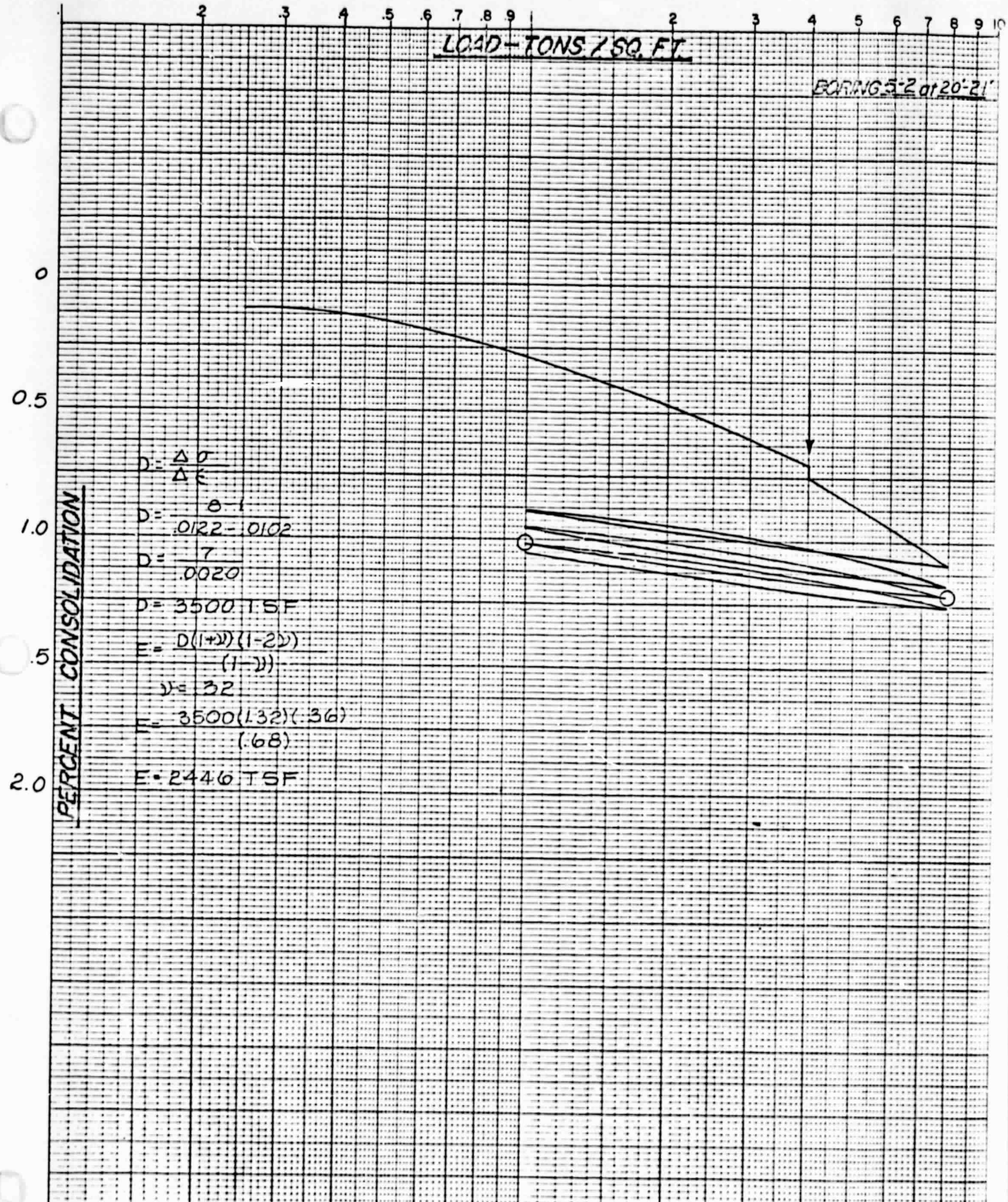


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 4/1/79

Form CC2

PLATE E-10

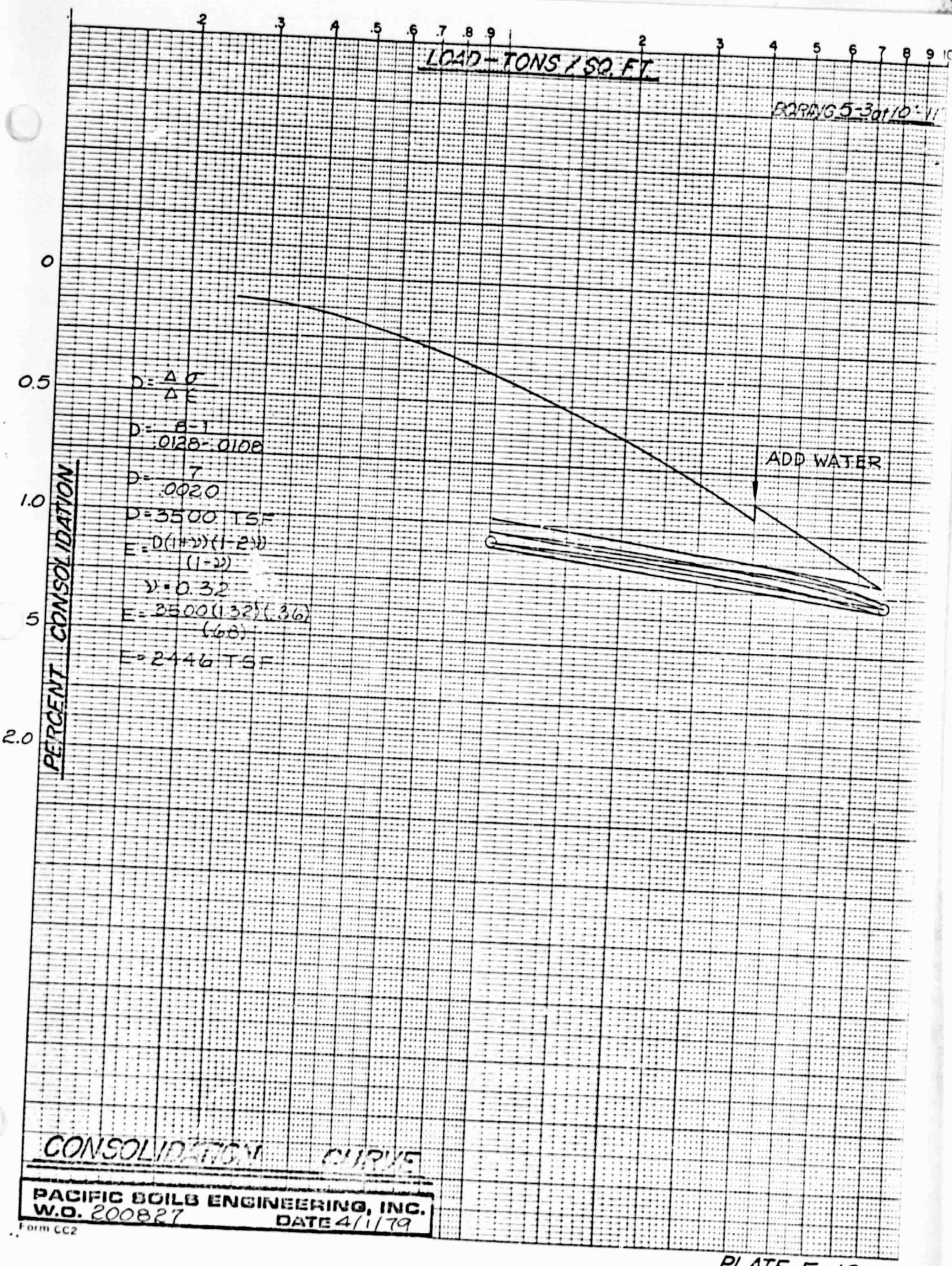


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-11

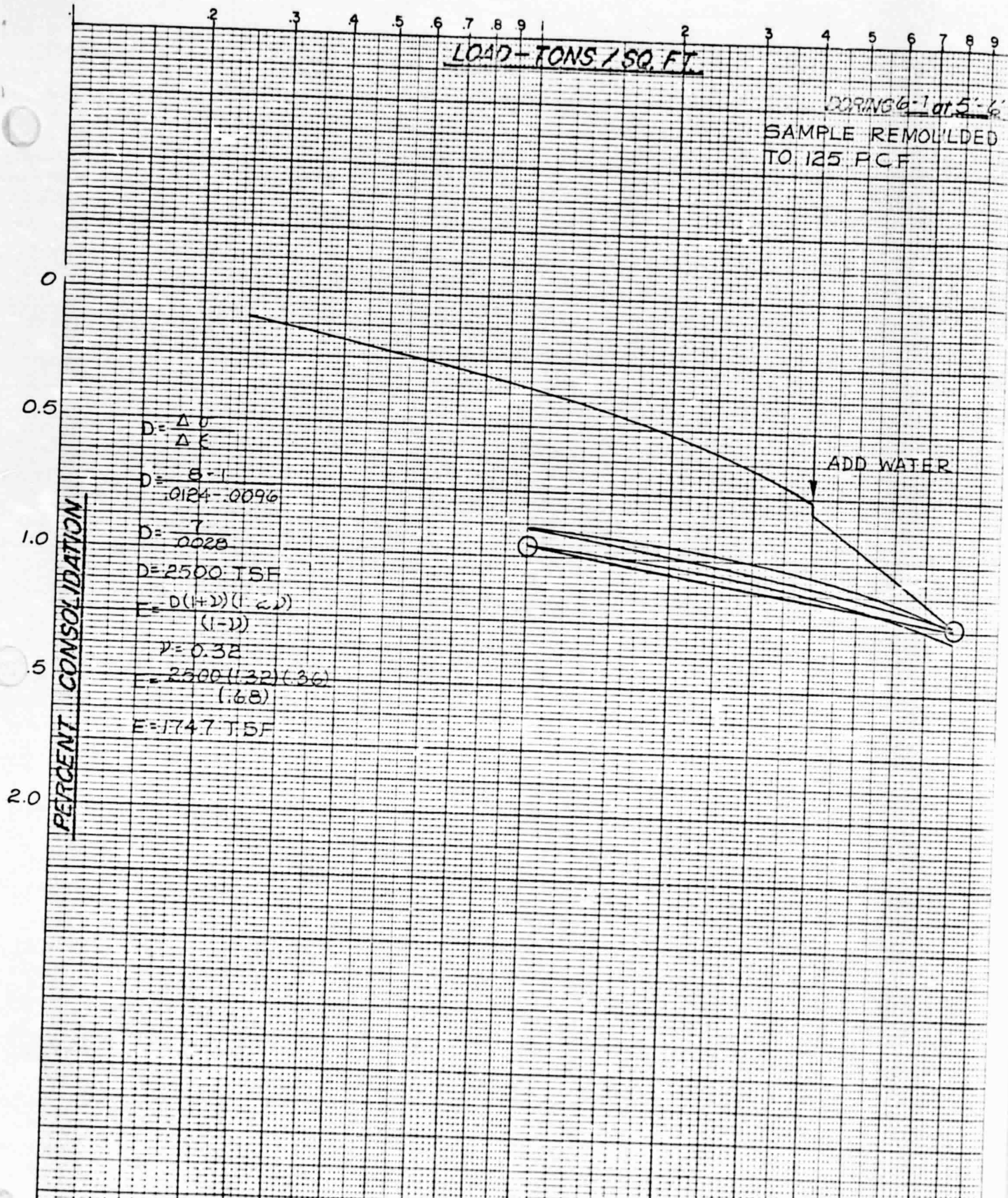


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 DATE 4/1/79

Form CC2

PLATE E-12

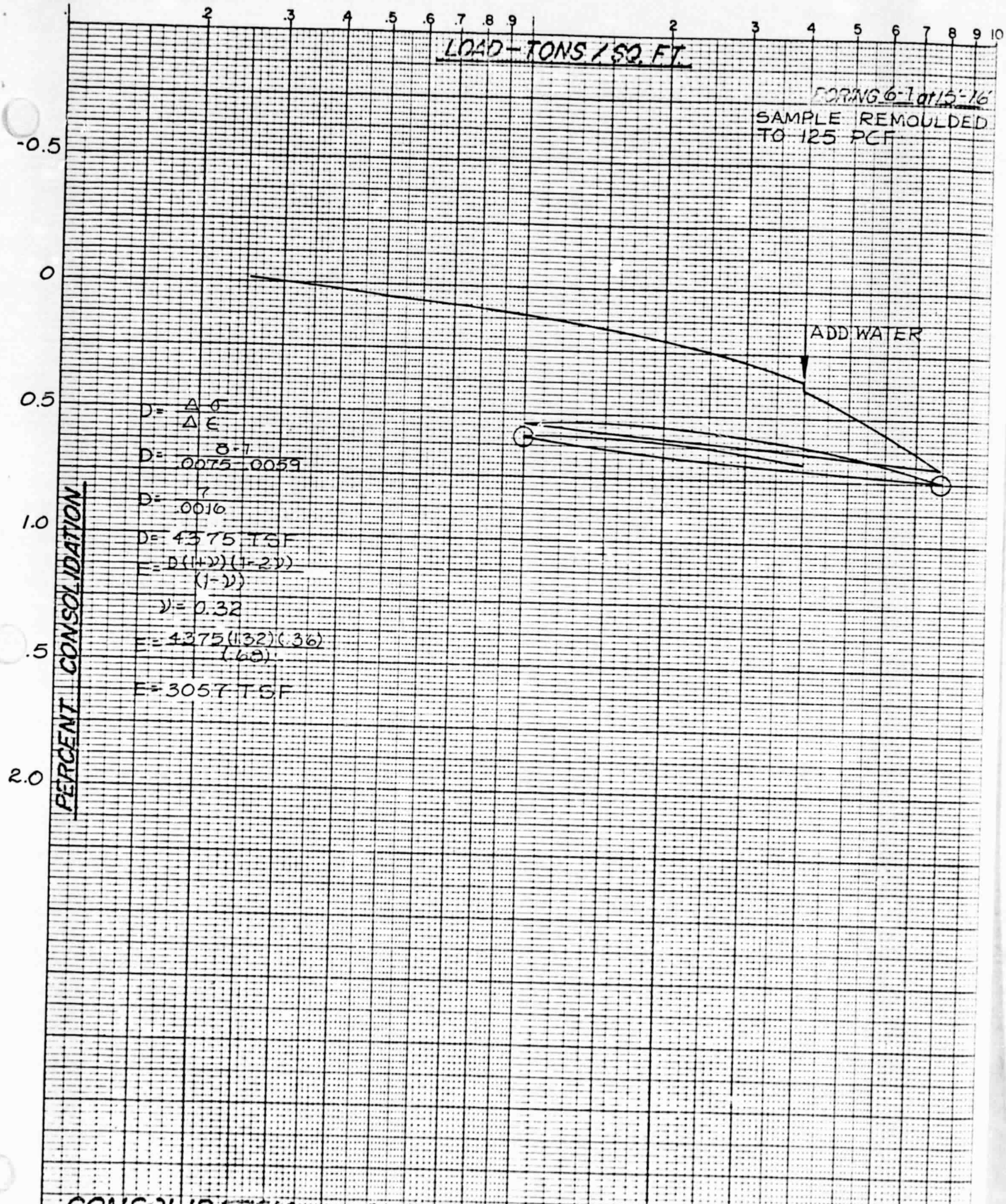


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-13

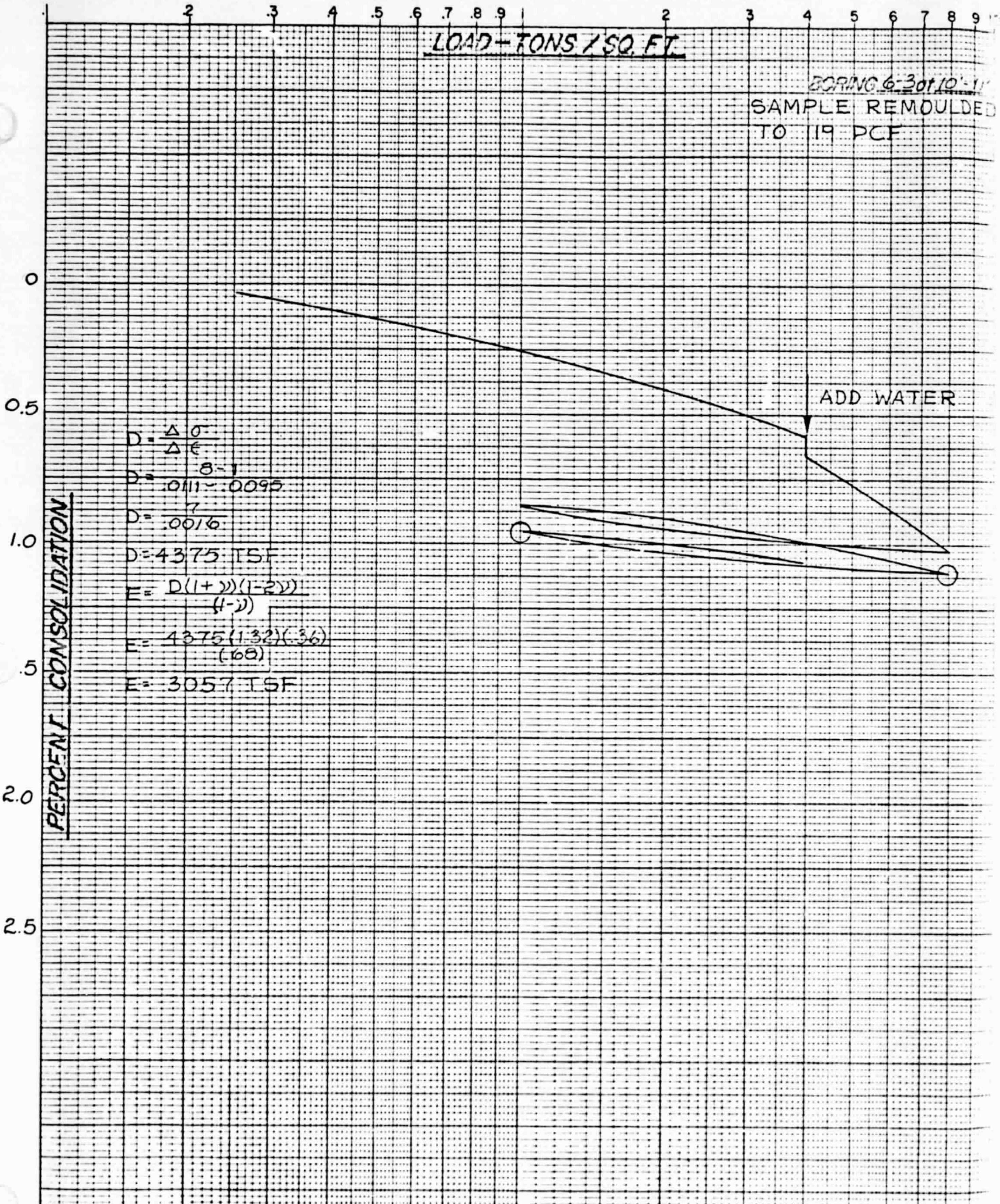


CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-14



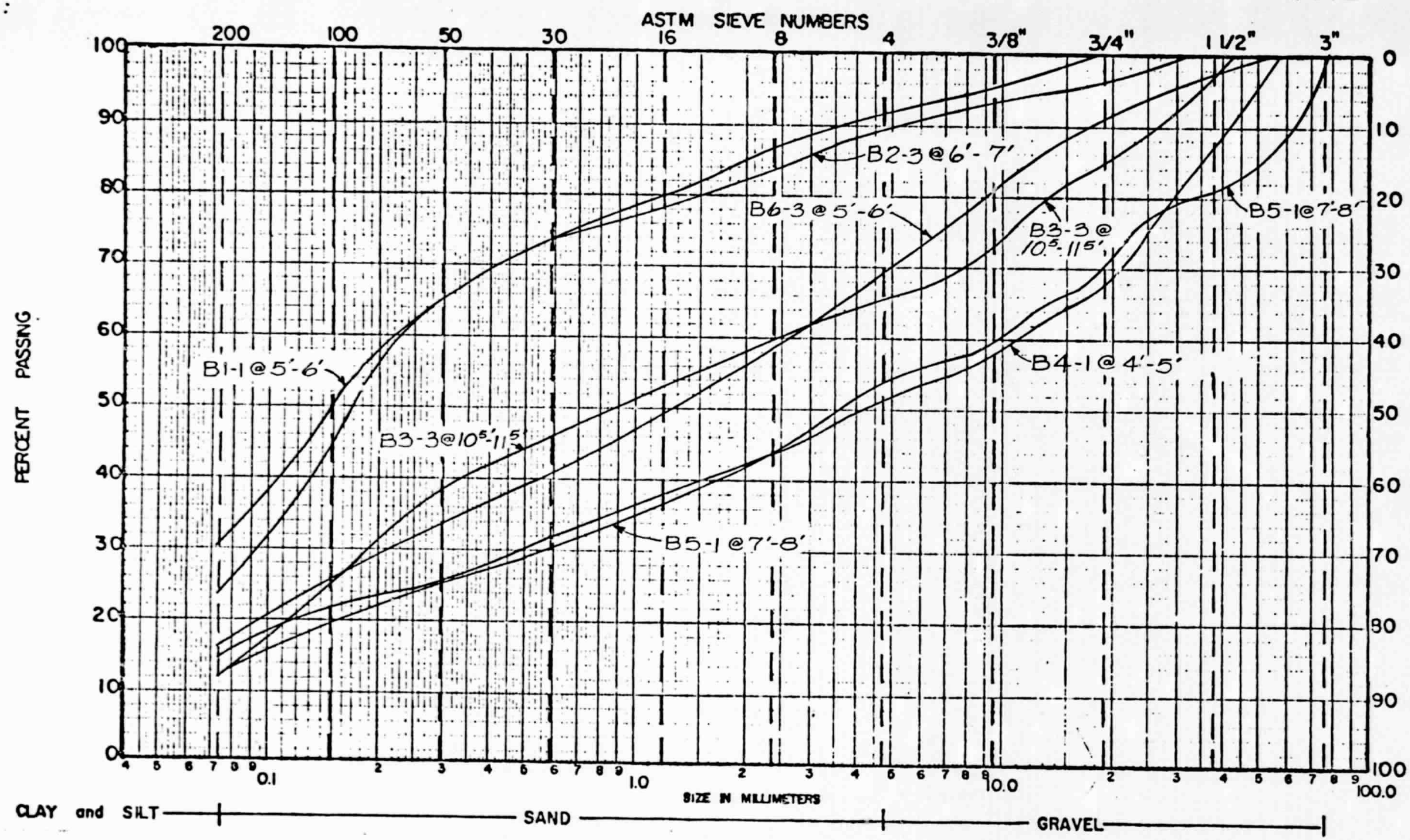
CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.

