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COMMERCIAL LIGHT WATER REACTOR TRITIUM EXTRACTION FACILITY GEOTECHNICAL SUMMARY REPORT (U)

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Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under Contract No. DE-AC09-96SR18500

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	Page 34	**Changed maximum CSR_E and a_{max}**
	Appendix D	**Replaced**

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EXECUTIVE SUMMARY

Introduction

A geotechnical investigation program has been completed for the Circulating Light Water Reactor - Tritium Extraction Facility (CLWR-TEF) at the Savannah River Site (SRS). The program consisted of reviewing previous geotechnical and geologic data and reports, performing subsurface field exploration, field and laboratory testing and geologic and engineering analyses. The purpose of this investigation was to characterize the subsurface conditions for the CLWR-TEF in terms of subsurface stratigraphy and engineering properties for design and to perform selected engineering analyses. The objectives of the evaluation were to establish site-specific geologic conditions, obtain representative engineering properties of the subsurface and potential fill materials, evaluate the lateral and vertical extent of any soft zones encountered, and perform engineering analyses for slope stability, bearing capacity and settlement, and liquefaction potential. In addition, provide general recommendations for construction and earthwork.

Background

The CLWR-TEF is located in the General Separations Area (GSA) in the central part of the SRS (Figure 1). Within the GSA, the CLWR-TEF is situated in the northern portion of H-Area, directly west of the Replacement Tritium Facility (RTF) (Appendix E). An extensive geotechnical evaluation was performed for the RTF in 1993 (BSRI, 1993) and was used to supplement the investigations described herein.

Currently, the site is relatively level with grade being at approximately elevation 290 ft, MSL. Numerous trailers, warehouse facilities and other structures are located in the immediate area and will be relocated prior to construction.

Investigations

The field investigations performed for this evaluation consisted of:

- Five piezocone penetration test soundings (CPTU),
- Seventeen seismic piezocone penetration test soundings (SCPTU),
- Seven standard penetration test (SPT)/ undisturbed (UD) borings, and
- One direct push sample.

In addition, existing information was reviewed and used, in particular the information from the RTF, which is located approximately 200 feet to the east. Field investigations for the RTF included:

- Drilling of 33 exploratory borings
- Completion of two crosshole geophysical arrays
- Geophysical logging of four boreholes
- Installation of three piezometers
- Eight CPTUs

- Five SCPTUs

In the laboratory, samples representative of the various strata were classified with respect to their plasticity and gradation characteristics, in-place natural water content and density. Triaxial and consolidation tests were carried out on typical samples to define the strength and compressibility characteristics of the soils under static load. Since the soils were found to be very similar to the soils previously tested at the SRS, the dynamic properties (modulus and damping) and the dynamic strength of the various foundation materials were determined based on geologic stratigraphy and the unique site-wide relationships developed for the SRS.

Geology and Shallow Stratigraphy

Eocene and Miocene sediments within the GSA consist of unconsolidated deposits of sands, silty to clayey sands and clays. Shallow sediments of the Altamaha, Tobacco Road, and Upper Dry Branch formations are generally silty to clayey sands. Carbonate-rich horizons, of Eocene age, are found sporadically in the Lower Dry Branch and underlying Santee formations. These carbonate horizons are interspersed with sands and clays in a complex manner. In general, these carbonate buildups (layers) appear to be oriented northeast-southwest and parallel the strike of the coastal shoreline at the time of deposition.

Weight of rod and occasional rod drops have occurred in calcareous sediments as described in drilling reports for the GSA. Most of these "soft zones" are sediment-filled with a fine-grained sand.

The exploratory work completed during this investigation, supplemented with information from previous work at the site, disclosed rather uniform subsurface conditions that were consistent with the previous work at the RTF. The sands and clayey sands of the Altamaha and Tobacco Road formation extend from the ground surface to a depth of about 55 feet. These sands are underlain by about 56 feet of the dense sands and soft to medium clays of the Dry Branch formation (the Upper Dry Branch, Tan Clay and Lower Dry Branch), which are in turn, underlain by about 47 feet of silty to clayey sands of the Santee formation. Very stiff clays and dense sands of the Congaree formation underlie the Santee to the depths investigated.

Local soft soil zones were encountered in SPT boring H-TEF-B2 and SCPTU sounding H-TEF-C21 in the Santee formation. Investigations and previous experience indicate these zones are pockets of softer material with limited lateral extent. The soft soil zone encountered during this investigation was no thicker than 3 feet and circular in nature, about 35 feet in diameter. Groundwater was encountered in the borings at about elevation of approximately 252 feet MSL (a depth of about 38 feet), which is consistent with groundwater measurements in the northern portion of H-Area. For design purposes, a groundwater level of elevation 260 feet MSL is recommended.

Bearing Capacity and Static Settlement

Bearing capacities for the site soils were evaluated for various foundation configurations in the CLWR-TEF area. Results indicated that the soils in the CLWR-TEF area generally provide adequate strength for the foundations considered up to loads of 6 ksf. It is expected that the actual foundation loads will be in the range of 1 to 2 ksf. For this load range, the expected static settlement is less than 1 to 2 inches.

The exception is the Remote Handling Building (RHB) and Corridor 116. The RHB will be founded at a depth of about 31 feet below grade. The resulting excavation will cause the foundation subgrade to heave due to stress relief (unloading) during construction. The amount of stress relief depends on the soil properties and the length of time the excavation remains open. The amount of heave could be in the range of 3 to 4 inches. Since the load of the RHB is equal to or slightly less than the soil removed, the resulting settlement will be elastic and will be less than the amount of heave. Thus, the RHB could realize up to 3 to 4 inches of static settlement during construction.

Liquefaction

The liquefaction potential of the foundation soil was evaluated both qualitatively and quantitatively. Qualitatively, the measured shear wave velocity, grain size, and plasticity results of the foundation soils show that the potential for liquefaction is negligible. Quantitatively, the results showed that the foundation soils are not susceptible to liquefaction for the Performance Category 3 ground motion used. However, isolated pockets of material exist where the factor of safety is slightly less than one. The overall factor of safety for the foundation soils is generally greater than 1.5. Estimated dynamic settlement resulting from the ground motion ranges from less than 1/2-inch to 3 inches, with the average for the site ranging from approximately 3/4 to 2 inches.

Expected Settlement

Settlement for the facilities may occur in the following ways: 1) static settlement due to application of dead and live load, 2) dynamic settlement due to a seismic event, 3) settlement due to an underconsolidated soft layer at depth, and 4) secondary consolidation or creep. Analysis show that the total settlement for the Tritium Processing Building (TPB) ranges from approximately 2 ½ to 4 ½ inches, broken down as follows:

- 1 inch of static settlement,
- 1 to 3 inches of dynamic settlement, and
- ½ inch of secondary consolidation

The differential settlement can be assumed to be ½ of the total settlement. For the RHB, analysis shows that the total settlement (including maximum computed recompression) ranges from approximately 5 to 6 ½ inches, broken down as follows:

- 3 to 4 inches of static settlement (all being recompression during construction),
- ½ to 1 inch of dynamic settlement,
- ½ inch of secondary consolidation, and
- 1 inch of settlement due to underconsolidated soft zones

As discussed in the report, the 3 to 4 inches of static settlement is recompression of the subgrade soils due to stress relief during construction. Since the weight of the RHB is equal to or slightly less than (based on current information) the excavated soil, the static settlement (recompression) will occur concurrent with load application. Thus, the completed RHB would potentially realize approximately 2 to 2 ½ inches of movement during operation.

The final total and differential settlement for all of the facilities will depend on the construction sequence, the actual configuration, the final foundation loading, and any variation in soil conditions from those encountered.

Slope Stability

There are no permanent slopes associated with this facility. However, it is assumed a sloped excavation will be constructed for the RHB. Analysis shows that the temporary slope will be stable for slopes of 1-1/2 horizontal to 1 vertical. It is recommended that a 10 foot wide bench be constructed at the mid-height of the slope and that the slope be protected from the environment.

TABLE OF CONTENTS

EXECUTIVE SUMMARY iv

TABLE OF CONTENTS viii

LIST OF ACRONYMS, SYMBOLS AND TERMINOLOGY xi

LIST OF TABLES xvi

LIST OF FIGURES xvii

1.0 INTRODUCTION 1

1.1 PURPOSE AND OBJECTIVES 1
1.2 SCOPE OF THE INVESTIGATION 1
1.3 PROPOSED FACILITIES 1
1.4 EXISTING INFORMATION 2
1.5 QUALITY ASSURANCE 3

2.0 Geology and Seismology 4

2.1 GEOLOGY 4
  2.1.1 Cretaceous Sediments 4
  2.1.2 Tertiary Sediments 5
2.2 SEISMIC EVALUATIONS 7

3.0 Subsurface Exploration 9

3.1 FIELD TEST LOCATION AND CLEARANCE 9
3.2 EQUIPMENT AND FIELD TEST METHODS 10
  3.2.1 Exploration Contractors and Equipment 10
    3.2.1.1 Applied Research Associates (ARA) 10
    3.2.1.2 Graves Environmental 11
3.3 FIELD TEST METHODS 11
  3.3.1 Standard Penetration Test (SPT) 11
  3.3.2 Undisturbed Sampling 12
  3.3.3 Direct Push (CPT) Samples 12
  3.3.4 Piezocone Penetration Soundings 12
3.4 BOREHOLE AND PENETRATION ABANDONMENT 13
3.5 SAMPLE PREPARATION, HANDLING, STORAGE, TRANSPORTATION, AND CONTROL 13

4.0 Laboratory Testing 14

4.1 METHODOLOGY 14
4.2 LABORATORY TESTING PROGRAM 14
5.0 SUBSURFACE CONDITIONS 16
5.1 ENGINEERING STRATIGRAPHY 16
  5.1.1 Altamaha (Layer 1) 16

5.1.2 Tobacco Road Formation (Layers 1B, 1A, 2 and 3) 17
5.1.3 Dry Branch Formation (Layers 4A, 4, 5 and 6) 18
5.1.4 Santee/Tinker Formations (Layer 7) 19
5.1.5 Warley Hill Formation 20
5.2 GROUNDWATER 20
5.3 SOFT ZONES 20

6.0 Engineering properties 23

6.1 STATIC PROPERTIES 23
6.2 DYNAMIC PROPERTIES 23
6.2.1 Shear Modulus and Damping Ratios 23
6.2.2 Shear Wave Velocities 25

7.0 Engineering Evaluations 27

7.1 BEARING CAPACITY AND STATIC SETTLEMENT 27
7.1.1 Computation of Bearing Capacity and Static Settlement 27
7.1.2 Remote Handling Building 28
7.2 SLOPE STABILITY 29
7.3 LATERAL EARTH PRESSURE 29
7.4 MODULUS OF SUBGRADE REACTION 30
7.5 SECONDARY SETTLEMENT 31
7.6 SEISMIC DESIGN CRITERIA 31
7.6.1 Design Response Spectra 31
7.6.2 Soil Property Type 32
7.7 LIQUEFACTION AND DYNAMIC SETTLEMENT 32
7.7.1 Quantitative Evaluations 32
7.7.2 Qualitative Evaluations 34
7.8 SOFT ZONE SETTLEMENT 35
7.10 TOTAL AND DIFFERENTIAL SETTLEMENT 35

8.0 Design and Construction 37

8.1 SITE PREPARATION 37
8.1.1 Excavation of the Remote Handling Building (RHB) 38
8.1.2 Product Transfer Trench 39
8.2 COMPACTION AND FILL 39
8.3 SETTLEMENT MONITORING 41

9.0 Conclusions and recommendations 42

REFERENCES 45

TABLES T-1A

FIGURES F-1A

APPENDIXES

Appendix A Seismic Piezocone Penetration Test soundings and Piezocone Penetration Test soundings

Appendix B Geotechnical Boring Logs

Appendix C Laboratory Test Results

Appendix D Liquefaction Analysis Results

Appendix E Facility Layout and Exploration Location Plan and Subsurface Cross-Sections

LIST OF ACRONYMS, SYMBOLS AND TERMINOLOGY

a_{max}	peak horizontal ground acceleration
APSF	Actinide Packaging and Storage Facility
ARA	Applied Research Associates
arkosic	a sandstone or sand containing more than 25% feldspar
ASTM	American Society for Testing Materials
B	foundation width
biomoldic	composed of, or containing shell molds
bpf	blows per foot
BSRI	Bechtel Savannah River, Inc.
c	total cohesion
c'	effective cohesion
calcareous	containing calcium carbonate
carbonate	a compound containing the radical CO_3^{+2}
C_c	compression index
CD	consolidated drained triaxial test
CH	highly plastic clay
clastic	consisting of fragments of rock that have been transported
CLWR-TEF	Commercial Light Water Reactor – Tritium Extraction Facility
C_n	vertical effective stress correction factor for SPT-N
COE	Corps of Engineers
CPT	cone penetration test sounding
CPTU	piezocone penetration test sounding
C_r	recompression index (static settlement)
Cretaceous	Geological Period from 136 mybp to 65 mybp
CSR_E	cyclic stress ratio generated by the earthquake
CSR_L	cyclic stress ratio required to induce liquefaction in the soil
CU	consolidated undrained triaxial test
C_v	coefficient of consolidation
D	foundation depth
D_{50}	mean grain size

DBE	Design Basis Earthquake
deltaic	of, or produced by, deltas
Devonian	Geological Period from 395 mybp to 345 mybp
DOE	Department of Energy
D_r	relative density
El	Elevation relative to Mean Sea Level
e_0	initial void ratio
Eocence	Geological Epoch from 38 mybp to 54 mybp
EPRI	Electric Power Research Institute
facies	general appearance of one part of a rock or sedimentary body
feldspathic	containing feldspar
fluvial	produced by river action
fps	feet per second
FR	CPT friction ratio
F_s	CPT sleeve friction
FS	factor of safety
ft	foot or feet
g	acceleration of gravity
G	shear modulus
GC	Green Clay
GEI	Geotechnical Engineers, Inc.
glauconite	a green mineral closely related to the micas, commonly of marine origin
G_{max}	low strain shear modulus
GSA	General Separations Area
GWT	groundwater table
H	layer thickness
HCl	hydrogen chloride
HLW	High Level Waste
Holocene	Geological Epoch from 10,000 years to present
HTF	H-Area Tank Farm
Hz	Hertz. cycles per second
ISO	International Standards Organization
ITP	In-Tank Precipitation Facility

Jurassic	Geological Period from 190 mybp to 136 mybp
k	modulus of subgrade reaction
k_1	coefficient of subgrade reaction for 1 foot by 1 foot plate
K_σ	effective confining pressure correction factor
kaolin	a common hydrous, aluminum silicate, clay mineral
kaolinitic	of or containing kaolin
KASS	K-Area Soil Stabilization
kcf	Kip per cubic foot
kip	1,000 pounds
km	kilometer
ksf	Kips per square foot
L	foundation length
LAW	Law Engineering
lignite	a brown-black, low grade coal
lithofacies	the rock record of any sedimentary environment
LL	liquid limit
LLNL	Lawrence Livermore National Laboratory
M	Magnitude
m/sec	meters per second
m_b	Body wave magnitude
Mesozoic	Geological Era from 225 mybp to 65 mybp
MH	high plasticity silt
micaceous	containing mica
Miocene	Geological Epoch from 26 mybp to 7 mybp
ML	low plasticity silt
mm	millimeter
MSF	earthquake magnitude scaling factor
MSL	mean sea level, ft
mybp	million years before present
N-value	Sum of second and third set of recorded blows from the SPT
N1	SPT N-value normalized to 1 tsf
(N1)60	SPT N-value normalized to 1 tsf and 60% max. hammer energy ratio
NRC	Nuclear Regulatory Commission

OCR	overconsolidation ratio
OD	outside diameter
Oligocene	Geological Epoch from 38 mybp to 26 mybp
Ordovician	Geological Period from 500 mybp to 430 mybp
P	P-wave, compressional seismic wave
PI	Plastic Index
Paleocene	Geological Epoch from 65 mybp to 54 mybp
Paleozoic	Geological Era from 570 mybp to 225 mybp
PC	Performance Category
p_c	preconsolidation pressure
pcf	pounds per cubic foot
Pennsylvanian	Geological Period from 325 mybp to 280 mybp
Permian	Geological Period from 280 mybp to 225 mybp
PI	plasticity index
PL	plastic limit
Pleistocene	Geological Epoch from 2.5 mybp to 10,000 years before present
Pliocene.	Geological Epoch from 7 mybp to 2.5 mybp
psf	pounds per square foot
psi	Pounds per square inch
PSV	pseudospectral velocity
Q	crustal structure
QA	quality assurance
Q_a	allowable bearing pressure
q_c or Q_c	CPT tip resistance
$(q_c)_1$	CPT tip resistance normalized to 1 ton per square foot
QC	quality control
Quaternary	Geological Period from 2.5 mybp to present
Recent	Geological Epoch from 10,000 years to present (i.e., Holocene)
RTF	Replacement Tritium Facility
r_u	pore water pressure ratio $= \Delta u/\sigma_0'$
SC	clayey sand
SCPTU	seismic piezocone penetration test sounding
SGS	Site Geotechnical Services

siliciclastic	Composed predominately of clastic sediments rich in silica
SM	silty sand
SP	poorly graded sand
SPT	Standard Penetration Test
SRS	Savannah River Site
ST	Shelby tube (soil sampling)
ST	Santee/Tinker Formation
STD	standard
t	time
terrigenous	Deposited in or on the earth's crust
Tertiary	Geological Period from 65 mybp to 2.5 mybp
Triassic	Geological Period from 225 mybp to 190 mybp
tsf	tons per square foot
UD	undisturbed
UHS	Uniform Hazard Spectra
US	United States
USACOE	United States Army Corps of Engineers
USNRC	U. S. Nuclear Regulatory Commission
V_s	Shear wave velocity
$(v_s)_1$	Shear wave velocity normalized to 1 ton per square foot
WC	water content (moisture content)
WSRC	Westinghouse Savannah River Company
ε	shear strain
ε_r	reference strain
ϕ	total friction angle
ϕ'	effective friction angle
γ	unit weight of soil
ρ	mass density of the soil
σ_1, σ_3	principal normal stresses
τ	shear stress

LIST OF TABLES

Table 1	SCPTU and CPTU Locations in the Northern Section of the Tritium Area
Table 2	Borehole Locations in the Northern Section of the Tritium Area
Table 3	Recommended Soil Properties
Table 4	Reference Strain
Table 5	Damping Ratio versus Shear Strain

LIST OF FIGURES

Figure 1	Savannah River Site Map
Figure 2	SRS General stratigraphy
Figure 3	SRS site-wide design response spectra
Figure 4	Idealized cross-section for the CLWR-TEF site
Figure 5	Overconsolidation ratio versus elevations
Figure 6	Compression index versus Initial void ratio
Figure 7	Compression index versus moisture content
Figure 8	Compression index versus percent fines
Figure 9	Compression index versus plasticity index
Figure 10	Shear modulus reduction and variation of damping ratios with cyclic strain amplitude
Figure 11	Normalized cone tip resistance and friction ratio versus cyclic stress ratio required for initial liquefaction (from Reference 7.10)
Figure 12	Comparison of effective confining pressure correction factor ($K\sigma$) for SRS with $K\sigma$ from other sources (from Reference 7.10)
Figure 13	Volumetric strain as a function of safety factor against initial liquefaction (from Reference 7.10)
Figure 14	Derivation of relationship between pore water pressure ratio (r_u) and Volumetric strain after liquefaction (from Reference 7.10)
Figure 15	Relationship between cyclic shear strain amplitude, number of cycles, and pore water pressure increase for Santee Formation (from Reference 7.10)
Figure 16	Chinese criteria for clayey soils at CLWR-TEF facility (References 7.15 and 7.16)
Figure 17	Correlation between average shear wave velocity and cyclic stress ratio Required for Liquefaction (Reference 7.17)
Figure 18	Correlation between normalized shear wave velocity and cyclic stress ratio Required for Liquefaction (Reference 7.18)
Figure 19	Liquefaction potential chart based on shear wave velocity of a sand layer and 20 cycles of strong motion (Reference 7.19)

1.0 INTRODUCTION

This report summarizes the geotechnical investigation for the Commercial Light Water Reactor – Tritium Extraction Facility (CLWR-TEF) at the Savannah River Site (SRS).

The Commercial Light Water Reactor (CLWR) Project will establish the production capability and operations systems necessary to produce tritium in a commercial reactor so that tritium can be delivered to the nuclear weapons stockpile by the date specified in the project schedule. The CLWR-TEF Project will establish the processes, equipment, and facilities for production-scale extraction of tritium which minimize personnel exposure, minimize environmental releases, minimize waste generation, and provide reasonable capital and operation expenses (Ref. 1.1, 1.2, 1.3, 1.4). The CLWR-TEF Project site will be located in the H-Area of the SRS (Figure 1).

1.1 Purpose and Objectives

The purpose of this investigation is to characterize the subsurface conditions at the proposed Commercial Light Water Reactor - Tritium Extraction Facility project site; and to provide geotechnical information, including soil properties, engineering evaluations, and recommendations, for the design and construction of the facilities.

The objectives of this investigation are:

1. Determine subsurface conditions including selected soil properties,
2. Determine allowable bearing capacity and settlements resulting from static loading on the subsurface soils,
3. Evaluate the applicability of SRS site-wide PC3 spectra to CLWR-TEF facilities,
4. Evaluate the potential for liquefaction and dynamic settlement, and
5. Provide site preparation recommendations.

1.2 Scope of the Investigation

The scope of the investigation includes:

1. Conduct subsurface exploration,
2. Perform laboratory tests,
3. Perform geotechnical analyses,
4. Perform engineering evaluation, and
5. Prepare a geotechnical report.

1.3 Proposed Facilities

New facilities will be installed at the project site. These facilities include: 264-H, Tritium Processing Building (TPB); 264-1H, Support Building; 264-2H, Remote Handling Building (RHB); 264-3H, Cooling Towers; 264-4H, H & V Supply Air Platform; 264-5H, Gas Cylinder Storage Shed; 264-6H, Chiller Building; 264-7H, Exhaust Stack; 252-68H, Electrical Substation; 254-21H, Diesel Generator Building; 902-7H, Fire Protection Valve House; and Liquid Nitrogen Tanks.

The Performance Categories of these facilities are being determined and may range from PC1, PC2, to PC3. The Functional Classifications of these facilities are being determined and may range from General Services (GS), Production Support (PS), to Safety Significant (SS) (Ref. 1.2, 1.3, 1.4). Performance Categories, Functional Classifications (Ref. 1.5), and approximate dimensions (Ref. 1.1) assumed for the facilities for the proposed project are:

1. Main Building, 124 feet by 243 feet mat foundation, including 264-H, Tritium Processing Building, PC3, SS; and 264-1H, Support Building, PC1, GS.
2. 264-2H, Remote Handling Building, PC3, SS, 78 feet by 216 feet mat foundation.
3. 264-H, Room 116, Corridor, PC3, SS, 16.5 feet by 25 feet mat foundation.
4. 264-3H, Cooling Towers, PC1, GS, 20 feet by 34 feet with four 6 feet by 6 feet footings.
5. 264-4H, H & V Supply Air Platform, PC1, PS, 17 feet by 42 feet with eight 6.5 feet by 5 feet footings.
6. 264-5H, Gas Cylinder Storage Shed, PC1, PS, 8 feet by 25.5 feet mat foundation.
7. 264-6H, Chiller Building, PC2, PS, 46 feet by 70 feet with four 6 feet by 6 feet footings.
8. 264-7H, Exhaust Stack, PC3, SS, 27 feet by 27 feet mat foundation.
9. 252-68H, Electrical Substation, PC1, PS, 20 feet by 100 feet mat foundation.
10. 254-21H, Diesel Generator Building, PC2, PS, 25 feet by 58 feet mat foundation.
11. 902-7H, Fire Protection Valve House, PC2, PS, 10 feet by 10 feet mat foundation.
12. Liquid Nitrogen Tanks, PC1, PS, 19 feet by 22 feet mat foundation.

The above information is subject to change during the design process. The locations and configurations of the facilities (Ref. 1.1) are shown on the Facility Layout and Exploration Location Plan in Appendix E.

1.4 Existing Information

The proposed facilities will be constructed in the northwest section of the Tritium Area. The Tritium Area is located in the northwest portion of H-Area. The natural terrain in the project site gently slopes towards the northwest from approximately 290 feet Mean Sea Level (MSL) to approximately 280 feet MSL. The major portion of the project site is unpaved and covered with grass or gravel. Some of the areas are paved with asphalt or concrete; however, two warehouse buildings, several pre-manufactured buildings, storage sheds, utility equipment pads, and timber walkways are currently located at the project site.

Geotechnical investigations were performed previously in the vicinity of the project site. Investigations for Building 233-H, Replacement Tritium Facility (RTF) have provided valuable data for the CLWR-TEF project site. Investigations for the RTF site included Standard Penetration Test (SPT) boreholes, undisturbed (UD) sample boreholes, Seismic Piezocone Penetration Test (SCPTU) soundings, Piezocone Penetration Test (CPTU) soundings, Cross-hole seismic wave measurements, laboratory tests, and engineering analyses (Ref 1.6). Information on deep stratum in the H-Area, based on the data from a deep borehole (MMP-2A-SB) on the southwest side of the H-Area, has also been incorporated into this investigation.

1.5 Quality Assurance

Quality related activities performed by WSRC during the Geotechnical Investigation were controlled in accordance with the WSRC QA Program as delineated in WSRC Procedure Manual 1Q, Quality Assurance Manual (Ref. 1.7). Activities performed by SGS personnel were also controlled via compliance to the applicable administrative and technical procedures contained in WSRC Procedure Manual E9, Site Geotechnical Services (Ref. 1.8).

Cone Penetration Testing was controlled in accordance with the Quality Assurance Plan for WSRC Subcontract AB53066-N with Applied Research & Associates, Inc., Revision 0 (Ref. 1.9), and the Quality Assurance Program for Piezo/Seismic Cone Penetration Tests (Ref. 1.10). Subcontractor compliance with their implementing procedures and instructions (ARA-Q-101 through 107) (Ref. 1.11) also ensured the integrity of CPTU results and interpretations.

Soils testing performed by Law Engineering was accomplished through compliance with the Law Engineering QA Program as delineated in their QA manual, Law Engineering Quality Assurance Manual, Revision 0 (Ref. 1.12), applicable Work and Test Procedures, and applicable national/industry test standards (as specified in procurement specification).

SGS QA provided quality oversight over all quality related activities of the geotechnical investigation. SGS QA oversight activities included the review and approval of all technical and quality procedures and instructions developed specifically for the investigation and review of engineering calculations.

QA/QC activities were also performed by Law Engineering and Applied Research & Associates personnel as prescribed in their respective QA programs, QA plans, and QA technical procedures.

2.0 GEOLOGY AND SEISMOLOGY

2.1 Geology

Basement lithologies at the SRS consist primarily of crystalline igneous and metamorphic rocks, possible Late Precambrian to Late Paleozoic age, and of Early to Middle Mesozoic (Triassic to Jurassic) rocks that occur in isolated, fault-bounded basins either exposed within the crystalline belts or buried beneath the coastal plain sediments (Ref. 2.1).

The Coastal Plain stratigraphic section is divided into several formations and groups based principally on age and lithology. Sediments range in age from Late Cretaceous through Tertiary. The lithostratigraphic sequence at the General Separations Area (GSA) is composed mostly of terrigenous clastic sediments interspersed with carbonate-rich clastic sediments and limestones. The clastic facies consist of gravel, pebbly sand, clayey sand, silt, clay, and sandy clay. The calcareous facies consist of calcareous sand and mud, limestone, sandy limestone, and sandy and muddy limestone. These Cretaceous through Tertiary sediments are described in the following sections and depicted in Figure 2, beginning with the deepest formations and progressing to the surficial sediments.

2.1.1 Cretaceous Sediments

The Cape Fear Formation is the basal unit of the Coastal Plain stratigraphic section and is composed of poorly sorted, silty-to-clayey quartz sand and interbedded clay. The sand is arkosic in places. Muscovite and iron sulfide are also present. The Cape Fear Formation is more indurated than the other Cretaceous formations because of the high clay content and abundance of cristobalite in the sediment matrix. Sand is commonly medium-grained, but ranges from very fine to coarse-grained. Pebbly zones are present in many parts of the section.

The Cape Fear Formation is about 30 feet thick at the northwestern SRS boundary and thickens to more than 180 feet near the southeastern boundary. The environment of deposition has been interpreted as upper delta plain (Ref. 2.2).

The Middendorf Formation unconformably overlies the Cape Fear Formation with a sharp, distinct contact. This formation is dominantly a medium to coarse-grained quartz sand with moderate to good sorting. Pebbly zones are common as well as clay clasts. Some parts of the unit are feldspathic, micaceous, and lignitic zones. The sand of the Middendorf Formation is much cleaner and less indurated than sand in the Cape Fear Formation. Cross-bedding is well developed in the lower part of the section in some areas. A clay layer up to 80 feet thick forms the top of the formation. Another clay-rich zone is present near the middle of the formation in places at SRS. In the northern part of SRS, the formation is highly colored and composed mostly of sand. The thick clay bodies observed downdip within SRS are missing in the north, although clay interbeds up to 2 feet in thickness are present.

The formation is approximately 130 feet thick near the northwestern boundary of SRS and thickens to more than 180 feet near the southeastern boundary. The Middendorf Formation at SRS was probably deposited in fluvial and deltaic environments (Ref. 2.2).

The Black Creek Formation is composed of sand, silt, and clay. The upper part of the formation is mostly clay and silt, while the lower part consists of silty micaceous sand. Sorting is generally moderate to poor. The sand is micaceous and becomes lignitic in the central and southwestern parts of the SRS. Layers of pebbles and clay clasts are common. Feldspathic zones are present. The upper, clayey, silty section of the Black Creek Formation is divided into three lithofacies, each trending across SRS from southwest to northeast. The northwestern lithofacies is a massive 20 to 40 feet thick clay that is highly oxidized. The Black Creek Formation in the central part of SRS is dominantly dark to light, micaceous silty sand with thin interbeds of clay. The southeastern lithofacies is also fine-grained and consists mostly of dark clay interlaminated with silt. Dark, fine- to medium-grained, fining-upward sand is present within the unit. Iron sulfides are common.

The Black Creek Formation is about 110 feet thick at the northwestern boundary of SRS and thickens to more than 250 feet near the southeastern boundary of the site. Most of the Black Creek Formation was probably deposited in a lower delta plain environment, except for the light-colored sand in the northwestern part of SRS, which was probably deposited in an upper delta plain environment.

The Steel Creek Formation is dark, glauconitic, fine-grained sand and silt with marine fossils (dinoflagellates). The lower part of the Steel Creek Formation is sandy with a pebble-rich zone at its base suggesting a basal unconformity. This lower section consists of poorly to well-sorted, fine- to coarse-grained quartz sand and silty sand and is very micaceous in places. The upper part of the Steel Creek Formation is a clay that varies from more than 50 feet to less than 3 feet in thickness at SRS. Fining upward sands are interbedded with the clay in some areas. Steel Creek Formation probably formed in an upper delta plain environment in the southwest and in a lower delta plain in the northeast. It is about 110 feet thick at the northwestern SRS boundary and 130 feet thick at the southeastern boundary.

2.1.2 Tertiary Sediments

Paleocene

The Sawdust Landing Formation, the lowermost Paleocene unit, rests unconformably on Cretaceous sediments and consists mostly of yellow, orange, tan and gray, poorly sorted, micaceous, silty, and clayey quartz sand interbedded with gray clay. It is locally feldspathic and iron sulfide and lignite are common in the darker sections.

The overlying Lang Syne Formation consists of dark gray and black lignitic clay and poorly to moderately sorted, micaceous, lignitic, silty quartz sand and pebbly sand. Glauconite is common in the southeastern part of the unit. Feldspar occurs locally and iron sulfide and cristobalite are common in the darker colored part of the unit.

The Snapp Formation, the uppermost Paleocene unit, consists typically of light gray, tan, orange, and yellow, medium-to coarse-grained quartz sand and pebbly sand interbedded with kaolinitic clay. Dark muscovite and lignite-bearing sand is less common. The Snapp in the northwest part of SRS is a less silty, better sorted sand with thinner clay interbeds.

The depositional environment for Paleocene unit grades from upper to lower delta plain (deltaic) and marginal marine from northwest to southeast across SRS.

Eocene

The Fishburne Formation of Fallaw and Price (Ref. 2.3) is a tan, orange, yellow, brown, and white, fine to coarse, moderately well-sorted, loose sand. Pebbly zones are common. Clay layers are characteristically found near the middle and top of the unit. It is characteristically about 30 feet thick at SRS. The presence of glauconite and dinoflagellate assemblages suggest a shallow marine environment of deposition.

The Congaree Formation unconformably overlies the Fishburne Formation and consists of well sorted, well rounded, and fine- to coarse-grained quartz sand. Thin clay laminae occur throughout the formation, but are more common in the lower part. In some areas a thin clay-rich glauconite-bearing layer separates the Congaree from the underlying Fishburne Formation. Pebble layers, clay clasts, and glauconite are locally present. Both siliceous and calcareous cement have been observed in the upper part of the Congaree Formation at SRS. The unit increases in thickness from about 60 feet on the northwest to about 80 feet in the southeast, and is interpreted as a shallow marine environment of deposition.

The Warley Hill Member (Ref. 2.4) overlies the Congaree Formation. It consists of variable clay, clayey sand, and silty fine-to medium-grained quartz sand and locally contains glauconite. Thickness varies from a few inches to 15 feet. The Warley Hill is sometimes included in the informal hydrostratigraphic unit known as the "green clay."

The Tinker-Santee Formation overlies the Warley Hill interval and includes several distinct lithofacies. The light colored, moderately to well sorted, fine to coarse, sometimes calcareous quartz sands that predominate towards the north and northwestern parts of SRS have been termed the Tinker Formation (Ref. 2.4). The amount of calcareous material within the Tinker Formation increases from northwest to southeast across SRS and grades into the Santee Limestone towards the southeast. The Santee Limestone consists of cream-colored, micritic to shelly, partially indurated to indurated, biomoldic limestone, indicative of an open, unrestricted shallow marine environment. Previously, the Tinker-Santee interval was termed the McBean Formation or McBean Member of the Lisbon Formation, or the Santee Formation (Ref. 2.2, 2.5, 2.6).

The Clinchfield Formation overlies the Tinker Formation and consists of fine- to coarse-grained, locally calcareous, quartz sand. An indurated, bioclastic and biomoldic, glauconitic limestone facies, commonly containing abundant echinoid fragments (Periarchis lyelli), is designated as the Utley Limestone Member. The amount of calcareous material increases downdip (i.e., to the southeast). This unit was not indicated in CLWR-TEF boreholes.

The Dry Branch Formation overlies the Clinchfield Formation. The Dry Branch Formation has been subdivided into the Griffins Landing, Twiggs Clay, and the Irwinton Sand Members. The Griffins Landing Member is a distinctive carbonate-bearing facies that interfingers with the Twiggs Clay Member which consists of clay beds of variable thickness interbedded with clayey sand. The Griffins Landing is characterized by the presence of Crassostrea gigantissima (giant oyster shells) often found in growth positions. These carbonate occurrences are discontinuous and probably represent oyster beds developed in a back barrier or transitional environment, and the clays probably represent marsh and tidal flat deposits. The Irwinton Sand Member contains moderately-to well-sorted quartz sand, locally interlaminated with clay. In general, the Irwinton Sand generally maintains a superior stratigraphic position to Twiggs Clay and the Griffins Landing Members. The entire formation thickens from about 50 feet near the northwestern boundary of SRS to approximately 80 feet to the southeast. Members of the Dry Branch Formation were not differentiated in this investigation.

The Tobacco Road Formation conformably overlies the Dry Branch Formation. A coarse layer that may contain a flat pebble conglomerate is characteristic at the contact point between the two formations. The formation typically contains moderately- to poorly-sorted, red, brown to variegated purple and orange, quartz sand with clay stringers. Trace fossils, especially burrows of Ophiomorpha, are locally abundant. Pebble layers and muscovite are distributed locally throughout the formation. A heavy mineral concentration, sometimes present at this boundary, may produce radioactivity that assists in identifying the contact on gamma-ray logs.

Younger than Eocene

The 'Upland Unit' is an informal stratigraphic term that has been applied to local deposits that outcrop at higher elevations in the coastal plain of southwestern South Carolina (Ref. 2.7. 2.8). Units in a similar stratigraphic position in Georgia are usually called the Altamaha Formation. Outcrops and surface exposures are very common in the SRS area. Dark red, brown, orange, poorly sorted clayey to silty sand locally contains lenses and layers of conglomerate, pebbly sand and clay. Cross bedding and white flecks that may be weathered feldspar are locally common. The Upland Unit, locally up to 70 feet thick, is generally fluvial and forms a scoured, erosional surface on the Tobacco Road Formation. The age of this unit has not been definitively determined, and correlation with similar deposits in the region is not yet clear. Prowell, et. al. (Ref. 2.2) and Nystrom et al. (Ref. 2.8) have proposed a Miocene age. Work in progress (Ref. 2.9) suggests that at least in part, the age of sediments in this interval may be as old as Late Eocene.

2.2 Seismic Evaluations

The Generic Safety Analysis Report (SAR) (Ref 2.10) contains a detailed description of SRS seismic hazards, a summary of applicable DOE seismic standards, and a history of the earthquake design basis development for SRS facilities. The reader is referred to that document for the seismology background.

Current SRS site-wide design basis earthquake (DBE) spectra are reported in Ref. 2.11. The site-wide design basis spectra meet the requirements of DOE Standards 1020 (Ref. 2.12) and 1023 (Ref. 2.13). Performance Category 3 and 4 (PC3 and PC4) spectra are developed for the SRS bedrock/soil interface and for soil free-surface. Figure 3 shows the SRS site-wide design response spectra.

These spectra meet DOE-STD-1023 (Ref. 2.13) requirements for mean based spectra that have an annual probability of exceedance of 5×10^{-4} (PC3) and 1×10^{-4} (PC4). The bedrock design basis spectrum was derived by averaging the Electric Power Research Institute (Ref. 2.14) and the Lawrence Livermore National Laboratory (Ref. 2.15) mean uniform hazard spectrum (UHS), appropriate for bedrock conditions at the SRS. Following DOE-STD-1023 (Ref. 2.13), the PC3 bedrock hazard spectrum was broadened by using two deterministically-derived spectral shapes; one anchored at the average of 5 to 10 Hz and the other at the average of 1 to 2.5 Hz. The spectral shapes were derived from Random Vibration Theory (RVT) (Ref. 2.16) models of ground motion for average earthquake magnitudes and distances controlling the 5 to 10 and 1 to 2.5 Hz seismic hazard. These earthquake magnitudes ranged from 5.4 to 5.7 (M_w) and distances 70 to 105 km. Similarly, a 1 x 10^{-4}/yr bedrock and soil spectra were also derived for PC4 facilities. The site-wide soil spectrum was developed by computing the mean soil response from a statistically derived soil model. The soil model was derived from the SRS database consisting of laboratory estimates of soil specimen dynamic properties, a variety of geophysical estimates of shear-wave velocity in soil and bedrock, and geological and geotechnical investigations from boreholes and geophysical logs. In addition to the measured site-wide variability, the model accounts for variability in bedrock and soil column thickness.

DOE-STD-1023 (1996) also requires a deterministic ground motion check using the largest historical earthquake within 200 km having a moment magnitude greater than 6. For the SRS, this check was conducted for ground motions associated with a repeat of the 1886 Charleston earthquake ($M_w = 7.3$). Following DOE-STD-1023 (Ref. 2.13), the median and 84th percentile ground motion spectra were used to meet the PC3 and PC4 performance criteria respectively.

According to WSRC (Ref. 2.17), the spectra are considered "committed" in accordance with the E7 Manual (Ref. 2.18). For application of the spectra to a particular facility, the spectra must be "confirmed" by conducting a review of the stratigraphic conditions at the site for consistency with the database used to develop the site-wide spectra (Ref. 2.11). Site specific CLWR-TEF velocity and stratigraphy data have been reviewed and found to be consistent with the data used for the site-wide spectra. Thus, the PC3 broadened free-field spectrum, contained in Ref. 2.11 is "confirmed" for engineering analysis of the CLWR-TEF, as discussed in Section 7.7.

3.0 SUBSURFACE EXPLORATION

Subsurface information in H-Area is available from pre-construction boreholes drilled for the initial foundation investigations, post construction soils investigations, and from recently completed geotechnical investigation programs. In the vicinity of the CLWR-TEF project area, a geotechnical investigation for the Replacement Tritium Facility (RTF) was completed in 1993 (Ref. 1.6). This information was used to develop the geotechnical investigation program for the CLWR-TEF.

Between September 1997 and April 1998, the subsurface exploration for the CLWR-TEF was executed. The primary intent of the program was to acquire information to characterize the subsurface conditions in terms of static and dynamic properties. This was accomplished by developing a shallow engineering stratigraphy for the area and comparing the subsurface conditions and stratigraphy directly with the extensive characterization previously completed for the RTF and other H-area facilities.

The CLWR-TEF subsurface exploration consisted of a series of standard penetration test (SPT) with undisturbed (UD) sample boreholes, seismic piezocone penetrometer test (SCPTU) and non-seismic piezocone penetrometer test (CPTU) soundings. In summary, the following boreholes and information acquired as part of this investigation have been used for the characterization of the subsurface materials within the project area:

- Seventeen SCPTU soundings,
- Five CPTU soundings,
- Seven SPT/UD boreholes,
- One Direct Push Sample,
- 33 RTF- SPT/UD boreholes,
- Eight RTF CPTU soundings,
- Five RTF SCPTUs, and
- Two RTF Cross-hole Surveys.

SCPTUs and CPTUs in the vicinity of the project site are summarized in Table 1. Boreholes in the vicinity of the project site are summarized in Table 2. Field exploratory locations along with the proposed facilities are shown in Appendix E, Facility Layout and Exploration Location Plan. Appendix A contains the SCPTU and CPTU sounding results including the sleeve resistance, tip resistance, pore pressure, and friction ratio. Shear and compressive wave velocities are also included for the SCPTUs. Appendix B contains the Geotechnical Boring Logs for the boreholes.

3.1 Field Test Location and Clearance

The selection of the borehole locations, cone soundings, and other field work was based primarily on the following criteria and factors:

- Existing structures and the proposed facility layout,
- Data coverage,
- Existing data availability,

- Type of data required,
- Under-and-above ground interferences, and
- Operation restrictions.

Approval of the selected location for the field work was preceded by a series of work coordination steps as summarized below (the organization responsible for each step is noted in parentheses):

- Selection of general area based upon the factors listed above (SGS),
- Preliminary interference research (Construction Layout),
- Ground penetrating radar survey (Operations Department),
- Preparation of work package (SGS),
- Work Process Control (Operations Department), and
- Field survey (Construction Layout).

3.2 Equipment and Field Test Methods

All equipment used in the field investigations met applicable ASTM standards and site standards and procedures as listed below (Ref. 1.8, 3.1, 3.2):

- WSRC E9 SGS-GT-202 - Drilling Practices,
- WSRC E9 SGS-GT-203 - Sample Preparation, Handling and Storage,
- WSRC E9 SGS-GT-206 - Engineering Soil Descriptions,
- WSRC E9 SGS-GT-207 - Field Log Preparation,
- WSRC E9 SGS-GT-210 - Standard Penetration Test,
- WSRC E9 SGS-GT-211 - Cone Penetration Test Soundings,
- WSRC 3Q5 Manual - Hydrogeologic Data Collection, and
- ASTM D1587-83 - Thin-walled Tube Sampling of Soils (Shelby).

3.2.1 Exploration Contractors and Equipment

One drilling contractor was utilized for the boreholes, SPT testing, and undisturbed soil sampling (Shelby tubes). One contractor was used for all cone soundings. A description of the scope of each contractor and the equipment used is provided below.

3.2.1.1 Applied Research Associates (ARA)

Applied Research Associates (ARA) performed all CPT field and data processing activities. The rig and crew have been used extensively on recent geotechnical programs at SRS including the ITP/HTF investigation, RTF, KASS, Par Pond, F-Area, APSF and others.

The CPT rig utilized was a 22-ton rig capable of 30 ton mass push when fully ballasted. The push rod and piezocone utilized conformed with ASTM D5778-95 consistent with WSRC E9 SGS-GT-211 - Cone Penetration Test Soundings (Ref. 1.8). This rig was equipped with a hydraulic skid coupled to the surface beneath the rig for generating a shear wave source. Compression waves were generated with a hammer located on the outside of the rig. All components were controlled by the operator.

3.2.1.2 Graves Environmental

Graves Environmental, Inc., performed the drilling and sampling for all boreholes. All Graves Environmental drillers involved with the drilling and sampling activities were experienced, and also had been involved with numerous geotechnical investigations at the SRS including the RTF and ITP/HTF investigation.

A Failing 1500 drill rig was used to advance the boreholes. The Failing 1500 drill rig is gas-driven with a 40-foot mast. The rig has a 23-foot Kelly assembly which allows for a 20-foot stroke and is capable of mud rotary, augering, and rotary coring techniques. The drill string is controlled by the Kelly arrangement, as well as, by a mechanical winch. This type rig was used for all boreholes.

3.3 Field Test Methods

3.3.1 Standard Penetration Test (SPT)

Continuous SPT with intermittent shelby tube samples, were performed in boreholes HTEF-B1 and HTEF-B2 located underneath the heavily loaded portion of the facility. Borehole HTEF-B3, HTEF-B4 and HTEF-B5 were continuously sampled in the upper 30 feet changing to five feet centers for about the next 90 feet and continuous for the remaining depth of the boreholes (about another 40 feet typically). Borehole HTEF-B6 was drilled to obtain a single missed shelby tube interval and borehole HTEF-B7 was drilled adjacent to HTEF-B4 to obtain SPT measurements between depths of 88 to 100 feet due to a no recovery zone noted in this interval.

Tests were performed in accordance with WSRC E9 SGS-GT-210 (Ref. 1.8) using a standard 24-inch long by 2-inch outside diameter (OD), split-spoon sampler with a bleeder and check valve located above the sampler, NWJ drill stem, and a 140-lb safety hammer falling 30 inches. SPT testing was performed by driving the split spoon sampler 18 inches, unless refusal per ASTM D 1586-84 (Ref. 3.2). SPT N-values were determined by adding the number of blows required to drive the split-spoon sampler the last 12 inches of the standard 18-inch drive. The general test procedure, as noted in sequence, is outlined below:

- Split spoon is lowered into nominal 4-inch diameter borehole,
- Depth is checked and any rod settlement noted,
- Six-inch intervals, totaling 18 inches, are marked on the drill rod above the turntable,
- Sampler is driven by blows applied using a 30-inch stroke with the rope wrapped twice over the cathead,
- Sampler retrieved and recovery noted,
- Sampled interval reamed out to nominal 4 inches, and
- Process repeated.

Prior to each SPT test, the Geotechnical Oversight verified that the spoon was properly assembled, making sure the bleeder and check valve were clean and the drive shoe was in good condition.

3.3.2 Undisturbed Sampling

The selection of the sampling interval was based on the results of previously pushed SCPTU soundings. Undisturbed soil samples were obtained for laboratory testing with direct push shelby tubes in accordance with ASTM D1587 (Ref. 3.2).

The shelby tubes used were galvanized steel with a 3 inch OD, 0.065 inch wall thickness, and a length of 30 inches. Drilling was accomplished by mud rotary methods to the predetermined sampling depth. Drilling requirements for undisturbed sampling boreholes required that fluid pressures be kept as low as practical, while maintaining fluid return up the borehole. Drill bits with side discharge, or, in the case of tricone bits, with bottom deflectors, were required for reaming and advancing the borehole. All boreholes were advanced 6 inches past the previous SPT interval before pushing shelby tubes. The drill stem was then tripped out and the bit removed. The Shelby tube head with a ball check valve was then attached and lowered to the bottom of the borehole. Borehole depth was checked against the drilled depth and noted. The maximum push length was marked on the drill stem and the rod hydraulically advanced a full 24 inches or until 600 psi hydraulic pressure was reached. Once the advance was made, the tube was allowed to sit for a minimum of 5 minutes. When ready to retrieve the sample, the drill string was rotated about 90 degrees to shear the sample off the surrounding soil.

When each sample was brought out of the borehole, the bottom and top were capped with plastic slip-on caps. If a gap was noted between the bottom tube edge and sample, a filler material was placed in the gap prior to placing the cap. Details of final sample preparation are provided in a following Section 3.5.

3.3.3 Direct Push (CPT) Samples

Direct push samples were acquired adjacent to borehole HTEF-C9 in an interval where a softer zone was noted. This procedure involves using a typical CPT rig to hydraulically push a cone to the target sample depth. Once the target depth is reached, a retrieval tool on a wire cable is lowered down the push rod and the tip is released. The cable is then used to hold the tip in place as the sampler is advanced. The CPT sampler is capable of acquiring a 44 inches long by 1.4-inch diameter continuous sample. The cutting shoe on the leading edge of the sampler cuts the soil which passes into the barrel. An inner liner consisting of stainless steel, brass or clear high density plastic is used to capture the sample. These samples were handled and transported in the same manner as shelby tube samples.

3.3.4 Piezocone Penetration Soundings

CPTU soundings, including seismic (SCPTU), were performed in accordance with WSRC E9 SGS-GT-211 (Ref. 1.8). The CPTU was used to provide a continuous soil profile, which is important when defining the extent of soft and/or loose soil zones. All but 5 of the 22 soundings included shear wave velocity surveys at 3-foot intervals. Target depths were based upon the estimated elevation of the top of the Congaree Formation (average depth is approximately 160 feet). However, actual depths varied, depending upon ground surface elevations and subsurface conditions.

3.4 Borehole and Penetration Abandonment

Abandonment of boreholes and CPT soundings was performed per WSRC Manual 3Q5, Hydrogeologic Data Collection, Chapters 6, 9, and 10 (Ref. 3.1). The standard grout mix consisted of the following:

- One sack Type 1 Portland Cement (94 lb sack),
- Two pounds of dry sodium bentonite, and
- 6.5 to 7.5 gallons of potable water.
- All boreholes were abandoned immediately upon completion of testing. Grouting was accomplished via the tremie method. The grout pipe was lowered to the bottom of the borehole and grout was injected until the borehole fluid was displaced and grout returned to the surface. All boreholes were grouted to the surface and topped off until the column remained static.

CPT soundings were abandoned by pressure grouting thorough a push rod which was re-pushed down to the bottom of the sounding. A grout tube extending to the bottom of the push rod was used to pump grout into the hole as the push rod was retracted. Holes were topped off until the column remained static.

3.5 Sample Preparation, Handling, Storage, Transportation, and Control

In general, all undisturbed samples were prepared and handled in accordance with WSRC E9 SGS-GT-203 - Sample Preparation, Handling and Storage. Shelby tubes were checked for conformance with ASTM D1587-83 (Ref. 3.2).

Once shelby tube samples were obtained, the samples were trimmed, measured, and sealed. Plastic caps were placed over both ends of each tube, then taped and each tube labeled. These samples were maintained and transported in vertical tube boxes capable of holding four tubes. For SPT boreholes, a single sample was collected from the sample spoon. If a material change occurred within the sample, additional samples were collected, as appropriate. Samples were placed in 8-ounce glass jars. The tops were closed tightly, wrapped, sealed with electrical tape, and samples were labeled on the lid.

All soil samples selected for testing were turned over to Law Engineering for transporting to their laboratory in Atlanta.

4.0 LABORATORY TESTING

4.1 Methodology

Soil laboratory testing was performed on disturbed and undisturbed samples. Soil testing included index tests, strength tests, and consolidation tests.

Soils were classified visually according to the Unified Soil Classification System. Classification was supplemented by Index tests, such as Moisture Content ASTM D 2216-92, Atterberg Limits ASTM D 4318-95, Grain-size Analysis ASTM D 422-63 (1990), Hydrometer test ASTM D 2217, and Specific Gravity ASTM D 854-92 (Ref. 3.2).

Two types of strength tests were performed: (1) Consolidated Undrained Test (CU) with Pore Pressure ASTM D 4767-88: In this triaxial shear test, complete consolidation of the test specimen is permitted under the confining pressure. Then, with the water content held constant, the specimen is loaded to failure by increasing the deviator stress. Specimens must as a general rule be completely saturated before application of the deviator stress; (2) Consolidated Drained Test (CD): In this triaxial shear test, complete consolidation of the test specimen is permitted under the confining pressure and during the loading of the specimen to failure by increasing the deviator stress. Consequently, no excess pore pressure exists at the time of failure.

Consolidation tests were performed in accordance with ASTM 2435-90 (Ref. 3.2). The consolidation test is a one-dimensional consolidation of soil specimen. In this test, a laterally confined soil is subjected to successively increased vertical pressure, allowing free drainage from the top and bottom surface. The results of the test is presented in a void ratio-pressure curve (E log P curve).

4.2 Laboratory Testing Program

A total of 57 sieve analyses, 50 Atterberg limits, 39 unit weights, 39 moisture contents, 8 strength tests (5 CUs and 3 CDs), and 13 consolidation tests for the project site were used to evaluate the engineering properties.

Of the 45 Atterberg limit test samples (excluding the 5 direct push samples), 3 of the 6 samples in Layer 4A/4, 2 of the 4 samples in Layer 5, 6 of the 7 samples in Layer 6, and 4 of the 9 samples in Layer 7 are found to be non-plastic. Unit weight and moisture content determinations are from unit weight tests, strength tests, and consolidation tests. Test results from direct push samples in Layer 7; i. e., 6 sieve analysis, 5 Atterberg limits, and 5 unit weights; are biased toward soft soil and were not used in determining the engineering properties.

Including the test results for the RTF site, 30 strength and 36 consolidation test results were used for obtaining the strength and consolidation properties. The number of tests for each engineering layer used for this investigation are summarized below:

Layer	Sieve Analysis	Atterberg Limit	Unit Weight	Moisture Content	Strength*		Consolidation Test*
					CU	CD	
Fill	0	0	0	0	1	2	2
1	12	7	1	1	1	0	1
1A/1B	4	4	4	4	1	1	2
2	3	3	11	11	2	3	7
3	5	5	8	8	3	2	5
4A/4	6	6	0	0	2	2	1
5	4	4	4	4	1	5	4
6	7	7	0	0	0	0	1
7	16	14	11	11	2	2	13
Total	57	50	39	39	13	17	36

* Include results from RTF

5.0 SUBSURFACE CONDITIONS

5.1 Engineering Stratigraphy

The shallow subsurface (surface to about 180 feet deep) has been divided into 7 engineering layers based on interpreted SCPTU measurements and adjacent soil borehole data. Layers were determined from changes in tip resistances, friction ratio, pore pressure signatures, sample descriptions and SPT N-values. This approach differs from the work done for the RTF which divided the subsurface based primarily on geologic formations. The stratigraphy between RTF and the CLWR-TEF project site was correlated to provide a basis for utilizing the information available from the RTF investigation. Subsurface cross-sections (Appendix D) were developed which extend through the RTF area. See Appendix E for cross-section locations. CPT soundings and boreholes at the RTF were directly correlated with the layers established for the CLWR-TEF area. The geology of the area was determined from regional type wells and recent geologic cross-sections (Ref 5.1). Subsurface cross-sections presented in Appendix D show selected CPT sounding plots with interpreted geology and engineering stratigraphy applicable to the CLWR-TEF area. The following sections describe the physical attributes used to delineate each engineering layer, as well as, depositional environment and lithologic variability. A brief summary of average SCPTU data, SPT N-values and laboratory determined properties are also presented in the following sections for the purpose of describing attributes of these layers. Table 3 provides engineering properties for each layer. Figure 4 provides the idealized cross-section of the CLWR-TEF site with selected soil properties. Discussions on engineering properties are presented in Section 6.

5.1.1 Altamaha (Layer 1)

Layer 1 is most probably the Altamaha Formation consisting of red, purple and brown well graded sands ranging from fine to gravel size. The depositional environment of these sediments is characterized as high energy fluvial (Ref. 2.4) such as river and stream channels and can reach thicknesses of up to 70 feet in parts of the SRS. The base of the Altamaha is distinguished by an irregular erosional surface therefore, the presence of rounded gravel is a good contact indicator. The Altamaha may also contain weathered feldspar fragments, which are less common in the Tobacco Road formation (Ref. 2.4). In general, when diagnostic indicators are not present, the contact is determined based on clay content. The Altamaha is in general more clayey than the Tobacco Road and often contains massive, oxidized clay beds whereas the Tobacco Road contains thinner clay layers (Ref. 2.4). The Altamaha/Tobacco Road contact at the project site was defined at the lithologic change from a thick, oxidized clay to a clayey sand near the top of the section. The contact on CPTU logs is indicated by a decrease in the tip stress and sleeve stress on the cone.

In the project area, this layer ranges in thickness from roughly 11 feet to 27 feet thick. On the CPTU log this layer is distinguished by a relatively high, irregular tip resistance and high sleeve resistance. Layer 1 attributes are given below.

Layer	Avg Thick (ft)	Avg Top El (MSL)	Avg Bot El (MSL)	Avg q_c (tsf)	Avg F_s (tsf)	Avg FR (%)	Avg V_s (fps)	Avg SPT N	Avg q_c/N	Avg PI	Avg % Fines	USCS
1	20	289	269	136	3.5	3.2	1,581	35	3.9	22	29	SC

5.1.2 Tobacco Road Formation (Layers 1B, 1A, 2 and 3)

The Tobacco Road formation is composed of red, orange, and purple sands to sandy clays at the project site. These sediments were deposited in low energy shallow marine transitional environments such as tidal flats. Much of the sediments are laminated or otherwise bioturbated well graded sands and clayey sands. As previously discussed, the contact between the Tobacco Road and the overlying Altamaha Formation is difficult to determine, unless a diagnostic indicator is present.

The upper boundary of the Tobacco Road at the project site was determined to lie at approximately 269 feet MSL. This elevation was compared to the regional formation contacts from well P-27, located to the southeast of H-Area. The elevation of the Tobacco Road at P-27 is approximately 253 feet MSL, based on geophysical well log correlations (Ref. 5.1). The core description for well P-27 shows the presence of a pebbly sand zone underlain by a clayey sand interval at approximately 261 feet MSL. The material above and below this interval is fairly consistent, therefore making it difficult to differentiate the Tobacco Road from the Altamaha. Therefore, the formation contact for the Tobacco Road at P-27 was determined to lie at approximately 261 feet MSL.

Layers 1B, 1A, 2 and 3 have been used to differentiate the Tobacco Road Formation. These layers are predominantly sands and clayey sands as determined by laboratory classification tests. Soils of the Layer 1B are distinguished from the underlying Layer 1A by lower tip and sleeve resistances. This layer is non-continuous and relatively thin across the project site. Layer 1A is marked by an increased tip and sleeve resistance. Layer 2 is distinguished by a further decrease in tip resistances and an increase in sleeve resistances resulting in a moderate friction ratio. Transition to Layer 3 is noted primarily as a decrease in sleeve resistance. Attributes for Layers 1B, 1A, 2, and 3 are listed below:

Layer	Avg Thick (ft)	Avg Top El (MSL)	Avg Bot El (MSL)	Avg q_c (tsf)	Avg F_s (tsf)	Avg FR (%)	Avg V_s (fps)	Avg SPT N	Avg q_c/N	Avg PI	Avg % Fines	USCS
1B/1A	7	269	262	113	1.9	1.8	1,292	43	2.6	11	20	SC/SM
2	8	262	254	44	1.9	4.6	1,199	20	2.2	23	32	SC/SM
3	19	254	234	53	1.2	2.6	1,122	17	3.2	11	16	SM/SC

5.1.3 Dry Branch Formation (Layers 4A, 4, 5 and 6)

The Dry Branch Formation appears as a yellow and brown sand to clayey sand, with white clay laminations and occasional manganese staining. It is easily distinguished from the overlying Tobacco Road at the project site by its color. The contact may be obscured when the Tobacco Road appears as a yellow sand, however, the Tobacco Road is generally more clayey than the Dry Branch and may exhibit a mottled appearance, especially near the contact. The contact can also be determined by the presence of a flat pebble zone, where present, which is an indicator of the Dry Branch/Tobacco Road contact. The Dry Branch Formation sediments were deposited in a transitional sequence between near shore and bay or lagoon environments (Ref. 2.4).

The upper boundary of the Dry Branch at the project site was determined to lie at approximately 234 feet MSL. This elevation was compared to the regional formation contacts from well P-27, located to the southeast of H-Area. Geophysical well log correlations place the elevation of the Dry Branch at approximately 226 feet MSL at P-27. The core description for this well shows a medium reddish brown with variegated light yellowish orange clean sand at 234 feet MSL; However, this sample was the only core recovery within a nine foot interval. The stratigraphic section above the interval is a light yellowish and reddish orange sand with 15-20% fines, while the section below the sample is light yellowish orange sand with less than 10% fines. The similarities between the sample and the underlying material leads to the determination that the Dry Branch/Tobacco Road contact lies at approximately 234 feet MSL at P-27.

The Dry Branch/Tobacco Road contact is indicated on the CPTU log by an increase in the tip resistance and a decrease in the sleeve resistance. Layers 4A, 4, 5 and 6 are used to subdivide the Dry Branch. Layer 4A is distinguished from the overlying Layer 3 by an increase in tip resistance and a decrease in sleeve resistance. Layer 4A and the underlying Layer 4 have similar CPTU characteristics however, the average tip resistance slightly less than Layer 4 tip resistances. Layer 5 is marked by a sharp decrease in tip resistances. Sleeve resistances are also markedly lower than Layer 4; however, pore pressures are significantly higher through this interval. This layer is considered to be correlative to the "tan clay" which is a regional geologic member of the Dry Branch. Layer 6 most probably includes the lower sand unit of the Dry Branch as well as the Tinker Sands. The Dry Branch Formation overlies the Tinker but the formation contact is very difficult to determine since the grain size distribution and color of the units are similar; however, the Dry Branch appears to become coarser grained and may exhibit mottling and significant manganese staining just above the contact.

The similar lithology and material characteristics between these units made it difficult to divide. As seen from the CPTU measurements, Layer 6 has higher tip resistances than Layer 5 which is indicative of a more sandy layer.

Layer	Avg Thick (ft)	Avg Top El (MSL)	Avg Bot El (MSL)	Avg q_c (tsf)	Avg F_s (tsf)	Avg FR (%)	Avg V_s (fps)	Avg SPT N	Avg q_c/N	Avg PI	Avg % Fines	USCS
4A/4	36	234	199	158	0.8	0.6	1,097	37	4.2	11	12	SP-SM
5	7	199	192	43	0.4	1.2	1,096	15	2.9	20	18	SC/SM
6	28	192	164	165	1.0	0.7	1,151	48	3.5	10	10	SP-SM

5.1.4 Santee/Tinker Formations (Layer 7)

Within the project area, the Tinker Formation overlies the Santee and is described as a light brown and reddish brown, very dense, fine to coarse grained, poorly to well graded sand. The Santee Formation at the project site is composed of light brown, yellow, green, and white silty to clayey sands. The contact between the Santee and Tinker formations is primarily determined based on clay content and color at the project site. The top of the Santee/Tinker formations was determined to be approximately 176 feet MSL. This elevation was compared to the regional formation contacts from well P-27, located to the southeast of H-Area. The elevation of the Santee at P-27 is approximately 177 feet MSL, based on geophysical well log interpretation (Ref. 5.1).

The Santee/Tinker Formations represent the most complex geologic unit in the shallow subsurface of the Savannah River Site. It is depositionally complex and highly variable in both its lithology and material properties. The layer consists of complex sequences of limestones, carbonate muds, carbonate sands, and muddy sands. Within the project area, little carbonate is noted with the dominant lithology being sands and silty sands.

CPTU logs for the Santee/Tinker contact indicate a sharp decrease in the tip and sleeve resistances, and an increase on the friction ratio and pore pressures. This is interpreted as a lithology change from a dense sand at the base of the Tinker to a clayey sand at the top of the Santee.

The contact between the Santee/Tinker Formation and the overlying Dry Branch Formation is generally seen on the CPTU logs as a sharp decrease in the pore pressure measurement. This layer is characterized by thin, alternating layers of low and high CPTU tip resistances and friction ratios. Characteristically, CPTU soundings in this layer show a pronounced sawtooth trace due to large variations in the CPTU tip resistances over relatively small vertical intervals. This highly variable pattern suggests interfingering of alternating lenses of clayey and silty sands with more resistant, silica-cemented sediments and less resistant, calcareous sediments, and appears to be a result of rapid lateral and vertical changes in the nature of the materials originally deposited in this interval.

Layer	Avg Thick (ft)	Avg Top El (MSL)	Avg Bot El (MSL)	Avg q_c (tsf)	Avg F_s (tsf)	Avg FR (%)	Avg V_s (fps)	Avg SPT N	Avg q_c/N	Avg PI	Avg % Fines	USCS
7	30	164	134	91	1.9	2.1	1,158	41	2.2	9	21	SM/SC

5.1.5 Warley Hill Formation

The Warley Hill exhibits a range of lithologies across the SRS; however, at the project site, it primarily appears as a green, gray, and yellow clay to silt with varying amounts of sand. The formation contact with the overlying Santee Formation is often distinguished by the presence of a dark grayish green clay to sandy clay informally known as the 'green clay.' The Warley Hill/Santee interface is not as striking when the 'green clay' is not present at a given location; however, the contact may be identified by a lithologic change from a brown, yellow, or light gray clayey sand to the Warley Hill clay and silt described above.

CPTU logs at the project site exhibit a moderate decrease in tip stress and sleeve stress, accompanied by a rise in the friction ratio and a response in the pore pressure at the Warley Hill/Santee contact. The decrease in tip stress indicates a less dense layer, and the decrease in sleeve stress is characteristic of a relative decrease in the clay and silt content of the material. The increase in friction ratio and subsequent rise in the pore pressure following the contact spike indicate a higher fines composition for the Warley Hill.

The upper contact of the Warley Hill at the project site was determined to lie at approximately 134 feet MSL. The contact was identified based upon the stratigraphic location of the 'green clay' interval, where present, within the SPT boreholes. This elevation was compared to the regional formation contacts from well P-27, located to the southeast of H-Area. The elevation of the Warley Hill at P-27 is approximately 132 feet MSL, based on geophysical log correlations. Core data obtained for well P-27 confirms the contact determined from the geophysical logs. The 'green clay' interval is described at approximately 131 feet MSL in well P-27.

5.2 Groundwater

The groundwater table elevation is estimated at 252 feet MSL. A seasonal fluctuation of ground water elevation is estimated to be ± 5 feet. Groundwater elevation was based on the data from the Savannah River Site's Groundwater Monitoring Program reports (Ref. 5.2). A groundwater level of elevation 260 feet MSL is recommended for design purpose.

5.3 Soft Zones

Weight of rod and occasional rod drops have been described in numerous drilling reports for monitoring wells and geotechnical boreholes located in the central part of the SRS. Early subsurface investigations performed by the USACOE (Ref. 5.3) frequently described these zones as soft zones, or even voids, and numerous subsequent subsurface investigations have described these same conditions at the SRS. These soft zones typically occur in the carbonate-bearing sediments of the Santee Limestone, The Utley Limestone and the Griffins Landing Member of the lower Dry Branch Formation. The prevailing assumption about the origin of these soft zones is dissolutioning of carbonate-rich, clastic sediments, resulting in vugular porosity (open pore space). When drilling these zones, the drill rod meets little shear resistance and drops (Ref. 5.4). However, much of the time, recovery of soil in the sampler precludes the zone from being characterized as a void.

Soft zone delineation criteria dates back to the K-Area Seismic Investigation (Ref. 5.4) and is identified by rod drops, loss of drilling fluid, or CPTU tip resistance less than 15 tons per square foot (which is equal to that expected for a normally consolidated medium plastic clay at depths of 115 to 145 feet below the ground surface). Currently, soft zones are indicated from SPT N values less than 5 or CPT tip resistances less than 15 tsf over an interval of two feet or greater. Of the seven boreholes and 17 cone soundings performed during the geotechnical investigation for the CLWR-TEF, only one SPT borehole and one CPT sounding indicated soft zones greater than two feet thick. Soft zones, regardless of thickness, are summarized for all boreholes and cone soundings as follows:

ID No.	Top Elevation (feet MSL)	Bottom Elevation (feet MSL)	Thickness (feet)	Notes
HTEF-C1	192.14	191.08	1.06	$q_c < 15$ tsf
HTEF-C2	167.27	166.88	0.39	$q_c < 15$ tsf
	165.43	163.9	1.53	$q_c < 15$ tsf
HTEF-C3	148.91	148.68	0.55	$q_c < 15$ tsf
HTEF-C5	193.83	193.67	0.16	$q_c < 15$ tsf
	160.11	159.32	0.79	$q_c < 15$ tsf
HTEF-C7	165.37	165.18	0.19	$q_c < 15$ tsf
HTEF-C9	168.37	167.66	0.71	$q_c < 15$ tsf
	164.59	162.97	1.62	$q_c < 15$ tsf
HTEF-C10	148.20	147.29	0.91	$q_c < 15$ tsf
HTEF-C18	166.96	166.23	0.73	$q_c < 15$ tsf
HTEF-C19	164.20	163.97	0.23	$q_c < 15$ tsf
HTEF-C20	281.57	281.18	0.39	$q_c < 15$ tsf
HTEF-C21	147.48	144.88	2.60	$q_c < 15$ tsf
HTEF-B1	228.70	227.20	1.50	Blows 4-1-3
	150.70	149.20	1.50	Blows 1-0-3
HTEF-B2	168.20	167.70	0.50	Blows WR/6"-8-37
	148.20	145.20	3.00	Blows WR/36"
HTEF-B3	198.60	197.85	0.75	Blows WR/9"-4/3"-6
	195.10	194.85	0.25	Blows WR/3"-2/3"-6-15
HTEF-B5	197.60	196.60	1.00	Blows WH/12"-4

Note: Shading indicates zones meeting soft zone criteria.

From the table above, three distinct horizons are noted. The upper most horizon (Tan Clay) is encountered at approximately Elevation 193 feet MSL and the average thickness of soft zones in the horizon is about 0.6 feet. The next horizon (Upper Santee) is at approximately Elevation 165 feet MSL with an average soft zone thickness around 0.7 feet. The lower most horizon (Lower Santee) is noted at approximately Elevation 145 feet MSL with an average thickness of about 1.7 feet. Elevations of these horizons generally vary within 5 feet. A plot of overconsolidation ratio versus elevation, Figure 5, for the RTF and CLWR-TEF data confirms these three horizons. The preponderance of data indicates that the deeper (below 200 feet MSL) subsurface soils are at least normally consolidated. However, the Lower Santee horizon has been assumed to have under-consolidated pockets with an OCR of 0.7. Settlement associated with this horizon is discussed in Section 7.8.

Borehole HTEF-B2 had a 36 inch interval of rod drop at a depth of approximately 144 feet. Confirmatory CPTUs were pushed approximately 20 feet away in three opposing locations to attempt to delineate the extent of the soft zone (Appendix E). The two CPTUs to the south (HTEF-C19 and HTEFC-20) showed no indication of soft material and the CPTU to the north (HTEF-C18) encountered early refusal within a very stiff layer in the strata. Two additional CPTUs were pushed at distances of 10 and 30 feet from HTEF-B2 in the direction of HTEF-C18. The CPTU at a distance of 10 feet (HTEF-C21) showed indications of soft material (i.e. tip resistance less than 15 tsf) approximately 2.6 feet thick. The CPTU at 30 feet (HTEF-C22) showed no signs of the soft zone. Based on these CPTUs, the soft zone is constrained, fairly small in size, and consistent with soft zones seen at RTF, In-Tank Precipitation Facility (ITP) (Ref. 5.5), and the Actinide Package and Storage Facility (APSF), i.e., less than about 50 feet wide (Ref. 5.6). In summary, an isolated soft zone pocket about 40 feet in diameter by 3 feet thick in the vicinity of HTEF-B2 and HTEF-C21 can be assumed.

6.0 ENGINEERING PROPERTIES

Engineering properties are categorized as static properties and dynamic properties. Field and laboratory tests were performed at the project site to evaluate the properties of the soils. In additional to the test data obtained from the project site, test results performed for the RTF project are used to obtain the strength and consolidation properties (Section 4.2) and previous studies on nonlinear dynamic soil properties are used for the dynamic shear modulus and damping properties (Section 6.2). Recommended engineering properties are based on the evaluation of the test results and engineering judgement.

Section 6.1 presents the static properties of the soils underlying the project site. Section 6.2 discusses the dynamic properties of these subsurface soils. The engineering properties for each layer are summarized in Table 3.

6.1 Static Properties

Static properties were obtained from field and laboratory tests. In-situ measurements such as the SCPTU data (tip resistance, shear and compression wave velocities, sleeve friction, friction ratio, and pore pressure) and SPT N-value were obtained in the field. Laboratory tests were performed on selected soil samples obtained from the field in order to determine static properties such as strength and compressibility. Strength and consolidation test results from the laboratory testing for CLWR-TEF were also combined with the results from the nearby RTF to determine the properties for design (Ref. 6.1, 6.2).

A key issue is the compressibility of the subsurface soils. Fourteen one-dimensional laboratory consolidation tests were performed on subsurface soils from the CLWR-TEF in order to identify the compressibility characteristics of the shallow (<200 feet) clays. Compression indices from the consolidation tests were compared to initial void ratio, plasticity index, percent fines, and moisture content. The data obtained at CLWR-TEF were superimposed over data previously obtained in the General Separations Area (GSA) during the H-Tank Farm and F-Area Investigations. Comparison of CLWR-TEF and existing data (denoted by a "+" on each figure) are shown in Figures 6 through 9.

6.2 Dynamic Properties

6.2.1 Shear Modulus and Damping Ratios

Dynamic responses of the soil are governed primarily by the shear modulus and damping characteristics of the soil. Shear moduli are computed based on field measurements and laboratory tests. Field measurements provide the in-situ shear wave velocities at various depths, and the laboratory tests determine the wet densities of different types of soils. Reductions of shear moduli and damping ratios due to strain levels are based on an extensive study of nonlinear dynamic soil properties conducted previously (Ref. 6.5).

The shear modulus is defined as the ratio of the shear stress to the shear strain. The shear modulus equals its maximum at very low shear strain and decreases when the shear strain increases. The maximum shear modulus for the soil at a specific depth is computed as:

$$G_{max} = \rho\ V_s{}^2$$

where ρ is the mass density of the soil and defined as:

$$\rho = \gamma / g$$

where γ is the unit weight of the soil and g is the gravitational acceleration.

Extensive study (Ref. 6.5) performed on soils at SRS has concluded that the ratio of shear modulus to the maximum shear modulus can be defined as a function of strain:

$$G/G_{max} = 1 / (1 + \varepsilon / \varepsilon_r)$$

where ε is the desired value of shear strain and ε_r is the reference strain. Table 4 provided the recommended reference strains for various soils at the SRS. Figure 10(a) shows the plot of recommended G/G_{max} ratio versus strain for the SRS.

Due to the curvilinear stress-strain relationship of the soil, the damping ratio is a function of the strain. The study referred in the previous section also provides the relationship between damping ratio and strain. Table 5 provides the recommended damping ratio versus strain relationship for various soils at SRS. Figure 10(b) shows the plot of recommended damping ratio versus strain for the SRS.

Strain dependant curves presented in Figures 4 and 5 were developed for the SRS based on geologic formation, soil type, and depth. The appropriate assignment of these curves to the shallow stratigraphy of the CLWR-TEF is a factor of many considerations. These include:

1. Determining the geologic formational boundaries at the CLWR-TEF and a factor of confidence in defining these boundaries
2. The material characteristics of the geologic units based on available classification data and interpreted CPTU measurements
3. The comparison of generalized soil type dynamic curves versus geologic formation based curves
4. The soil classification of individual samples used within the referenced report as applicable to project area stratigraphy.
5. Past application of the subject curves on other projects

The basis for the assignment of the appropriate dynamic curves (shear modulus and damping) is summarized below:

Altamaha (Layer 1)

This geologic formation is the shallow most layer and is relatively thin (0 to 20 feet thick) throughout the project area. This layer can be recognized on the CPTU plots as having both high tip and sleeve measurements. Sieve data on this unit indicates an SC material with an average of about 30 percent fines. The Upland curve is assigned to this layer.

Tobacco Road (Layers 1B, 1A, 2, and 3)

The Tobacco Road can be divided into as many as 4 layers; however, Layer 1B is present in only two of the CPTU soundings (HTEF-C2 and HTEF-C3). Friction ratios through this layer are relatively high (1-6 percent). Sieve data from this interval indicates predominantly SC material with an average of about 25 percent fines. Individual samples used to construct the Tobacco Road and Shallow Clay dynamic curves were reviewed for applicability to this layer. Samples used for the Tobacco Road curve contain a slight majority of SM material. The number of samples used to construct the Shallow Clay curve is significantly low and contains only one sample from the Tobacco Road. Based on this information the Tobacco Road curve was assigned to these layers.

Dry Branch and Santee (Layers 4A, 4, 5, 6, and 7)

The Dry Branch is subdivided into four sublayers. Layers 4A, 4, and 6 are distinguished by high tip resistances and low pore pressures indicative of more sandy material. The geologic formational boundary between the Dry Branch and Santee is within Layer 6; however, the engineering soil characteristics do not warrant subdividing this layer. Layer 5 is distinguished by low tip resistances, relatively high friction ratios and pore pressures, and more indicative of clayey materials. Average fines content of this layer is about 30 percent. Based on this information, the dynamic curves for the Dry Branch/Santee Sands were assigned to layers 4A, 4, 6, and 7. The dynamic curves for shallow clays were assigned to Layer 5.

In summary, the assignment of dynamic curves (shear modulus and damping) generally follows the geologic formations. The only exception is the Tan Clay sublayer of the Dry Branch Formation (Layer 5) which is considered to be a relatively thick (about 5 feet) nearly continuous layer throughout project area. The assignment of curves to the engineering stratigraphic layers are summarized as following:

Engineering Layer	Dynamic Curve
1	Upland
1B/1A	Tobacco Road
3	Tobacco Road
4A/4	Dry Branch/Santee
5	Shallow Clay
6	Dry Branch/Santee
7	Dry Branch/Santee

6.2.2 Shear Wave Velocities

Shear wave velocities are measured at each SCPTU. Travel times for the shear waves at different depths between two points are recorded. The shear wave velocity v_s is then computed by:

v_s = distance between the two locations / the travel time for the shear wave.

By averaging the wave velocities at selected depth intervals around a specific location, a shear wave velocity profile was established (Ref. 6.6). Table 3 contains the mean shear wave velocity profile for the project site, which compares favorably with crosshole and downhole measurements at RTF (Ref. 1.6).

7.0 ENGINEERING EVALUATIONS

7.1 Bearing Capacity and Static Settlement

For satisfactory performance, a good foundation for any structure must consider four separate criteria. First, it must have an acceptable factor of safety against a bearing capacity failure in the foundation soils under the maximum design load. Second, settlement (both differential and total) during the life of the facility must not be of a magnitude that will cause structural or architectural damage, endanger piping connections, or impair the operational efficiency of the facility. Third, environmental and other factors such as shrinking and swelling soils, earthquakes and vibrations, ground water, underground defects, and adjacent structures must be considered. Fourth, the selection of the foundation to satisfy the above three criteria must be economically feasible in relation to its function and the overall cost of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base area of the structure, soil conditions, settlement tolerances, and any serviceability requirements. Where more than one foundation type satisfies the criteria, then scheduling, material availability, or local practice may govern the final selection.

For the proposed facilities, the subsurface conditions indicate that all of the structures can be placed on shallow footings and mat foundations. The limiting criteria will be the tolerable settlement each structure can accommodate.

7.1.1 Computation of Bearing Capacity and Static Settlement

The general Terzaghi static bearing capacity formula for continuous and square footings was used to estimate the allowable bearing capacities (Ref. 7.1). These formulas require an effective friction angle (ϕ'), unit weight of upper soil layers, and width of the foundation systems. Soil properties from Table 3 were used to determine the bearing capacities. The allowable bearing capacity for each facility was calculated at 1.5 feet of embedment in native or structural fill soils for a settlement of one inch. Foundation elevation of each facility, except for RHB, is assumed to be the same as the TPB. Bearing capacities were calculated using a safety factor of 3 against ultimate bearing failure.

Static settlement was calculated based on one dimensional consolidation theory with Boussinesq stress distribution to determine stress increase due to foundation loading (Ref. 7.2) and the effect of adjacent structures. The properties used for the analysis are given in Table 3.

Under each proposed structure, settlement of subsurface soil layers was calculated to the top of layer 4A or to twice the width of the building structure, whichever is deeper. The differential settlement is assumed to be one half of the total settlement. Except for the RHB, the foundation elevation of each facility is assumed to be the same as the TPB. The calculation considers the influence of the foundation type and cross-section profile of sublayers under each structure. The allowable bearing capacities for one inch of static settlement are summarized in the following table:

Facility	Assumed Dimension (feet x feet)	Allowable Bearing Capacity (psf)
Main Building	124 x 243	1,000
Corridor No. 116	16.5 x 50	3,700
Cooling Towers	6 x 6	4,000
H & V Supply Air Platform	8 - 6.5 x 5	5,000
Gas Cylinder Storage Shed	8 x 25.5	2,700
Chiller Building	6 x 6	5,000
Exhaust Stack	27 x 27	2,000
Electrical Substation	20 x 100	2,500
Diesel Generator Building	25 x 58	2,000
Fire Protection Valve House	10 x 10	4,000
Liquid Nitrogen Tanks	19 x 22	2,000

Note, the allowable bearing pressure given for Corridor No. 116 is based on homogeneous well compacted backfill. It does not take into account the effect that surcharge load will have on the underlying corridor No. 210, which lies about 12 feet directly below Corridor No. 116. Corridor No. 116 and The Remote Handling Building will be discussed separately in Section 7.1.2.

For wind, seismic, and other forms of temporary or intermittent loading, the allowable bearing capacity may be increased by one third from the allowable static bearing capacity (Ref. 6.3).

7.1.2 Remote Handling Building

For the Remote Handling Building, the bottom of the foundation slab is approximately 31 feet below existing grade. The current assumed gross load of the RHB is equivalent to the load of the excavated soil; e. g. the net load on the subsurface foundation soil is near zero. Thus, the static virgin settlement will be near zero. However, stress relief due to the excavated soils will occur and was considered in the settlement evaluation. Soils subject to stress relief elastically rebound causing subsurface layers to stretch (heave) in an upward direction. The amount of upward (heave) movement of the soils is calculated using the rebound portion of the e-log p curve from the consolidation test results (C_r). Stress relief and subsequent heave is time dependent and will occur as the foundation soils are unloaded.

As construction proceeds and the foundation is loaded, the subsurface soil layers will recompress, and settlement takes place. Since the weight of the RHB is approximately equal to the weight of the soil removed, the amount of settlement (recompression) is approximately equal to the upward movement (heave) of the soil. The amount of upward movement depends on the overall construction schedule i.e., the duration of the excavation and the duration of building construction. A larger recompression will be expected if the duration between the beginning of the excavation to the completion of the facility is longer. However, the amount of the recompression should not exceed the maximum amount of the upward movement (heave). Since the amount of the heave is difficult to predict both in terms of the magnitude and time, it is recommended that the amount of heave and settlement be measured (see Section 8.3).

Corridor No. 116 is supported on an independent structural slab on fill, which in turn, is supported on the roof slab of RHB Corridor No. 210. Therefore, the settlement of Corridor No. 116 depends on the settlement of the fill beneath its foundation as well as the settlement of the RHB. Thus, after corridor 116 is constructed it will settle about 1 inch due to compression of the fill (if loaded to the maximum allowable bearing pressure of 3,700 psf) and an undetermined amount due to continued recompression of the soils beneath the RHB.

The southern section of the Main Building is constructed on structural fill, which is backfilled on a slope excavated for the construction of the RHB. The fill daylights approximately 20 feet under the building slab. However, the entire building area is underlain by on-site fill that will be removed to a depth of 4 to 6 feet below foundation. Therefore, the building will be constructed on uniform layer of compacted fill. In all other building areas the thickness of structural fill recommended to be placed under each structure is considered in the settlement calculation.

A portion of the Product Transfer Trench will be installed under the H & V Supply Air Platform. Therefore, the maximum settlement of Product Transfer Trench may be equivalent to the settlement of H & V Supply Air Platform.

7.2 Slope Stability

During construction of the Remote Handling Building, a temporary cut slope will be established on all sides except to the west where the slope gently tapers off to grade for vehicle access. The maximum depth of the cut slope will be approximately 31 feet deep. Slope stability analyses were performed on typical 1-1/2 horizontal to 1 vertical and 2 horizontal to 1 vertical cut slopes using effective stress soil properties for layer 1A/1B. Based on the Bishop method (Reference 7.3) and an effective stress friction angle of 33 degrees and an effective stress cohesion of 100 psf, safety factors of 1.5 and 1.9 were computed for 1-1/2 horizontal to 1 vertical and 2 horizontal to 1 vertical slopes, respectively. The analyses did not consider any loading due to construction surcharge and any dynamic loading.

7.3 Lateral Earth Pressure

Underground facilities shall be designed to resist the lateral earth pressure. Lateral pressure shall include the static soil lateral pressure, hydrostatic pressure, surcharge load, equipment load during backfill, and seismic load.

The recommended coefficients of lateral earth pressure are as follows.

Soil Type	Effective Friction Angle ϕ' (degrees)	At-rest Earth Pressure Coefficient K_o	Active Earth Pressure Coefficient K_a	Passive Earth Pressure Coefficient K_p
Compacted Fill	35	0.43	0.27	3.70
On-Site Native Soils	33	0.46	0.29	3.40

Hydrostatic pressure shall be computed by considering the ground water elevation at 260 feet MSL. Static earth and permanent surcharge load should be based on the structural design criteria and the at-rest earth pressure coefficient. The effect of compaction equipment load on walls shall be based on the method proposed by Duncan, et. al. (Ref. 7.4). The seismic lateral pressure should be computed using ASCE 4-86 (Ref. 7.5) or equivalent.

7.4 Modulus of Subgrade Reaction.

The SCPTU tip resistance and SPT N values at the proposed site indicate that the relative density of soils in the zone of influence fall in the medium density range. Therefore, k_1 ranges between 120 and 600 kcf (Ref. 7.6). For this case a reasonable value of k_1 would be 300 kcf.

The modulus of subgrade reaction is calculated using the following formula:

$$k = k_1 \left[(B+1)/2B\right]^2$$

where k = modulus of subgrade reaction for a slab

k_1 = coefficient of subgrade reaction for 1 foot by 1 foot plate

B = footing width

The following table provides a range of modulus of subgrade reaction values (k) for medium dense sand for various foundation widths, and for k_1 values of 120, 300, and 600 kcf.

Foundation Width (feet)	Modulus of Subgrade Reaction (kip/ft^3)		
	k_1=120 kip/ft^3	k_1=300 kip/ft^3	k_1=600 kip/ft^3
6	41	102	204
8	38	95	190
10	36	91	182
20	33	83	165
25	32	81	162
50	31	78	156
75	31	77	154
100	31	77	153
125	30	76	152

However, the value of k (and then k_1) is a function of load and settlement, and will vary due to the effect of unloading and loading during construction. Thus, it is recommended that a range of values be assumed for design, similar to the range given above.

7.5 Secondary Settlement

Site experience in H- and S-Areas indicates that the rate of secondary consolidation for the site is small, on the order of 0.3 inch over 30 years, for structural loading in the range of 3 to 6 ksf (Ref. 5.5). It is expected that this settlement will be uniform and not contribute to any differential settlement.

7.6 Seismic Design Criteria

7.6.1 Design Response Spectra

In March of 1997 the Site Geotechnical Services Department (SGS) issued "committed" SRS site-wide design response spectra (Ref. 2.11). In order for the spectra to be used as "confirmed", SGS must review the stratigraphic conditions at the facility or site being considered for seismic evaluation. SGS has examined the stratigraphic conditions for the project site to validate the suitability of the site-wide PC3 response spectra (Ref. 2.17). There are no topographic or subsurface features that could significantly alter ground motion over the modeled cases. The soil column thicknesses and bedrock type match ranges used in developing the design spectra. The velocity profiles measured at the project site are within the variances used in developing the design spectra, and the formations at the project site are reasonably close to the basecase formations used to develop the design spectra. Thus, the use of the site wide PC3 surface response spectrum (Figure 3) is justified.

It should be noted that the PC3 design spectrum is intended for simple response analysis. It is not appropriate for soil-structure interaction analysis. In addition the PC3 design spectrum represents a surface response and is not representative of an embedded response.

7.6.2 Soil Property Type

For Building code design, the soil profile type for the proposed site based on UBC (Ref. 6.3) is classified as S_D. The soil profile type based on SBC (Ref. 6.4) is classified as S_3.

7.7 Liquefaction and Dynamic Settlement

Liquefaction for the project site was evaluated both quantitatively and qualitatively. The quantitative method evaluating liquefaction settlement uses a cyclic stress approach and shear strain approach depending on the formation being analyzed. The qualitative evaluations include the Chinese Criteria for Clayey Soils and three empirical shear wave velocity approaches.

7.7.1 Quantitative Evaluations

The liquefaction potential and resulting dynamic settlement was evaluated quantitatively using existing SRS methodology. That methodology being:

- For PC3 facilities, develop two bedrock time histories. A mean-based spectrum that has an annual probability of exceedance of 5×10^{-4} and a deterministic ground motion check. The two time histories used for the CLWR-TEF analysis were a PC3 (random phase) and a Charleston 50th percentile (random phase), documented in Ref. 7.7.
- Choose a "Best Estimate" deep soil profile or use the nearest deep hole data, if available, for the deep (greater than about 150 feet deep) soil profile. For CLWR-TEF the shear wave velocities and lithologies for the deep geologic profile are from borehole MMP-2A-SB, located on the southwest side of H-Area (Ref. 7.8 and 7.9).
- Use the site-specific SCPTU soundings for the shallow (less than about 150 feet deep) soil profile. The shallow geologic profile for dynamic soil response analysis at the project site was developed using shallow stratigraphic picks and shear wave velocities from Ref. 6.1 and Appendix B.
- Convolve each of the time histories from the top of rock through the deep and shallow soil profiles to the ground surface using SHAKE91 (Ref. 7.12). This results in stresses and strains throughout the soil column. For CLWR-TEF there are 28 SHAKE runs (2 time histories through 1 deep soil profile combined with 14 shallow soil profiles).
- For the soils below the water table but above the Santee formation, compare the induced stresses with the soil strength derived from the SRS site-specific shallow soil strength curves and compute the factor of safety against liquefaction.
- For the soils below the water table but above the Santee formation, use the site-specific relationship between liquefaction factor of safety and volumetric strain to compute dynamic settlement.

- For the Santee formation soils below the water table use the shear strain from SHAKE and Santee pore pressure ratio relationship to compute dynamic settlement.
- It is assumed that there is no dynamic settlement contribution for the soils below the Santee formation nor for soils above the water table.

The details of how this methodology was applied to CLWR-TEF are discussed in the remainder of this section.

For the sediments below the water table but above the Santee formation liquefaction settlement is calculated using a cyclic stress approach. Because of the depth of the Santee formation, the shear strain levels just approach the threshold required to generate excess pore pressure. Therefore, the shear strain methodology is used to compute settlement in the Santee due to partial liquefaction. Dynamic settlement of unsaturated (i.e., above the water table) sands was ignored, because of their small contribution to the total dynamic settlement.

At the SRS an extensive laboratory testing program has been implemented to determine site-specific dynamic strength and dynamic settlement characteristics of SRS soils. The site-specific relationships and their use in determining dynamic settlement are discussed below.

The cyclic stress approach used to evaluate the sediments between the water table and the Santee formation uses normalized tip stress $(q_c)_1$ and friction ratio to determine cyclic stress ratio causing liquefaction (CSR_L) (see Figure 11). The CSR_L is then multiplied by factors that correct for effective confining pressure (K_σ) and earthquake magnitude scaling factor (MSF). A site-specific K_σ relationship presented in Figure 12 (Ref. 7.10) is used to correct for effective confining pressure as opposed to correction straight from the literature. The magnitude scaling factors for the PC3 and the Charleston 50th earthquakes are 1.9 and 1.1, respectively (Ref. 7.20). Factor of Safety against liquefaction (FS) can then be calculated by dividing CSR_L by CSR_E.

$$FS = \frac{CSR_L \cdot K_\sigma \cdot MSF}{\mathrm{CSR_E}}$$

In addition, site specific volumetric strain curves (see Figure 13) have been developed specifically for SRS (Ref. 7.10 and 7.11). The volumetric strain curves give volumetric strain as a function of $(q_c)_1$ and factor of safety against liquefaction.

Extensive studies (Ref. 7.10 and 5.4) have shown that the Santee formation will not liquefy as a result of the design basis earthquake. However, dynamic settlement may occur due to partial liquefaction and the dissipation of pore water pressures after a seismic event. The strain approach used to evaluate the Santee settlement uses the relationship shown in Figure 14 (Ref. 7.10). The recompression index (C_r) and initial void ratio (e_o) for the Santee are average values for the Santee formation (see Table 3). The pore water pressure ratio (r_u) is obtained using strains in the Santee formation from the SHAKE analysis and the site-specific r_u relationship shown in Figure 15 (Ref. 7.10).

The liquefaction and dynamic settlement analyses using SRS site-specific relationships suggest that the soil columns beneath the project site are not susceptible to liquefaction for the mean based (m_b=6.1) PC3 earthquake. Settlements for the mean based (m_b=6.1) PC3 earthquake range from about 0 to 3/4 inch. Plots summarizing the PC3 liquefaction analysis, including factor of safety and cumulative settlement are presented in Appendix D.

Dynamic settlement for the project site, based on the Charleston 50th percentile deterministic check, ranges from less than about ½ inch to 3 inches. Plots summarizing the Charleston 50th percentile liquefaction analysis are presented in Appendix D. For more detail regarding the liquefaction and dynamic settlement analysis refer to References 7.13 and 6.6.

7.7.2 Qualitative Evaluations

The qualitative evaluation included the Chinese Criteria for Clayey Soils (Ref. 7.15 and 7.16), and empirical shear wave velocity approaches developed by Seed et al. (Ref. 7.17), Kayen et al. (Ref. 7.18) and Stokoe et al. (Ref. 7.19).

The Chinese Criteria for Clayey Soils states that clayey soils which satisfy all three following conditions are vulnerable to liquefaction or serious loss of strength:

1. Laboratory-determined water content (increased by two percent) greater than 90 percent of the laboratory-determined liquid limit (increased by one percent);
2. Liquid limit (increased by one percent) less than 35 percent; and
3. Clay content (i.e., particles < 0.005mm) (decreased by five percent) is less than 15 percent.

The test data used to evaluate the project site in conjunction with the Chinese Criteria are plotted in Figure 16. Only one sample point lies marginally within the test range.

The Seed et al. method relating average shear wave velocity (V_s) to CSR_L is presented in Figure 17. The average V_s for the CLWR-TEF soil layers are presented in Section 6.2. Soil layer five has the lowest average shear wave velocity, V_s = 1096 fps, which equates to a CSR_L of 0.345. The SHAKE analysis discussed in Section 7.7.1 had a maximum CSR_E of **0.12**. Based on this method no liquefaction is expected at the project site.

The Kayen et al. method shown in Figure 18 relates normalized shear wave velocity $(V_s)_1$ to CSR_L. The lowest normalized shear wave velocity is 243 meters per second, which equates to a CSR_L greater than 0.3. The SHAKE analysis discussed in Section 7.7.1 had a maximum CSR_E of **0.12**. Based on this method no liquefaction is expected at the project site.

The Stokoe et al. method combines maximum acceleration (a_{max}) and shear wave velocity to determine the likelihood of liquefaction. The Stokoe et al. chart (Figure 19) shows that for a V_s greater than 500 fps, the required maximum ground acceleration to produce liquefaction is about 0.25g. At CLWR-TEF the minimum shear wave velocity encountered was 770 fps and would require a maximum acceleration much greater than 0.25g. The expected a_{max} is **0.16**g. Therefore, based on this method no liquefaction is expected at the project site.

In conclusion the qualitative methods for determining the likelihood of liquefaction indicate that liquefaction will not occur at the project site for PC3 ground motions.

7.8 Soft Zone Settlement

Analyses indicate that the soft zones at CLWR-TEF are similar with respect to composition and compressibility characteristics as those observed at the ITP in H-Area (Ref. 5.5) and soft zones recently encountered at the APSF in F-Area (Ref. 5.6).

The current assumptions regarding soft zones at the SRS are that they are under-consolidated isolated pockets of soil that are bridged by dense over-consolidated layers of clayey sand. The loss of strength of such a bridge during the design earthquake raises the question as to how much settlement will be observed at the surface when the full weight of the overburden load bears on these pockets. Two key components are necessary to estimate the settlement at the surface; (a) the compression of the soft zone at depth, and (b) the propagation of that compression through the soil column to the surface.

The compression of the soft zone at depth is estimated using the following equation:

$$S = H\ CR\ Log\ (1/OCR)$$

Where S is the settlement in inches, H is the thickness of the soft zone in inches, CR is the compression ratio of the soft zone, and OCR is the over-consolidation ratio of the soft zone. At ITP and APSF, conservative estimates of CR and OCR of 0.24 and 0.7, respectively, were used. At CLWR-TEF, CR and OCR of 0.24 and 0.7, respectively, are also used. Using these conservative values and a thickness of 3 feet as observed in HTEF-C21 and HTEF-B2, a compression of 1.3 inches is calculated for the soft zone at depth.

FLAC (Ref. 7.14) analyses have been performed at APSF and ITP to propagate the effects of such a collapse to the surface through the soil column. The ratio of the settlement seen at the surface to the soft zone compression at depth in the APSF and ITP analyses ranges from approximately 0.5 to 1.0. Using an average ratio of 0.75, the settlement observed at the surface at CLWR-TEF in the soft location will be less than one inch. For the purpose of design, it is recommended that a soft zone total settlement of one inch and a soft zone differential settlement of one half inch be used.

7.10 Total and Differential Settlement

Settlement of the facilities will have four components; static, dynamic, long-term secondary consolidation, and any effect from soft zones at depth. Each of these components has been presented and discussed previously. Based on these results, the estimated total and differential settlements are summarized below for each of the facilities:

Facility	Static	Dynamic	Soft zone	Secondary consolidation	Total	Differential
Main Building	1	1 - 3	0	½	2 ½ - 4 ½	1 ¼ - 2 ¼
Remote Handling Building (1)	3 - 4	½ - 1	1	½	5 – 6 ½	2 ½ - 3 ¼
Corridor No. 116 (2)	4 ¼	½ - 1	0	½	5 ¼ - 5 ¾	2 ½ - 3
Cooling Towers	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
H & V Supply Air Platform	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Gas Cylinder Storage Shed	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Chiller Building	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Exhaust Stack	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Electrical Substation	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Diesel Generator Building	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Diesel Generator Building	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Fire Protection Valve House	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼
Liquid Nitrogen Tanks	1	½ - 1	0	½	2 – 2 ½	1 –1 ¼

(1) Recompression settlement, should occur during construction. The actual post construction total settlement should be 2 to 2 ½ inches.

(2) Recompression settlement due to RHB loading, should occur during construction. The actual post construction total settlement should be 1 to 1 ½ inches.

8.0 DESIGN AND CONSTRUCTION

8.1 Site Preparation

Prior to grading, existing above-ground and underground facilities shall be demolished and removed. Existing facilities may include, but are not limited to foundations, concrete, tanks, machinery, equipment, pavements, utility lines and storm inlets. Excavation made by the removal of existing facilities shall be properly backfilled in accordance with requirements for engineered fill provided in Section 8.2. Any soil exposed by the demolition operations, which are deemed soft or unsuitable shall be excavated and replaced with engineered fill.

Prior to construction, any loose material, vegetation, debris, and topsoil in the unpaved areas and foundation material underlying the pavement shall be removed to the original ground surface. Vegetated surface of sites shall be stripped to remove all existing vegetation and topsoil. It is estimated that stripping depths of 8 to 10 inches may be necessary. Stripped materials from the site may not be used as engineered fill but may be stockpiled and used for landscaping purposes.

The final excavation surface shall be made using smooth blade equipment. The bearing surface for footings, grade beams, floor slabs, and other load carrying foundations shall be undisturbed naturally deposited soil or compacted structural fill. The depth of the removed soils should be observed in the field by a geotechnical engineer. Subgrade for fills supporting loaded areas shall be proof-rolled in the presence of a geotechnical engineer to identify any loose or soft zones. All areas that "pump" or appear to be soft shall be removed to a depth approved by the Geotechnical Engineer and replaced by structural fill.

In the event that substandard materials are encountered at the construction elevation, they shall be removed. Where excavation is performed to elevations below those shown on the design drawings, the planned elevation shall be re-established by backfilling and compacting with structural fill.

Based on existing data, the depth of the on-site fill may range from 2 to 8 feet below existing grade. The on-site fill is unsuitable to support the proposed structures. The on-site fill soils should be removed and be recompacted as structural fill, then new structural fill should be placed to achieve proposed pad elevation. The grading work at each structure location is estimated in the following table:

Facility	Soil to be Removed and Compacted under Facility (feet)	Soil to be Removed and Compacted beyond Facility Limits (feet)
Main Building	3	5
Remote Handling Building	0	0
Corridor No. 116	0	3
Cooling Towers	4	3
H & V Supply Air Platform	8	0
Gas Cylinder Storage Shed	3	3
Chiller Building	4	3
Exhaust Stack	8	3
Electrical Substation	4	3
Diesel Generator Building	4	3
Fire Protection Valve House	6	3
Liquid Nitrogen Tanks	2	3

Bearing surfaces shall be protected from weather to prevent deterioration or softening. Water shall not be permitted to accumulate in excavations. Care shall be exercised in making sure that existing buried structures and underground utilities are removed within the facility areas.

On-site soils that are free of organic material and debris and meet criteria specified in Section 8.2 may be used as engineered fill. Engineered fill shall be placed and compacted as described in Section 8.2. If construction takes place during winter months, care shall be exercised to prevent construction on frozen soils. Final grading shall promote drainage away from the building foundations to prevent the accumulation of water during heavy rainfall, as well as to reduce any possible frost action in the natural on-site soils. In addition, fill materials shall not contain snow or ice or be placed in a frozen condition (Ref. 8.1).

Additional site preparation recommendations can be found in Sections 5.2 and 5.3, SRS Engineering Practices Manual, WSRC-IM-95-58, Guide No. 02224-G, Revision 0, March 31, 1997 (Ref. 8.1).

8.1.1 Excavation of the Remote Handling Building (RHB)

Excavation of the remote handling area should be initiated by excavating cut slopes in sequence from top to bottom at a slope no steeper than 1-1/2 horizontal to 1 vertical with a 10 feet wide bench at the slope mid-height. Wheel tractor-scrapers can be used to haul excavated soils. The outer edge of the slope should be elevated to establish a berm to prevent runoff water on the slope. Once 1-1/2 horizontal to 1 vertical slope is achieved, it is recommended that slope surfaces should be thoroughly backrolled and sloughs should be repaired immediately. A set back 10 feet should be established on top of the slope to prevent temporary surcharge load near the top of the slope.

At the top of the slope and on the slope bench, a temporary V-ditch should be 0established and routed to a lower water disposal point. Similarly, water should be channeled out at the slope toes to a lower point where a sump-pump system can dispose the water to existing storm drains.

As a precaution measure, plastic sheeting should be readily available or kept on hand, to protect all slope areas from saturation by periods of heavy or prolonged rainfall. If slope failures occur, the Site Geotechnical Services (SGS) technical representative should be contacted for a field review of site conditions and development of recommendations for evaluation and repair.

After excavation operation is completed, a total of upward movement (heave) up to 3.8 inches is expected to occur over a gradual period as discussed in Section 7.2. Precise grading prior to placing the foundation will bring the grade to proposed elevation. The majority of the settlement due to building static load is expected to take place during building construction.

8.1.2 Product Transfer Trench

The portion of the Product Transfer Trench below the foundation of the H & V Supply Air Platform should be backfilled with structural fills. The casing of the trench should be designed to withstand the building load due to the H & V Supply Air Platform.

The portion of the Product Transfer Trench crossing the existing road should be backfilled with compacted structural fill to at least 5 feet on each side of the trench to spread the load beyond the trench section. The casing should be designed to withstand the traffic load on the road.

8.2 Compaction and Fill

Engineered fill includes structural fill and common fill. Structural fill is defined as any backfill under slabs, footings, and pavements and around structures. It shall consist of sands and silty sands free of organic material, loam, debris, ice or frozen soil and have a plasticity index less than 15 percent. Structural fill shall meet the following gradation requirements as specified in the engineering guide 02224-G, Rev. 0 (Ref. 8.1).

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	95-100
No. 10	85-100
No. 20	70-95
No. 40	35-85
No. 60	15-70
No. 140	2-20
No. 200	0-15

On-site silty and clayey sand, free of organic matter and debris, may be used for common fill only. Common fill is defined as fill outside of slabs, footings, and pavement and a minimum of 5 feet away from any below ground structure. Common fill shall meet the following gradation requirements as specified in the engineering guide 02224-G, Rev. 0 (Ref. 8.1).

Sieve Size	Percent Passing by Weight
3/4 inch	100
3/8 inch	95-100
No. 4	85-100
No. 10	75-100
No. 20	50-100
No. 40	25-95
No. 60	15-80
No. 140	2-30
No. 200	0-25

Fill shall be placed in successive uniform loose layers and to a depth at which recommended densities can be obtained. However, in no case shall loose fill, placed for compaction, exceed 9 inches when hand-operated mechanical equipment is used and 12 inches when self-propelled or towed mechanical equipment is used. Oversize material shall be removed from the backfill.

The moisture content during compaction shall be within ± 3 % of optimum moisture content determined per ASTM D1557 (Ref. 3.2). Fill material shall be moisture conditioned, as far as practical, in the stockpiles or borrow sources. After placement of loose material in the fill area, the moisture content shall be adjusted as necessary to bring the material within required moisture content limits. ASTM D2216, D3017, or D4643 (Ref. 3.2) shall be used to determine moisture content.

Fill material that is too wet or too dry shall not be compacted until the moisture content is brought within the specified limits. Fill material that is soft and yielding as a result of excess water shall be replaced with suitable material or worked and allowed to dry out to the specified moisture content and recompacted.

Structural fill shall be compacted to a minimum density of 95 % of maximum dry density determined in accordance with ASTM D1557 (Ref. 3.2). Common backfill shall be compacted to a minimum of 90 % of the maximum dry density determined in accordance with ASTM D1557 (Ref. 3.2). Field testing shall be performed to verify compliance with compaction and fill material requirements. Refer to Section 5.11, SRS engineering guide 02224-G, (Ref. 8.1).

Additional recommendations regarding placement of fill can be found in Sections 5.5, 5.7 and 5.8, SRS Engineering Practices Manual, WSRC-IM-95-58, Guide No. 02224-G, (Ref. 8.1).

8.3 Settlement Monitoring

Prior to construction, three heave monitoring points shall be installed in the footprint of the excavation for the RHB to monitor the heave of the foundation soils during excavation (unloading). The monitoring points shall be Borros anchors or equivalent, installed at a depth of 5 feet below the proposed foundation level and shall be capable of detecting movement to 0.005 foot. Survey readings shall be taken daily during excavation, recording heave and excavation depth. Once the base mat is poured, these points shall be transferred to the base mat (should be coordinated with installation of the settlement monitoring points).

Monitoring points shall be installed on the RHB foundation. At least nine monitoring points shall be installed initially on the mat foundation, as follows:

- One each at the four corners;
- One in the center near the cross wall;
- Two along the east-west sides of the base mat at mid-span;
- One near the center of the cross wall between the Water Cracker and the Remote Process cell; and
- One near the center of the cross wall between Cask Decon Area and the Cask Receiving Area.

These monitoring points may be transferred to locations above ground elevation prior to backfilling around the RHB. However, once the structure is "out of the ground", it is recommended that the settlement points be transferred near the ground surface for easy access.

Similarly, a minimum of five settlement monitoring points shall be installed on the foundation for the TPB (one near each corner and one near the center) and four on the foundation (one near each corner) of the stack foundation.

Settlement surveying shall be conduced weekly as soon as the monitoring points are installed, monthly after the placement of the foundation mat, and yearly after the initial operation of the RHB. For each monitoring reading, estimates of dead and live load shall also be made for the facility. Field surveyed results shall be transmitted to SGS for evaluation.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The subsurface conditions are characterized based on boreholes, SCPTUs, CPTUs, and laboratory testing of samples from this investigation. Subsurface data obtained from previous investigations are also reviewed and considered. The conclusions of the investigation are:

1. Grading
   - All grading work shall be performed in accordance with Section 8.1, Site Preparation and Section 8.2, Compaction and Fill. Grading work should be performed in accordance with the table presented in Section 8.1.
   - Excavation of the RHB building and subsequent construction should be accomplished in accordance with the recommendations detailed in Section 8.1.1.
   - Backfilling recommendations for the Product Transfer Trench should be accomplished in accordance with recommendations presented in Section 8.1.2.
   - Utility trenches extending under buildings, traffic areas and walkways should be backfilled with structural fill based on recommendations provided in Section 8.2. Backfill soils should be properly compacted to ensure against water migration underneath structures.
   - On-site fill is unsuitable to support the proposed facilities.
2. Foundations
   - All foundations shall be constructed on undisturbed, naturally-deposited or properly compacted soils.
   - Allowable bearing capacity for each structure is summarized in Section 7.1. For temporary dynamic loading these values can be increased by one third.
   - Estimated total and differential settlements are summarized in Section 7.10
   - The total static settlement (recompression) of the RHB and Corridor No. 116 is discussed in Section 7.8
   - The configuration beneath Corridor No. 116 should be reviewed.
   - Maximum settlement of Product Transfer Trench may be equivalent to the settlement of H & V Supply Platform.
   - Minimum width is 2 feet for both square spread footings and strip footings.
   - Minimum embedment depth is one and one half foot for all foundations.
   - Minimum frost depth is 6 inches.

3. Floor Slabs and footings

   - In locations where the floor slabs and footings are to be placed, the exposed undisturbed soil shall be proof-rolled in the presence of a geotechnical engineer in order to identify any loose or soft areas.
   - Floor slabs may be placed on properly-compacted structural fill or on the undisturbed, naturally-deposited soils. It is recommended that footings bear directly on undisturbed, naturally deposited soils but may bear on properly-compacted structural backfill if necessary. Soft or loose areas shall be removed and replaced with properly compacted structural backfill.

4. Miscellaneous:

   - Structures, equipment, and utility lines shall be designed to accommodate the expected total and differential settlements as summarized in Section 7.10.
   - For the computation of earthquake loading as given in UBC (Ref. 6.3), the soil profile type shall be S_D. For the computation of earthquake loading as given in SBC (Ref. 6.4), the soil profile type shall be S_3.
   - The existing SRS site PC-3 surface response spectra is applicable for the facilities.
   - Liquefaction is not expected to occur, however pockets of partial liquefaction will cause from less than 1 to over 3 inches of dynamic settlement.
   - A ground water elevation of 260 feet MSL shall be considered for the design.
   - All asphalt and concrete pavement, foundation material underlying the pavement, topsoil, and organic material shall be removed within the footprint of the building so that floor slabs, footings, and underground utility lines may bear directly on natural soils or structural fills.
   - Compaction shall be done using self-propelled compaction equipment, where possible. In areas sensitive to vibration, small or hand-operated compactor may be used.
   - Lateral earth pressure coefficients for compacted fill are as follows (based on internal friction angle $\phi' = 35$ degrees). See section 7.3 for at-rest, active, and passive earth pressure coefficients. Compaction against footings or basement walls will cause an increase in lateral earth pressure.
   - Vertical subgrade modulus for a 1 foot by 1 foot plate (k_1) is in the range of 120 to 600 kcf with the plate bearing directly on the undisturbed, naturally-deposited soil or properly compacted soils. For on-site soils a reasonable k_1 value would be 300 kcf. For well compacted soils k_1 value would be 600 kcf.
   - Base friction factor (f_s) for mass concrete on structural fill is 0.43; for layers 1, and 1B/1A f_s is 0.4.
   - Adequate efforts must be made to minimize soil erosion and sediment laden runoff to the surrounding area. Any increase in stormwater runoff must be

- retained and released slowly using sound stormwater management practices consistent with federal, state, local, and site practices.
- Heave and settlement monitoring points shall be installed per recommendation discussed in Section 8.3.
- A geotechnical engineer should observe all excavations to determine:
    a. If subsurface conditions revealed are consistent with those discovered during the explorations.
    b. Proper bearing stratum is exposed at the proposed foundation excavation depths.
    c. Foundation excavations are properly prepared, cleaned and dewatered prior to backfill and concrete placement.
- A geotechnical engineer should oversee placement of structural fill.

REFERENCES

1.1 C-SOW-H-00009, Scope of Work, Civil, Structural, and Architectural Systems, CLWR-TEF, Rev. 2, April 7, 1997.

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TABLES

CPTU No.	North Coordinate	East Coordinate	Elevation (feet) MSL	Depth (feet)	Date (year)
HTEF-C1	73,548	61,456	280.2	156	1997
HTEF-C2	73,468	61,442	283.3	158	1997
HTEF-C3	73,413	61,488	285.9	160	1997
HTEF-C4	73,264	61,483	288.3	162	1997
HTEF-C5	73,270	61,575	287.8	162	1997
HTEF-C6	73,301	61,736	294.1	171	1997
HTEF-C7	73,390	61,751	291.2	168	1997
HTEF-C8	73,382	61,583	287.4	163	1997
HTEF-C9	73,423	61,670	288.1	163	1997
HTEF-C10	73,455	61,774	288.5	164	1997
HTEF-C11	73,506	61,573	284.9	159	1997
HTEF-C12	73,541	61,649	288.1	163	1997
HTEF-C13	73,302	61,639	292.1	167	1997
HTEF-C14	73,181	61,916	299.7	35	1997
HTEF-C15	73,569	62,248	288.8	35	1997
HTEF-C16	73,480	62,248	288.4	35	1997
HTEF-C17	73,368	61,634	288.7	165	1998
HTEF-C18	73,340	61,676	291.9	139	1998
HTEF-C19	73,309	61,691	293.5	151	1998
HTEF-C20	73,312	61,656	292.3	174	1998
HTEF-C21	73,330	61,673	292.2	169	1998
HTEF-C22	73,349	61,674	291.8	167	1998
HRTF-1	73,600	62,114	289.9	170	1993
HRTF-3	73,611	62,055	290.2	26	1993
HRTF-4	73,610	61,015	290.2	170	1993
HRTF-6	73,600	61,965	290.7	168	1993
HRTF-7	73,598	61,923	290.6	168	1993
HRTF-9	73,543	61,920	290.0	170	1993
HRTF-10	73,499	61,912	290.5	141	1993
HRTF-11	73,475	61,907	290.1	170	1993
HRTF-13	73,422	61,921	290.8	168	1993
HRTF-14	73,391	61,902	290.4	167	1993
HRTF-15	73,346	61,903	291.7	172	1993
HRTF-17	73,317	61,959	294.0	170	1993
HRTF-19	73,318	62,019	294.4	170	1993

Table 1 SCPTU and CPTU Locations in the Northern Section of the Tritium Area

Borehole No.	North Coordinate	East Coordinate	Elevation (feet) MSL	Depth (Feet)	Date (year)
HTEF-B1	73,331	61,587	287.7	158.5	1998
HTEF-B2	73,320	61,675	292.7	165.5	1998
HTEF-B3	73,431	61,670	288.1	159.5	1998
HTEF-B4	73,400	61,541	286.6	157.8	1998
HTEF-B5	73,467	61,628	287.1	156.0	1998
HTEF-B6	73,305	61,640	291.6	36.0	1998
HTEF-B7	73,400	61,535	286.6	100.0	1998
H-101	73,565	61,850	281.3	46.5	1984
H-102	73,565	62,150	278.0	46.5	1984
H-103	73,350	61,850	292.9	51.5	1984
H-104	73,350	62,150	295.7	51.5	1984
H-113	73,443	62,025	289.9	180.3	1984
H-114	73,353	62,025	293.4	91.5	1984
H-115	73,553	62,025	282.4	76.5	1984
H-116	73,480	62,144	289.0	21.5	1984
H-117	73,408	62,144	293.2	21.5	1984
H-118U	73,325	62,088	294.3	21.5	1984
H-119U	73,250	62,088	296.5	21.5	1984
B1	73,354	61,928	291.5	198.5	1992
B2	73,588	61,928	289.3	197.9	1992
B3	73,588	62,121	288.5	201.3	1992
B4	73,368	62,210	289.7	198.3	1992
B5	73,461	62,139	291.0	198.3	1992
B5A	73,466	62,139	291.0	131.0	1992
B6	73,344	62,065	293.4	9.0	1992
B6A	73,342	62,032	293.4	199.3	1992
B7	73,461	62,184	290.1	198.4	1992
B8	73,354	61,918	291.4	205.0	1992
B9	73,354	61,908	291.2	205.0	1992
B10	73,588	62,131	288.4	205.0	1992
B11	73,588	62,141	288.1	205.0	1992
B12	73,593	62,121	288.8	74.0	1993
B13	73,600	62,020	290.2	161.5	1993
B13A	73,600	62,010	290.2	61.5	1993
B13B	73,600	62,014	290.2	67.9	1993
B14	73,588	61,923	289.4	74.5	1993
B15	73,466	61,902	290.2	158.5	1993
B16	73,349	61,913	291.7	72.0	1993
B17	73,857	62,063	256.4	37.5	1993
B20	73,857	62,033	256.4	36.2	1993

Table 2 Borehole Locations in the Northern Section of the Tritium Area

Layer Identification	0	1	1B/1A	2	3	4A & 4	5	6	7
Description	Structural Fill	Altamaha	Upper Tobacco Road	Upper Tobacco Road	Lower Tobacco Road	Upper Dry Branch	Tan Clay	Lower Dry Branch	Santee
SPT N-value	-	35	43	20	17	37	15	48	41
Tip Stress tsf	-	136	113	44	53	158	43	165	91
Sleeve Friction tsf	-	3.5	1.9	1.9	1.2	0.8	0.4	1.0	1.9
Friction Ratio%	-	3.2	1.8	4.7	3.5	0.6	1.2	0.7	2.1
Q_c / N	-	3.9	2.6	2.2	3.2	4.2	2.9	3.5	2.2
Water Content %	-	23	17	19	27	-	24	-	36
Wet Density pcf	-	120	116	123	118	-	122	-	114
Liquid Limit %	-	44	34	48	38	36	44	33	37
Plastic Index %	-	22	11	23	11	11	20	10	9
Fines %	-	29	20	32	16	12	18	10	21
Cohesion psf	-	0	0	0	0	0	0	-	0
Friction angle degree	-	31	31	25	25	31	31	-	27
Effective Cohesion, psf	0	0	0	0	0	0	0	0	0
Eff Friction Angle, degree	35	33	33	33	33	31	31	31	32
Void Ratio	0.5302	0.7302	0.6874	0.6667	0.7931	-	0.6684	0.7181	0.8316
Compression Index	0.051	0.162	0.146	0.217	0.173	0.520	0.113	0.072	0.237
Recompression Index	0.0063	0.0158	0.0155	0.0177	0.0292	0.0044	0.0068	0.0107	0.0159
OCR	-	4 - 7	1 - 3	1 - 3	1 – 2½	-	1 – 2½	1½ - 2½	0.7 – 2
K_a	0.27	0.29	0.29	-	-	-	-	-	-
K_p	3.7	3.4	3.4	-	-	-	-	-	-
K_0	0.43	0.46	0.46	-	-	-	-	-	-
k_1	Note 1	-	-	-	-	-	-	-	-
f_s	0.43	0.4	0.4	-	-	-	-	-	-
V_s, fps	-	1,580	1,290	1,200	1,120	1,090	1,090	1,150	1,150

Note 1: see Section 7.4

Table 3 Recommended Soil Properties

Formation Description	Reference Strain ε_r (%)
Stiff Upland Sands	0.021
Tobacco Road and Snapp Sands	0.044
Dry Branch, Santee, Warley Hill, and Congaree Sands	0.077
Four Mile Sands and any other Unrepresented Shallow Sands	0.066
Shallow Clays	0.148
Deep Sands	0.111
Deep Clays	0.230

Table 4 Reference Strain

Strain (%)	Formation						
	A	B	C	D	E	F	G
0.00001	1.059	0.625	0.825	0.674	1.296	0.489	0.992
0.0001	1.059	0.625	0.825	0.674	1.296	0.489	0.992
0.0002	1.103	0.647	0.835	0.687	1.292	0.497	0.990
0.0003	1.151	0.670	0.846	0.702	1.293	0.505	0.991
0.0005	1.248	0.717	0.871	0.733	1.300	0.524	0.995
0.001	1.493	0.835	0.936	0.811	1.326	0.570	1.013
0.002	1.973	1.070	1.070	0.970	1.389	0.665	1.054
0.003	2.434	1.300	1.205	1.127	1.456	0.759	1.097
0.005	3.302	1.747	1.470	1.435	1.594	0.945	1.186
0.01	5.201	2.790	2.108	2.171	1.938	1.398	1.410
0.02	8.165	4.605	3.281	3.505	2.603	2.251	1.851
0.03	10.407	6.139	4.336	4.686	3.233	3.039	2.276
0.05	13.639	8.614	6.162	6.692	4.392	4.453	3.080
0.1	18.317	12.799	9.605	10.363	6.820	7.289	4.856
0.2		17.425	13.951	14.825	10.356	11.179	7.671
0.3			16.683		12.884	13.799	9.833
0.5					16.317	17.210	12.995

Formation Description

A. Stiff Upland Sands

B. Tobacco Road and Snapp Sands

C. Dry Branch, Santee, Warley Hill, and Congaree Sands

D. Four Mile Sands and any other Unrepresented Shallow Sands

E. Shallow Clays

F. Deep Sands

G. Deep Clays

Table 5 Damping Ratio versus Shear Strain

FIGURES

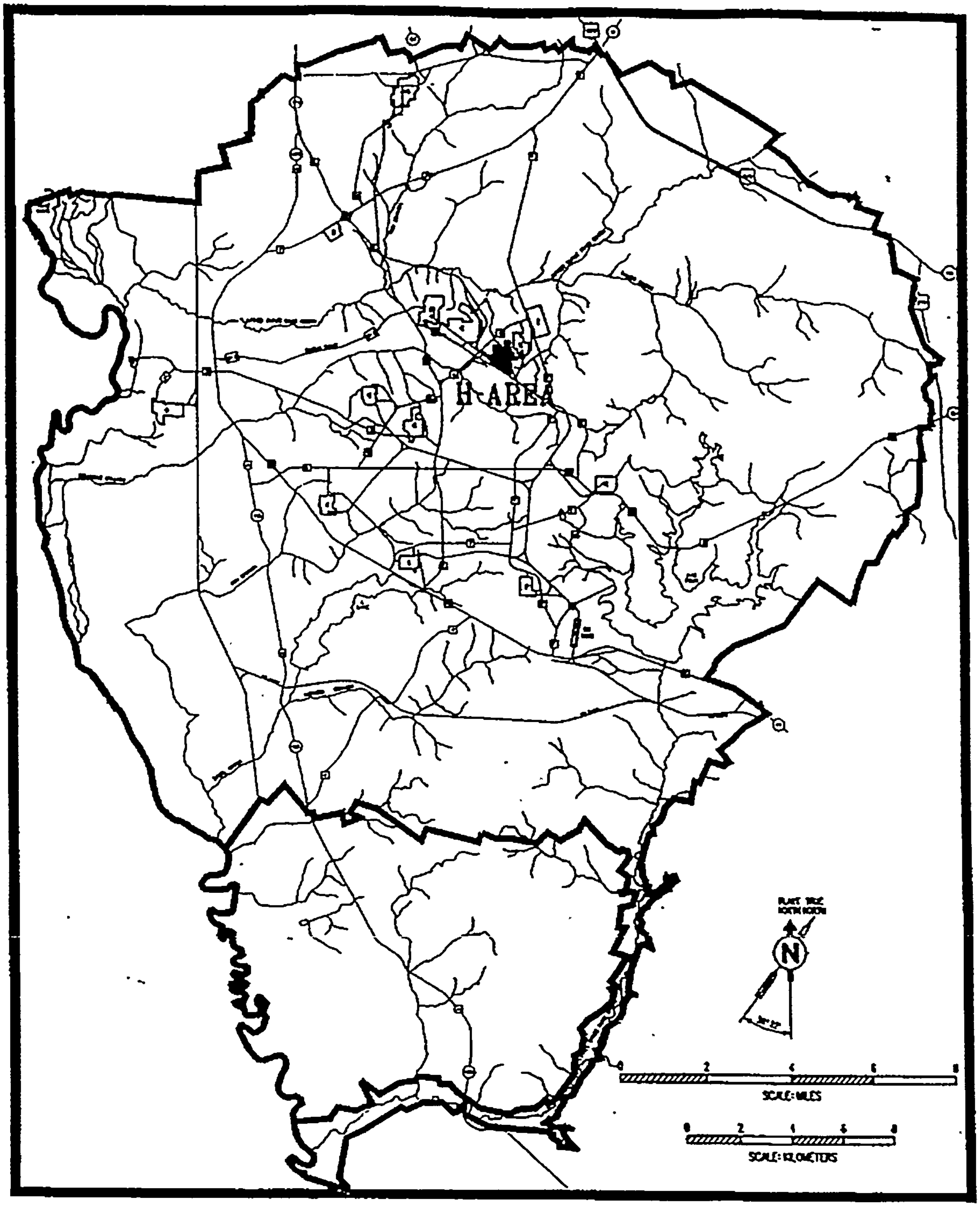


Figure 1. Savannah River Site map

Age		Group	Formation		WELL P-27 (MSL) (ft)
Tertiary	Miocene?	Barnwell Group	Altamaha		273
	Late Eocene		Tobacco Road Sand		253
			Dry Branch Formation	Irwinton Sand Member, Griffin Landing Member	226
			Clinchfield Formation		N/A
	Middle Eocene	Orangeburg Group	Santee Limestone	McBean Member Caw Caw Member Warley Hill Member	167
	Early Eocene		Congaree Formation		132
		Black Mingo Group	Fishburne Formation		108
	Paleocene		Snapp Formation		88
			Lang Syne, Saw Dust Landing Formation		48
Late Cretaceous	Maestrichtian	Lumbee Group	Steel Creek Formation		-9
	Campanian		Black Creek Formation		-54
	Santonian		Middendorf Formation		-189
		Cape Fear Formation			-438
Late Triassic		Newark Supergroup			N/A
Paleozoic and Cryptozoic (?)		"crystallines"			

Figure 2 SRS General Stratigraphic Chart

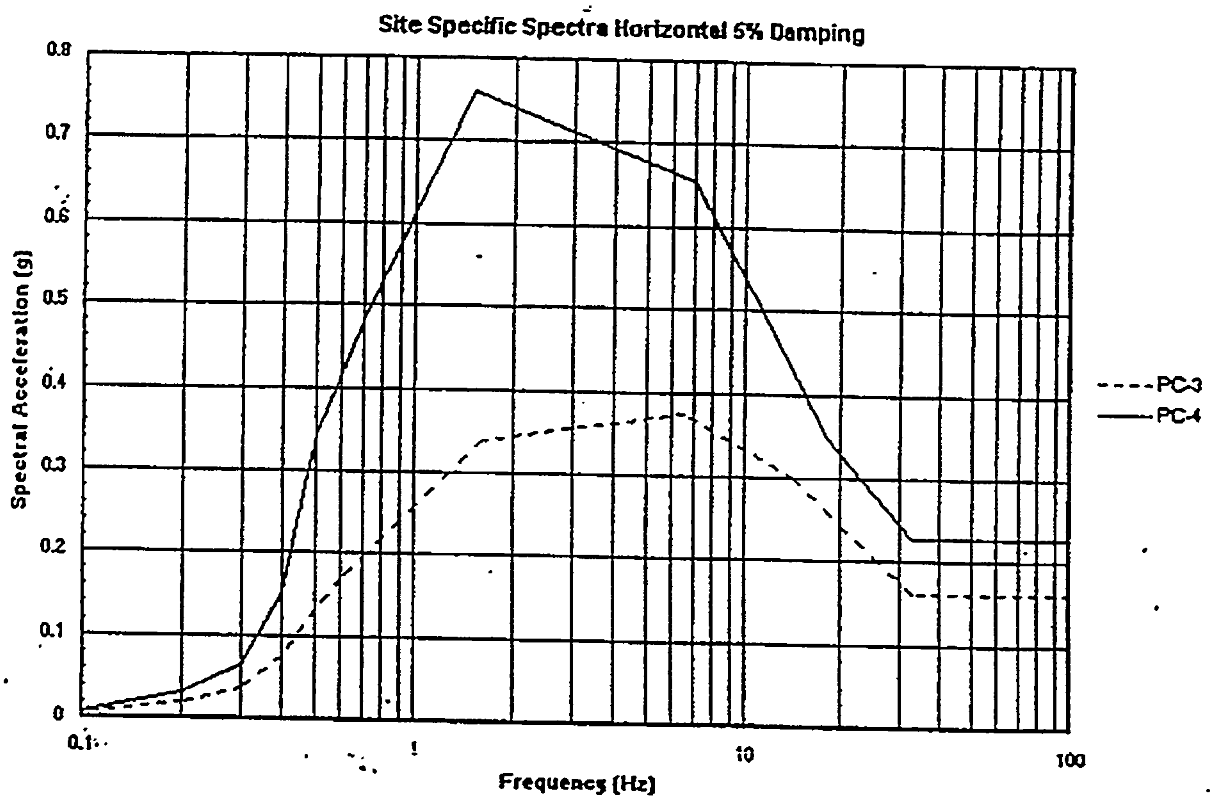
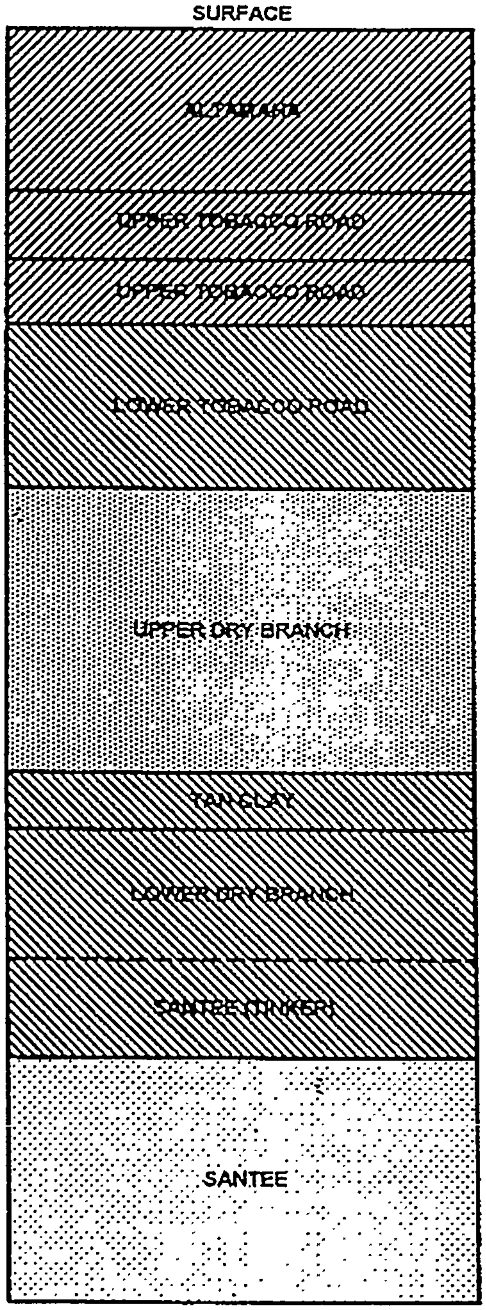


Figure 3 SRS site-wide design response spectra



Layer	Average Elevation (feet MSL)	Poisson's ratio	Total unit weight (pcf)	Shear wave velocity (feet/sec)
	289 (3.4)			
1	269 (2.2)	0.25	120	1581 (160)
1B/1A	265 ± 5 ▽ 262 (2.2)		116	1292 (168)
2	254 (2.8)	0.47	123	1199 (80)
3	234 (1.8)		118	1122 (102)
4A/4	199 (2.0)		125 (Note 3)	1097 (77)
5	192 (2.2)		122	1096 (108)
6	176 (1.3) 164 (2.3)		125 (Note 3)	1151 (189)
7	134 (1.8)		114	1158 (250)

1. Numbers shown are average values, for stratigraphy under specific facility, see cross-section
2. Numbers in parentheses are standard deviations
3. Based on RTF data

Figure 4 Idealized cross-section for the CLWR-TEF site

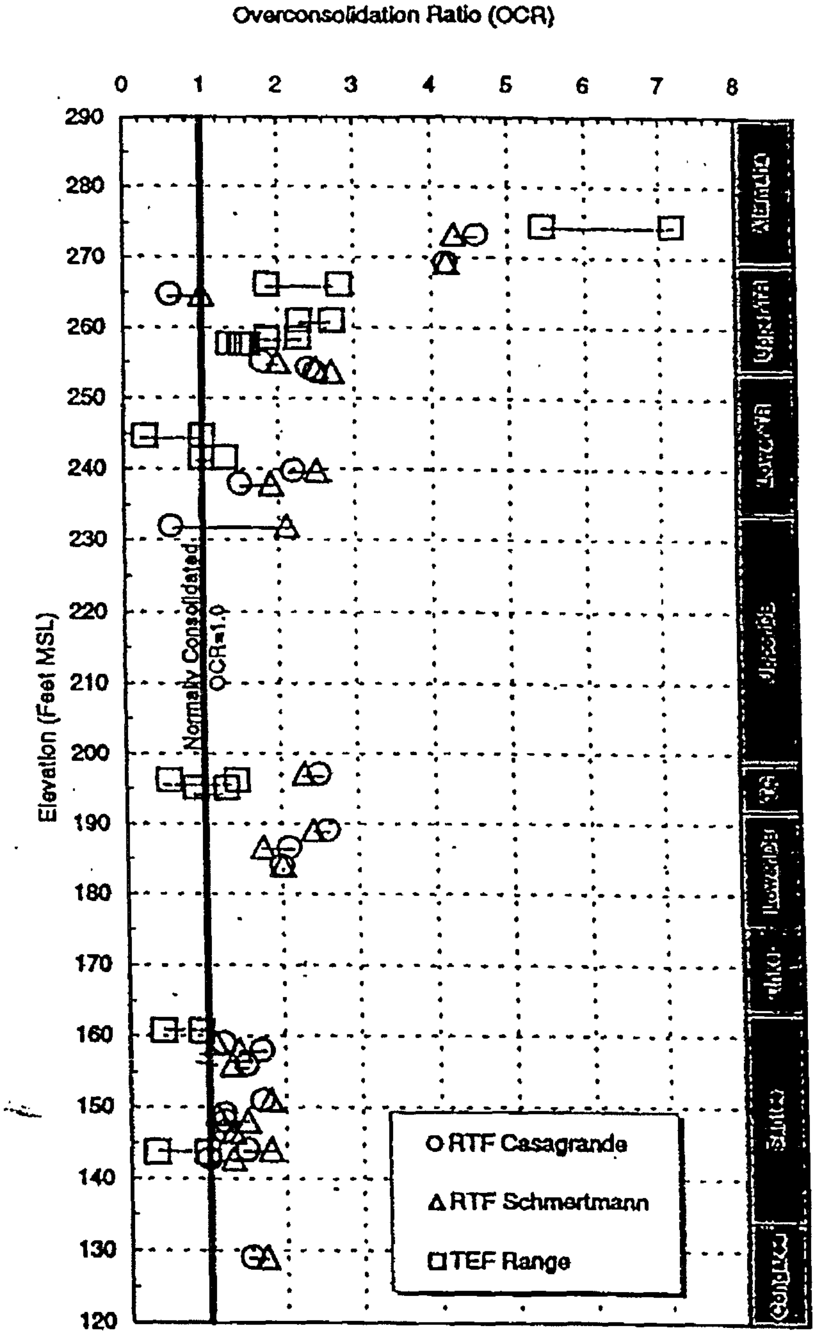


Figure 5 Overconsolidation ratio versus elevations

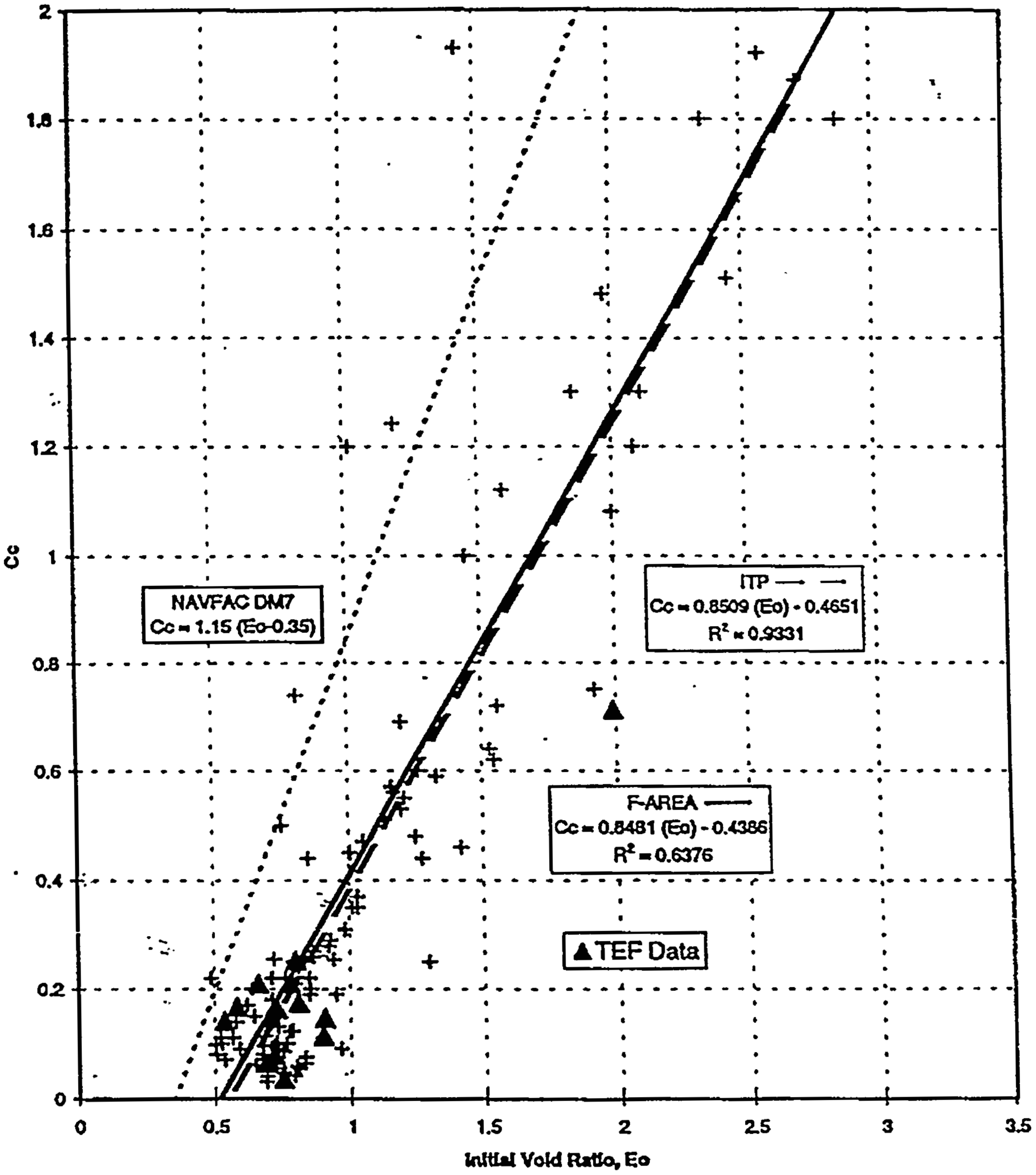


Figure 6 Compression index versus Initial void ratio

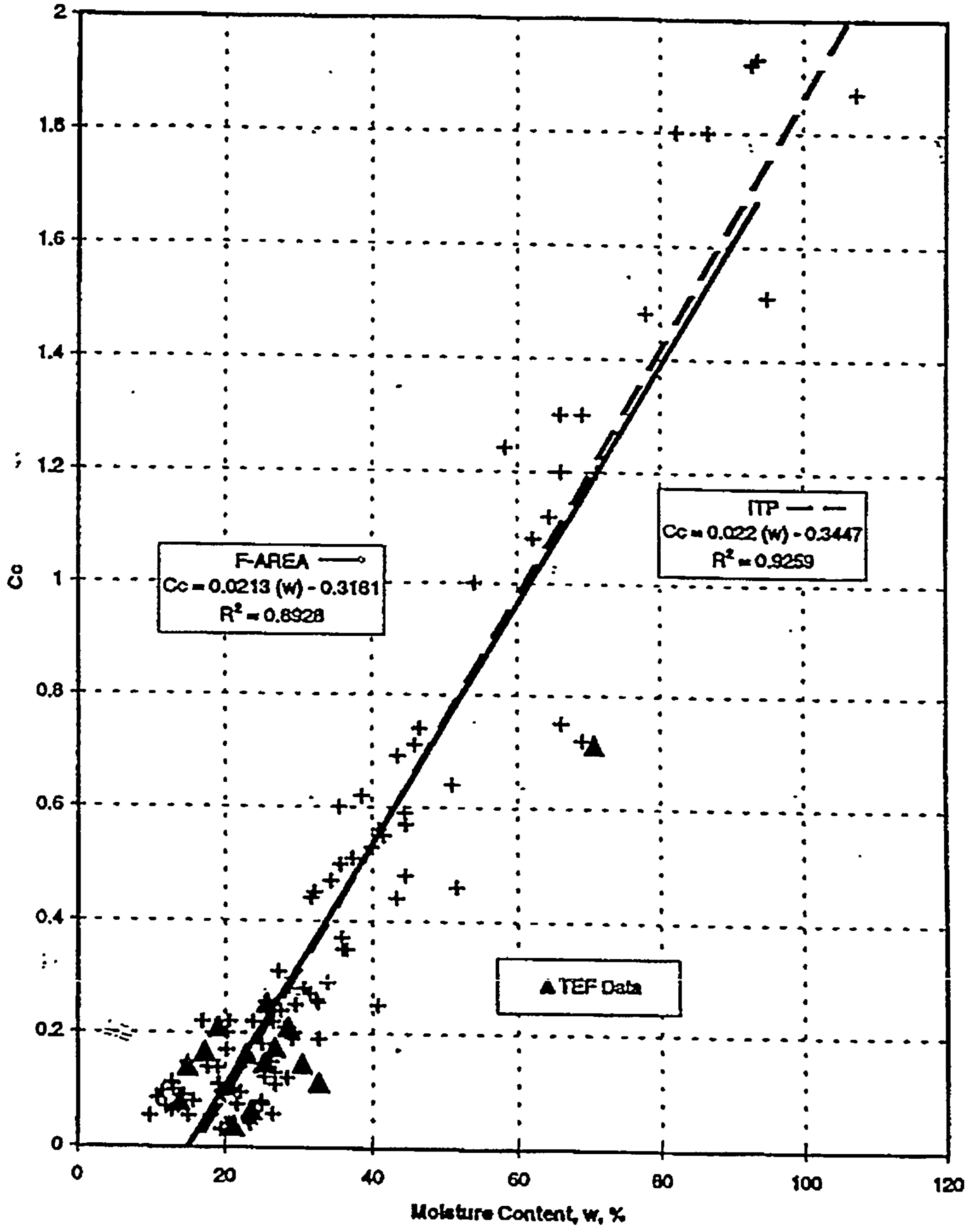


Figure 7 Compression index versus moisture content

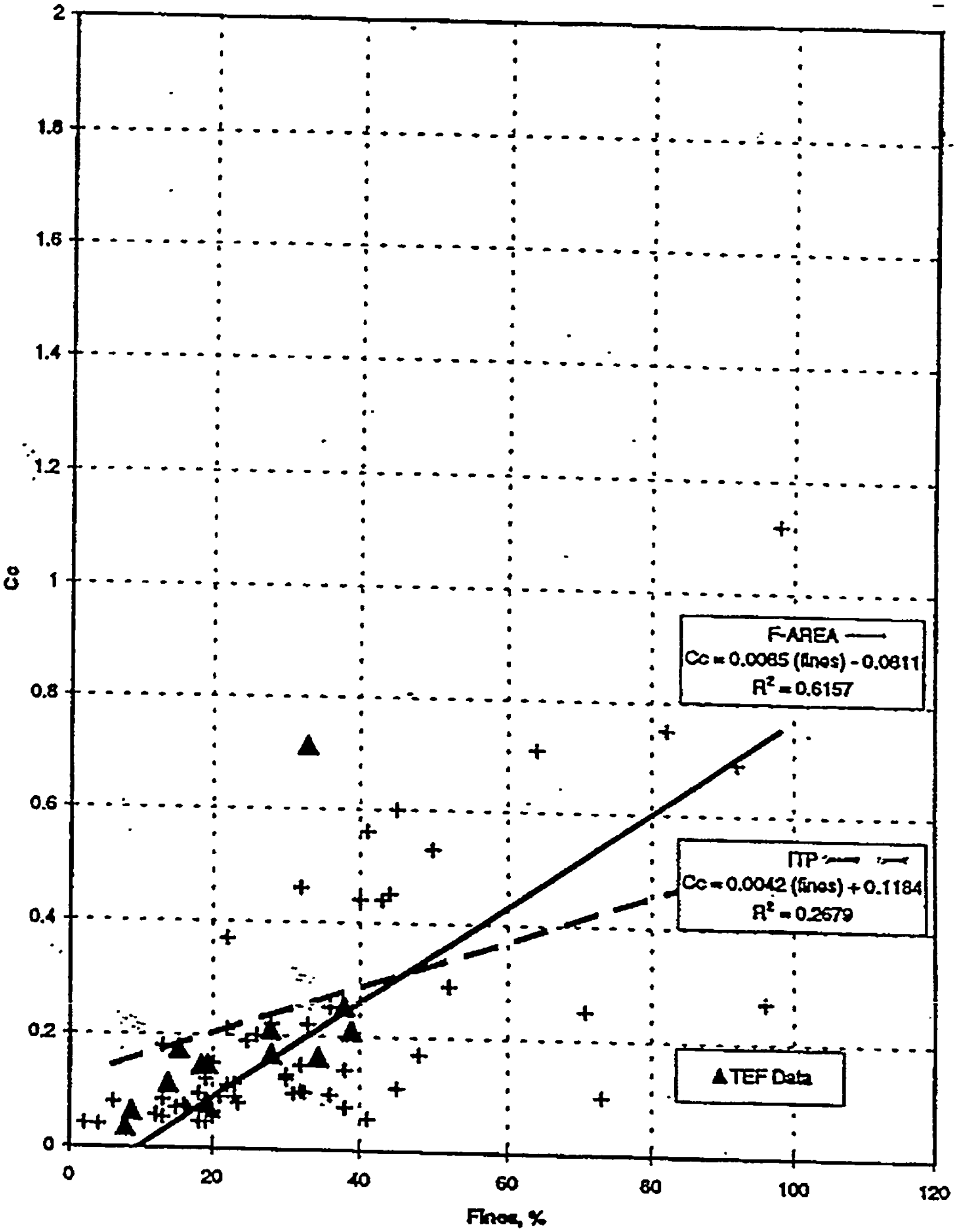


Figure 8 Compression index versus percent fines

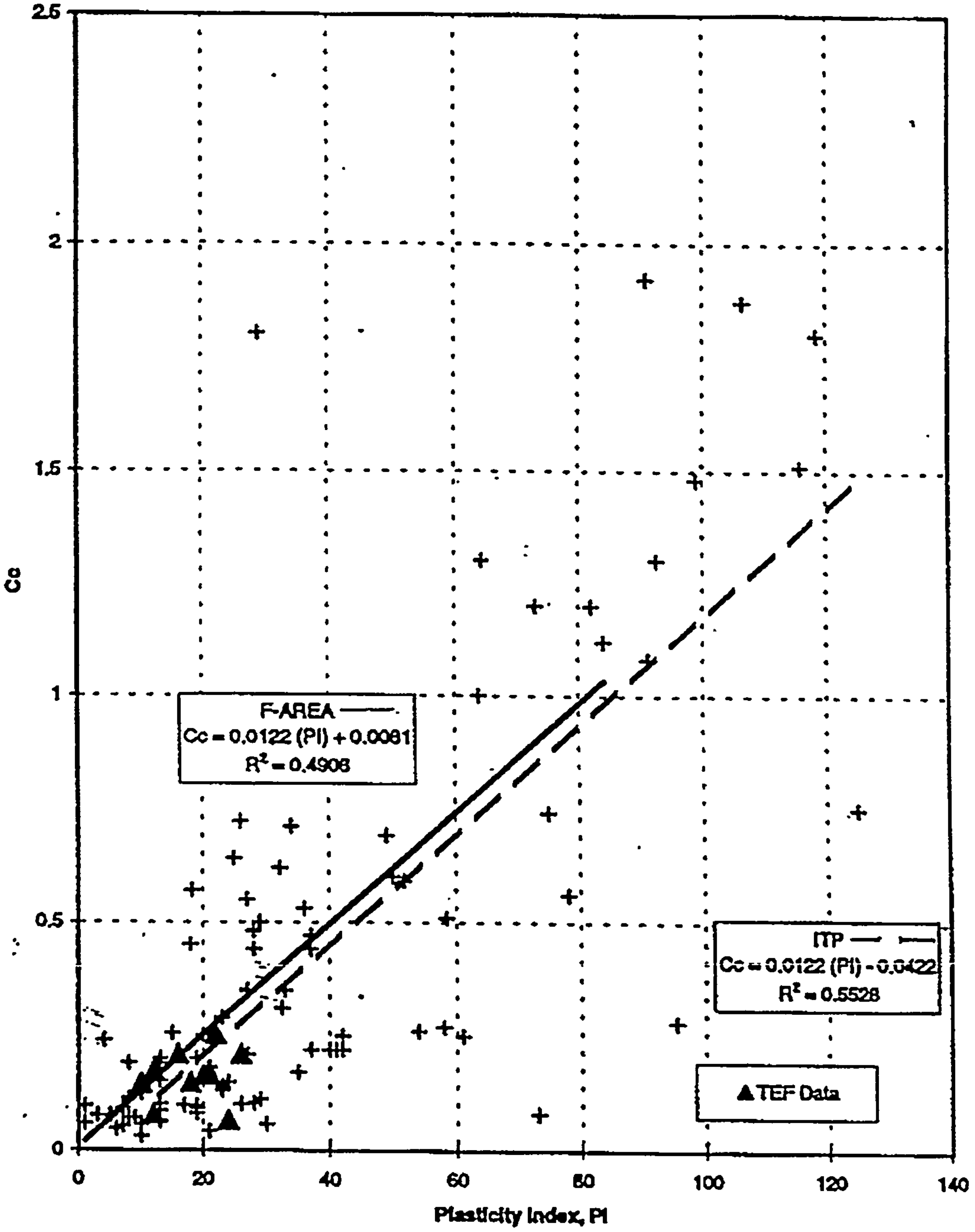


Figure 9 Compression index versus plasticity index

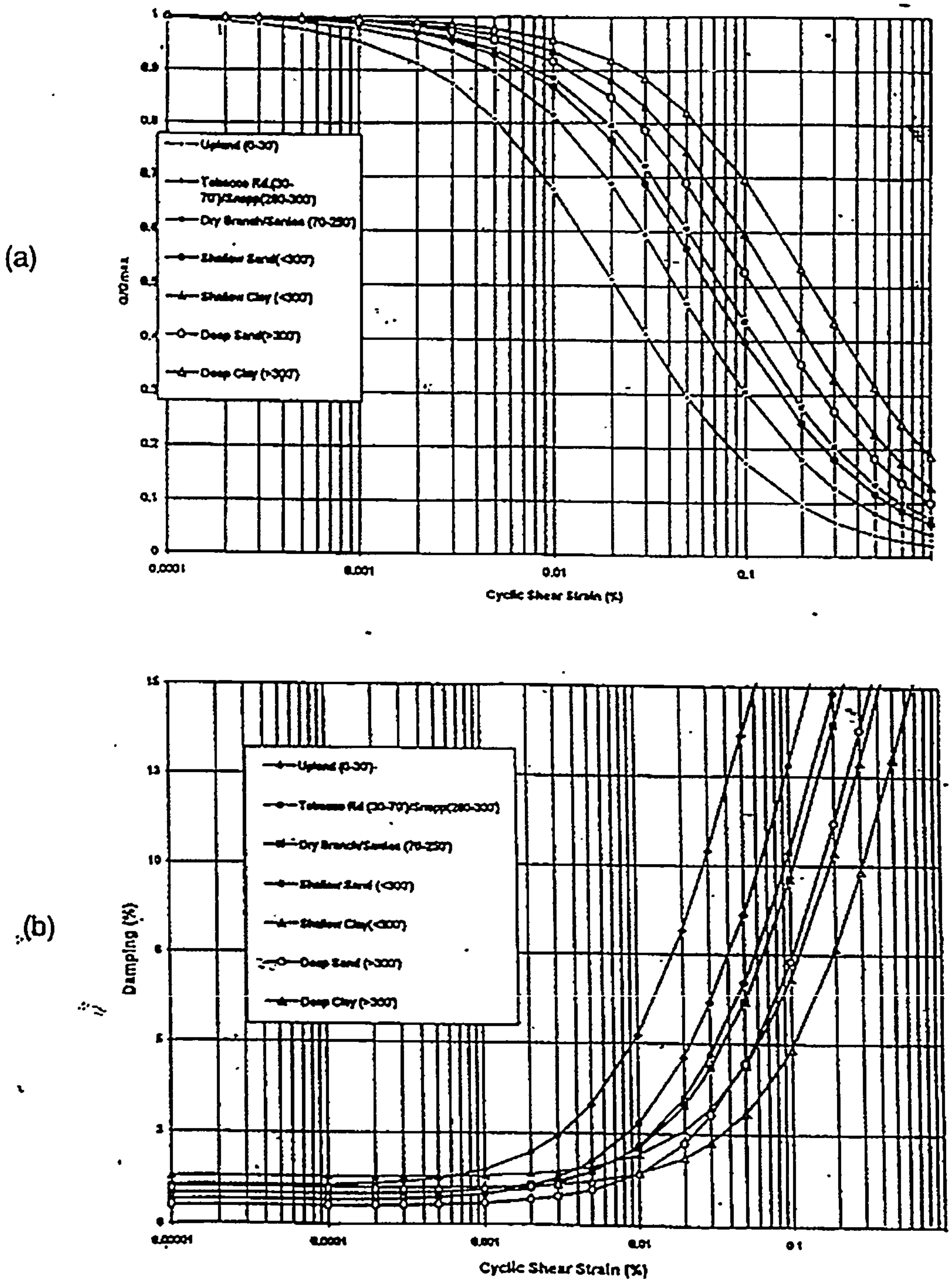


Figure 10 Shear modulus reduction and variation of damping ratios with cyclic strain amplitude

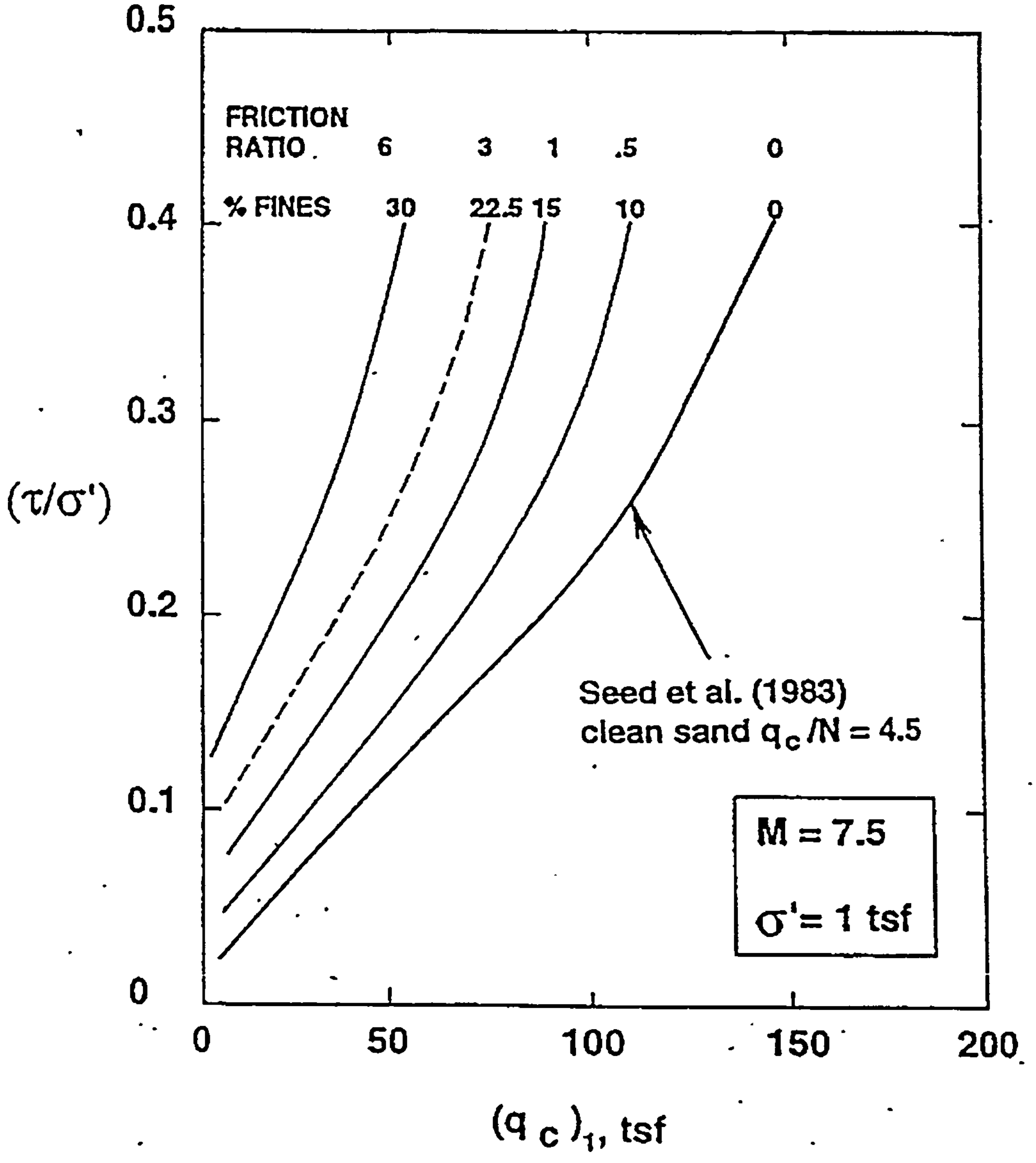


Figure 11. Normalized cone tip resistance and friction ratio versus cyclic stress ratio required for initial liquefaction (from Reference 7.10)

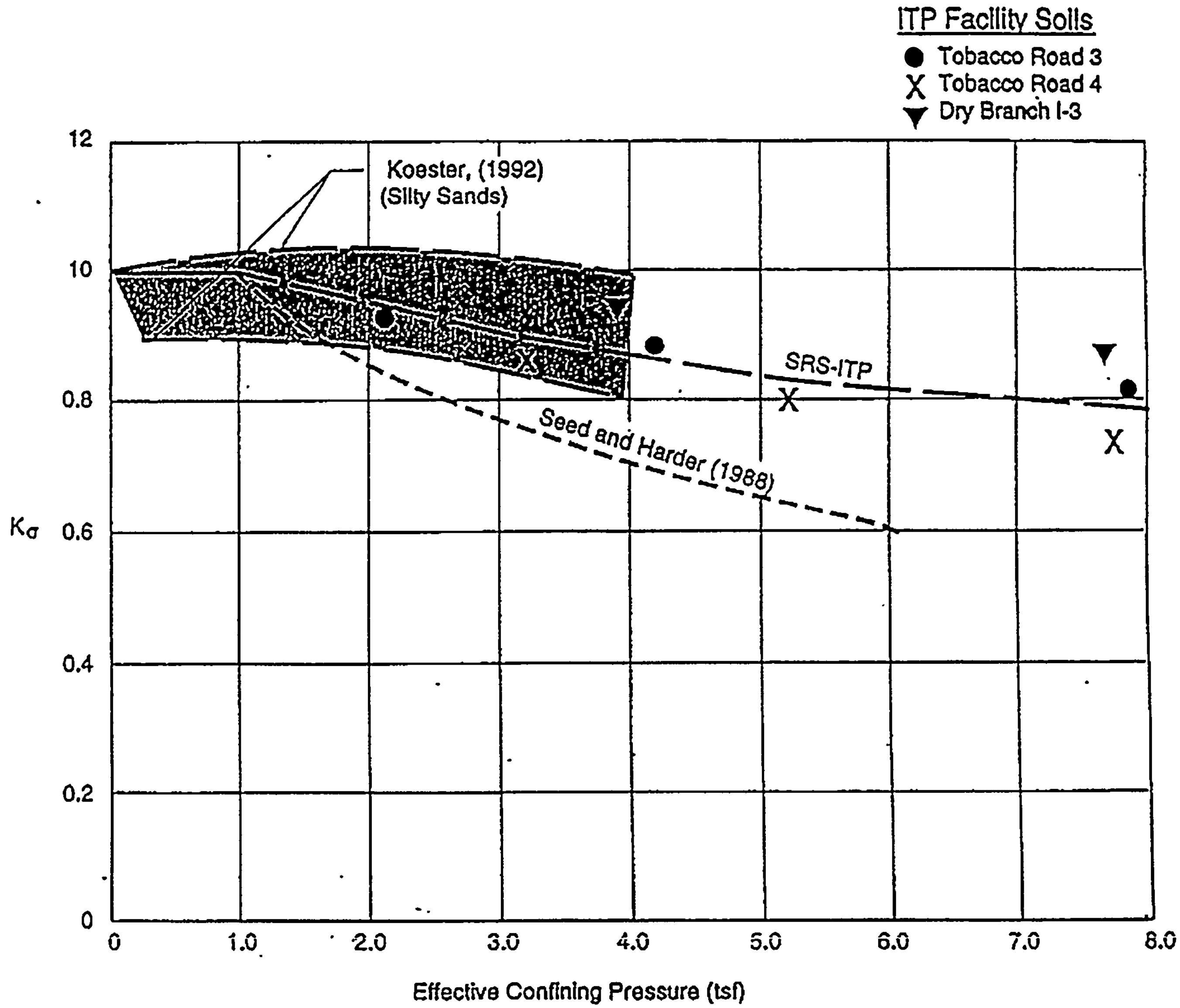


Figure 12. Comparison of effective confining pressure correction factor (K)
for SRS with K from other sources (from Reference 7.10)

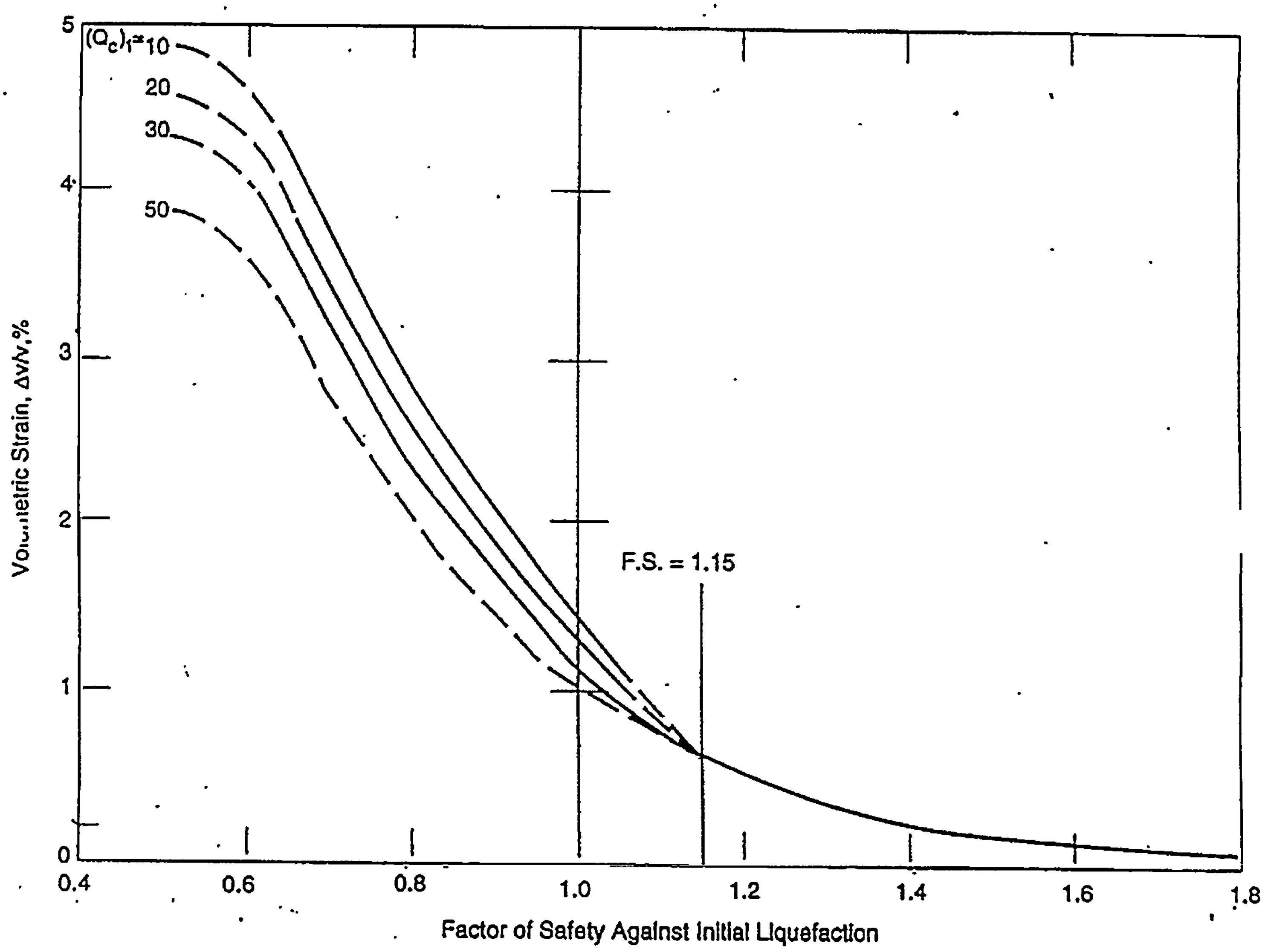
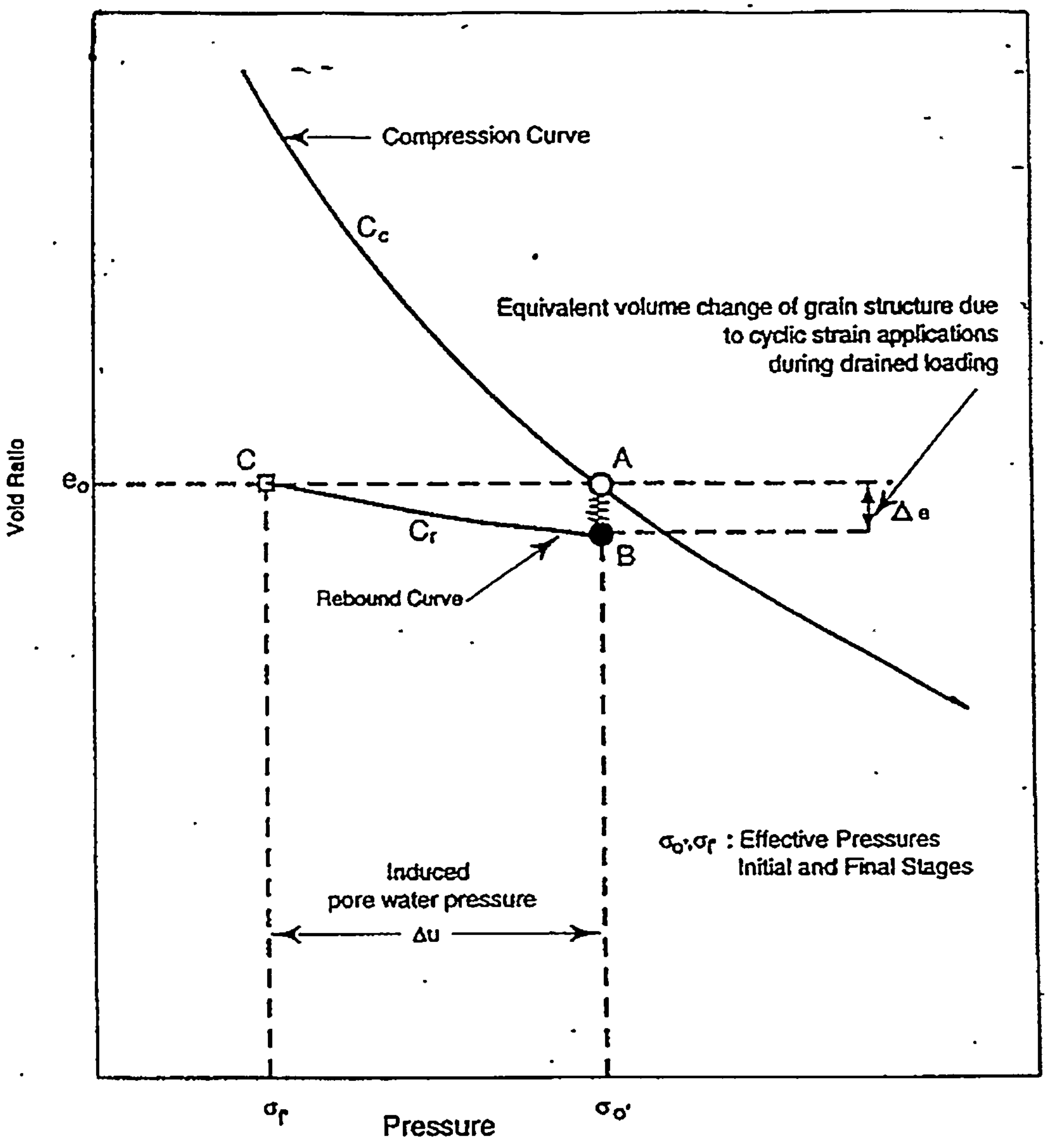


Figure 13. Volumetric strain as a function of safety factor against initial liquefaction (from Reference 7.10)



. Ref.: Seed, Arango, Chan, 1975

$$\frac{\Delta V}{V} = \frac{\Delta H}{H} = \frac{C_r}{1 + e_o} \log \frac{(\sigma_o' - \Delta U) + \Delta U}{\sigma_o' - \Delta U}$$

$$= \frac{C_r}{1 + e_o} \log \frac{\sigma_o'}{\sigma_o' - \Delta U}$$

$$= \frac{C_r}{1 + e_o} \log \frac{1}{1 - \Delta U / \sigma_o'} = \frac{C_r}{1 + e_o} \log \frac{1}{1 - r_u}$$

Figure 14. Derivation of relationship between pore water pressure ratio (r_u) and volumetric strain after liquefaction (from Reference 7.10)

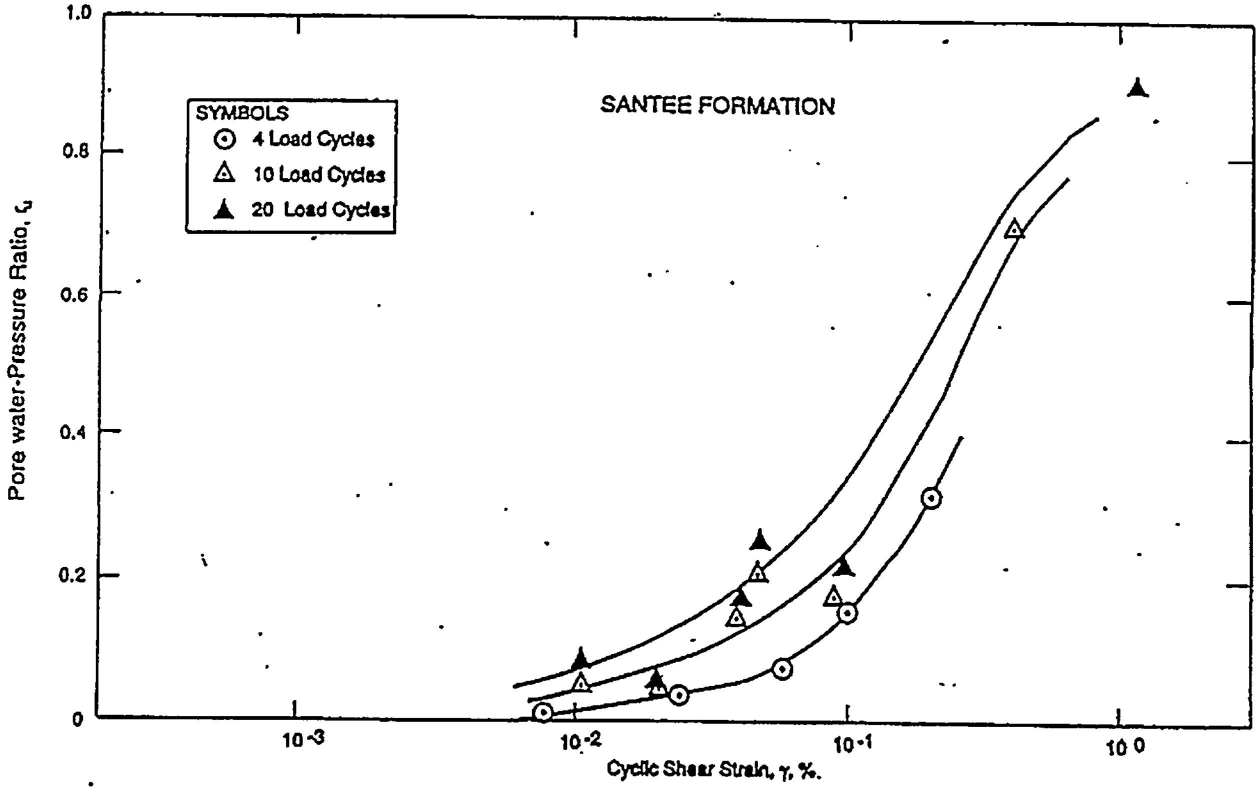


Figure 15. Relationship between cyclic shear strain amplitude, number of cycles, and pore water pressure increase for Santee Formation (from Reference 7.10)

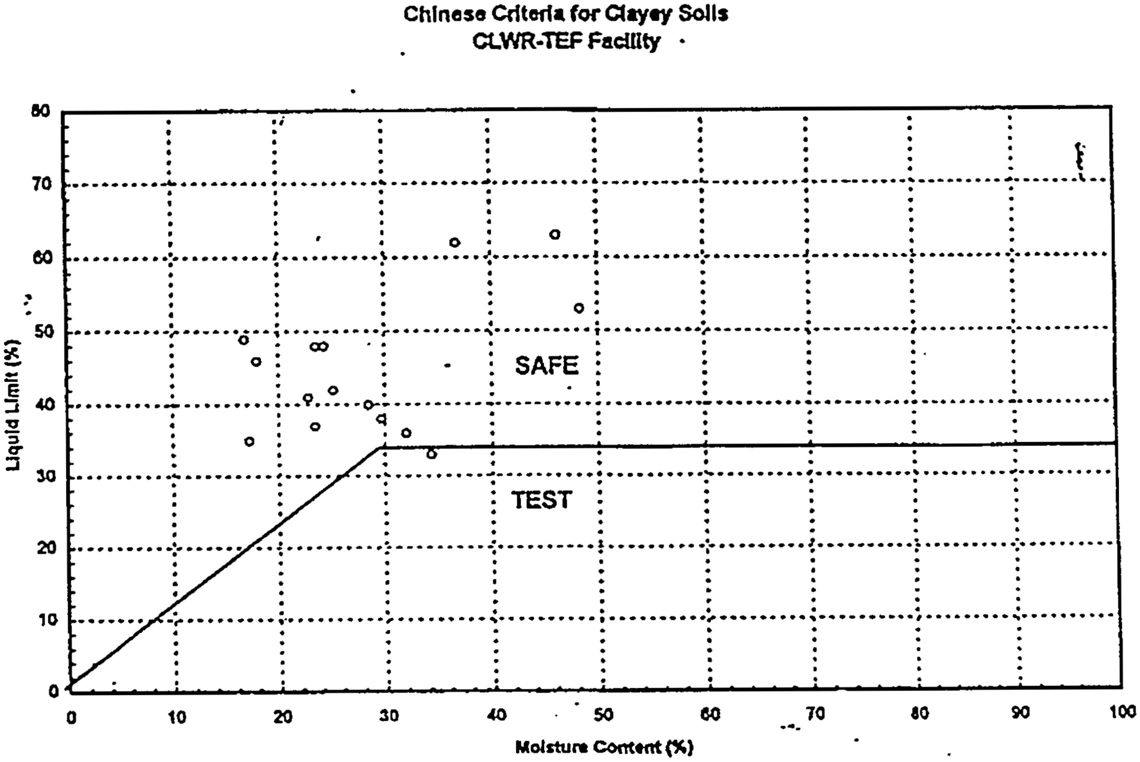
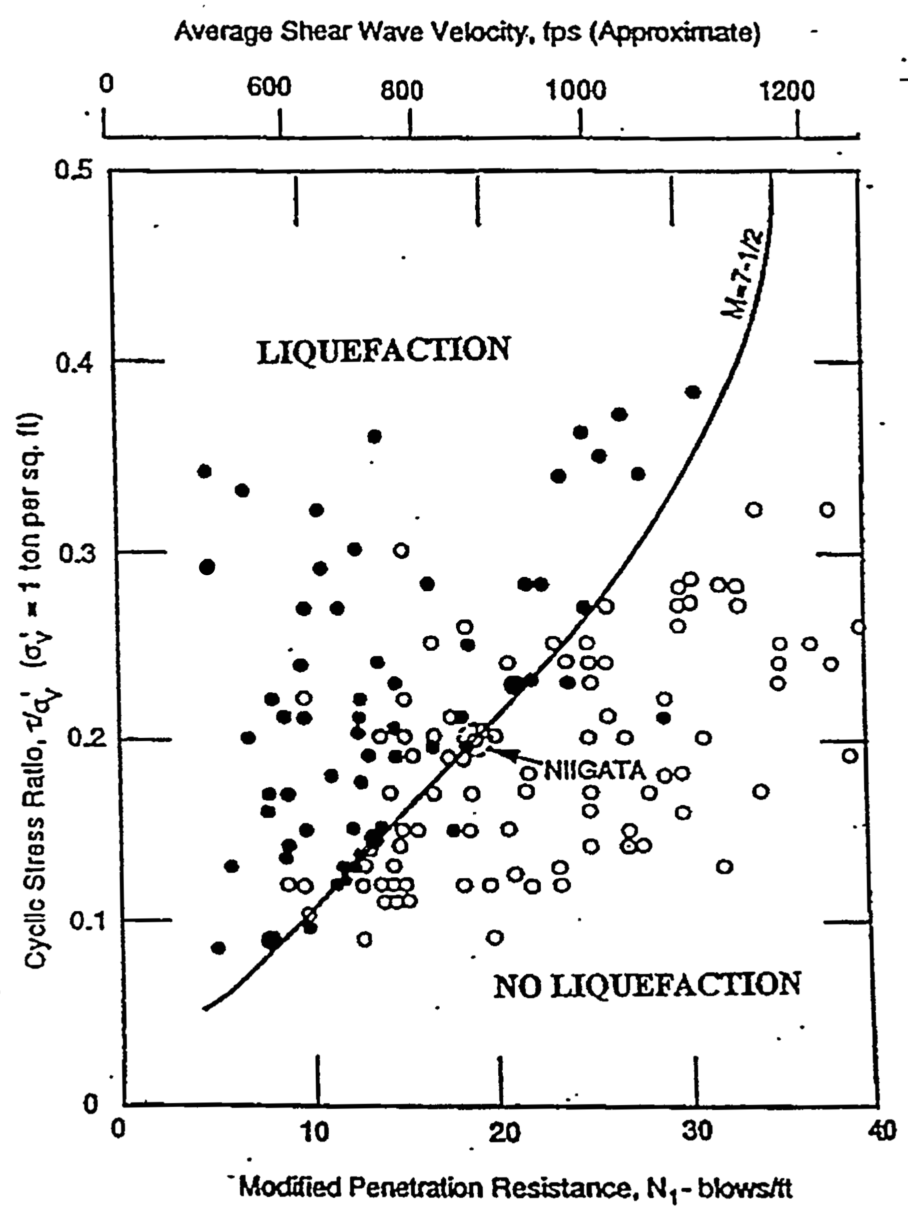


Figure 16 Chinese criteria for clayey soils at CLWR-TEF facility (References 7.15 and 7.16)



Ref.: Seed, Idriss, and Arango, (1983)

LEGEND

- ● Limits set by Chinese Code (1974)
- ● Liquefaction
- ○ No Liquefaction

Figure 17. Correlation between average shear wave velocity and cyclic stress ratio required for liquefaction (Reference 7.17)

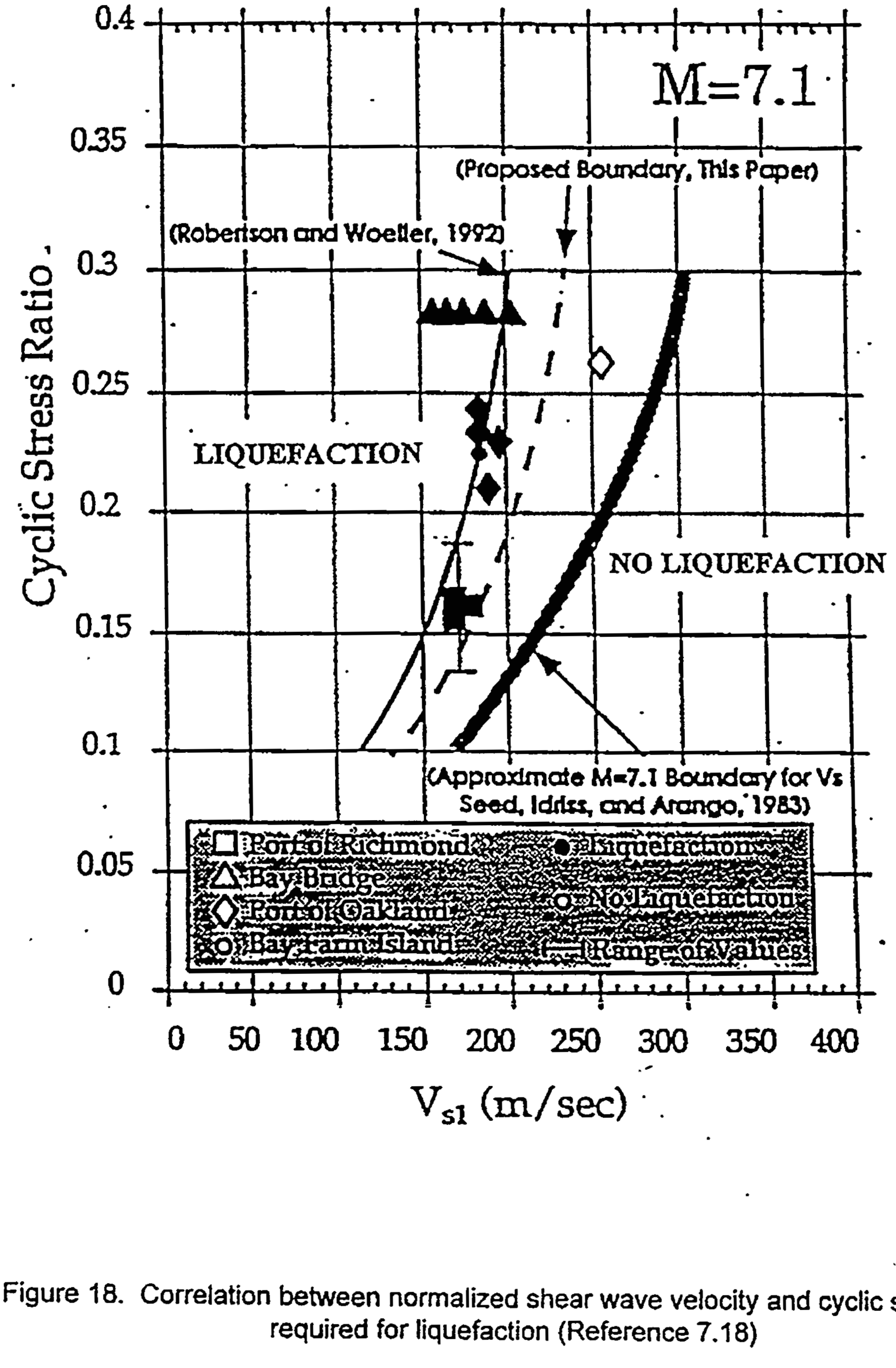


Figure 18. Correlation between normalized shear wave velocity and cyclic stress ratio required for liquefaction (Reference 7.18)

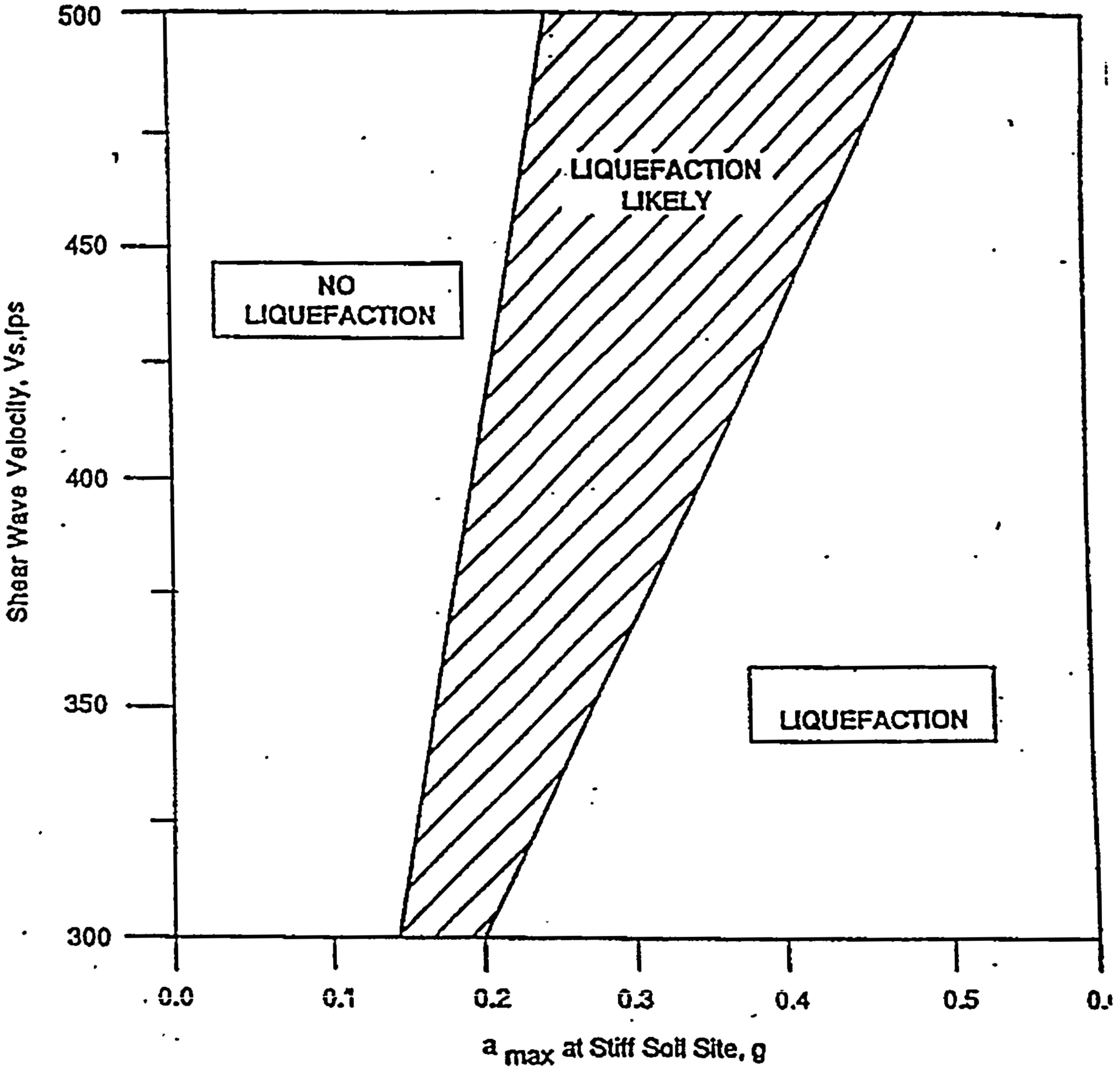


Figure 19. Liquefaction potential chart based on shear wave velocity of a sand layer and 20 cycles of strong motion (Reference 7.19)

Appendix A

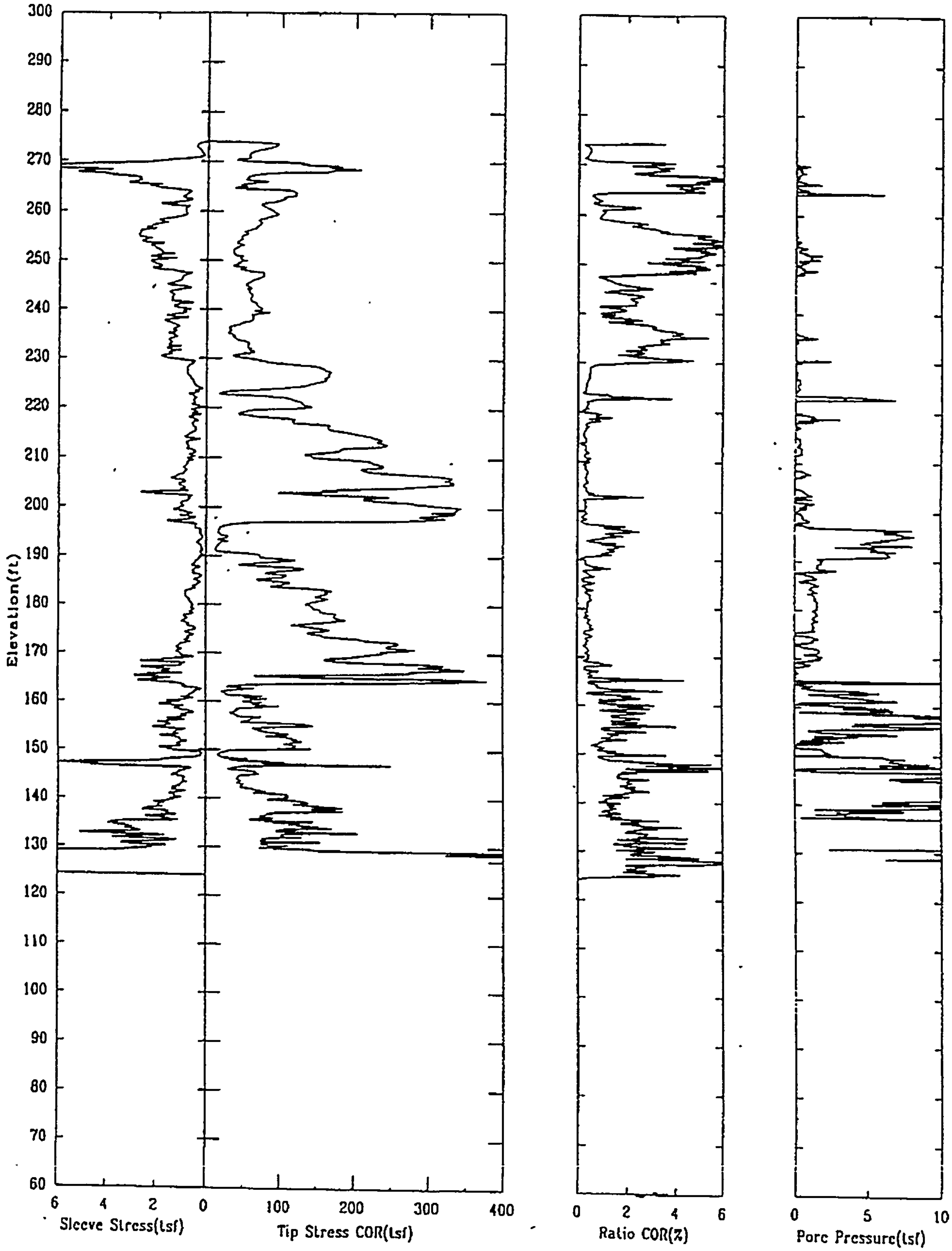
Seismic Piezocone Penetration Test soundings

and

Peizocone Penetration Test soundings

HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

North 73548.0 East 61456.0 Elevation 280.2

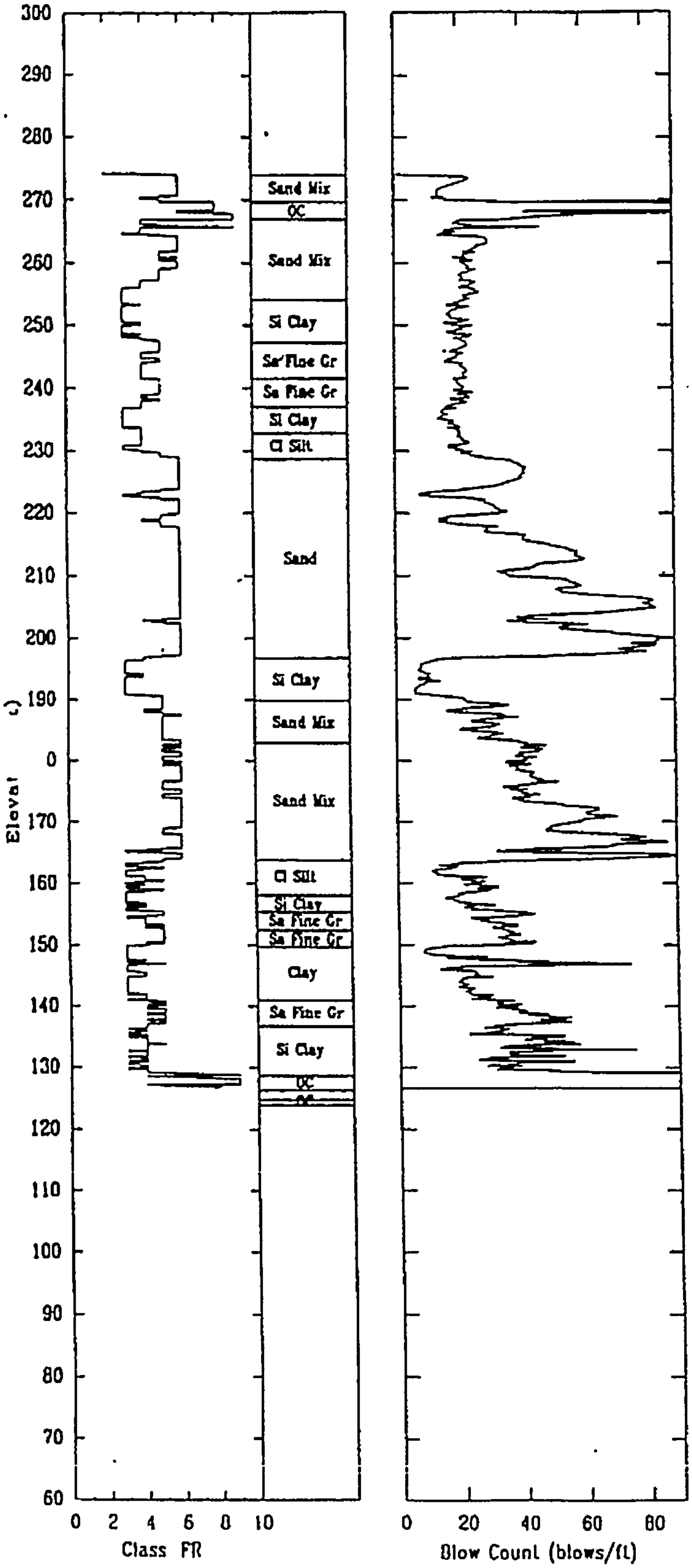


File 3160701 ECP

A-2

HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

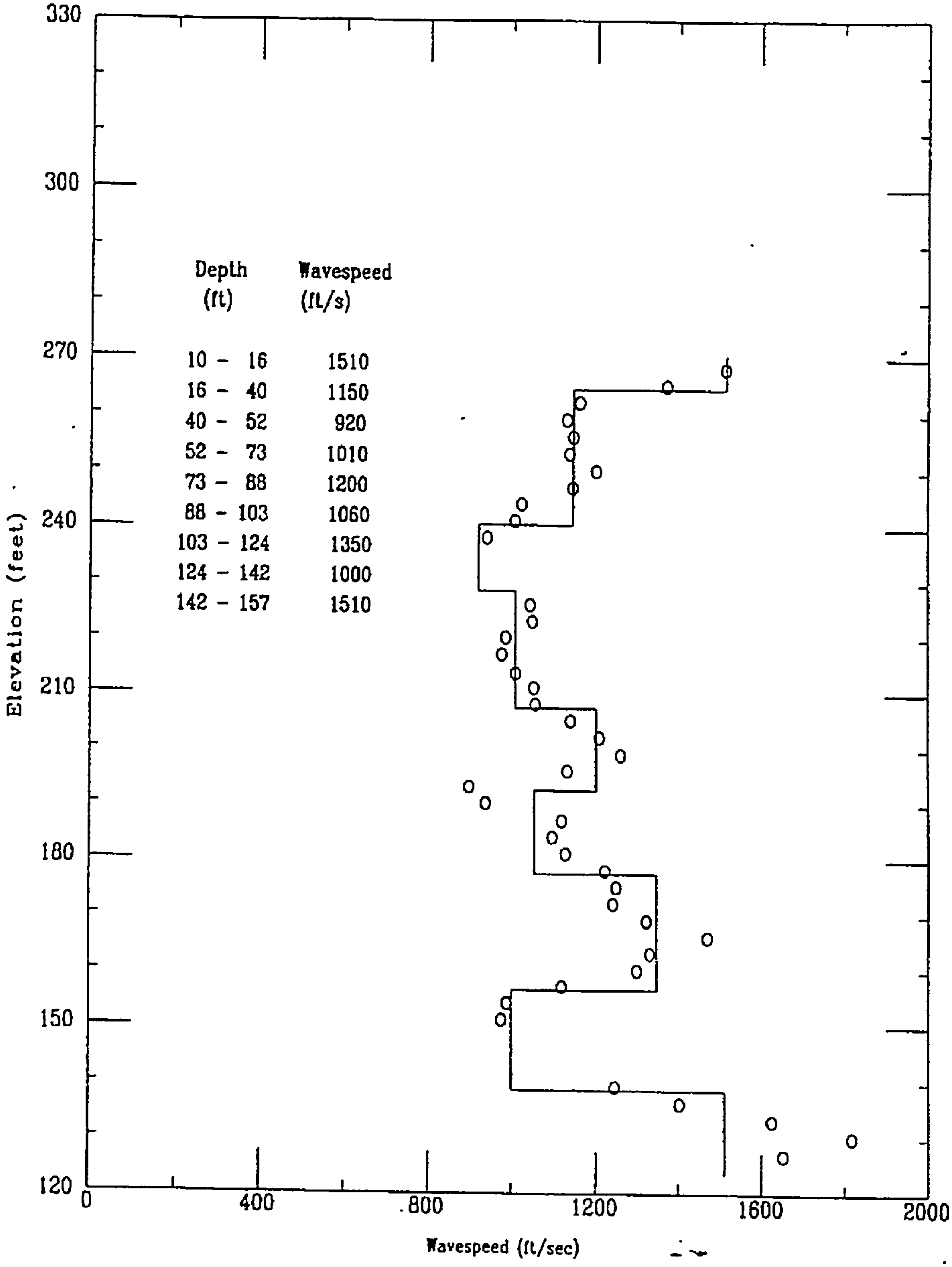
North 73548.0 East 61456.0 Elevation 280.2