W.O. 200827 **DATE** 4/1/79

Form CC2

PLATE E-15



MECHANICAL ANALYSIS

PLATE F-1

PACIFIC SOILS ENGINEERING, INC.

1402 W. 240TH STREET, HARBOR CITY, CALIFORNIA 90710, TEL.: (213) 325-7272 OR 775-6771

W.O. 200827

DATE 4/11/79

TABLE II

LABORATORY MAXIMUM DENSITY AND OPTIMUM MOISTURE

METHOD OF TEST: ASTM:D 1557-70 (Method A, 5 layers)

Boring No.	Depth (feet)	Soil Type	Opt.Moist. (%)	Max.Dry Density (lbs/cu.ft.)
1-1	5 - 6	Silty Sand	13.0	120.0
2-2	2 - 3	Silty Sand	9.5	118.0
2-3	6 - 7	Gravelly Silty Sand	13.5	117.0
3-3	10.5-11.5	Gravelly Silty Sand	10.0	127.0
4-1	4 - 5	Sandy Gravel	9.5	132.0
5-1	7 - 8	Sandy Gravel	11.0	124.0
6-3	5 - 6	Gravelly Silty Sand	11.5	126.0

TABLE III

CALIFORNIA BEARING RATIO TEST

Boring 2-2 Depth 2 - 3 ft.

Penetration (inches)	Load (psi)	% of Standard
0.10	956	96
0.20	753	50
0.30	670	35
0.40	766	33
0.50	821	32

APPENDIX E

CALCULATIONS FOR
TOTAL SETTLEMENT DUE TO DEAD LOAD
DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD
BEARING CAPACITY, AND
LATERAL RESISTANCE

PIONEER STATION, DSS 11

JET PROPULSION LABORATORY
GOLDSTONE, CALIFORNIA

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

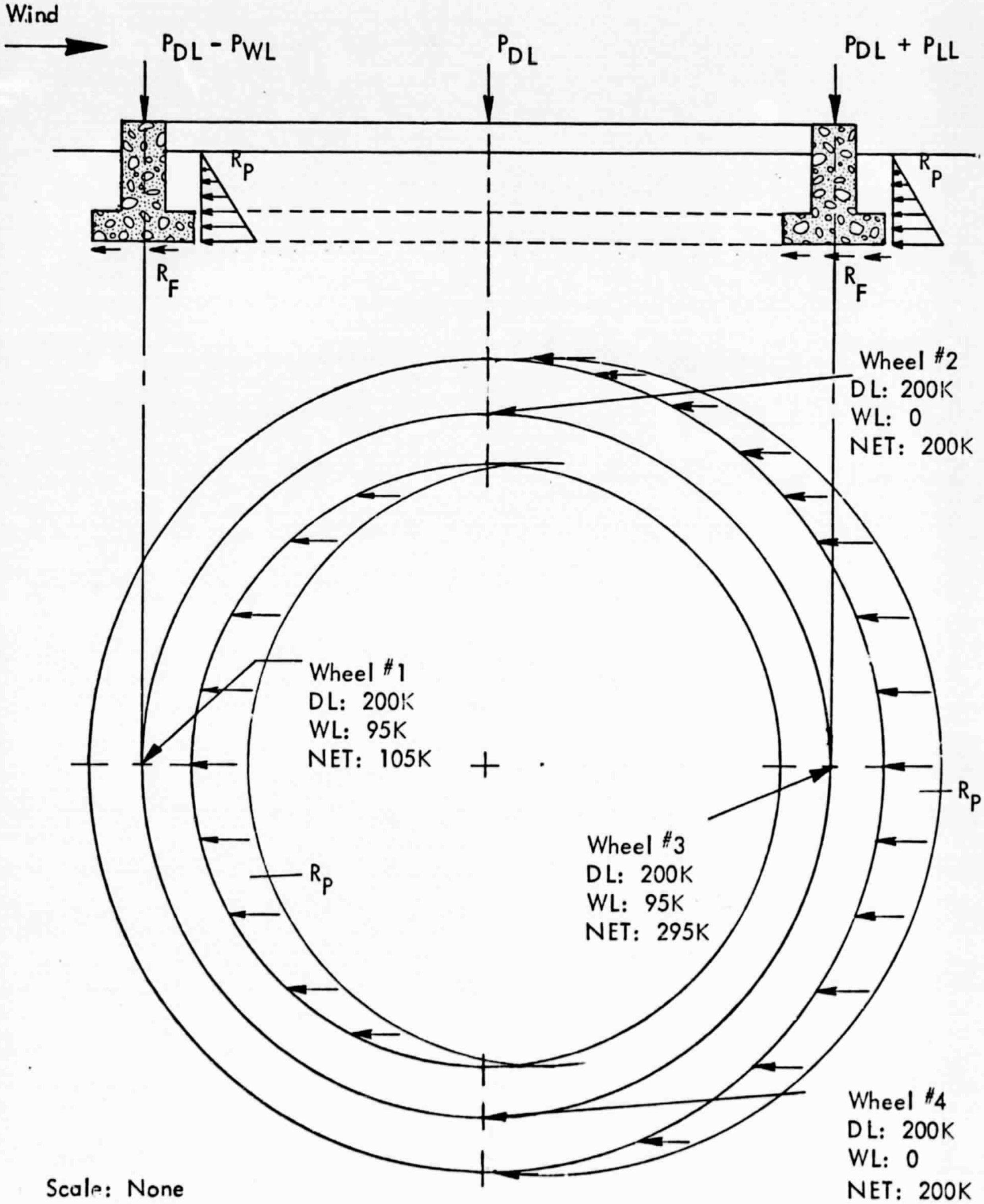
1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 1 OF 39

SUBJECT Proposed 130-feet Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California Wind Loading Diagram

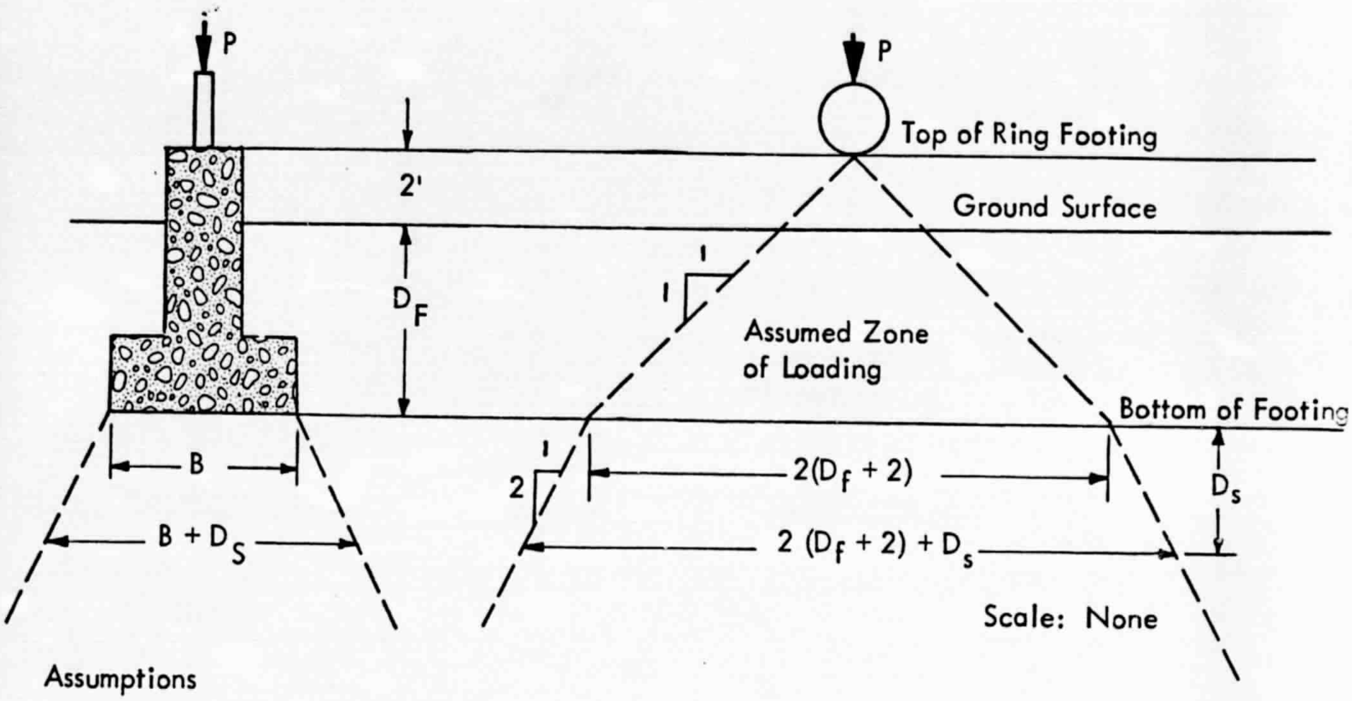


Scale: None

DATE 3-26-79 | **PACIFIC SOILS ENGINEERING, INC.** | WORK ORDER 200827

BY JSS | 1402 WEST 240TH STREET, HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 2 OF 39

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California — Basic Assumptions for Settlement Calculations

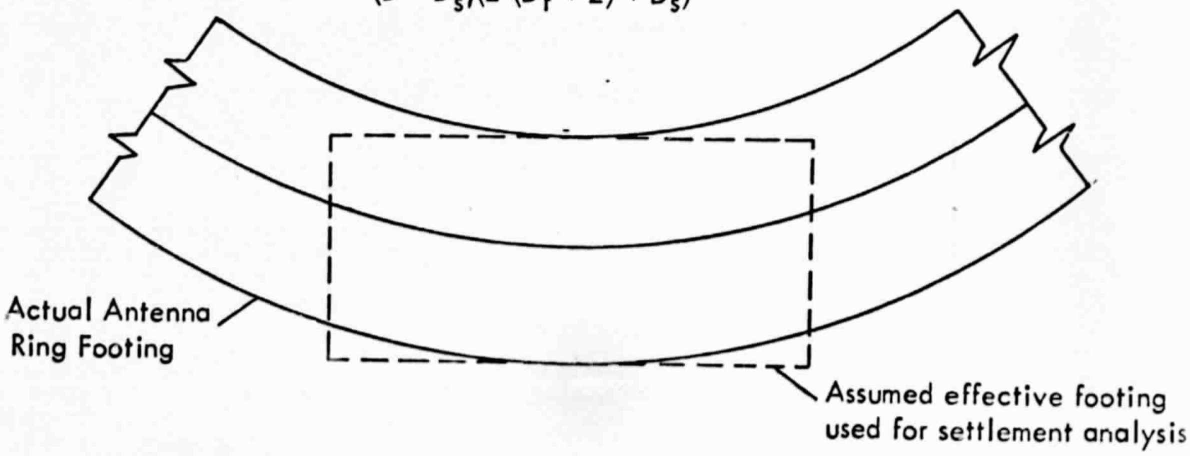


Assumptions

1. Concrete will dissipate the point load, P, evenly with depth at 1:1 slope
2. Soil will dissipate the load evenly with depth at 1/2:1 slope

Thus, the change in vertical pressure acting on the soil (ΔP) at any depth D_s below the bottom of the footing is approximately equal to:

$$\Delta P \approx \frac{P}{(B + D_s)(2\,(D_f + 2) + D_s)}$$



DATE 3-26-79 | PACIFIC SOILS ENGINEERING, INC. | WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 1

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 1-1 @ 15'-16'

B = 5 ft. γ = 119 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.45	0.87	1.32	0.43	1.04	0.61	0.37
10–15	12.5	0.74	0.37	1.11	0.67	0.91	0.24	0.14
15–20	17.5	1.04	0.22	1.26	0.87	1.00	0.13	0.08
20–25	22.5	1.34	0.14	1.48	1.05	1.13	0.08	0.05
25–30	27.5	1.64	0.10	1.74	1.20	1.24	0.04	0.02
30–35	32.5	1.93	0.07	2.00	1.32	1.34	0.02	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.67 inches

* from Consolidation Curve

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 4 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 1

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 2-3 @ 6'-7' / 1-1 @ 15'-16'

B = 5 ft. γ = 119 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.45	0.87	1.32	0.28	0.54	0.26	0.16
10–15	12.5	0.74	0.37	1.11	0.67	0.91	0.24	0.14
15–20	17.5	1.04	0.22	1.26	0.87	1.00	0.13	0.08
20–25	22.5	1.34	0.14	1.48	1.05	1.13	0.08	0.05
25–30	27.5	1.64	0.10	1.74	1.20	1.24	0.04	0.02
30–35	32.5	1.93	0.07	2.00	1.32	1.34	0.02	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.46 inches

* from Consolidation Curve

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 5 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 1

TOTAL SETTLEMENT CALCULATIONS

D_f = 10 ft. P = 200 kips Reference Consol. Curve 1-1 @ 15'-16'

B = 8 ft. γ = 119 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
10–15	12.5	0.74	0.37	1.11	0.67	0.93	0.26	0.16
15–20	17.5	1.04	0.20	1.24	0.88	1.00	0.12	0.07
20–25	22.5	1.34	0.13	1.47	1.05	1.12	0.07	0.04
25–30	27.5	1.64	0.09	1.73	1.20	1.24	0.04	0.02
30–35	32.5	1.93	0.07	2.00	1.32	1.34	0.02	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.30 inches

* from Consolidation Curve

DATE 3-26-79 PACIFIC SOILS ENGINEERING, INC. WORK ORDER 200827

BY JSS 1402 WEST 240TH STREET HARBOR CITY, CALIFORNIA 90710 SHEET NO. 6 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)

Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 1

TOTAL SETTLEMENT CALCULATIONS

D_f = 12 ft. P = 200 kips Reference Consol. Curve 1-1 @ 15'-16'

B = 6 ft. γ = 119 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
12–17	14.5	0.86	0.40	1.26	0.74	1.01	0.27	0.16
17–22	19.5	1.16	0.21	1.37	0.96	1.07	0.11	0.07
22–27	24.5	1.46	0.13	1.59	1.12	1.18	0.06	0.04
27–32	29.5	1.76	0.09	1.85	1.25	1.28	0.03	0.02
32–37	34.5	2.05	0.07	2.12	1.36	1.38	0.02	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.30 inches

* from Consolidation Curve

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BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 7 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 2

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 2-1 @ 15'-16'

B = 8 ft. γ = 118 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.44	0.60	1.04	0.56	1.16	0.60	0.36
10–15	12.5	0.74	0.30	1.04	0.88	1.16	0.28	0.17
15–20	17.5	1.03	0.18	1.21	1.16	1.30	0.14	0.08
20–25	22.5	1.33	0.12	1.45	1.38	1.45	0.07	0.04
25–30	27.5	1.62	0.09	1.71	1.57	1.62	0.05	0.03

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.68 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 8 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 2

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 2-3 @ 6'-7', 2-1 @ 15'-16'

B = 8 ft. γ = 118 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.44	0.60	1.04	0.27	0.48	0.21	0.13
10–15	12.5	0.74	0.30	1.04	0.88	1.16	0.28	0.17
15–20	17.5	1.03	0.18	1.21	1.16	1.30	0.14	0.08
20–25	22.5	1.33	0.12	1.45	1.38	1.45	0.07	0.04
25–30	27.5	1.62	0.09	1.71	1.57	1.62	0.05	0.03

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.45 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 2

TOTAL SETTLEMENT CALCULATIONS

D_f = 10 ft. P = 200 kips Reference Consol. Curve 2-1 @ 15'-16'