File 3160701 ECP

HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

Shear Wave Speeds

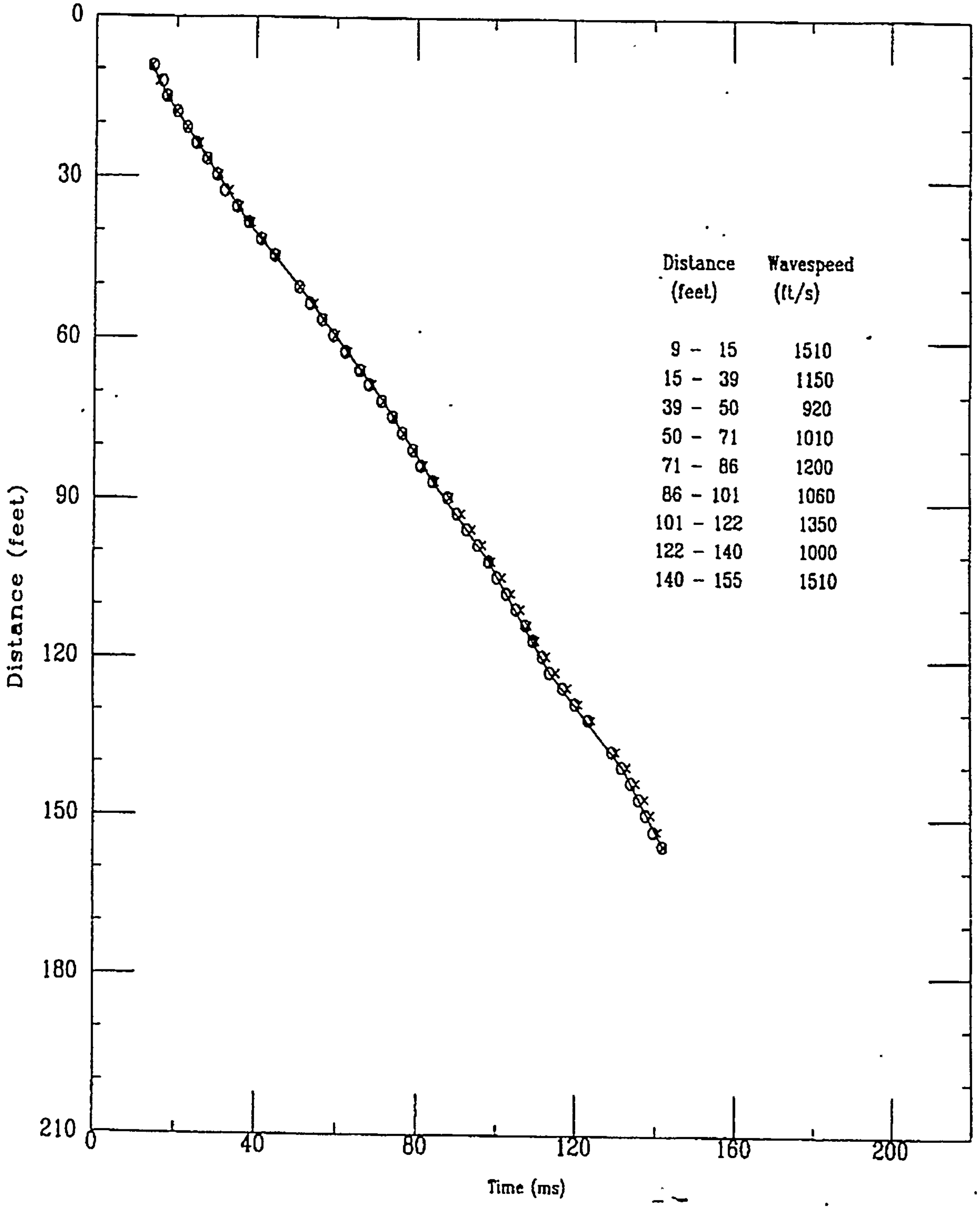


Depth (ft)	Wavespeed (ft/s)
10 - 16	1510
16 - 40	1150
40 - 52	920
52 - 73	1010
73 - 88	1200
88 - 103	1060
103 - 124	1350
124 - 142	1000
142 - 157	1510

File 3160701S

HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

Shear Wave Time of Peak



Distance (feet)	Wavespeed (ft/s)
9 - 15	1510
15 - 39	1150
39 - 50	920
50 - 71	1010
71 - 86	1200
86 - 101	1060
101 - 122	1350
122 - 140	1000
140 - 155	1510

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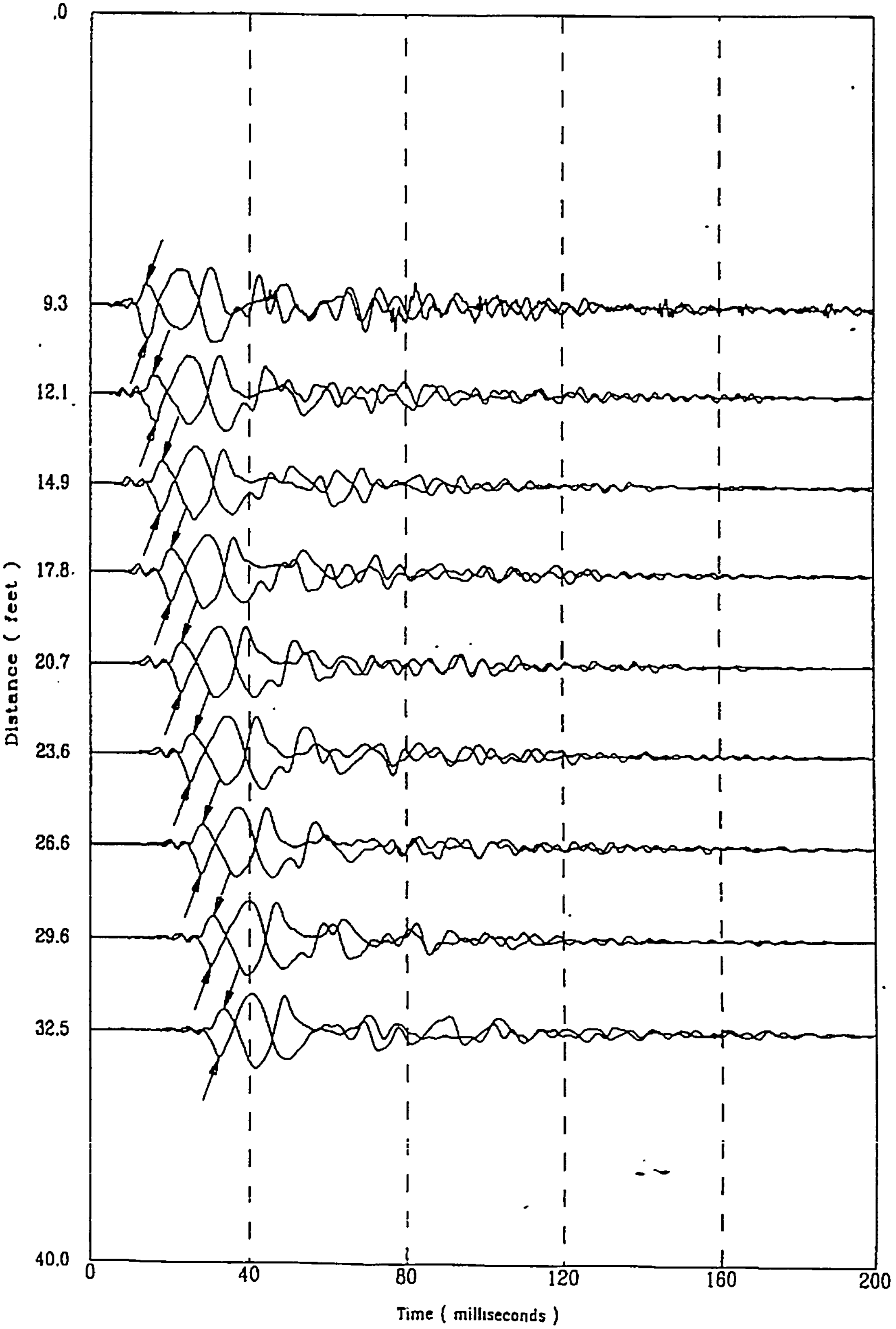
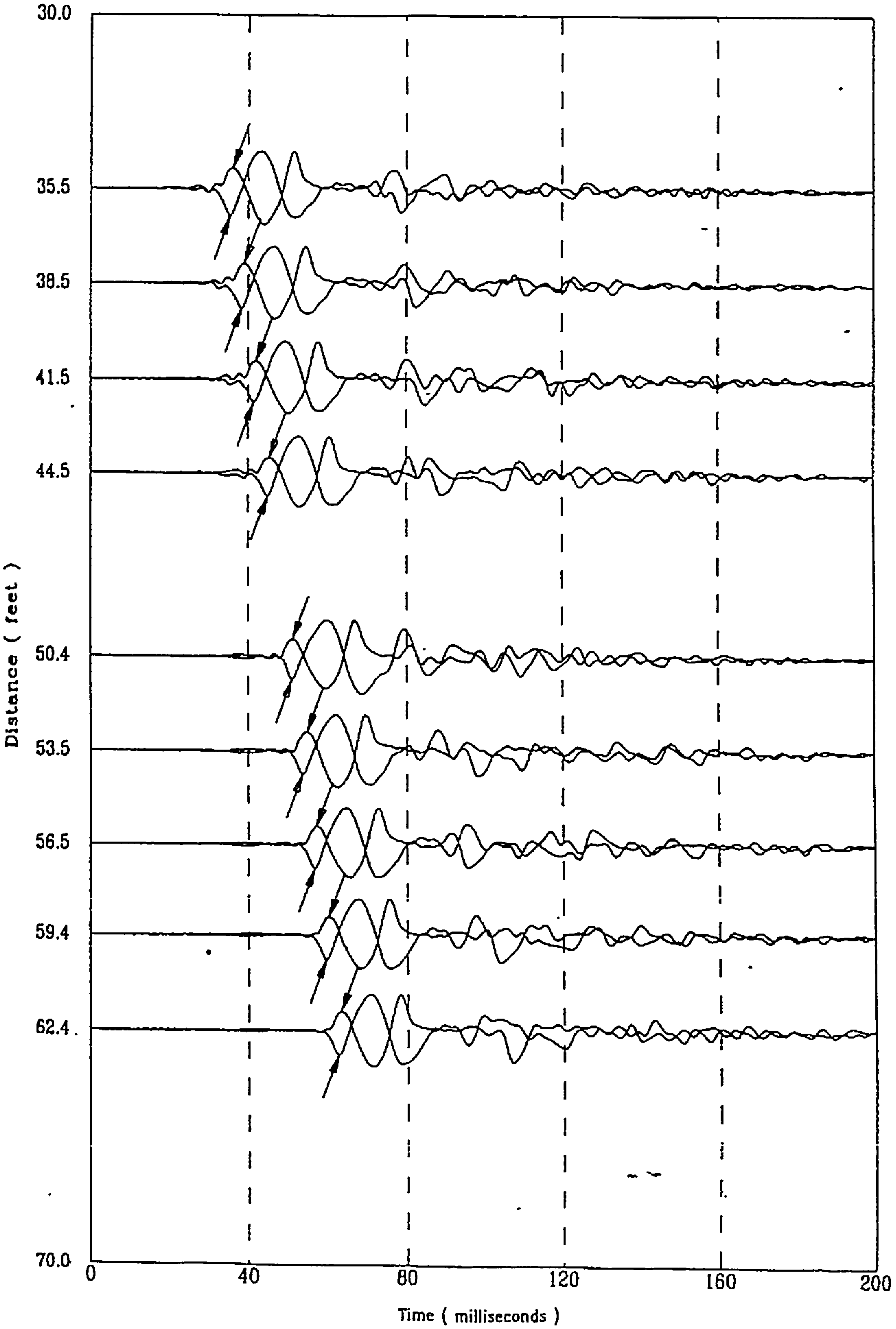
S Wave
10/16/97



File 3160701S

Applied Research Associates Inc.
HTEF-C1

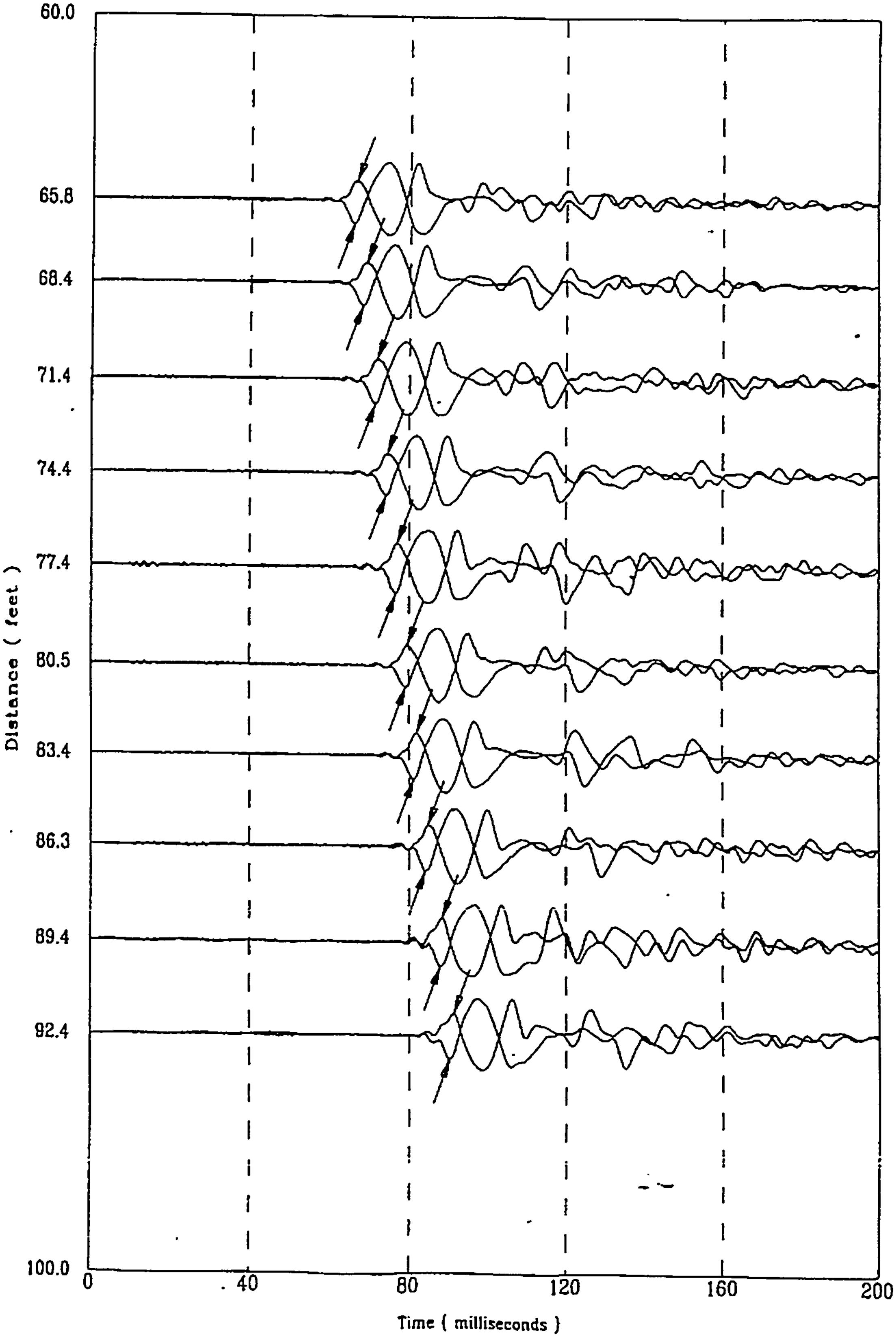
S Wave
10/16/97



File 3160701S

Applied Research Associates Inc.
HTEF-C1

S Wave
10/16/97



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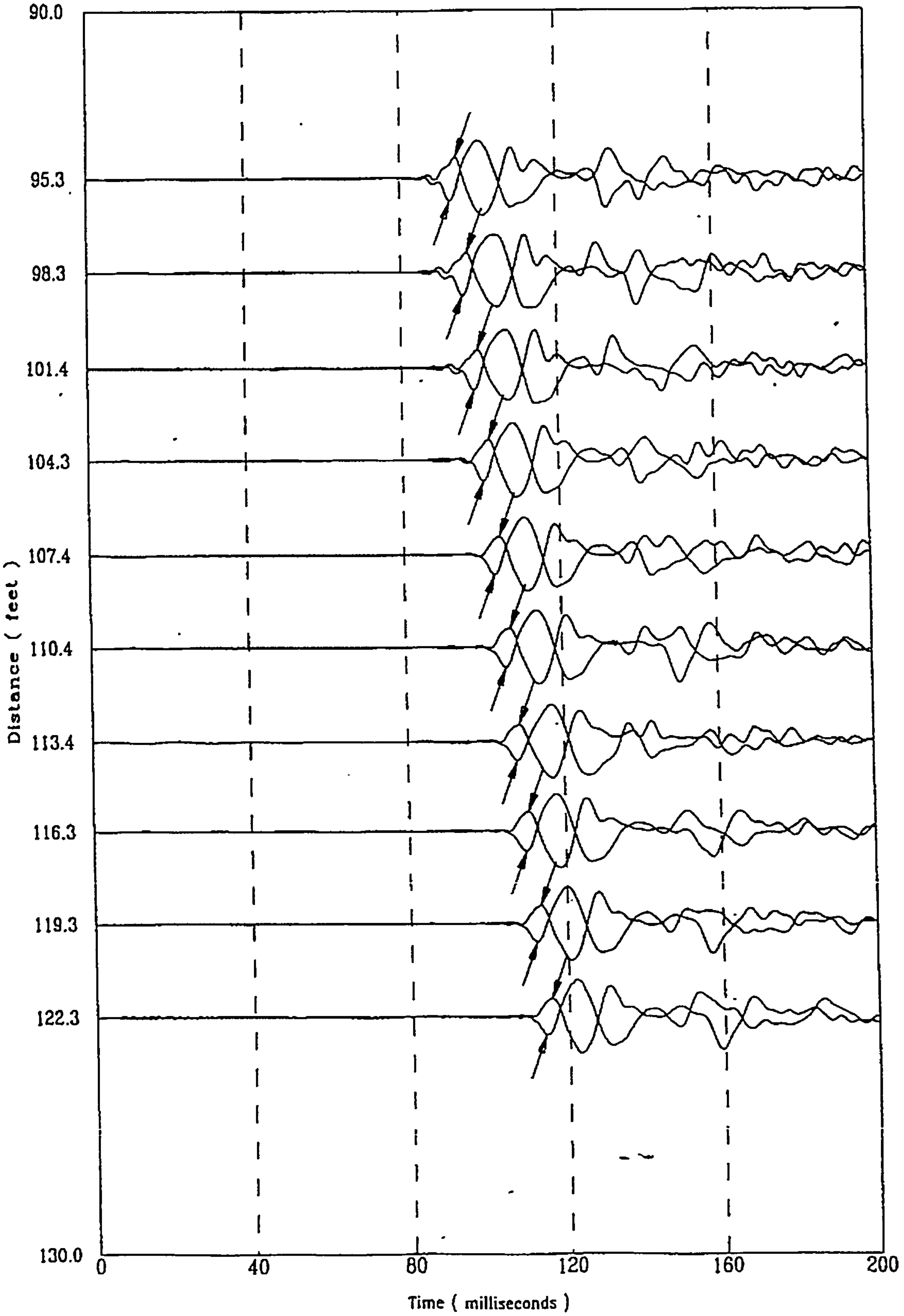
Applied Research Associates Inc.
HTEF-C1

S Wave
10/16/97



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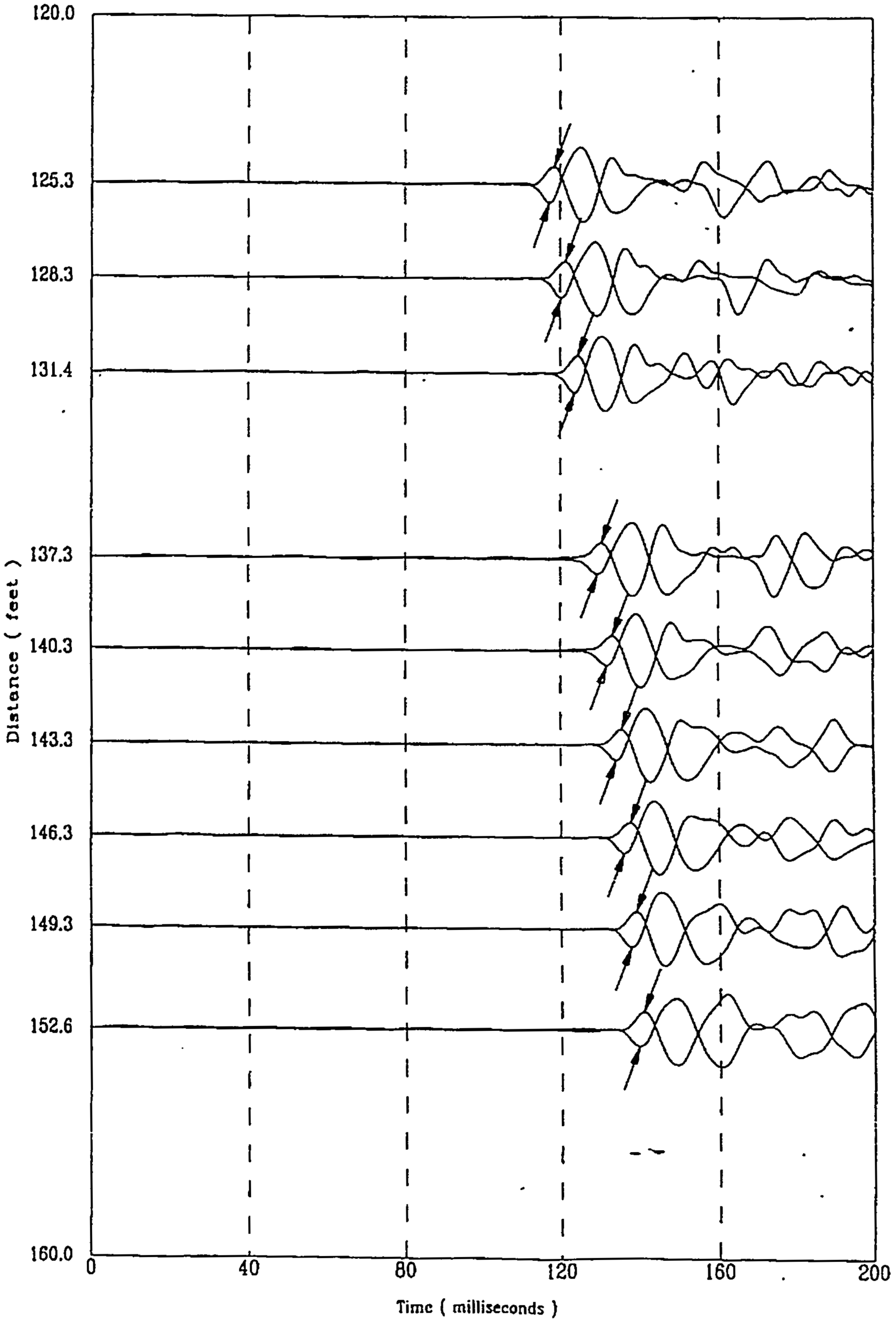
Applied Research Associates Inc.
HTEF-C1

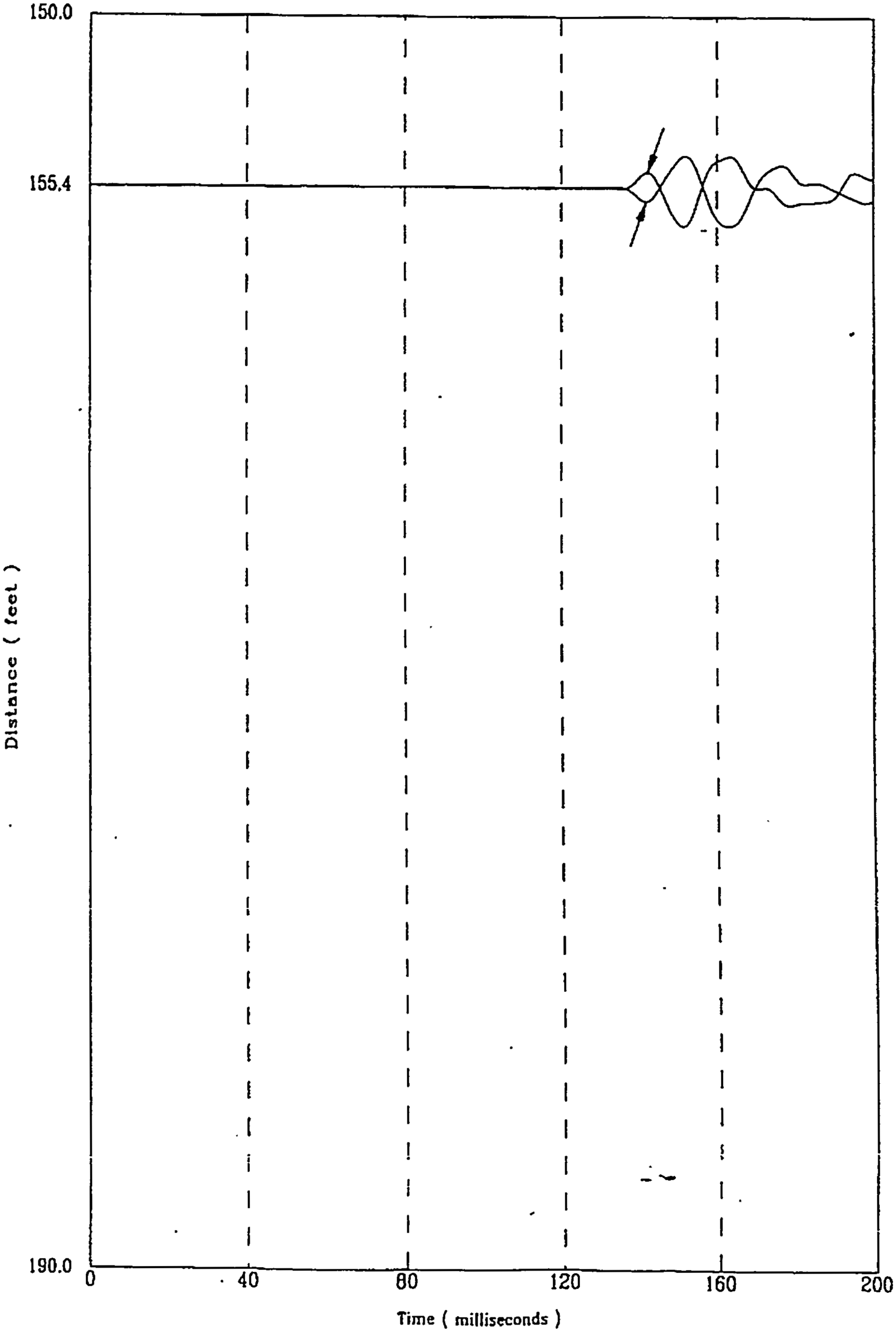
S Wave
10/16/97



File 31607025

Applied Research Associates Inc.
HTEF-C1

S Wave
10/16/97



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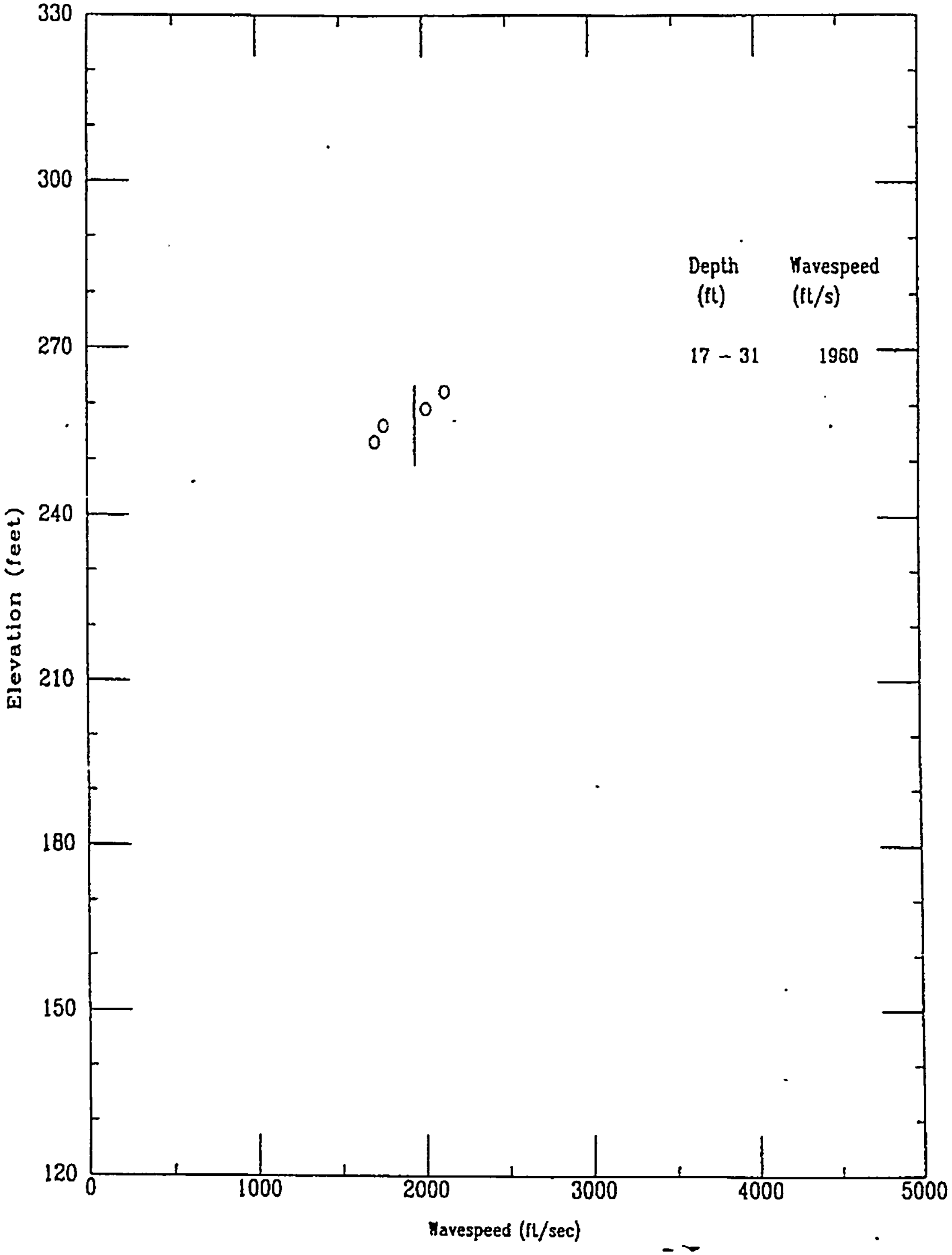
HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

Compression Wave Speeds



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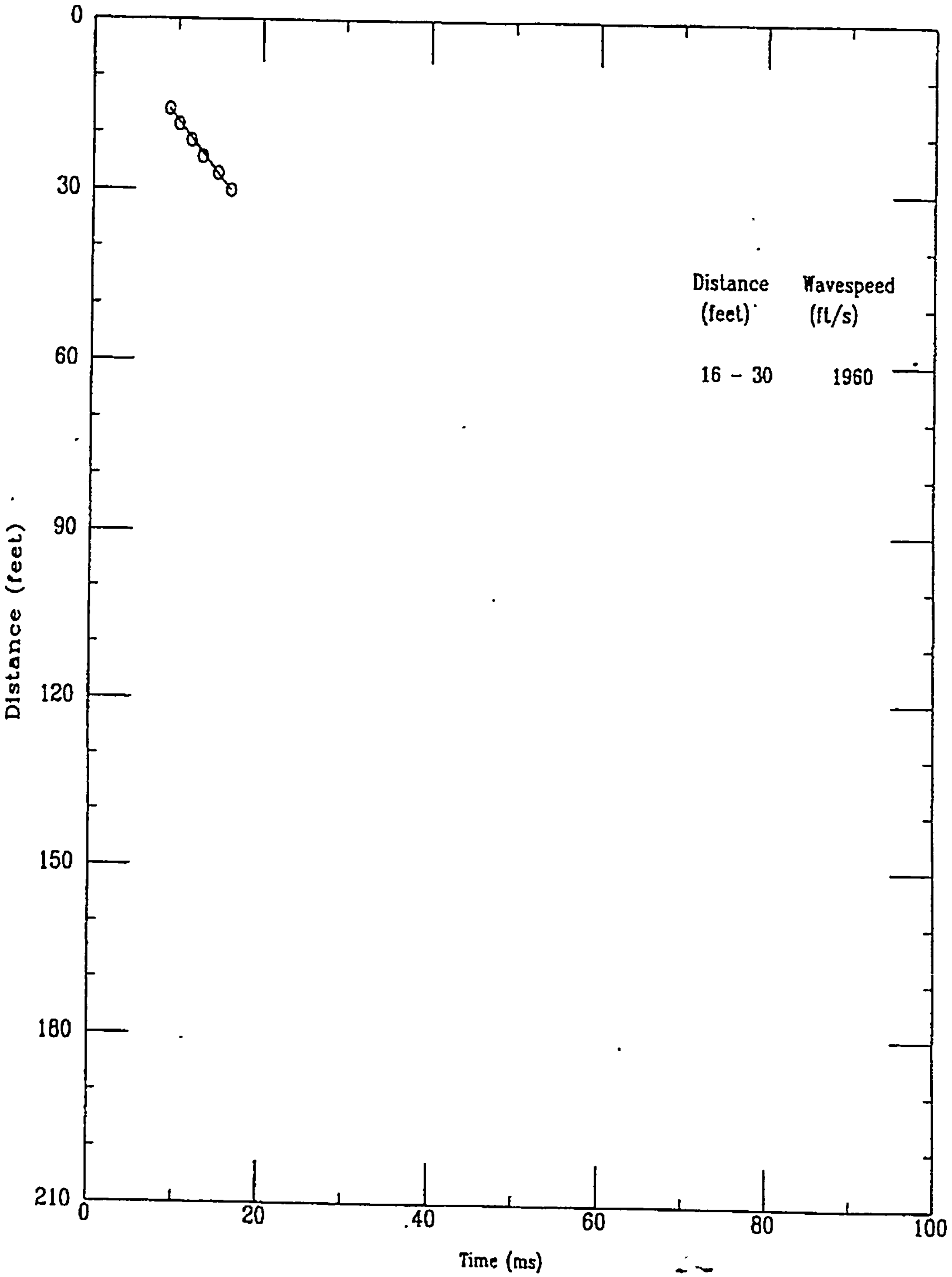
HTEF-C01 APPLIED RESEARCH ASSOCIATES, INC. 10/16/97

Compression Wave Time of Peak



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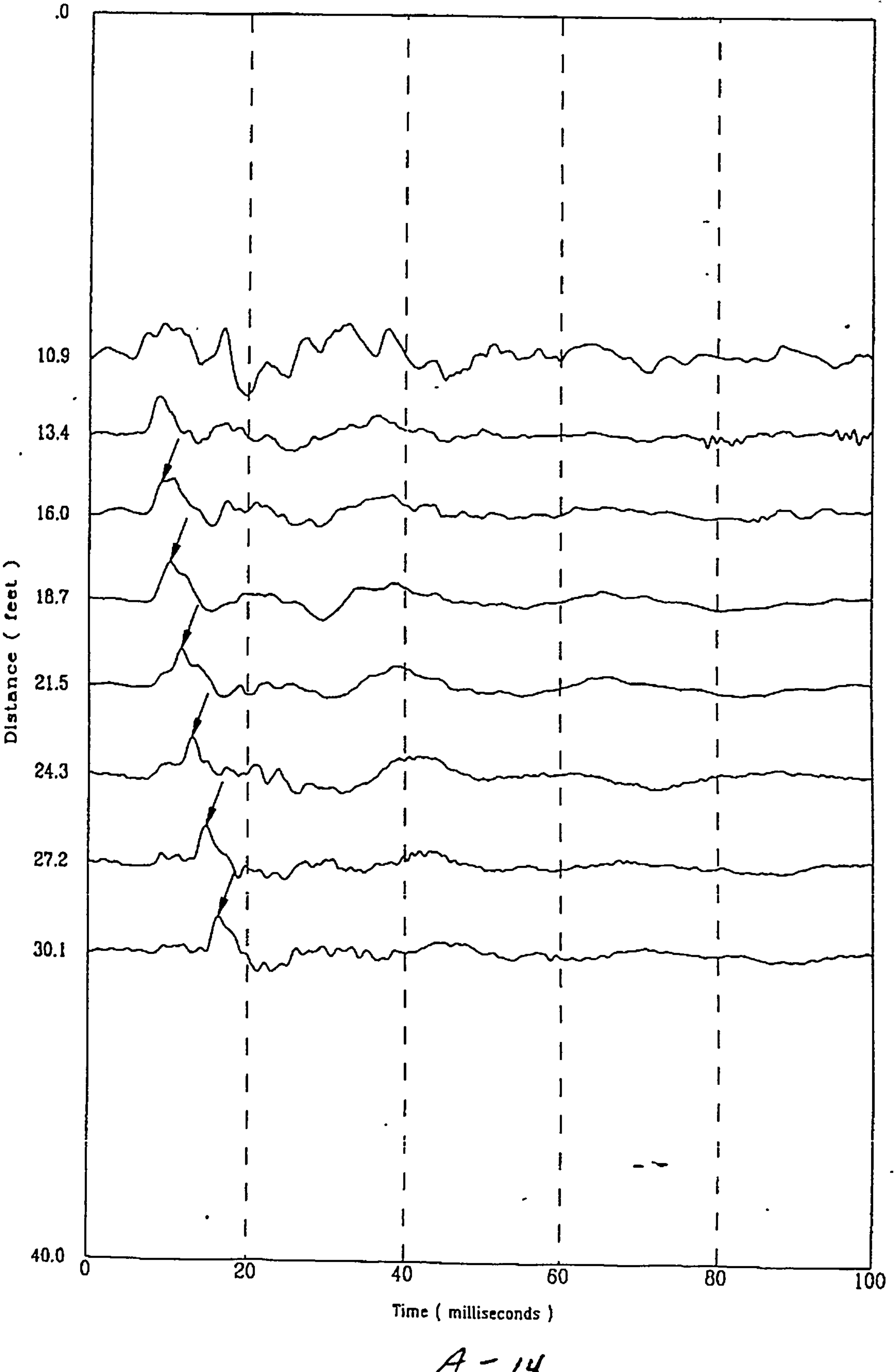
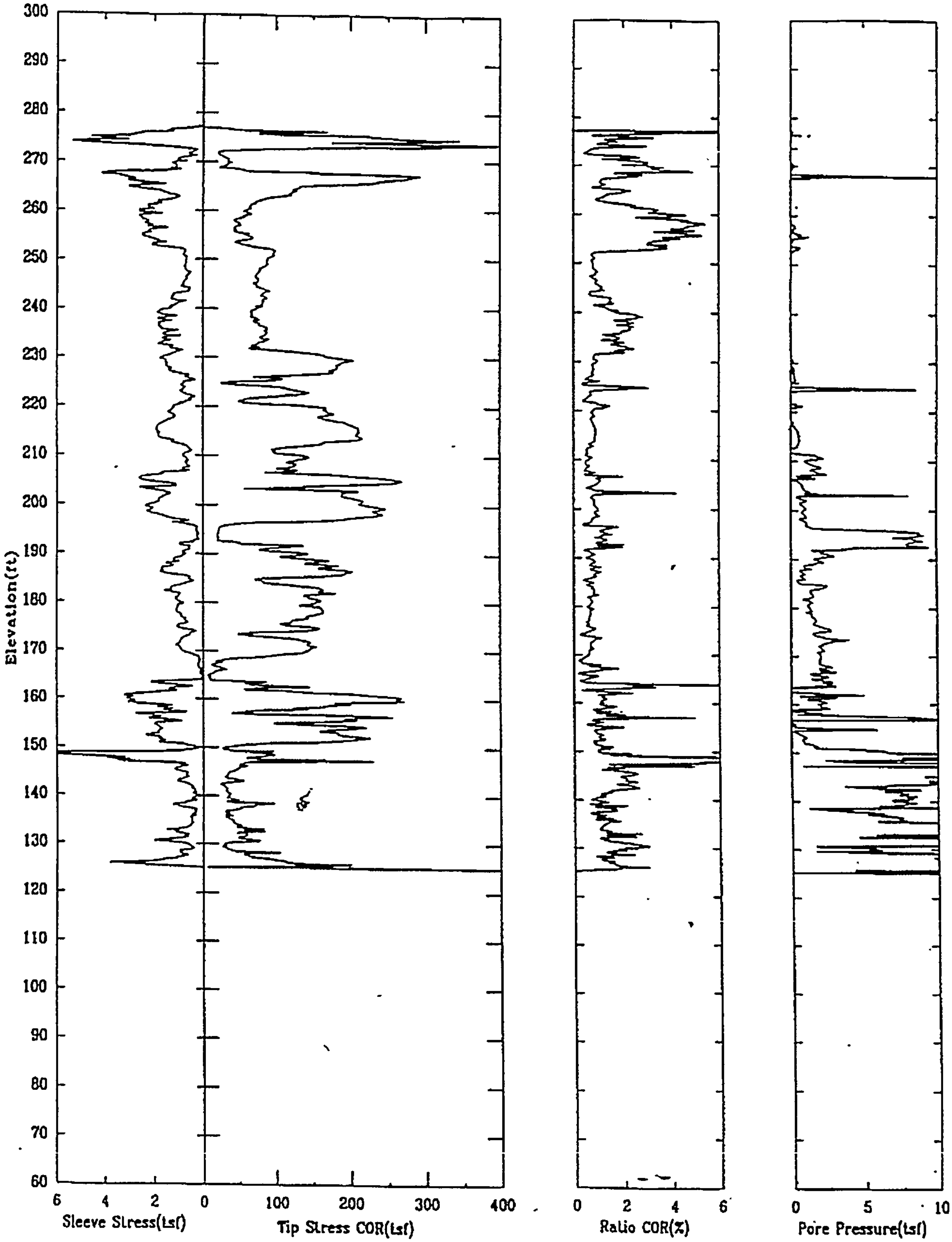
Applied Research Associates Inc.
HTEF-C1

P Wave
10/16/97



File 3160701S

HTEF-C02 APPLIED RESEARCH ASSOCIATES, INC. 10/13/97
North 73468.0 East 61442.0 Elevation 283.3



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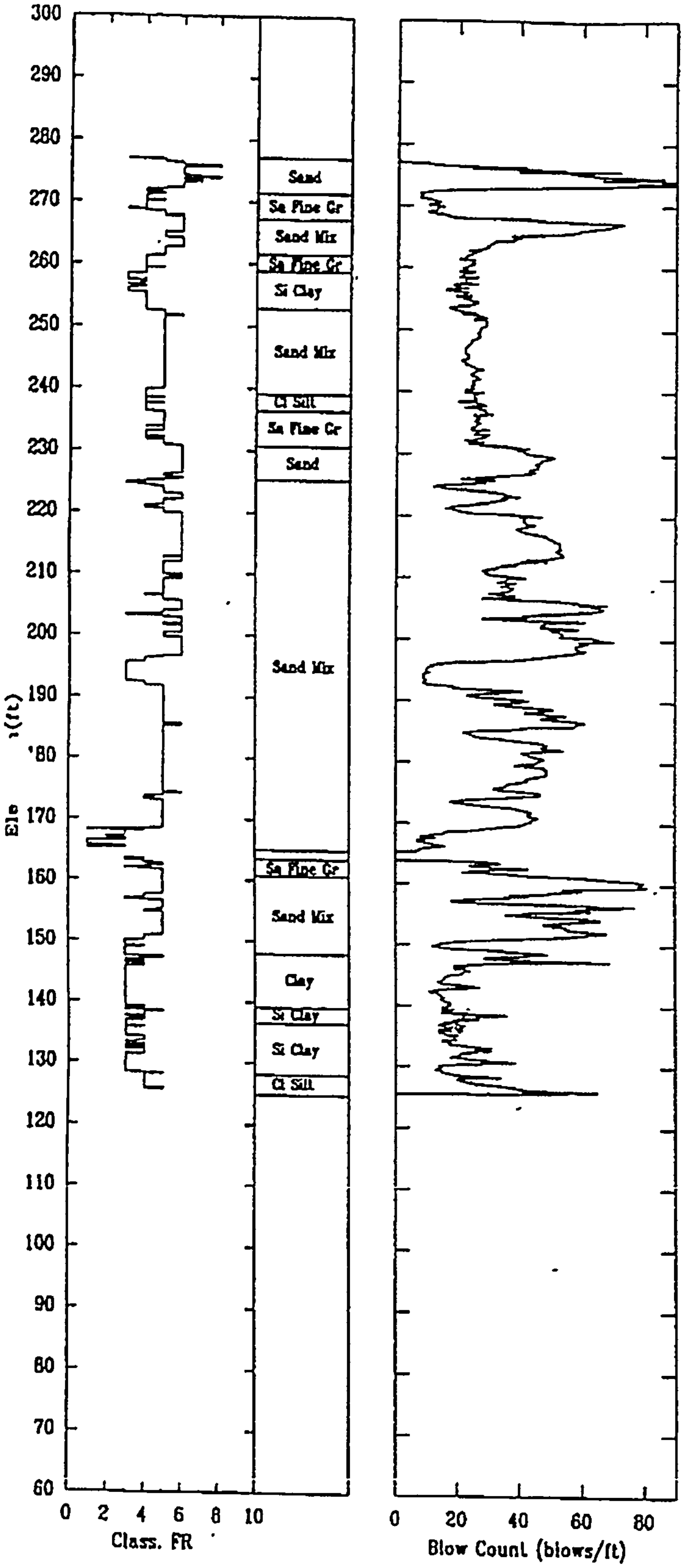
HTEF-C02 APPLIED RESEARCH ASSOCIATES, INC. 10/13/97

North 73468.0 East 61442.0 Elevation 283.3



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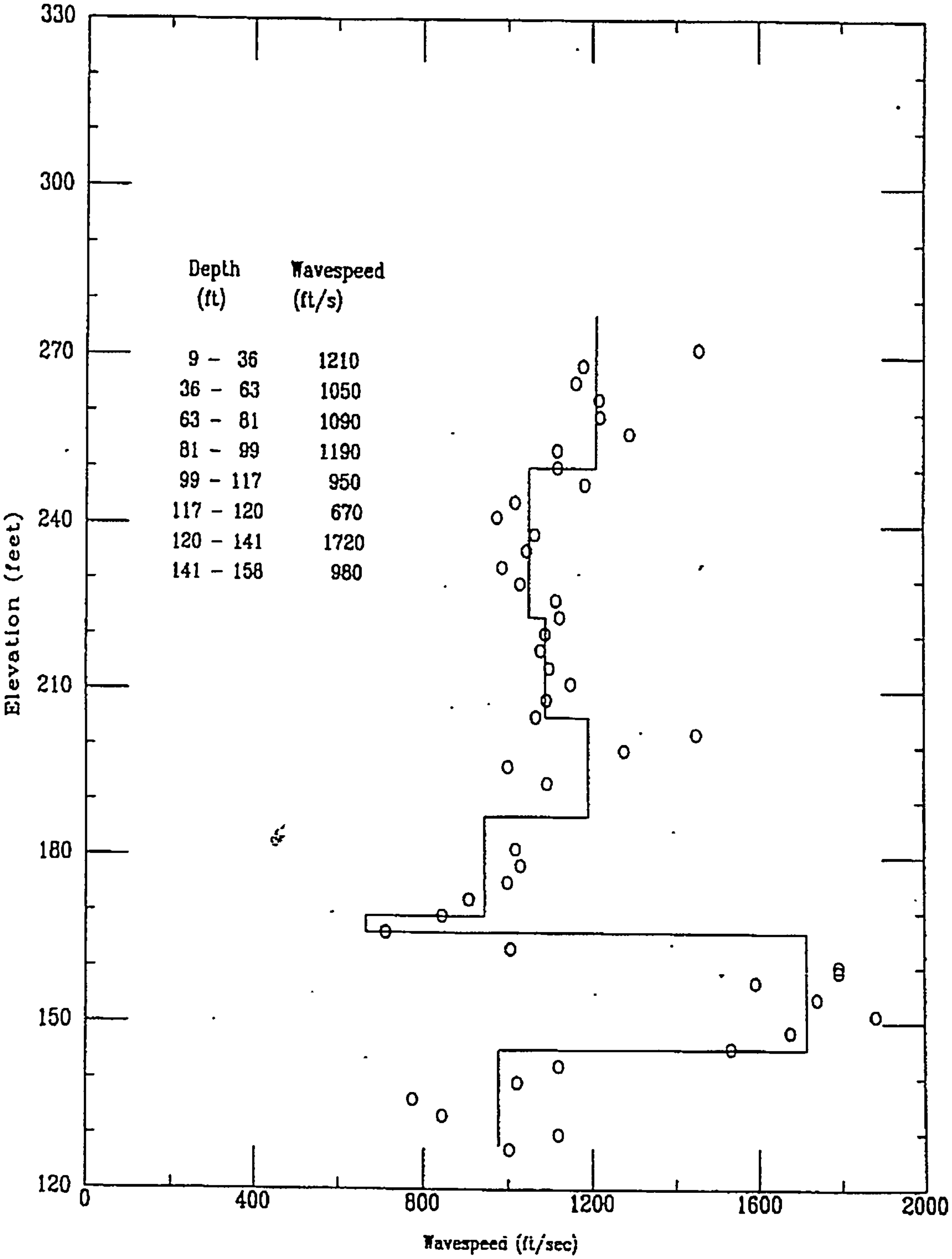
HTEF-C02 APPLIED RESEARCH ASSOCIATES, INC. 10/13/97

Shear Wave Speeds

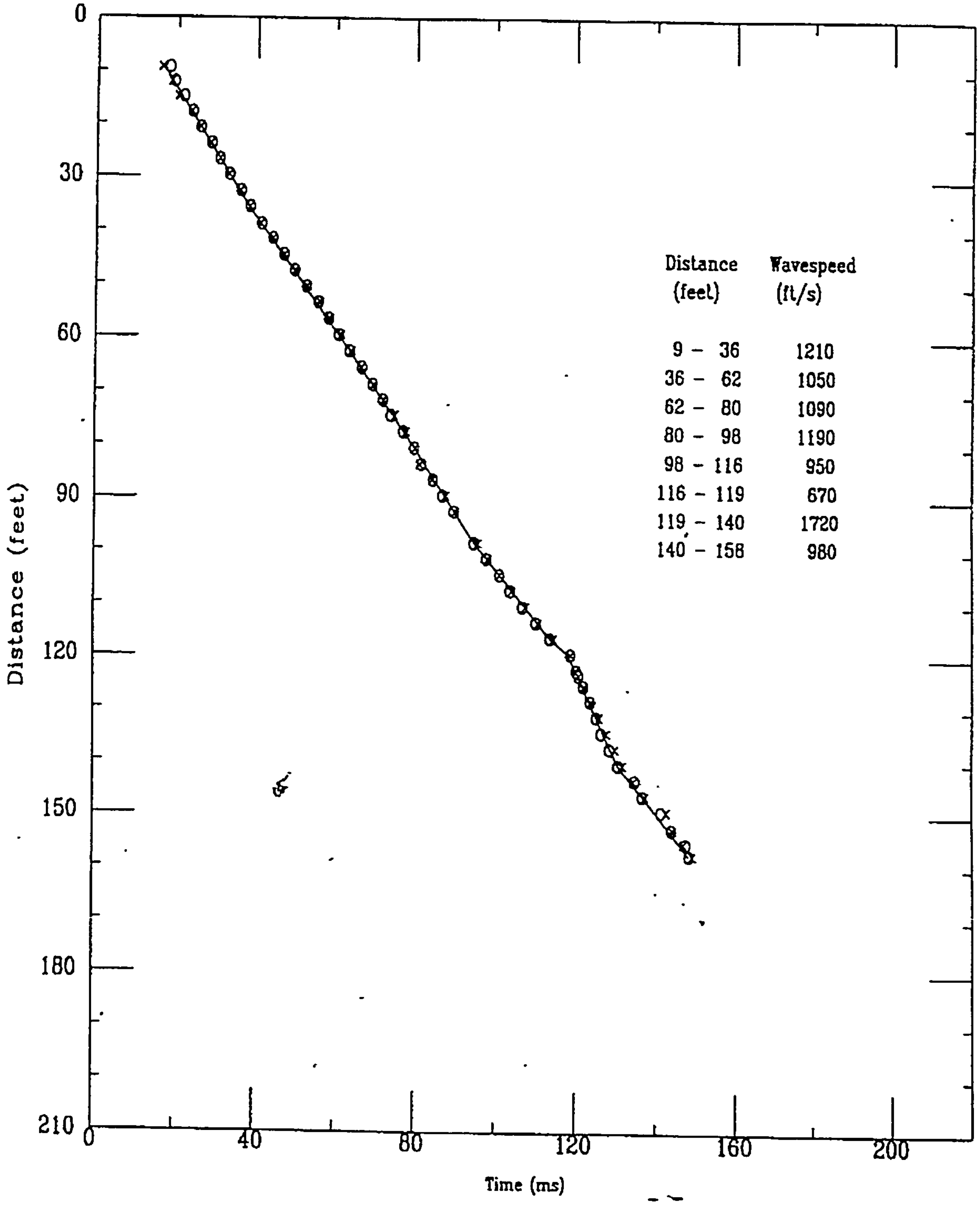


Depth (ft)	Wavespeed (ft/s)
9 - 36	1210
36 - 63	1050
63 - 81	1090
81 - 99	1190
99 - 117	950
117 - 120	670
120 - 141	1720
141 - 158	980

File 3130701S

HTEF-C02 APPLIED RESEARCH ASSOCIATES, INC. 10/13/97

Shear Wave Time of Peak

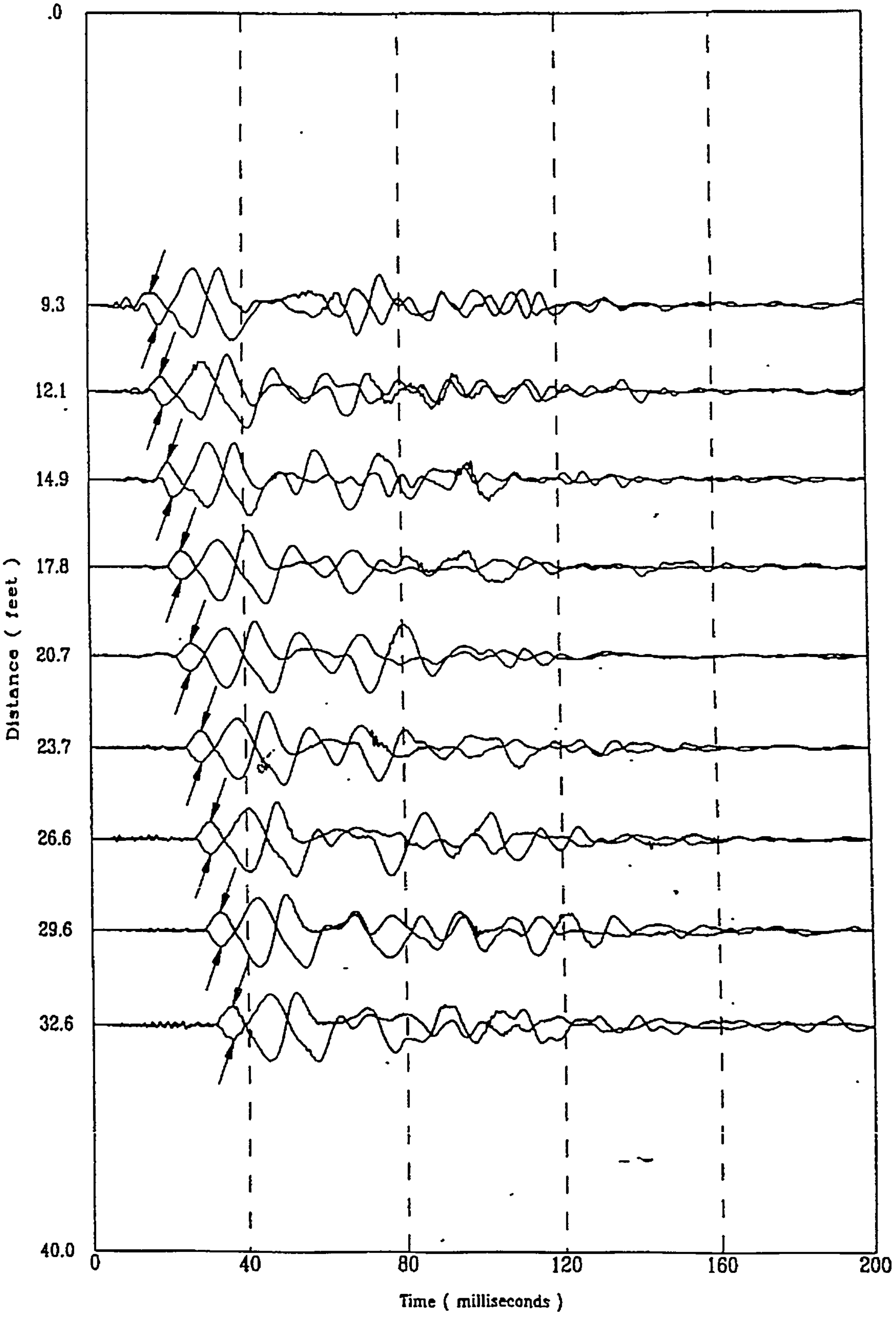


Distance (feet)	Wavespeed (ft/s)
9 - 36	1210
36 - 62	1050
62 - 80	1090
80 - 98	1190
98 - 116	950
116 - 119	670
119 - 140	1720
140 - 158	980

File 3130701S

Applied Research Associates Inc.
HTEF-C2

S Wave
10/13/97



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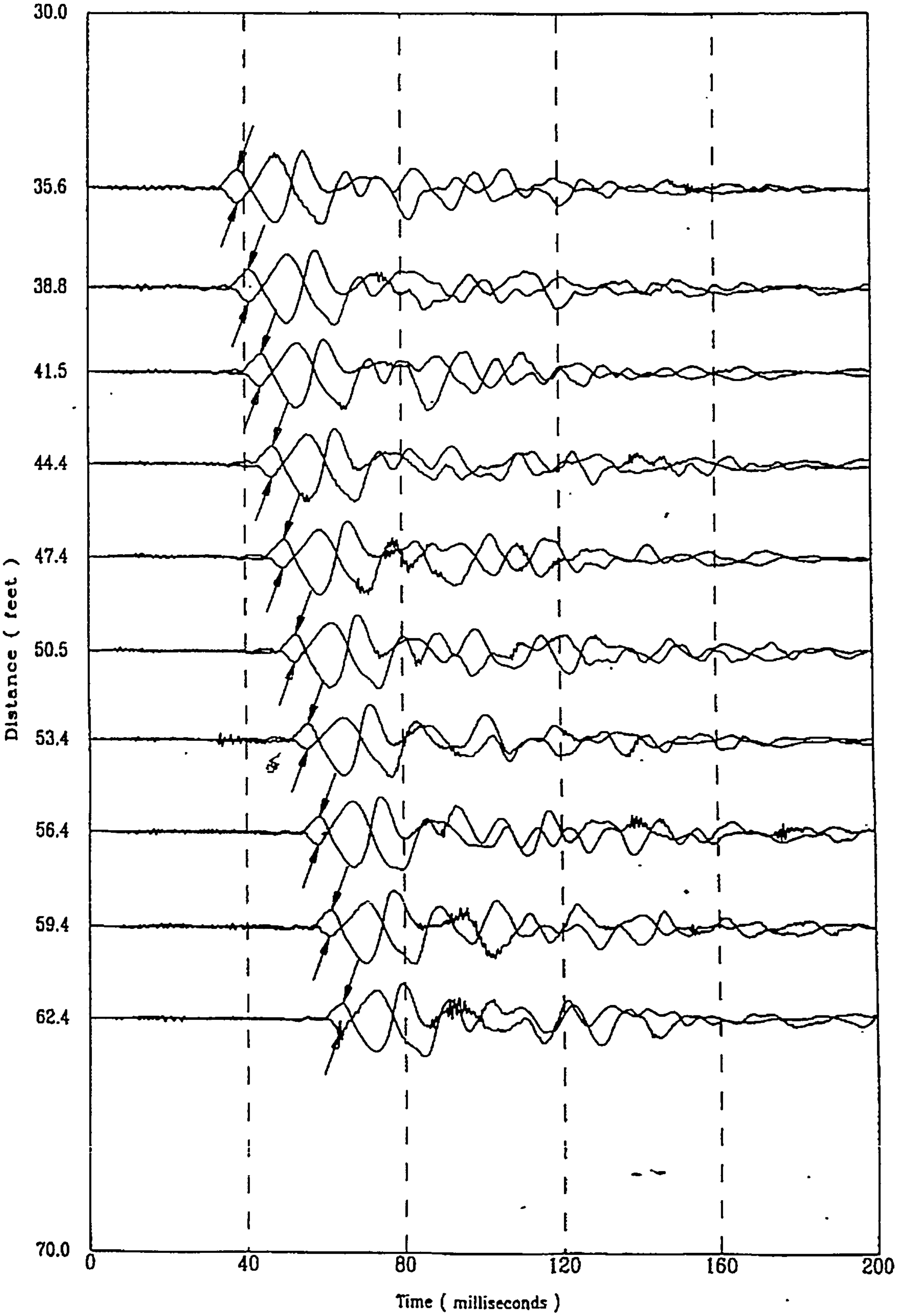
Applied Research Associates Inc.
HTEF-C2

S Wave
10/13/97



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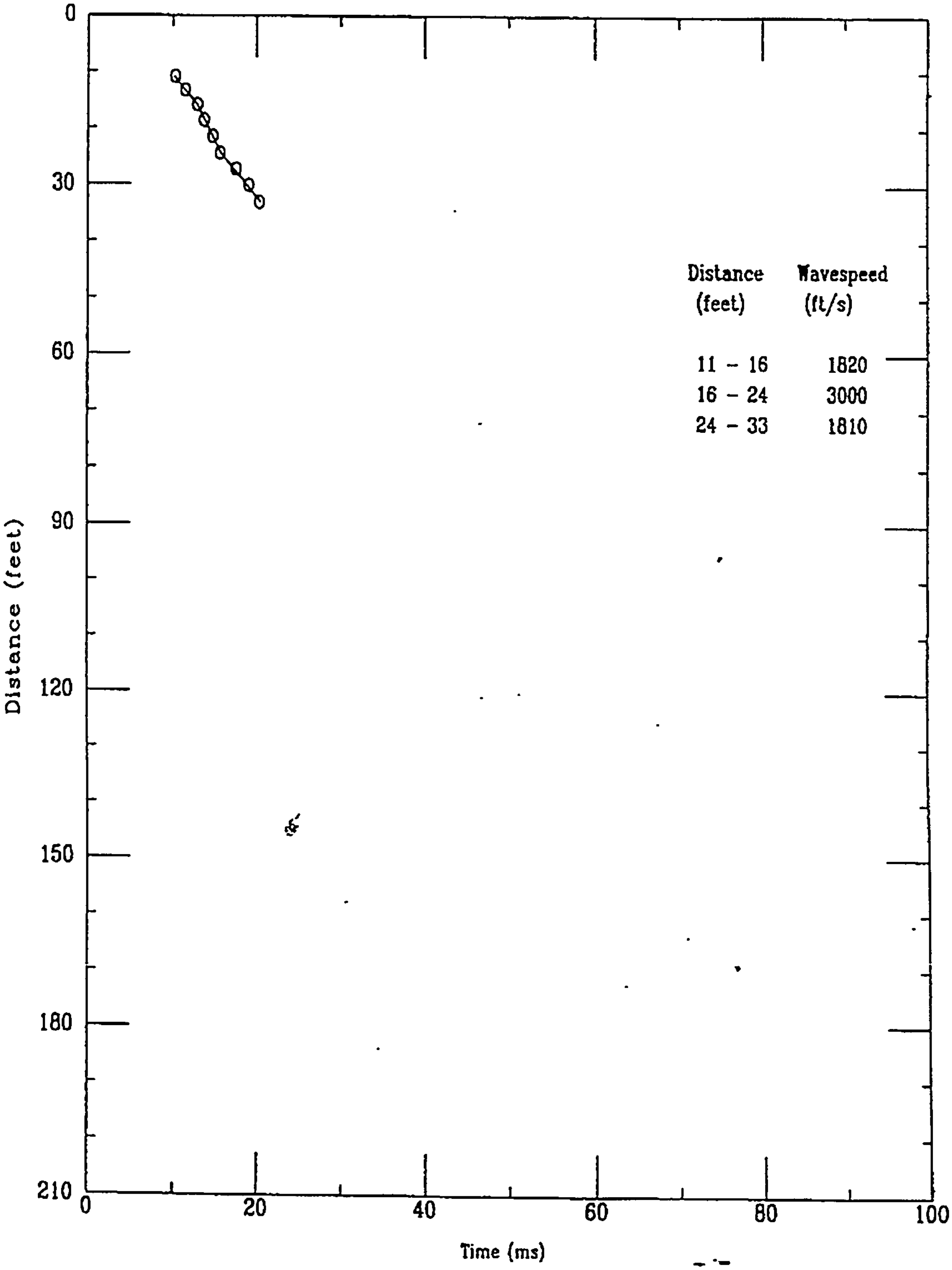
HTEF-C02 APPLIED RESEARCH ASSOCIATES, INC. 10/13/97

Compression Wave Time of Peak

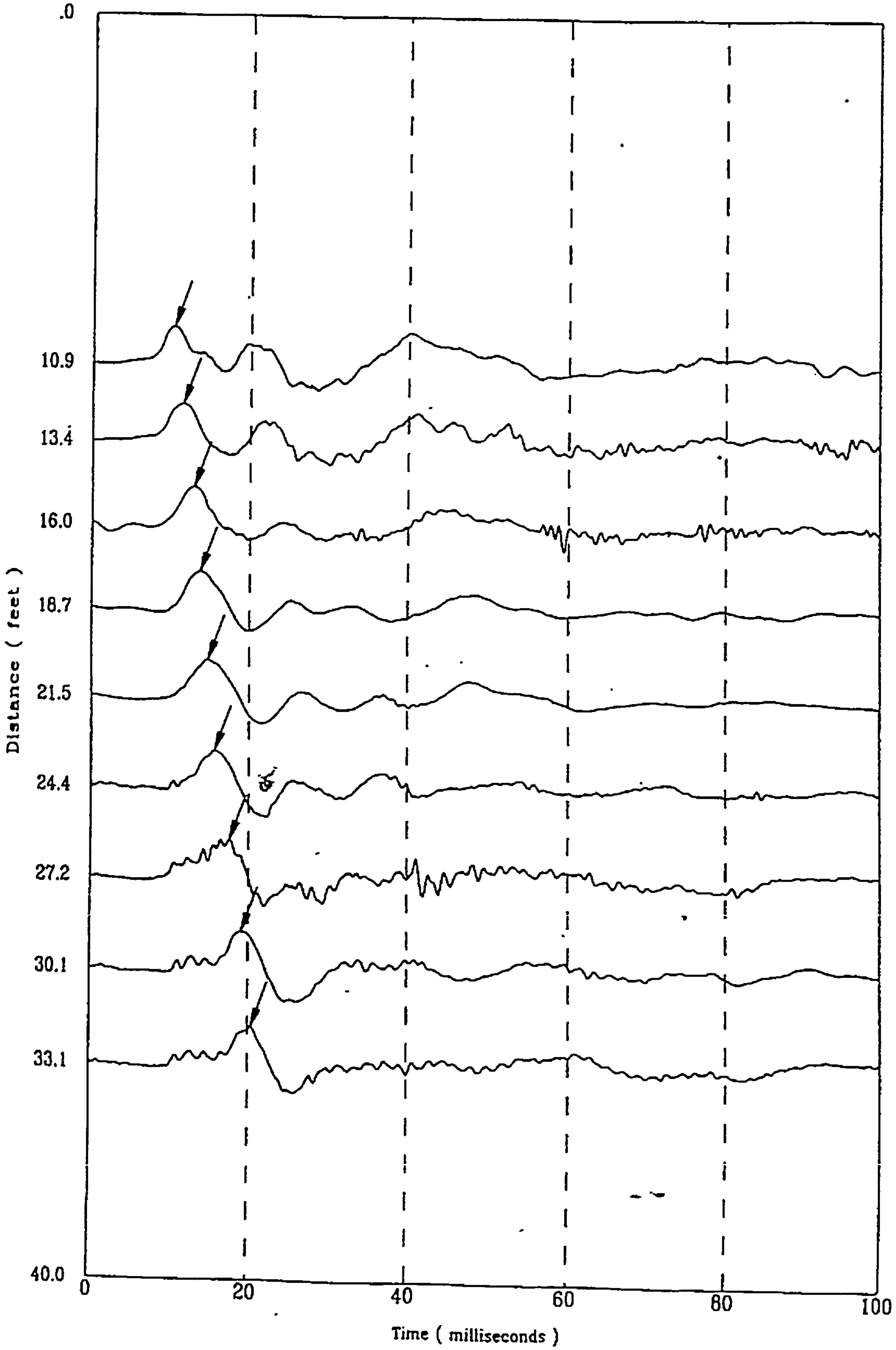


Distance (feet)	Wavespeed (ft/s)
11 - 16	1820
16 - 24	3000
24 - 33	1810

File 31307015

Applied Research Associates Inc.
HTEF-C2

P Wave
10/13/97



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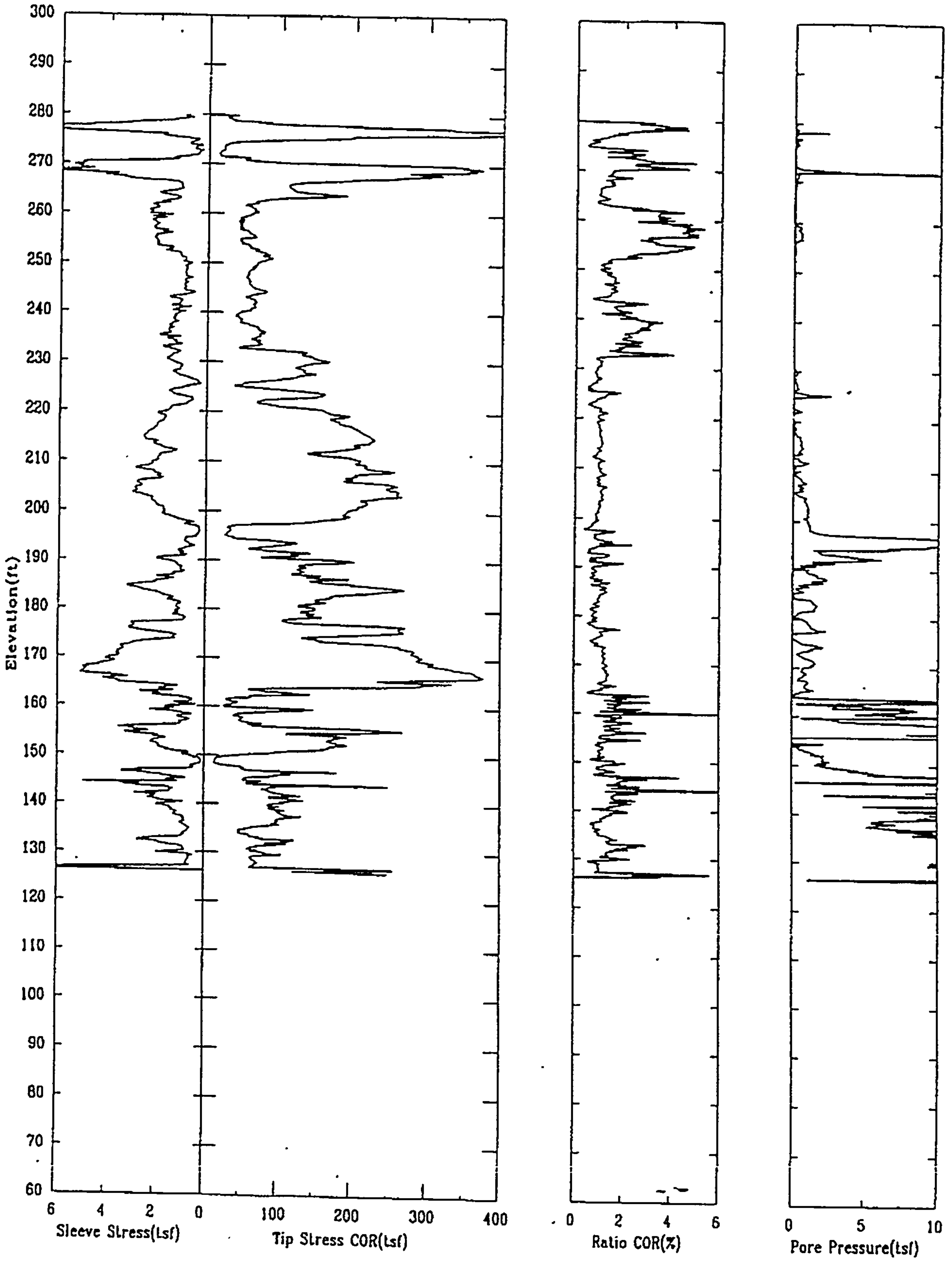
HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

North 73413.0 East 61488.0 Elevation 285.9



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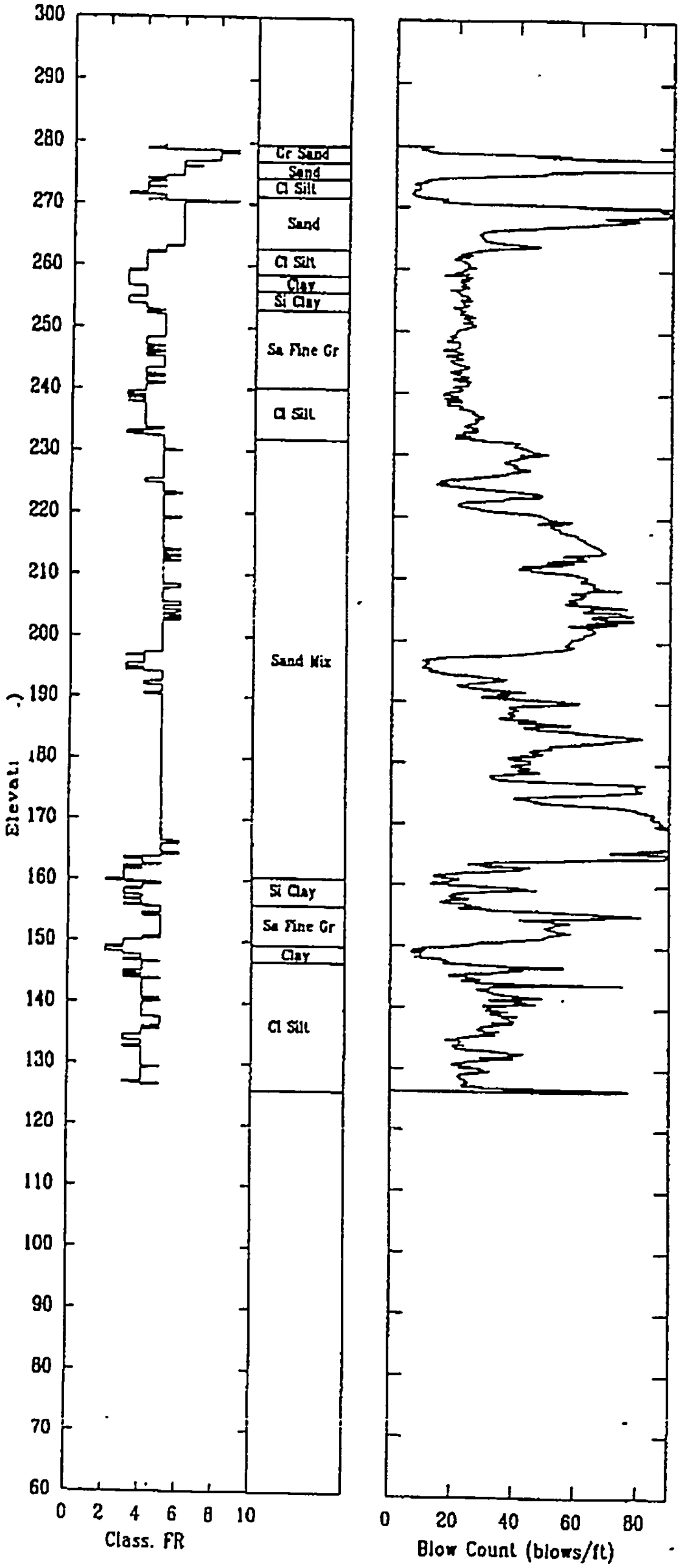
A - 28

HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

North 73413.0 East 61488.0 Elevation 285.9



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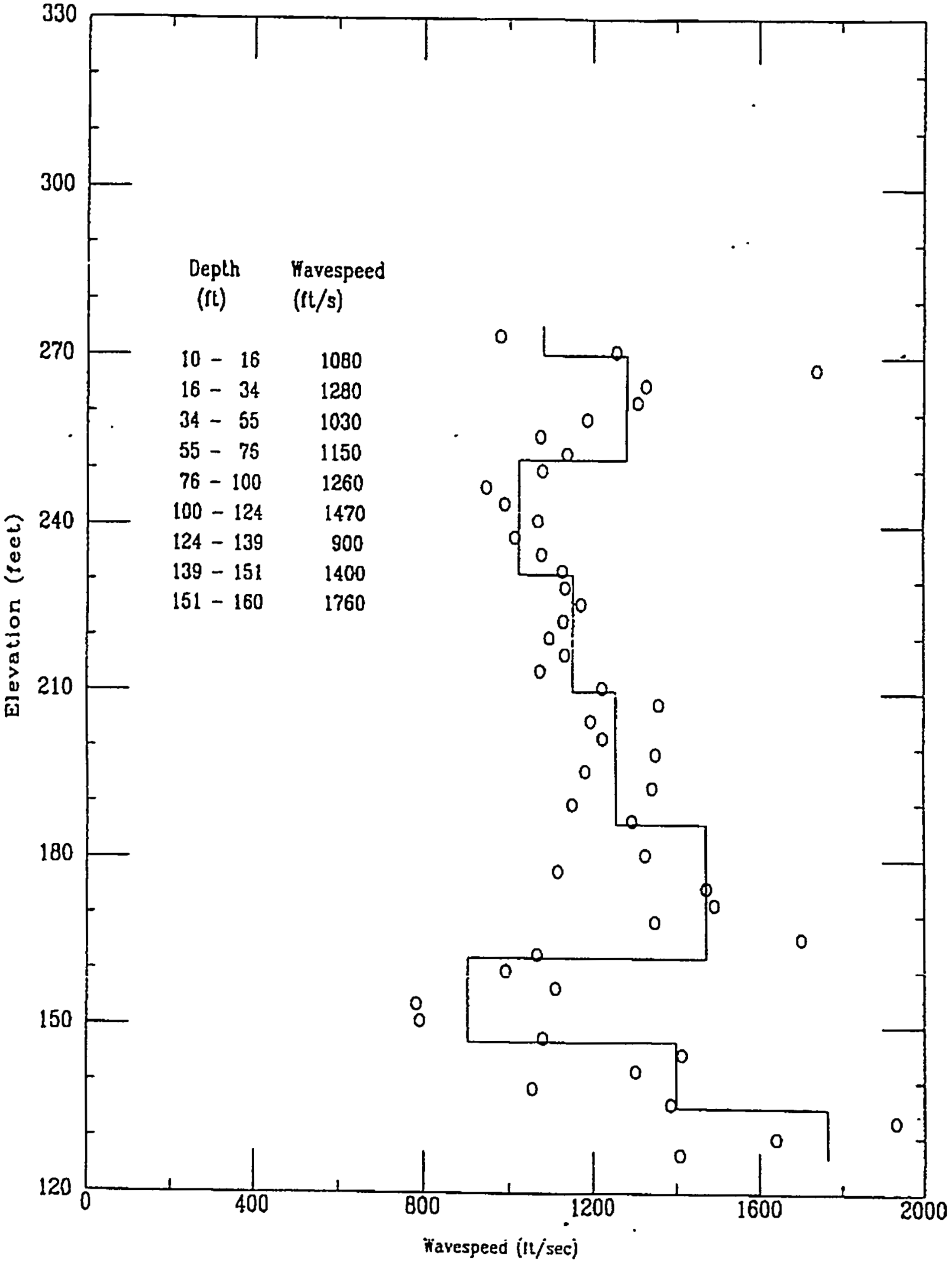
A-29

HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

Shear Wave Speeds

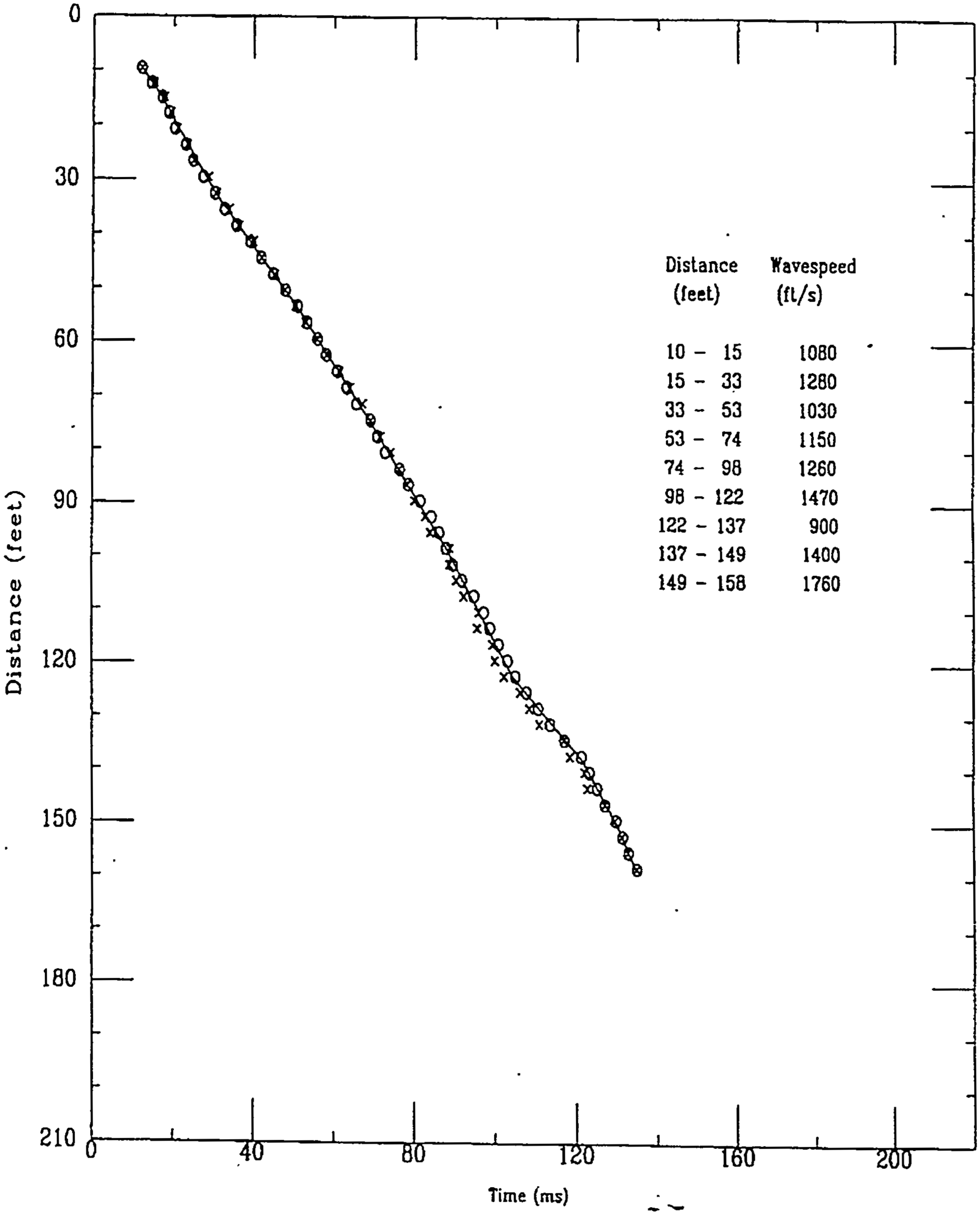


Depth (ft)	Wavespeed (ft/s)
10 - 16	1080
16 - 34	1280
34 - 55	1030
55 - 76	1150
76 - 100	1260
100 - 124	1470
124 - 139	900
139 - 151	1400
151 - 160	1760

File 3140701S

HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

Shear Wave Time of Peak

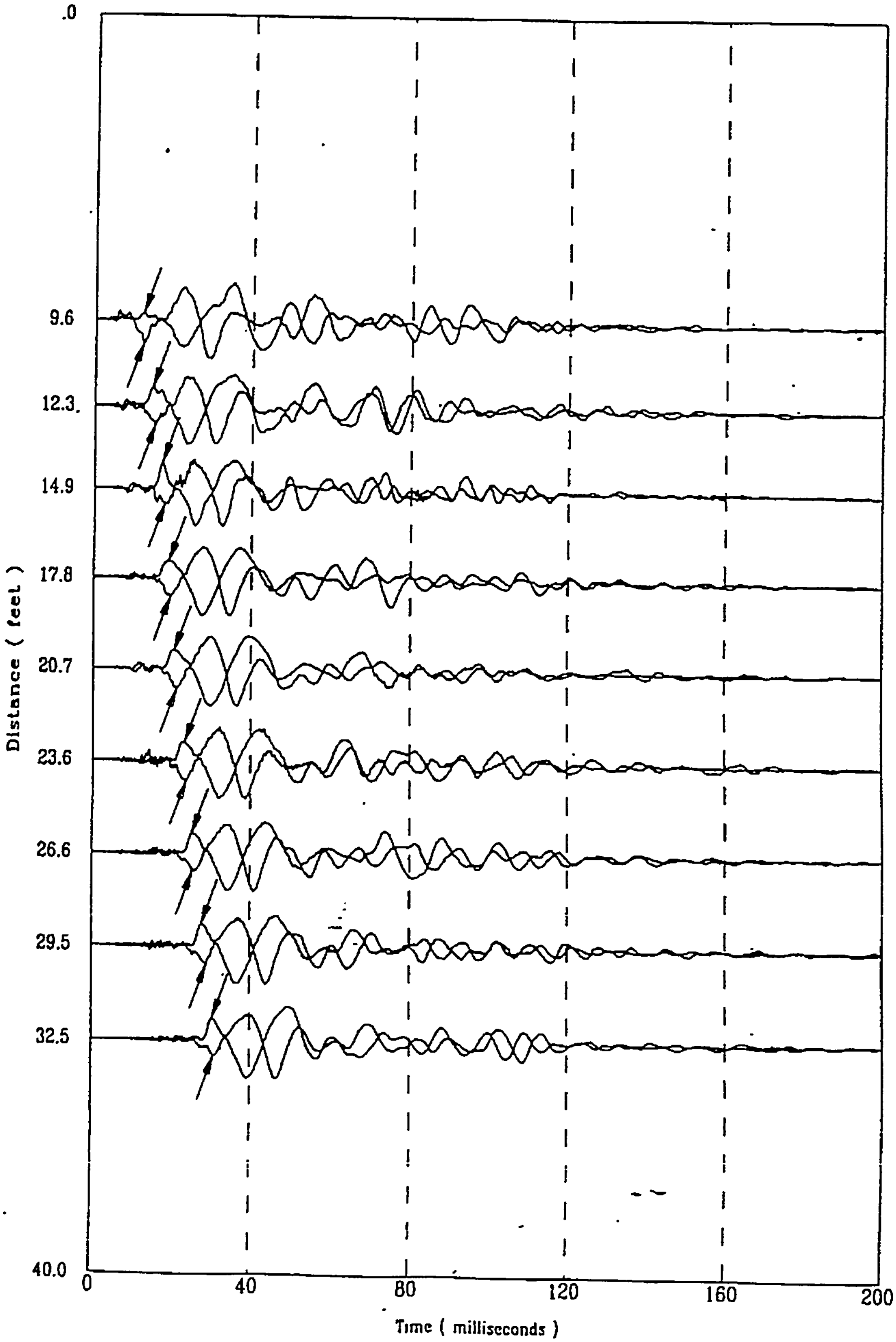


Distance (feet)	Wavespeed (ft/s)
10 - 15	1080
15 - 33	1280
33 - 53	1030
53 - 74	1150
74 - 98	1260
98 - 122	1470
122 - 137	900
137 - 149	1400
149 - 158	1760

File 3140701S

Applied Research Associates Inc.
HTEF-C3

S Wave
10/14/97



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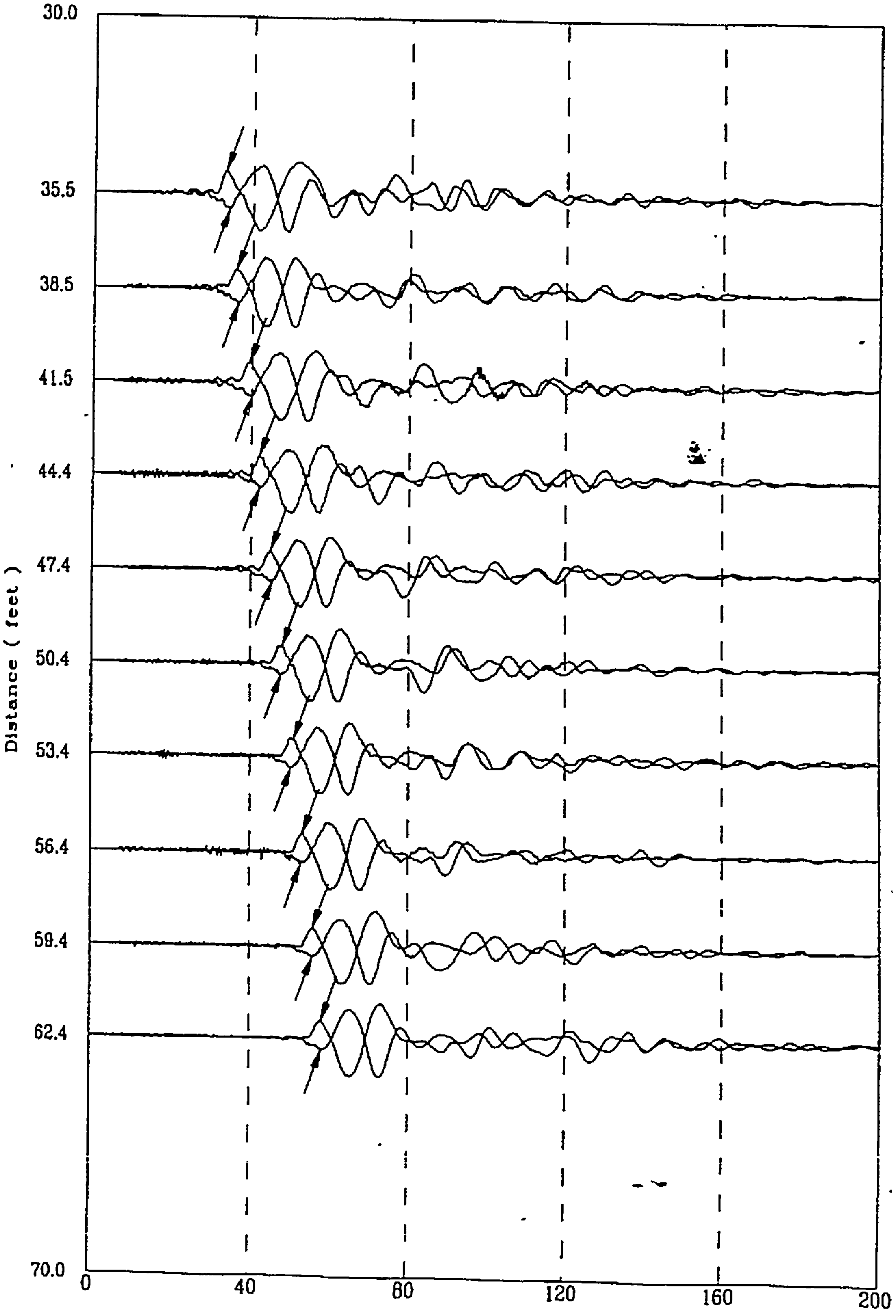
HTEF-C3

S Wave
10/14/97



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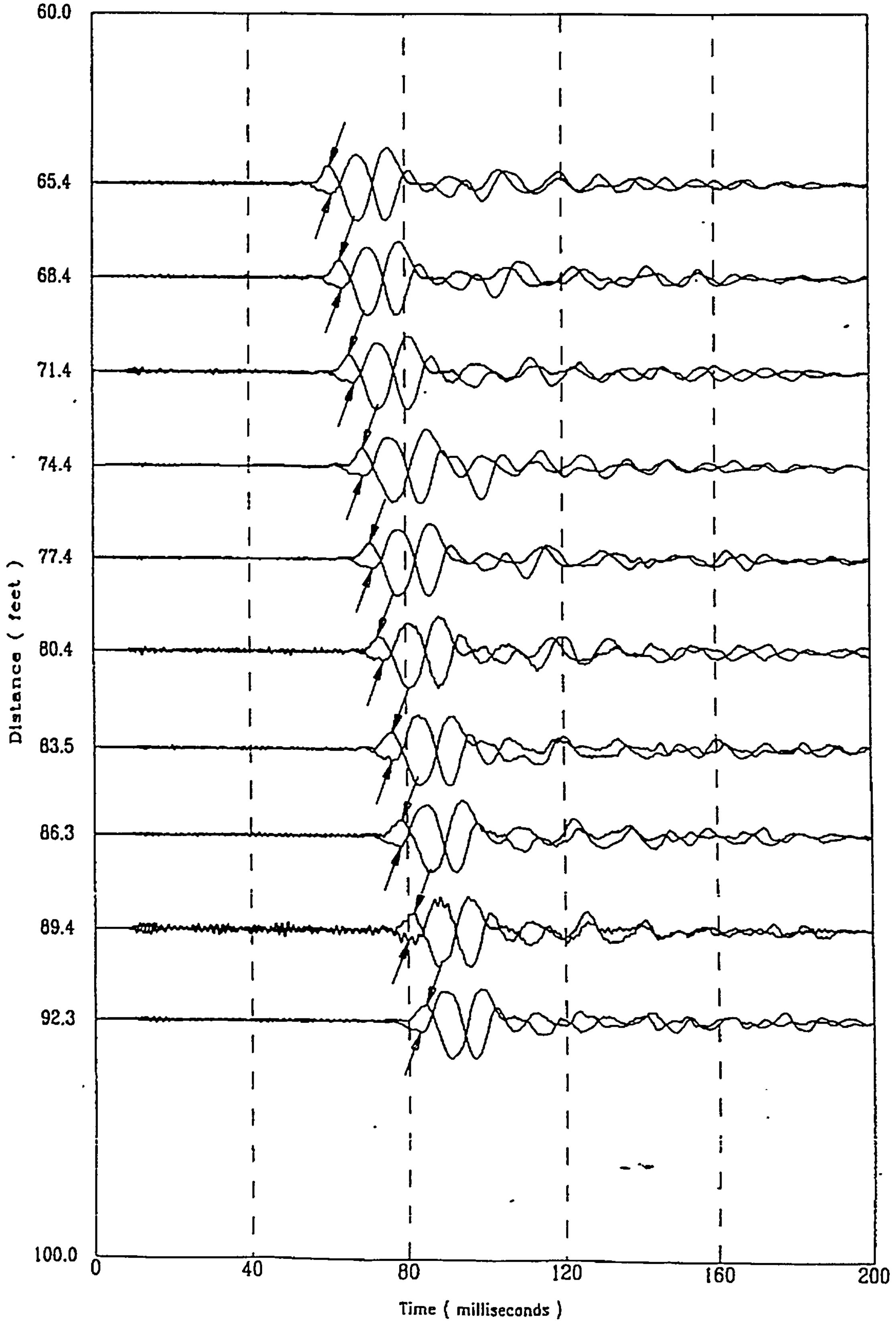
S Wave
10/14/97



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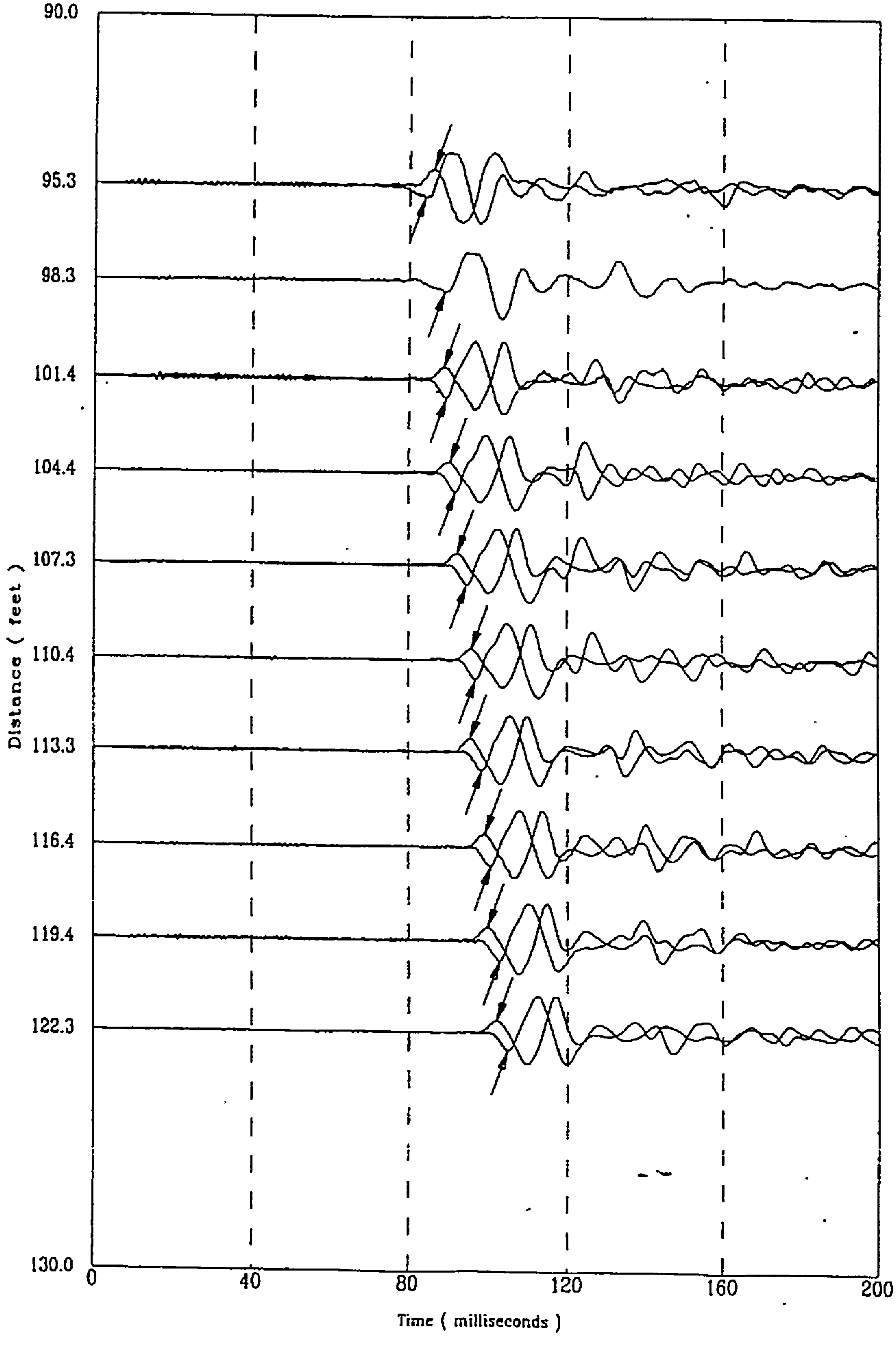
S Wave
10/14/97



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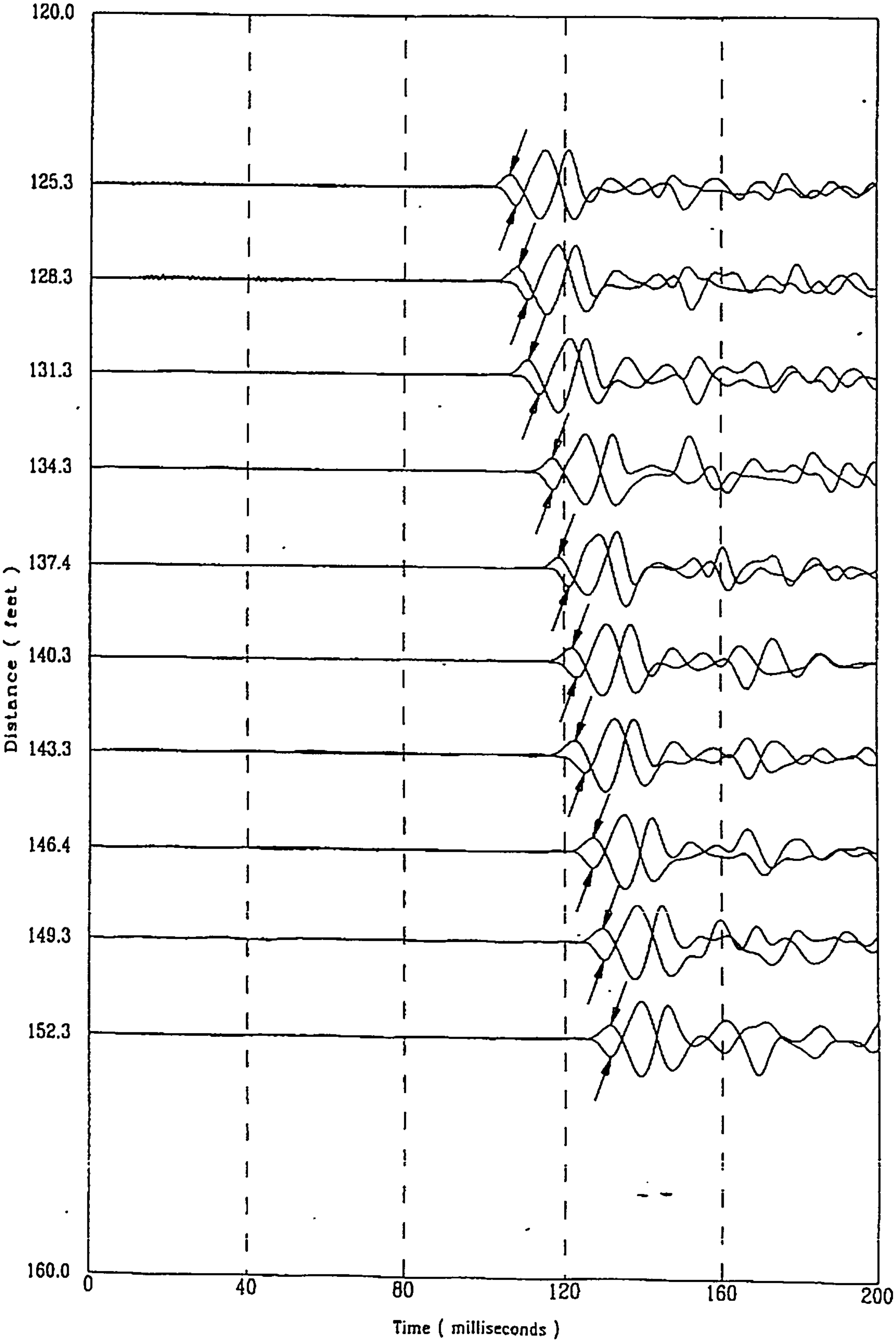
Applied Research Associates Inc.
HTEF-C3

S Wave
10/14/97



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Applied Research Associates Inc.
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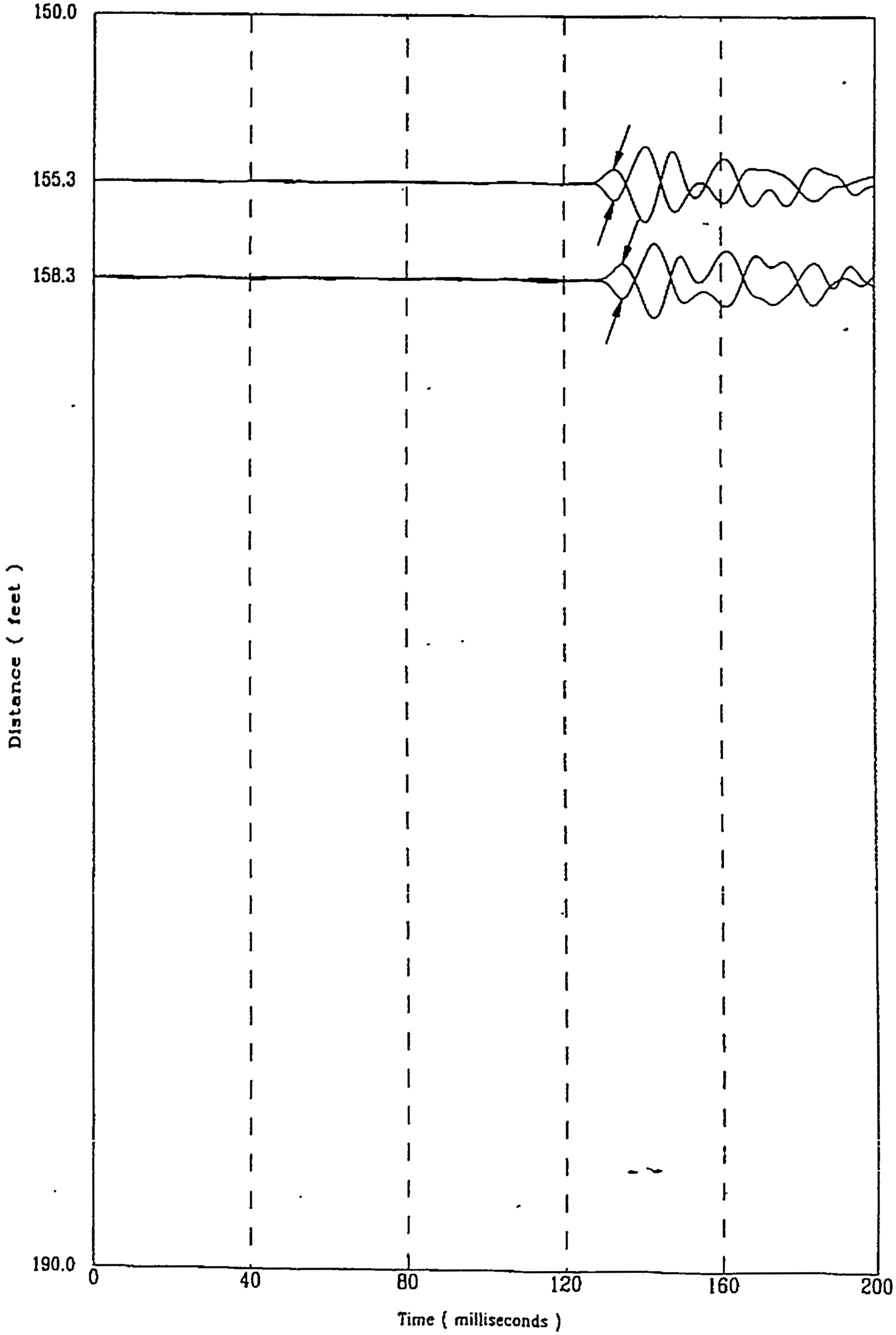
S Wave
10/14/97



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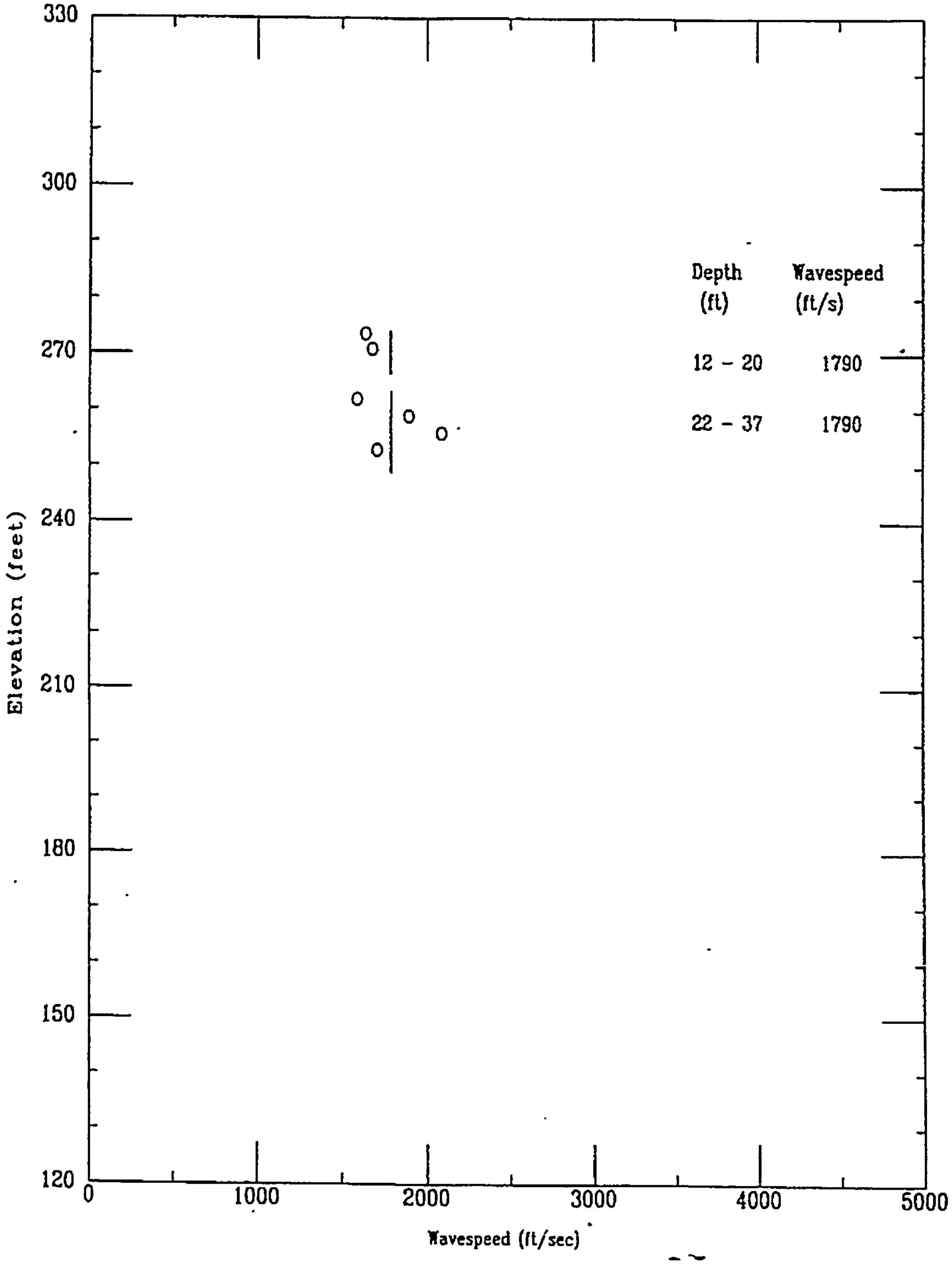
HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

Compression Wave Speeds



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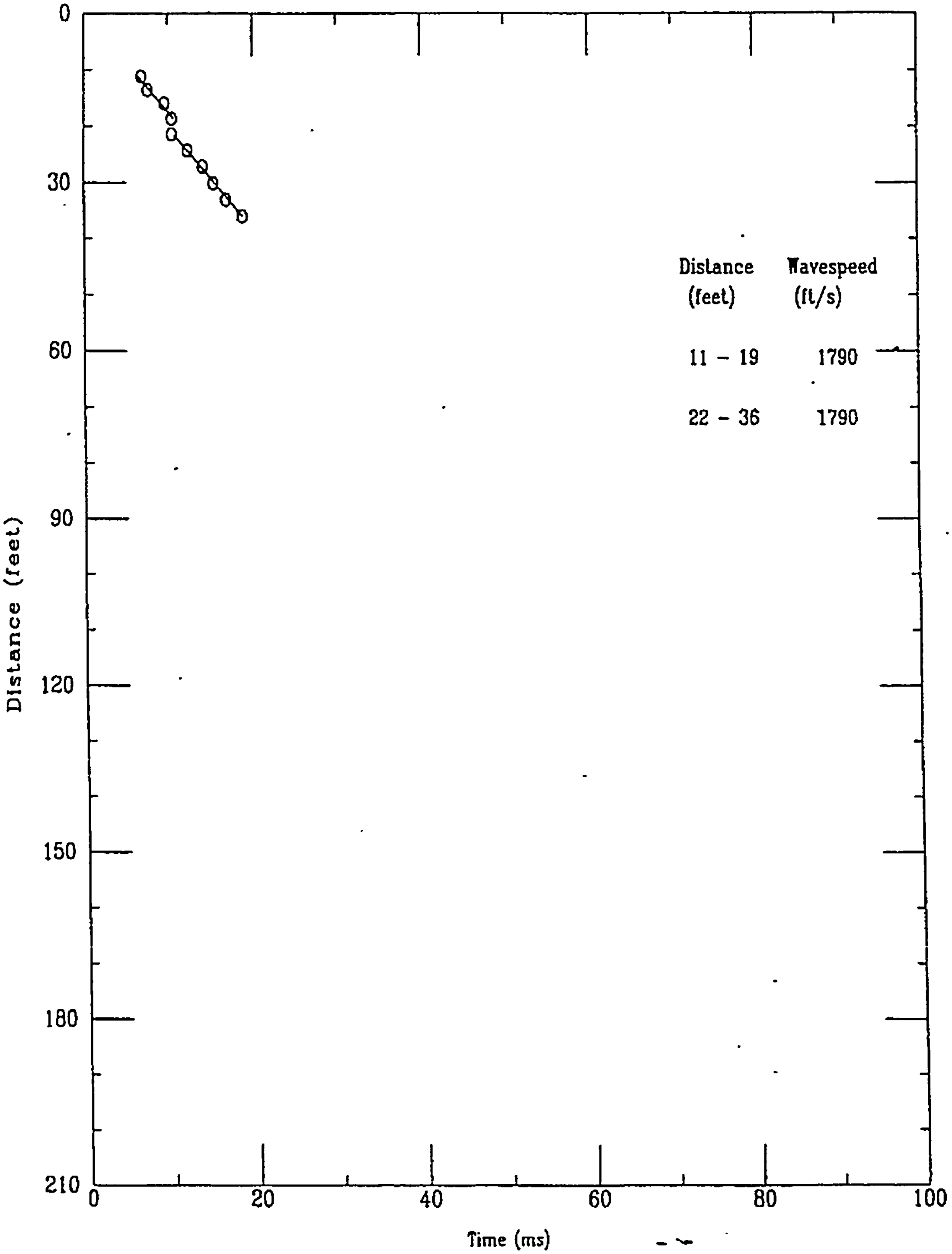
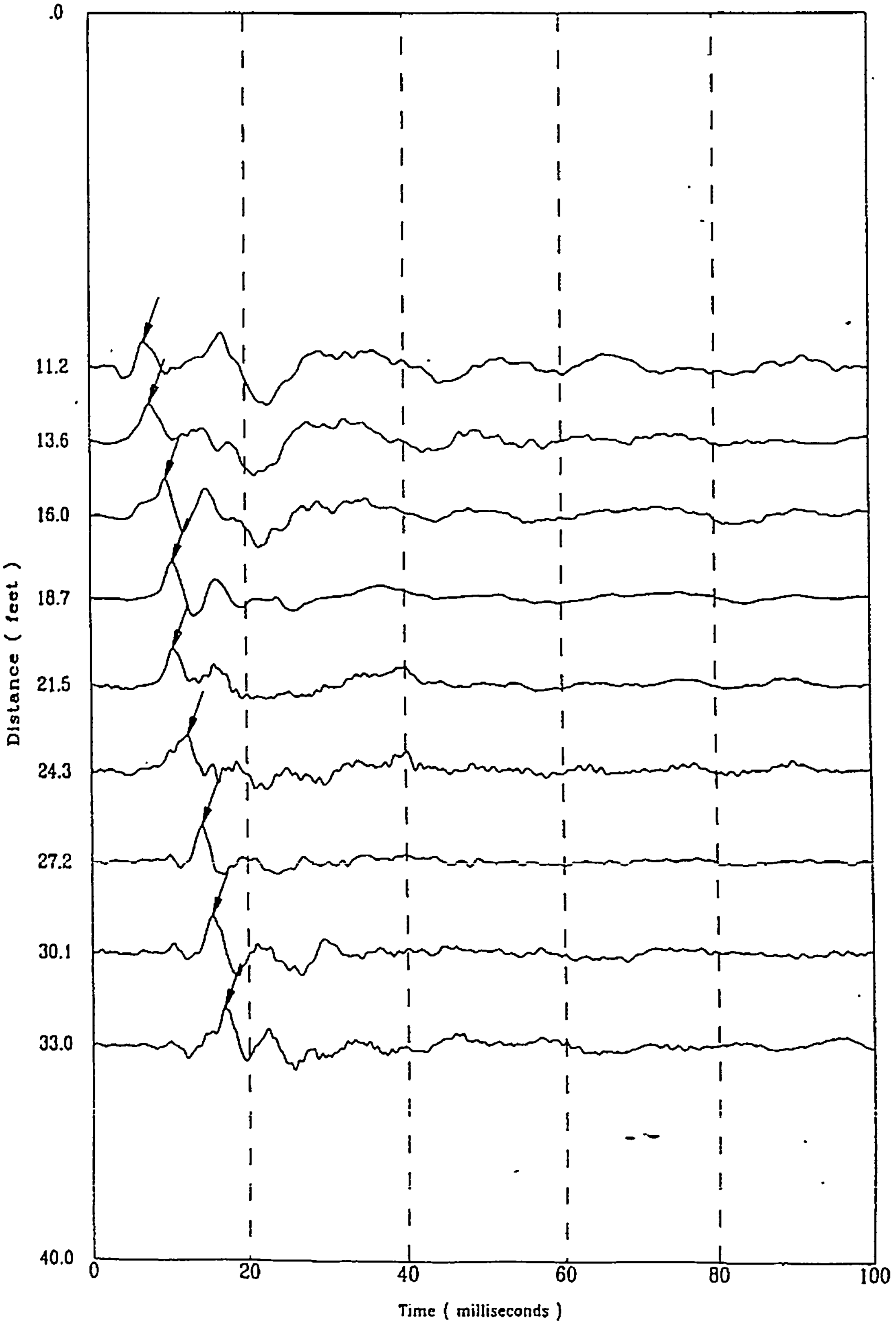
HTEF-C03 APPLIED RESEARCH ASSOCIATES, INC. 10/14/97

Compression Wave Time of Peak



File 3140701S

Applied Research Associates Inc. P Wave
HTEF-C3 10/14/97



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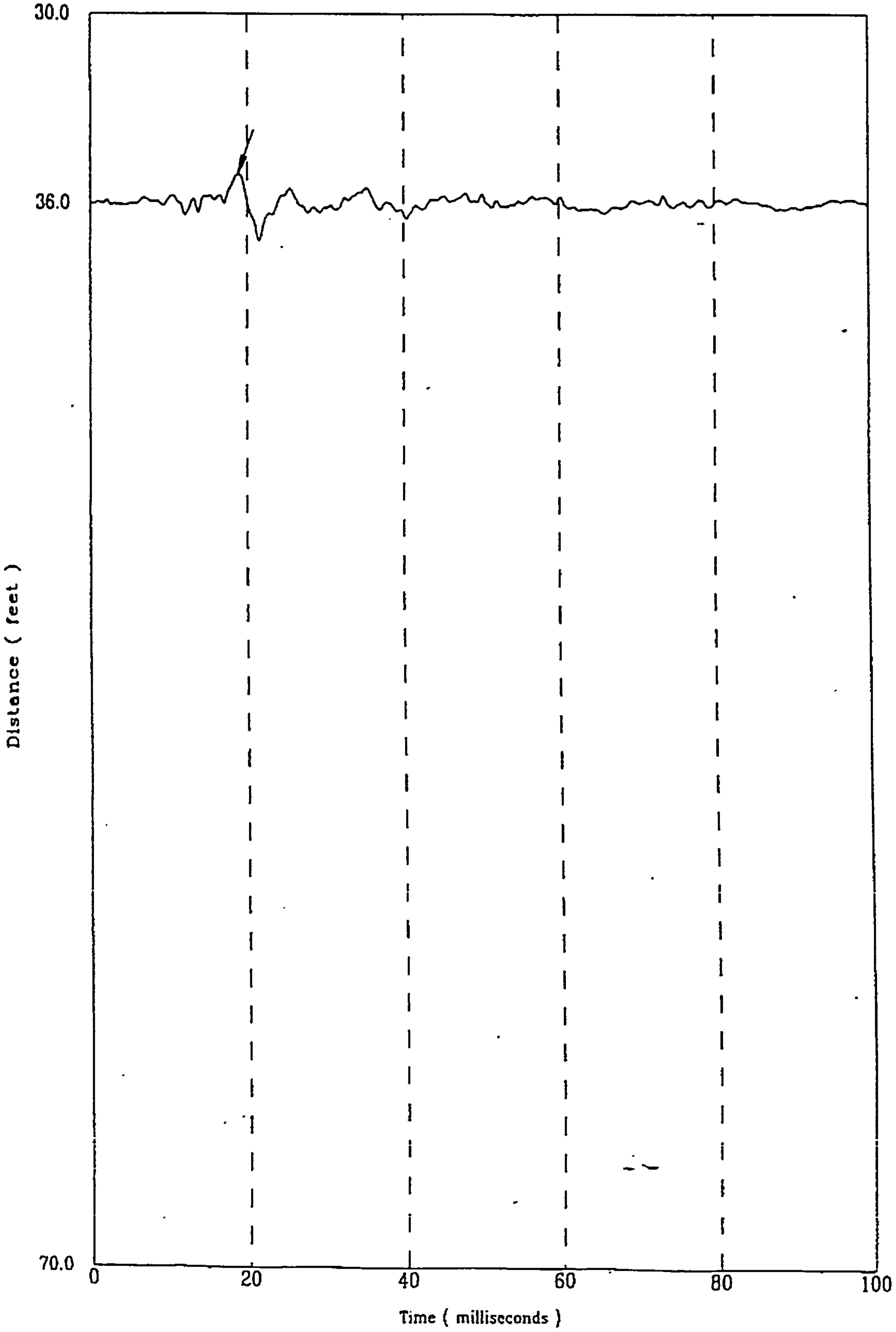
A-4n

Applied Research Associates Inc.
HTEF-C3

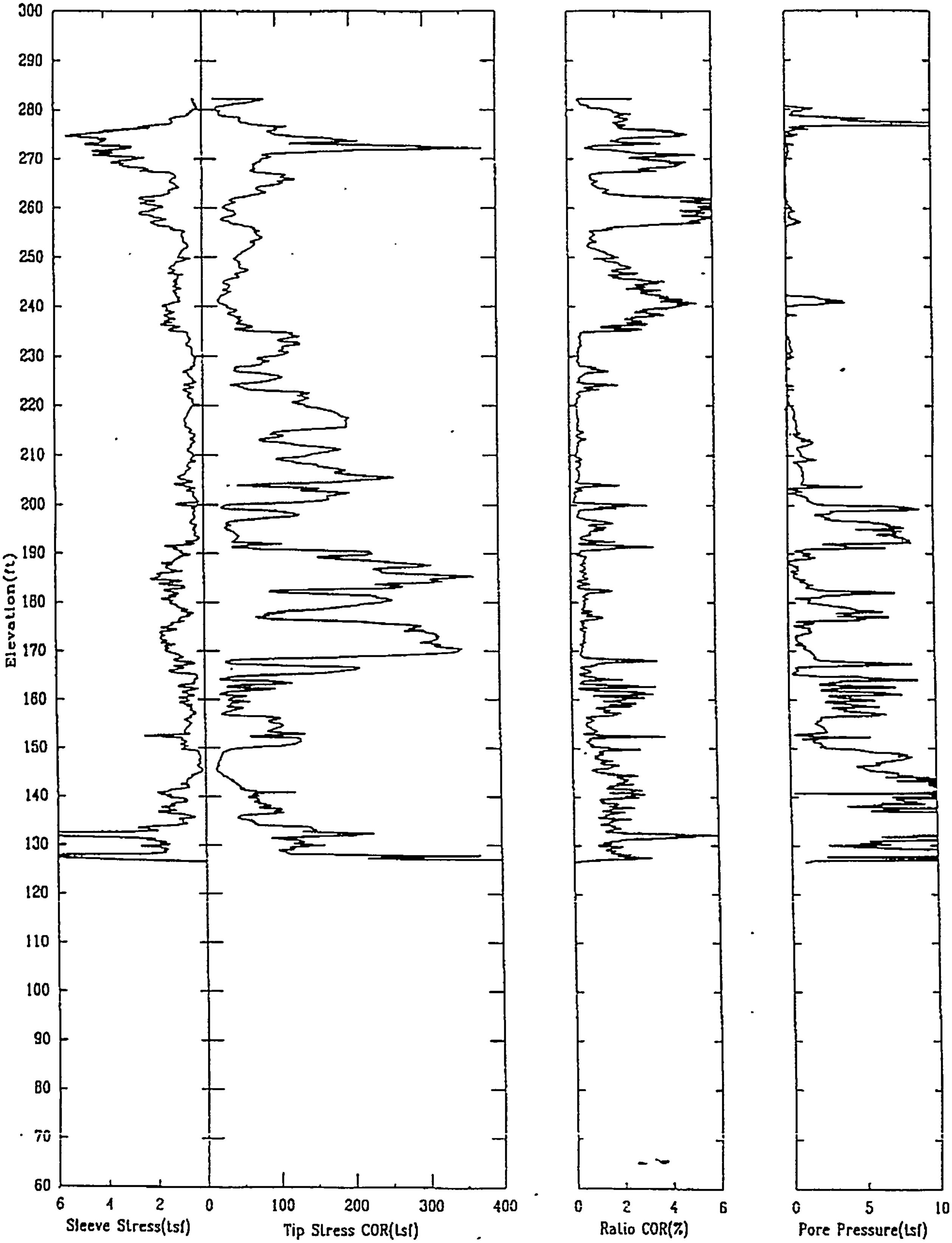
P Wave
10/14/97



File 3140701S

HTEF-C04 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

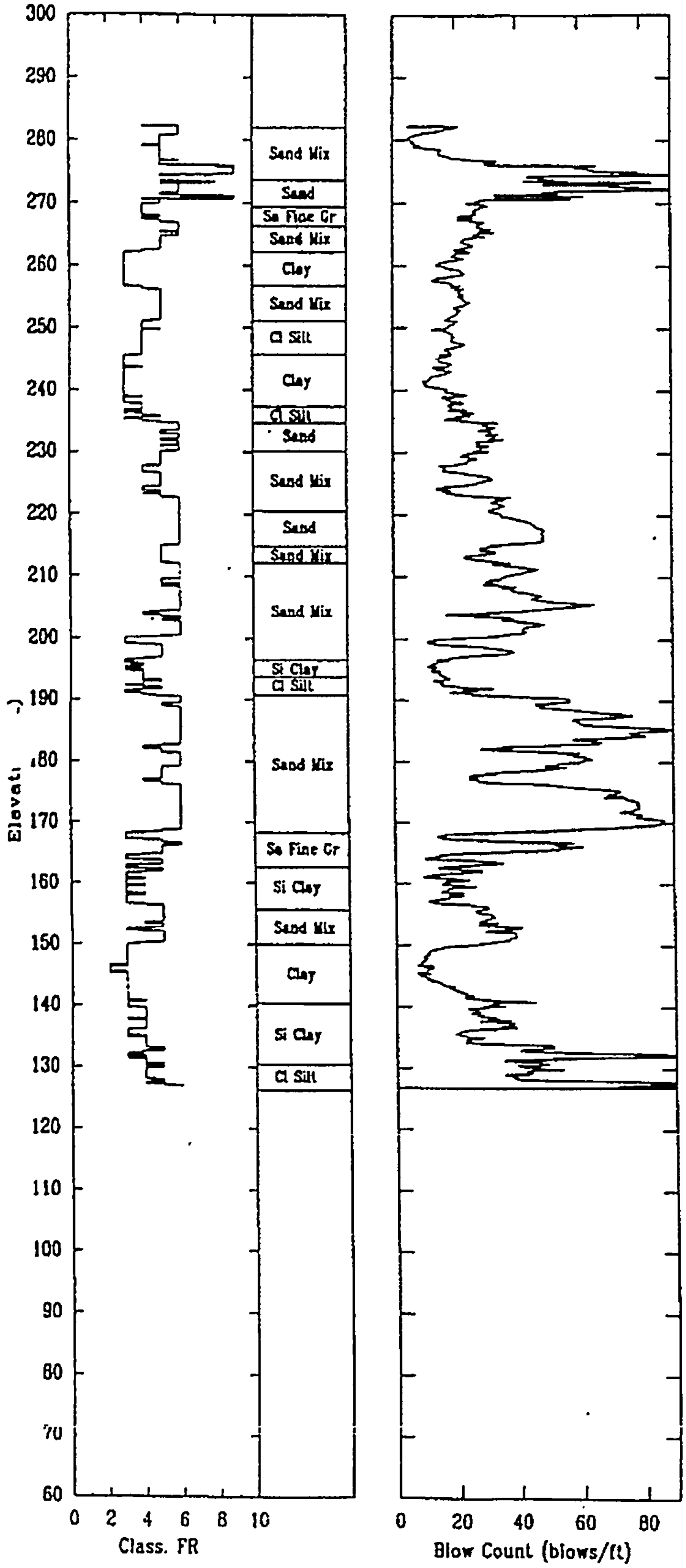
North 73264.0 East 61483.0 Elevation 288.3



File 3270701.ECP

HTEF-C04 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

North 73264.0 East 61483.0 Elevation 288.3

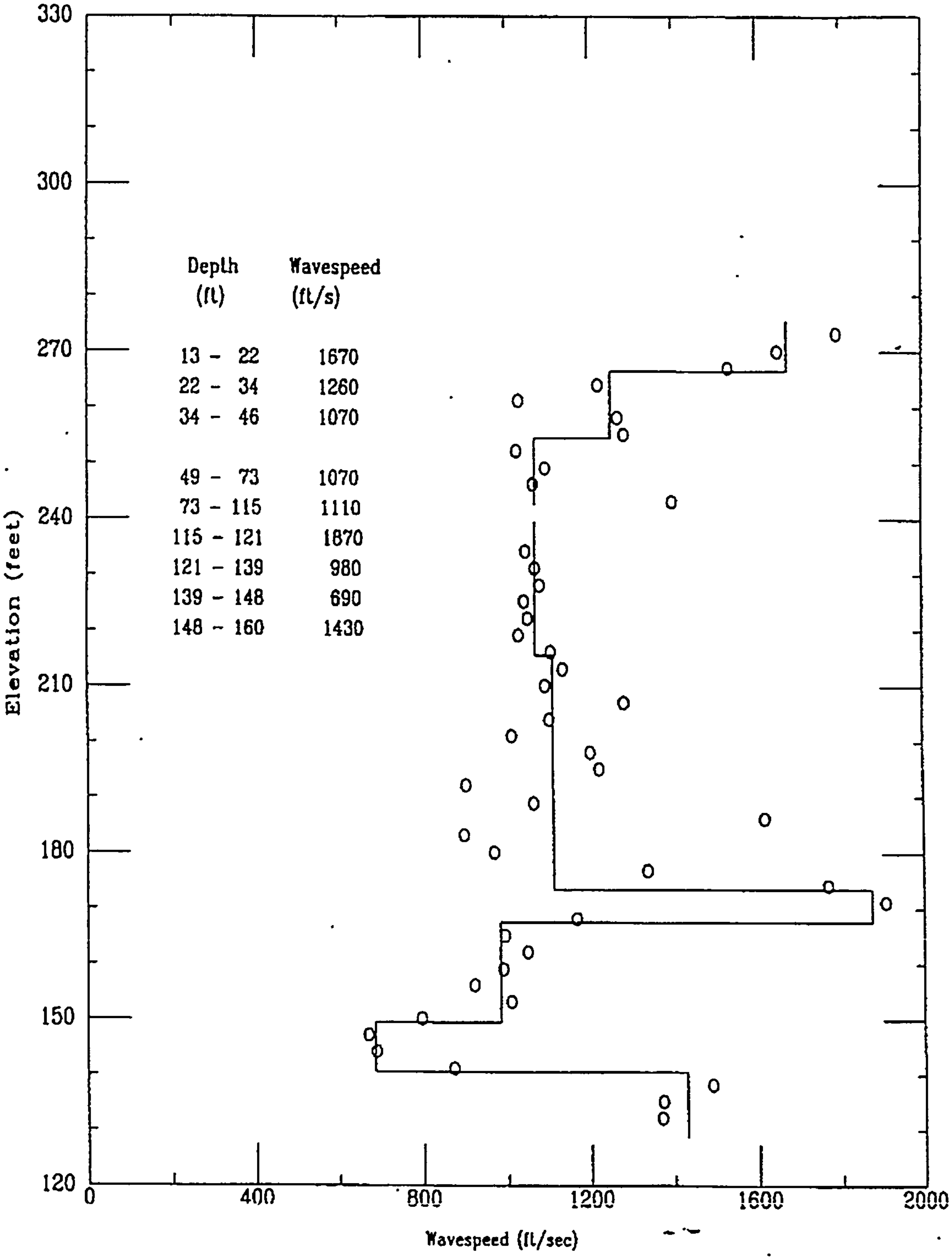


File 3270701.ECP

A-43

HTEF-C04 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

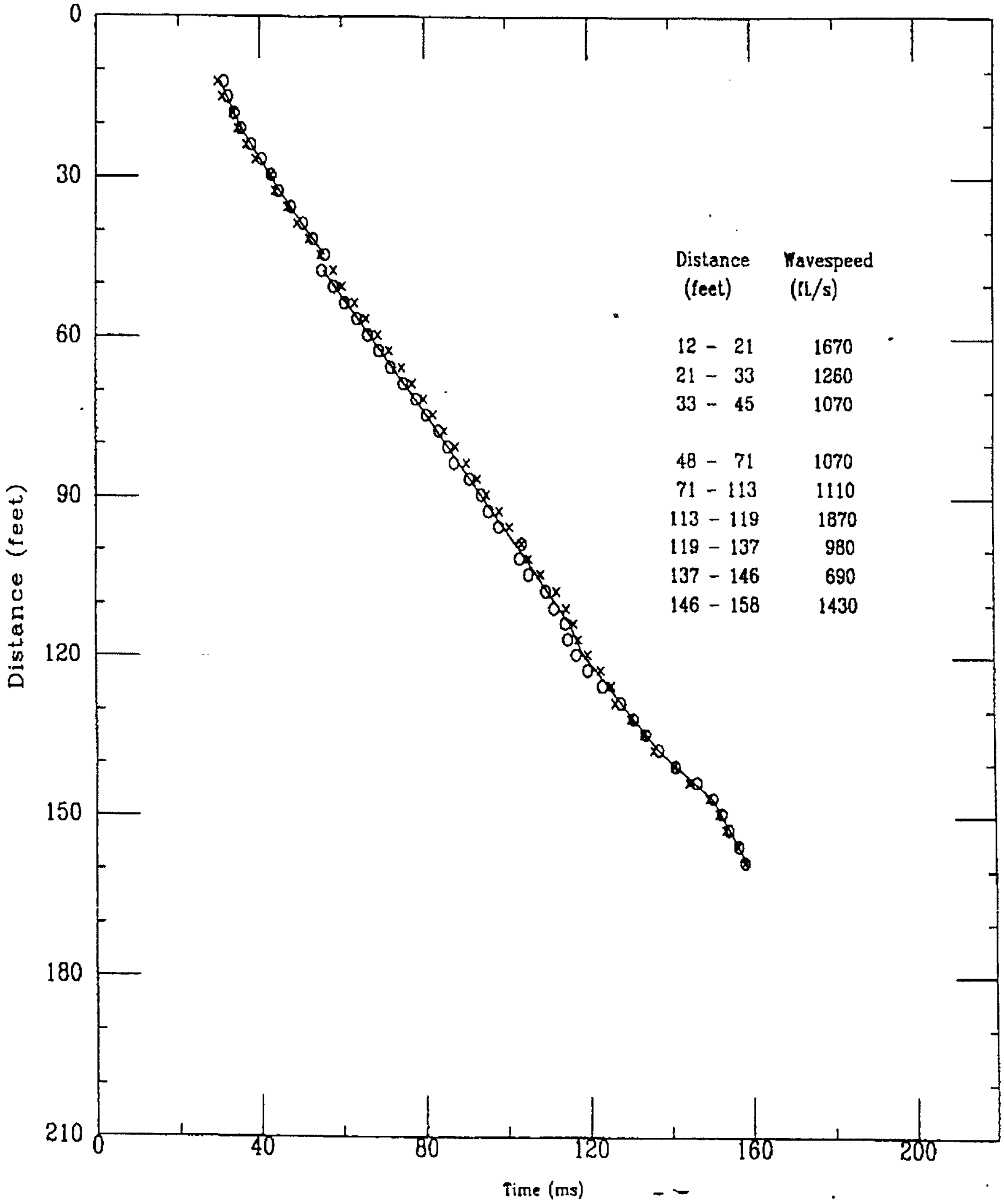
Shear Wave Speeds



File 3270701S

HTEF-C04 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

Shear Wave Time of Peak

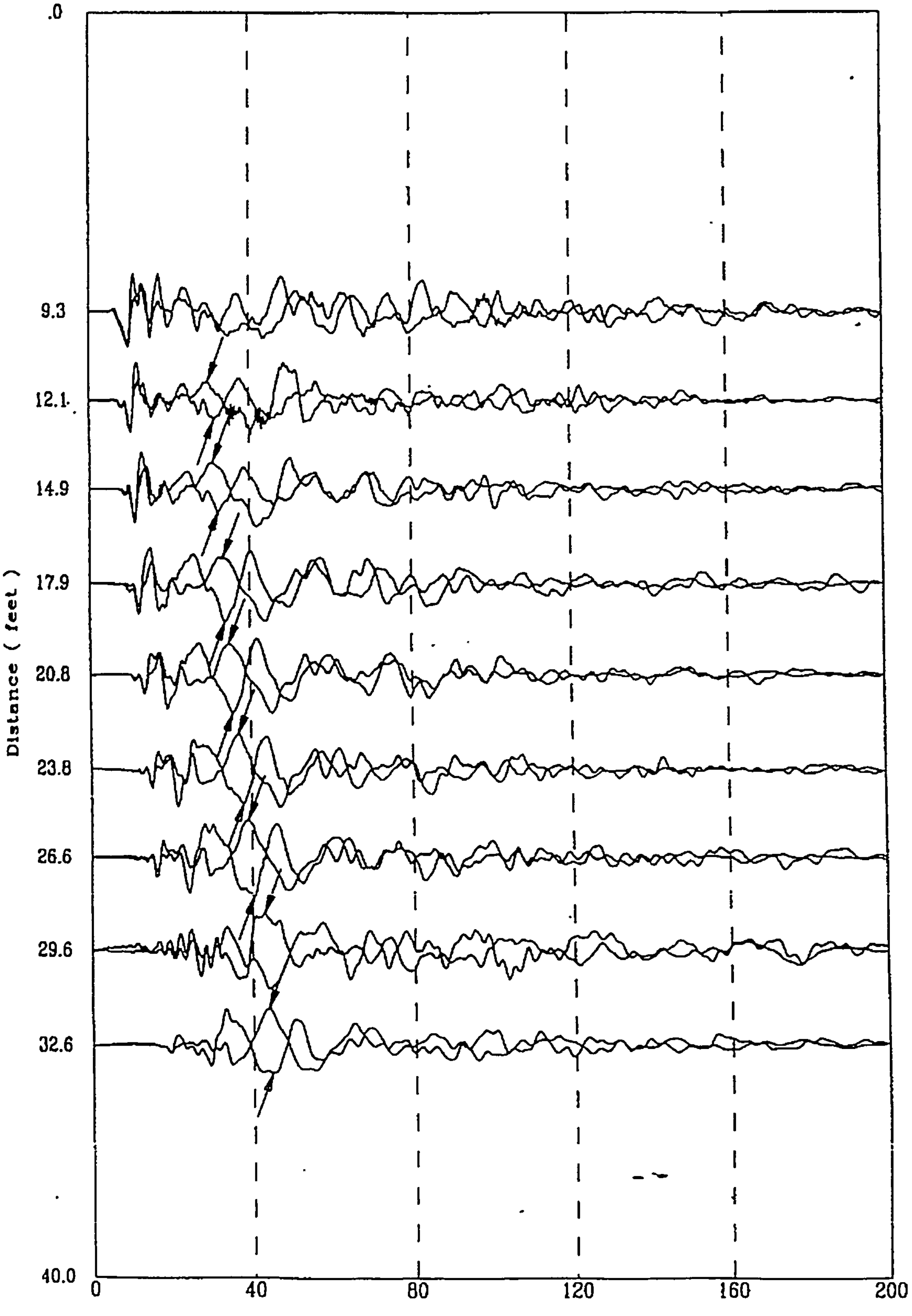


Distance (feet)	Wavespeed (ft/s)
12 - 21	1670
21 - 33	1260
33 - 45	1070
48 - 71	1070
71 - 113	1110
113 - 119	1870
119 - 137	980
137 - 146	690
146 - 158	1430

File 3270701S

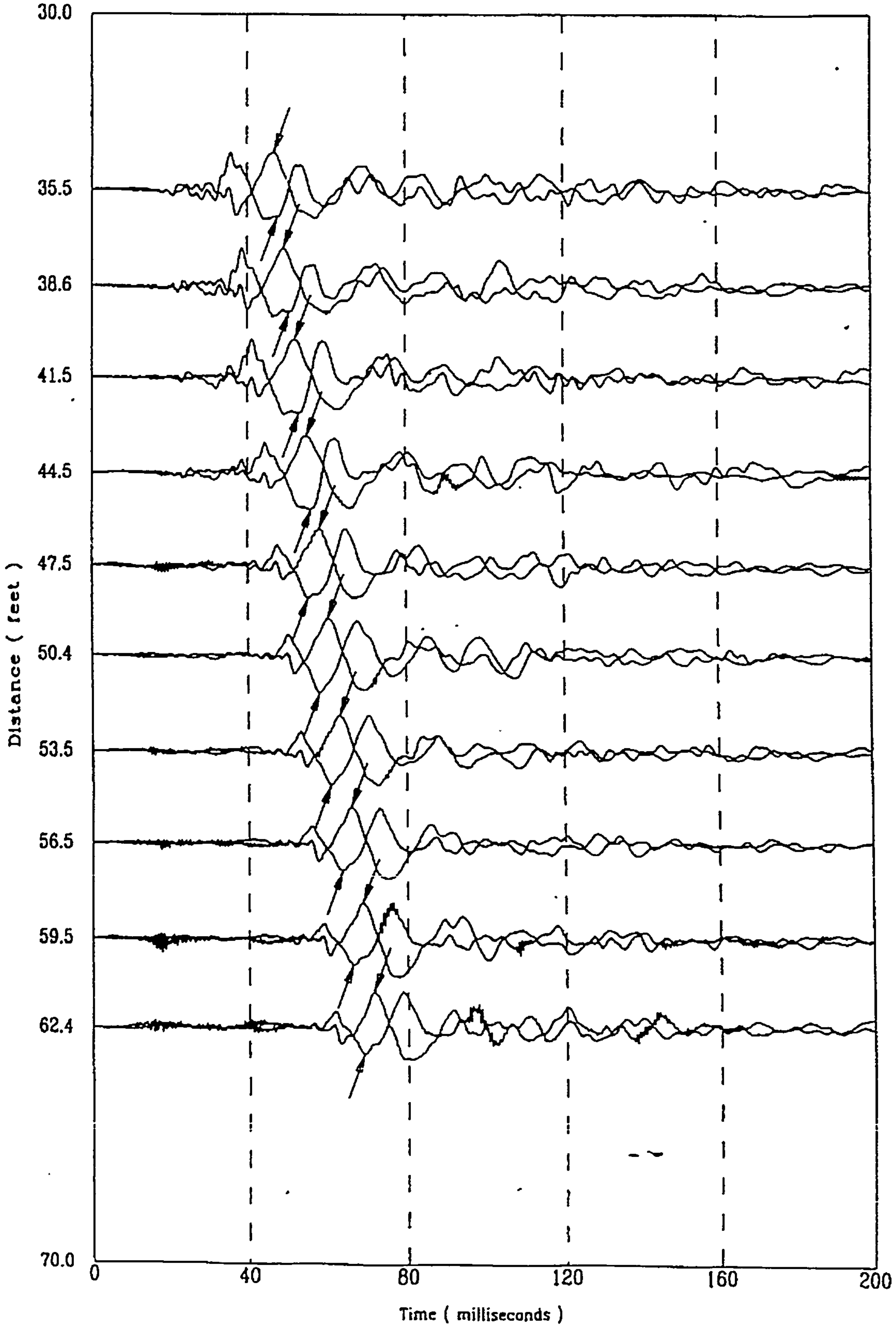
Applied Research Associates Inc.
HTEF-C04

S Wave
10/27/97



File 32707015

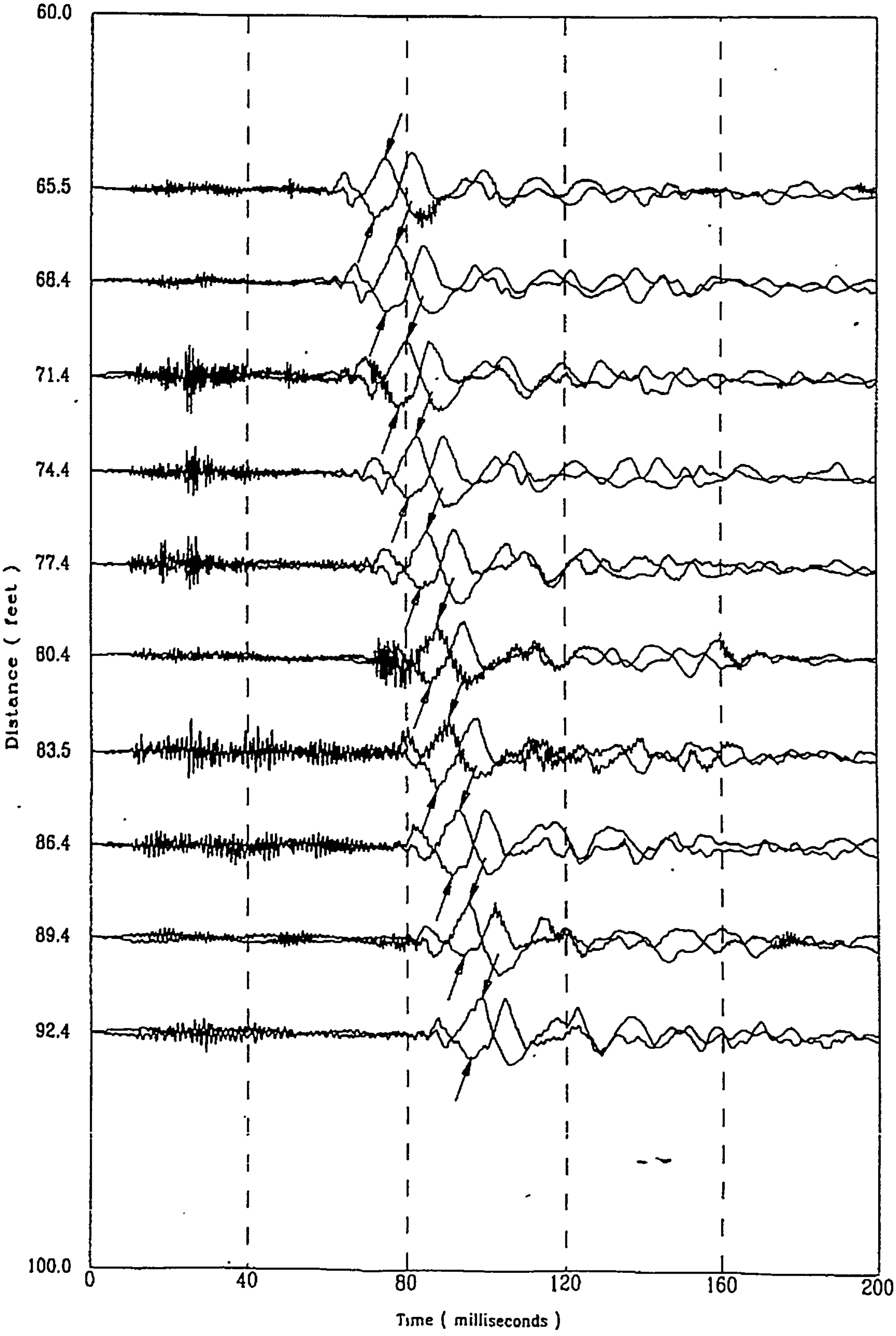
Applied Research Associates Inc. S Wave
HTEF-C04 10/27/97



File 3270701S

Applied Research Associates Inc.
HTEF-C04

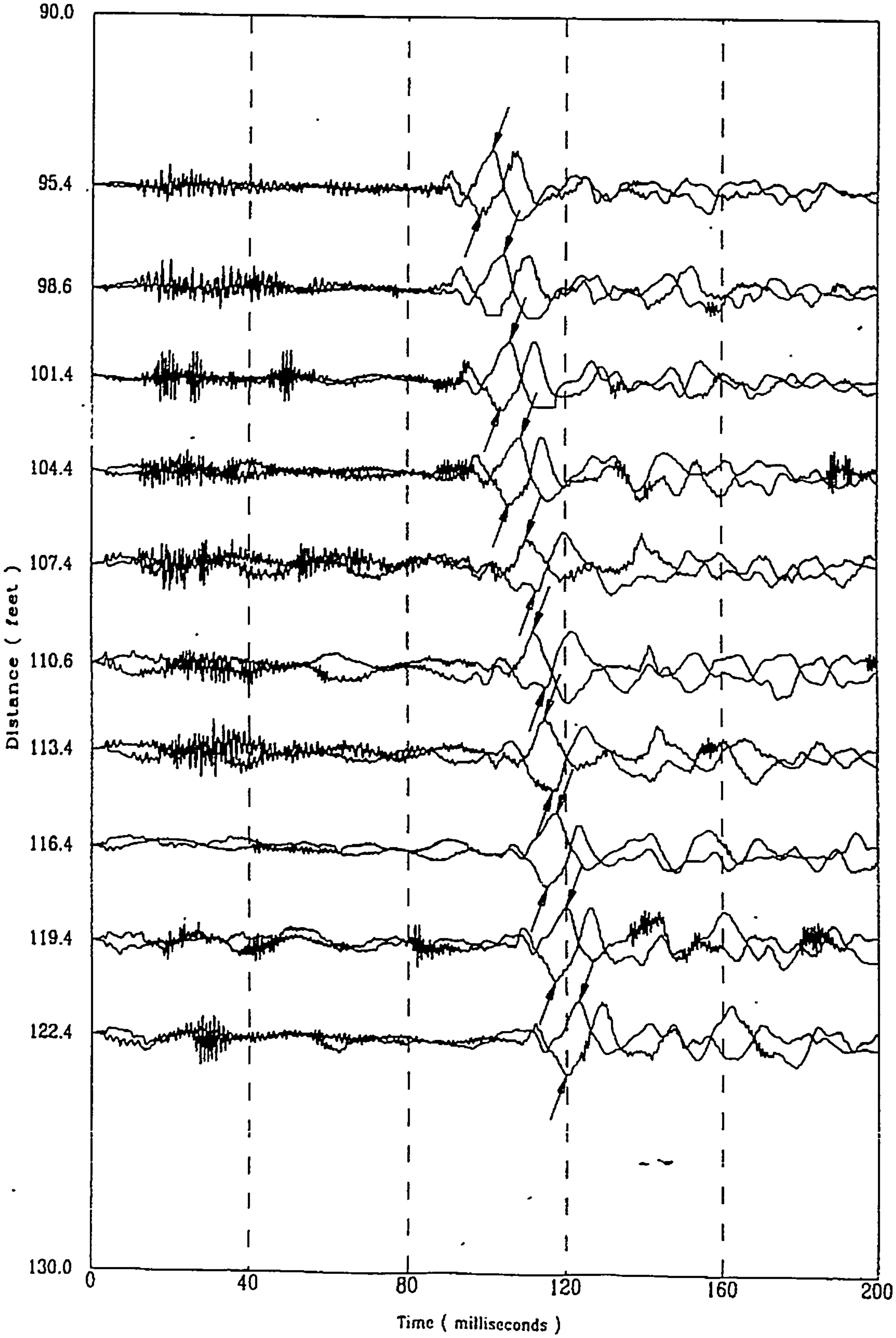
S Wave
10/27/97



File 32707015

Applied Research Associates Inc.
HTEF-C04

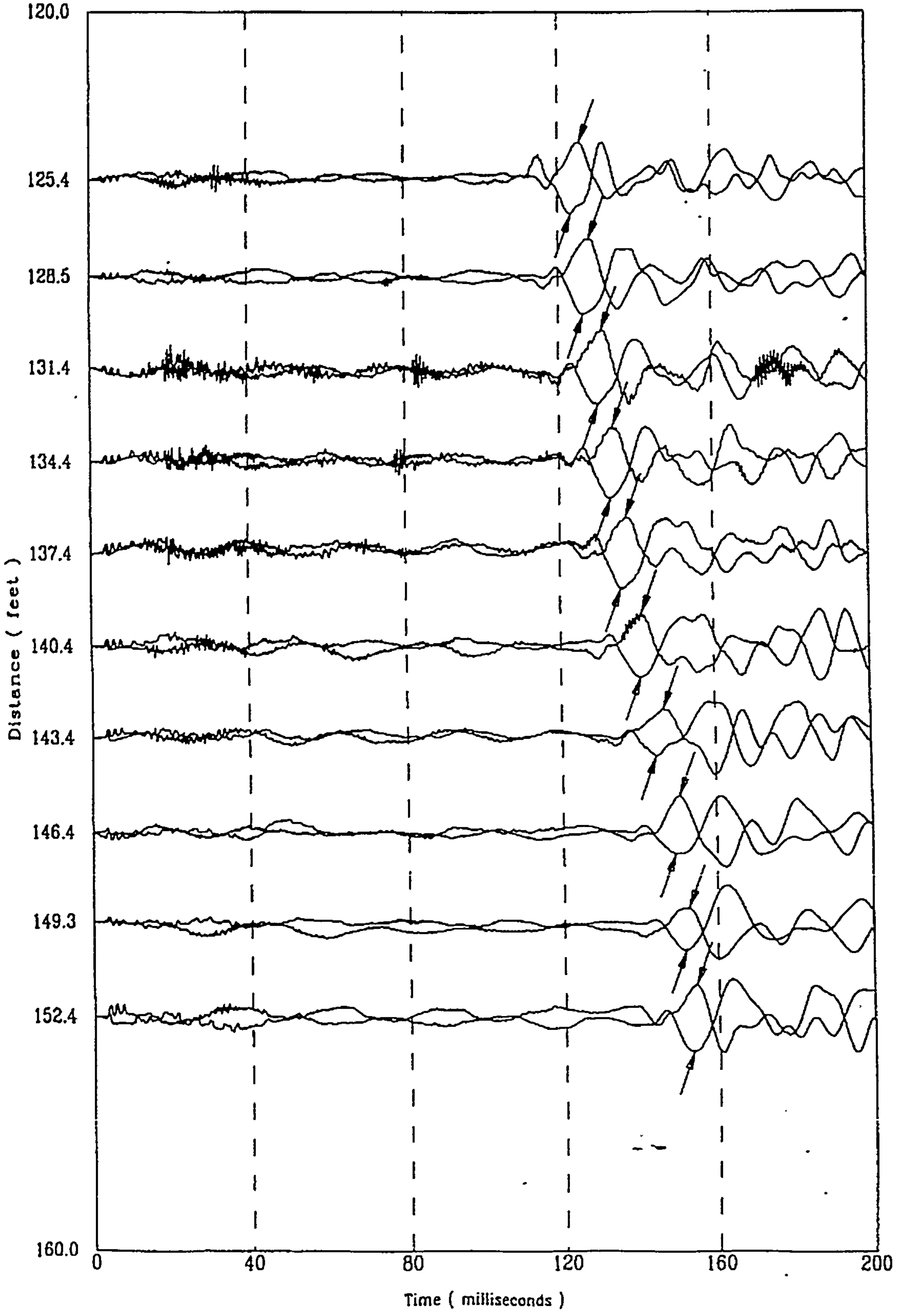
S Wave
10/27/97



File 3270702S

Applied Research Associates Inc.
HTEF-C04

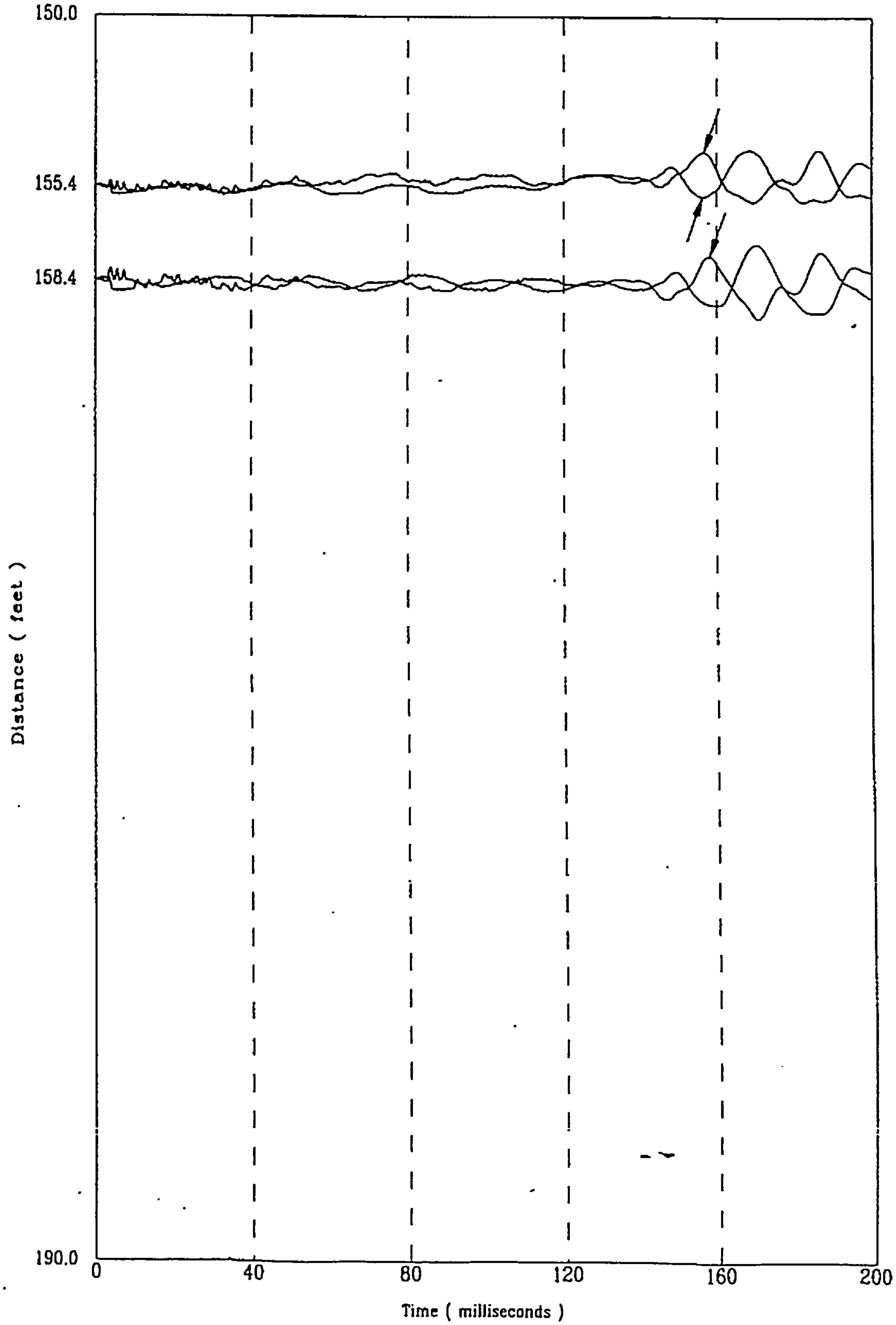
S Wave
10/27/97



File 3270702S

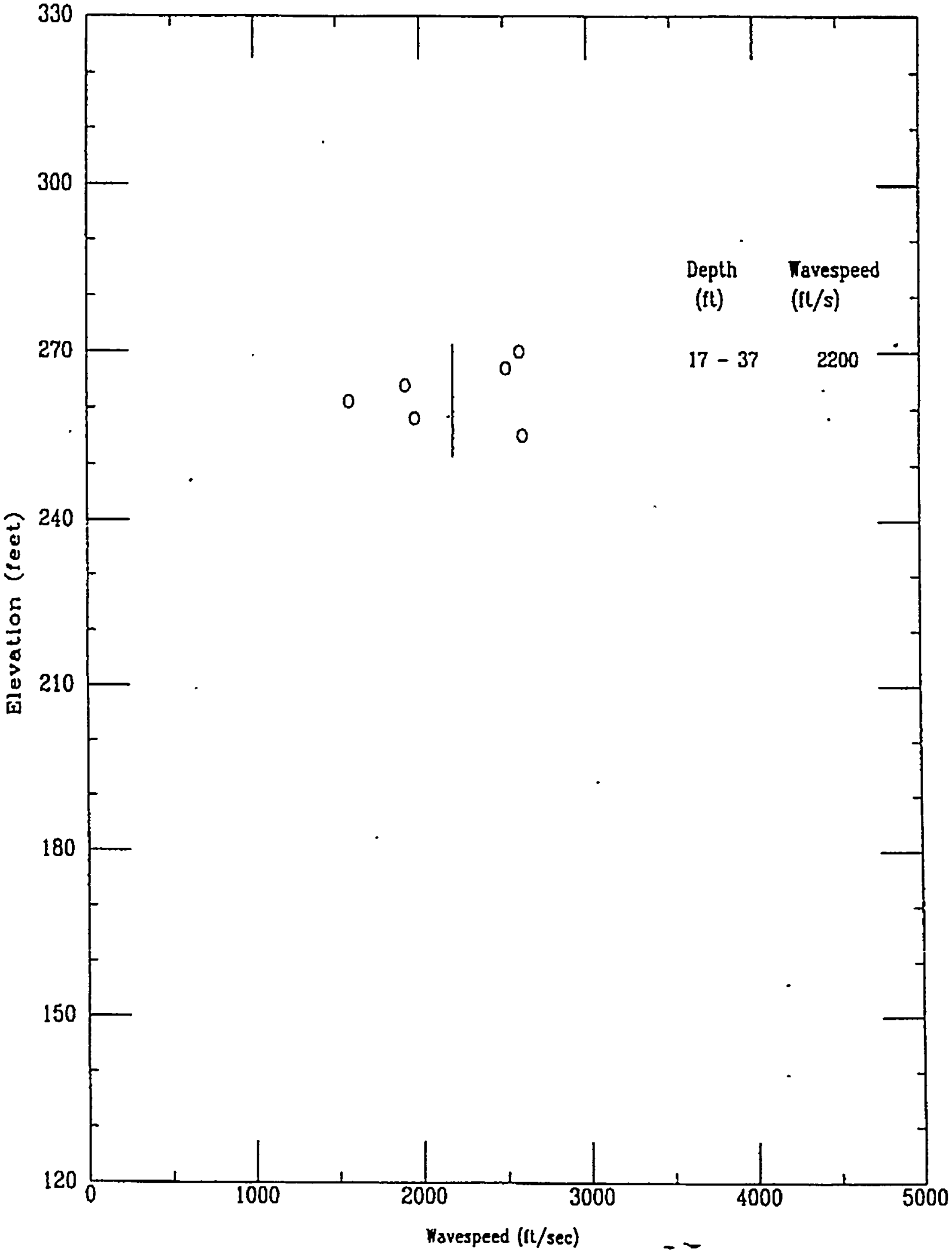
Applied Research Associates Inc.
HTEF-C04

S Wave
10/27/97



File 3270702S

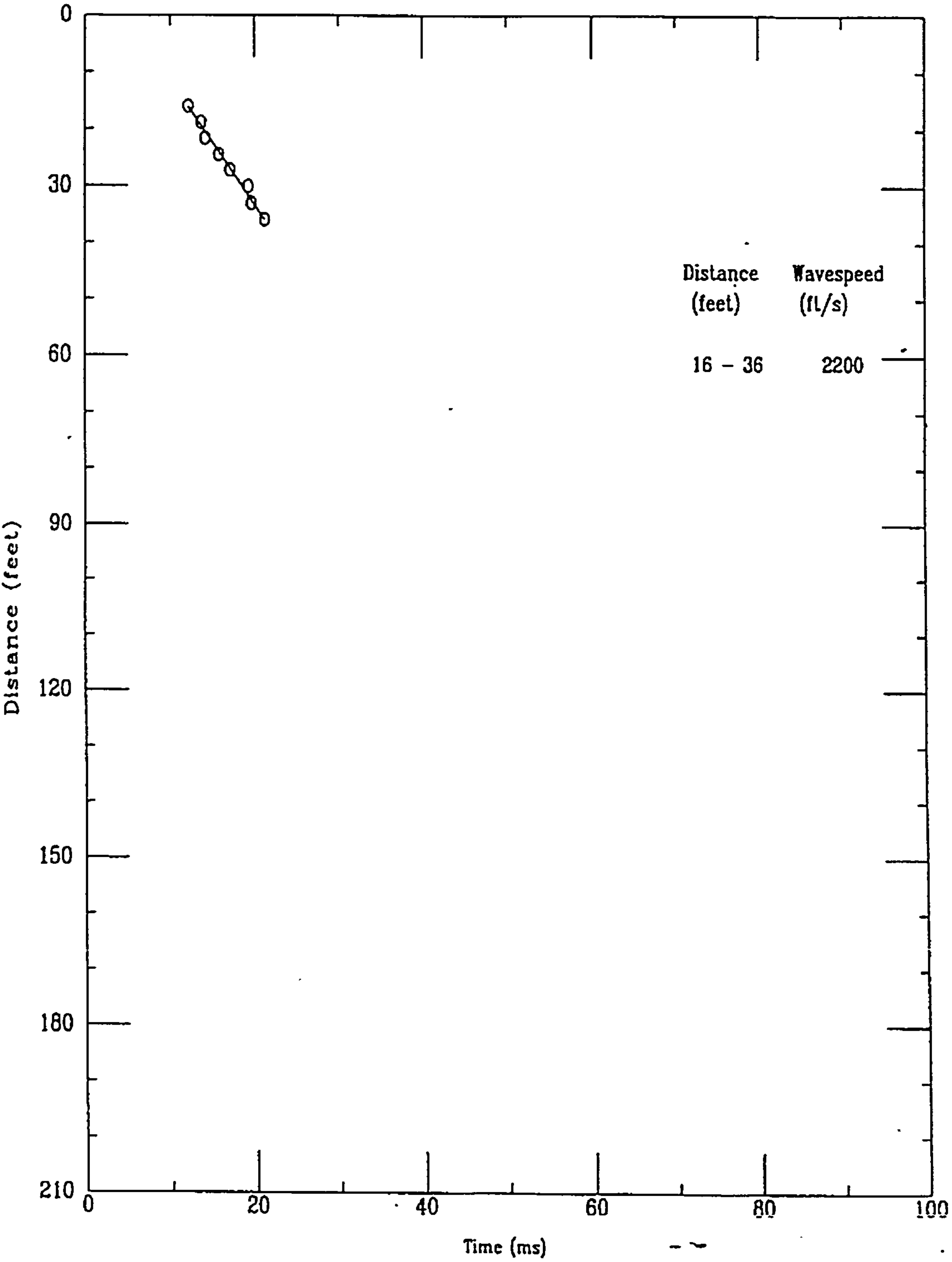
Compression Wave Speeds



File 3270701S

HTEF-C04 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

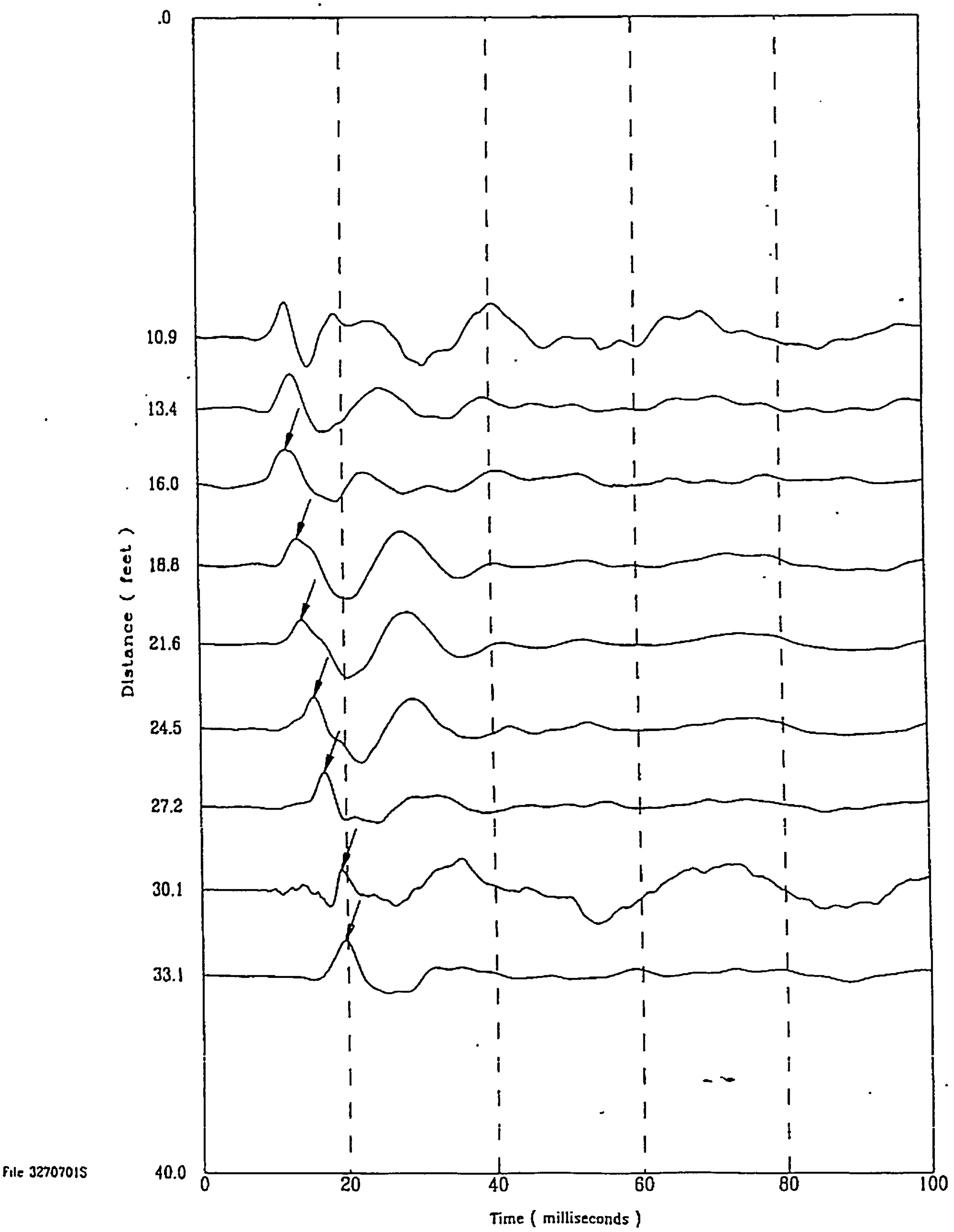
Compression Wave Time of Peak



File 3270701S

Applied Research Associates Inc.
HTEF-C04

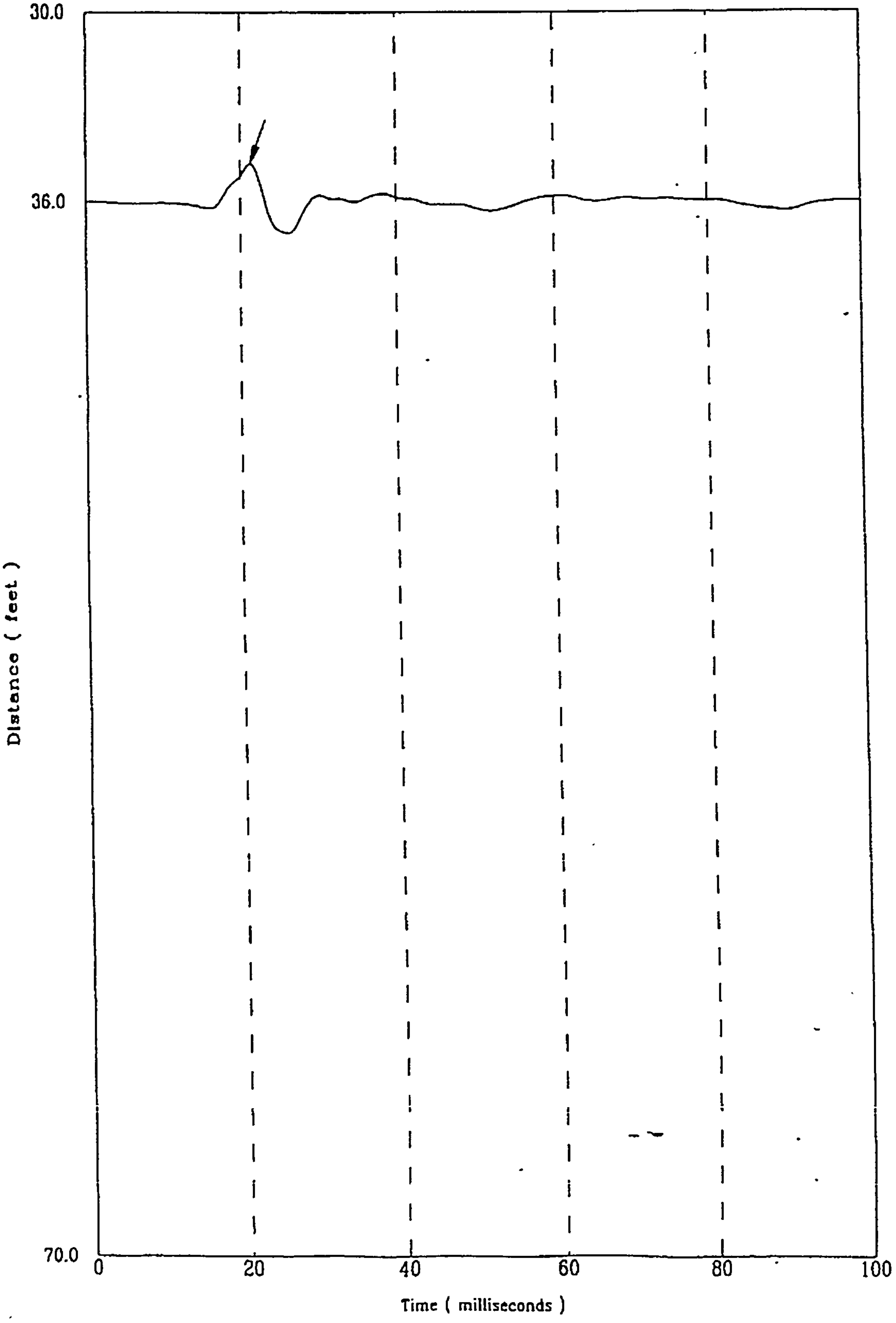
P Wave
10/27/97



A-54

Applied Research Associates Inc.
HTEF-C04

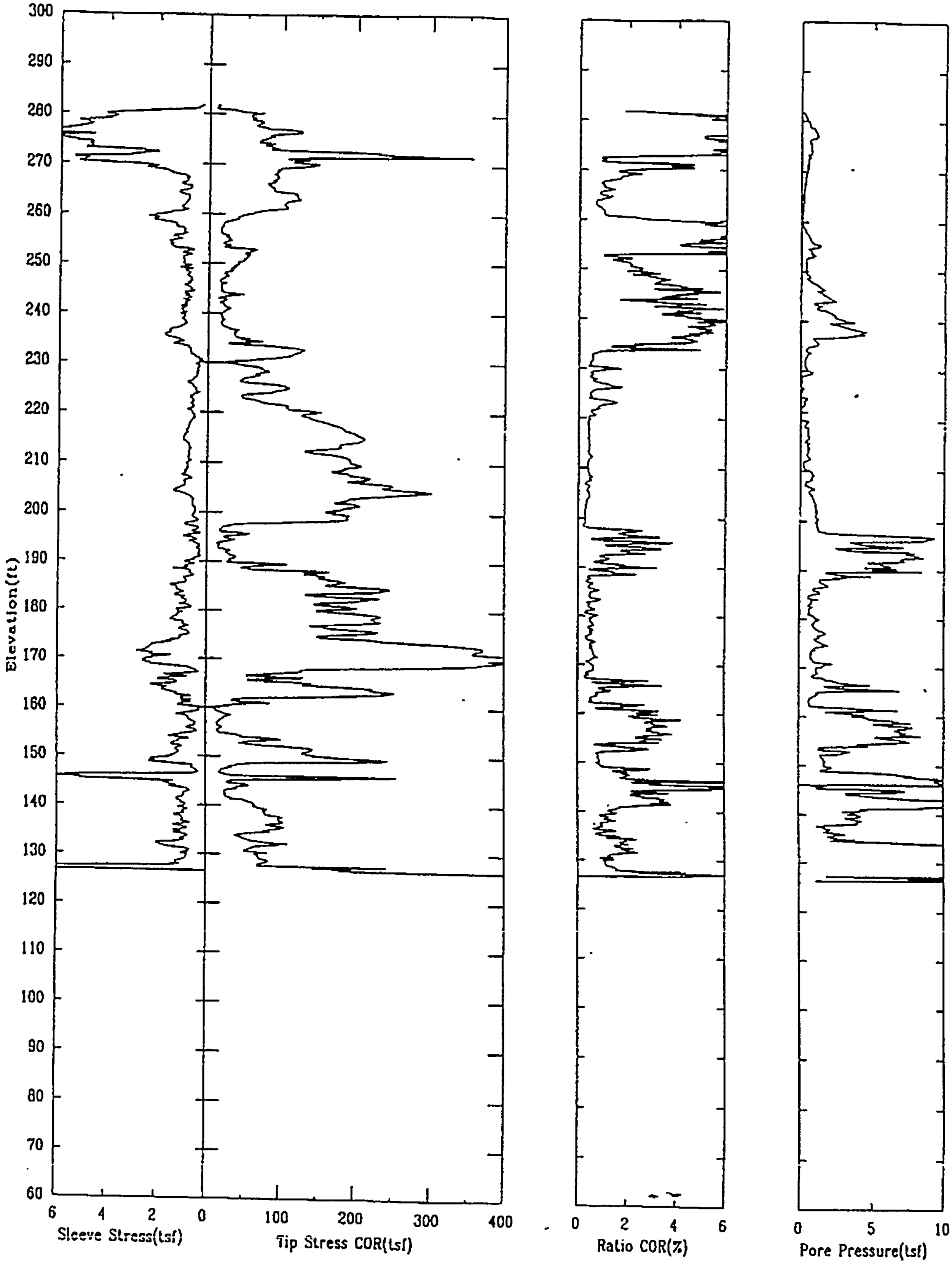
P Wave
10/27/97



File 3270701S

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

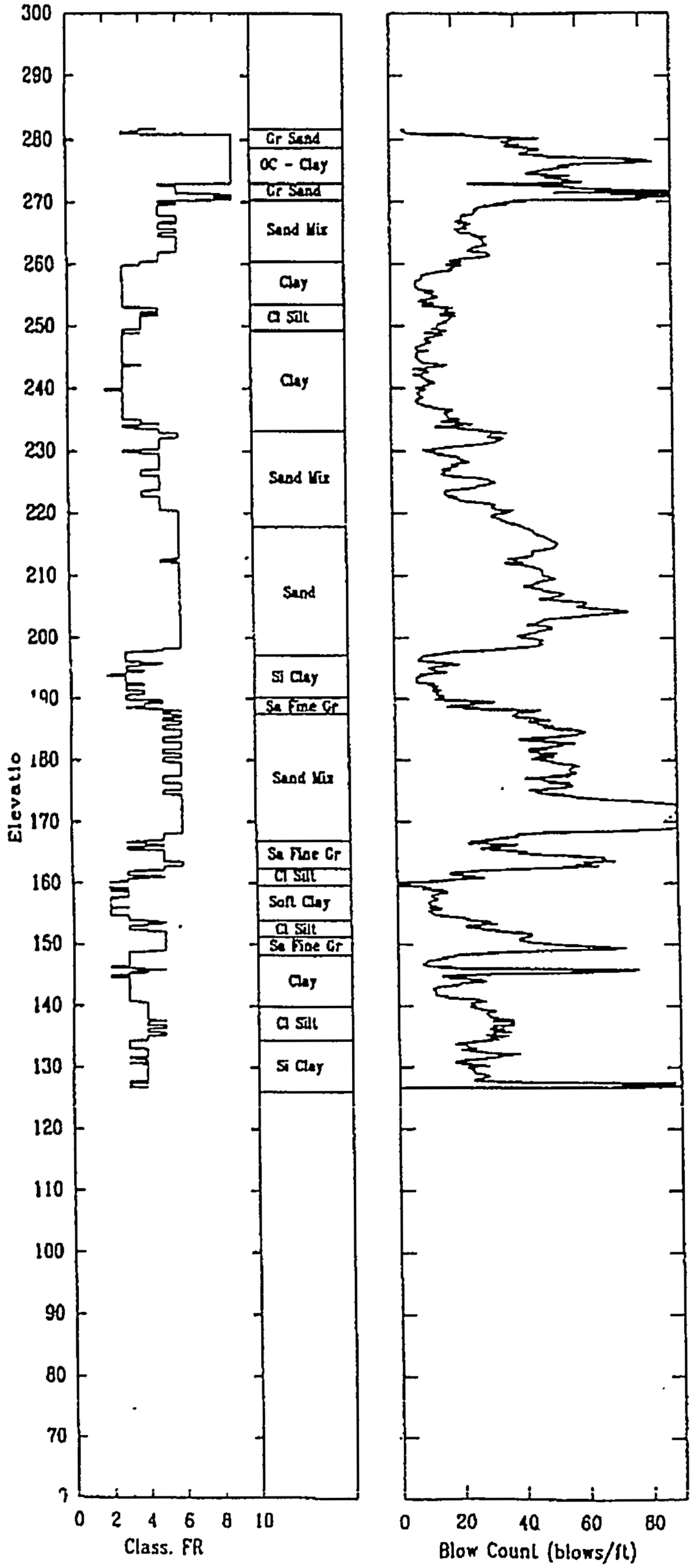
North 73270.0 East 61575.0 Elevation 287.8



File 3270704.ECP

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

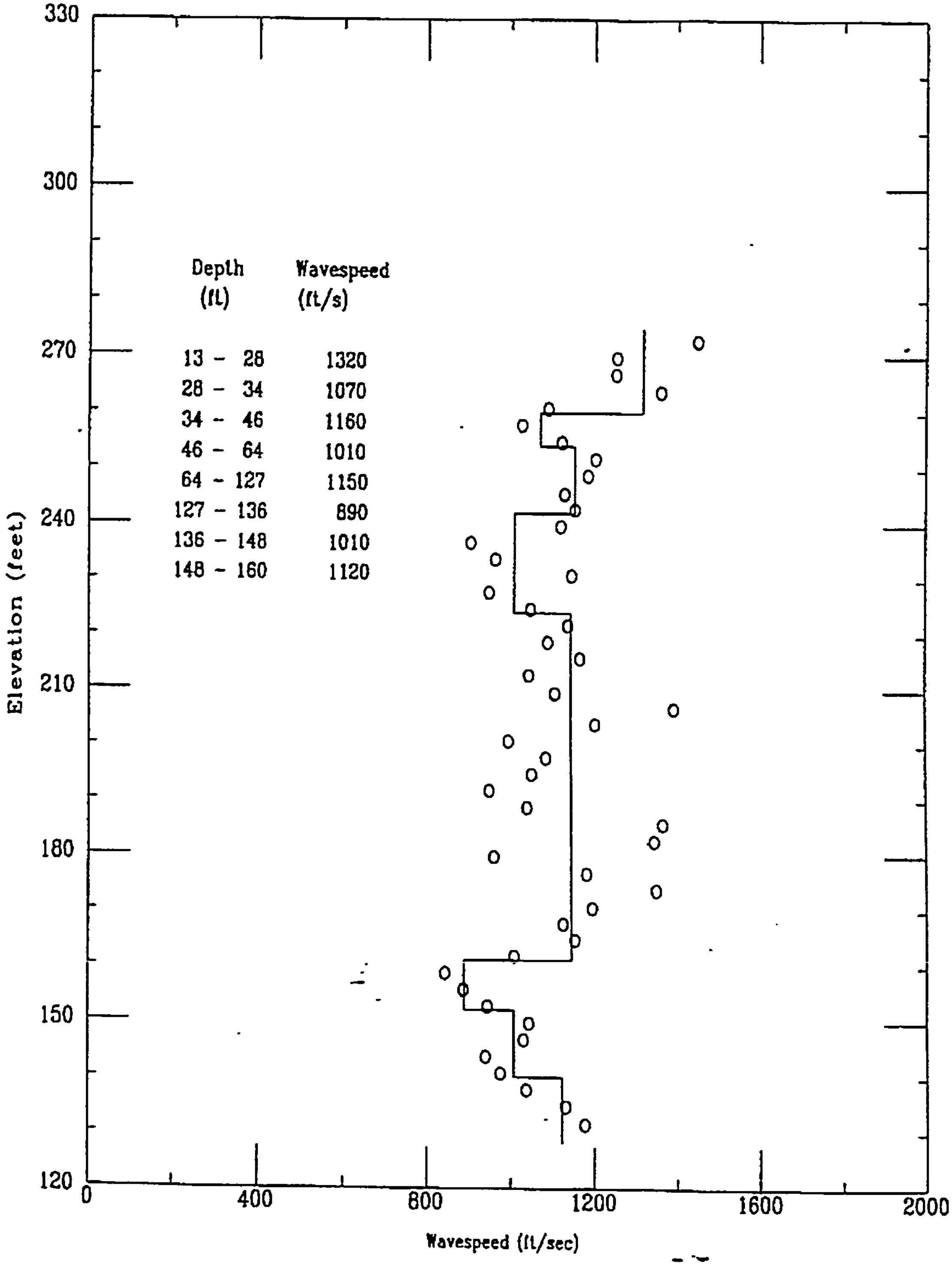
North 73270.0 East 61575.0 Elevation 287.8



File 3270704.ECP

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

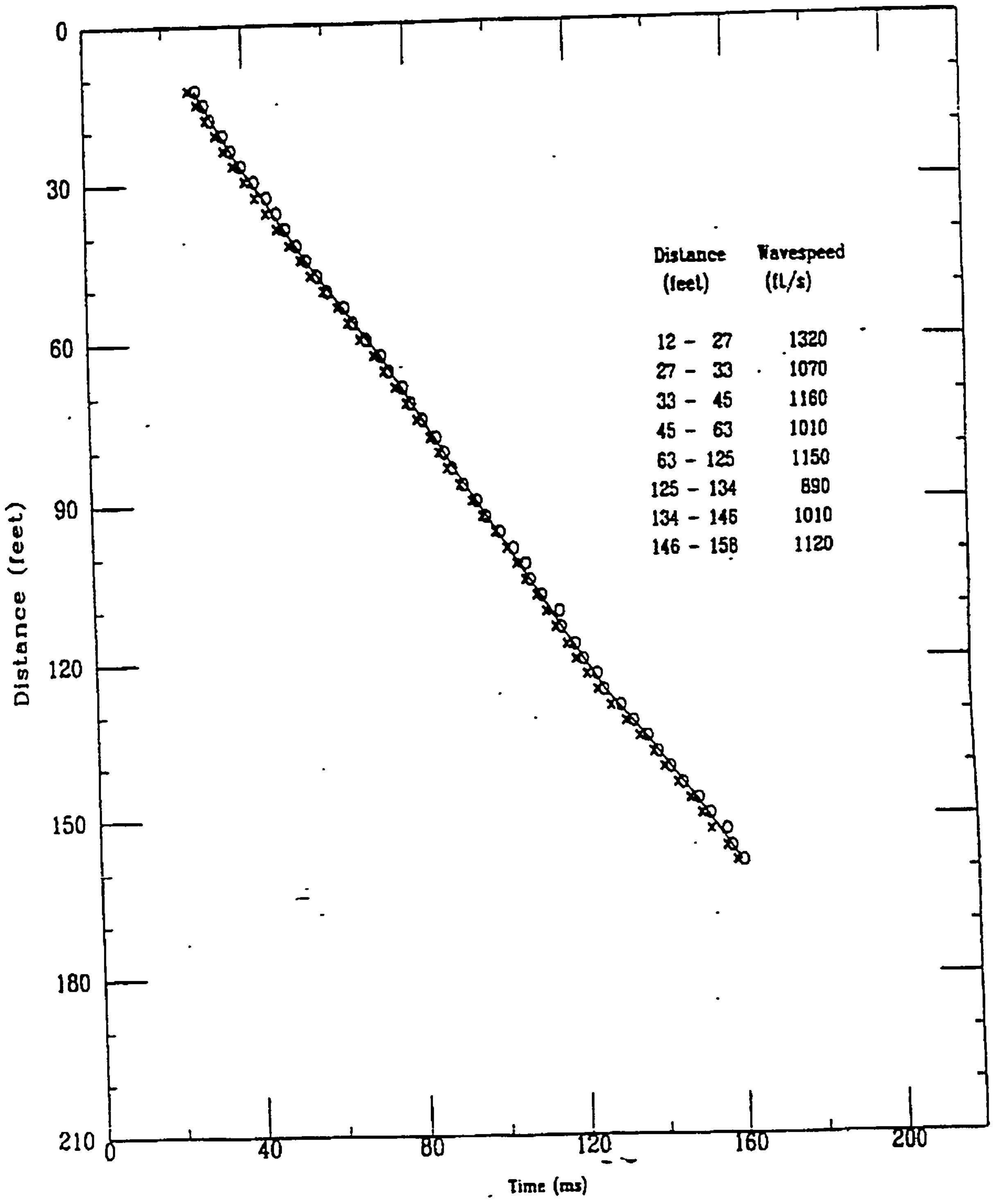
Shear Wave Speeds



Depth (ft)	Wavespeed (ft/s)
13 - 28	1320
28 - 34	1070
34 - 46	1160
46 - 64	1010
64 - 127	1150
127 - 136	890
136 - 148	1010
148 - 160	1120

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

Shear Wave Time of Peak

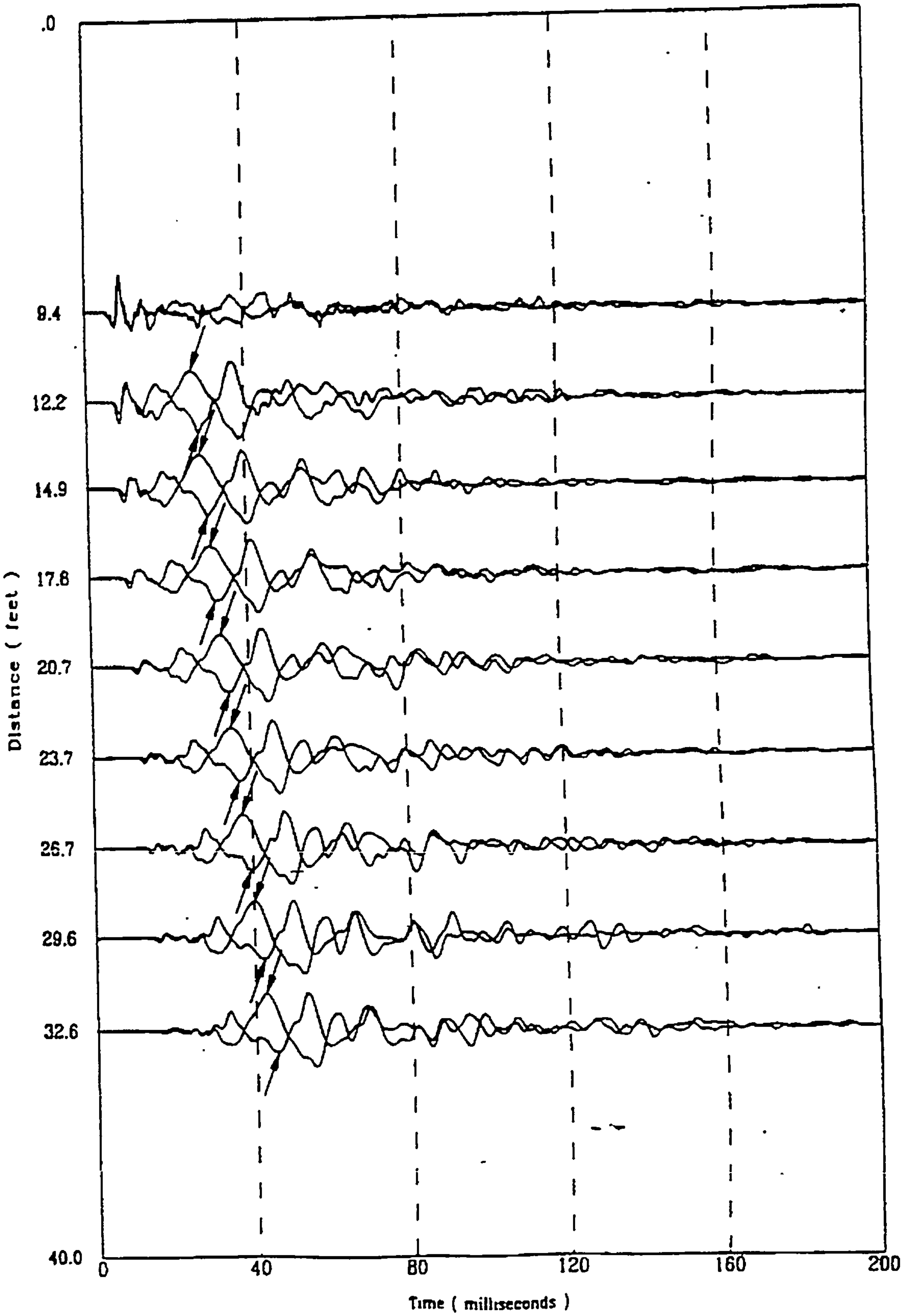


Distance (feet)	Wavespeed (ft/s)
12 - 27	1320
27 - 33	1070
33 - 45	1160
45 - 63	1010
63 - 125	1150
125 - 134	890
134 - 146	1010
146 - 158	1120

File 3270704S

Applied Research Associates Inc.
HTEF-C05

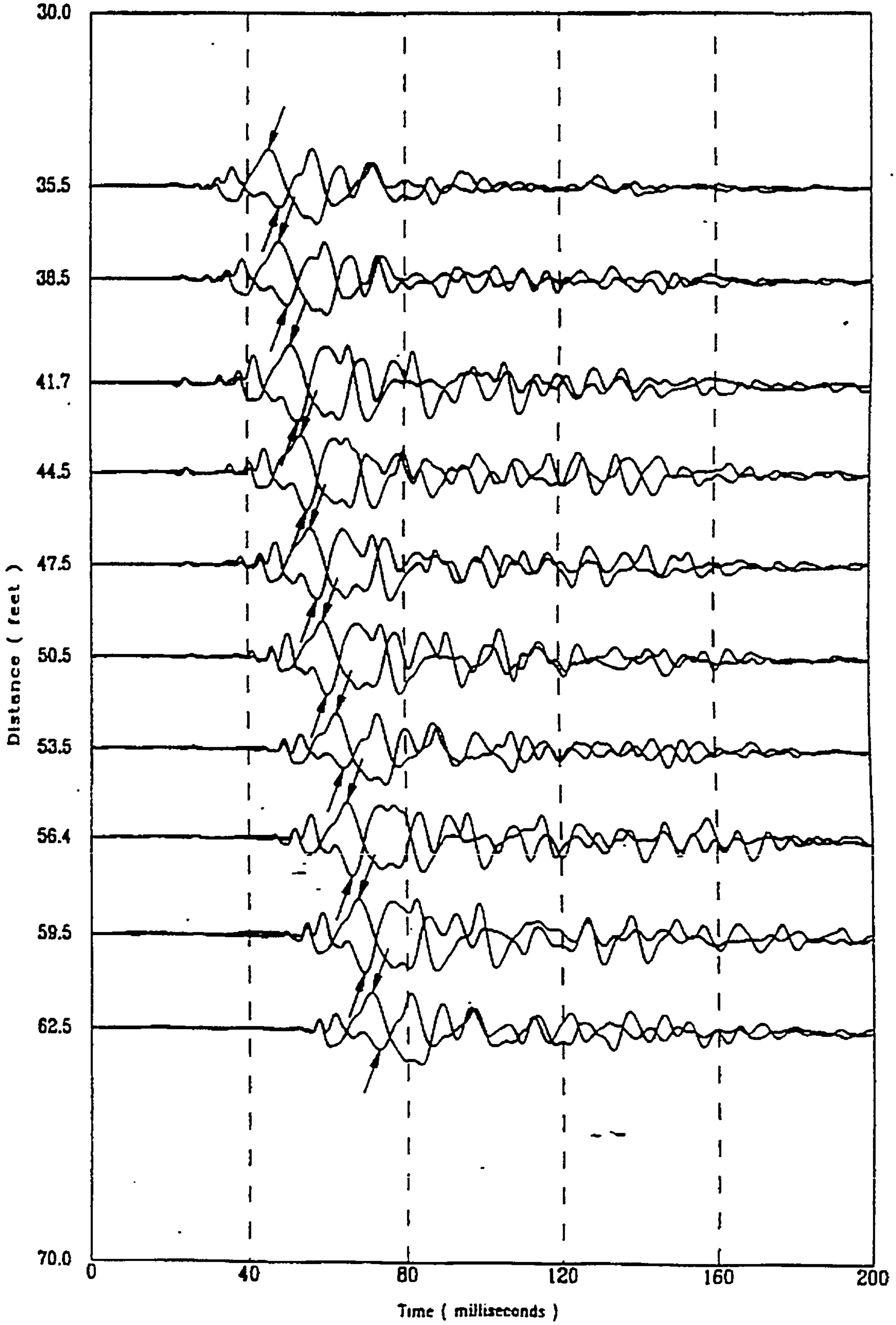
S Wave
10/27/97



File 32707045

Applied Research Associates Inc.
HTEF-C05

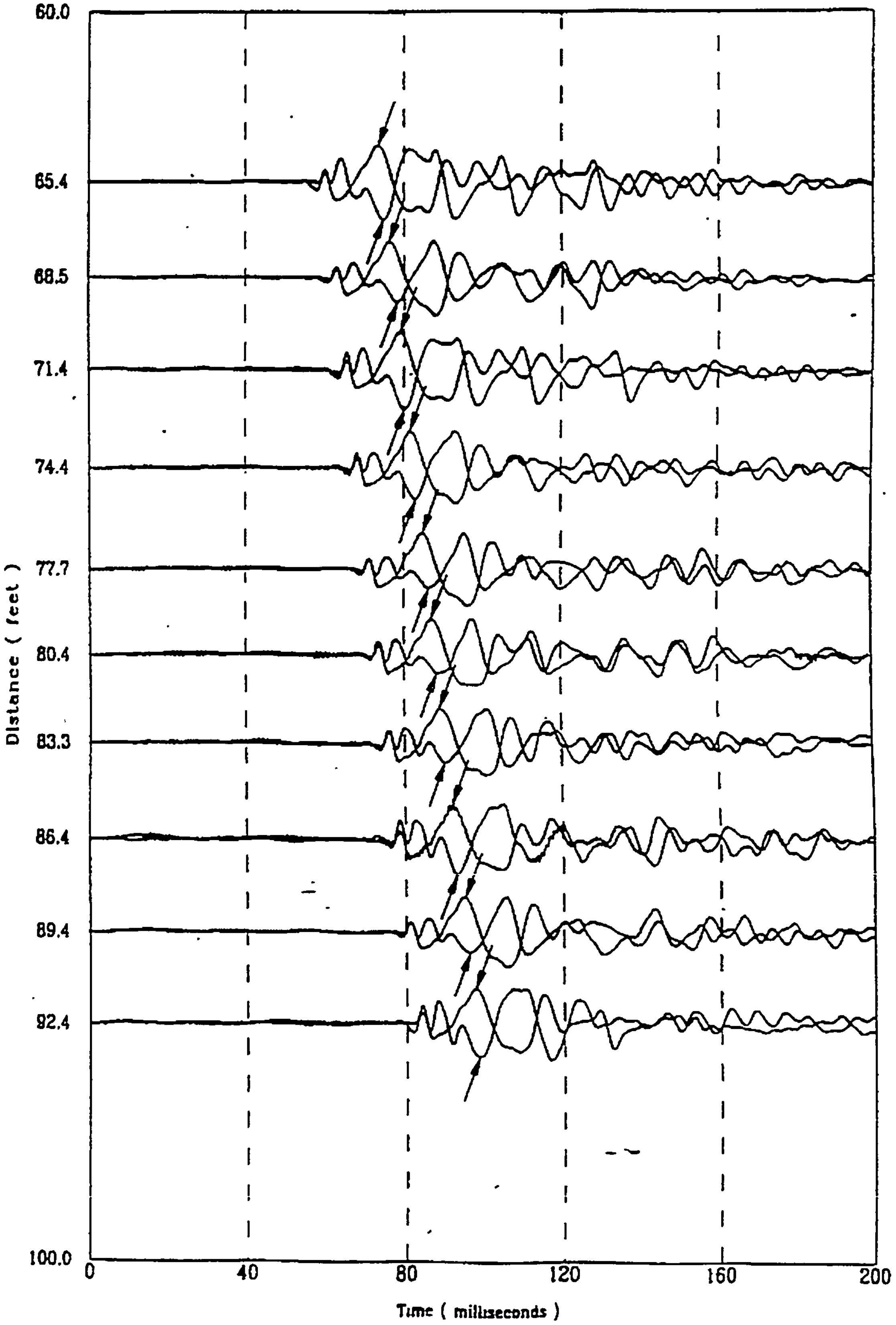
S Wave
10/27/97



File 32707045

A -61

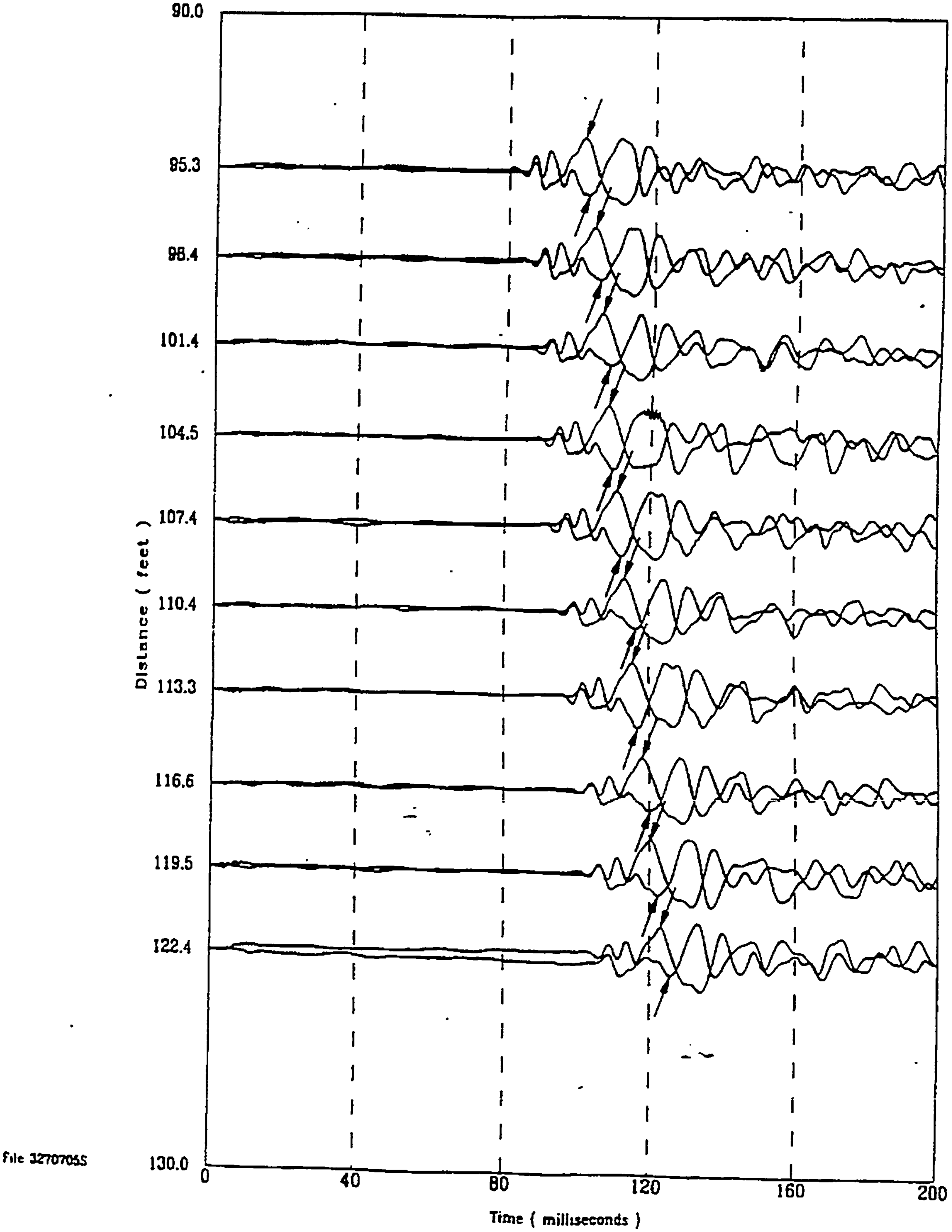
Applied Research Associates Inc. S Wave
HTEF-C05 10/27/97



File 3270704S

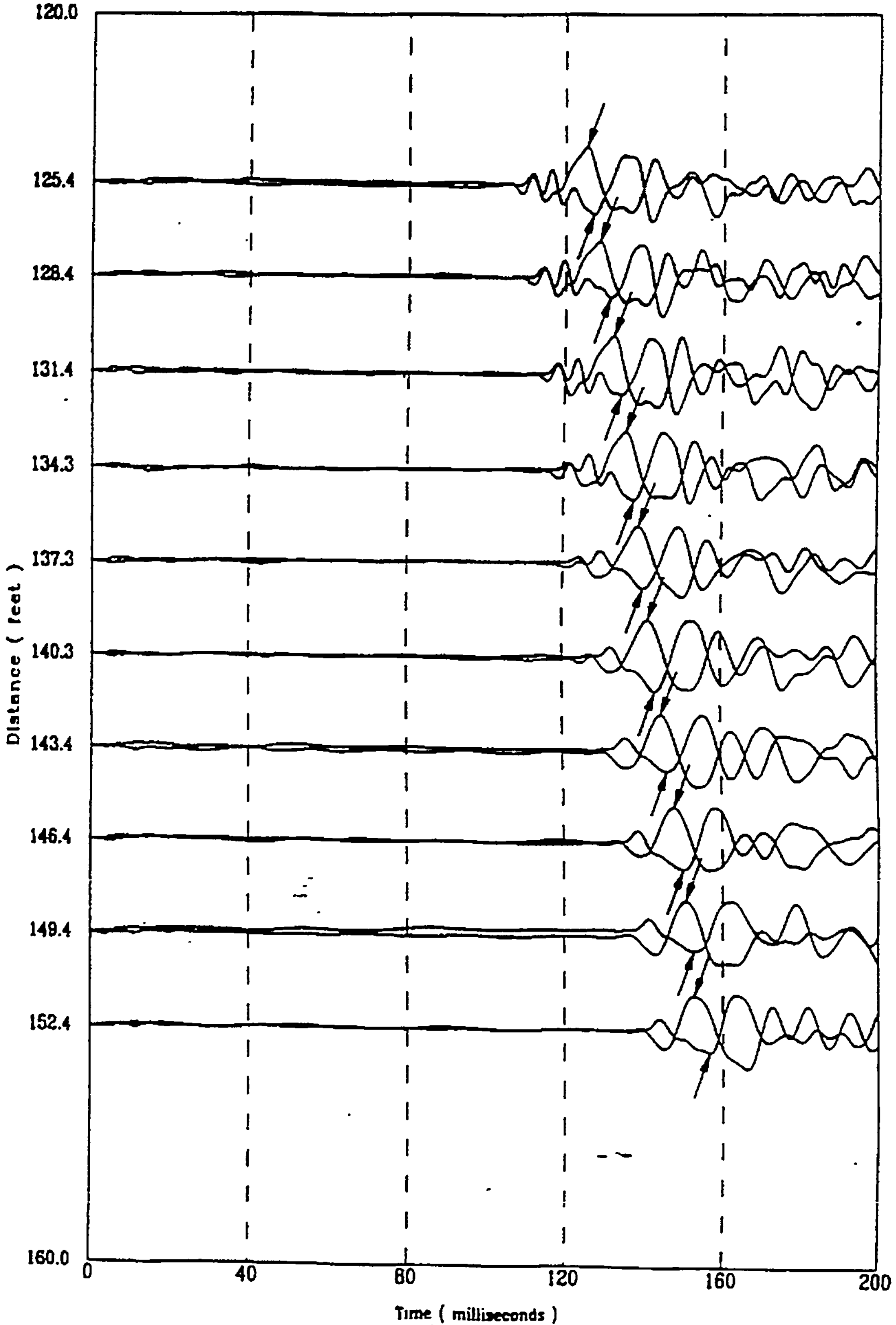
Applied Research Associates Inc.
HTEF-C05

S Wave
10/27/97



Applied Research Associates Inc.
HTEF-C05

S Wave
10/27/97

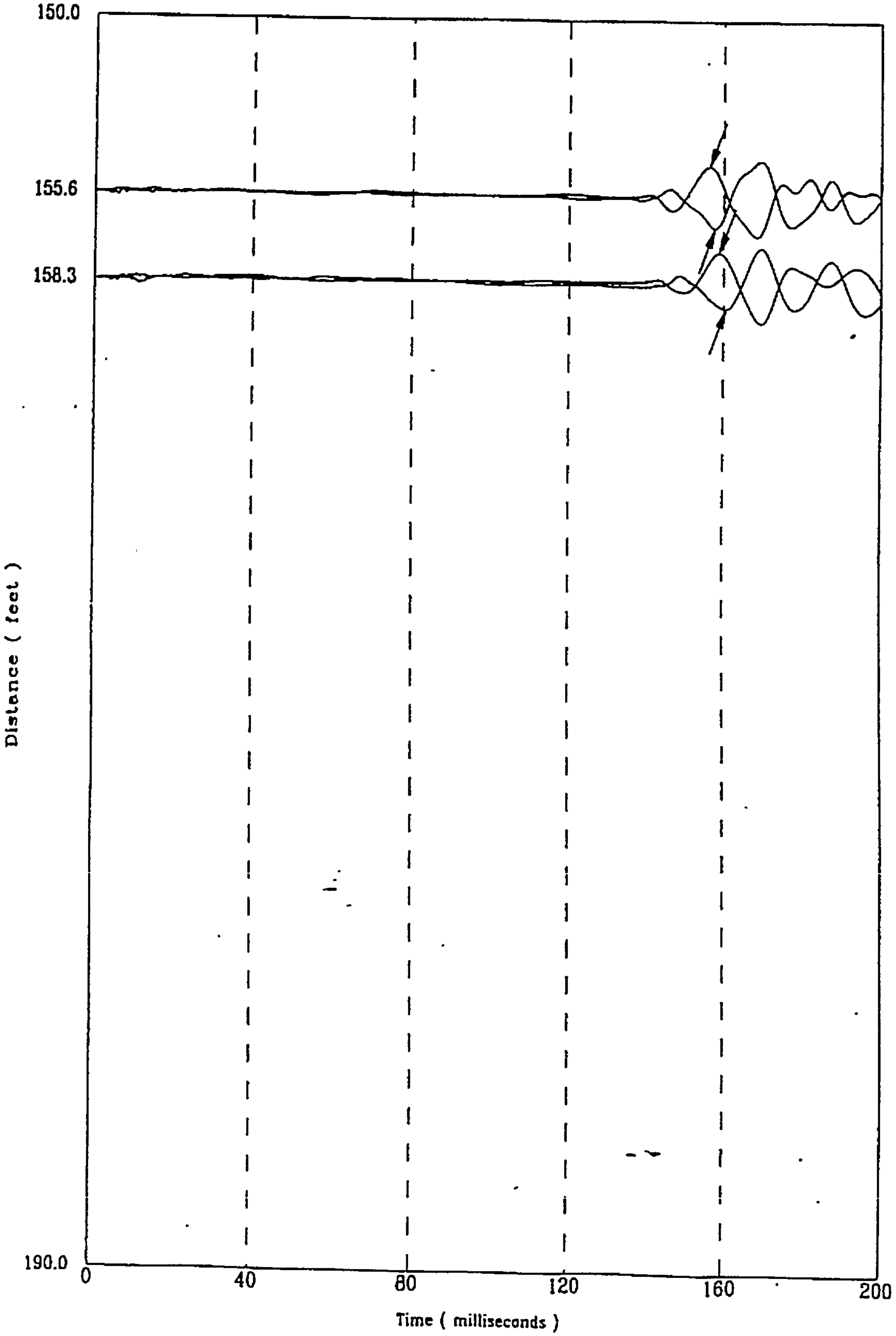


File 32707055

A-64

Applied Research Associates Inc.
HTEF-C05

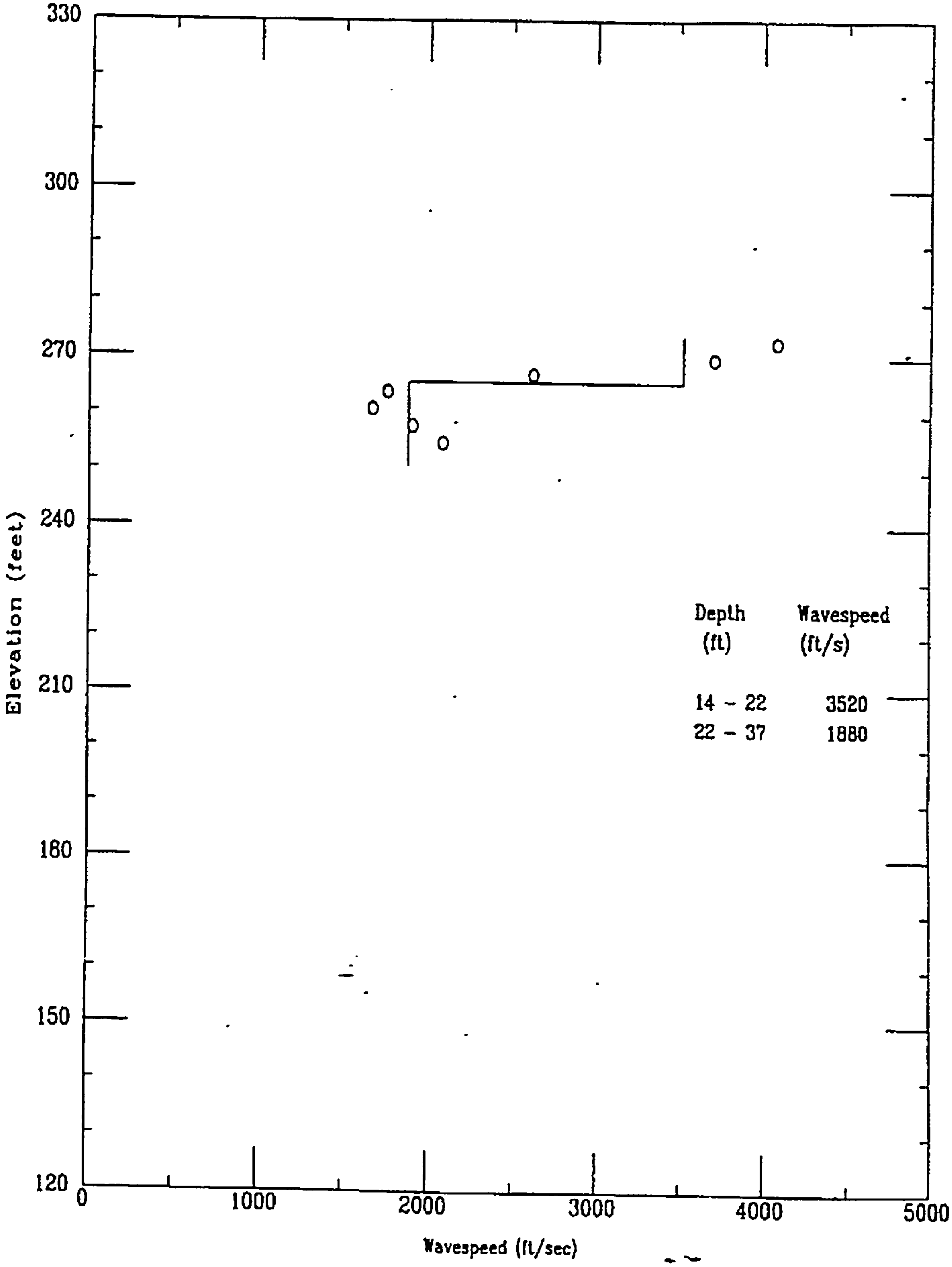
S Wave
10/27/97



File 3270705S

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

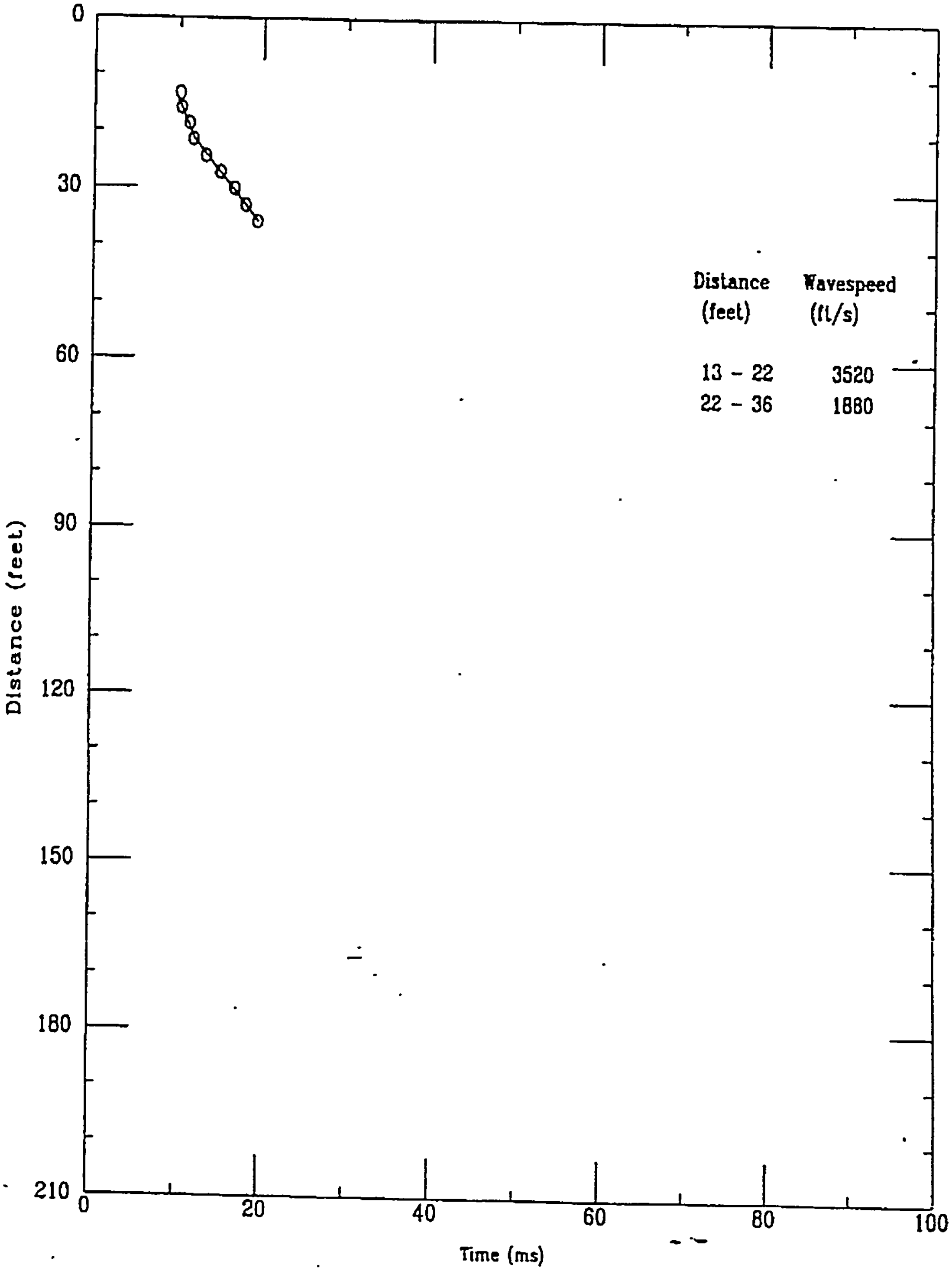
Compression Wave Speeds



File 3270704S

HTEF-C05 APPLIED RESEARCH ASSOCIATES, INC. 10/27/97

Compression Wave Time of Peak

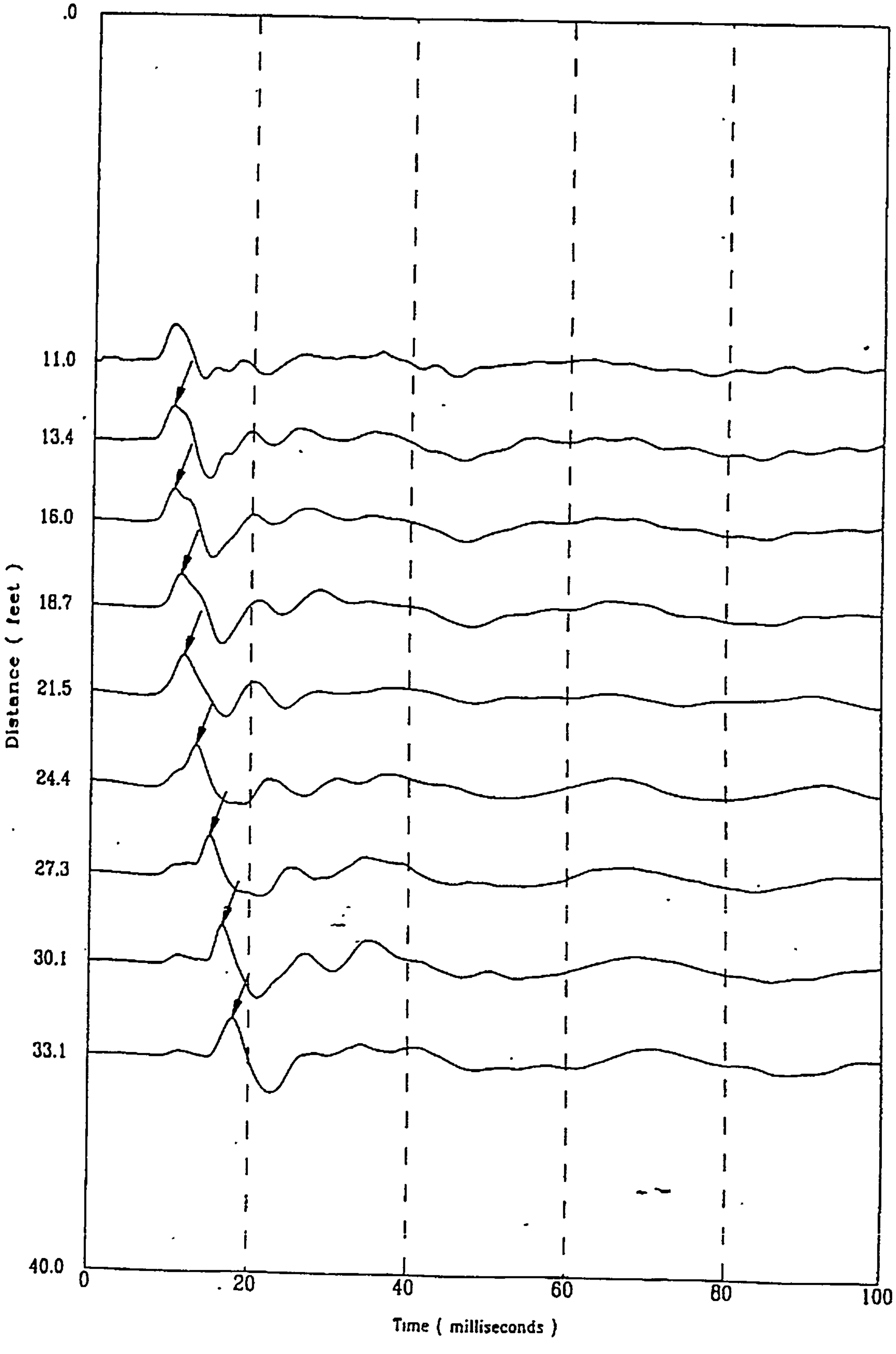


Distance (feet)	Wavespeed (ft/s)
13 - 22	3520
22 - 36	1880

File 3270704S

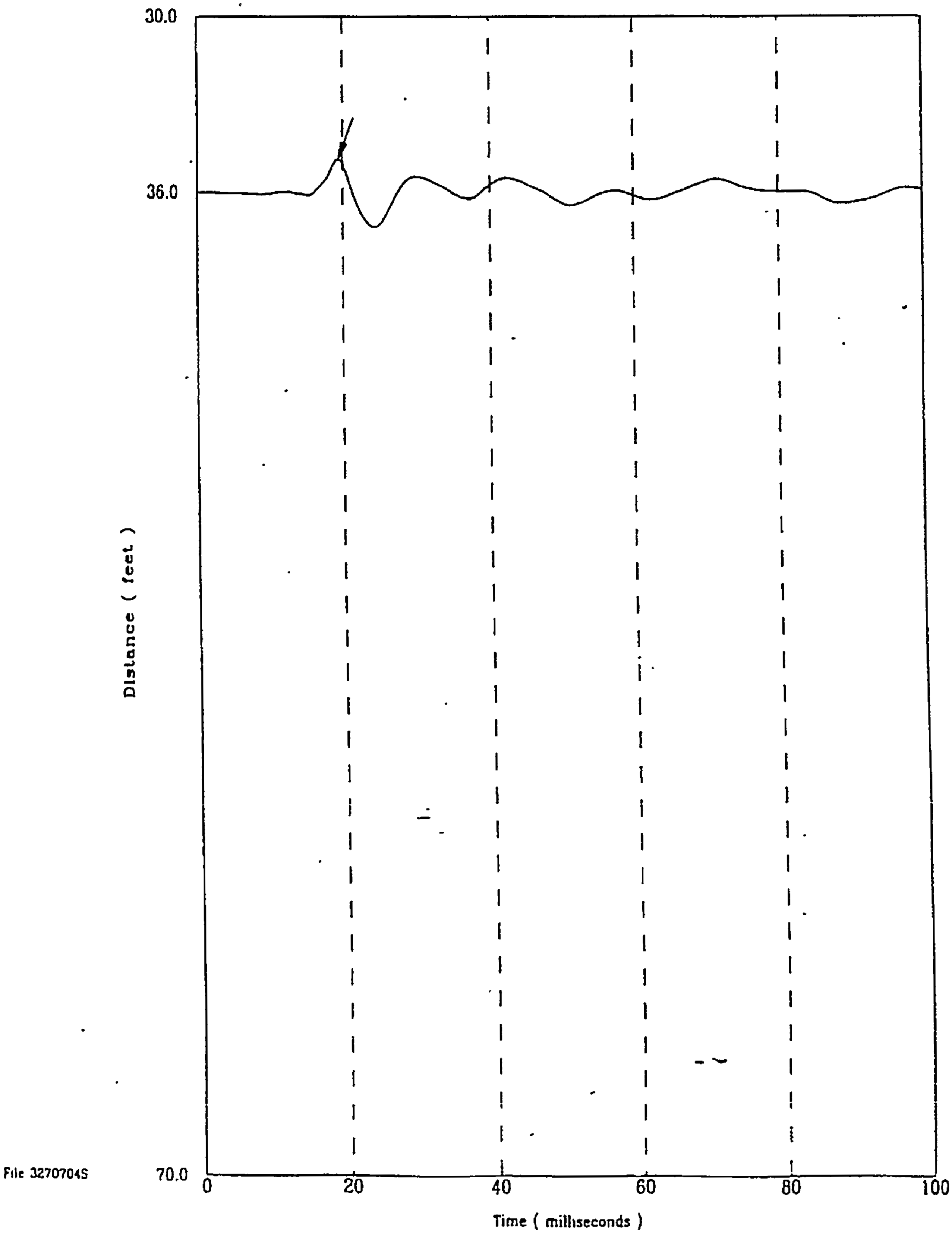
Applied Research Associates Inc.
HTEF-C05

P Wave
10/27/97



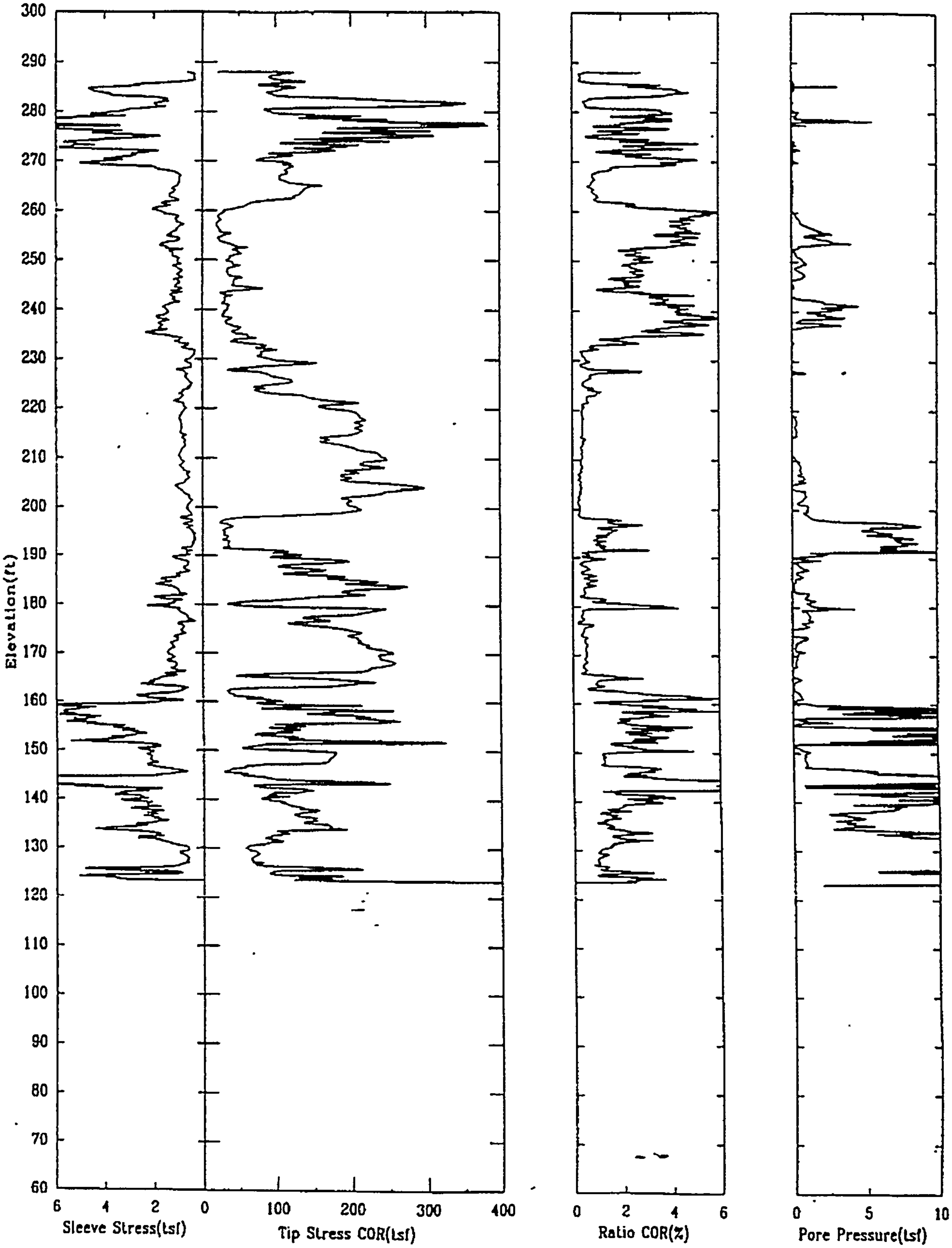
File 3270704S

Applied Research Associates Inc. P Wave
HTEF-C05 10/27/97



HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

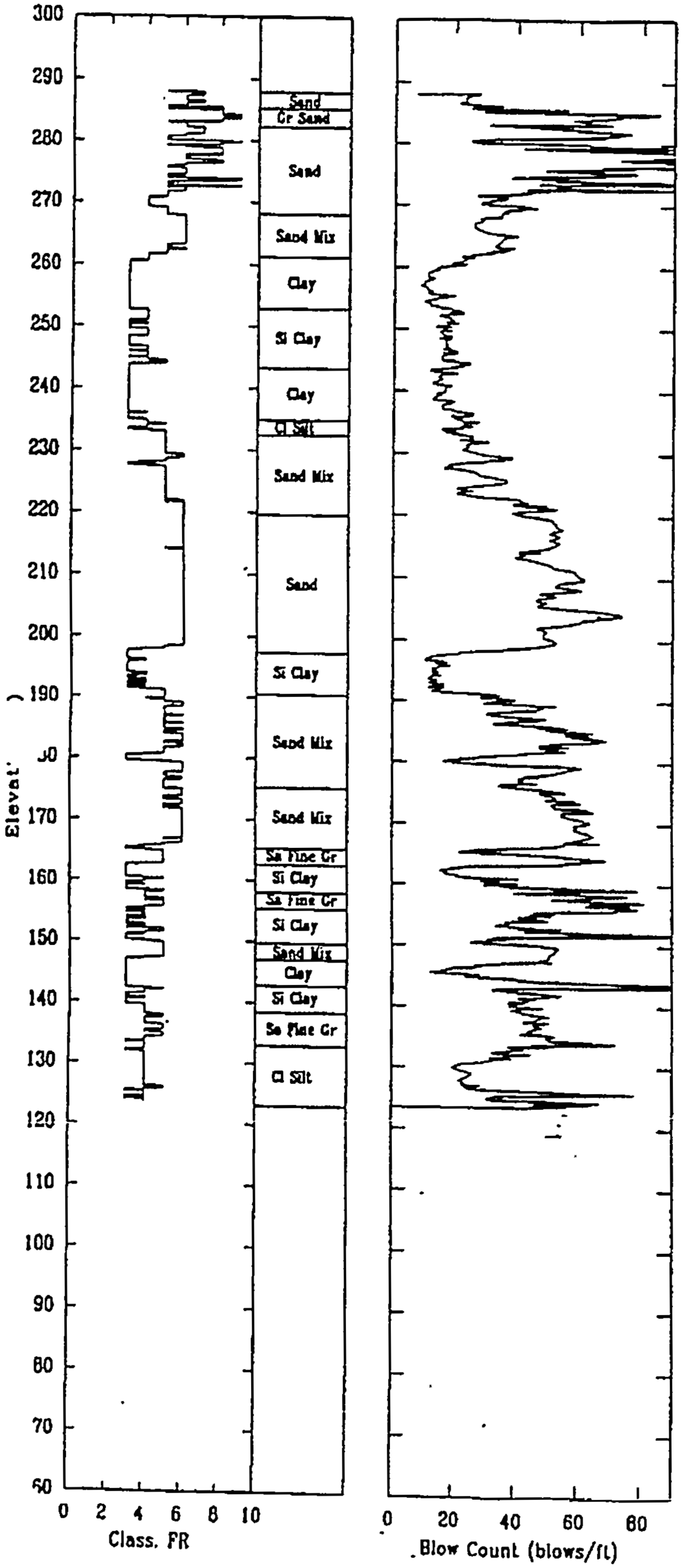
North 73301.0 East 61736.0 Elevation 294.1



File 3240701.ECP

HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

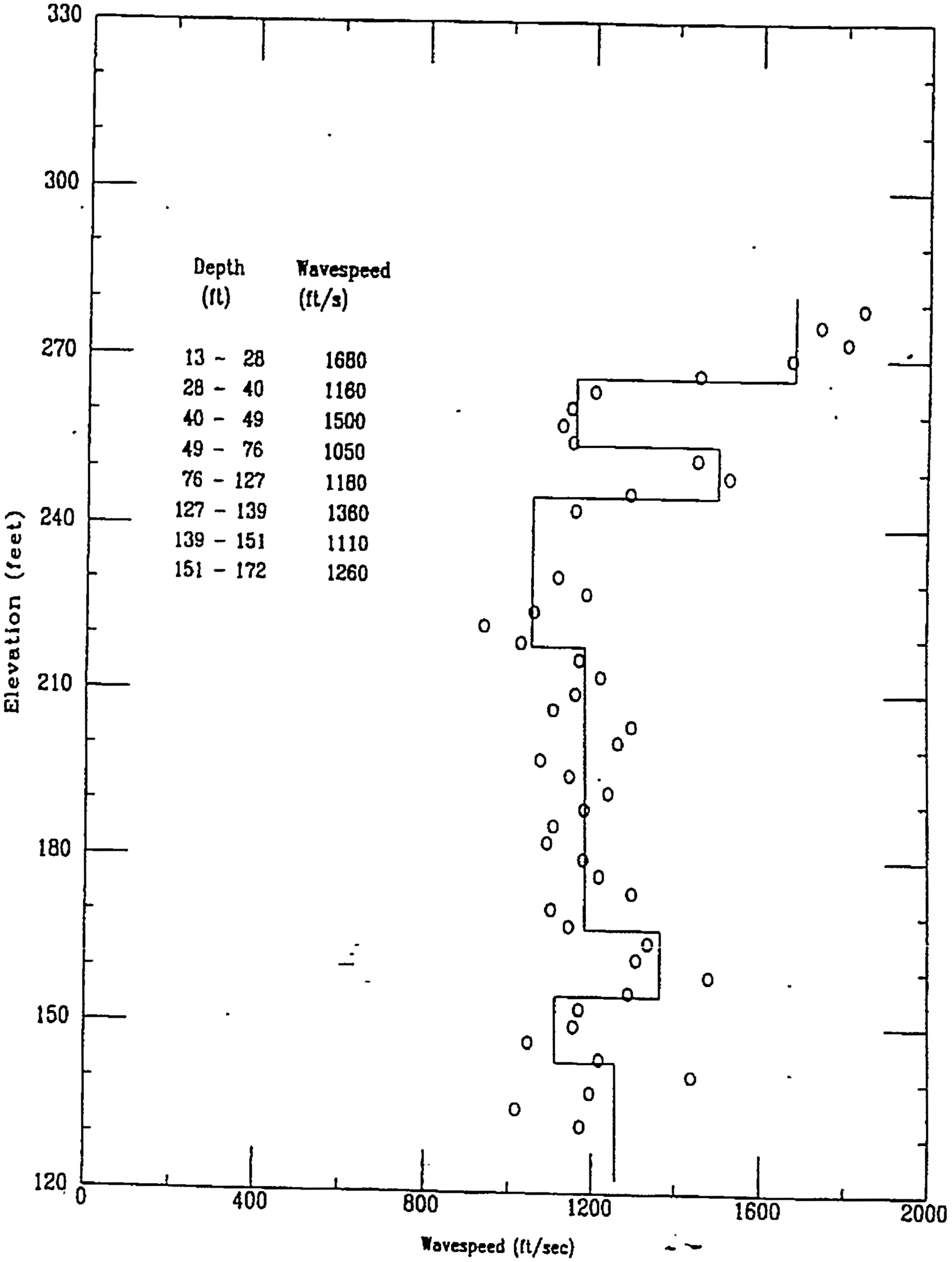
North 73301.0 East 61736.0 Elevation 294.1



File 3240701.ECP

HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

Shear Wave Speeds



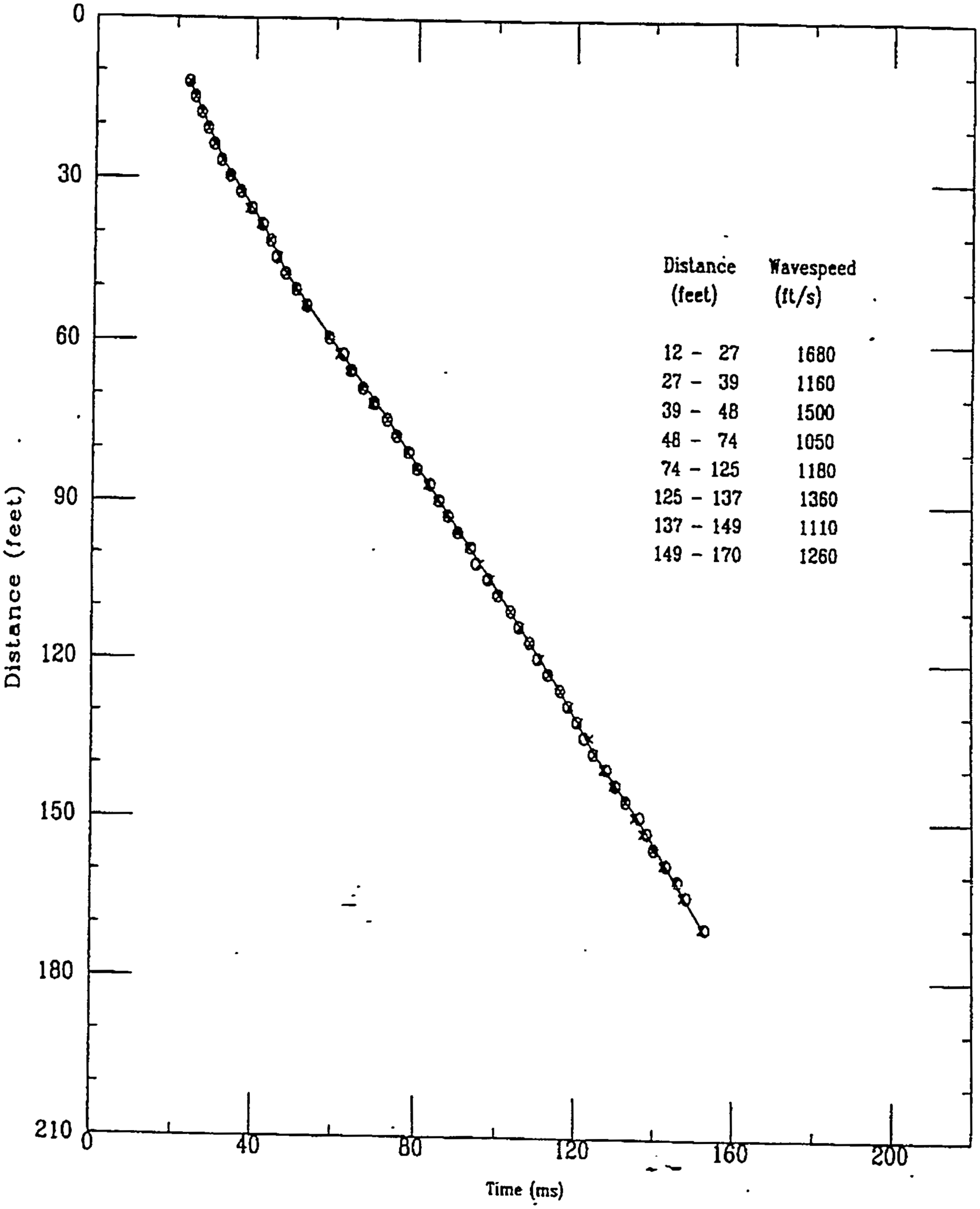
Depth (ft)	Wavespeed (ft/s)
13 - 28	1680
28 - 40	1160
40 - 49	1500
49 - 76	1050
76 - 127	1180
127 - 139	1360
139 - 151	1110
151 - 172	1260

File 3240701S

A-12

HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

Shear Wave Time of Peak

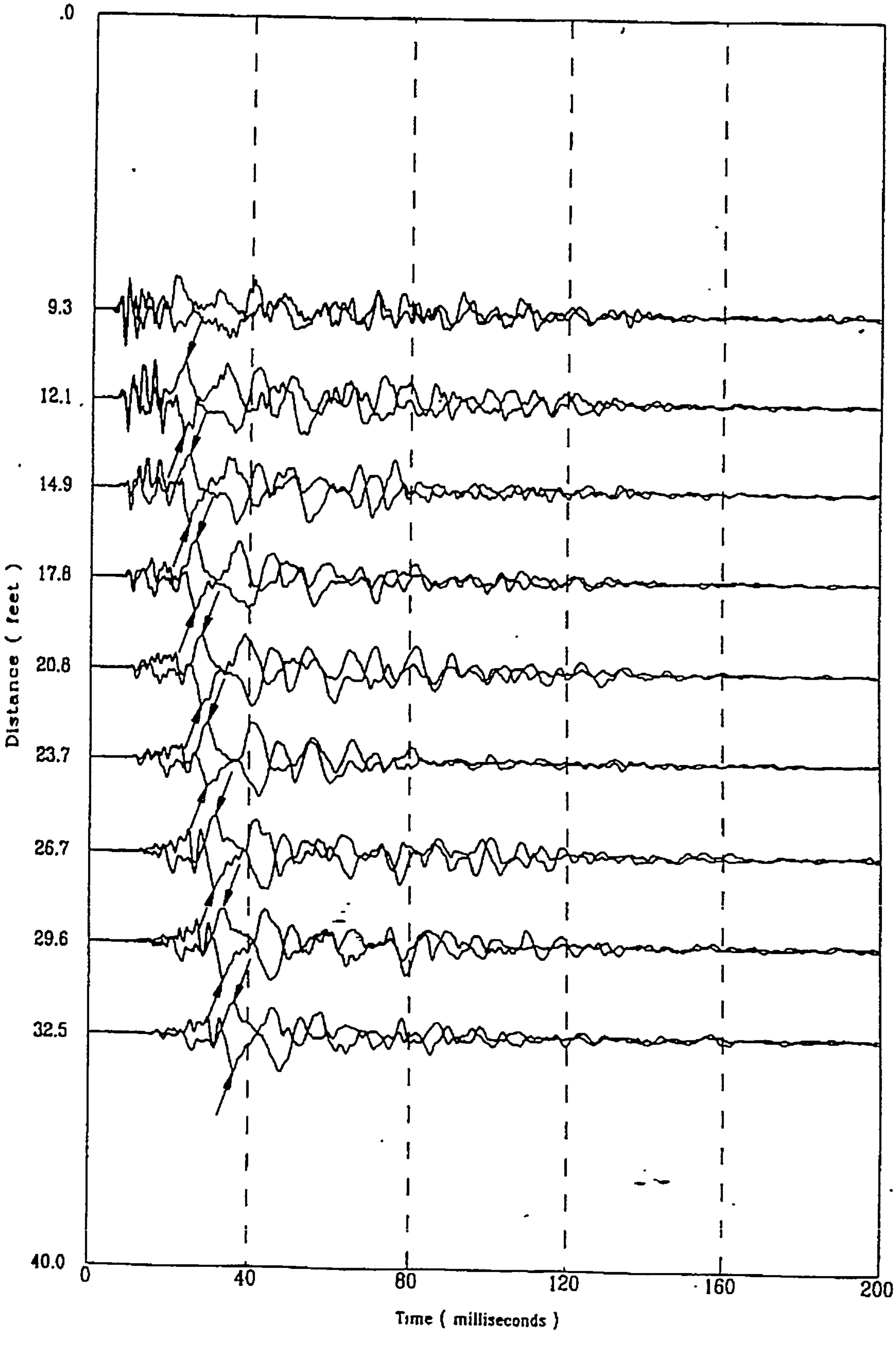


Distance (feet)	Wavespeed (ft/s)
12 - 27	1680
27 - 39	1160
39 - 48	1500
48 - 74	1050
74 - 125	1180
125 - 137	1360
137 - 149	1110
149 - 170	1260

File 3240701S

Applied Research Associates Inc.
HTEF-C06

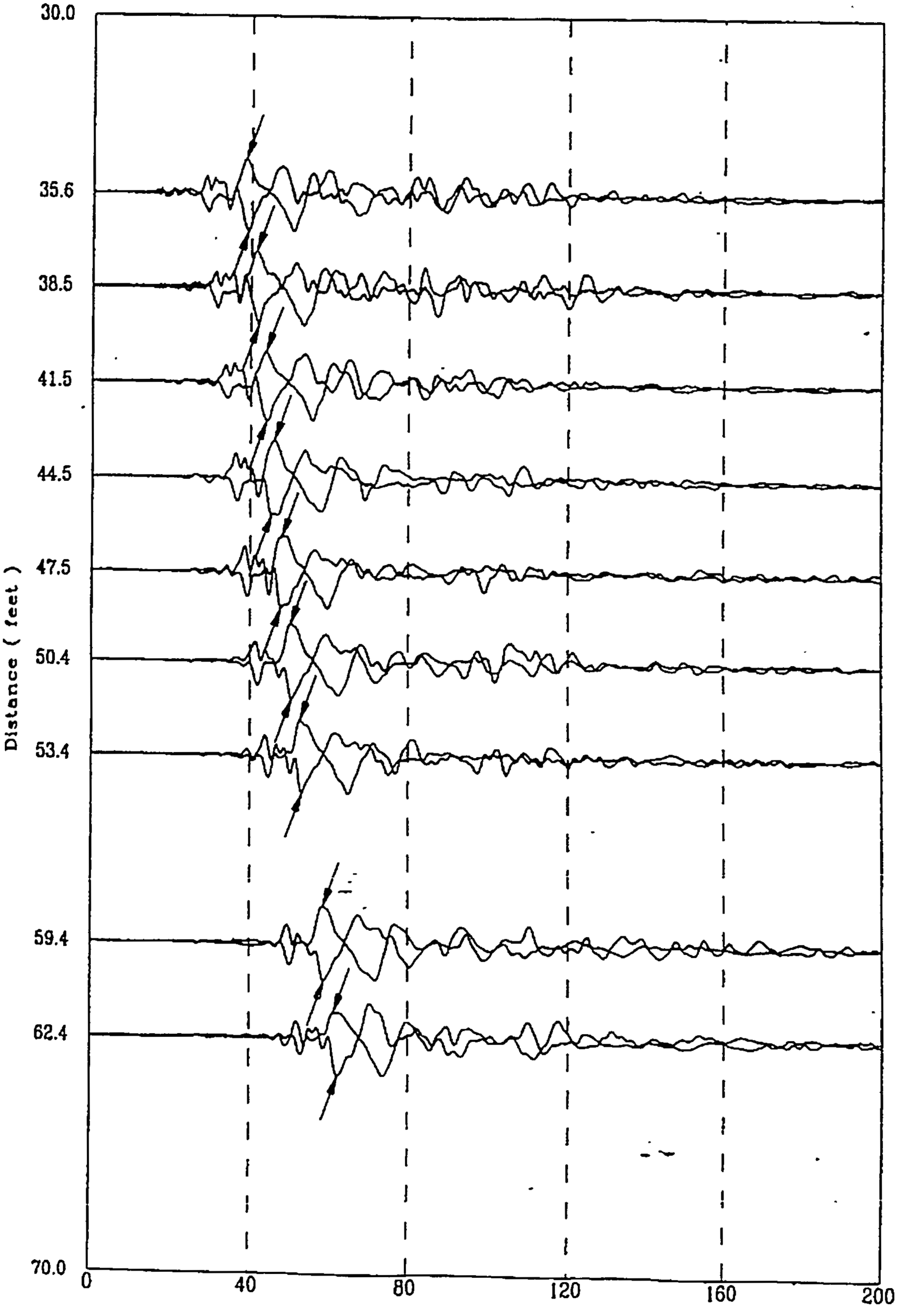
S Wave
10/24/97



File 32407015

Applied Research Associates Inc.
HTEF-C06

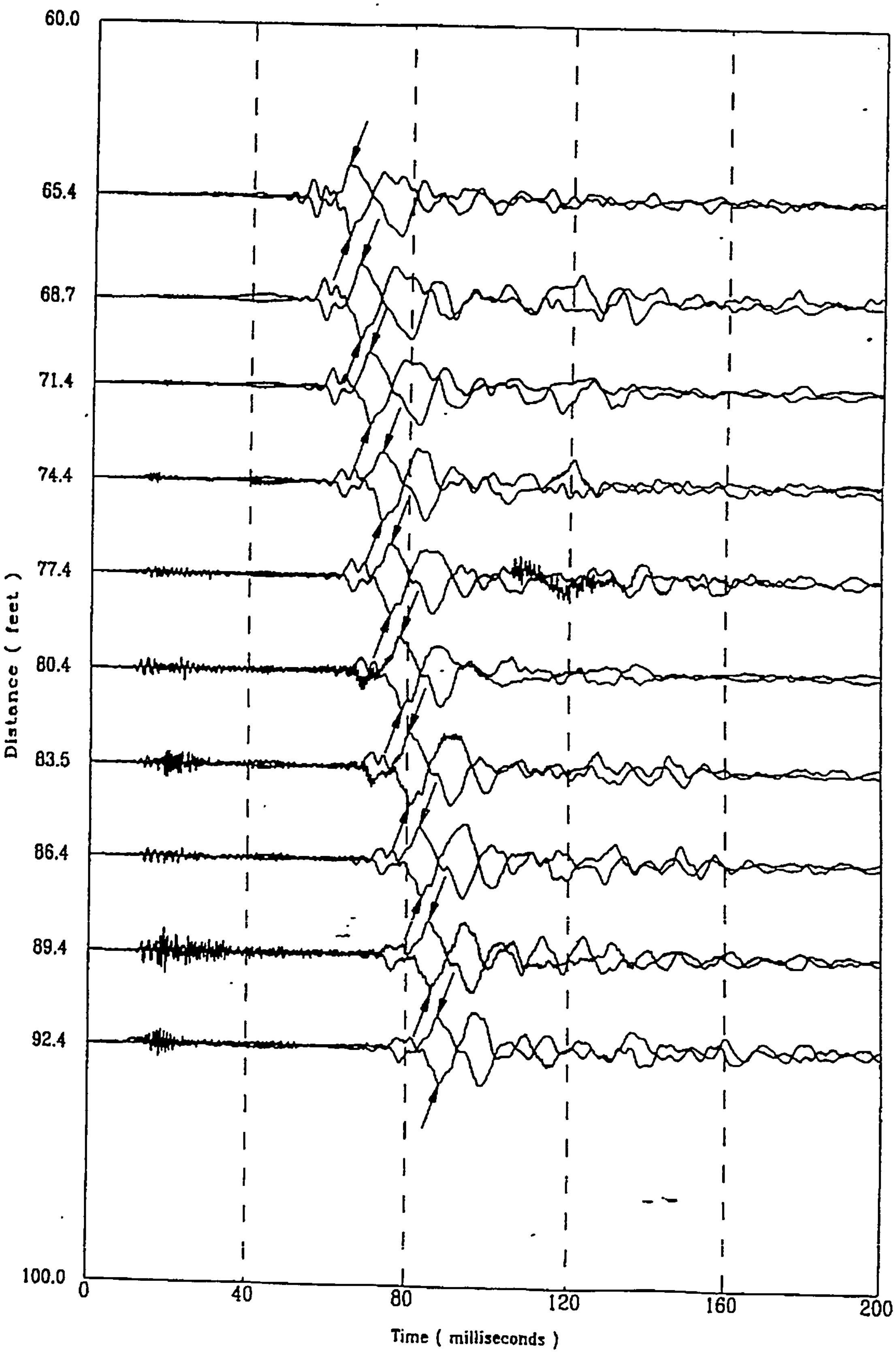
S Wave
10/24/97



File 3240701S

Applied Research Associates Inc.
HTEF-C06

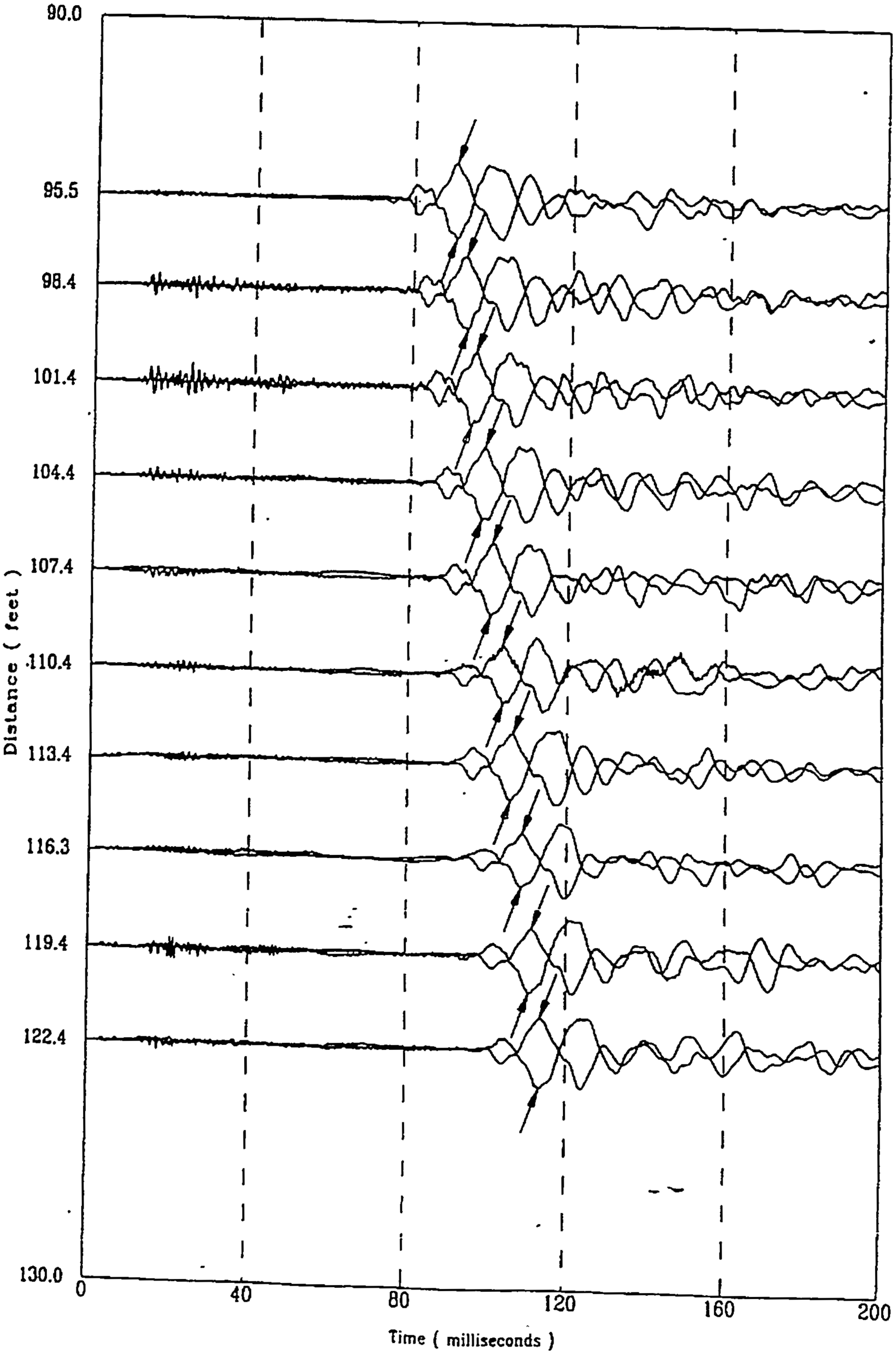
S Wave
10/24/97



File 32407015

Applied Research Associates Inc.
HTEF-C06

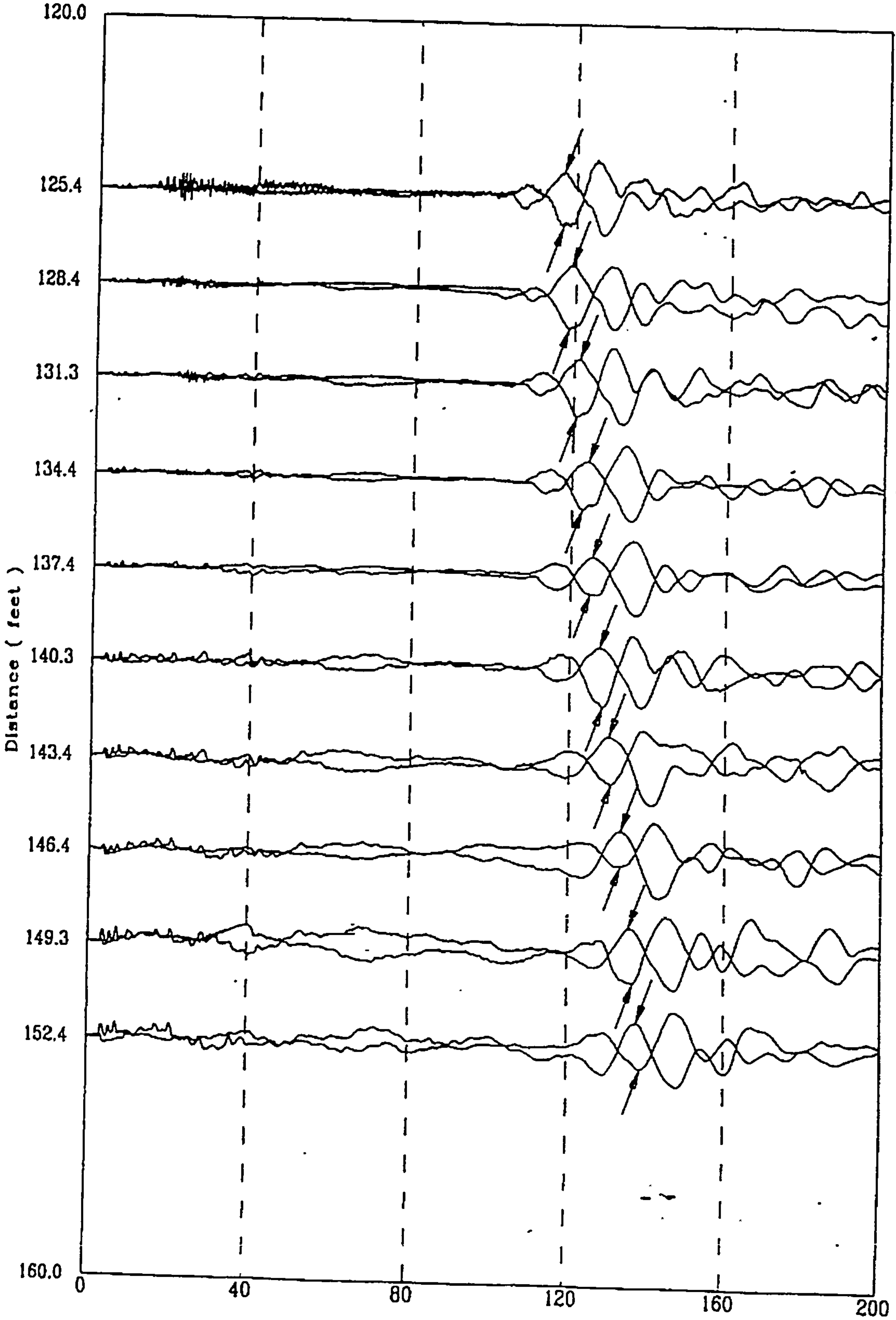
S Wave
10/24/97



File 3240702S

Applied Research Associates Inc.
HTEF-C06

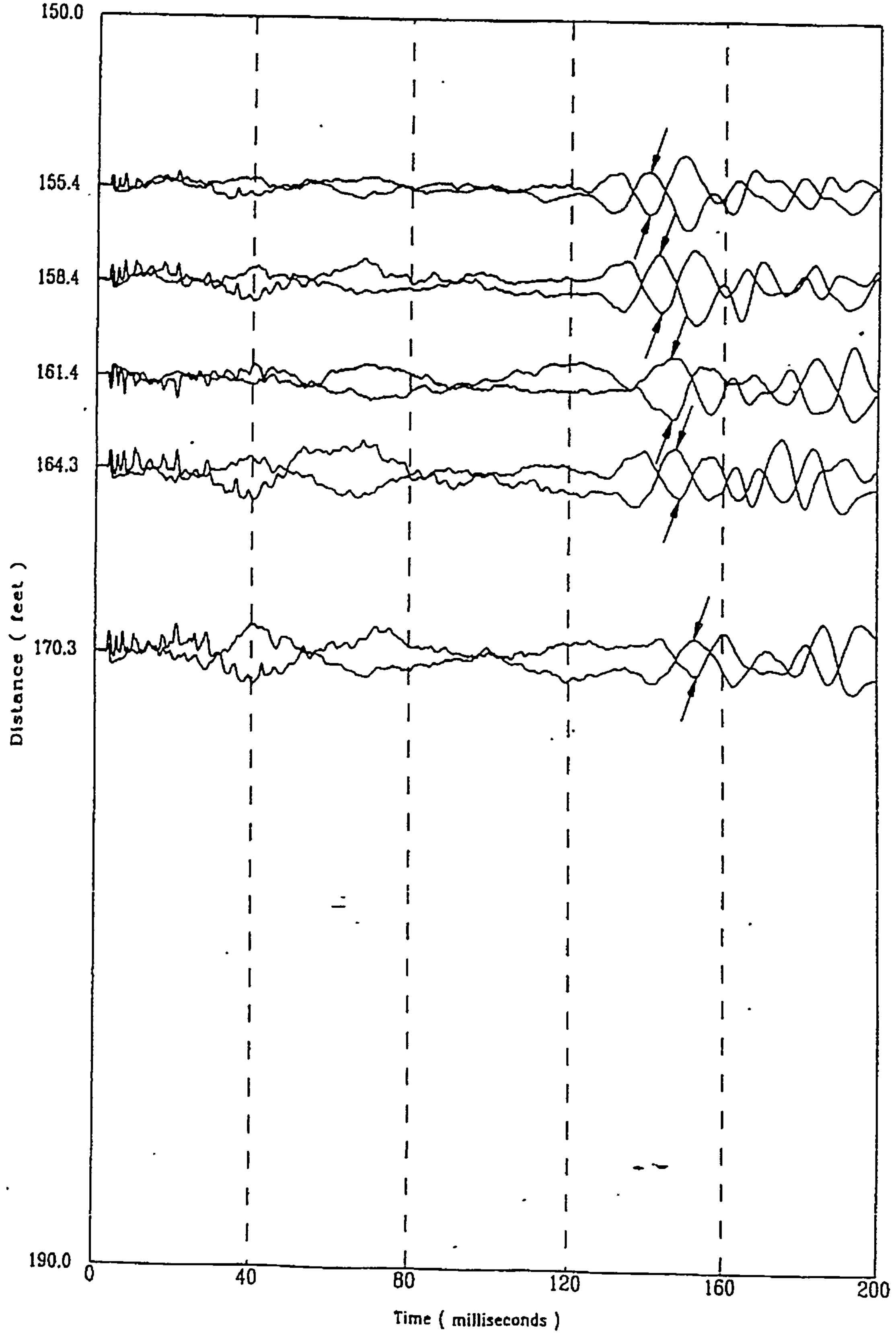
S Wave
10/24/97



ile 3240702S

Applied Research Associates Inc.
HTEF-C06

S Wave
10/24/97

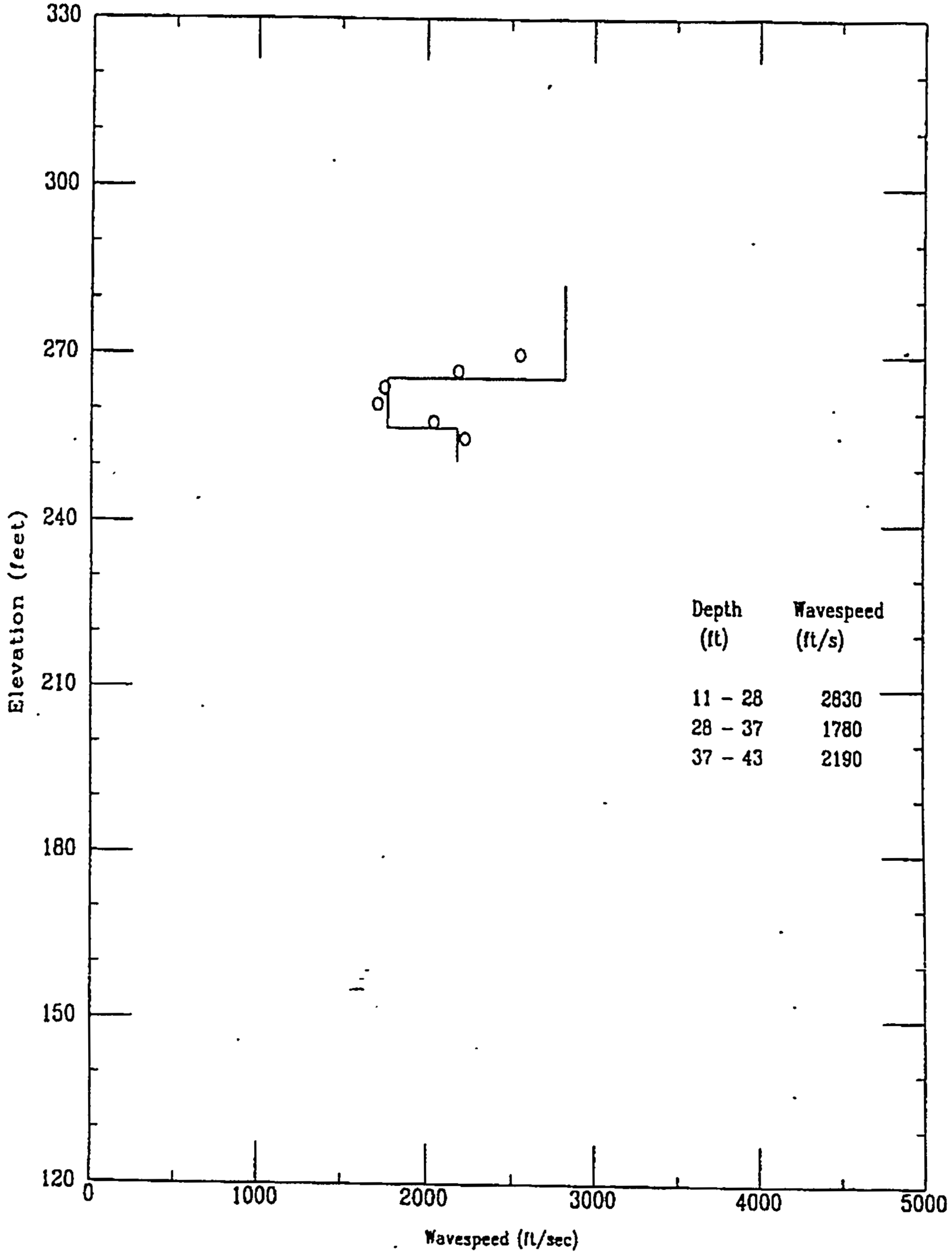


File 32407025

A-79

HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

Compression Wave Speeds

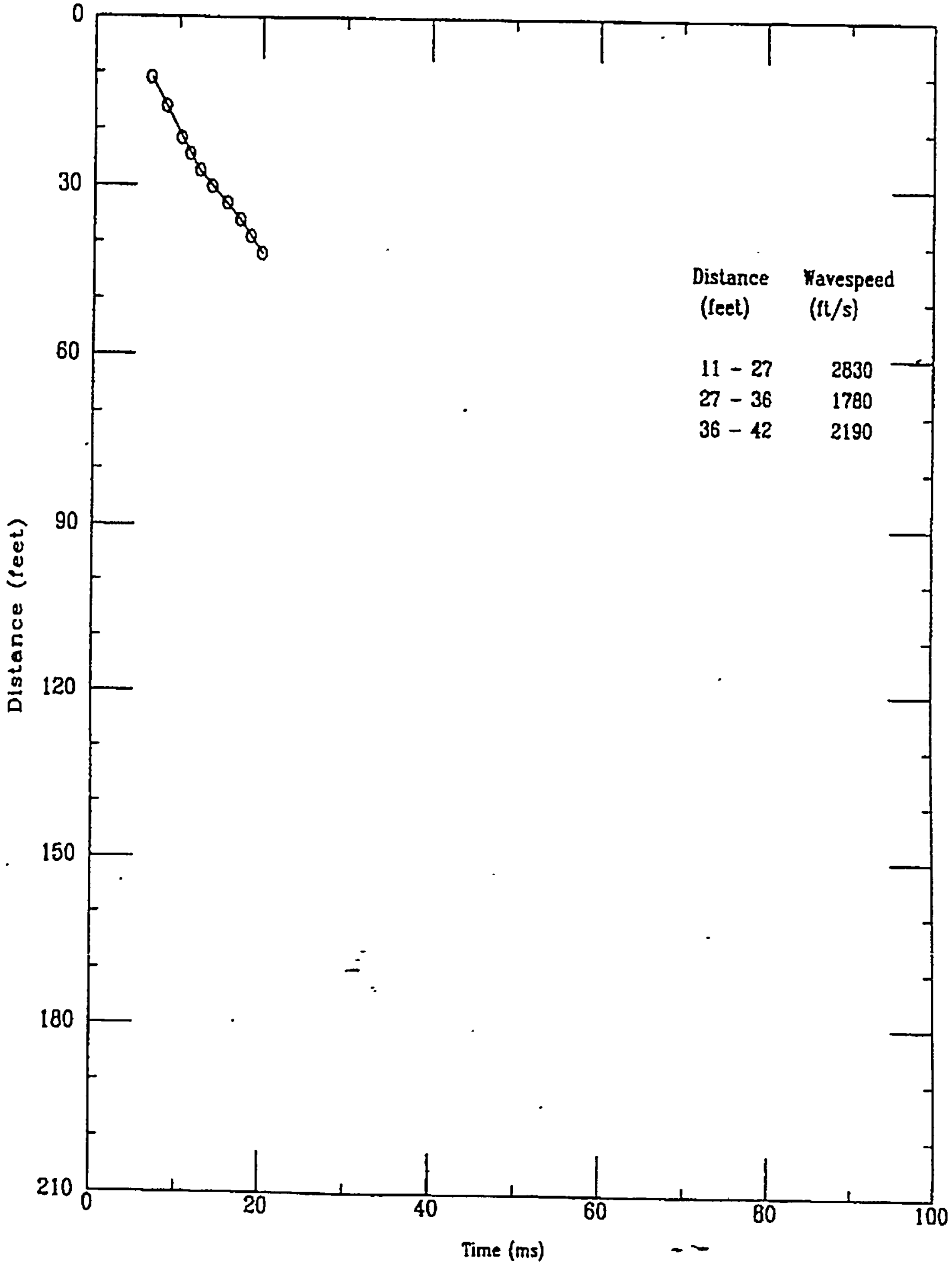


Depth (ft)	Wavespeed (ft/s)
11 - 28	2830
28 - 37	1780
37 - 43	2190

File 3240701S

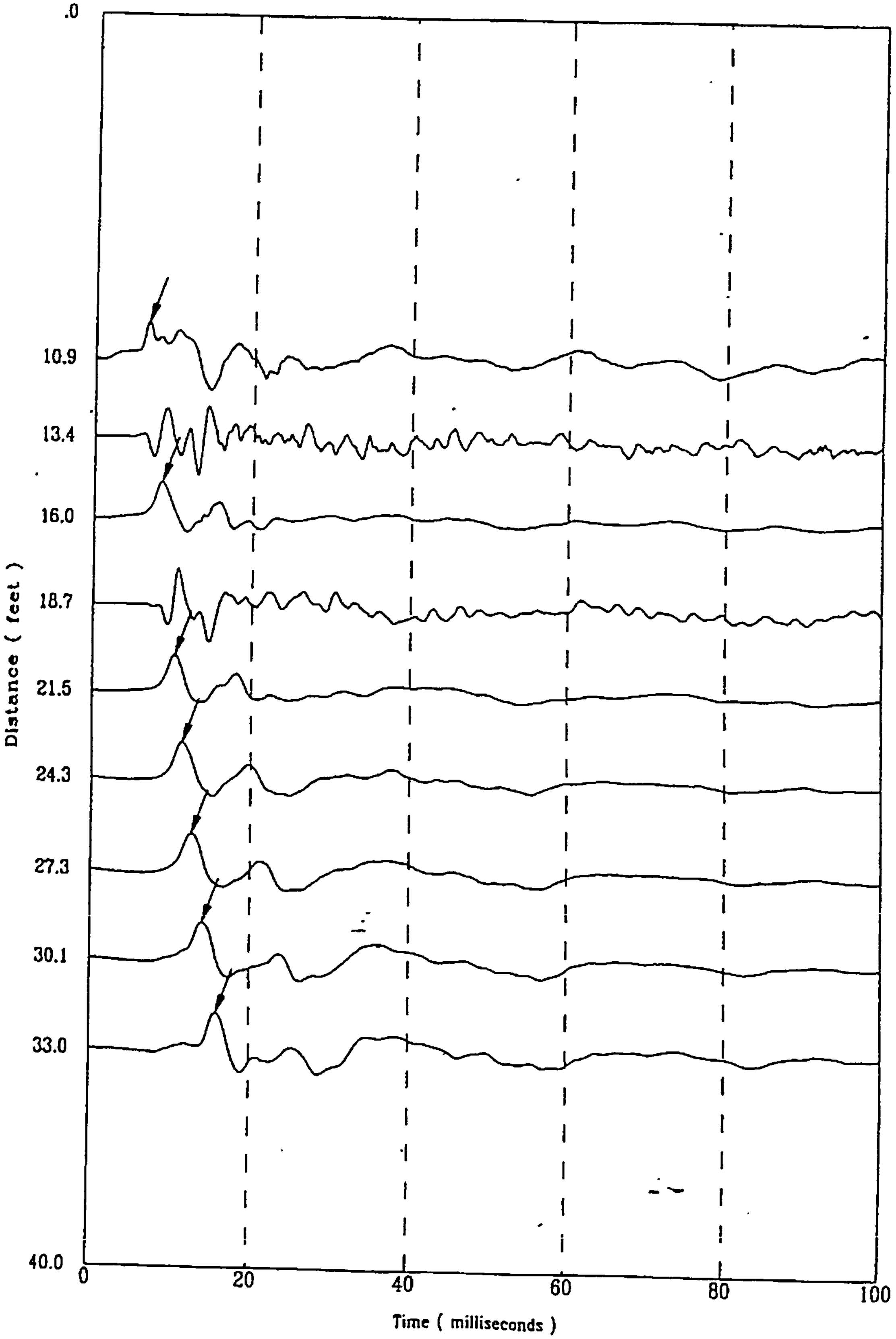
HTEF-C06 APPLIED RESEARCH ASSOCIATES, INC. 10/24/97

Compression Wave Time of Peak



Applied Research Associates Inc.
HTEF-C06

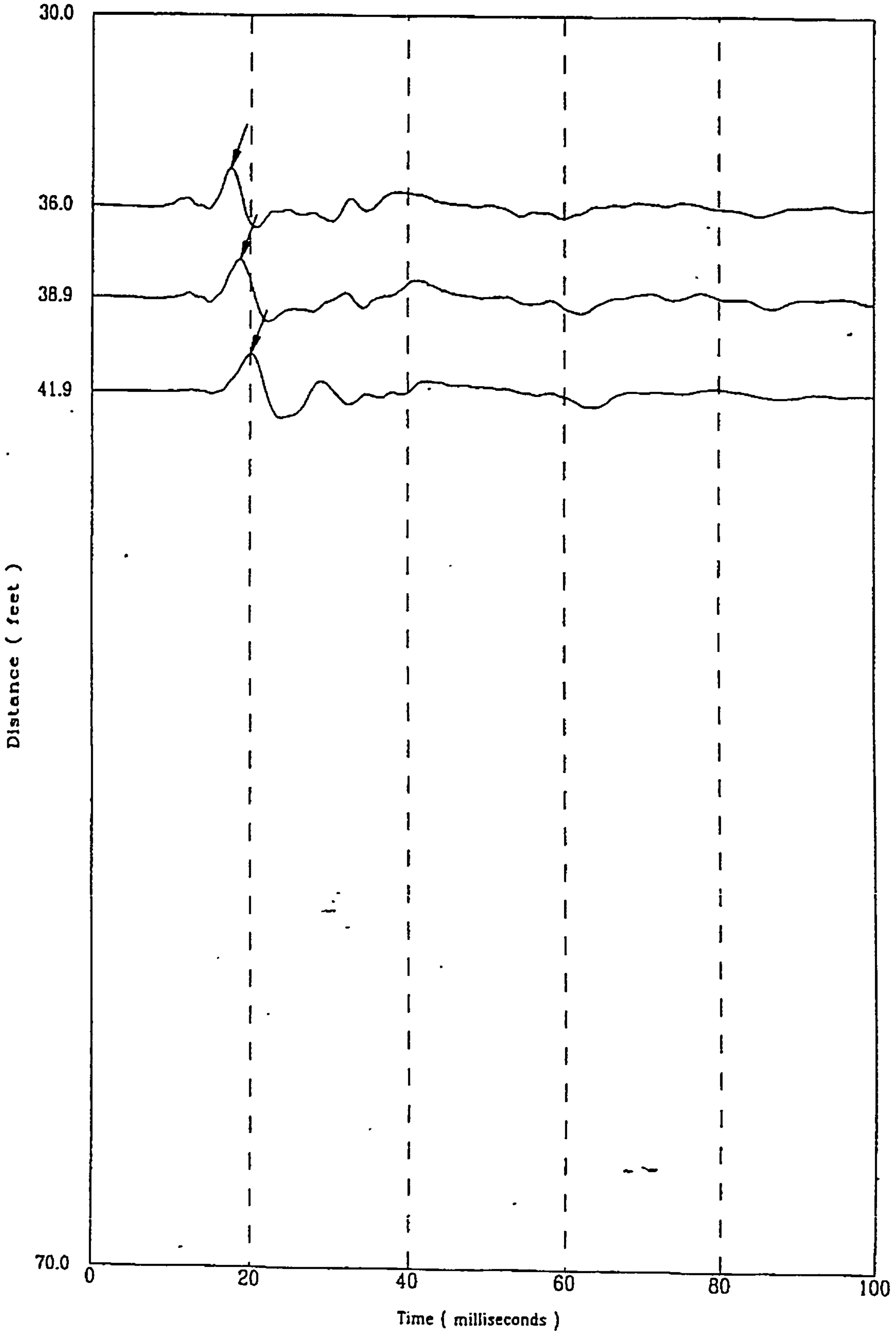
P Wave
10/24/97



le 3240701S

Applied Research Associates Inc.
HTEF-C06

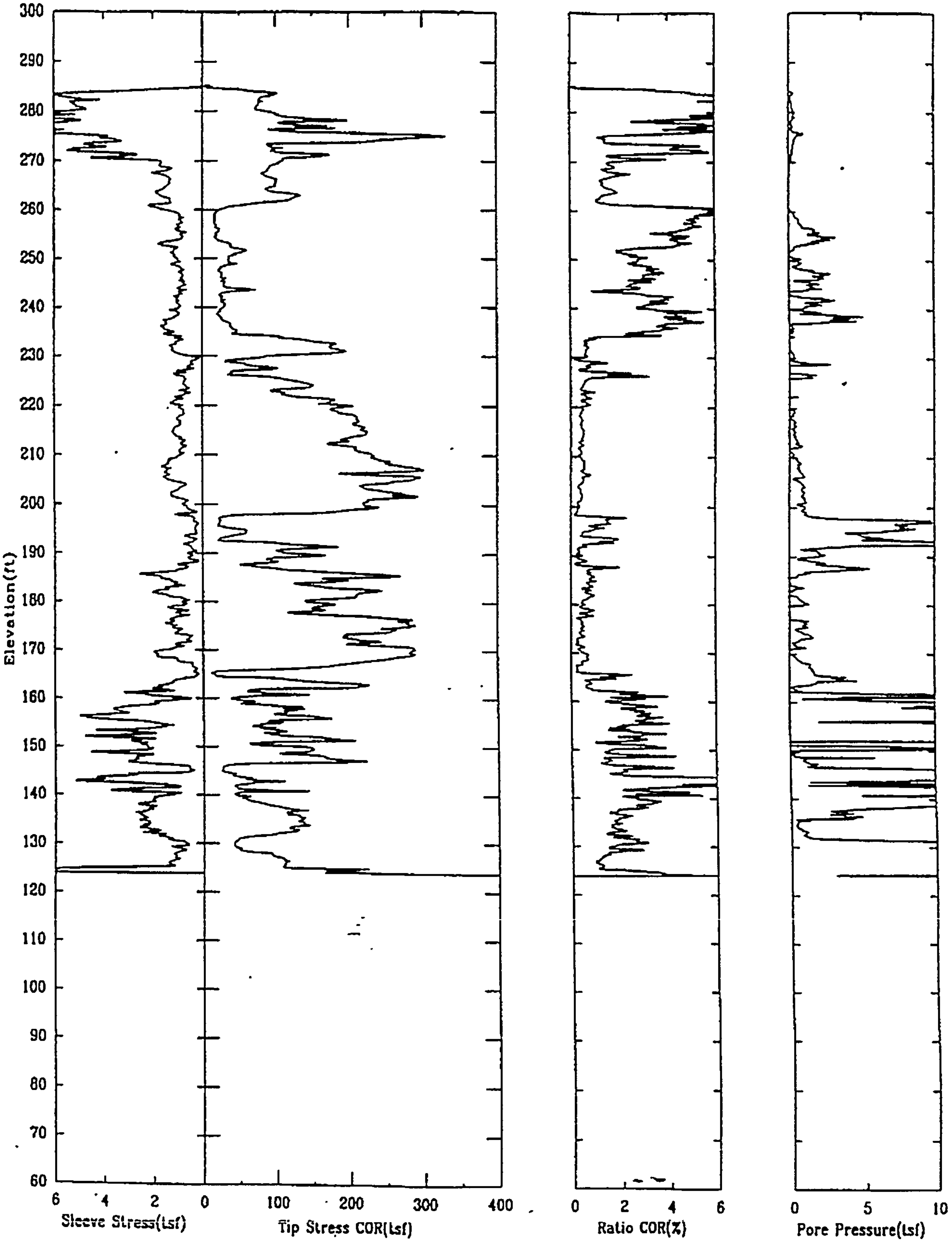
P Wave
10/24/97



File 3240701S

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

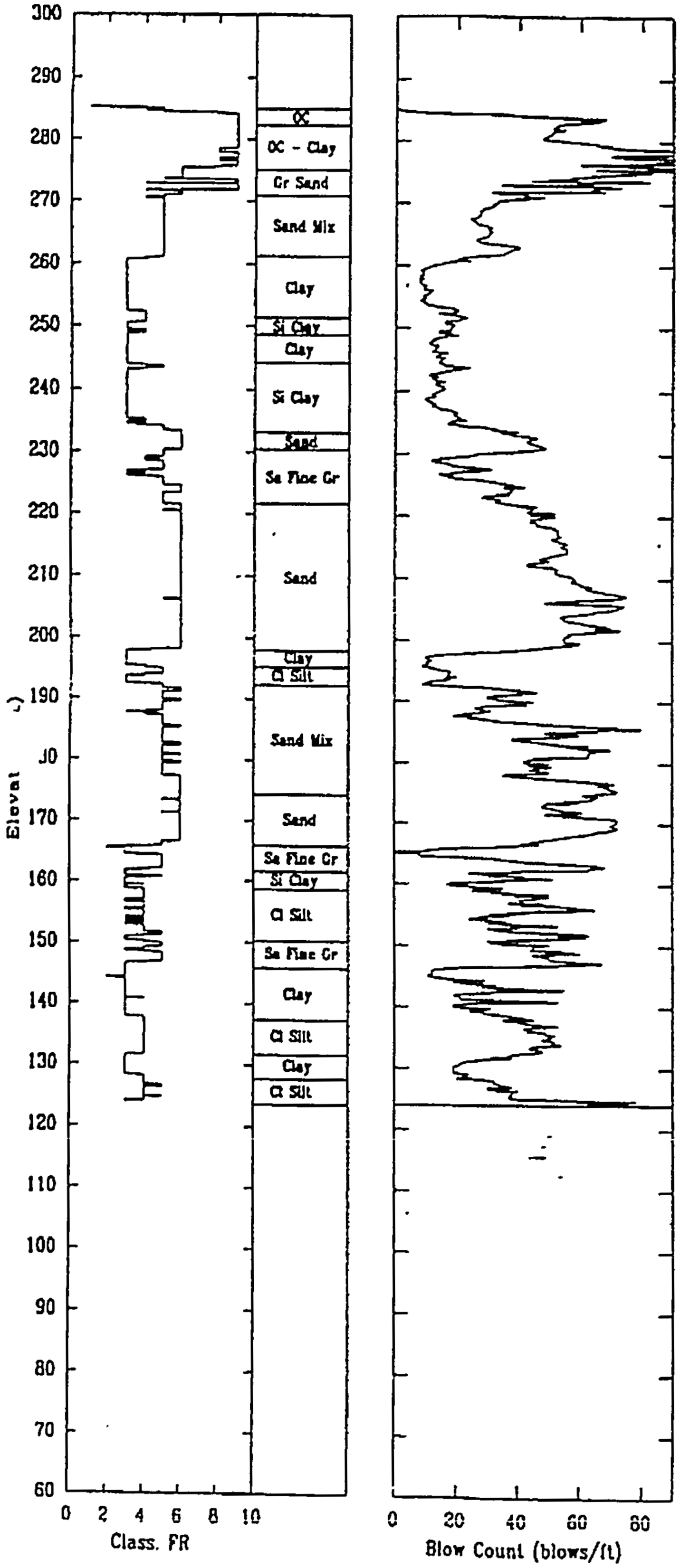
North 73390.0 East 61751.0 Elevation 291.2



File 3220704.ECP

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

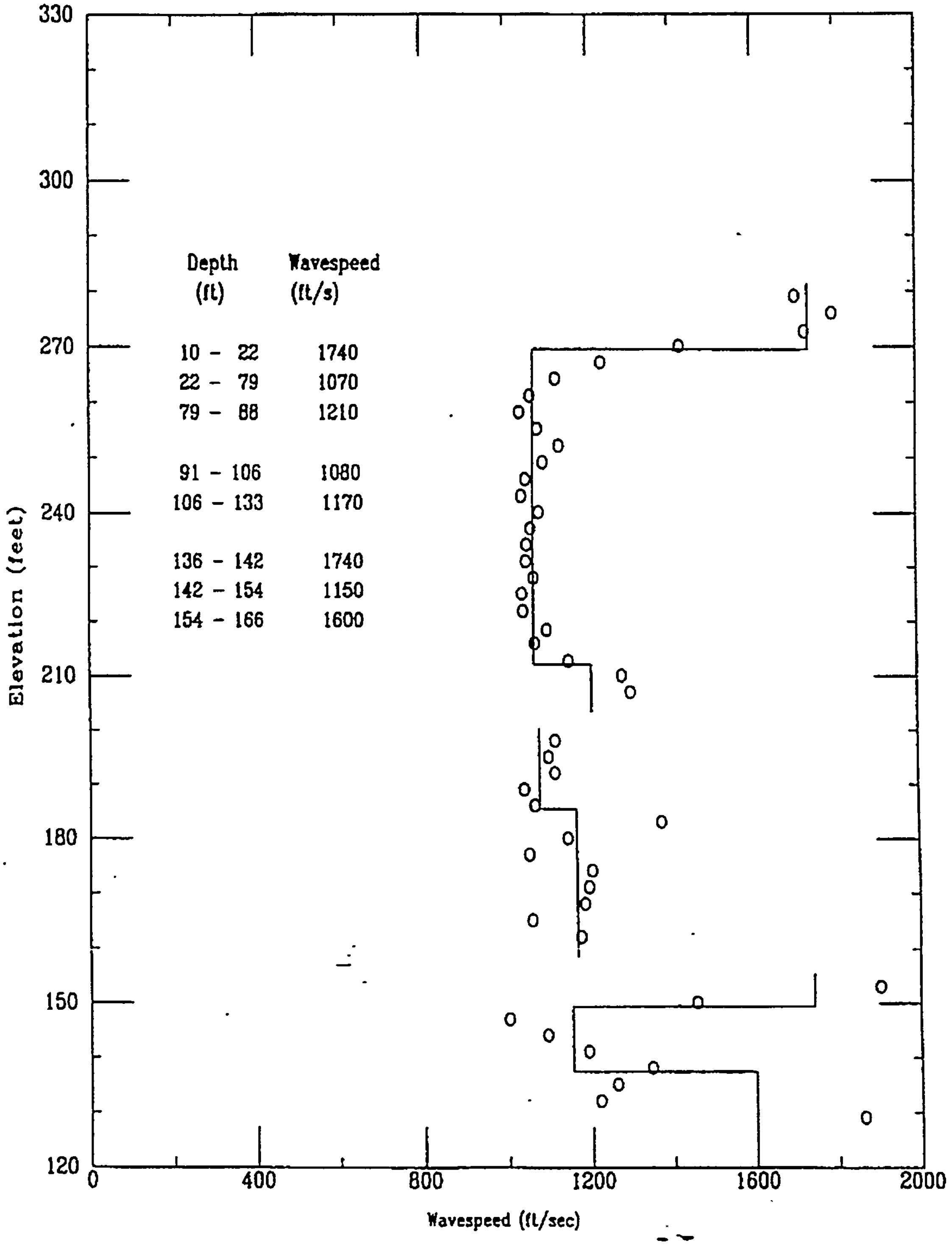
North 73390.0 East 61751.0 Elevation 291.2



File 3220704.ECP

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Shear Wave Speeds

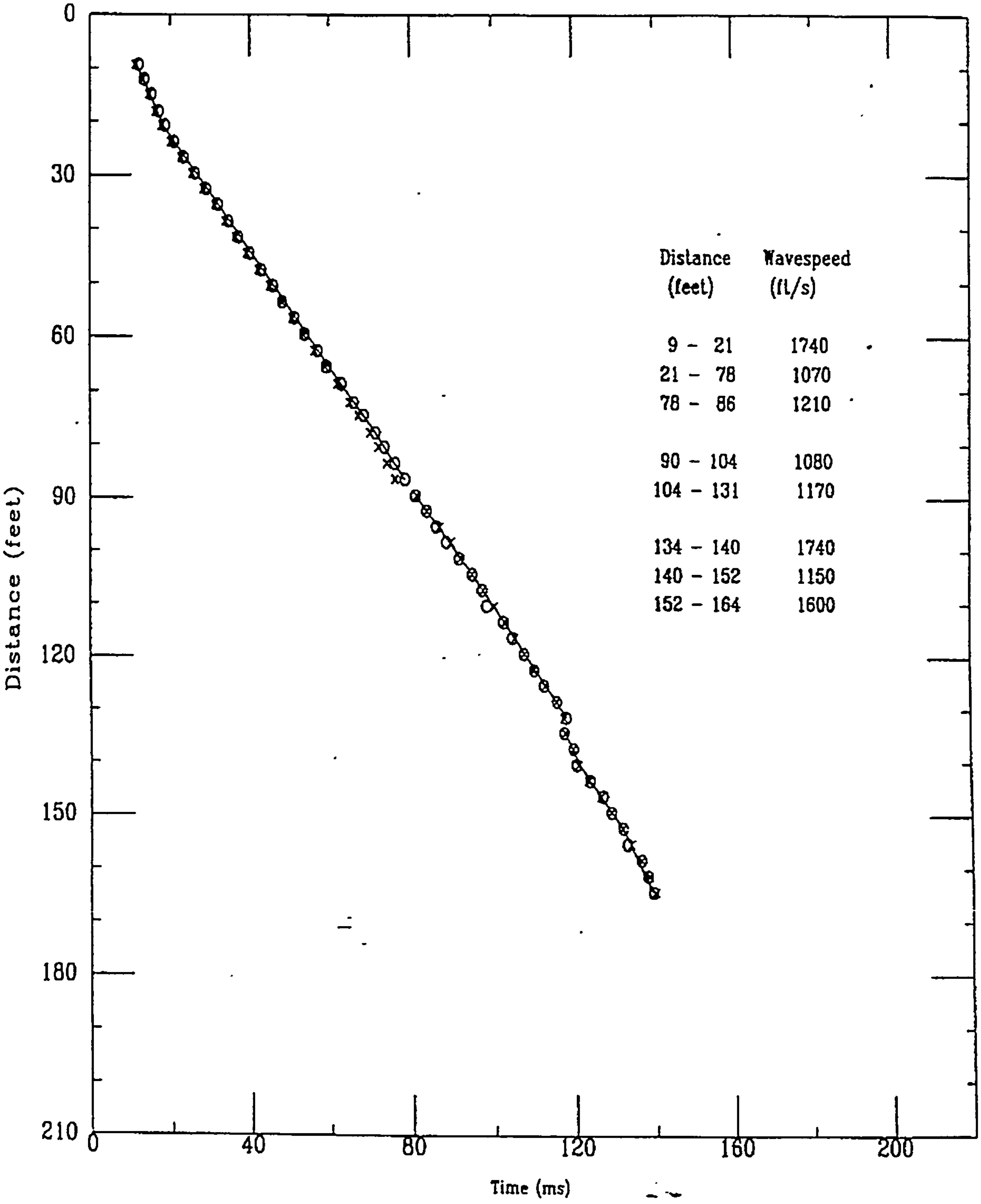


Depth (ft)	Wavespeed (ft/s)
10 - 22	1740
22 - 79	1070
79 - 88	1210
91 - 106	1080
106 - 133	1170
136 - 142	1740
142 - 154	1150
154 - 166	1600

File 3220704S

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Shear Wave Time of Peak

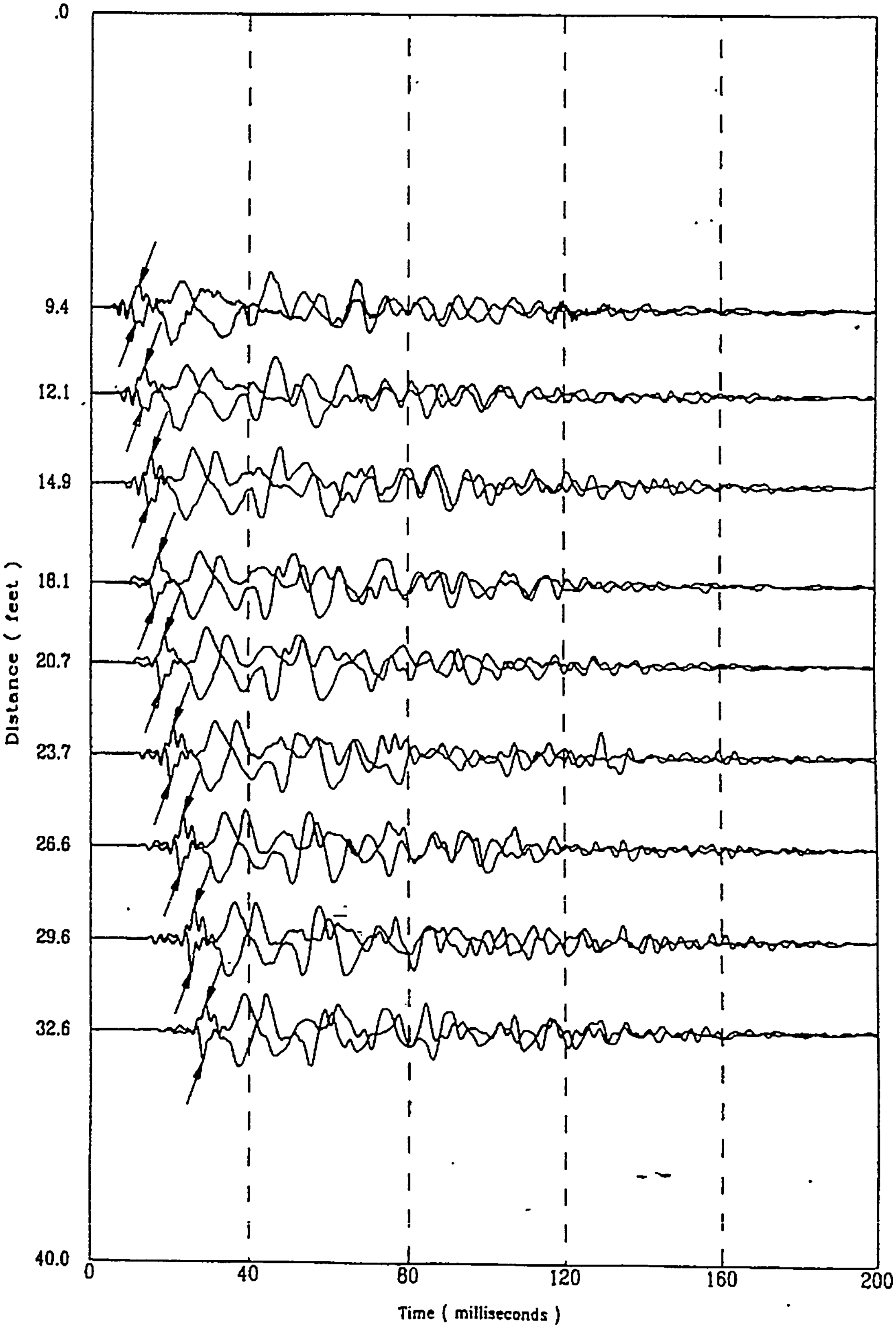


Distance (feet)	Wavespeed (ft/s)
9 - 21	1740
21 - 78	1070
78 - 86	1210
90 - 104	1080
104 - 131	1170
134 - 140	1740
140 - 152	1150
152 - 164	1600

File 3220704S

Applied Research Associates Inc.
HTEF-C07

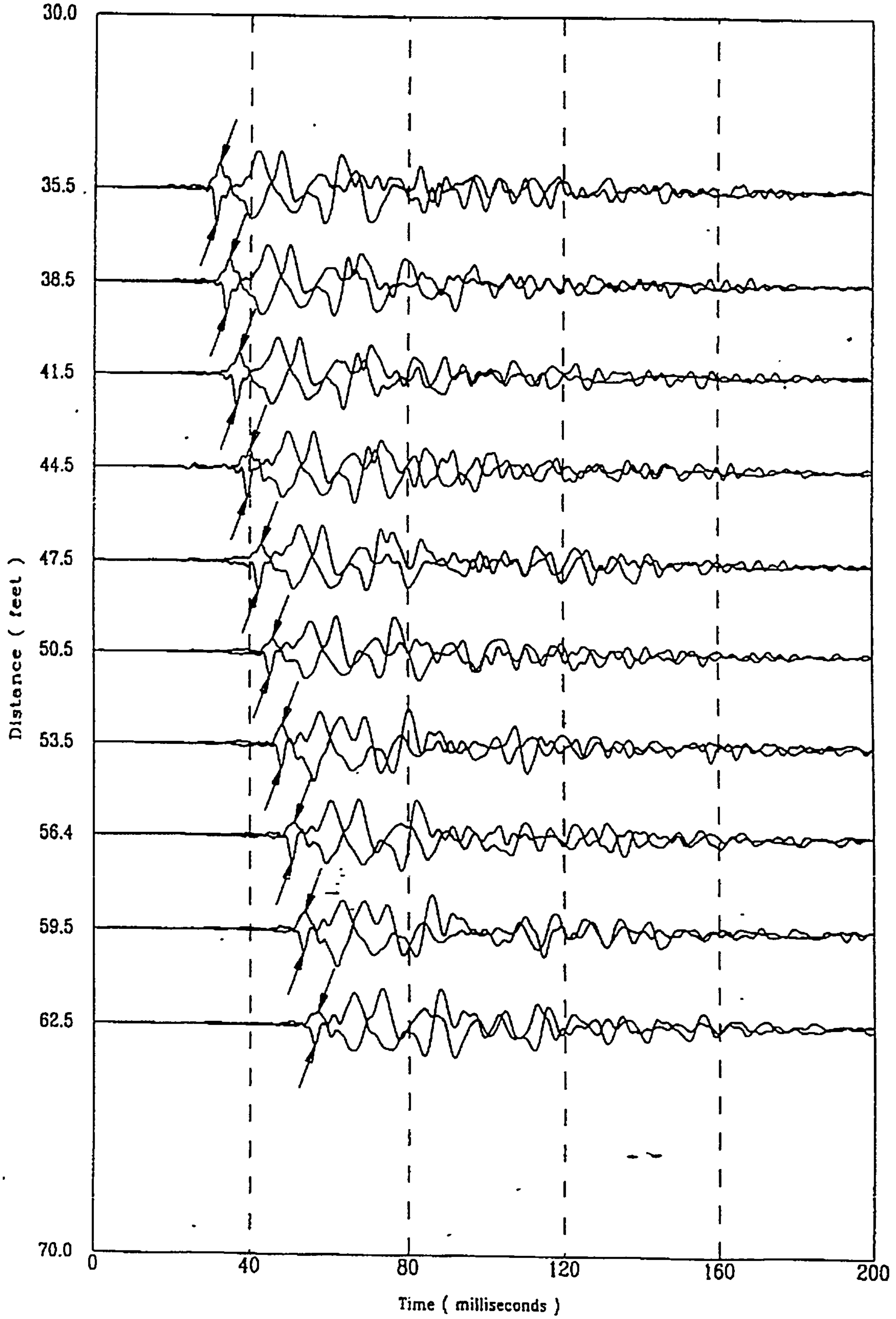
S Wave
10/22/97



File 32207045

Applied Research Associates Inc.
HTEF-C07

S Wave
10/22/97

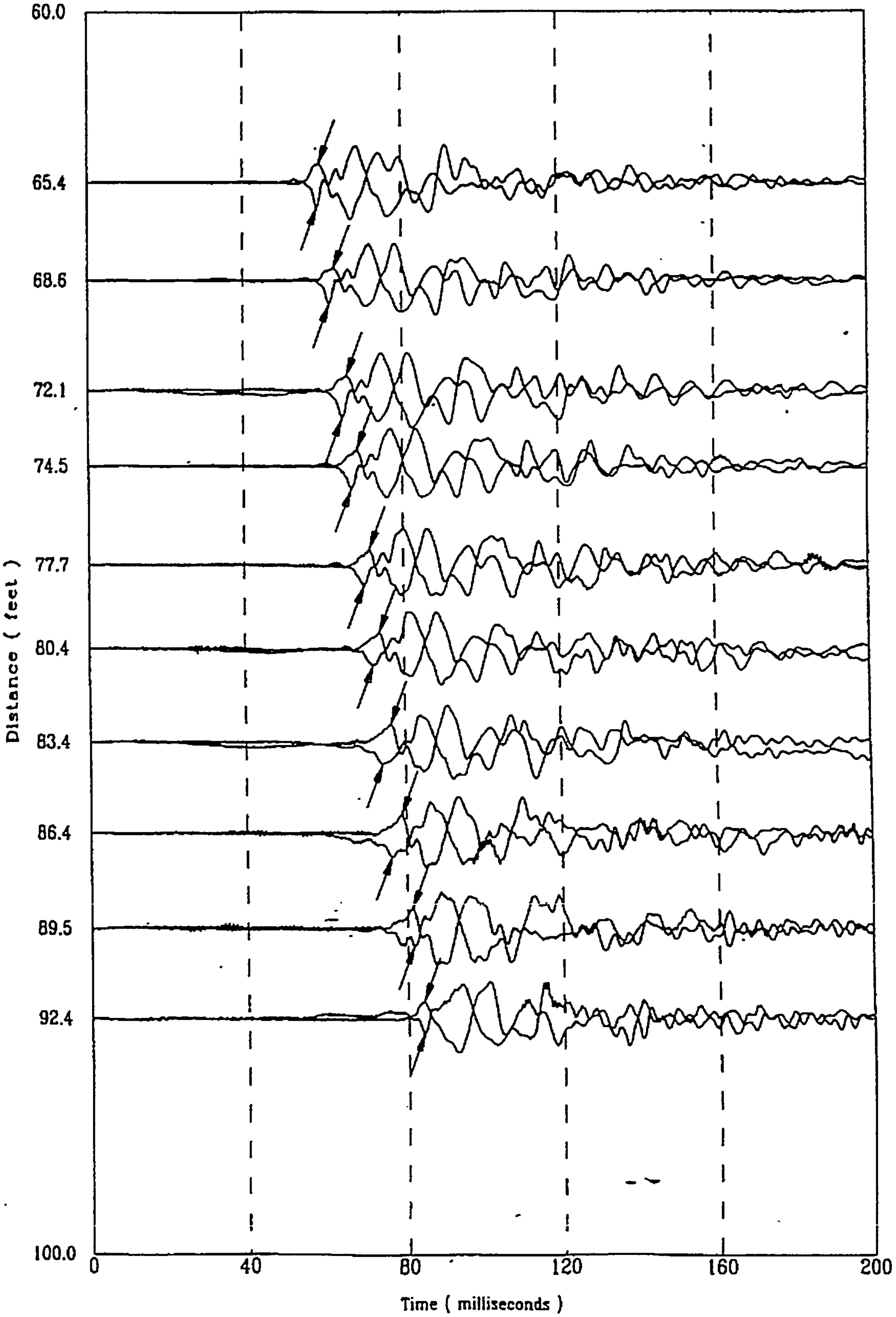


File 3220704S

A-89

Applied Research Associates Inc.
HTEF-C07

S Wave
10/22/97

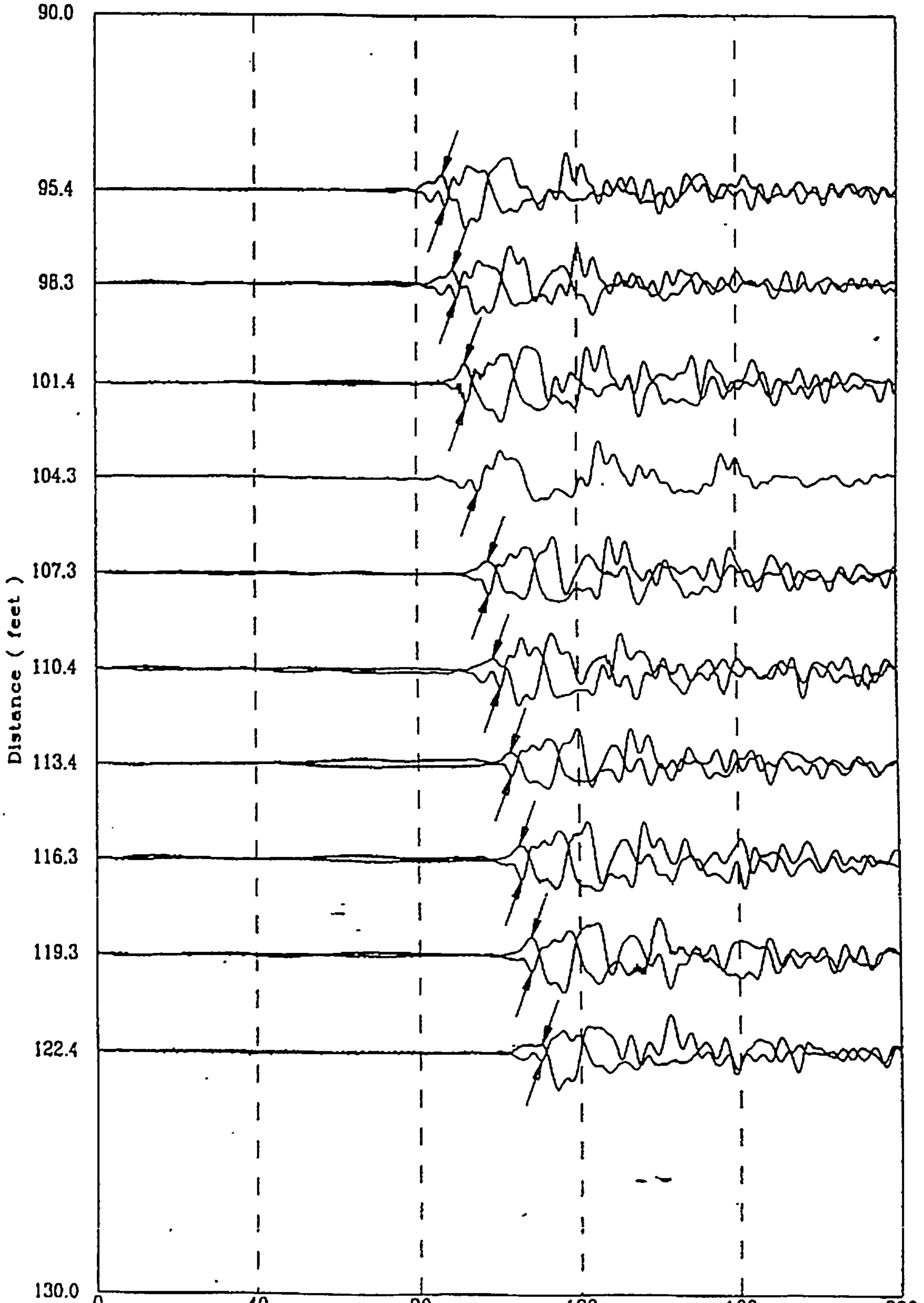


File 3220704S

A-90

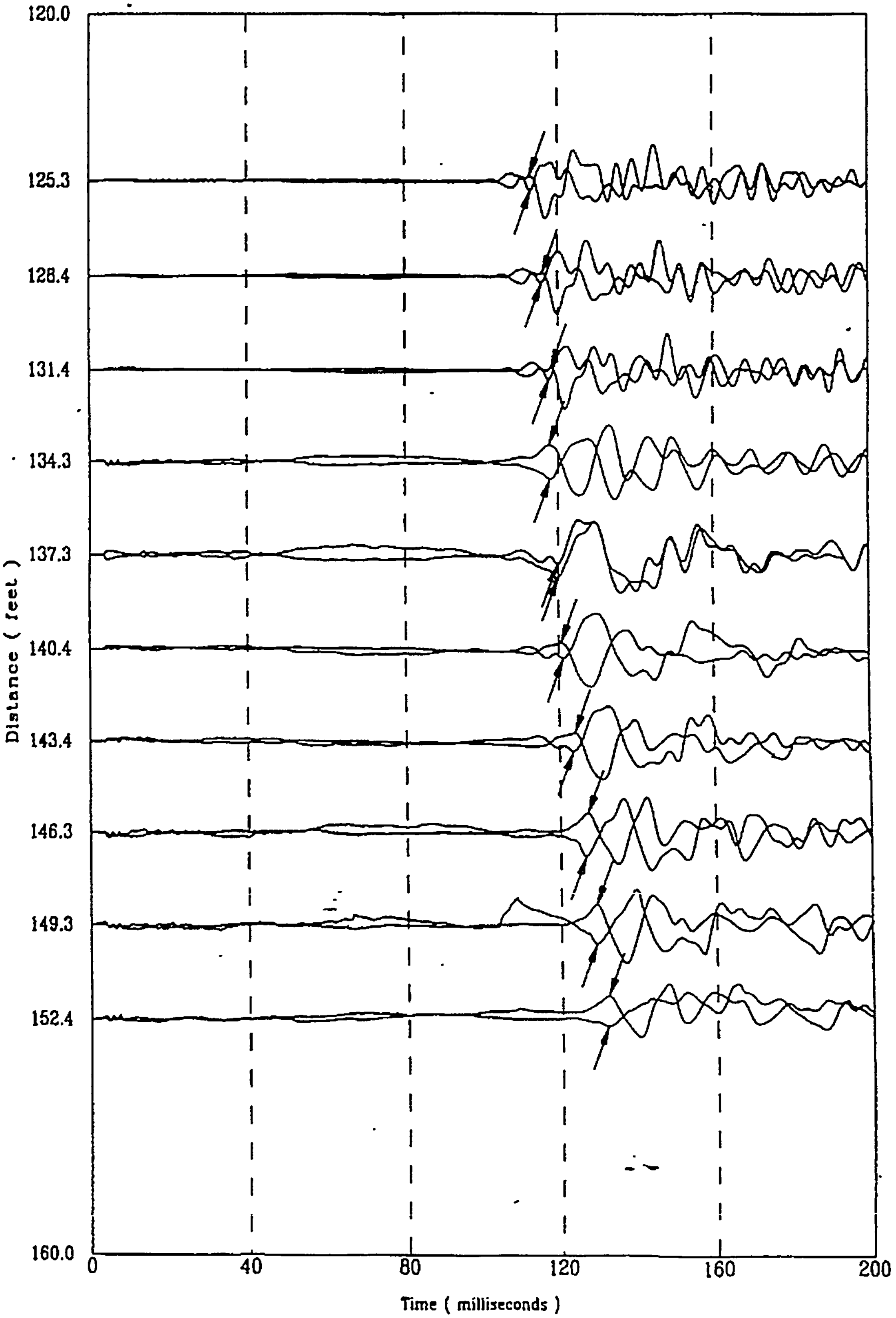
Applied Research Associates Inc.
HTEF-C07

S Wave
10/22/97



File 3220705S

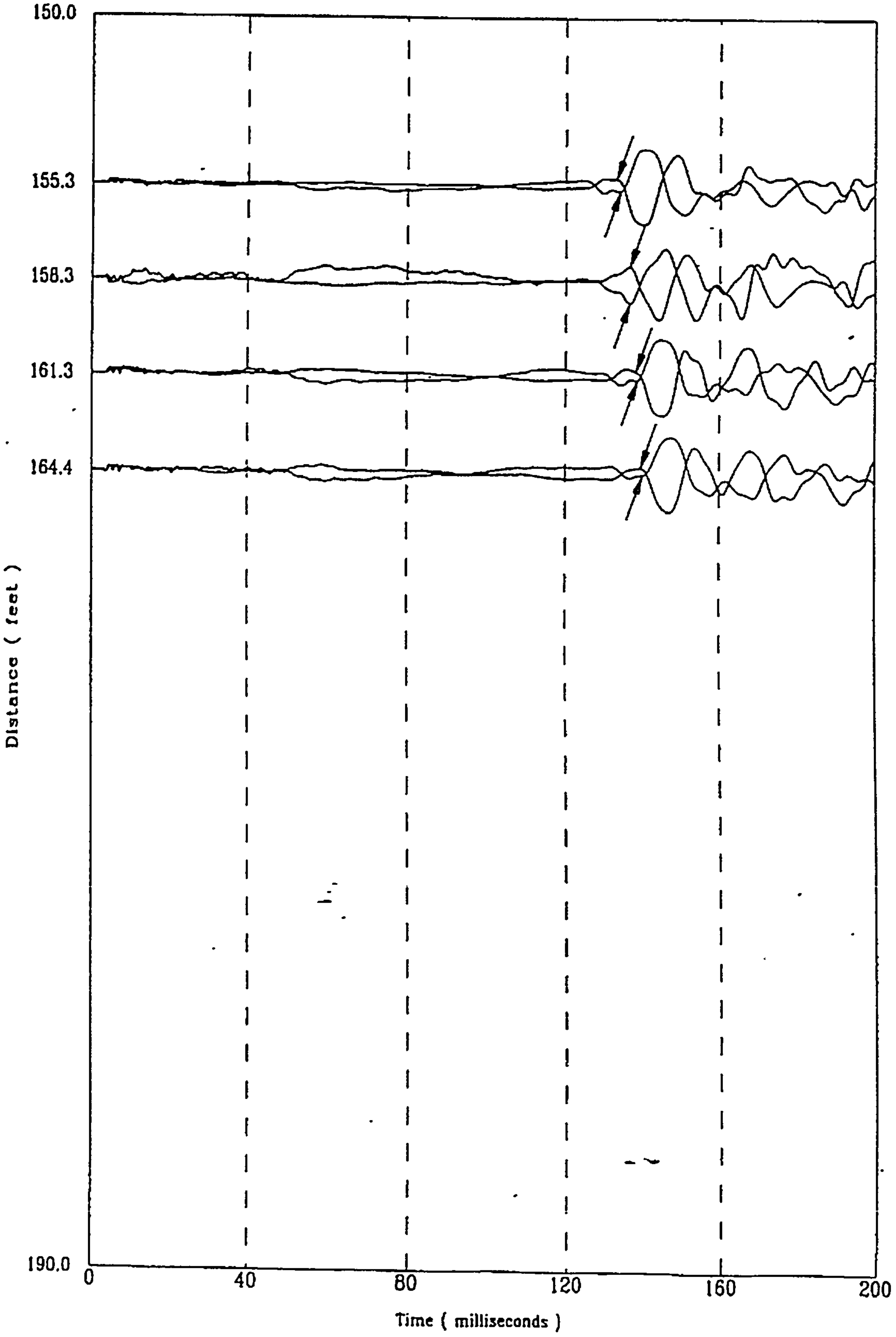
Applied Research Associates Inc. S Wave
HTEF-C07 10/22/97



File 3220705S

Applied Research Associates Inc.
HTEF-C07

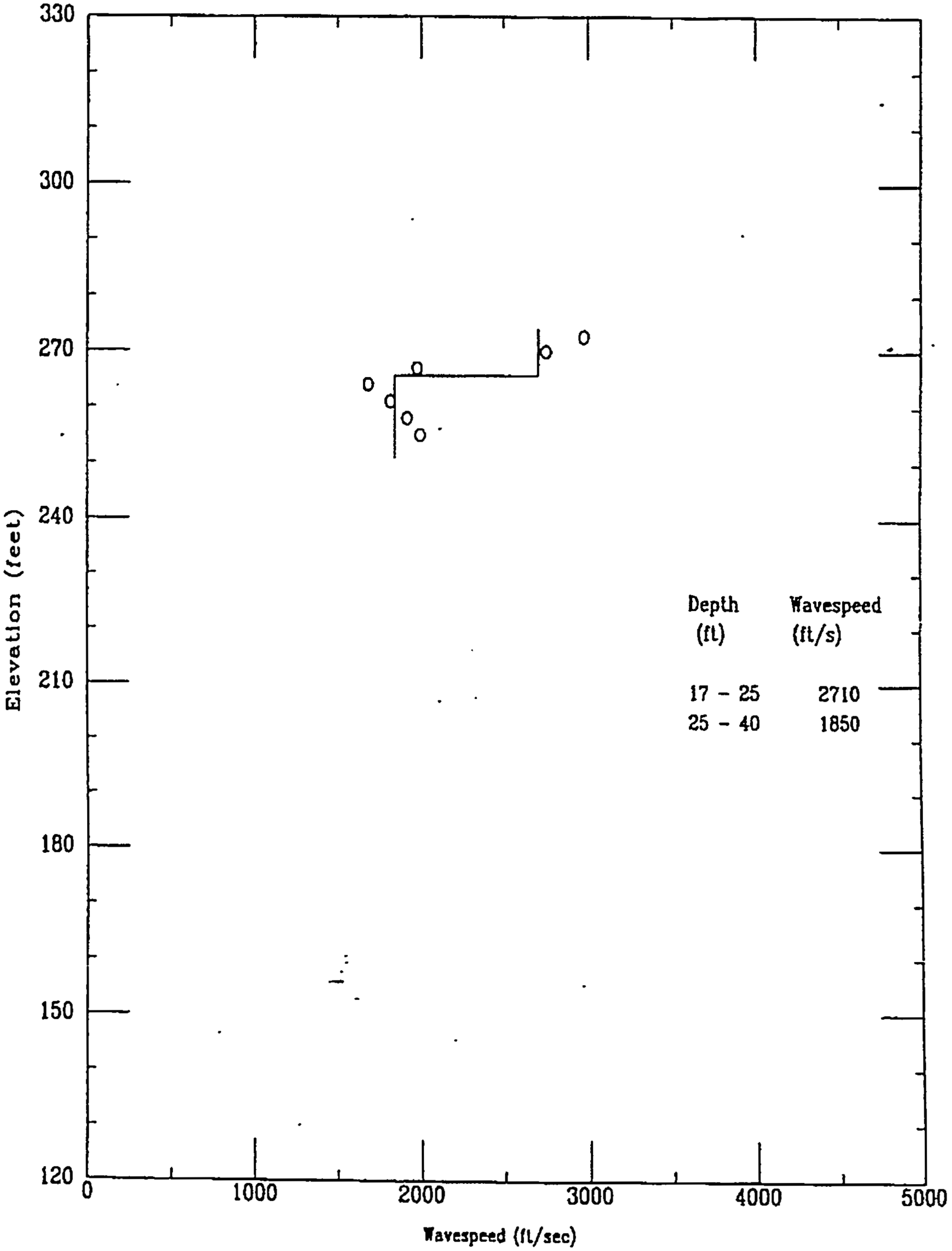
S Wave
10/22/97



File 3220705S

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Compression Wave Speeds

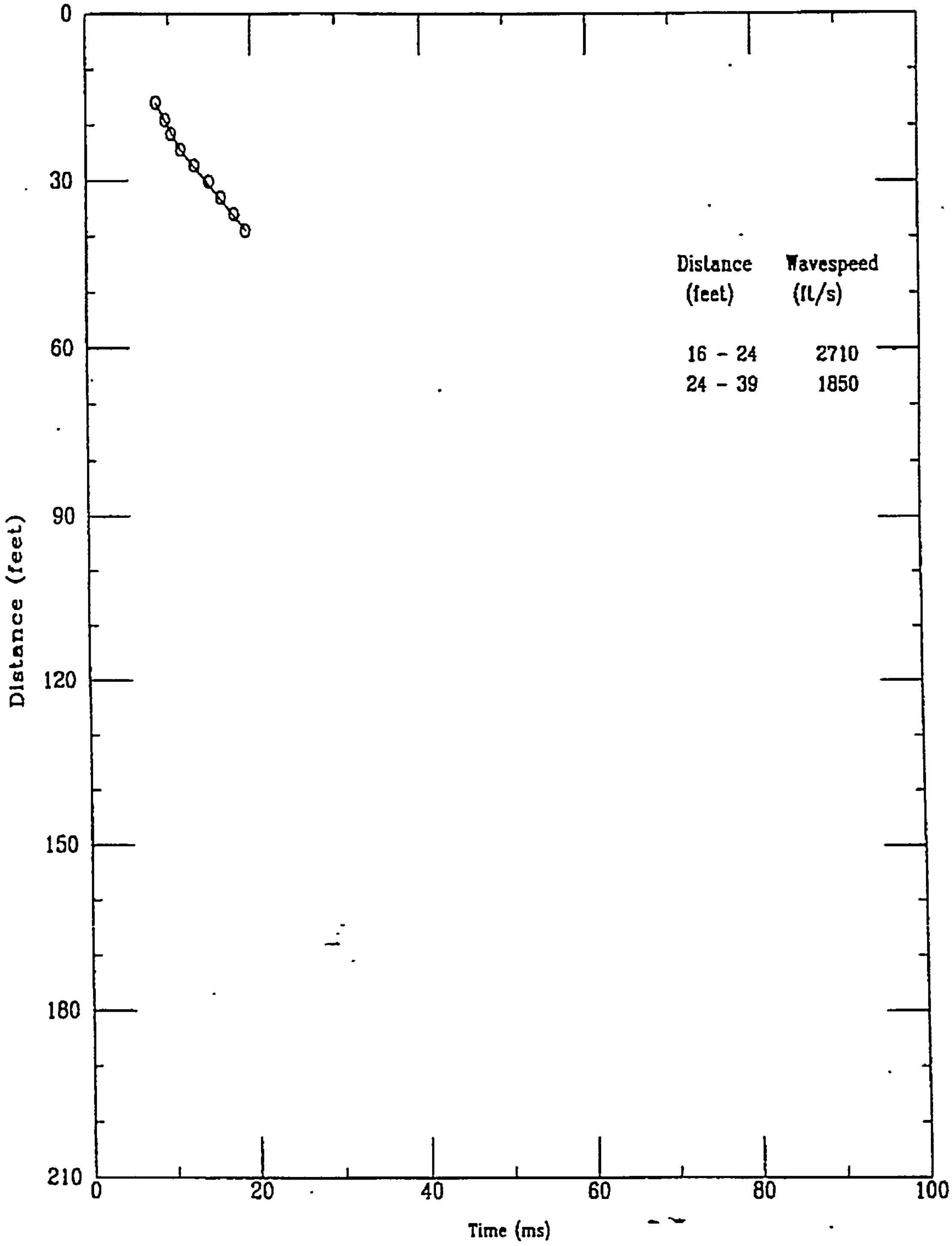


Depth (ft)	Wavespeed (ft/s)
17 - 25	2710
25 - 40	1850

File 3220704S

HTEF-C07 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Compression Wave Time of Peak

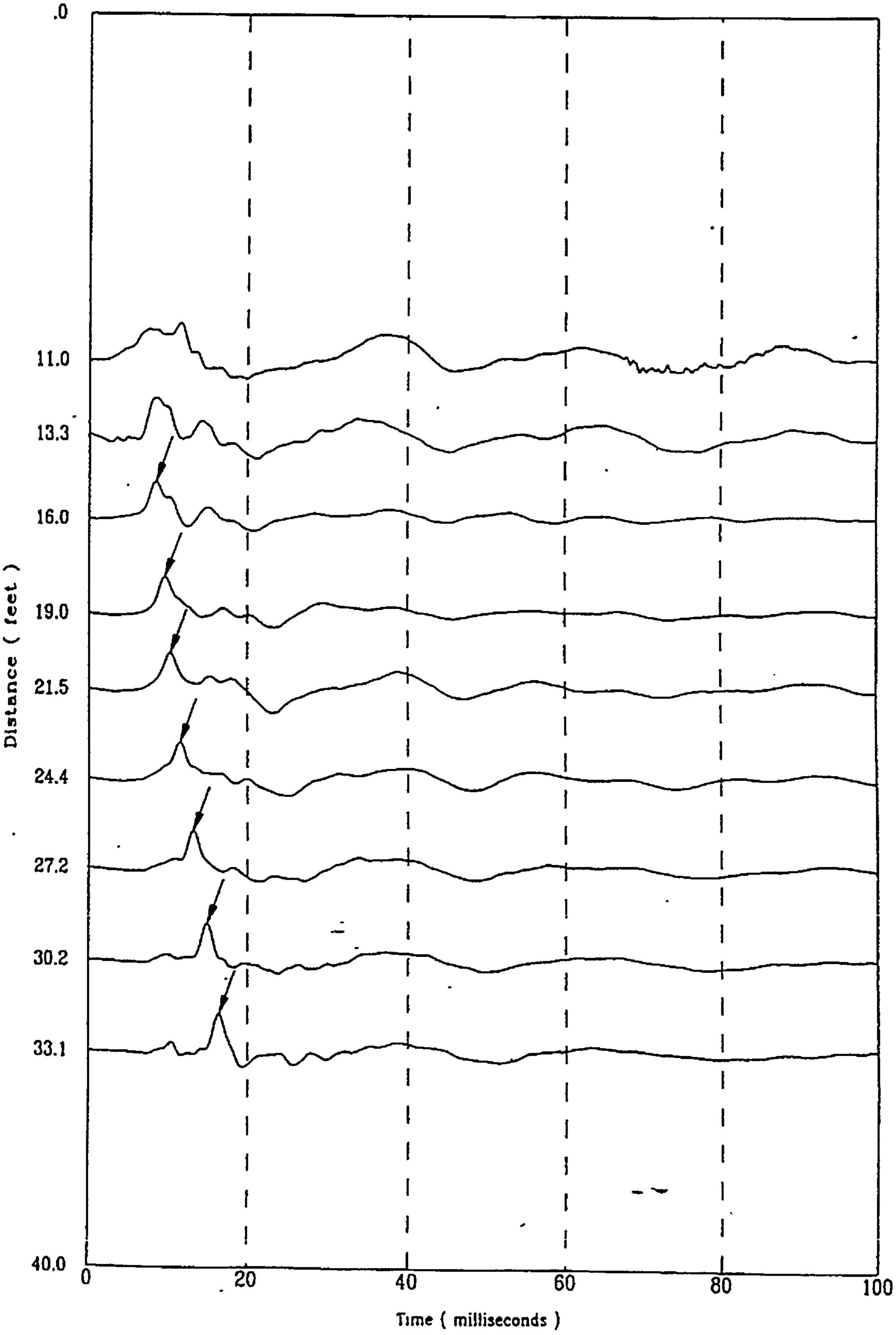


Distance (feet)	Wavespeed (ft/s)
16 - 24	2710
24 - 39	1850

File 3220704S

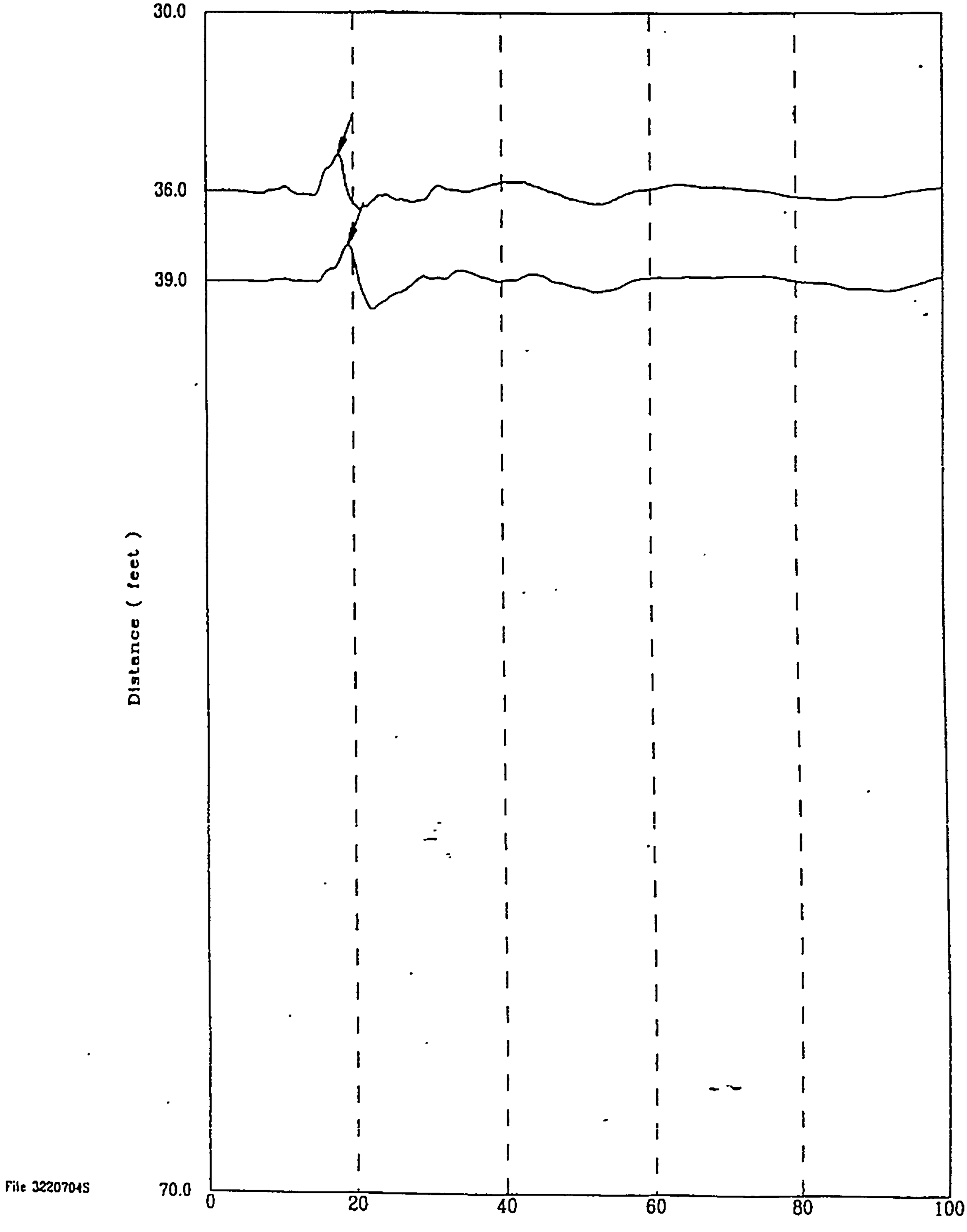
Applied Research Associates Inc.
HTEF-C07

P Wave
10/22/97



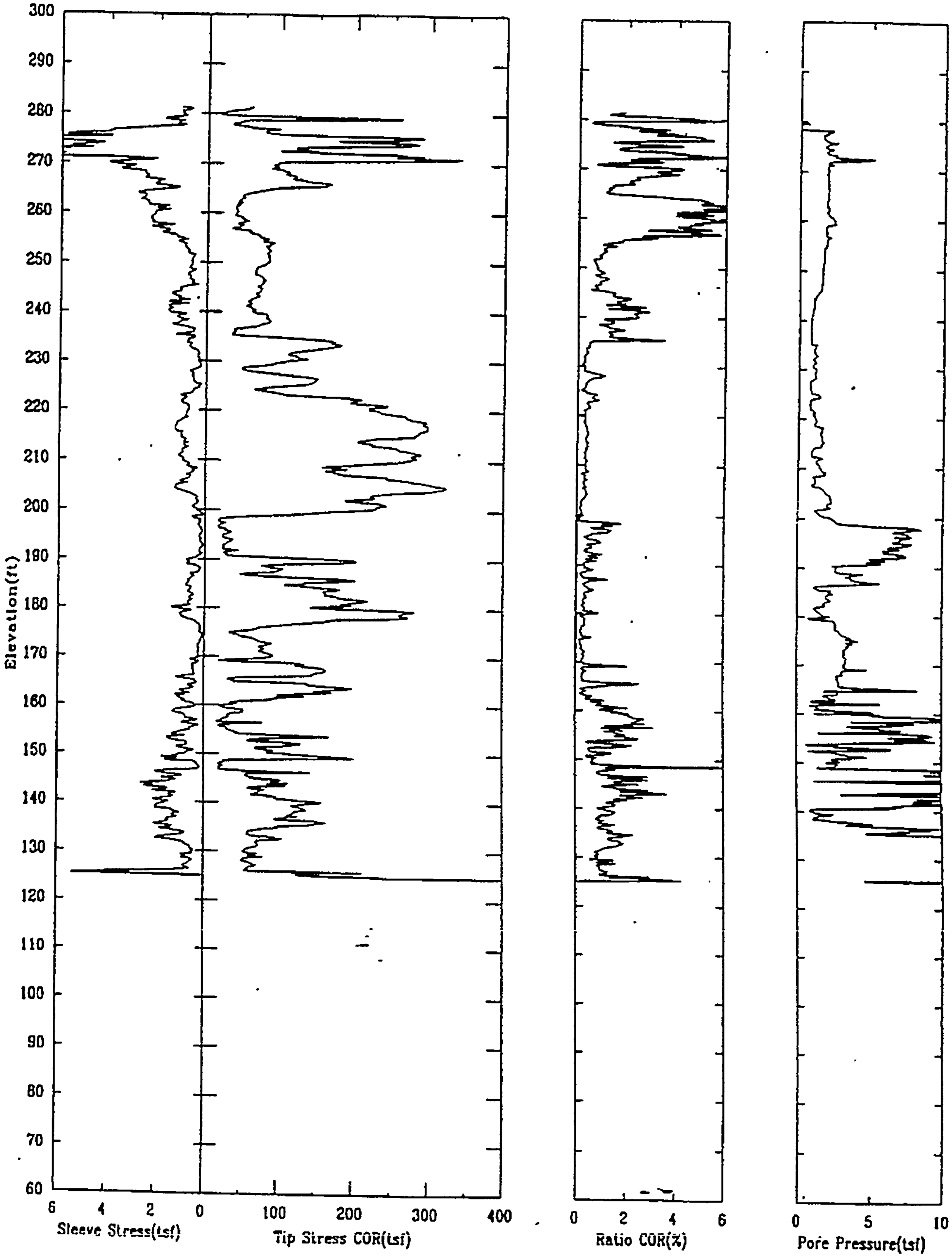
File 32207045

Applied Research Associates Inc. P Wave
HTEF-C07 10/22/97



HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

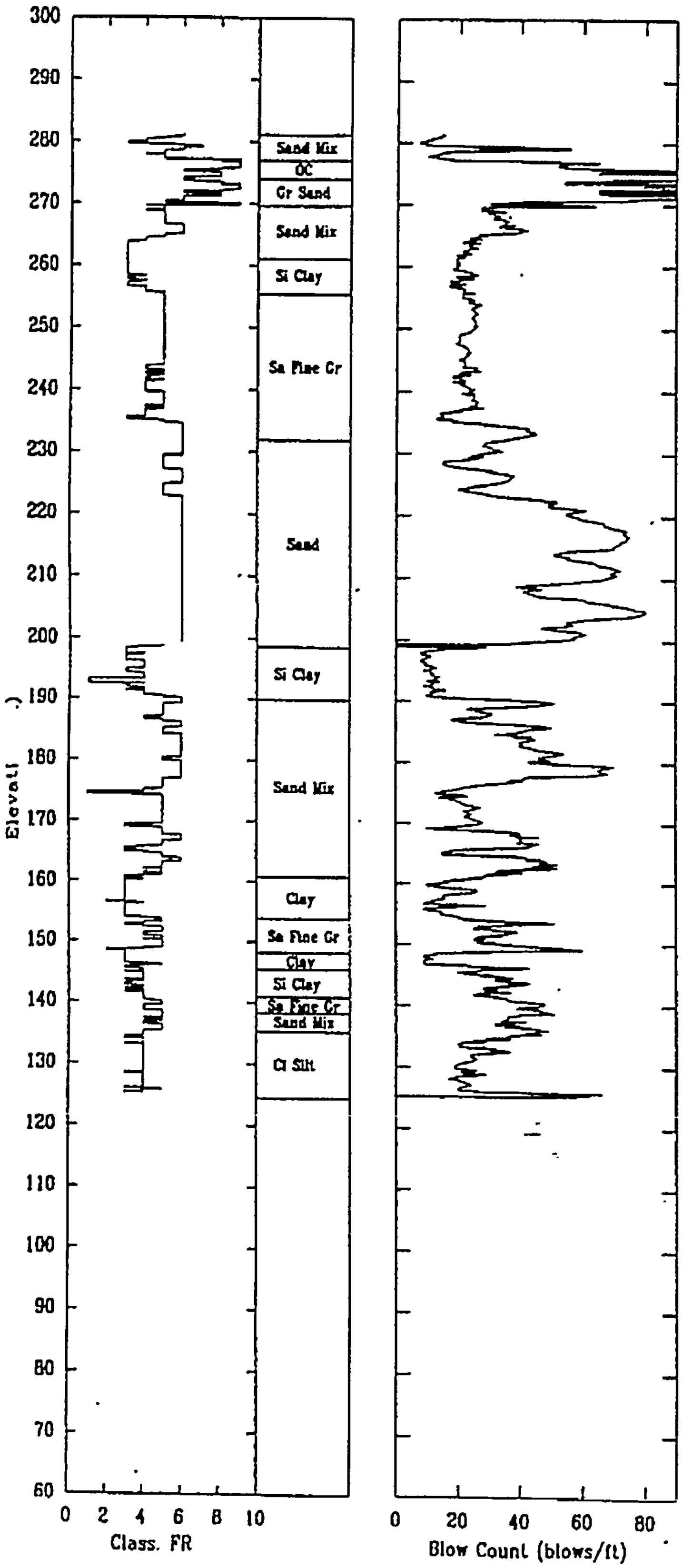
North 73382.0 East 61583.0 Elevation 287.4



File 3150703.ECP

HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

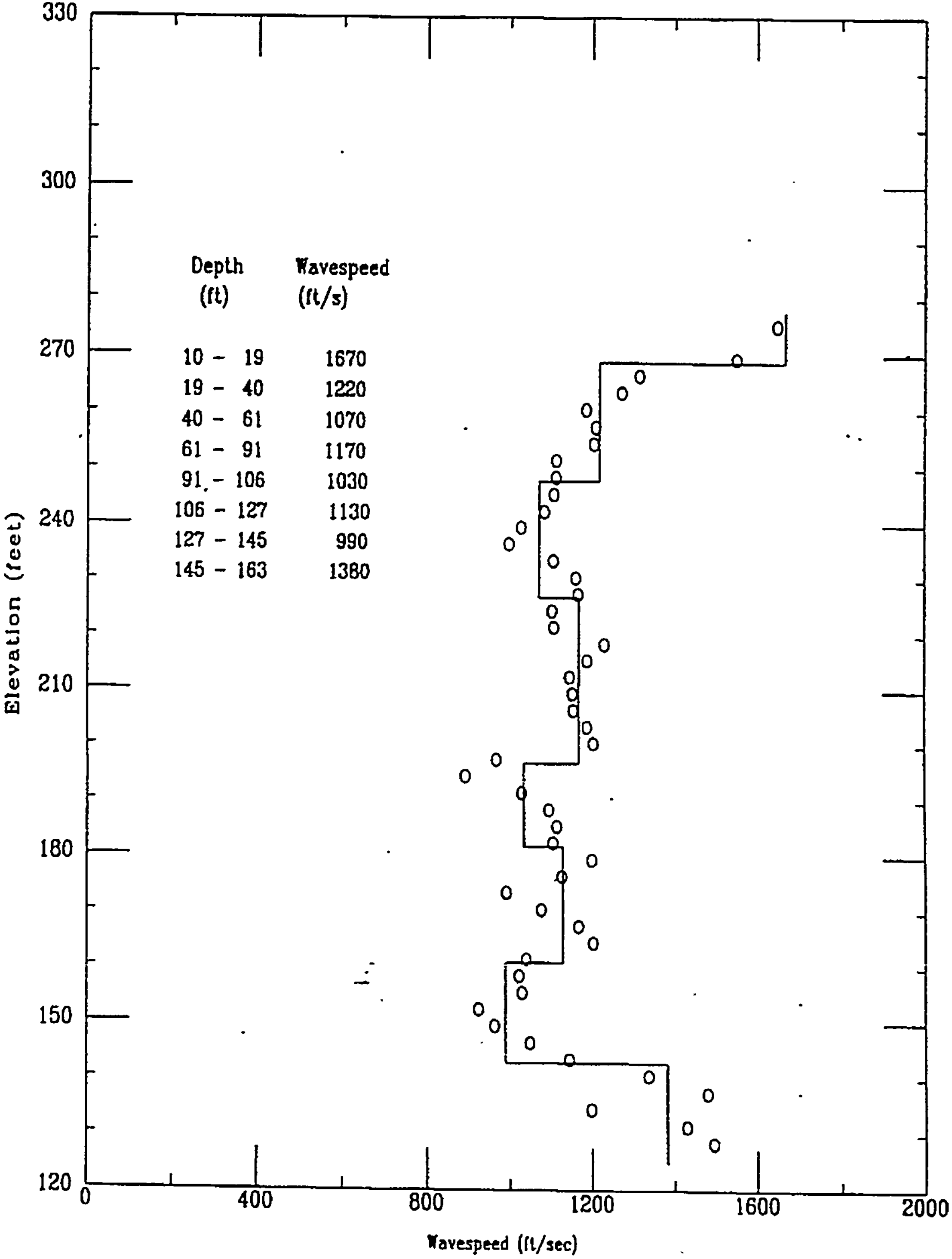
North 73382.0 East 61583.0 Elevation 287.4



File 3150703 ECP

HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

Shear Wave Speeds

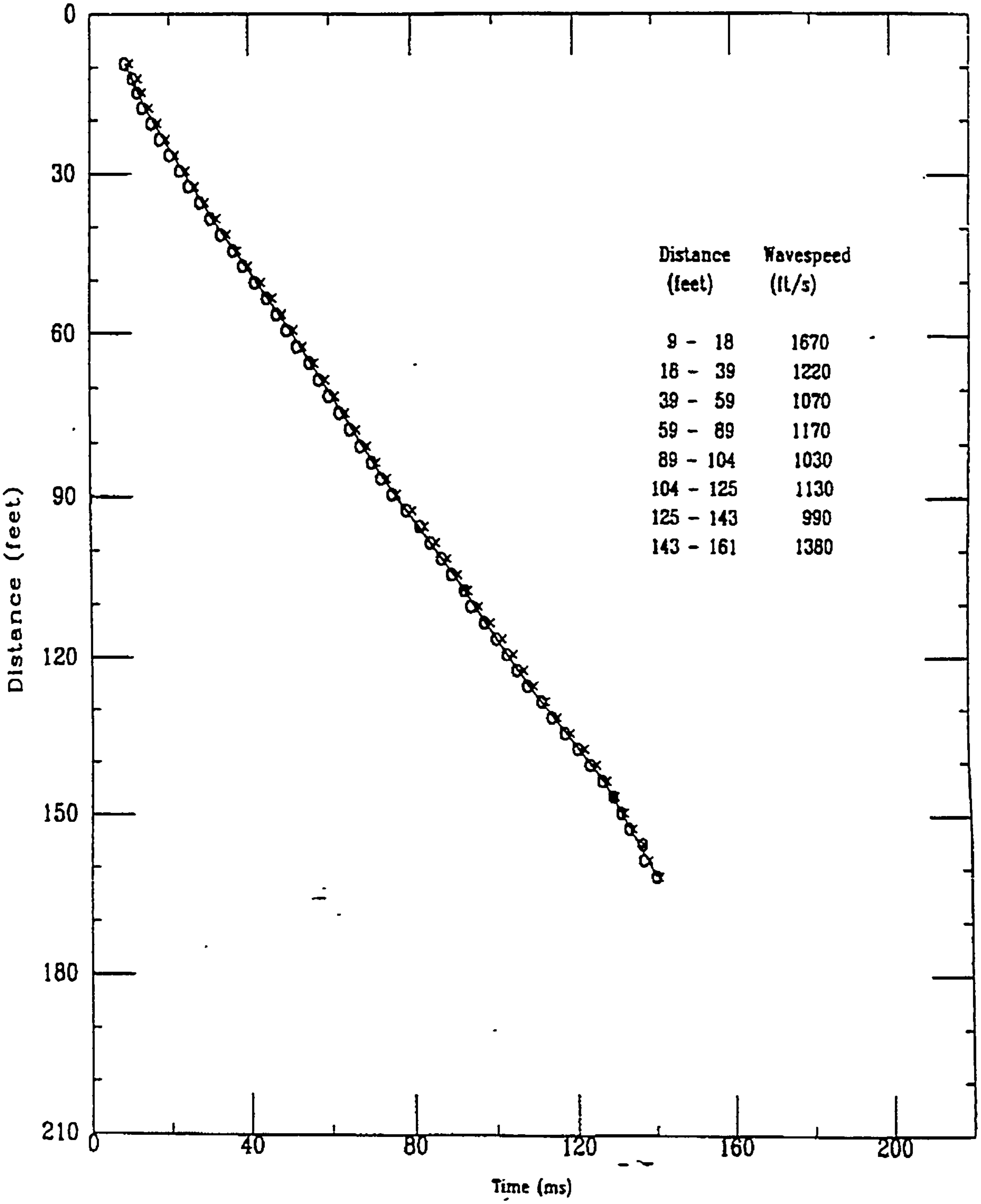


Depth (ft)	Wavespeed (ft/s)
10 - 19	1670
19 - 40	1220
40 - 61	1070
61 - 91	1170
91 - 106	1030
106 - 127	1130
127 - 145	990
145 - 163	1380

File 3150703S

HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

Shear Wave Time of Peak

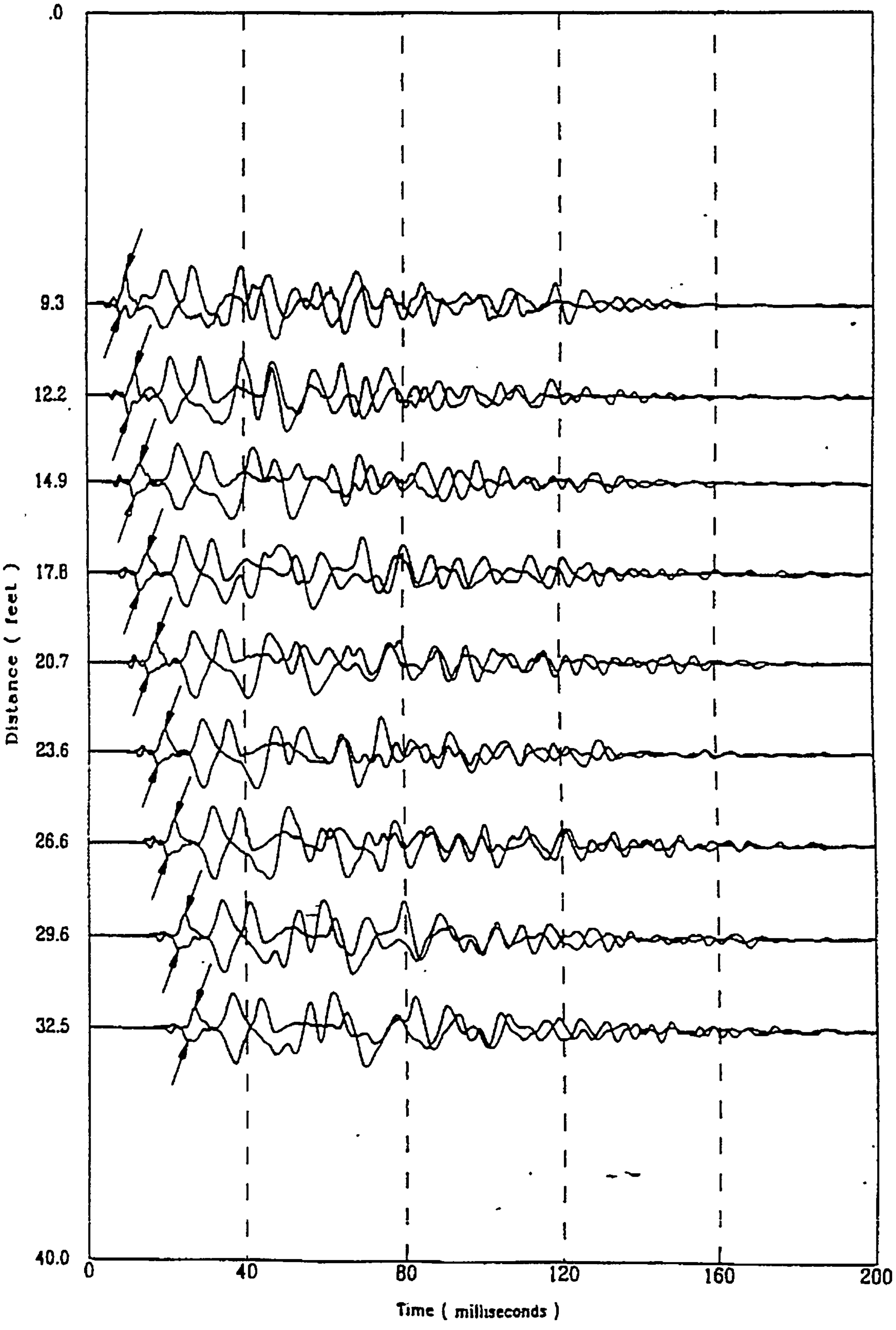


Distance (feet)	Wavespeed (ft/s)
9 - 18	1670
18 - 39	1220
39 - 59	1070
59 - 89	1170
89 - 104	1030
104 - 125	1130
125 - 143	990
143 - 161	1380

File 31507035

Applied Research Associates Inc.
HTEF-C8

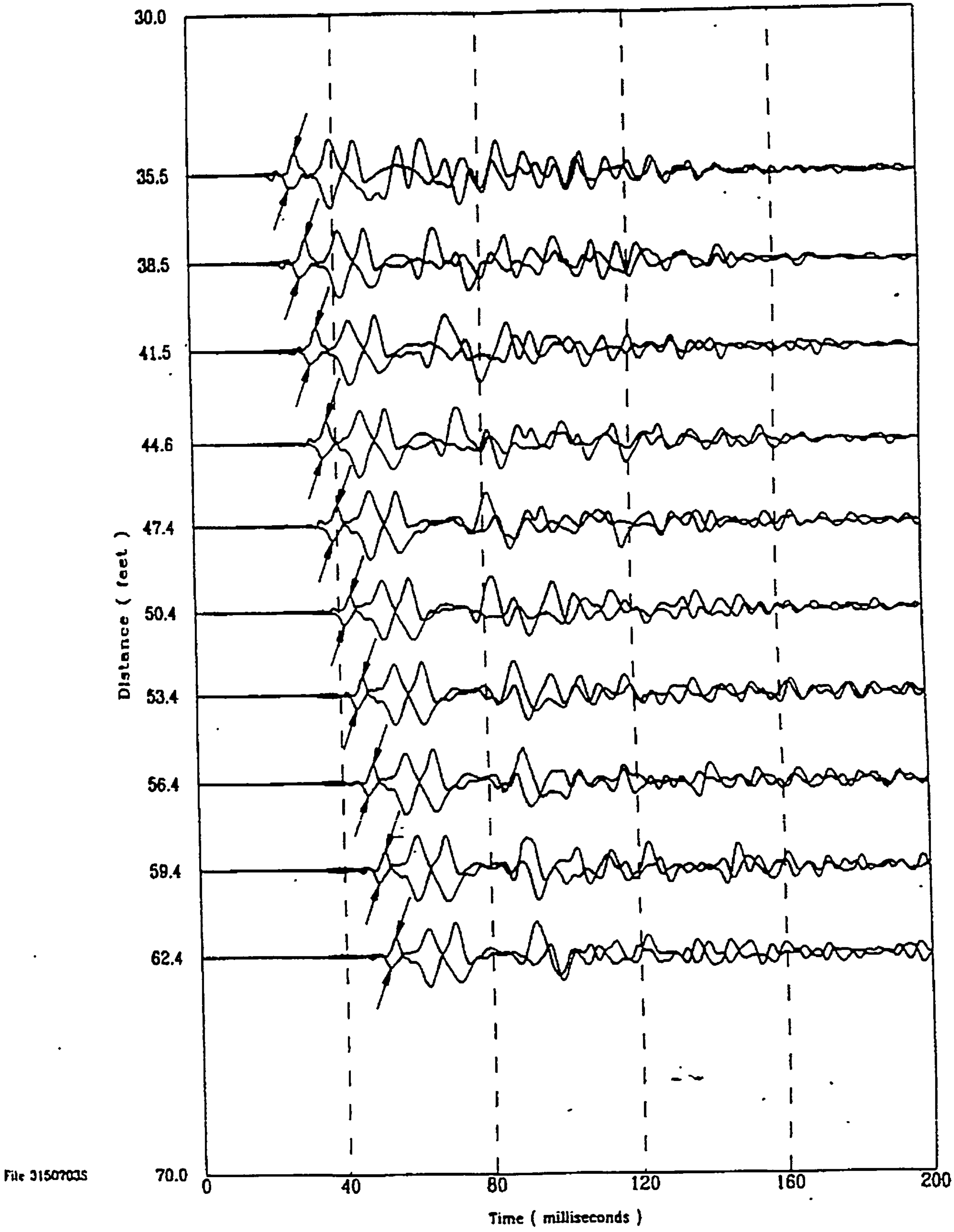
S Wave
10/15/97



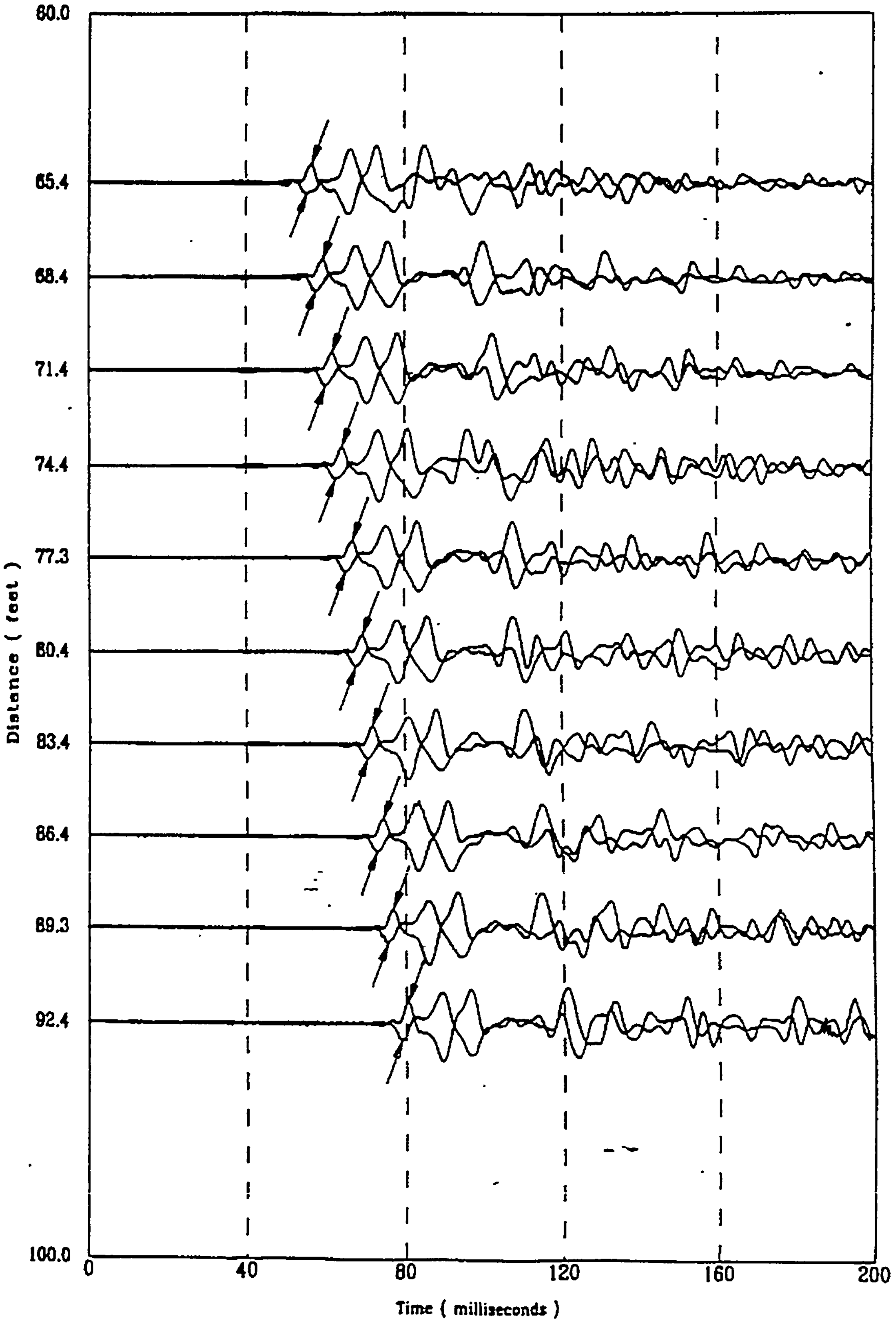
File 31507035

Applied Research Associates Inc.
HTEF-C8

S Wave
10/15/97

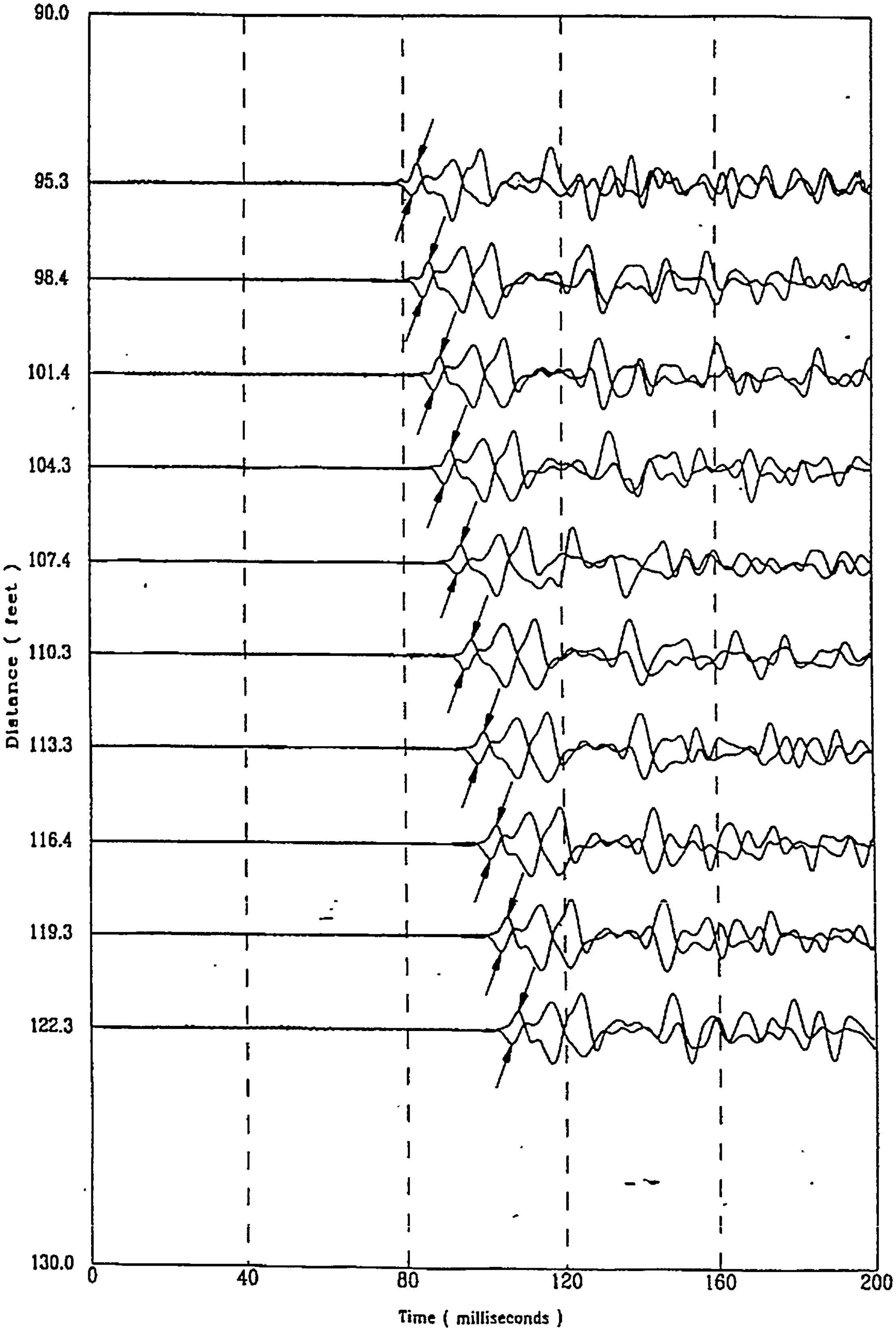


Applied Research Associates Inc. S Wave
HTEF-C8 10/15/97



File 3150703S

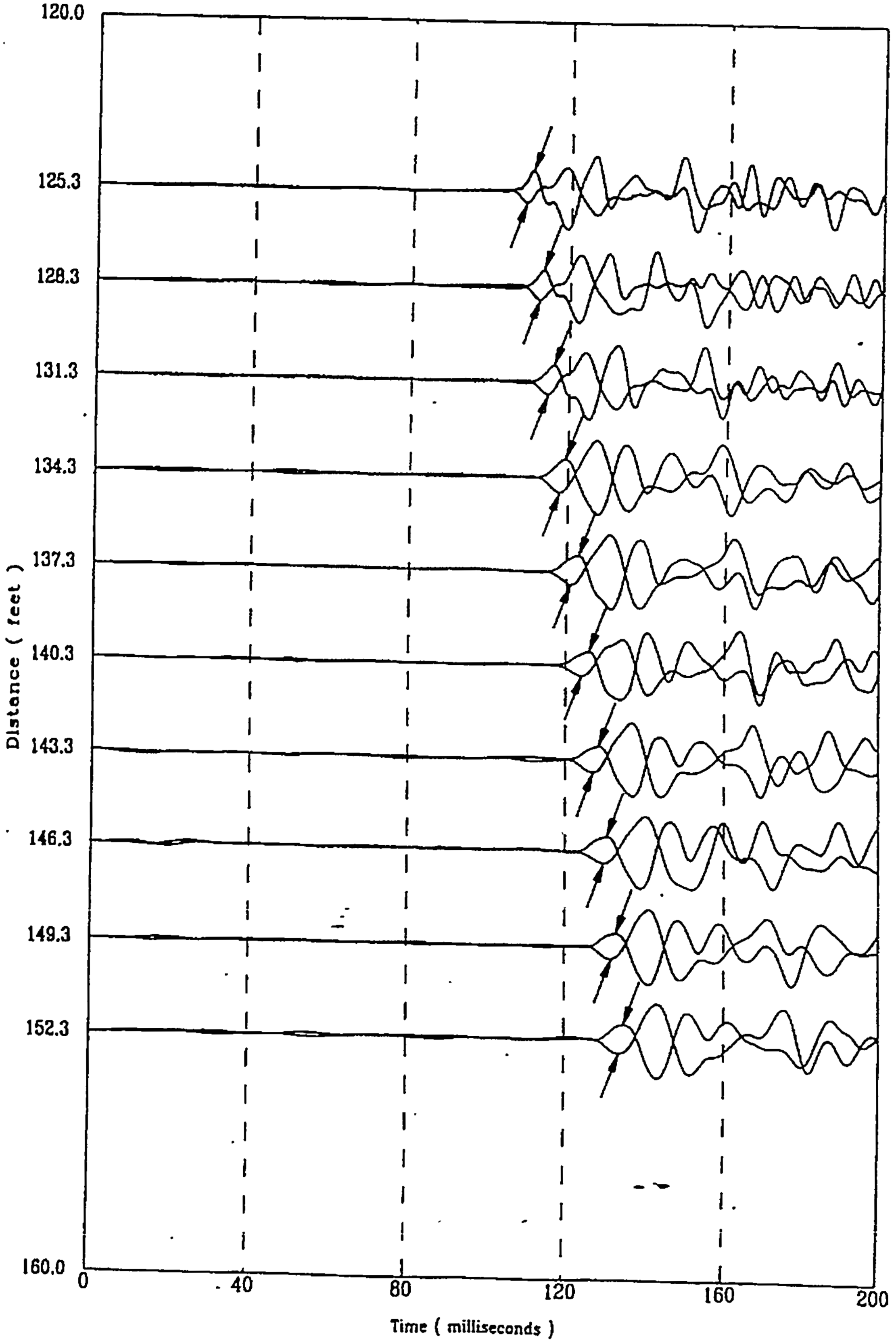
Applied Research Associates Inc. S Wave
HTEF-C8 10/15/97



File 3150703S

Applied Research Associates Inc.
HTEF-C8

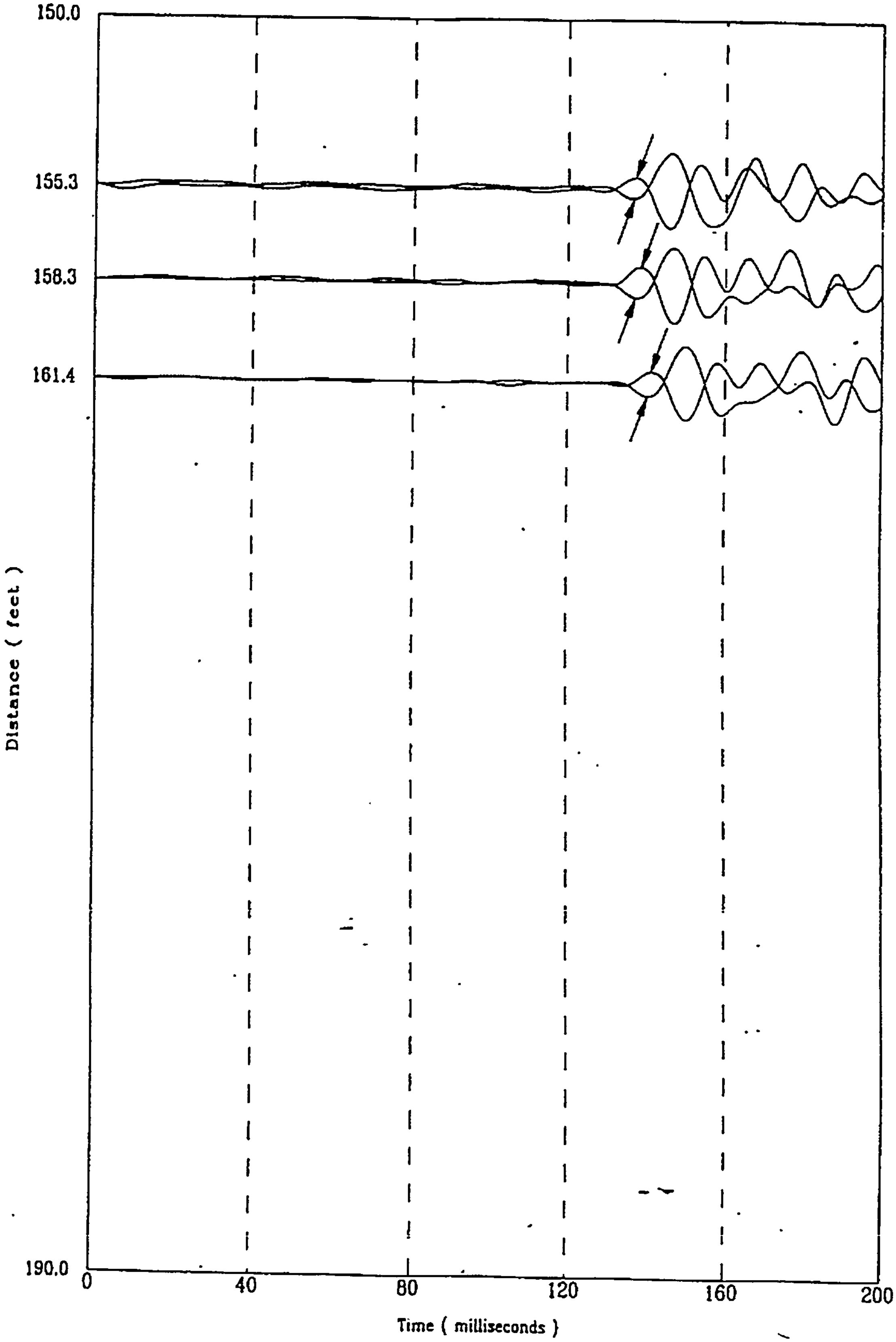
S Wave
10/15/97



File 3150704S

Applied Research Associates Inc.
HTEF-C8

S Wave
10/15/97

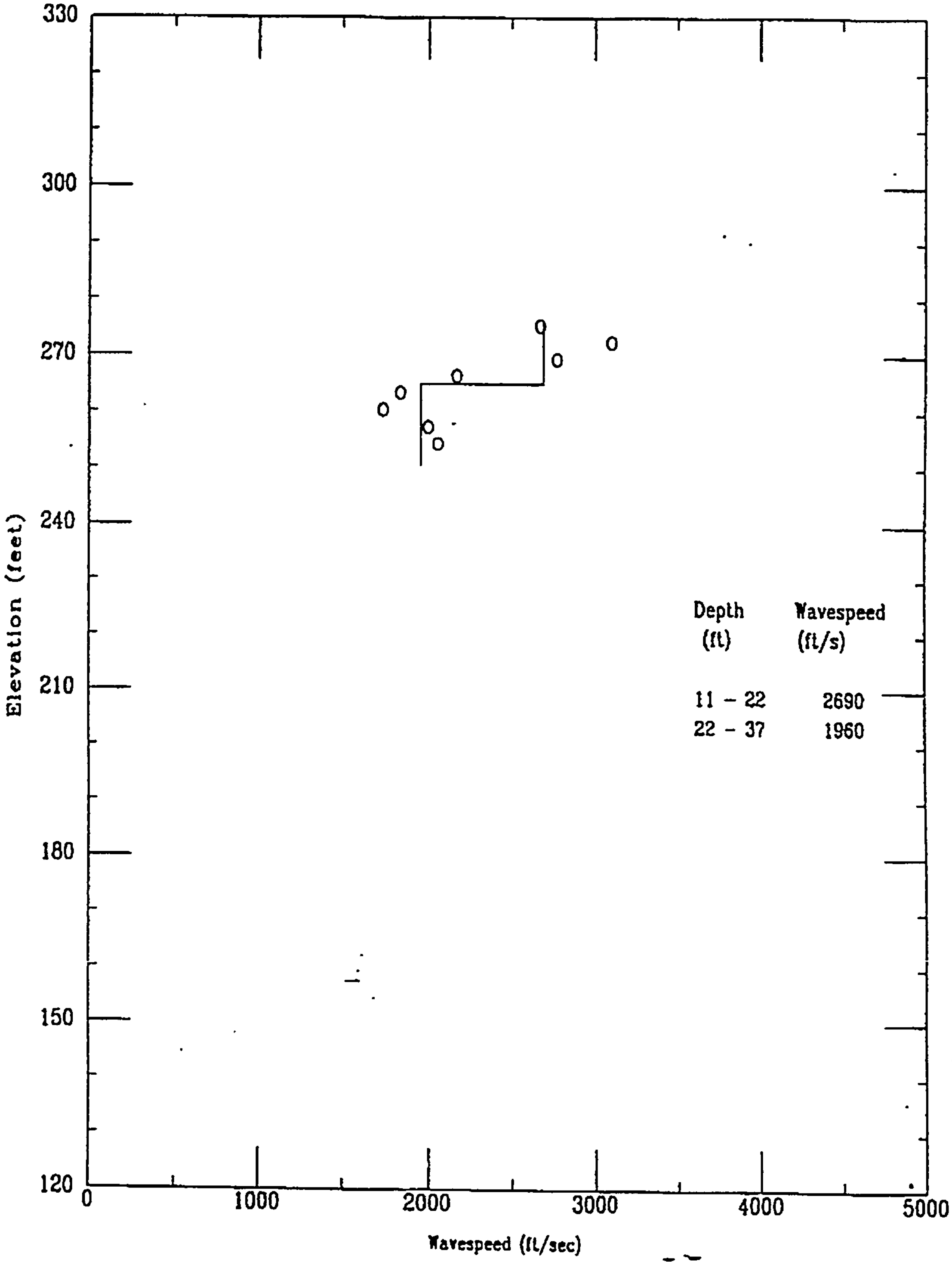


File 3150704S

A-107

HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

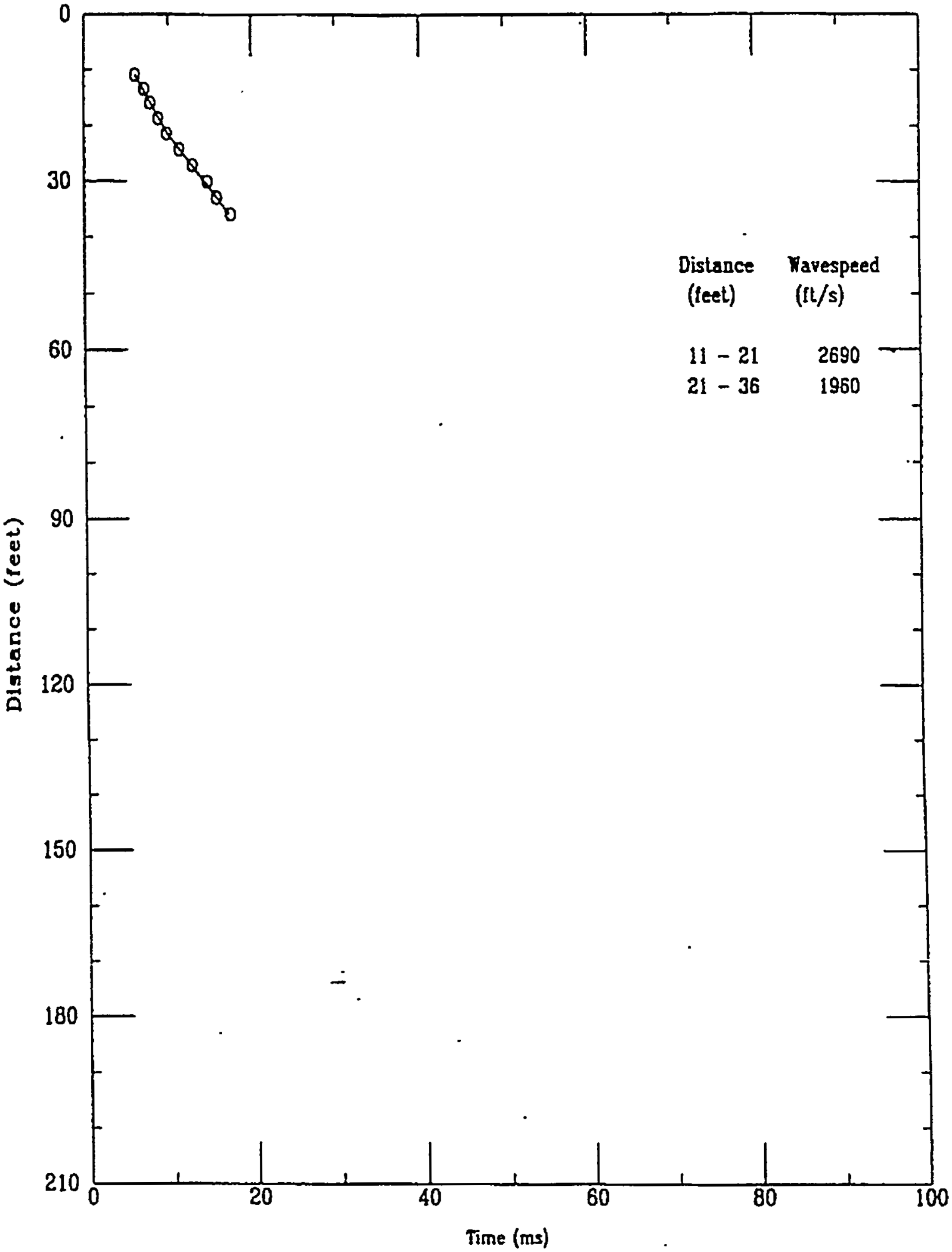
Compression Wave Speeds



File 31507035

HTEF-C08 APPLIED RESEARCH ASSOCIATES, INC. 10/15/97

Compression Wave Time of Peak

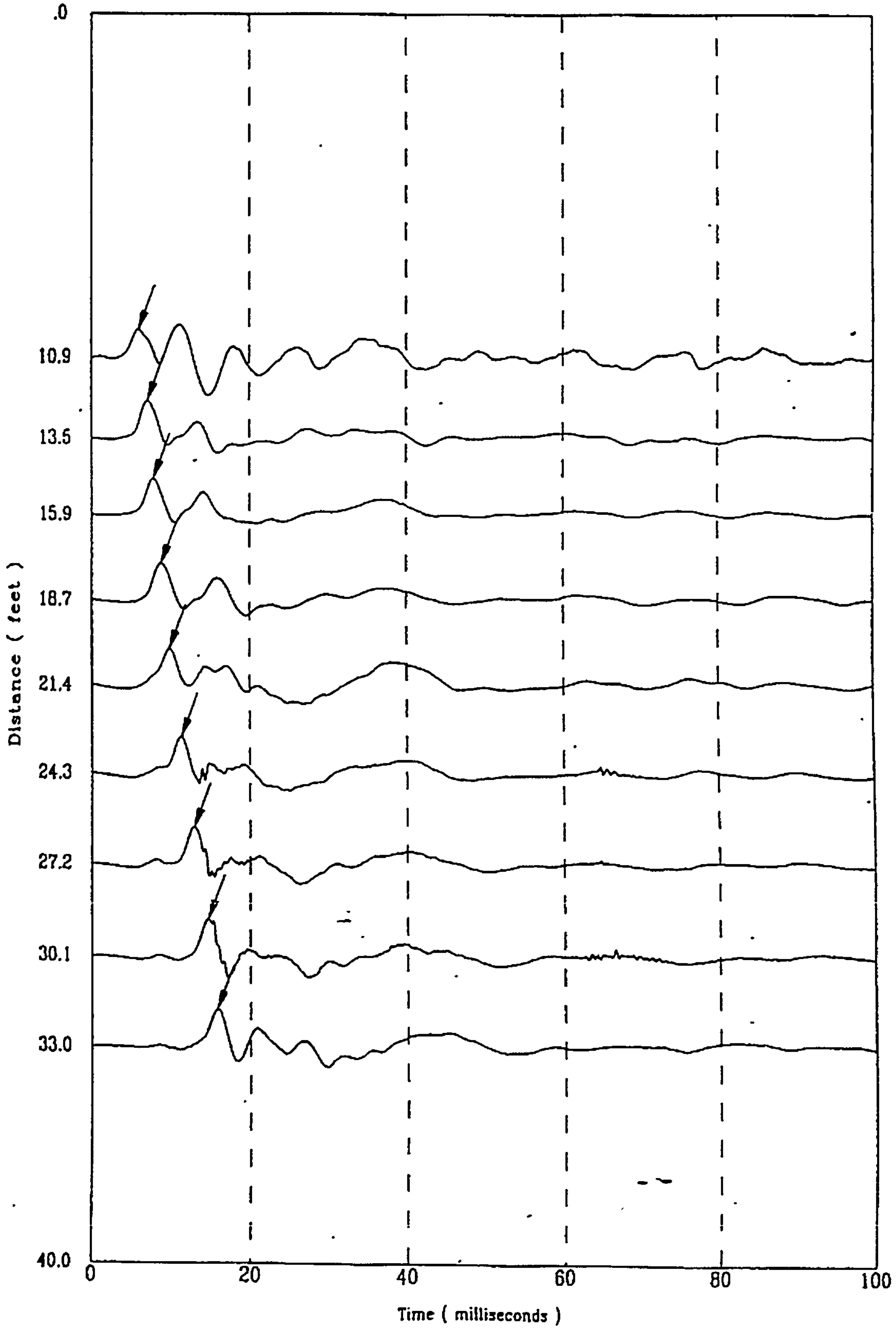


Distance (feet)	Wavespeed (ft/s)
11 - 21	2690
21 - 36	1960

File 3150703S

Applied Research Associates Inc.
HTEF-C8

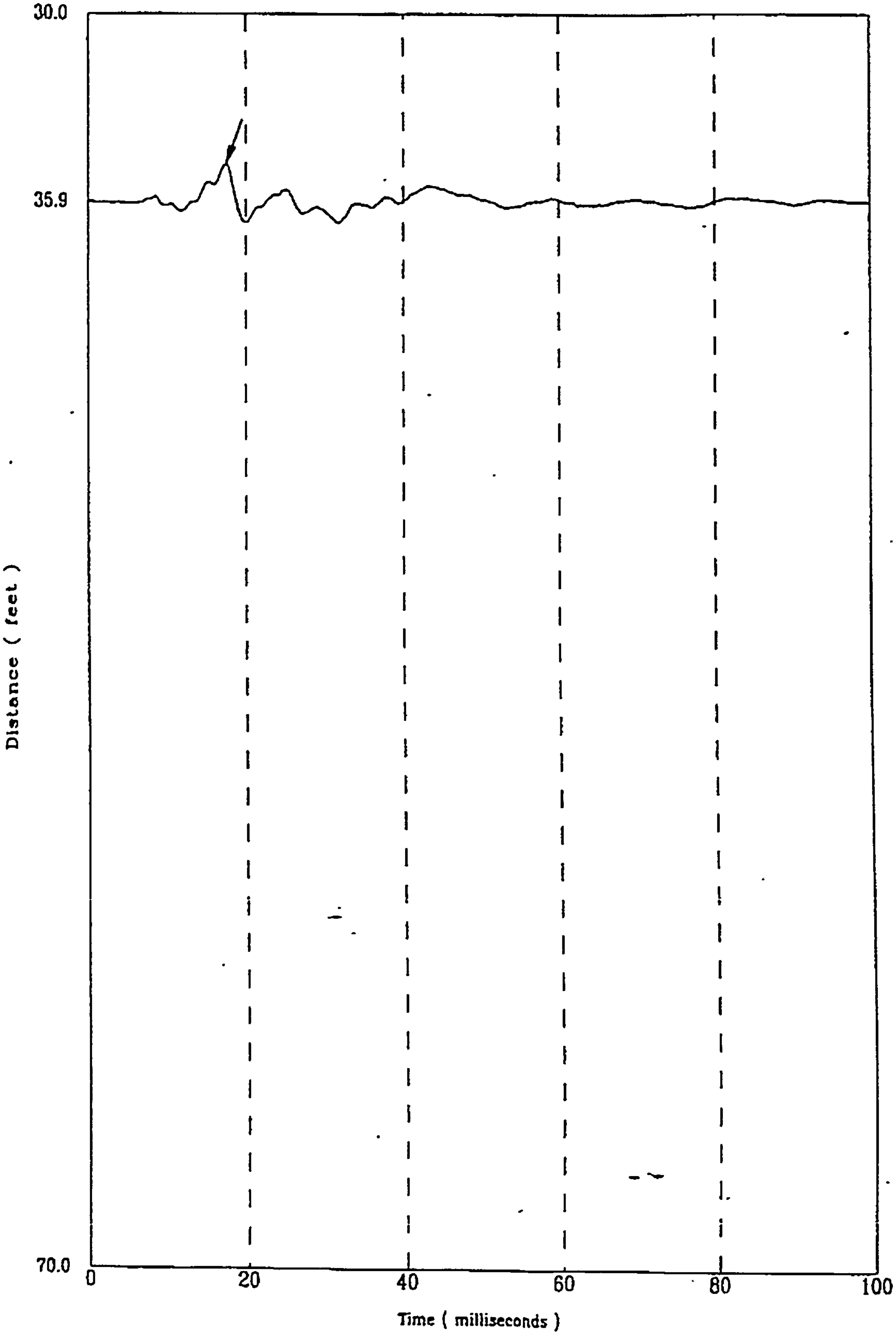
P Wave
10/15/97



File 3150703S

Applied Research Associates Inc.
HTEF-C8

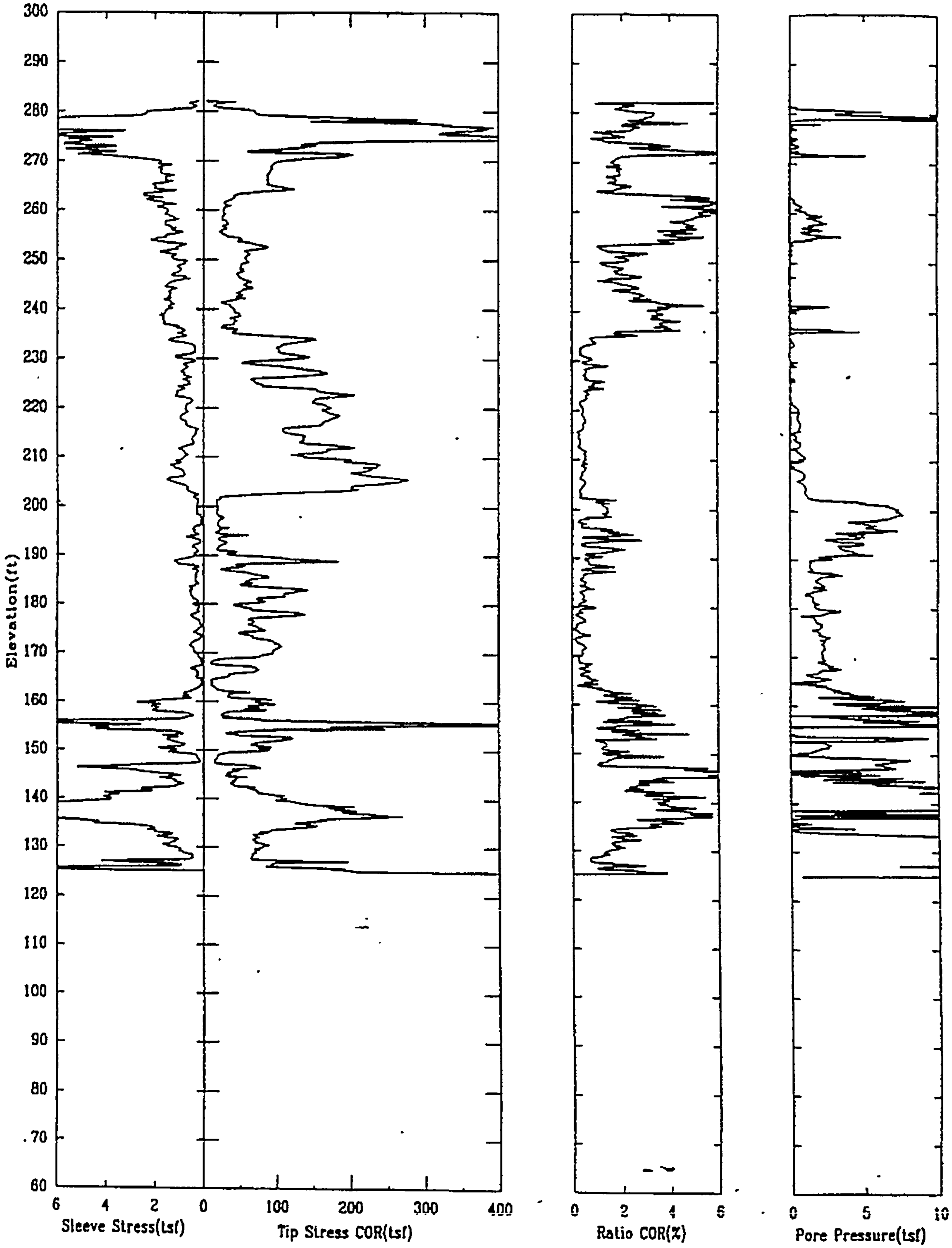
P Wave
10/15/97



File 31507035

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

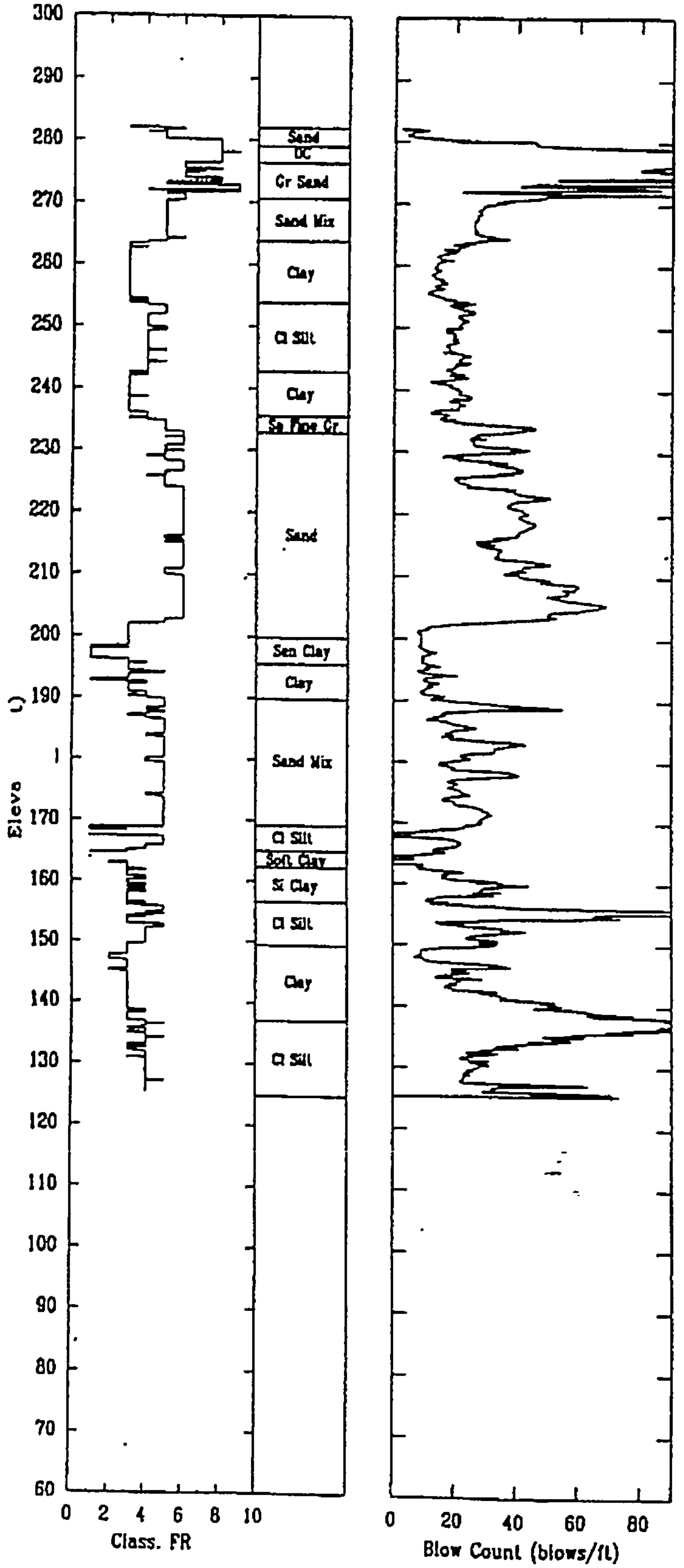
North 73423.0 East 61670.0 Elevation 288.1



File 3220701.ECP

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

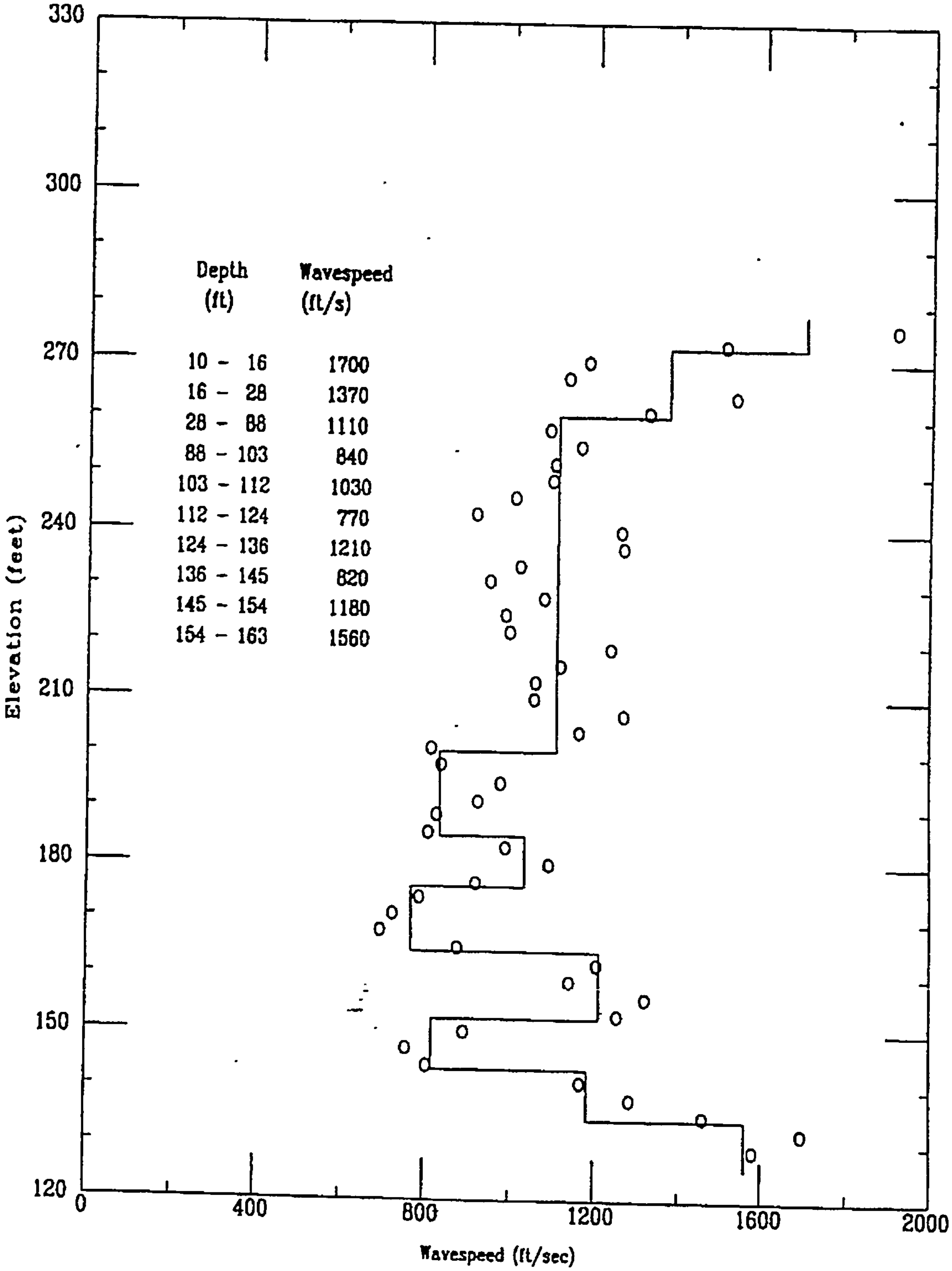
North 73423.0 East 61670.0 Elevation 288.1



File 3220701.ECP

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Shear Wave Speeds

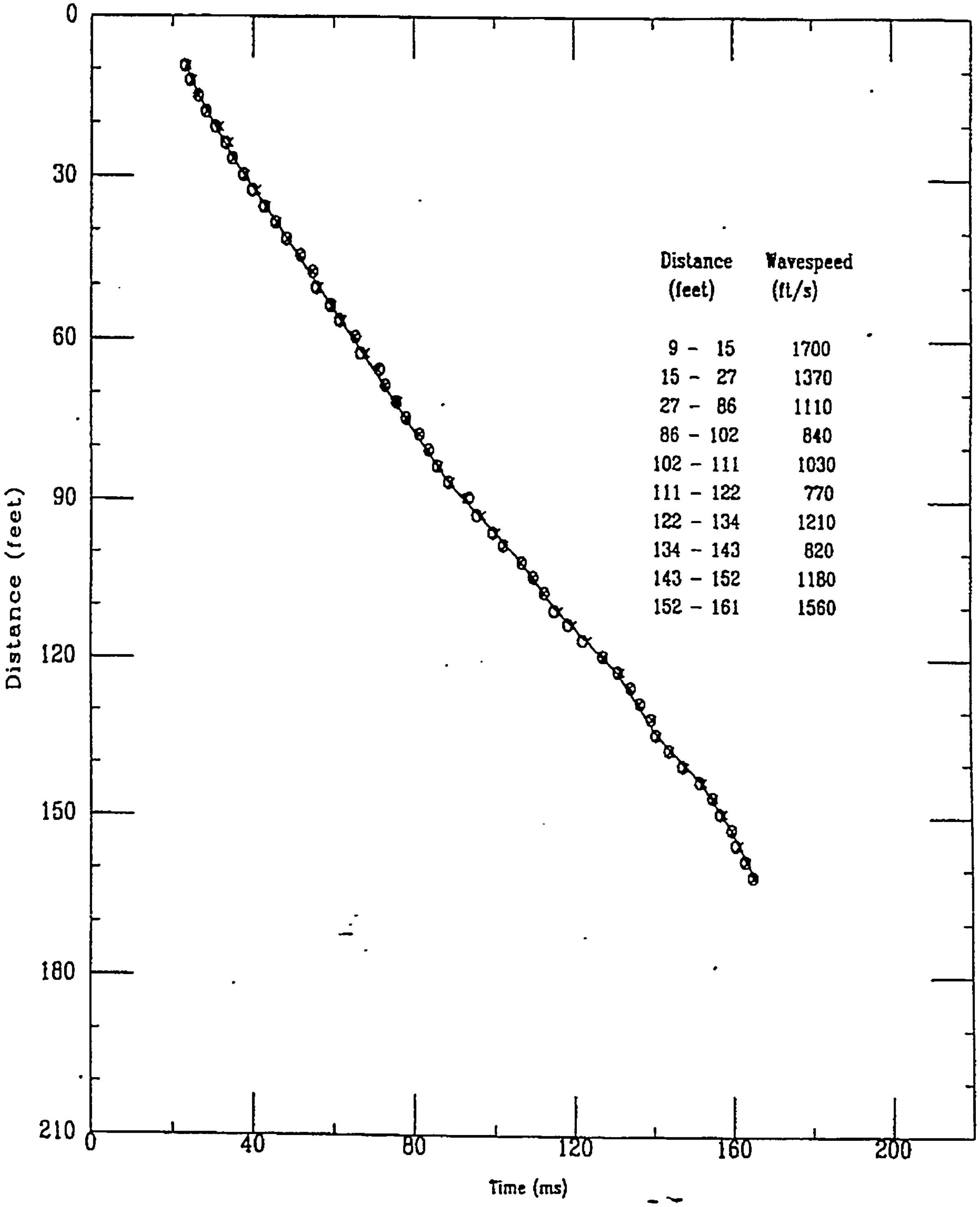


Depth (ft)	Wavespeed (ft/s)
10 - 16	1700
16 - 28	1370
28 - 88	1110
88 - 103	840
103 - 112	1030
112 - 124	770
124 - 136	1210
136 - 145	820
145 - 154	1180
154 - 163	1560