B = 14 ft. γ = 118 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
10–15	12.5	0.74	0.23	0.97	0.89	1.10	0.21	0.13
15–20	17.5	1.03	0.15	1.18	1.12	1.27	0.15	0.09
20–25	22.5	1.33	0.10	1.43	1.37	1.44	0.07	0.04
25–30	27.5	1.62	0.08	1.70	1.55	1.59	0.04	0.02
30–35	32.5	1.92	0.06	1.98	1.73	1.77	0.04	0.02

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.30 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

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BY JSS

SHEET NO. 10 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 2

TOTAL SETTLEMENT CALCULATIONS

D_f = 12 ft. P = 200 kips Reference Consol. Curve 2-1 @ 15'-16'

B = 12 ft. γ = 118 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
12–17	14.5	0.86	0.23	1.09	1.00	1.20	0.20	0.12
17–22	19.5	1.15	0.14	1.29	1.25	1.35	0.10	0.06
22–27	24.5	1.45	0.10	1.55	1.44	1.51	0.07	0.04
27–32	29.5	1.74	0.07	1.81	1.61	1.66	0.05	0.03
32–37	34.5	2.04	0.06	2.10	1.80	1.83	0.03	0.02

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.27 inches

* from Consolidation Curve

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SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 3

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 3-1 @15'-16'

B = 5 ft. γ = 121 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.45	0.87	1.32	0.42	0.98	0.56	0.34
10–15	12.5	0.76	0.37	1.13	0.65	0.88	0.23	0.14
15–20	17.5	1.06	0.22	1.28	0.83	0.96	0.13	0.08
20–25	22.5	1.36	0.14	1.50	1.01	1.08	0.07	0.04
25–30	27.5	1.66	0.10	1.76	1.16	1.20	0.04	0.02
30–35	32.5	1.97	0.07	2.04	1.30	1.33	0.03	0.02

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.64 inches

* from Consolidation Curve

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BY JSS

PACIFIC SOILS ENGINEERING, INC.

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HARBOR CITY, CALIFORNIA 90710

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SHEET NO. 12 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT CALCULATIONS, ANTENNA NO. 3

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 2-3 @ 6'-7', 3-1 @ 15'-16'

B = 5 ft. γ = 121 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.45	0.87	1.32	0.28	0.54	0.26	0.16
10–15	12.5	0.76	0.37	1.13	0.65	0.88	0.23	0.14
15–20	17.5	1.06	0.22	1.28	0.83	0.96	0.13	0.08
20–25	22.5	1.36	0.14	1.50	1.01	1.08	0.07	0.04
25–30	27.5	1.66	0.10	1.76	1.16	1.20	0.04	0.02
30–35	32.5	1.97	0.07	2.04	1.30	1.33	0.03	0.02

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.46 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 13 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 3

TOTAL SETTLEMENT CALCULATIONS

D_f = 10 ft. P = 200 kips Reference Consol. Curve 3-1 @ 15'-16'

B = 10 ft. γ = 121 pcf H = 5 ft.

	Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
10–15	12.5	0.76	0.31	1.07	0.65	0.85	0.20	0.10	
15–20	17.5	1.06	0.18	1.24	0.82	0.95	0.13	0.08	
20–25	22.5	1.36	0.12	1.48	1.00	1.06	0.06	0.04	
25–30	27.5	1.66	0.09	1.75	1.16	1.20	0.04	0.02	
30–35	32.5	1.97	0.07	2.04	1.30	1.33	0.03	0.02	

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.26 inches

* from Consolidation Curve

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BY JSS

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

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SHEET NO. 14 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 4

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 4-2 @ 10'-11'

B = 5 ft. γ = 121 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.45	0.87	1.32	0.23	0.48	0.25	0.15
10–15	12.5	0.76	0.37	1.13	0.33	0.44	0.11	0.07
15–20	17.5	1.06	0.22	1.28	0.42	0.47	0.05	0.03
20–25	22.5	1.36	0.14	1.50	0.48	0.52	0.04	0.02
25–30	27.5	1.66	0.10	1.76	0.56	0.58	0.02	0.01
30–35	32.5	1.97	0.07	2.04	0.60	0.61	0.01	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.29 inches

* from Consolidation Curve

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 15 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 5

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 5-3 @ 10'-11'

B = 5 ft. γ = 121 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5, 10	7.5	0.45	0.87	1.32	0.17	0.48	0.31	0.19
15	12.5	0.76	0.37	1.13	0.30	0.42	0.12	0.07
20	17.5	1.06	0.22	1.28	0.41	0.47	0.06	0.04
25	22.5	1.36	0.14	1.50	0.49	0.52	0.03	0.02
30	27.5	1.66	0.10	1.76	0.56	0.58	0.02	0.01
35	32.5	1.97	0.07	2.04	0.62	0.64	0.02	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.34 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 16 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California TOTAL SETTLEMENT DUE TO DEAD LOAD, ANTENNA NO. 6

TOTAL SETTLEMENT CALCULATIONS

D_f = 5 ft. P = 200 kips Reference Consol. Curve 6-1 @ 5'-6'

B = 5 ft. γ = 128 pcf H = 5 ft.

Depth - (feet)	Effective Depth - (feet)	Po - Initial Vertical Stress (tsf)	ΔP - Change in Vertical Stress (tsf)	Pf - Final Stress (tsf)	So - % Consolidation for Po *	S_f - % Consolidation for P_f *	ΔS - Change in % Consolidation	ΔH
5–10	7.5	0.48	0.87	1.35	0.22	0.42	0.20	0.12
10–15	12.5	0.80	0.37	1.17	0.31	0.39	0.08	0.05
15–20	17.5	1.12	0.22	1.34	0.37	0.42	0.05	0.03
20–25	22.5	1.44	0.14	1.58	0.44	0.46	0.02	0.01
25–30	27.5	1.76	0.10	1.86	0.49	0.50	0.01	0.01

TOTAL SETTLEMENT = $\Sigma \Delta H$ = 0.22 inches

* from Consolidation Curve

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

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BY JSS

SHEET NO. 17 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 1

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 5 ft. D_f = 5 ft. H = 5 ft. E = 1687 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
5				
	7.5	0.77	0.03	0.03
10				
	12.5	0.35	0.01	0.04
15				
	17.5	0.20	0.01	0.05
20				
	22.5	0.13	0.00	0.05
25				

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

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SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 1

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 8 ft. D_f = 10 ft. H = 5 ft. E = 1687 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	Δ H* Differential Settlement (in.)	ΣΔ H Total Diff. Settlement (in.)
10–15	12.5	0.34	0.01	0.01
15–20	17.5	0.19	0.01	0.02
20–25	22.5	0.13	0.00	0.02

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

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PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY J S S

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 1

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 6 ft. D_f = 12 ft. H = 5 ft. E = 1687 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
12–17	14.5	0.37	0.01	0.01
17–22	19.5	0.20	0.01	0.02
22–27	24.5	0.13	0.00	0.02

$$^{*}\Delta H = \frac{\Delta P}{E} \times H$$

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
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BY JSS

SHEET NO. 20 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 2

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 8 ft. D_f = 5 ft. H = 5 ft. E = 582 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	Δ H* Differential Settlement (in.)	ΣΔ H Total Diff. Settlement (in.)
5–10	7.5	0.55	0.06	0.06
10–15	12.5	0.29	0.03	0.09
15–20	17.5	0.17	0.02	0.11
20–25	22.5	0.12	0.01	0.12
25–30	27.5	0.09	0.01	0.13

$$*\Delta H = \frac{\Delta P}{E} \times H$$

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BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 2

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 14 ft. D_f = 10 ft. H = 5 ft. E = 582 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	Δ H* Differential Settlement (in.)	ΣΔ H Total Diff. Settlement (in.)
10 – 15	12.5	0.22	0.02	0.02
15 – 20	17.5	0.14	0.01	0.03
20 – 25	22.5	0.10	0.01	0.04
25 – 30	27.5	0.07	0.01	0.05
30 – 35	32.5	0.06	0.01	0.06

$$*\Delta H = \frac{\Delta P}{E} \times H$$

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 2

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 12 ft. D_f = 12 ft. H = 5 ft. E = 528 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
12–17	14.5	0.21	0.02	0.02
17–22	19.5	0.14	0.01	0.03
22–27	24.5	0.10	0.01	0.04
27–32	29.5	0.07	0.01	0.05
32–37	34.5	0.05	0.01	0.06

$$^{*}\Delta H = \frac{\Delta P}{E} \times H$$

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 23 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 3

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 5 ft. D_f = 5 ft. H = 5 ft. E = 815 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
5 – 10	7.5	0.77	0.06	0.06
10 – 15	12.5	0.35	0.03	0.09
15 – 2.	17.5	0.20	0.01	0.10
2. – 25	22.5	0.13	0.01	0.11
25 – 30	27.5	0.09	0.01	0.12

$$*\Delta H = \frac{\Delta P}{E} \times H$$

DATE 3-26-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY JSS 1402 WEST 240TH STREET HARBOR CITY, CALIFORNIA 90710 SHEET NO. 24 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 3

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 10 ft. D_f = 10 ft. H = 5 ft. E = 815 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
10	12.5	0.29	0.02	0.02
15	17.5	0.17	0.01	0.03
20	22.5	0.12	0.01	0.04
25	27.5	0.08	0.01	0.05
30				

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

DATE 3-26-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 25 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 4

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 5 ft. D_f = 5 ft. H = 5 ft. E = 1587 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
5				
	7.5	0.77	0.03	0.03
10				
	12.5	0.35	0.01	0.04
15				
	17.5	0.20	0.01	0.05
20				
	22.5	0.13	0.00	0.05
25				

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

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BY JSS | 1402 WEST 240TH STREET HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 26 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 5

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 5 ft. D_f = 5 ft. H = 5 ft. E = 1881 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	ΣΔH Total Diff. Settlement (in.)
5	7.5	0.77	0.02	0.02
10	12.5	0.35	0.01	0.03
15	17.5	0.20	0.01	0.04
20	22.5	0.13	0.00	0.04
25				

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

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PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SHEET NO. 27 OF 39

SUBJECT Proposed 130-foot diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California DIFFERENTIAL SETTLEMENT DUE TO WIND LOAD, ANTENNA NO. 6

DIFFERENTIAL SETTLEMENT CALCULATIONS

Max. Diff. P. = 190 kips

B = 5 ft. D_f = 5 ft. H = 5 ft. E = 1747 tsf

Depth - (feet)	Effective Depth - (feet)	ΔP - Change in Vertical Stress (tsf)	ΔH* Differential Settlement (in.)	$\Sigma \Delta H$ Total Diff. Settlement (in.)
5–10	7.5	0.77	0.03	0.03
10–15	12.5	0.35	0.01	0.04
15–20	17.5	0.20	0.01	0.05
20–25	22.5	0.13	0.00	0.05

$$^*\Delta H = \frac{\Delta P}{E} \times H$$

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California BEARING CAPACITY CALCULATIONS, ANTENNA NO. 1

ϕ = 34 deg. C = 200 psf γ = 119 pcf

N_c = 42 N_γ = 32 N_q = 29

B = 5 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = CN_c + 0.5\gamma B N_\gamma + \gamma D_f N_q$$

$$q = 200(42) + 0.5(119)\ 5\ (32) + 119(5)\ (29)$$

$$q = 35,175 \text{ psf}$$

MAXIMUM BEARING REQUIRED:

$$Q = P_{dl} + P_{wl}/\text{effective footing size}$$

$$Q = 200 + 95/(5 \times 14) = 4.214 \text{ ksf} = 4,214 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max. Bearing Required}}$$

$$F.S. = \frac{35,175}{4,214}$$

$$F.S. = 8.3$$

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California BEARING CAPACITY CALCULATIONS, ANTENNA NO. 2

ϕ = 29 deg. C = 225 psf γ = 118 pcf

N_c = 27.5 N_γ = 13.5 N_q = 16

B = 8 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = C N_c + 0.5 \gamma B N_\gamma + \gamma D_f N_q$$

$$q = 225 (27.5) + 0.5(118)(8)(13.5) + 118 (5) 16$$

$$q = 22{,}000 \text{ psf}$$

MAXIMUM BEARING REQUIRED

$$Q = P_{dl} + P_{wl}/\text{effective footing size}$$

$$Q = 200 + 95/(8 \times 14)$$

$$Q = 2.634 \text{ ksf} = 2{,}634 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max.Bearing Required}}$$

$$F.S. = \frac{22{,}000}{2{,}634}$$

$$F.S. = 8.4$$

DATE 3-26-79 **PACIFIC SOILS ENGINEERING, INC.** WORK ORDER 200827

BY JSS 1402 WEST 240TH STREET HARBOR CITY, CALIFORNIA 90710 SHEET NO. 30 OF 39

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11) Goldstone, California BEARING CAPACITY CALCULATIONS, ANTENNA NO. 3

ϕ = 33 deg. C = 250 psf γ = 121 pcf

N_c = 39 N_γ = 27 N_q = 26

B = 5 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = C N_c + 0.5 \gamma B N_\gamma + \gamma D_f N_q$$

$$q = 250(39) + 0.5(121)\ 5(27) + 121(5)26$$

$$q = 33,648 \text{ psf}$$

MAXIMUM BEARING REQUIRED

$$Q = P_{dl} + P_{wl} / \text{effective footing size}$$

$$Q = 200 + 95/(5 \times 14)$$

$$Q = 4.214 \text{ ksf} = 4,214 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max. Bearing Required}}$$

$$F.S. = \frac{33,648}{4,214}$$

$$F.S. = 8.0$$

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California BEARING CAPACITY CALCULATIONS, ANTENNA NO. 4

ϕ = 34 deg. C = 700 psf γ = 121 pcf

N_c = 42 N_γ = 32 N_q = 29

B = 5 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = CN_c + 0.5\gamma B N_\gamma + \gamma D_f N_q$$

$$q = 700(42) + 0.5(121)(5)(32) + 121(5)(29)$$

$$q = 56{,}625 \text{ psf}$$

MAXIMUM BEARING REQUIRED:

$$Q = P_{dl} + P_{wl} / \text{effective footing size}$$

$$Q = 200 + 95/(5 \times 14)$$

$$Q = 4.214 \text{ ksf} = 4{,}214 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max. Bearing Required}}$$

$$F.S. = \frac{56{,}625}{4{,}214}$$

$$F.S. = 13.4$$

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California BEARING CAPACITY CALCULATIONS, ANTENNA NO. 5

ϕ = 35 deg. C = 425 psf γ = 121 pcf

N_c = 46 N_γ = 37 N_q = 33

B = 5 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = C N_c + 0.5 \gamma B N_\gamma + \gamma D_f N_q$$

$$q = 425(46) + 0.5(121)\ 5(37) + 121(5)\ 33$$

$$q = 50{,}708 \text{ psf}$$

MAXIMUM BEARING REQUIRED:

$$Q = P_{dl} + P_{wl} / \text{effective footing size.}$$

$$Q = 200 + 95/(5 \times 14)$$

$$Q = 4.214 \text{ ksf} = 4{,}214 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max.Bearing Required}}$$

$$F.S. = \frac{50{,}708}{4{,}214}$$

$$F.S. = 12.0$$

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 33 OF 39

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California BEARING CAPACITY CALCULATION, ANTENNA NO. 6

ϕ = 27   C = 375 psf γ = 128 pcf

N_c = 24 N_γ = 9 N_q = 13

B = 5 ft. D_f = 5 ft.

BEARING CAPACITY:

$$q = C N_c + 0.5 \gamma B N_\gamma + \gamma D_f N_q$$

$$q = 375(24) + 0.5 (128)(5) (9) + 128(5) 13$$

$$q = 20{,}200$$

MAXIMUM BEARING REQUIRED:

$$Q = P_{dl} + P_{wl} / \text{effective footing size}$$

$$Q = 200 + 95 / (5 \times 14)$$

$$Q = 4.214 \text{ ksf} = 4{,}214 \text{ psf}$$

FACTOR OF SAFETY:

$$F.S. = \frac{\text{Bearing Capacity}}{\text{Max. Bearing Required}}$$

$$F.S. = \frac{20{,}200}{4{,}214}$$

$$F.S. = 4.8$$

DATE 3-26-79

PACIFIC SOILS ENGINEERING, INC.

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

WORK ORDER 200827

BY JSS

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California LATERAL RESISTANCE CALCULATIONS, ANTENNA NO. 1

B = 5 ft. D_f = 5 ft. γ = 119 pcf

Ø = 34 deg. C = 200 pcf Coefficient of Friction = .25

L = 2 x diameter = 180 ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE

$$R_p = [1/2\,\gamma D_f^2 \tan^2 (45 + Ø/2) + 2\,C\,D_f \tan (45 + Ø/2)]\,L$$

$$R_p = [1/2\,(119)\,(5)^2 \tan^2 (45 + 34/2) + 2\,(200)\,5 \tan (45 + 34/2)]\,180$$

$$R_p = 1624{,}000 \text{ lb.} = 1624 \text{ kips}$$

LATERAL RESISTANCE DUE TO FRICTION

R_f = Total Dead Load x Coefficient of Friction + C x Effective Footing Size

R_f = 800 kips x .25 + .2 x 5 x 14 x4

R_f = 256 kips

FACTOR OF SAFETY FOR WIND LOADING

F.S. = $(R_p + R_f)$ / Lateral Wind Load

$$F.S. = \frac{(1624 + 256)}{190} = 9.9$$

FACTOR OF SAFETY FOR SEISMIC LOADING

F.S. = $(R_p + R_f)$ / Lateral Seismic Load

$$F.S. = \frac{(1624 + 256)}{240} = 7.8$$

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PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

SHEET NO. 35 OF 39

SUBJECT Proposed 130 foot Diameter Antenna Array, Pioneer Site (DSS-11).
Goldstone, California LATERAL RESISTANCE CALCULATIONS, ANTENNA NO. 2

$B = 8$ ft. $D_f = 5$ ft. $\gamma = 118$ pcf

$\phi = 29$ deg. $C = 225$ psf Coefficient of Friction = .25

$L = 2 \times$ Diameter $= 180$ ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE

$$R_p = [\,1/2\,\gamma D_f^2 \tan^2 (45 + \phi/2) + 2\,C\,D_f \tan (45 + \phi/2)\,]\ L$$

$$R_p = [\,1/2\,(118)\,(5)^2 \tan^2 (45 + 29/2) + 2\,(225)\,(5) \tan (45 + 29/2)\,]\ 180$$

$$R_p = 1452{,}000 \text{ lb} = 1452 \text{ kips}$$

LATERAL RESISTANCE DUE TO FRICTION

R_f = Total Dead Load x Coefficient of Friction + C x Effective Footing Size

$$R_f = 800 \times .25 + .225 \times 8 \times 14 \times 4$$

$$R_f = 300 \text{ kips}$$

FACTOR OF SAFETY FOR WIND LOAD

F.S. = $(R_p + R_f)$ / Lateral Wind Load

$$F.S. = \frac{1452 + 300}{190} = 9.2$$

FACTOR OF SAFETY FOR SEISMIC LOADING

F.S. = $(R_p + R_f)$ / Lateral Seismic Load

$$F.S. = \frac{1452 + 300}{240} = 7.3$$

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1402 WEST 240TH STREET
HARBOR CITY, CALIFORNIA 90710