File 3220701S

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Shear Wave Time of Peak



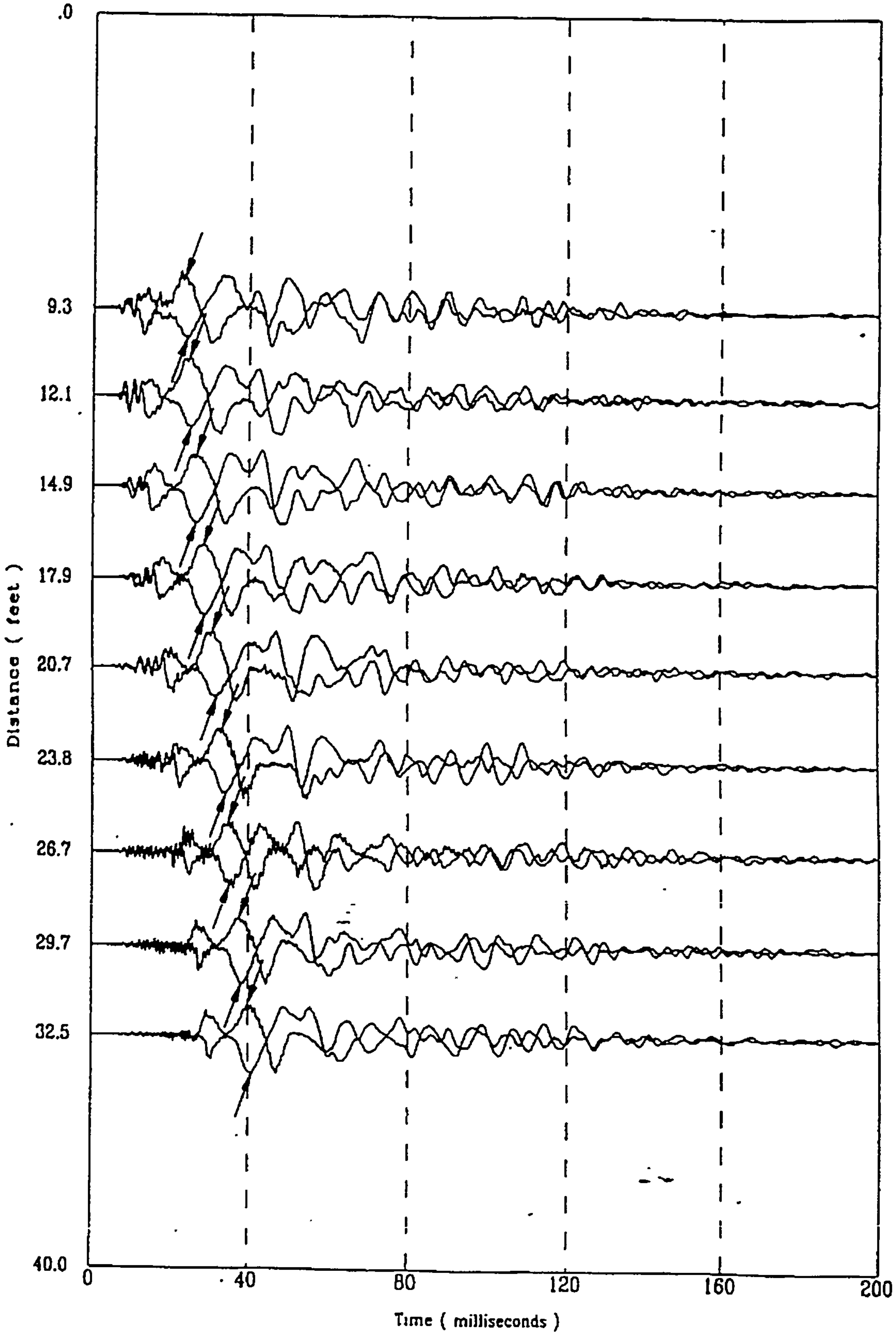
Distance (feet)	Wavespeed (ft/s)
9 - 15	1700
15 - 27	1370
27 - 86	1110
86 - 102	840
102 - 111	1030
111 - 122	770
122 - 134	1210
134 - 143	820
143 - 152	1180
152 - 161	1560

File 32207015

A-115

Applied Research Associates Inc.
HTEF-C09

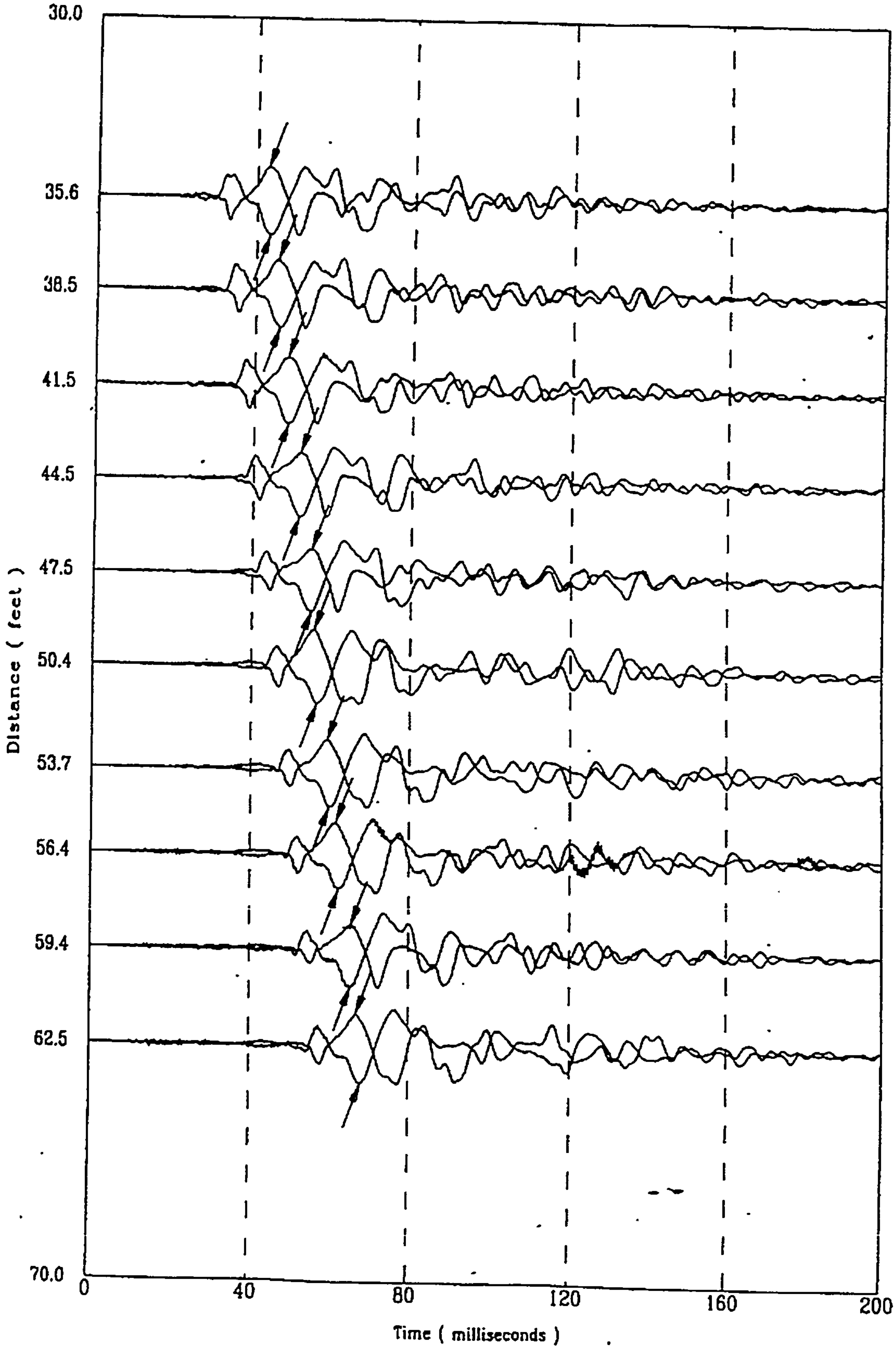
S Wave
10/22/97



File 32207015

Applied Research Associates Inc.
HTEF-C09

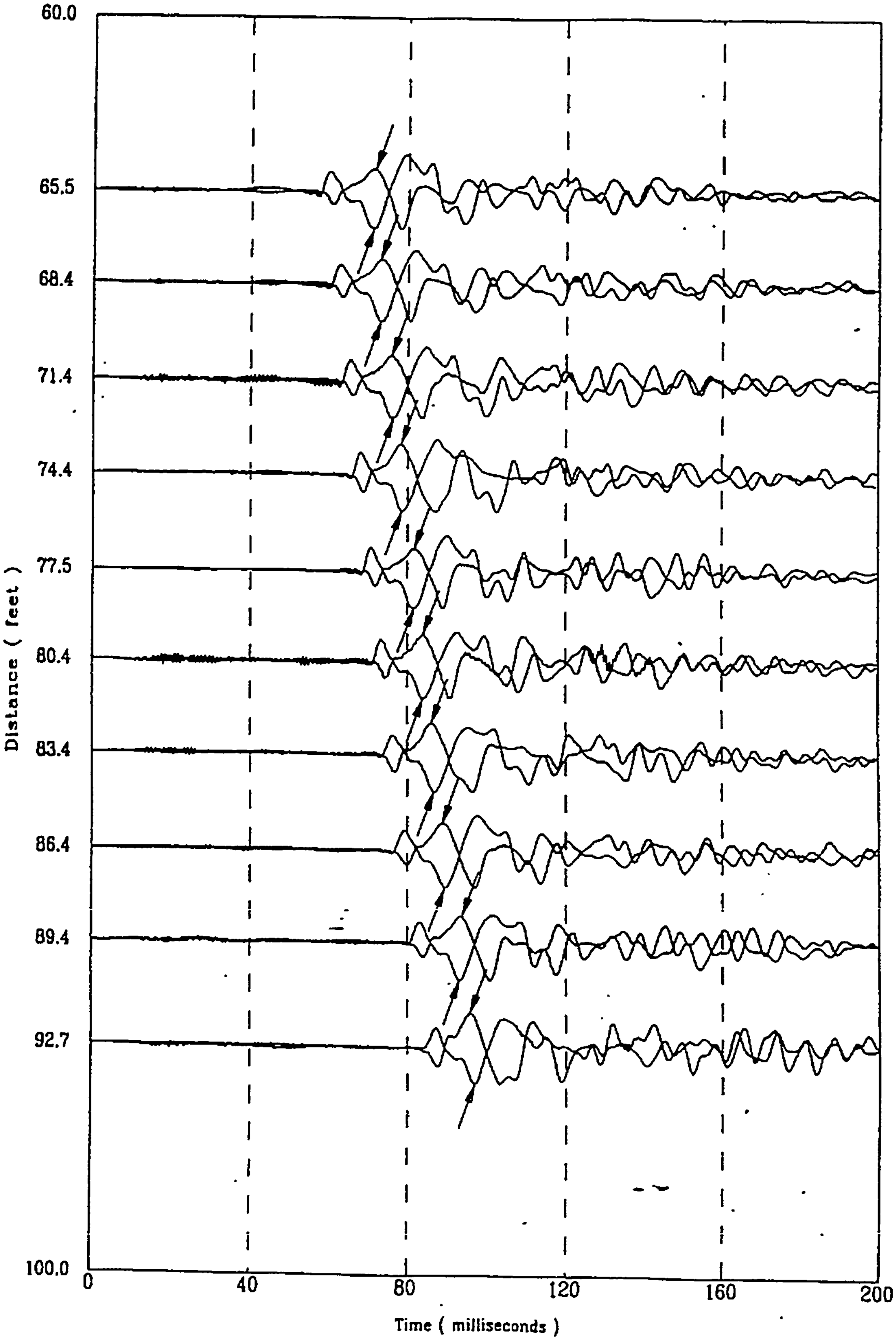
S Wave
10/22/97



File 3220701S

Applied Research Associates Inc.
HTEF-C09

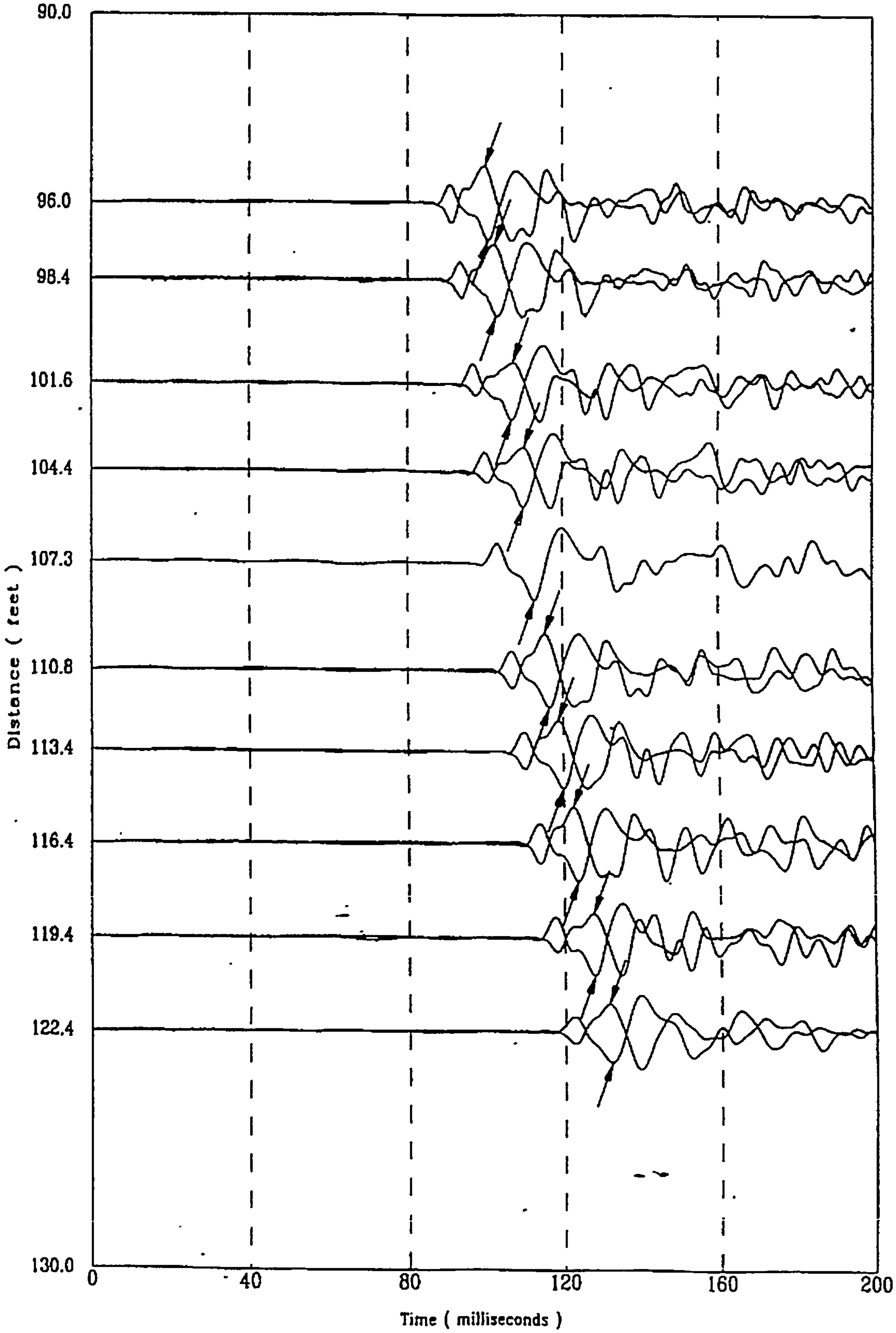
S Wave
10/22/97



File 3220701S

Applied Research Associates Inc.
HTEF-C09

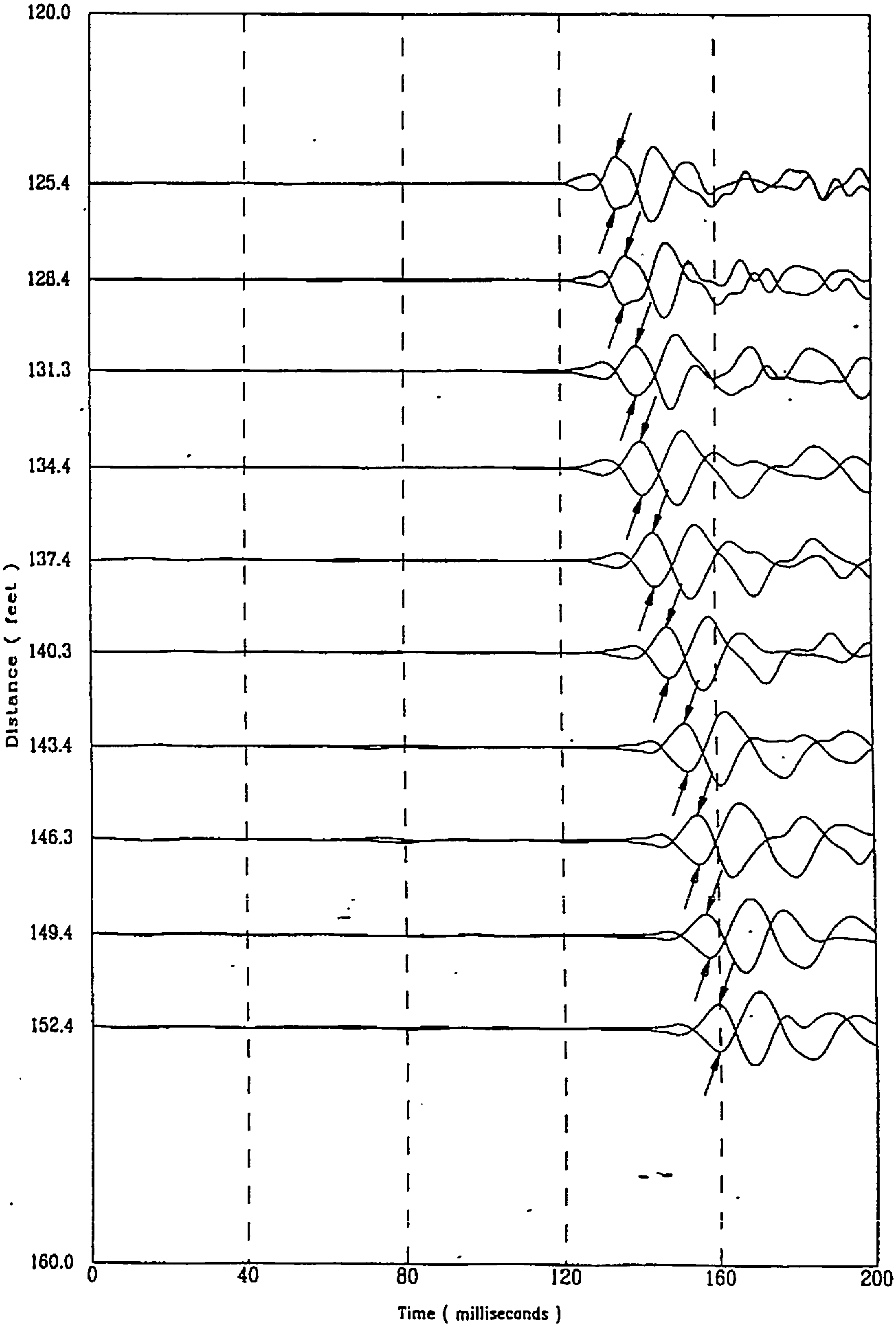
S Wave
10/22/97



File 3220702S

Applied Research Associates Inc.
HTEF-C09

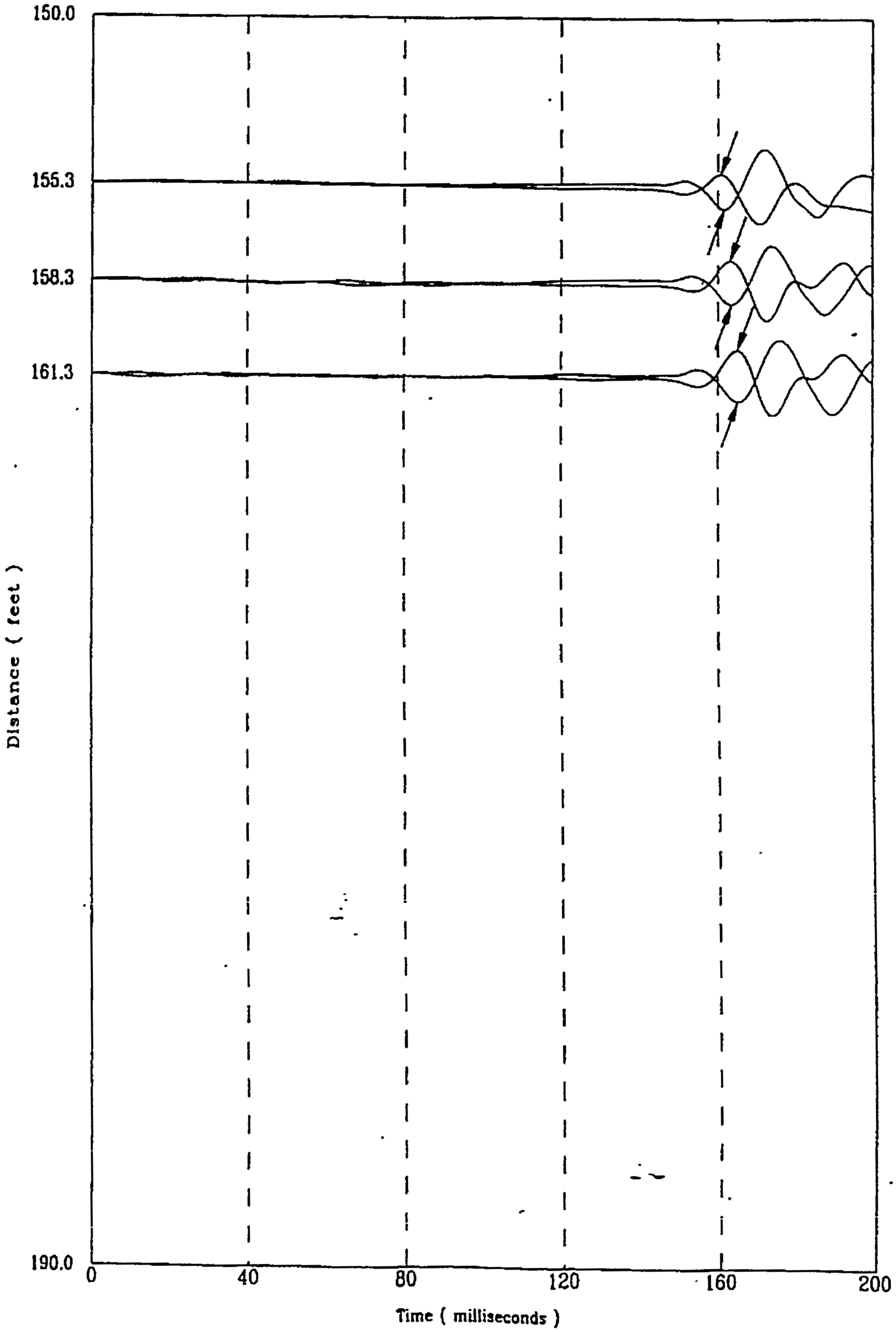
S Wave
10/22/97



File 32207025

Applied Research Associates Inc.
HTEF-C09

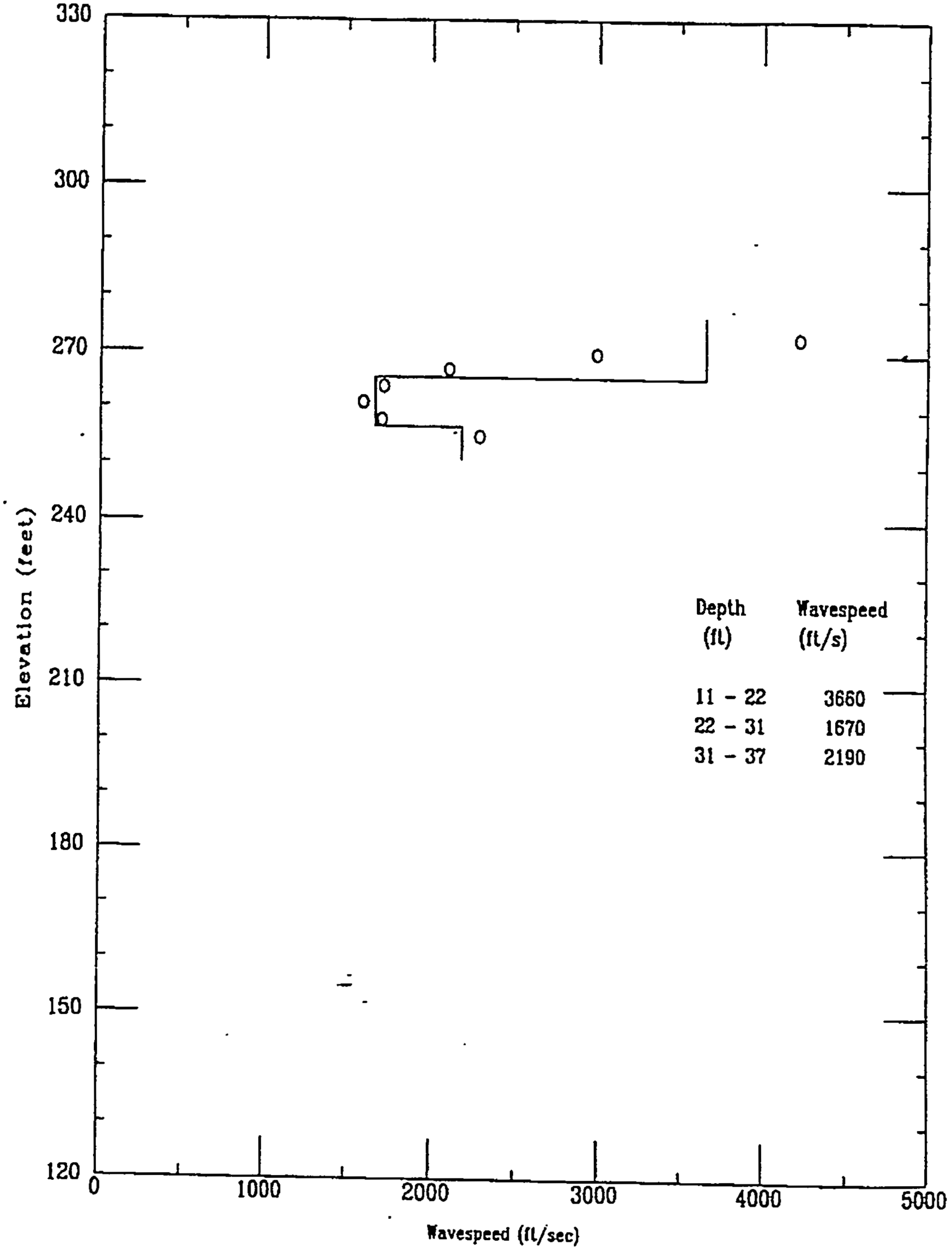
S Wave
10/22/97



File 3220702S

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Compression Wave Speeds

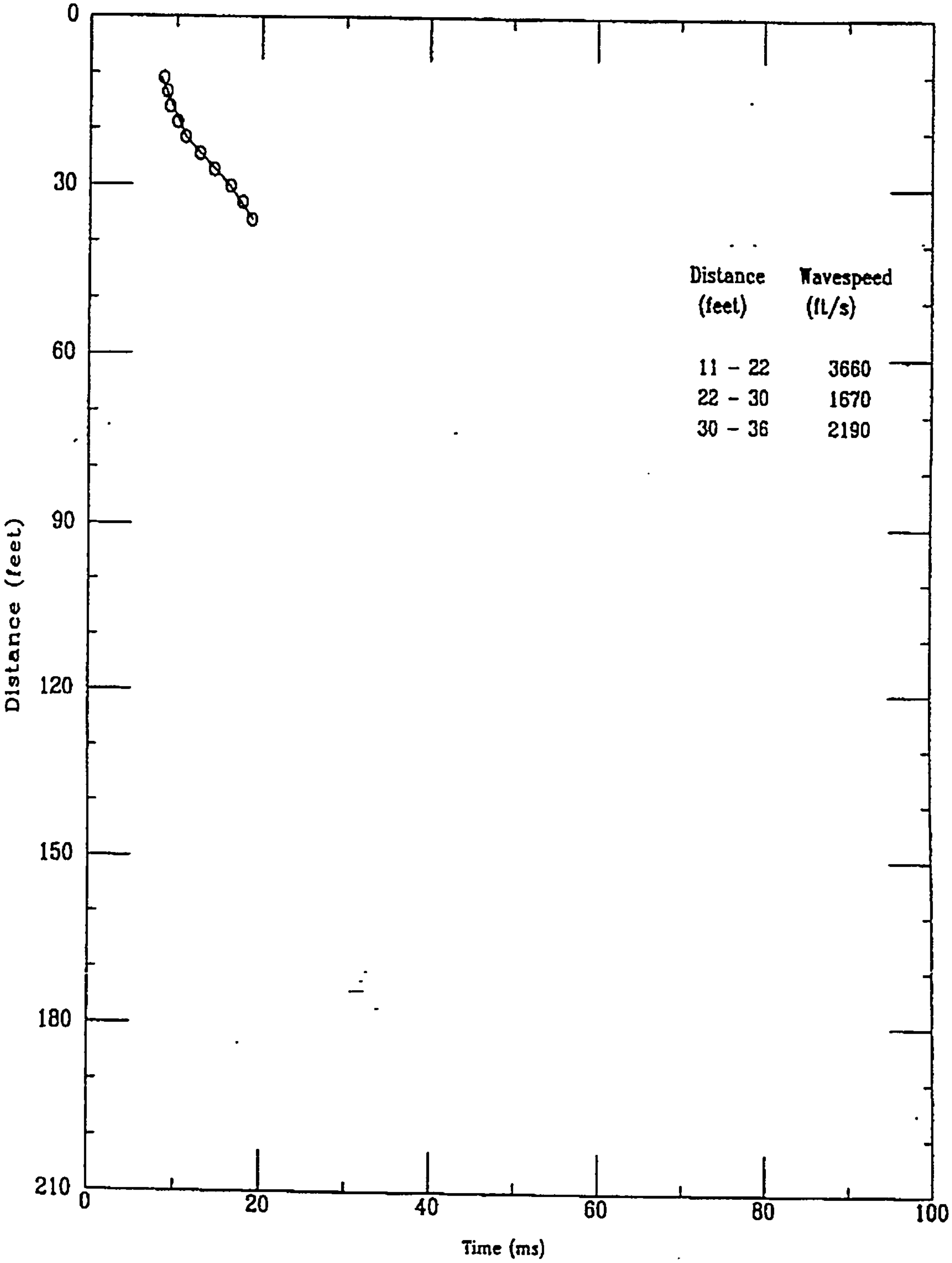


Depth (ft)	Wavespeed (ft/s)
11 - 22	3660
22 - 31	1670
31 - 37	2190

File 3220701S

HTEF-C09 APPLIED RESEARCH ASSOCIATES, INC. 10/22/97

Compression Wave Time of Peak

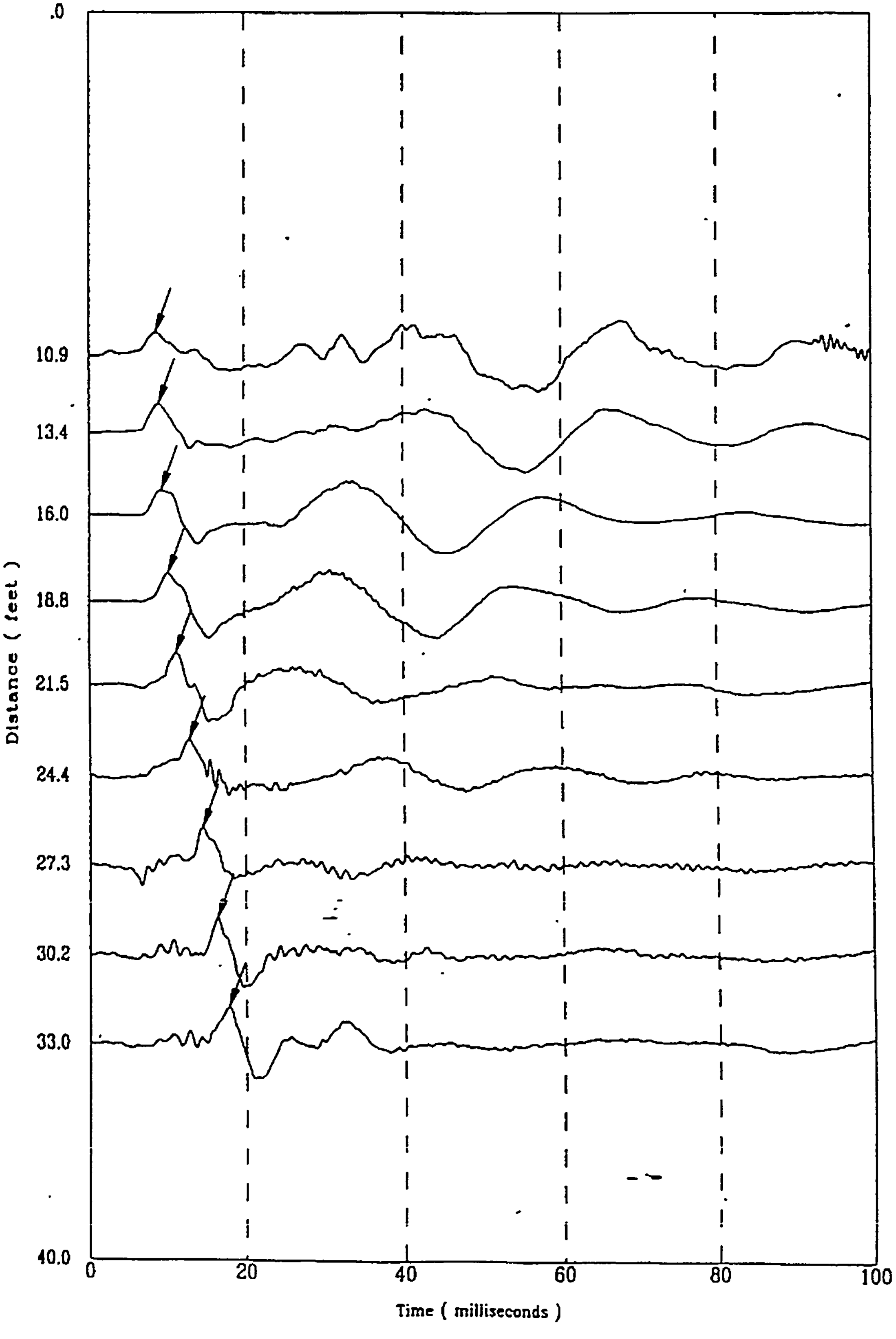


Distance (feet)	Wavespeed (ft/s)
11 - 22	3660
22 - 30	1670
30 - 36	2190

File 32207015

Applied Research Associates Inc.
HTEF-C09

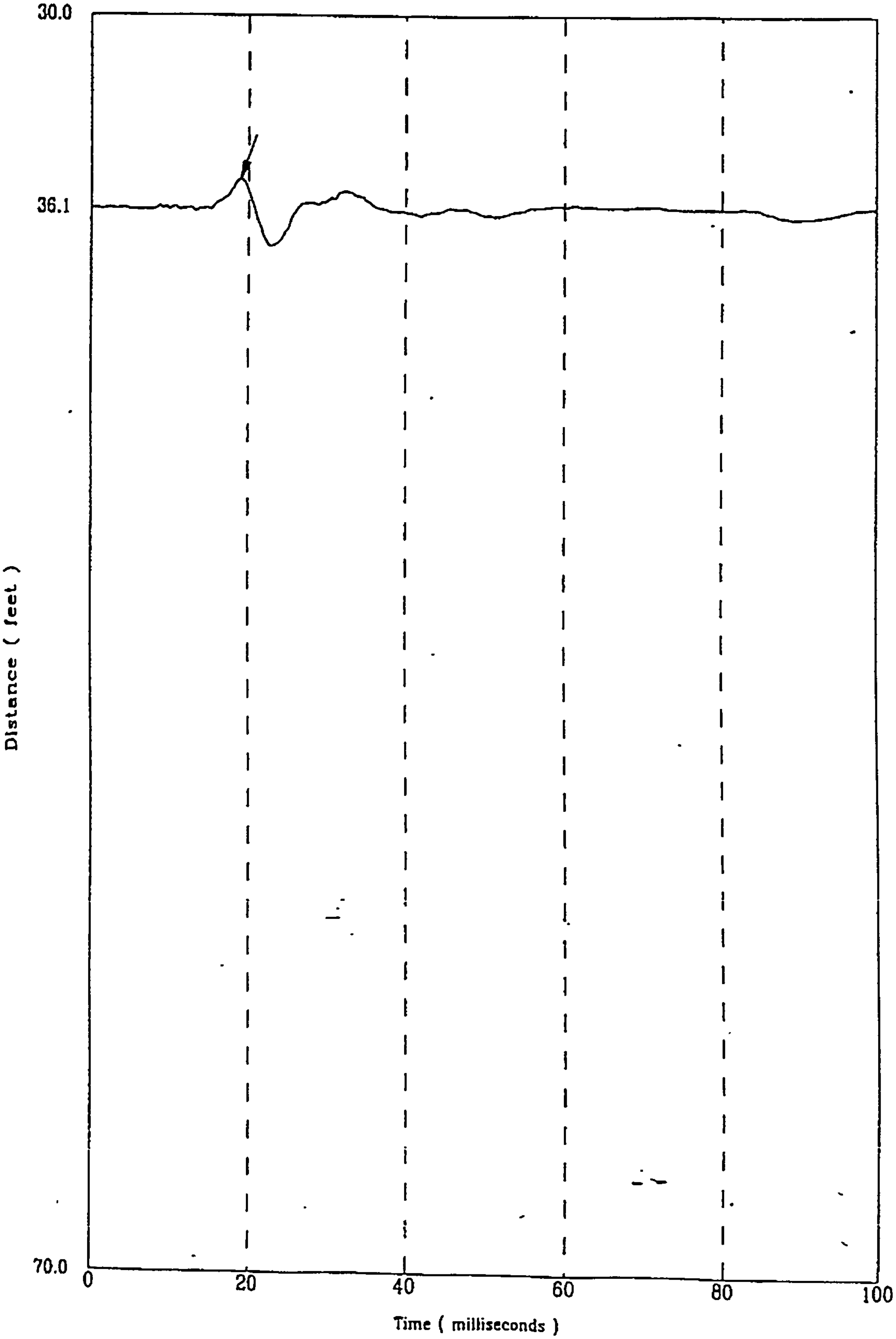
P Wave
10/22/97



File 3220701S

Applied Research Associates Inc.
HTEF-C09

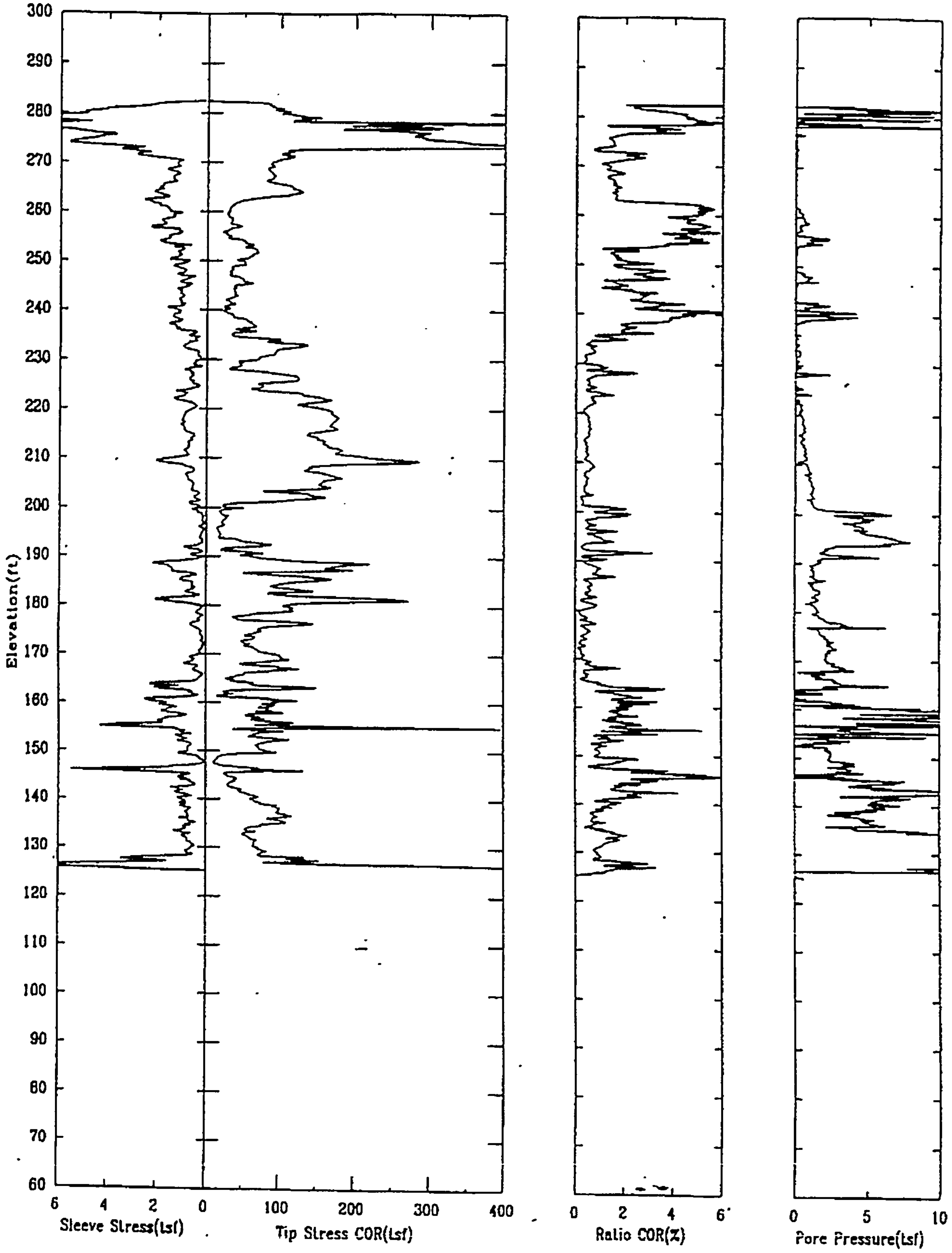
P Wave
10/22/97



File 32207015

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

North 73455.0 East 61774.0 Elevation 288.5

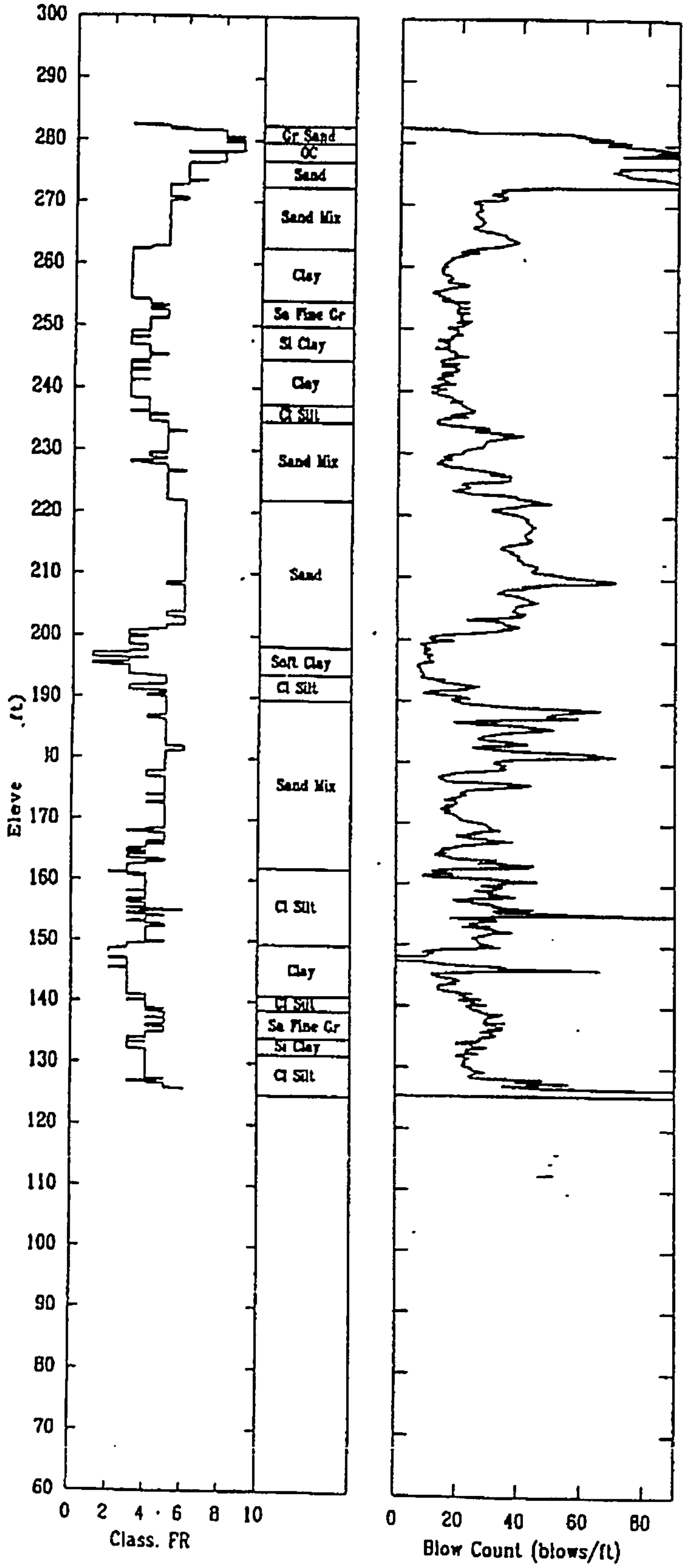


File 3230701.ECP

A-126

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

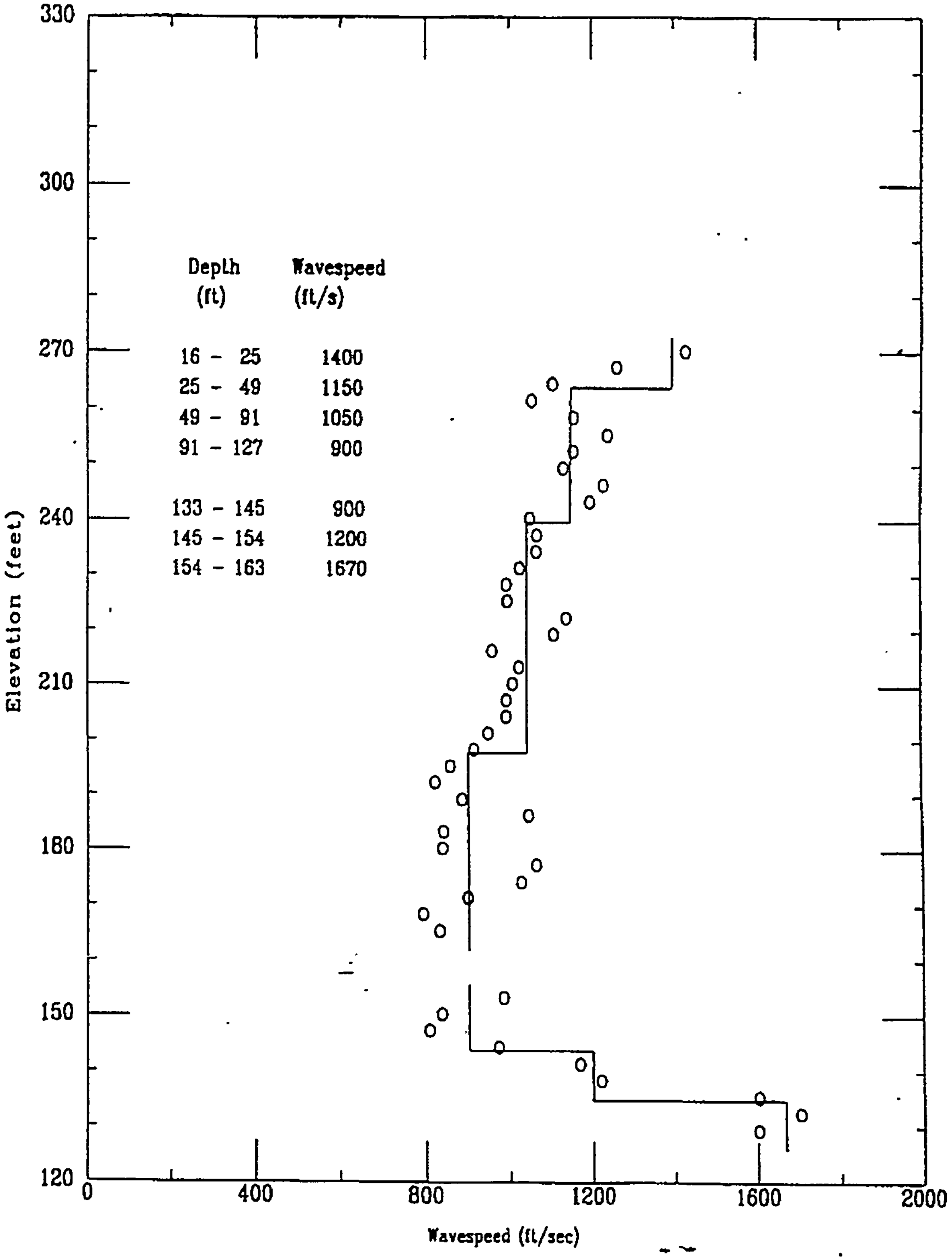
North 73455.0 East 61774.0 Elevation 288.5



File 3230701.ECP

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

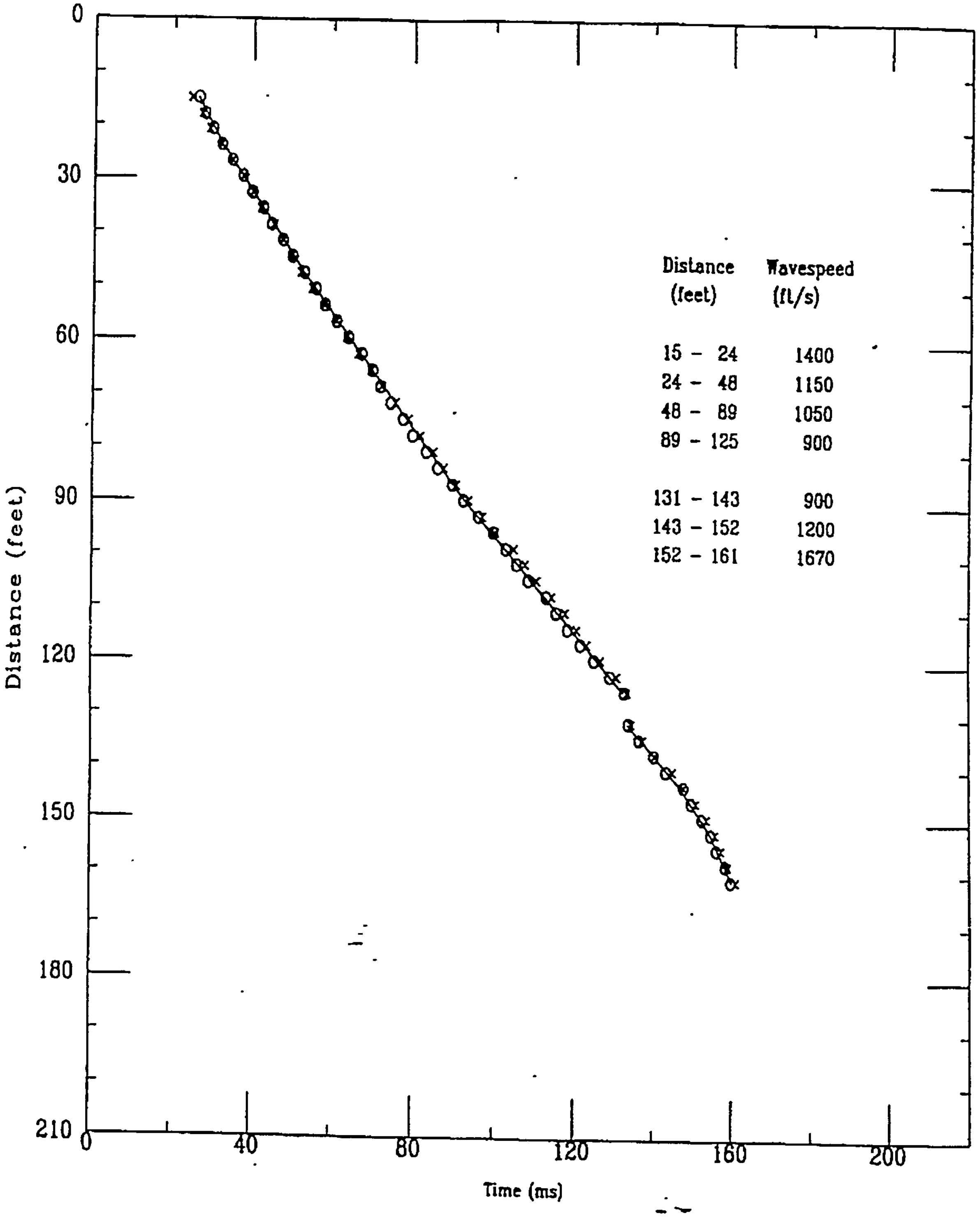
Shear Wave Speeds



File 3230701S

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

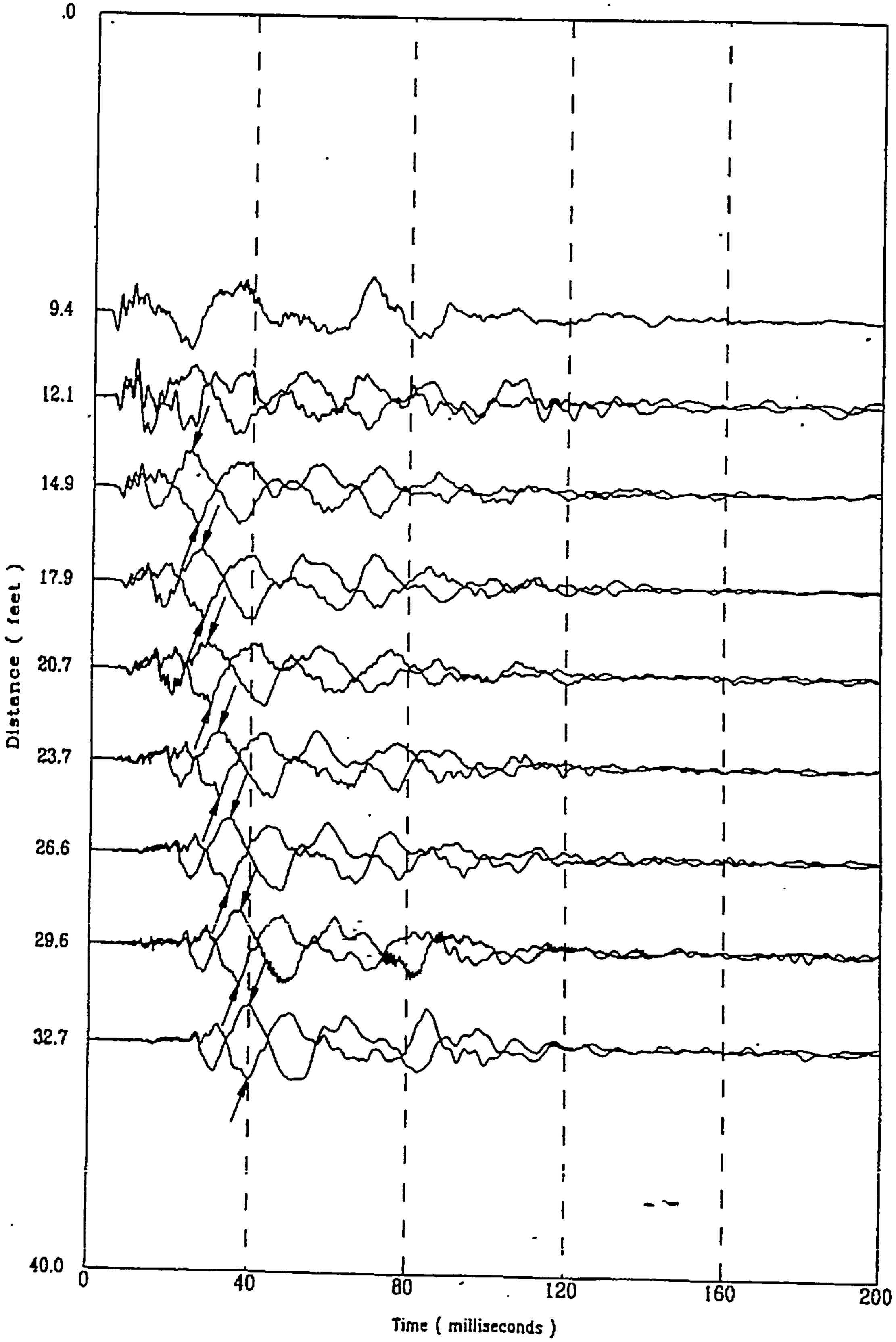
Shear Wave Time of Peak



File 32307015

Applied Research Associates Inc.
HTEF-C10

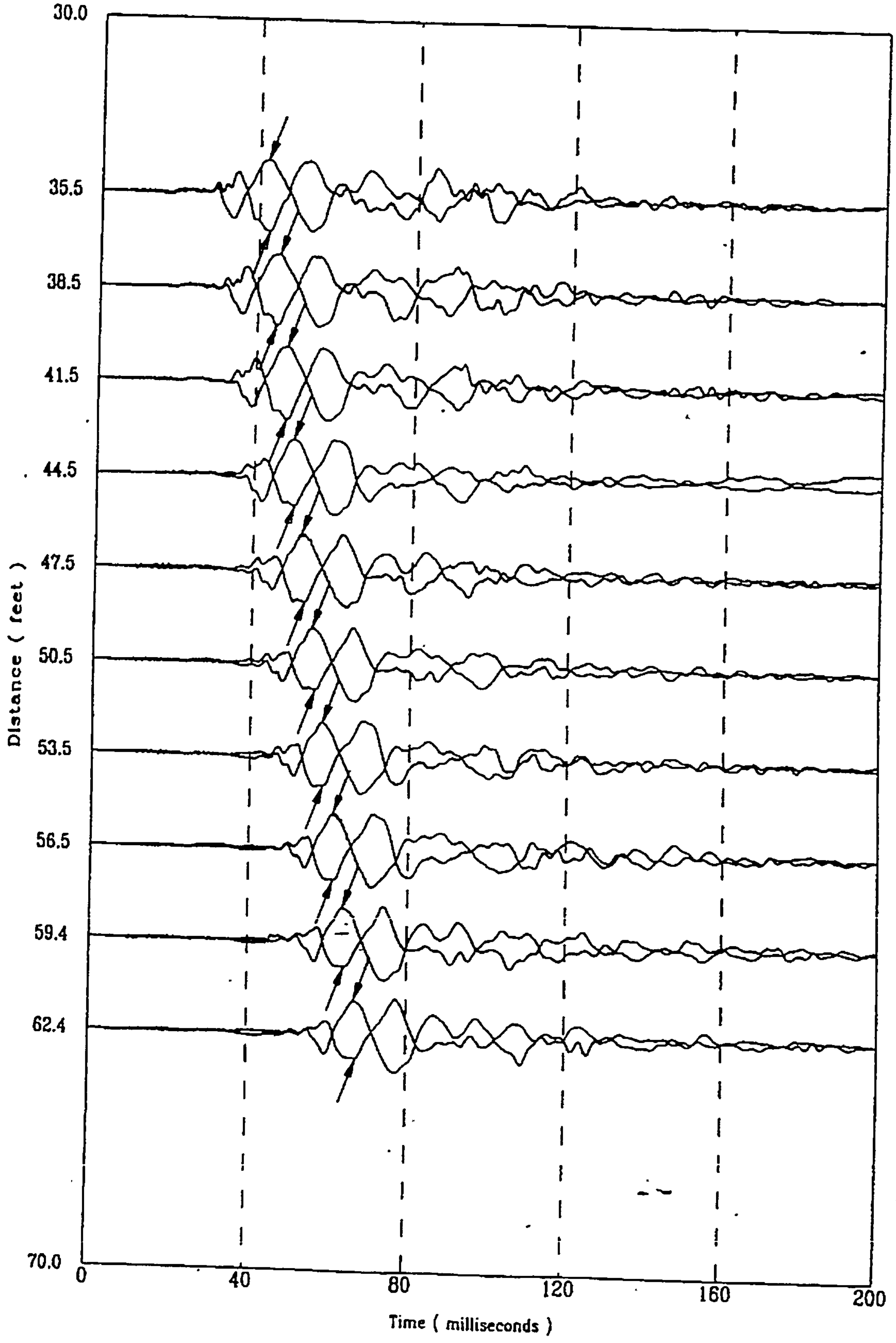
S Wave
10/23/97



File 3230701S

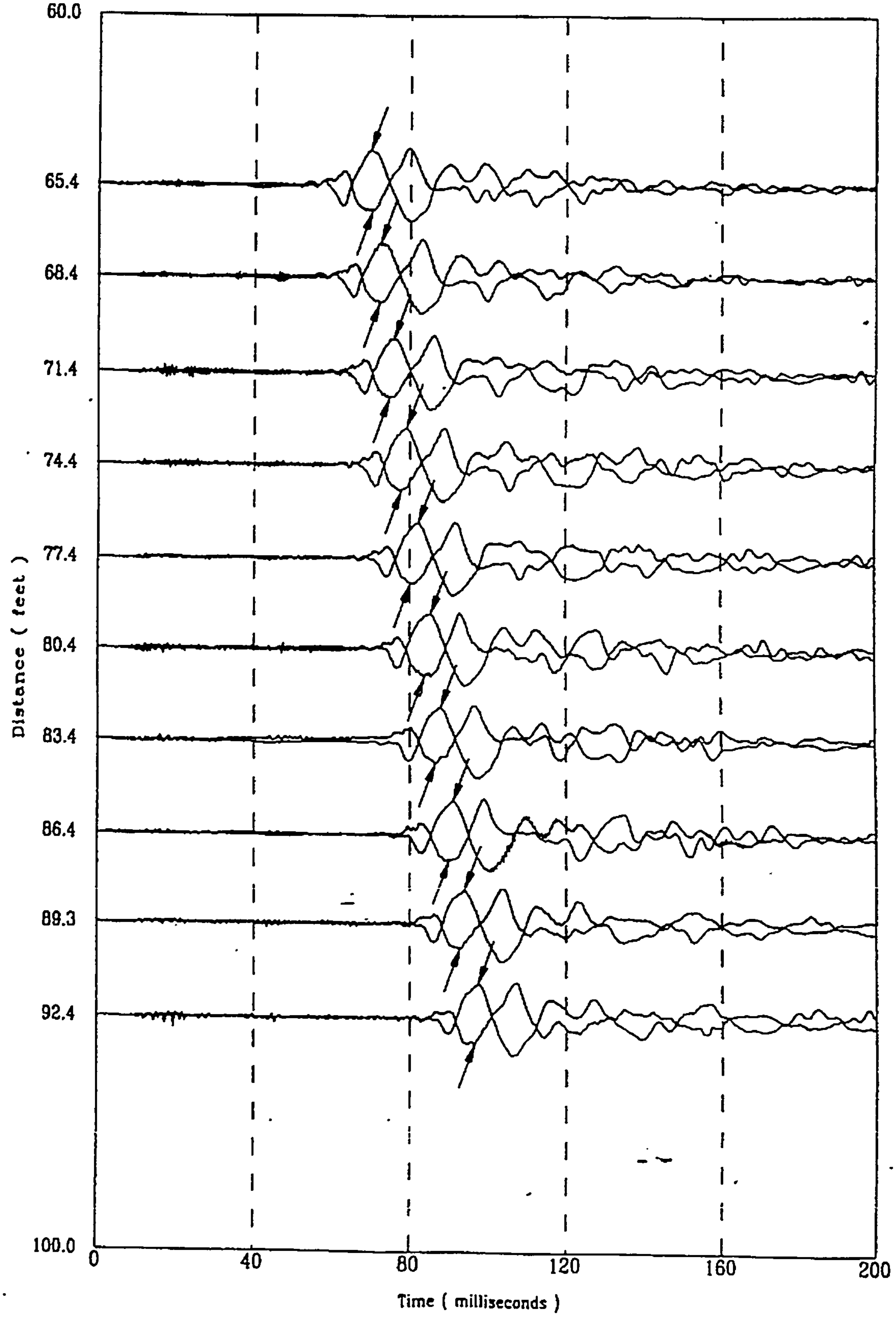
Applied Research Associates Inc.
HTEF-C10

S Wave
10/23/97



Applied Research Associates Inc.
HTEF-C10

S Wave
10/23/97

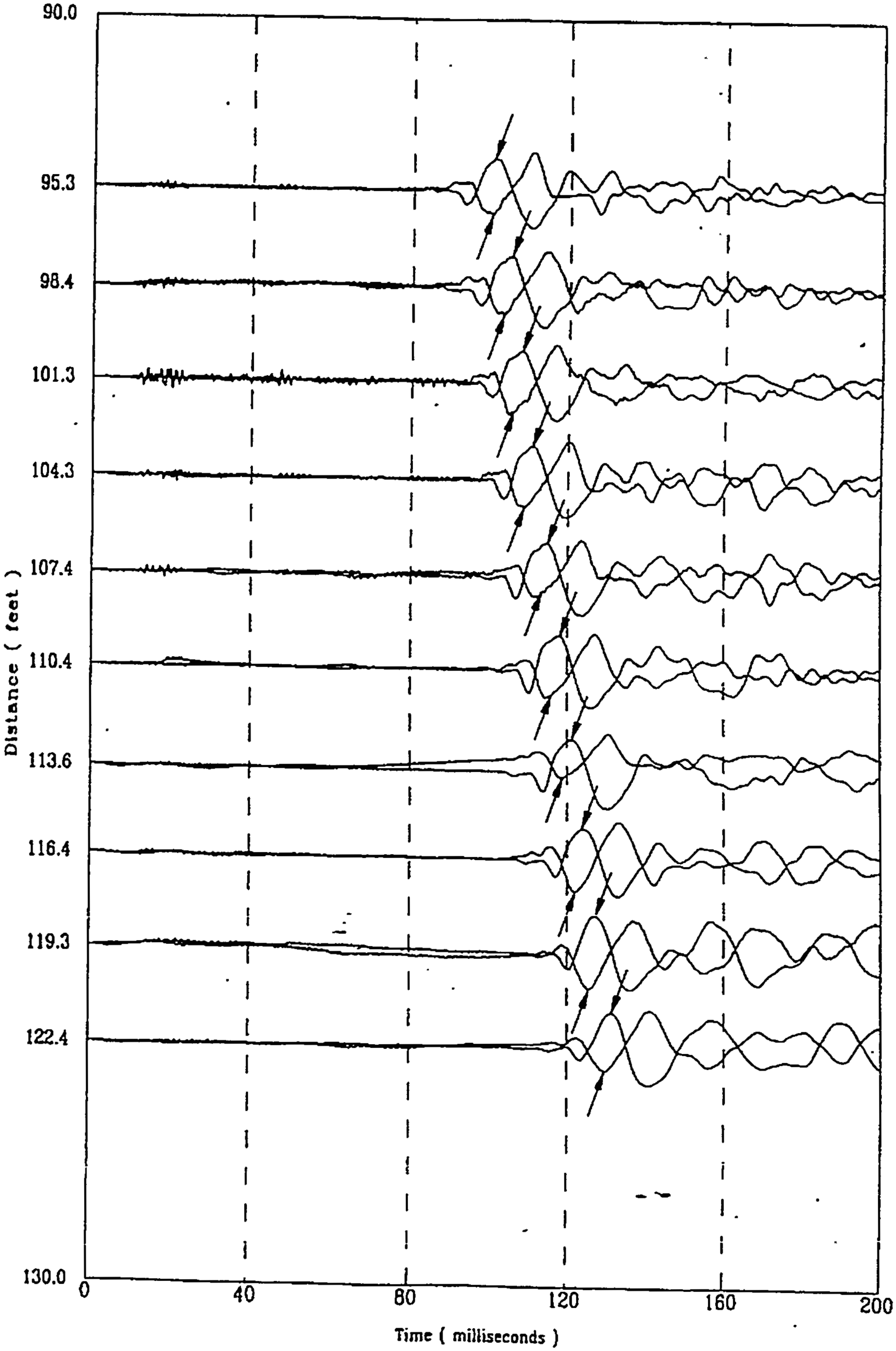


File 3230701S

A-132

Applied Research Associates Inc.
HTEF-C10

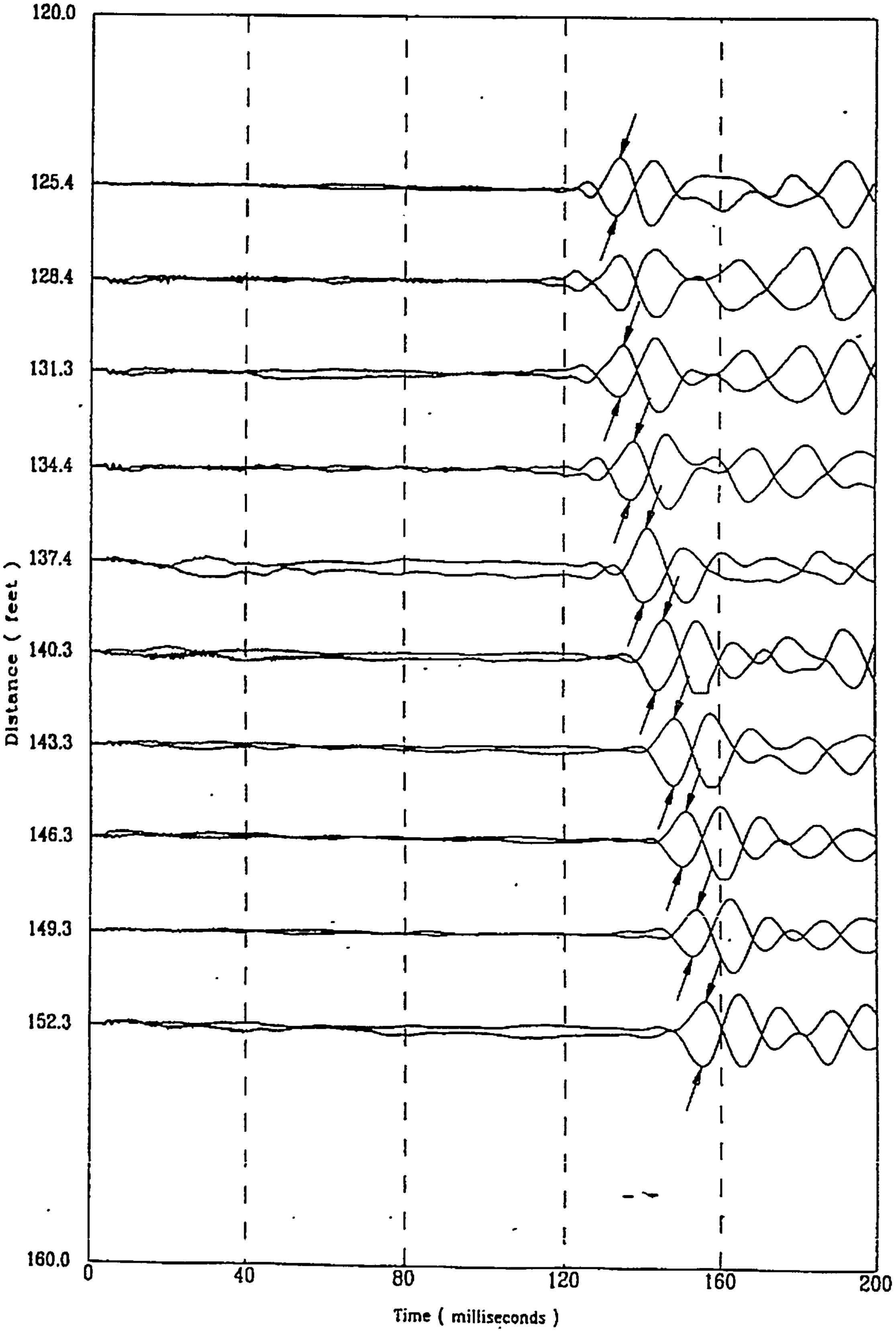
S Wave
10/23/97



File 3230702S

Applied Research Associates Inc.
HTEF-C10

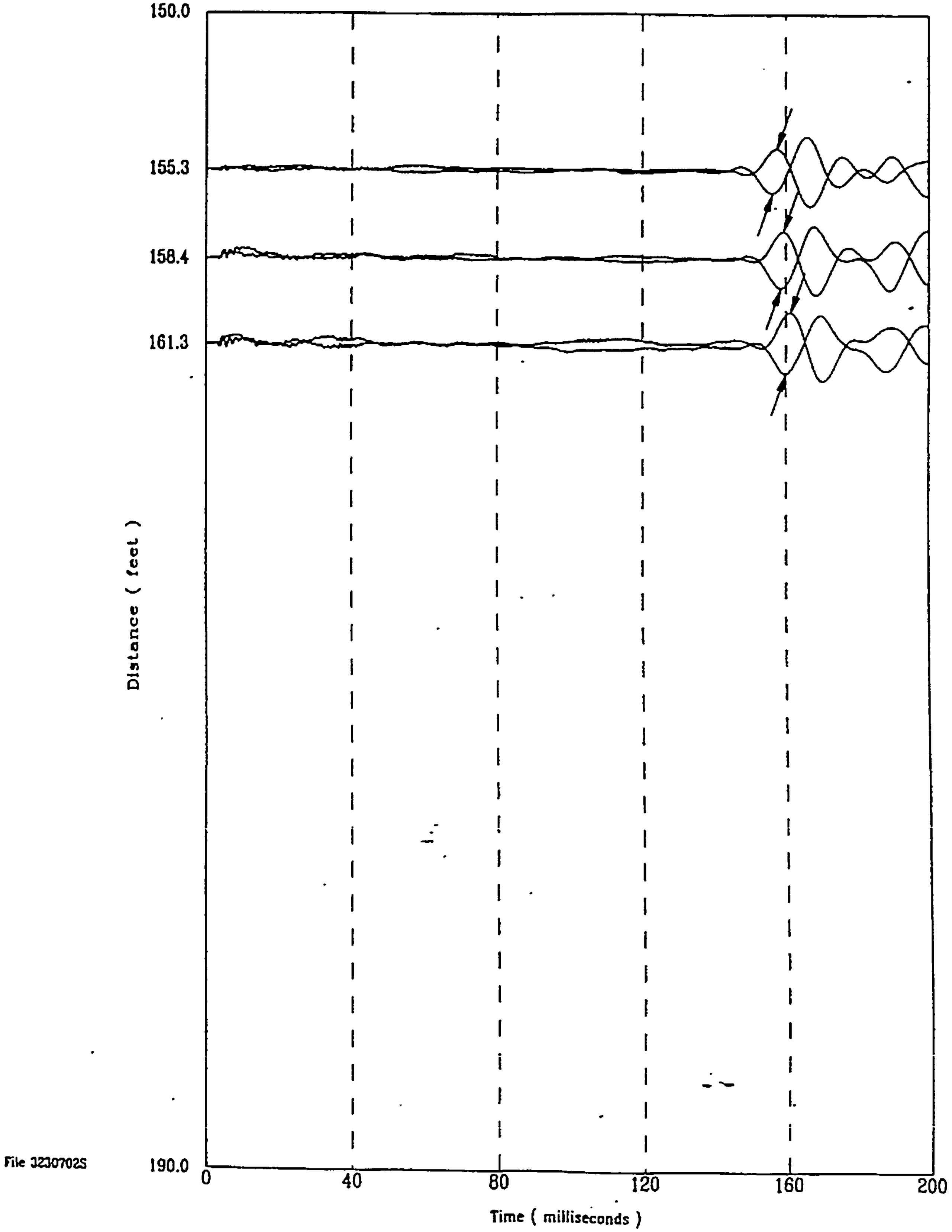
S Wave
10/23/97



File 32307025

Applied Research Associates Inc.
HTEF-C10

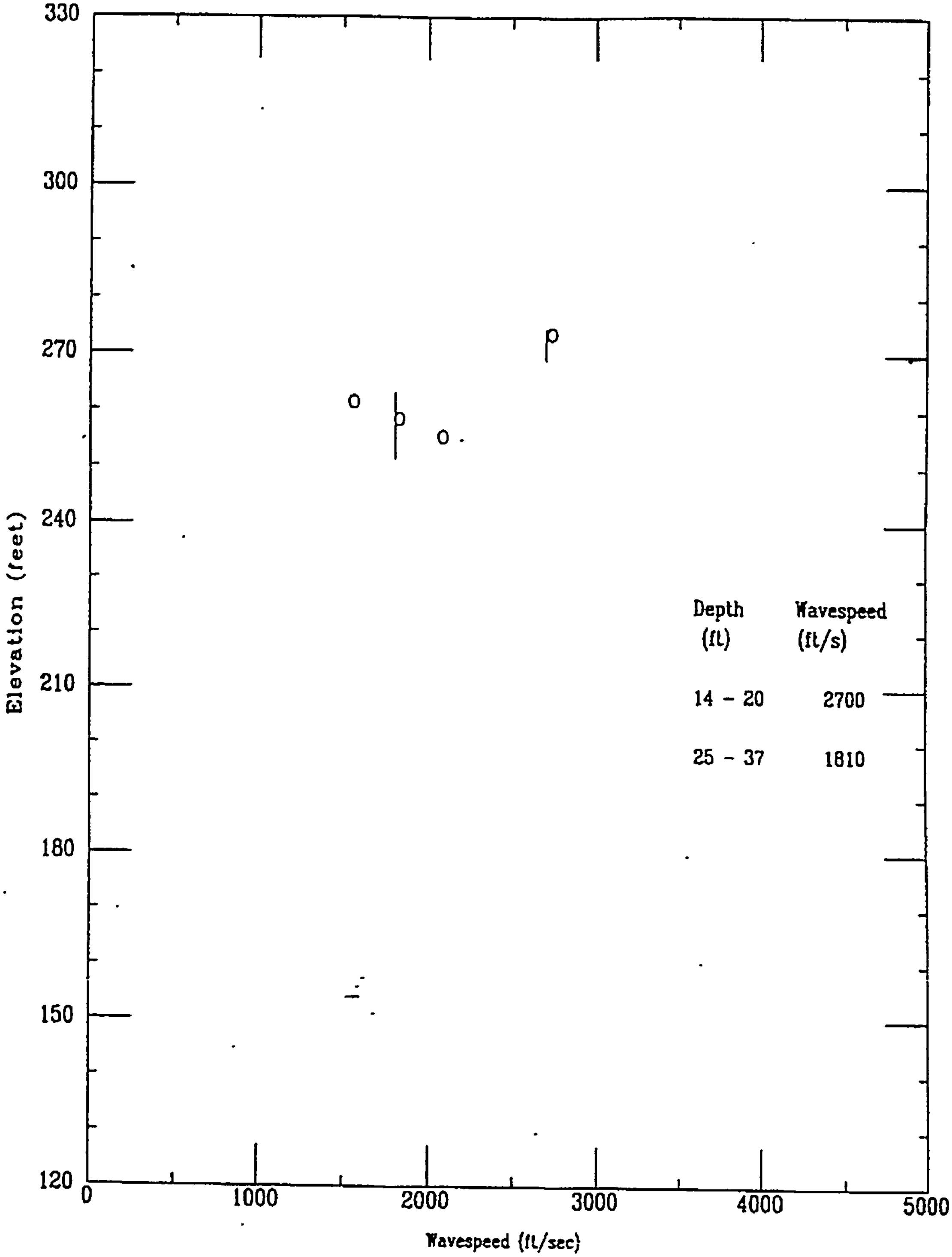
S Wave
10/23/97



A-135

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

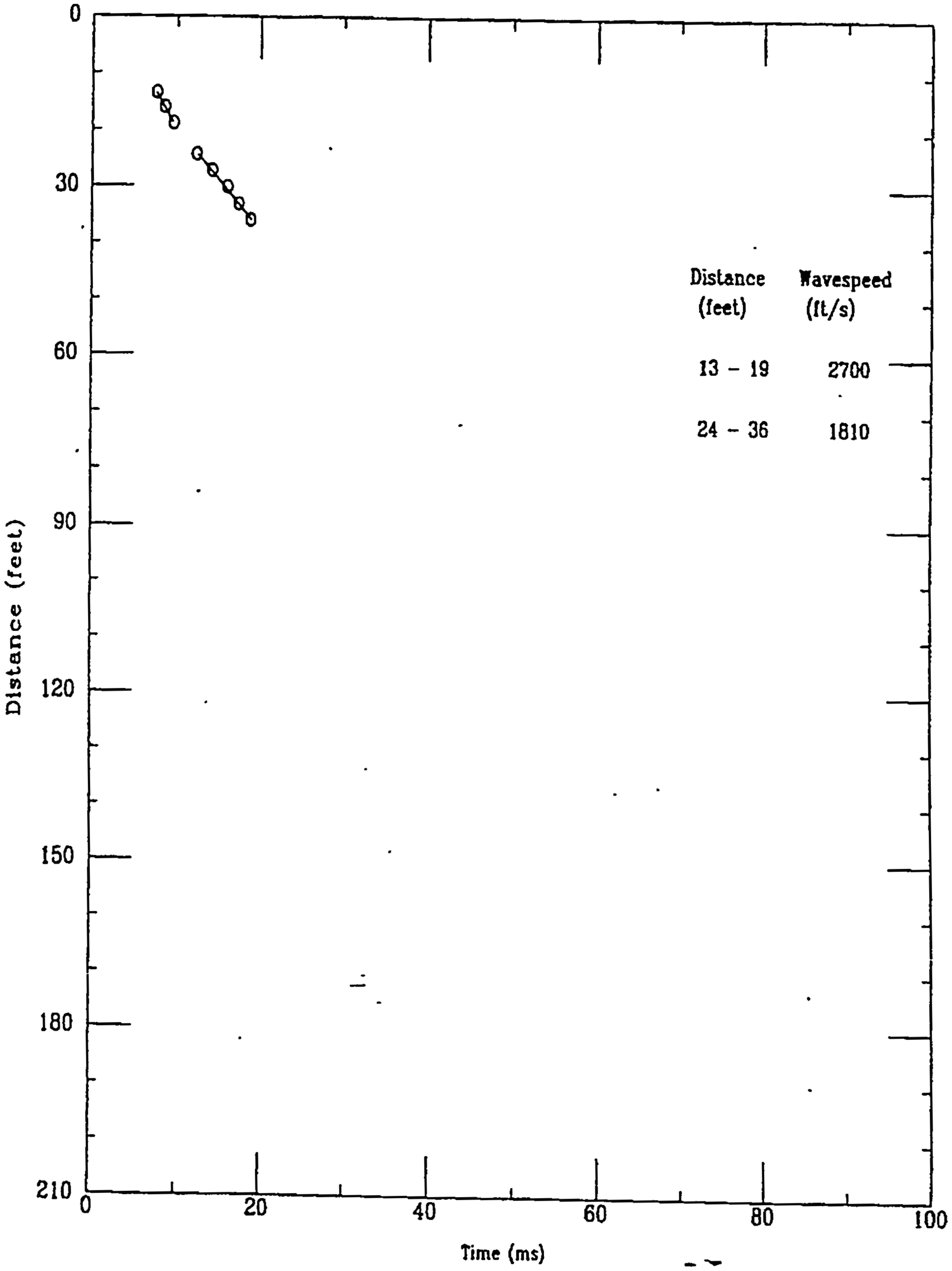
Compression Wave Speeds



File 3230701S

HTEF-C10 APPLIED RESEARCH ASSOCIATES, INC. 10/23/97

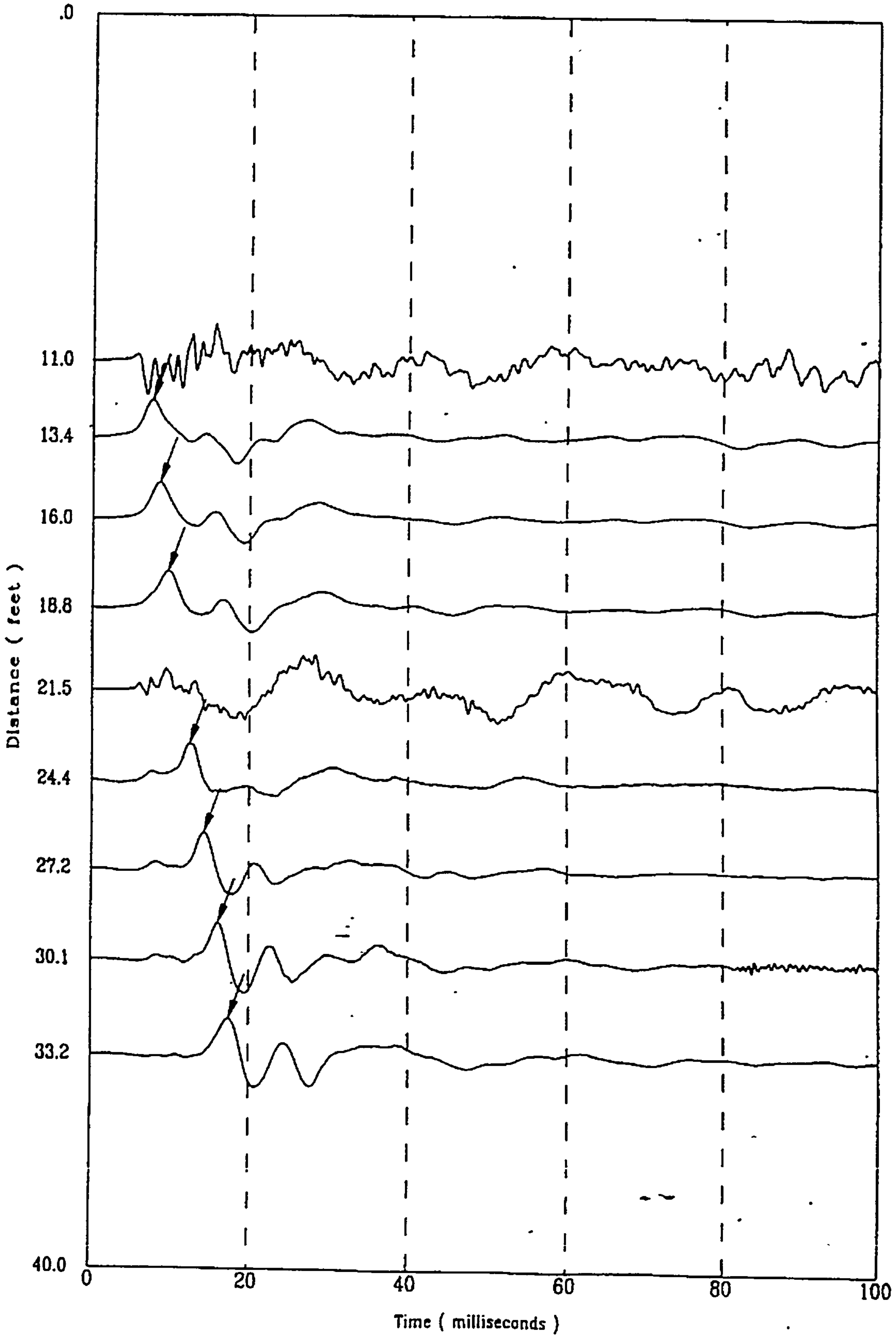
Compression Wave Time of Peak



File 3230701S

Applied Research Associates Inc.
HTEF-C10

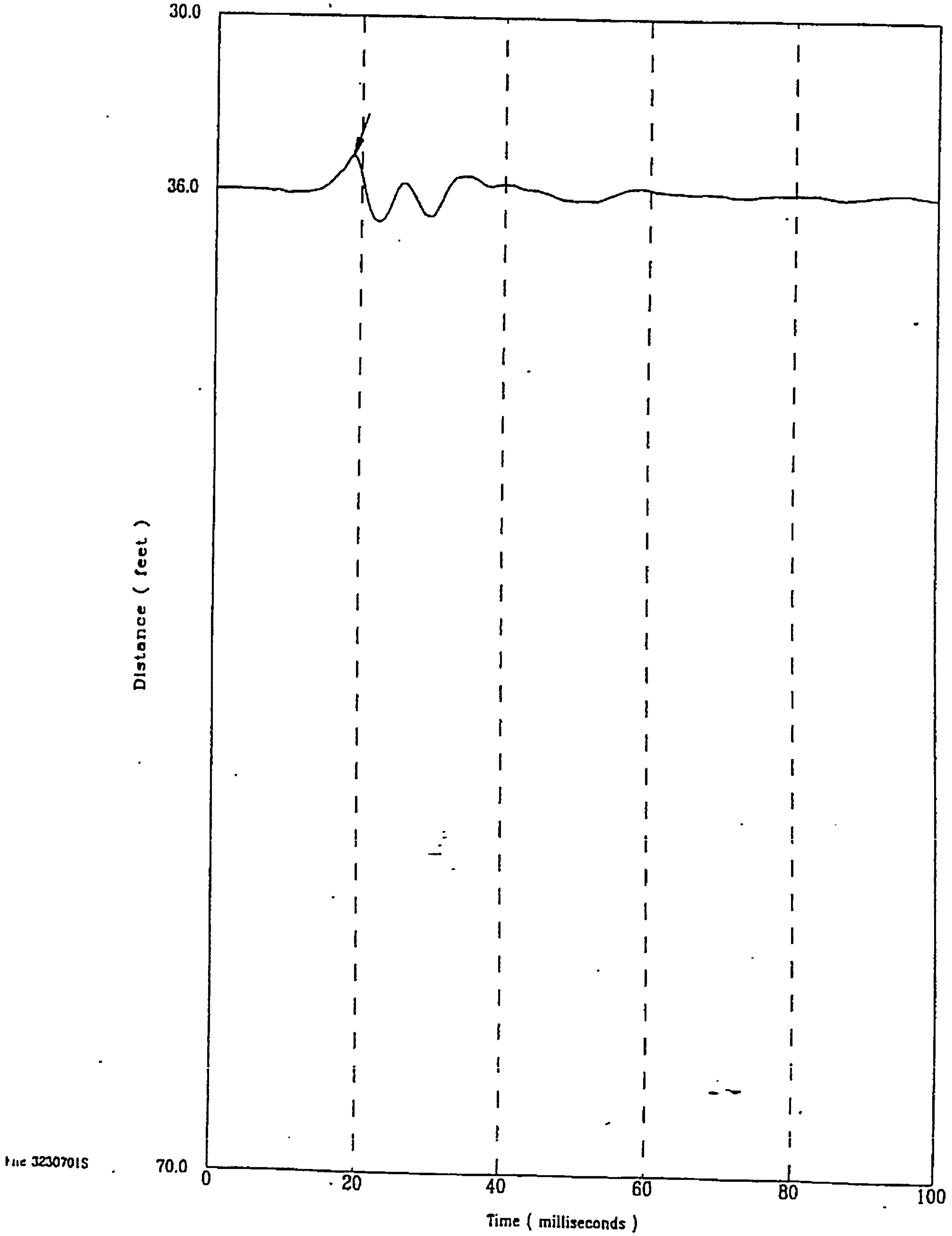
P Wave
10/23/97



File 32307015

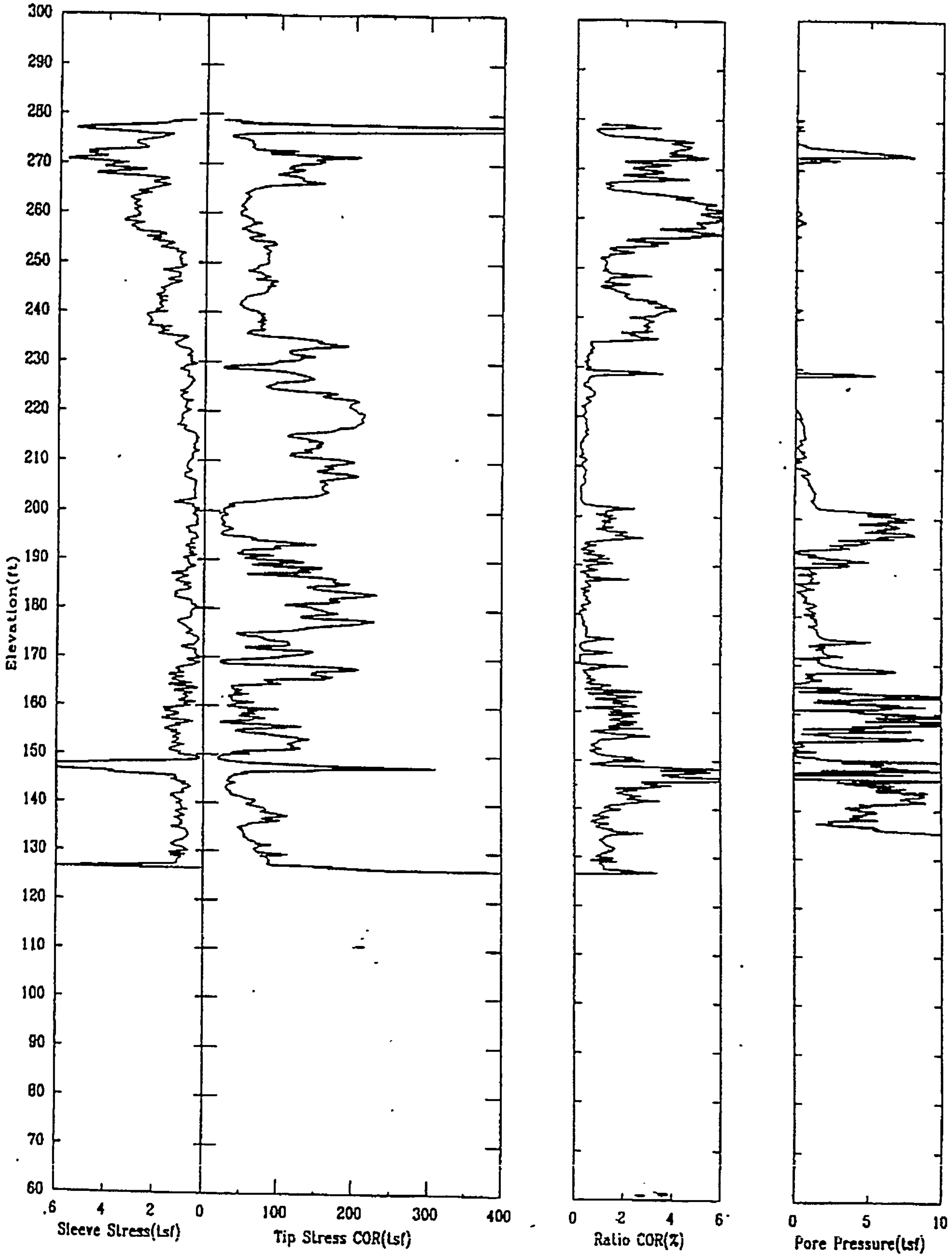
Applied Research Associates Inc.
HTEF-C10

P Wave
10/23/97



HTEF-C11 APPLIED RESEARCH ASSOCIATES, INC. 10/20/97

North 73506.0 East 61573.0 Elevation 284.9

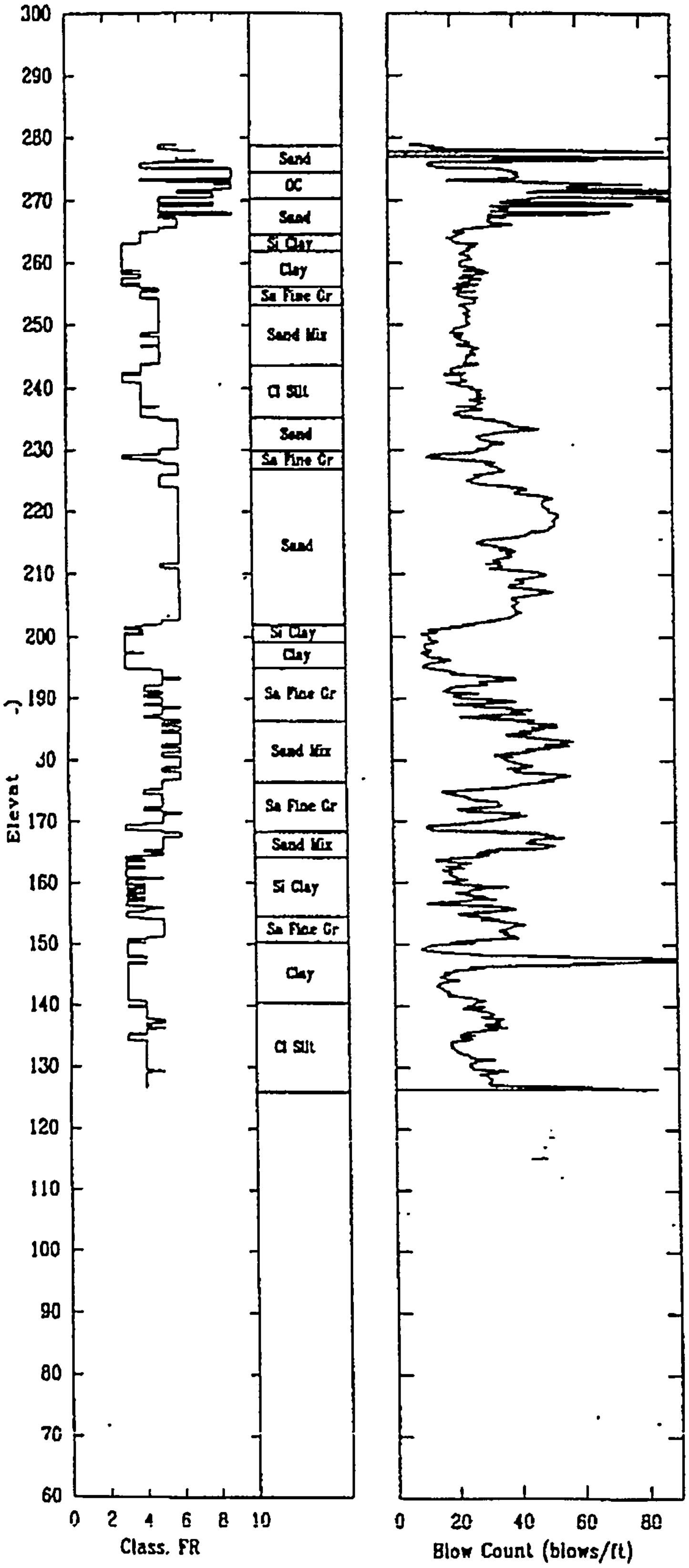


File 3200701.ECP

A-140

HTEF-C11 APPLIED RESEARCH ASSOCIATES, INC. 10/20/97

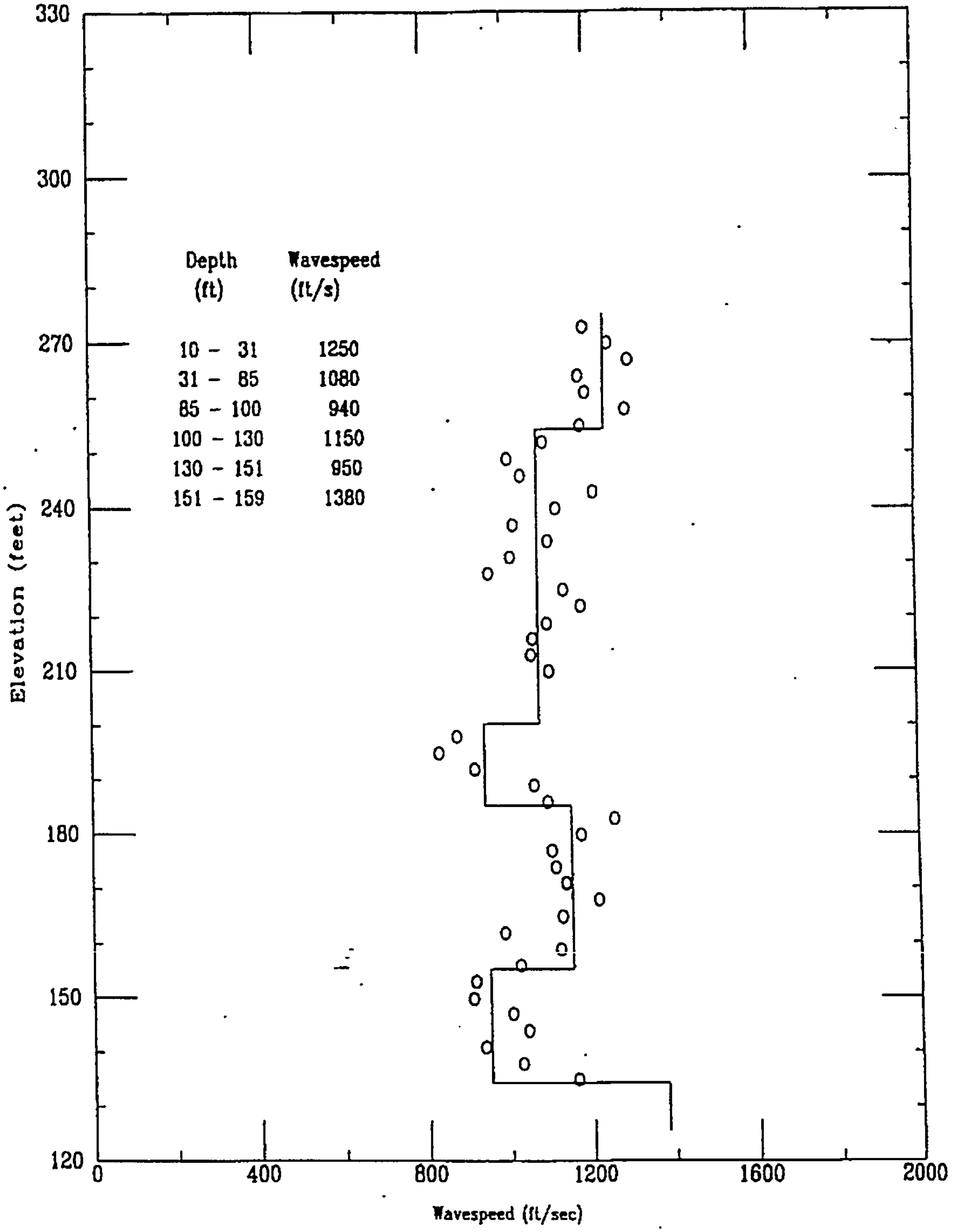
North 73506.0 East 61573.0 Elevation 284.9



File 3200701.ECP

HTEF-C11 APPLIED RESEARCH ASSOCIATES; INC. 10/20/97

Shear Wave Speeds

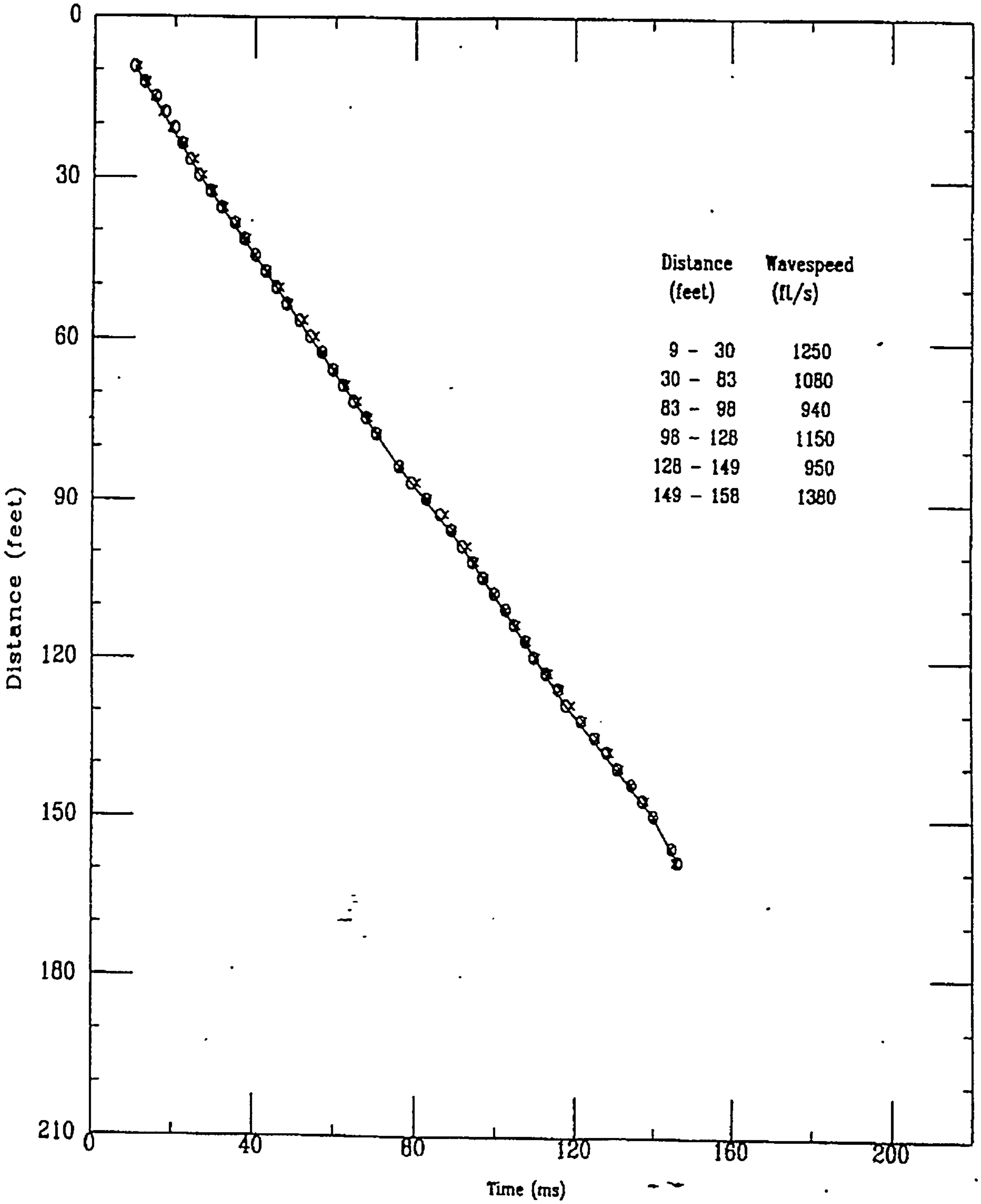


Depth (ft)	Wavespeed (ft/s)
10 - 31	1250
31 - 85	1080
85 - 100	940
100 - 130	1150
130 - 151	950
151 - 159	1380

File 32007015

HTEF-C11 APPLIED RESEARCH ASSOCIATES, INC. 10/20/97

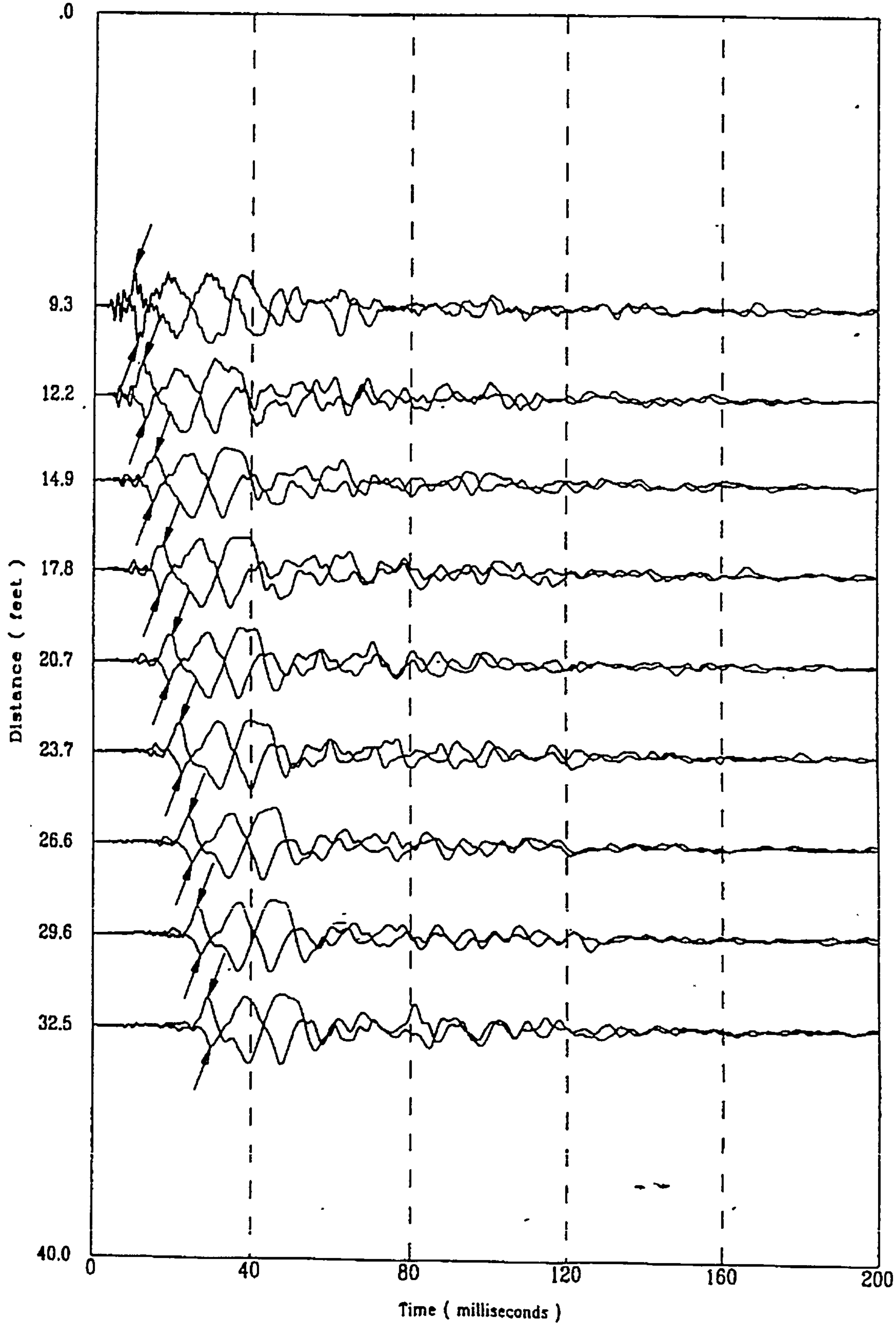
Shear Wave Time of Peak



Distance (feet)	Wavespeed (ft/s)
9 - 30	1250
30 - 83	1080
83 - 98	940
98 - 128	1150
128 - 149	950
149 - 158	1380

Applied Research Associates Inc.
HTEF-C11

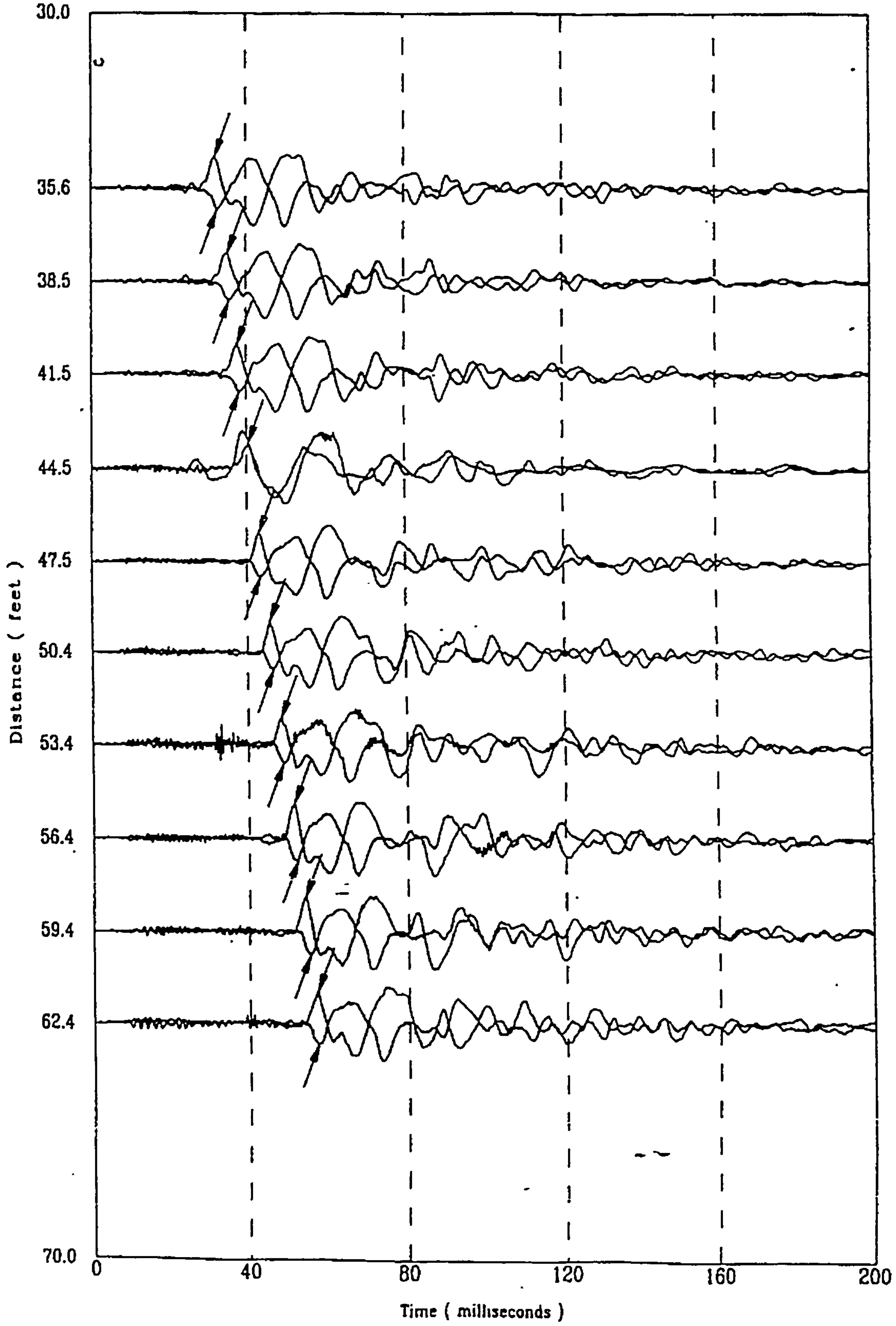
S Wave
10/20/97



File 32007015

A-144

Applied Research Associates Inc.　　S Wave
HTEF-C11　　10/20/97

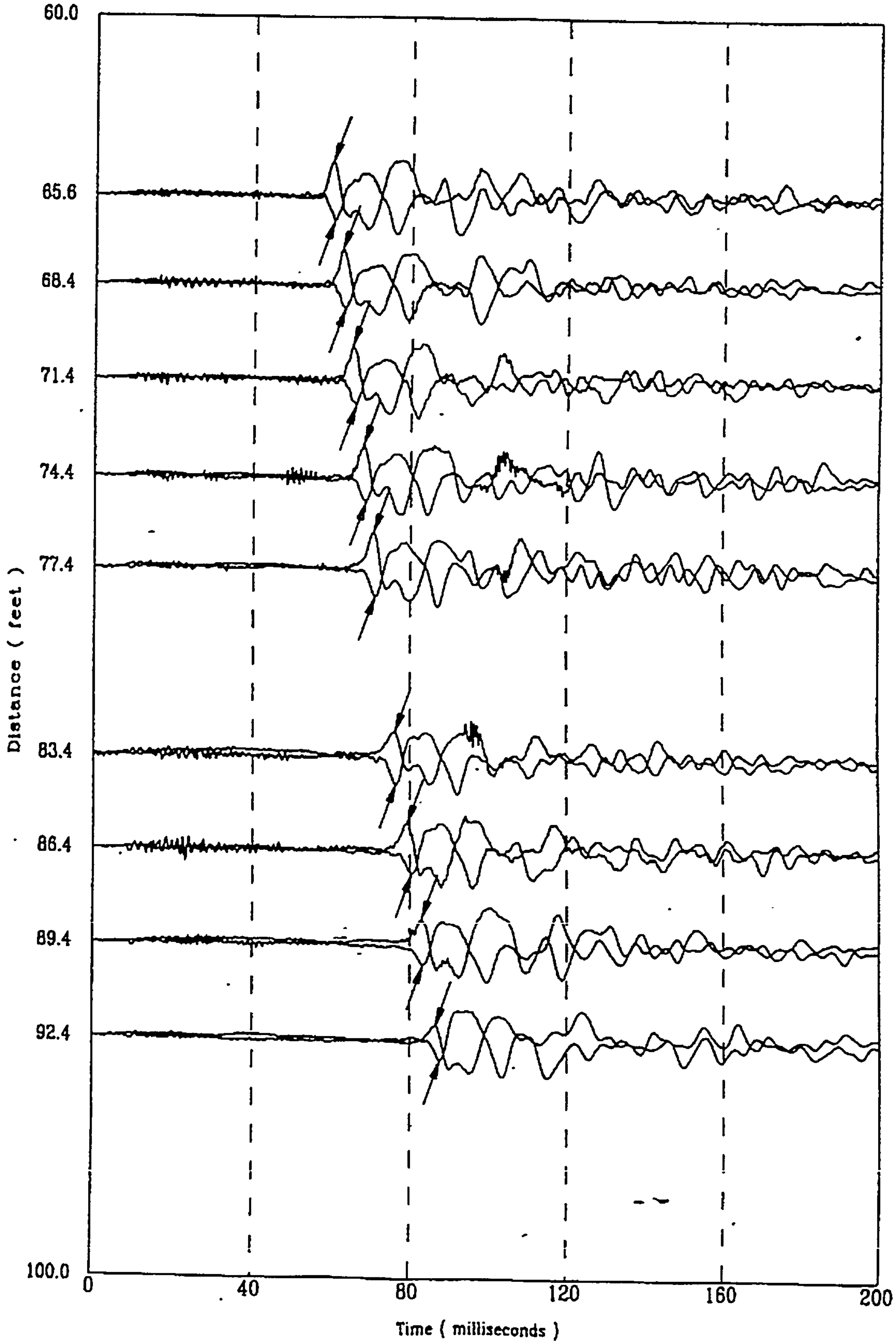


File 3200701S

A-145

Applied Research Associates Inc.
HTEF-C11

S Wave
10/20/97

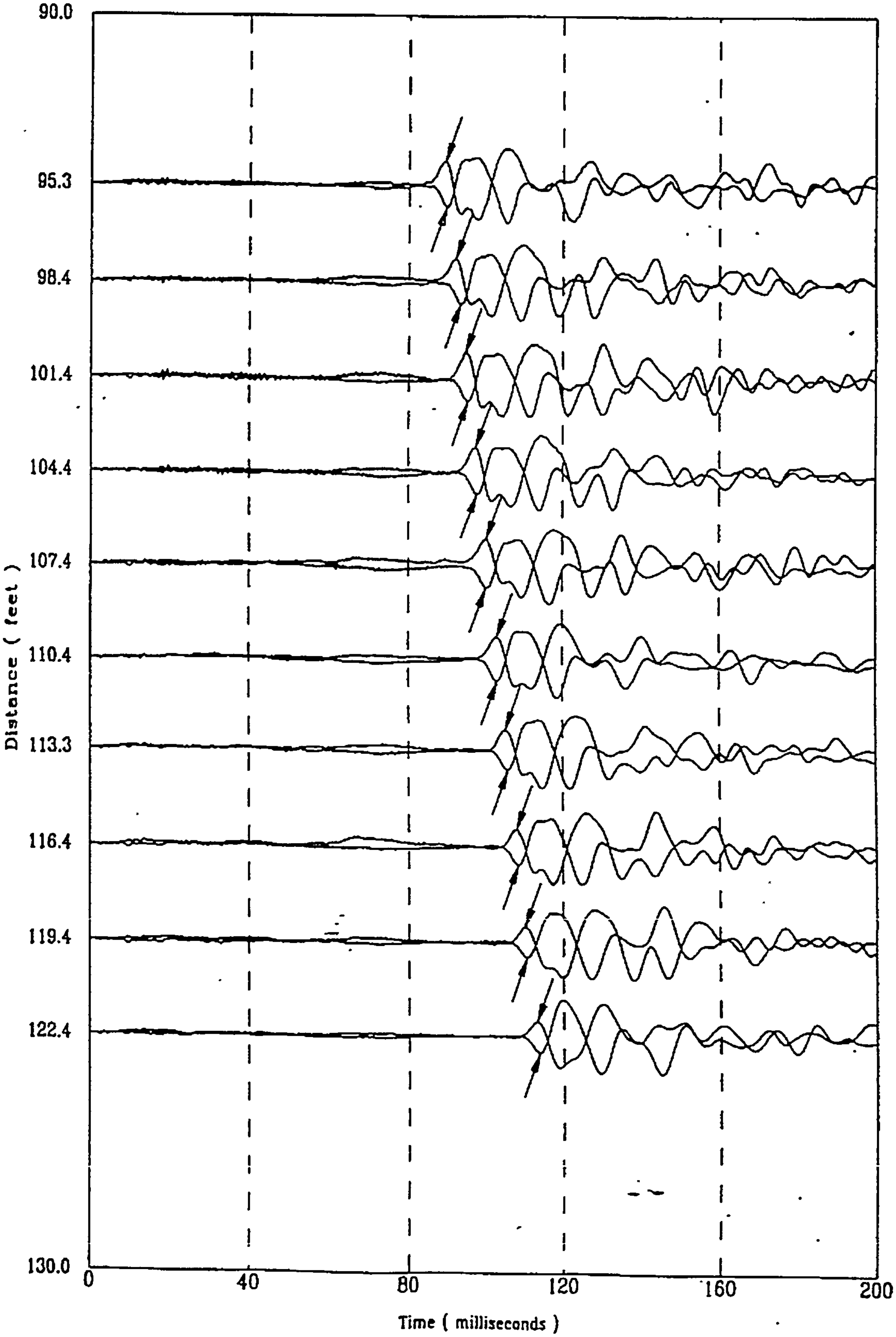


File 32007015

A-146

Applied Research Associates Inc.
HTEF-C11

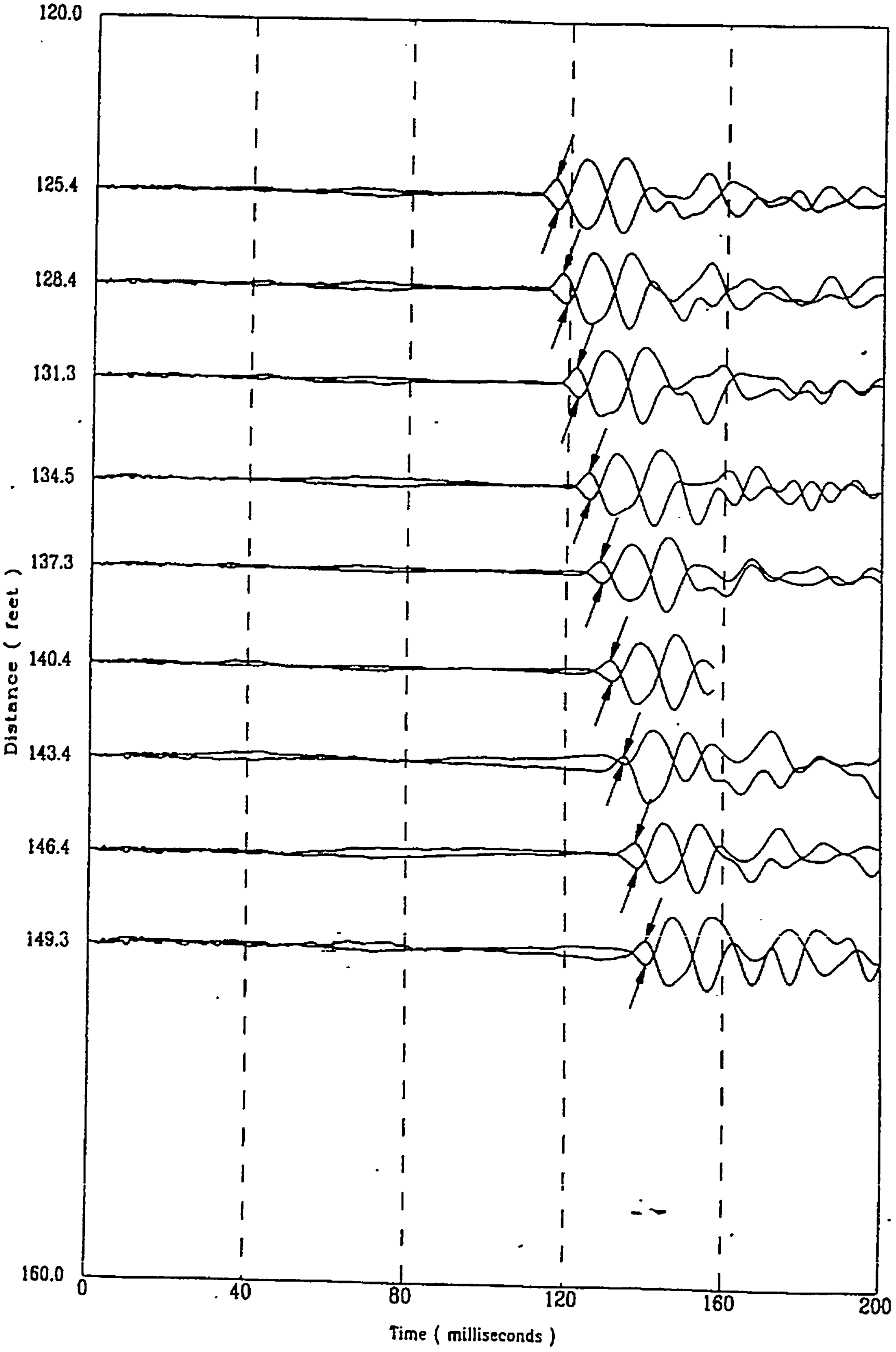
S Wave
10/20/97



File 32007015

Applied Research Associates Inc.
HTEF-C11

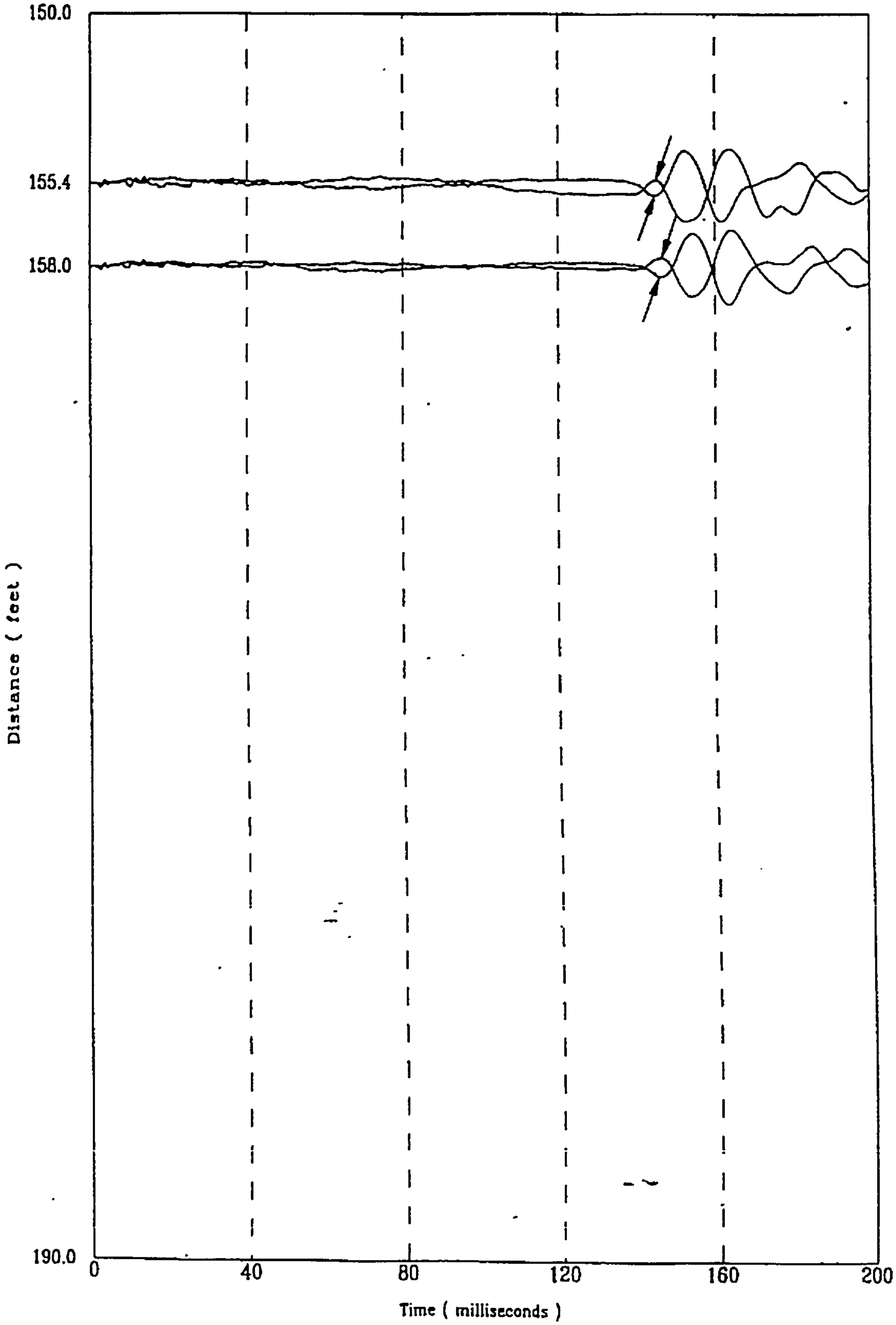
S Wave
10/20/97



... J200702S

Applied Research Associates Inc.
HTEF-C11

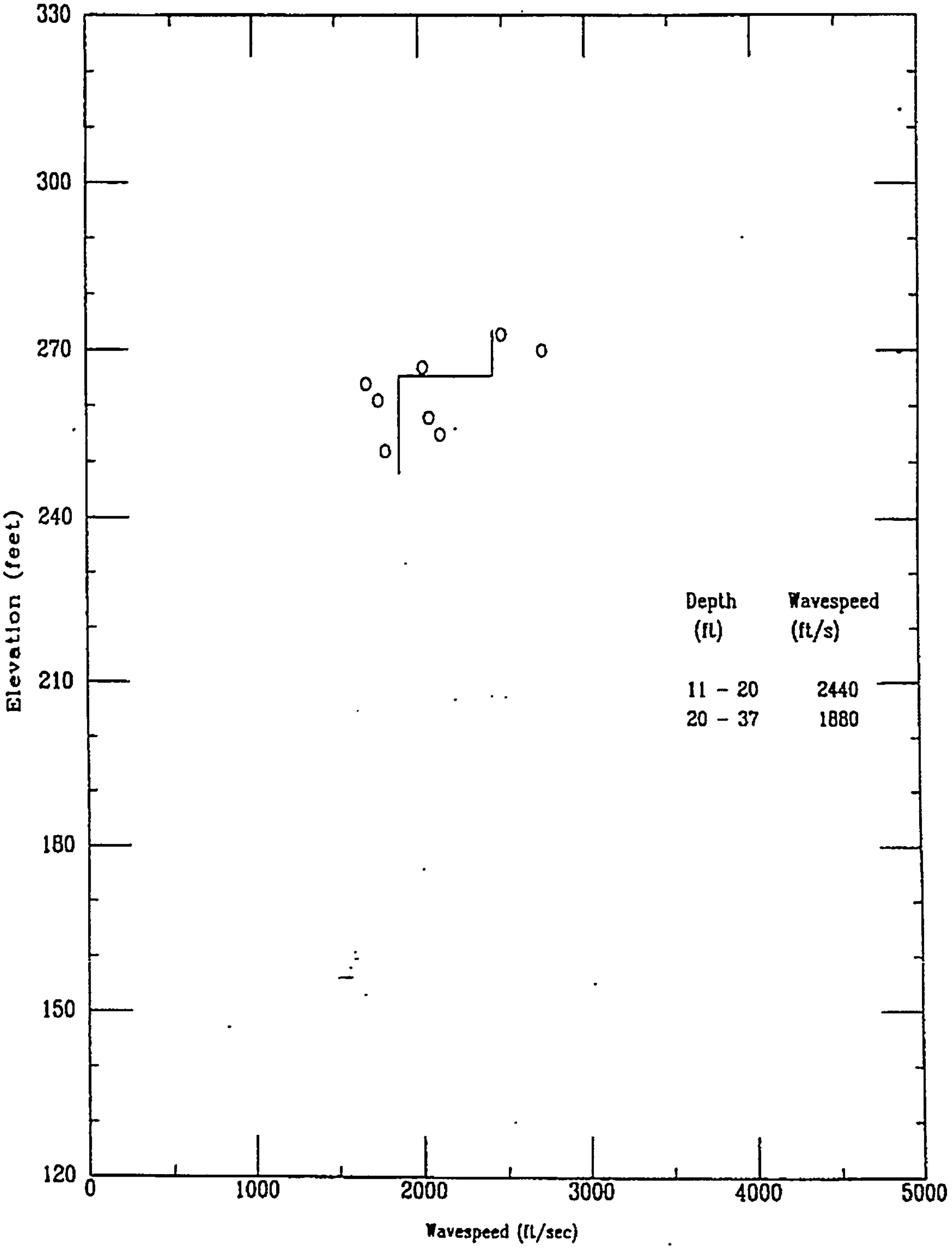
S Wave
10/20/97



File 3200702S

HTEF-C11 APPLIED RESEARCH ASSOCIATES, INC. 10/20/97

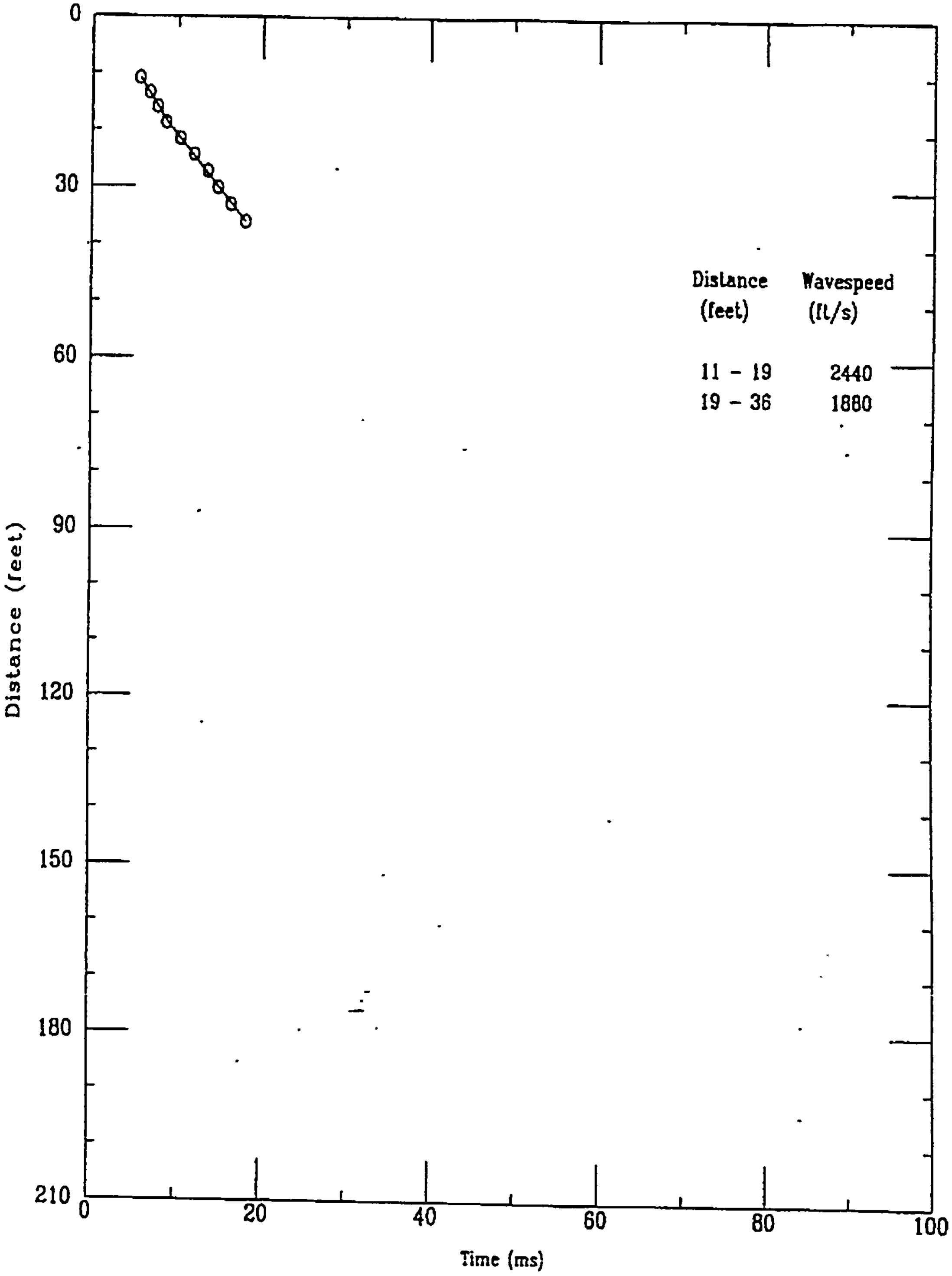
Compression Wave Speeds



File 3200701S

HTEF-C11 APPLIED RESEARCH ASSOCIATES, INC. 10/20/97

Compression Wave Time of Peak

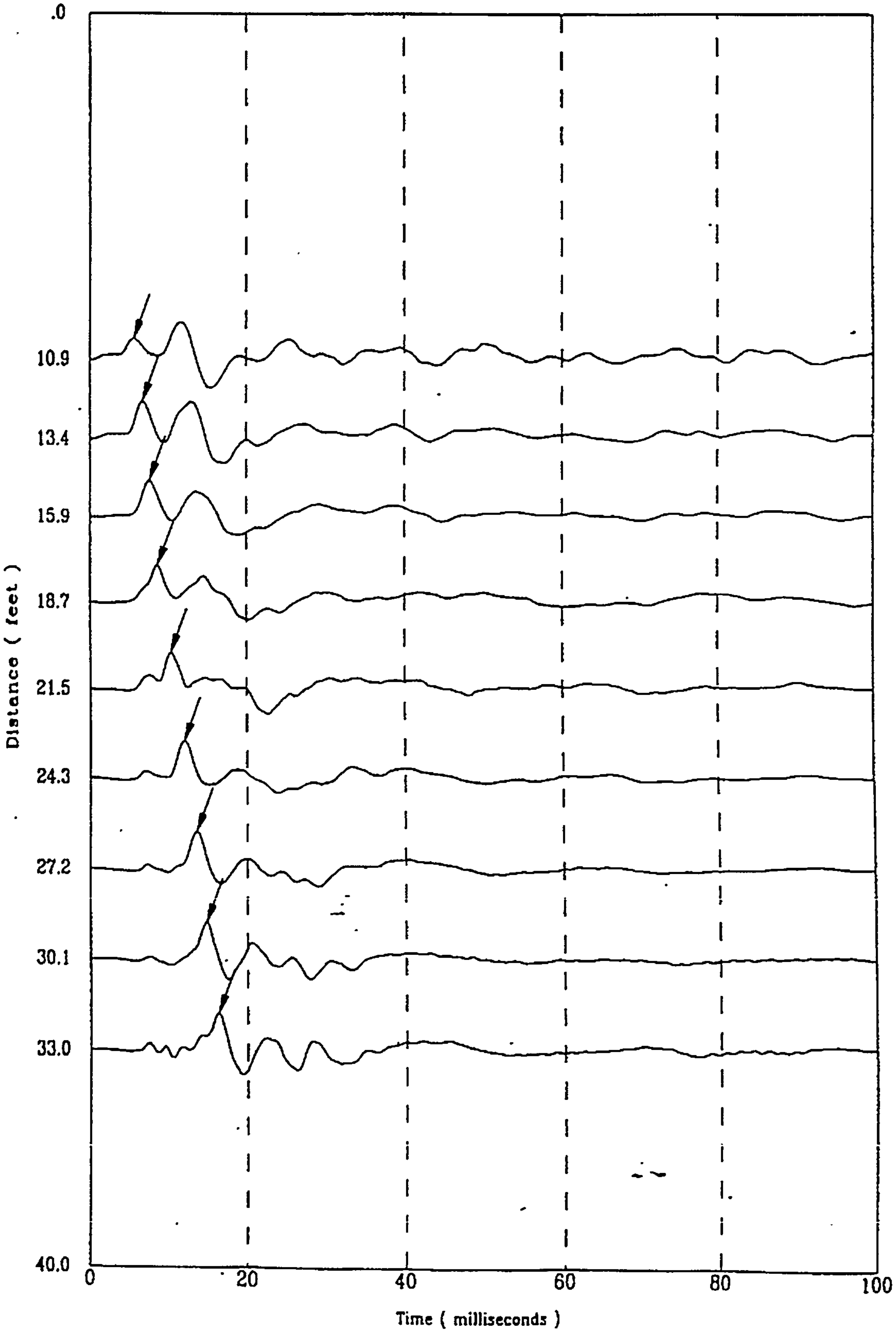


Distance (feet)	Wavespeed (ft/s)
11 - 19	2440
19 - 36	1880

File 3200701S

Applied Research Associates Inc.
HTEF-C11

P Wave
10/20/97

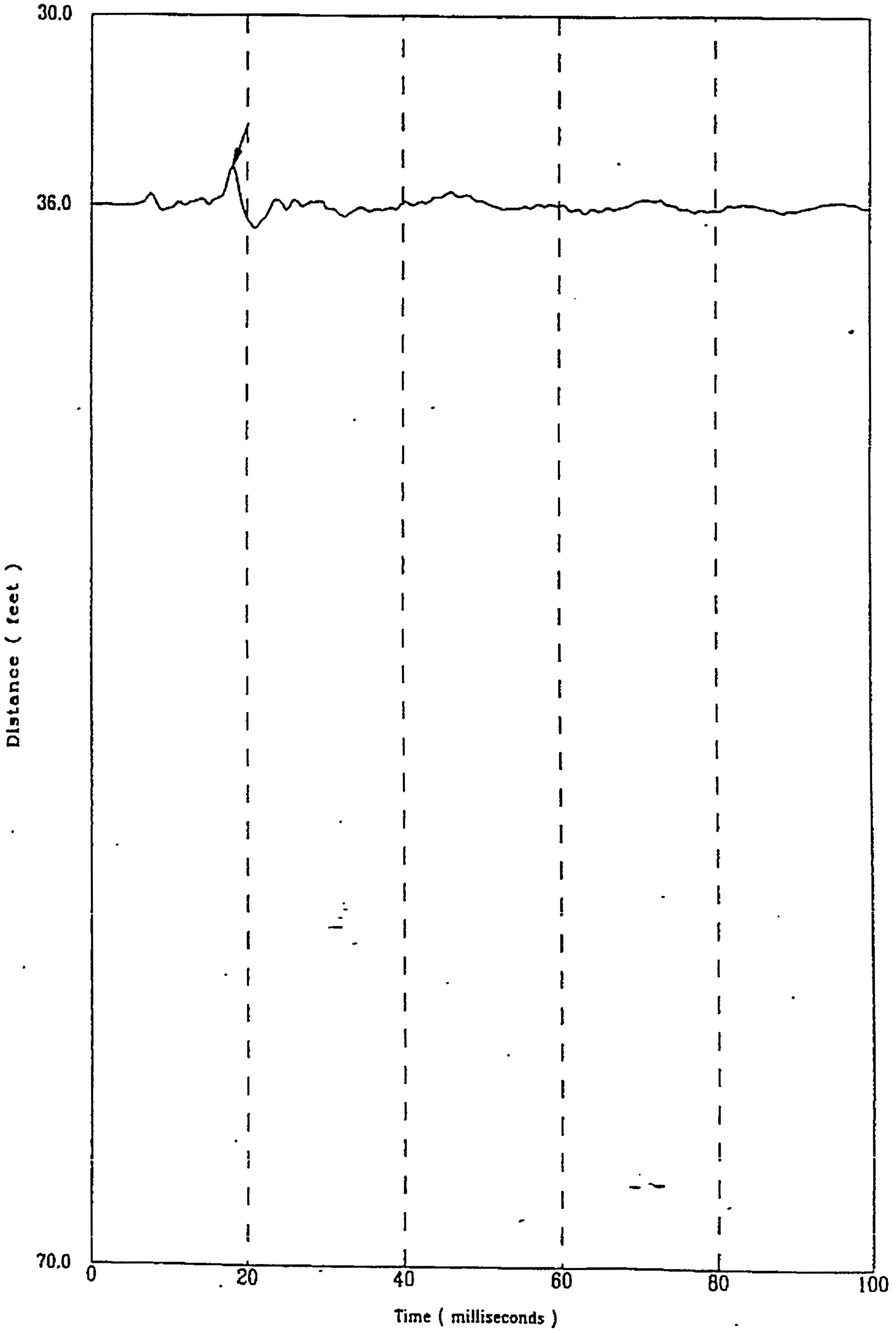


File 3200701S

A-152

Applied Research Associates Inc.
HTEF-C11

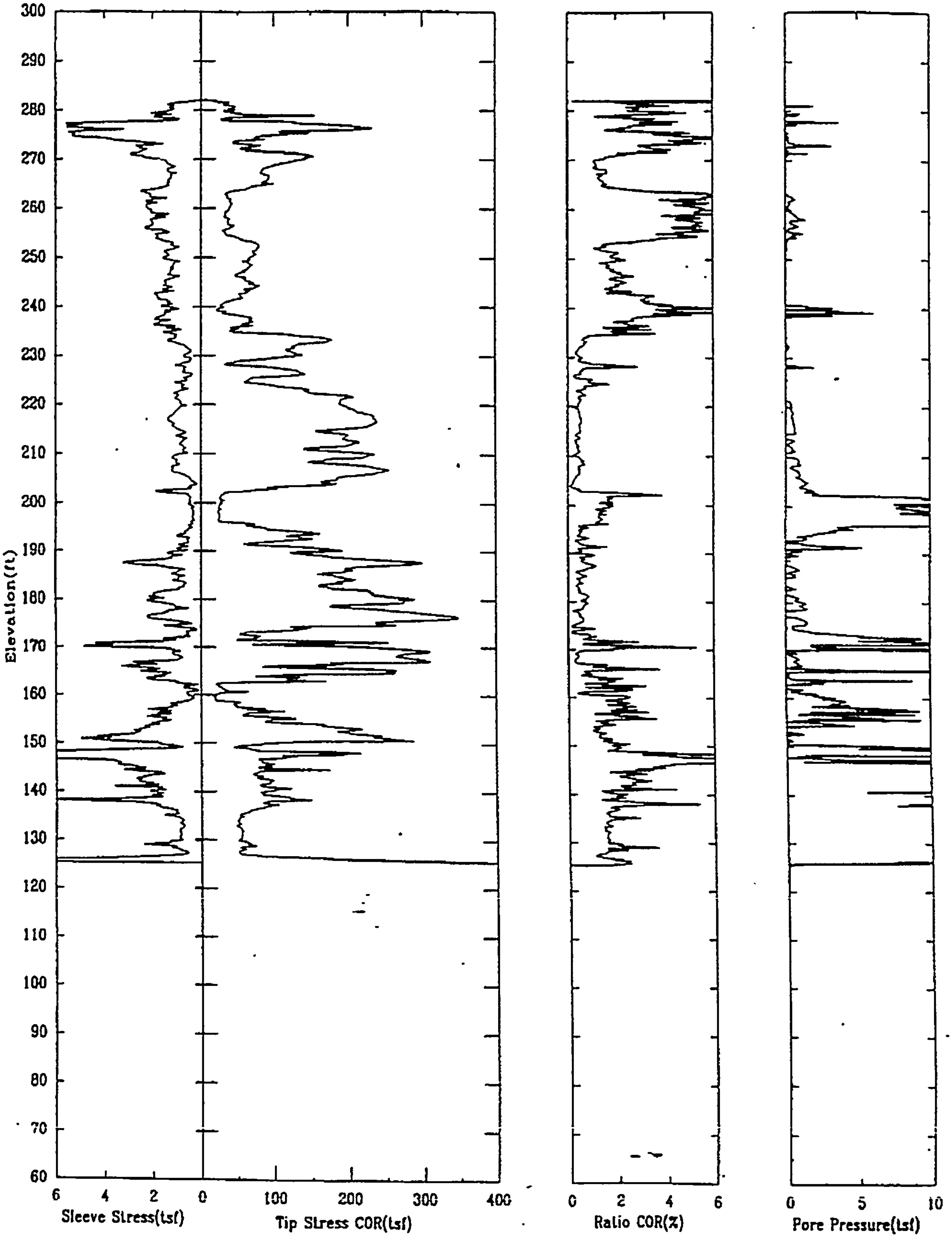
P Wave
10/20/97



File 3200701S

HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

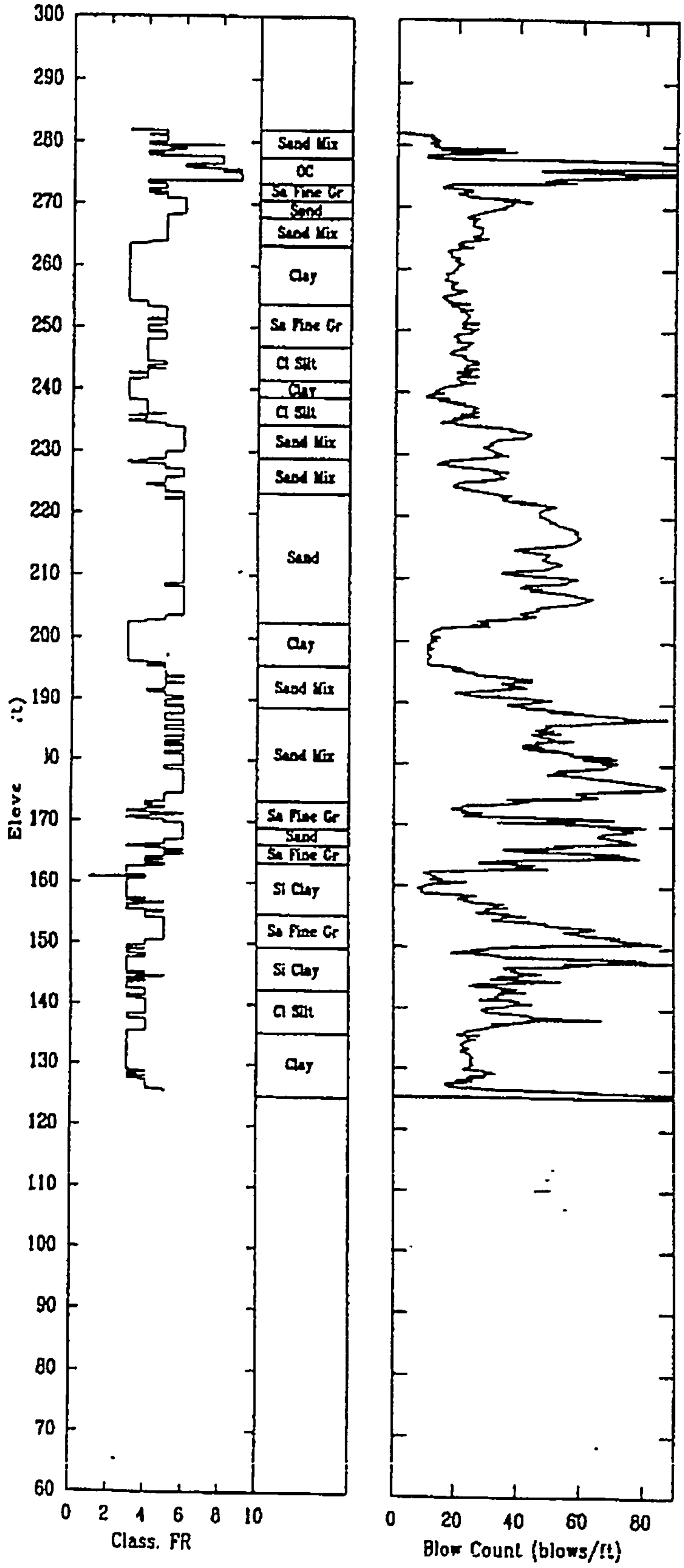
North 73541.0 East 61649.0 Elevation 288.1



File 3210701.ECP

HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

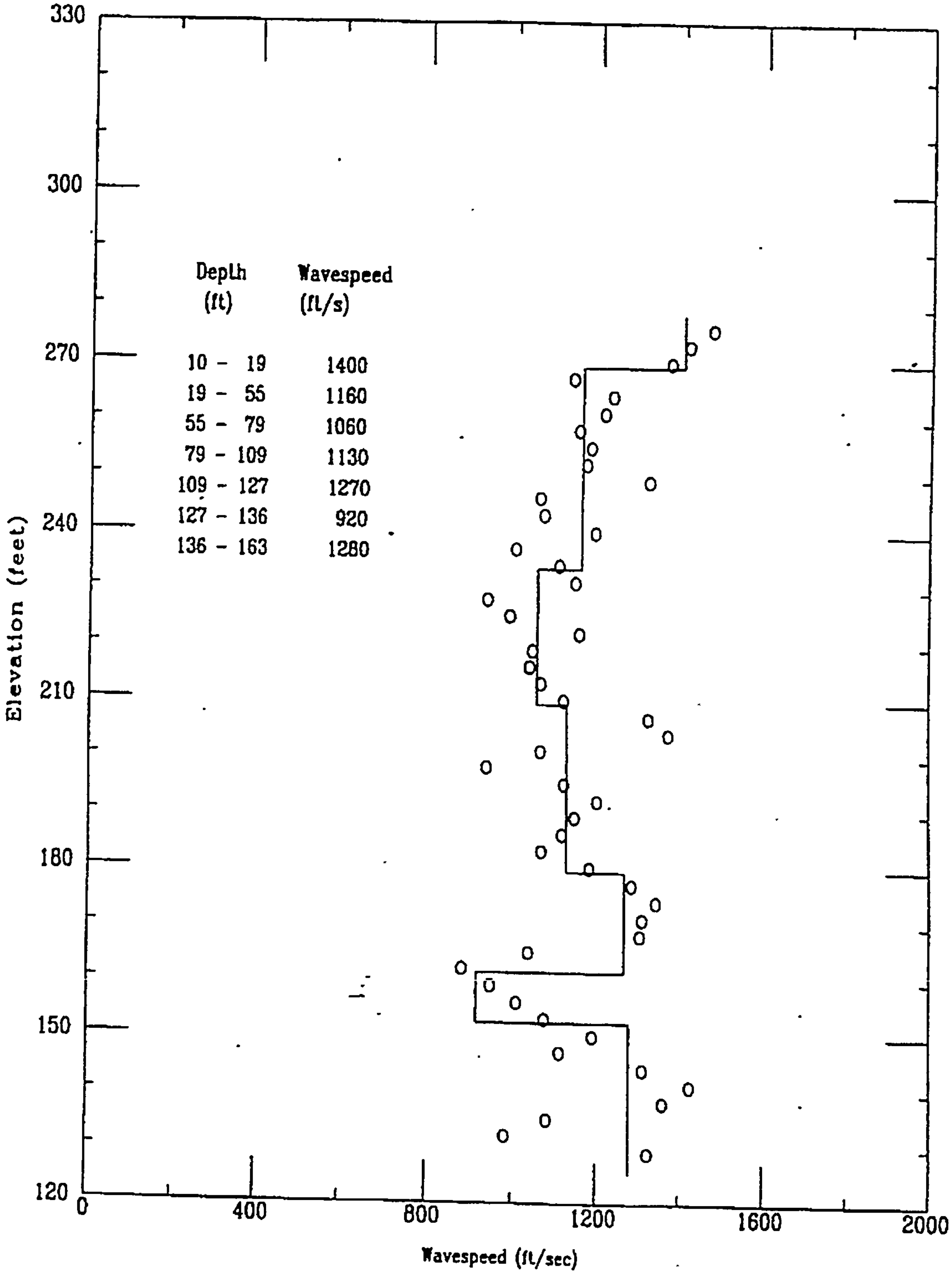
North 73541.0 East 61649.0 Elevation 288.1



File 3210701.ECP

HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

Shear Wave Speeds

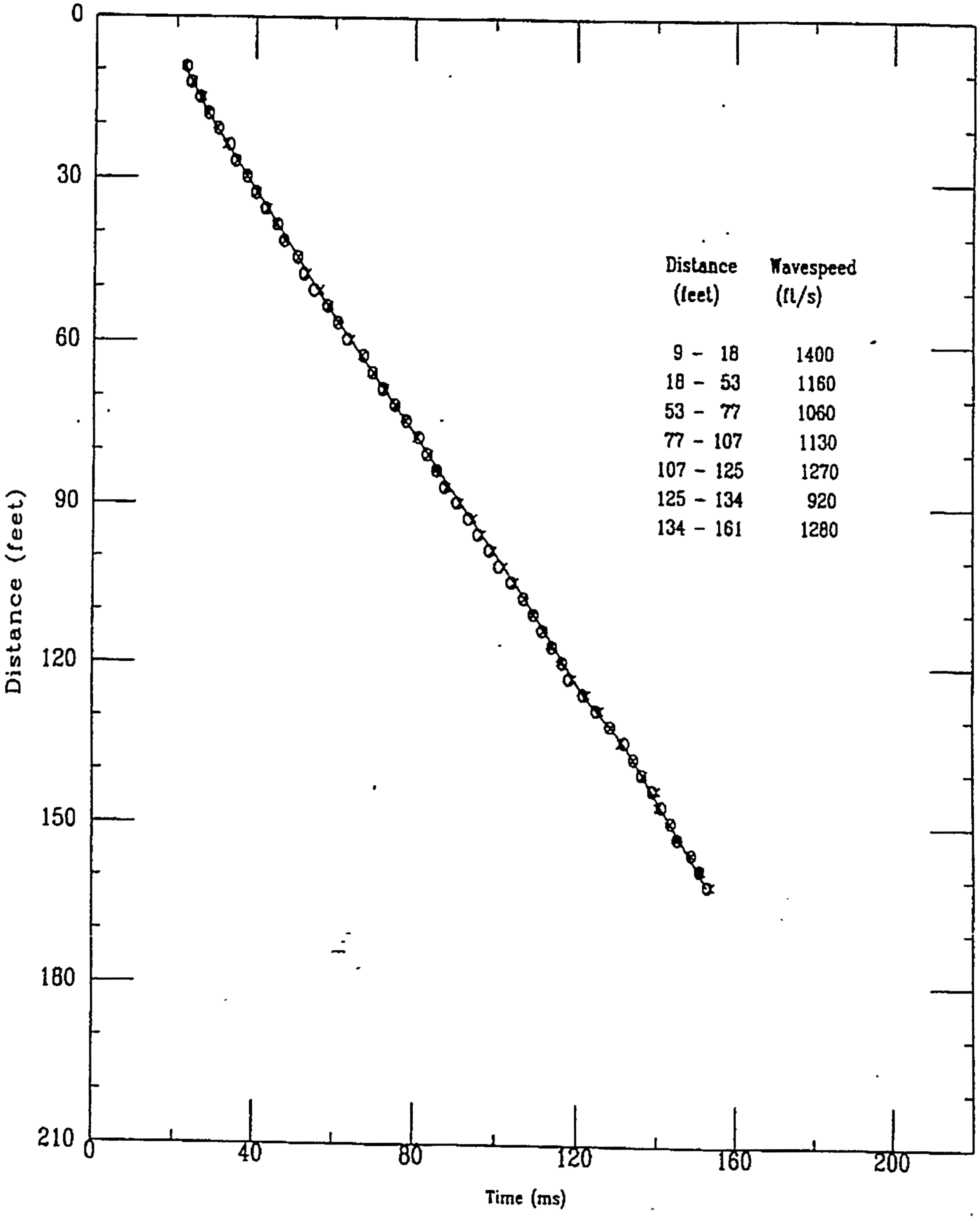


Depth (ft)	Wavespeed (ft/s)
10 - 19	1400
19 - 55	1160
55 - 79	1060
79 - 109	1130
109 - 127	1270
127 - 136	920
136 - 163	1280

File 3210701S

HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

Shear Wave Time of Peak



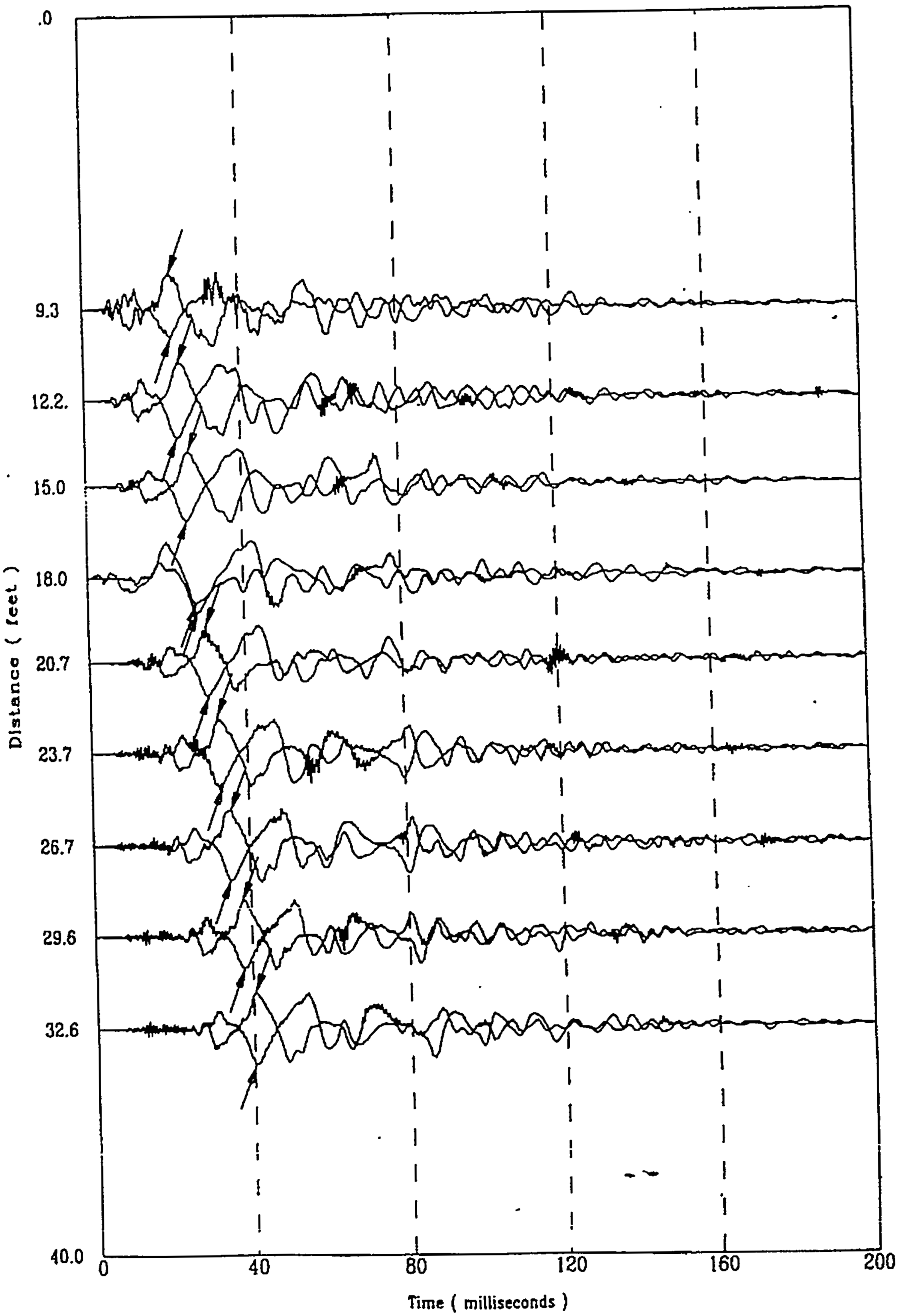
Distance (feet)	Wavespeed (ft/s)
9 - 18	1400
18 - 53	1160
53 - 77	1060
77 - 107	1130
107 - 125	1270
125 - 134	920
134 - 161	1280

File 32107015

A-157

Applied Research Associates Inc.
HTEF-C12

S Wave
10/21/97

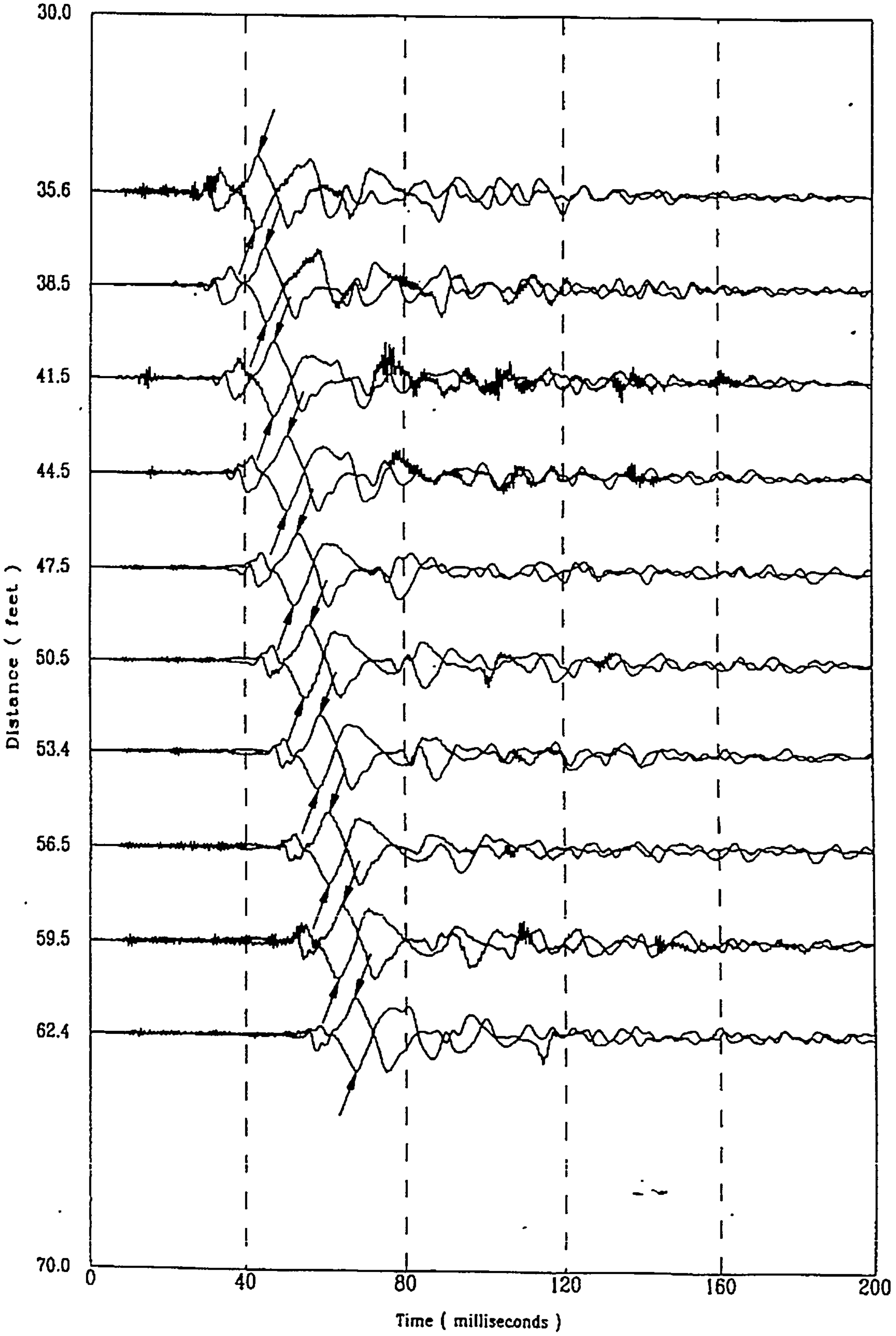


File 3210701S

A-158

Applied Research Associates Inc.
HTEF-C12

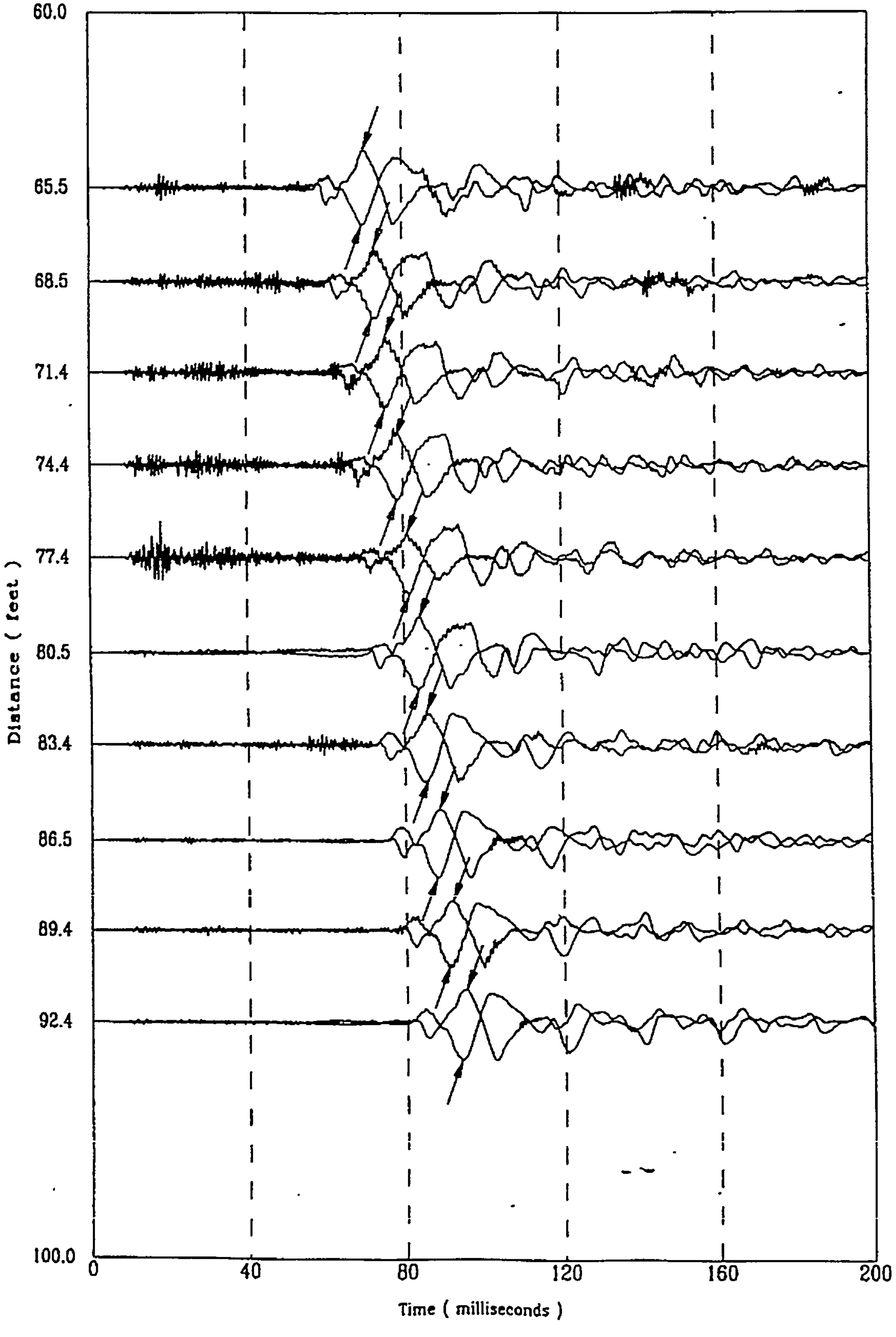
S Wave
10/21/97



File 32107015

Applied Research Associates Inc.
HTEF-C12

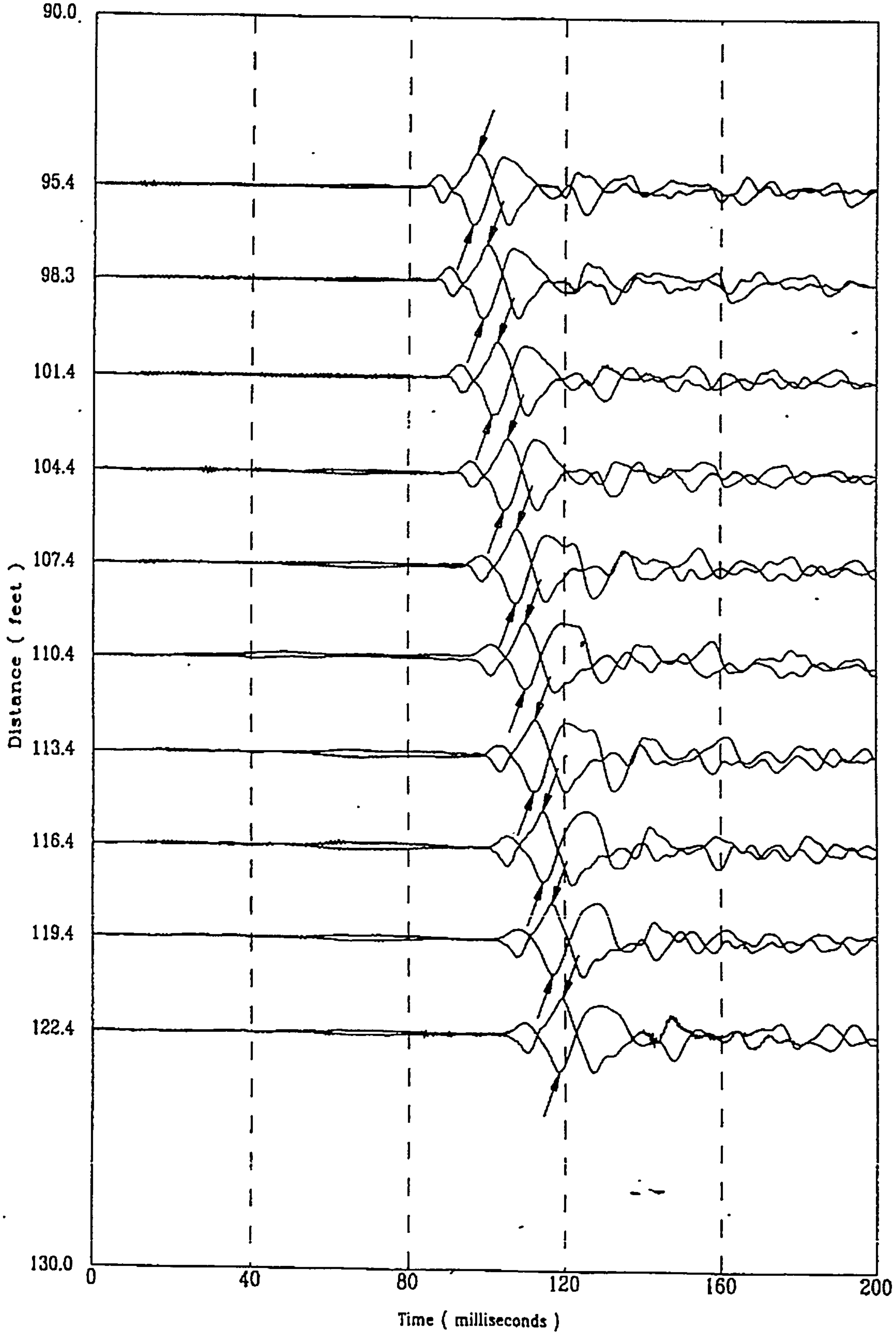
S Wave
10/21/97



File 3210701S

Applied Research Associates Inc.
HTEF-C12

S Wave
10/21/97

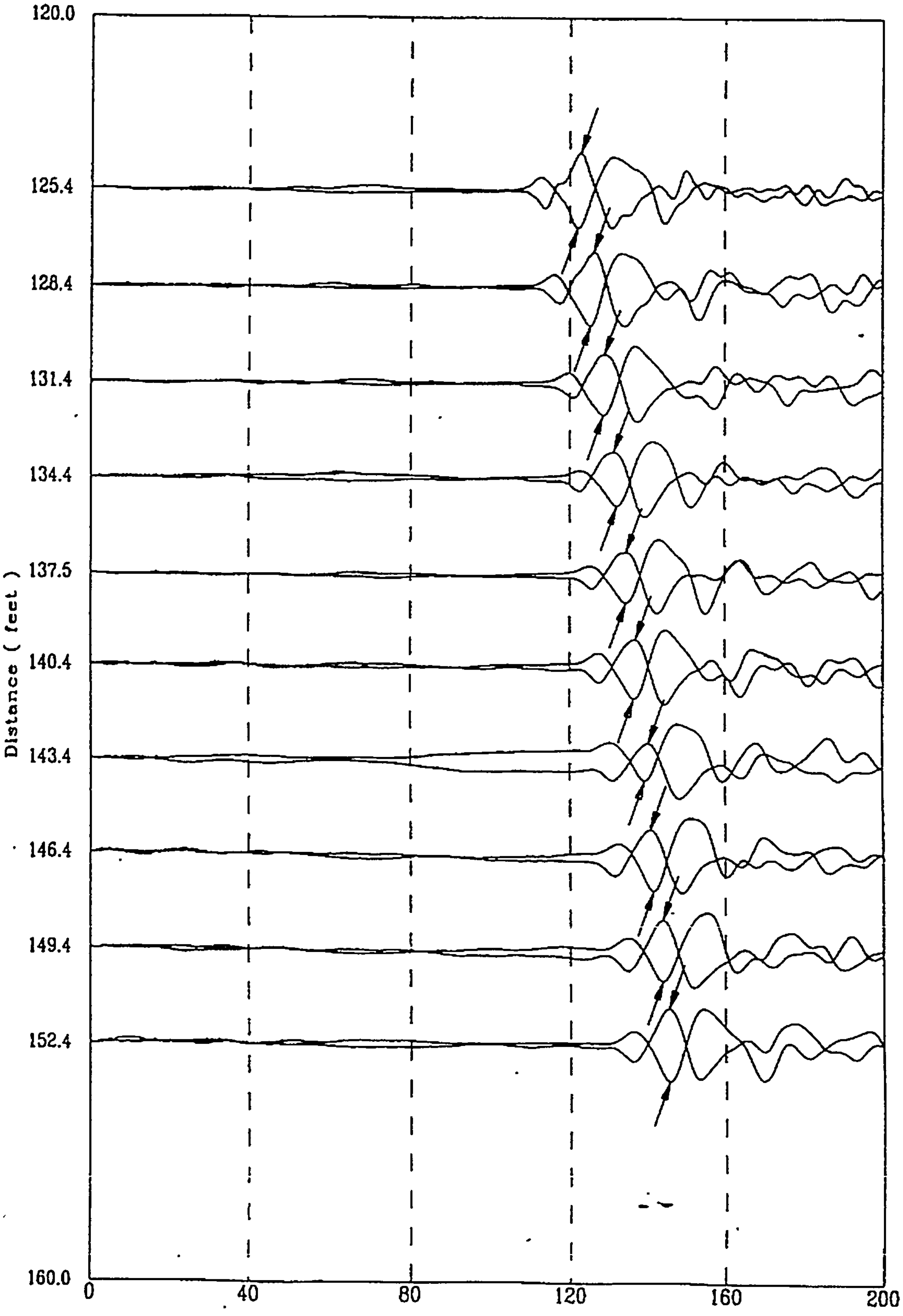


File 3210702S

A-161

Applied Research Associates Inc.
HTEF-C12

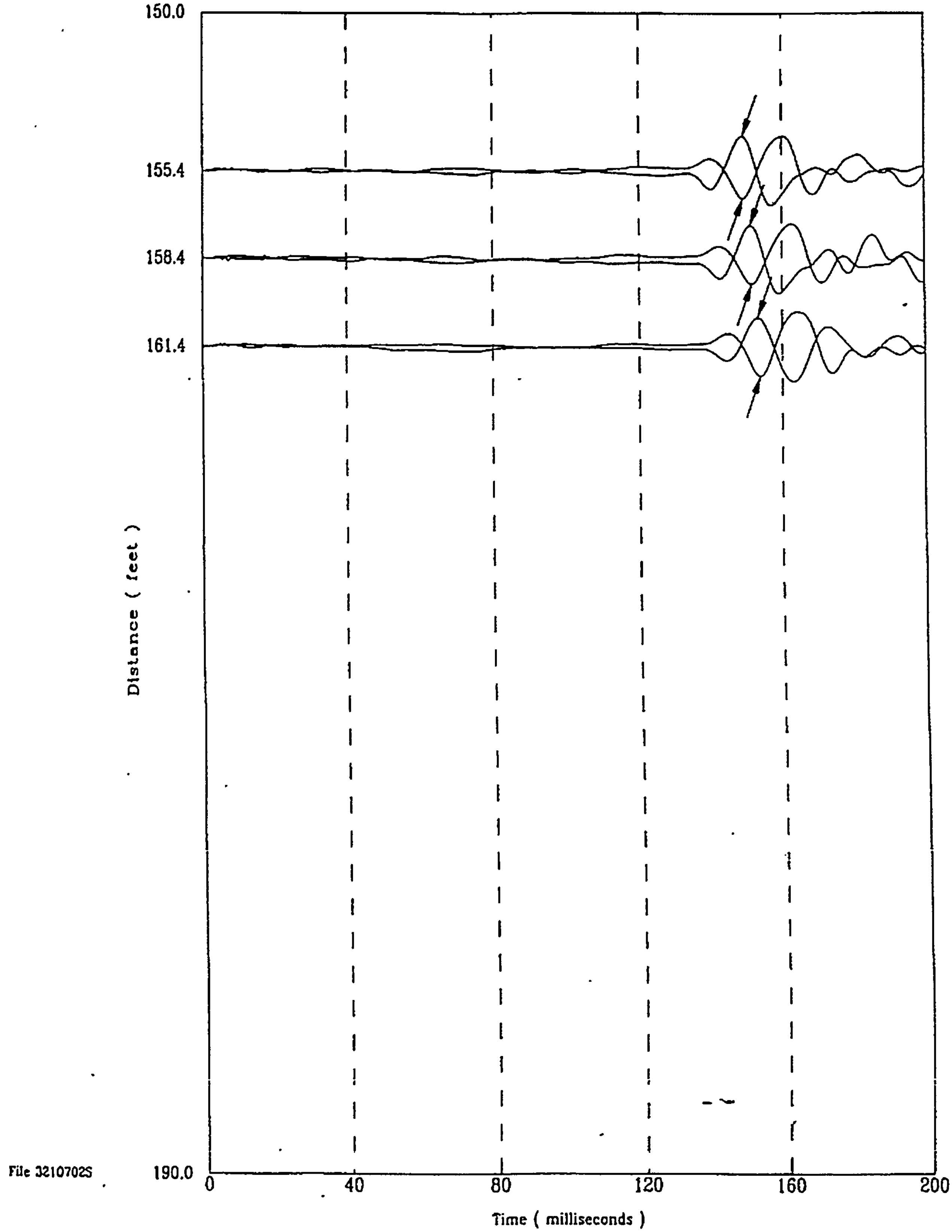
S Wave
10/21/97



File 32107025

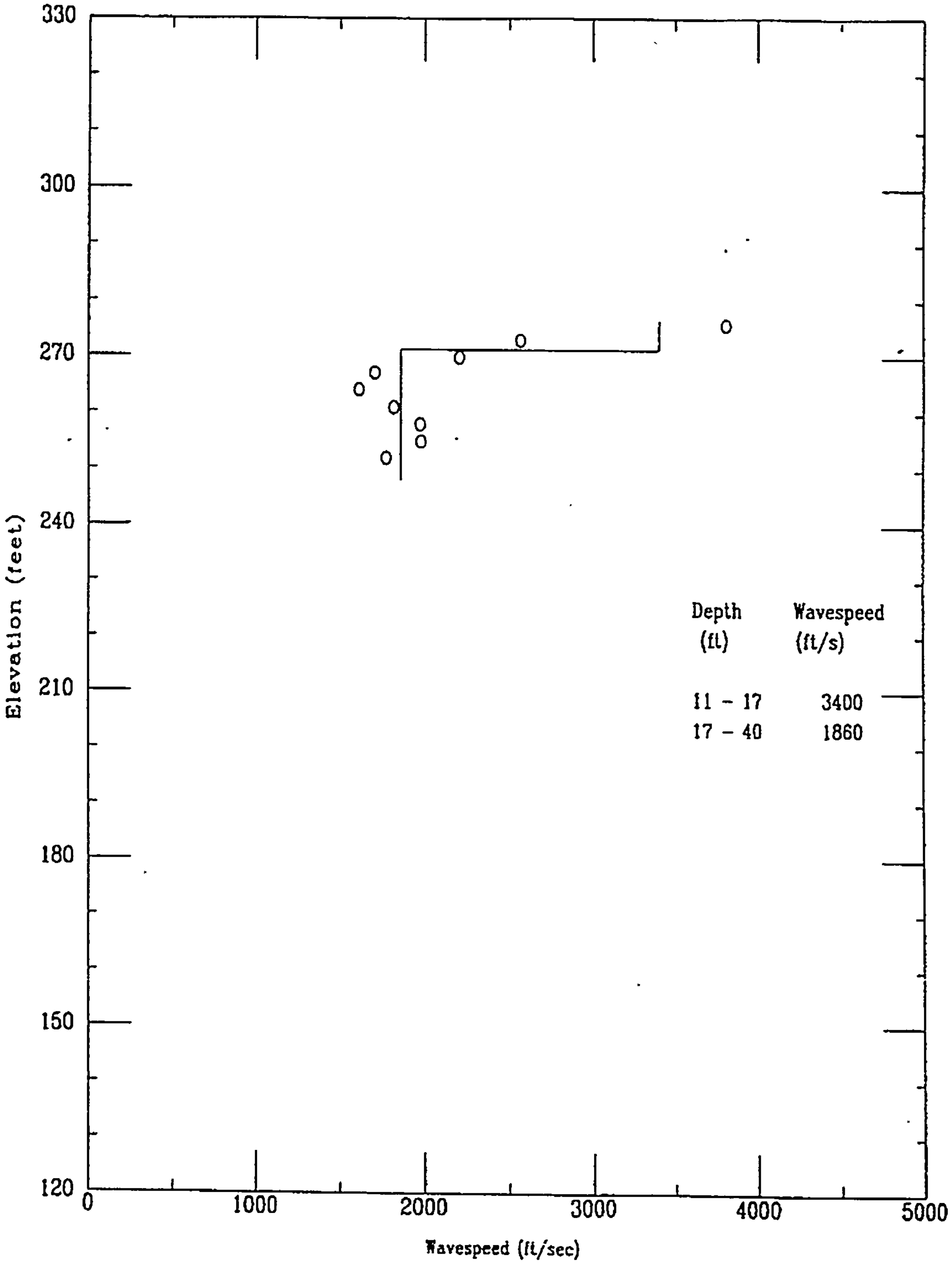
Applied Research Associates Inc.
HTEF-C12

S Wave
10/21/97



HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

Compression Wave Speeds

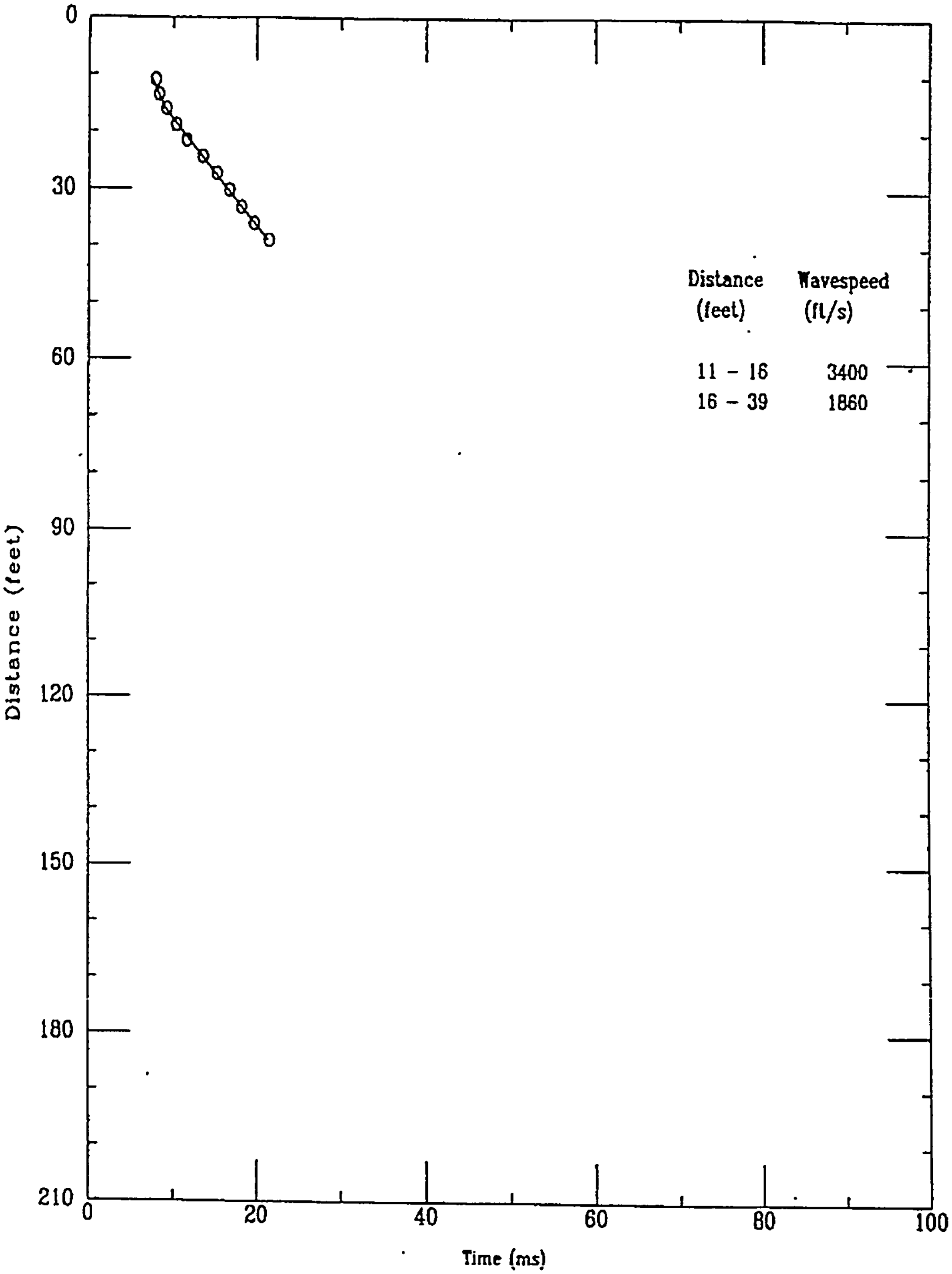


Depth (ft)	Wavespeed (ft/s)
11 - 17	3400
17 - 40	1860

File 3210701S

HTEF-C12 APPLIED RESEARCH ASSOCIATES, INC. 10/21/97

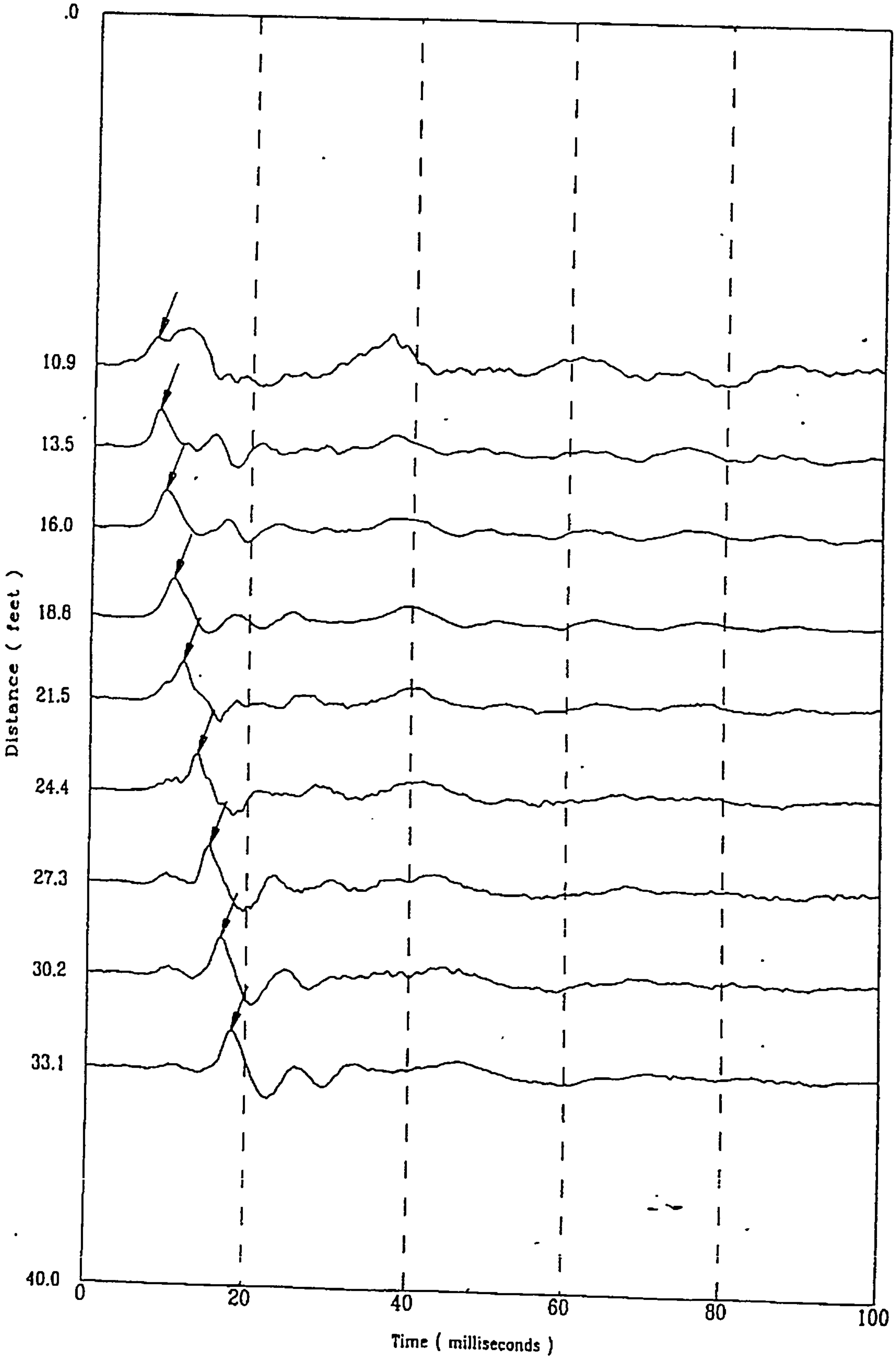
Compression Wave Time of Peak



File 3210701S

Applied Research Associates Inc.
HTEF-C12

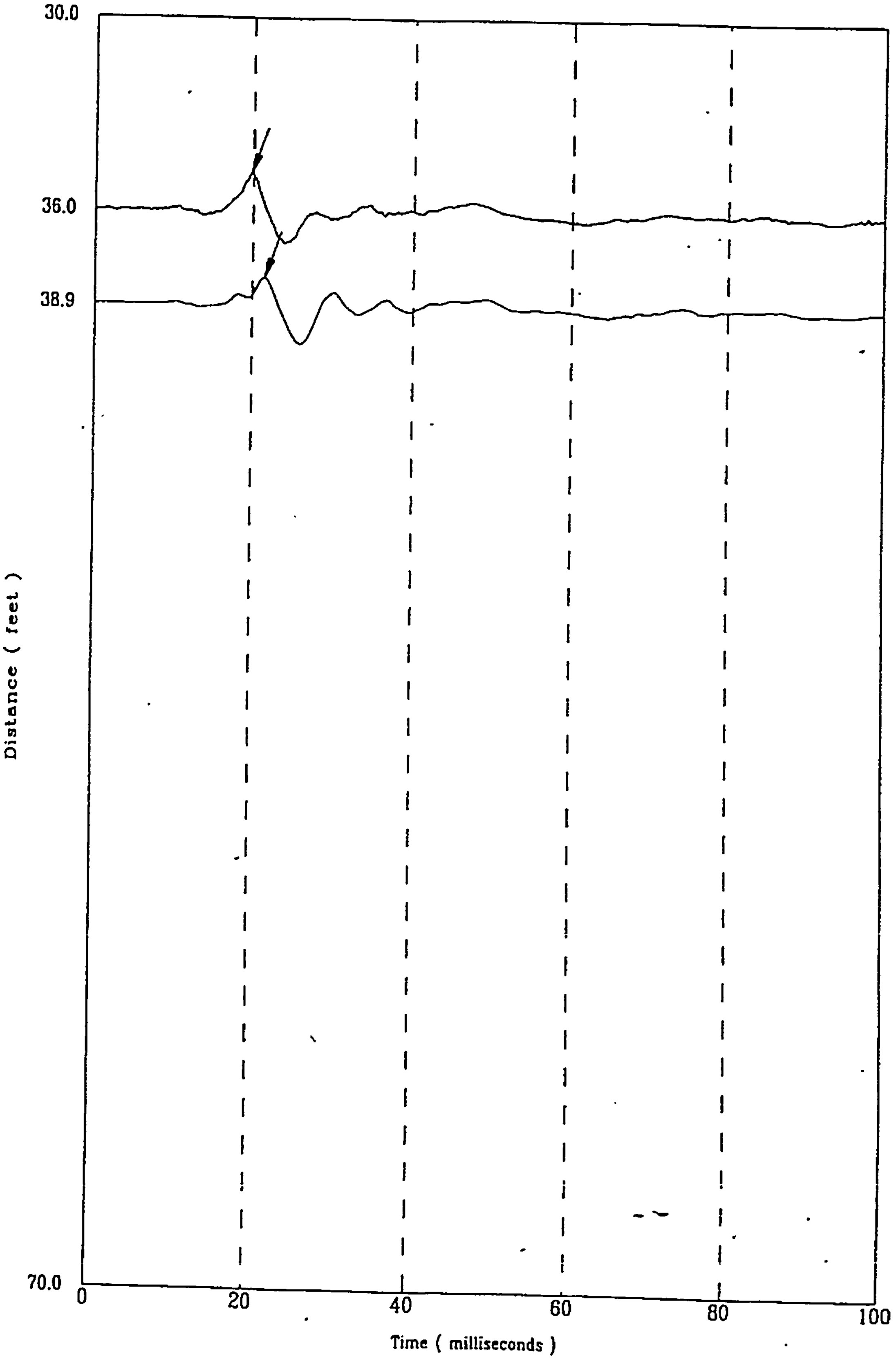
P Wave
10/21/97



File 3210701S

Applied Research Associates Inc.
HTEF-C12

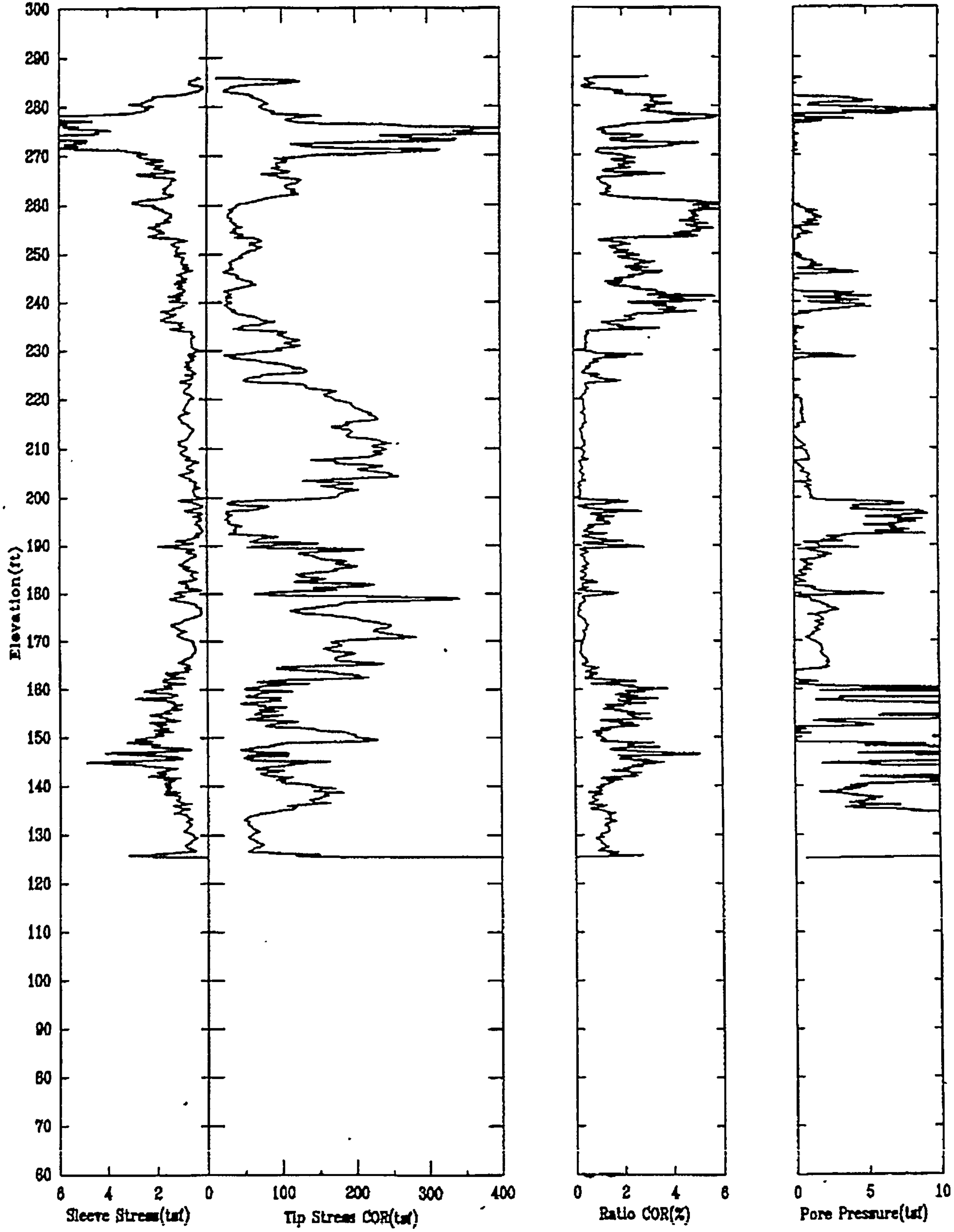
P Wave
10/21/97



A-167

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

North 73302.0 East 61639.0 Elevation 292.1

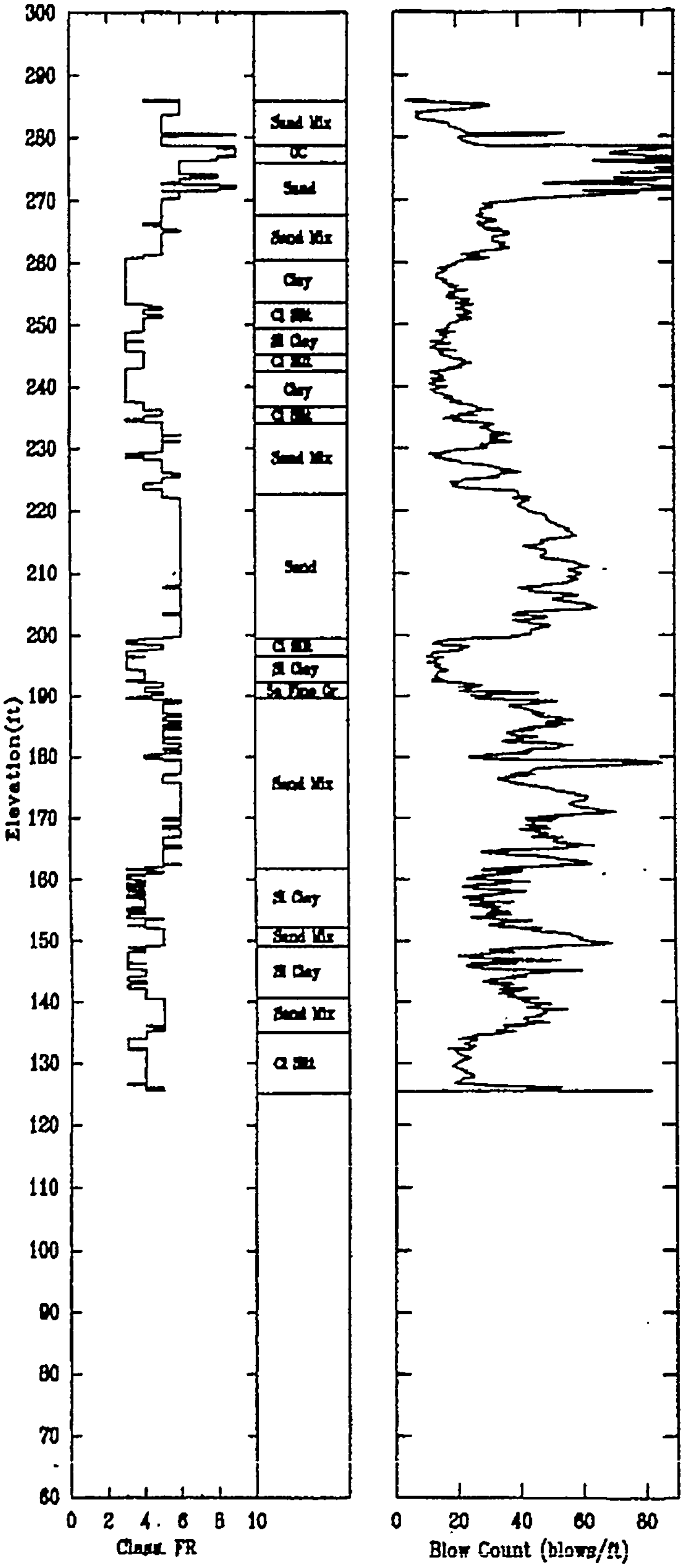


File 3260701.ECP

A-168

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

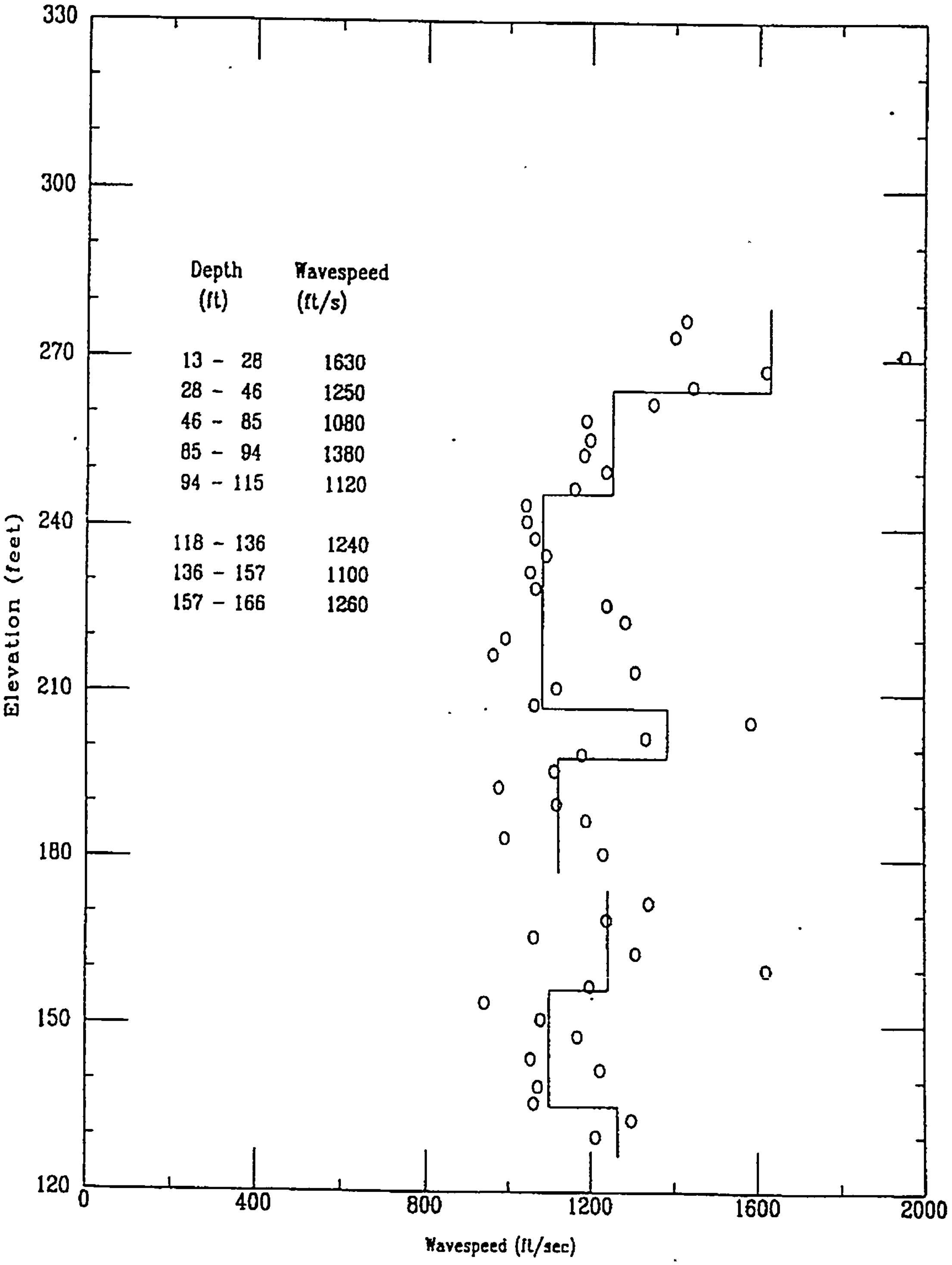
North 73302.0 East 61639.0 Elevation 292.1



File 3280701.ECP

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

Shear Wave Speeds

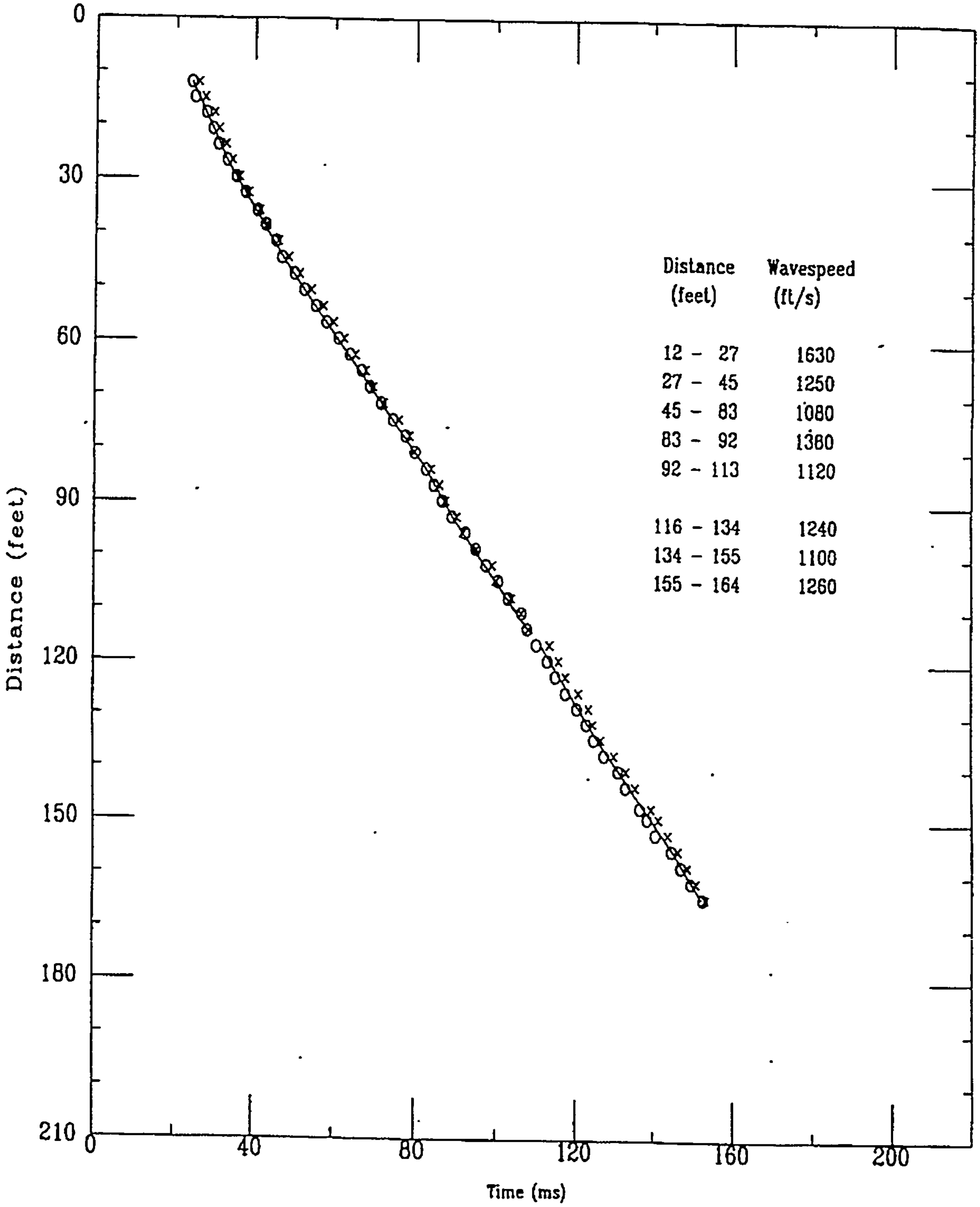


Depth (ft)	Wavespeed (ft/s)
13 - 28	1630
28 - 46	1250
46 - 85	1080
85 - 94	1380
94 - 115	1120
118 - 136	1240
136 - 157	1100
157 - 166	1260

File 32807015

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

Shear Wave Time of Peak

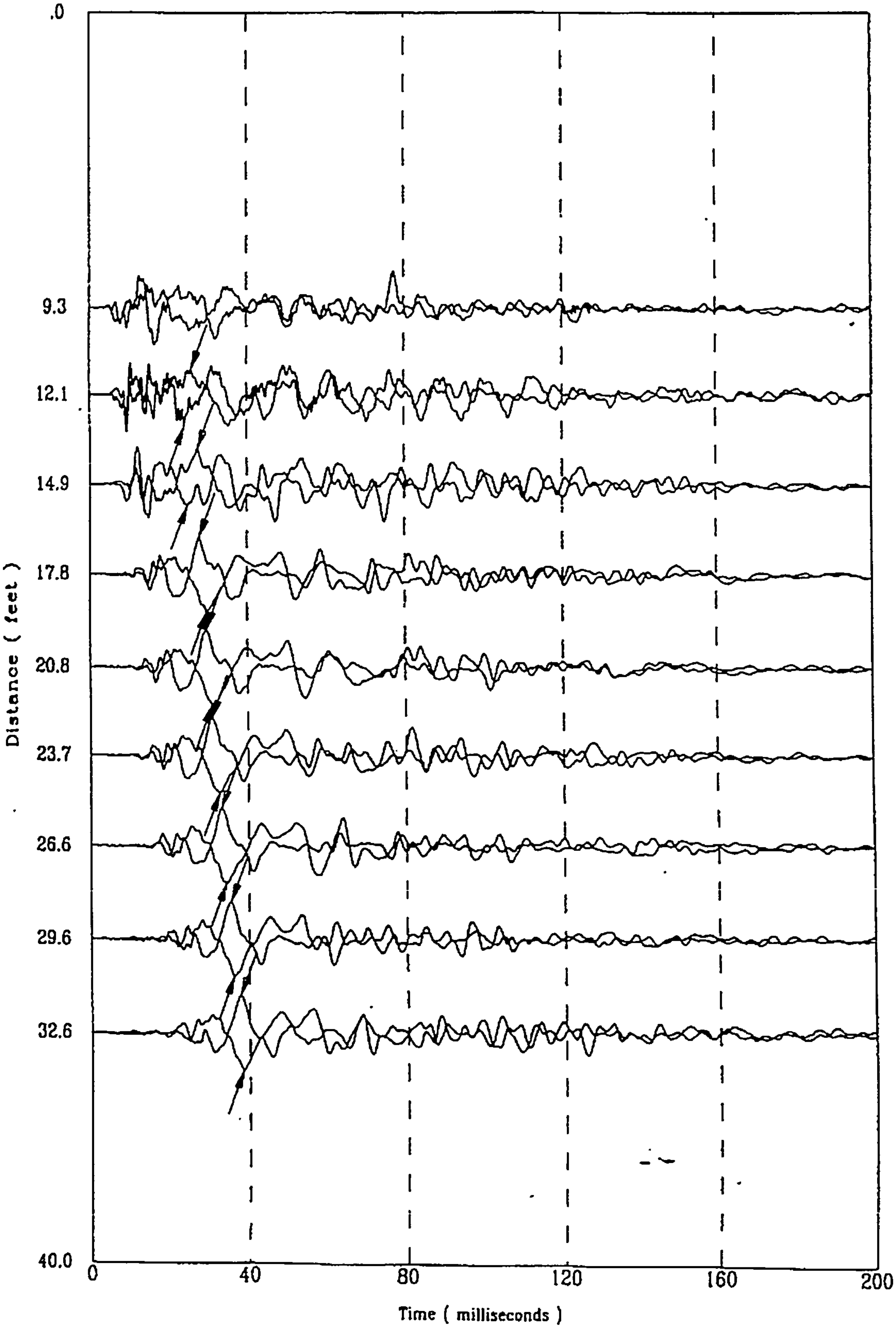


Distance (feet)	Wavespeed (ft/s)
12 - 27	1630
27 - 45	1250
45 - 83	1080
83 - 92	1360
92 - 113	1120
116 - 134	1240
134 - 155	1100
155 - 164	1260

File 32807015

Applied Research Associates Inc.
HTEF-C13

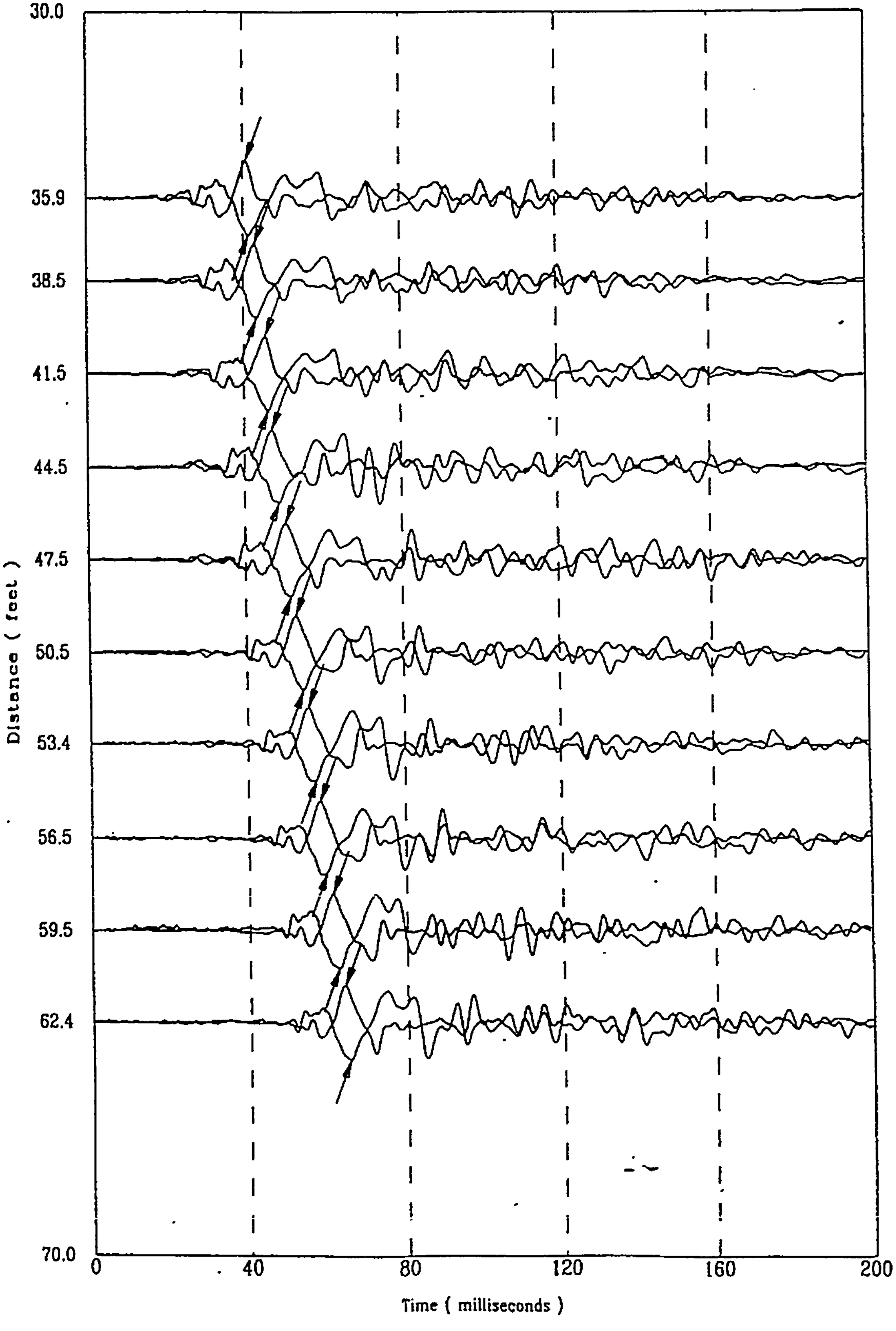
S Wave
10/28/97



File 32807015

Applied Research Associates Inc.
HTEF-C13

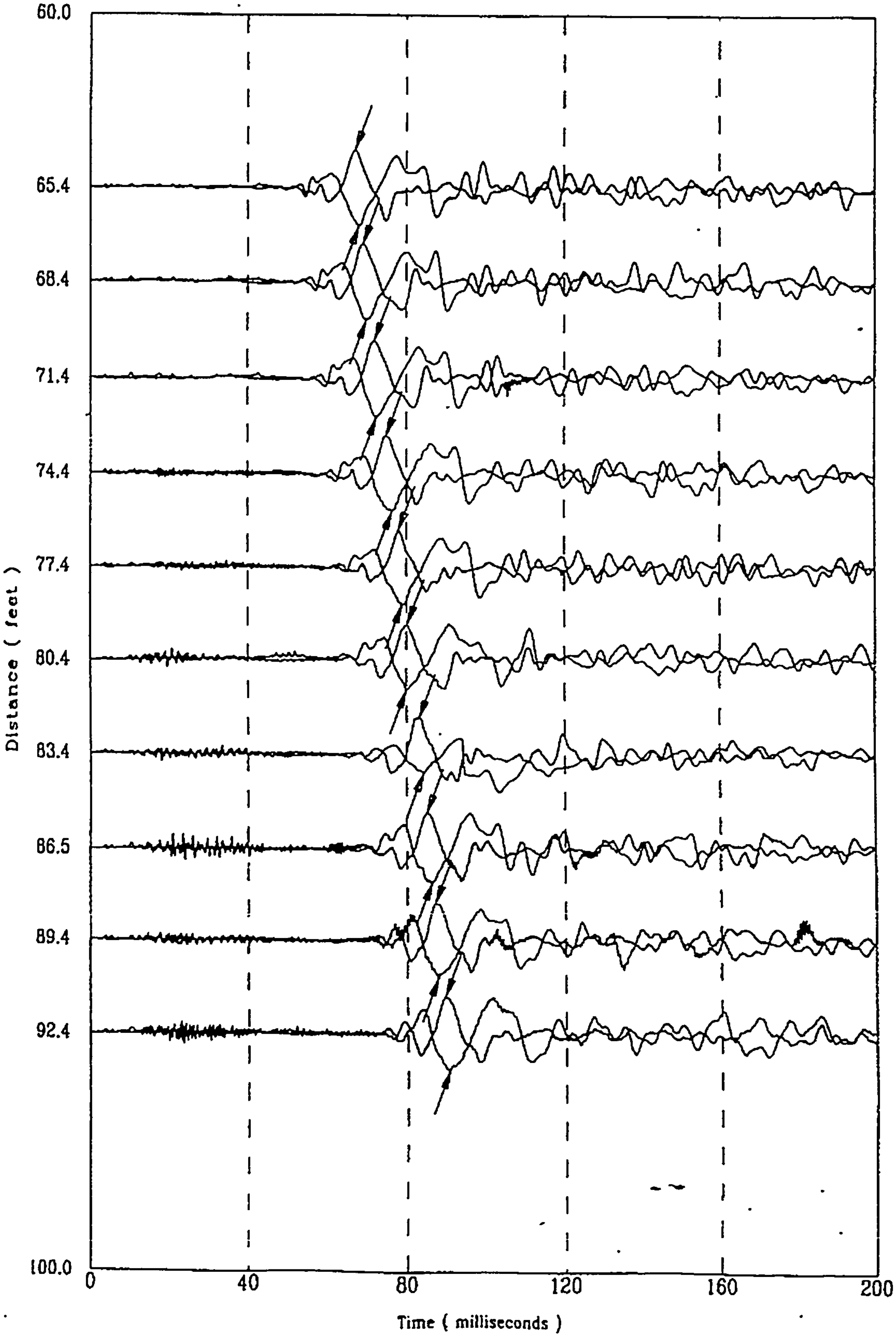
S Wave
10/28/97



File 32807015

Applied Research Associates Inc.
HTEF-C13

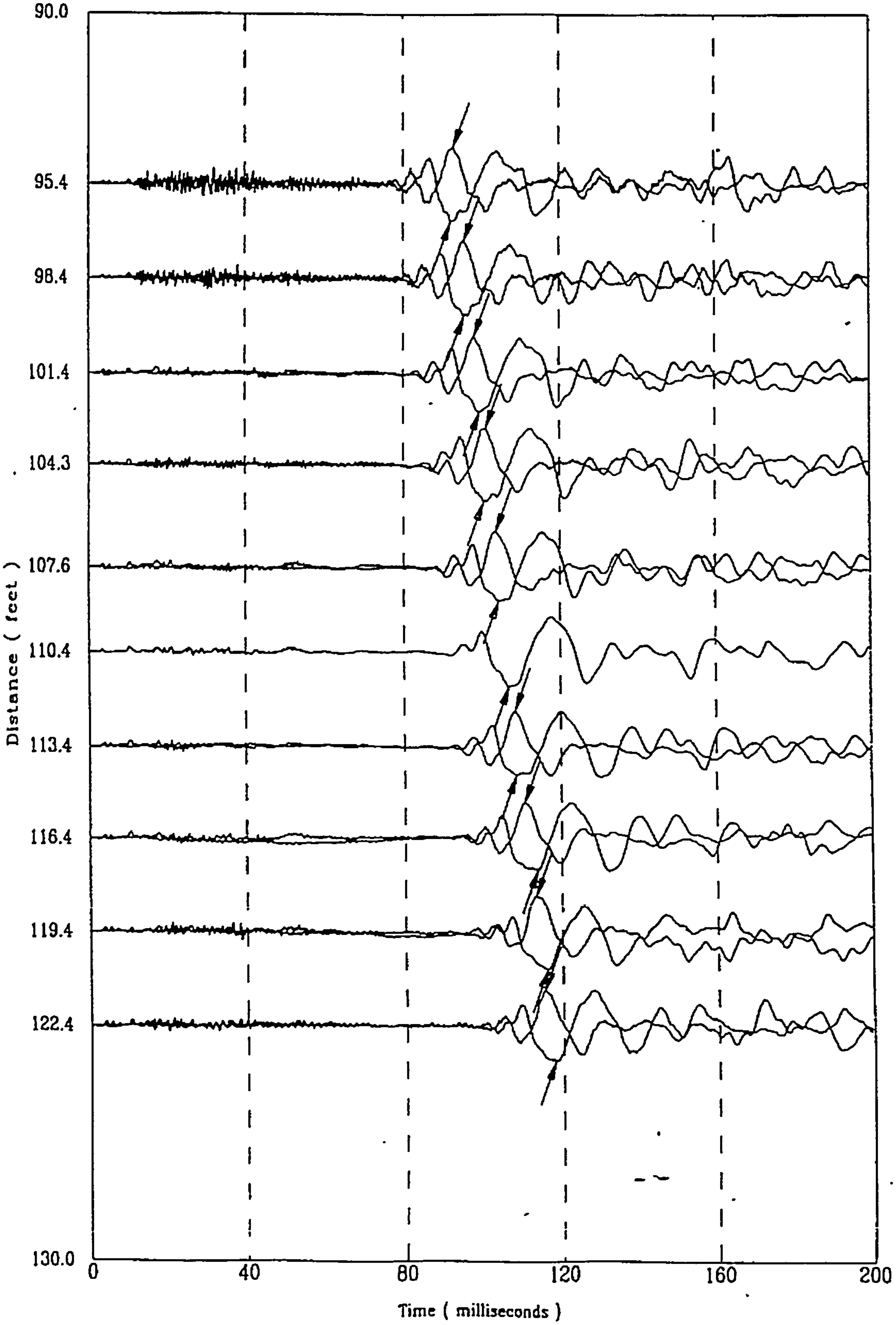
S Wave
10/28/97



File 3280701S

Applied Research Associates Inc.
HTEF-C13

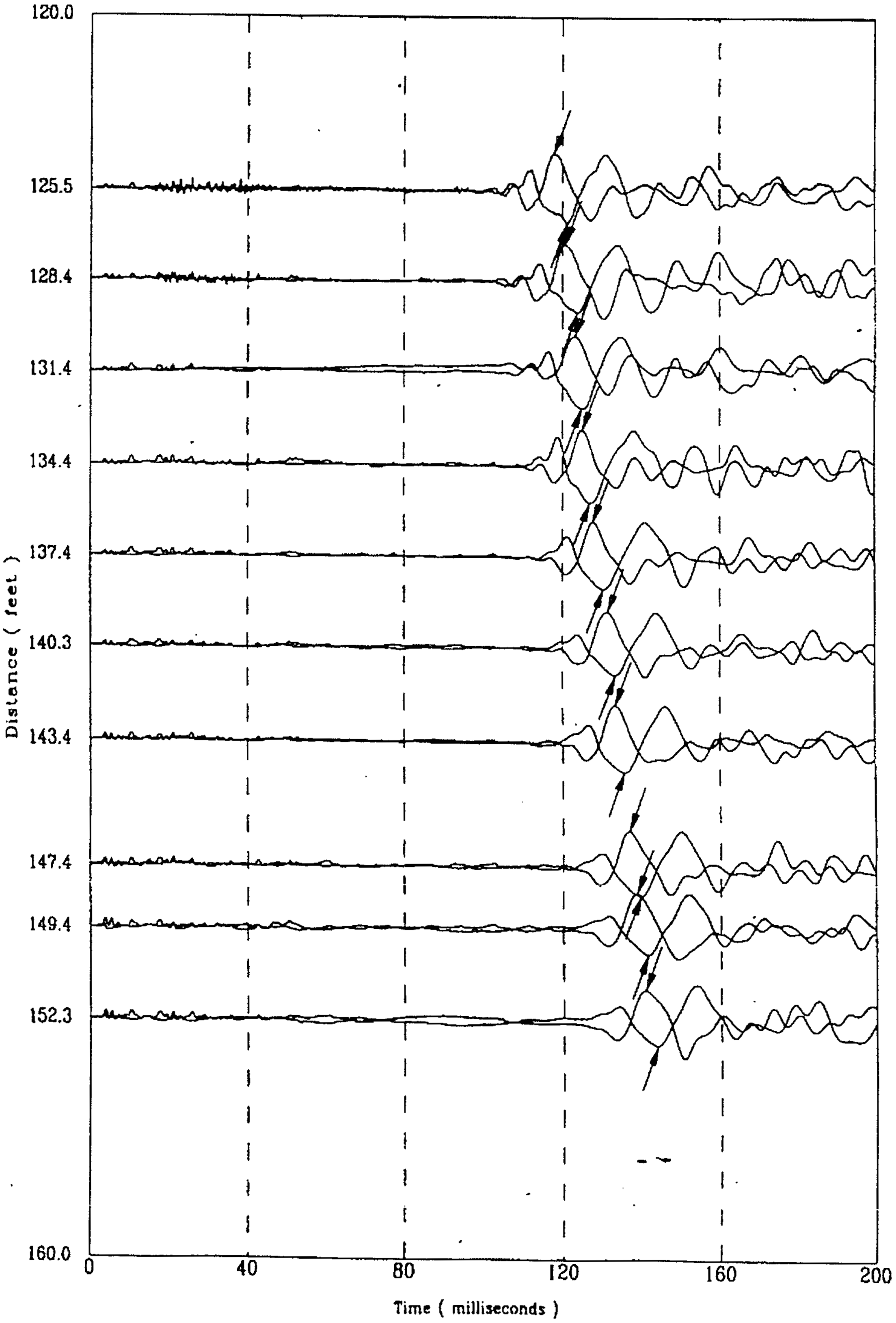
S Wave
10/28/97



File 3280702S

Applied Research Associates Inc.
HTEF-C13

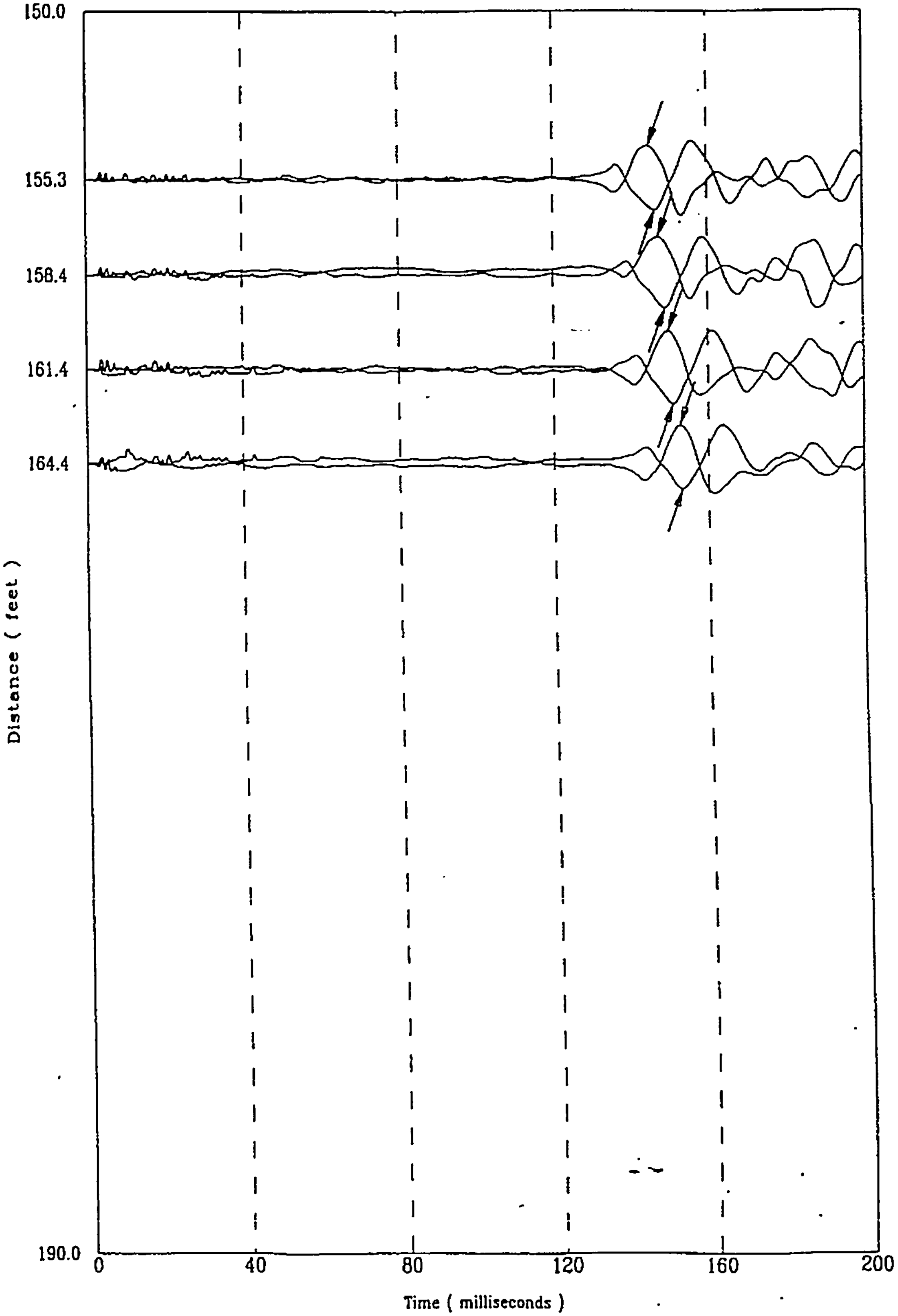
S Wave
10/28/97



File 3280702S

Applied Research Associates Inc.
HTEF-C13

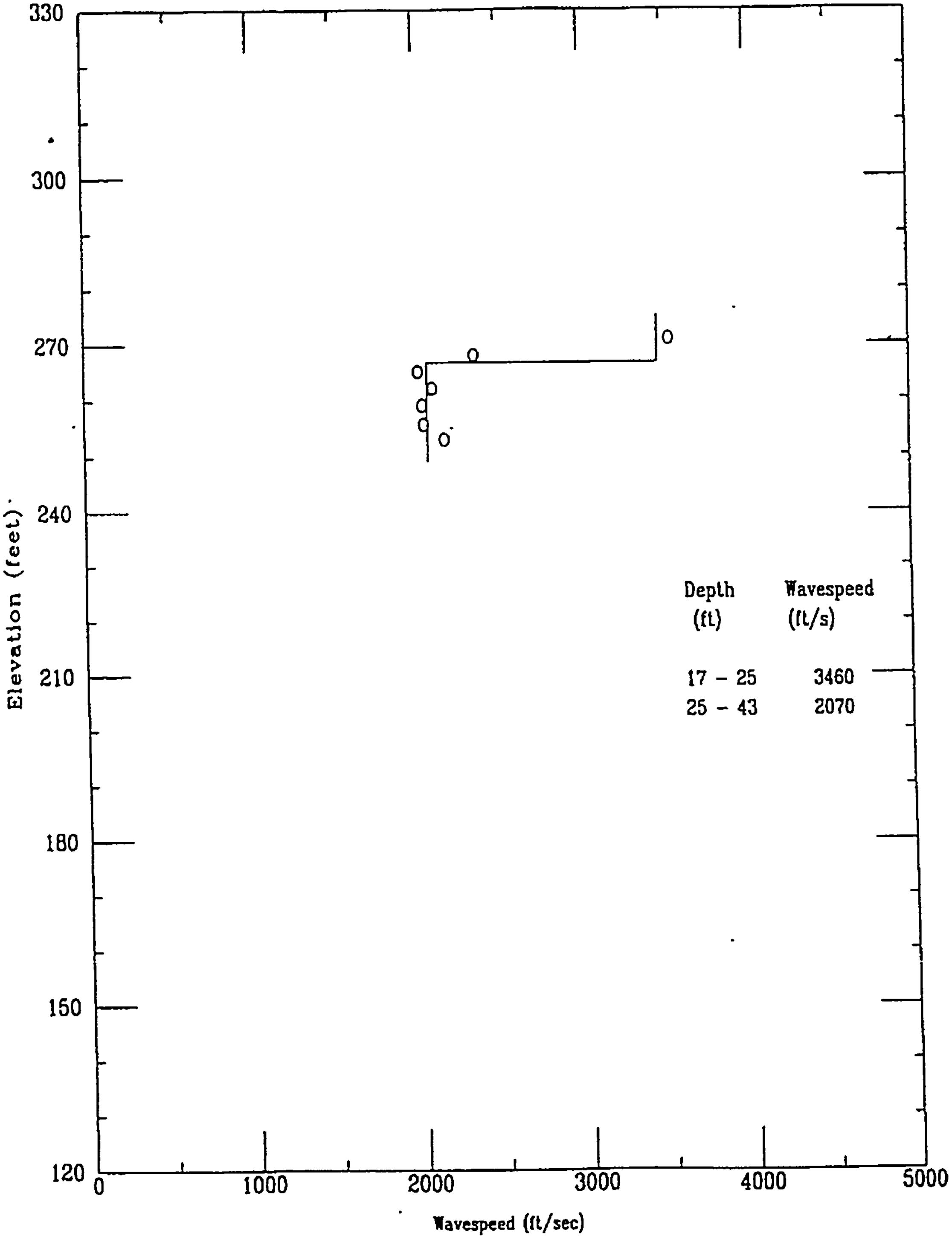
S Wave
10/28/97



File 3280702S

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

Compression Wave Speeds

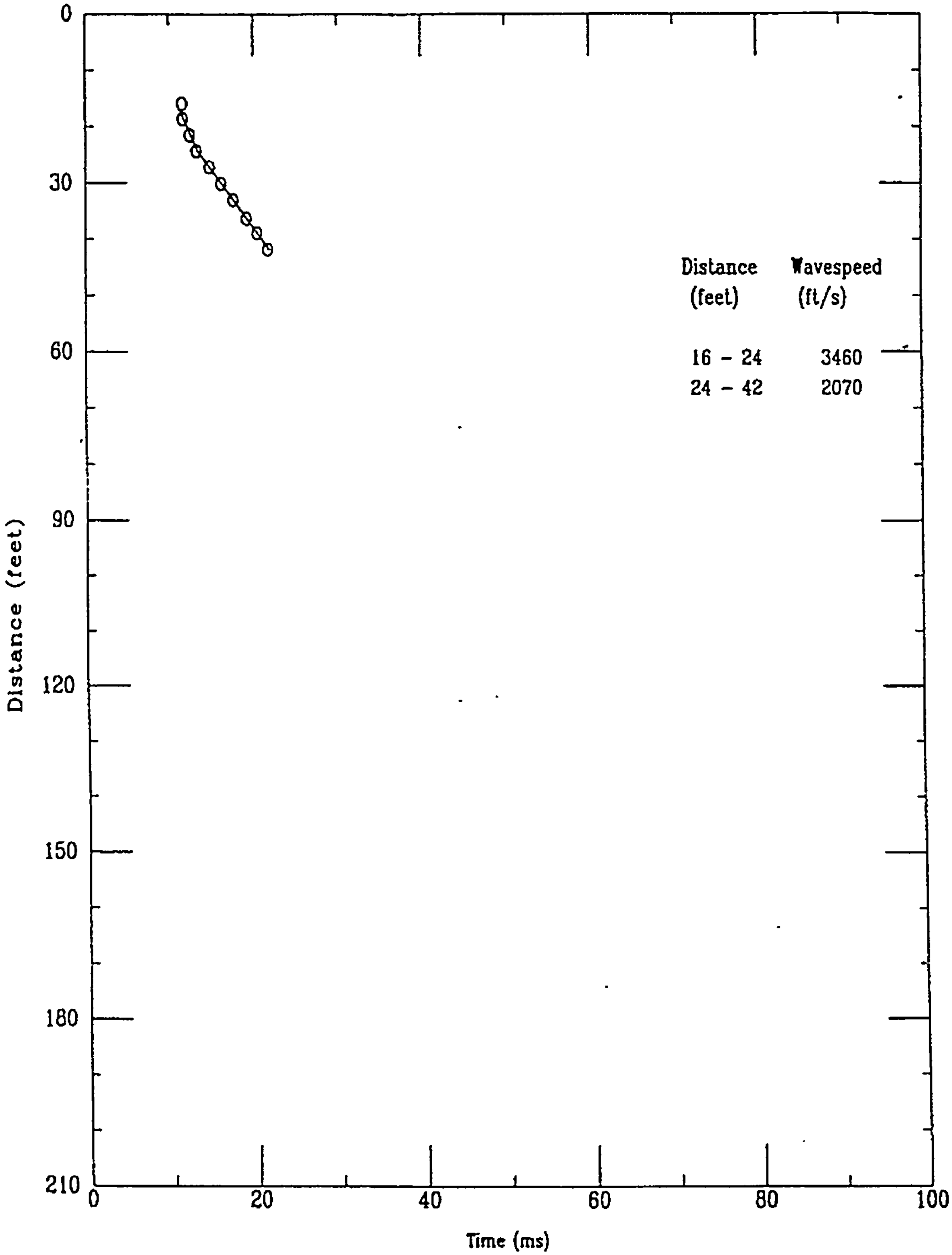


Depth (ft)	Wavespeed (ft/s)
17 - 25	3460
25 - 43	2070

File 3280701S

HTEF-C13 APPLIED RESEARCH ASSOCIATES, INC. 10/28/97

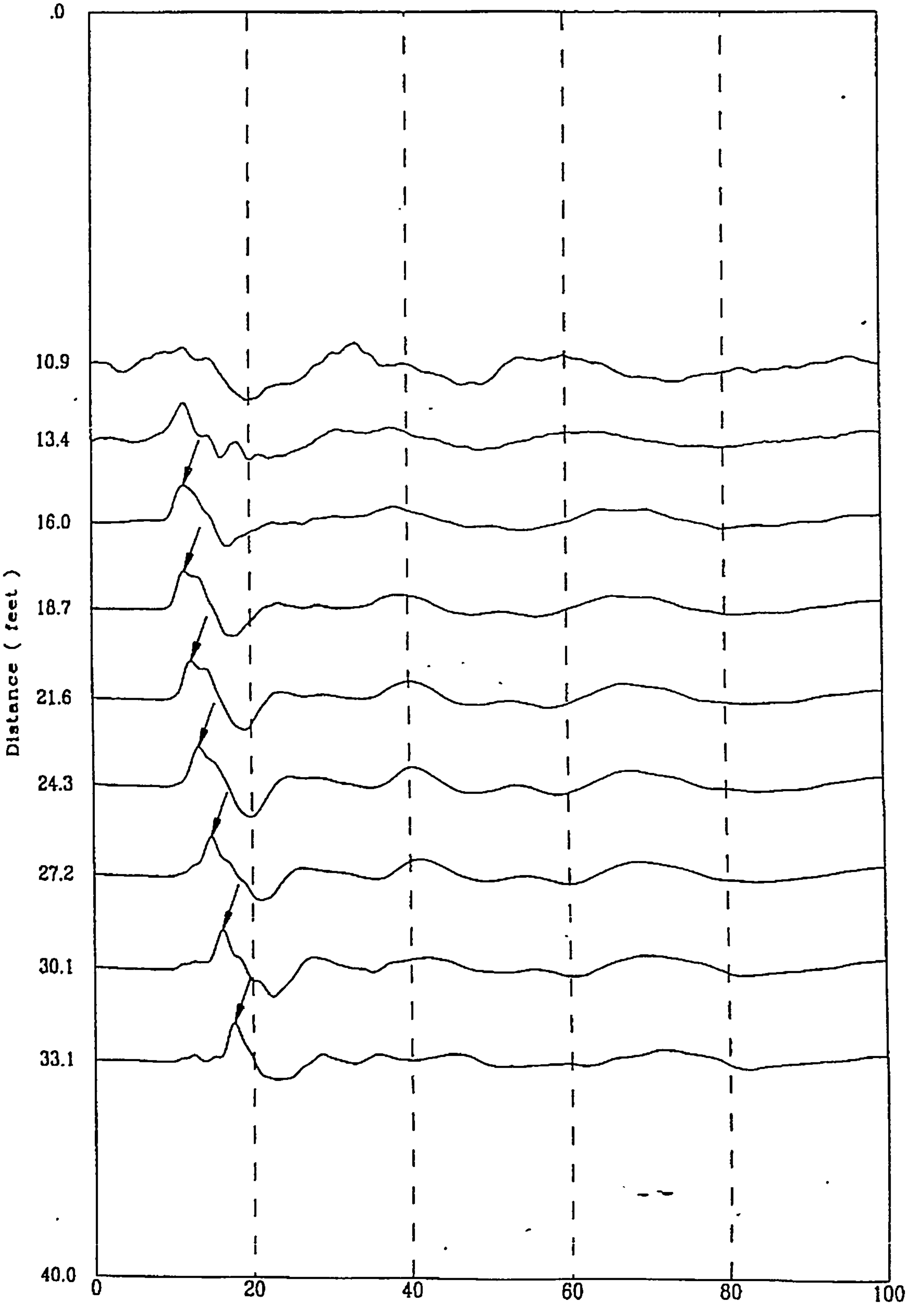
Compression Wave Time of Peak



Distance (feet)	Wavespeed (ft/s)
16 - 24	3460
24 - 42	2070

File 3280701S

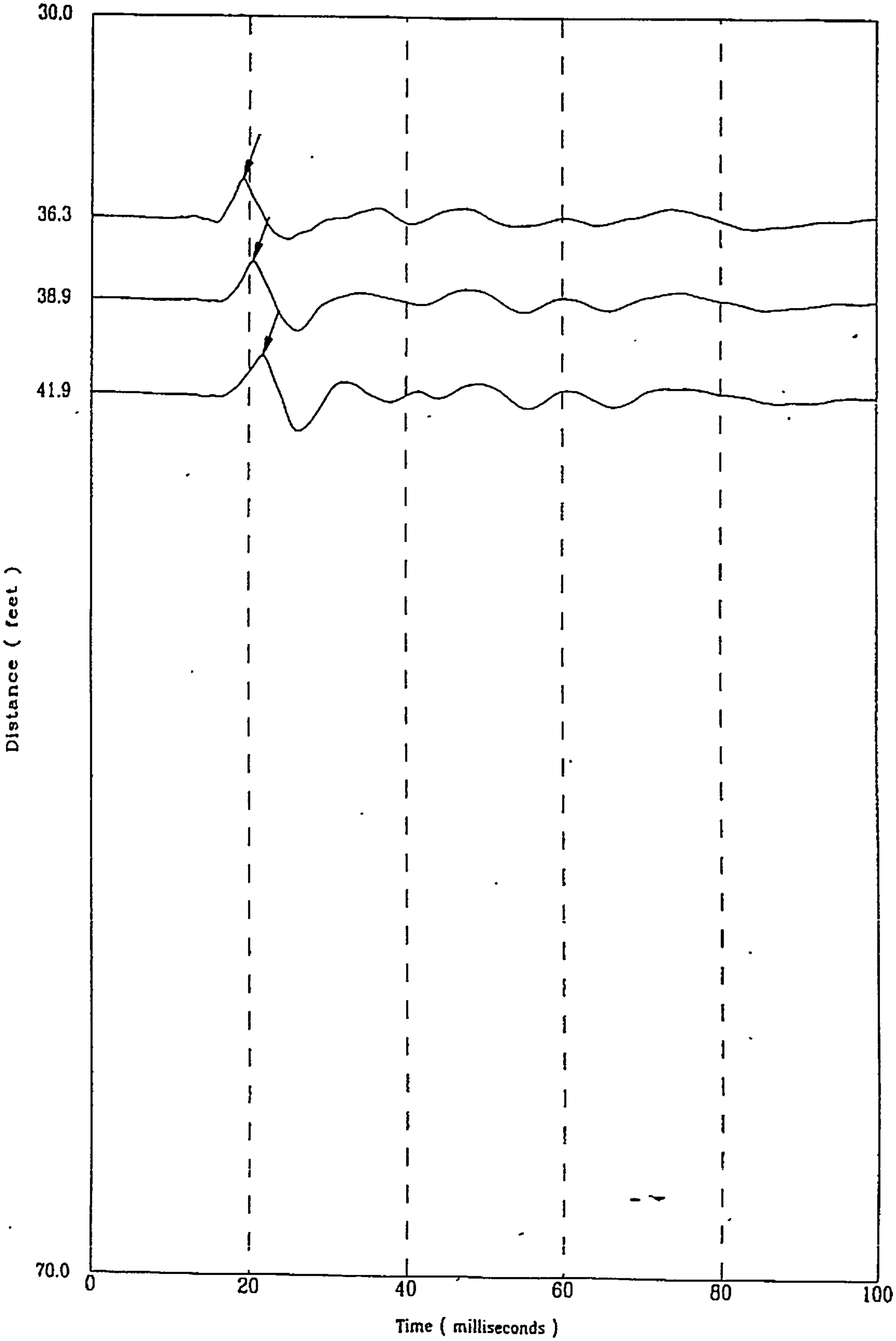
Applied Research Associates Inc. P Wave
HTEF-C13 10/28/97



File 3280701S

Applied Research Associates Inc.
HTEF-C13

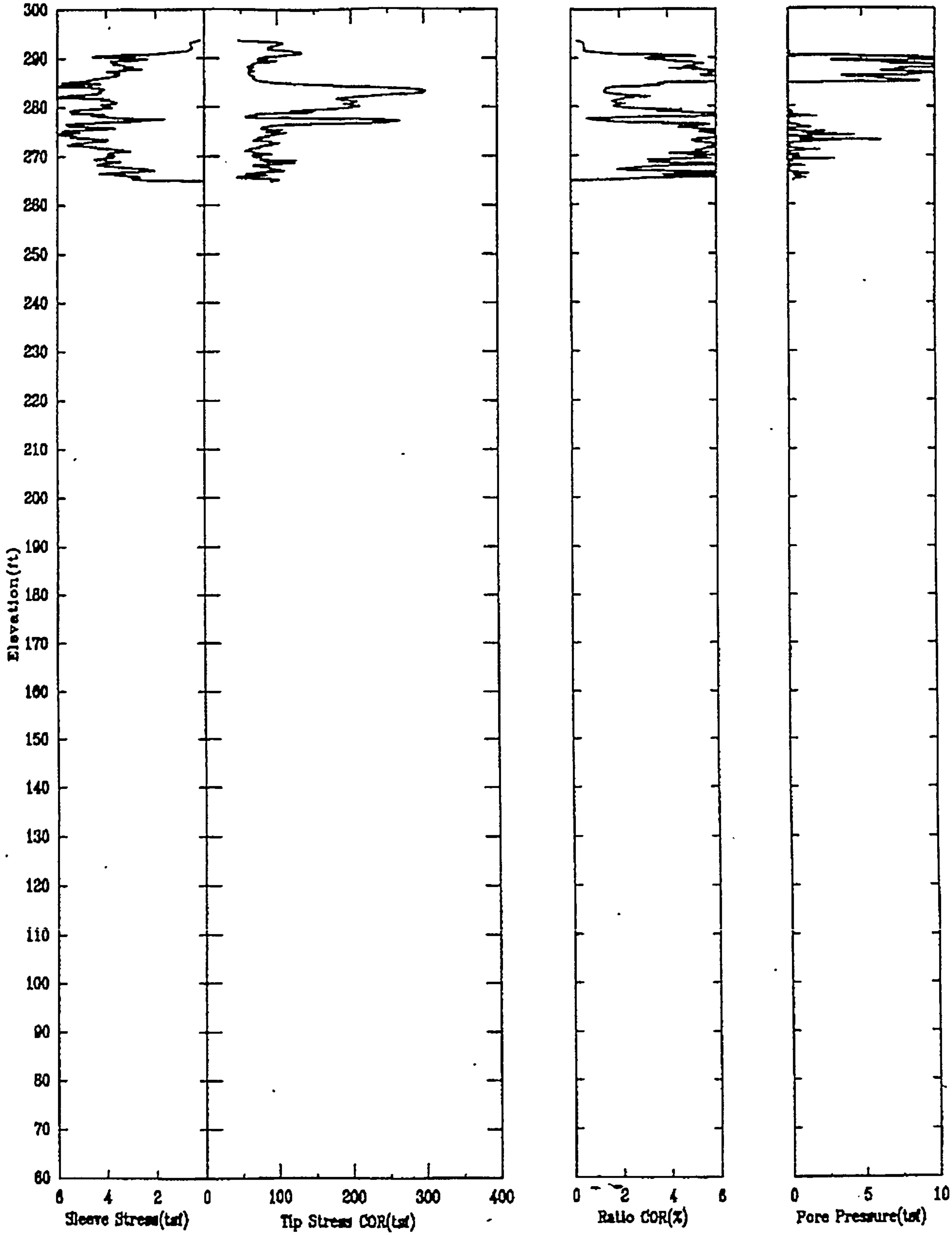
P Wave
10/28/97



File 3280701S

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

North 73181.0 East 61915.5 Elevation 299.7

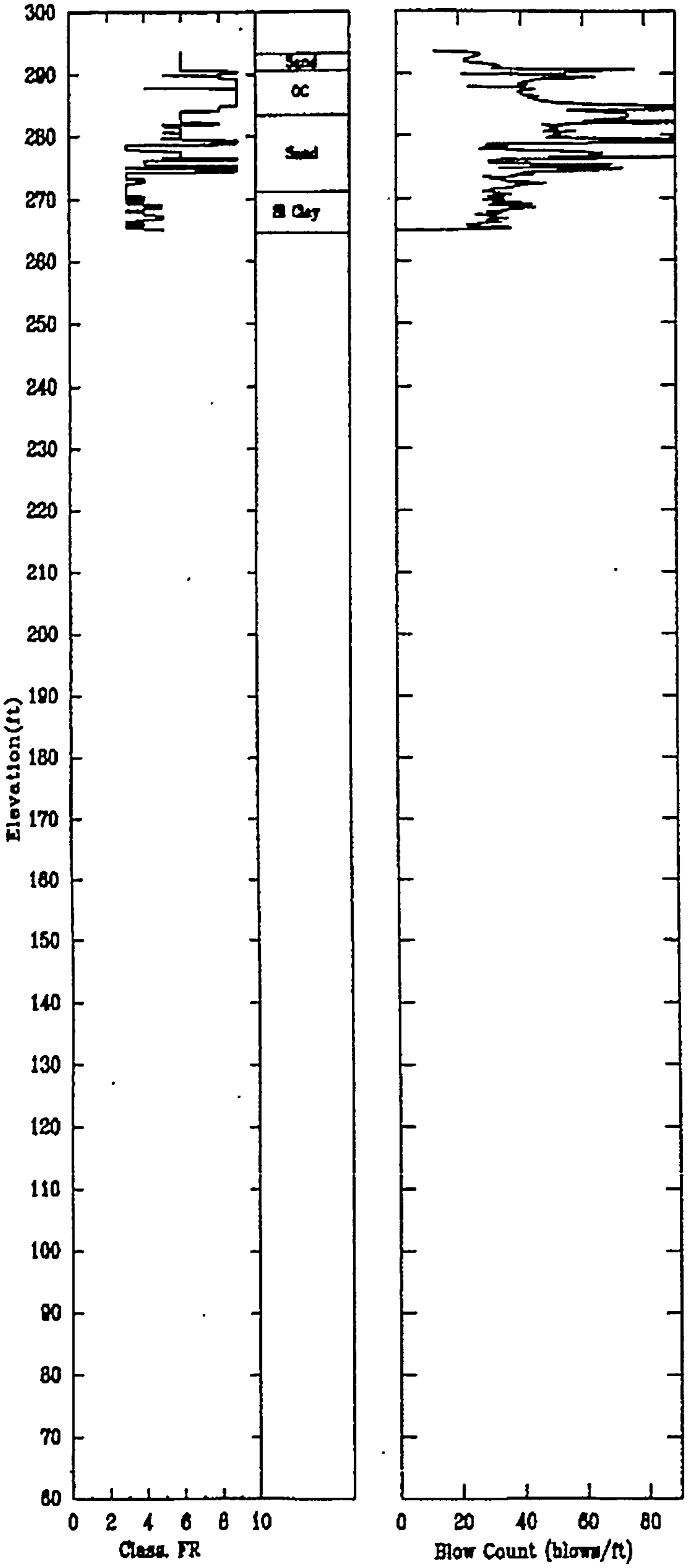


File 3290702.ECP

A-182

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

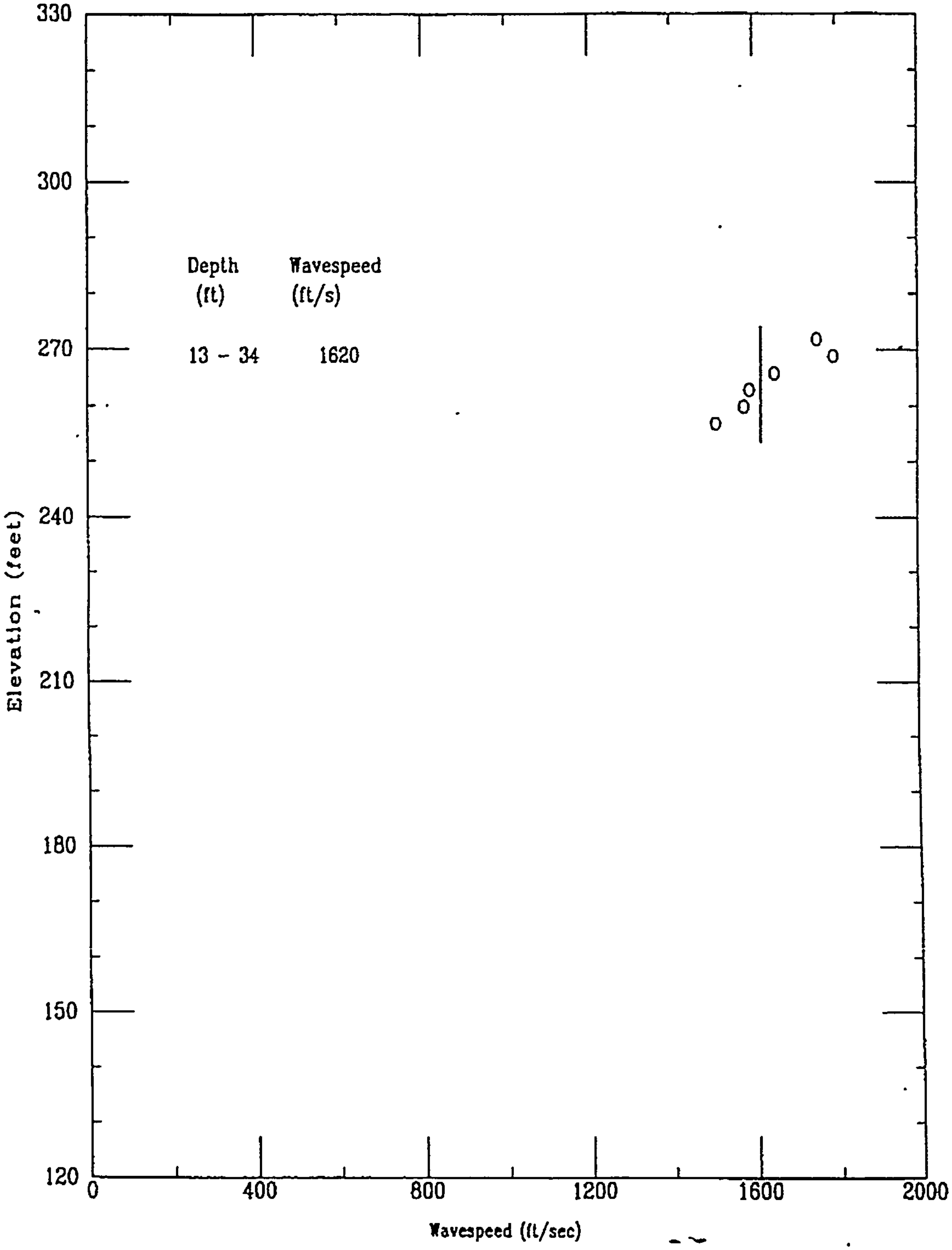
North 73181.0 East 61915.5 Elevation 299.7



File 3290702.ECP

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

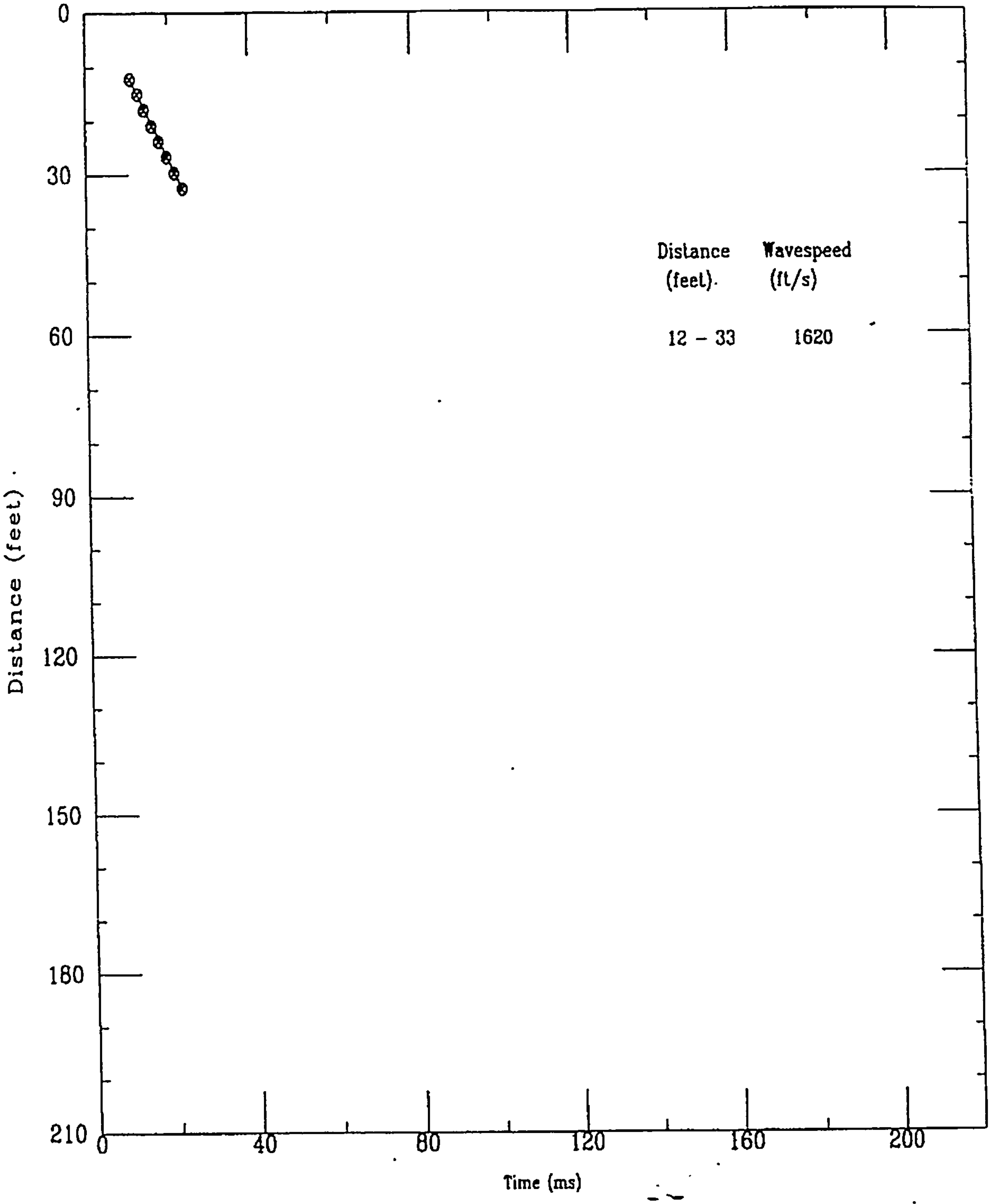
Shear Wave Speeds



File 3290702S

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

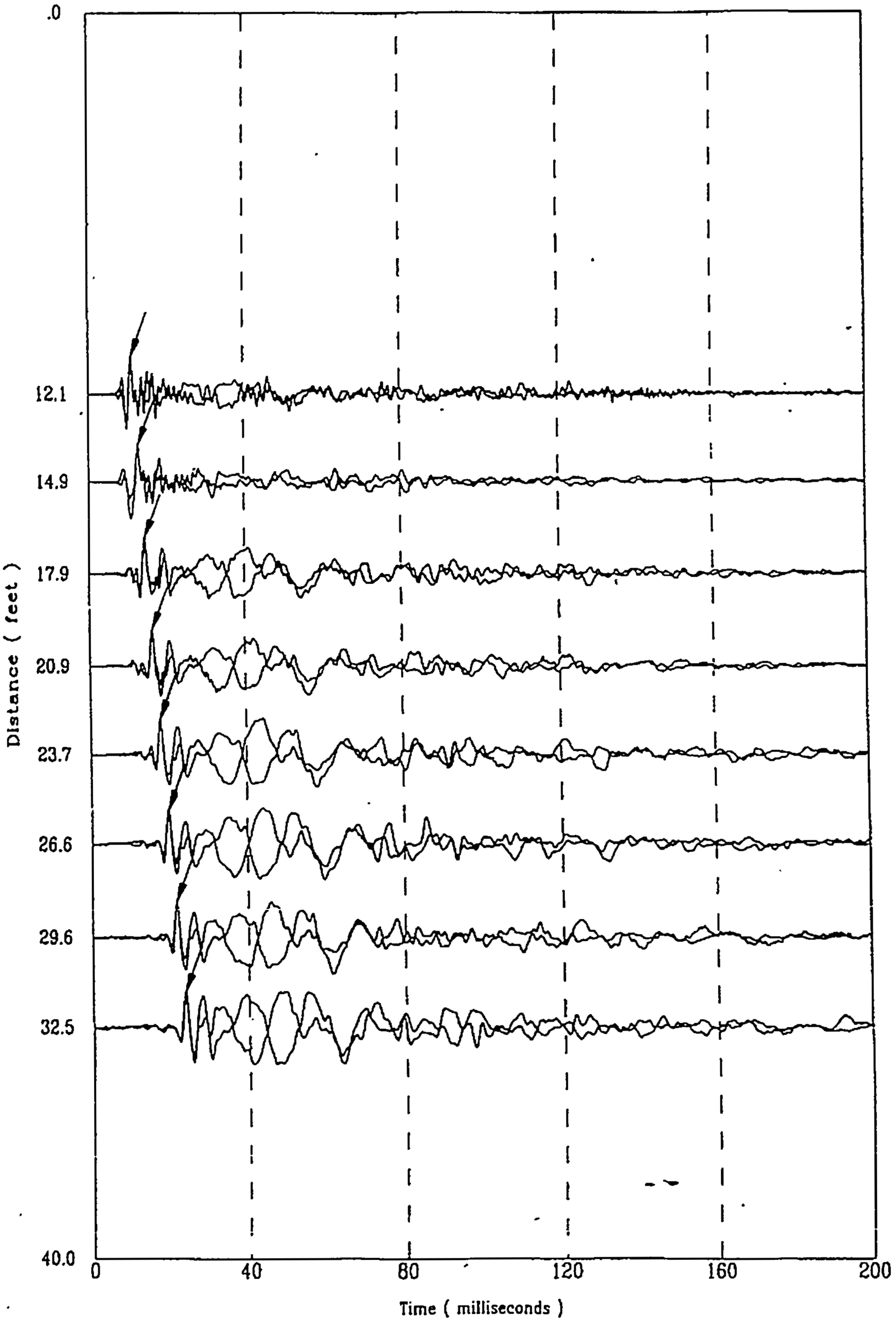
Shear Wave Time of Peak



File 3290702S

Applied Research Associates Inc.
HTEF-C14

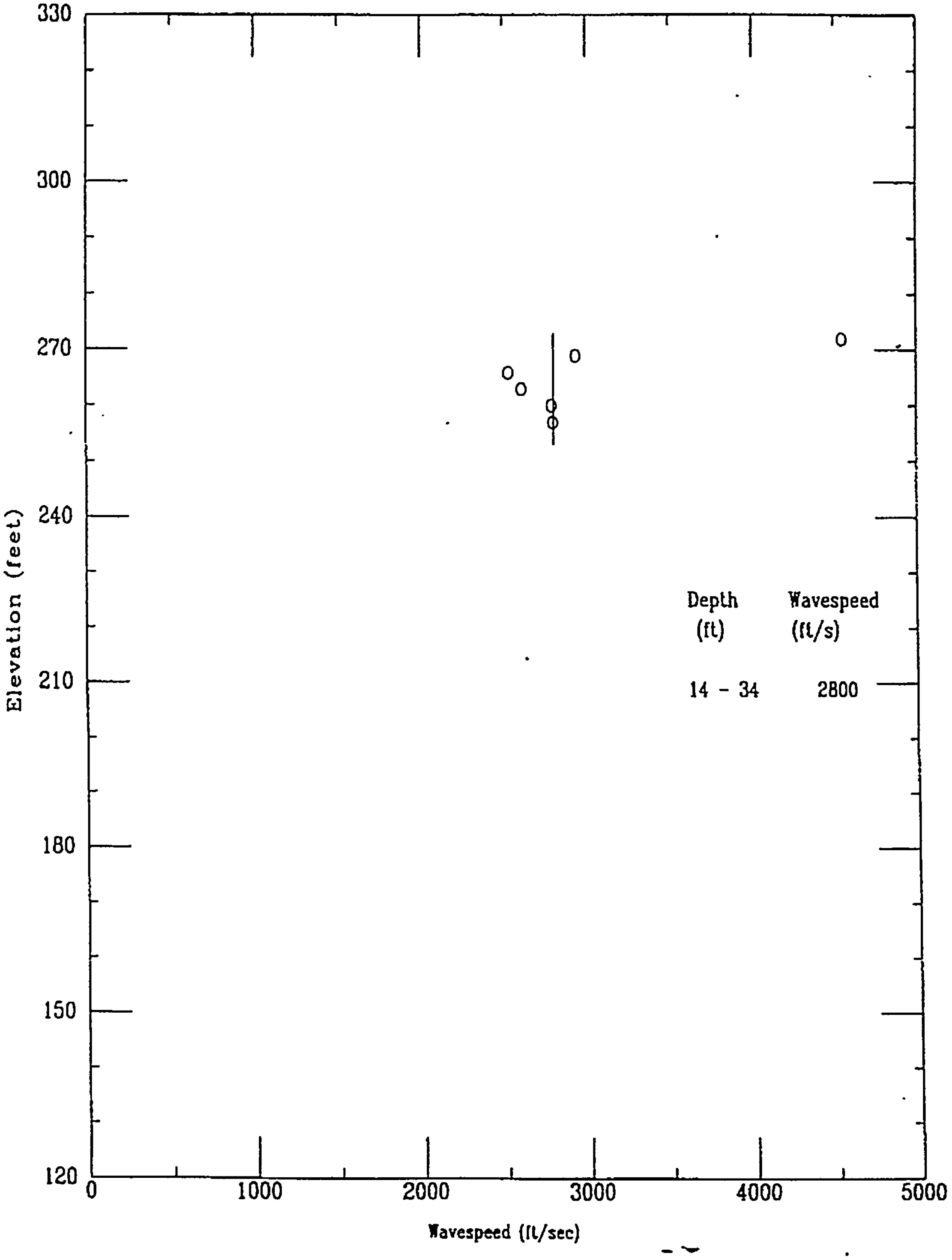
S Wave
10/29/97



File 3290702S

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

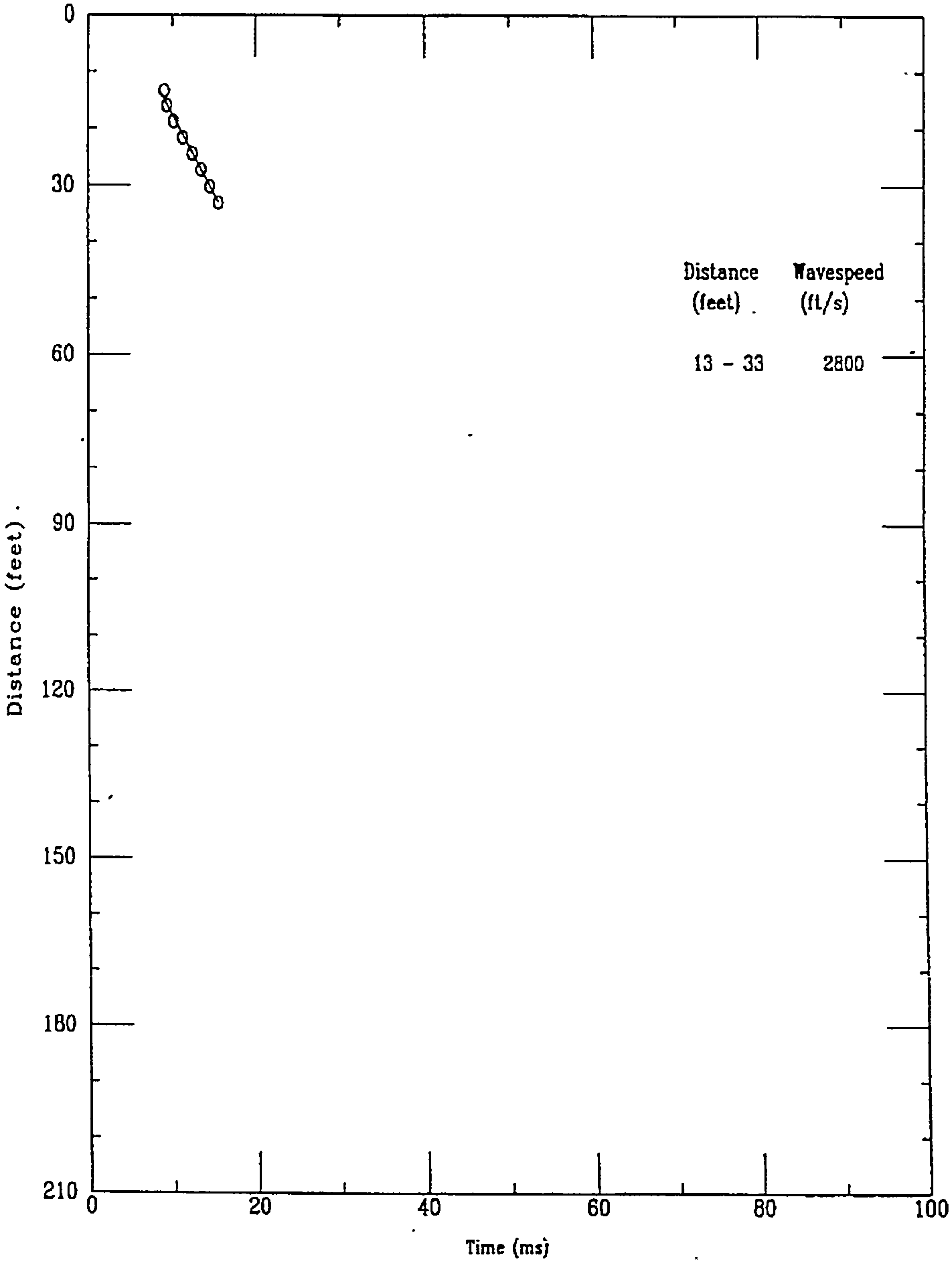
Compression Wave Speeds



File 3290702S

HTEF-C14 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

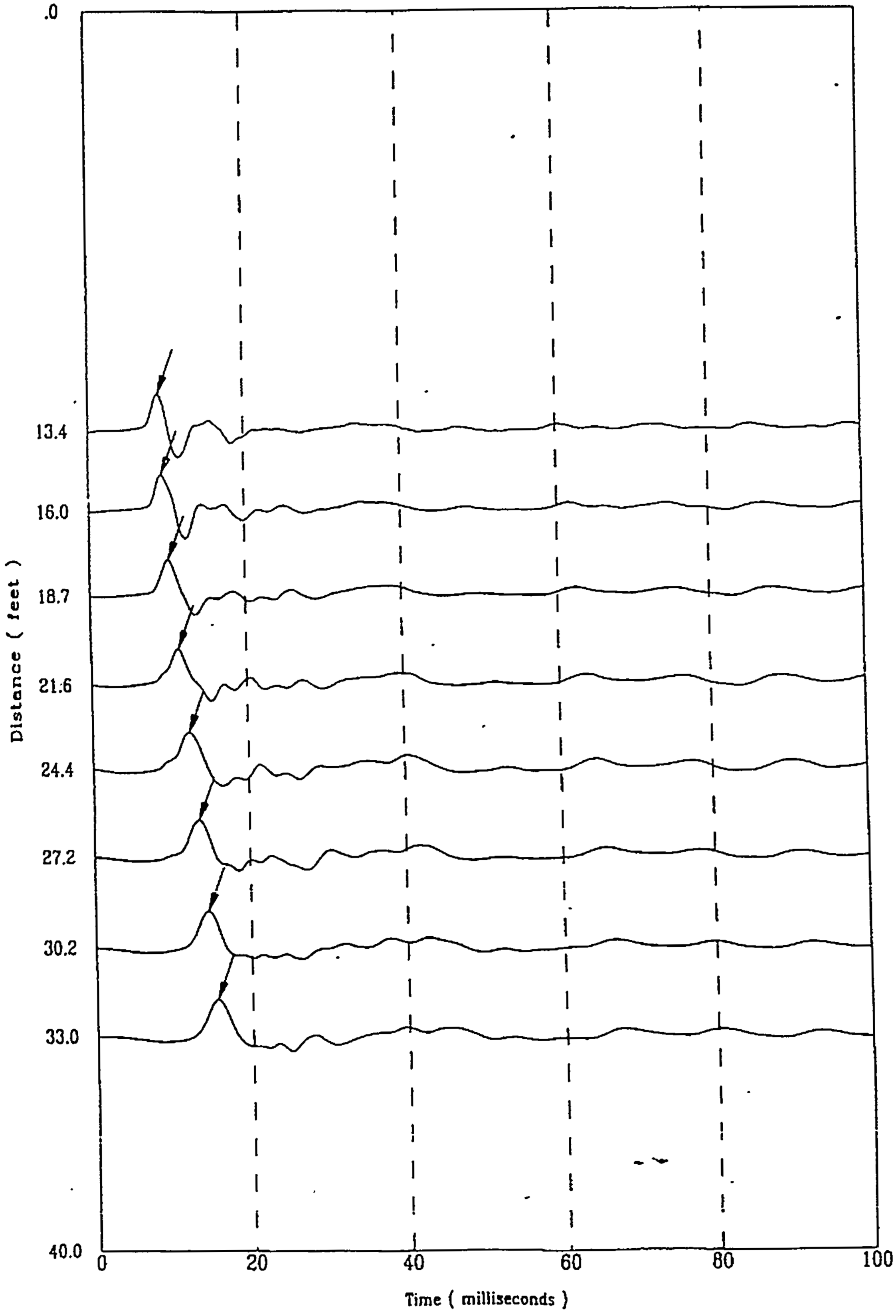
Compression Wave Time of Peak



File 3290702S

Applied Research Associates Inc.
HTEF-C14

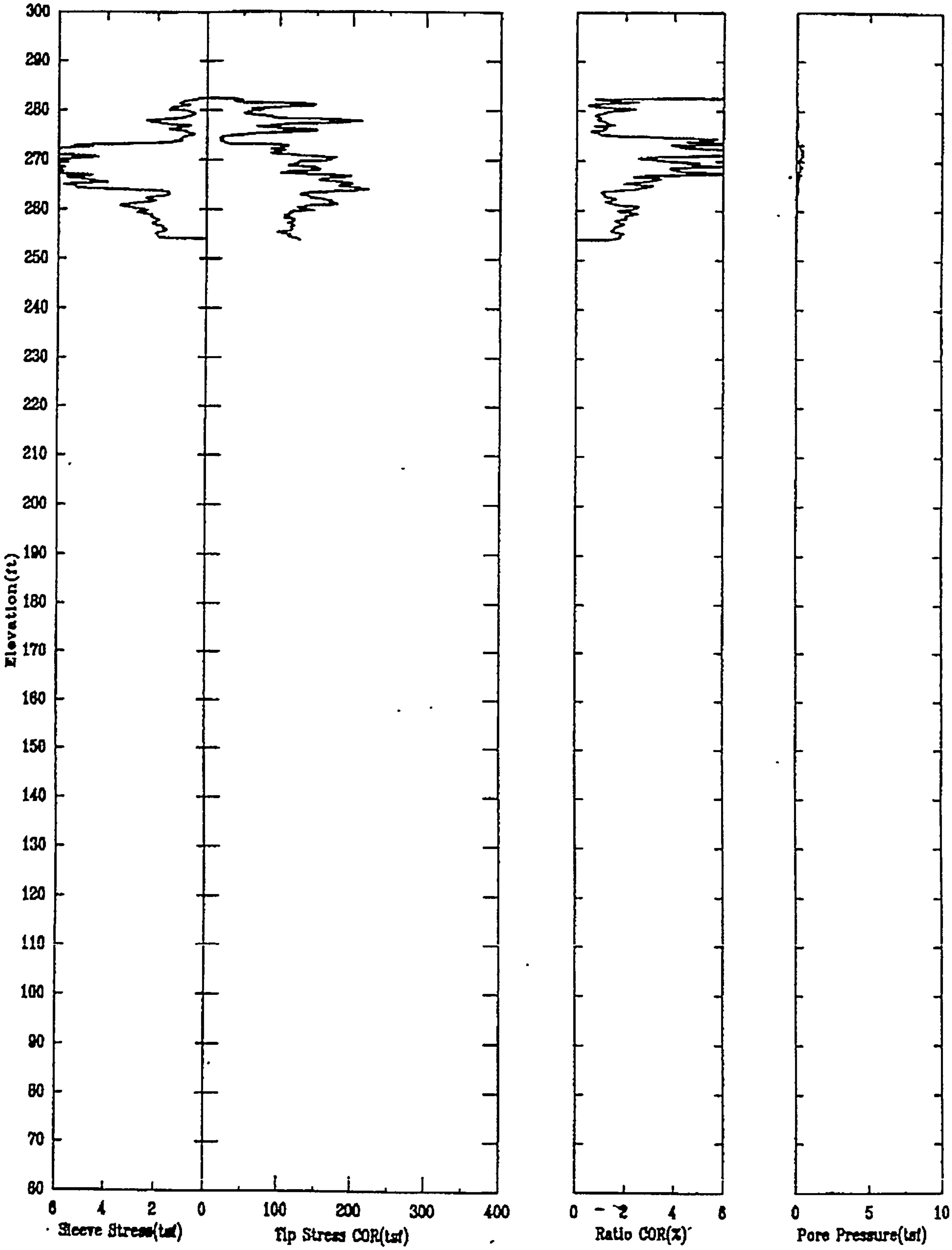
P Wave
10/29/97



File 3290702S

HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

North 73569.0 East 62247.5 Elevation 288.8

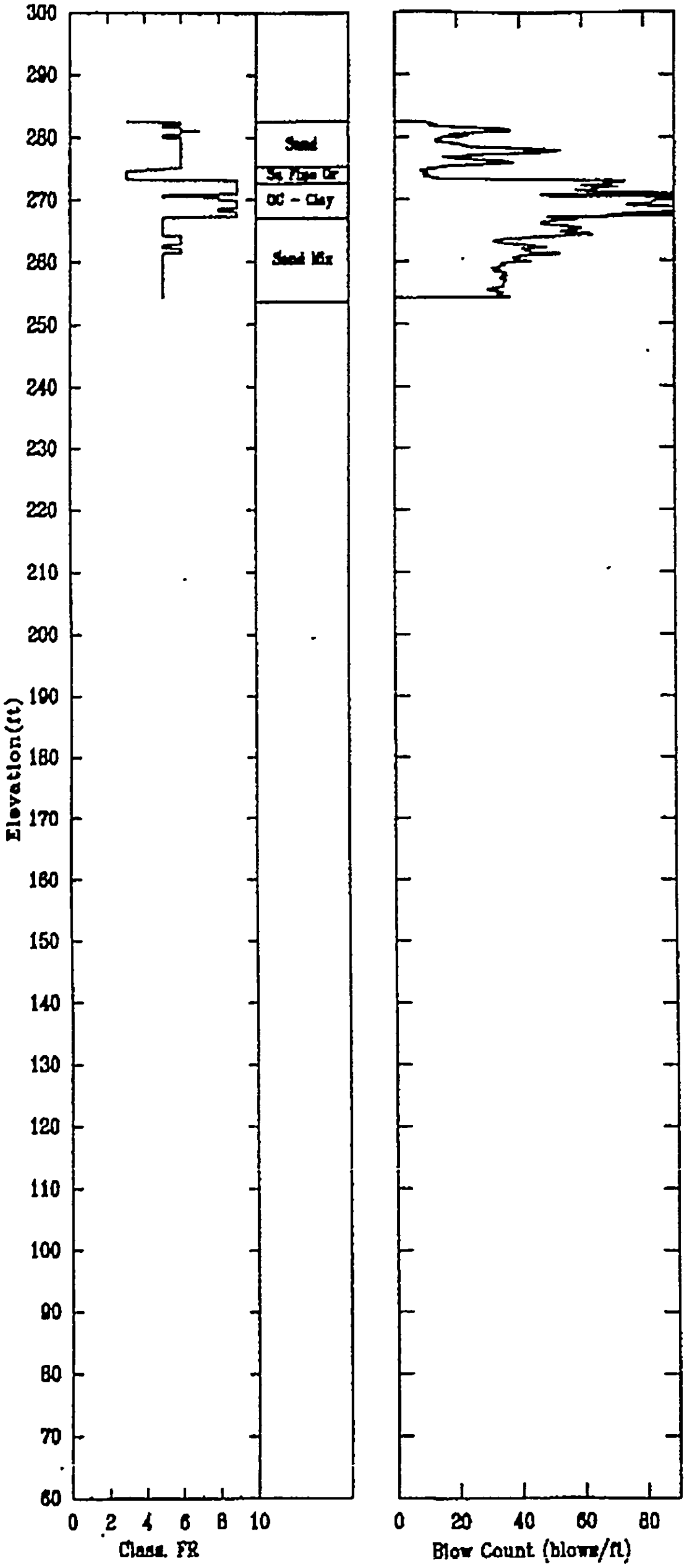


File 3290706.ECP

A-190

HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

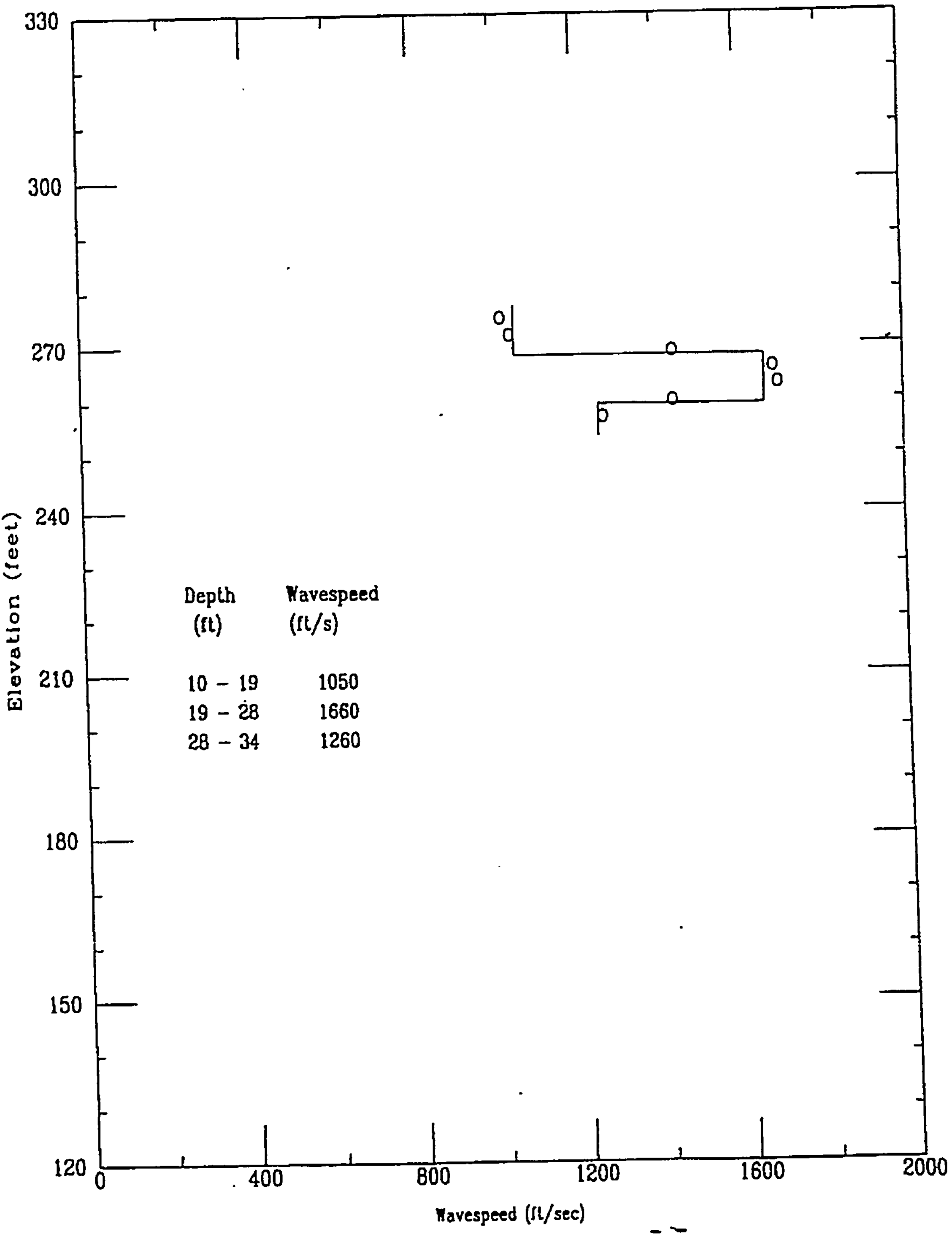
North 73569.0 East 62247.5 Elevation 288.8



File 3290706.ECP

HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

Shear Wave Speeds

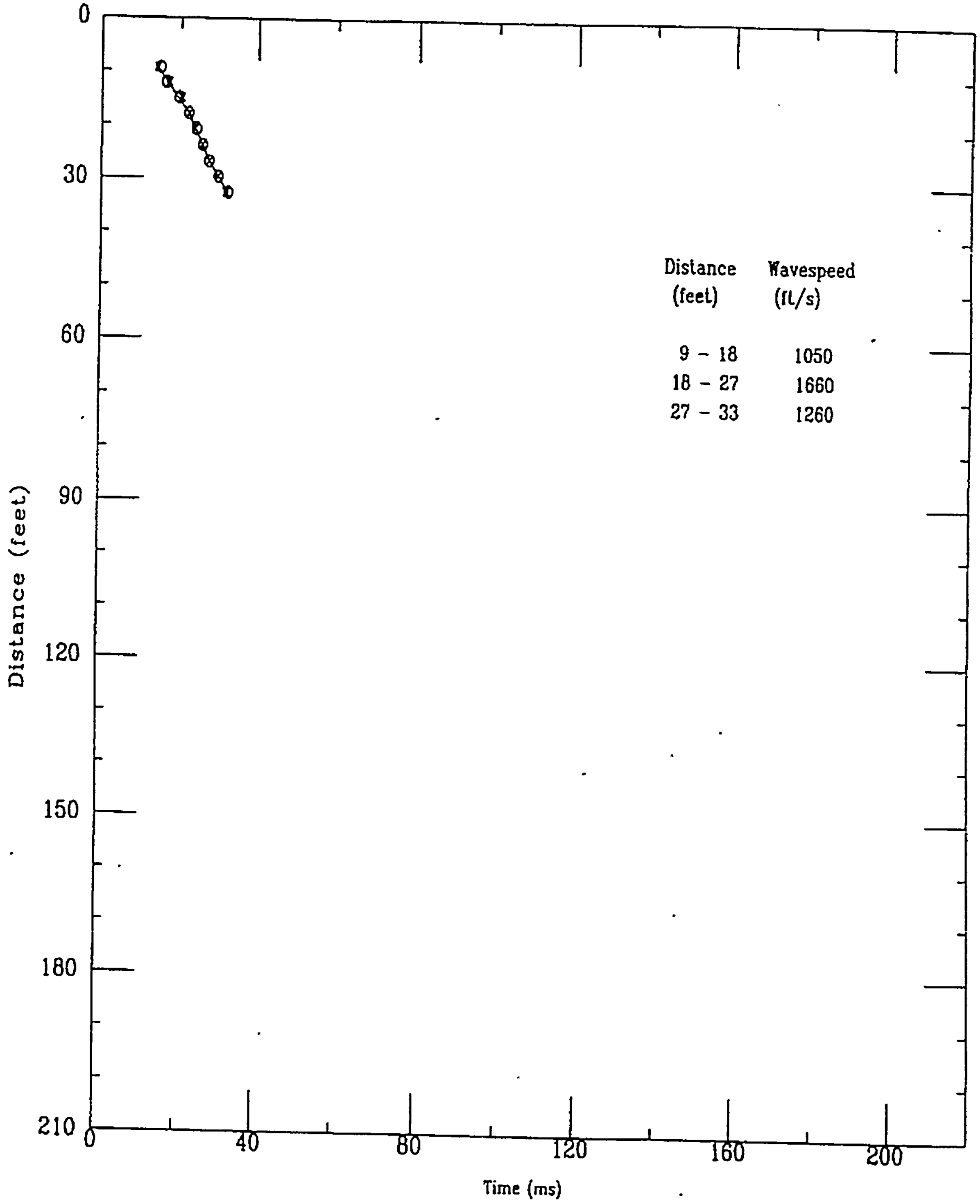


Depth (ft)	Wavespeed (ft/s)
10 - 19	1050
19 - 28	1660
28 - 34	1260

File 3290706S

HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

Shear Wave Time of Peak

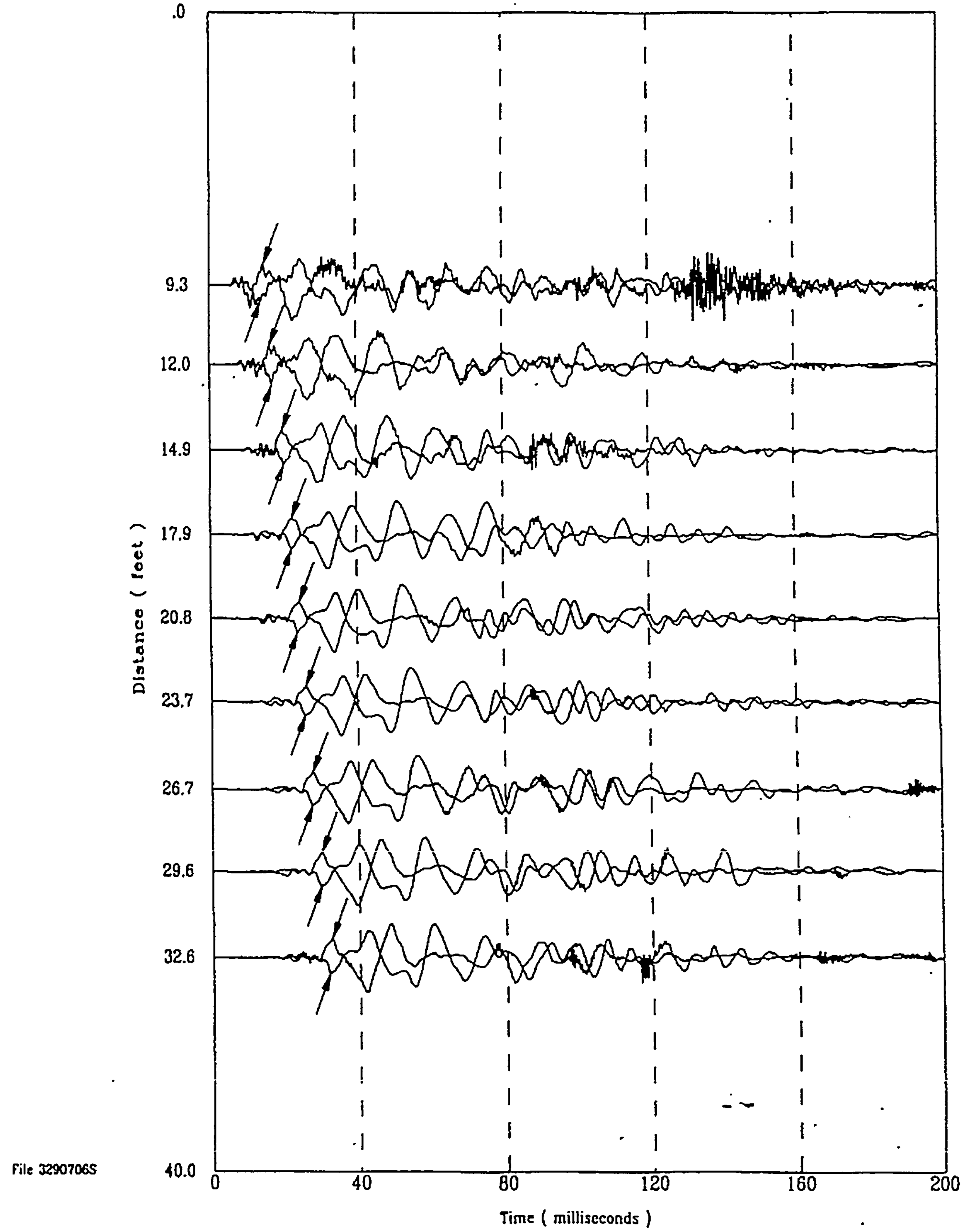


Distance (feet)	Wavespeed (ft/s)
9 - 18	1050
18 - 27	1660
27 - 33	1260

File 3290706S

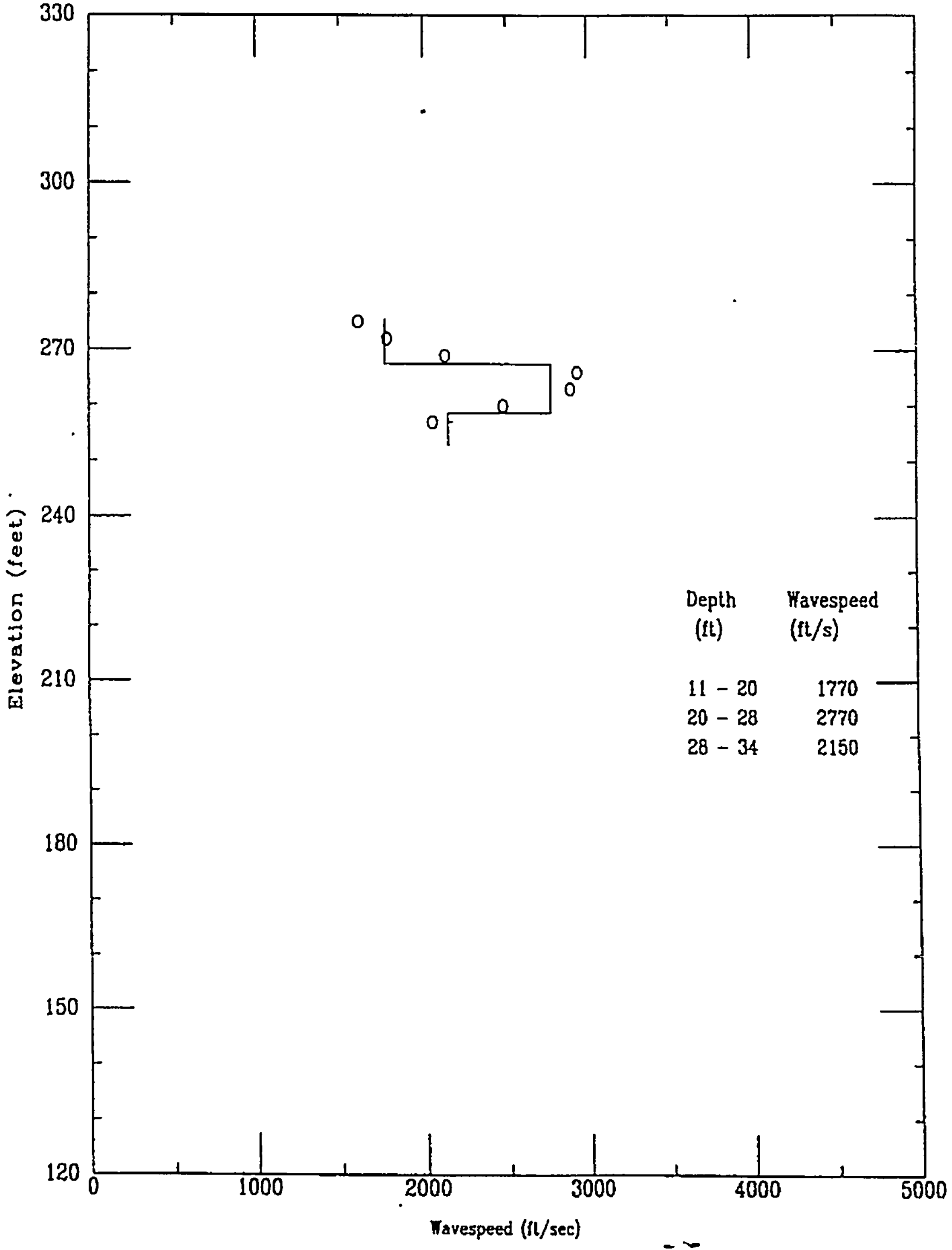
Applied Research Associates Inc.
HTEF-C15

S Wave
10/29/97



HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

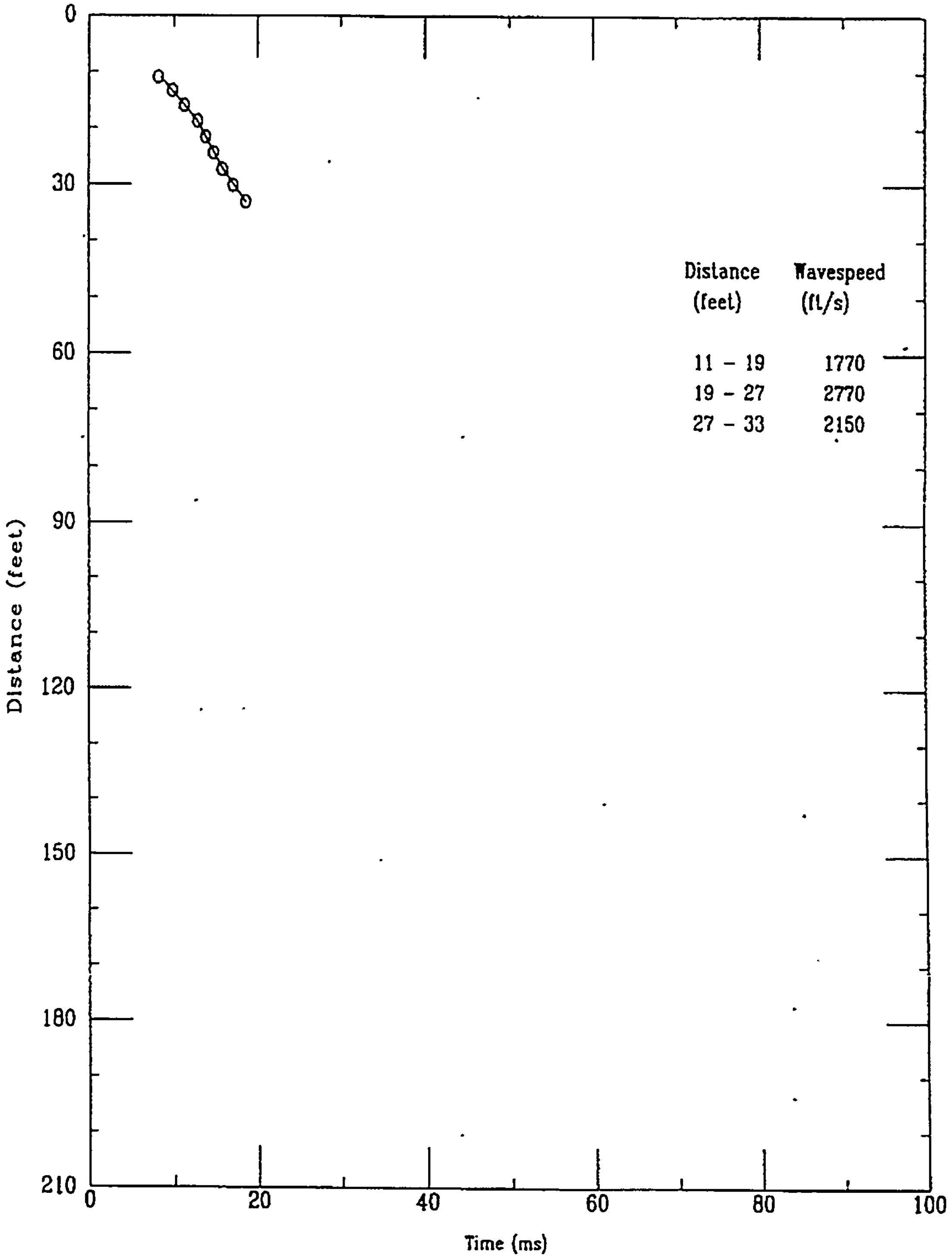
Compression Wave Speeds



File 3290706S

HTEF-C15 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

Compression Wave Time of Peak

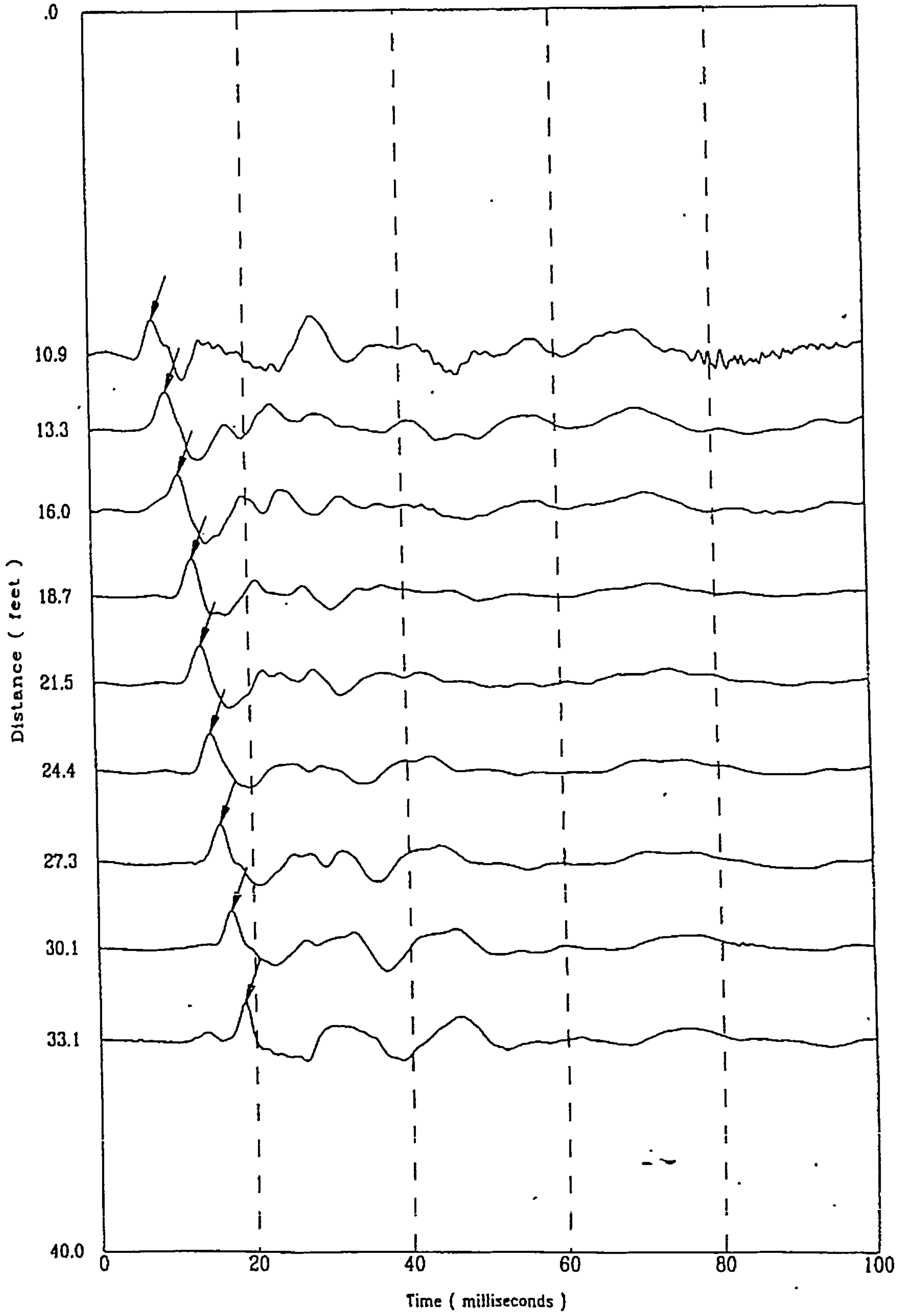


Distance (feet)	Wavespeed (ft/s)
11 - 19	1770
19 - 27	2770
27 - 33	2150

File 3290706S

Applied Research Associates Inc.
HTEF-C15

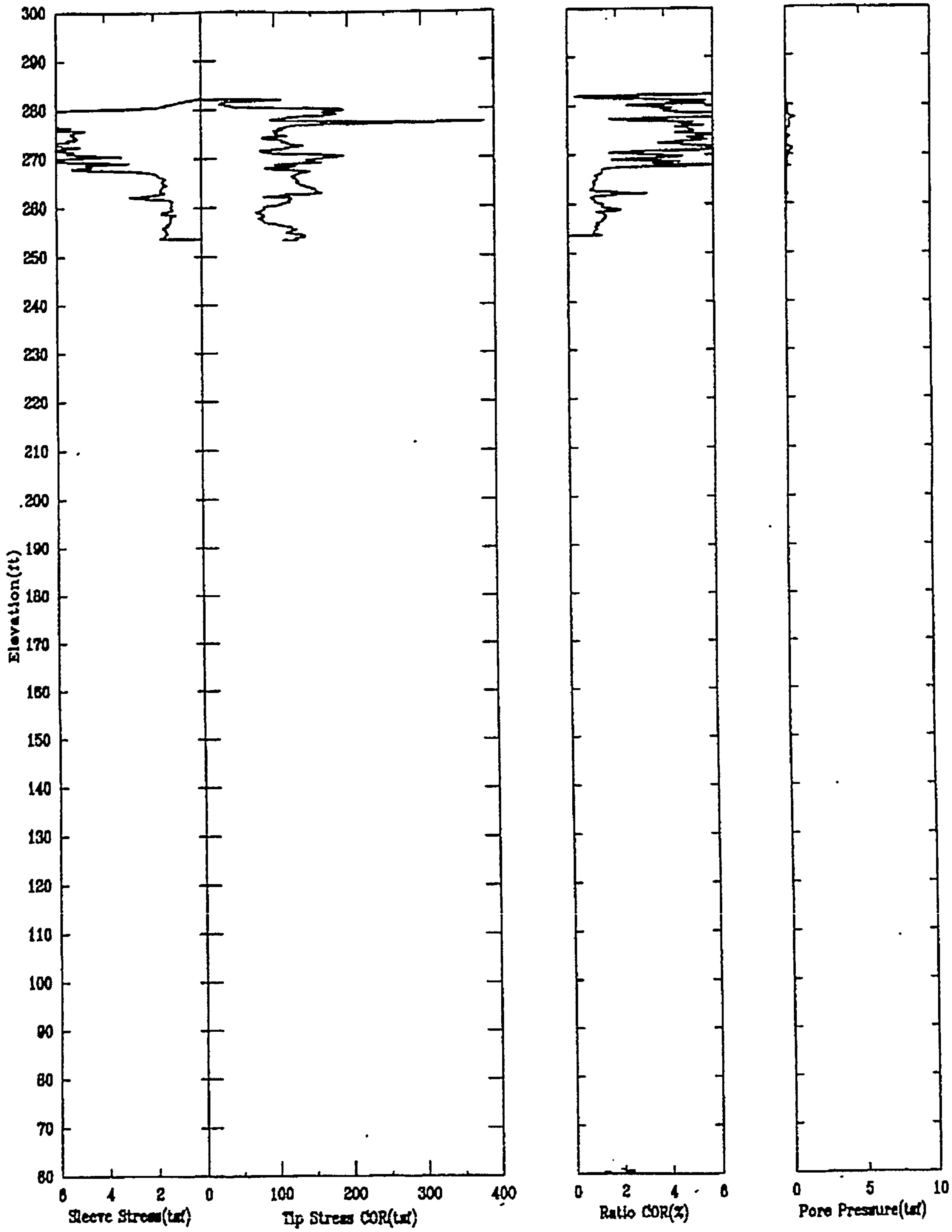
P Wave
10/29/97



File 3290706S

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

North 73480.0 East 62247.5 Elevation 288.4

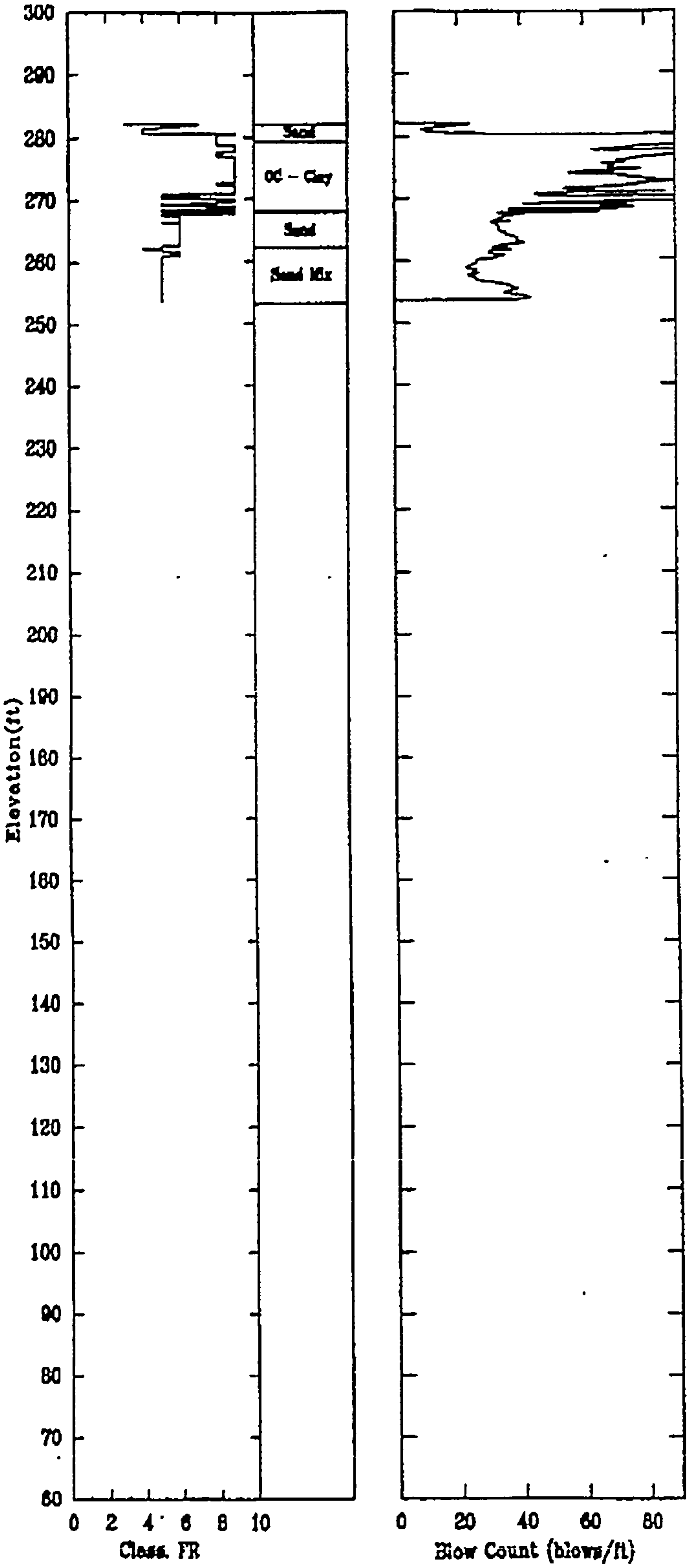


File 3290704.ECP

A-198

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

North 73480.0 East 62247.5 Elevation 288.4

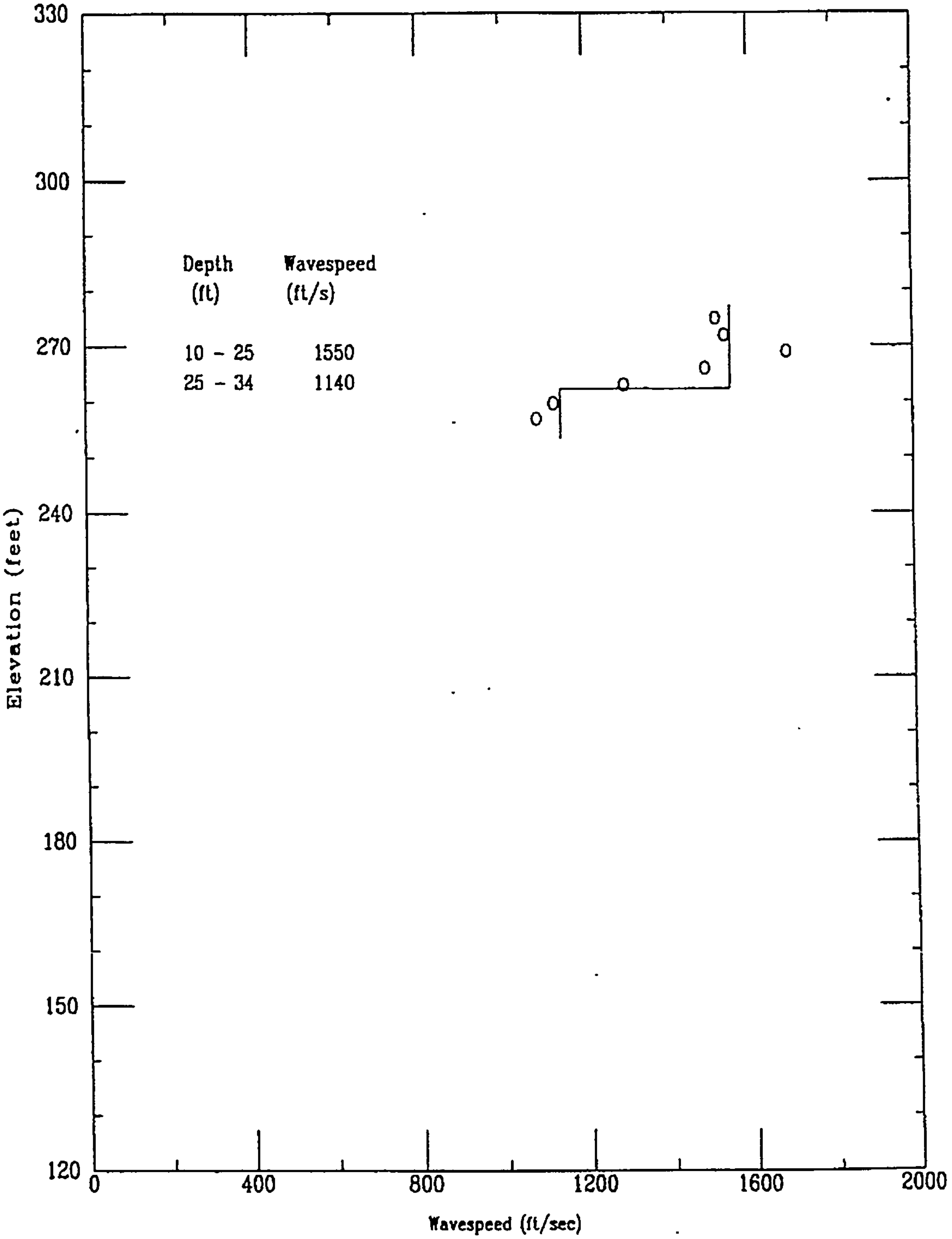


File 3290704.ECP

A-199

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

Shear Wave Speeds



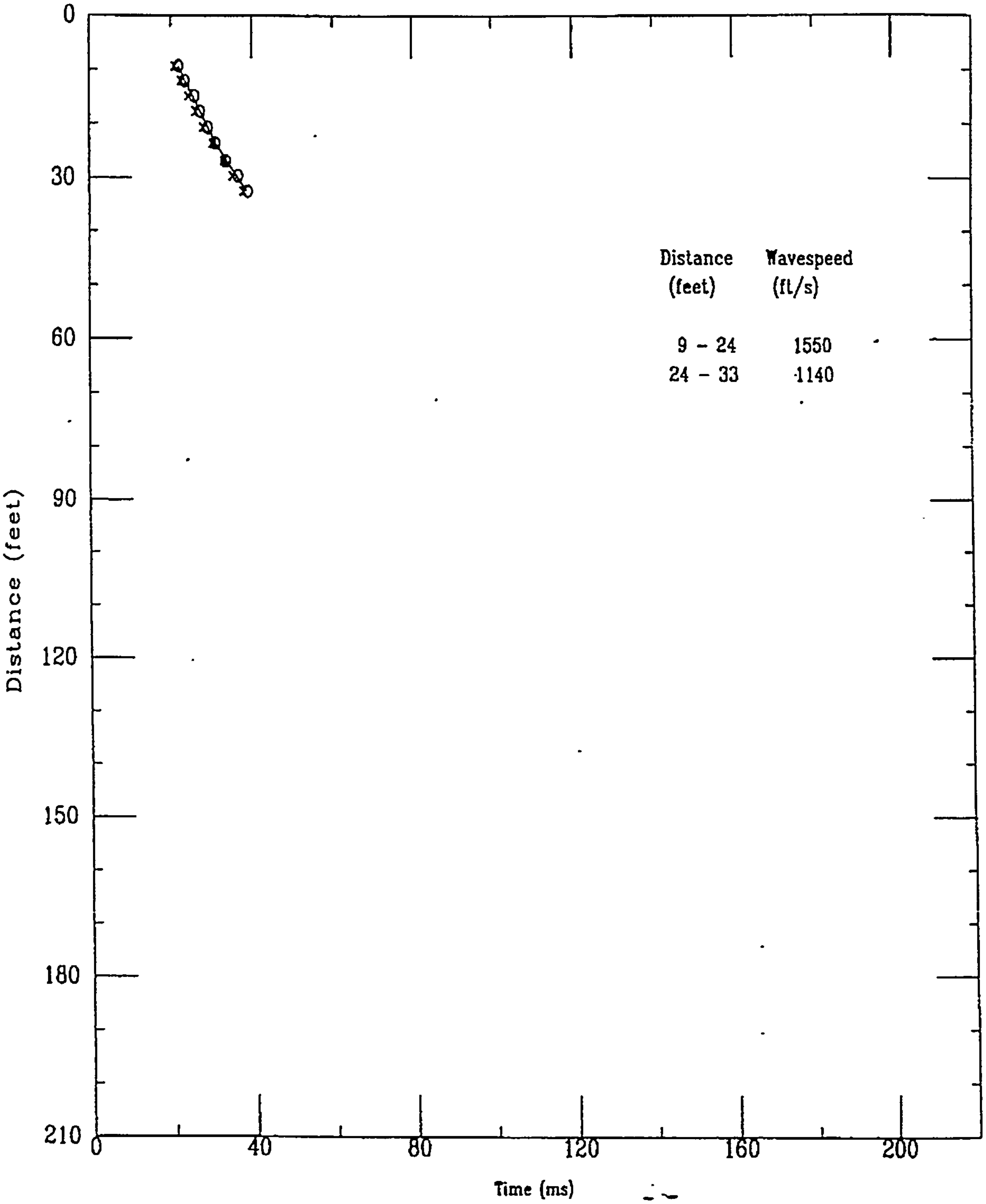
Depth (ft)	Wavespeed (ft/s)
10 - 25	1550
25 - 34	1140

File 3290704S

A-200

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

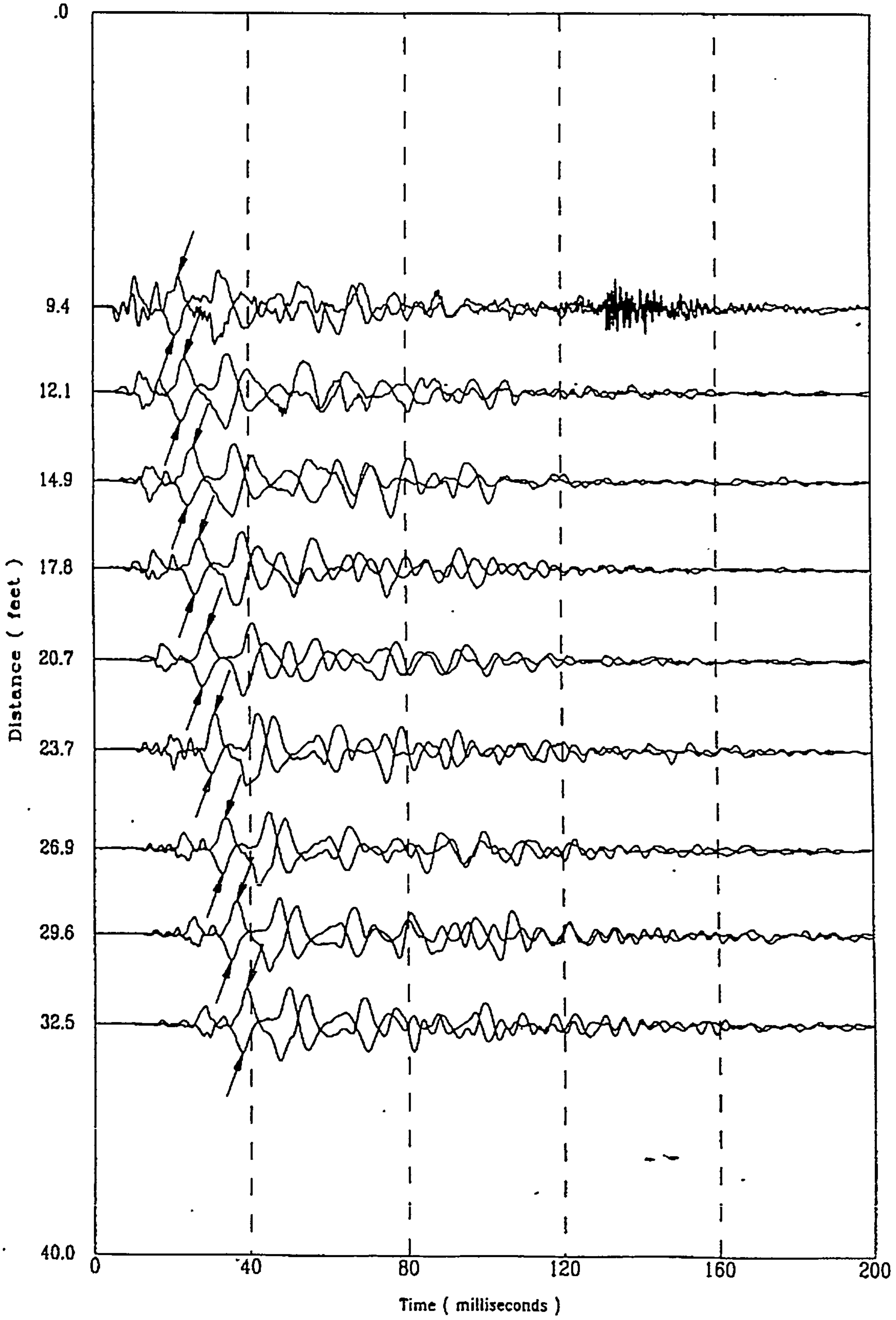
Shear Wave Time of Peak



File 3290704S

Applied Research Associates Inc.
HTEF-C16

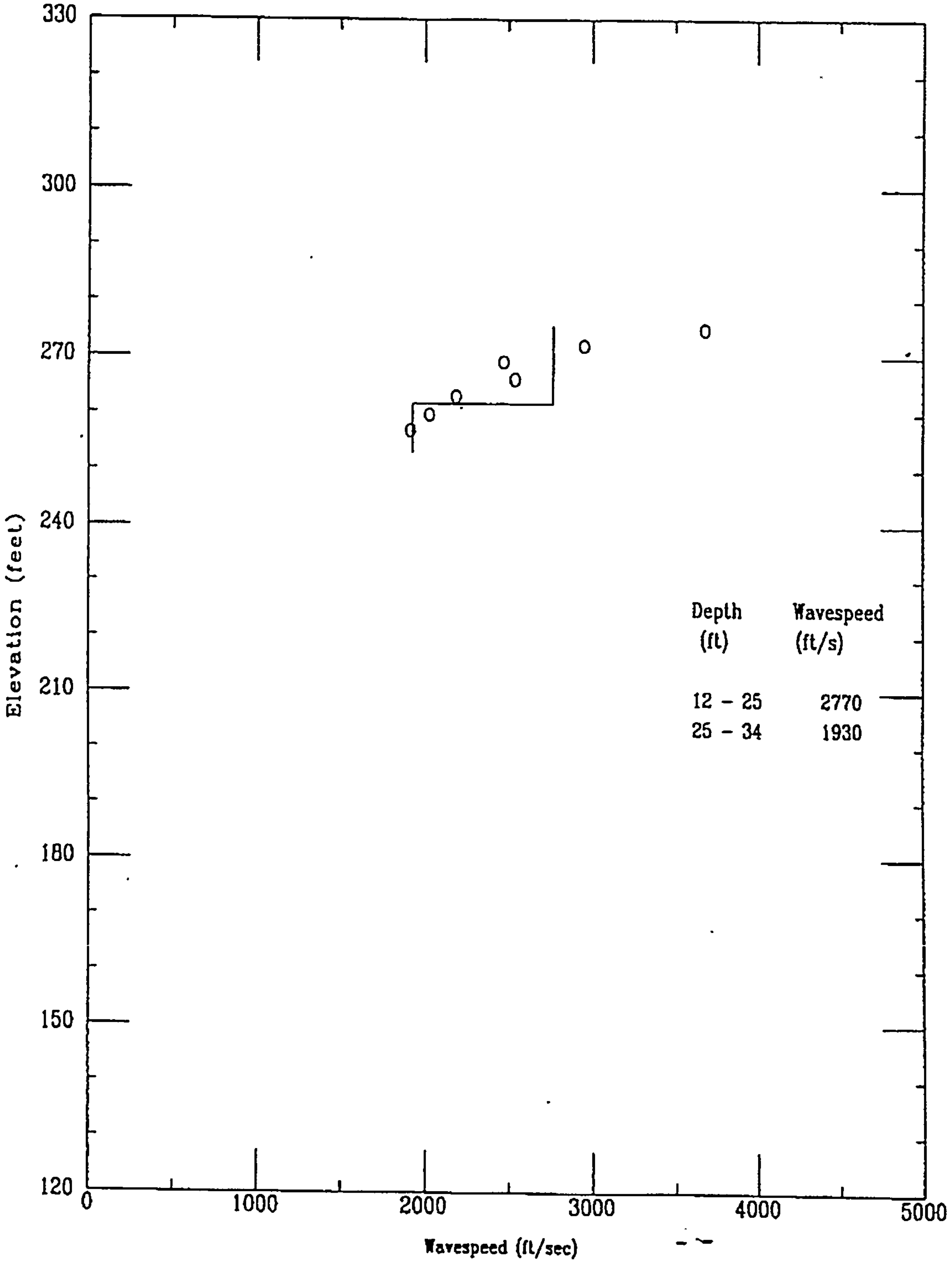
S Wave
10/29/97



File 3290704S

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

Compression Wave Speeds

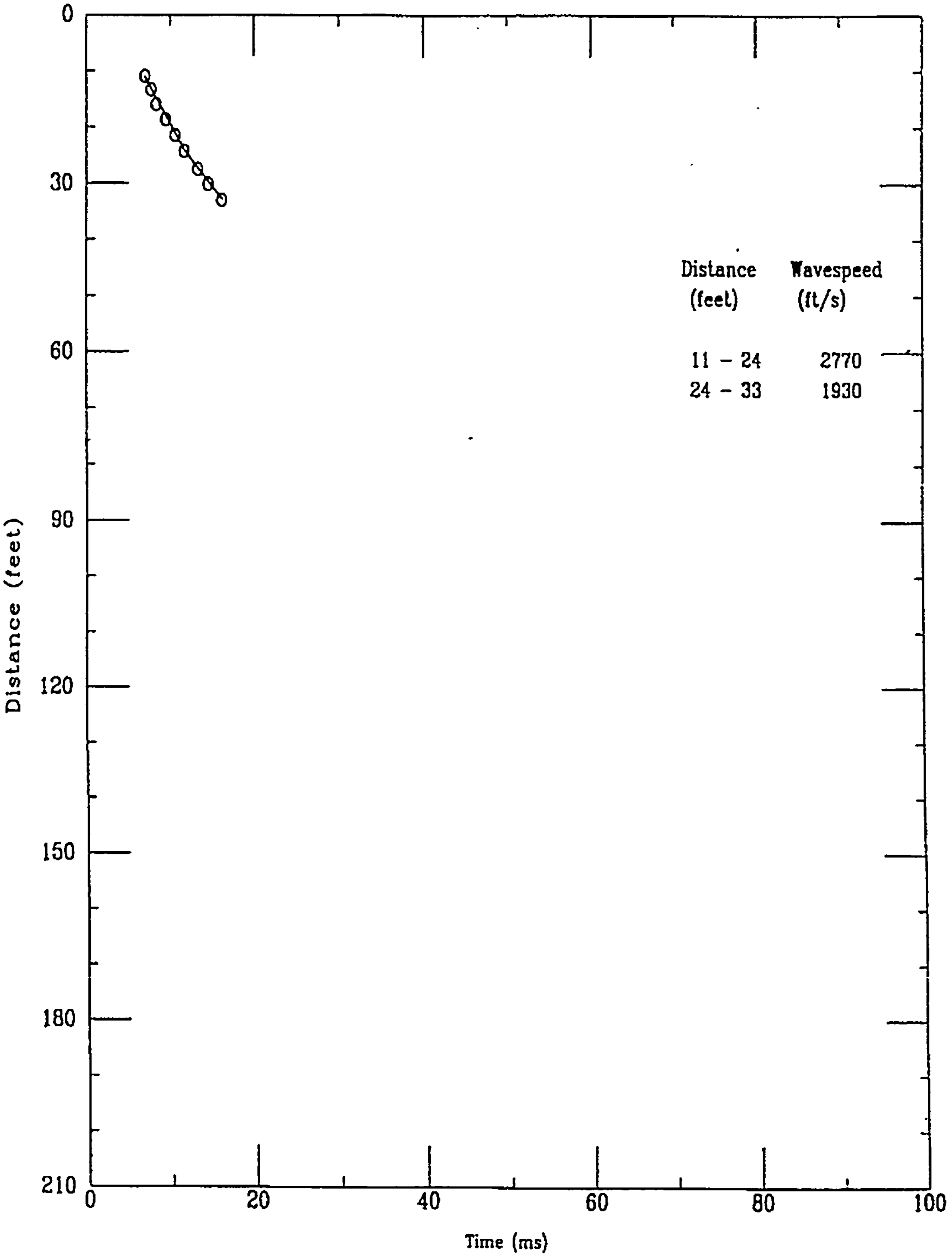


File 3290704S

A-203

HTEF-C16 APPLIED RESEARCH ASSOCIATES, INC. 10/29/97

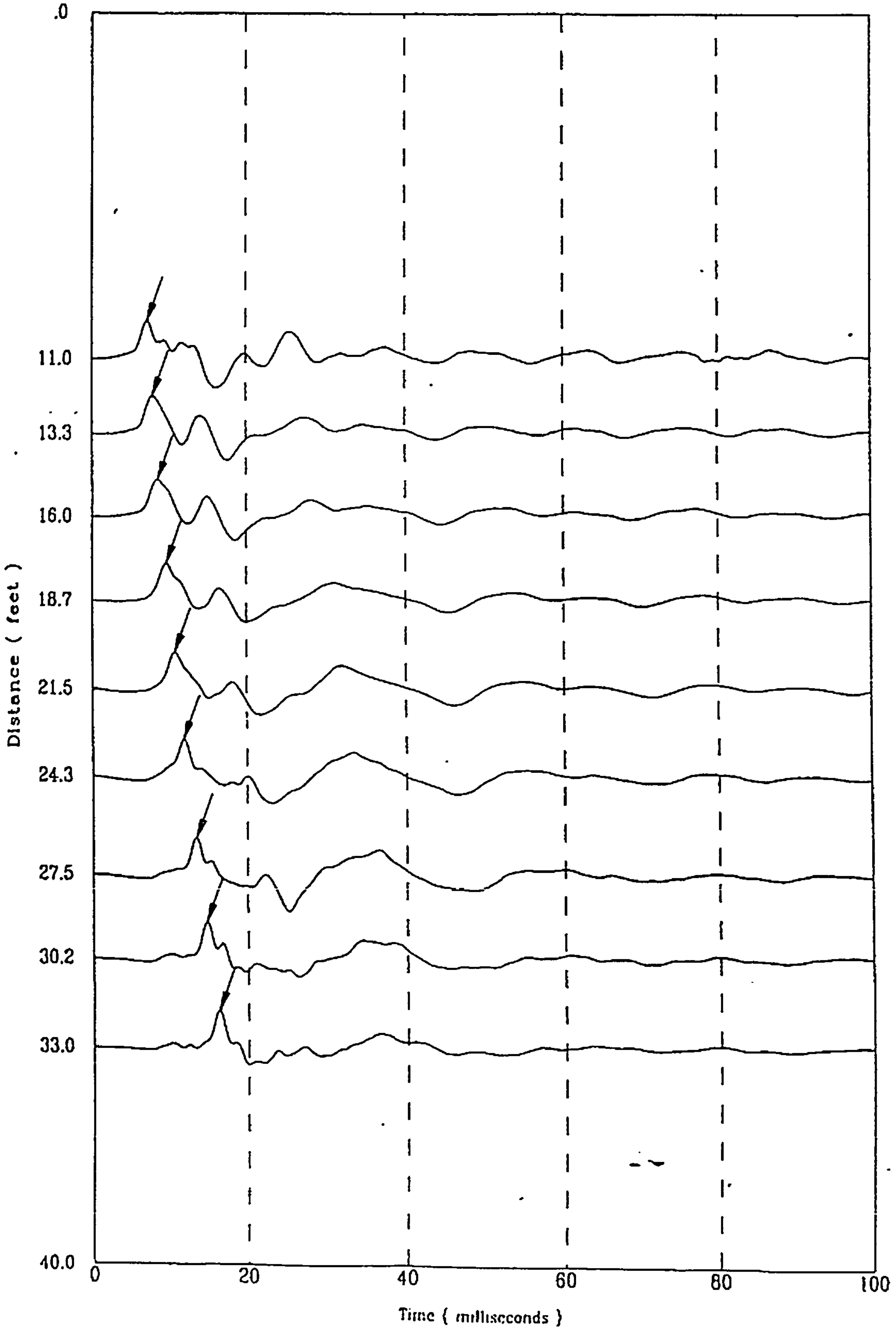
Compression Wave Time of Peak



File 3290704S

Applied Research Associates Inc.
HTEF-C16

P Wave
10/29/97

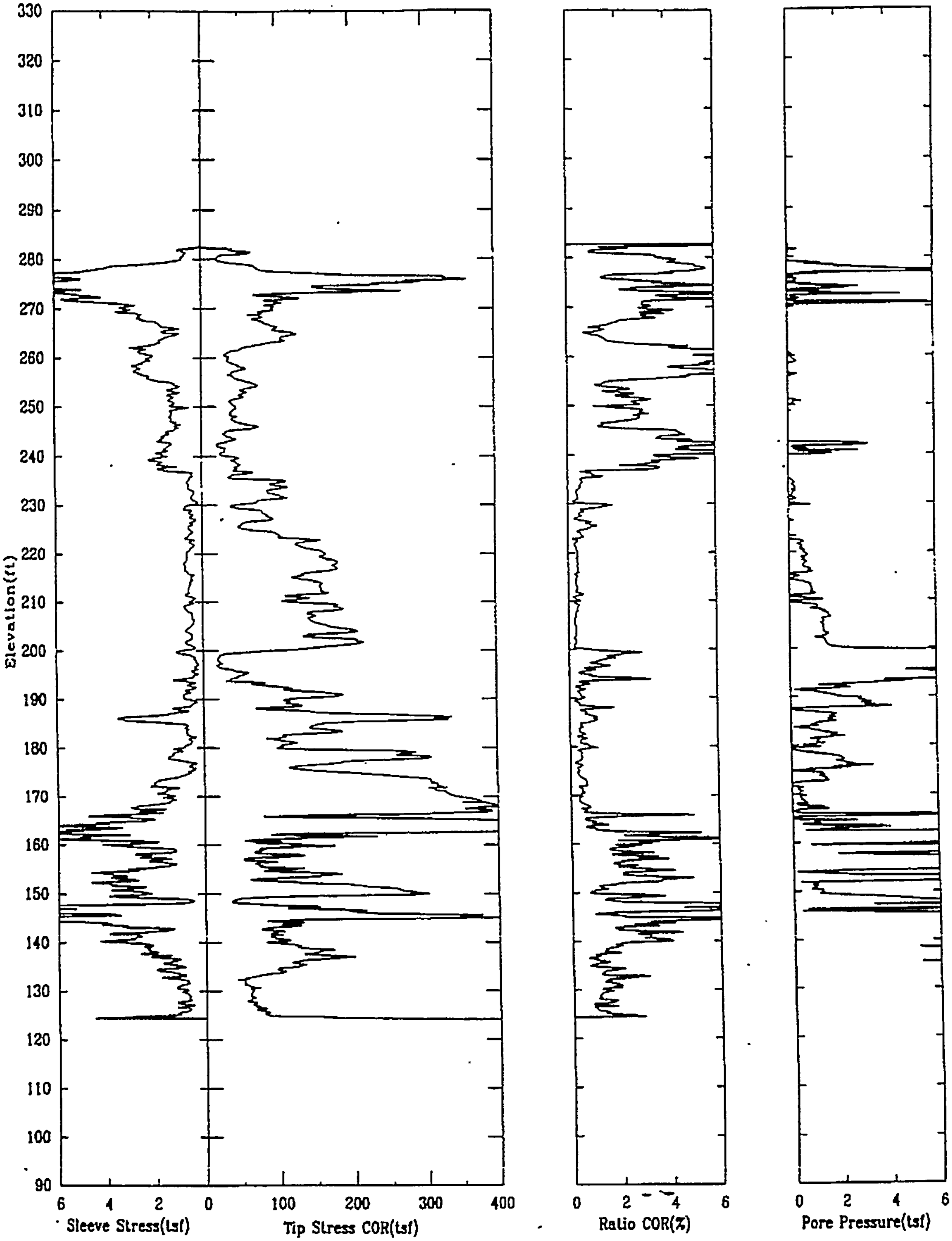


File 32907045

A-205

HTEF-C17 APPLIED RESEARCH ASSOCIATES, INC. 02/03/98

North 73367.65 East 61633.61 Elevation 288.72

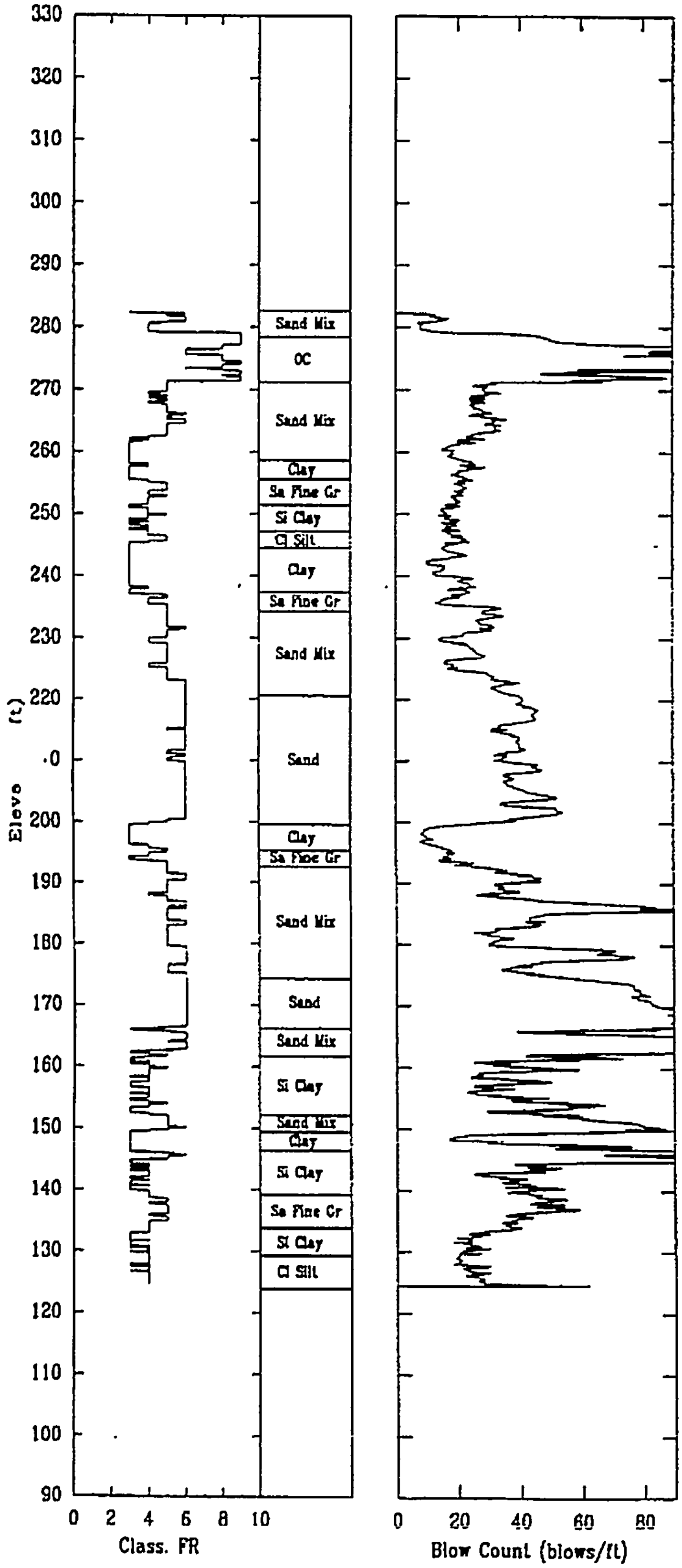


File 4031801B.ECP

A-206

HTEF-C17 APPLIED RESEARCH ASSOCIATES, INC. 02/03/98

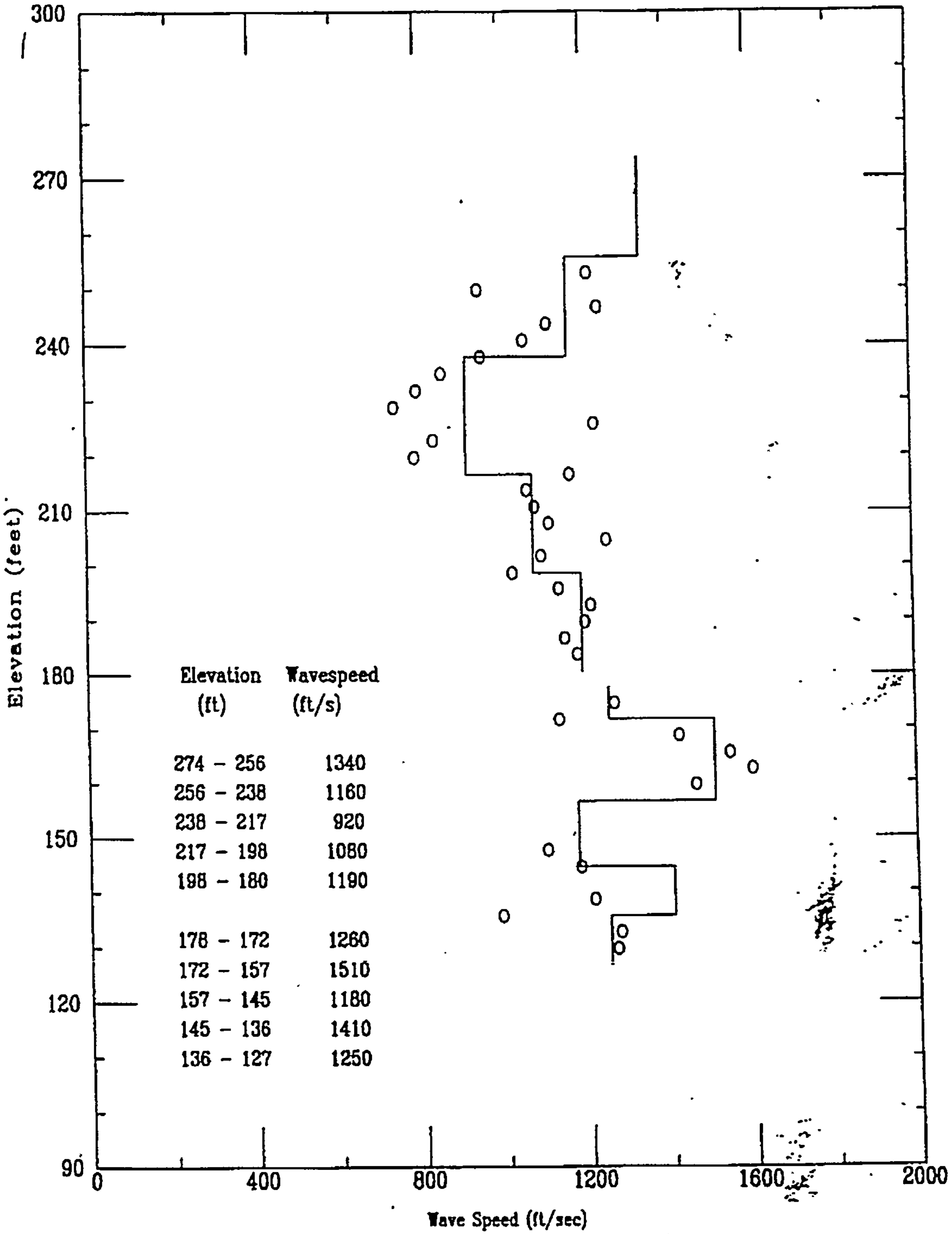
North 73367.65 East 61633.61 Elevation 288.72



File 403f801B.ECP

HTEF-C17 APPLIED RESEARCH ASSOCIATES, INC. 02/04/98

Shear Wave Speeds

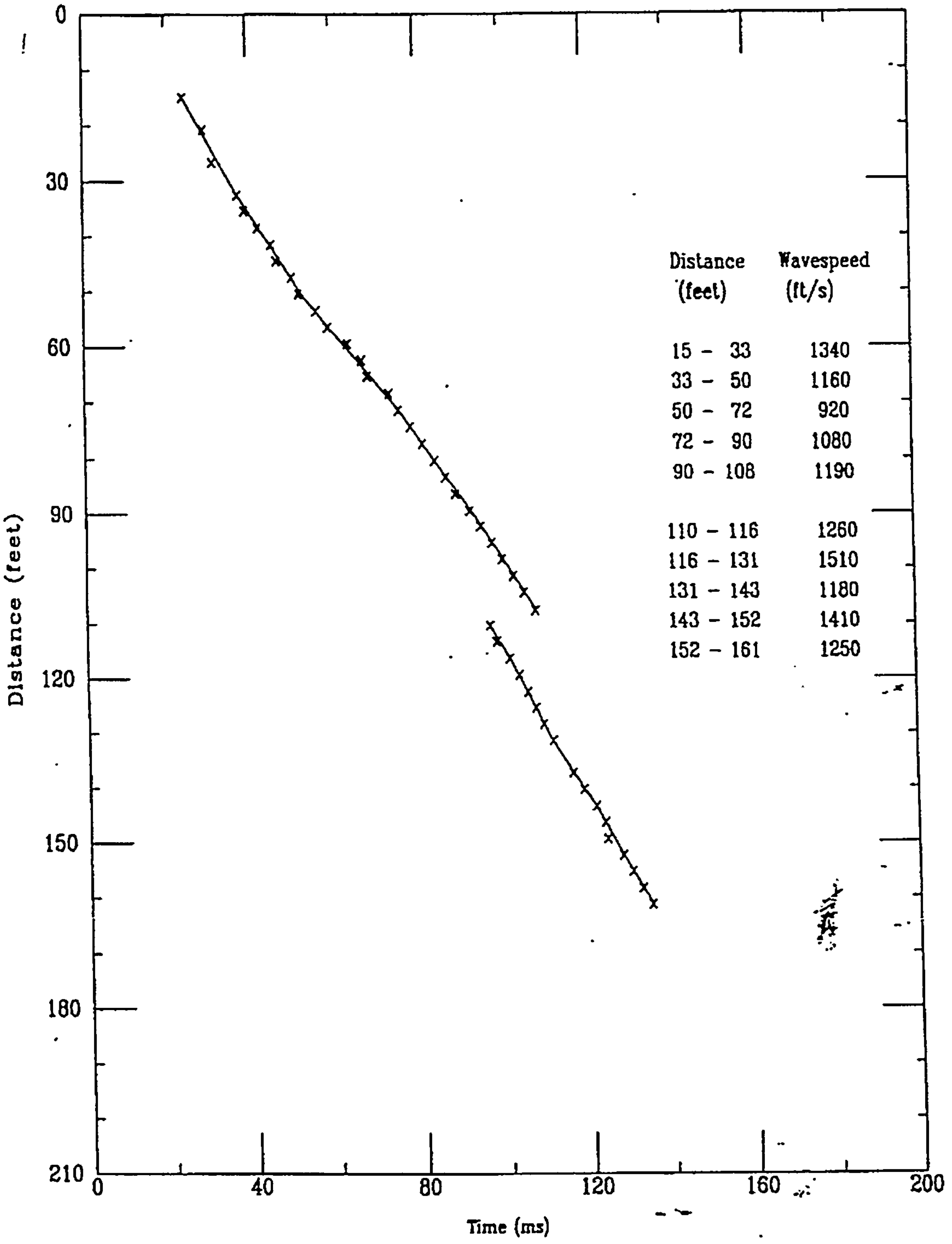


Elevation (ft)	Wavespeed (ft/s)
274 - 256	1340
256 - 238	1160
238 - 217	920
217 - 198	1080
198 - 180	1190
178 - 172	1260
172 - 157	1510
157 - 145	1180
145 - 136	1410
136 - 127	1250

File 403/8015

A-208

Shear Wave Time of Peak

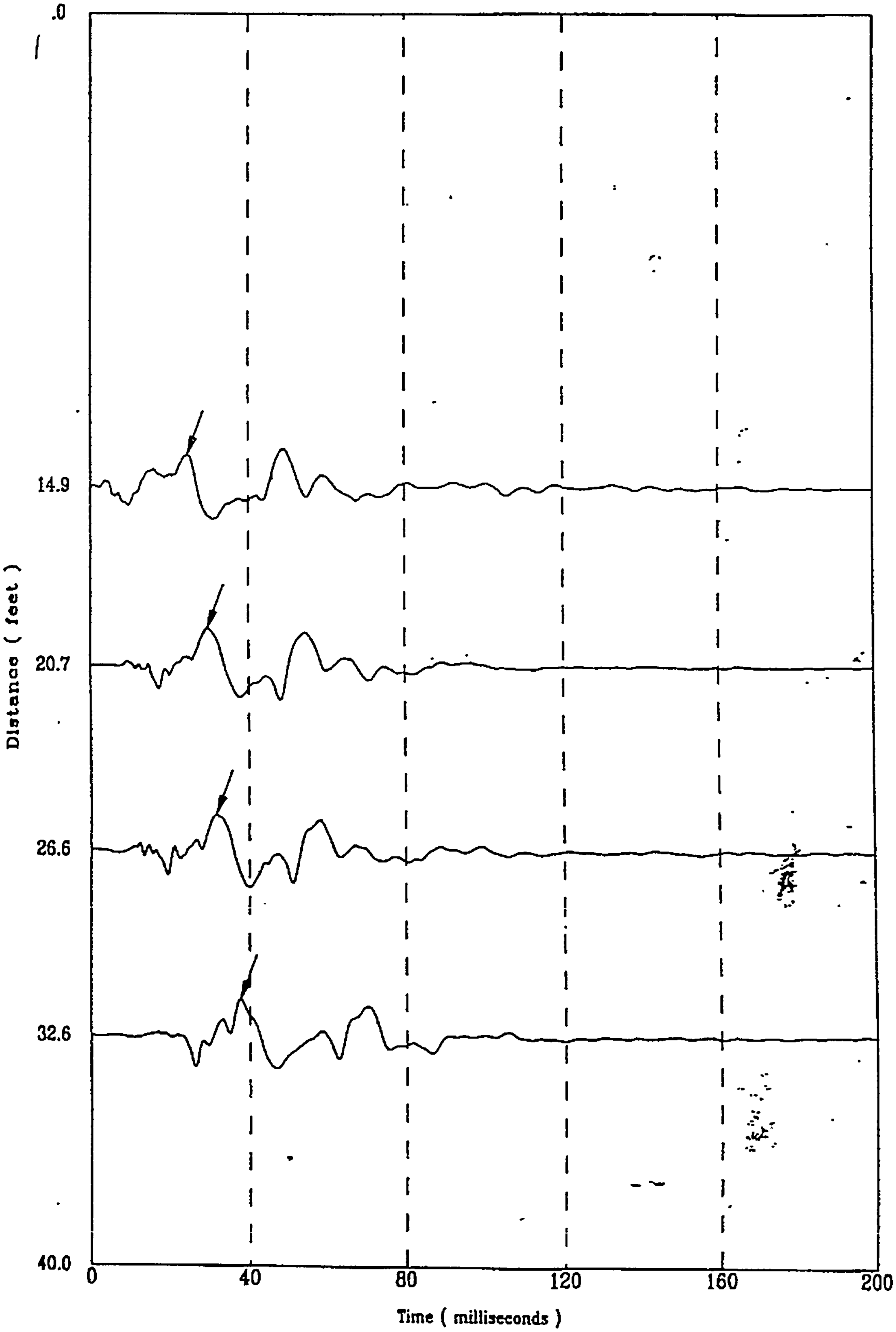


Distance (feet)	Wavespeed (ft/s)
15 - 33	1340
33 - 50	1160
50 - 72	920
72 - 90	1080
90 - 108	1190
110 - 116	1260
116 - 131	1510
131 - 143	1180
143 - 152	1410
152 - 161	1250

File 403f801S

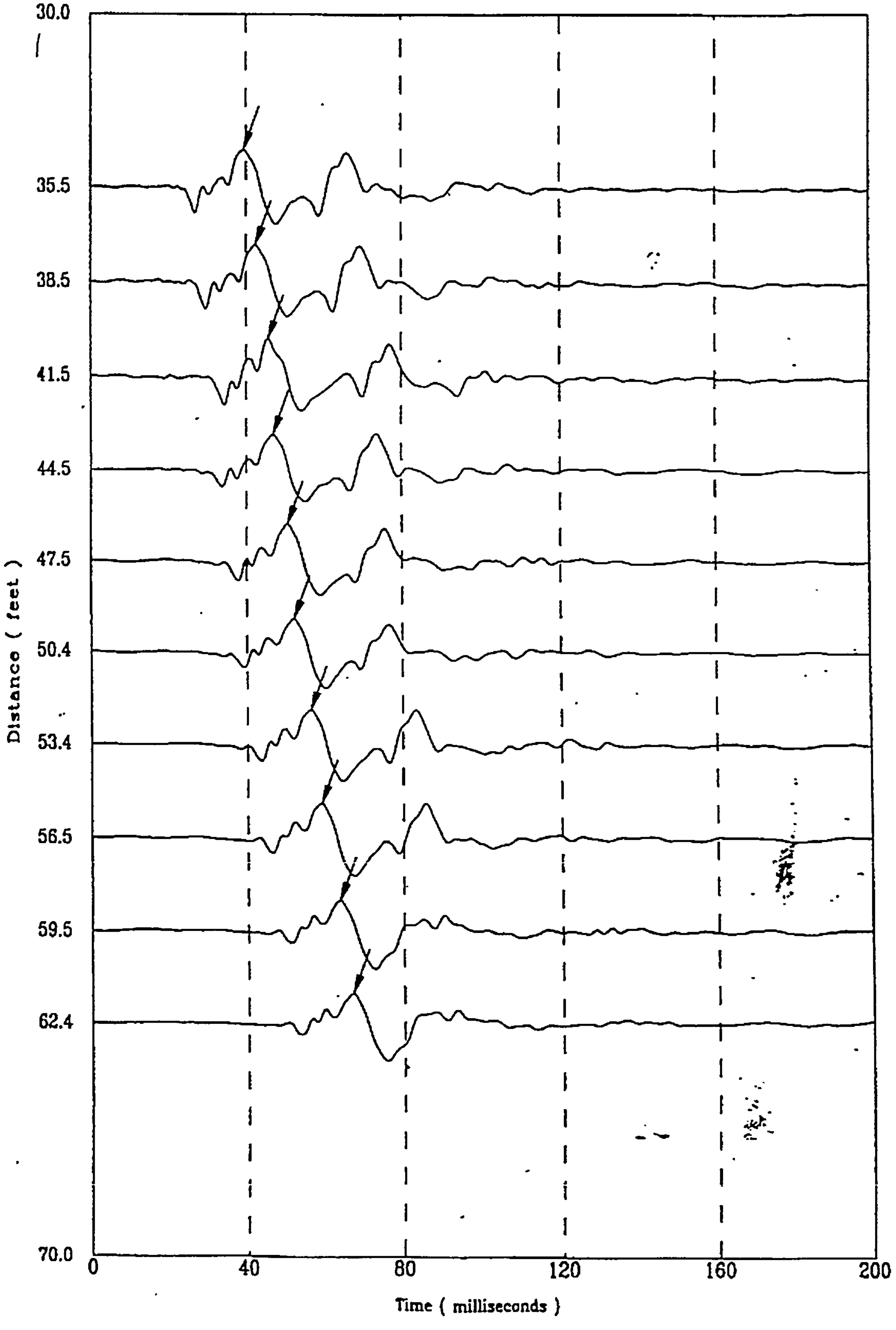
Applied Research Associates, Inc.
HTEF-C17

S Wave
02/03/98



File 4030601S

Applied Research Associates, Inc. S Wave
HTEF-C17 02/04/98

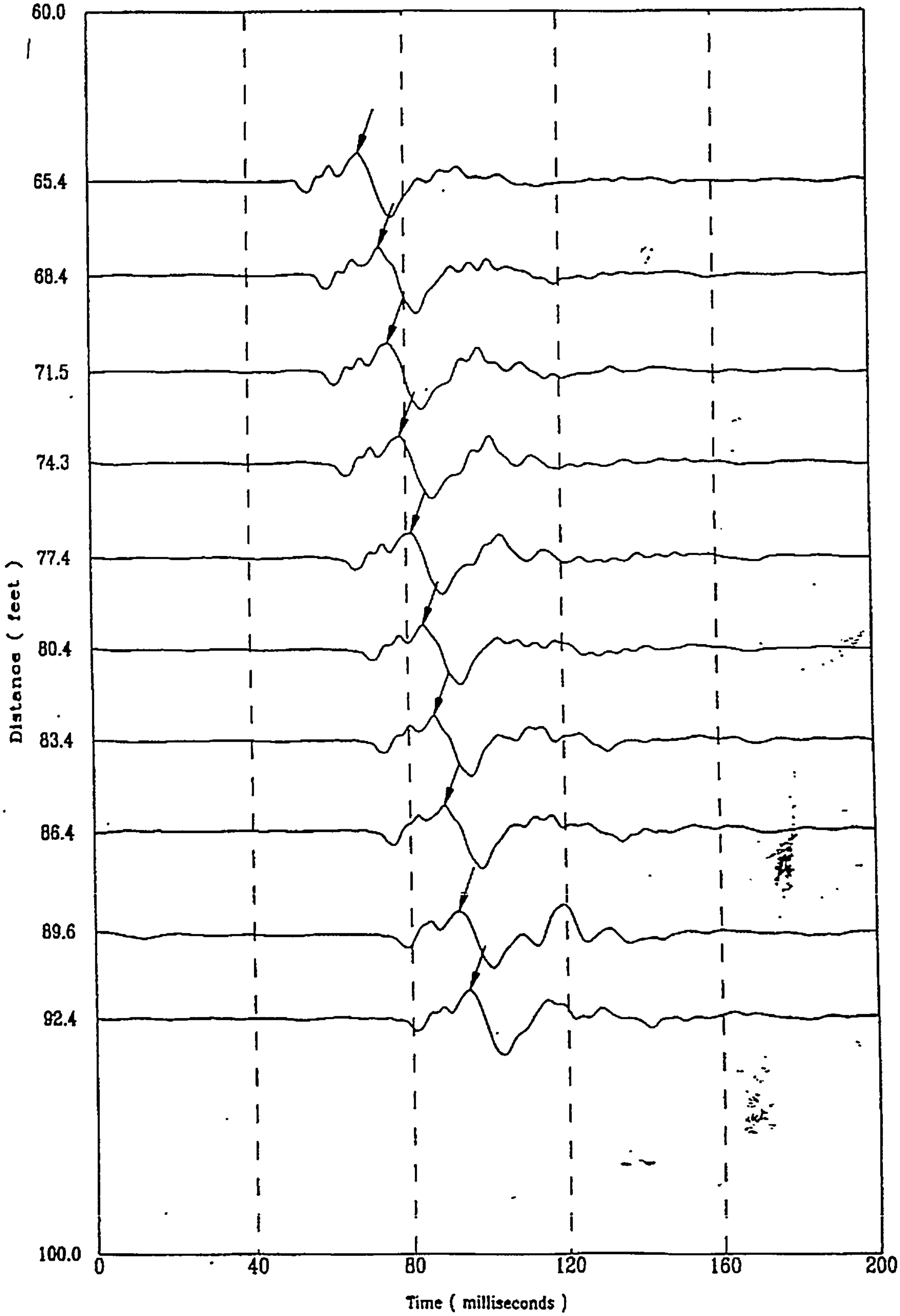


File 4031801S

A-11

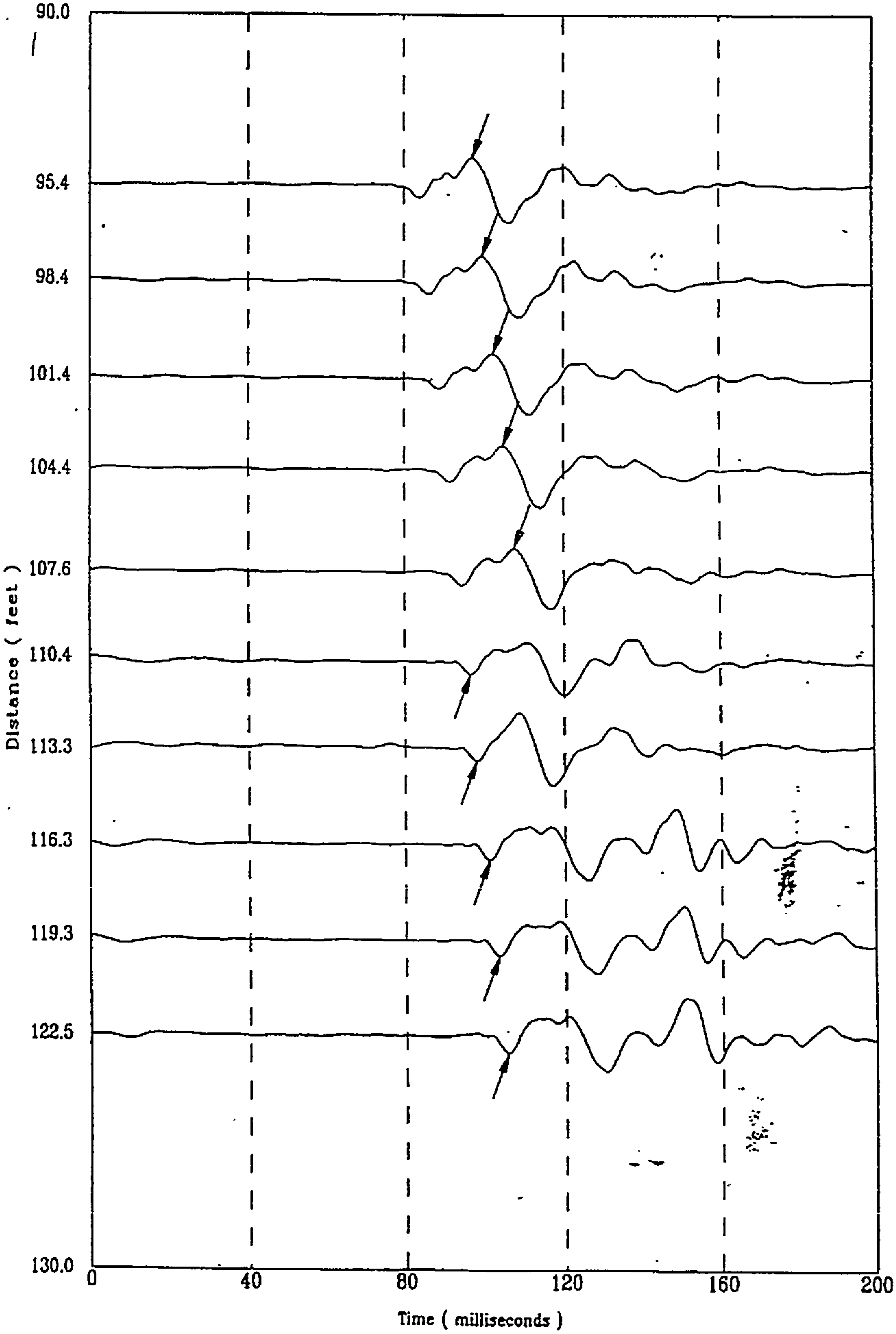
Applied Research Associates, Inc.
HTEF-C17

S Wave
02/04/98



File 4037801S

Applied Research Associates, Inc. S Wave
HTEF-C17 02/04/98

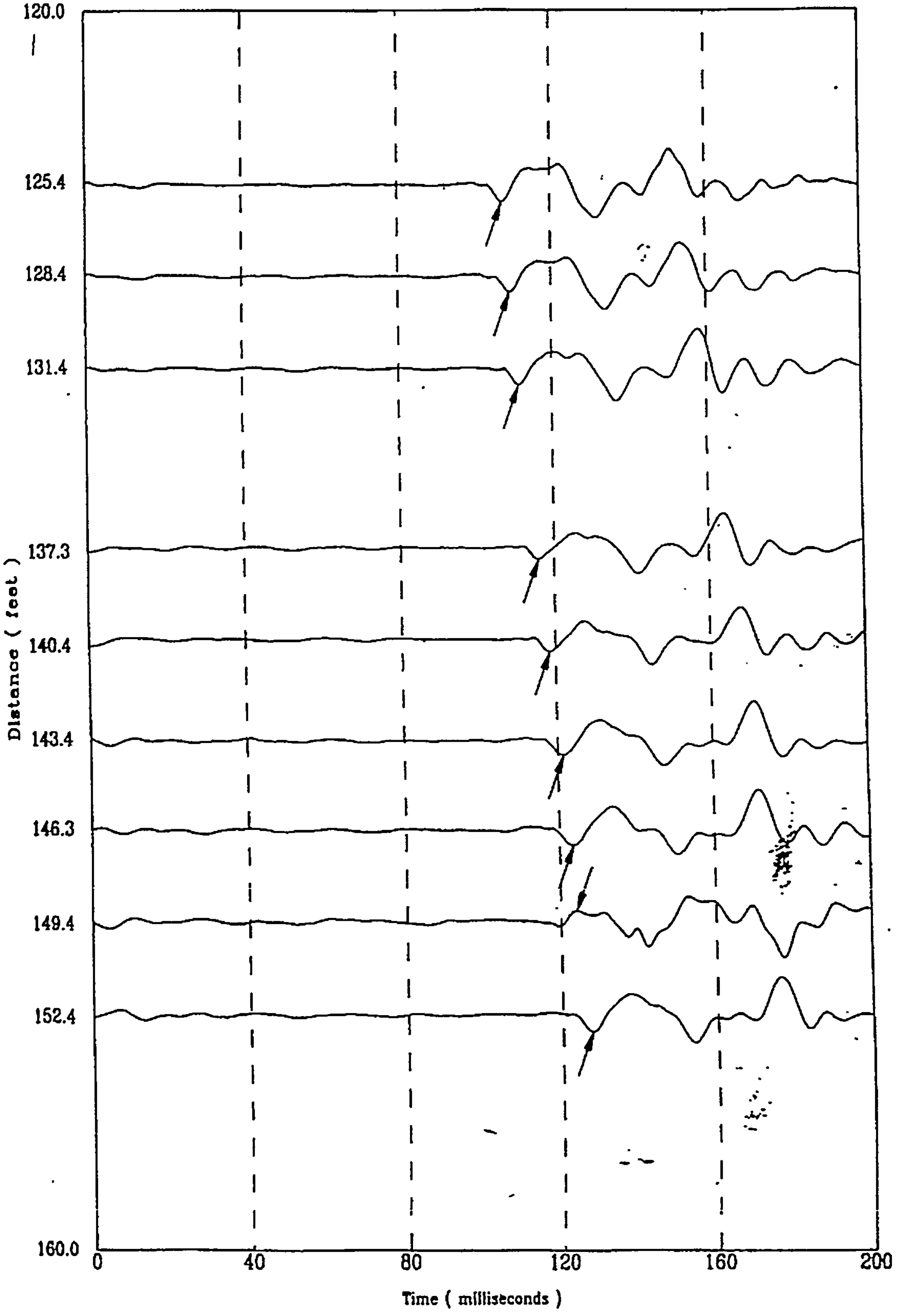


File 403/801S

A-213

Applied Research Associates, Inc.
HTEF-C17

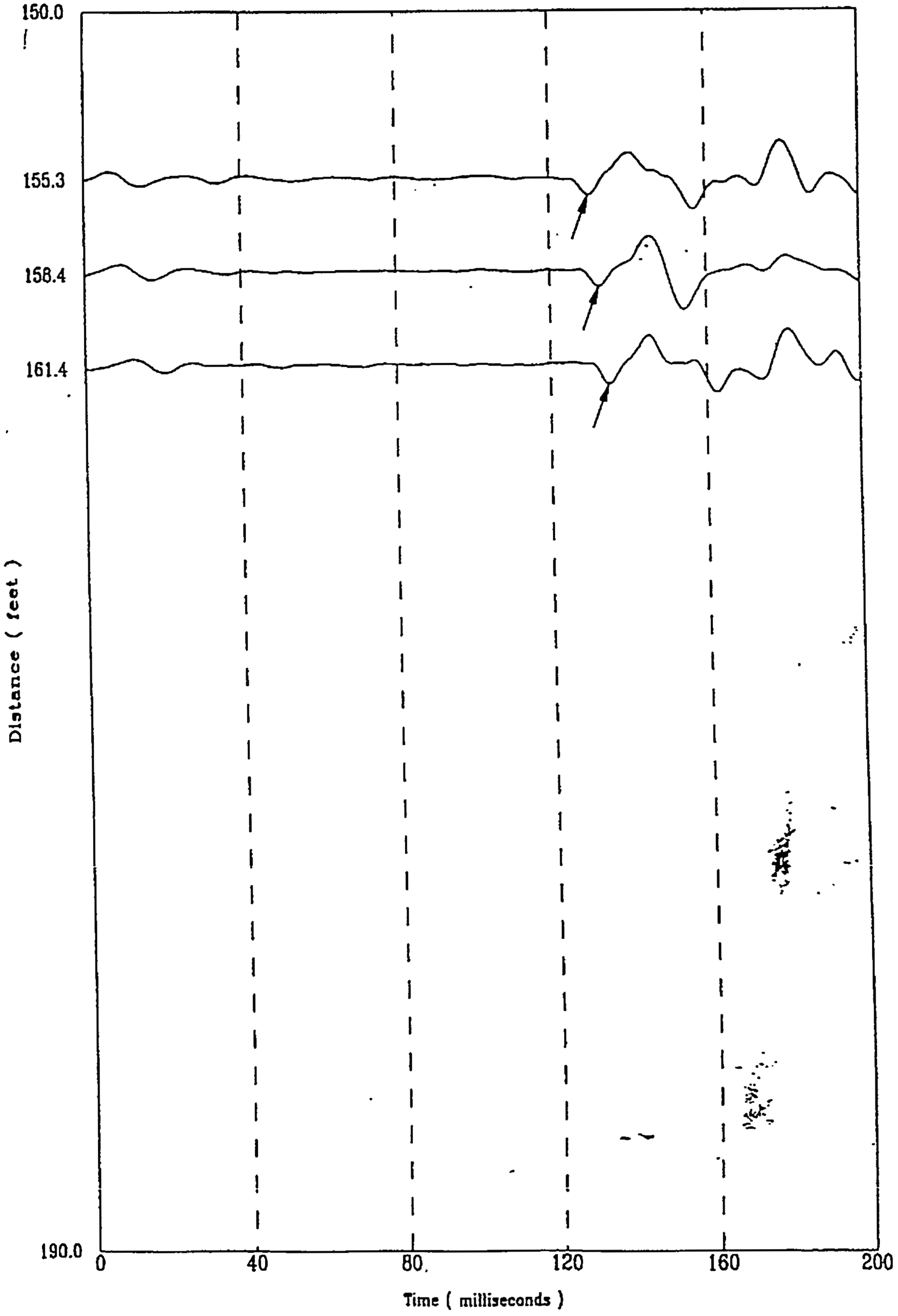
S Wave
02/04/98



File 403/801S

Applied Research Associates, Inc.
HTEF-C17

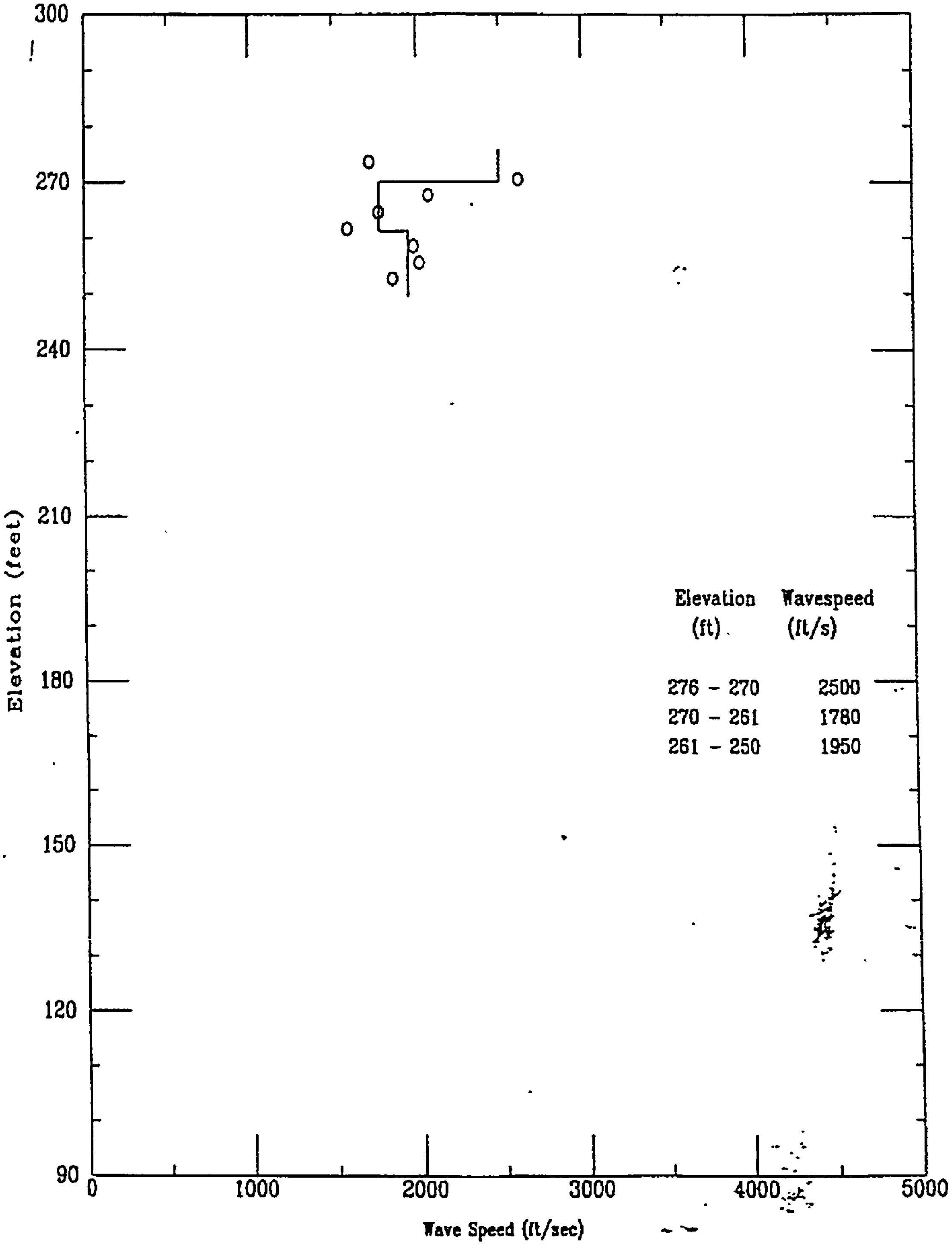
S Wave
02/04/98



File 4031801S

HTEF-C17 APPLIED RESEARCH ASSOCIATES, INC. 02/04/98

Compression Wave Speeds

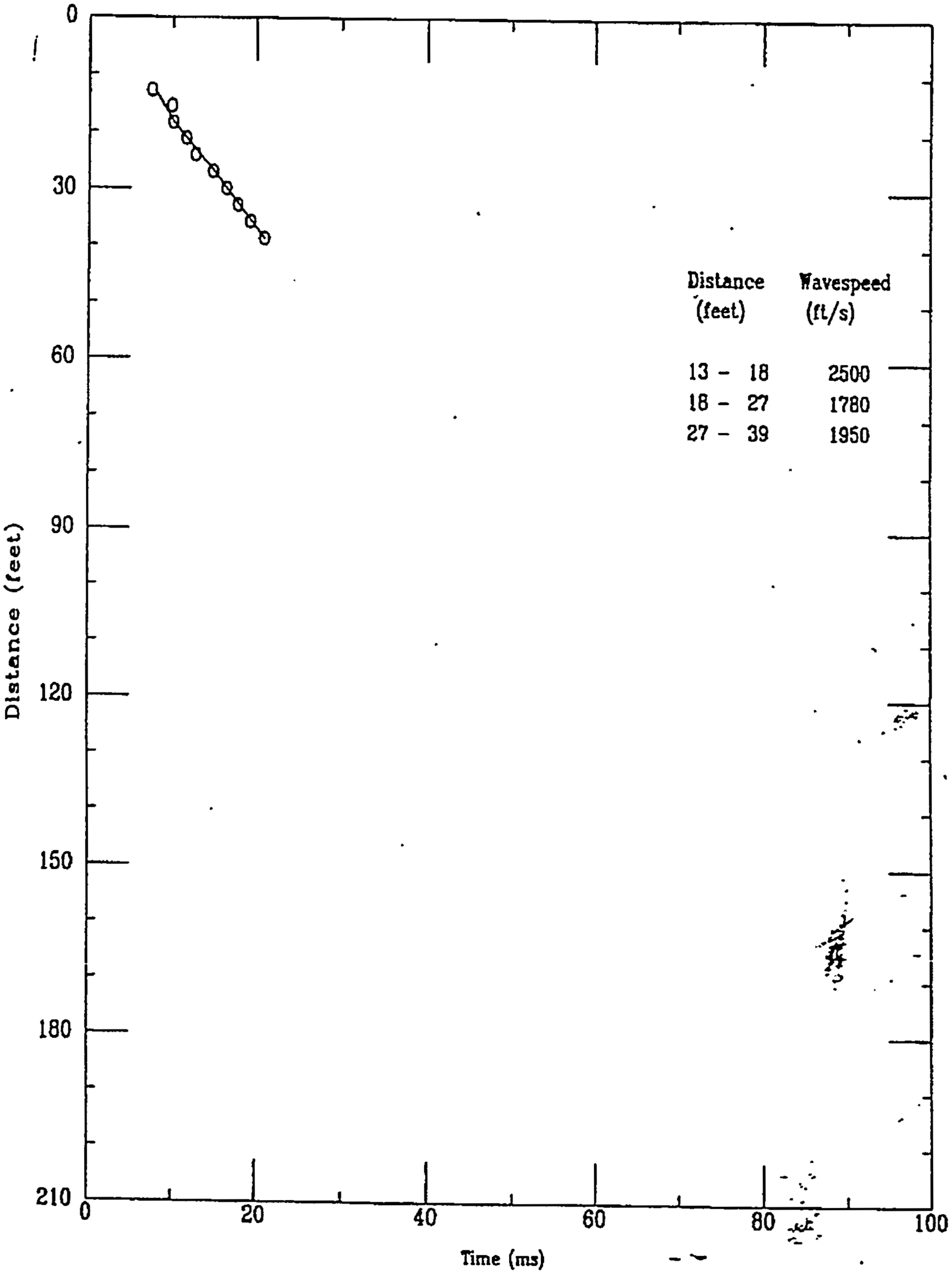


Elevation (ft)	Wavespeed (ft/s)
276 - 270	2500
270 - 261	1780
261 - 250	1950

File 403I801S

HTEF-C17 APPLIED RESEARCH ASSOCIATES, INC. 02/04/98

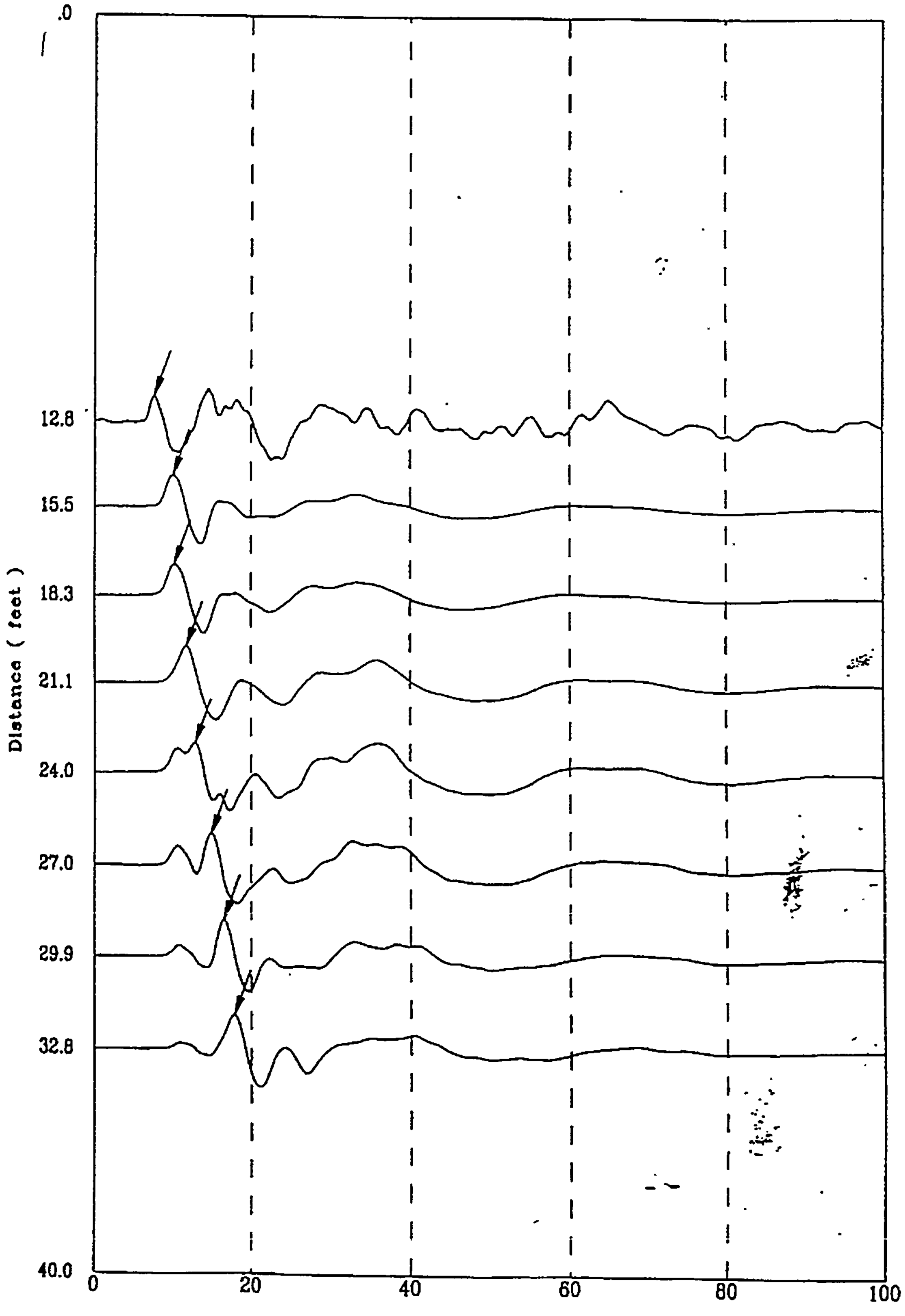
Compression Wave Time of Peak



File 4031801S

Applied Research Associates, Inc.
HTEF-C17

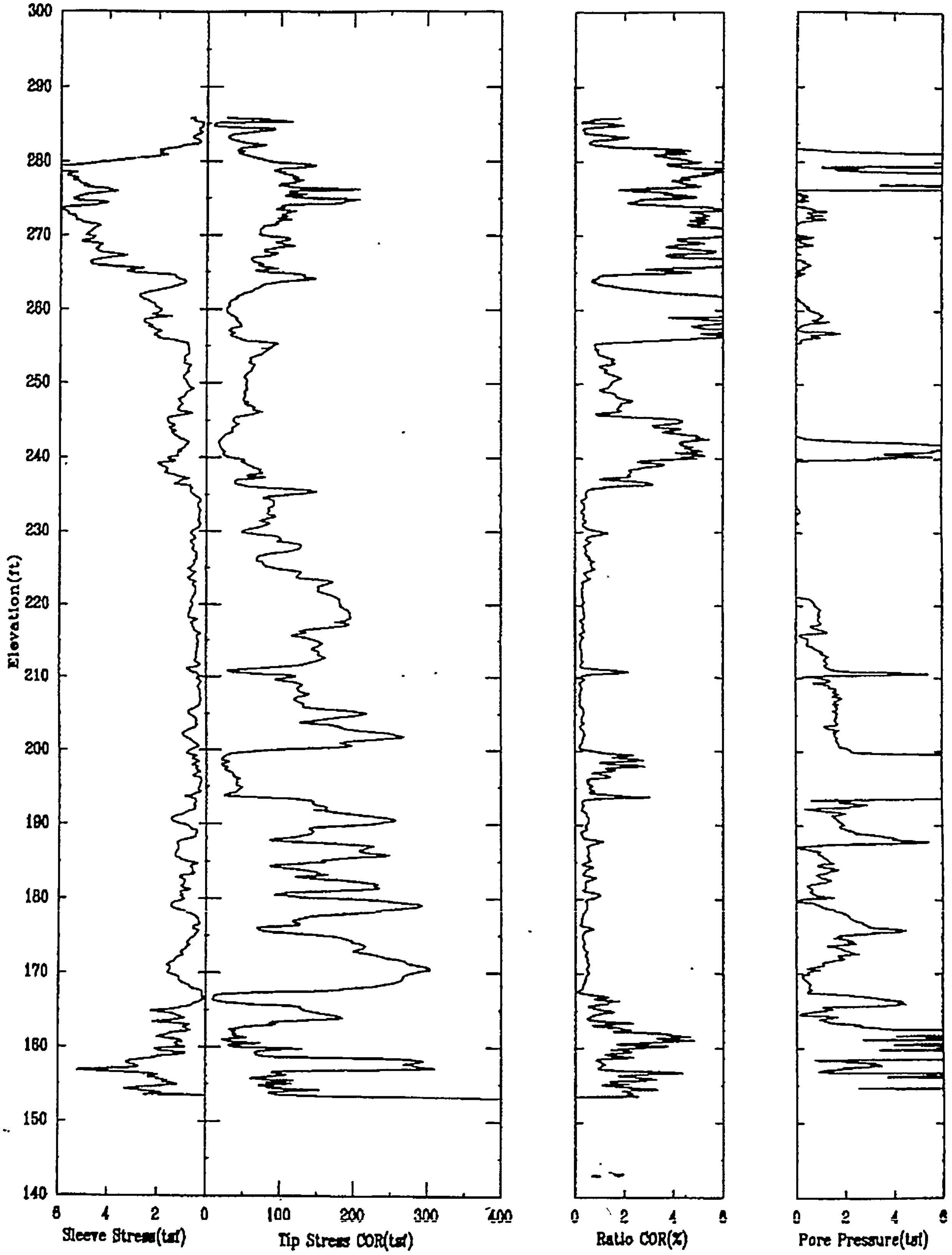
P Wave
02/03/98



File 403f501S

HTEF-C18 APPLIED RESEARCH ASSOCIATES, INC. 01/30/98

North 73340.07 East 61676.13 Elevation 291.94

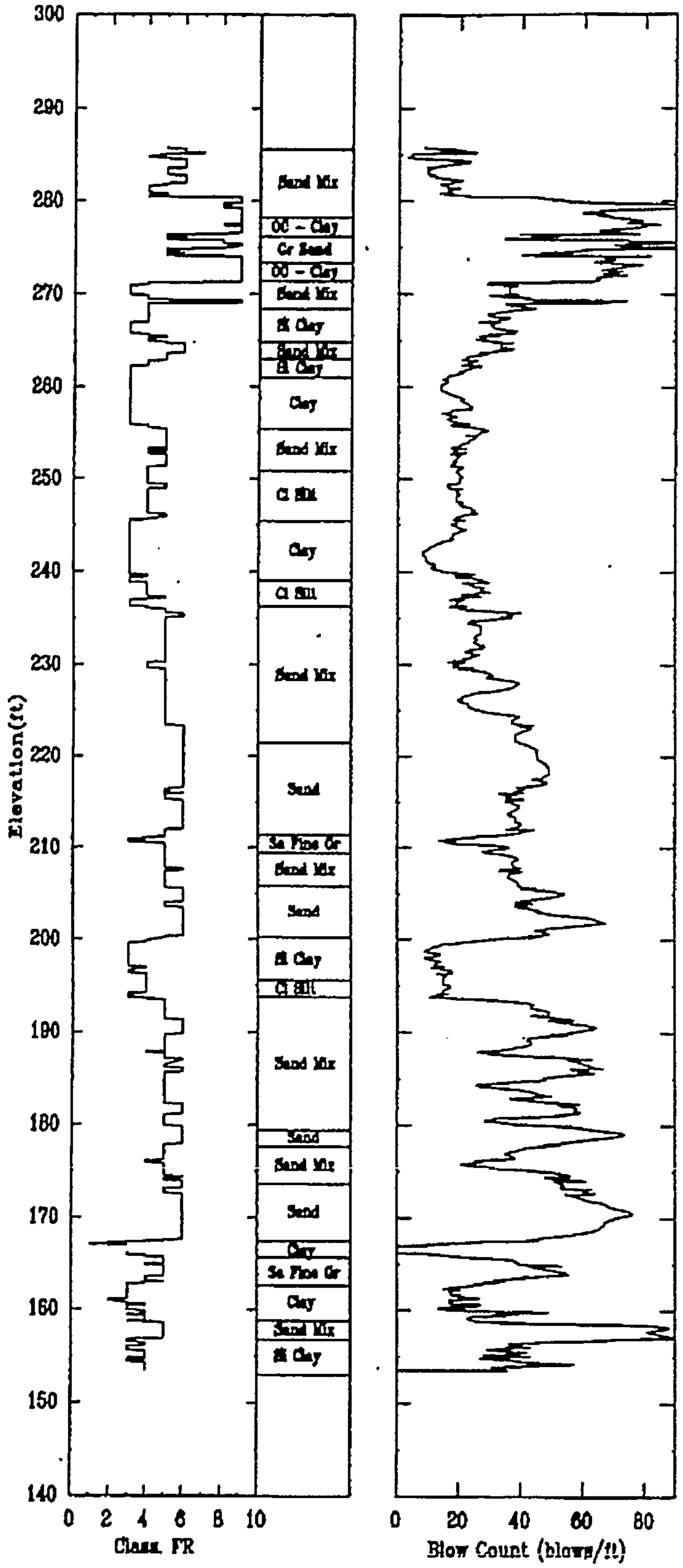


File 430j801.ECP

A - 219

HTEF-C18 APPLIED RESEARCH ASSOCIATES, INC. 01/30/98

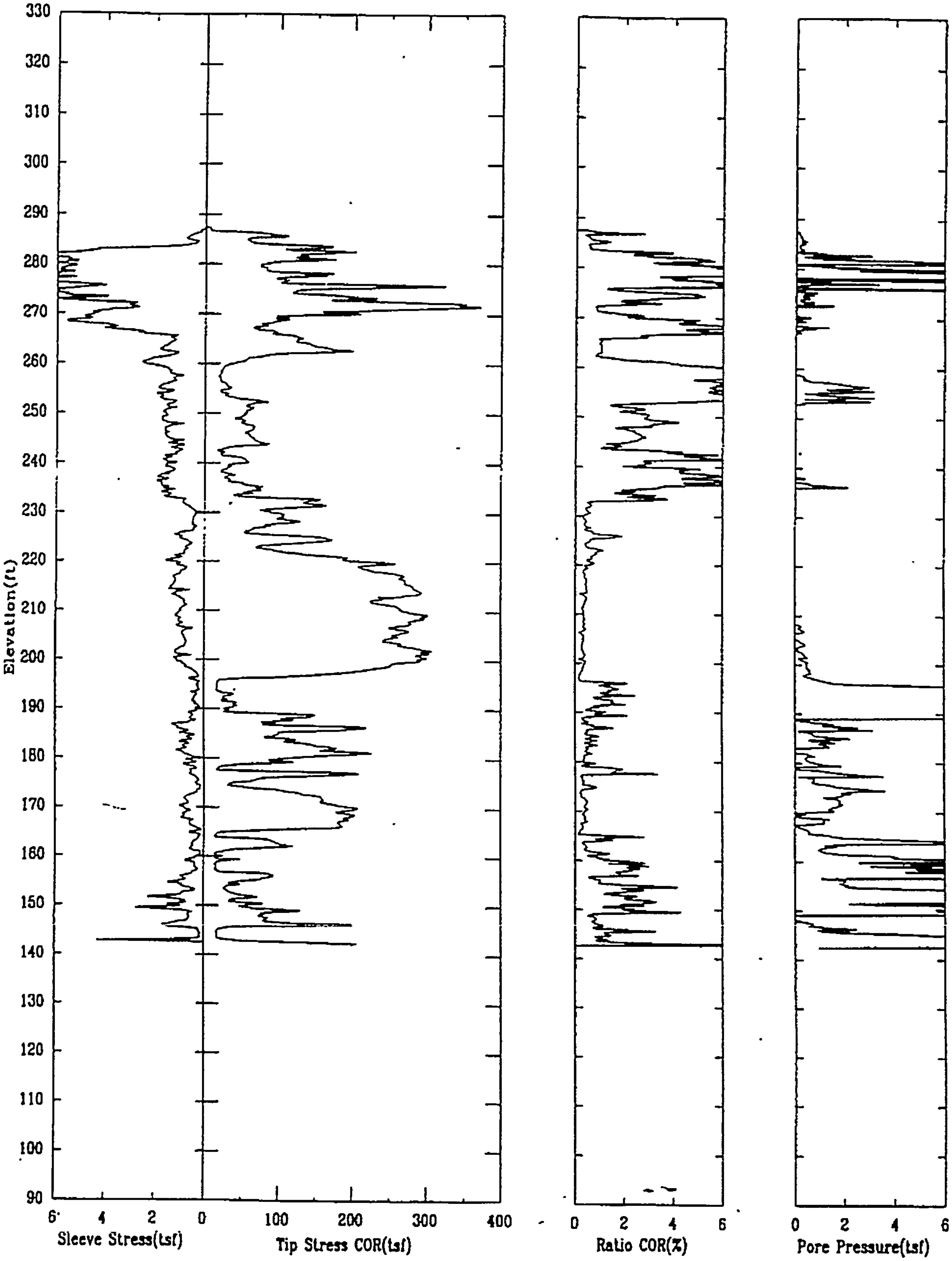
North 73340.07 East 61676.13 Elevation 291.94