BY JSS | SHEET NO. 36 OF 39

SUBJECT Proposed 130-foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California LATERAL RESISTANCE CALCULATIONS, ANTENNA NO. 3

$B = 5$ ft. $D_f = 5$ ft. $\gamma = 121$ pcf

$\phi = 33$ deg. $C = 250$ psf Coefficient of Friction = .25

$L = 2 \times \text{Diameter} = 180$ ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE

$$R_p = [\,1/2\,\gamma\, D_f^2 \tan^2 (45 + \phi/2) + 2\,C\,D_f \tan(45 + \phi/2)\,]\ L$$

$$R_p = [\,1/2\,(121)\,(5)^2 \tan^2 (45 + 33/2) + 2\,(250)\,(5) \tan(45 + 33/2)\,]\ 180$$

$$R_p = 1752{,}000 \text{ lb} = 1752 \text{ kips}$$

LATERAL RESISTANCE DUE TO FRICTION

$$R_f = \text{Total Dead Load} \times \text{Coefficient Friction} + C \times \text{Effective Footing Size}$$

$$R_f = 800 \times .25 + .250 \times 5 \times 14 \times 4$$

$$R_f = 270 \text{ kips}$$

FACTOR OF SAFETY FOR WIND LOADING

$$F.S. = (R_p + R_f) / \text{Lateral Wind Load}$$

$$F.S. = \frac{1752 + 270}{190} = 10.6$$

FACTOR OF SAFETY FOR SEISMIC LOADING

$$F.S. = (R_p + R_f) / \text{Lateral Seismic Load}$$

$$F.S. = \frac{1752 + 270}{240} = 8.4$$

B = 5 ft. D_f = 5 ft. γ = 121 pcf

Ø = 34 deg. C = 700 psf Coefficient of Friction = .25

L = 2 x Diameter = 180 ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE:

$R_p = [1/2\ \gamma D_f^2 \tan^2 (45 + Ø/2 + 2\ C\ D_f \tan (45 + Ø/2)]\ L$

$R_p = [1/2\ (121)(5)^2 \tan^2 (45 + 34/2) + 2\ (700)\ 5 \tan (45 + 34/2)]\ L$

R_p = 3,332,000 lbs. = 3,332 kips

LATERAL RESISTANCE DUE TO FRICTION:

R_f = Total Dead Load x Coefficient of Friction + C x Effective Footing Size

R_f = 800 x .25 + .70 x 5 x 14 x 4

R_f = 396 kips

FACTOR OF SAFETY FOR WIND LOADING:

F.S. = $(R_p + R_f)$ / Lateral Wind Load

$$F.S. = \frac{3,332 + 396}{190} = 19.6$$

FACTOR OF SAFETY FOR SEISMIC LOADING:

F.S. = $(R_p + R_f)$ / Lateral Seismic Load

$$F.S. = \frac{3,332 + 396}{240} = 15.5$$

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PACIFIC SOILS ENGINEERING, INC.

WORK ORDER 200827

BY JSS

1402 WEST 240TH STREET
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SUBJECT Proposed 130 foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California LATERAL RESISTANCE CALCULATIONS, ANTENNA NO. 5

$B = 5$ ft. $D_f = 5$ ft. $\gamma = 121$ pcf

$\phi = 35$ deg. $C = 425$ psf Coefficient of Friction = .25

$L = 2 \times$ Diameter $= 180$ ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE:

$$R_p = [1/2 \; \gamma D_f^2 \tan(45 + \phi/2) + 2\, C D_f \tan(45 + \phi/2)]\; L$$

$$R_p = [1/2\,(121)(5)^2 \tan(45 + 35/2) + 2\,(425)\,5 \tan(45 + 35/2)]\; 180$$

$$R_p = 2{,}474{,}000 \text{ lbs.} = 2{,}474 \text{ kips}$$

LATERAL RESISTANCE DUE TO FRICTION:

R_f = Total Dead Load x Coefficient of Friction + C x Effective Footing Size

$$R_f = 800 \times .25 + .425 \times 5 \times 14 \times 4$$

$$R_f = 320 \text{ kips}$$

FACTOR OF SAFETY FOR WIND LOADING:

F.S. = $(R_p + R_f)$ / Lateral Wind Load

$$F.S. = \frac{2{,}474 + 320}{190} = 14.7$$

FACTOR OF SAFETY FOR SEISMIC LOADING:

F.S. = $(R_p + R_f)$ / Lateral Seismic Loading

$$F.S. = \frac{2{,}474 + 320}{240} = 11.6$$

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BY JSS | 1402 WEST 240TH STREET, HARBOR CITY, CALIFORNIA 90710 | SHEET NO. 39 OF 39

SUBJECT Proposed 130 foot Diameter Antenna Array, Pioneer Site (DSS-11)
Goldstone, California LATERAL RESISTANCE CALCULATIONS, ANTENNA NO. 6

$B = 5$ ft. $D_f = 5$ ft. $\gamma = 128$ pcf

$\phi = 27$ deg. $C = 375$ psf Coefficient of Friction = .25

$L = 2 \times$ Diameter $= 180$ ft.

LATERAL RESISTANCE DUE TO PASSIVE PRESSURE:

$$R_p = [1/2\ \gamma D_f^2 \tan^2 (45 + \phi/2) + 2\ C\ D_f \tan (45 + \phi/2)]\ L$$

$$R_p = [1/2\ (128)(5)^2 \tan^2 (45 + 27/2) + 2(375)(5) \tan (45 + 27/2)]\ L$$

$$R_p = 1{,}868{,}000 \text{ lbs.} = 1{,}868 \text{ kips}$$

LATERAL RESISTANCE DUE TO FRICTION:

R_f = Total Dead Load x Coefficient of Friction + C x Effective Footing Size

R_f = 800 K x .25 + .375 x 5 x 14 x 4

= 305 kips

FACTOR OF SAFETY FOR WIND LOADING:

F.S. = $(R_p + R_f)$ / Lateral Wind Load

$$F.S. = \frac{1{,}868 + 305}{190} = 11.4$$

FACTOR OF SAFETY FOR SEISMIC LOADING:

F.S. = $(R_p + R_f)$ / Lateral Seismic Load

$$F.S. = \frac{1{,}868 + 305}{240} = 9.1$$

Work Order 200827

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LEGEND

Qal Alluvium

Tda Dark andesite

Tt Tuff

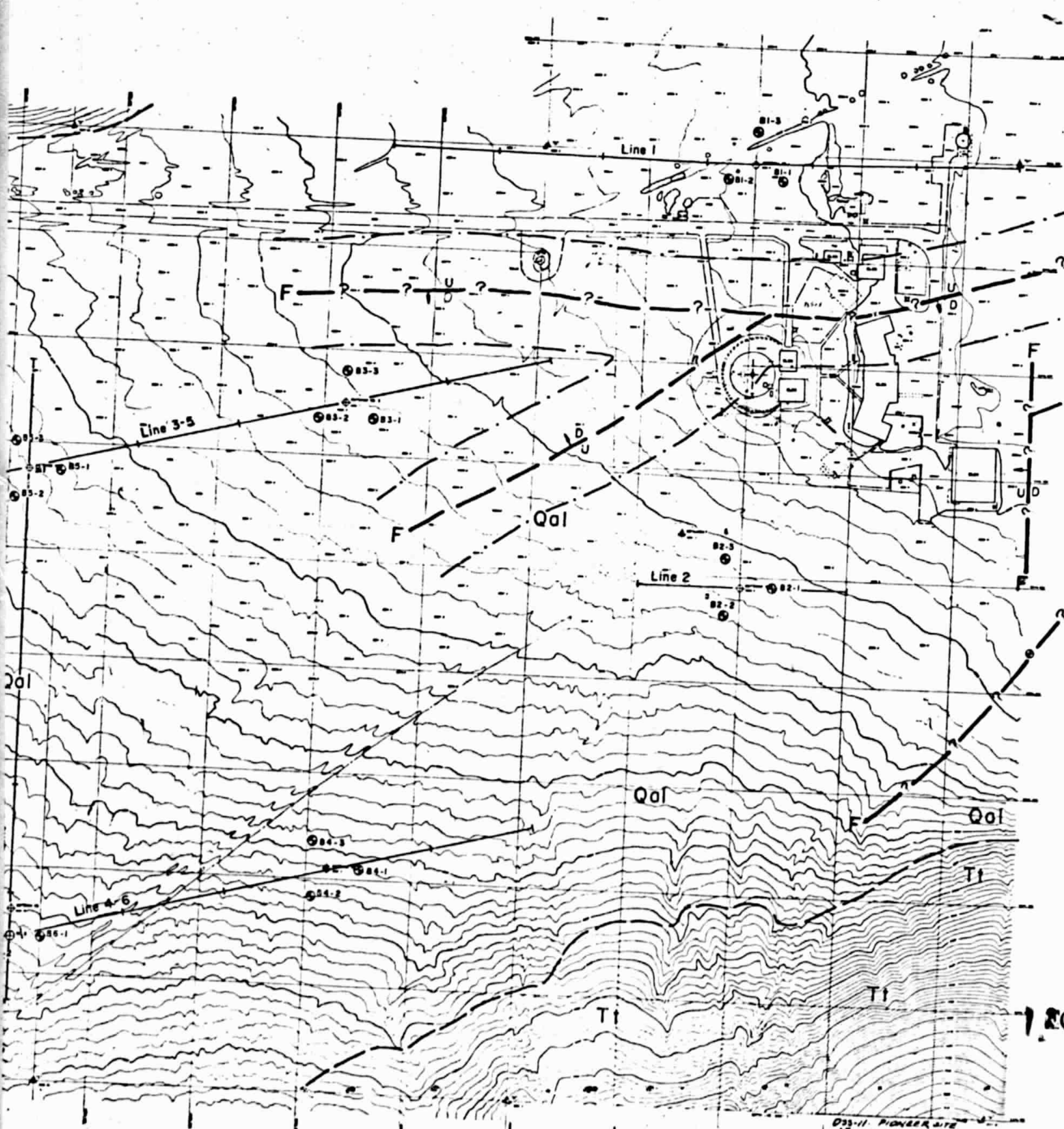
Geologic contact

F Approximate fault trace.