File 430j801.ECP

HTEF-C19 APPLIED RESEARCH ASSOCIATES, INC. 01/31/98

North 73308.77 East 61690.86 Elevation 293.46

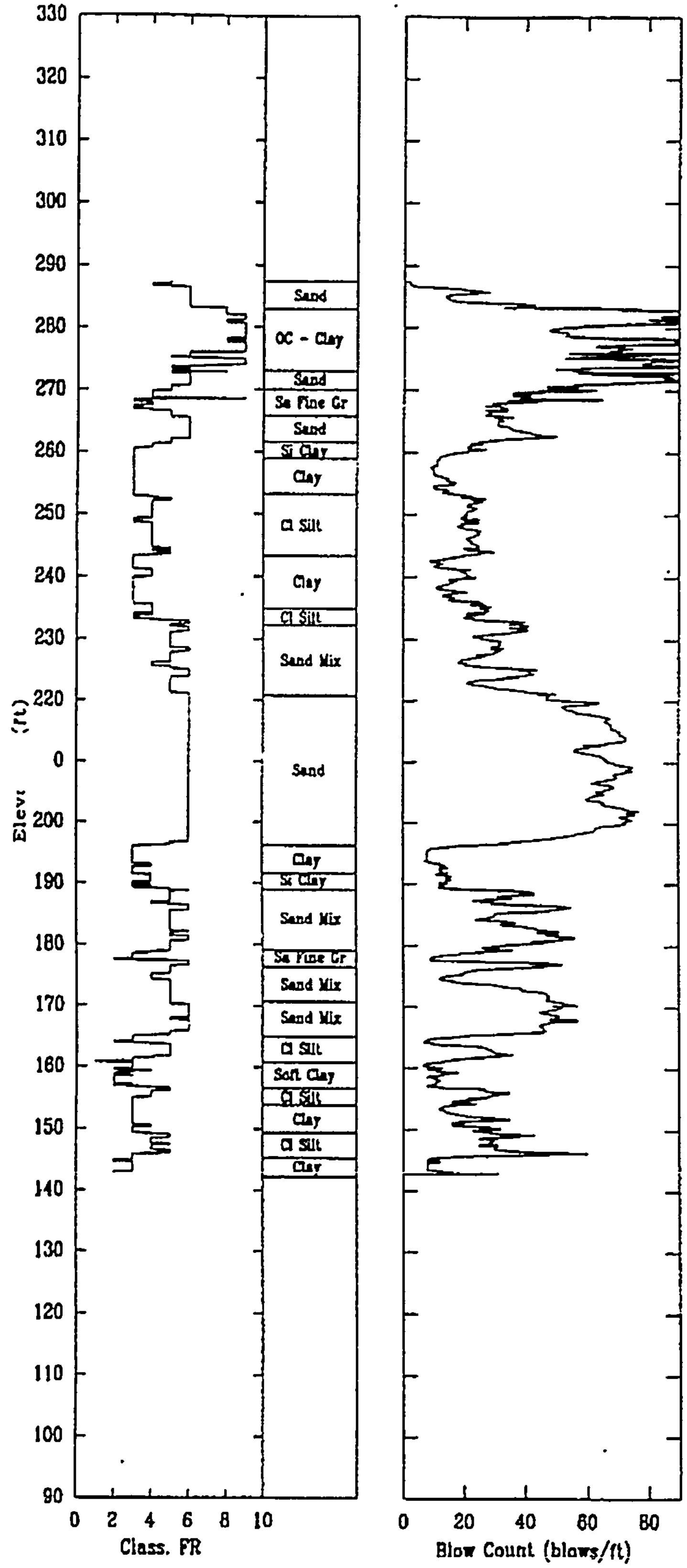


File 431j801.ECP

A-221

HTEF-C19 APPLIED RESEARCH ASSOCIATES, INC. 01/31/98

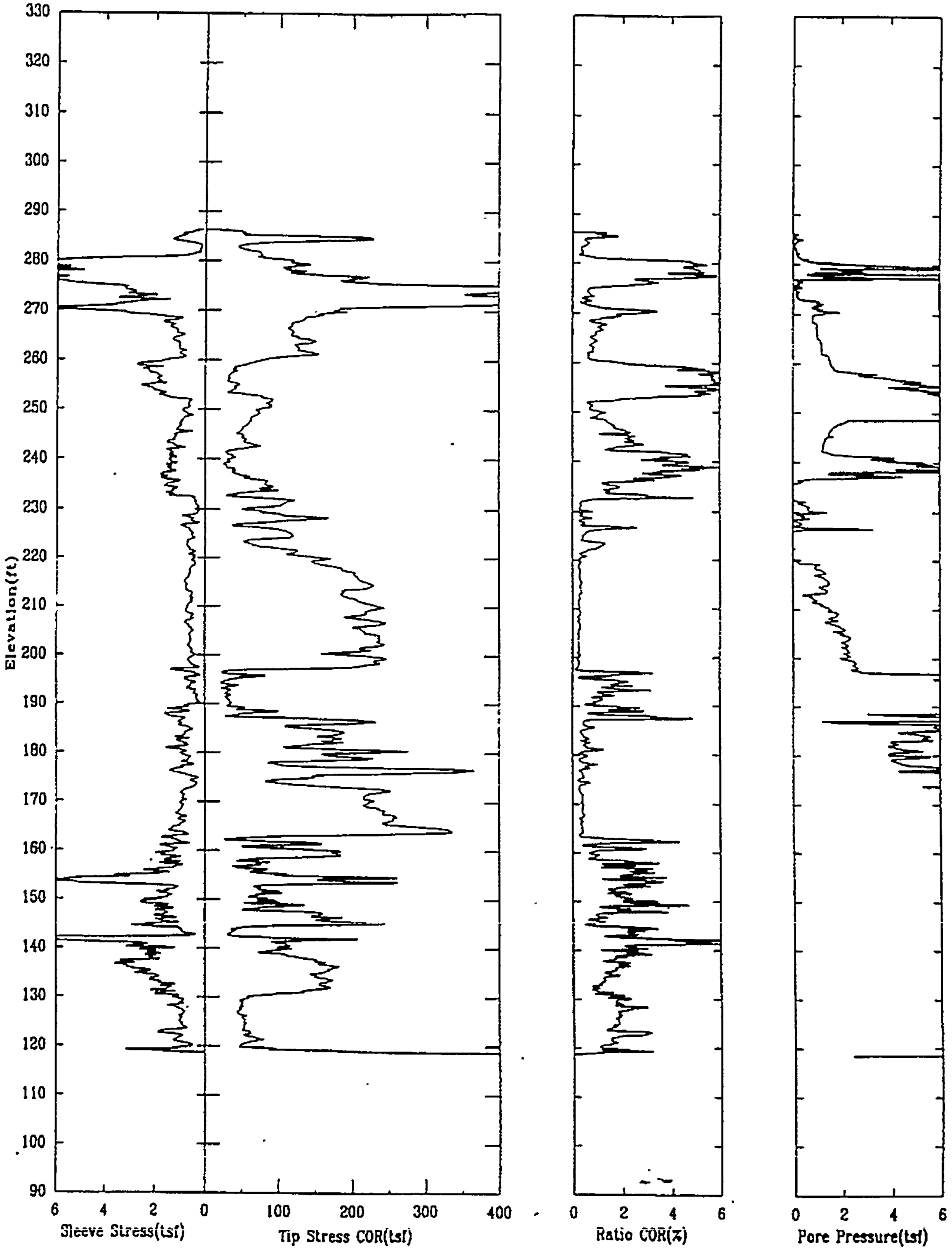
North 73308.77 East 61690.86 Elevation 293.46



File 431j801.ECP

HTEF-C20 APPLIED RESEARCH ASSOCIATES, INC. 02/02/98

North 73311.65 East 61656.40 Elevation 292.32

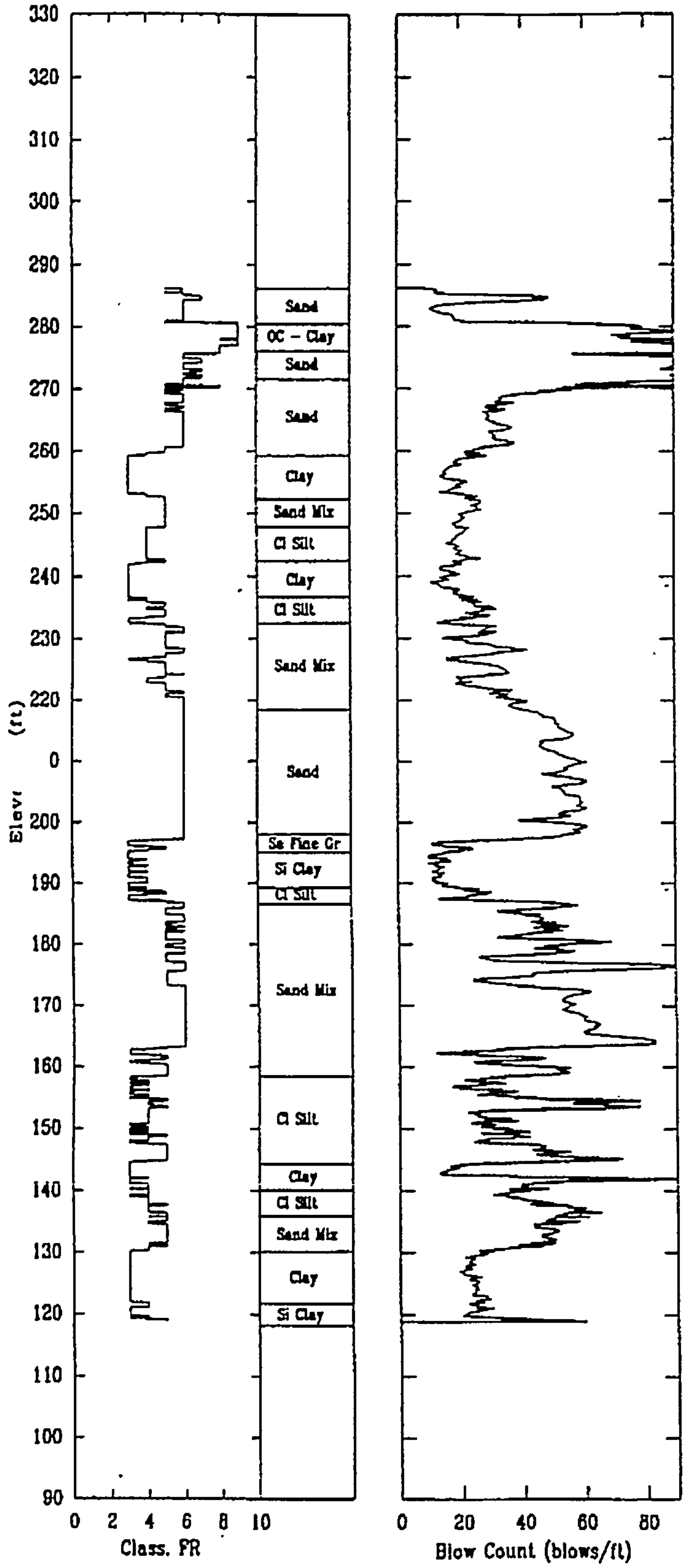


File 402F801.ECP

A-223

HTEF-C20 APPLIED RESEARCH ASSOCIATES, INC. 02/02/98

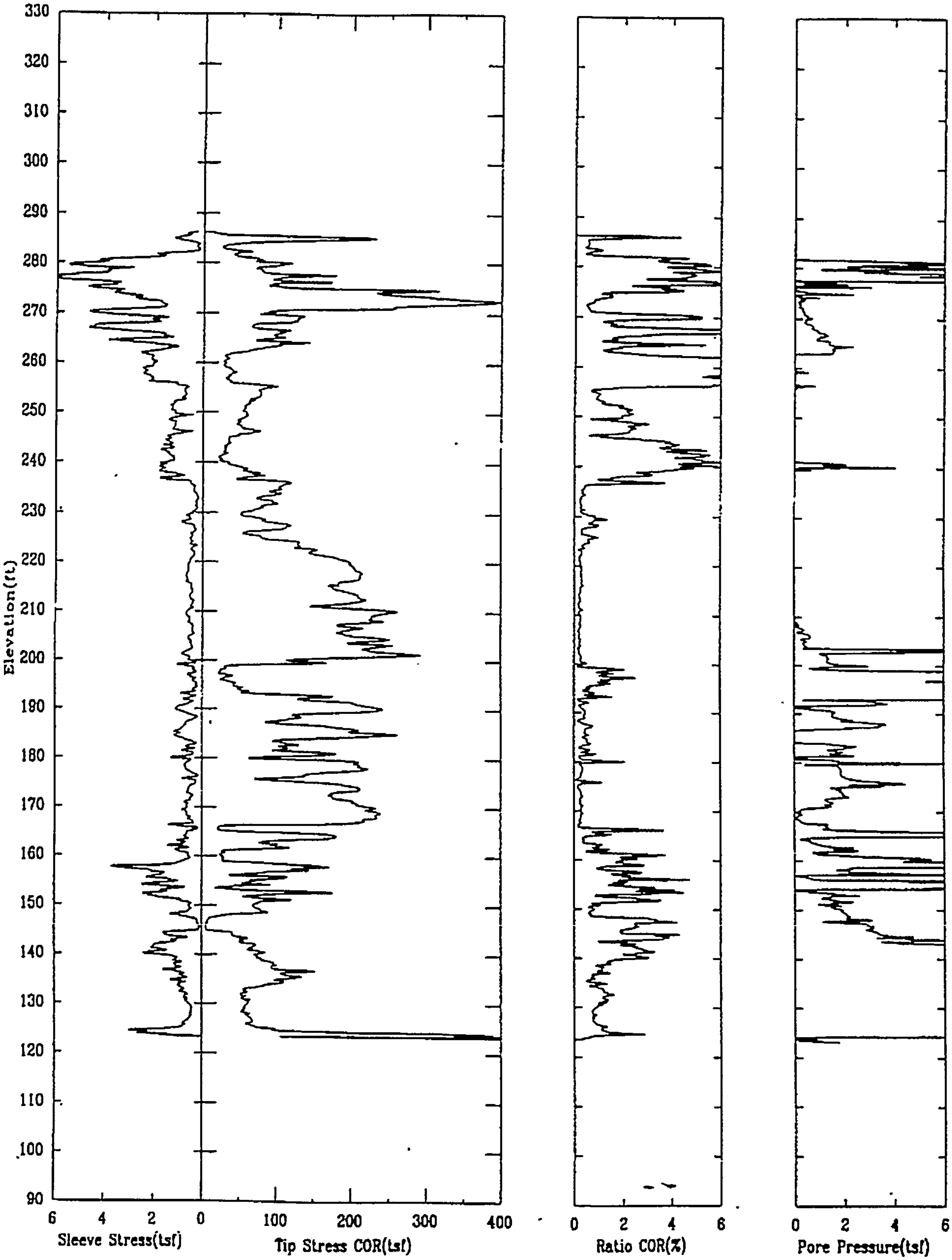
North 73311.65 East 61656.40 Elevation 292.32



File 402F801.ECP

HTEF-C21 APPLIED RESEARCH ASSOCIATES, INC. 02/06/98

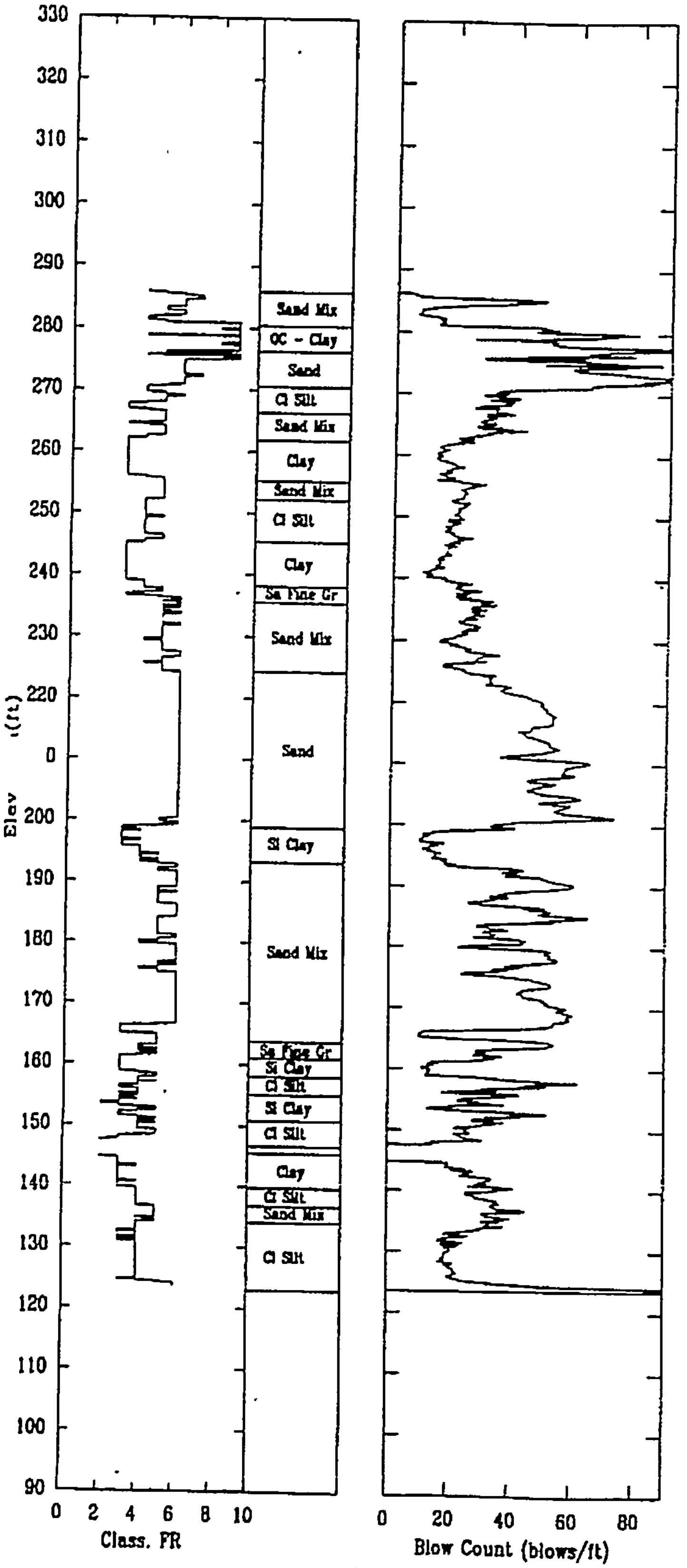
North 73330.09 East 61673.28 Elevation 292.21



File 406f801b.ECP

HTEF-C21 APPLIED RESEARCH ASSOCIATES, INC. 02/06/98

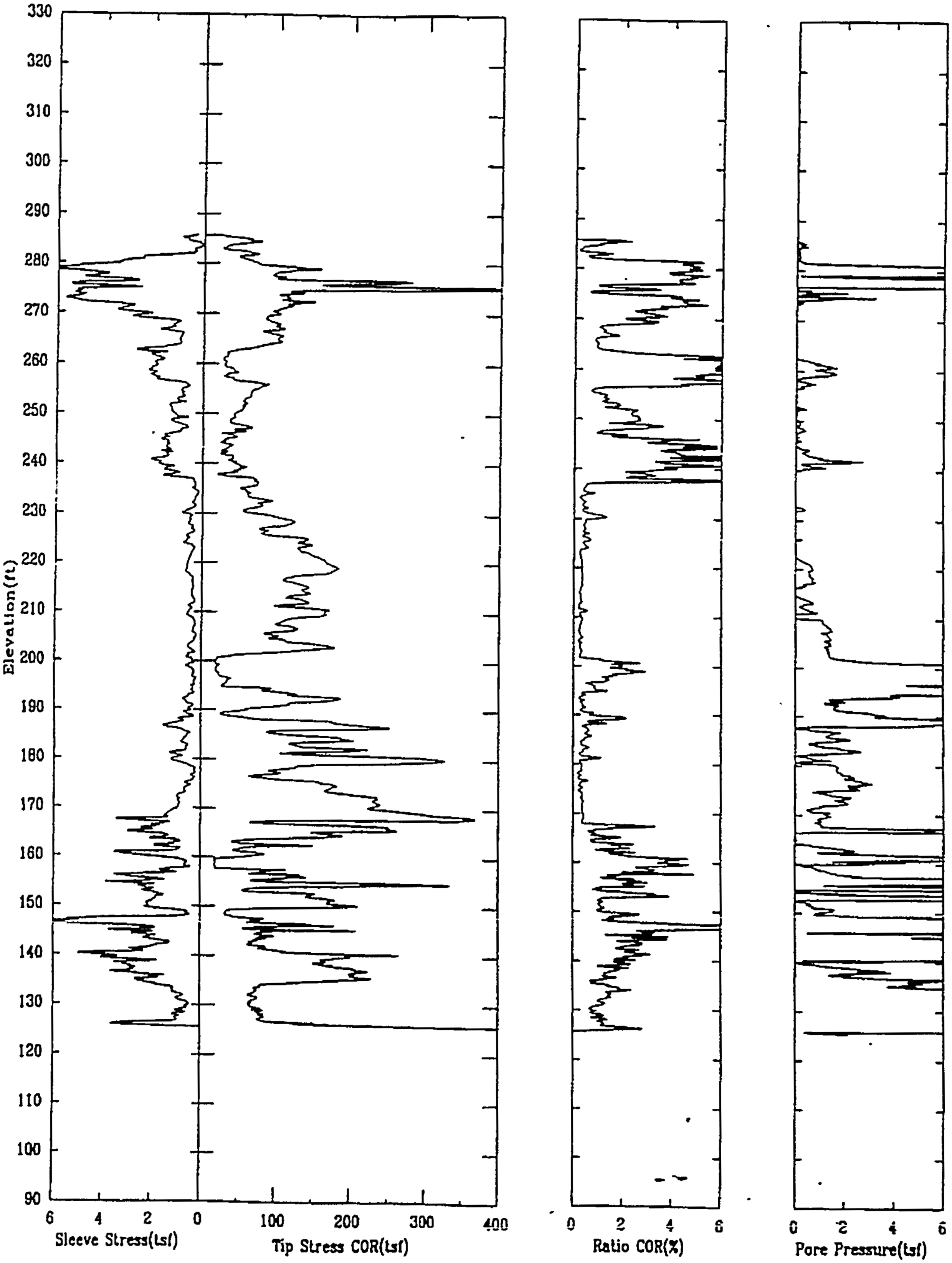
North 73330.09 East 61673.28 Elevation 292.21



File 408f801b.ECP

HTEF-C22 APPLIED RESEARCH ASSOCIATES, INC. 02/12/98

North 73348.9 East 61674.3 Elevation 291.8

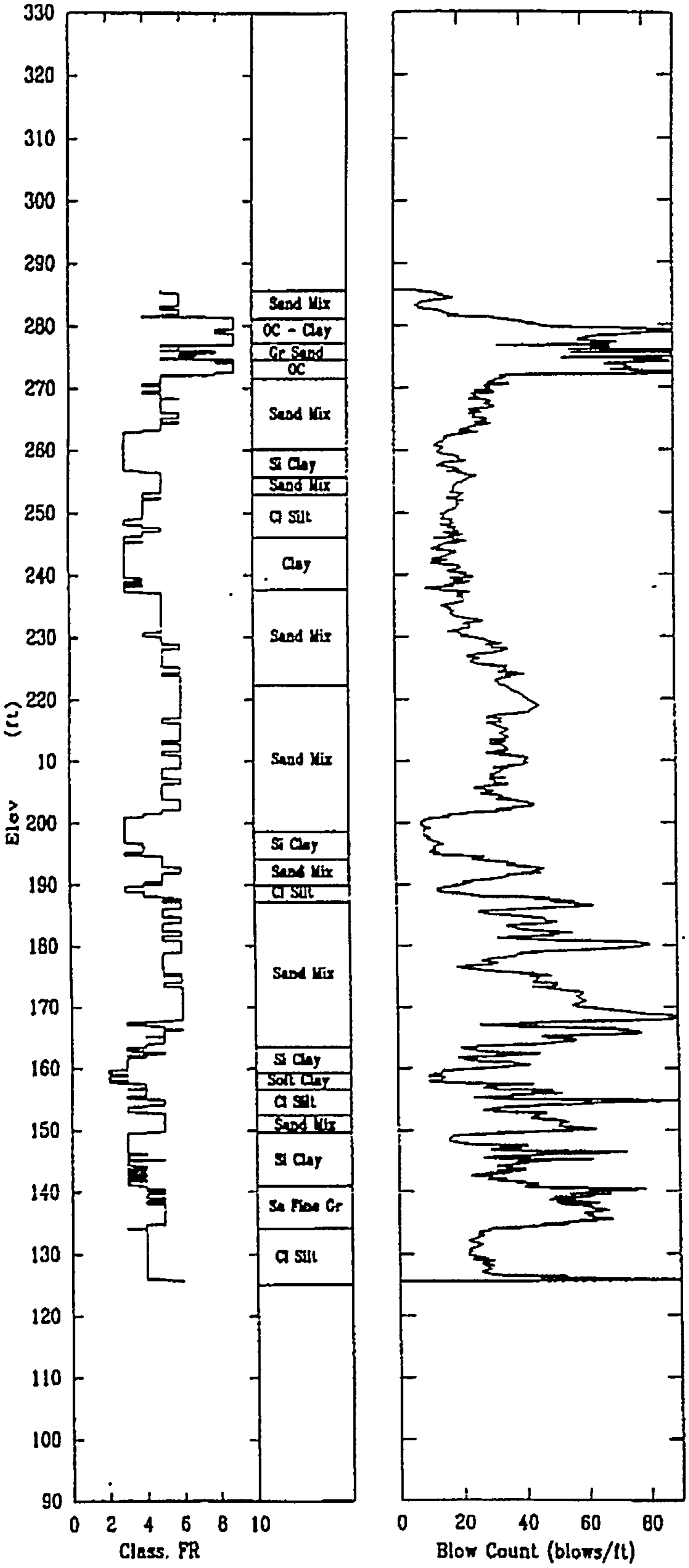


File 412fB01.ECP

A-227

HTEF-C22 APPLIED RESEARCH ASSOCIATES, INC. 02/12/98

North 73348.9 East 61674.3 Elevation 291.8



File 4121801.ECP

Appendix B

Geotechnical Boring Logs

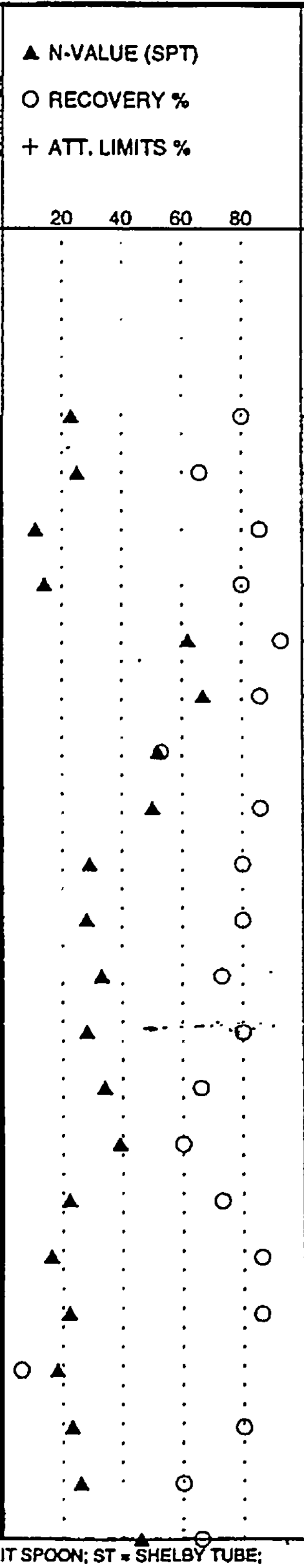
GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	1 OF 5	HTEF

SITE	COORDINATES	ANGLE FROM HORIZONTAL
HTEF	N 73331 E 61587	90

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	SAMPLE HAMMER WEIGHT/FALL	TOTAL DEPT
12/9/97	12/23/97	Graves/B. Cunningham	Failing 1500	3 7/8 in	140 lb/30 in	158.5

GROUND EL.	DEPTH/EL. GROUND WATER	LOGGED BY:
287.7	∇ / ▼ /	N. Kidd/SAIC



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
		287.7			
SS 1	7-13-10	281.2	5	CLAYEY SAND (SC); medium reddish brown with occasional white mottles; medium dense; moist; fine to medium grained	
SS 2	6-10-15	279.7		same as above; trace coarse sand	
SS 3	6-6-5	278.2		same as above; fine grained	
SS 4	4-6-8	276.7	10	same as above	
SS 5	12-24-38	275.2		same as above; very dense; fine to medium grained; trace water rounded gravel	Tobacco Road
SS 6	16-17-50	273.7		same as above	
SS 7	29-23-29	272.2	15	SILTY SAND (SM); dark red; very dense; moist; fine to medium grained	
SS 8	17-25-25	270.7		CLAYEY SAND (SC); medium gray with some red mottles; dense; damp; medium grained	
SS 9	10-13-16	269.2		same as above; with some silty sand layers; medium dense; moist; angular; trace coarse sand	
SS 10	11-12-16	267.7		same as above; fine to medium grained	
SS 11	14-14-19	266.2	20	same as above; dense; subangular to angular	
SS 12	12-15-13	264.7		SILTY SAND (SM) with thin clayey sand interlayers; dark red with medium brown layers; medium dense; moist	
SS 13	12-16-18	263.2		same as above; dense; medium brown with 1-2 inches of white, tan and red layers	
SS 14	13-19-20	261.7	25	same as above; fine grained; trace mica	
SS 15	10-10-12	260.2		SANDY SILT (ML); dark red with light gray to white interlayers; very stiff; moist; sand fraction is fine grained with some thin silty sand and clayey sand lenses	
SS 16	7-8-8	258.7		same as above; trace sandy clay lenses; medium brown, red, tan, and gray irregular patches	
SS 17	7-10-12	257.2	30	SANDY LEAN CLAY (CL); medium brown with red and white mottled zones; very stiff; moist; sand fraction is fine to medium grained	
SS 18	11-10-8	255.7		CLAYEY SAND (SC); medium red and brown; medium dense; moist; fine to medium grained, no core catcher resulted in poor recovery	
SS 19	7-10-13	254.2		same as above; with light gray zones; medium grained, some lower coarse sand	
SS 20	12-12-14	252.7		same as above	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

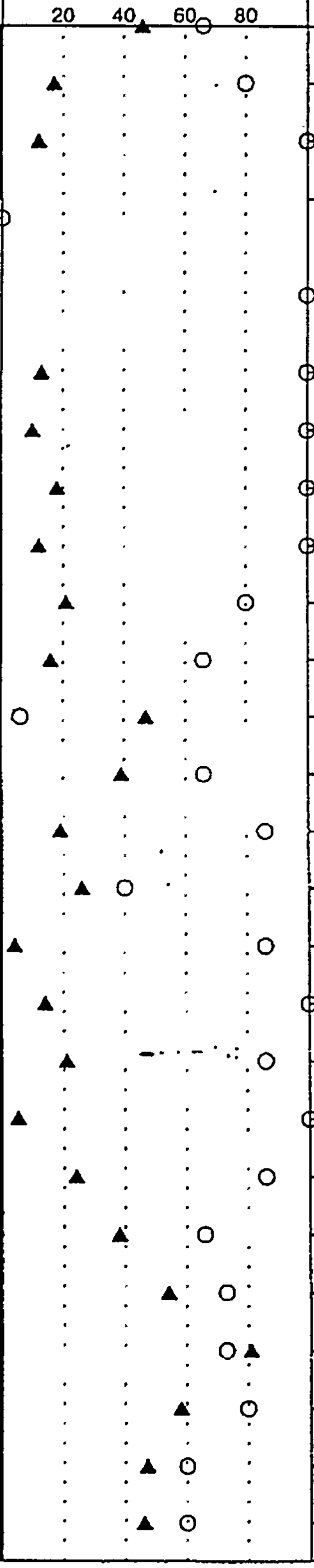
HOLE NO.
HTEF-B1

B-3

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 5	HTEF-B

▲ N-VALUE (SPT)
○ RECOVERY %
+ ATT. LIMITS %



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 21	16-24-22	251.2		same as above; dense; fine to medium grained	
SS 22	10-10-7	249.7		same as above; medium dense	
SS 23	7-5-7	248.2		same as above	
ST 1		245.7	40	no recovery	
ST 2		243.7		CLAYEY SAND (SC); medium yellowish brown with light gray zones; moist; fine to medium grained with trace coarse	
SS 24	6-4-9	242.2	45	same as above; lowest 0.5 ft are light red; medium dense	
SS 25	5-4-6	240.7		same as above; top 0.5 ft are light red with white laminations; loose; fine grained	
SS 26	4-6-12	239.2		same as above; medium dense	
SS 27	4-5-7	237.7		same as above; with sandy clay interbeds; medium brownish yellow becoming medium brownish red at the bottom of the interval	
SS 28	6-9-12	236.2	50	same as above; fine to medium grained	
SS 29	6-7-9	234.7		CLAYEY SAND (SC); medium reddish brown; medium dense; moist; fine to medium grained	
SS 30	5-24-23	233.2		same as above; dark red; dense; wet	
SS 31	22-15-24	231.7	55	SILTY SAND (SM); medium yellowish brown top half of interval is medium red; dense; wet; medium grained	Dry Branch
SS 32	12-8-11	230.2		same as above; medium dense; fine to medium grained	
SS 33	14-12-14	228.7		same as above; dark yellowish brown	
SS 34	4-1-3	227.2	60	CLAYEY SAND (SC); medium yellowish brown; very loose; wet; fine to medium grained	
SS 35	2-4-10	225.7		SILTY SAND (SM); medium brownish yellow; medium dense; wet; fine to medium grained	
SS 36	10-10-11	224.2		same as above	
SS 37	2-2-3	222.7		CLAYEY SAND (SC); medium yellowish brown; loose; wet; fine to medium grained	
SS 38	4-11-13	221.2	65	SILTY SAND (SM); medium yellowish brown; medium dense; wet; fine to medium grained	
SS 39	15-17-21	219.7		CLAYEY SAND (SC) with silty sand interbeds; medium brown; dense; wet; fine to medium grained	
SS 40	20-25-29	218.2		SILTY SAND (SM); medium brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 41	28-35-46	216.7	70	same as above; medium brownish yellow; medium to coarse grained, trace gravel	
SS 42	24-29-29	215.2		POORLY GRADED SAND (SP) trace silt; medium brownish yellow; very dense; wet; subangular; poorly graded; medium to coarse grained	
SS 43	24-23-24	213.7		SILTY SAND (SM); medium brownish yellow; dense; wet; subangular; poorly graded; medium to coarse grained	
SS	19-21-25			CLAYEY SAND (SC); medium yellowish brown;	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

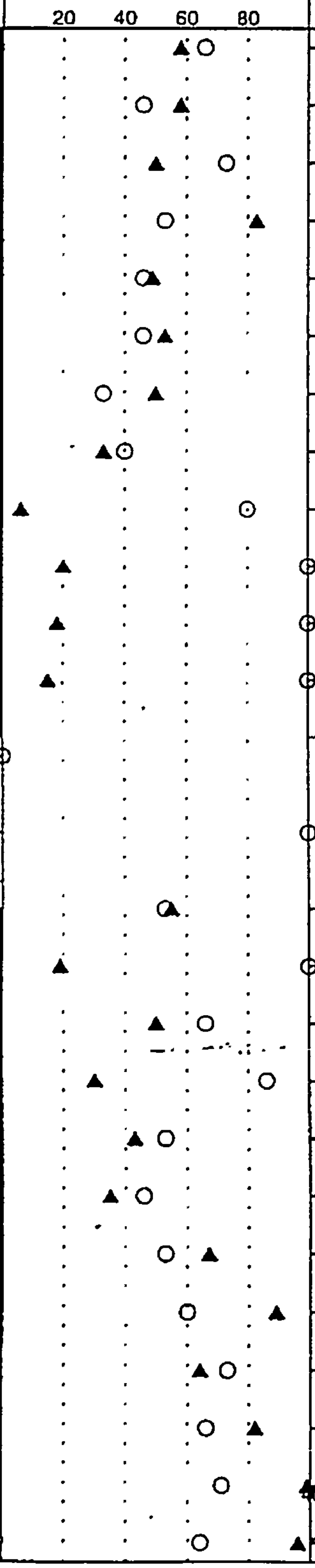
SITE	HOLE NO.
FINAL LOG	HTEF-B1

B-4

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	3 OF 5	HTEF-

▲ N-VALUE (SPT)
○ RECOVERY %
+ ATT. LIMITS %



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
44				dense; wet; subangular; poorly graded; fine to medium grained	
SS 45	22-30-28	212.2		POORLY GRADED SAND WITH SILT (SP-SM); light brown; very dense; wet; subangular; poorly graded; medium to coarse grained	
SS 46	20-29-29	210.7		POORLY GRADED SAND (SP); light brown; very dense; wet; subangular; poorly graded; medium to coarse grained	
SS 47	19-25-25	209.2		POORLY GRADED SAND WITH CLAY (SP-SC); medium yellowish brown; dense; wet; subangular; poorly graded; fine to medium grained with a 0.1-0.2 ft zone of coarse sand	
SS 48	15-36-47	207.7	80	POORLY GRADED SAND WITH SILT (SP-SM); medium yellowish brown; very dense; wet; subangular; poorly graded; medium to coarse grained	
SS 49	13-21-28	206.2			
SS 50	18-25-28	204.7		POORLY GRADED SAND (SP); light brown; dense; wet; subrounded; poorly graded; coarse grained trace heavy minerals	
SS 51	17-20-30	203.2	85	WELL GRADED SAND (SW) trace silt; medium brown; very dense; wet; subrounded; well graded; medium to coarse grained	
SS 52	15-19-14	201.7		POORLY GRADED SAND (SP) trace silt; medium brown; dense; wet; subrounded; poorly graded; medium to coarse grained	
SS 53	8-1-5	200.2 199.4		same as above CLAYEY SAND (SC); dark blackish brown; loose; wet; subangular; medium to coarse grained grades into underlying portion of the interval	
SS 54	4-9-11	198.7	90	Interbedded SILTY and SANDY LEAN CLAY (CL); very light yellowish brown, black, white multicolored; firm to very stiff; wet; low to medium plasticity, sand fraction is medium to coarse grained	Tan Clay Interval
SS 55	7-7-11	197.2			
SS 56	5-6-9	195.7		same as above; trace heavy minerals CLAYEY SAND (SC); light yellowish brown with light brown clay laminae; medium dense; wet; subangular; fine to medium grained	
ST 3		194.2	95	same as above no recovery	
ST 4		191.7		same as above; medium to coarse grained	
		190.4			
SS 57	23-23-32			POORLY GRADED SAND (SP) trace silt; light brown with several black nodules (Mn?); very dense; wet; subangular; poorly graded; coarse grained	
SS 58	16-12-7	188.2	100	same as above; medium dense; medium to coarse grained	
SS 59	20-25-25	186.7		same as above; dense	
SS 60	13-10-20	185.2		same as above; light reddish brown; medium dense; light gray wispy clay laminae at base of interval	
SS 61	13-19-24	183.7	105	same as above; dense	
SS 62	15-14-21	182.2		same as above; trace heavy minerals	
SS 63	31-45-22	180.7		CLAYEY SAND (SC); light brown with white wisps; very dense; wet; subangular; well graded; medium to coarse grained	
SS 64	11-45-44	179.2		same as above; silty; also light yellow and medium reddish brown zones; fine to coarse grained; black wisps (Mn?)	
SS 65	26-38-26	178.0 177.7	110	POORLY GRADED SAND (SP) trace silt; med brown; very dense; wet; subangular; poorly graded; cse grained	
SS 66	15-35-47	176.2		WELL GRADED SAND (SW) trace silt; lt brown, med reddish brown in places; very dense; wet; subangular; well graded; fine to cse grained; sparse black nodules (Mn?)	
SS 67	40-49-50/5in	174.7		CLAYEY SAND (SC); lt brown; med brownish yellow in places; very dense; wet; subangular; well	Tinker?
		173.5 173.3			

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

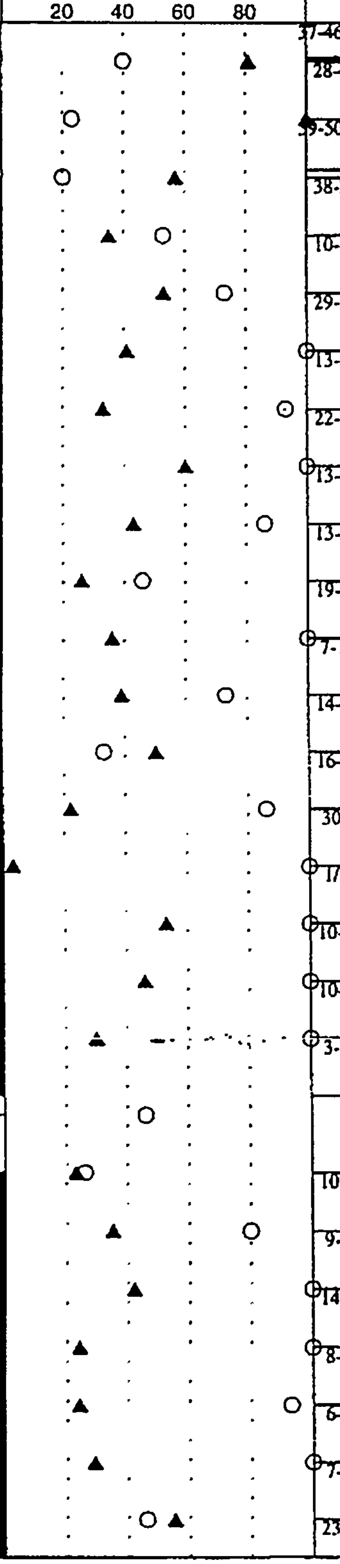
SITE		HOLE NO.
	FINAL LOG	HTEF-B1

B-5

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	4 OF 5	HTEF-B1

▲ N-VALUE (SPT)
○ RECOVERY %
\+ ATT. LIMITS %



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT
SS 68	37-46-50/5in	171.8	
SS 69	28-40-41	170.2	
SS 70	39-50-50/4in	168.9	
SS 71	38-30-27	167.2	120
SS 72	10-11-24	165.7	
SS 73	29-30-23	164.2	
SS 74	13-15-26	162.7	125
SS 75	22-16-17	161.2	
SS 76	13-30-30	159.7	
SS 77	13-16-27	158.2	
SS 78	19-14-12	156.7	130
SS 79	7-10-26	155.2	
SS 80	14-12-27	153.7	
SS 81	16-22-28	152.2	135
SS 82	30-16-6	150.7	
SS 83	1/16"-3	149.2	
SS 84	10-21-32	148.8 148.6 147.7	140
SS 85	10-22-24	146.2	
SS 86	3-12-18	144.7	
ST 5		142.7	145
SS 87	10-10-13	141.2	
SS 88	9-14-21	139.7	
SS 89	14-20-22	138.2	
SS 90	8-11-13	136.7	150
SS 91	6-12-12	135.2	
SS 92	7-12-17	133.7	
SS	23-25-30		

DESCRIPTION AND CLASSIFICATION

graded; med to cse grained

WELL GRADED SAND (SW) trace silt; lt brown; very dense; wet; subangular; well graded; sparse black nodules (Mn?)

same as above

POORLY GRADED SAND (SP) trace silt; light brown; very dense; wet; subangular; poorly graded; fine to medium grained

same as above; medium grained

same as above; medium to coarse grained

same as above; with silt; well graded; fine to med grained

CLAYEY SAND (SC) trace silt with lean clay and poorly graded sand interbeds; med yellowish brown; dense; wet; subangular; well graded; fine to cse grained

POORLY GRADED SAND (SP) trace silt with silty sand interbeds; lt brown with white wisps; very dense; wet; subangular; poorly graded; fine to med grained, sparse black nodules (Mn?)

CLAYEY SAND (SC) calcareous?, also zones of sandy clay and silty sand; white with lt brown zones; dense; wet; subangular; well graded; med to cse grained

SILTY SAND (SM) trace clay with sandy lean clay interbeds; white with med brownish green zones and lt yellowish brown; dense; wet; subangular; well graded; fine to med grained

same as above; with thin zones of clayey sand; light green; very dense

same as above; trace clay; hard white nodule at base of interval (calcareous cementation?)

SILTY SAND (SM); lt green; med dense; wet; subangular; well graded; fine to cse grained, shell fragments, some hard zones (calcareous cementation?)

same as above; with lt brown bands near the bottom of the interval; dense; fine to med grained, coarser near interval bottom

CLAYEY SAND (SC) trace silt; lt brownish yellow with white bands; dense; wet; subangular; well graded; fine to med grained, with white wispy clays

same as above

same as above; with white wispy clays; medium dense; coarser at bottom of interval

same as above; with thin clay laminae; very loose; lowest 0.2 ft cemented sand & white hard nodules; 0.1 ft hard zone at 138.0 ft

same as above; very dense

POORLY GRADED SAND (SP) trace silt; lt brownish yellow; very dense; wet; subangular; poorly graded; med grained

SILTY SAND (SM) trace clay; lt brownish yellow with lt gray streaks; very dense; wet; subangular; fine to med grained, trace heavy minerals

same as above; with zones of clayey sand; medium dense

SILTY SAND (SM); lt brownish yellow; med dense; wet; subangular; well graded; fine to med grained, small clay pods in places

CLAYEY SAND (SC); med brownish red with med yellowish brown zones; med dense; wet; subangular; well graded; fine to med grained

SILTY SAND (SM) trace clay; lt brown; med dense; wet; subangular; well graded; fine to med grained

same as above; light yellowish brown; dense

same as above

same as above; with wispy light green clay; medium dense

same as above; with wispy light green clay laminae near the bottom of the interval

SANDY LEAN CLAY (CL); medium brownish yellow with light green wisps; very stiff; wet; medium plasticity; sand fraction is fine grained

CLAYEY SAND (SC); medium reddish yellow

NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING

Santee

Warley Hill

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

HOLE NO. HTEF-B1

B-6

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	5 OF 5	HTEF-

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
93	■	○▲		132.2		▨	with light greenish gray mottles; very dense; wet; subangular; well graded; fine to medium grained	
SS 94	■		21-24-28			▨	SANDY LEAN CLAY (CL); dark yellowish red with light green wisps; hard; wet; medium plasticity; sand fraction is fine grained	
	■	▲		130.7		▨		
SS 95	■		27-28-27			▨	LEAN CLAY (CL) with sparse gravel size grains; medium green with light reddish yellow zones and reddish yellow mottles; hard; wet; low plasticity	
				129.2				

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

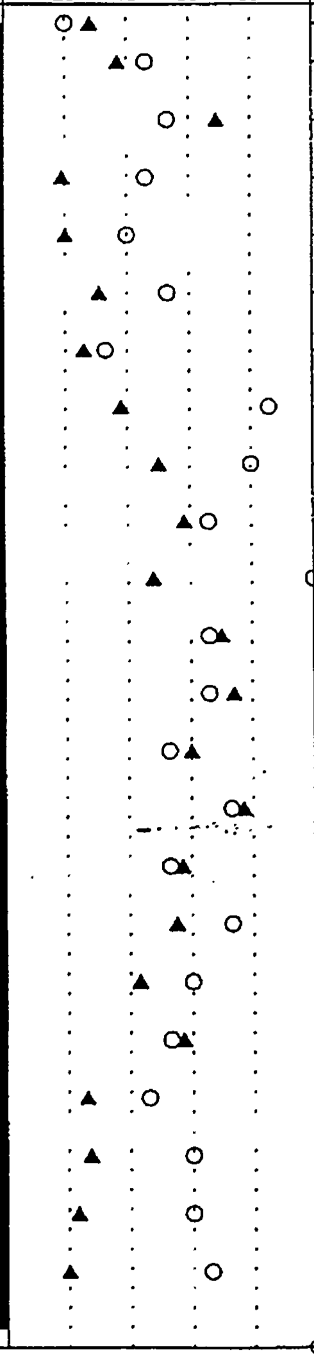
FINAL LOG

HOLE NO.
HTEF-B1

B-7

GEOTECHNICAL LOG

PROJECT TEF			JOB NO. HTEF	SHEET NO. 1 OF 5	HOLE NO. HTEF-B
SITE HTEF	COORDINATES N 73320 E 61675			ANGLE FROM HORIZONTAL 90	
BEGUN 12/29/97	COMPLETED 1/21/98	DRILLER Graves/B. Cunningham&A. Jackson	DRILL MAKE AND MODEL Failing 1500	HOLE SIZE 3 7/8 in	SAMPLE HAMMER WEIGHT/FALL 140 lb/30 in
TOTAL DEPT 165.5	GROUND EL. 292.7	DEPTH/EL. GROUND WATER ▽ / ▼ /	LOGGED BY: N. Kidd/SAIC		



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
		292.7			
SS 1	0-17-11	291.2		CLAYEY SAND (SC); medium red; medium dense; dry; subangular; well graded; medium to coarse grained	
SS 2	12-13-24	289.7		same as above; dense	
SS 3	43-35-34	288.2		SANDY LEAN CLAY WITH GRAVEL (CL); medium red with light brown zones; very hard; dry; low plasticity; coarse fraction varies from fine sand to gravel; brown zone is fine to medium grained sand	
SS 4	12-10-9	286.7	5		
SS 5	7-9-11	285.2		SANDY LEAN CLAY (CL); medium reddish brown; very stiff; dry; low plasticity; sand fraction is fine to coarse grained same as above; trace gravel; damp	
SS 6	17-17-14	283.7		POORLY GRADED SAND WITH SILT (SP-SM); medium brown; dense; damp; subangular; poorly graded; fine to medium grained	
SS 7	8-11-15	282.2	10	SILTY SAND (SM); medium yellowish brown; medium dense; damp; subangular; poorly graded; fine to medium grained	
SS 8	13-15-23	280.7		SANDY LEAN CLAY (CL); medium grayish brown, reddish brown, with red and gray mottles; hard; damp to moist; low plasticity; sand fraction is fine grained	
SS 9	14-22-28	279.2		same as above	
SS 10	21-27-31	277.7		same as above	
SS 11	19-24-24	276.2	15	LEAN CLAY (CL) trace fine sand; medium grayish brown with gray zones; hard; damp; medium plasticity	
SS 12	38-29-41	274.7		CLAYEY SAND (SC) with silty sand interbeds; medium gray with red and brown zones; very dense; moist; subangular; poorly graded; fine to medium grained	Tobacco Road
SS 13	38-36-38	273.6 273.2		same as above LEAN CLAY (CL) trace sand; light reddish gray; very hard; damp; medium plasticity	
SS 14	31-34-26	271.7	20	CLAYEY SAND (SC); medium red with a white sandy clay zone at top of interval; very dense; moist; subangular; well graded; medium to coarse grained	
SS 15	38-42-35	270.2			
SS 16	29-33-24	268.7		SILTY SAND (SM) trace clay; medium red with medium yellow zones; very dense; dry; subangular; well graded; medium to coarse grained; top 2 inches are white sandy clay	
SS 17	11-22-33	267.2	25	same as above SANDY LEAN CLAY (CL); white with red mottles; hard; damp; low plasticity; sand fraction is fine to coarse grained	
SS 18	20-21-22	265.7		CLAYEY SAND (SC); white with dark red and light yellow mottles; dense; damp; subangular; well graded; medium to coarse grained	
SS 19	18-27-30	264.2		same as above; with zones of sandy clay; dark red with yellow and white zones; very dense	
SS 20	13-13-13	262.7		same as above; medium dense; well graded; fine to medium grained	
SS 21	10-14-13	261.2	30	SANDY LEAN CLAY (CL) trace mica; dark red with purple and white bands; very stiff; damp; medium plasticity; sand fraction is fine grained	
SS 22	7-11-12	259.7		same as above; red, white, and yellow; sand is fine to medium grained	
SS 23	6-9-11	258.2		same as above; medium yellowish brown with white mottles; sand is fine to coarse grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

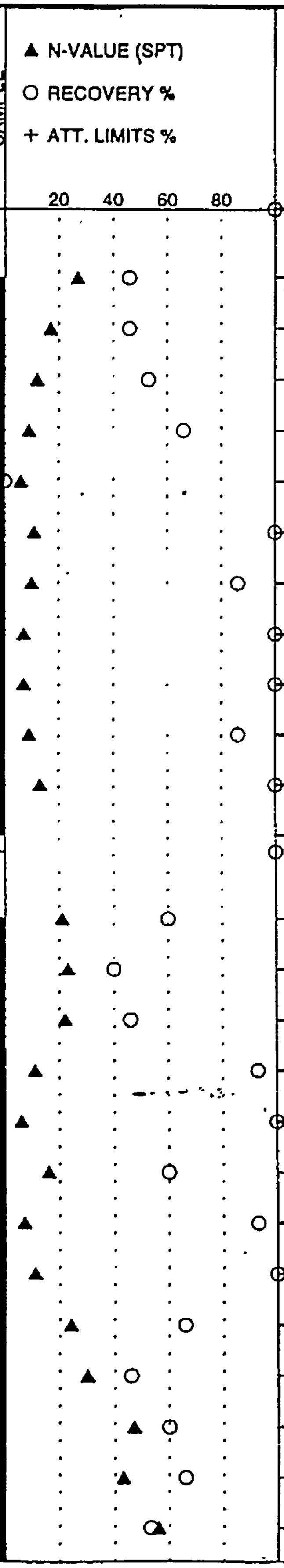
FINAL LOG

HOLE NO.
HTEF-B2

B-8

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 5	HTEF



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
ST 1		255.7		same as above; white with red and light brownish yellow motdes; sand fraction is medium to coarse grained	
SS 24	10-15-12	254.2		CLAYEY SAND (SC); medium red with white zones; medium dense; damp; subangular; well graded; medium to coarse grained	
SS 25	10-9-8	252.7		same as above; fine to medium grained	
SS 26	7-6-6	251.2	40	same as above	
SS 27	5-4-5	249.7		same as above; loose	
SS 28	4-3-3	248.2		no recovery	
SS 29	4-6-5	246.7	45	same as above; medium dense; fine to coarse grained	
SS 30	6-5-5	245.2		same as above; loose	
SS 31	4-3-4	243.7		same as above; medium brownish yellow with white streaks and red zones; moist; fine to medium grained	
SS 32	3-3-4	242.2	50	SILTY SAND (SM); medium brownish yellow with interlaminated white streaks; loose; moist; subangular; well graded; fine grained	
SS 33	3-4-5	240.7		same as above; with medium red zones; damp	
SS 34	3-6-7	239.2		CLAYEY SAND (SC); medium red with medium brownish yellow zones; medium dense; damp; subangular; well graded; fine to medium grained	
ST 2		236.7	55	same as above; with dark brown bands; moist; medium to coarse grained	
SS 35	3-10-11	235.2		same as above; medium brownish yellow with medium red zones; wet; medium grained	
SS 36	6-12-11	233.7		same as above; medium brown; medium to coarse grained	Dry Branch
SS 37	7-14-8	232.2	60	same as above; light brown	
SS 38	6-7-4	230.7		same as above; medium yellowish brown with black zones; medium grained	
SS 39	2-2-4	229.2		same as above; medium brown; loose; medium to coarse grained	
SS 40	7-7-9	227.7		SILTY SAND (SM); medium yellowish brown; medium dense; wet; subangular; well graded; fine to medium grained	
SS 41	10-4-3	226.2	65	POORLY GRADED SAND WITH CLAY (SP-SC); medium brown; loose; wet; subangular; poorly graded; fine to medium grained	
SS 42	2-2-9	224.7		CLAYEY SAND (SC); medium brown; medium dense; wet; subangular; well graded; fine to medium grained	
SS 43	10-11-13	223.2		POORLY GRADED SAND WITH SILT (SP-SM); medium brown; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 44	12-14-16	221.7	70	POORLY GRADED SAND WITH CLAY (SP-SC); medium brown with medium brownish yellow bands; medium dense; wet; subangular; poorly graded; medium grained	
SS 45	17-22-25	220.2		same as above; dense	
SS 46	17-21-22	218.7		POORLY GRADED SAND (SP) trace silt; medium brown; dense; wet; subangular; poorly graded; medium grained	
SS .	19-28-28			POORLY GRADED SAND WITH SILT (SP-SM);	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

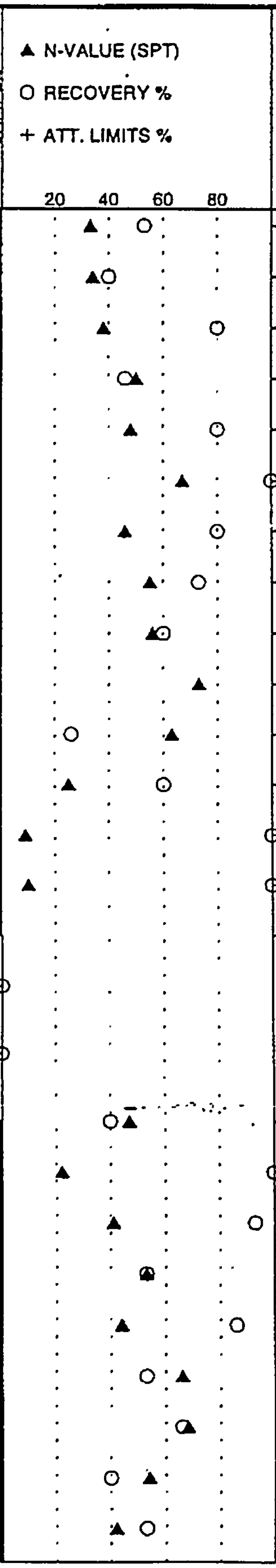
FINAL LOG

HOLE NO.
HTEF-B2

B-9

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	3 OF 5	HTEF-B2



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
47				medium brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 48	19-16-17	217.2		same as above; dense; black pellets (Mn?)	
SS 49	8-15-19	215.7		SILTY SAND (SM) trace clay; medium brown; dense; wet; subangular; well graded; fine to medium grained	
SS 50	17-19-19	214.2		POORLY GRADED SAND WITH SILT (SP-SM); light brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 51	18-27-23	212.7	80	same as above	
SS 52	19-25-23	211.2		same as above; subrounded	
SS 53	31-32-35	209.7		POORLY GRADED SAND (SP) trace silt; light brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 54	20-21-25	208.2	85	same as above; dense	
SS 55	10-23-32	206.7		WELL GRADED SAND WITH SILT (SW-SM); light brown; very dense; wet; subangular; well graded; fine to medium grained	
SS 56	21-26-30	205.2		POORLY GRADED SAND (SP) trace silt; light brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 57	19-31-42	203.7	90	same as above	
SS 58	27-29-34	202.2		same as above with some coarse grains	
SS 59	17-17-8	200.7		SILTY SAND (SM); medium brown; medium dense; wet; subangular; well graded; fine to coarse grained	
SS 60	3-5-4	199.2		SANDY LEAN CLAY (CL) with zones of clayey sand; medium brown with white wisps; stiff; wet; medium plasticity; sand is fine to medium grained; this appears to be a transitional zone; large black nodule (Mn?)	Tan Clay Interval
SS 61	5-3-7	197.7	95		
		196.2		SILTY SAND (SM); medium brown; loose; wet; subangular; well graded; fine to medium grained	
ST 3				no recovery	
ST 4		192.7	100	no recovery	
SS 62	6-13-34	190.7		POORLY GRADED SAND WITH SILT (SP-SM); light brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 63	7-6-16	189.2		SILTY SAND (SM) trace clay; medium brown; medium dense; wet; subangular; well graded; fine to medium grained; black pellets (Mn?)	
SS 64	4-13-28	187.7	105	POORLY GRADED SAND WITH SILT (SP-SM); light brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 65	17-28-25	186.2		same as above; very dense	
SS 66	21-23-21	184.7		same as above; dense	
SS 67	12-32-34	183.2	110	same as above; very dense; last 0.2 feet is sand trace silt	
SS 68	14-35-33	181.7		SILTY SAND (SM); medium brown with yellow zones; very dense; wet; subangular; well graded; fine to medium grained	
SS 69	16-29-25	180.2		POORLY GRADED SAND WITH SILT (SP-SM); light brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS	8-17-25	178.7		same as above; with orange zones; dense	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

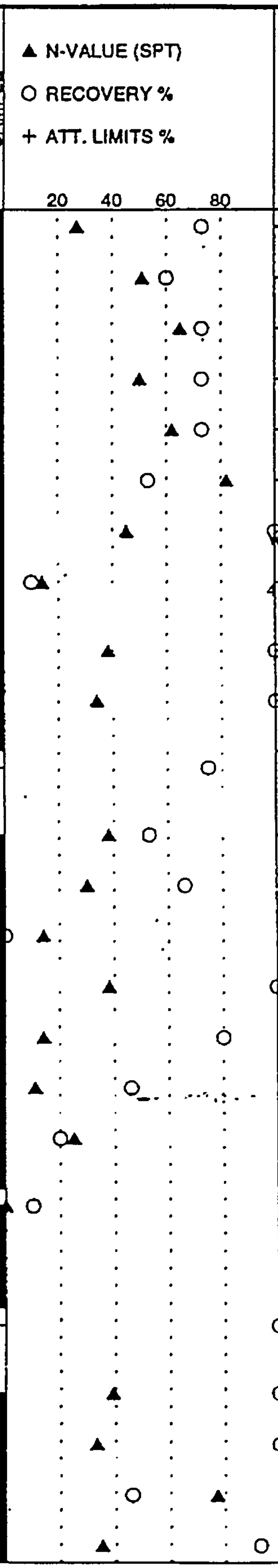
FINAL LOG

HOLE NO. **HTEF-B2**

B-10

GEOTECHNICAL LOG

PROJECT: TEF
JOB NO.: HTEF
SHEET NO.: 4 OF 5
HOLE NO.: HTEF



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
70					
SS 71	10-10-17	177.2		SILTY SAND (SM); light brown; medium dense; wet; subangular; well graded; fine to medium grained	Tinker?
SS 72	9-21-30	175.7		same as above; very dense	
		174.7		POORLY GRADED SAND (SP) trace silt; light brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 73	12-30-35	174.2		same as above; with silt	
SS 74	22-24-26	172.7	120	same as above; trace silt; dense	
SS 75	23-29-33	171.2		same as above; very dense; trace mica and heavy minerals	
SS 76	36-43-39	169.7		same as above; with silt	
SS 77	WR/6in-8-37	168.2	125	SANDY LEAN CLAY (CL) clayey sand in places; dark brown; dense; wet; subangular; well graded; fine to medium grained, abundant black pellets (Mn?)	Santee
SS 78	41-12-2/12in	166.7		POORLY GRADED SAND (SP) trace silt; light brownish white; medium dense; wet; subangular; poorly graded; sand is fine grained	
SS 79	10-17-21	164.7		SILTY SAND (SM); white with light brown streaks; dense; dry; subangular; well graded; fine to medium grained; some pelecypod shells	
SS 80	5-8-26	163.2	130	same as above; very light green; moist; poorly graded; fine grained	
ST 5		161.7		POORLY GRADED SAND WITH SILT (SP-SM); very light green; moist; subangular; poorly graded; fine grained	
SS 81	19-17-21	159.2		same as above; dense; wet; fine to medium grained	
SS 82	17-14-16	157.7	135	same as above; medium dense	
SS 83	6-6-8	156.2		no recovery	
SS 84	4-20-18	154.7		SILTY SAND (SM); very light green with white zones; dense; wet; subangular; well graded; fine to medium grained	
SS 85	5-9-5	153.2	140	same as above; light greenish brown with white zones; medium dense	
SS 86	6-8-3	151.7		same as above; very light green	
SS 87	13-20-5	150.2		same as above; well graded	
SS 88	WR/36in	148.7	145	POORLY GRADED SAND WITH SILT (SP-SM) very light green with light brown zones; very loose; wet; subangular; poorly graded	
ST 6		145.2		SILTY SAND (SM); light yellowish brown; moist; subangular, well graded	
SS 89	9-14-25	142.7	150	same as above; dense; fine to medium grained	
SS 90	6-10-23	141.2		same as above	
SS 91	20-36-41	139.7		POORLY GRADED SAND WITH SILT (SP-SM) light brown; very dense; wet; subangular; poorly graded; fine to medium grained; white silicified	
		138.2			

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

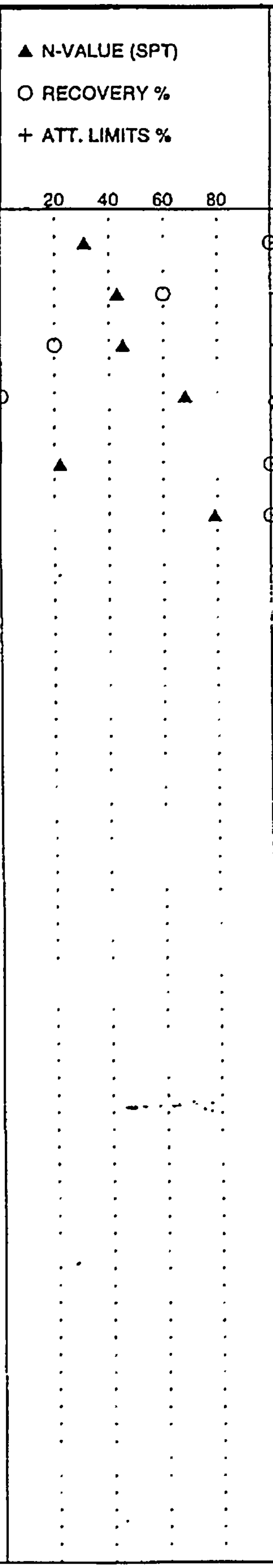
SITE: FINAL LOG

HOLE NO. HTEF-B2

B-11

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	5 OF 5	HTEF-B



SAMP. TYPE AND NO.	BLOW/ COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 92	6-11-24	136.7		zone (hard; sandstone) at top of interval same as above; light yellowish brown; dense	
SS 93	6-11-20	135.2		SILTY SAND (SM); light yellowish brown; dense; wet; subangular; well graded; fine to medium grained	
SS 94	11-17-26	133.7		same as above; light greenish brown	
SS 95	15-18-27	132.2	160	same as above	
SS 96	9-18-50/4in	130.9		no recovery; shoe stripped off split spoon; 0.5 ft drilled out before next SPT interval	
SS 97	9-10-12	128.7		SANDY LEAN CLAY (CL); very dark grayish green; very stiff; wet; medium plasticity; sand fraction is fine to medium grained; this interval marks the 'green clay' contact	Warley Hill
SS 98	13-31-48	127.2	165	ELASTIC SILT (MH); very dark yellowish green; very hard; wet; low plasticity; trace mica	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

HOLE NO. **HTEF-B2**

B-12

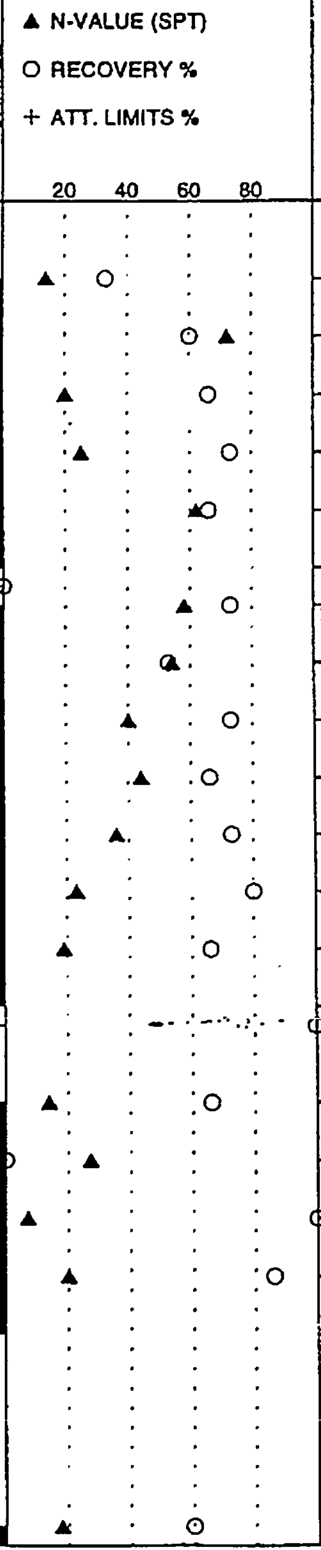
GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	1 OF 5	HTEF

SITE	COORDINATES	ANGLE FROM HORIZONTAL
HTEF	N 73431 E 61670	90

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	SAMPLE HAMMER WEIGHT/FALL	TOTAL DEPT
1/5/98	1/13/98	Graves/A. Jackson	Failing 1500	3 7/8 in	140 lb/30 in	159.5

GROUND EL.	DEPTH/EL. GROUND WATER	LOGGED BY:
288.1	▽ 39.5/248.6 1/9/98 ▼ /	R. Gelinas/SAIC



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
		288.1			
SS 1	6-6-8	284.6		CLAYEY SAND (SC) trace crushed stone; medium reddish brown; medium dense; damp; poorly graded; subangular; medium to lower coarse grained. material may be FILL	
SS 2	13-28-44	283.1	5	same as above; very dense; upper 0.5 ft may be FILL	
SS 3	24-11-9	281.6		SILTY SAND (SM); medium brown; medium dense; moist; subangular; fine to medium grained	
SS 4	3-10-15	280.1		SANDY LEAN CLAY (CL); medium reddish brown; moist; very stiff; low plasticity; sand fraction is fine grained	
SS 5	9-31-31	278.6		CLAYEY SAND (SC); medium brown with red and light gray oxidation zones; very dense; moist; poorly graded subangular	
ST 1		278.0	10	no recovery on 2 inch push; tube tip bent badly	
SS 6	21-27-31	276.1		LEAN CLAY WITH SAND (CL), portions are sandy clay; light brownish gray with few red zones; hard; damp; low plasticity; sand fraction is fine grained	
SS 7	14-25-29	274.6		SANDY LEAN CLAY (CL); light gray with few red spots; hard; damp; low plasticity; sand fraction is fine grained	Tobacco Road
SS 8	15-17-23	273.1	15	CLAYEY SAND (SC); light gray with medium red bands every 3-4 inches; dense; damp; poorly graded; subangular; fine to medium grained	
SS 9	11-12-32	271.6		LEAN CLAY (CL), trace fine sand; light gray and medium red bands; hard; damp; low plasticity	
SS 10	19-21-15	270.1		CLAYEY SAND (SC); medium red with few light gray zones; dense; moist; poorly graded; subangular; medium to lower coarse grained	
SS 11	7-12-11	268.6		same as above; with some silty sand layers; medium dense; fine to medium grained	
SS 12	7-9-10	267.1	20	same as above	
ST 2		265.6		same as above; trace mica	
		264.6		SILTY SAND (SM), trace muscovite mica; medium gray; moist; poorly graded; subangular; fine grained (bottom of tube)	
SS 13	7-7-7	263.1	25	SILT WITH SAND (ML), and some silty sand layers; medium reddish brown with gray and yellowish brown zones; stiff; moist; low plasticity; sand fraction is fine grained	
SS 14	7-10-17	261.6		no recovery; catcher is missing a few teeth; put new core catcher in shoe	
SS 15	1-2-5	260.1		SANDY LEAN CLAY (CL), some layers trace to with sand; medium brownish red and highly variable gray, yellowish brown and white; firm; moist; medium plasticity; sand fraction very fine to fine grained	
SS 16	7-9-11	258.6	30	LEAN CLAY (CL), trace to with sand; medium yellowish brown with some red and light gray zones; very stiff; moist; medium plasticity	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

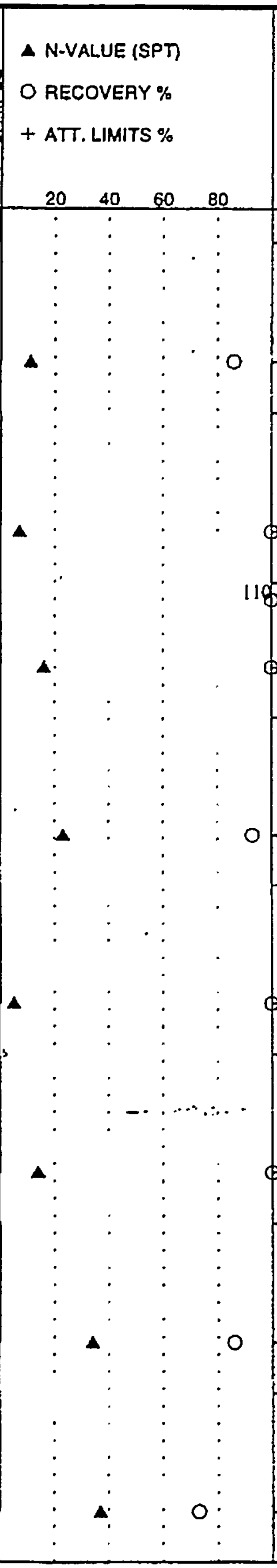
FINAL LOG

HOLE NO.
HTEF-B3

B-13

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 5	HTEF-B



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 17	5-8-10	252.1		CLAYEY SAND (SC), with some sandy clay layers; medium reddish brown with some red layers; medium dense; moist; poorly graded; subangular; fine to medium grained	
SS 18	5-5-6	247.1	40	SILTY SAND (SM); medium yellowish brown with medium red layers; medium dense; moist; poorly graded; subangular; fine to lower coarse grained	
SS 19	3-3-4	242.1	45	CLAYEY SAND (SC); medium yellowish brown; loose; wet; poorly graded; subangular; fine to medium grained	
ST 3				same as above; reddish brown and yellowish brown; moist; fine grained	
SS 20	6-6-10	239.6 238.1	50	same as above; medium dense	
SS 21	4-10-13	233.1	55	SILTY SAND (SM); with clay; medium brown with some reddish zones; medium dense; wet; poorly graded; subangular; fine to medium grained	Dry Branch
SS 22	2-2-3	228.1	60	CLAYEY SAND (SC); medium yellowish brown; loose; wet; poorly graded; subangular; fine to medium grained	
SS 23	2-5-9	223.1	65	same as above; few silty sand zones; medium reddish brown; medium dense	
SS 24	12-17-17	218.1	70	SILTY SAND (SM), few layers have trace clay; medium brown; dense; wet; poorly graded; subangular; fine to medium grained	
SS 25	5-13-24	213.1		CLAYEY SAND (SC); medium yellowish brown; dense; wet; poorly graded; subangular; fine to	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE	HOLE NO.
FINAL LOG	HTEF-B3

B-14

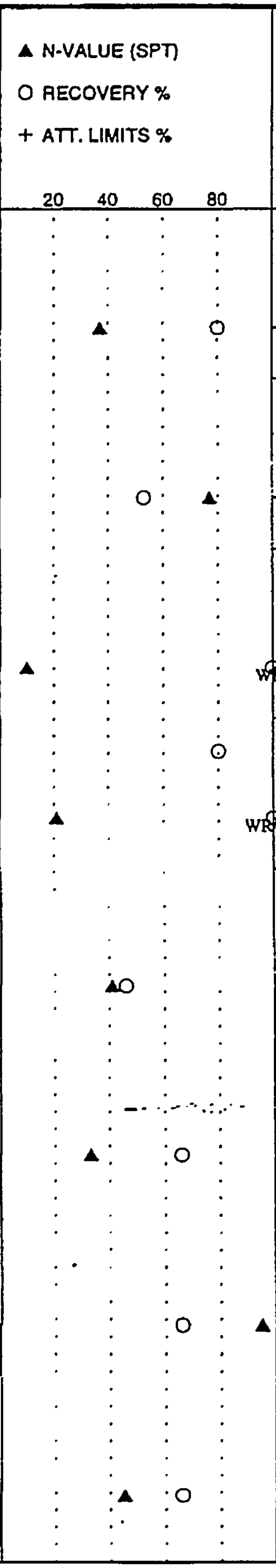
GEOTECHNICAL LOG

PROJECT: TEF

JOB NO.: HTEF

SHEET NO.: 3 OF 5

HOLE NO.: HTEF



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
				medium grained	
SS 26	6-15-22	208.1	80	SILTY SAND (SM); medium yellowish brown; dense; wet; poorly graded; subangular; fine to medium grained	
SS 27	14-32-45	203.1	85	same as above; with some light gray zones; very dense; angular; medium to lower coarse grained	
SS 28	WR/9in-4/3in-6	198.1	90	LEAN CLAY WITH SAND (CL); medium yellowish gray and yellowish brown; stiff; moist; medium plasticity; some manganese stained zones, sand fraction is fine grained	Tan Clay Interval
ST 4		195.1		SILTY SAND (SM); light brownish gray; wet; poorly graded; subangular; fine to lower coarse grained	
SS 29	WR/3in-2/3in-6-15	193.6	95	CLAYEY SAND (SC), with silty sand interbeds; medium grayish brown; medium dense; wet; poorly graded; subangular; fine to medium grained with some manganese staining	
SS 30	15-21-20	188.6	100	SILTY SAND (SM); light brown and light grayish brown; dense; wet; poorly graded; subangular; fine to medium grained	
SS 31	4-10-23	183.6	105	POORLY GRADED SAND WITH SILT (SP-SM); light brown; dense; wet; poorly graded; subangular; fine to medium grained	
SS 32	31-50-45	178.6	110	POORLY GRADED SAND WITH SILT (SP-SM), some silty sand interbeds; light grayish brown; very dense; wet; poorly graded; subangular; fine to lower coarse grained	Tinker?
SS 33	4-16-29	173.6		POORLY GRADED SAND WITH CLAY (SP-SC); light grayish brown; dense; wet; poorly graded; subangular; fine to medium grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

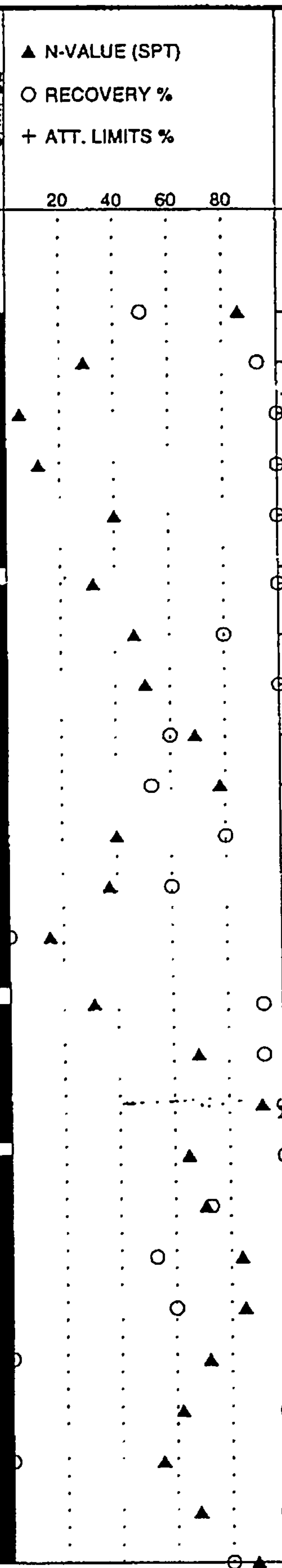
FINAL LOG

HOLE NO. **HTEF-B3**

B-15

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	4 OF 5	HTEF-B



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 34	16-33-53	168.6		POORLY GRADED SAND WITH SILT (SP-SM); light brown; very dense; wet; poorly graded; subangular; fine to medium grained	
SS 35	10-11-18	167.1	120	CLAYEY SAND (SC); medium grayish brown with light gray layers; medium dense; wet; poorly graded; subangular; fine to medium grained	
SS 36	2-2-3	167.0 165.6		FAT CLAY (CH); dark gray; very soft; wet; high plasticity; not enough sample to jar	Santee
SS 37	1-5-7	164.1		CLAYEY SAND (SC); light grayish brown; firm; wet; poorly graded; subangular; very fine to fine grained	
SS 38	7-16-24	162.6	125	SANDY SILT (ML), with few silty sand interbeds; light whiteish gray and light tan and brown; stiff; moist; low plasticity; sand fraction very fine to fine grained (calcareous?)	
SS 39	12-16-16	160.6		CLAYEY SAND (SC); medium grayish brown and light gray; dense; moist; poorly graded; subangular; sand is fine to medium grained	
SS 40	10-19-28	159.1		SILTY SAND (SM), with sandy silt interbeds; light brownish gray; dense; moist; poorly graded; subangular; fine to lower medium grained same as above; parts carbonate cemented	
SS 41	23-20-31	157.6	130	CLAYEY SAND (SC); light brown; very dense; moist; poorly graded; subangular; fine grained	
SS 42	21-25-44	156.1		SILTY SAND (SM); light gray; very dense; moist; poorly graded; angular; tip of spoon contains 0.25 inch fragments of light gray santee limestone	
SS 43	25-48-30	154.6		same as above; portions clayey	
SS 44	12-14-26	153.1		same as above; light greenish brown; dense; wet	
SS 45	18-16-21	151.6	135	same as above; with sandy silt portions and limestone fragments	
SS 46	13-8-7	150.1		no recovery; core catcher is good	
SS 47	2-8-23	148.1		SANDY SILT (ML); light yellowish green; hard; wet; low plasticity; sand fraction is very fine grained	
SS 48	6-23-46	146.6	140	SILTY SAND (SM), with limestone fragments; light yellowish green; very dense; wet; poorly graded; angular; some lower coarse sand	
SS 49	23-42-50/1in	145.5		ELASTIC SILT (MH), with very fine sand; light greenish brown with few small reddish oxidation zones; very hard; wet; low plasticity	
SS 50	9-28-37	143.6		SILTY SAND (SM); medium yellowish brown; very dense; wet; poorly graded; angular; very fine grained	
SS 51	11-25-46	142.1	145	same as above; very fine to fine grained	
SS 52	19-38-46	140.6		same as above; some portions are sandy silt; very fine grained	
SS 53	15-34-51	139.1		same as above	
SS 54	19-22-50	137.6	150	no recovery	
SS 55	21-25-37	136.1		same as above; some portions with clay; moist; subangular; fine to medium grained	
SS 56	17-22-33	134.6		no recovery - teeth broken off catcher	
SS 57	17-28-40	133.1		SILTY SAND (SM), with clay; medium grayish yellowish brown; very dense; moist; poorly graded;	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

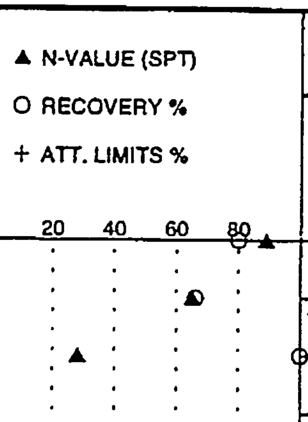
FINAL LOG

HOLE NO.
HTEF-B

B-16

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	5 OF 5	HTF



SAMP. TYPE AND NO.	SAMPLE	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 58	■	19-49-40			▨	subangular; very fine to medium grained	
			131.6		▨	CLAYEY SAND (SC); medium yellowish brown with light gray clay rip up clasts; very dense; moist; poorly graded; subangular; fine to medium grained	
SS 59	■	23-33-32			▨		Warley Hill
			130.1		▨	LEAN CLAY (CL), with fine sand; medium brown grading to greenish gray at 157.7 ft; very hard; moist; medium plasticity; sand is fine grained and decreases in percentage with depth; green clay at 157.7 ft	
SS 60	■	9-15-13			▨		
			128.6			FAT CLAY (CH), portions are sandy; very dark greenish gray; very stiff; moist; high plasticity; sand fraction is fine grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

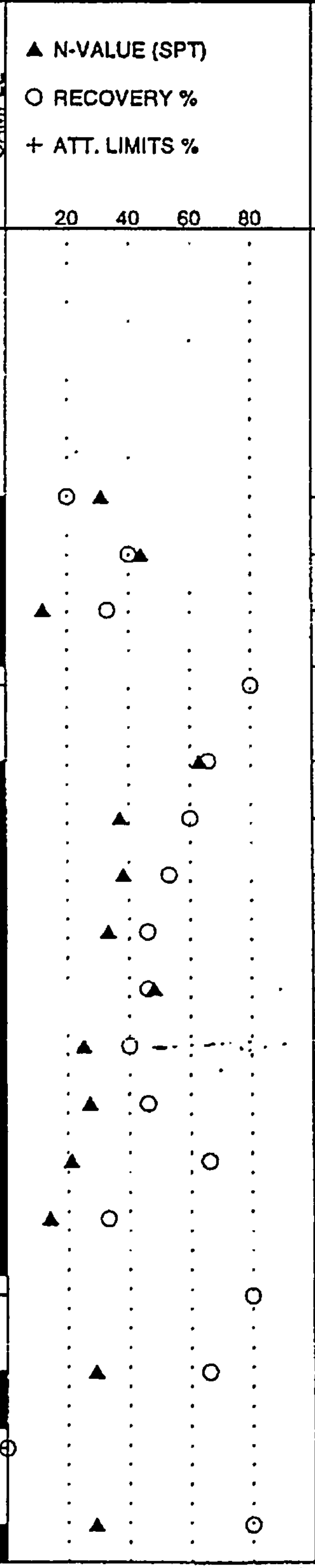
FINAL LOG

HOLE NO.
HTEF-B3

B-17

GEOTECHNICAL LOG

PROJECT TEF				JOB NO. HTEF	SHEET NO. 1 OF 5	HOLE NO. HTEF-B4	
SITE HTEF		COORDINATES N 73400 E 61541			ANGLE FROM HORIZONTAL 90		
BEGUN 1/21/98	COMPLETED 2/2/98	DRILLER Graves/B. Cunningham	DRILL MAKE AND MODEL Failing 1500	HOLE SIZE 3 7/8 in	SAMPLE HAMMER WEIGHT/FALL 140 lb/30 in	TOTAL DEPTH 157.8	
GROUND EL. 286.6	DEPTH/EL. GROUND WATER ▽ 39.1/247.5 ▼ /	LOGGED BY: N. Kidd/SAIC					



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
		286.6			
			5		
SS 1	6-7-24	278.1		CLAYEY SAND (SC); light red, yellow, and yellowish red; dense; dry; subangular; poorly graded; fine to medium grained	
SS 2	27-29-15	276.6	10	POORLY GRADED SAND WITH SILT (SP-SM); dark yellowish gray; dense; dry; subangular; poorly graded ; fine to medium grained	
SS 3	8-6-6	275.1		CLAYEY SAND (SC); medium brown; medium dense; damp; subangular; well graded; fine to medium grained with some coarse grains	
ST 1		272.6		LEAN CLAY (CL) trace sand; light yellowish brown, white, and yellow; dry; medium plasticity; sand is fine grained	
SS 4	29-25-38	271.1	15	POORLY GRADED SAND WITH CLAY (SP-SC); medium red; very dense; dry; subangular; poorly graded; fine to medium grained	Tobacco Road
SS 5	23-21-16	269.6		same as above; with some zones of clayey sand; dense; angular	
SS 6	15-19-19	268.1		CLAYEY SAND (SC) silty in places; medium red, yellow, and white; dense; damp; subangular; poorly graded; fine to medium grained	
SS 7	11-17-16	266.6	20	same as above; moist	
SS 8	16-24-24	265.1		same as above; damp; angular	
SS 9	16-11-14	263.6		POORLY GRADED SAND WITH CLAY (SP-SC) some zones of clayey sand; medium red, white, yellow, light purple, and light purplish gray; medium dense; dry; subangular; poorly graded; fine to medium grained	
SS 10	12-13-14	262.1		SANDY LEAN CLAY (CL) with clay zones; medium red, white, yellow, purple, and orange; very stiff; damp; medium plasticity	
SS 11	9-9-12	260.6	25	same as above; sand fraction is fine grained	
SS 12	5-6-8	259.1		same as above; stiff	
ST 2		256.6	30	CLAYEY SAND (SC); medium red; damp; subangular; poorly graded; fine to medium grained	
SS 13	10-11-18	255.1		SANDY LEAN CLAY (CL) with some clayey sand zones; medium red, purple, yellow, and white; very stiff; moist; medium plasticity; sand fraction is fine to medium grained	
ST 3		252.6		no recovery	
SS	12-15-14			CLAYEY SAND (SC) sand is silty in places;	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

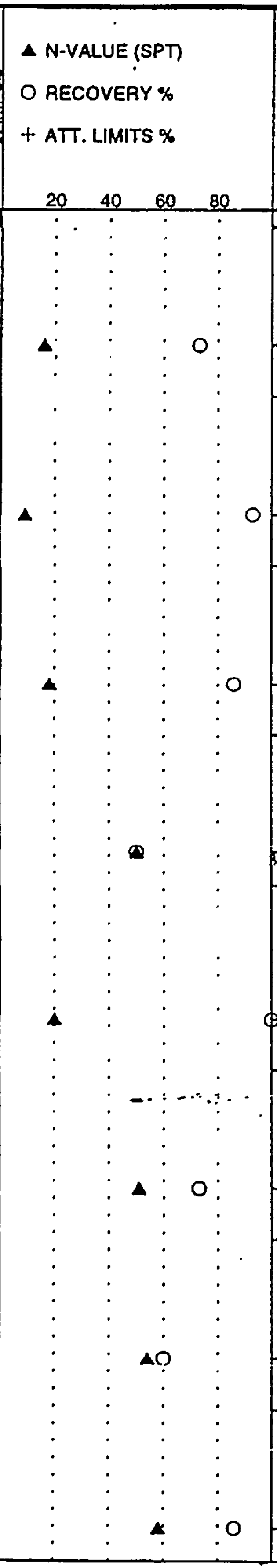
FINAL LOG

HOLE NO.
HTEF-B4

B-18

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 5	HTEF



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
14		251.1		medium red and yellowish brown with white streaks; medium dense; moist; subangular; poorly graded; sand fraction is fine to medium grained	
SS 15	9-8-8	246.1	40	SILTY SAND (SM) clayey sand in places; medium yellowish brown with red bands and white streaks; medium dense; moist; subangular; poorly graded; fine to medium grained with lower coarse in places	
SS 16	4-3-6	241.1	45	same as above; loose; wet	
SS 17	9-9-9	236.1	50	same as above; medium yellowish brown; medium dense	
SS 18	34-50/5.5in	231.6	55	POORLY GRADED SAND (SP) trace silt; medium yellowish brown; very dense; wet; subangular; poorly graded; fine to medium grained	Dry Branch
SS 19	3-5-15	226.1	60	CLAYEY SAND (SC) silty in places; medium reddish brown and brownish yellow with white streaks; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 20	13-25-26	221.1	65	POORLY GRADED SAND WITH SILT (SP-SM); light yellowish brown becoming medium reddish brown at bottom of interval; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 21	33-28-26	216.1	70	POORLY GRADED SAND (SP) trace silt; light brown, reddish in places; very dense; wet; subangular; poorly graded; fine to medium grained	
SS	23-27-31			same as above; with white streaks; fine to medium	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

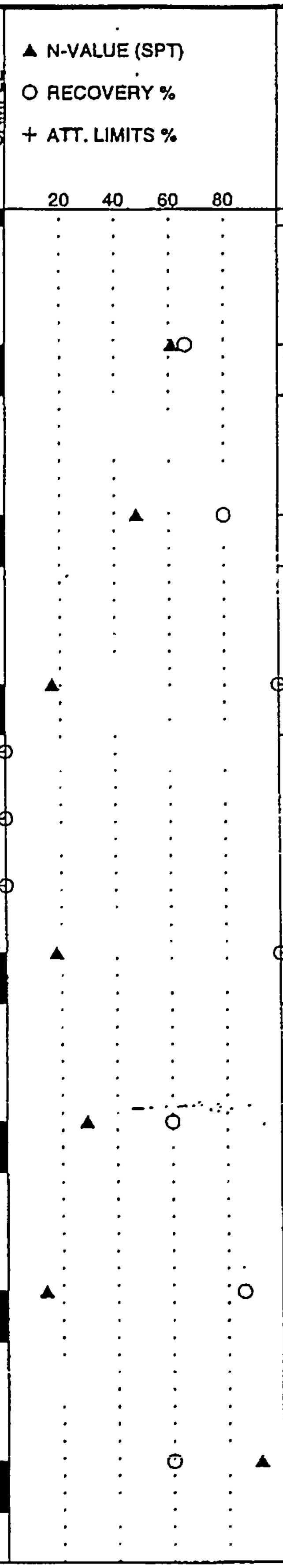
FINAL LOG

HOLE NO. HTEF-B4

B-19

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	3 OF 5	HTEF-B4



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
22		211.1		grained; black pellets (Mn?)	
SS 23	22-32-29	206.1	80	POORLY GRADED SAND WITH SILT (SP-SM) trace clay in places; light brown; very dense; wet; subangular; poorly graded; fine to medium grained; black pellets (Mn?)	
SS 24	18-26-22	201.1	85	same as above; dense	
SS 25	5-7-10	196.1	90	CLAYEY SAND (SC); very light brownish yellow with white streaks; medium dense; wet; subangular, poorly graded; fine to medium grained some lower coarse grained; black pellets (Mn?)	
ST 4		193.6		no recovery	Tan Clay Interval?
ST 5		191.6	95	no recovery	
ST 6		189.6		CLAYEY SAND (SC); medium brown; wet; subangular; poorly graded; no recovery in shelby tube. split spoon shows fine to medium grained sample with black pellets (Mn?)	
SS 26	4-8-10	188.1		same as above; becoming cleaner at the bottom of the interval; medium dense; medium grained	
			100		
SS 27	9-13-16	183.1		POORLY GRADED SAND (SP) trace silt some bands of silty sand; light brown; medium dense; wet; subangular; poorly graded; fine to medium grained; black pellets (Mn?)	
			105		
SS 28	6-6-8	178.1		POORLY GRADED SAND WITH SILT (SP-SM) trace clay; light brown; medium dense; wet; subangular; poorly graded; fine to medium grained	
			110		
SS 29	25-44-48	173.1		POORLY GRADED SAND (SP) trace silt; light brown; very dense; wet; subangular; poorly graded; fine to medium grained	Tinker?

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

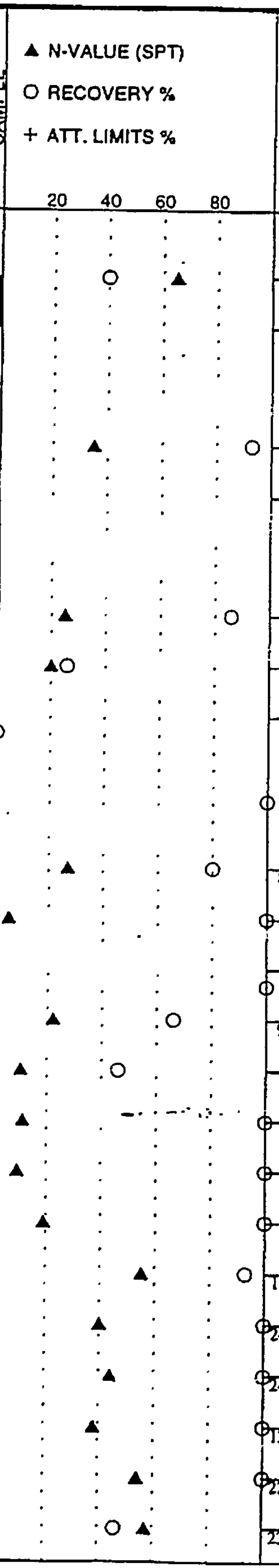
FINAL LOG

HOLE NO.
HTEF-B4

B-20

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	4 OF 5	HTF



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 30	14-31-34	168.1		same as above	
			120		
SS 31	19-19-16	163.1		same as above; with light brownish white clay wisps; dense; black streaks and pellets (Mn?); interval is more silty near the top	Santee
			125		
SS 32	5-9-16			SILTY SAND (SM); light brownish yellow with light brown zones; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 33	5-8-12	158.1		same as above; fine grained	
		156.6	130		
ST 7				same as above; with light brownish white clay wisps; light brownish yellow; wet; no recovery in shelby tube, split spoon lowered downhole to recover sample	
ST 8		154.1		same as above; light greenish yellow	
SS 34	8-13-14	152.1	135	POORLY GRADED SAND (SP) trace silt; light greenish yellow becoming light brownish yellow at the bottom of the interval; medium dense; wet; subangular; poorly graded; fine grained	
SS 35	1-2-3	150.6		CLAYEY SAND (SC) more like a silty sand in places; light greenish yellow with white streaks; loose; wet; subangular; poorly graded; fine grained	
		149.6			
ST 9				SILTY SAND (SM) slightly cemented; light yellow; moist; subangular; poorly graded; fine grained	
SS 36	9-10-12	147.6			
SS 37	6-4-6	146.1	140	CLAYEY SAND (SC) silty in places; medium reddish yellow with light brown mottles; medium dense; wet; subangular; poorly graded; fine grained; trace heavies	
SS 38	4-5-6	144.6		POORLY GRADED SAND WITH CLAY (SP-SC) silty in places; light reddish yellow with light greenish gray mottles; loose; wet; subangular; poorly graded; fine grained; trace heavies	
SS 39	2-3-6	143.1		CLAYEY SAND (SC) silty in places; medium reddish yellow; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 40	8-6-13	141.6	145	SILTY SAND (SM) with interbedded clayey sand; light greenish yellow with light yellowish red mottles; loose; wet; subangular; poorly graded; fine to medium grained	
SS 41	18-25-30	140.1		same as above; clayey in places; medium dense	
SS 42	24-21-19	138.6		same as above; very dense CLAYEY SAND (SC); medium yellowish brown with light green wisps of clay; dense; wet; subangular; poorly graded; fine to medium grained	
SS 43	24-24-20	137.1	150	SANDY LEAN CLAY (CL); medium reddish yellow with light greenish gray wisps of clayey sand; hard; wet; medium plasticity; sand fraction is fine to medium grained	Warley Hill
SS 44	12-16-22	135.6		LEAN CLAY WITH SAND (CL); interval is more sandy in the lowest 0.2-0.3 feet, becoming a sandy lean clay	
SS 45	22-22-32	134.1		SILT (ML) trace sand; dark yellowish red with medium greenish gray mottles; hard; moist; low plasticity; sand fraction is fine grained	
SS	23-34-23	132.6			

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

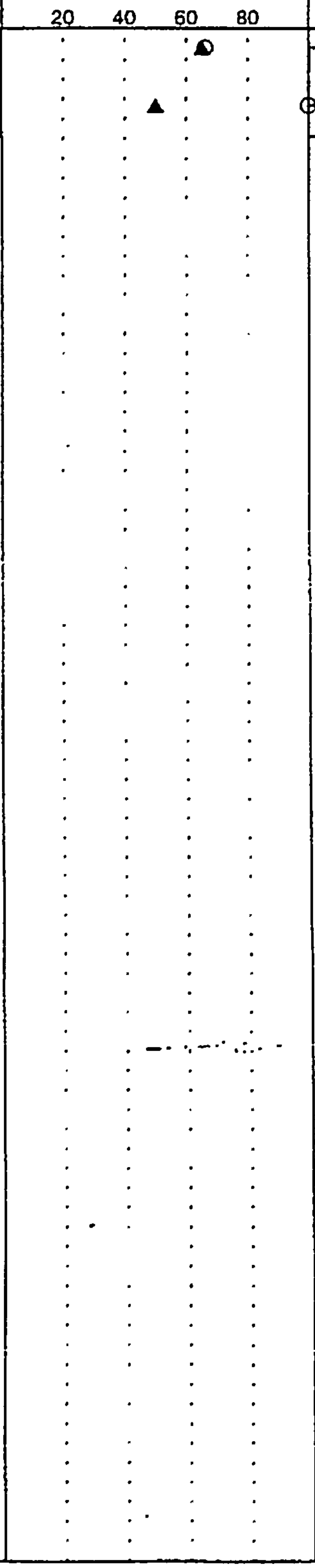
HOLE NO. **HTEF-B4**

B-21

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	5 OF 5	HTEF-B4

▲ N-VALUE (SPT)
○ RECOVERY %
+ ATT. LIMITS %



SAMP. TYPE AND NO.	SAMPLE	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
46	■		131.1		▨	LEAN CLAY WITH SAND (CL) containing interbedded silt in places; dark greenish brown with a band of medium yellowish red and a band of light gray; hard; moist; medium plasticity; light gray band and medium yellowish red band are similar to the previous few intervals; sand fraction is fine to medium grained	
SS 47	■	14-24-41	129.6		▨		
SS 48	■	15-50/3in	128.8		▨	FAT CLAY (CH) trace sand; very dark blackish green; very hard; wet; high plasticity; sand fraction is fine grained; trace lignite; 'green clay'	
						same as above; material in shoe is medium orange silty sand (top of congaree?)	

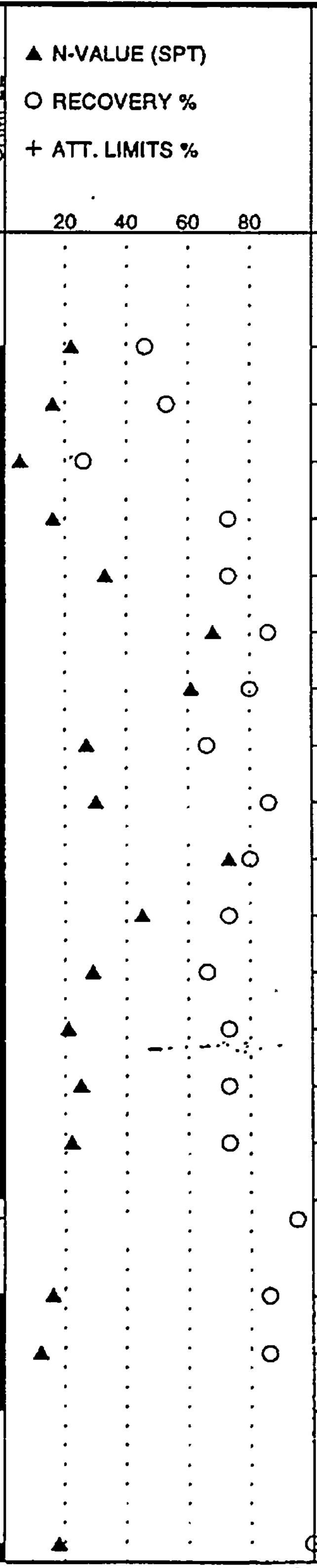
SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE	HOLE NO.
FINAL LOG	HTEF-B4

B-22

GEOTECHNICAL LOG

PROJECT TEF	JOB NO. HTEF	SHEET NO. 1 OF 5	HOLE NO. HTEF	
SITE HTEF	COORDINATES N 73467 E 61628	ANGLE FROM HORIZONTAL 90		
BEGUN 1/12/98	COMPLETED 1/28/98	DRILLER Graves/A. Jackson&E. Plush	DRILL MAKE AND MODEL Failing 1500	HOLE SIZE 3 7/8 in
SAMPLE HAMMER WEIGHT/FALL 140 lb/30 in	TOTAL DEPT 156.0	GROUND EL. 287.1	DEPTH/EL. GROUND WATER ▽ 39.7/247.4 1/28/98 ▼ /	LOGGED BY: R. Gelinas/SAIC



SAMP. TYPE AND NO.	BLOW COUNT
SS 1	6-12-10
SS 2	7-8-8
SS 3	3-3-2
SS 4	2-4-12
SS 5	7-14-19
SS 6	19-31-37
SS 7	12-19-42
SS 8	14-17-10
SS 9	4-7-23
SS 10	12-28-45
SS 11	16-21-24
SS 12	12-18-11
SS 13	8-10-11
SS 14	6-11-14
SS 15	11-12-10
ST 1	
SS 16	3-6-10
SS 17	4-4-8

ELEVATION IN FEET: 287.1, 282.6, 281.1, 279.6, 278.6, 278.1, 276.6, 275.1, 273.6, 272.1, 270.6, 269.1, 267.6, 266.1, 264.6, 263.1, 262.0, 261.6, 259.1, 257.6, 256.1

DEPTH IN FT: 5, 10, 15, 20, 25, 30

DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
CLAYEY SAND (SC) trace crushed stone and blue plastic (FILL); medium brownish red; medium dense; moist; subangular; poorly graded; fine to coarse grained	
same as above; likely FILL	
same as above; with chunks of gray clay (probable FILL); medium reddish brown and gray; loose	
same as above; medium dense	
SANDY LEAN CLAY (CL) with clayey sand interbeds; medium reddish brown; very stiff; moist; medium plasticity; sand is fine to medium grained	
LEAN CLAY WITH SAND (CL); red, brown, and light gray; hard; moist; medium plasticity; sand is fine grained	
same as above; very hard; damp	
same as above; some sandy silt interbeds; sand is very fine grained	
CLAYEY SAND (SC) with light gray coarser zones and few light yellowish gray lean clay interbeds; medium brownish red; medium dense; moist; angular; poorly graded; sand is fine to medium grained	Tobacco Road
SILT (ML) trace fine sand; medium yellowish gray and red; very stiff; damp; low plasticity	
CLAYEY SAND (SC) with lean clay interbeds; medium brownish red with yellowish brown clay layers; very dense; moist; subangular; poorly graded; fine to medium grained	
SILTY SAND (SM) with some clayey sand zones and a 2 in yellowish gray coarse sandy lean clay layer at 18.2 feet; medium brownish red; dense; moist; subangular; poorly graded; sand is fine to lower coarse grained	
CLAYEY SAND (SC) with a 2 inch yellowish gray gravelly lean clay layer at 20.5 feet; medium brownish red; medium dense; wet; angular; poorly graded; medium to lower coarse grained	
SILTY SAND (SM) with clayey sand interbeds; light brownish red, red and light gray; medium dense; moist; subangular; poorly graded; fine to medium grained	
CLAYEY SAND (SC); medium brownish gray with some yellowish brown zones; medium dense; damp; subangular; poorly graded; fine to medium grained	
POORLY GRADED SAND WITH SILT (SP-SM); medium reddish brown; medium dense; wet; subangular; poorly graded; fine to medium grained	
SILT WITH SAND (ML); light gray; very stiff; damp; low plasticity; sand is very fine grained	
ELASTIC SILT WITH SAND (MH); medium brownish red, light gray, and white; damp; medium plasticity; sand is fine to medium grained	
same as above; very stiff; trace fine sand	
LEAN CLAY WITH SAND (CL); medium yellowish brown, red, and white; stiff; damp; medium plasticity; sand is fine to medium grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE
FINAL LOG

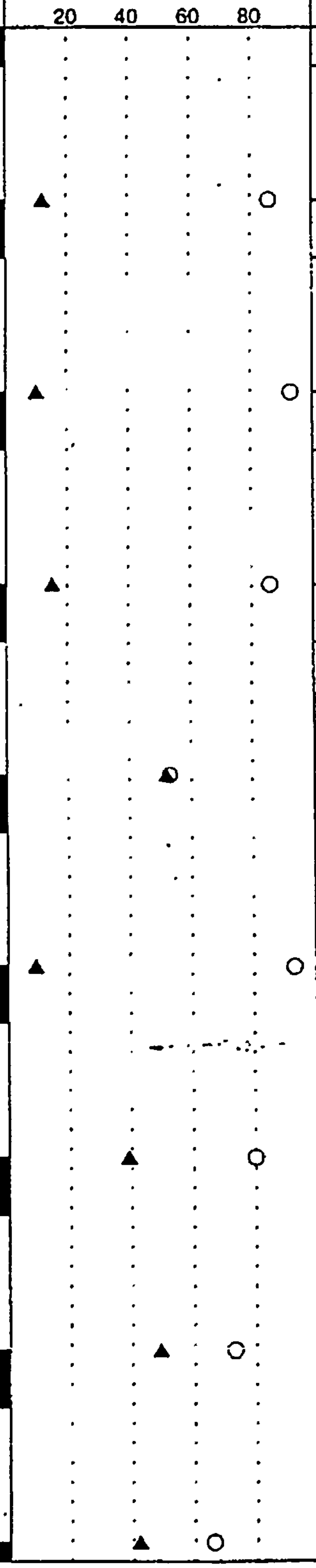
HOLE NO.
HTEF-B5

B-23

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 5	HTEF-B

▲ N-VALUE (SPT)
○ RECOVERY %
+ ATT. LIMITS %



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 18	6-7-11	251.1		CLAYEY SAND (SC); medium brown and white; medium dense; moist; subangular; poorly graded; fine to medium grained	
SS 19	3-5-7	246.1	40	same as above; angular	
SS 20	3-3-7	241.1	45	same as above; medium yellowish brown, reddish brown, and red; loose; subangular	
SS 21	4-7-8	236.1	50	same as above; medium dense	
SS 22	13-24-28	231.1	55	SILTY SAND (SM); medium brownish yellow; very dense; wet; subangular; poorly graded; fine to medium grained	Dry Branch
SS 23	2-1-8	226.1	60	CLAYEY SAND (SC); medium reddish brown; loose; wet; subangular; poorly graded; fine to medium grained	
SS 24	4-15-24	221.1	65	SILTY SAND (SM); medium brown and medium reddish brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 25	14-24-25	216.1	70	POORLY GRADED SAND WITH SILT (SP-SM); medium brown; dense; wet; subangular; poorly graded; fine to medium grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

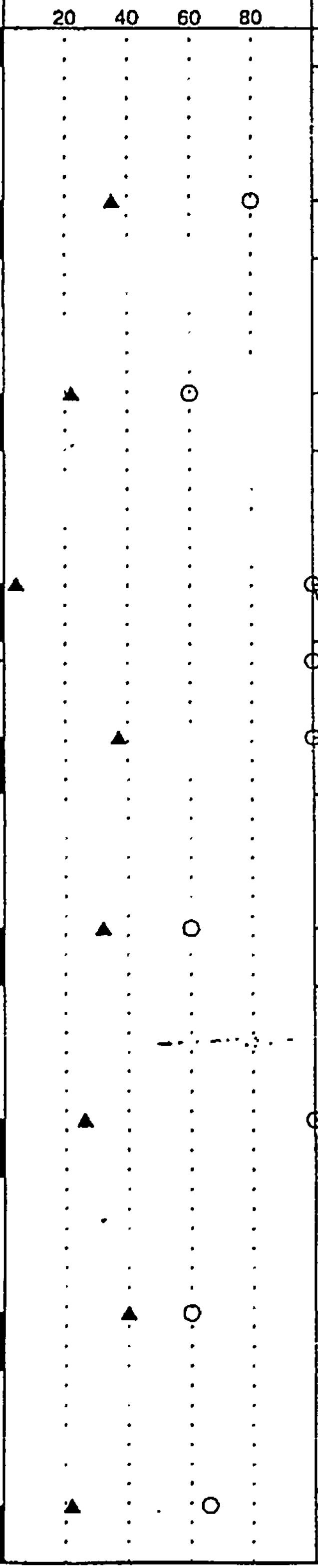
HOLE NO.
HTEF-B5

B-24

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	3 OF 5	HTEF

▲ N-VALUE (SPT)
○ RECOVERY %
+ ATT. LIMITS %



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 26	11-20-22	211.1		same as above; some silty sand interbeds	
SS 27	9-15-20	206.1	80	POORLY GRADED SAND (SP) trace silt; light brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 28	5-9-13	201.1	85	same as above; medium dense; angular; medium to lower coarse grained; trace charcoal? fragments	
SS 29	WH/12in-4	196.1	90	SANDY LEAN CLAY (CL) with some clayey sand layers; medium brown; soft; moist; medium plasticity; sand fraction is fine grained	Top Tan Clay
ST 2		194.6		CLAYEY SAND (SC); medium brown; wet; subangular; poorly graded; sand is fine to medium grained	
		193.6		SANDY LEAN CLAY (CL); medium brown; wet; medium plasticity; sand fraction is fine to medium grained	Bottom Tan Clay
SS 30	6-11-26	193.1		same as above	
		192.1	95	CLAYEY SAND (SC) with silty sand interbeds; medium brown; dense; wet; subangular; poorly graded; fine to coarse grained	
SS 31	8-12-20	187.1	100	POORLY GRADED SAND (SP) trace silt; light brown; dense; wet; subangular; poorly graded; fine to medium grained	
SS 32	4-9-17	182.1	105	POORLY GRADED SAND WITH CLAY (SP-SC) and sand with silt interbeds; medium brown; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 33	23-24-16	177.1	110	POORLY GRADED SAND (SP) trace silt; light brown; dense; wet; subangular; poorly graded; fine to medium grained	Tinker?
SS 34	4-8-14	172.1		POORLY GRADED SAND WITH SILT (SP-SM): medium brown; medium dense; wet; angular;	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

HOLE NO.
HTEF-B5

B-25

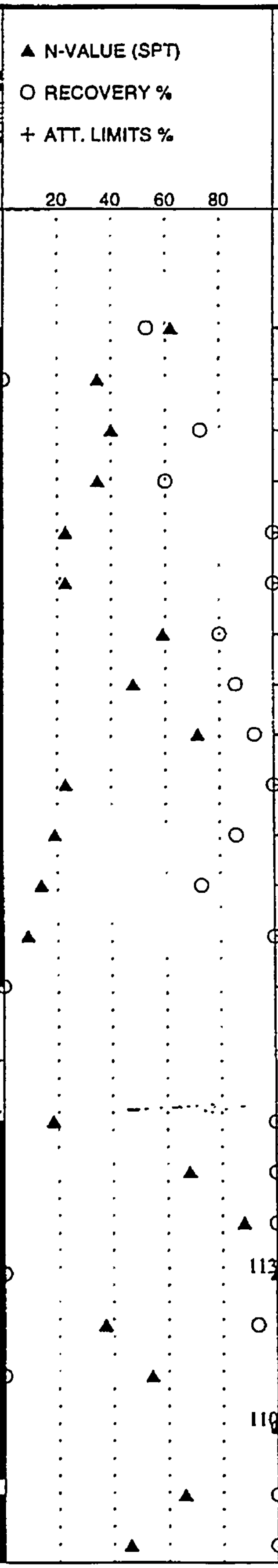
GEOTECHNICAL LOG

PROJECT: TEF

JOB NO.: HTEF

SHEET NO.: 4 OF 5

HOLE NO.: HTEF-B



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
				poorly graded; fine to lower coarse grained	
SS 35	5-28-34	167.1	120	POORLY GRADED SAND (SP) trace silt with some poorly graded sand trace clay interbeds; medium brown; very dense; wet; subangular; poorly graded; fine to medium grained	
SS 36	12-16-19	165.6		no recovery; catcher teeth mostly broken	
SS 37	12-21-19	164.1		CLAYEY SAND (SC) with interbeds of poorly graded sand and silty sand; medium brown and light brown; dense; wet; subangular; poorly graded; fine to medium grained; highly variable lithology	Santee
SS 38	11-18-17	162.6		same as above; moist; few black charcoal fragments	
SS 39	4-8-15	161.1	125	CLAYEY SAND (SC): light gray and brownish gray; medium dense; moist; angular; poorly graded; fine to upper medium grained	
SS 40	10-8-15	159.6		same as above; light greenish gray; wet; subangular	
SS 41	20-24-35	158.1		same as above; with 0.5 in limestone layers; light green; very dense; moist; very fine to fine grained	
SS 42	24-23-25	156.6	130	same as above; with highly weathered limestone fragments and some sandy lean clay layers; dense; wet; fine to medium grained	
SS 43	23-31-41	155.1		same as above; with limestone fragments and some silty sand interbeds; very dense; angular; fine to lower coarse grained	
SS 44	7-8-15	153.6		SILTY SAND (SM) trace clay and highly weathered limestone fragments; light green and grayish green; medium dense; wet; angular; poorly graded; very fine to fine grained	
SS 45	9-11-8	152.1	135	same as above; trace fine shell fragments; subangular; very fine grained	
SS 46	4-5-9	150.6		same as above; angular	
SS 47	7-5-4	149.1		CLAYEY SAND (SC) with some silty sand trace clay layers; light green and brownish green; loose; wet; subangular; poorly graded; very fine to fine grained	
ST 3		146.9	140	shelby tube lost down hole; overshoot with fishing tool by 1 ft to extract tube; no recovery and tube damaged/discarded	
SS 48	6-6-12	143.6		CLAYEY SAND (SC) with some silty sand interbeds; light brown with light gray zones; medium dense; moist; subangular; poorly graded; very fine to fine grained	
SS 49	11-22-46	142.1	145	same as above; with 0.5-1.5 inch dia white silica nodules; very dense; wet	
SS 50	37-43-45	140.6		SILTY SAND (SM); light greenish brown; very dense; moist; subangular; poorly graded; very fine to fine grained	
SS 51	33-58-55	139.1		no recovery; catcher is good	
SS 52	21-18-19	137.6		same as above; dense; wet; fine to medium grained	
SS 53	16-25-29	136.1	150	no recovery; catcher is good	
SS 54	26-38-72	134.6		SILTY SAND (SM) with light gray lean clay ripup clasts; medium yellowish brown with light gray blebs; very dense; damp; subangular; poorly graded; clay content increases with depth	
SS 55	14-29-37	133.0		CLAYEY SAND (SC): medium yellowish brown; very dense; damp; subangular; poorly graded; fine grained	
		132.6			Warley Hill

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

HOLE NO. HTEF-B5

B-26

GEOTECHNICAL LOG	PROJECT	JOB NO.	SHEET NO.	HOLE NO.
	TEF	HTEF	5 OF 5	HTEF

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
SS 56	■		17-20-26			▨	SANDY LEAN CLAY (CL); dark grayish green; very hard; damp; medium plasticity; green clay	
				131.1			same as above; hard; moist; sand is very fine to fine grained	

SS = SPLIT SPOON; ST = SHELBY TUBE; PS = STATIONARY PISTON; PB = PITCHER	SITE FINAL LOG	HOLE NO. HTEF-B5

B-27

GEOTECHNICAL LOG

PROJECT TEF	JOB NO. HTEF	SHEET NO. 1 OF 2	HOLE NO. HTEF-B	
SITE HTEF	COORDINATES N 73305 E 61640	ANGLE FROM HORIZONTAL 90		
BEGUN 1/28/98	COMPLETED 1/29/98	DRILLER Graves/E. Plush	DRILL MAKE AND MODEL Failing 1500	HOLE SIZE 3 7/8 in
SAMPLE HAMMER WEIGHT/FALL 140 lb/30 in	TOTAL DEPT 36.0	GROUND EL. 291.6	DEPTH/EL. GROUND WATER / /	LOGGED BY: R. Gelinas/SAIC

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
				291.6				
					5			
					10			
					15			
					20			
					25			
					30			
ST		114○				▨	CLAYEY SAND (SC); medium brown. yellowish	

SS = SPLIT SPOON; ST = SHELBY TUBE; PS = STATIONARY PISTON; PB = PITCHER	SITE FINAL LOG	HOLE NO. HTEF-B6

B-28

GEOTECHNICAL LOG	PROJECT TEF	JOB NO. HTEF	SHEET NO. 2 OF 2	HOLE NO. HTEF

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW/ COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
1				255.6		▨	brown, light gray, and purple; damp; angular; poorly graded; fine to medium grained grading to fine to lower coarse grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE
FINAL LOG

HOLE NO.
HTEF-B6

B-29

GEOTECHNICAL LOG

PROJECT TEF	JOB NO. HTEF	SHEET NO. 1 OF 3	HOLE NO. HTEF-B7	
SITE HTEF	COORDINATES N 73400 E 61535	ANGLE FROM HORIZONTAL 90		
BEGUN 2/2/98	COMPLETED 2/6/98	DRILLER Graves/B. Cunningham	DRILL MAKE AND MODEL Failing 1500	HOLE SIZE 3 7/8 in
SAMPLE HAMMER WEIGHT/FALL 140 lb/30 in	TOTAL DEPTH 100.0	GROUND EL. 286.6	DEPTH/EL. GROUND WATER ▽ / ▼ /	LOGGED BY: R. Gelinas/SAIC

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
				286.6				
					5			
					10			
					15			
					20			
					25			
					30			

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

HOLE NO.
HTEF-B7

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	2 OF 3	HTEF

SAMP. TYPE AND NO.	SAMPLE	▲ N-VALUE (SPT) ○ RECOVERY % + ATT. LIMITS % 20 40 60 80	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
					40			
					45			
					50			
					55			
					60			
					65			
					70			

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

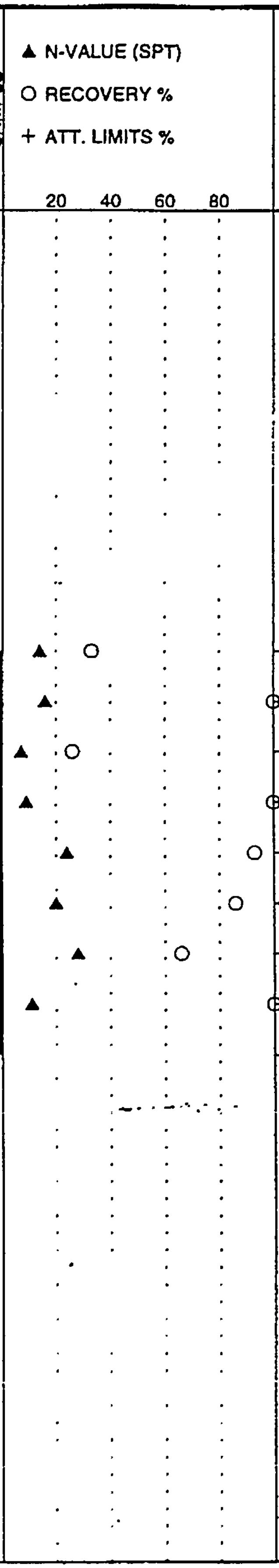
FINAL LOG

HOLE NO.
HTEF-B7

B-31

GEOTECHNICAL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
TEF	HTEF	3 OF 3	HTEF-I



SAMP. TYPE AND NO.	BLOW COUNT	ELEVATION IN FEET	DEPTH IN FT	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, CHARACTER OF DRILLING AND LABORATORY TESTING
			80		
			85		
SS 1	12-8-6	197.1		CLAYEY SAND (SC); medium brown with some black spots; medium dense; wet; angular; fine to lower coarse grained	
SS 2	6-7-9	195.6	90	same as above; subangular; poorly graded; fine to medium grained	
SS 3	4-3-4	194.1		same as above; with crushed stone fragments (cave material); loose	
SS 4	4-5-4	192.6		SILTY SAND (SM) with clayey sand interbeds; medium brown; loose; wet; subangular; poorly graded; fine to medium grained	
SS 5	4-9-15	191.1		same as above; trace clay; medium dense; fine to upper medium grained	
SS 6	15-4-16	189.6	95	CLAYEY SAND (SC) with silty sand interbeds; medium brown with black Mn zones; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 7	13-12-16	188.1		POORLY GRADED SAND WITH SILT (SP-SM); light brown with black Mn zones; medium dense; wet; subangular; poorly graded; fine to medium grained	
SS 8	6-4-7	186.6	100	CLAYEY SAND (SC); medium brown, light brown and light gray; medium dense; wet; subangular; poorly graded; fine to lower medium grained	

SS = SPLIT SPOON; ST = SHELBY TUBE;
PS = STATIONARY PISTON; PB = PITCHER

SITE

FINAL LOG

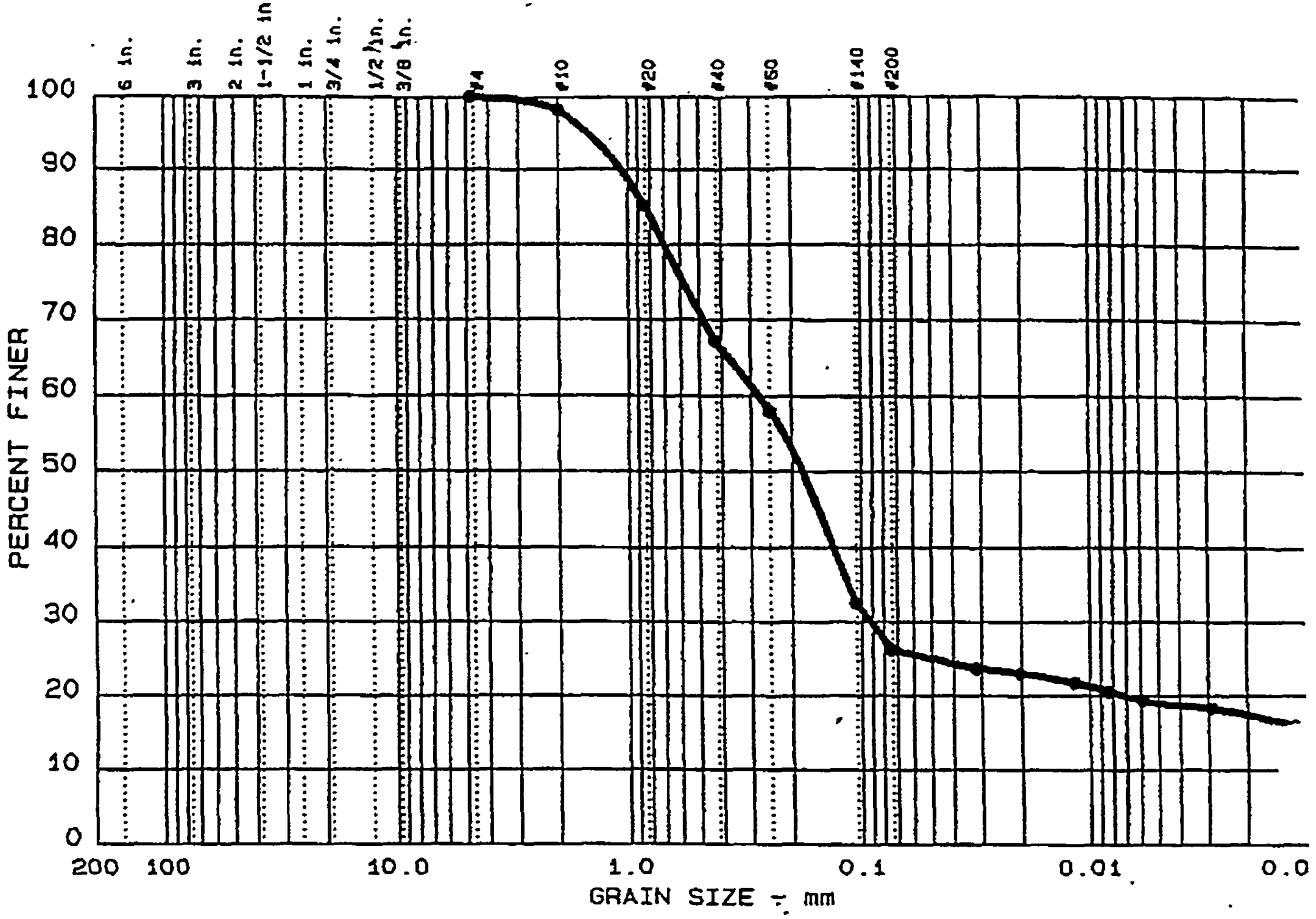
HOLE NO. HTEF-B7

Appendix C

Laboratory Test Results

C-2

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	0.0	73.9	7.1	19.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	50	27	0.83	0.28	0.18	0.091				

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown-Tan & White Clayey Sand	SC	A-2-7(1.9)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-9 @ 17-18.5 Ft.

Date: Jan.15, 1998

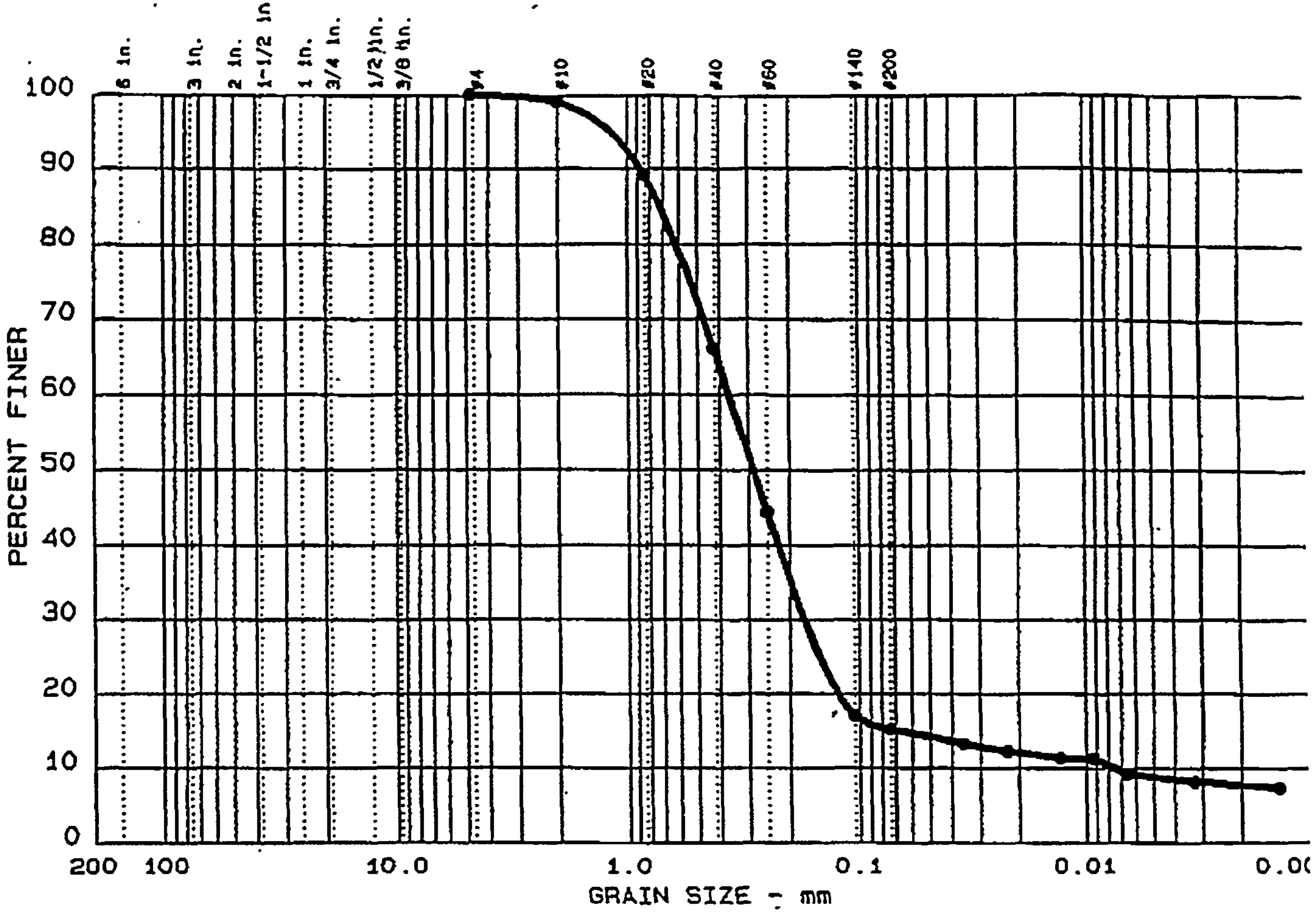
Remarks:
Tested by: Scd.JTm
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-3

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL.	% SAND	% SILT	% CLAY
●	1	0.0	0.0	84.8	6.4	8.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	37	12	0.72	0.36	0.28	0.174	0.0652	0.0073	11.35	49.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown & Tan Silty Sand	SM	A-2-6(0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-1 ST-2 @ 42-44 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

Reviewed by: Hb

Consolidation Sample

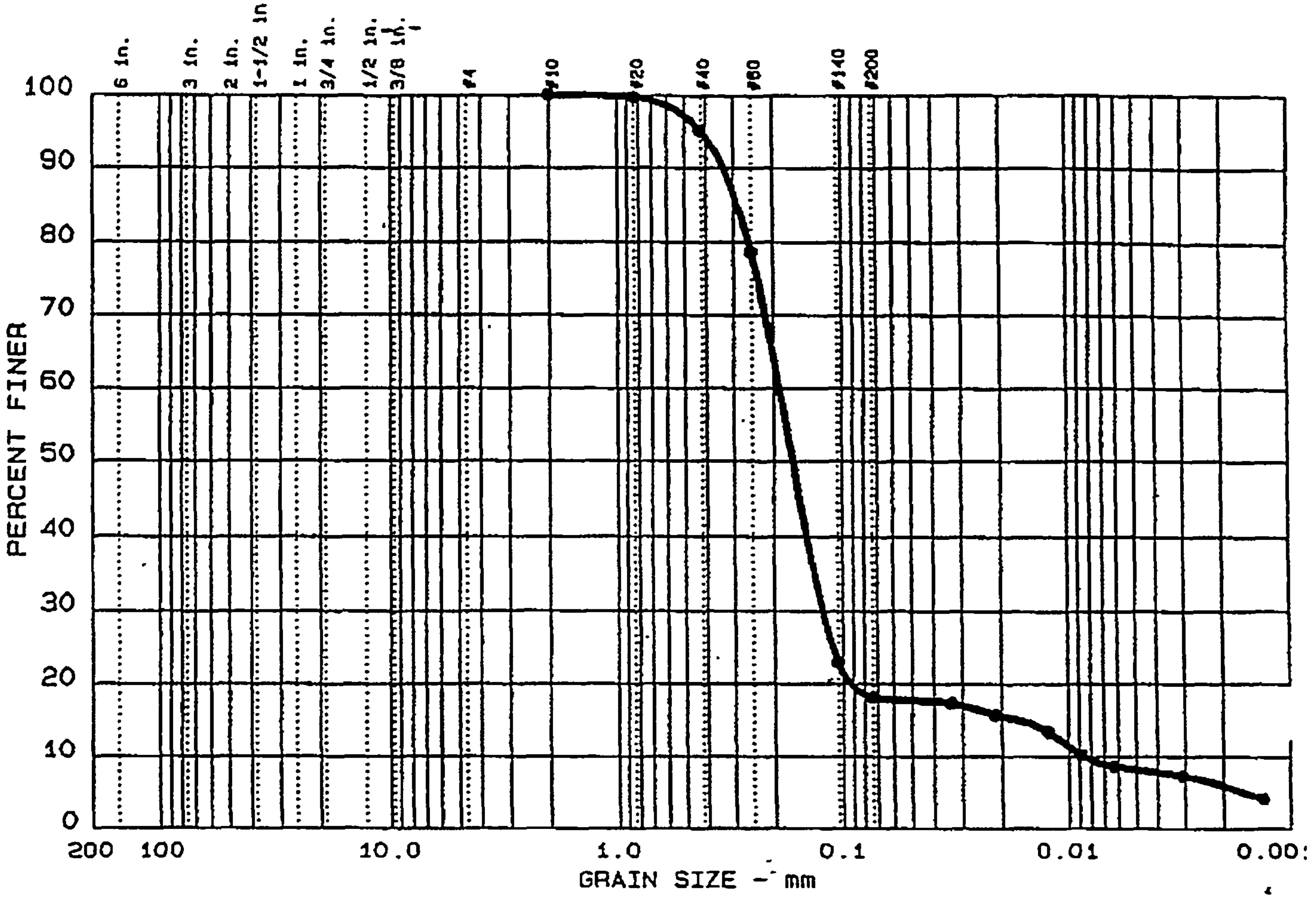
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No

C-4

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	9	0.0	0.0	81.9	10.0	8.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	38	11	0.29	0.19	0.17	0.122	0.0163	0.0085	9.40	22.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-6 (0.0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
◆ Location: HTEF B-1 Jar SS-26 @ 47-48.5 Ft.

Date: Jan. 15, 1998

Remarks:

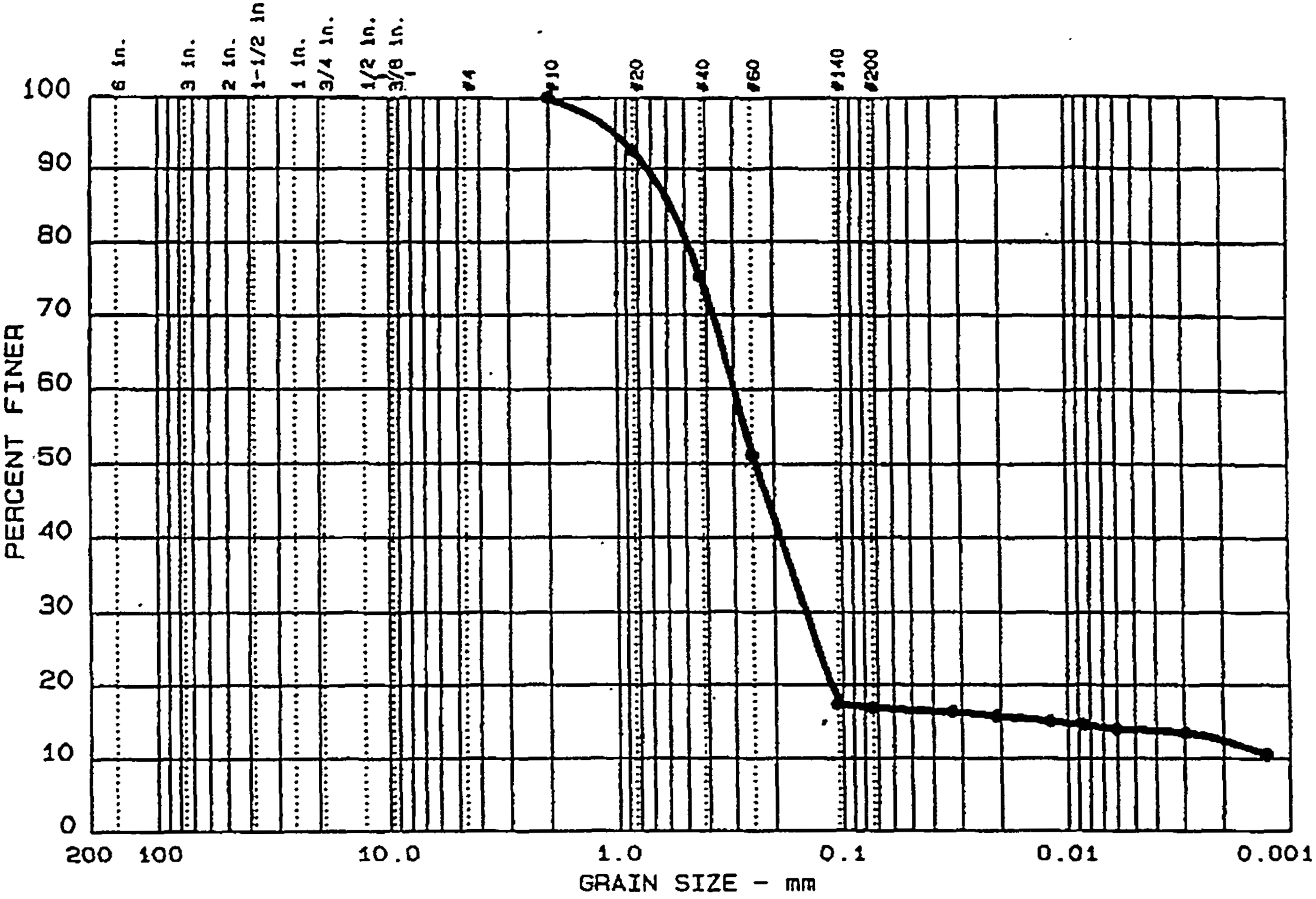
Tested by: SC+JTm

Reviewed by: Ho

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

C-5

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	0.0	83.2	3.1	13.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	40	13	0.57	0.30	0.24	0.145	0.0106			

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-6(0.1)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-34 @ 59-60.5 Ft.

Date: Jan.15, 1998

Remarks:

Tested by:

Reviewed by:

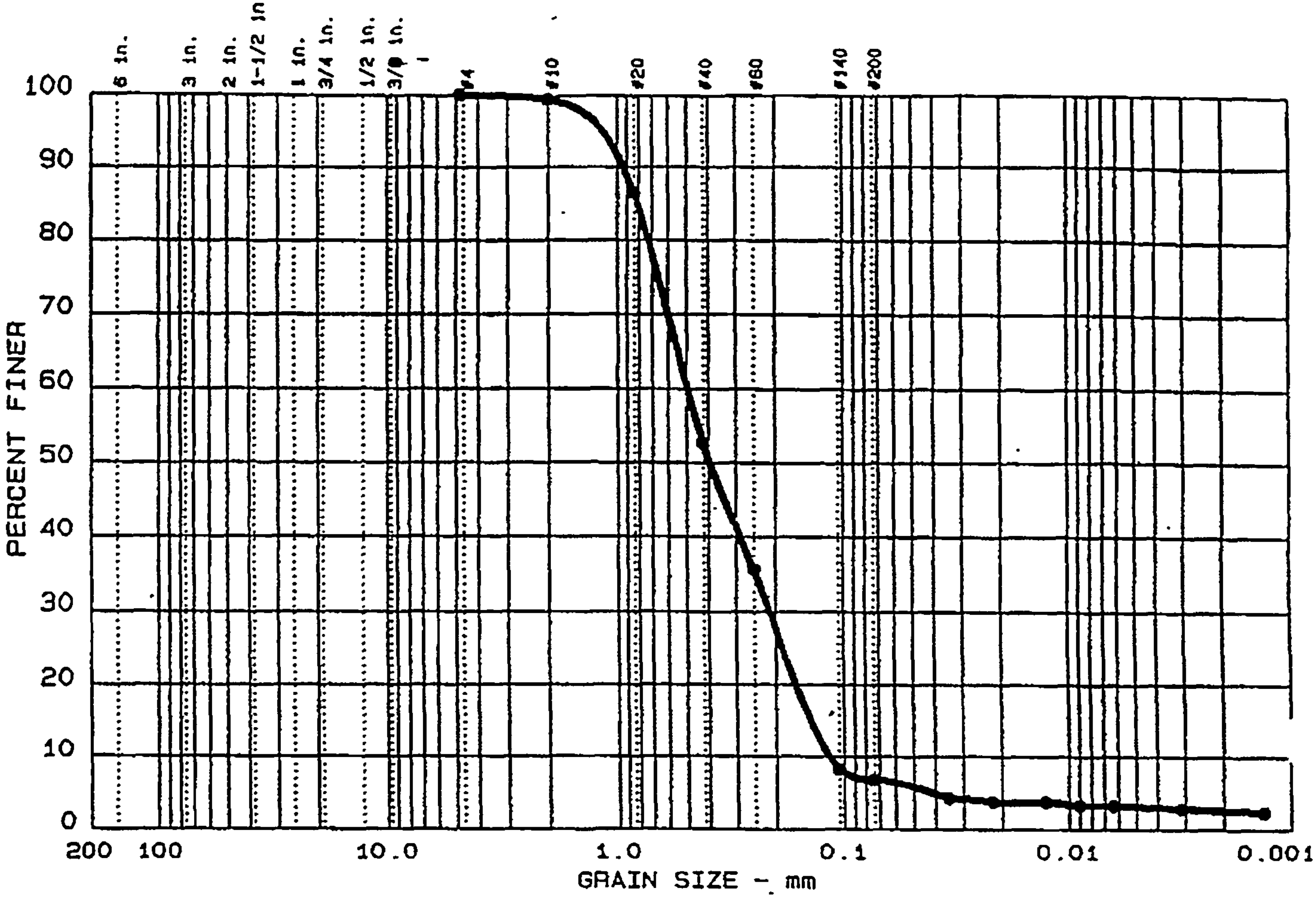
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

C-6

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	14	0.0	0.0	93.2	3.7	3.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL.	NP --	0.81	0.49	0.39	0.213	0.1406	0.1156	0.80	4.3

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-3

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-47 @ 78.5-80.0 Ft.

Date: Jan.15, 1998

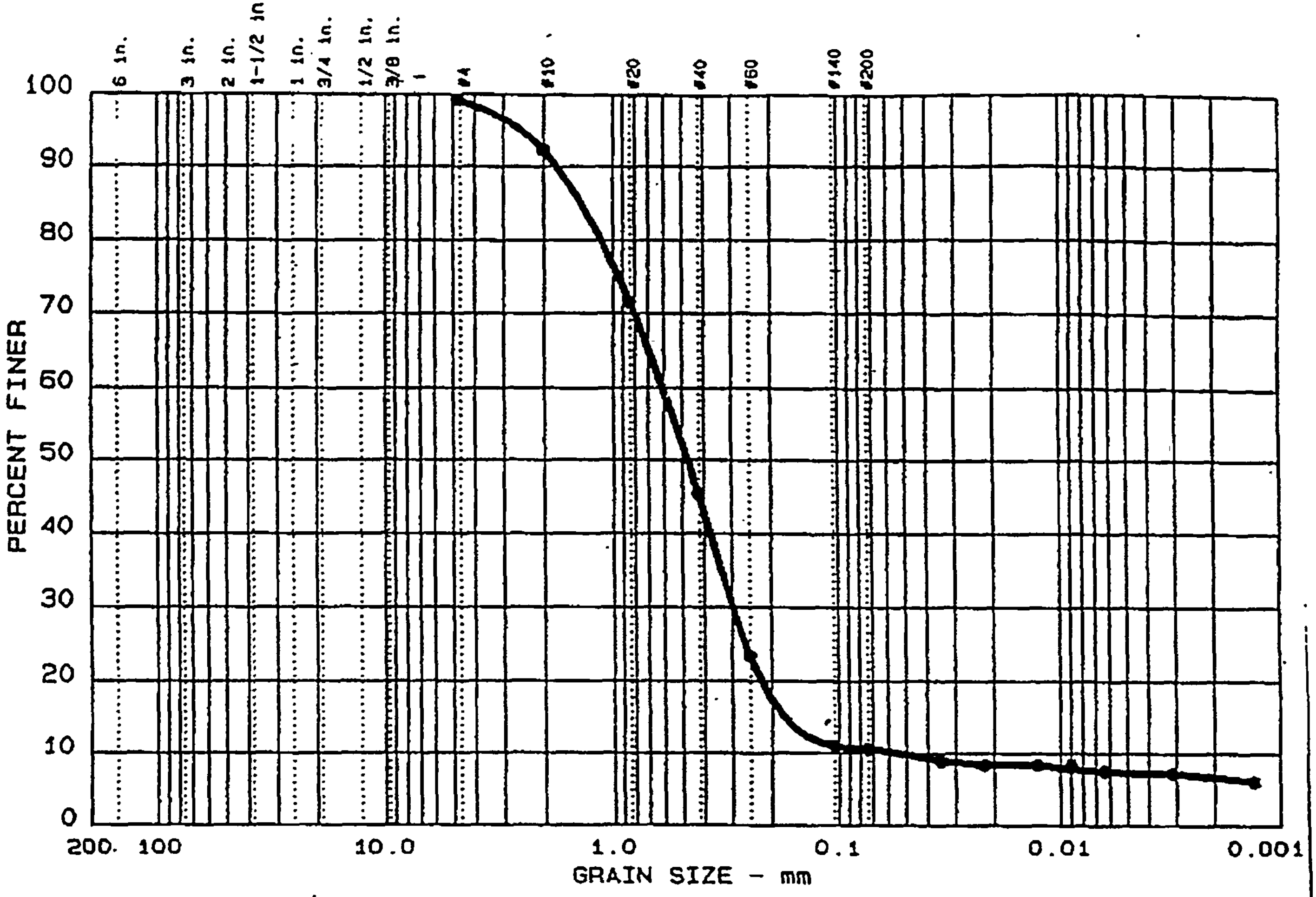
Remarks:
Tested by: SC & JTM
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-7

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.9	88.6	3.2	7.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	1.36	0.60	0.47	0.297	0.1750	0.0522	2.81	11.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Well Graded Sand with Silt	SW-SM	A-1-b

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 St-4 @ 96-98 Ft.

Date: Feb. 18, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

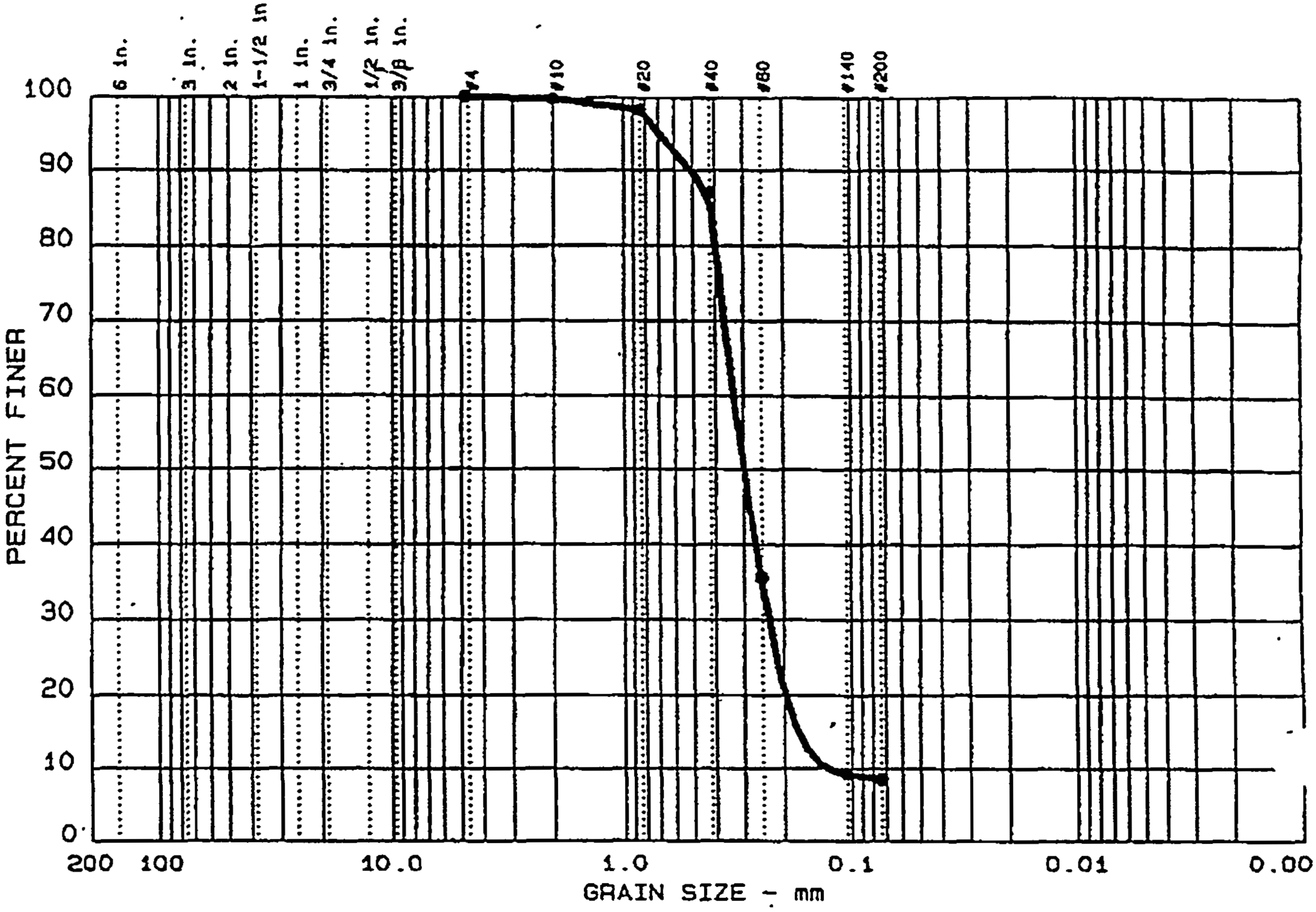
Remarks:
Tested by: SC
Reviewed by: Hs

Consolidation Sample

Figure No.

C-8

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	17	0.0	0.0	91.5	8.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.41	0.33	0.30	0.233	0.1730	0.1282	1.29	2.6

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-3

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-59 @ 101-102.5 Ft.

Date: Jan.15, 1998

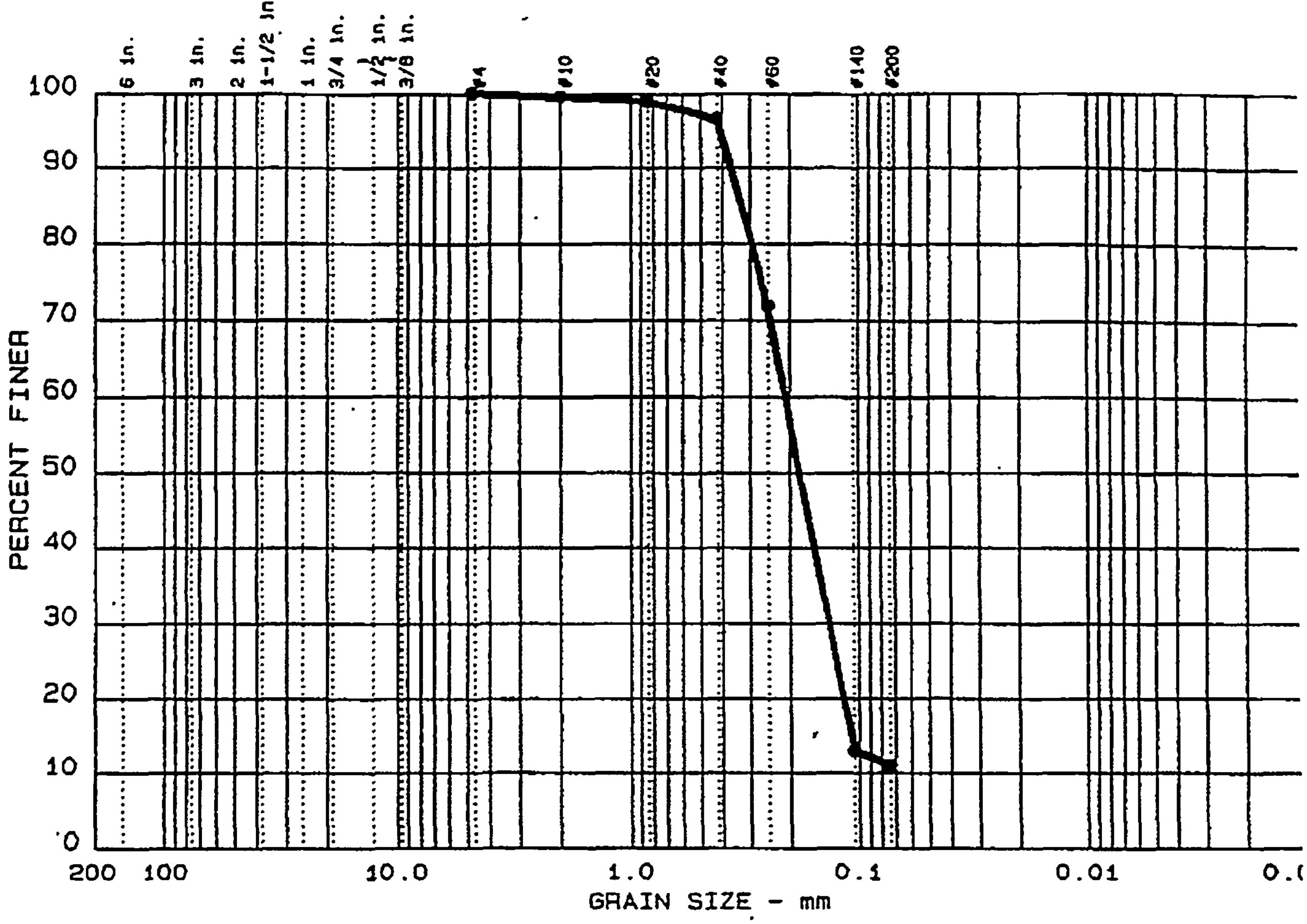
Remarks:
Tested by: SC+JTm
Reviewed by: Hs

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-9

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	16	0.0	0.0	89.0	11.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.33	0.21	0.16	0.135	0.1081			

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-2-4 (0.4)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-73 @ 122-123.5 Ft.

Date: Jan. 15, 1998

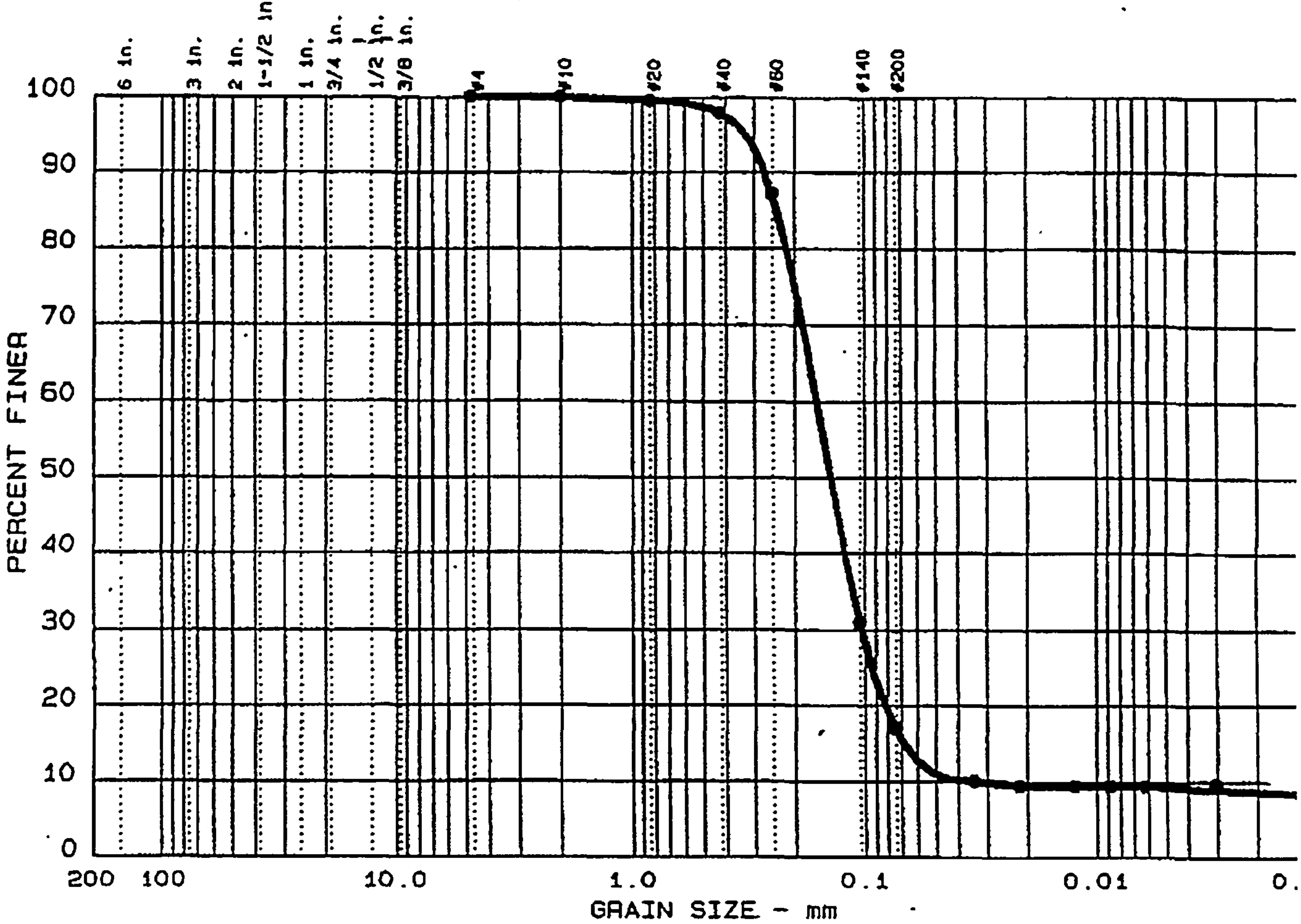
Remarks:
Tested by:
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-10

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLA
●	12	0.0	0.0	83.0	7.7	9.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●	NL	NP	0.24	0.16	0.14	0.103	0.0682	0.0301	2.20	5.

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-4 (0_0

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-82 @ 135.5-137 Ft.

Date: Jan. 15, 1998

Remarks:

Tested by:

Reviewed by:

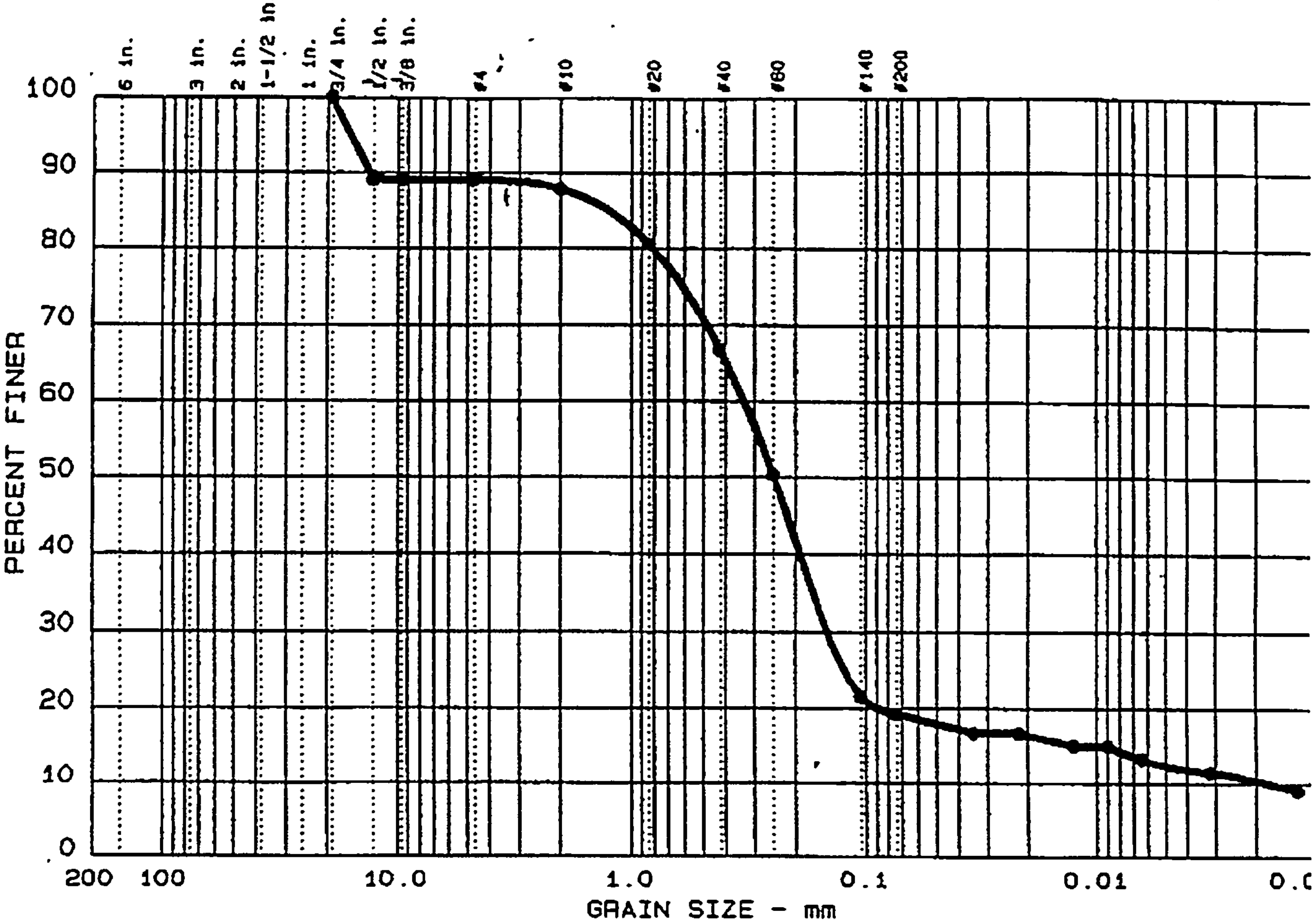
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

C-11

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	10.9	69.8	7.0	12.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	42	18	1.23	0.33	0.25	0.146	0.0090	0.0018	36.69	188.

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown & Purple Clayey Sand	SC	A-2-7 (0.3)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-1 ST-5 @ 143.5-145.0 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

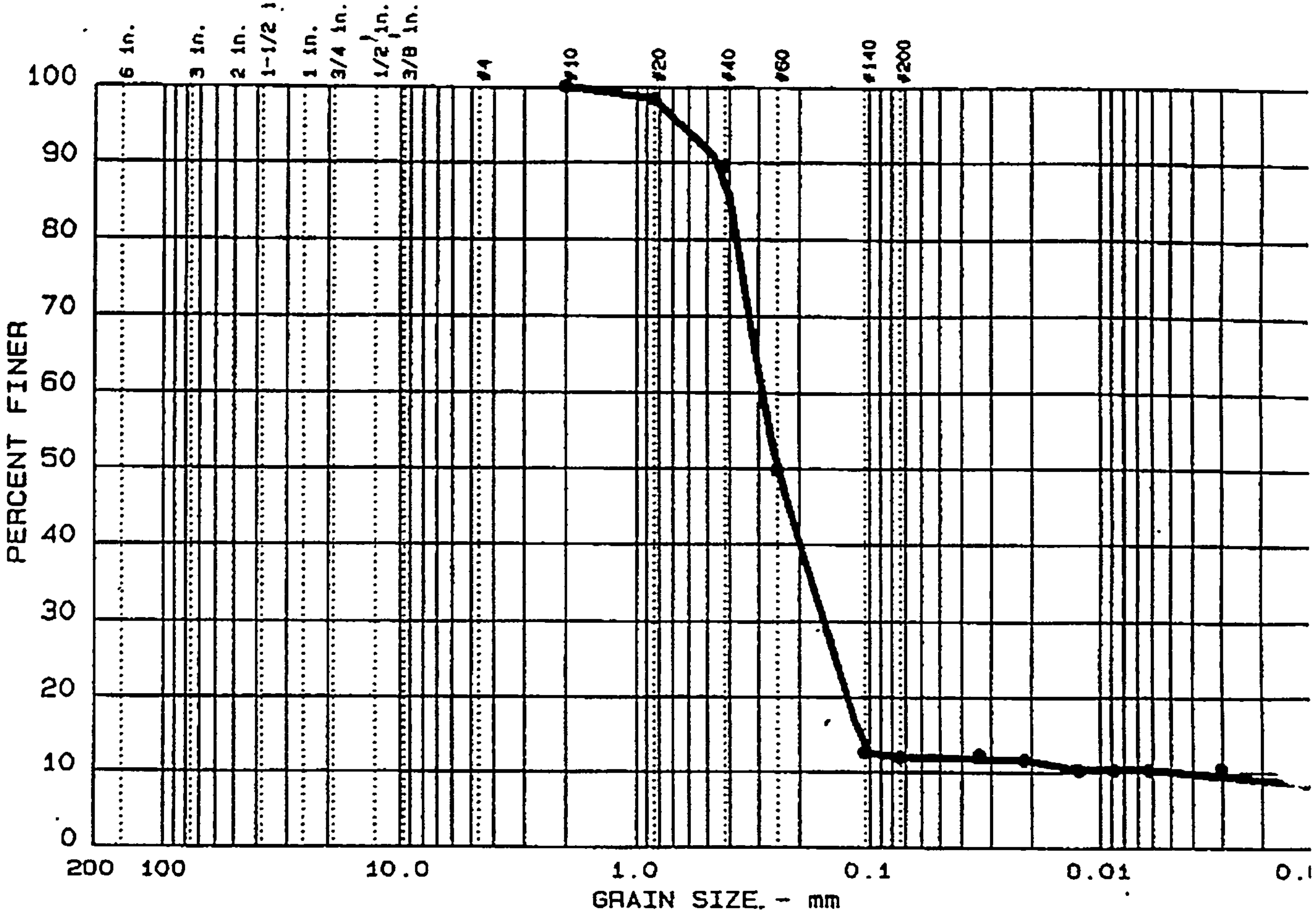
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-12

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	0.0	88.1	1.8	10.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●	32	5	0.40	0.29	0.25	0.157	0.1109	0.0044	19.75	65.

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-2-4 (0_0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-1 Jar SS-89 @ 148-149.5 Ft.

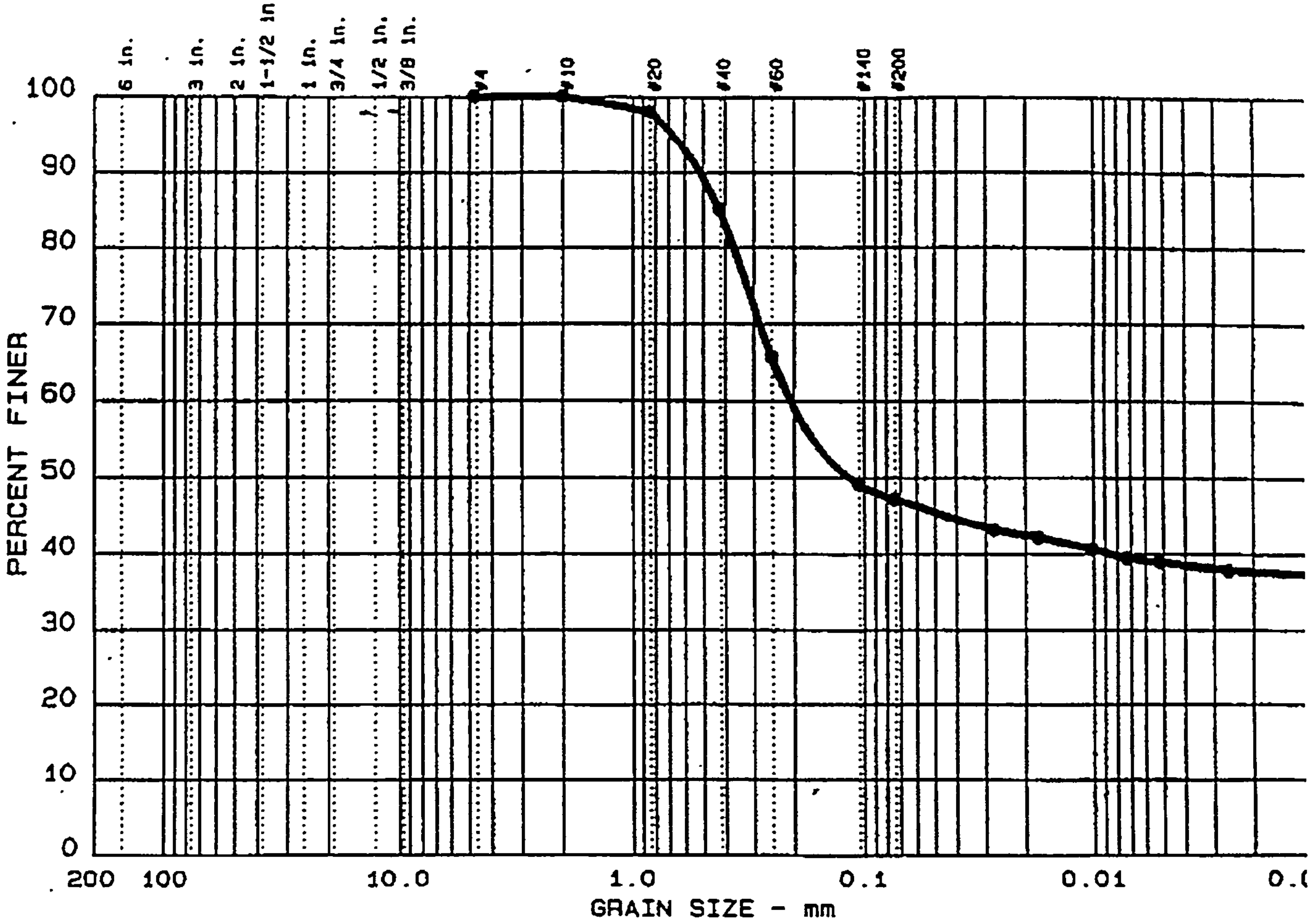
Date: Jan. 15, 1998

Remarks:
Tested by:
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	0.0	52.9	8.3	38.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●	51	20	0.42	0.21	0.12					

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-7-5(6.3)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-9 @ 12-13.5 Ft.

Date: Jan.27, 1998

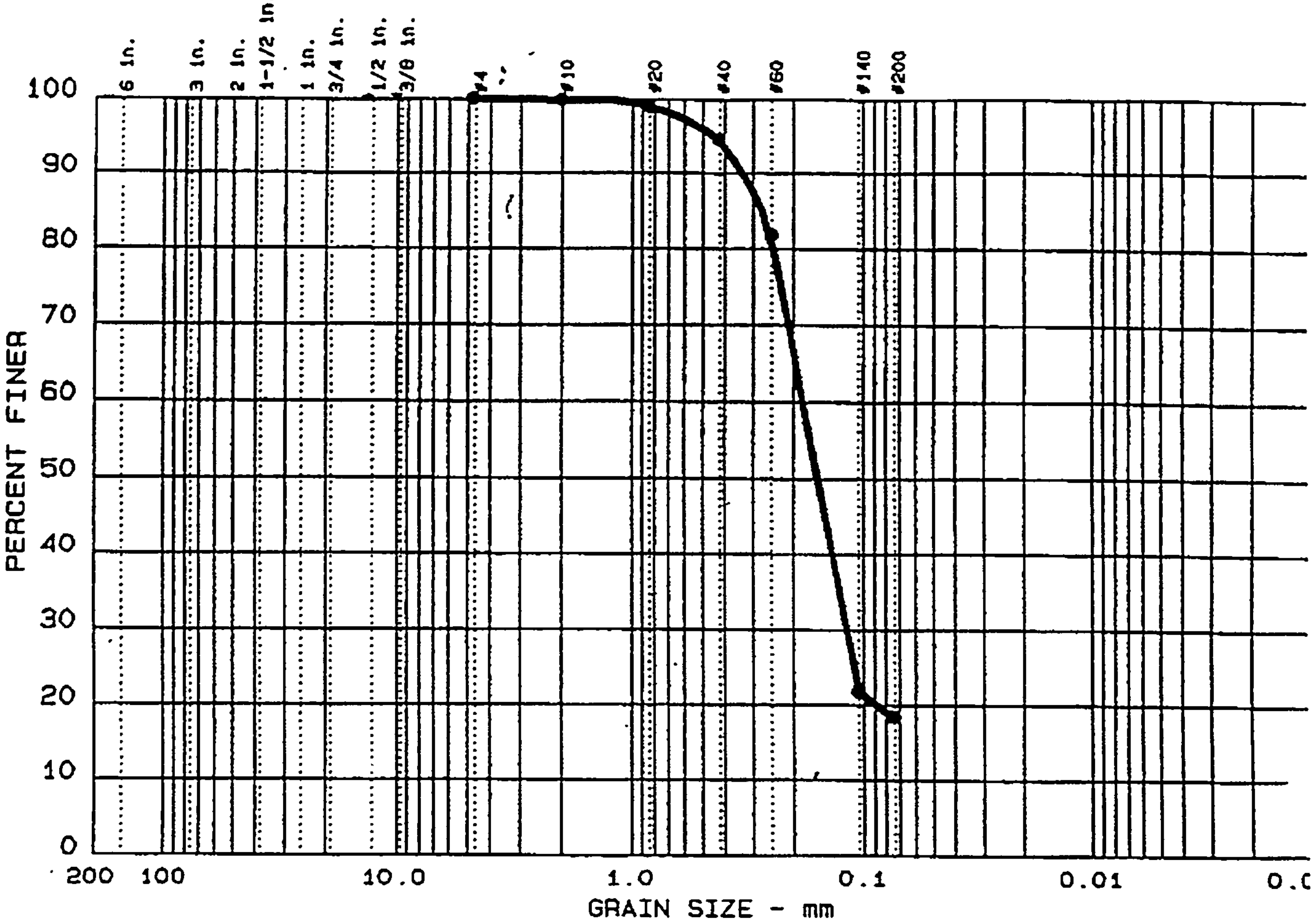
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-14

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	20	0.0	0.0	81.6	18.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	36	10	0.27	0.18	0.16	0.118				

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan & Red Brown Silty Sand	SM	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-32 @ 49-50.5 Ft.

Date: Jan.27, 1998

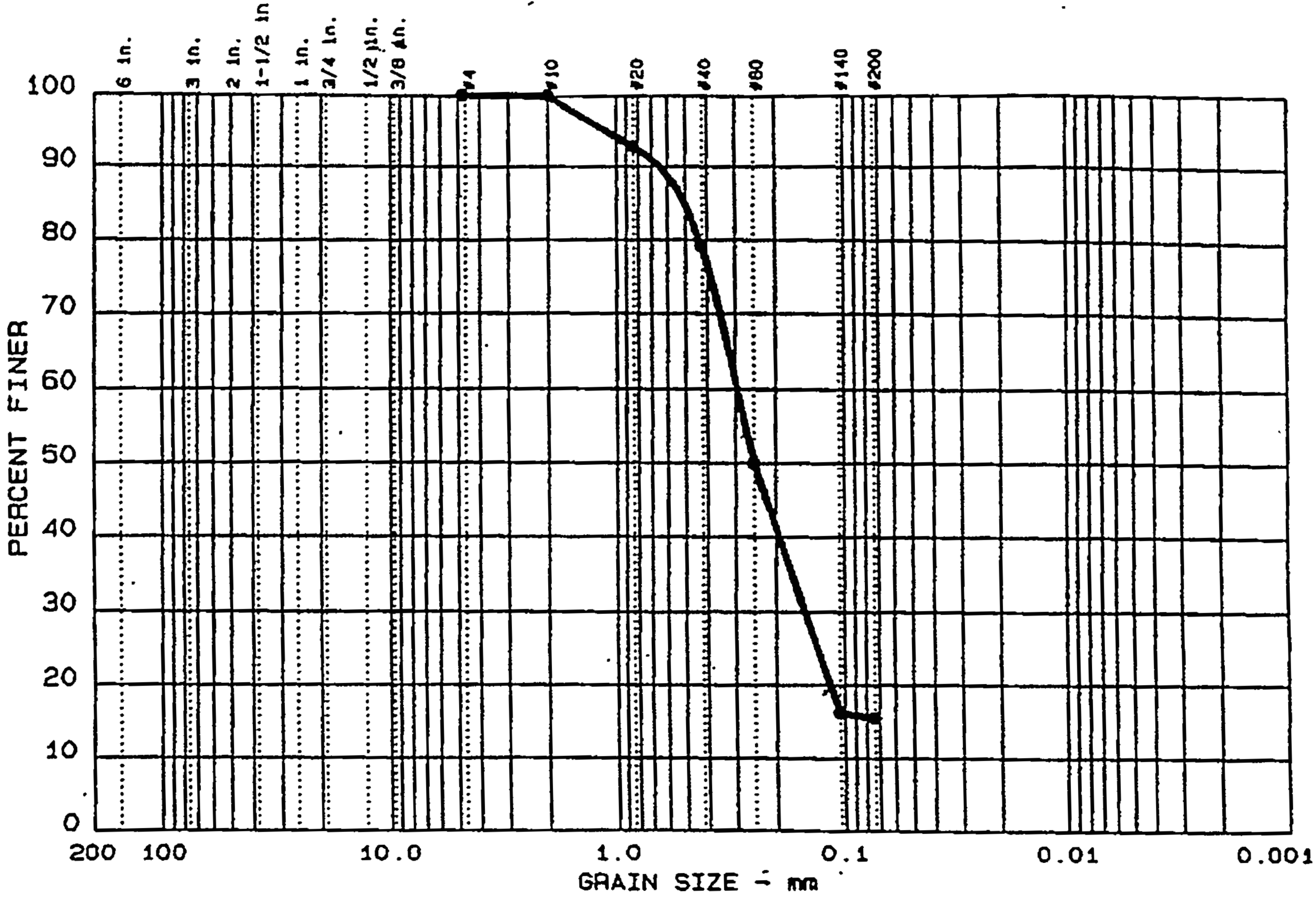
Remarks:
Tested by: SC
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-15

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	0.0	84.5	15.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	33	8	0.50	0.29	0.25	0.150				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-4(0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-39 @ 62-63.5 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

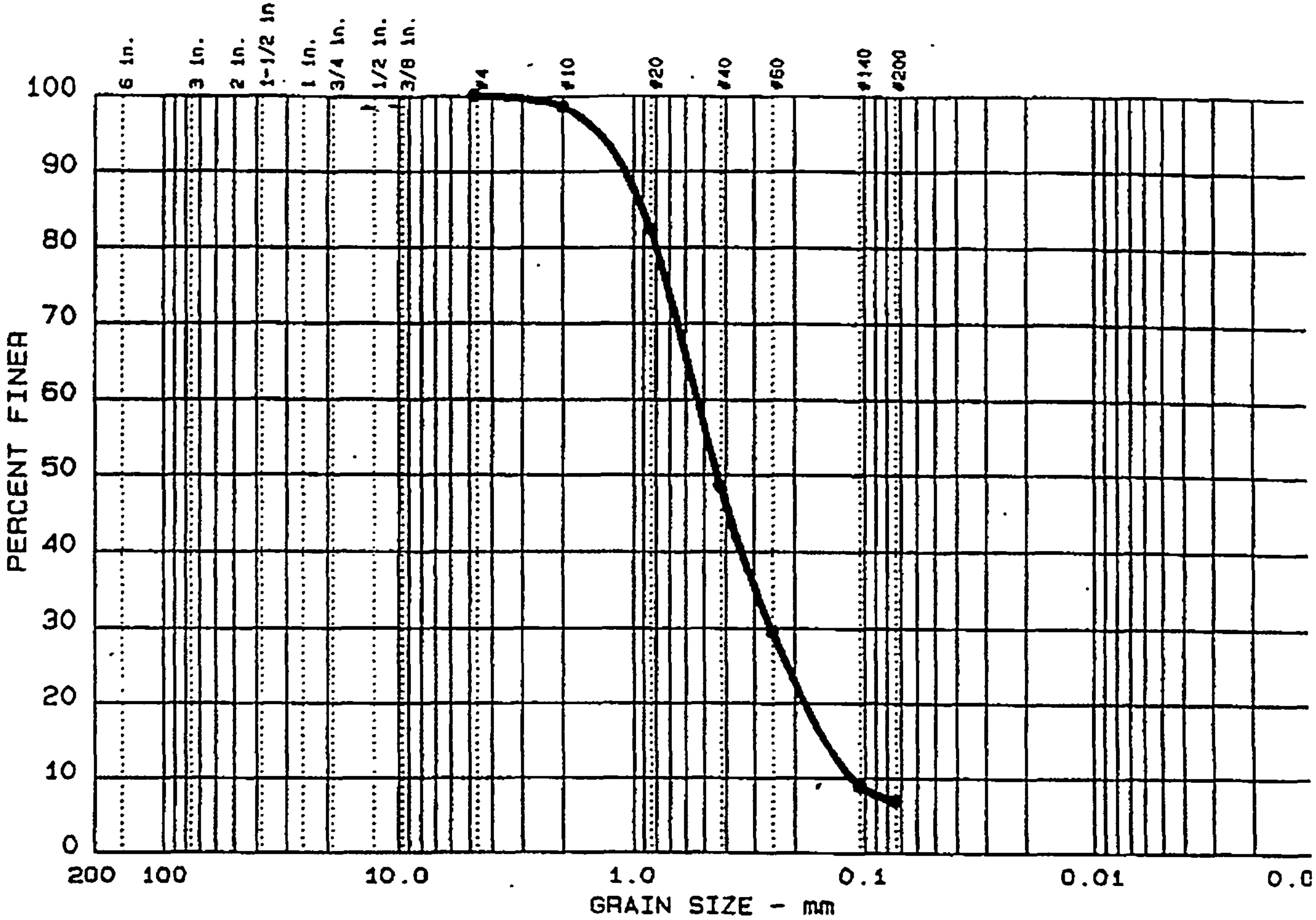
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC

C-16

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	6	0.0	0.0	93.1	6.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.90	0.53	0.43	0.253	0.1489	0.1143	1.06	4.6

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-1-b

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-52 @ 81.5-83.0 Ft.

Date: Jan.27, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Remarks:

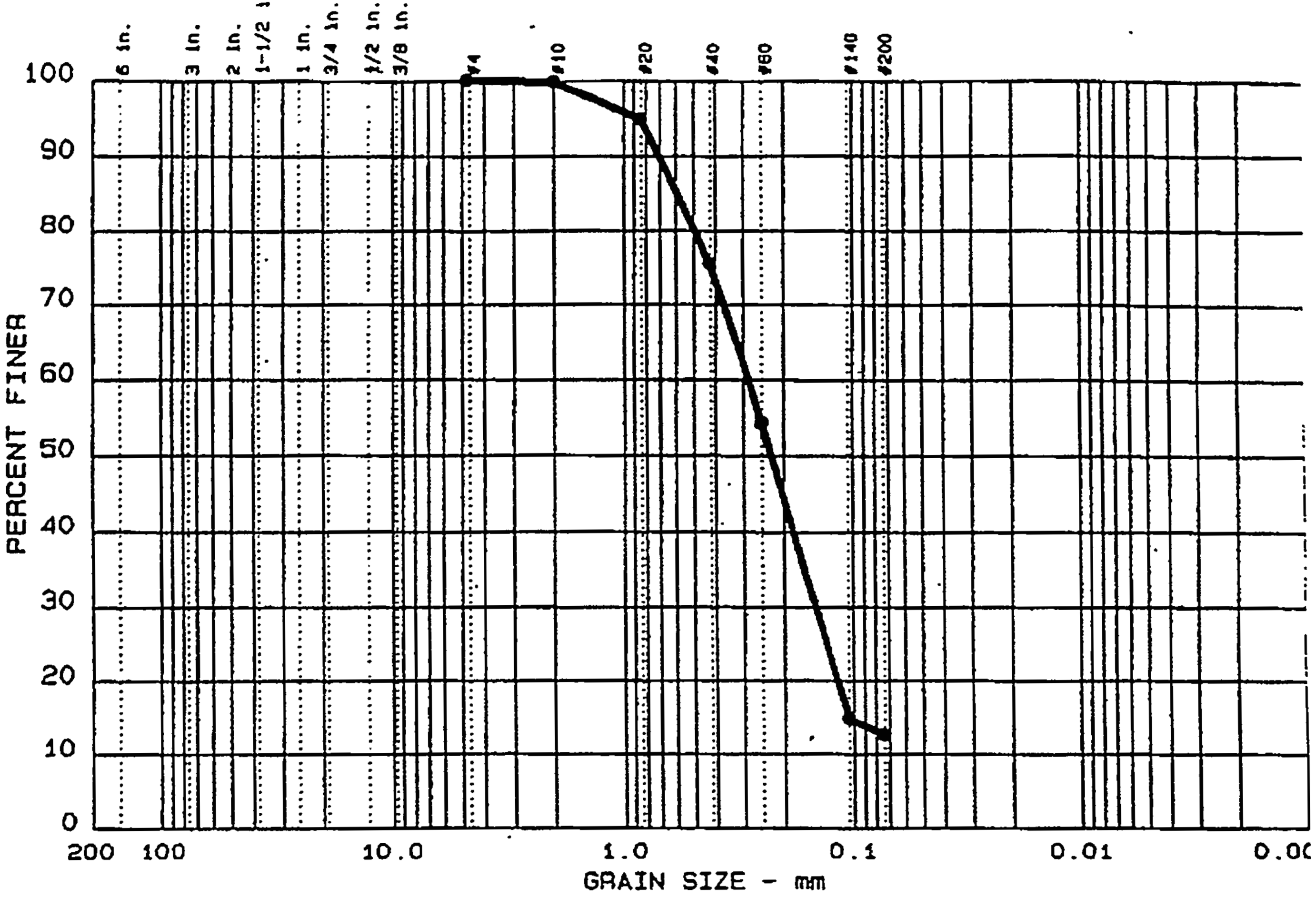
Tested by: SC

Reviewed by: Hb

Figure No.

C-17

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	7	0.0	0.0	87.4	12.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.58	0.28	0.23	0.146	0.1047			

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-4 (0.2)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-61 @ 95-96.5 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

Reviewed by: Hb

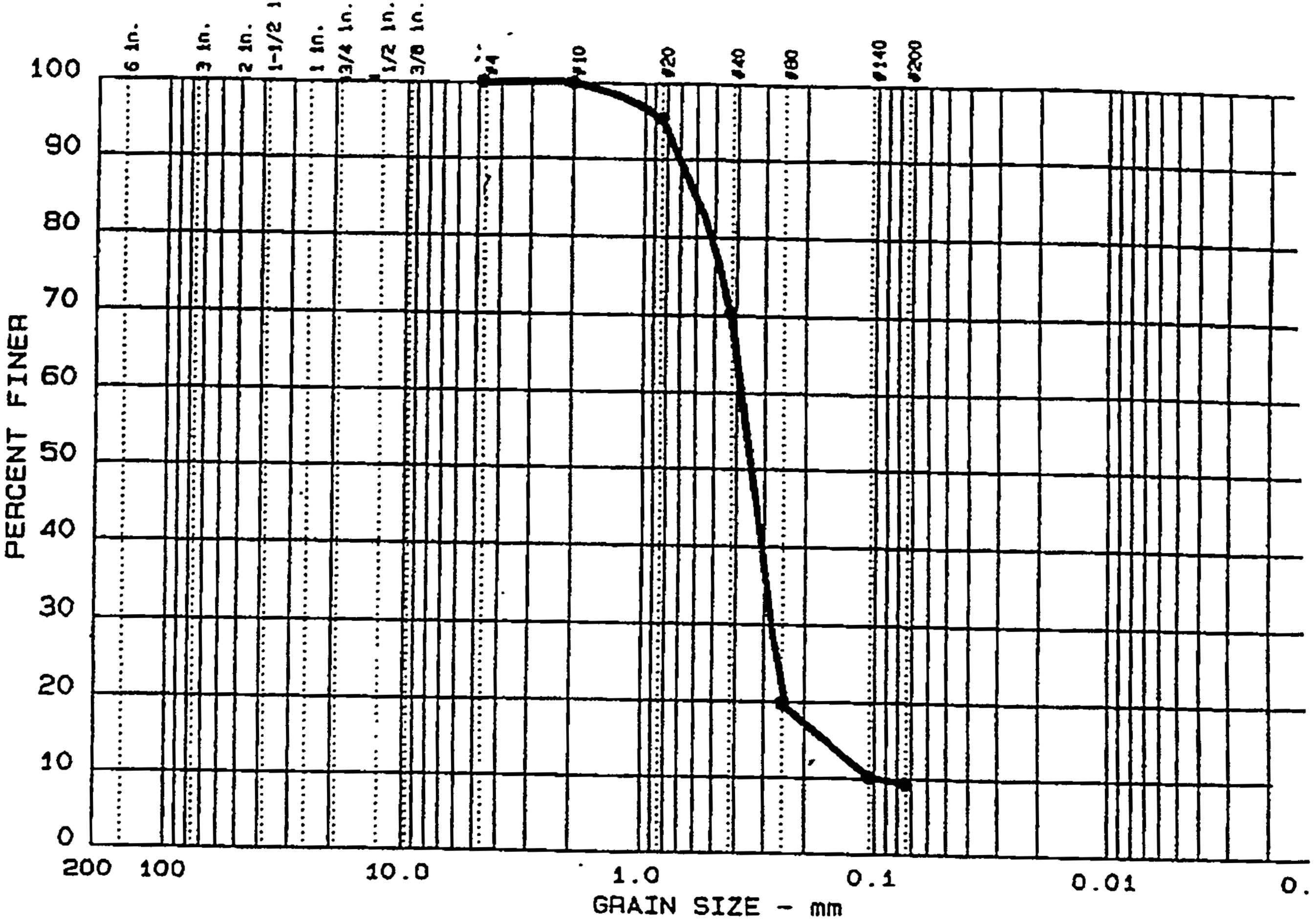
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

C-18

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	8	0.0	0.0	90.7	9.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●	NL	NP	0.59	0.38	0.34	0.278	0.1616	0.0930	2.20	4.

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-3

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-66 @ 108-109.5 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

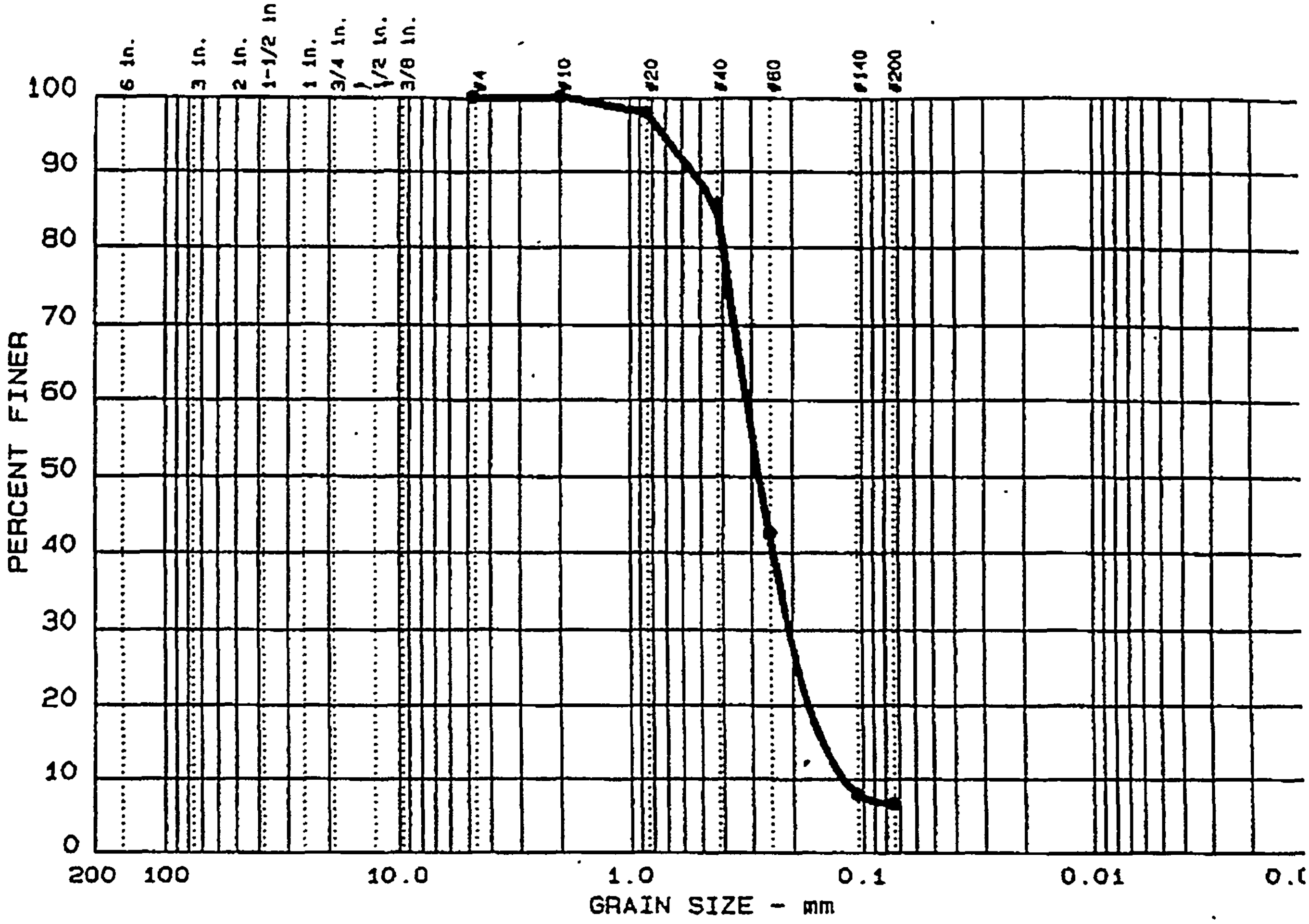
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-19

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	9	0.0	0.0	93.4	6.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.42	0.32	0.28	0.208	0.1501	0.1220	1.13	2.

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-3

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-75 @ 120-121.5 Ft.