B3-3 Approximate boring location.

Approximate location of seismic refraction lines-shot points indicated (1978-79 investigation).

Approximate limits of fault setback; recommended in 1973-74 investigation, reference no. 2.



FOLDOUT FRAME

PLATE 1.

D33-11 PIONEER SITE
1" = 100 FT.

PACIFIC SOILS ENGINEERING, INC.

LEGEND

Qal Alluvium

Tda Dark andesite

Tt Tuff

Geologic contact

F Approximate fault trace.

B3-3 ⊕ Approximate boring location.

Approximate location of seismic refraction lines-shot points indicated (1978-79 investigation)

Approximate limits of fault setback; recommended in 1973-74 investigation, reference no. 2.

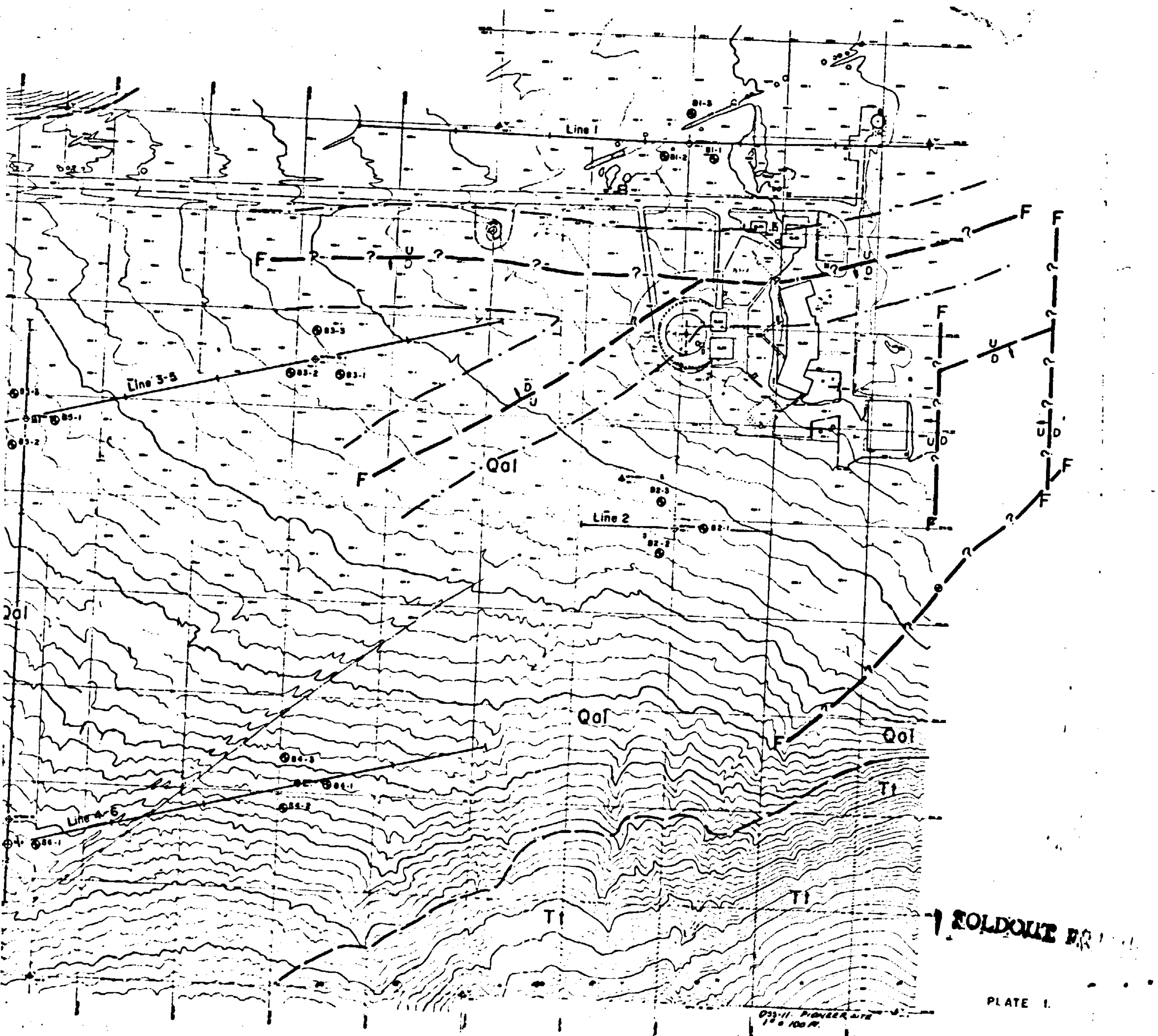


PLATE 1.

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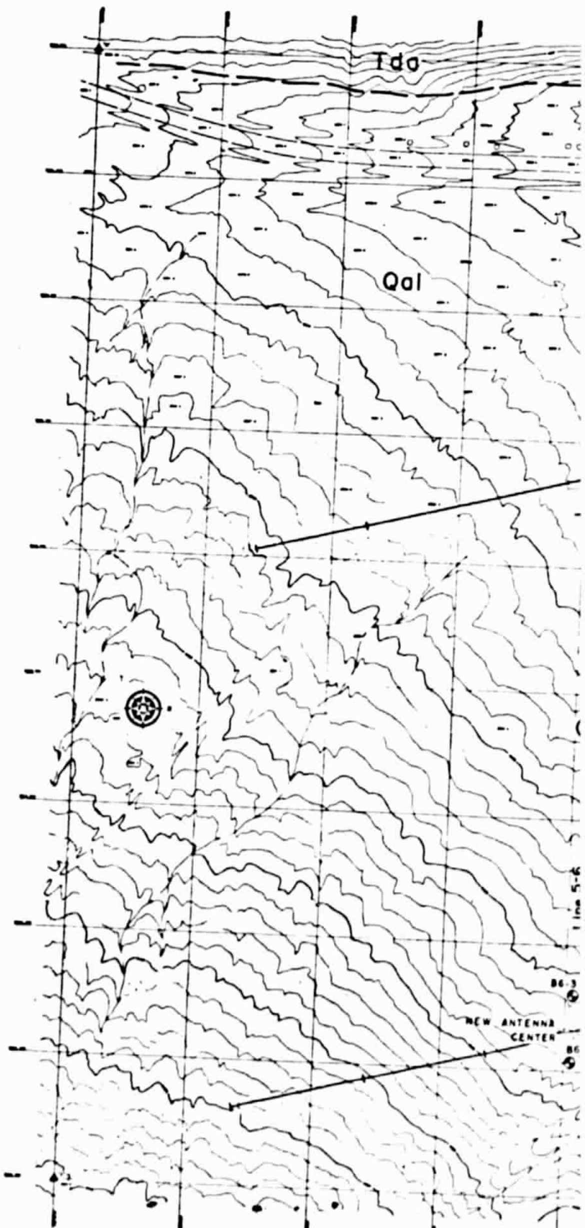

2 FOLDOUT FRAME

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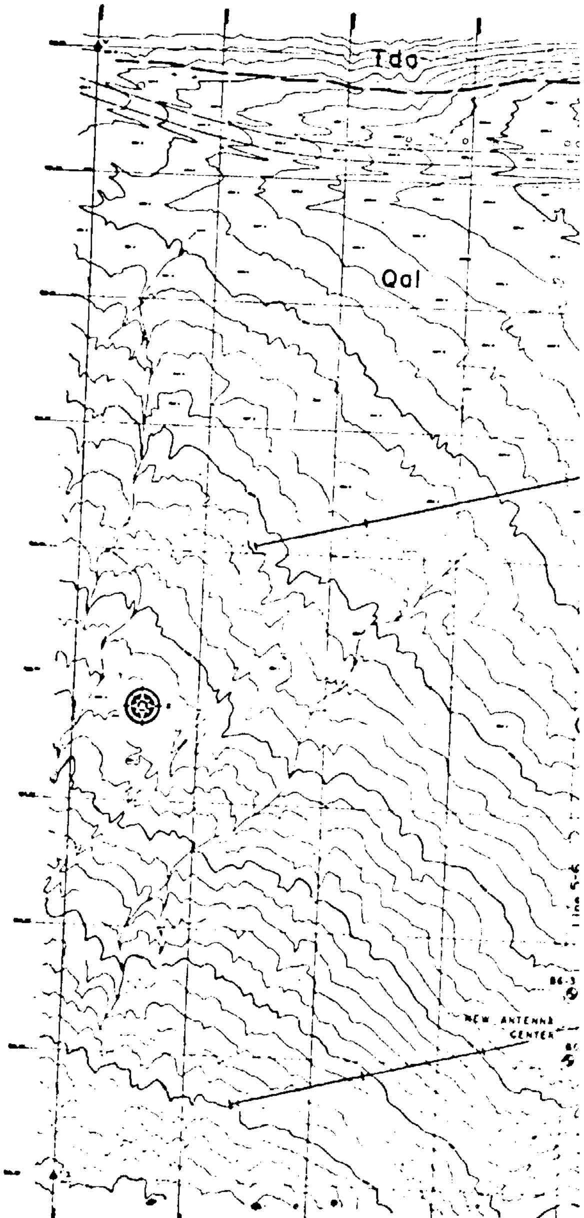

2 FOLDOUT FRAME