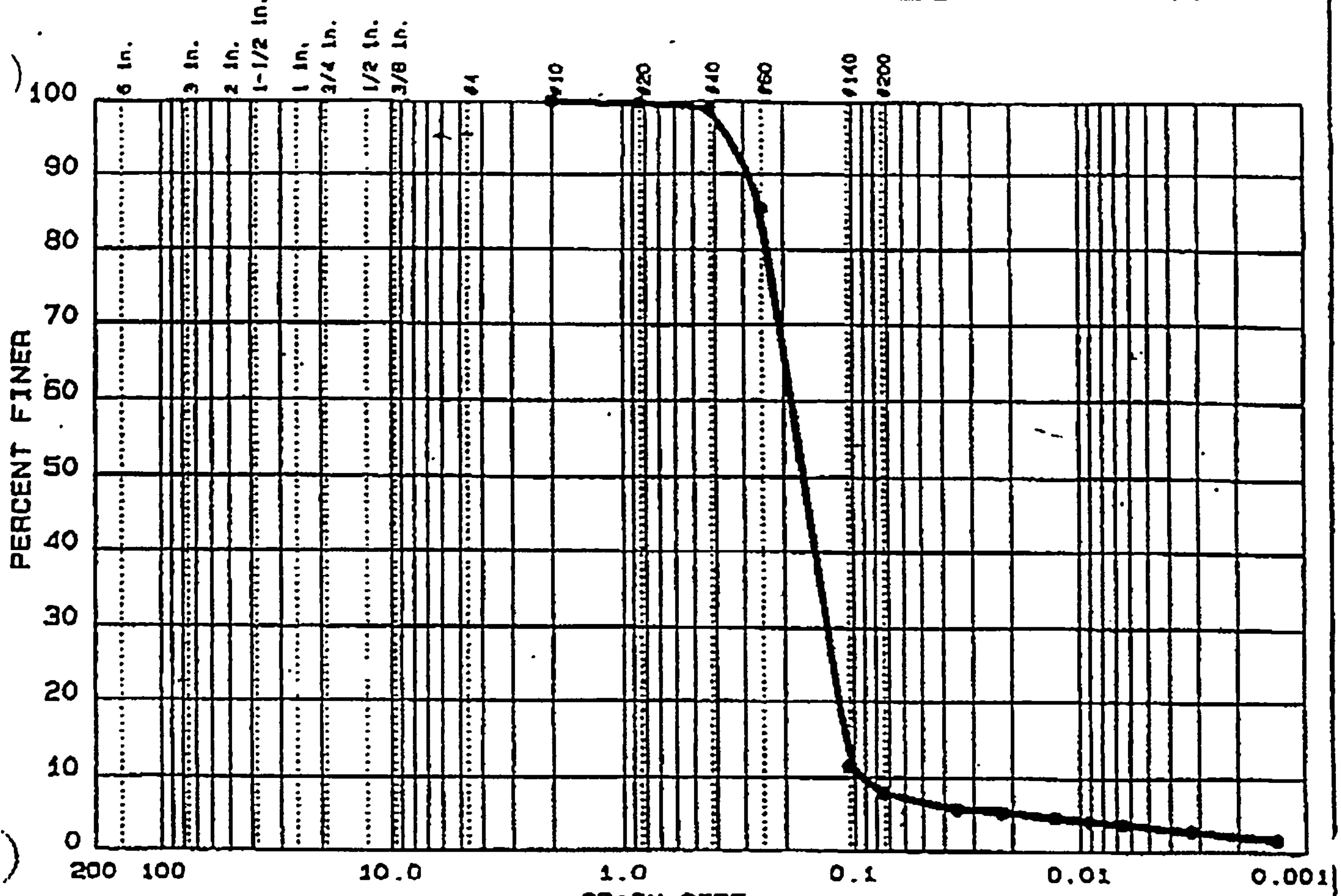
Date: Jan.27, 1998

Remarks:
Tested by: SC
Reviewed by: tb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	6	0.0	0.0	92.2	4.5	3.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.25	0.19	0.17	0.131	0.1095	0.0911	1.01	2.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Poorly Graded Sand with Silt	SP-SM	A-3

Project No.: 50123-6-1020.04
Project: 50161-7-0108 Task 12
● Location: HTEF B-2 St-5 @ 131.5-133.5 Ft.

te: Feb. 18, 1998

Remarks:
Tested by: JTm/SC
Reviewed by:

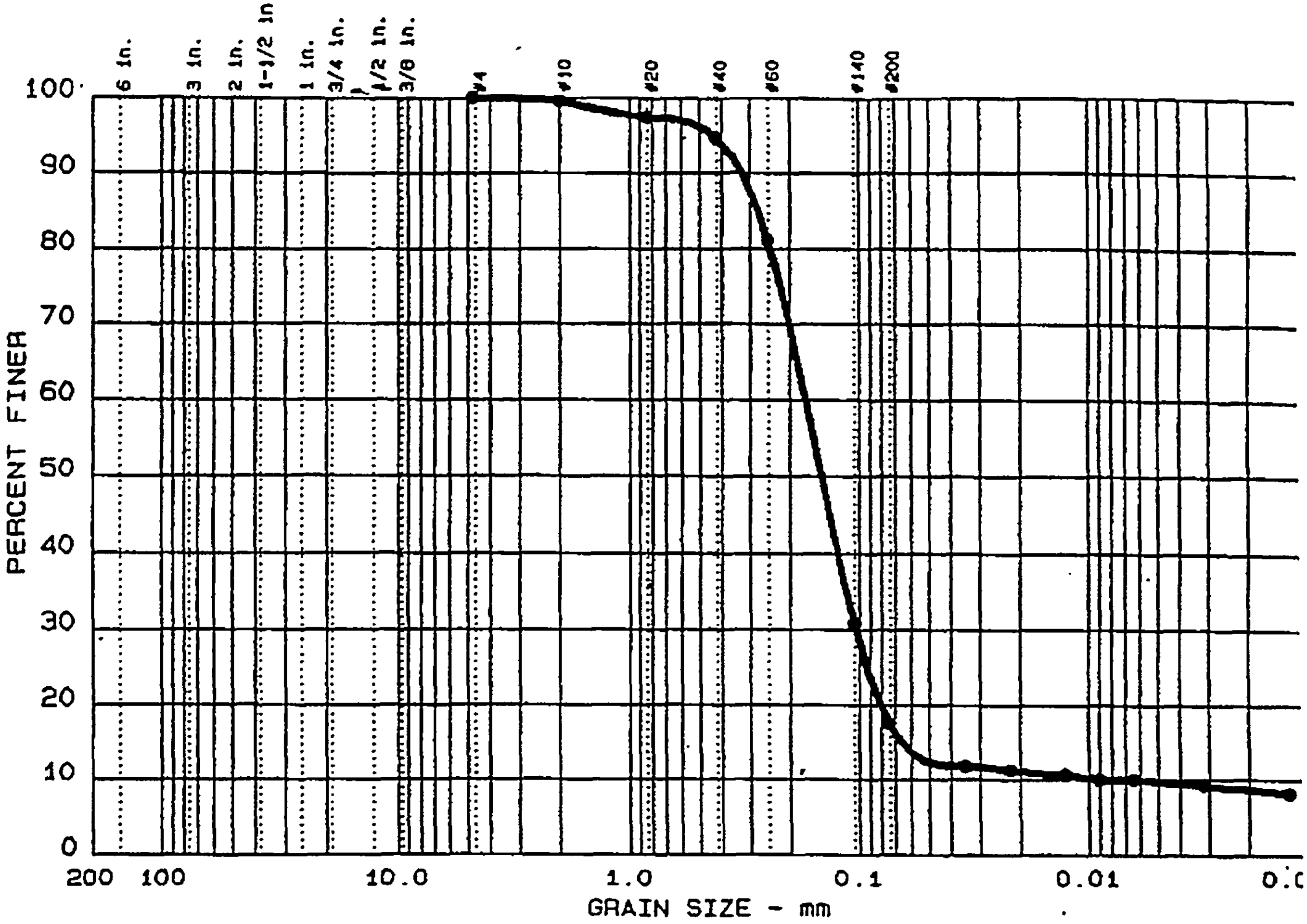
Consolidation Sample

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-21

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	0.0	82.4	7.9	9.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.28	0.17	0.15	0.103	0.0652	0.0091	6.87	18.

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-2 SS-88 @ 144.5-147.5 Ft.

Date: Jan.27, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

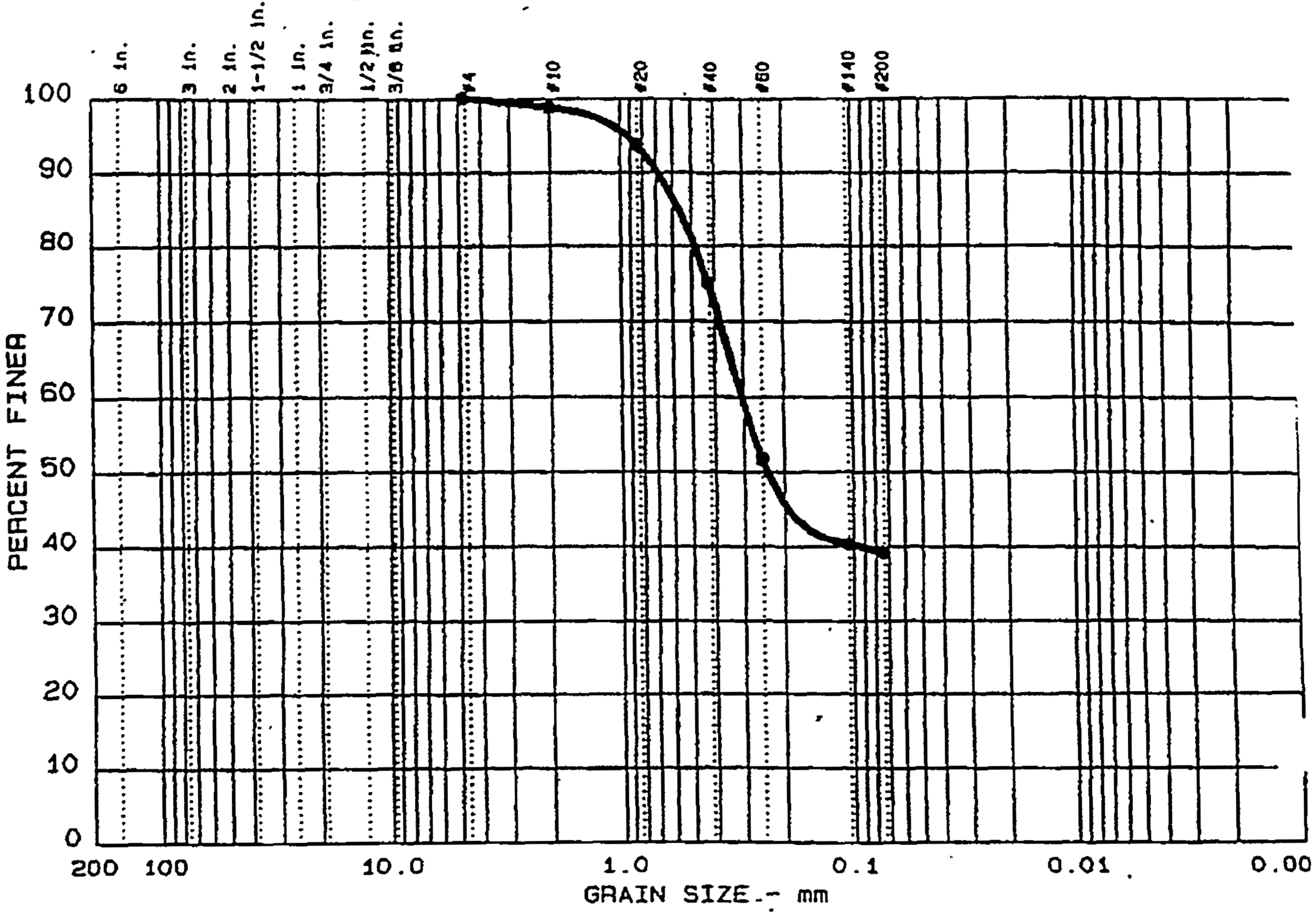
Remarks:

Tested by: SC

Reviewed by: HB

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	0.0	60.9	39.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	56	32	0.56	0.31	0.24					

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan & Red Brown Clayey Sand	SC	A-7-6 (5.4)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-6 @ 10.5-12 Ft.

Date: Jan.27, 1998

Remarks:

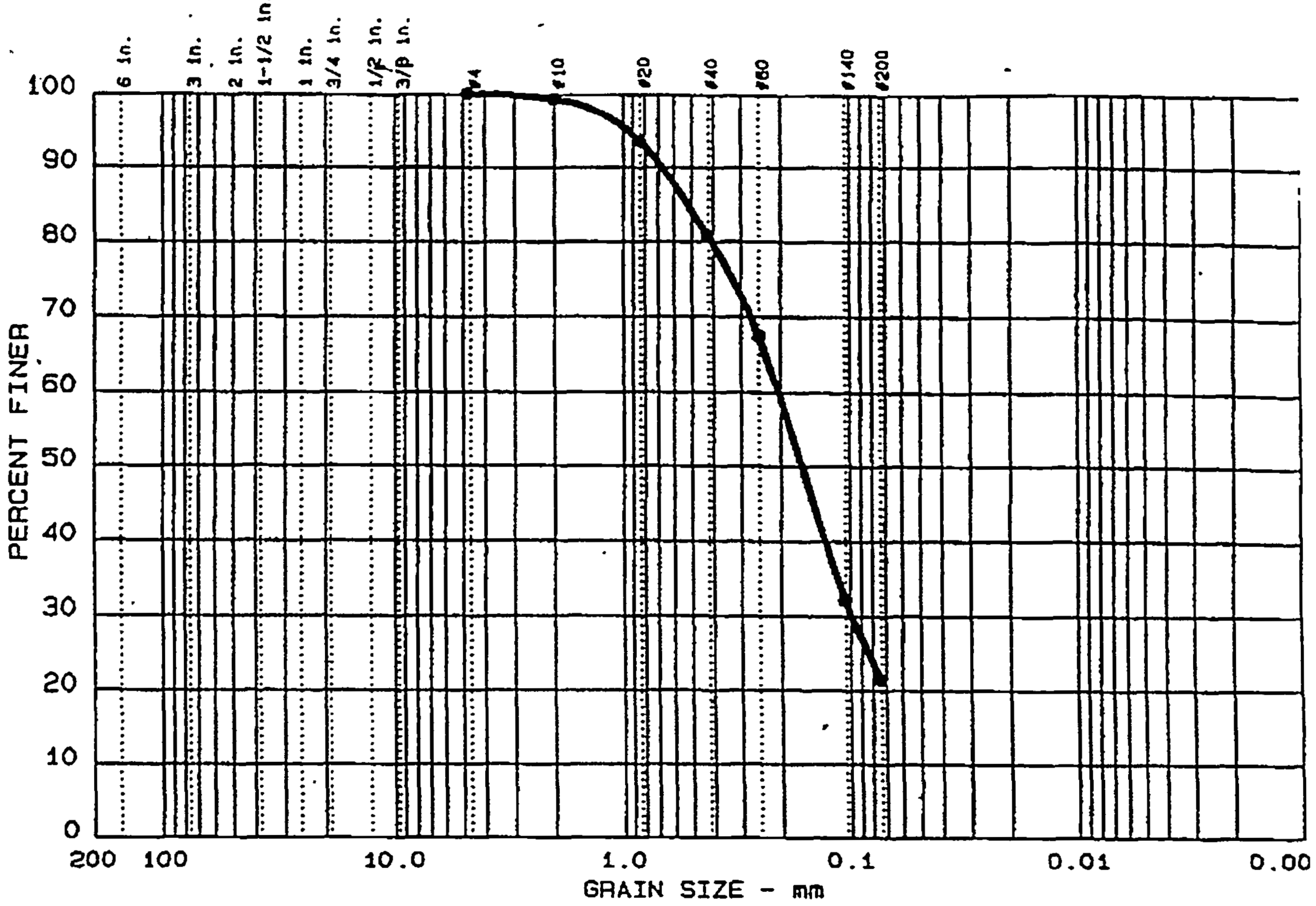
Tested by: SC

Reviewed by: HB

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.0	78.5	21.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	34	11	0.51	0.20	0.16	0.099				

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown Clayey Sand	SC	A-2-6 (0.1)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-12 @ 19.5-21 Ft.

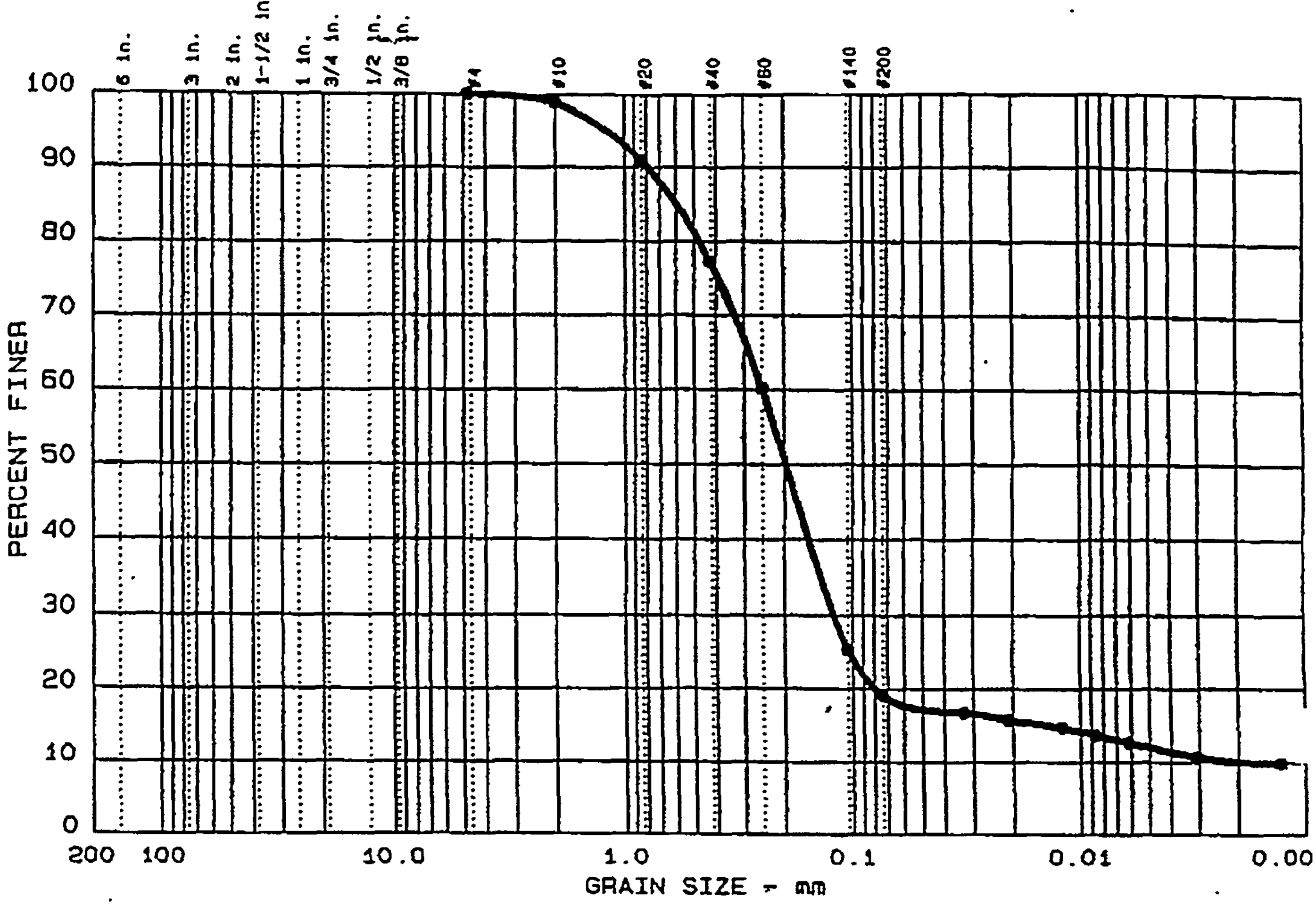
Date: Jan.27, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:
Tested by: SC
Reviewed by: Hb

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	0.0	80.9	7.1	12.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	35	12	0.59	0.25	0.20	0.121	0.0132	0.0019	31.22	130.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown Clayey Sand	SC	A-2-6(0.1)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-3 St-2 @ 21.5-23.5 Ft.

Date: Feb. 18, 1998

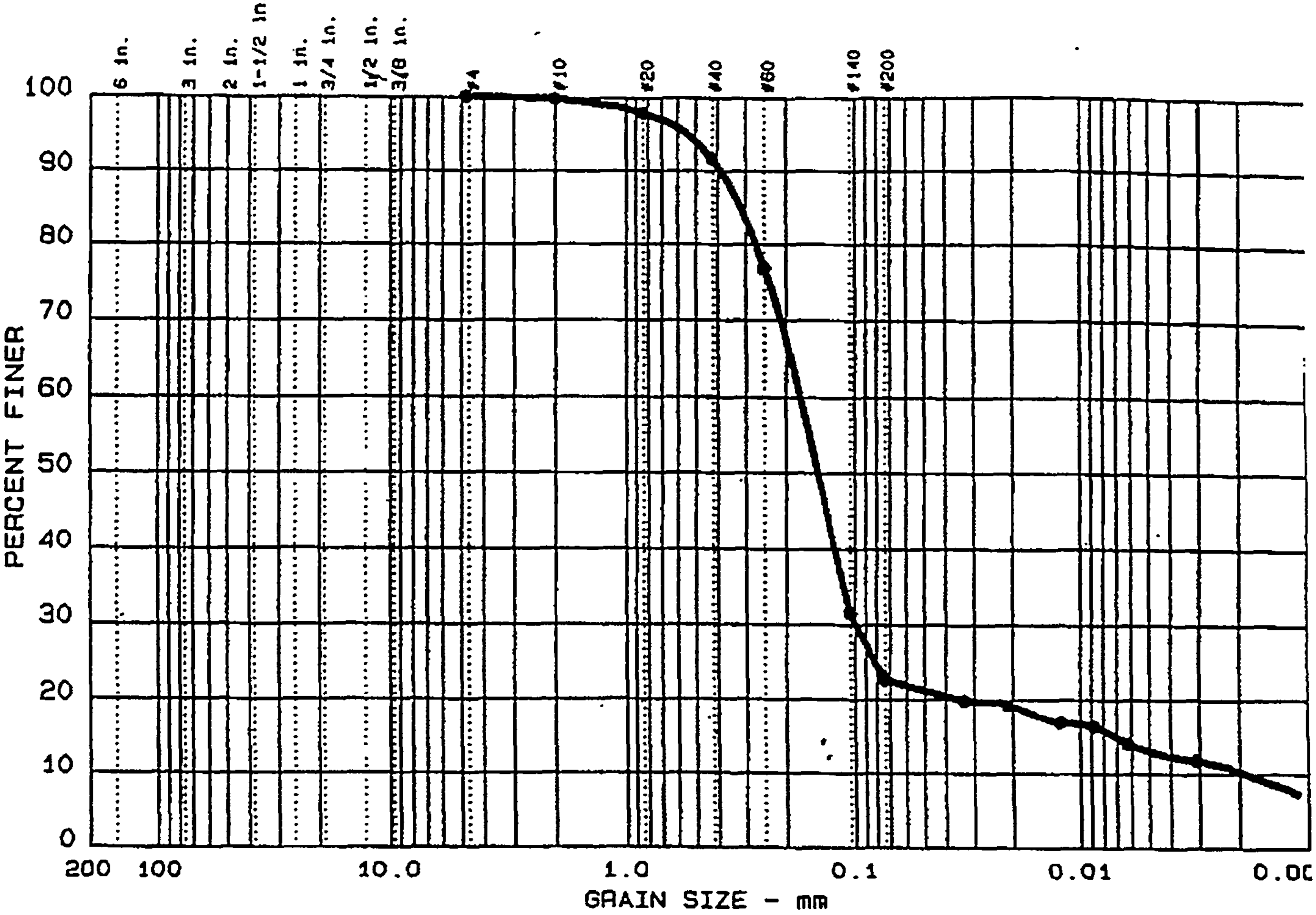
Remarks:
Tested by: SC
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

C-25

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	0.0	77.4	9.6	13.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	35	10	0.31	0.17	0.15	0.100	0.0069	0.0019	30.83	93.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-4 (0.0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
◆ Location: HTEF B-3 St-2 @ 21.5-23.5 Ft.

Date: Feb. 18, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

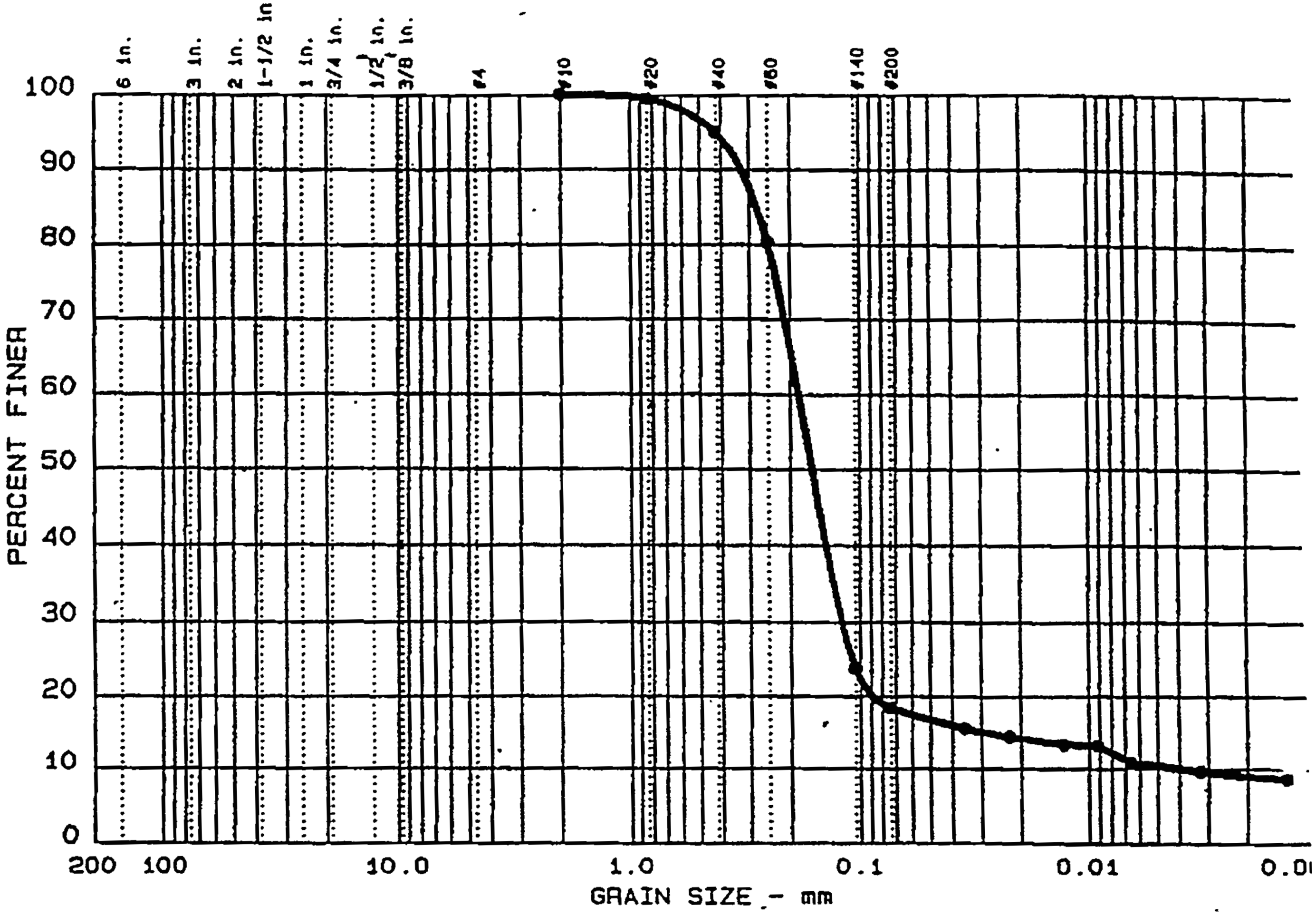
Remarks:
Tested by: SC/JTm
Reviewed by: HO

Consolidation Sample

Figure No.

C-26

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.0	81.6	8.0	10.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	38	10	0.28	0.18	0.16	0.120	0.0279	0.0036	21.65	50.6

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-4(0-0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 ST-3 @ 46.5 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

Reviewed by: Hb

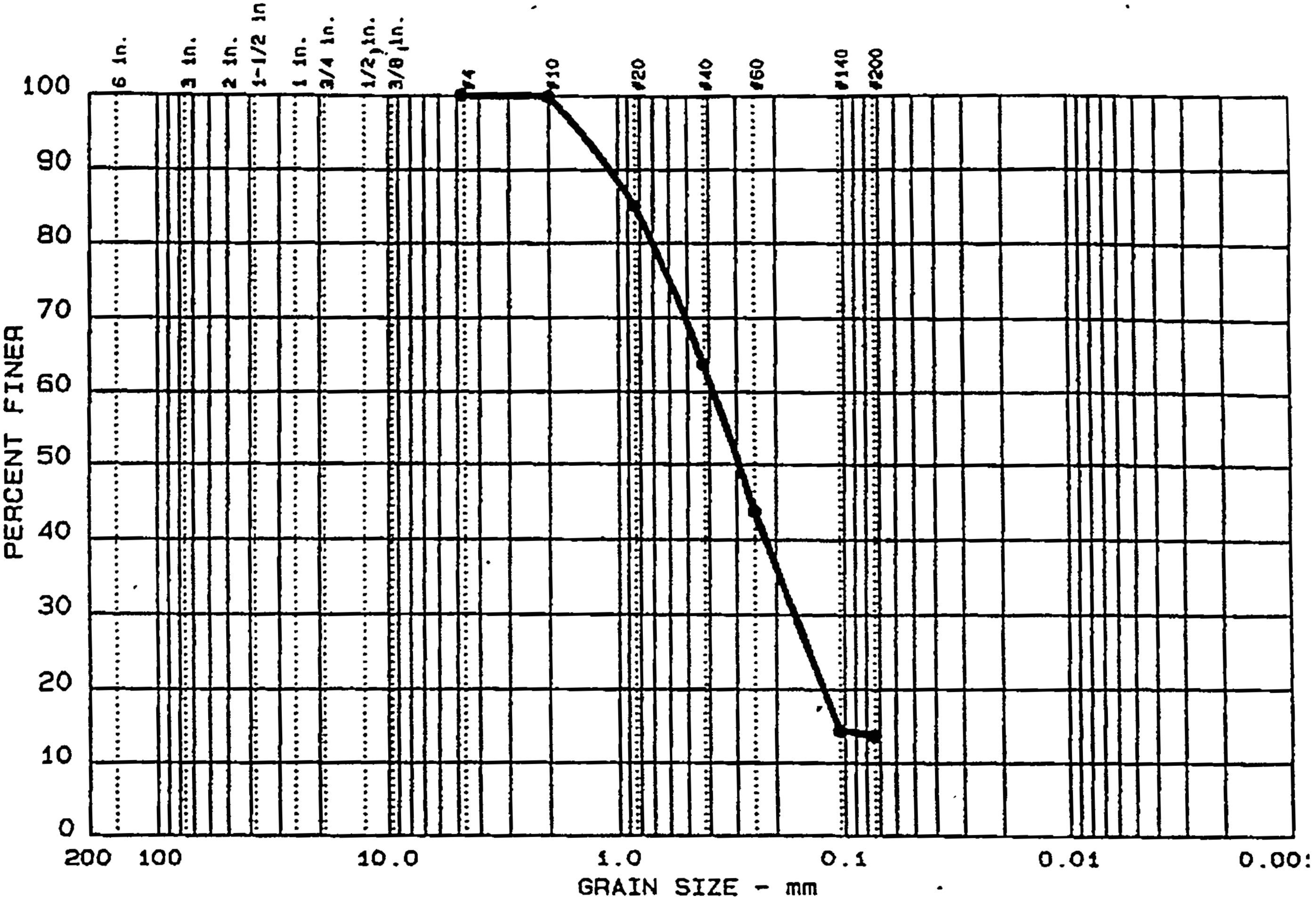
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

C-27

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	0.0	86.3	13.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	36	12	0.84	0.38	0.29	0.166	0.1068			

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Clayey Sand	SC	A-2-6 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-22 @ 58.5-60.0 Ft.

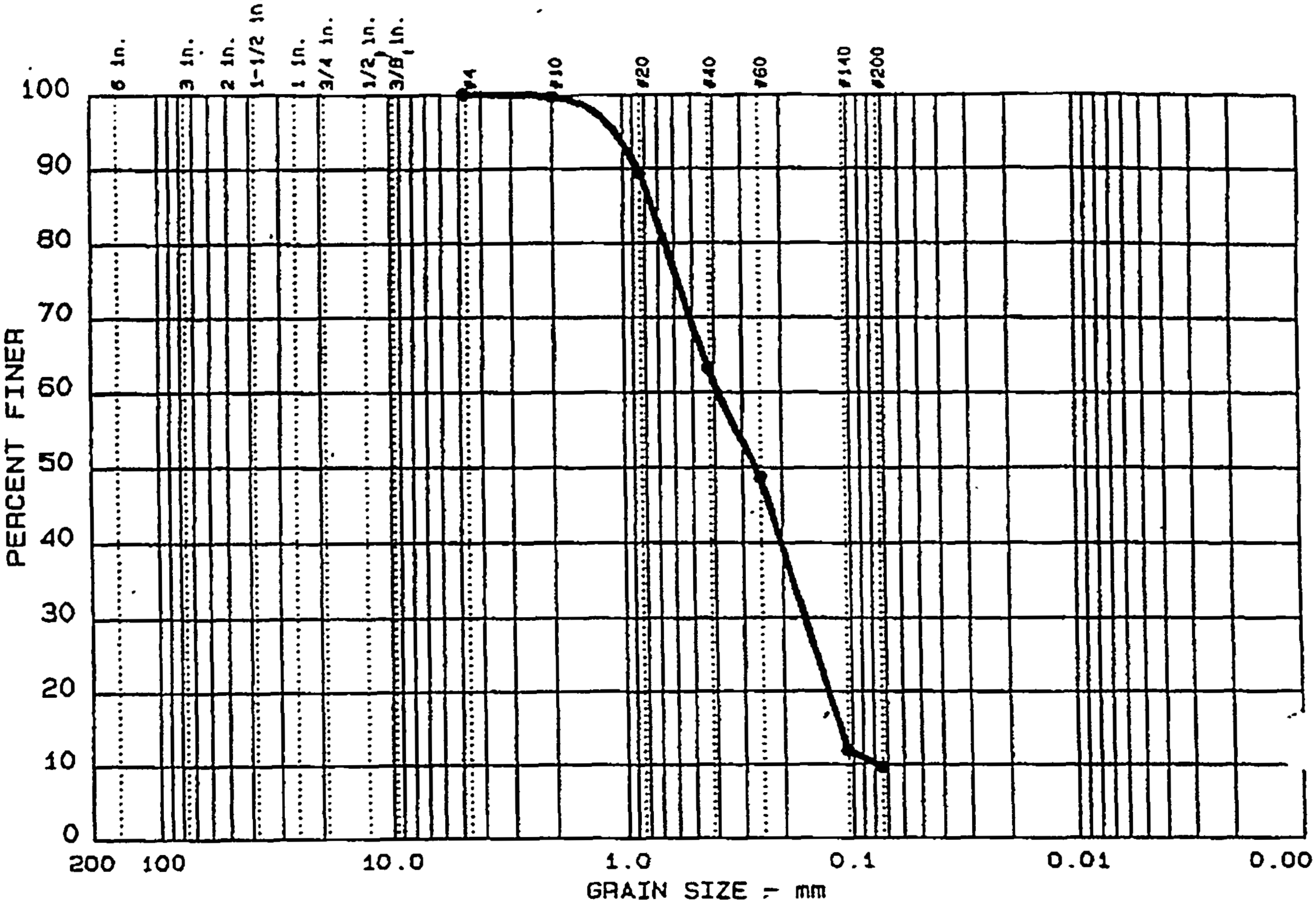
Date: Jan. 27, 1998

Remarks:
Tested by: SC
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	14	0.0	0.0	90.4	9.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.74	0.38	0.26	0.161	0.1126	0.0779	0.87	4.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Poorly Graded Sand with Silt	SP-SM	A-3 —

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-25 @ 73.5-75 Ft.

Date: Jan.27, 1998

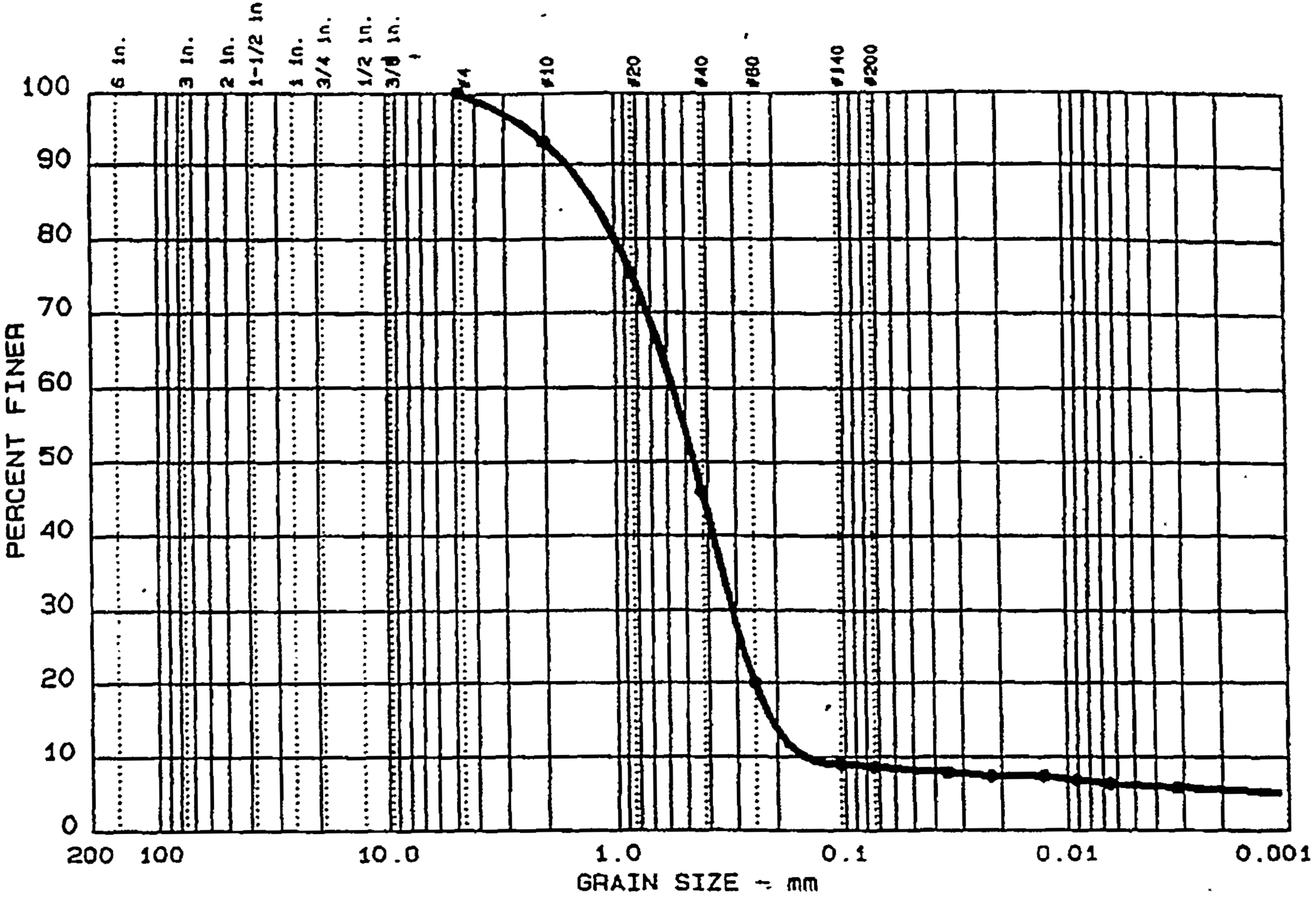
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-29

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.0	91.4	2.6	6.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	48	24	1.20	0.56	0.46	0.312	0.2128	0.1507	1.15	3.7

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Poorly Graded Sand with Clay	SP-SC	A-2-7 (0.0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: HTEF B-3 St-4 @ 91-93 Ft.

Date: Feb. 18, 1998

Remarks:
Tested by: SC/dTm
Reviewed by:

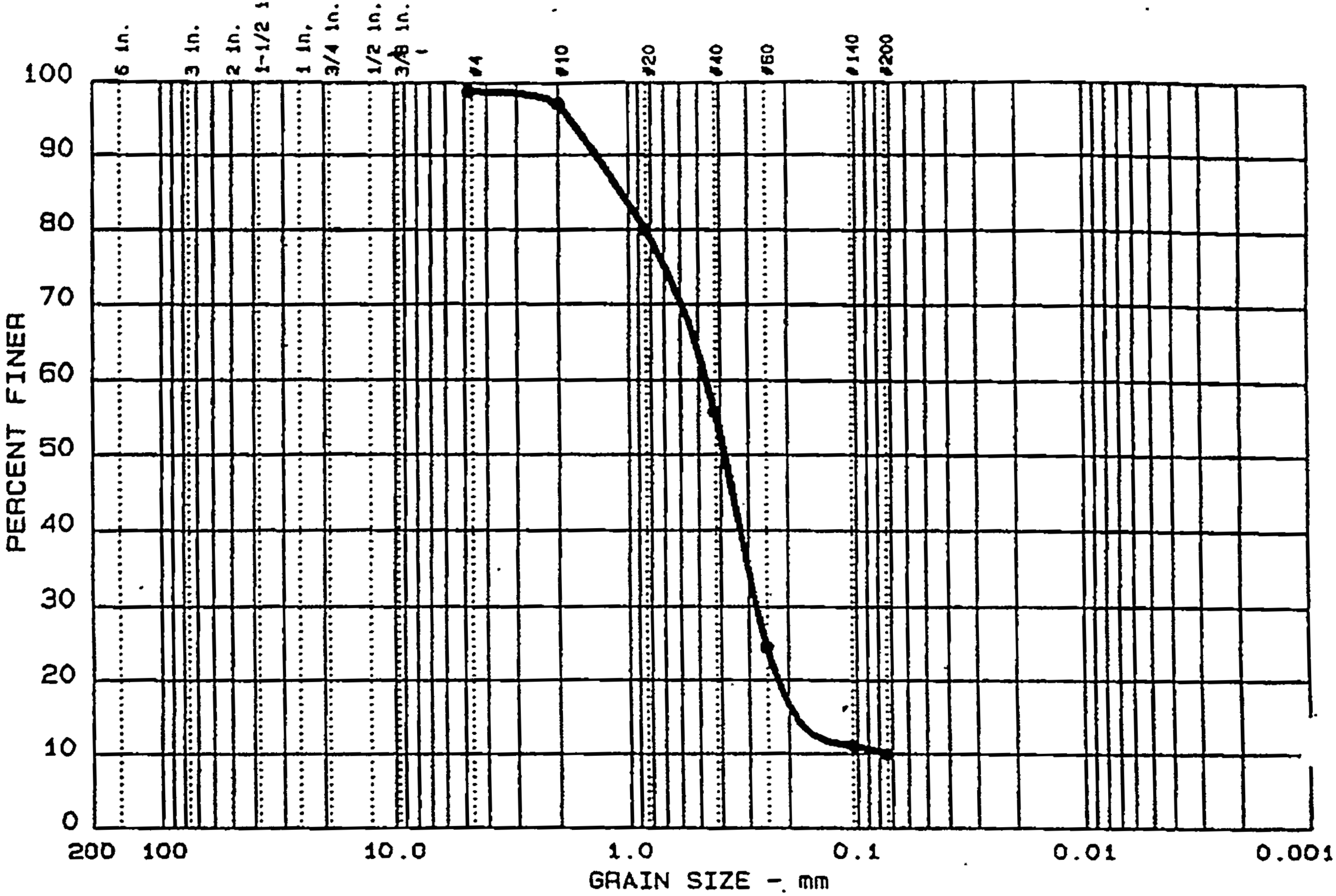
Consolidation Sample

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-30

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 15	0.0	1.3	88.8	9.9	

LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
● NL	NP	1.06	0.46	0.38	0.277	0.1851	0.0754	2.23	6.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Well Graded Sand with Silt	SW-SM	A-3

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF 8-3 SS-32 @ 108-109.5 Ft.

Date: Jan. 27, 1998

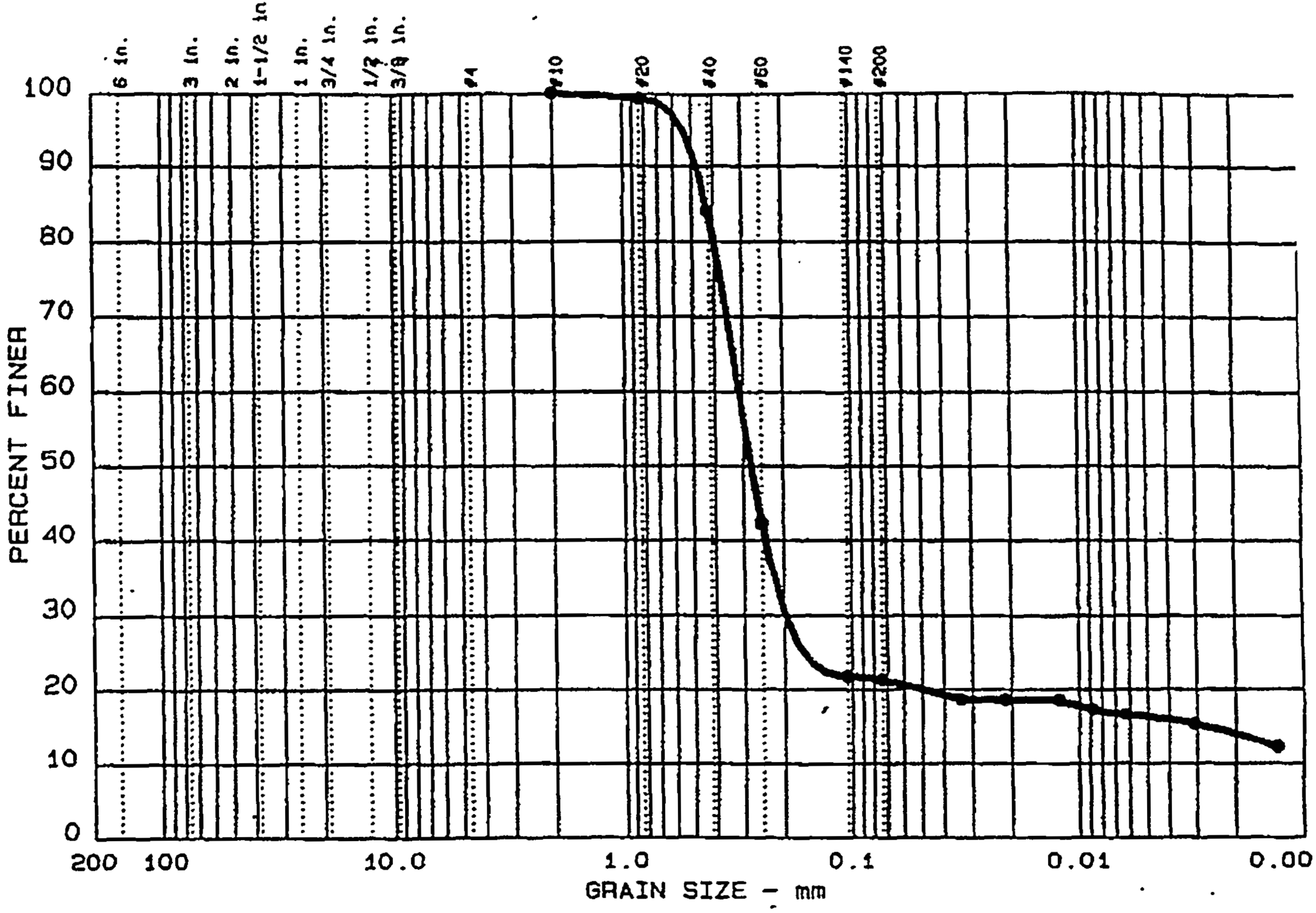
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-31

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	16	0.0	0.0	78.7	5.0	16.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	33	10	0.43	0.31	0.28	0.198	0.0027			

MATERIAL DESCRIPTION	USCS	AASHTO
● White & Brown Clayey Sand	SC	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-37 @ 122.5-124.0 Ft.

Date: Jan.27, 1998

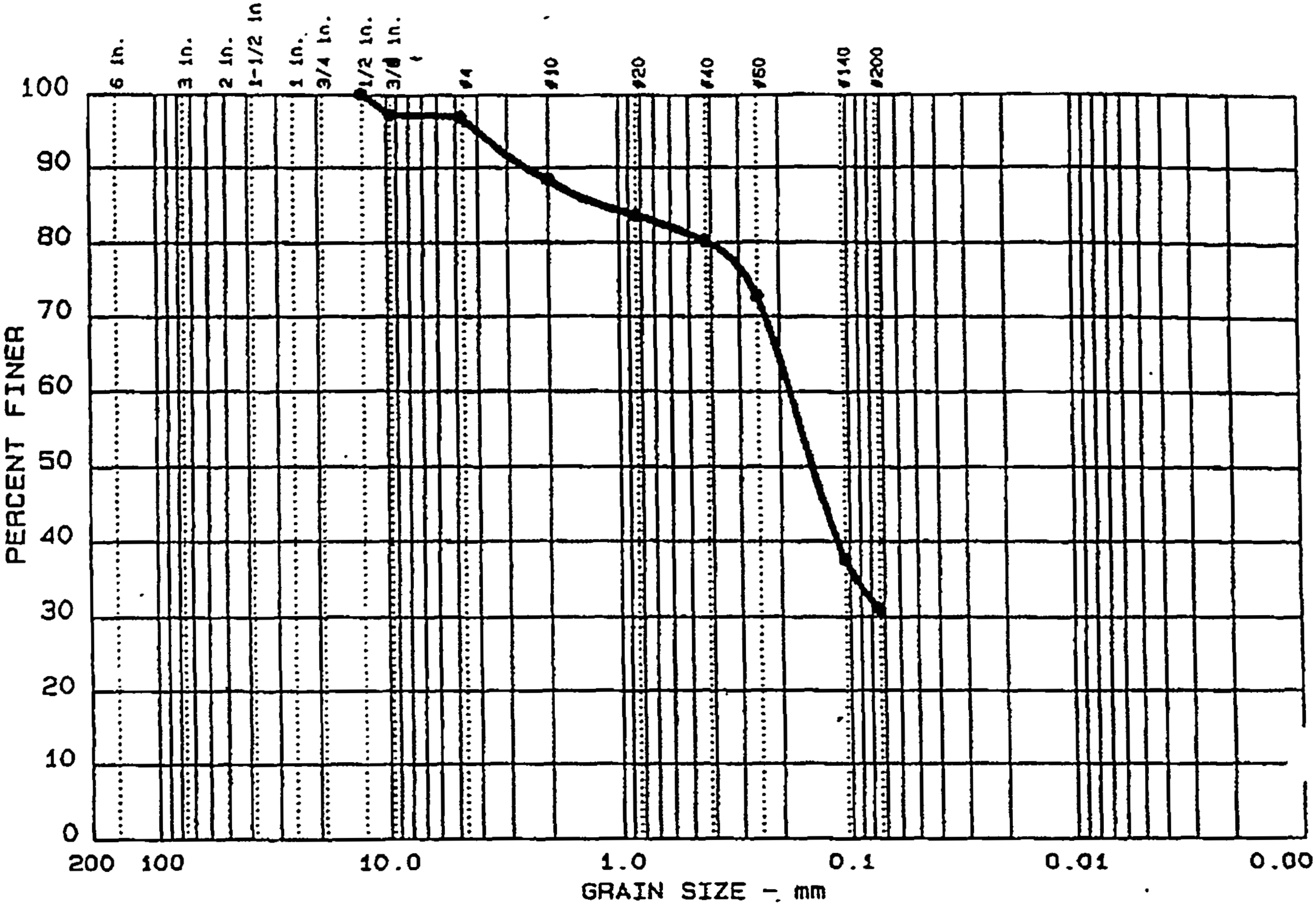
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-32

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	19	0.0	3.1	66.0	30.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	22	6	1.19	0.18	0.15					

MATERIAL DESCRIPTION	USCS	AASHTO
● White Clayey Silty Sand	SC-SM	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-43 @ 132-133.5 Ft.

Date: Jan.27. 1998

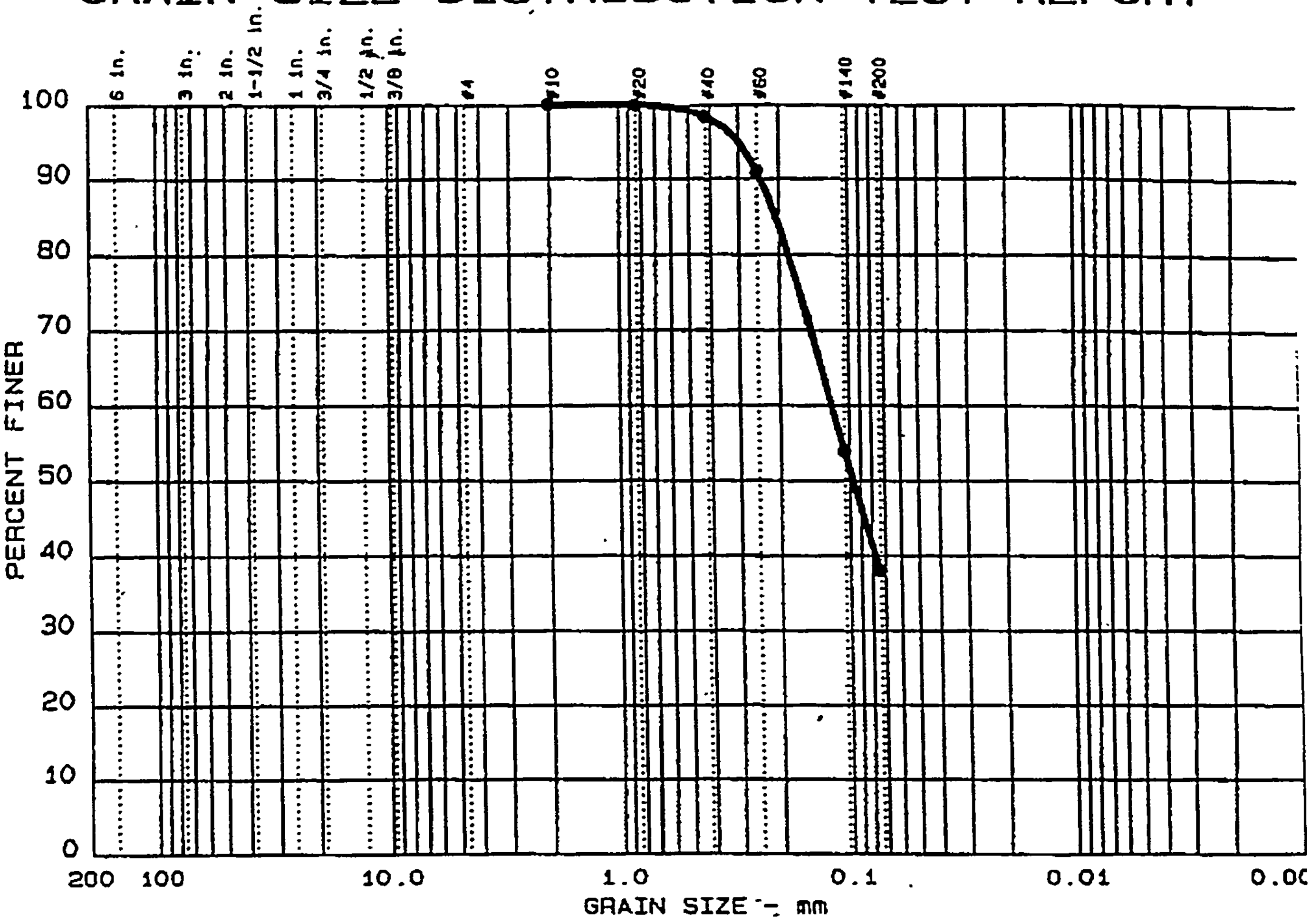
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-33

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	17	0.0	0.0	62.2	37.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	62	11	0.21	0.12	0.10					

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-7-5(1.2)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3 SS-48 @ 140-141.5 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

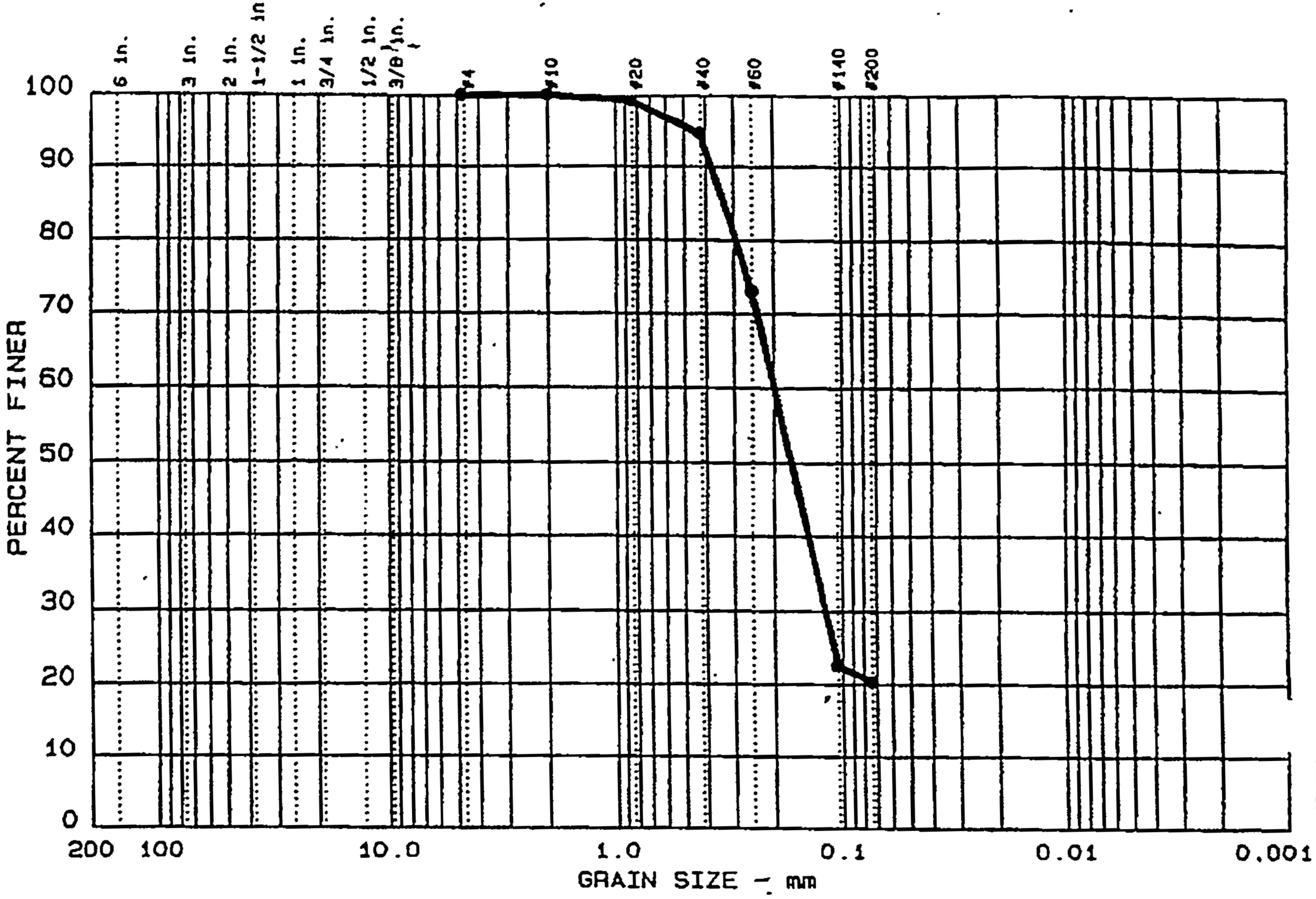
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC

Figure No

C-34

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	0.0	79.6	20.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	29	5	0.33	0.20	0.17	0.119				

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-4(0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-3SS-57 @ 153.5-155.0 Ft.

Date: Jan.27, 1998

Remarks:

Tested by: SC

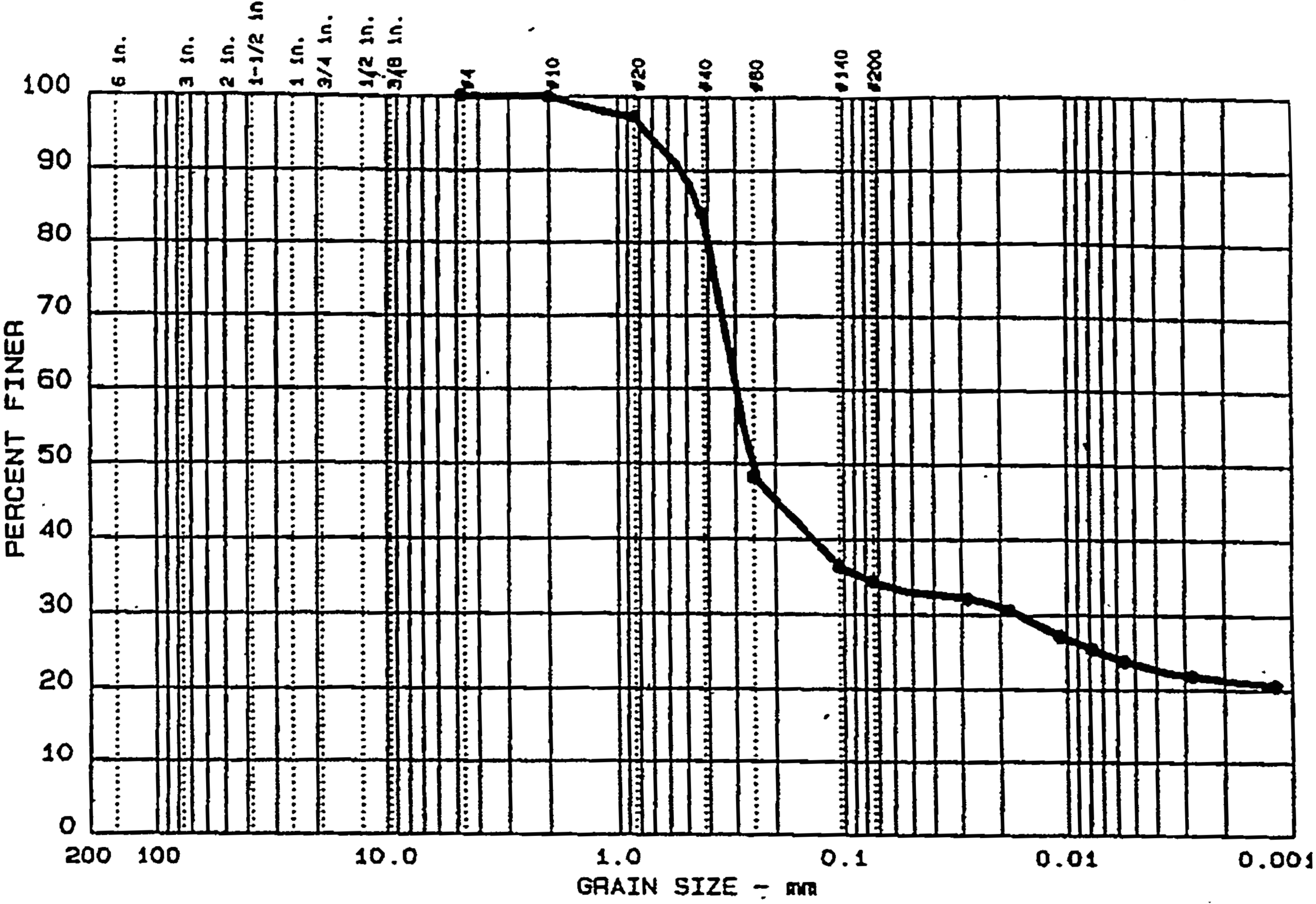
Reviewed by: Hb

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-35

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	0.0	65.6	10.9	23.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	41	20	0.43	0.30	0.26	0.017				

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey Sand	SC	A-2-7(1.9)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 St-1 @ 12-14 Ft.

Date: March 25, 1998

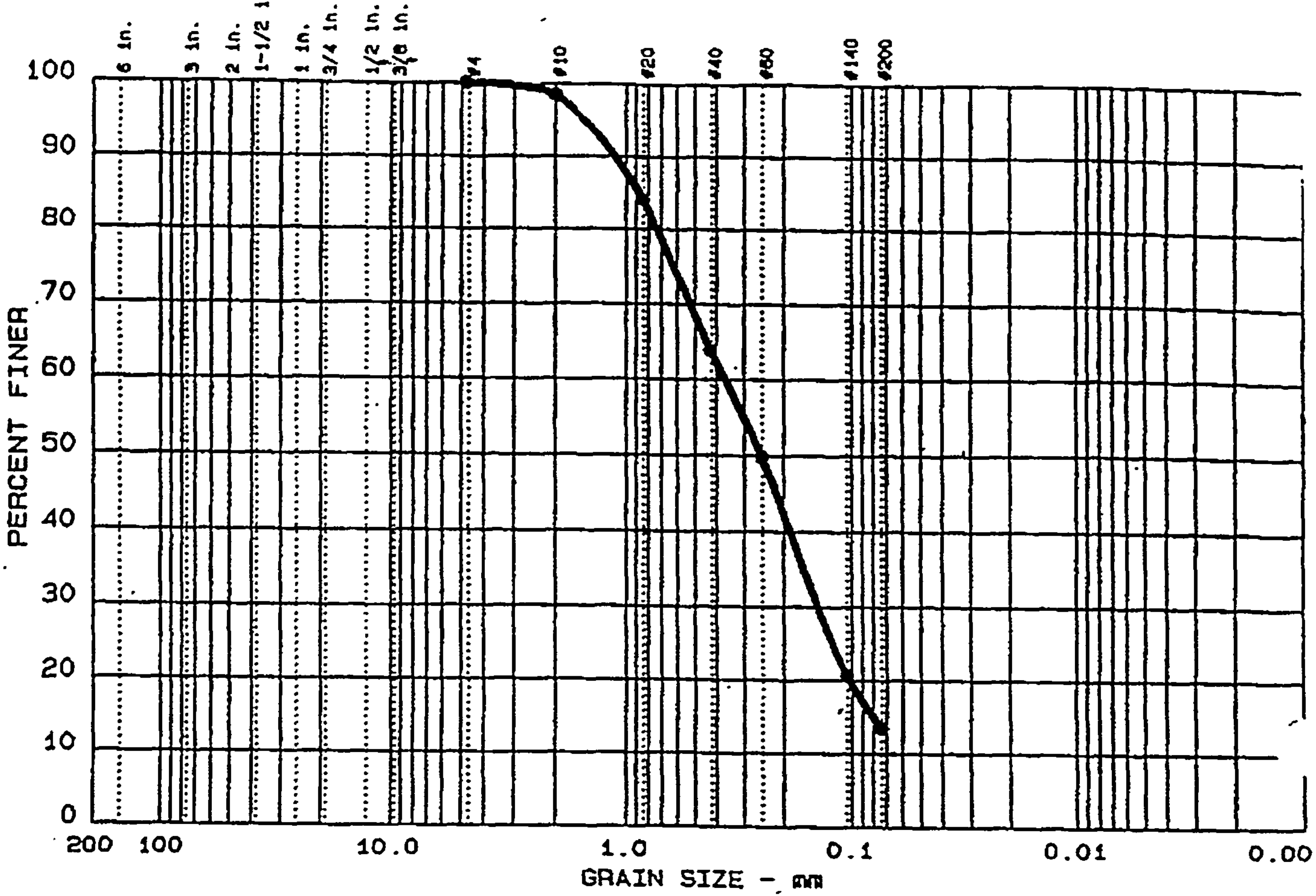
Remarks:
Tested by: JTm
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-36

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	0.0	86.5	13.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	35	12	0.87	0.36	0.25	0.142	0.0800			

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan & Red Brown Clayey Sand	SC	A-2-6 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 SS-7 @ 18 Ft.

Date: March 4, 1998

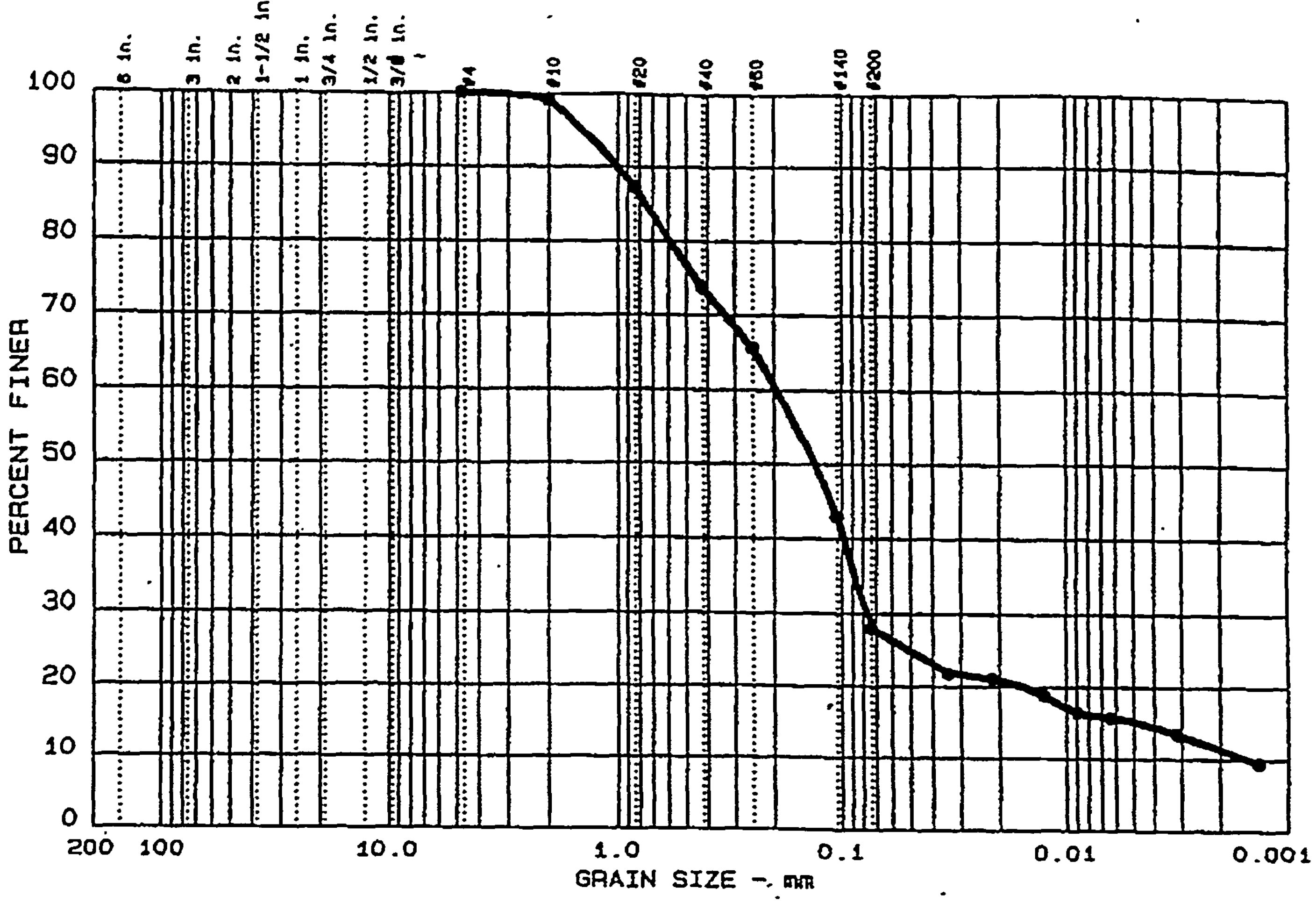
GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:
Tested by: JTM+SC
Reviewed by:

Figure No.

C-37

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.0	72.1	12.8	15.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	49	26	0.75	0.19	0.13	0.078	0.0047	0.0015	20.63	130.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Clayey Sand	SC	A-2-7 (2.1)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 St-2 @ 28 Ft.

Date: March 25, 1998

Remarks:

Tested by: JTM

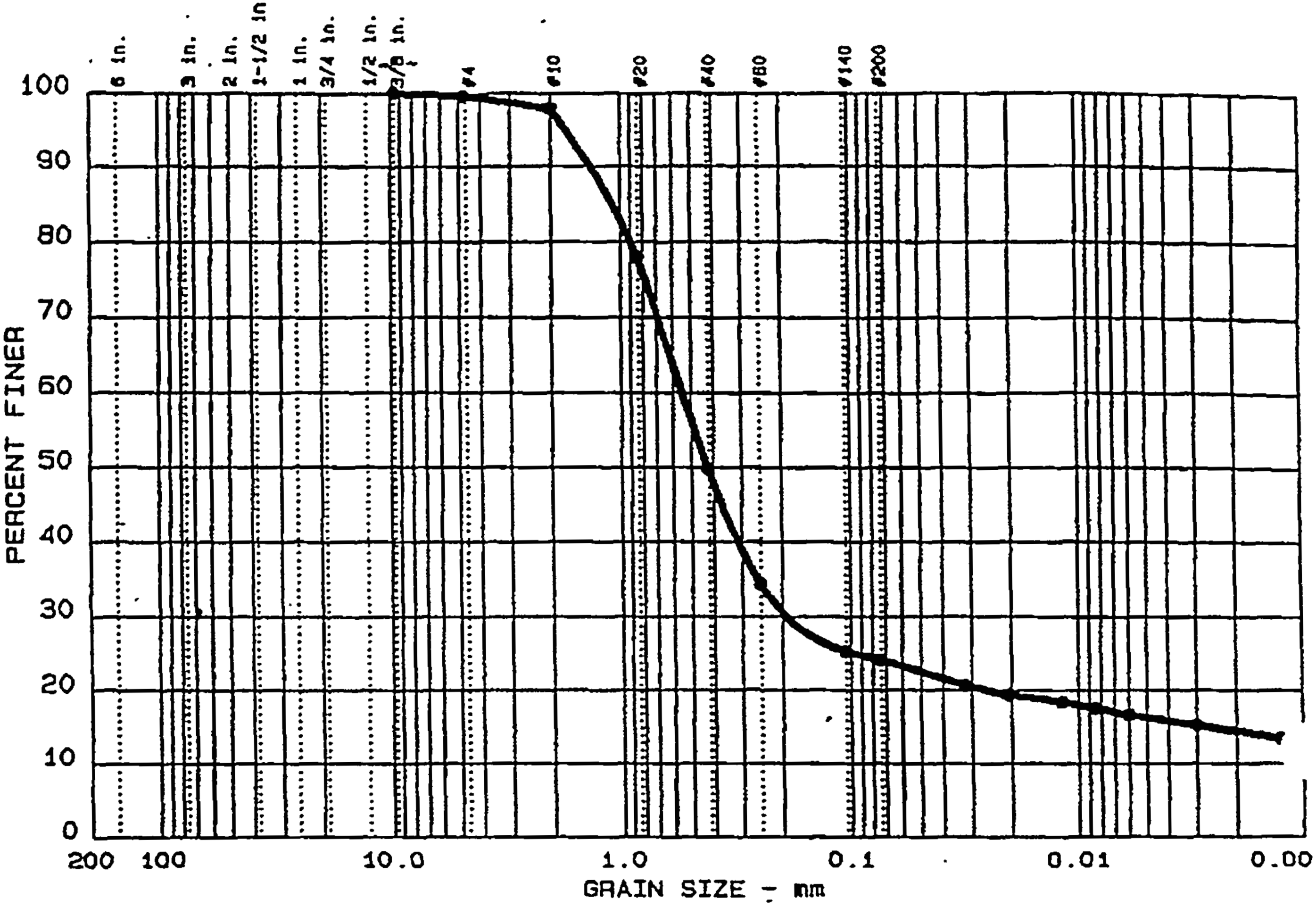
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	15	0.0	0.4	75.5	7.8	16.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	47	28	1.07	0.54	0.42	0.193	0.0026			

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Clayey Sand	SC	A-2-7 (1.6)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-5 SS-1 @ 3-4.5 Ft.

Date: March 4, 1998

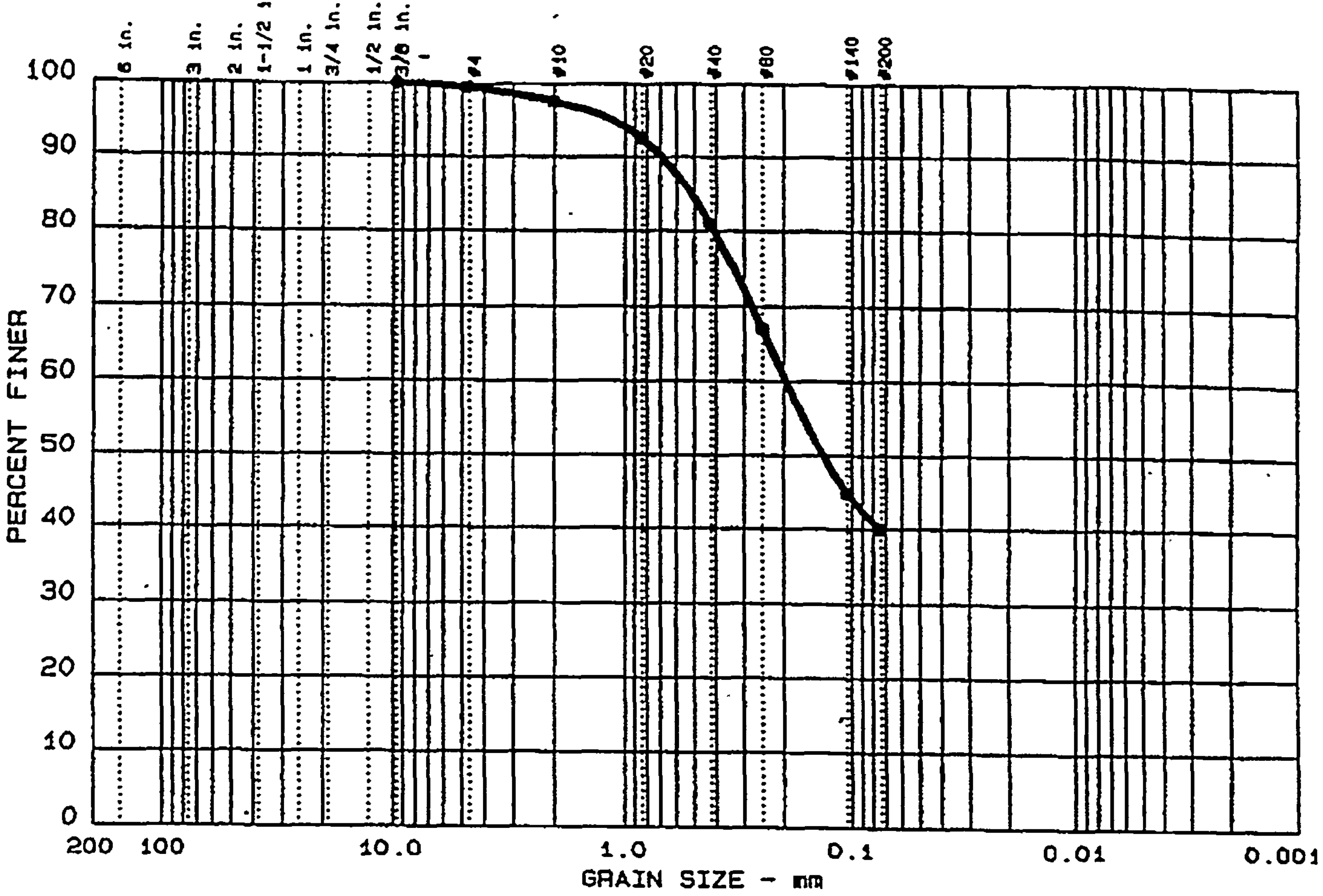
GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:
Tested by:
Reviewed by:

Figure No.

C-39

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	14	0.0	0.5	59.7	39.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	31	14	0.51	0.19	0.13					

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan & Red Brown Clayey Sand	SC	A-6(1.8)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-5 SS-6 @ 10.5-12 Ft.

Date: March 4, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:

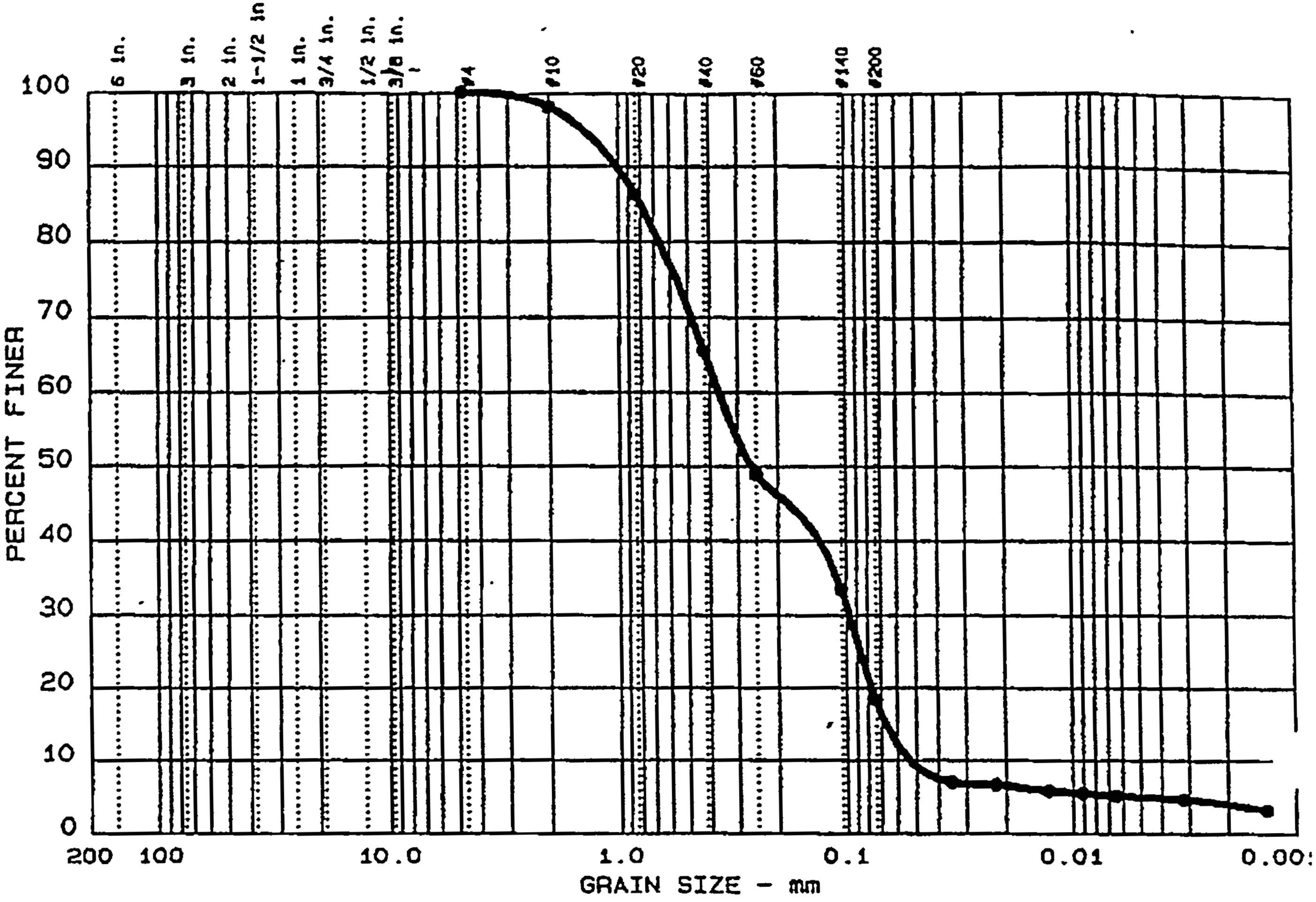
Tested by: SC

Reviewed by: HJ

Figure No.

C-40

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 16	0.0	0.0	81.6	13.4	5.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	30	10	0.79	0.36	0.26	0.097	0.0668	0.0531	0.49	6.8

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown Clayey Sand	SC	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-5 SS-12 @ 19.5-21.0 Ft.

Date: March 4, 1998

Remarks:

Tested by:

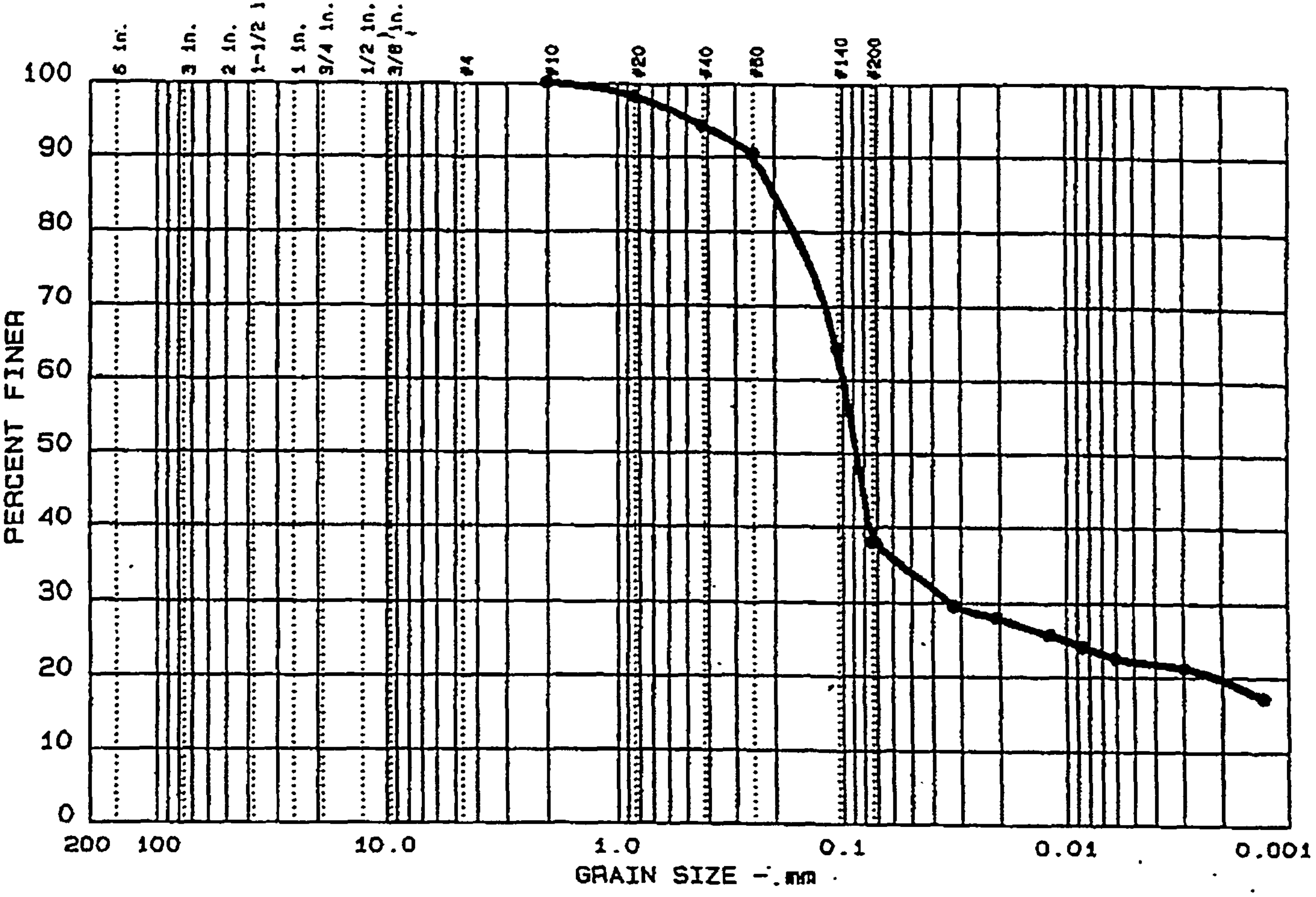
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-41

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	0.0	62.1	15.8	22.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	48	22	0.20	0.10	0.09	0.034				

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey Sand	SC	A-7-6(3.5)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
◆ Location: B-5 St-1 @ 26-28 Ft.

Date: April 6, 1998

Remarks:

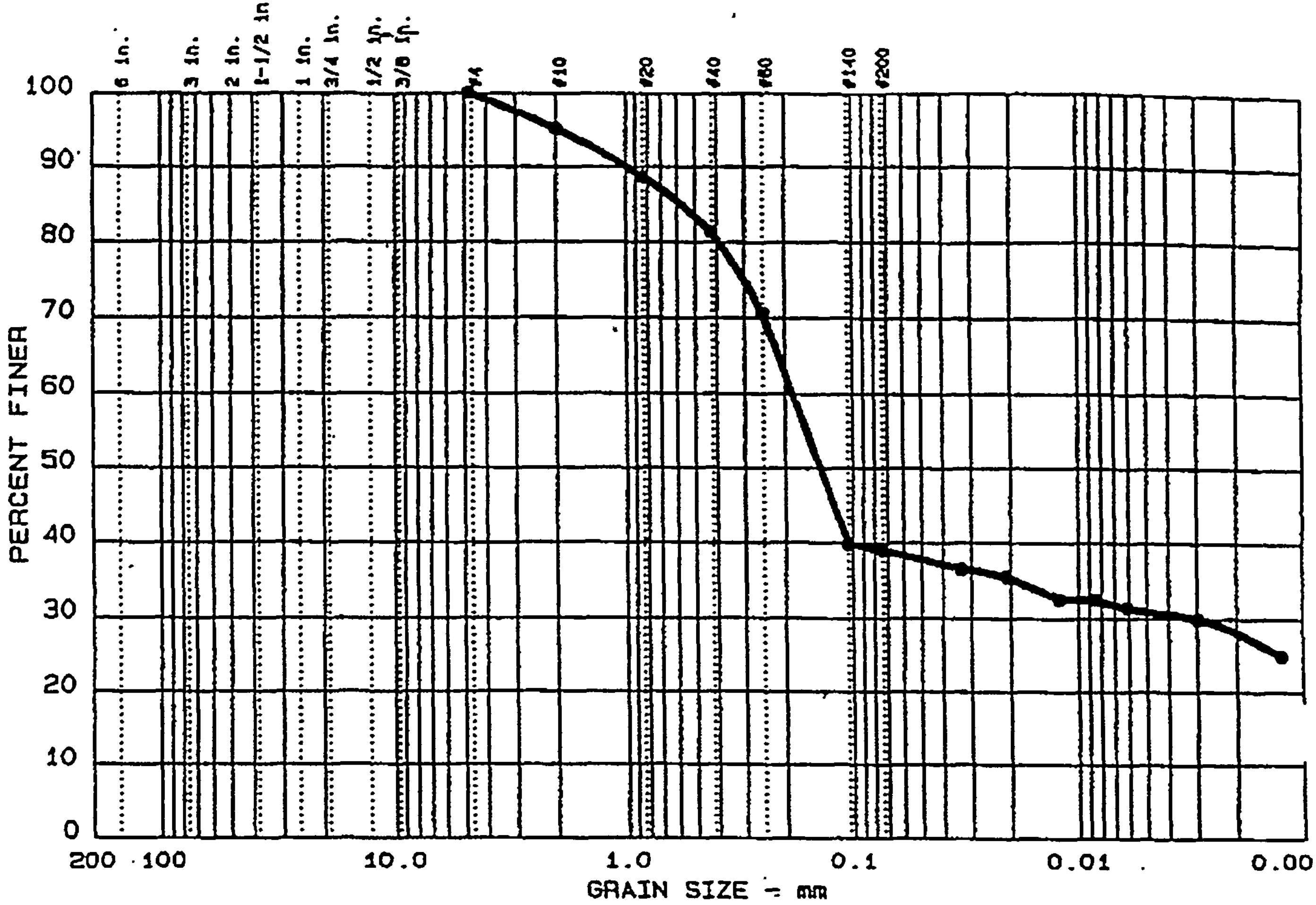
Tested by:

Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

C-42

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	0.0	61.1	8.1	30.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	40	16	0.57	0.19	0.14	0.003				

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey Sand	SC	A-6 (2.2)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-5 St-2 @ 91.5-93.5 Ft.

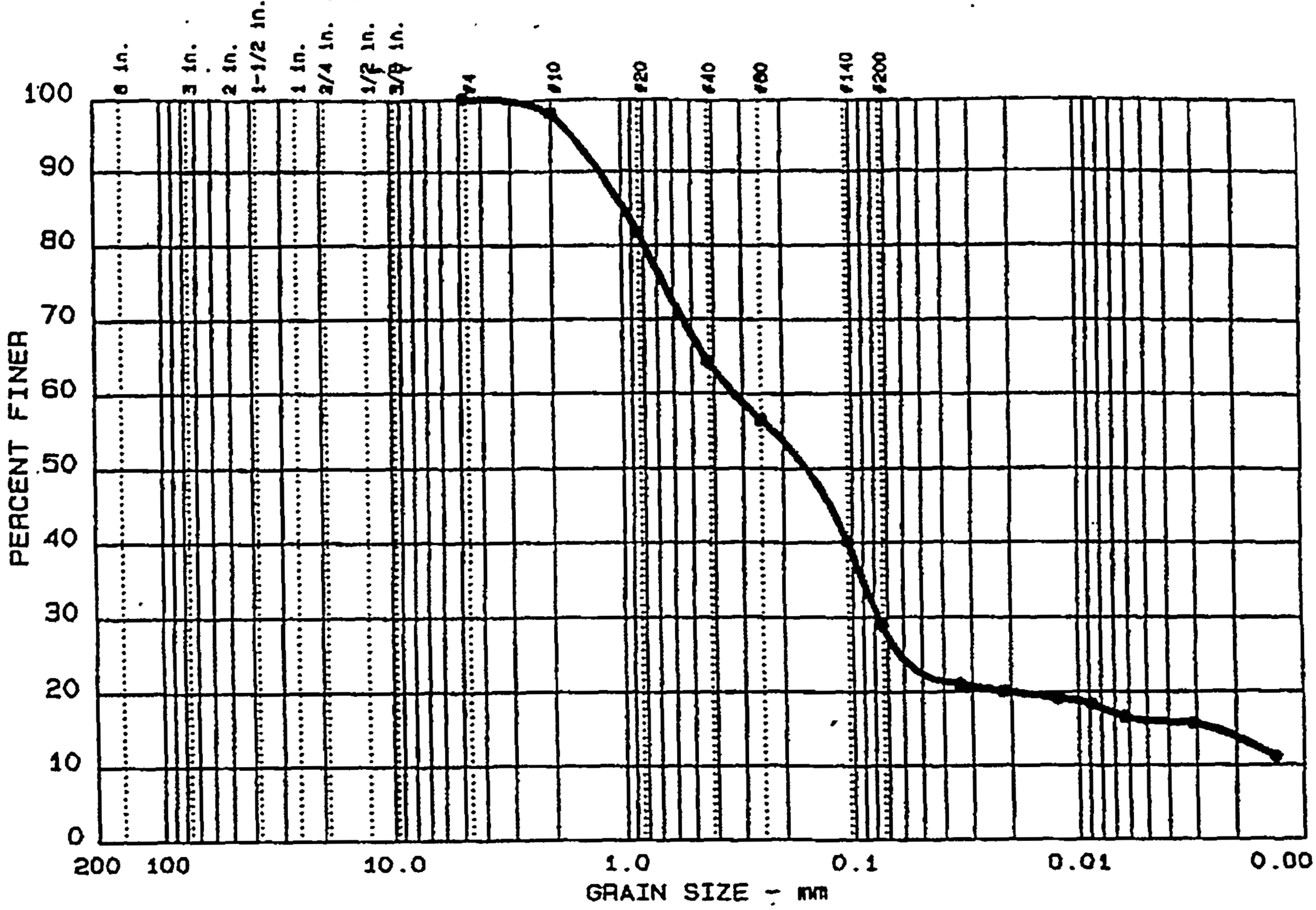
Date: April 13, 1998

Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

C-43

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	0.0	71.2	12.8	16.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	46	21	0.97	0.32	0.16	0.077	0.0024			

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey Sand	SC	A-2-7(1.5)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-6 St-1 @ 34-36 Ft.

Date: April 2, 1998

Remarks:

Tested by: SC

Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

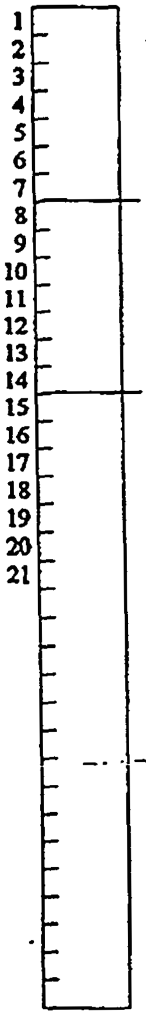
C-44

Sheet No.: 1

UNDISTURBED SAMPLE LOG

Project: Tritium Extraction Facility
Date: March 6,1998
Boring No: HTEF C9A
Sample No: Clear Tube
Depth: 123.3-125.1
Method of Sample Extrusion: Horizontal cut / Vertical extrude
At: Law Engr. - ATL
Total Length of Tube (inches), L : 21
By:
Checked By:

VISUAL DESCRIPTION



Section # 1
Brown & White Clayey Sand
to
Ditto

Moisture Content = 32.0%
Dry Density (PCF) = 92.6

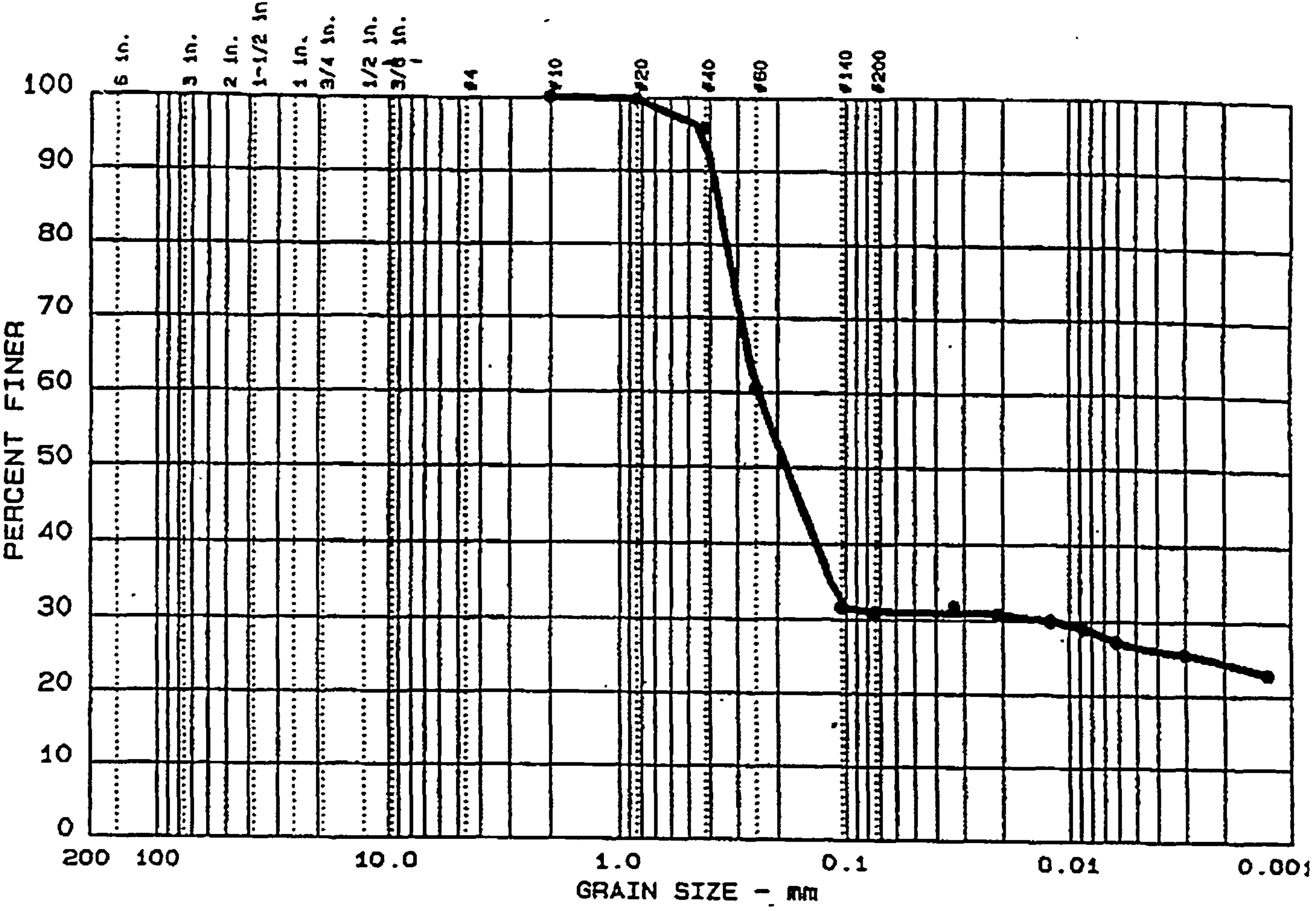
Section # 2
Brown & White Clayey Sand
to
Ditto

Moisture Contnet = 34.3%
Dry Density (PCF)= 87.6

Section # 3
Brown Silty Sand
to
Brown & White Clayey Sand

Remarks:

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	17	0.0	0.0	69.1	4.3	26.6

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	36	15	0.36	0.25	0.18	0.013				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown & White Clayey Sand	SC	A-2-6(0.8)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 123.3-125.1 Section 1

Date: March 4, 1998

Remarks:

Tested by:

Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-46

ed By: SC
Date: Febuary 27,1998

Reviewed By: HEJ
Date: March 6,1998

Job No.: 50161-7-0108
Job Name: Tritium Extraction Facility

TP-4A: UNIT WEIGHT OF SAMPLE
"TYPICAL"

Sample:
Boring No.: C9A
Depth: 122.3-125.1
Sample ID: Ud (Section # 1)

MEASUREMENTS (Nominal 6-inch cut sample height):

TOTAL SAMPLE HEIGHT (inches)			INSIDE DIAMETER OF CUT TUBE (inches)		
1	3.29				
2	3.28		top	1.37	
3	3.285		bottom	1.365	
Avg.	3.285	(H)	Avg.	1.368	(D)

MOISTURE CONTENT DETERMINATION

MOISTURE CONTENT		
Tare No.	SS-56	
Tare Weight	142.59	gm
Wet Wt. + Tare	216.24	gm
Dry Wt. + Tare	198.37	gm
Wt. of Water	17.87	gm
Dry Weight	55.78	gm
Moisture Content, *w*	32.04	%

TOTAL WEIGHT OF SOIL + TUBE SECTION	W_{s+t} =	154.76	gm
WEIGHT OF CLEAN, DRY TUBE SECTION	W_t =	0	gm
WET WEIGHT OF SOIL, $[(W_{s+t} - W_t)/454]$	W_s =	0.34	lbs
VOLUME OF SAMPLE, $[(pi*D^2/4)*H/1728]$	V =	0.00	ft^3
WET DENSITY, $[W_s / V]$	D_{DW} =	122.19	pcf
DRY DENSITY, $[D_{DW} /(1+w/100)]$	D_{DD} =	92.55	pcf

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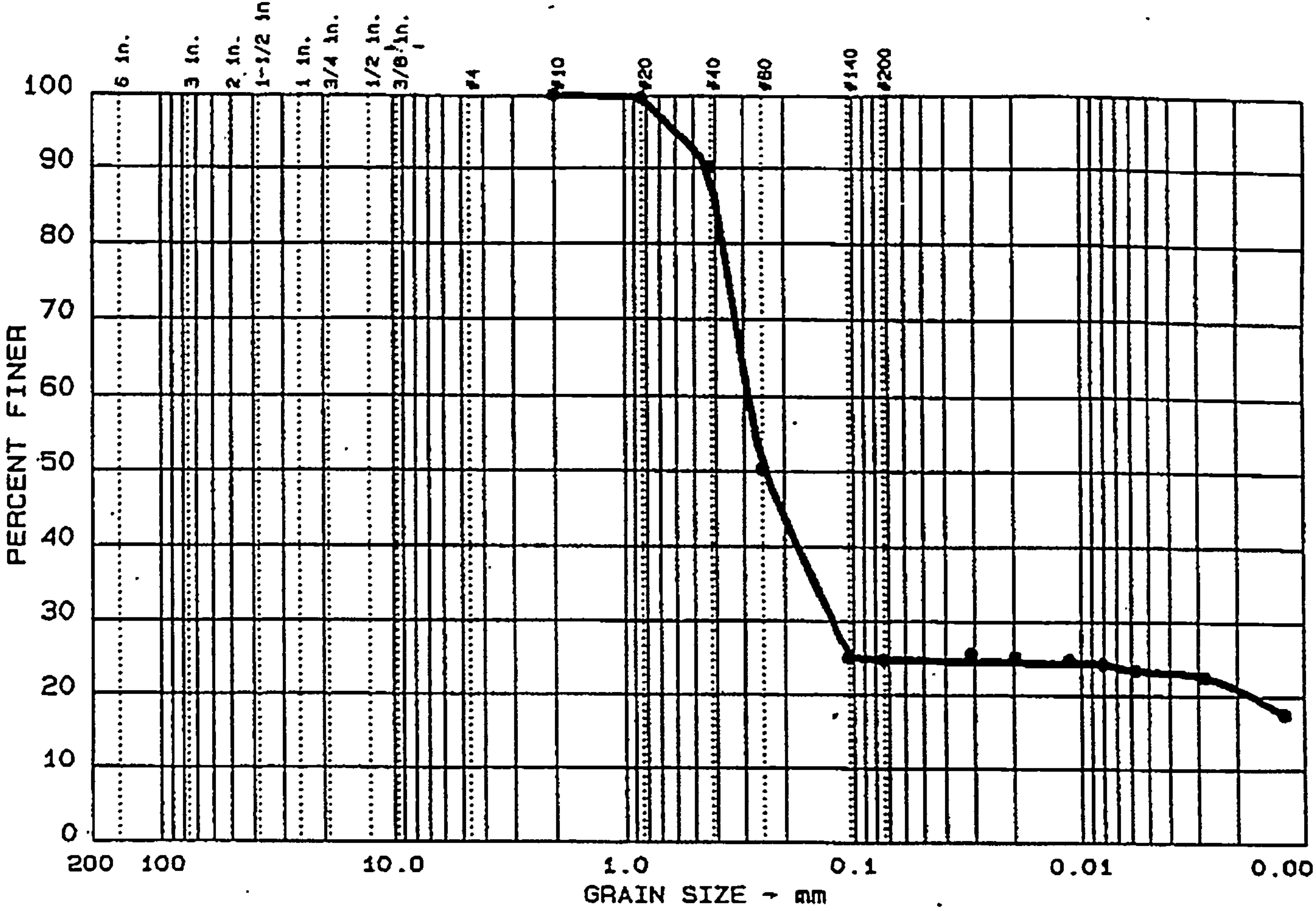
GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	0.0	75.3	1.5	23.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	33	10	0.39	0.29	0.25	0.125				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown & White Clayey Sand	SC	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 123.3-125.1 Section 2

Date: February 27, 1998

Remarks:
Tested by: SC JJ Tm
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

ted By: SC
e: Febuary 27,1998

Reviewed By: HEJ
Date: March 6,1998

Job No.: 50161-7-0108
Job Name: Tritium Extraction Facility

TP-4A: UNIT WEIGHT OF SAMPLE
"TYPICAL"

Sample:
Boring No.: C9A
Depth: 122.3-125.1
Sample ID: Ud (Section # 2)

MEASUREMENTS (Nominal 6-inch cut sample height):

TOTAL SAMPLE HEIGHT (inches)			INSIDE DIAMETER OF CUT TUBE (inches)		
1	3.28				
2	3.29		top	1.36	
3	3.29		bottom	1.36	
Avg.	3.287	(H)	Avg.	1.360	(D)

MOISTURE CONTENT DETERMINATION

MOISTURE CONTENT		
Tare No.	SS-27	
Tare Weight	97.63	gm
Wet Wt. + Tare	244.4	gm
Dry Wt. + Tare	206.9	gm
Wt. of Water	37.50	gm
Dry Weight	109.27	gm
Moisture Content, *w*	34.32	%

TOTAL WEIGHT OF SOIL + TUBE SECTION	W_{ds+t} =	147.42	gm
WEIGHT OF CLEAN, DRY TUBE SECTION	W_{dt} =	0	gm
WET WEIGHT OF SOIL, $[(W_{ds+t} - W_{dt})/454]$	W_{ds} =	0.33	lbs
VOLUME OF SAMPLE, $[(pi*D^2/4)*H/1728]$	V =	0.00	ft^3
WET DENSITY, $[W_{ds} / V]$	D_{DW} =	117.63	pcf
DRY DENSITY, $[D_{DW} /(1+w/100)]$	D_{DD} =	87.57	pcf

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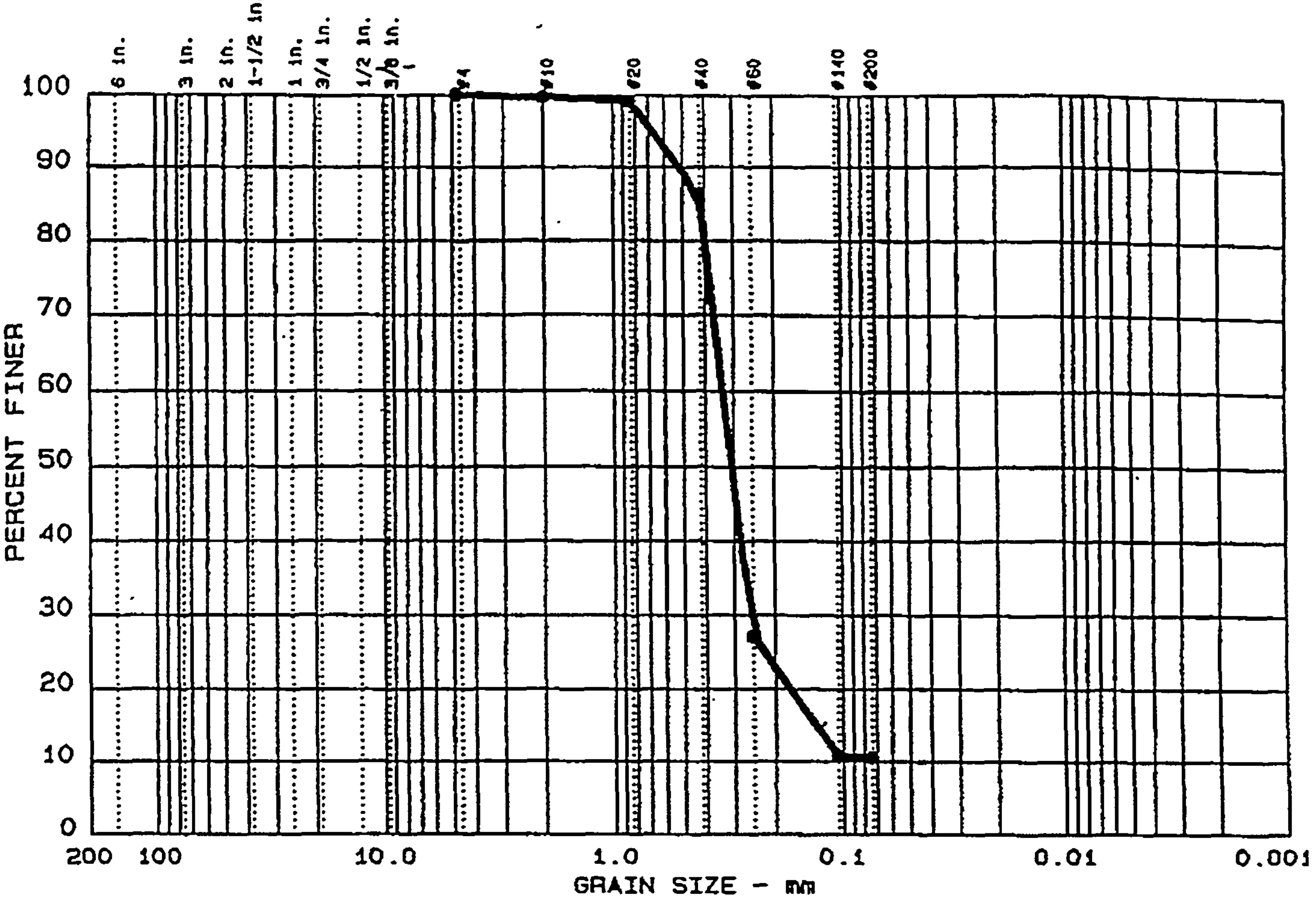
C-49

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	20	0.0	0.0	89.5	10.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.41	0.33	0.31	0.256	0.1314			

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Poorly Graded Sand with Silt	SP-SM	A-2-4(0.4)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 123.3-125.1 Section 3

Date: March 4, 1998

Remarks:
Tested by: SC
Reviewed by:

Bottom Section of Tube

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-50

Sheet No.: 1

UNDISTURBED SAMPLE LOG

Project: Tritium Extraction Facility

Date: March 6,1998

Boring No: HTEF C9A

Sample No: Clear Tube

Depth: 125.1-127

Method of Sample Extrusion: Horizontal cut / Vertical extrude

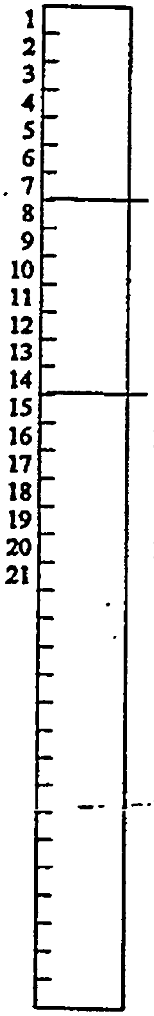
At: Law Engr. - ATL

Total Length of Tube (inches), L: 21

By: Hb

Checked By:

VISUAL DESCRIPTION



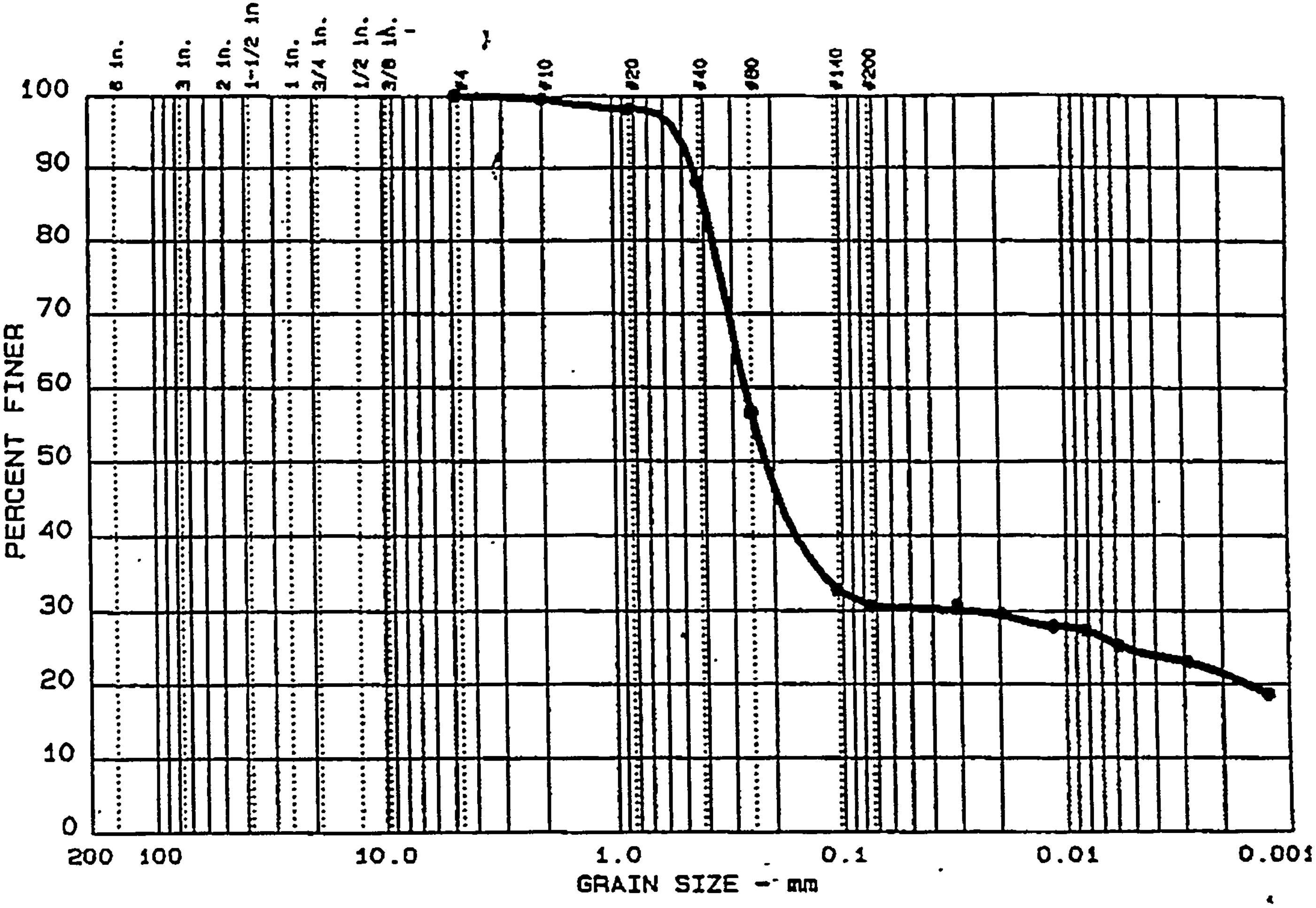
Section # 1 Brown & White Clayey Sand to Ditto	Moisture Content = 46.3% Dry Density (PCF) = 74.7
Section # 2 Brown Clayey Sand to Ditto	Moisture Contnet = 36.8% Dry Density (PCF)= 85.8
Section # 3 Brown Clayey Sand to Brown Clayey Sand	Moisture Content = 48.4% Dry Density (PCF)= 73.8

Remarks:

soil\forms\tubelog.wk3

C-51

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.0	69.5	6.0	24.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	63	32	0.39	0.26	0.22	0.037				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown & White Clayey Sand	SC	A-2-7 (3.3)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 125.1-127 Section 1

Date: February 27, 1998

Remarks:
Tested by: SC+JTm
Reviewed by: HD

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING INC

C-52

Tested By: SC
ute: Febuary 27,1998

Reviewed By: HEJ
Date: March 6,1998

Job No.: 50161-7-0108
Job Name: Tritium Extraction Facility

TP-4A: UNIT WEIGHT OF SAMPLE
"TYPICAL"

Sample:
Boring No.: C9A
Depth: 125.1-127
Sample ID: Ud (Section # 1)

MEASUREMENTS (Nominal 6-inch cut sample height):

TOTAL SAMPLE HEIGHT (inches)			INSIDE DIAMETER OF CUT TUBE (inches)		
1	3.3				
2	3.31		top	1.35	
3	3.29		bottom	1.342	
Avg.	3.300	(H)	Avg.	1.346	(D)

MOISTURE CONTENT DETERMINATION

MOISTURE CONTENT		
Tare No.	SS-9	
Tare Weight	89.53	gm
Wet Wt. + Tare	221.49	gm
Dry Wt. + Tare	179.71	gm
Wt of Water	41.78	gm
Dry Weight	90.18	gm
Moisture Content, *w*	46.33	%

TOTAL WEIGHT OF SOIL + TUBE SECTION	W_{ds+t} =	134.65	gm
WEIGHT OF CLEAN, DRY TUBE SECTION	W_{dt} =	0	gm
WET WEIGHT OF SOIL, $[(W_{ds+t} - W_{dt})/454]$	W_{ds} =	0.30	lbs
VOLUME OF SAMPLE, $[(pi*D^2/4)*H/1728]$	V =	0.00	ft^3
WET DENSITY, $[W_{ds} / V]$	D_{DW} =	109.24	pcf
DRY DENSITY, $[D_{DW} /(1+w/100)]$	D_{DD} =	74.65	pcf

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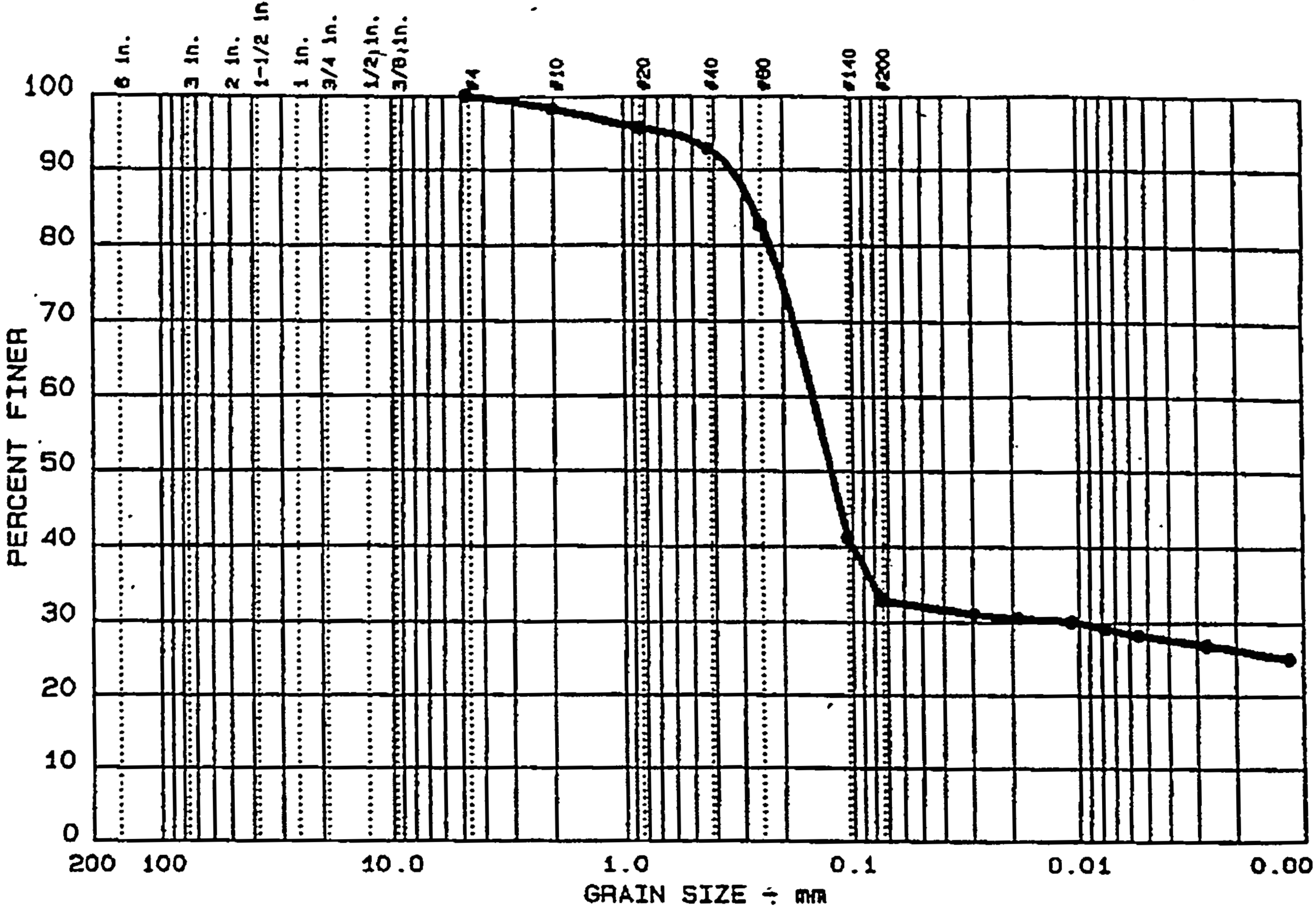
C-53

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	0.0	67.2	4.7	28.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	62	37	0.27	0.15	0.12	0.010				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Clayey Sand	SC	A-2-7 (4.9)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 125.1-127 Section 2

Date: March 4, 1998

Remarks:
Tested by: SCJ JTm
Reviewed by: HJ

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC

Tested By: SC
ite: Febuary 27,1998

Reviewed By: HEJ
Date: March 6,1998

Job No.: 50161-7-0108
Job Name: Tritium Extraction Facility

TP-4A: UNIT WEIGHT OF SAMPLE

"TYPICAL"

Sample:
Boring No.: C9A
Depth: 125.1-127
Sample ID: Ud (Section # 2)

MEASUREMENTS (Nominal 6-inch cut sample height):

TOTAL SAMPLE HEIGHT (inches)			INSIDE DIAMETER OF CUT TUBE (inches)		
1	3.29				
2	3.29		top	1.368	
3	3.29		bottom	1.365	
Avg.	3.290	(H)	Avg.	1.367	(D)

MOISTURE CONTENT DETERMINATION

MOISTURE CONTENT		
Tare No.	SS-20	
Tare Weight	89.14	gm
Wet Wt. + Tare	237.35	gm
Dry Wt. + Tare	197.48	gm
Wt. of Water	39.87	gm
Dry Weight	108.34	gm
Moisture Content, *w*	36.80	%

TOTAL WEIGHT OF SOIL + TUBE SECTION	W_{ds+t} =	148.67	gm
WEIGHT OF CLEAN, DRY TUBE SECTION	W_{dt} =	0	gm
WET WEIGHT OF SOIL, [$(W_{ds+t} - W_{dt})/454$]	W_{ds} =	0.33	lbs
VOLUME OF SAMPLE, [$(pi*D^2/4)*H/1728$]	V =	0.00	ft^3
WET DENSITY, [W_{ds} / V]	D_{DW} =	117.38	pcf
DRY DENSITY, [$D_{DW} /(1+w/100)$]	D_{DD} =	85.80	pcf

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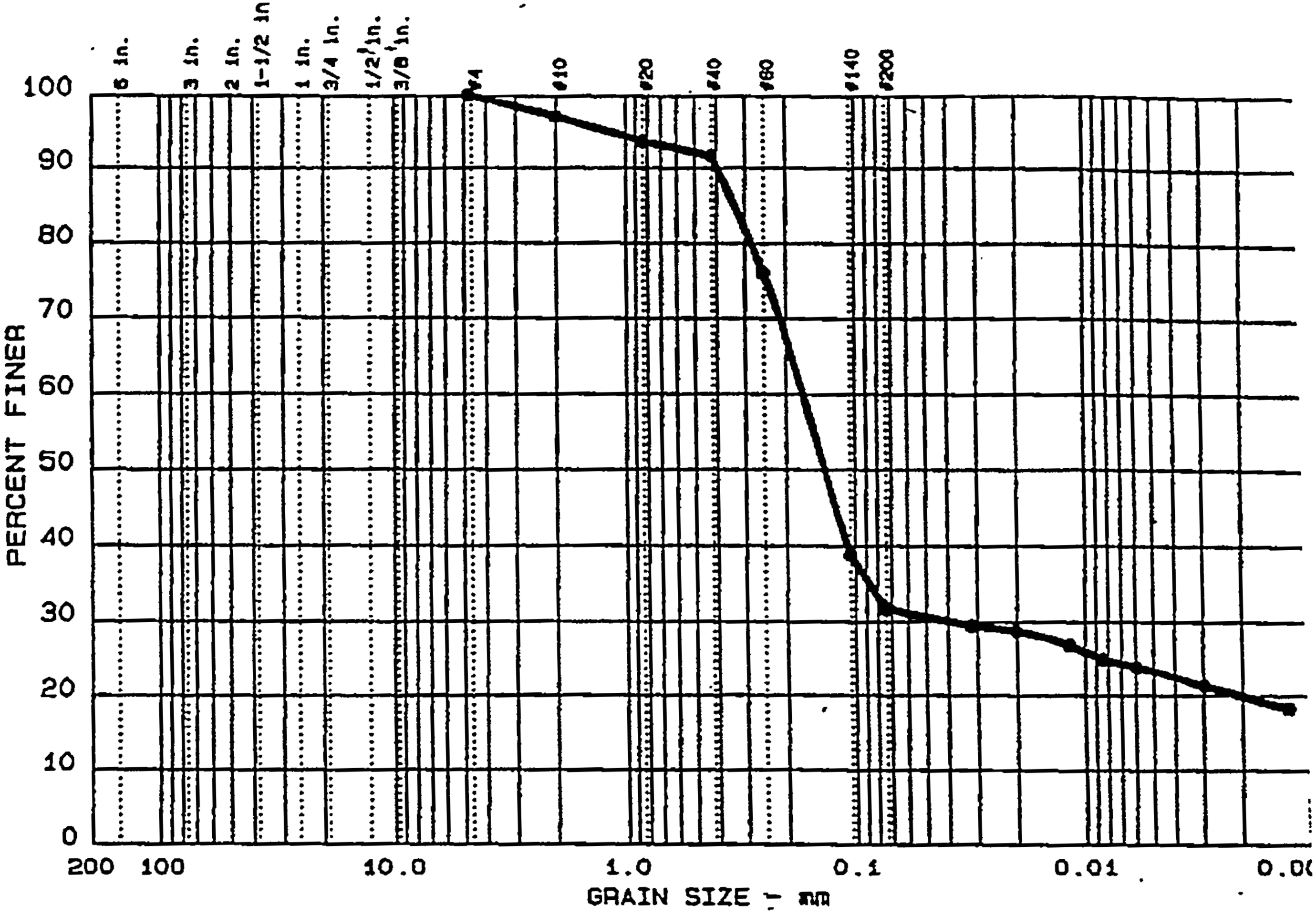
C-55

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	19	0.0	0.0	68.5	8.3	23.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	53	27	0.33	0.17	0.14	0.041				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Clayey Sand	SC	A-2-7 (2.9)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF C9A Ud @ 125.1-127 Section 3

Date: March 4, 1998

Remarks:

Tested by:

Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

C-56

Tested By: SC
Date: Febuary 27,1998

Reviewed By: HEJ
Date: March 6,1998

Job No.: 50161-7-0108
Job Name: Tritium Extraction Facility

TP-4A: UNIT WEIGHT OF SAMPLE
"TYPICAL"

Sample:
Boring No.: C9A
Depth: 125.1-127
Sample ID: Ud (Section # 3)

MEASUREMENTS (Nominal 6-inch cut sample height):

TOTAL SAMPLE HEIGHT (inches)			INSIDE DIAMETER OF CUT TUBE (inches)		
1	2.8				
2	2.8		top	1.37	
3	2.8		bottom	1.365	
Avg.	2.800	(H)	Avg.	1.368	(D)

MOISTURE CONTENT DETERMINATION

MOISTURE CONTENT		
Tare No.	SS-23	
Tare Weight	97.21	gm
Wet Wt. + Tare	214.91	gm
Dry Wt. + Tare	176.53	gm
Wt. of Water	38.38	gm
Dry Weight	79.32	gm
Moisture Content, *w*	48.39	%

TOTAL WEIGHT OF SOIL + TUBE SECTION	W_{s+t} =	118.28	gm
WEIGHT OF CLEAN, DRY TUBE SECTION	W_{t} =	0	gm
WET WEIGHT OF SOIL, $[(W_{s+t} - W_{t})/454]$	W_{ws} =	0.26	lbs
VOLUME OF SAMPLE, $[(pi*D^2/4)*H/1728]$	V =	0.00	ft^3
WET DENSITY, $[W_{ws} / V]$	D_{DW} =	109.57	pcf
DRY DENSITY, $[D_{DW} /(1+w/100)]$	D_{DD} =	73.84	pcf

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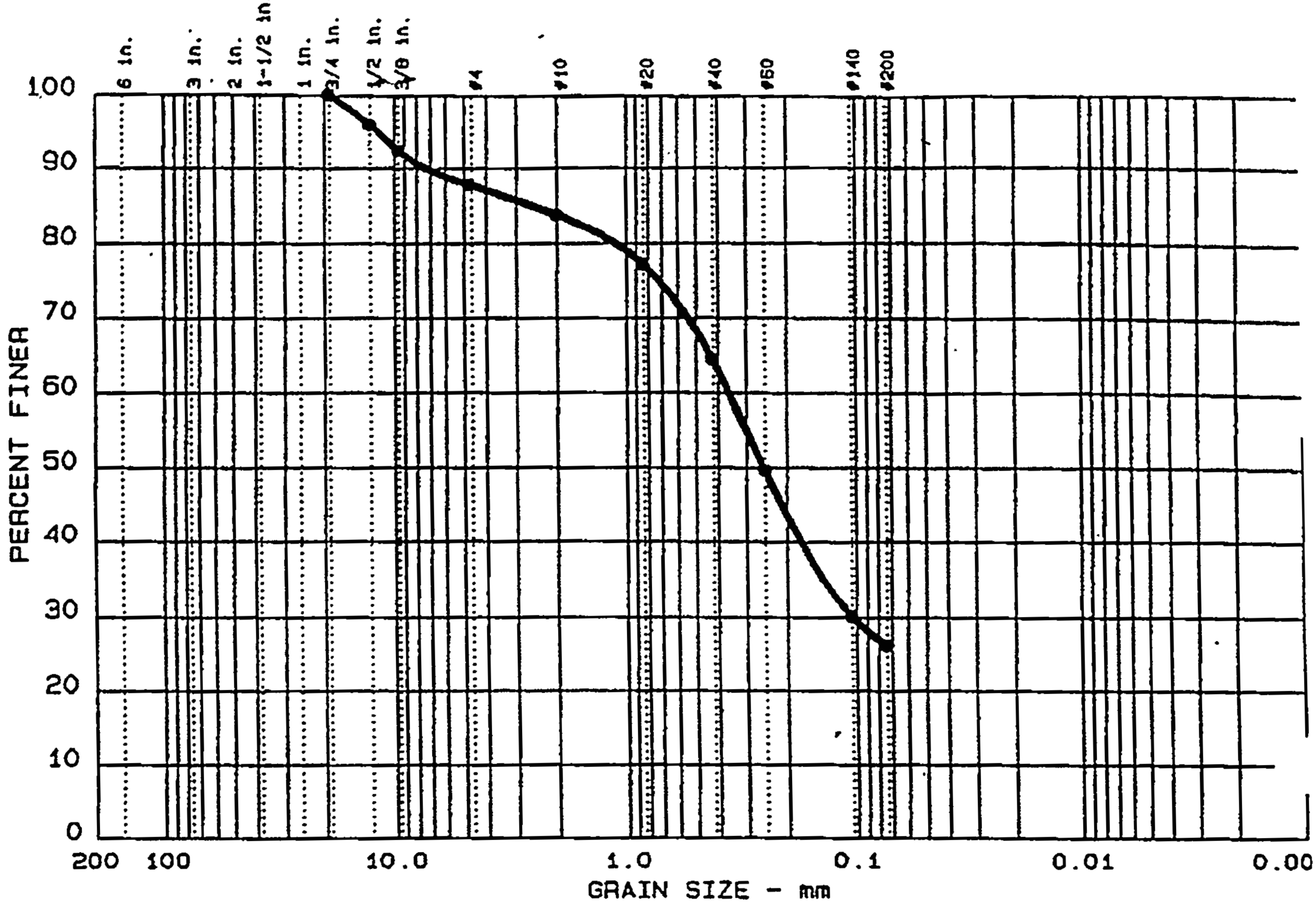
C-51

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	12.2	61.7	26.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			2.57	0.35	0.25	0.104				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand with Gravel	SM	A-2-4(0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: CPT-1 Bag @ 3

Date: Jan. 28, 1998

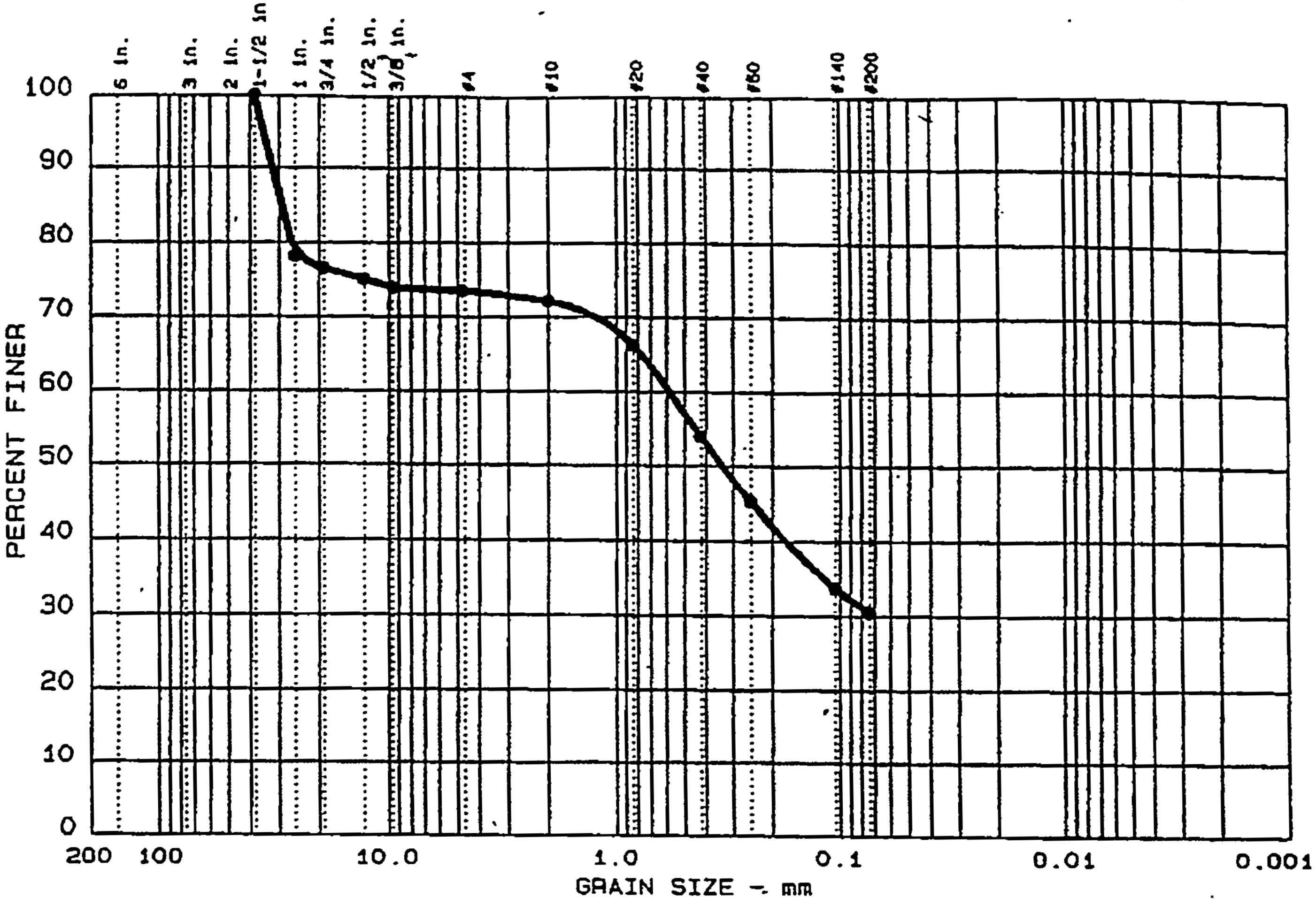
Remarks:
Tested by: SC
Reviewed by: HS

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

C-58

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	26.6	43.1	30.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●		-	28.84	0.58	0.33					

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand with Gravel	SM	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: CPT-3 Bag @ 3 Ft.

Date: Jan. 28, 1998

Remarks:

Tested by: SC

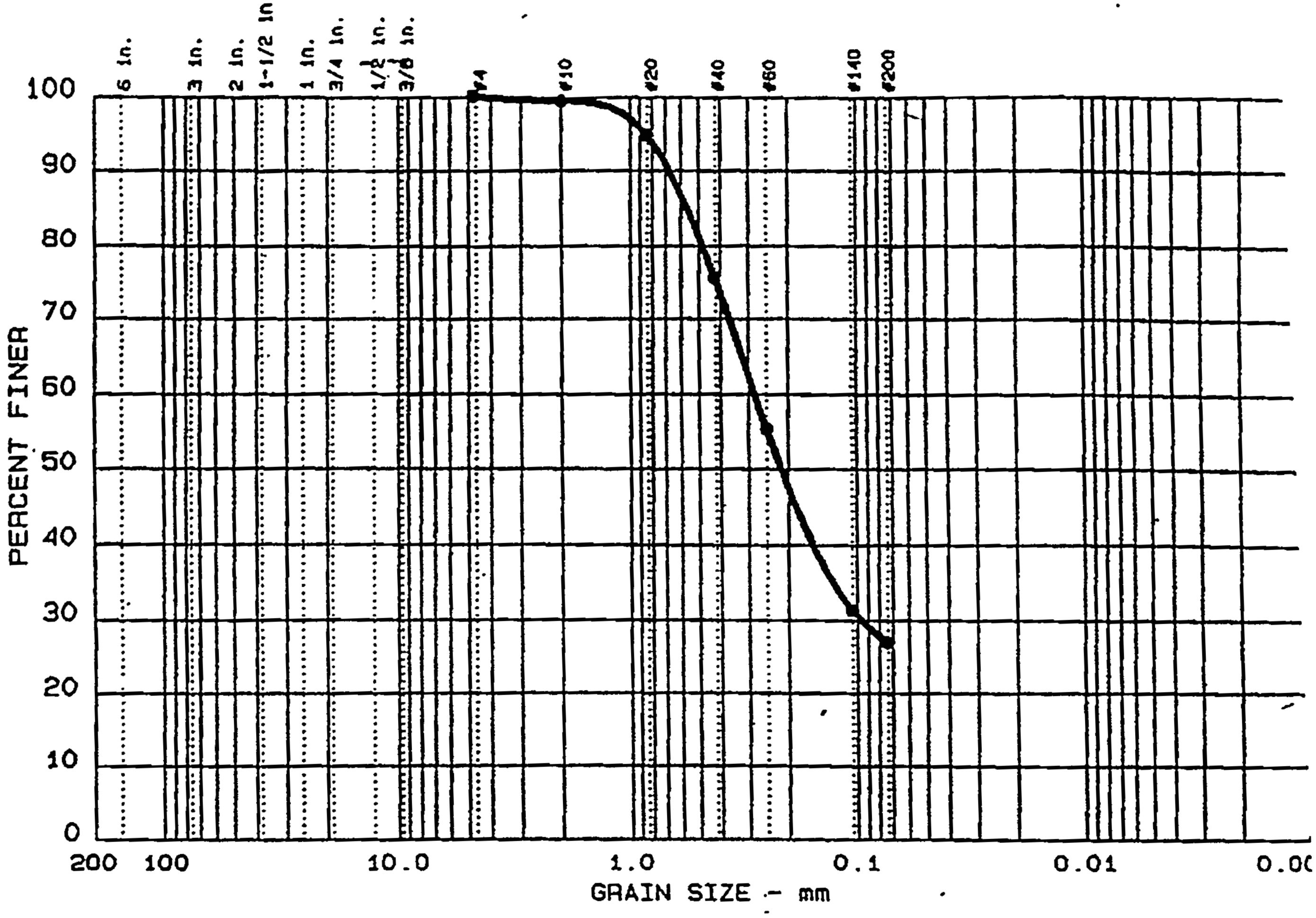
Reviewed by: HB

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

C-59

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	0.0	73.1	26.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●		--	0.55	0.28	0.22	0.096				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-4(0.0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: CPT-4 Bag @ 3 Ft.

Date: Jan.15, 1998

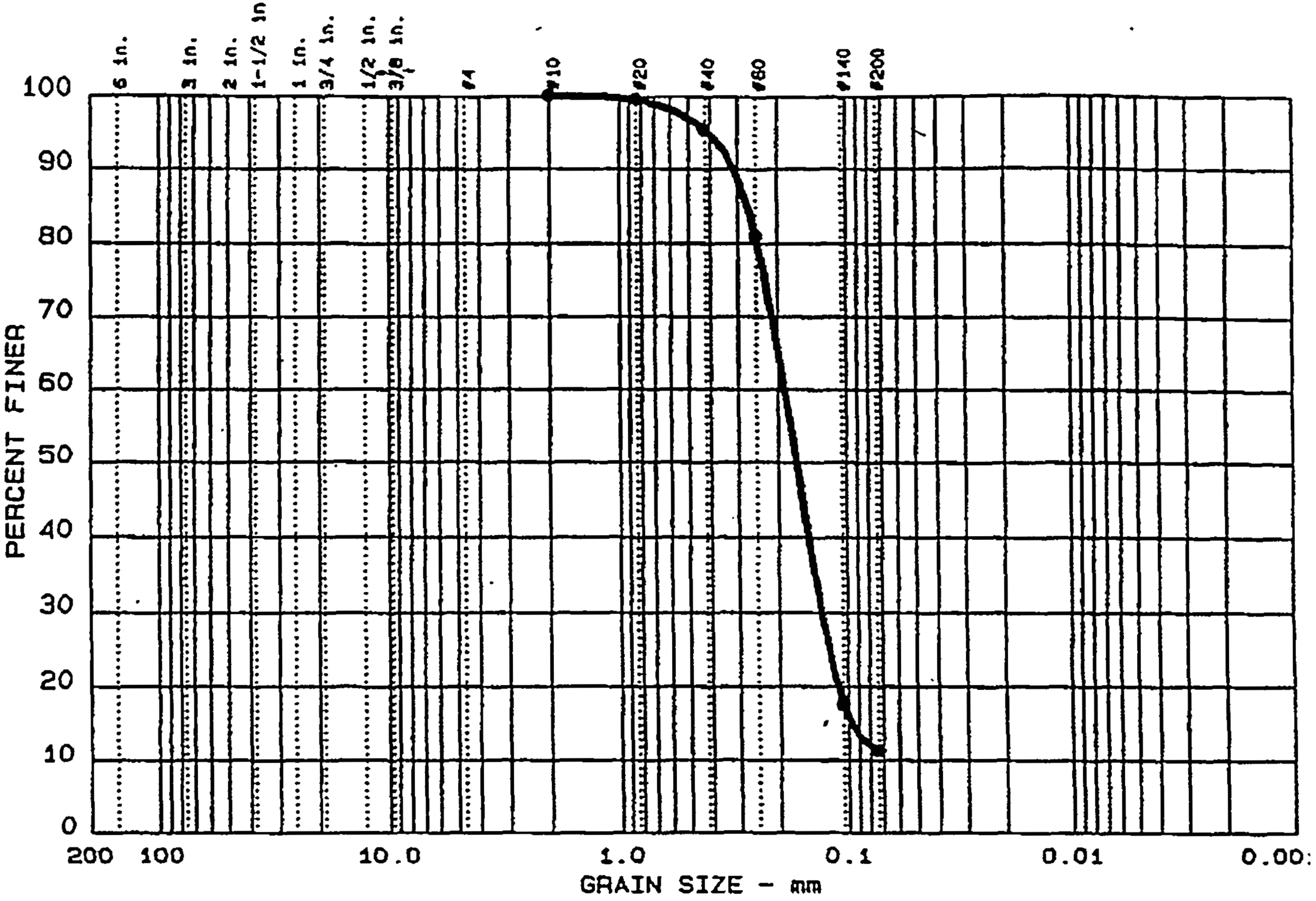
Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

C-60

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	0.0	88.6	11.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	41	14	0.27	0.19	0.17	0.130	0.0965			

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Poorly Graded Sand with Silt	SP-SM	A-2-7 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
◆ Location: HTEF B-4 SS-16 @ 44 Ft.

Date: March 4, 1998

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:

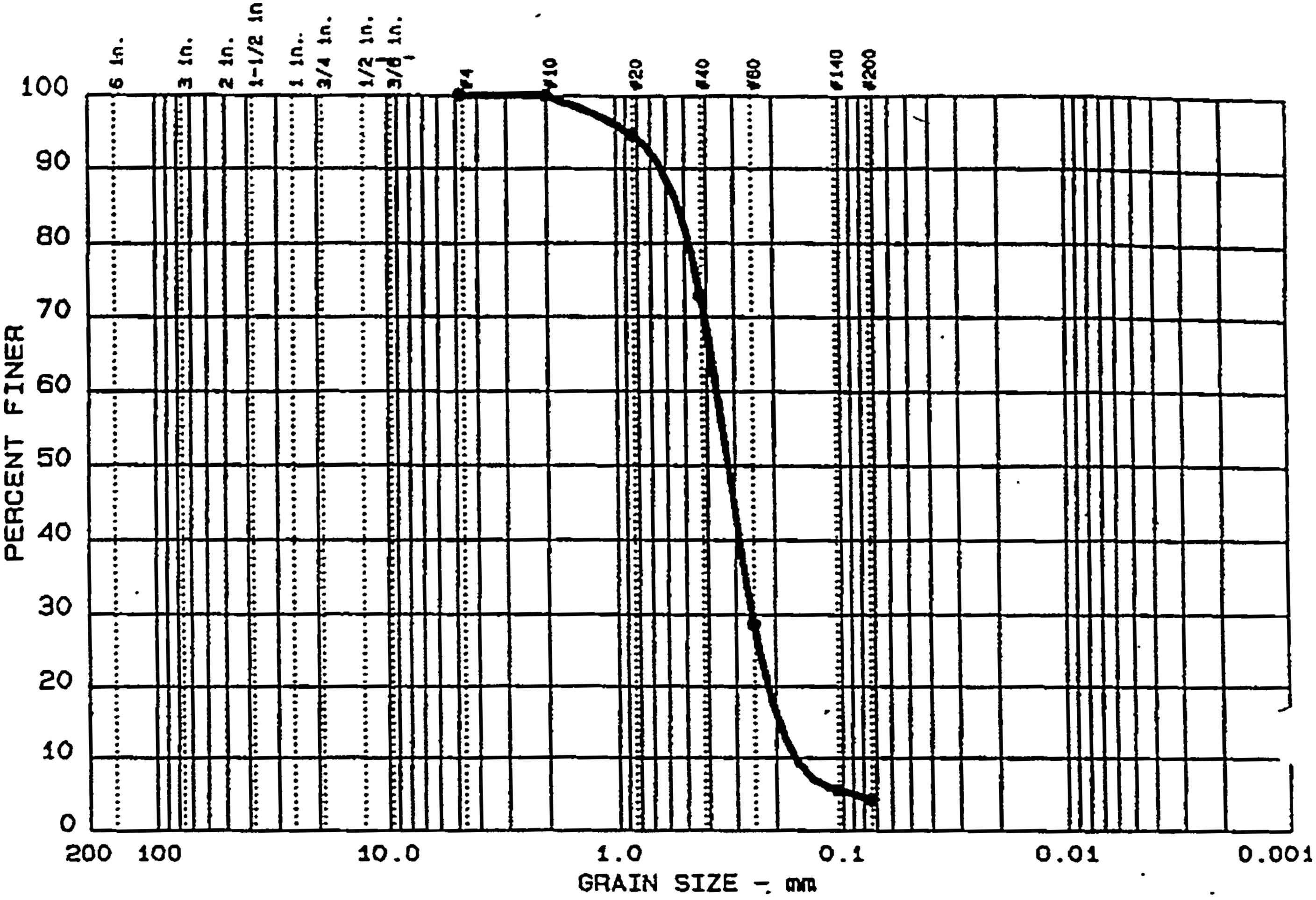
Tested by: JTm+SC

Reviewed by:

Figure No.

C-61

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.0	95.7	4.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.52	0.36	0.32	0.255	0.1945	0.1637	1.11	2.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Poorly Graded Sand	SP	A-3

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 SS-30 @ 117 Ft.

Date: March 4, 1998

Remarks:

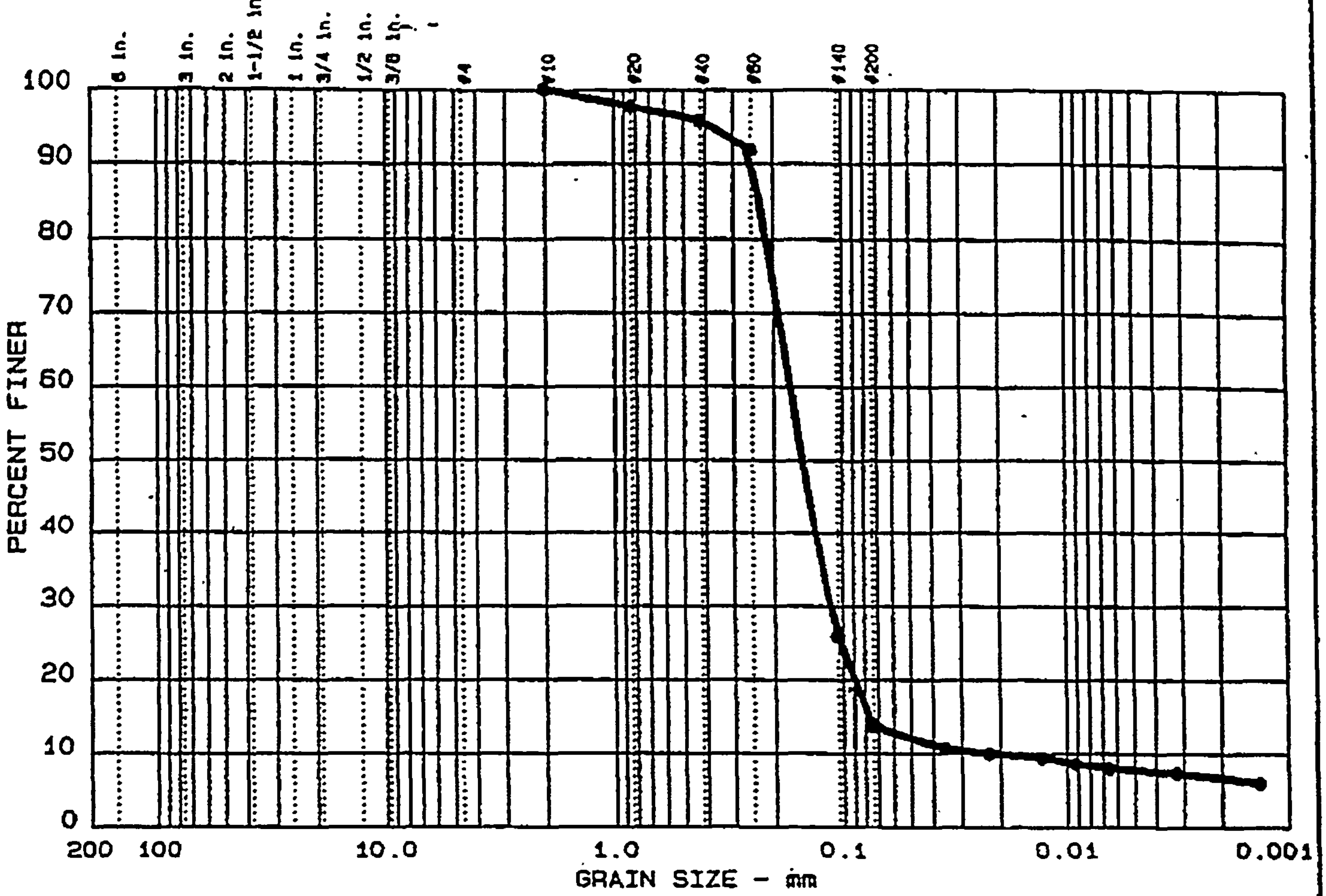
Tested by: JTM-SC

Reviewed by: HJ

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.0	86.3	5.9	7.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.23	0.17	0.15	0.113	0.0768	0.0197	3.80	8.6

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Silty Sand	SM	A-2-4(0.1)

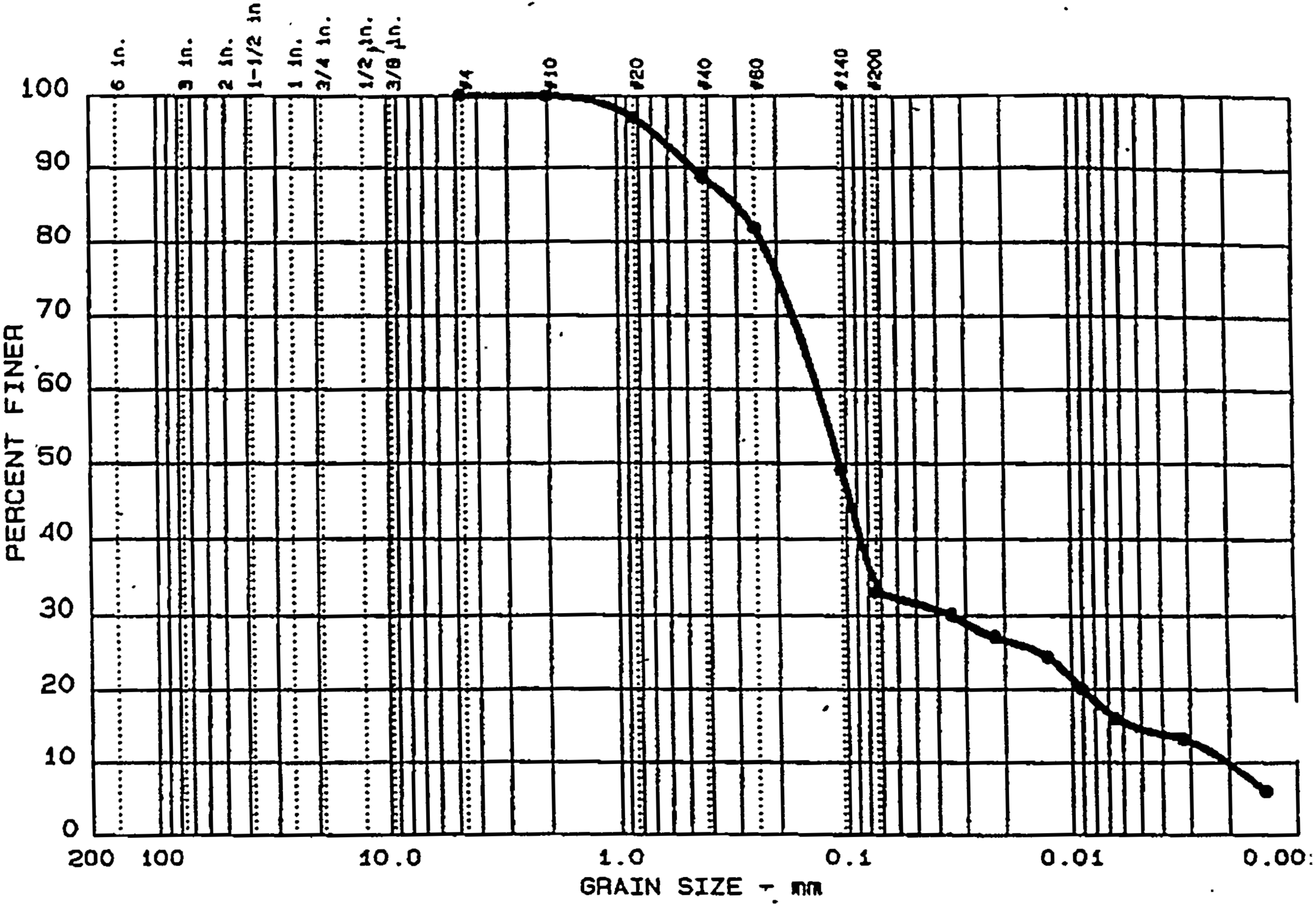
Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 ST-8 @ 132.5-134.5 Ft.

Date: March 25, 1998

Remarks:
Tested by: JTM
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING INC

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.0	67.1	18.4	14.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	0.30	0.13	0.11	0.034	0.0056	0.0020	4.37	66.1

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Sand	SM	A-2-4 (0.0)

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
● Location: HTEF B-4 St-9 @ 138 Ft.

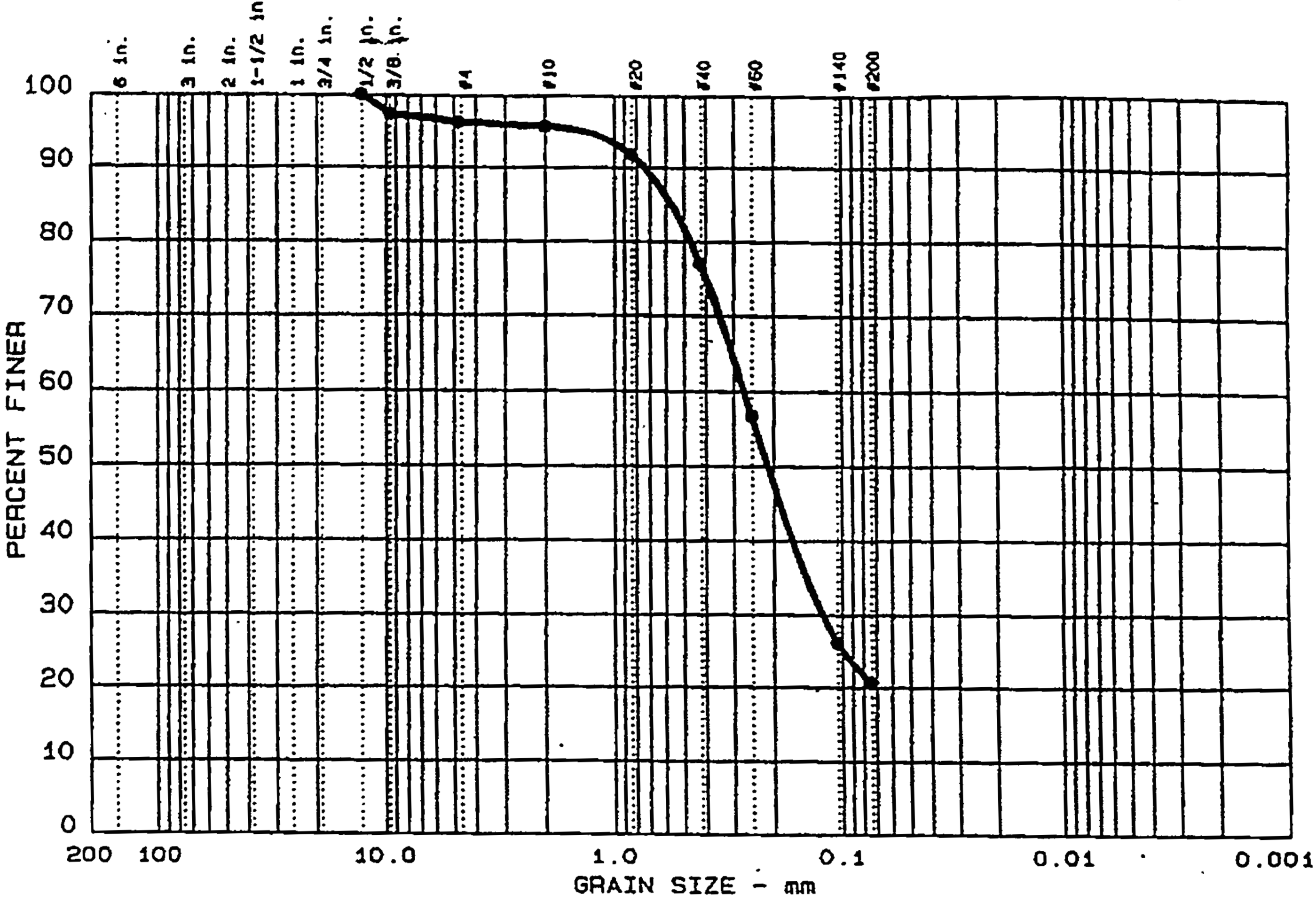
Date: April 9, 1998

Remarks:
Tested by: SC
Reviewed by:

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	19	0.0	3.7	75.6	20.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.56	0.27	0.21	0.123				

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Brown Silty Sand	SM	A-2-4 (0.0)

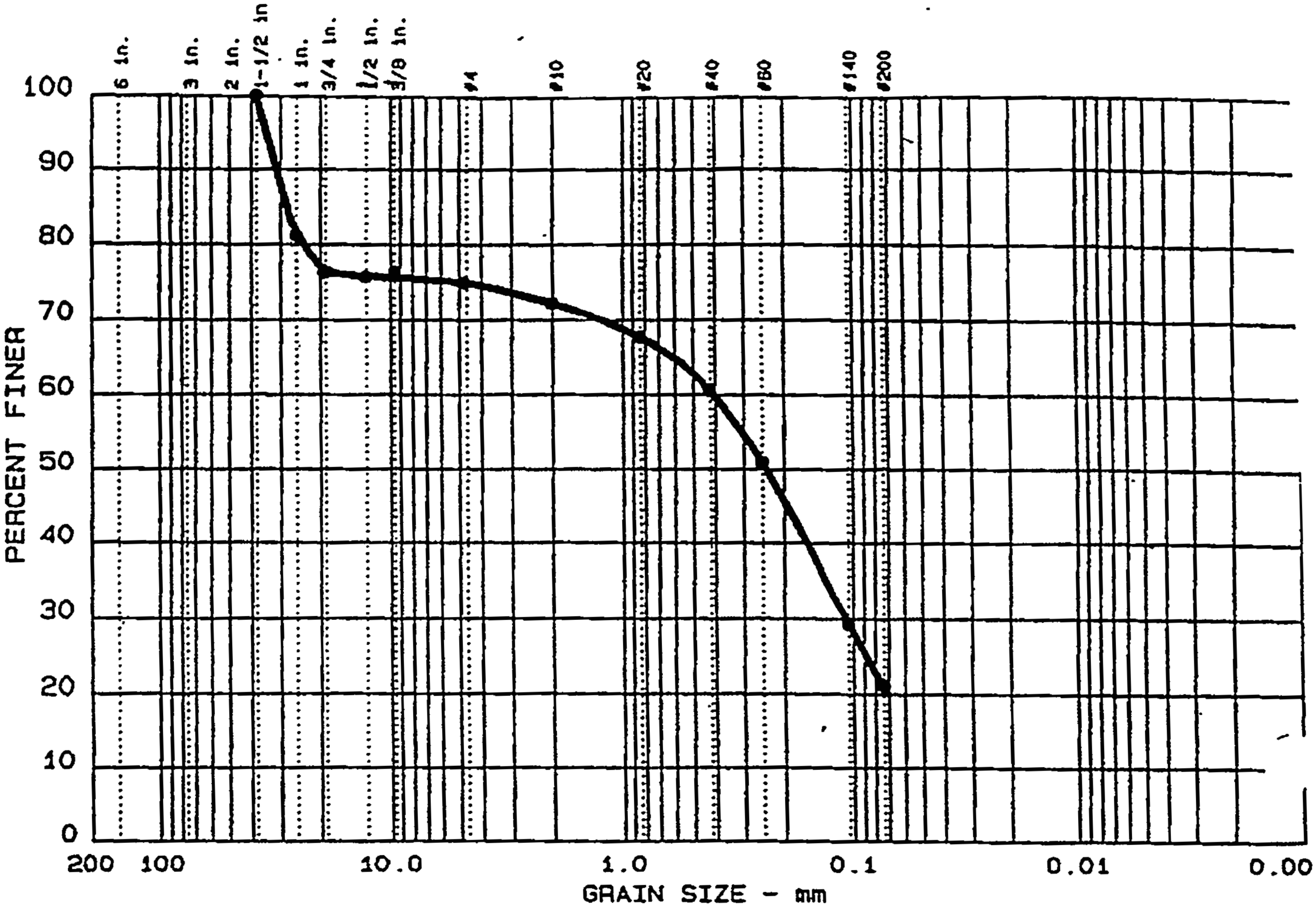
Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: CPT-7 Bag @ 3 Ft.

Date: Jan. 15, 1998

Remarks:
Tested by: SC
Reviewed by:

C-65

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	20	0.0	25.1	53.8	21.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			27.83	0.40	0.24	0.108				

MATERIAL DESCRIPTION	USCS	AASHTO
● Red Brown Silty Sand with Gravel	SM	A-2-4 (0.0)

Project No.: 50161-7-0108.12
Project: Tritium Extraction Facility
● Location: CPT-12 Bag @ 3 Ft.

Date: Jan. 15, 1998

Remarks:

Tested by: SC

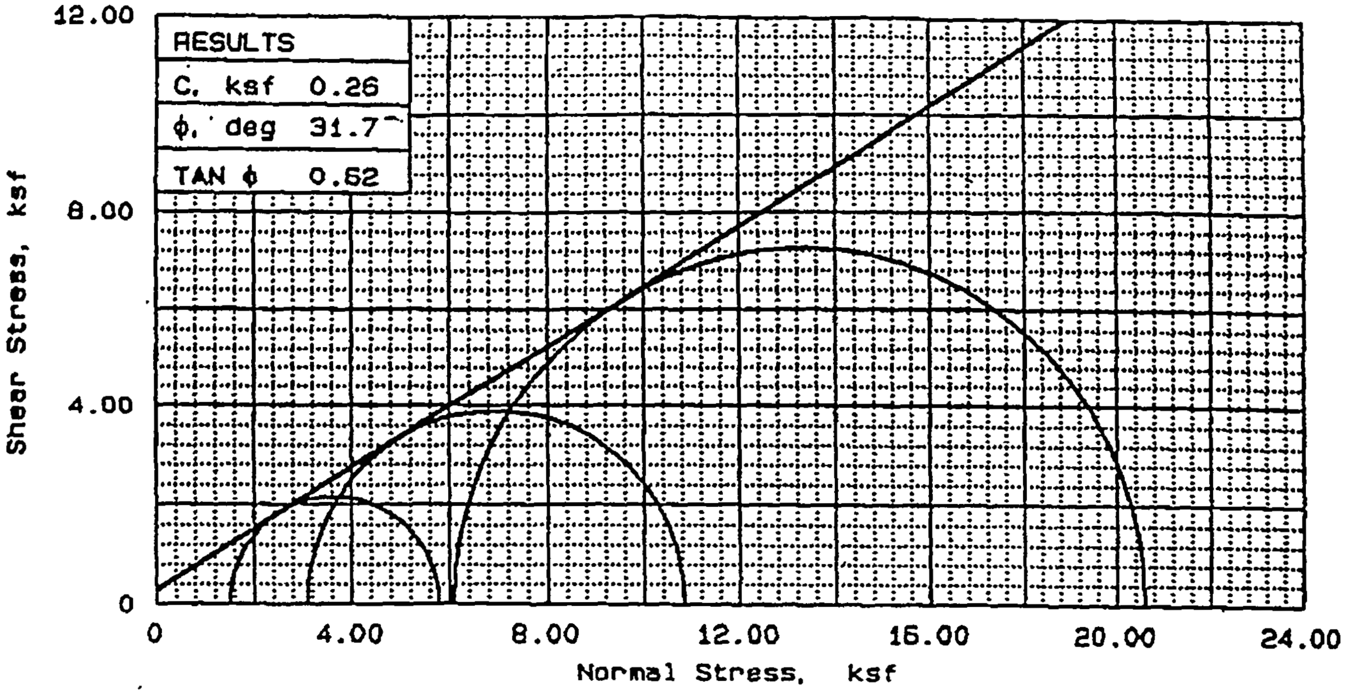
Reviewed by:

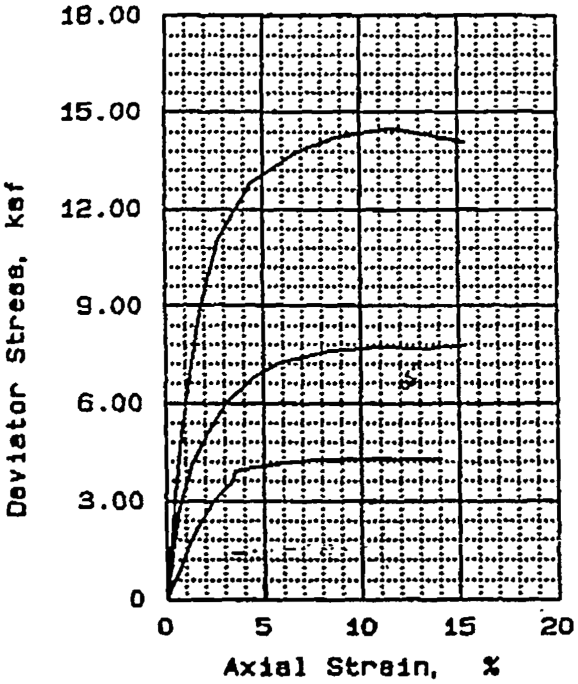
GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

Figure No.

C-66





	SAMPLE NO.	1	2	3
INITIAL	WATER CONTENT, %	22.5	21.5	23.1
	DRY DENSITY, pcf	97.7	97.9	95.8
	SATURATION, %	84.0	80.3	82.3
	VOID RATIO	0.724	0.721	0.760
	DIAMETER, in	2.85	2.84	2.86
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	25.6	24.7	27.0
	DRY DENSITY, pcf	99.7	101.1	97.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.691	0.667	0.729
	DIAMETER, in	2.83	2.81	2.85
	HEIGHT, in	5.97	5.96	5.94
	BACK PRESSURE, ksf	2.88	2.88	2.88
	CELL PRESSURE, ksf	4.38	5.98	8.99
	FAILURE STRESS, ksf.	4.29	7.76	14.49
	PORE PRESSURE, ksf			
	STRAIN RATE, %/min.	0.100	0.100	0.100
	ULTIMATE STRESS, ksf			
	PORE PRESSURE, ksf			
	σ_1 FAILURE, ksf	5.79	10.85	20.60
	σ_3 FAILURE, ksf	1.5	3.1	6.11

TYPE OF TEST:
Consolidated drained

SAMPLE TYPE: UD

DESCRIPTION: Brown Silty Sand

LL- PL- PI-

SPECIFIC GRAVITY- 2.70

REMARKS: Tested by: JTM

Reviewed by:

FIG. NO.

CLIENT:

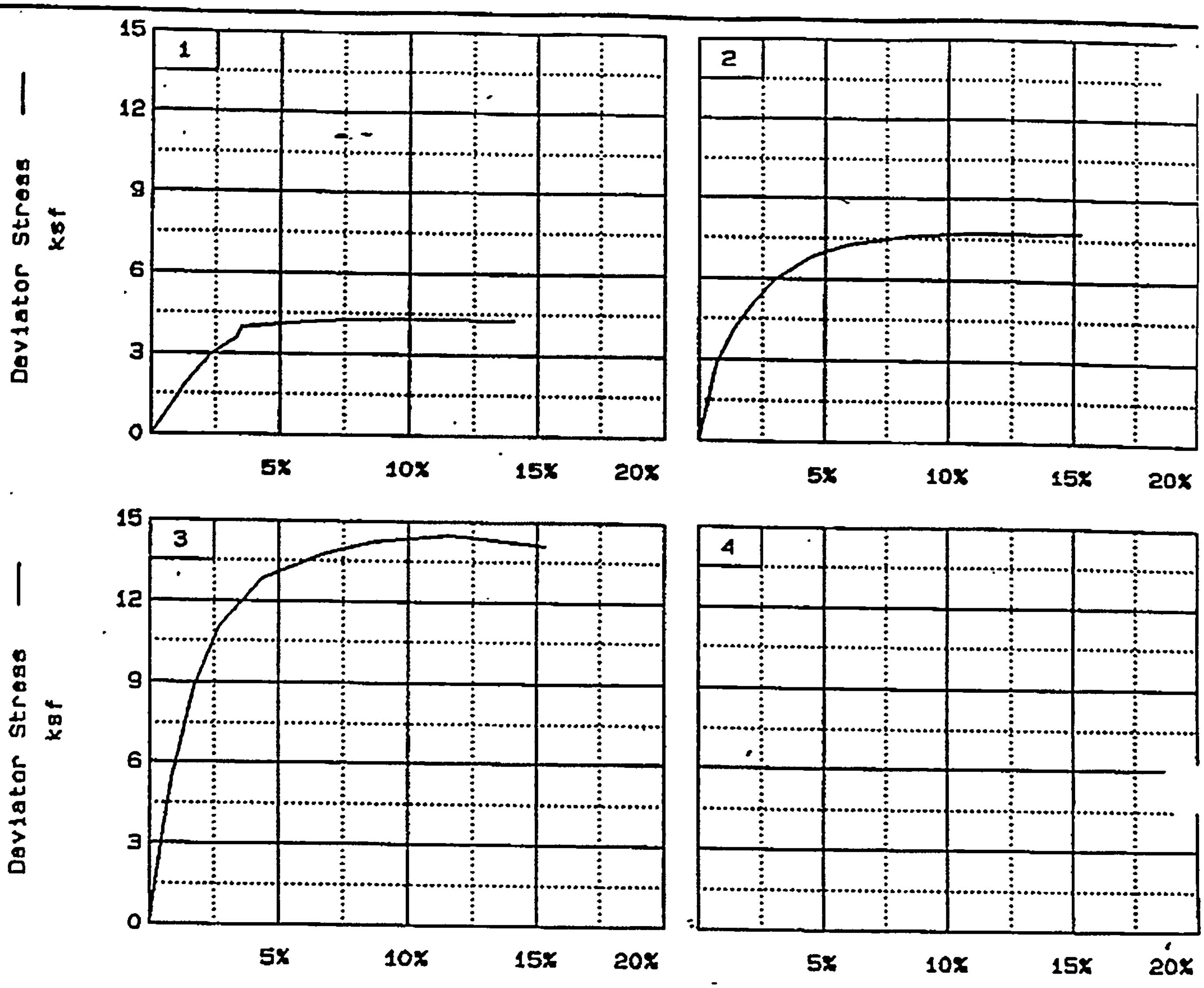
PROJECT: Tritium Extraction Facility

SAMPLE LOCATION: HTEF B-1
St-2 @ 42 Ft

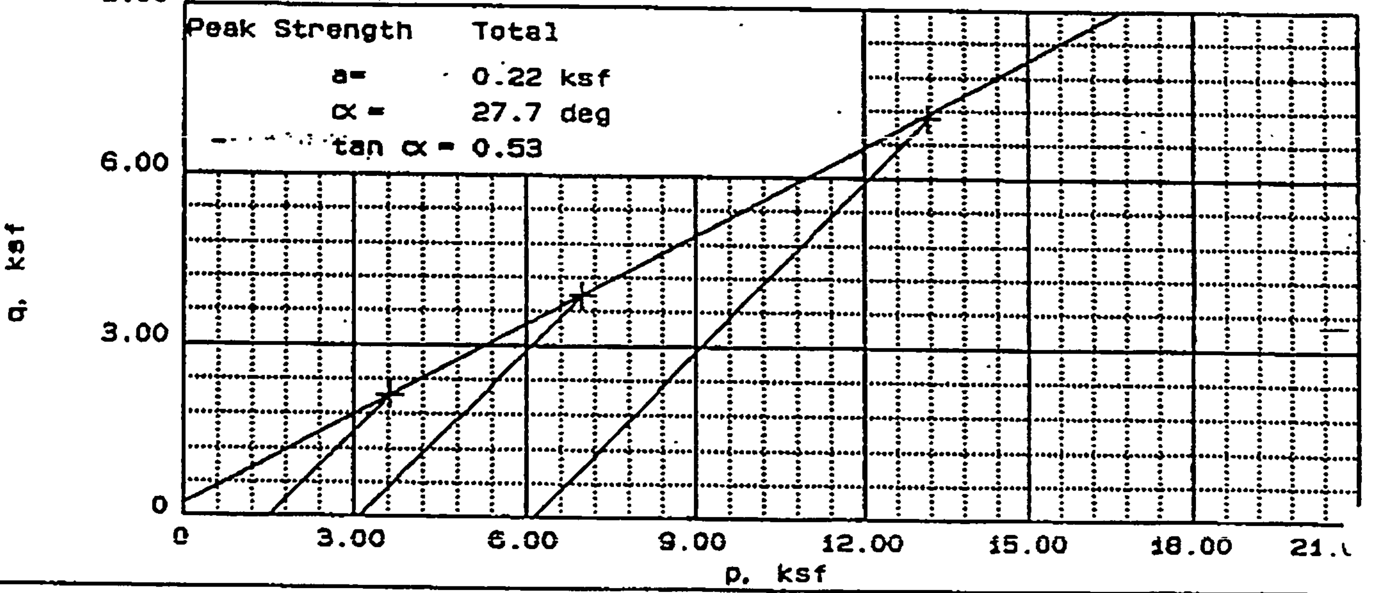
PROJ. NO.: 5016170108 DATE: April 6, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.



Stress Paths, + indicates end of test location



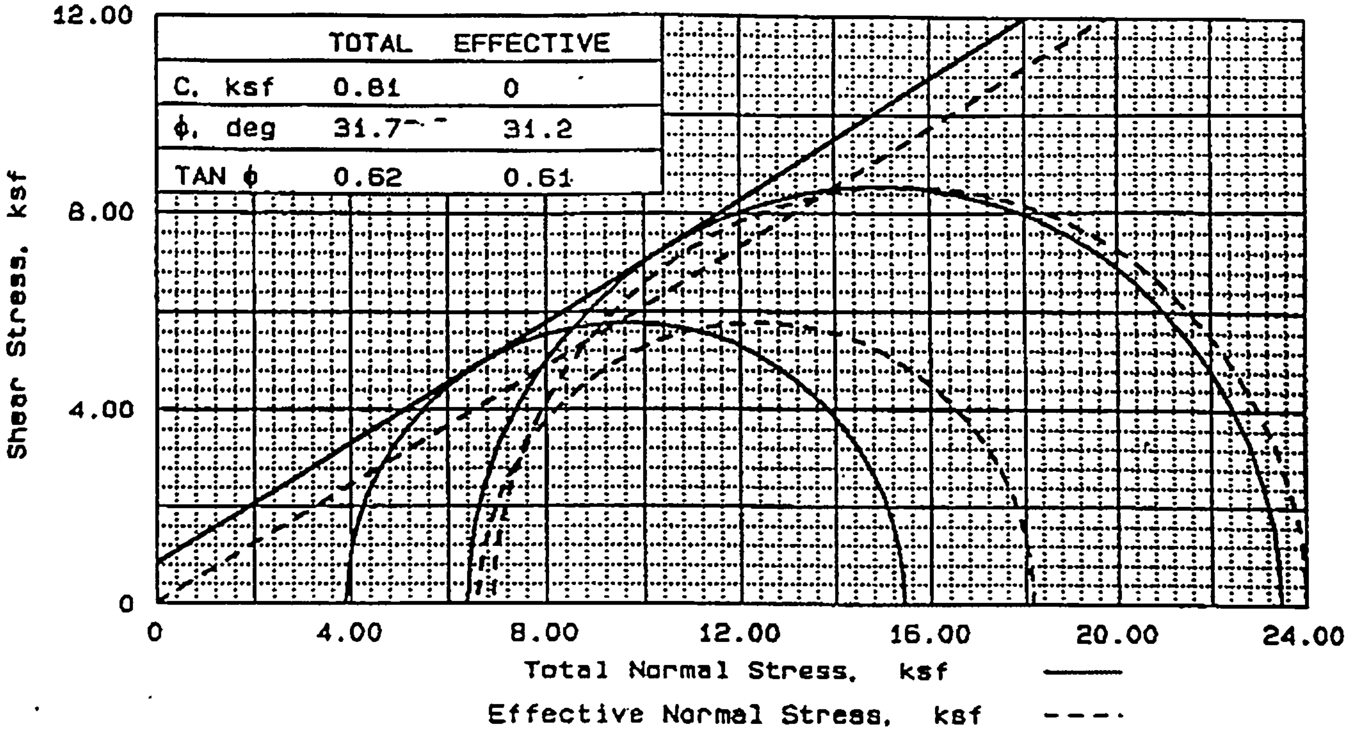
Client:

Project: Tritium Extraction Facility

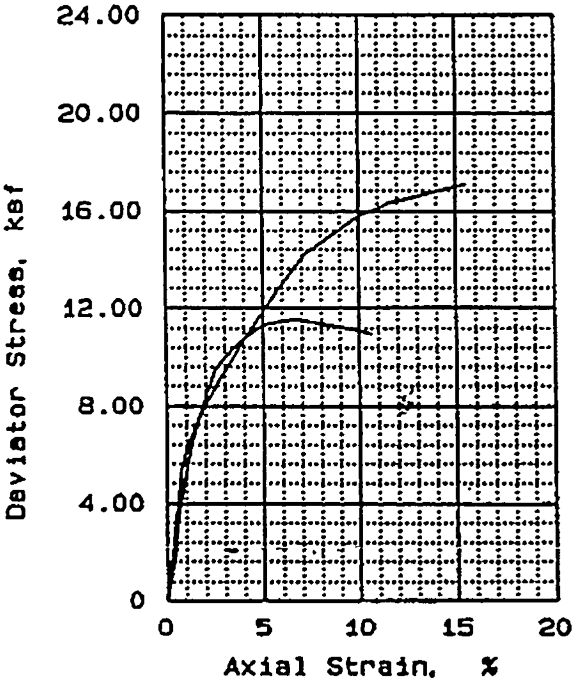
Location: HTEF B-1 St-2 @ 42 Ft

File: 0108128 Project No.: 5016170108 Page 2/2 Fig. No. ____

C-68



	TOTAL	EFFECTIVE
C, ksf	0.81	0
ϕ, deg	31.7	31.2
TAN ϕ	0.62	0.61



	SAMPLE NO.	1	2
INITIAL	WATER CONTENT, %	25.7	19.8
	DRY DENSITY, pcf	97.7	102.9
	SATURATION, %	95.9	83.9
	VOID RATIO	0.724	0.638
	DIAMETER, in	2.87	2.87
	HEIGHT, in	5.60	5.60
AT TEST	WATER CONTENT, %	25.7	22.5
	DRY DENSITY, pcf	99.5	104.9
	SATURATION, %	100.0	100.0
	VOID RATIO	0.694	0.608
	DIAMETER, in	2.84	2.85
	HEIGHT, in	5.59	5.57
	BACK PRESSURE, ksf	2.94	3.04
	CELL PRESSURE, ksf	6.84	9.43
	FAILURE STRESS, ksf	11.55	17.09
	PORE PRESSURE, ksf	0.22	2.51
	STRAIN RATE, %/min.	0.100	0.100
	ULTIMATE STRESS, ksf		
	PORE PRESSURE, ksf		
	$\bar{\sigma}_1$ FAILURE, ksf	18.18	24.01
	$\bar{\sigma}_3$ FAILURE, ksf	6.62	6.93

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Ud
DESCRIPTION:

LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by: HD

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

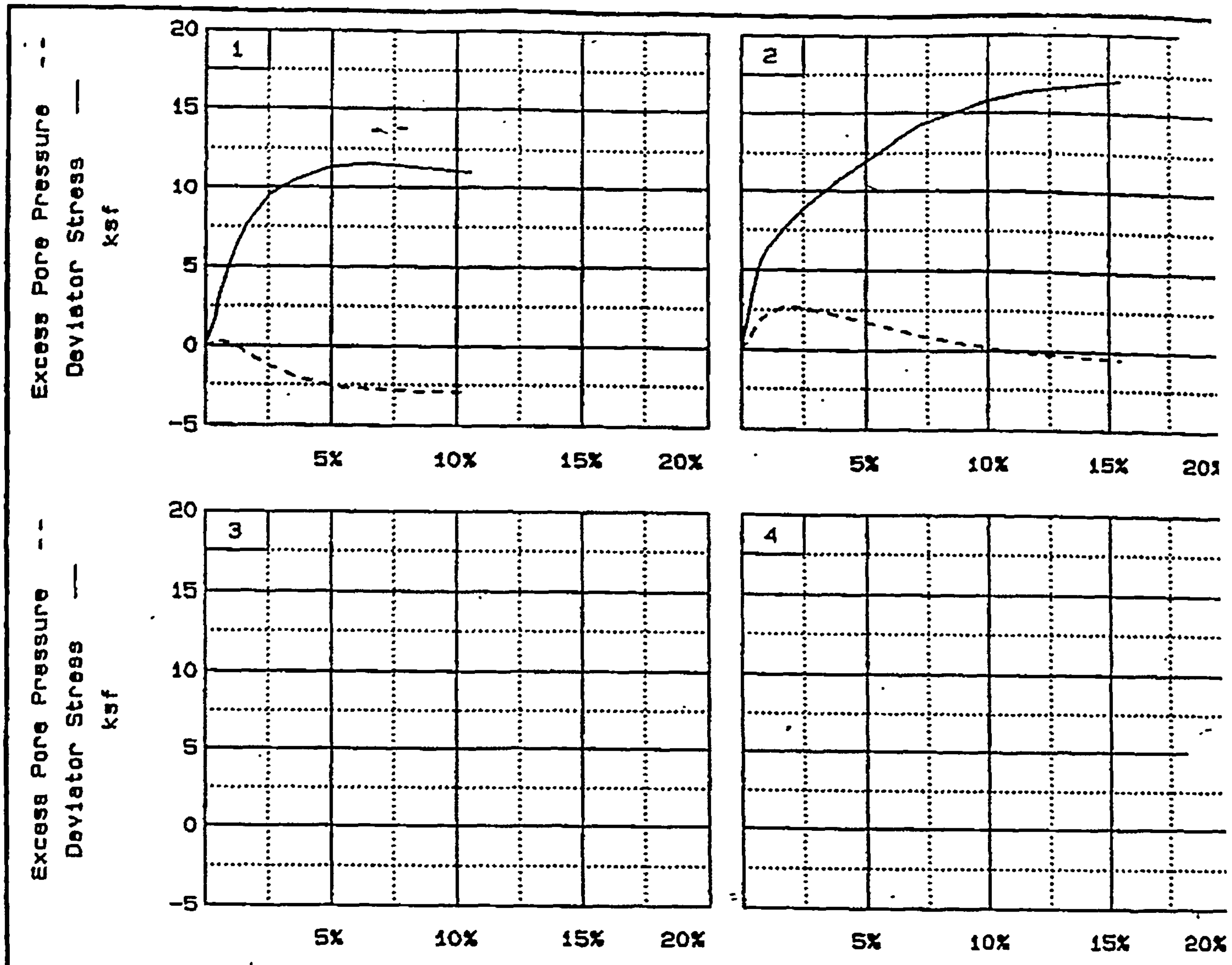
SAMPLE LOCATION: HTEF B-1
St-4 @ 96-98 Ft.

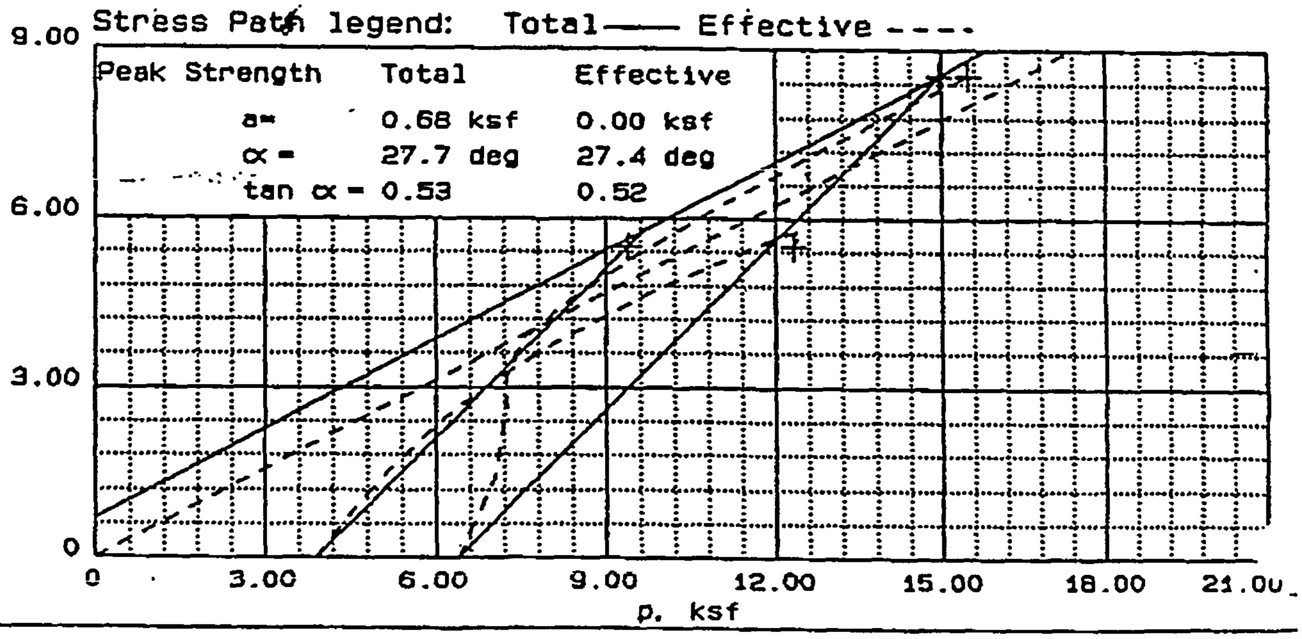
PROJ. NO.: 5016170108 DATE: April 14, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-69



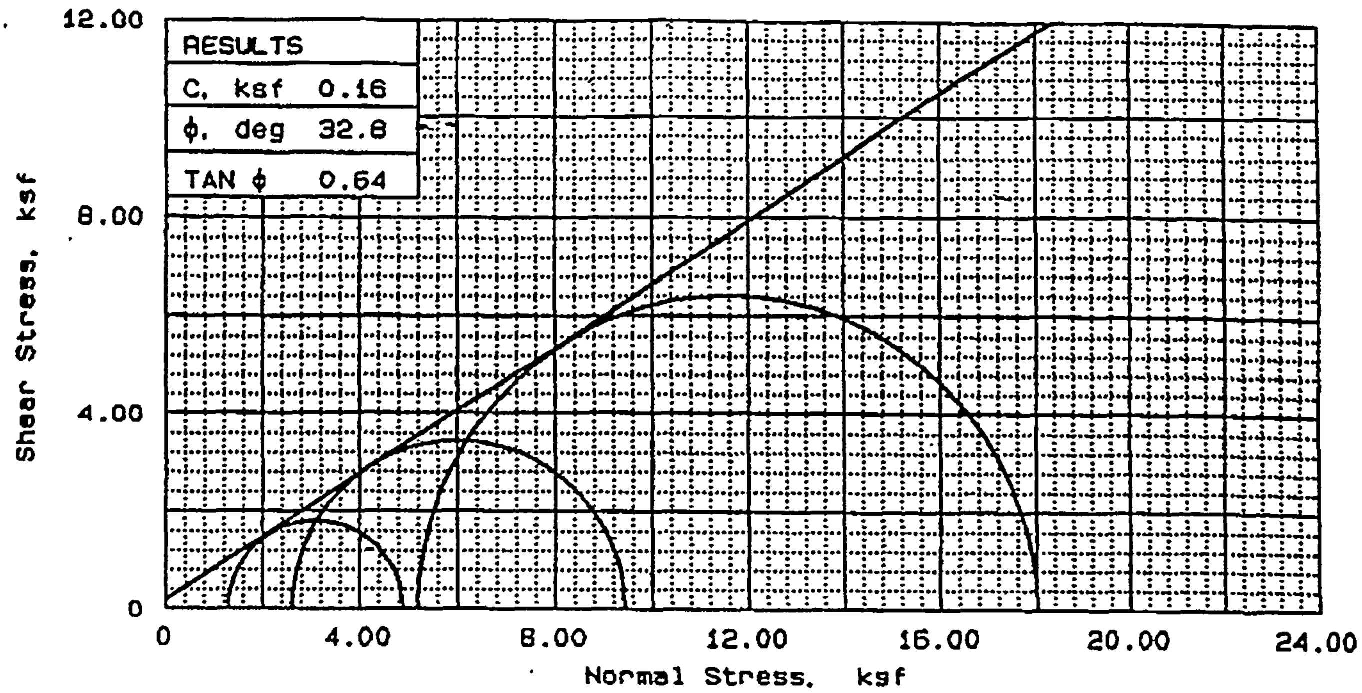


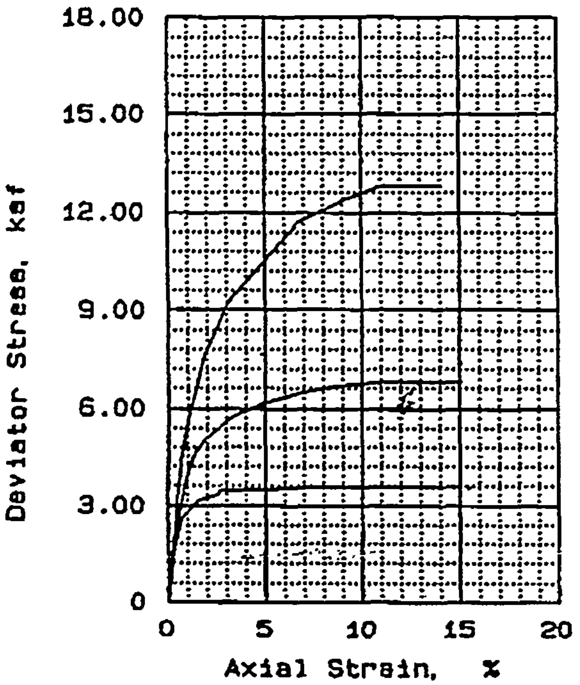
Client:

Project: Tritium Extraction Facility

Location: HTEF B-1 St-4 @ 96-98 Ft.

File: 010812F Project No.: 5016170108 Page 2/2 Fig. No. —





SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	18.7	17.9	18.4
	DRY DENSITY, pcf	97.2	103.0	100.1
	SATURATION, %	68.7	76.1	72.7
	VOID RATIO	0.734	0.637	0.684
	DIAMETER, in	2.86	2.85	2.86
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	25.1	22.0	24.8
	DRY DENSITY, pcf	100.4	105.7	100.9
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.679	0.595	0.671
	DIAMETER, in	2.82	2.82	2.85
	HEIGHT, in	5.97	5.99	5.99
BACK PRESSURE, ksf		2.88	2.88	2.88
CELL PRESSURE, ksf		8.08	5.49	4.18
FAILURE STRESS, ksf		12.83	6.83	3.59
PORE PRESSURE, ksf				
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
σ_1 FAILURE, ksf		18.03	9.44	4.89
σ_3 FAILURE, ksf		5.2	2.61	1.3

TYPE OF TEST:
Consolidated drained
SAMPLE TYPE: Ud
DESCRIPTION:

LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by: HB

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

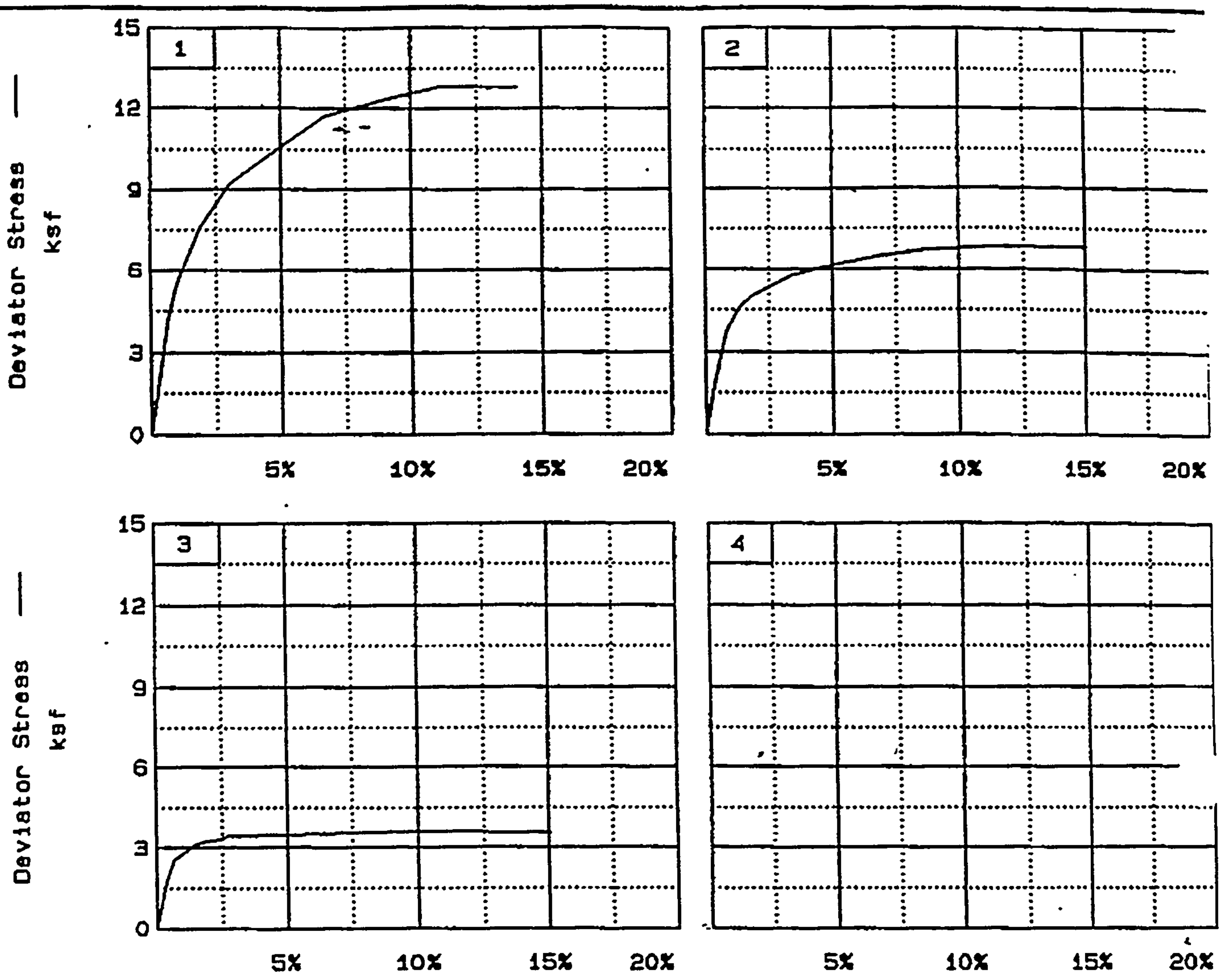
SAMPLE LOCATION: HTEF B-3
St-2 @ 21.5-23.5 Ft.

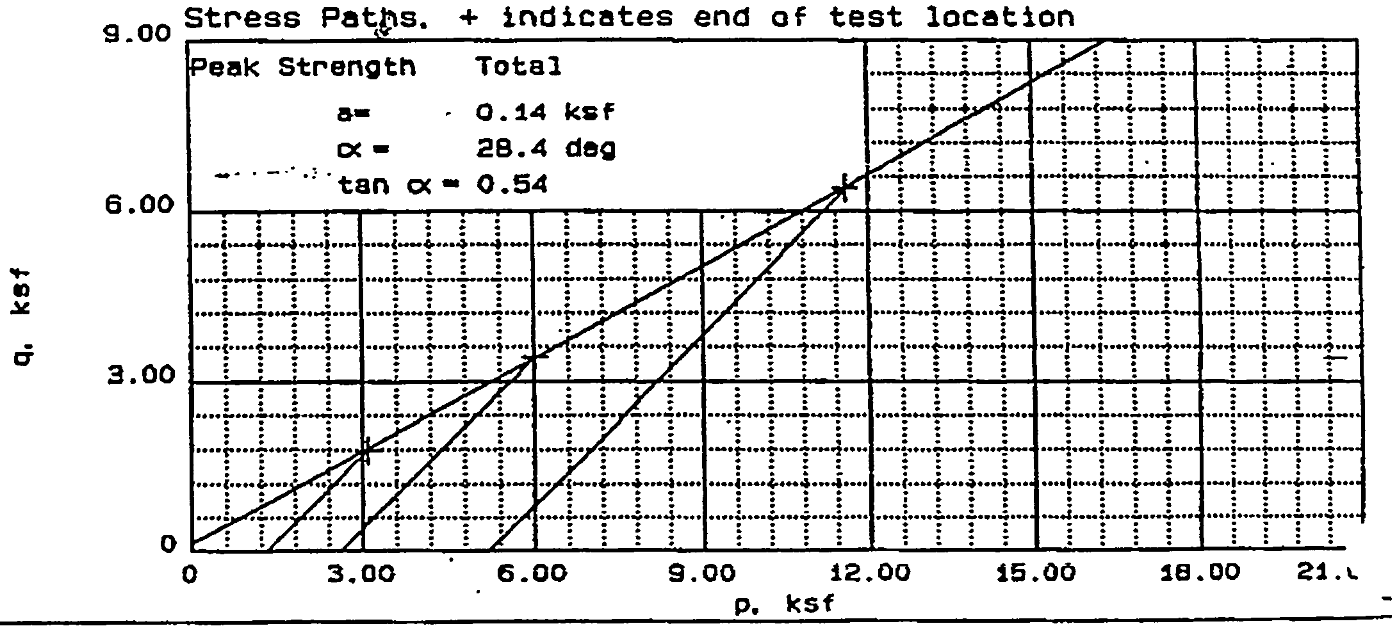
PROJ. NO.: 5016170108 DATE: April 14, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-71

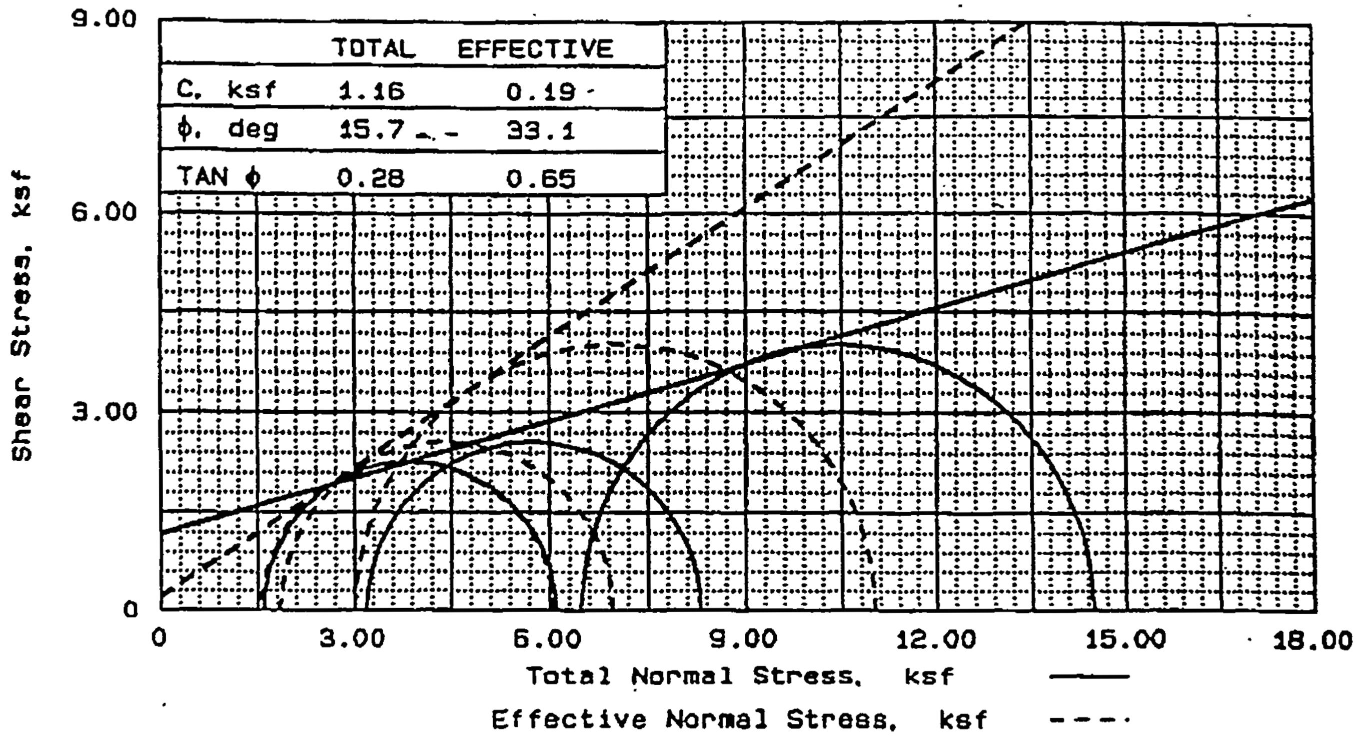


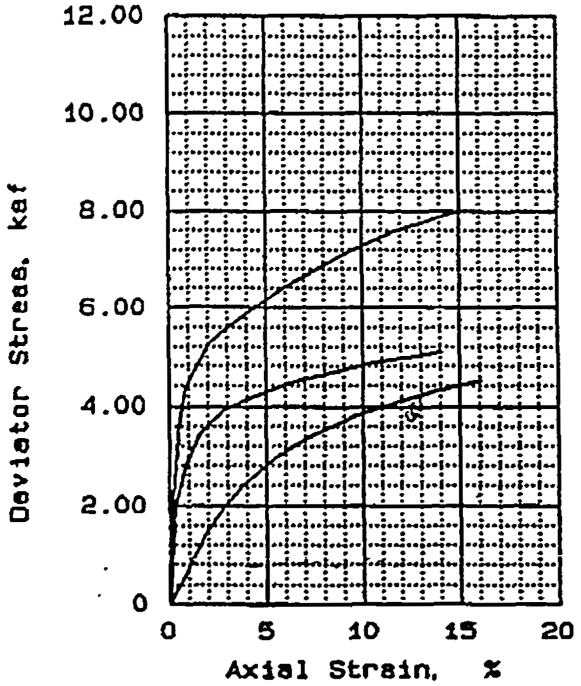

Stress Paths. + indicates end of test location

Client:
Project: Tritium Extraction Facility
Location: HTEF B-3 St-2 @ 21.5-23.5 Ft.
File: 010812D Project No.: 5016170108 Page 2/2 Fig. No. ____

C-72

	TOTAL	EFFECTIVE
C, ksf	1.16	0.19
ϕ, deg	15.7	33.1
TAN ϕ	0.28	0.65





SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	30.3	29.7	28.5
	DRY DENSITY, pcf	91.1	89.0	93.1
	SATURATION, %	96.1	89.5	94.7
	VOID RATIO	0.850	0.895	0.811
	DIAMETER, in	2.86	2.87	2.86
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	29.8	31.6	26.6
	DRY DENSITY, pcf	93.3	91.0	98.0
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.806	0.853	0.719
	DIAMETER, in	2.83	2.84	2.80
	HEIGHT, in	5.98	5.97	5.95
BACK PRESSURE, ksf		2.89	2.91	2.94
CELL PRESSURE, ksf		4.49	6.11	9.43
FAILURE STRESS, ksf		4.51	5.11	8.01
PORE PRESSURE, ksf		2.94	4.25	6.41
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		6.06	6.97	11.03
$\bar{\sigma}_3$ FAILURE, ksf		1.56	1.86	3.02

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: UD
DESCRIPTION: Red Brown & Tan
Silty Sand
LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by: HS

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

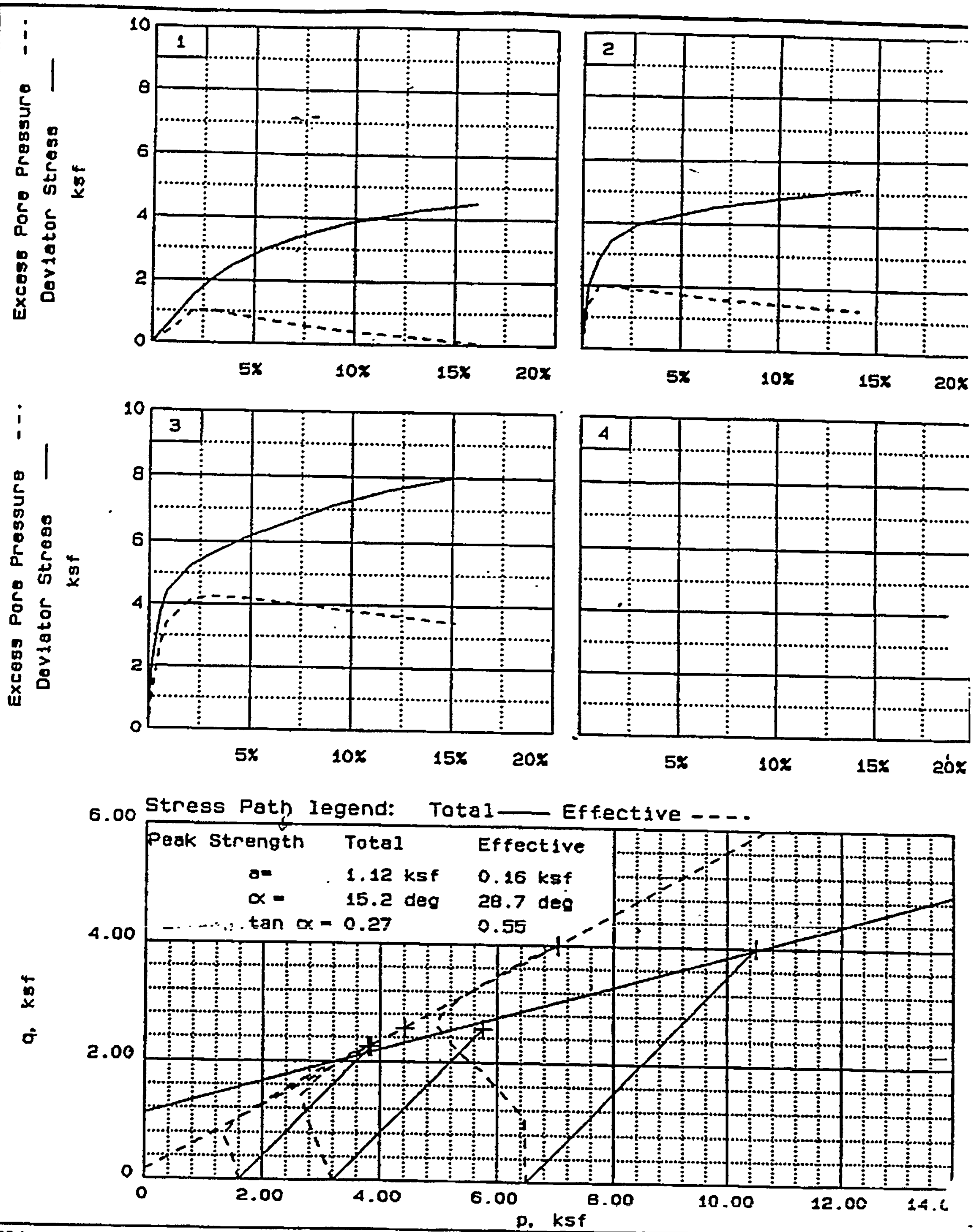
SAMPLE LOCATION: HTEF B-3
St-3 @ 46.5 Ft.

PROJ. NO.: 5016170106 DATE: April 6, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-73

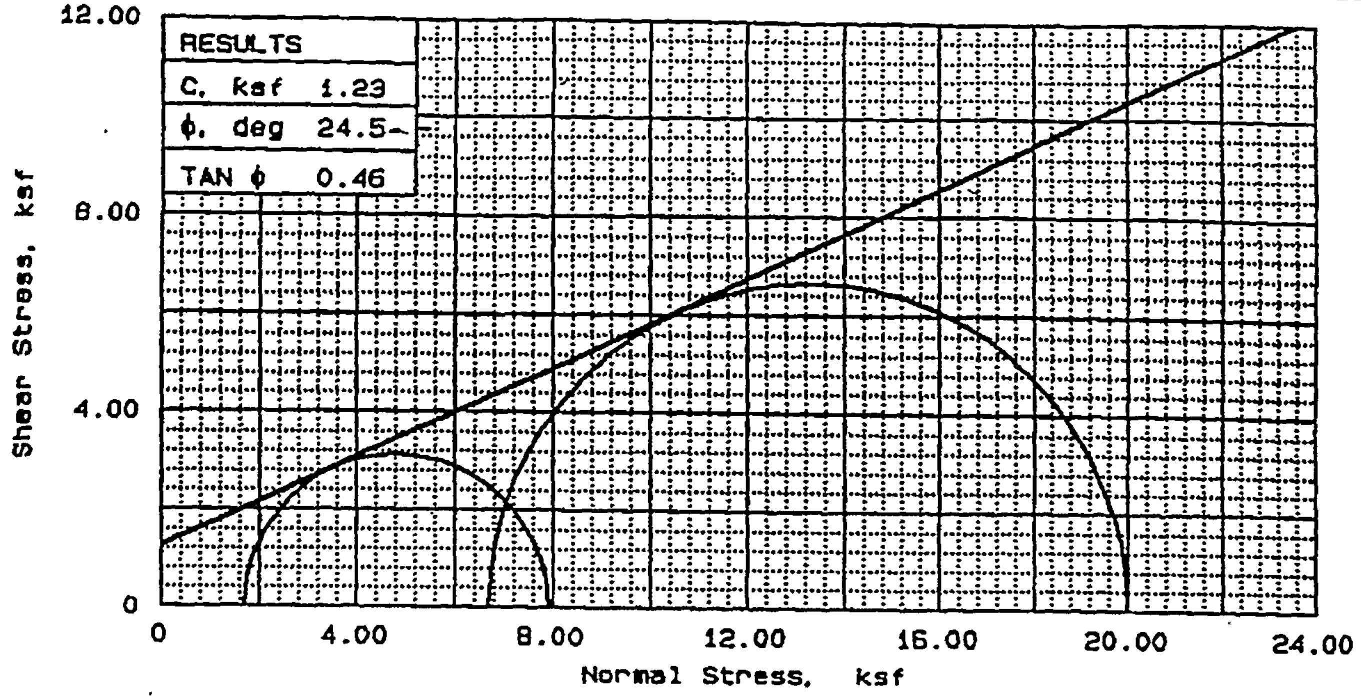


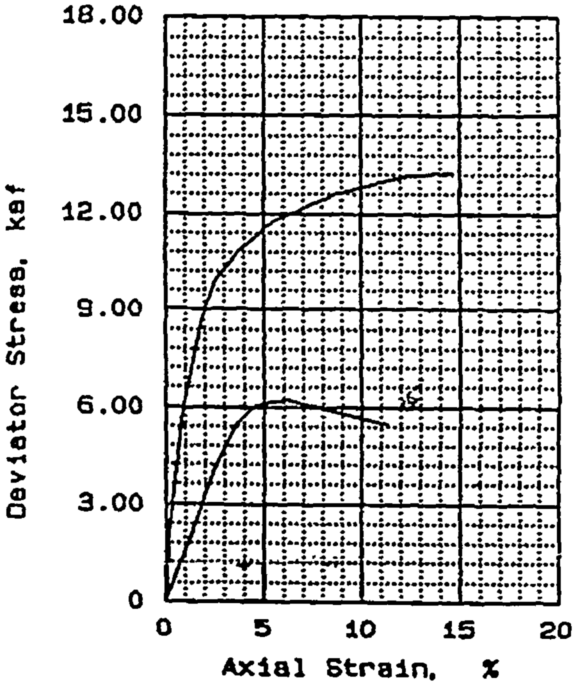
Client:

Project: Tritium Extraction Facility

Location: HTEF B-3 St-3 @ 46.5 Ft.

File: 010812C Project No.: 5016170108 Page 2/2 Fig. No. ____





	SAMPLE NO.	1	2
INITIAL	WATER CONTENT, %	14.7	16.8
	DRY DENSITY, pcf	113.0	107.2
	SATURATION, %	80.7	79.1
	VOID RATIO	0.492	0.573
	DIAMETER, in	2.88	2.87
	HEIGHT, in	5.05	6.00
AT TEST	WATER CONTENT, %	17.2	19.5
	DRY DENSITY, pcf	115.1	110.5
	SATURATION, %	100.0	100.0
	VOID RATIO	0.464	0.526
	DIAMETER, in	2.86	2.83
	HEIGHT, in	5.03	5.96
	BACK PRESSURE, ksf	2.88	2.88
	CELL PRESSURE, ksf	4.58	9.58
	FAILURE STRESS, ksf	6.22	13.30
	PORE PRESSURE, ksf		
	STRAIN RATE, %/min.	0.100	0.100
	ULTIMATE STRESS, ksf		
	PORE PRESSURE, ksf		
	σ_1 FAILURE, ksf	7.92	19.99
	σ_3 FAILURE, ksf	1.7	6.7

TYPE OF TEST:
Consolidated drained
SAMPLE TYPE: UD
DESCRIPTION: Red Brown Silty Sand
LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by:

Reviewed by:

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

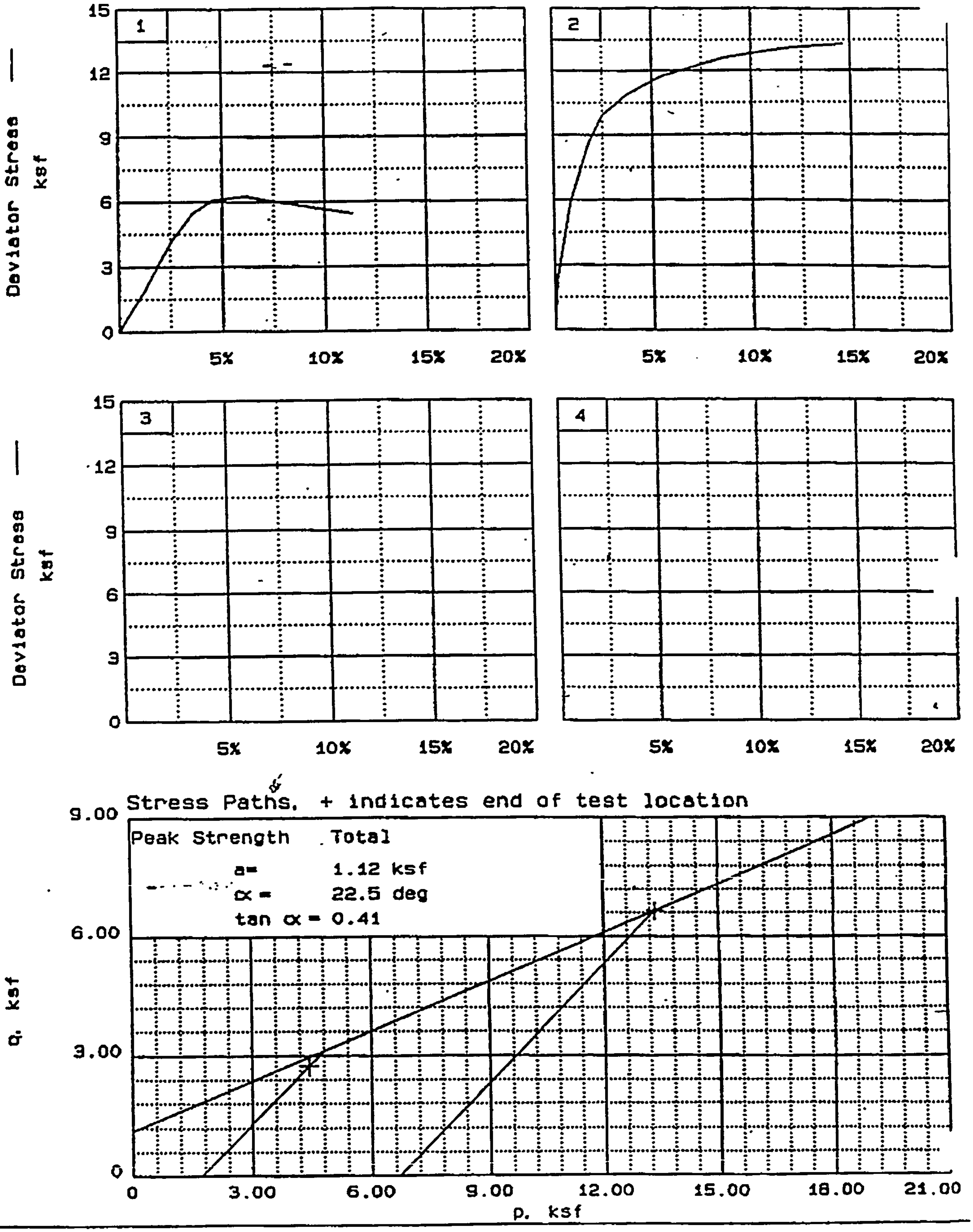
SAMPLE LOCATION: HTEF B-4
St-2 @ 28 Ft.

PROJ. NO.: 5016170108 DATE: April 6, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-75

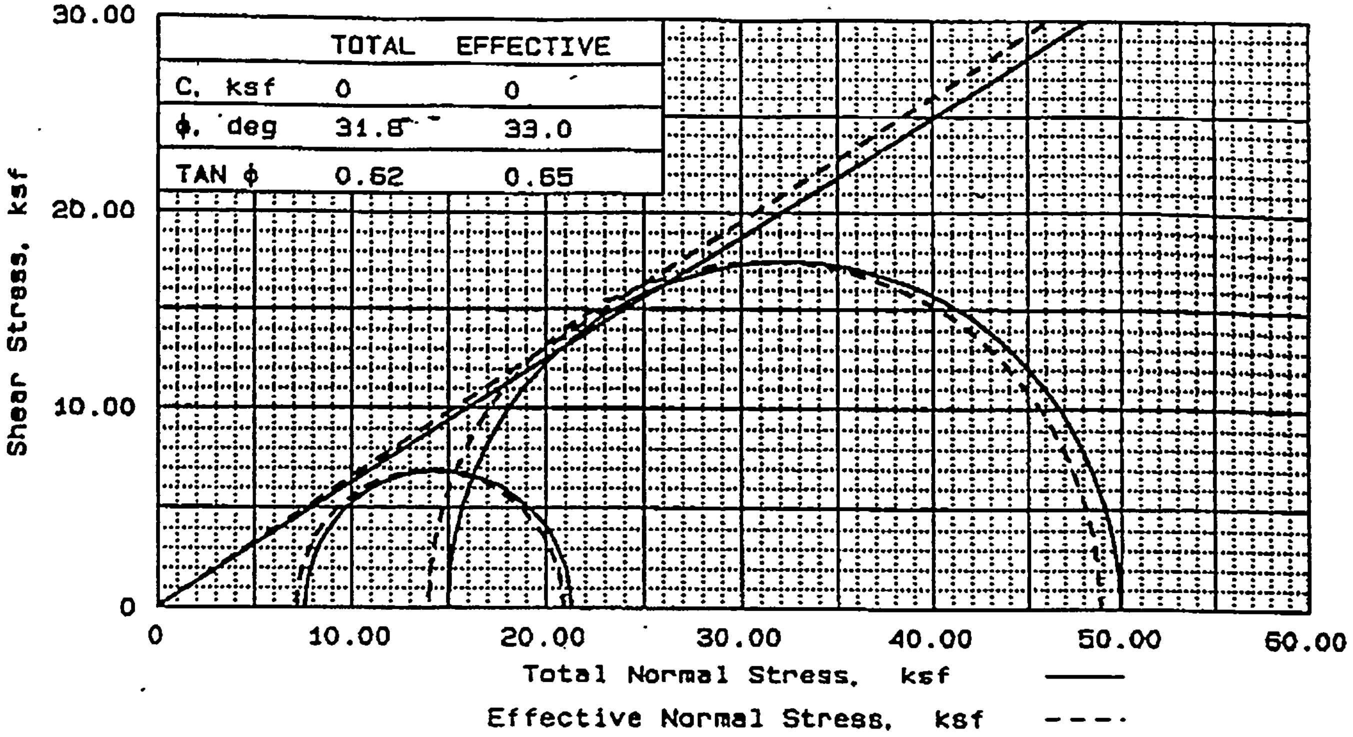


Client:

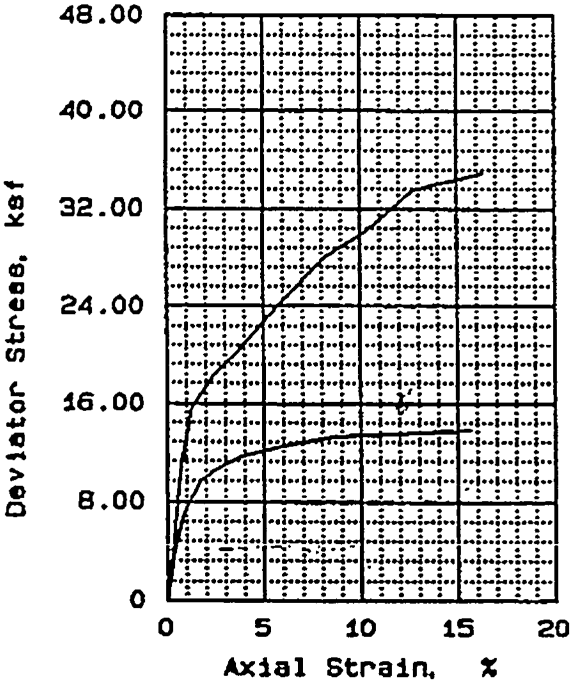
Project: Tritium Extraction Facility

Location: HTEF B-4 St-2 @ 28 Ft.

C-76



	TOTAL	EFFECTIVE
C, ksf	0	0
φ, deg	31.8	33.0
TAN φ	0.62	0.65



	SAMPLE NO.	1	2
INITIAL	WATER CONTENT, %	35.0	31.4
	DRY DENSITY, pcf	85.5	91.8
	SATURATION, %	97.2	101.2
	VOID RATIO	0.971	0.837
	DIAMETER, in	2.86	2.84
	HEIGHT, in	6.00	5.60
AT TEST	WATER CONTENT, %	34.5	29.4
	DRY DENSITY, pcf	87.2	94.0
	SATURATION, %	100.0	100.0
	VOID RATIO	0.932	0.793
	DIAMETER, in	2.84	2.83
	HEIGHT, in	5.96	5.51
	BACK PRESSURE, ksf	2.82	2.84
	CELL PRESSURE, ksf	10.42	17.84
	FAILURE STRESS, ksf	13.74	34.90
	PORE PRESSURE, ksf	3.24	3.84
	STRAIN RATE, %/min.	0.100	0.100
	ULTIMATE STRESS, ksf		
	PORE PRESSURE, ksf		
	$\bar{\sigma}_1$ FAILURE, ksf	20.92	48.89
	$\bar{\sigma}_3$ FAILURE, ksf	7.18	13.99

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Ud
DESCRIPTION: Tan Brown Silty Sand
LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by: lb

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

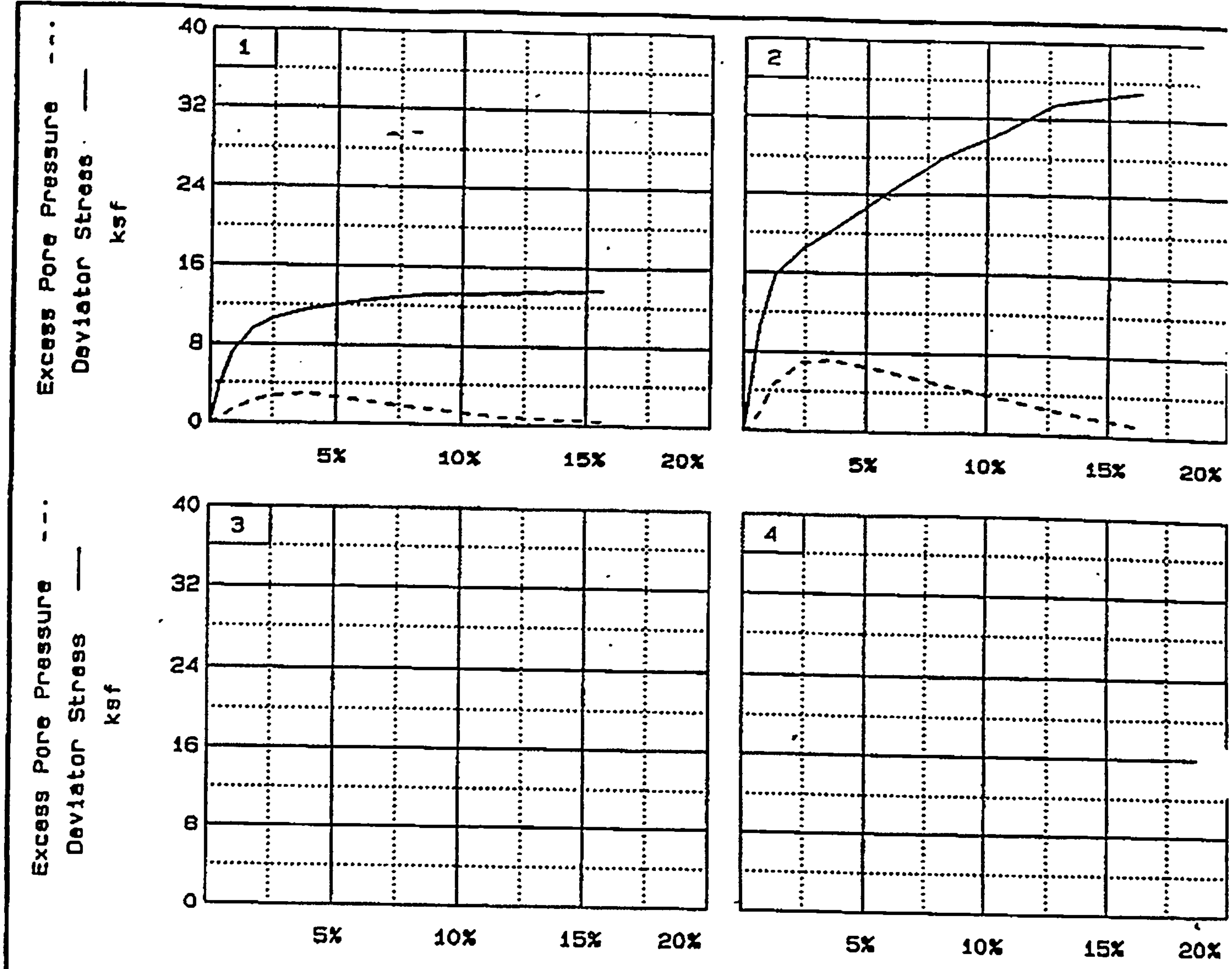
SAMPLE LOCATION: HTEF B-4
St-8 @ 132.5 Ft.

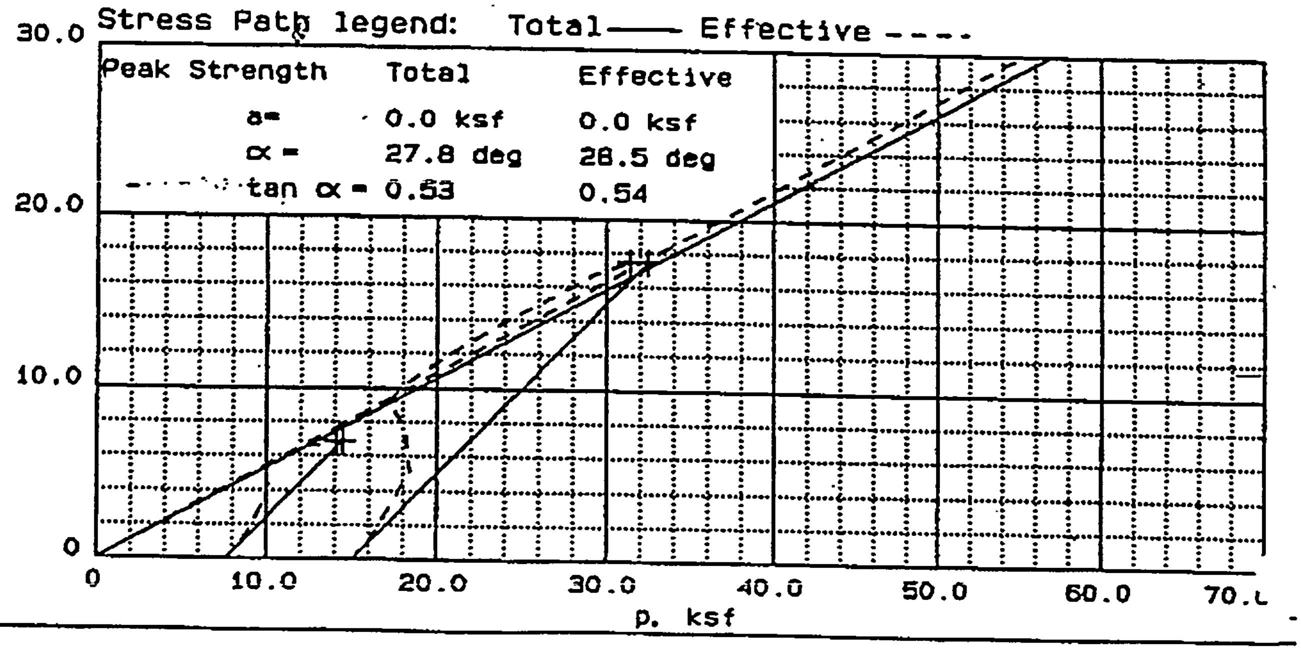
PROJ. NO.: 5016170108 DATE: April 6, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-77





Peak Strength	Total	Effective
a=	0.0 ksf	0.0 ksf
α =	27.8 deg	28.5 deg
tan α =	0.53	0.54

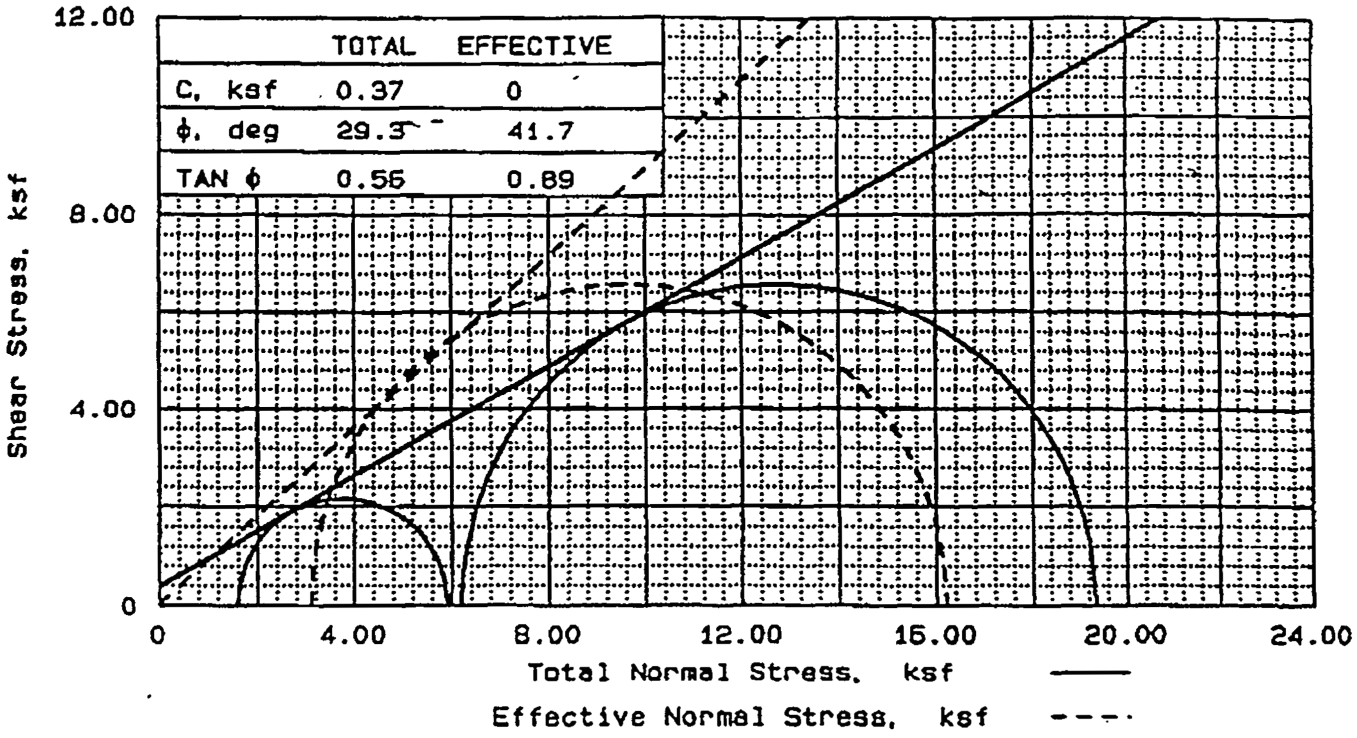
Client:

Project: Tritium Extraction Facility

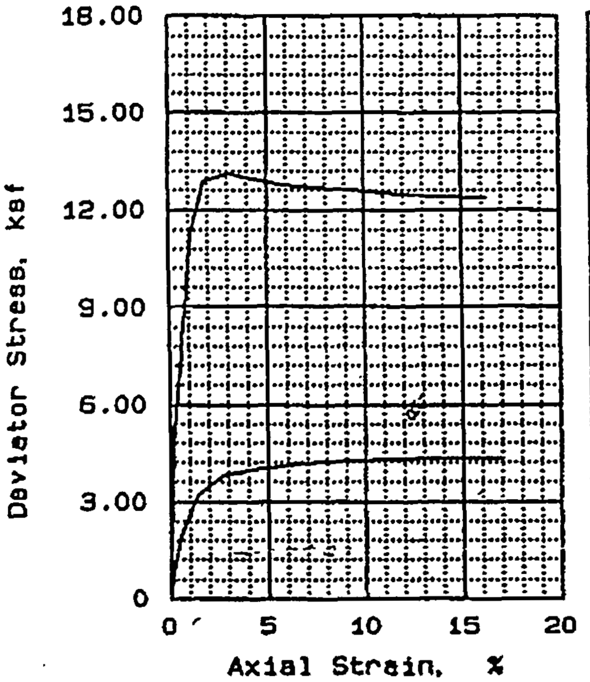
Location: HTEF B-4 St-8 @ 132.5 Ft.

File: 010812 Project No.: 5016170108 Page 2/2 Fig. No. ____

C-78



	TOTAL	EFFECTIVE
C, ksf	0.37	0
ϕ, deg	29.3	41.7
TAN ϕ	0.56	0.89



	SAMPLE NO.	1	2
INITIAL	WATER CONTENT, %	24.8	22.6
	DRY DENSITY, pcf	94.9	95.2
	SATURATION, %	86.2	79.2
	VOID RATIO	0.776	0.770
	DIAMETER, in	2.86	2.87
	HEIGHT, in	5.60	5.60
AT TEST	WATER CONTENT, %	26.9	27.9
	DRY DENSITY, pcf	97.7	96.1
	SATURATION, %	100.0	100.0
	VOID RATIO	0.725	0.754
	DIAMETER, in	2.83	2.86
	HEIGHT, in	5.55	5.58
	BACK PRESSURE, ksf	2.91	2.84
	CELL PRESSURE, ksf	9.12	4.44
	FAILURE STRESS, ksf	13.13	4.32
	PORE PRESSURE, ksf	6.02	2.82
	STRAIN RATE, %/min.	0.100	0.100
	ULTIMATE STRESS, ksf		
	PORE PRESSURE, ksf		
	$\bar{\sigma}_1$ FAILURE, ksf	16.22	5.93
	$\bar{\sigma}_3$ FAILURE, ksf	3.1	1.61

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Ud
DESCRIPTION:

LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by:

FIG. NO.

CLIENT:

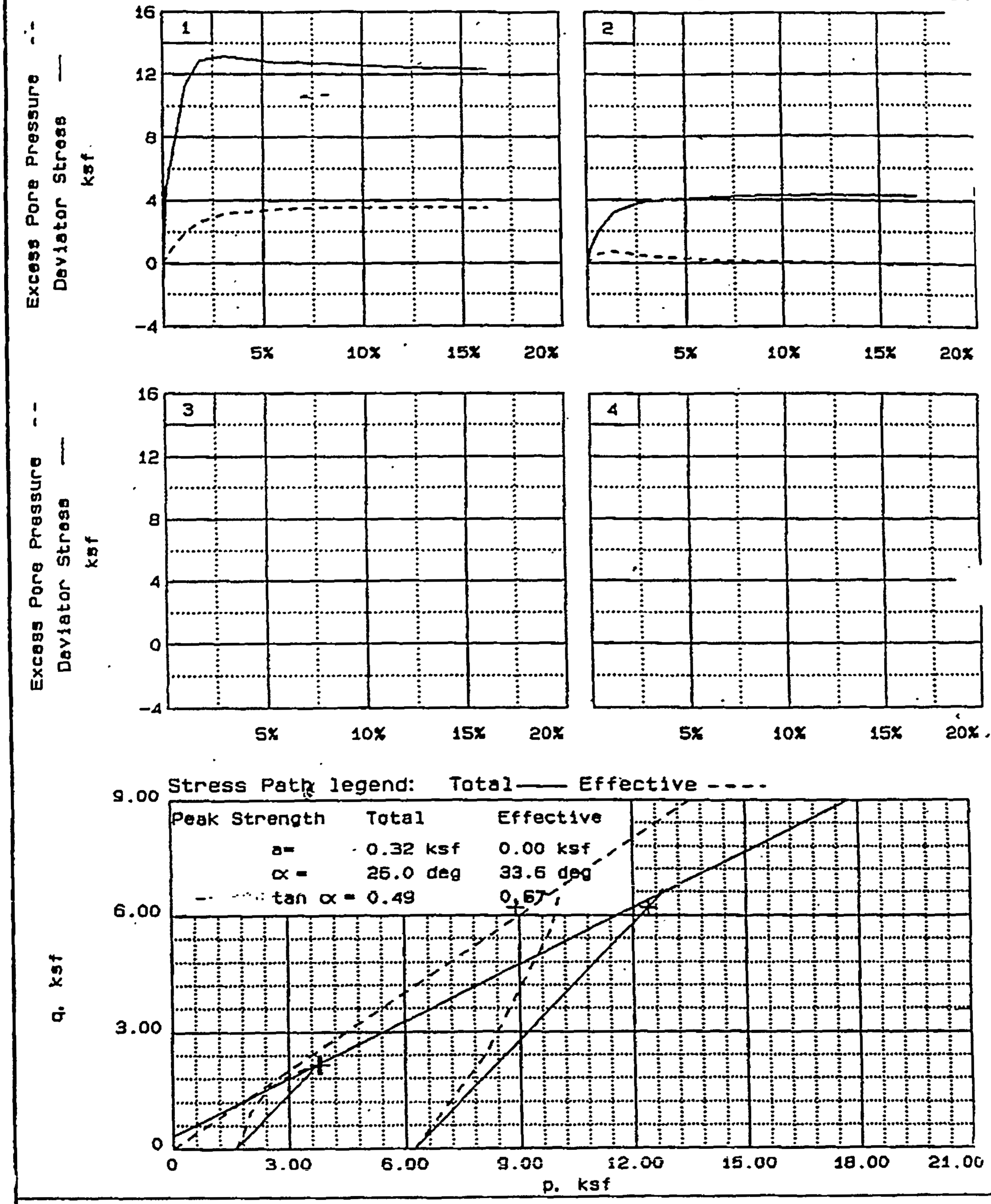
PROJECT: Tritium Extraction Facility

SAMPLE LOCATION: HTEF B-5
St-1 @ 26-28 Ft.

PROJ. NO.: 5016170108 DATE: April 14, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.



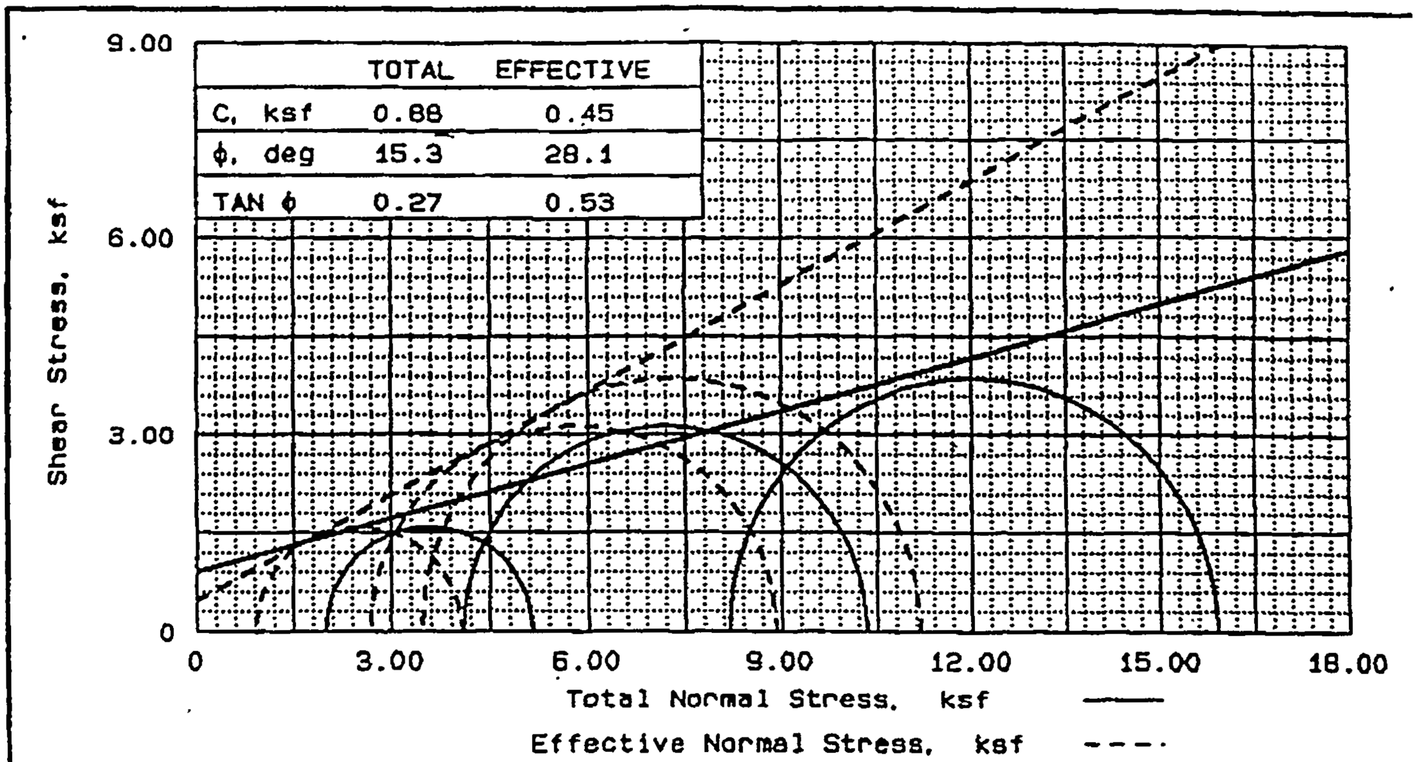
Client:

Project: Tritium Extraction Facility

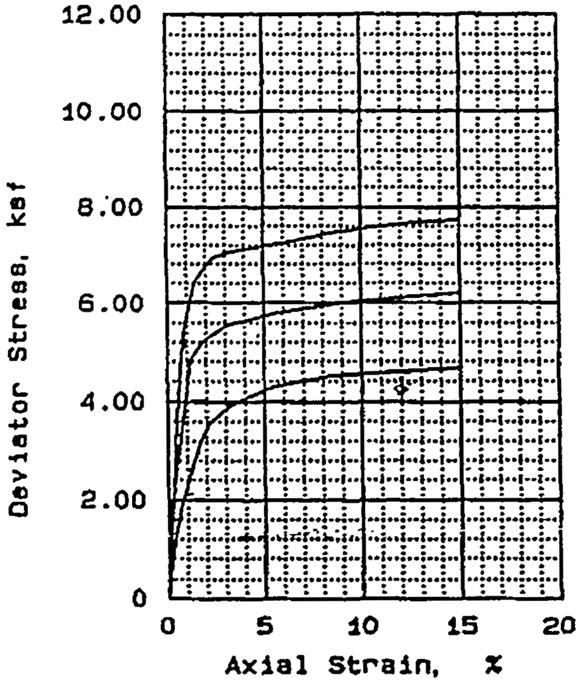
Location: HTEF 8-5 St-1 @ 26-28 Ft.

File: 010812E Project No.: 5016170108 Page 2/2 Fig. No. ——

C-80



	TOTAL	EFFECTIVE
C, ksf	0.88	0.45
ϕ, deg	15.3	28.1
TAN ϕ	0.27	0.53



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	19.6	17.7	17.5
	DRY DENSITY, pcf	104.7	107.7	107.6
	SATURATION, %	86.7	84.6	83.5
	VOID RATIO	0.610	0.565	0.567
	DIAMETER, in	2.86	2.86	2.86
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	21.4	19.5	19.1
	DRY DENSITY, pcf	106.9	110.3	111.2
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.577	0.528	0.516
	DIAMETER, in	2.83	2.84	2.83
	HEIGHT, in	5.98	5.95	5.93
BACK PRESSURE, ksf		2.89	2.98	2.79
CELL PRESSURE, ksf		4.89	7.08	10.99
FAILURE STRESS, ksf		3.15	6.23	7.71
PORE PRESSURE, ksf		3.97	4.39	7.52
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		4.07	8.93	11.18
$\bar{\sigma}_3$ FAILURE, ksf		0.92	2.69	3.47

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Ud
DESCRIPTION:

LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: Tested by: JTM

Reviewed by:

FIG. NO.

CLIENT:

PROJECT: Tritium Extraction Facility

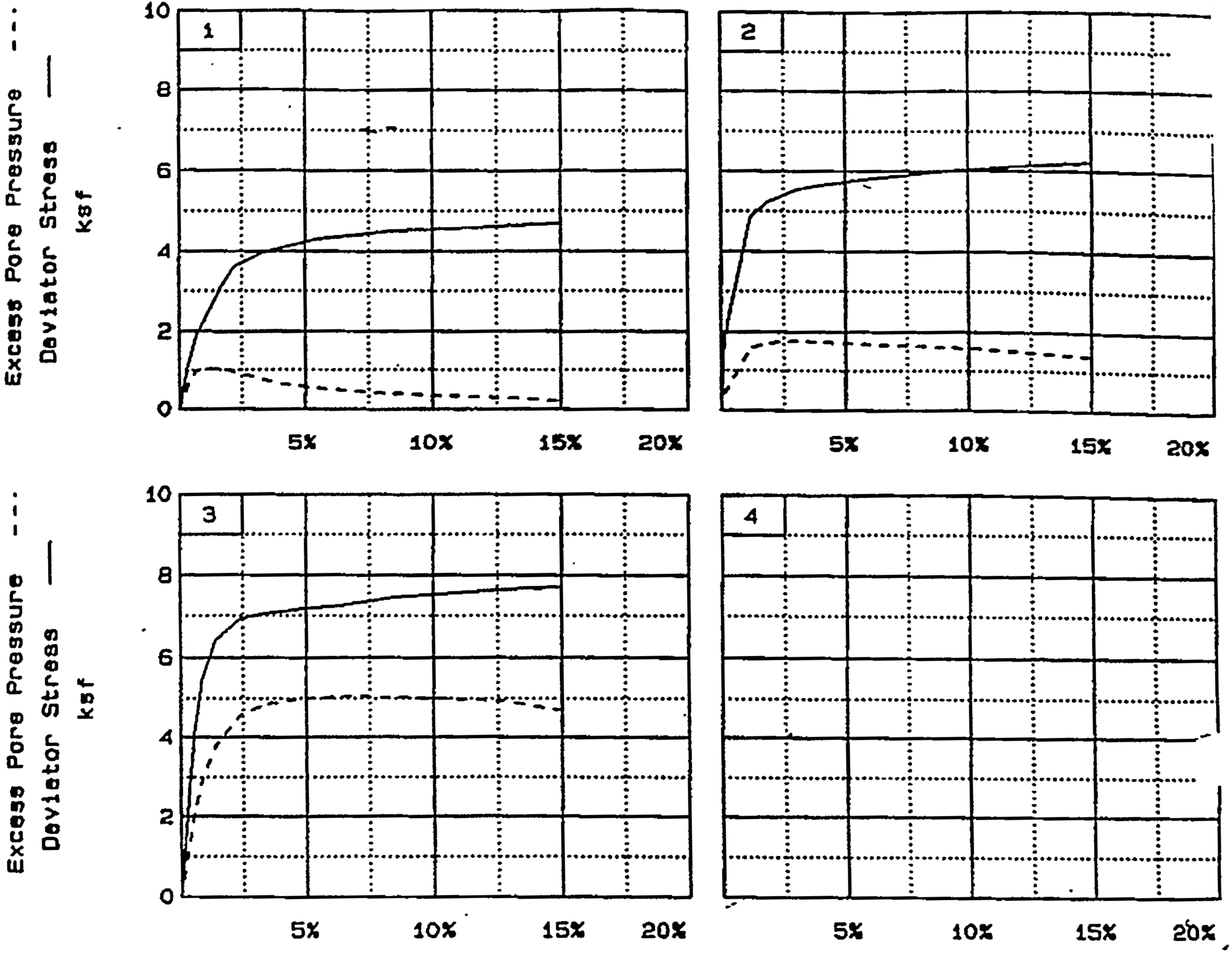
SAMPLE LOCATION: HTEF B-6
St-1 @ 34-36 Ft.

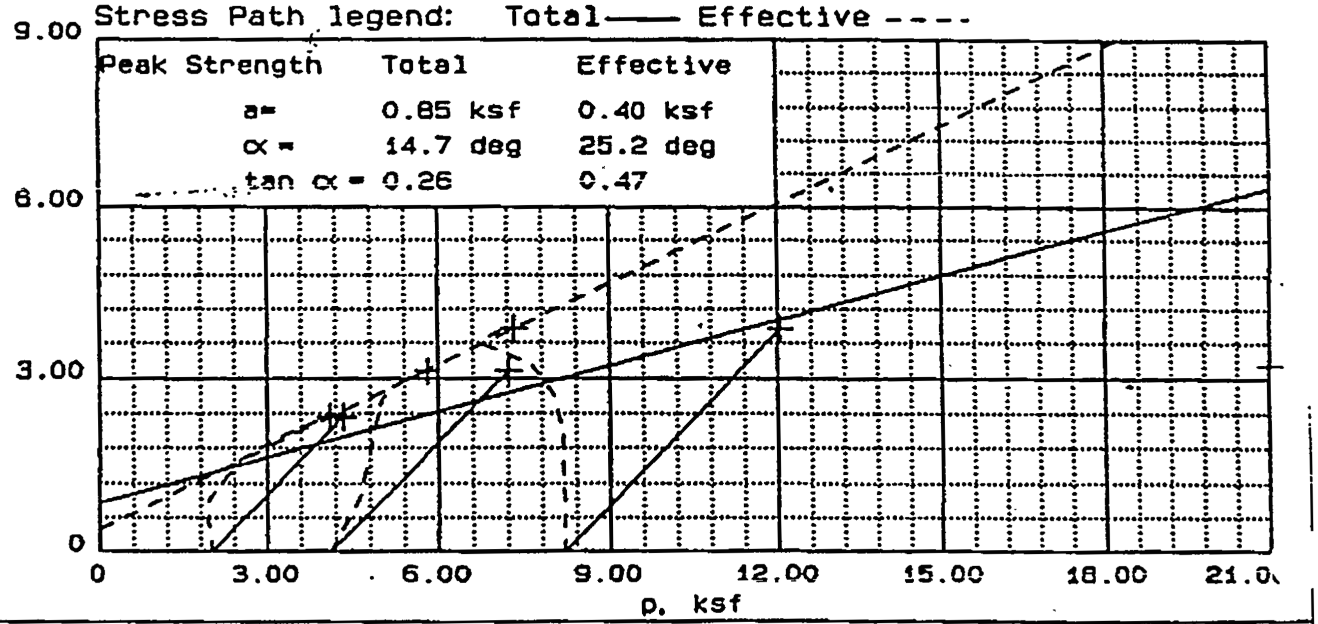
PROJ. NO.: 5016170108 DATE: April 14, 1998

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

C-81

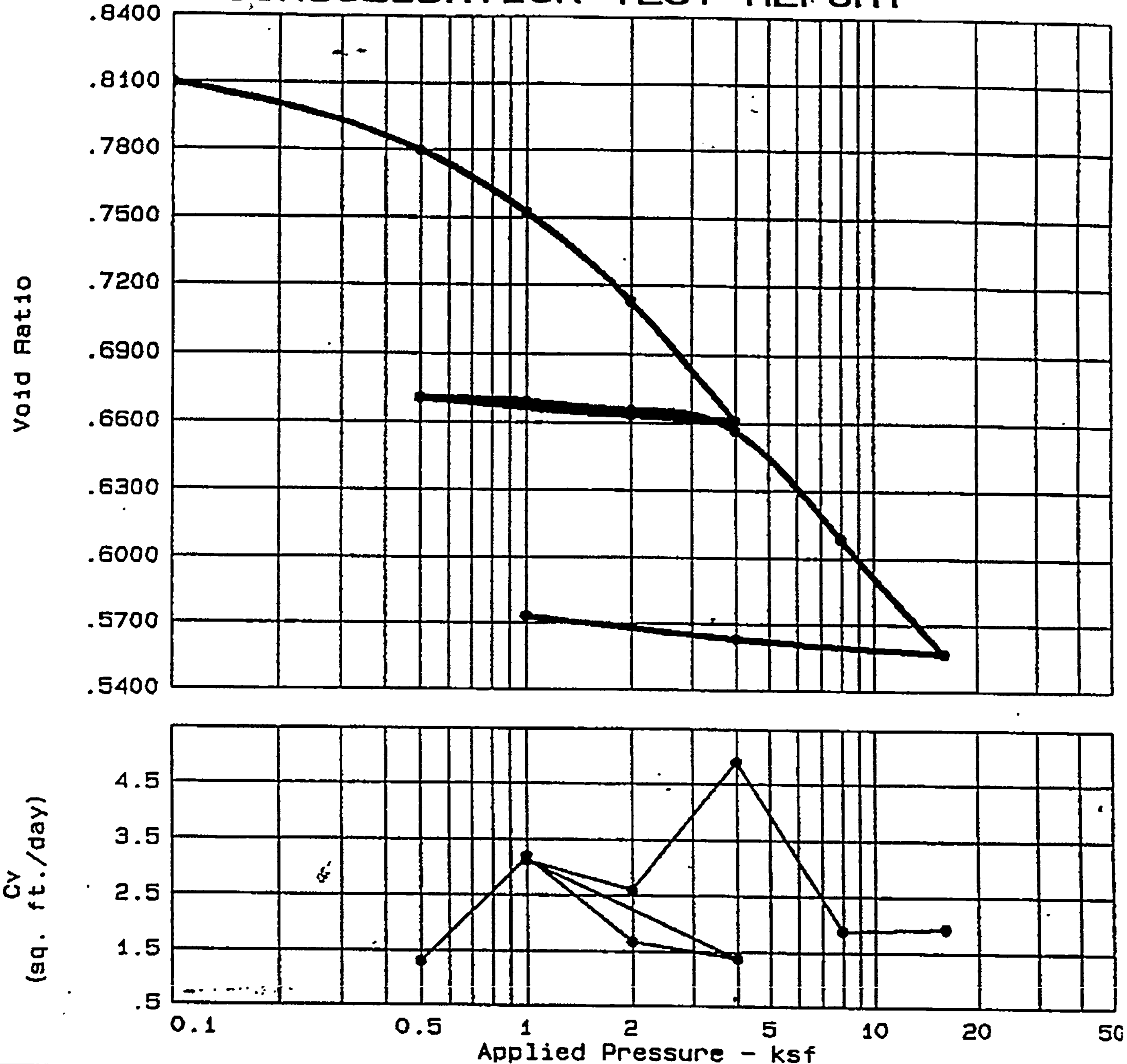




Peak Strength	Total	Effective
a=	0.85 ksf	0.40 ksf
α =	14.7 deg	25.2 deg
tan α =	0.26	0.47

Client;
Project: Tritium Extraction Facility
Location: HTEF B-6 St-1 @ 34-36 Ft.
File: 010812H Project No.: 5016170108 Page 2/2 Fig. No. ____

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	87.3 %	26.7	91.4	37	12	2.65	4.44	0.17	0.809

TEST RESULTS

Compression Index = 0.17

Project No.: 501161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-1
St-2 @ 42-44 Ft.
Date: Feb. 18, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Red Brown & Tan Silty Sand

Class: SM

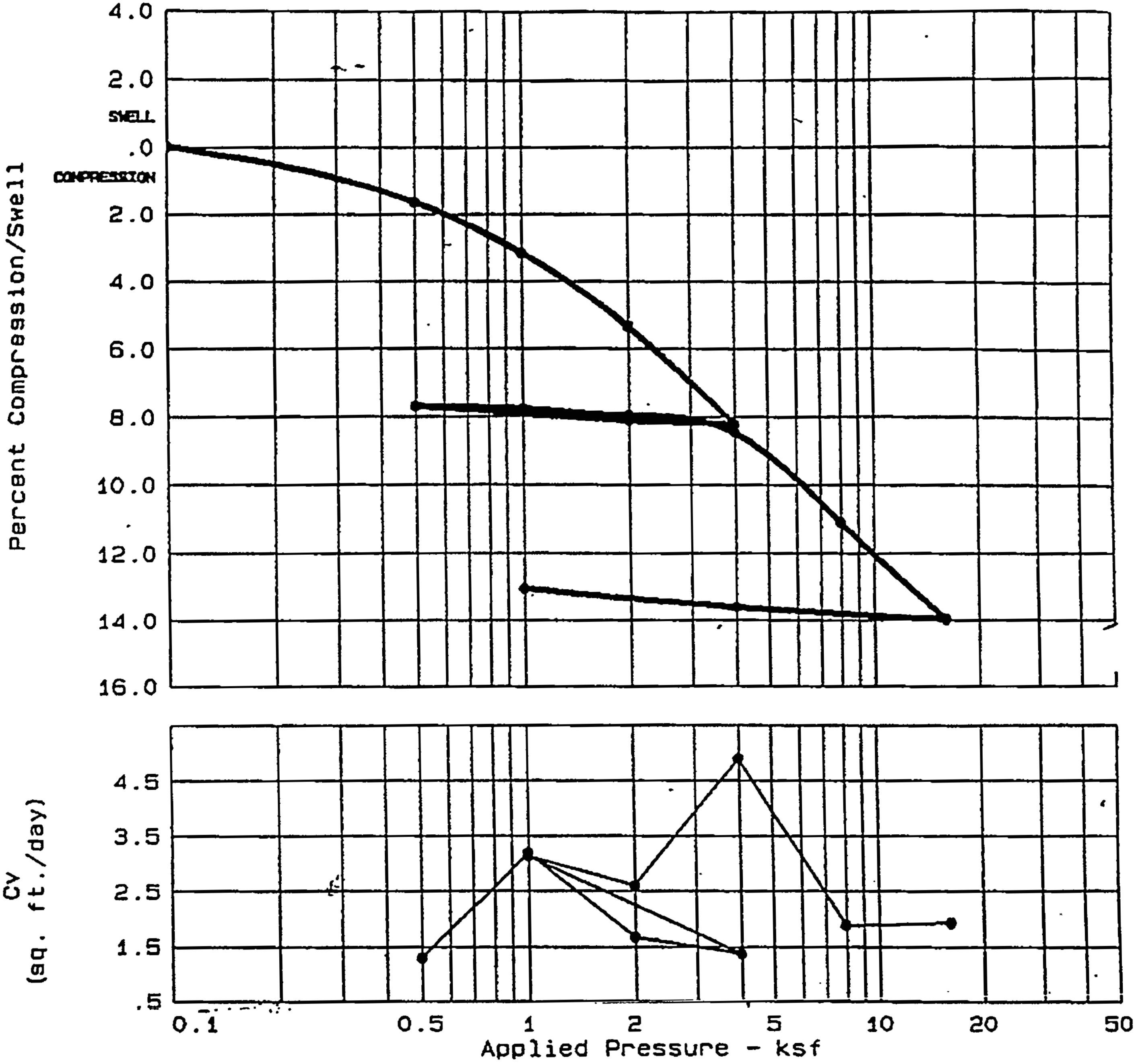
Remarks:

Tested by: JTm

Reviewed by:

C-83

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	87.3 %	26.7	91.4	37	12	2.65	4.44	0.17	0.8094

TEST RESULTS

Compression Index = 0.17

Project No.: 501161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF 8-1
St-2 @ 42-44 Ft.
Date: Feb. 18, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Red Brown & Tan Silty Sand

Class: SM

Remarks:

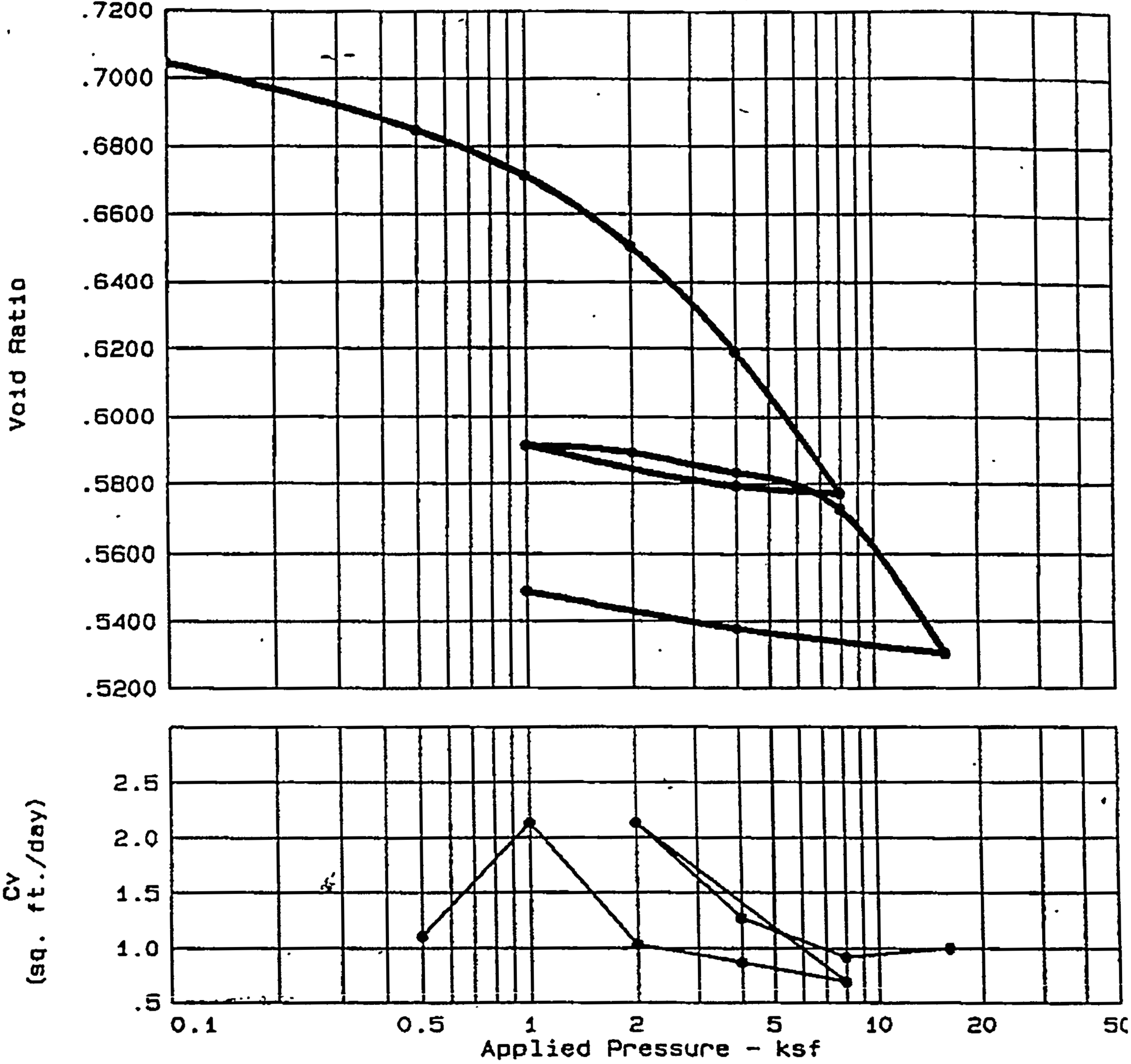
Tested by: JTM

Reviewed by:

Fig. No. ______

C-84

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_o
	94.8 %	25.2	97.1	42	18	2.65	8.22	0.14	0.704

TEST RESULTS

Compression Index = 0.14

MATERIAL DESCRIPTION

Brown-Purple Clayey Sand

Class: SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-1
St-5 @ 143.5-145.0 Ft.
Date: Feb. 18, 1998

Remarks:

Tested by: JTM

Reviewed by:

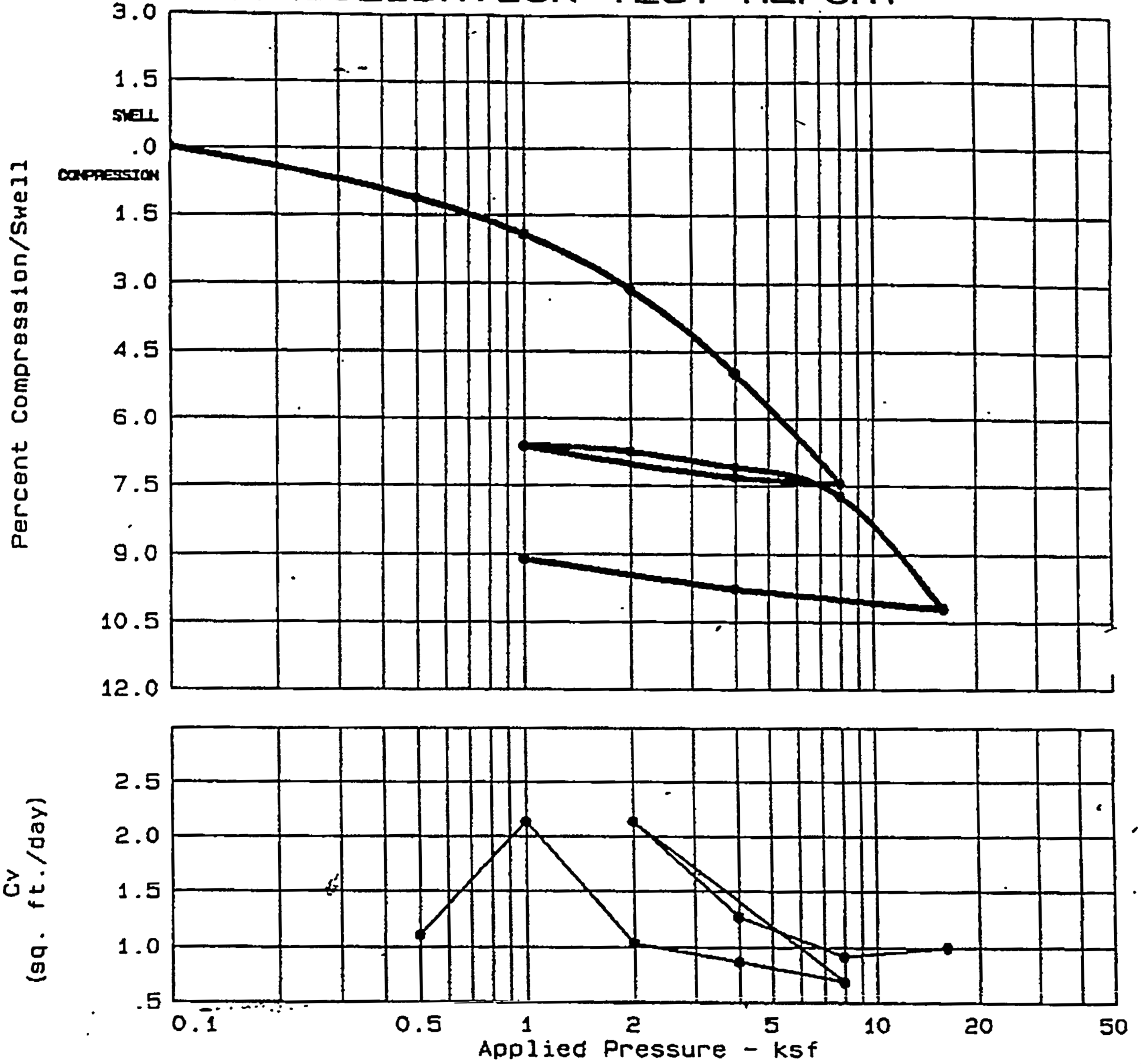
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No.

C-85

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	94.8 %	25.2	97.1	42	18	2.65	8.22	0.14	0.7041

TEST RESULTS

Compression Index = 0.14

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-1
St-5 @ 143.5-145.0 Ft.
Date: Feb. 18, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Brown-Purple Clayey Sand

Class: SC

Remarks:

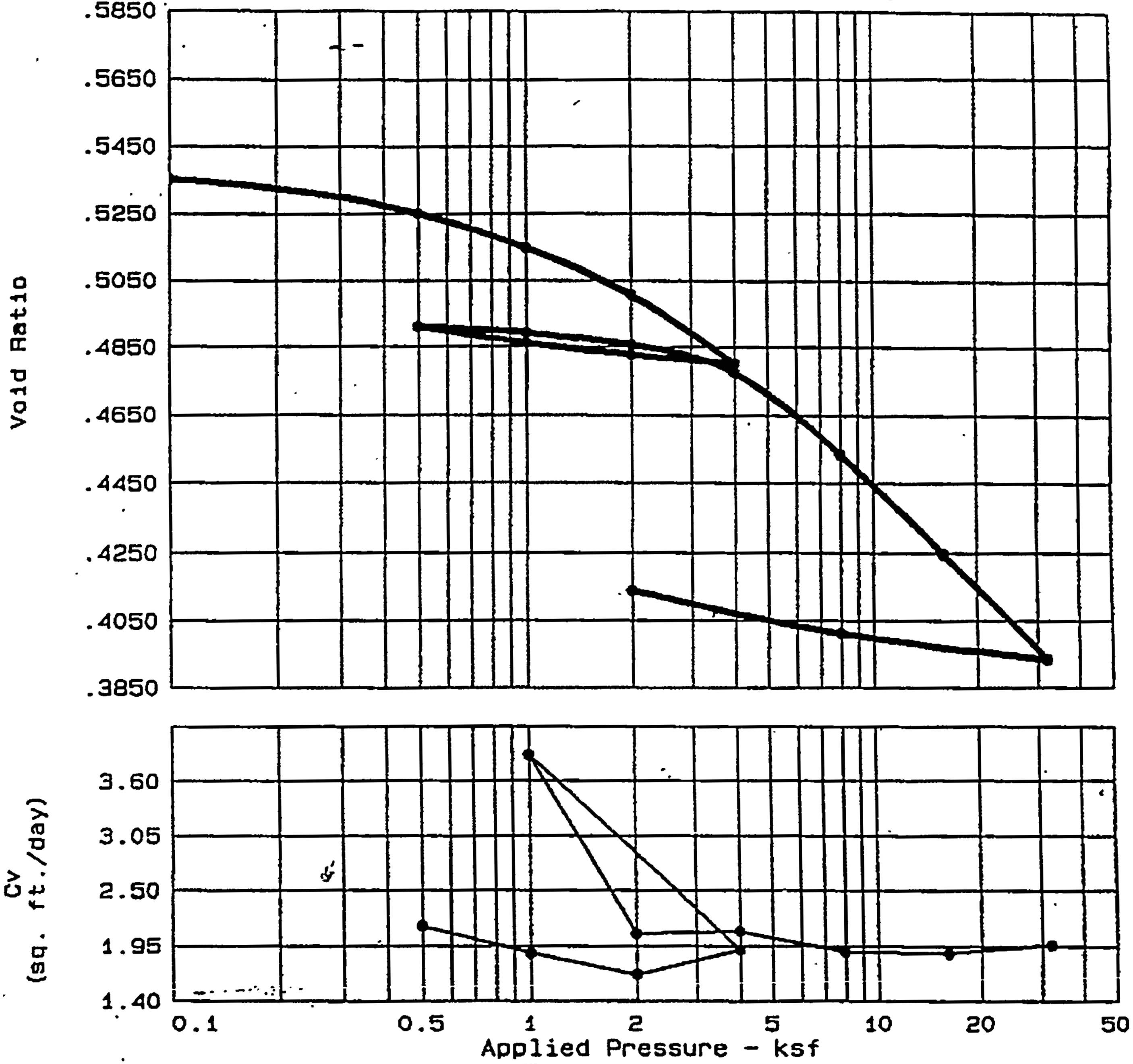
Tested by: JTM

Reviewed by:

Fig. No. ____

C-86

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	75.0 %	14.9	109.8			2.70	5.49	0.10	0.5352

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.10	

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-2
St-1 @ 35 Ft.
Date: April 15, 1998

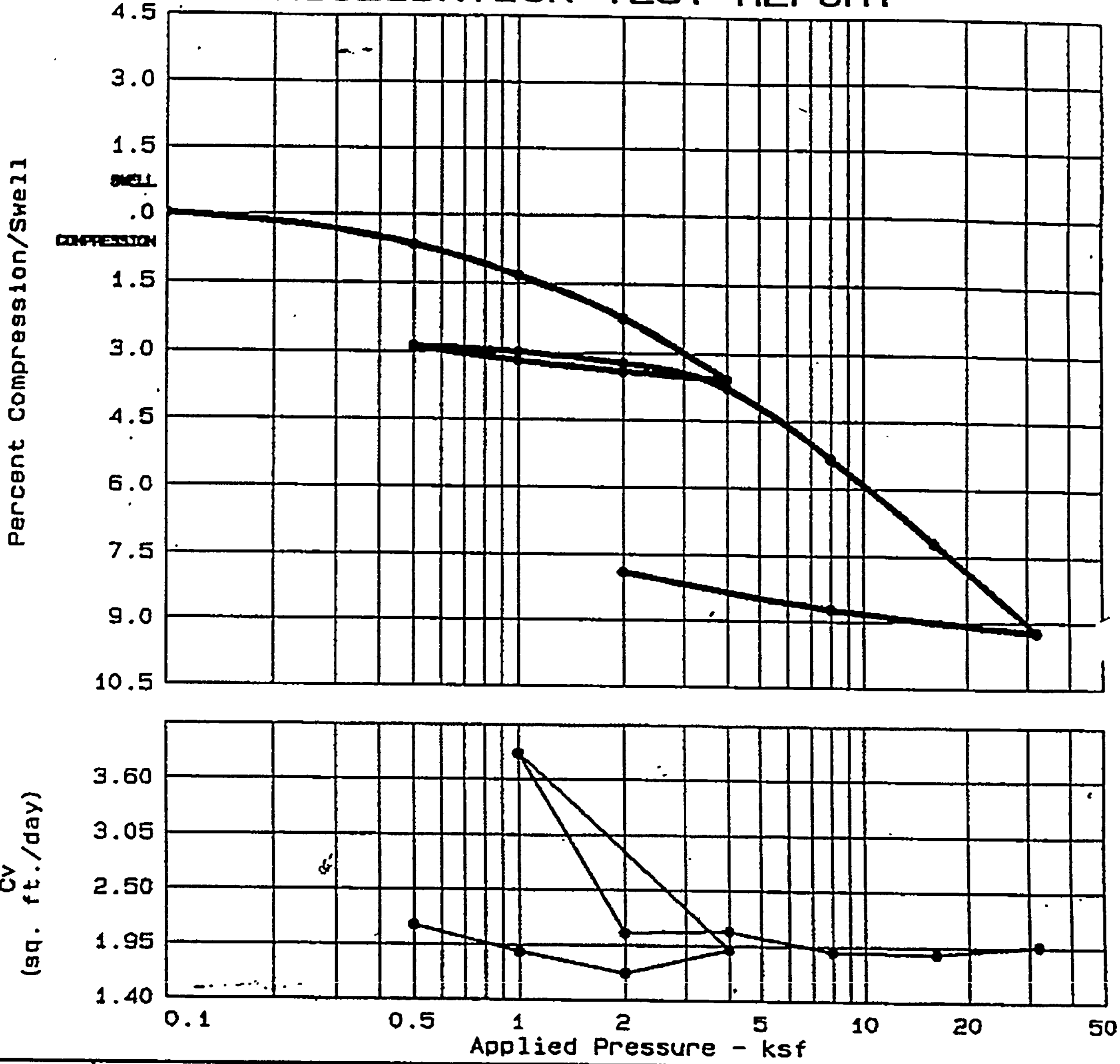
Remarks:
Tested by: JTM
Reviewed by: IP

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

C-87

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	75.0 %	14.9	109.8			2.70	5.49	0.10	0.5352

TEST RESULTS

Compression Index = 0.10

MATERIAL DESCRIPTION

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-2
St-1 @ 35 Ft.
Date: April 15, 1998

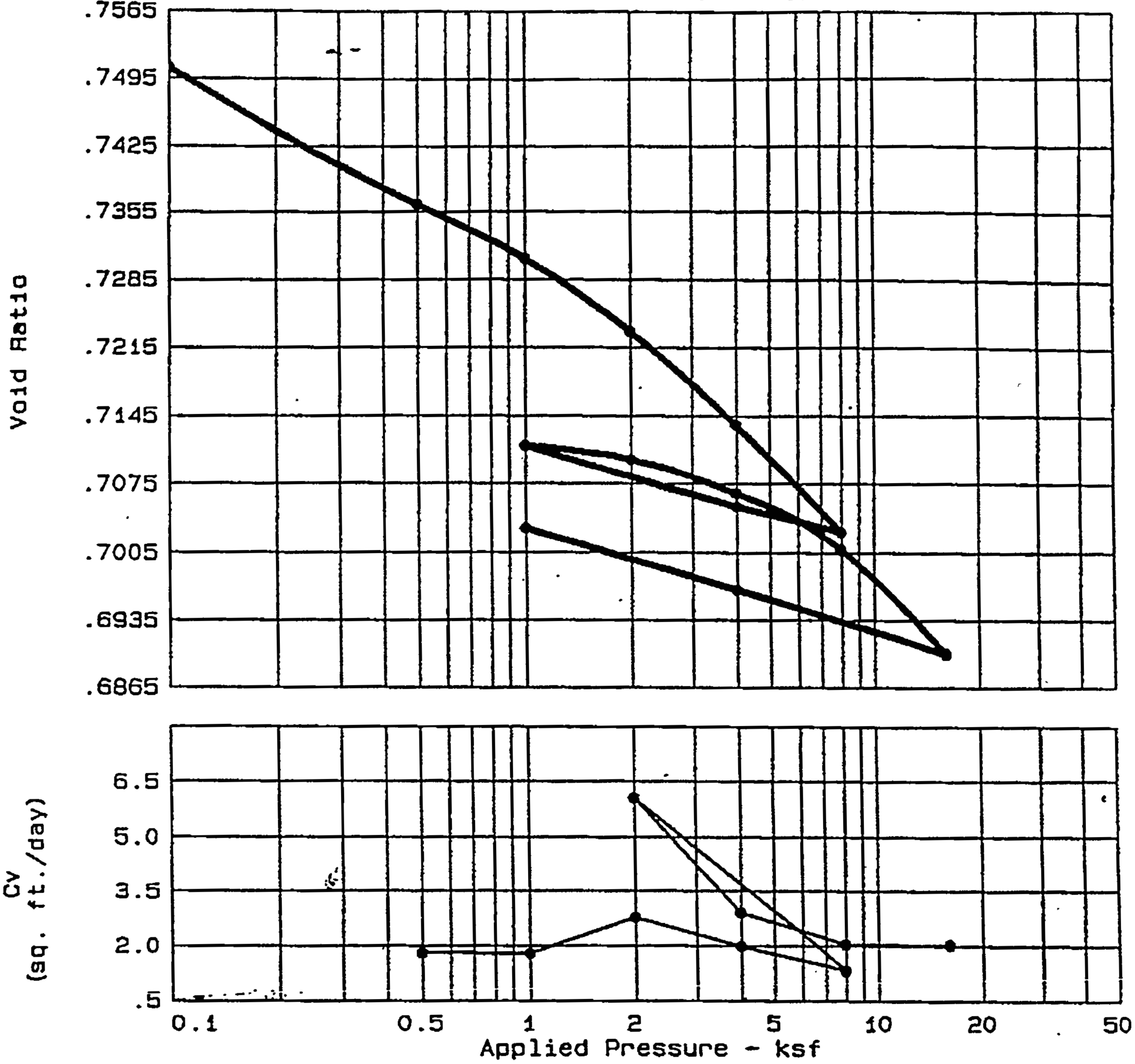
Remarks:
Tested by: JTM
Reviewed by: LB

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

C-88

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	74.4 %	21.1	94.5	NL	NP	2.65	8.31	0.04	0.750

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.04	Brown Poorly Graded Sand with Silt Class: SP-SM

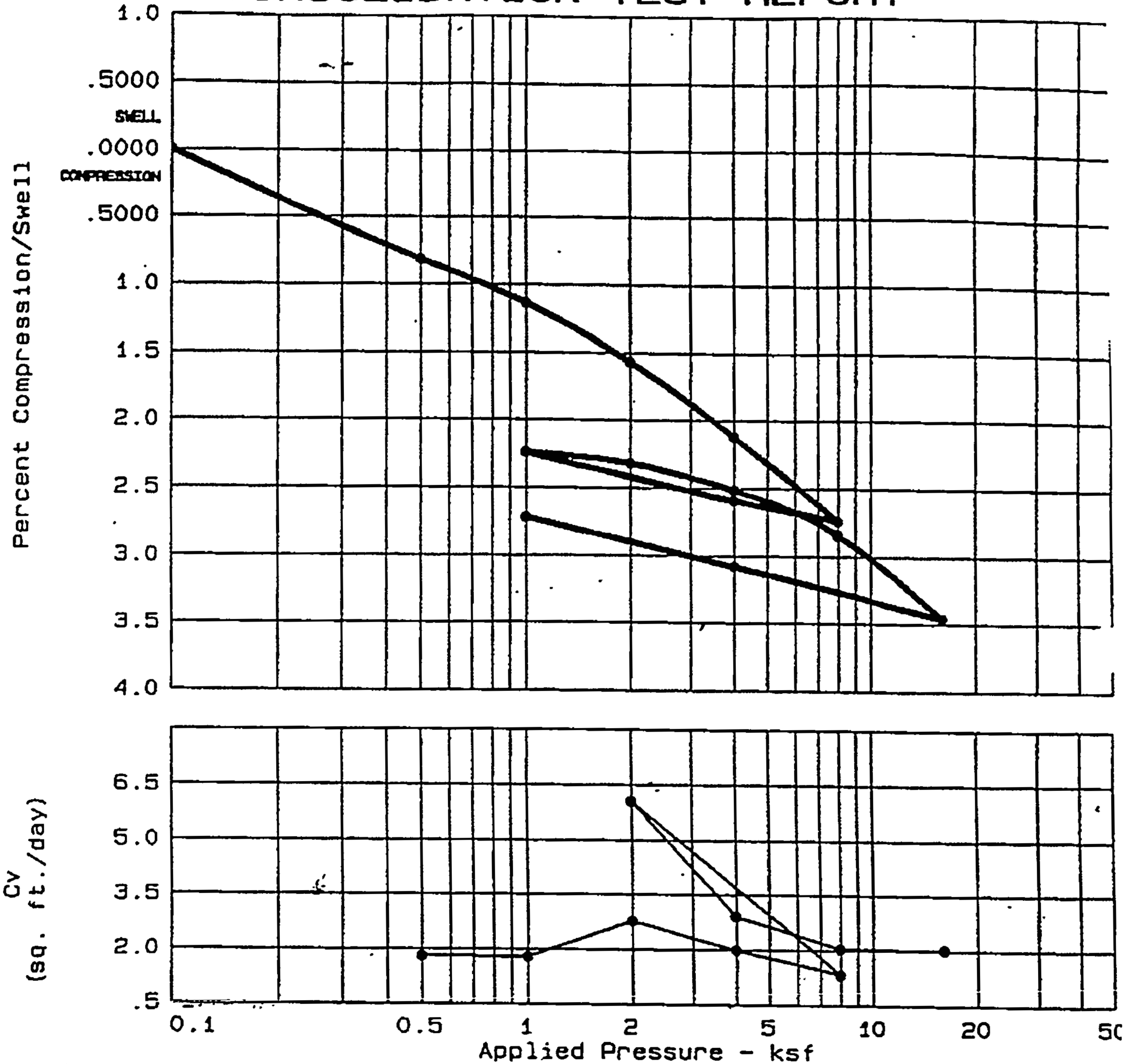
Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-2
St-5 @ 131.5-133.5 Ft.
Date: Feb. 18, 1998

Remarks:
Tested by: JTm
Reviewed by:

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_o
	74.4 %	21.1	94.5	NL	NP	2.65	8.31	0.04	0.750

TEST RESULTS

Compression Index = 0.04

MATERIAL DESCRIPTION

Brown Poorly Graded
Sand with Silt

Class: SP-SM

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-2
St-5 @ 131.5-133.5 Ft.
Date: Feb. 18, 1998

Remarks:

Tested by: JTM

Reviewed by: lb

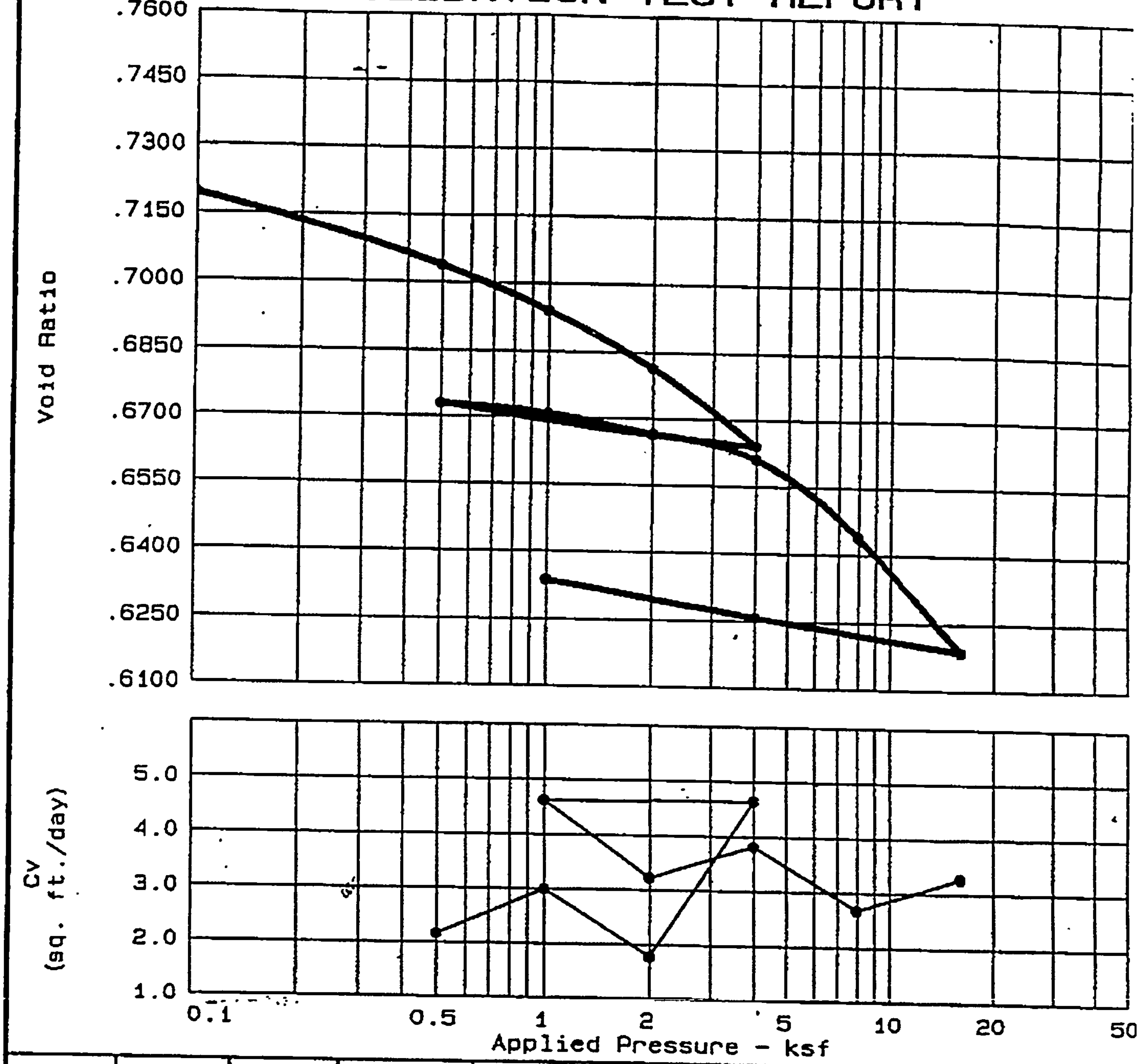
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No

C-90

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	51.2 %	13.9	96.2	35	12	2.65	5.40	0.08	0.719

TEST RESULTS

Compression Index = 0.08

MATERIAL DESCRIPTION

Red Brown Clayey

Class: SC

Remarks:

Tested by: JTM

Reviewed by: Hb

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-3
St-2 @ 21.5-23.5 Ft.
Date: Feb. 18, 1998

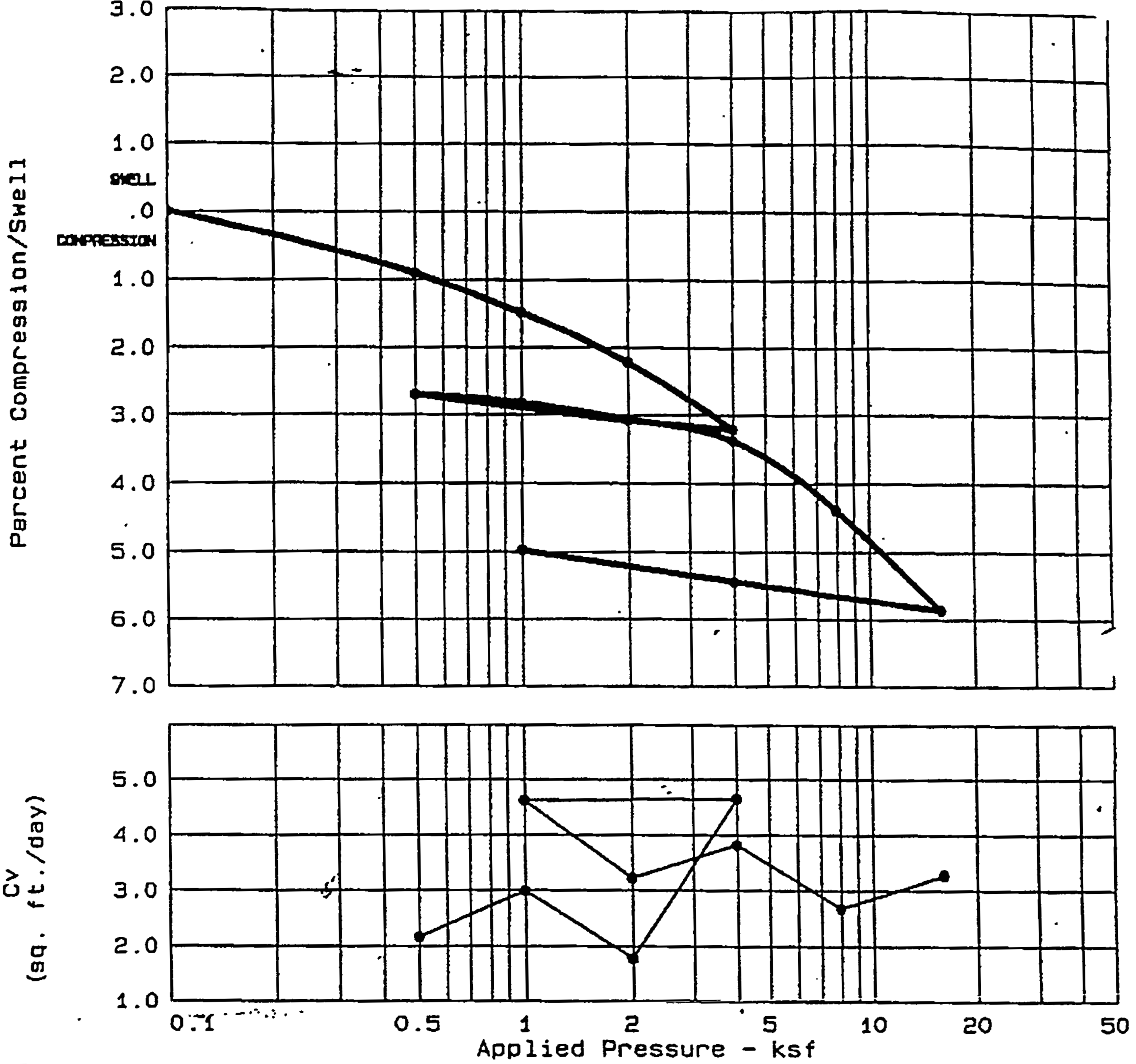
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No.

C-91

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	51.2 %	13.9	96.2	35	12	2.65	5.40	0.08	0.7194

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.08	Red Brown Clayey

Class: SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-3
St-2 @ 21.5-23.5 Ft.
Date: Feb. 18, 1998

Remarks:

Tested by: JTM

Reviewed by:

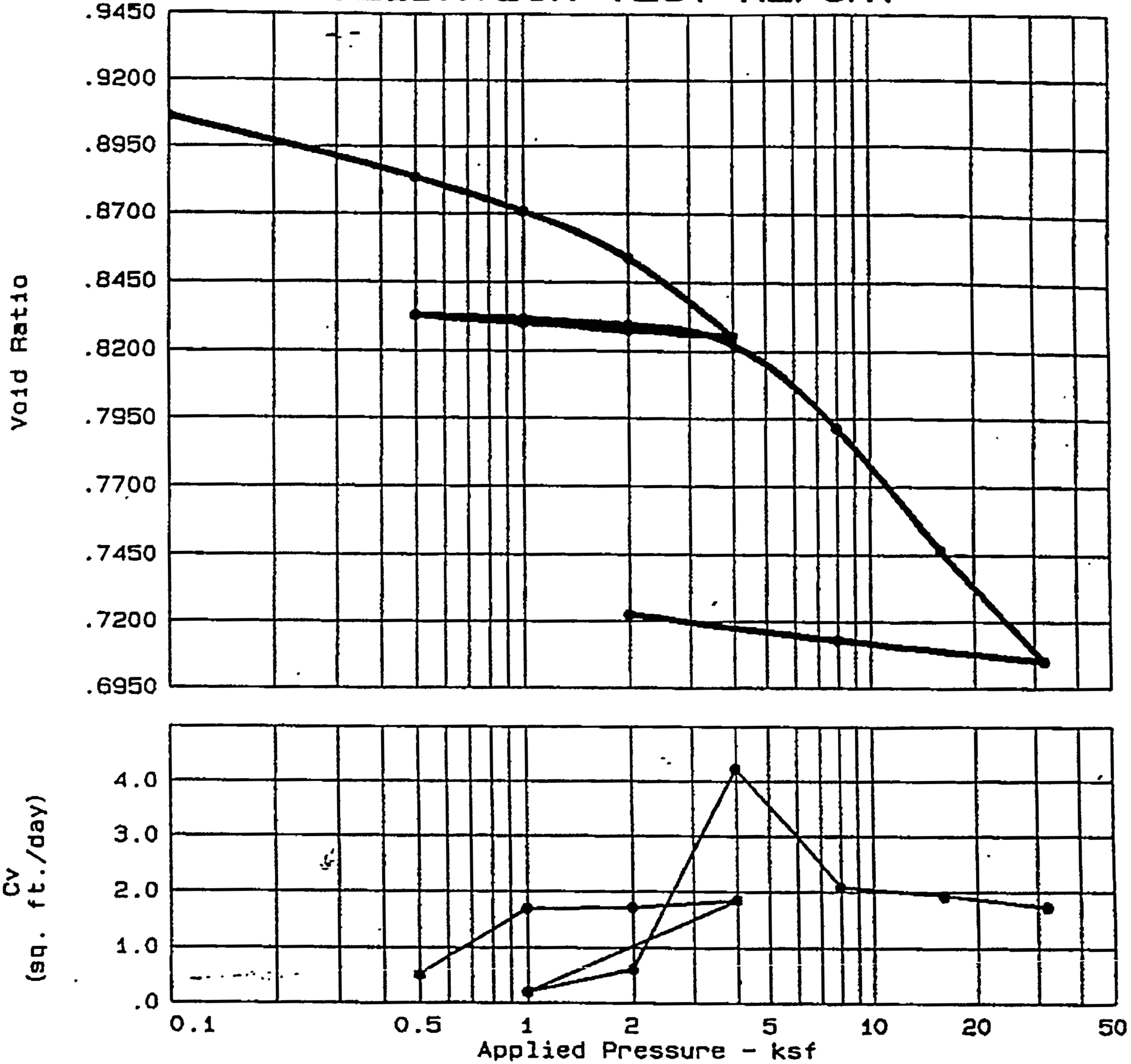
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No.______

C-92

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	90.5 %	30.4	88.4	38	10	2.70	4.80	0.14	0.9060

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.14	Brown Silty Sand Class: SM

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-3
St-3 @ 46.5 Ft.
Date: April 14, 1998

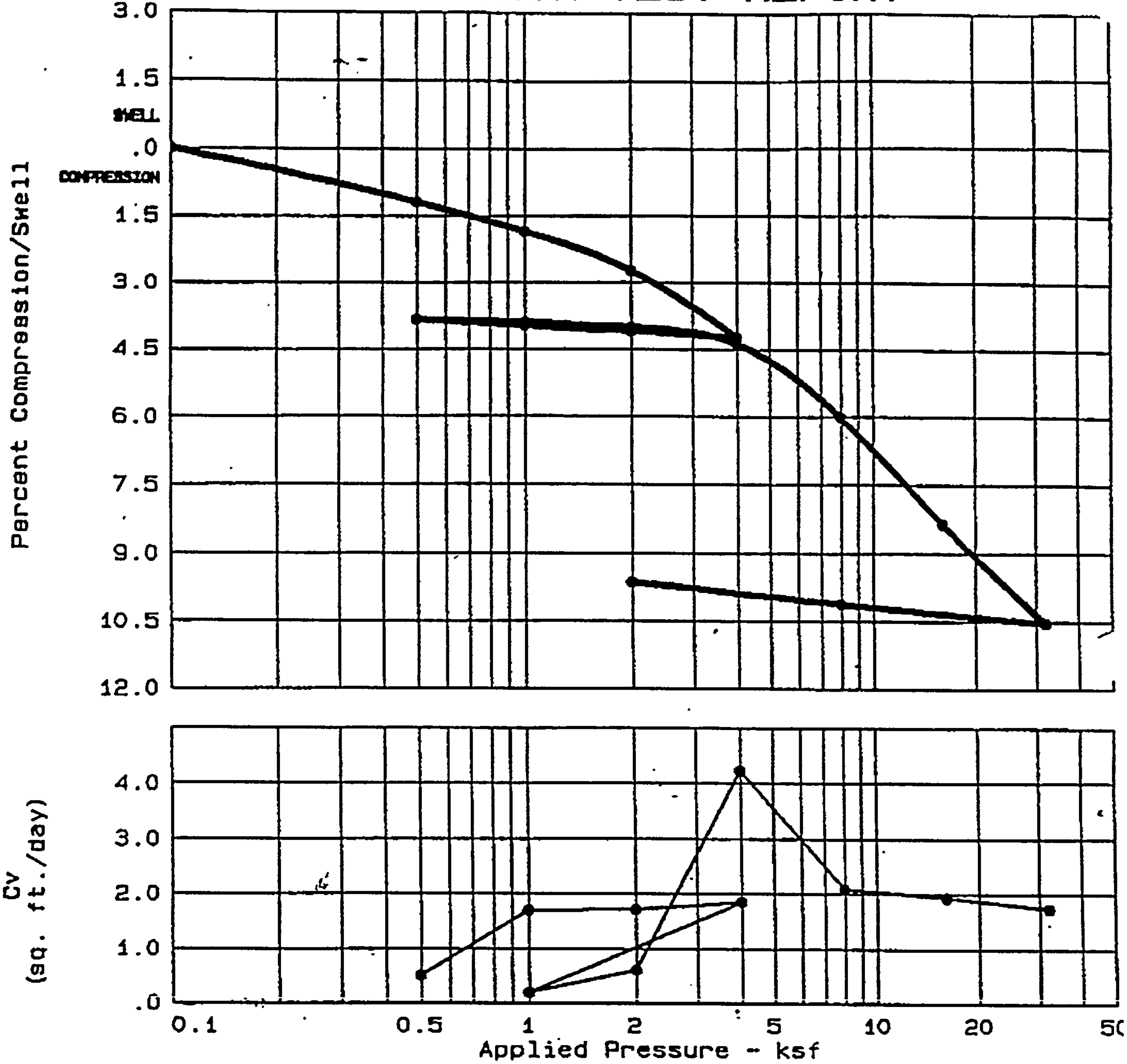
Remarks:
Tested by:
Reviewed by:

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC

C-93

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	90.6 %	30.4	88.4	38	10	2.70	4.80	0.14	0.906

TEST RESULTS

Compression Index - 0.14

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-3
St-3 @ 46.5 Ft.
Date: April 14, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Brown Silty Sand

Class: SM

Remarks:

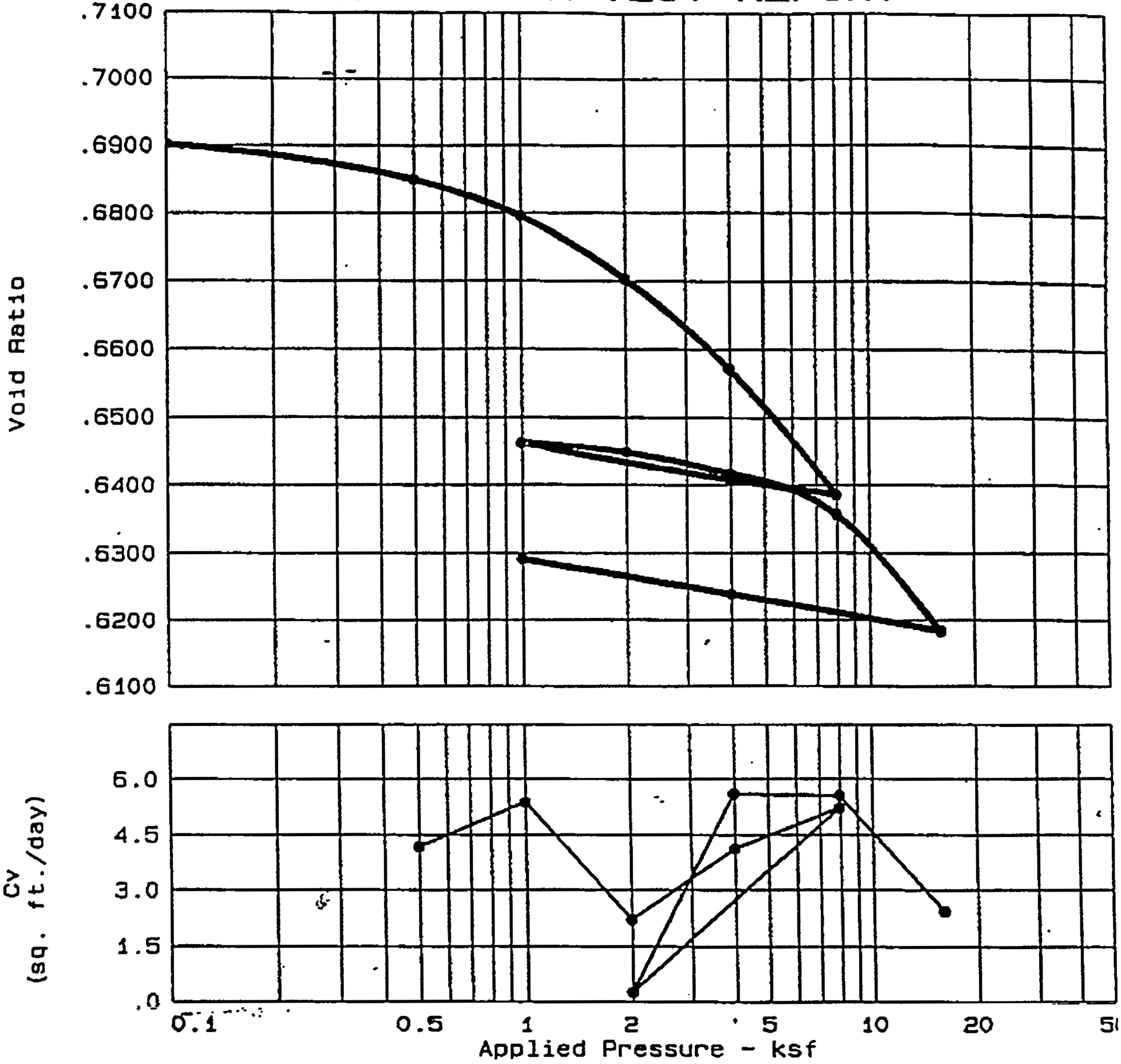
Tested by: JTM

Reviewed by: lb

Fig. No.

C-94

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	90.7 %	23.5	98.3	48	24	2.66	9.99	0.06	0.69

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.06	Reddish Brown Poorly Graded Sand with Clay Class: SP-SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Faciltuy
Location: HTEF B-3
St-4 @ 91-93 Ft.
Date: Feb. 18, 1998

Remarks:
Tested by: JTm
Reviewed by:

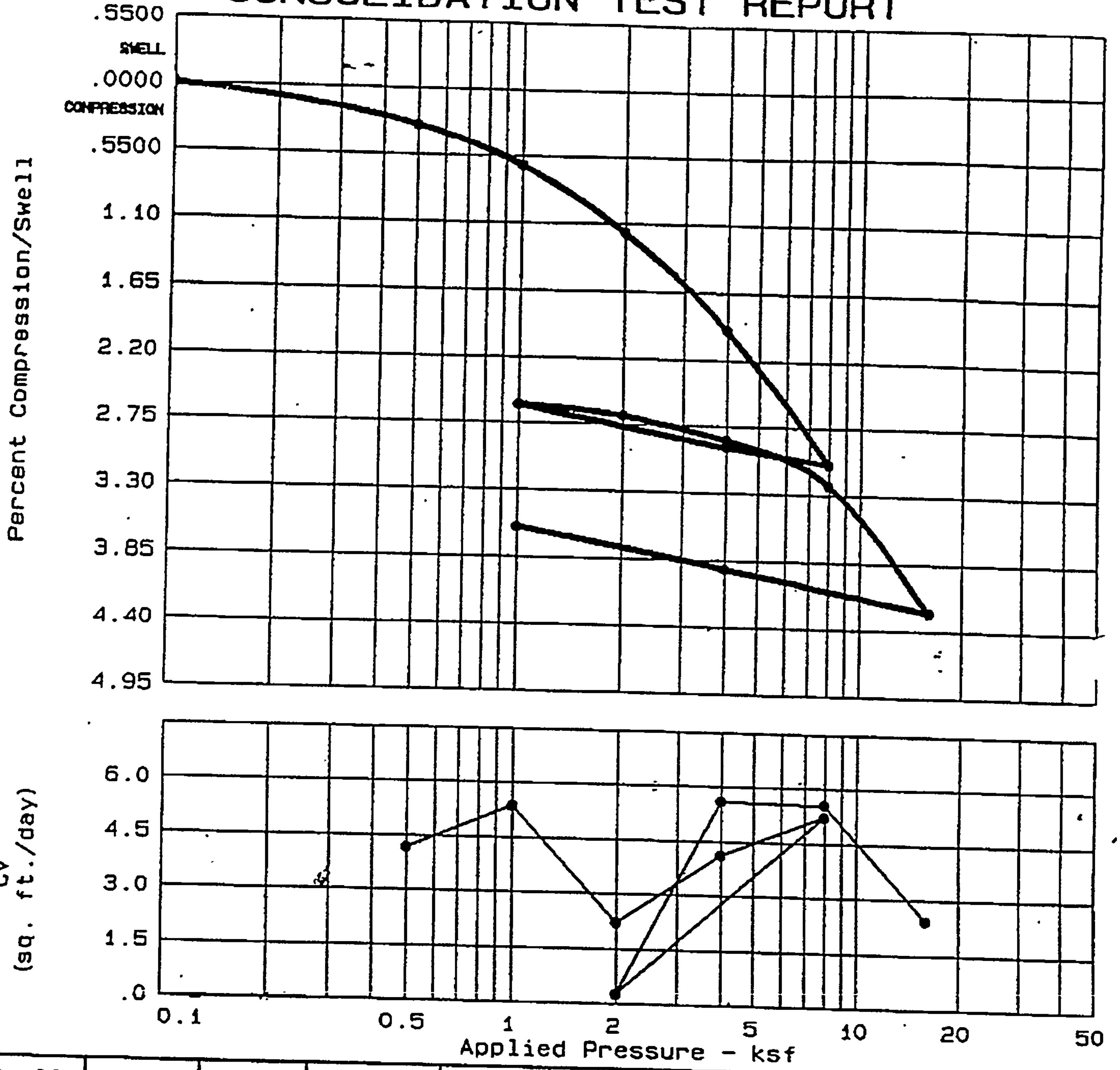
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No. ______

C-95

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	90.7 %	23.5	98.3	48	24	2.66	9.99	0.06	0.6901

TEST RESULTS

Compression Index = 0.06

MATERIAL DESCRIPTION

Reddish Brown Poorly Graded Sand with Clay

Class: SP-SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Faciltuy
Location: HTEF B-3
St-4 @ 91-93 Ft.
Date: Feb. 18, 1998

Remarks:

Tested by: JTM

Reviewed by:

CONSOLIDATION TEST REPORT

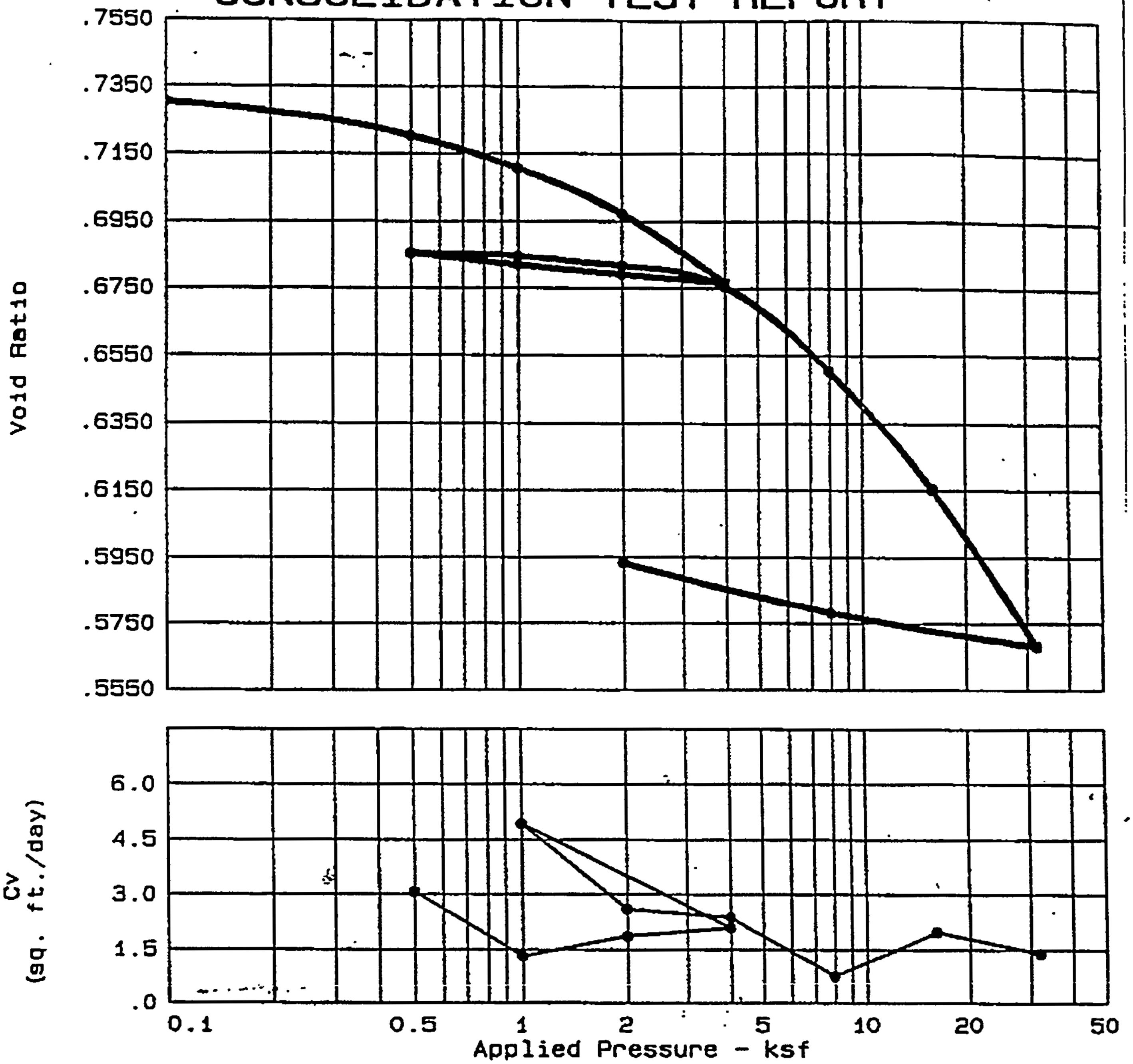
LAW ENGINEERING, INC.

95

Fig. No

C-96

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
.	84.2 %	22.8	97.4	41	20	2.70	7.52	0.16	0.7302

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.16	Reddish Brown Clayey Sand Class: SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extration Facility
Location: HTEF B-4
St-1 @ 12-14 Ft.
Date: April 22, 1998

Remarks:
Tested by JTM
Reviewed by:

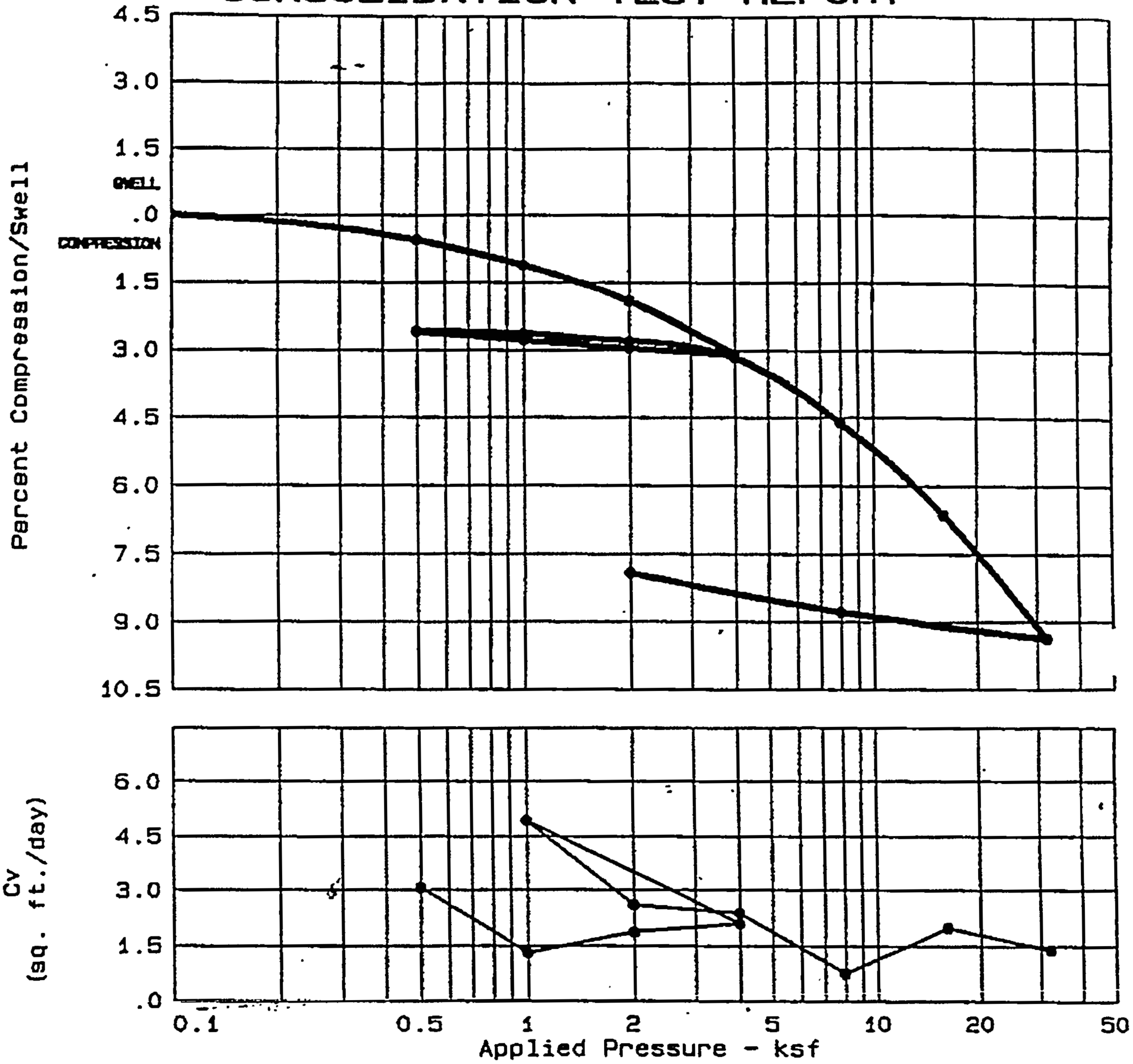
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No

C-97

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	84.2 %	22.8	97.4	41	20	2.70	7.52	0.16	0.7302

TEST RESULTS

Compression Index - 0.16

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-4
St-1 @ 12-14 Ft.
Date: April 22, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

Remarks:

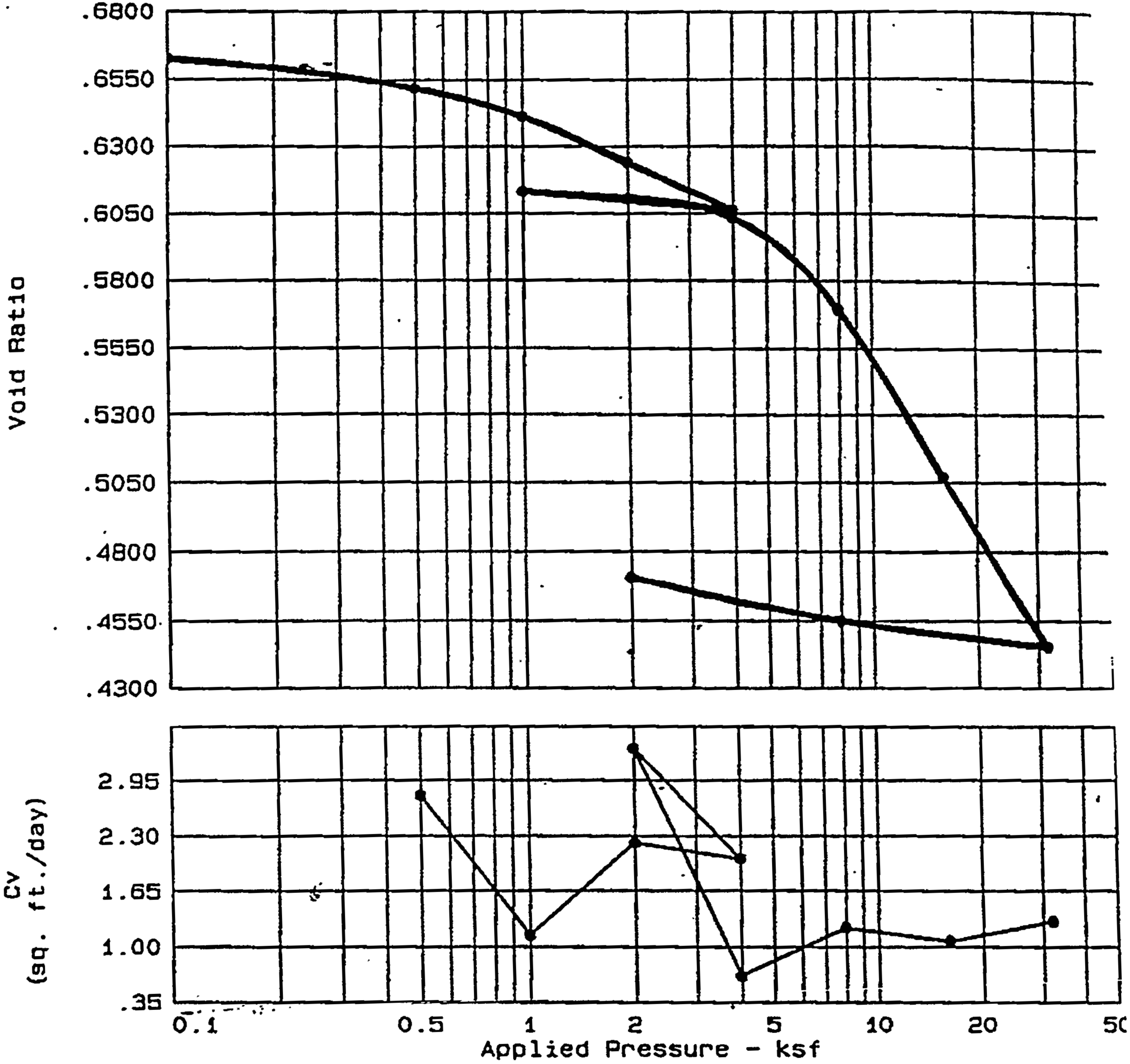
Tested by JTM

Reviewed by:

Fig. No.______

C-98

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	76.1 %	19.0	99.5	49	26	2.65	7.27	0.20	0.662

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.20	Tan Brown Clayey Sand

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-4
St-2 @ 28 Ft.
Date: March 26, 1998

Remarks:

Tested by: JTM

Reviewed by:

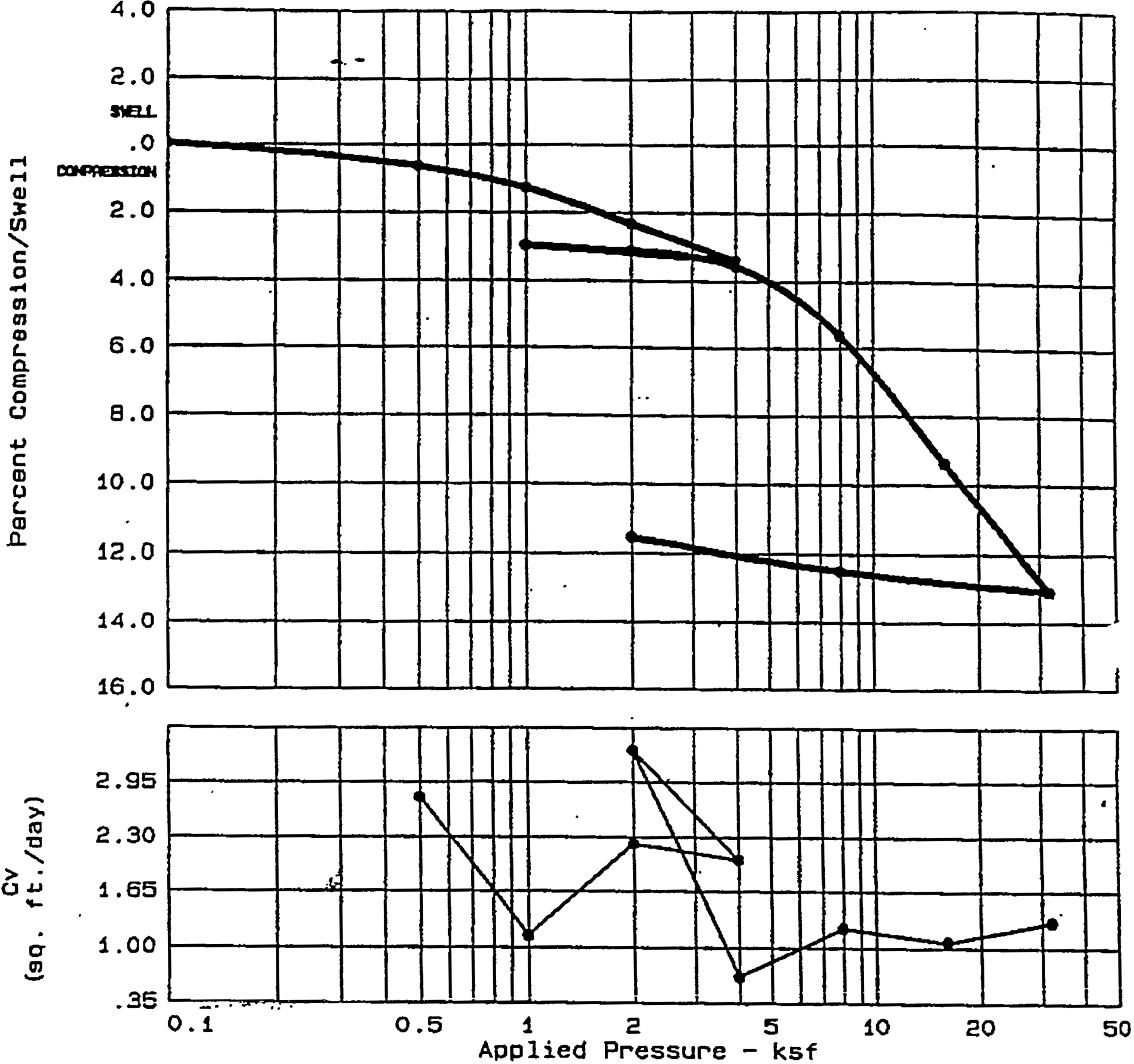
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No

C-99

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	76.1 %	19.0	99.5			2.65	7.27	0.20	0.6626

TEST RESULTS

Compression Index = 0.20

MATERIAL DESCRIPTION

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-4
St-2 @ 28 Ft.
Date: March 26, 1998

CONSOLIDATION TEST REPORT

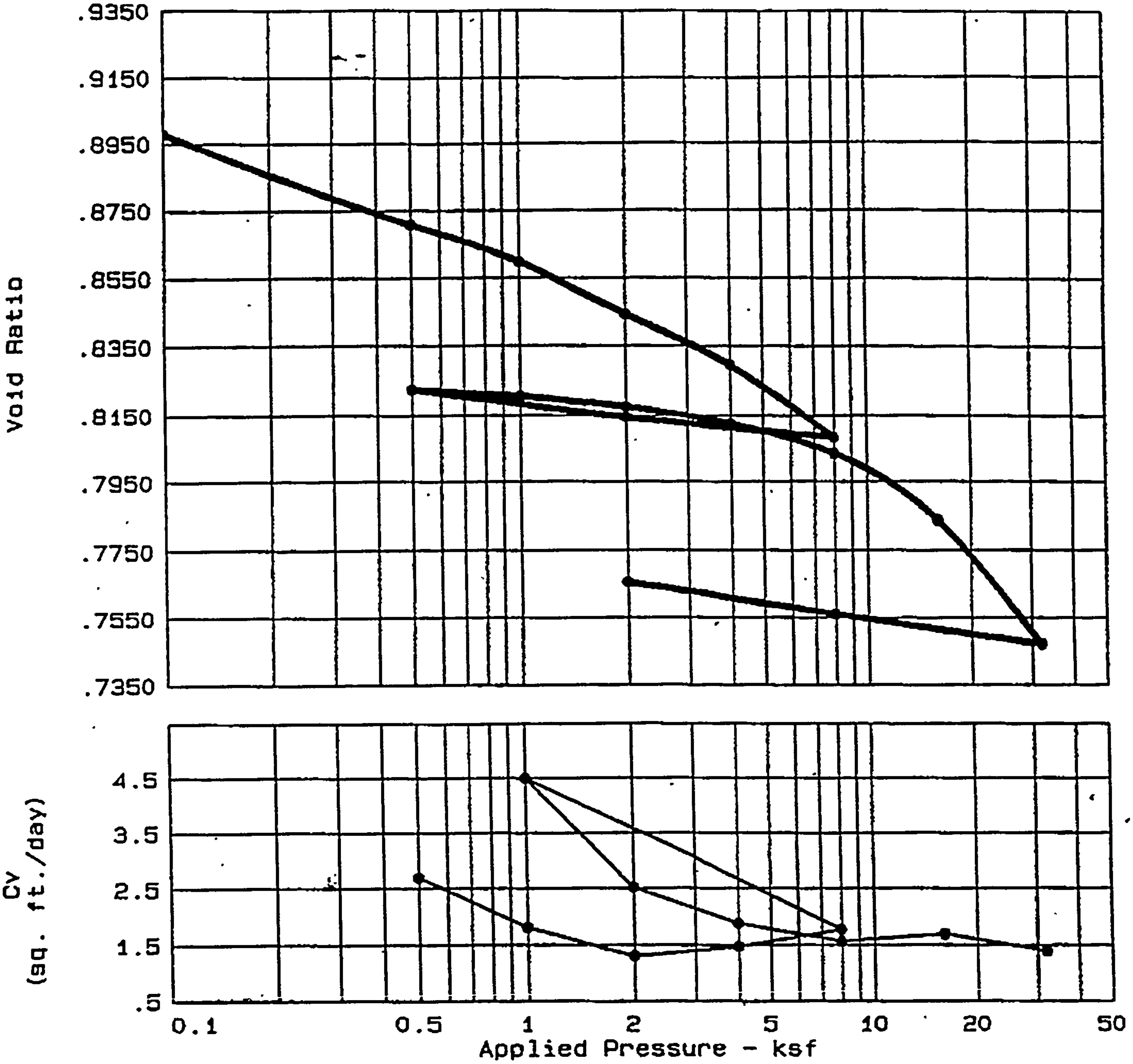
LAW ENGINEERING, INC.

Remarks:
Tested by:
Reviewed by:

Fig. No.

C-100

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Initial void ratio
	96.6 %	32.7	87.2	NL	NP	2.65	0.8977

TEST RESULTS

MATERIAL DESCRIPTION

Tan Silty Sand

Class: SM

Remarks:

Tested by: JTM

Reviewed by:

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-4
St-8 @ 132.5-134.5 Ft.
Date: March 26, 1998

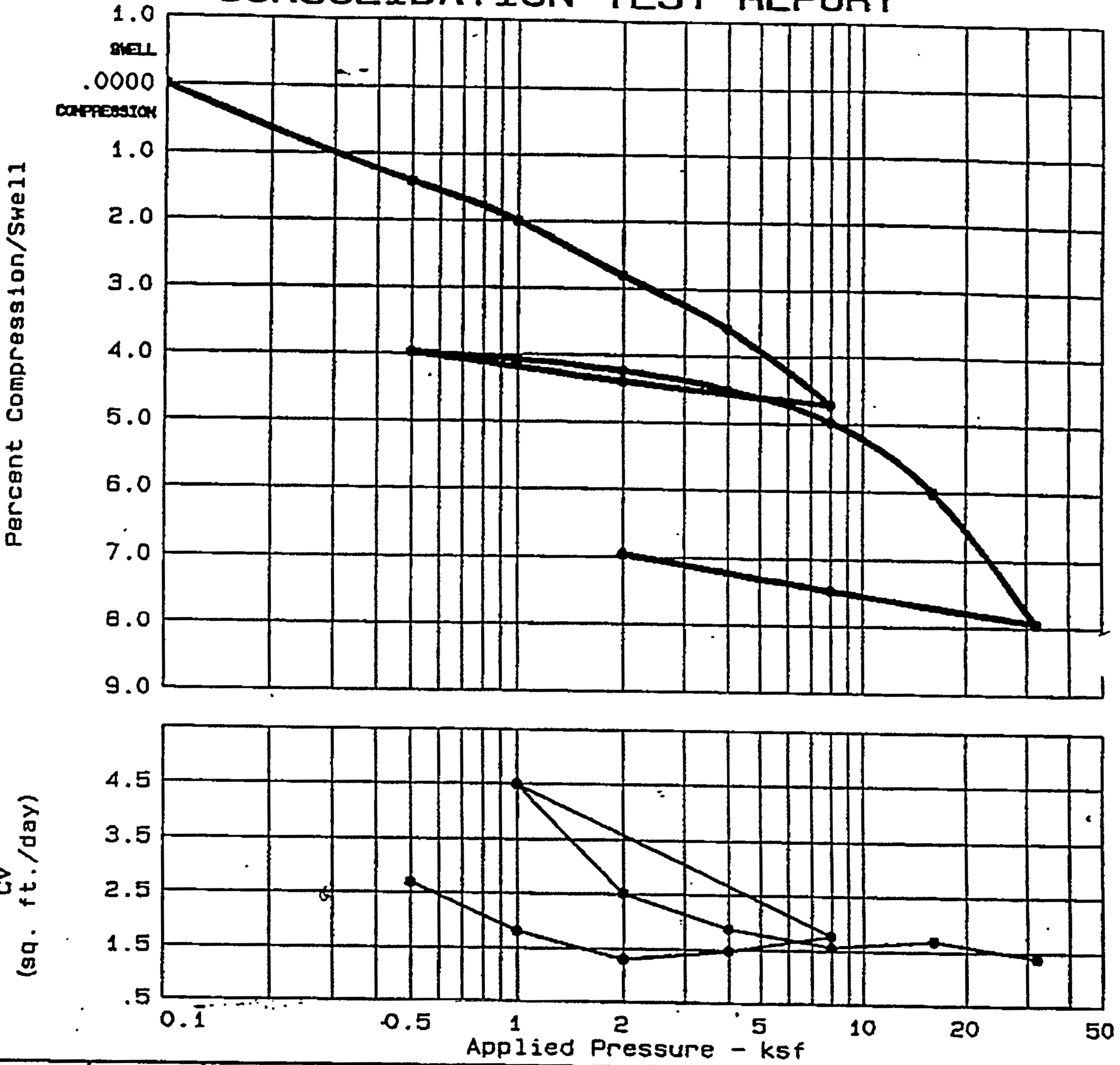
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No.

C-101

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Initial void ratio
	96.6 %	32.7	87.2			2.65	0.8977

TEST RESULTS	MATERIAL DESCRIPTION

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-4
St-8 @ 132.5-134.5 Ft.
Date: March 26, 1998

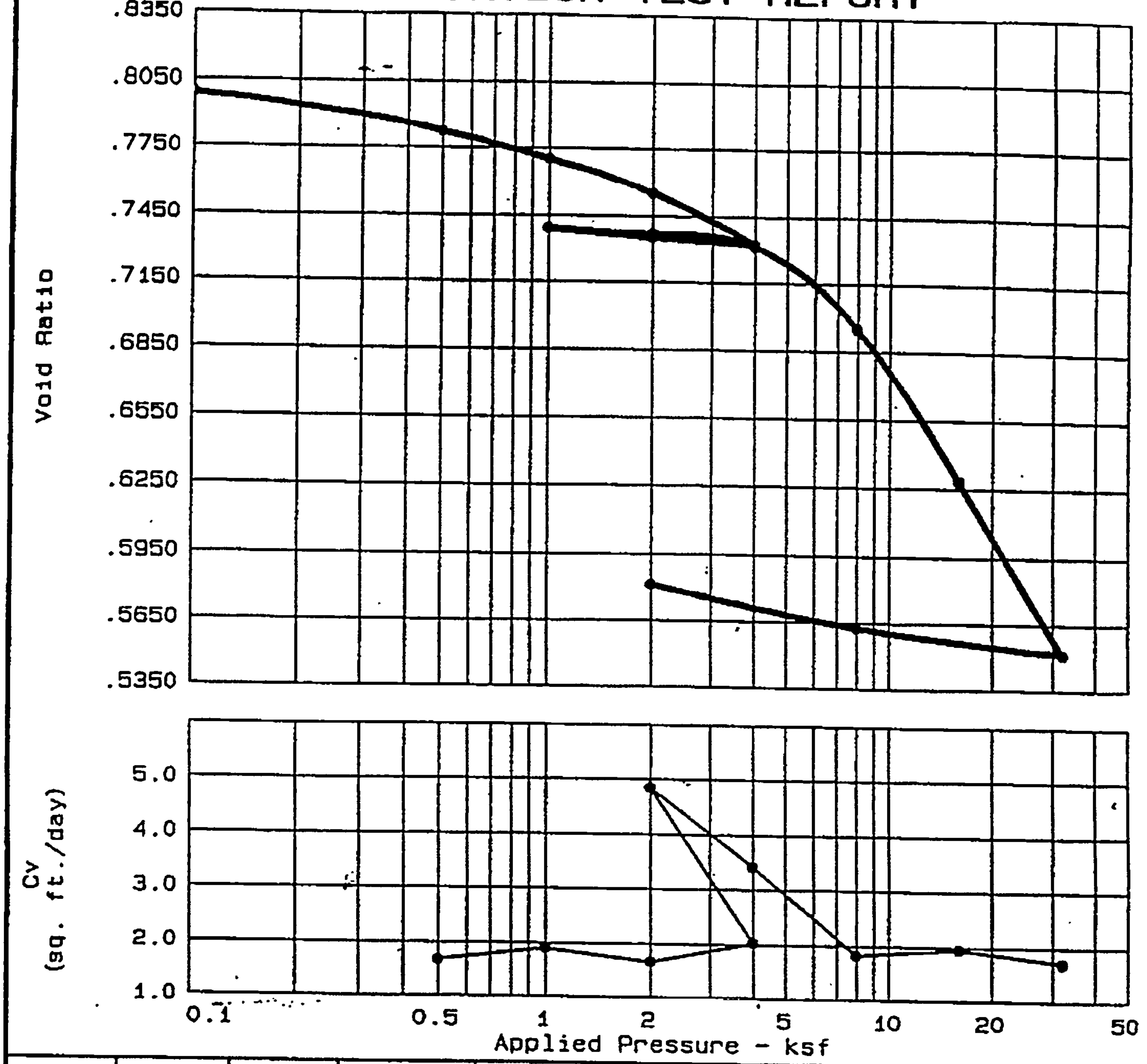
CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Remarks:
Tested by:
Reviewed by:
Fig. No.

C-102

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	85.1 %	25.6	92.0	48	22	2.65	6.81	0.25	0.7992

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.25	Reddish Brown Clayey Sand Class: SC

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF 8-5
St-1 @ 26-28 Ft.
Date: April 3, 1998

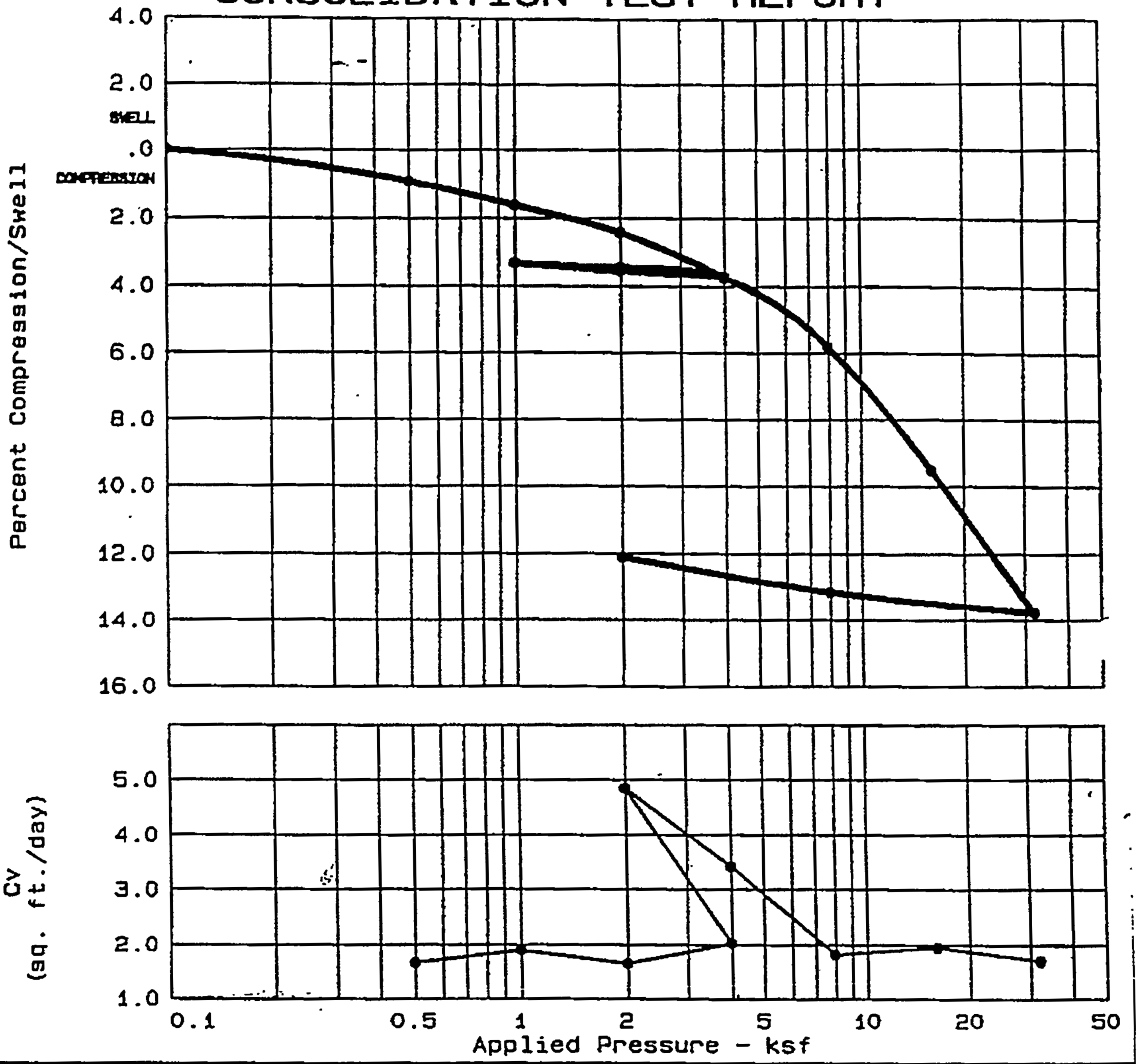
Remarks:
Tested by: JTM
Reviewed by:

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

Fig. No.______

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	85.1 %	25.6	92.0	48	22	2.65	6.81	0.25	0.7992

TEST RESULTS

Compression Index = 0.25

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-5
St-1 @ 26-28 Ft.
Date: April 3, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

Remarks:

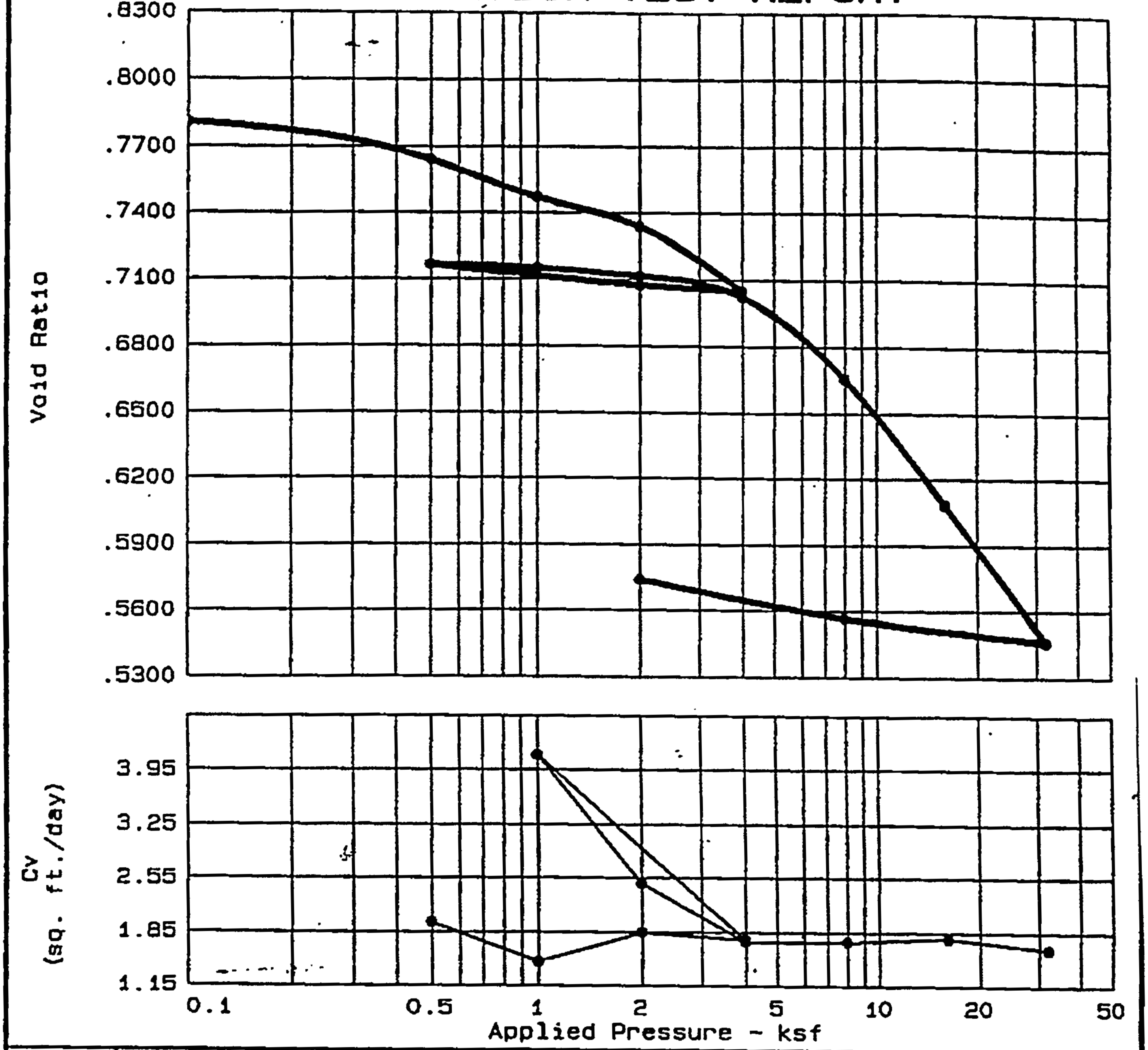
Tested by: JTM

Reviewed by: HS

Fig. No.

C-104

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_o
	96.7 %	28.5	92.9	40	16	2.65	6.21	0.21	0.7807

TEST RESULTS

Compression Index = 0.21

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: B-5
St-2 @ 91.5-93.5 Ft.
Date: April 3, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING. INC

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

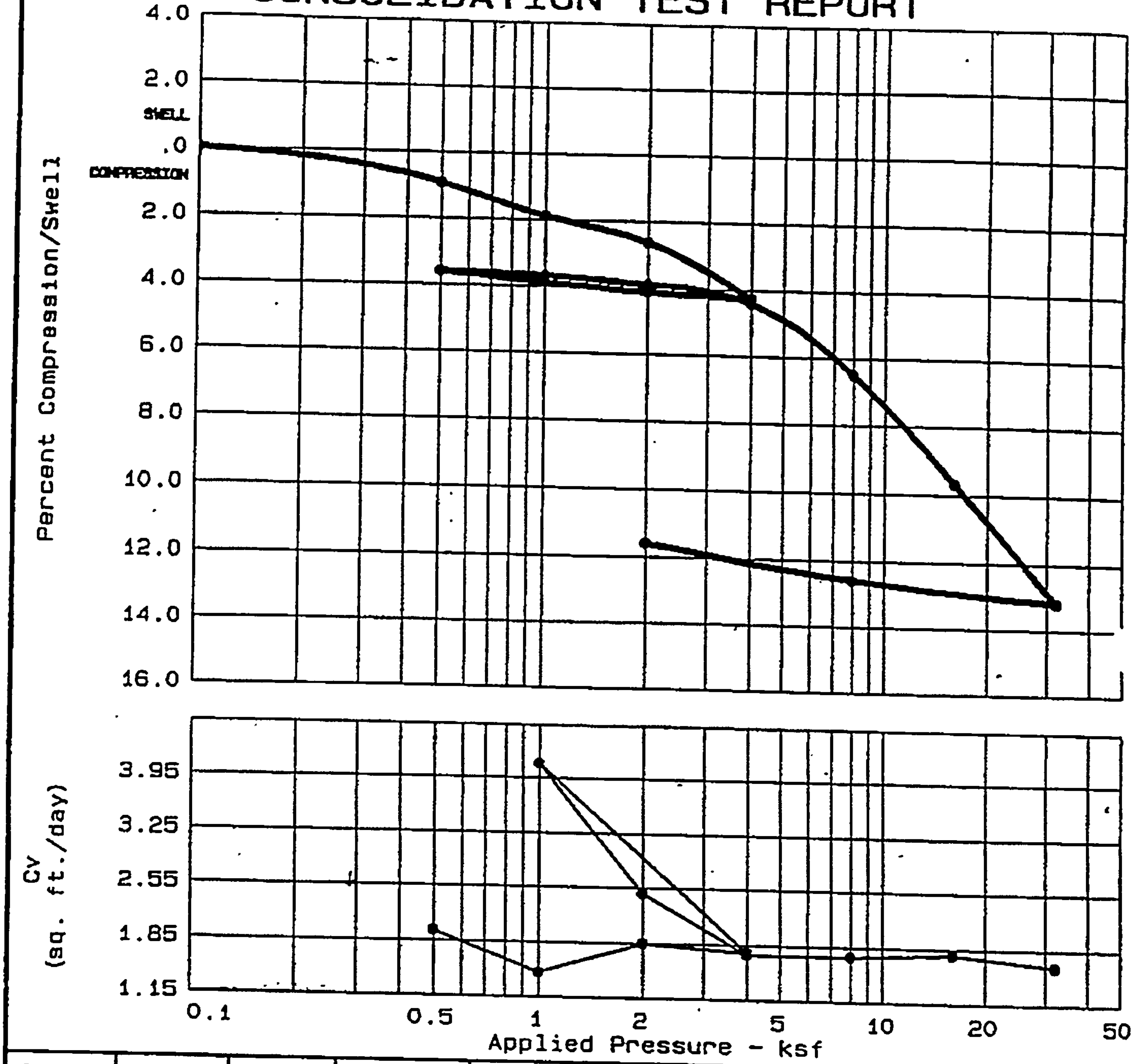
Remarks:

Tested by: Jtm

Reviewed by:

C-105

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	96.7 %	28.5	92.9	40	16	2.65	6.21	0.21	0.7807

TEST RESULTS

Compression Index = 0.21

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: B-5
St-2 @ 91.5-93.5 Ft.
Date: April 3, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

Remarks:

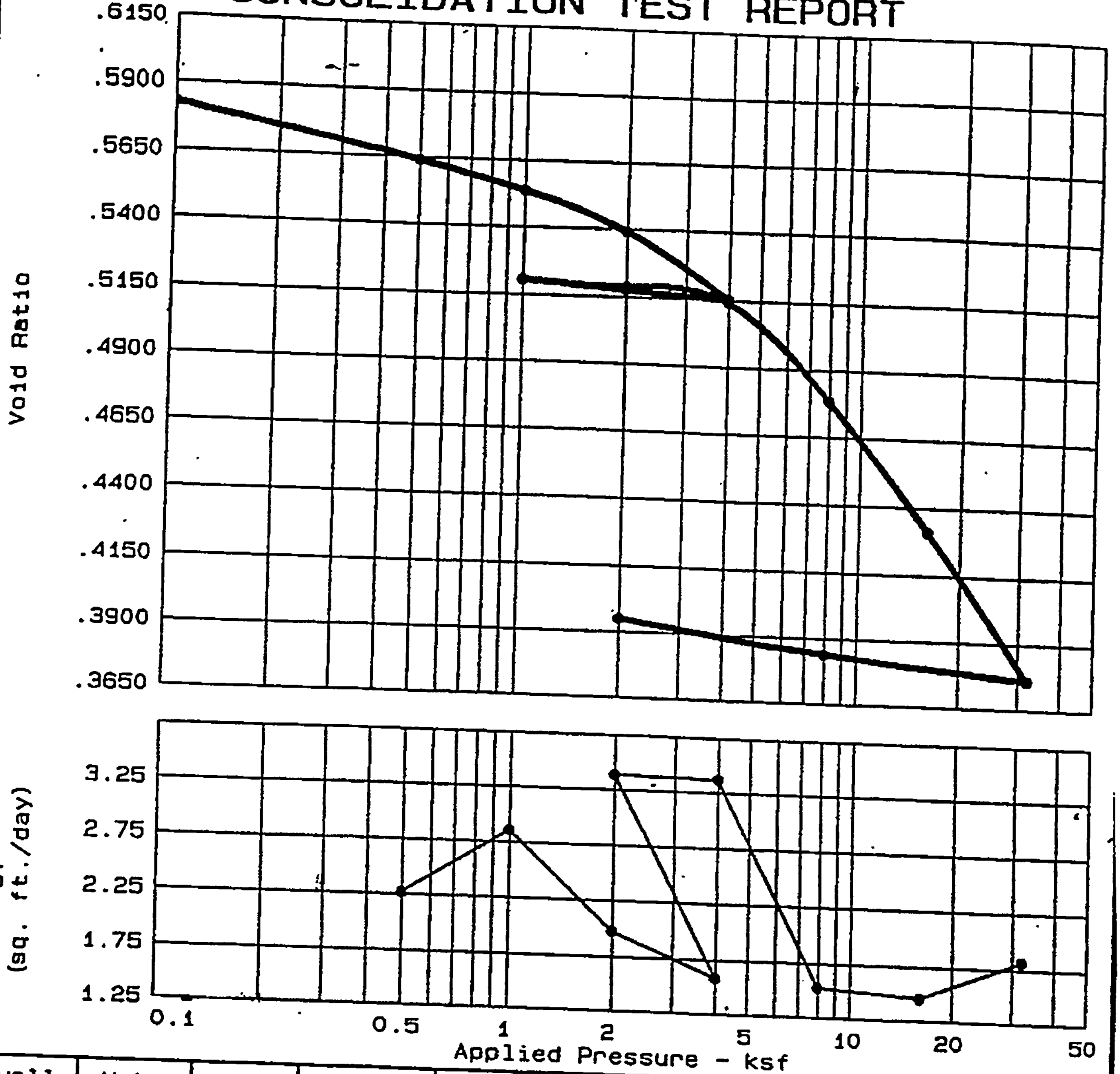
Tested by: JTM

Reviewed by: HS

Fig. No

C-106

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_0
	78.2 %	17.2	104.5	48	21	2.65	6.25	0.18	0.5828

TEST RESULTS

Compression Index = 0.18

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

Remarks:

Tested by: JTM

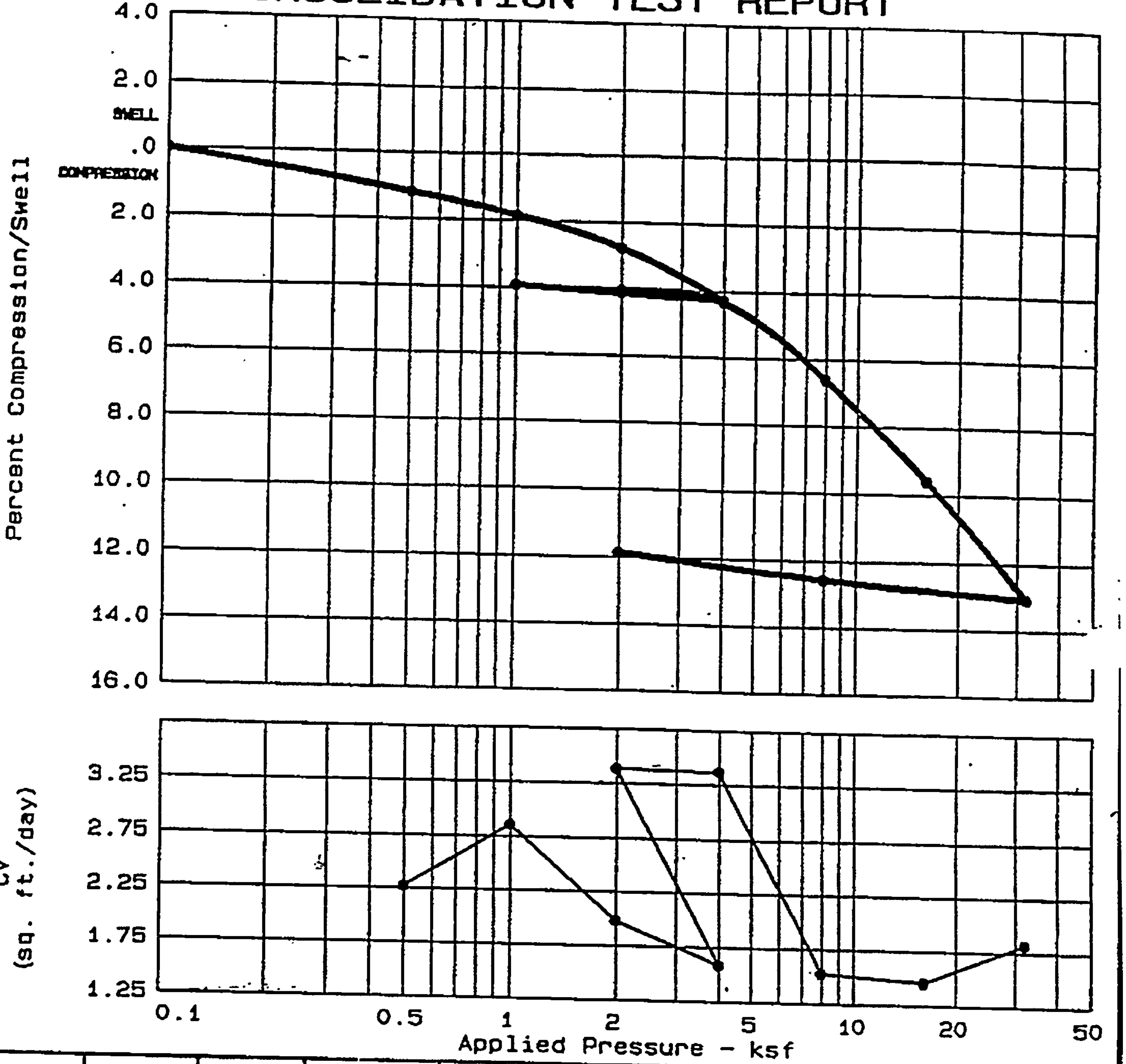
Reviewed by:

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-6
St-1 @ 34-36 Ft.
Date: April 1, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

CONSOLIDATION TEST REPORT



Swell press.	Nat. Sat.	Nat. Moist.	Dry Density	LL	PI	Sp.Gr.	Precons. press.	C_c	e_o
	78.2 %	17.2	104.5	48	21	2.65	6.25	0.18	0.5828

TEST RESULTS

Compression Index = 0.18

Project No.: 50161-7-0108 Task 12
Project: Tritium Extraction Facility
Location: HTEF B-6
St-1 @ 34-36 Ft.
Date: April 1, 1998

CONSOLIDATION TEST REPORT

LAW ENGINEERING, INC.

MATERIAL DESCRIPTION

Reddish Brown Clayey Sand

Class: SC

Remarks:

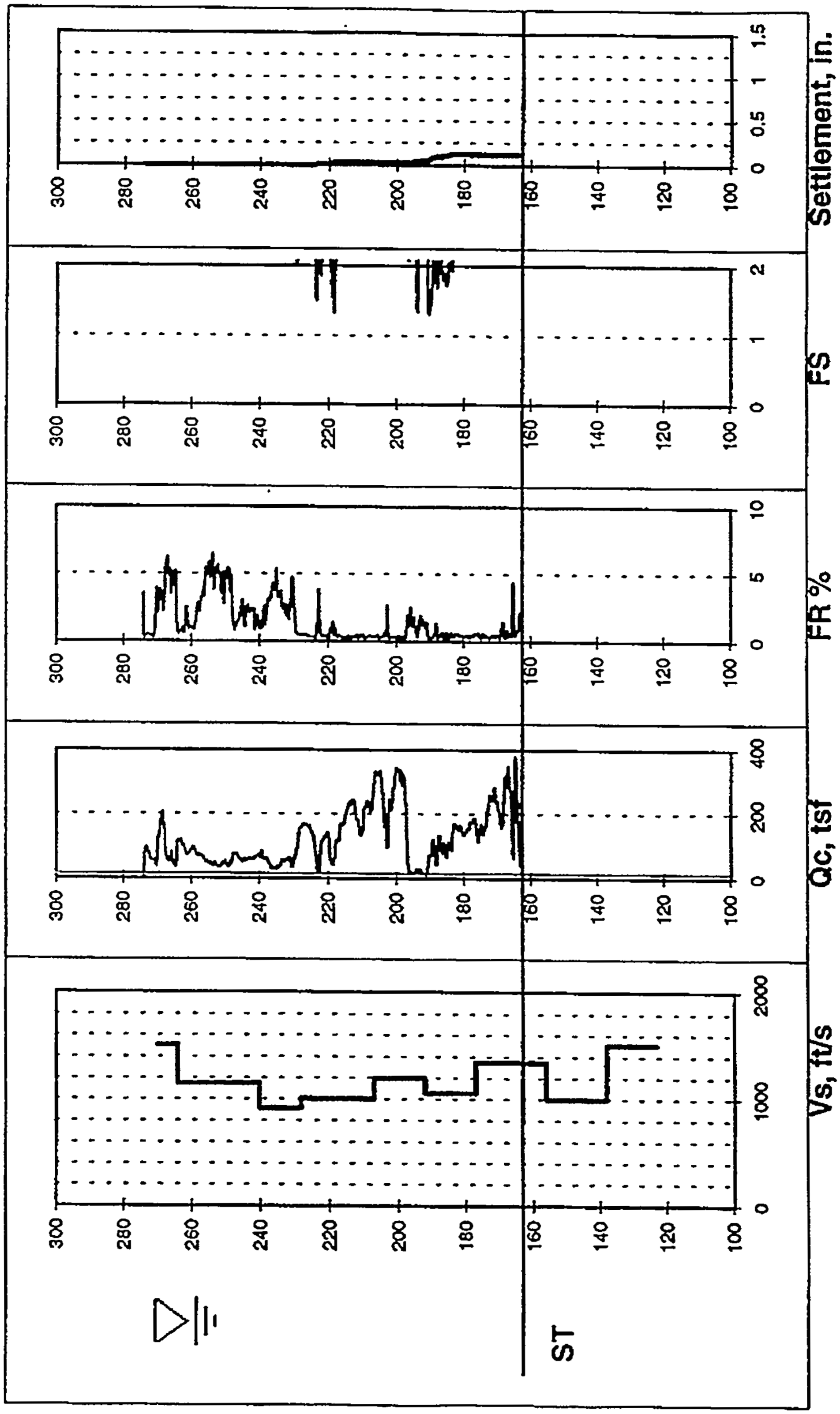
Tested by: JTM

Reviewed by:

Appendix D

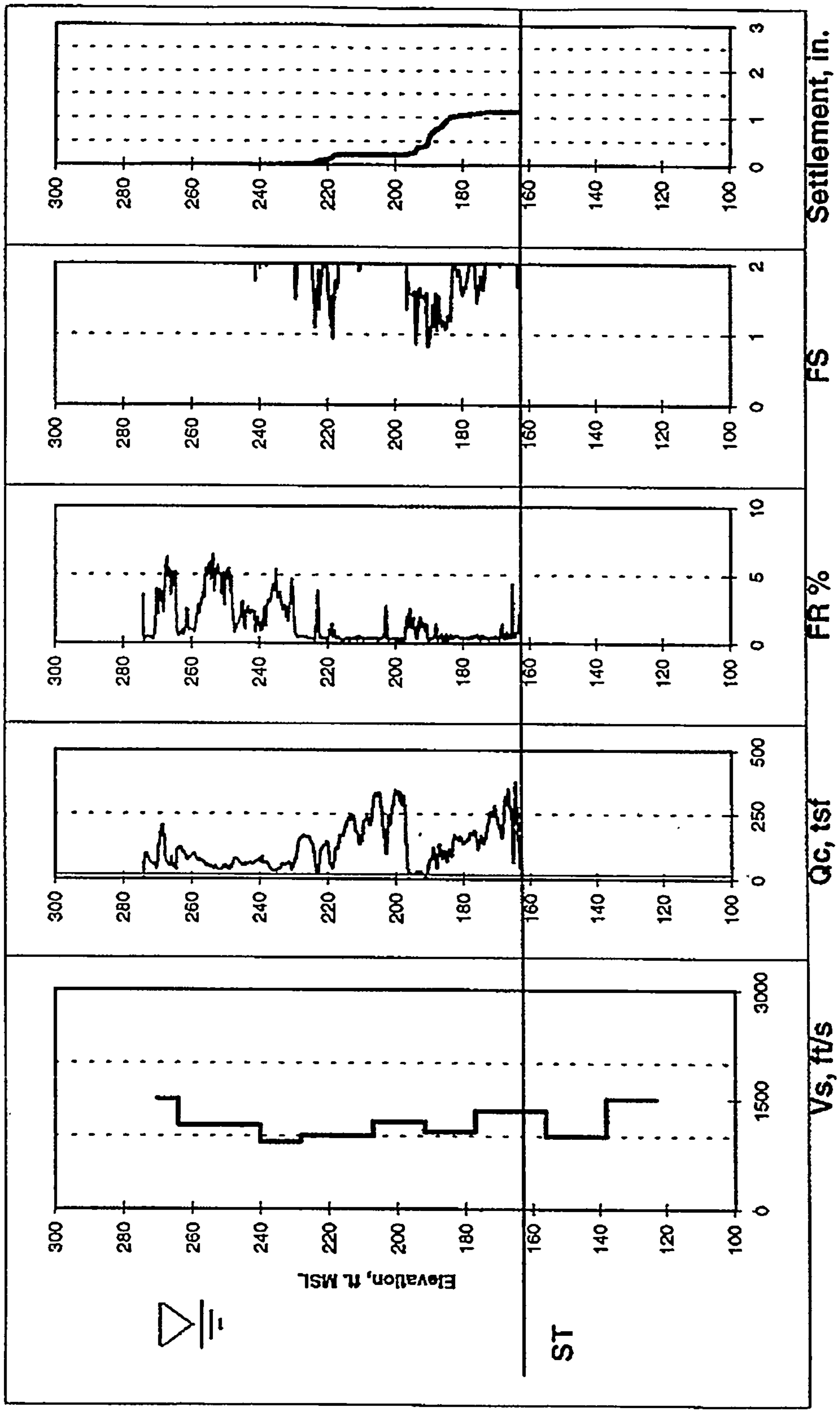
Liquefaction Analysis Results

11/13/98,htefc01.XLS,pc3



PC3 Ground Motion Earthquake
HTEF-C01

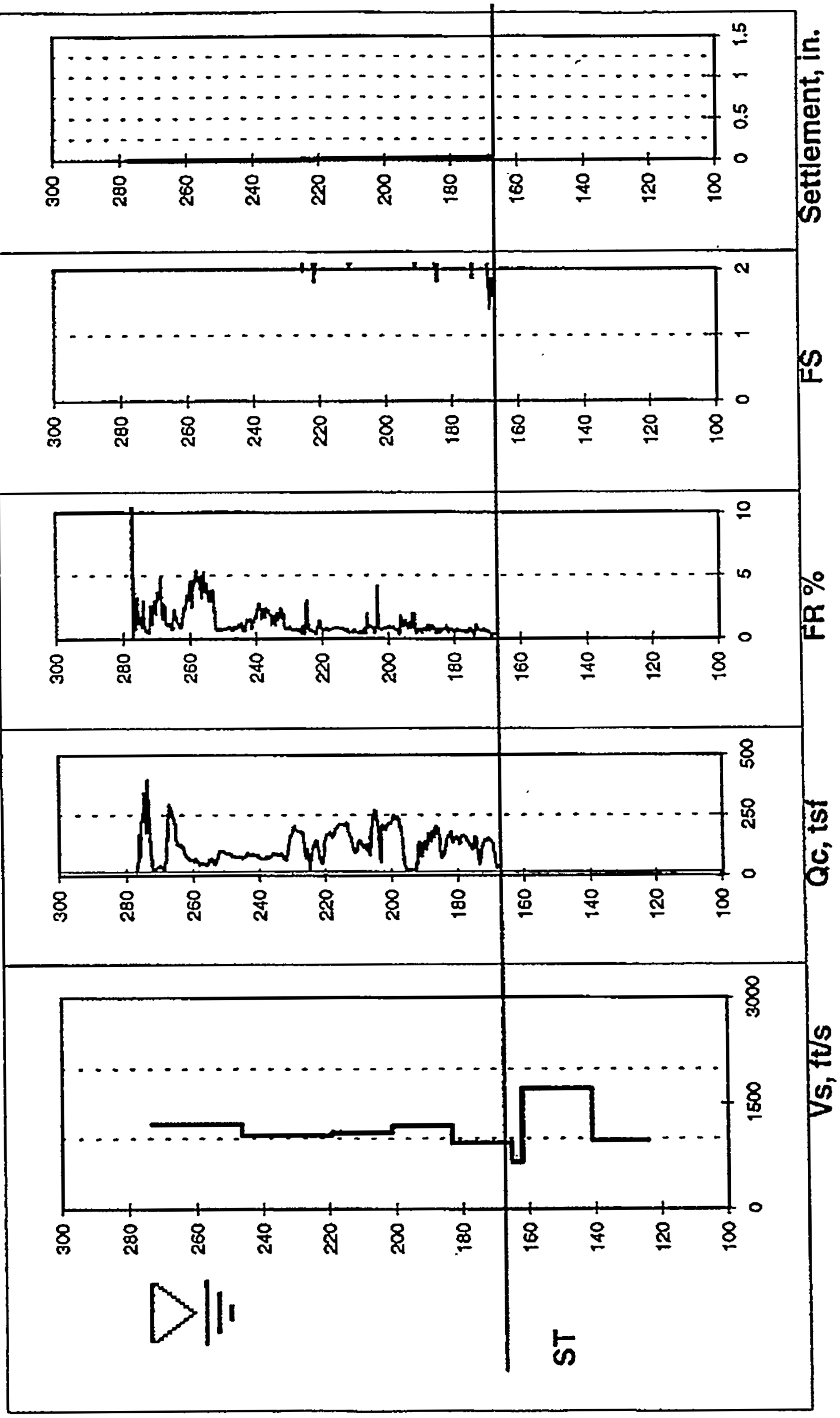
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C01



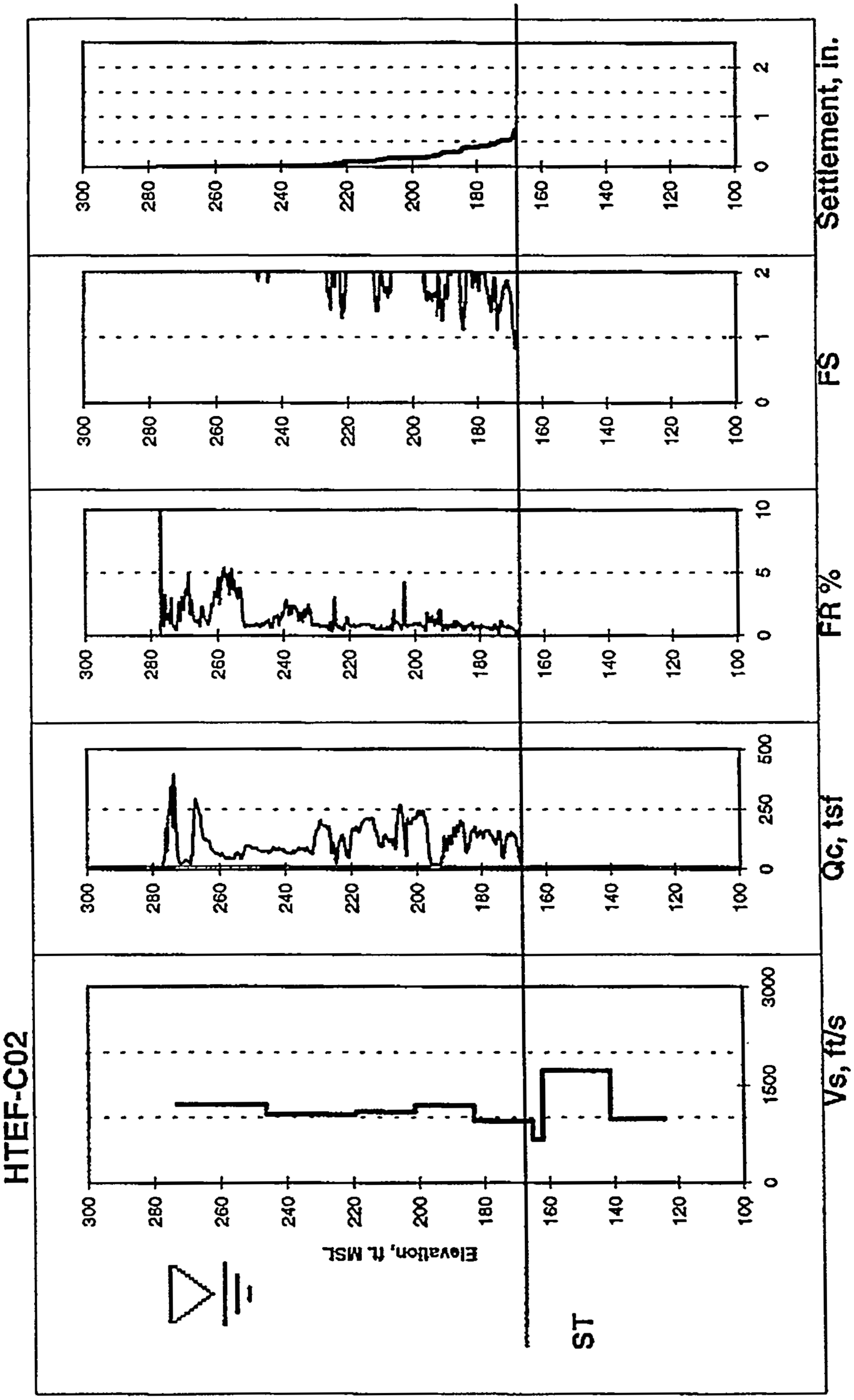
11/13/98,htefc01.XLS,c50

11/17/98,tefc02.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C02

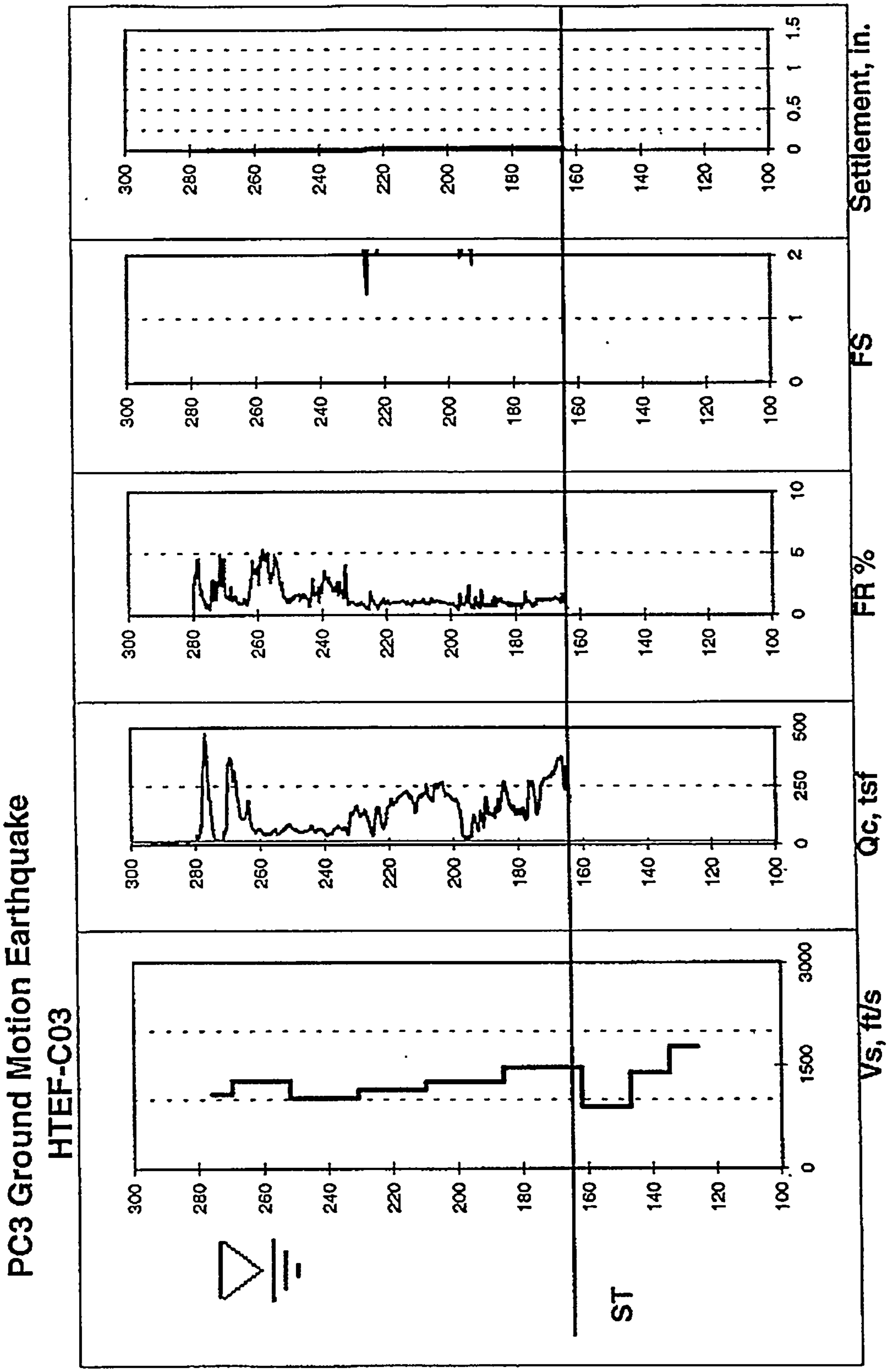


Charleston 50th Percentile Ground Motion Earthquake
HTEF-C02



11/17/98,tefc02.XLS,c50

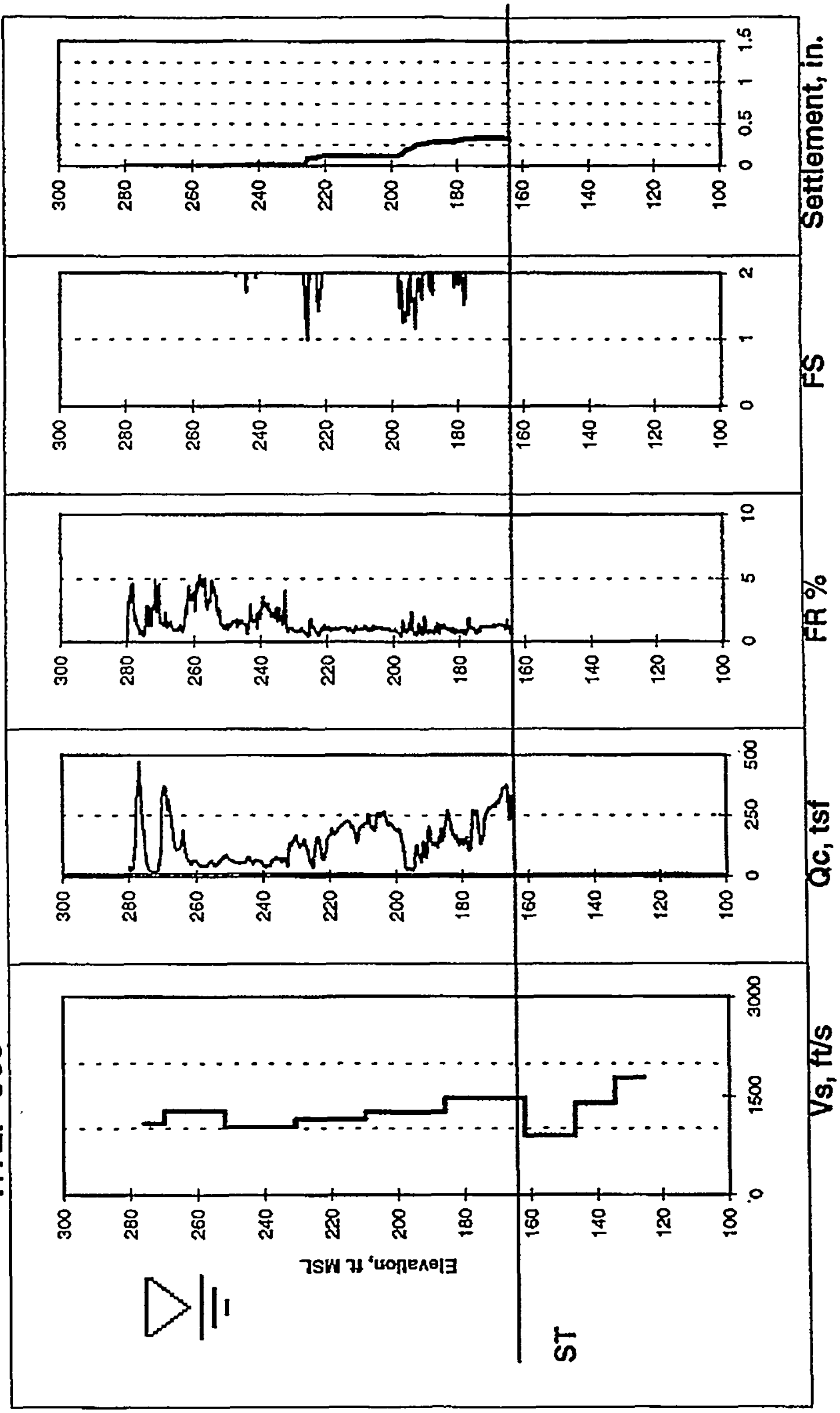
11/13/98,tefc03.XLS,pc3

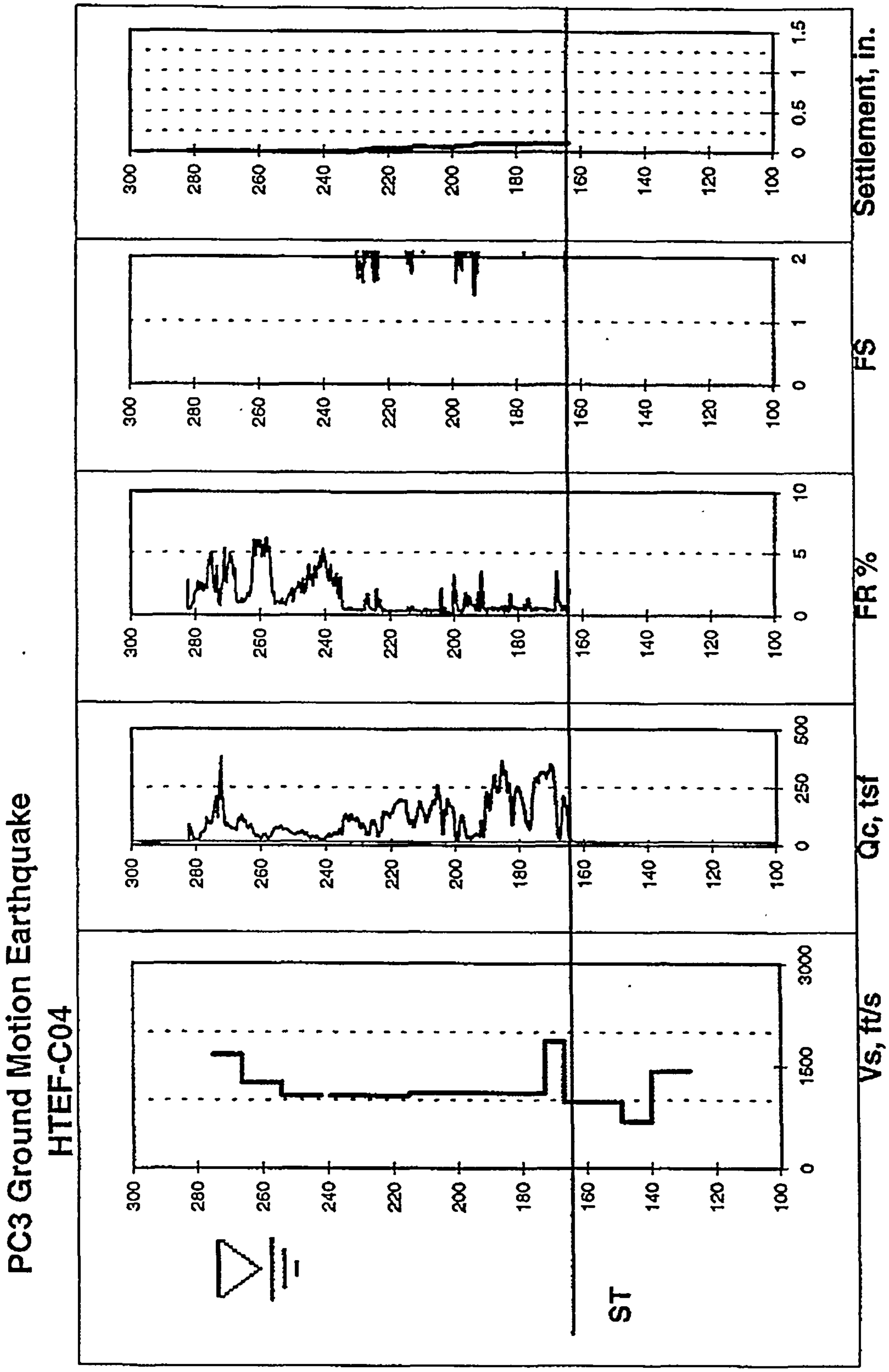


PC3 Ground Motion Earthquake
HTEF-C03

11/13/98,tefc03.XLS,c50

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C03





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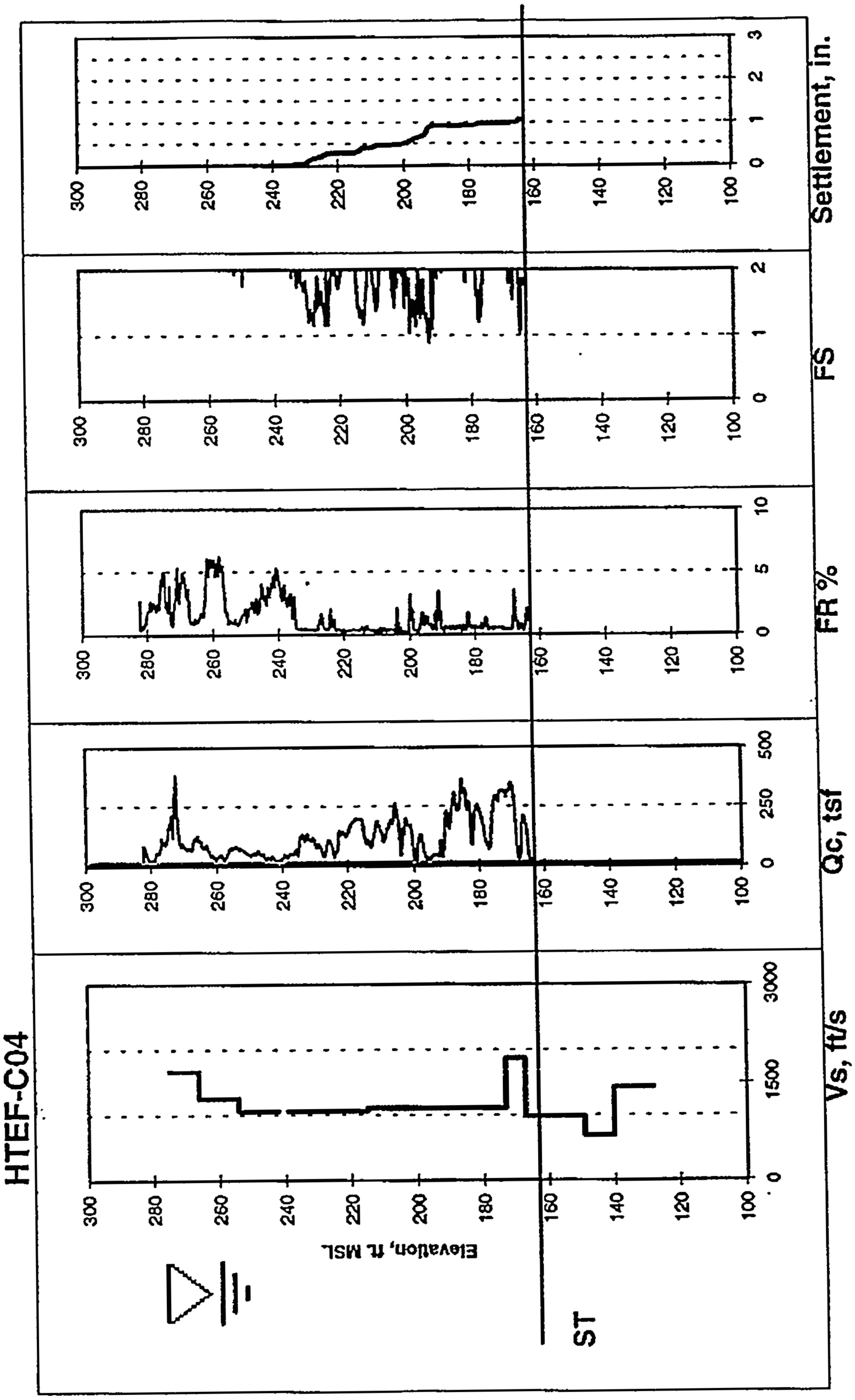
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C04



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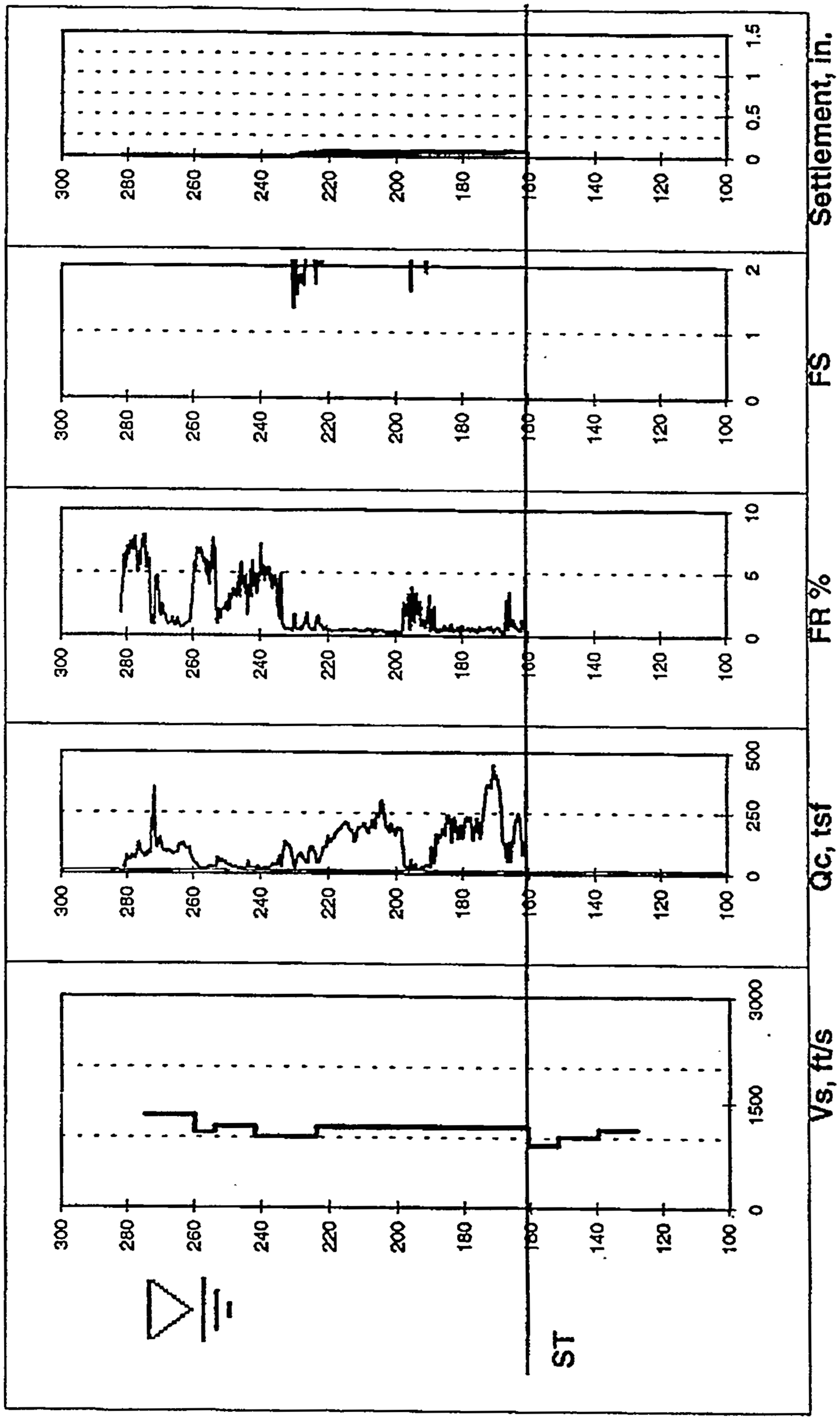
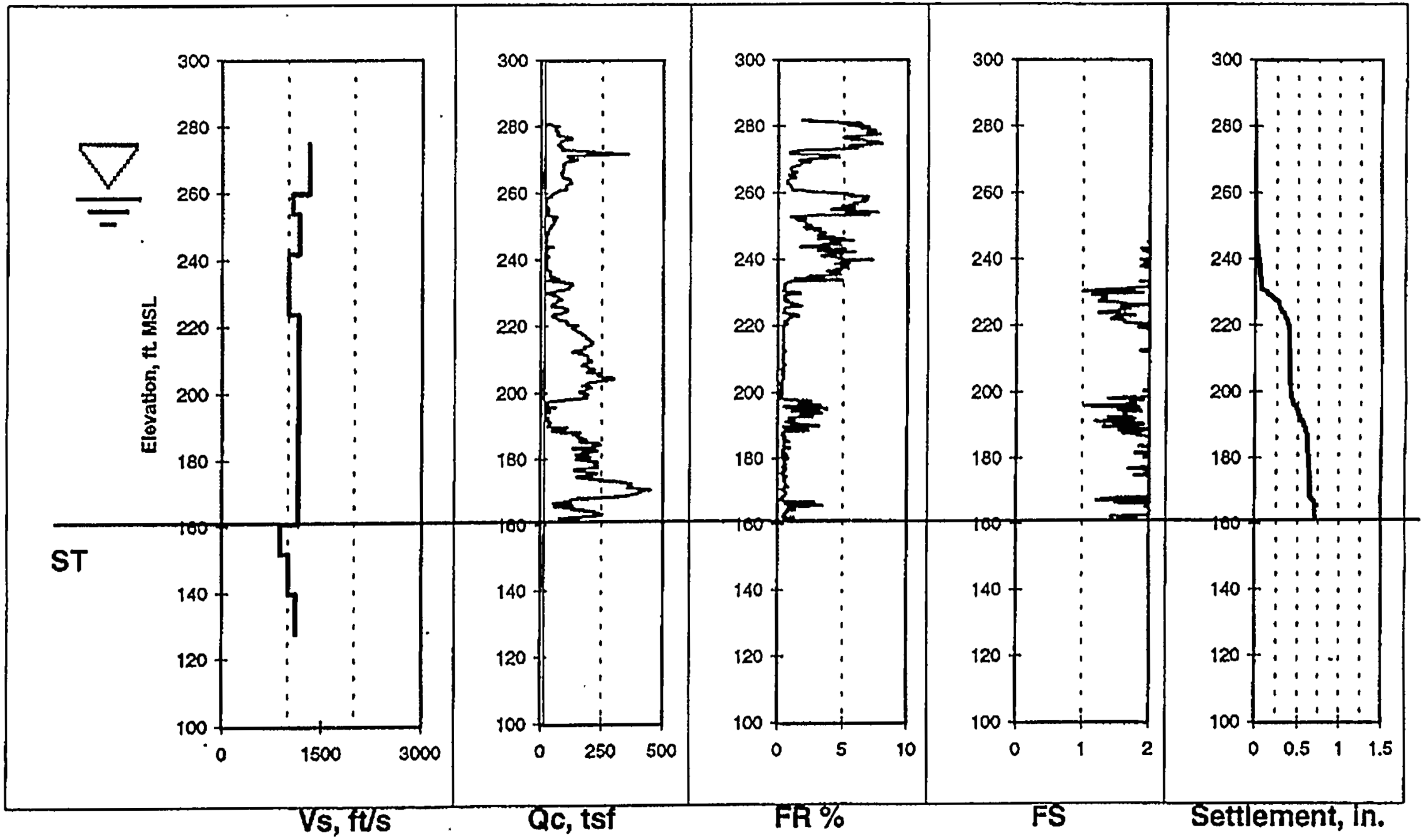
11/13/98,htefc05.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C05



Charleston 50th Percentile Ground Motion Earthquake
HTEF-C05



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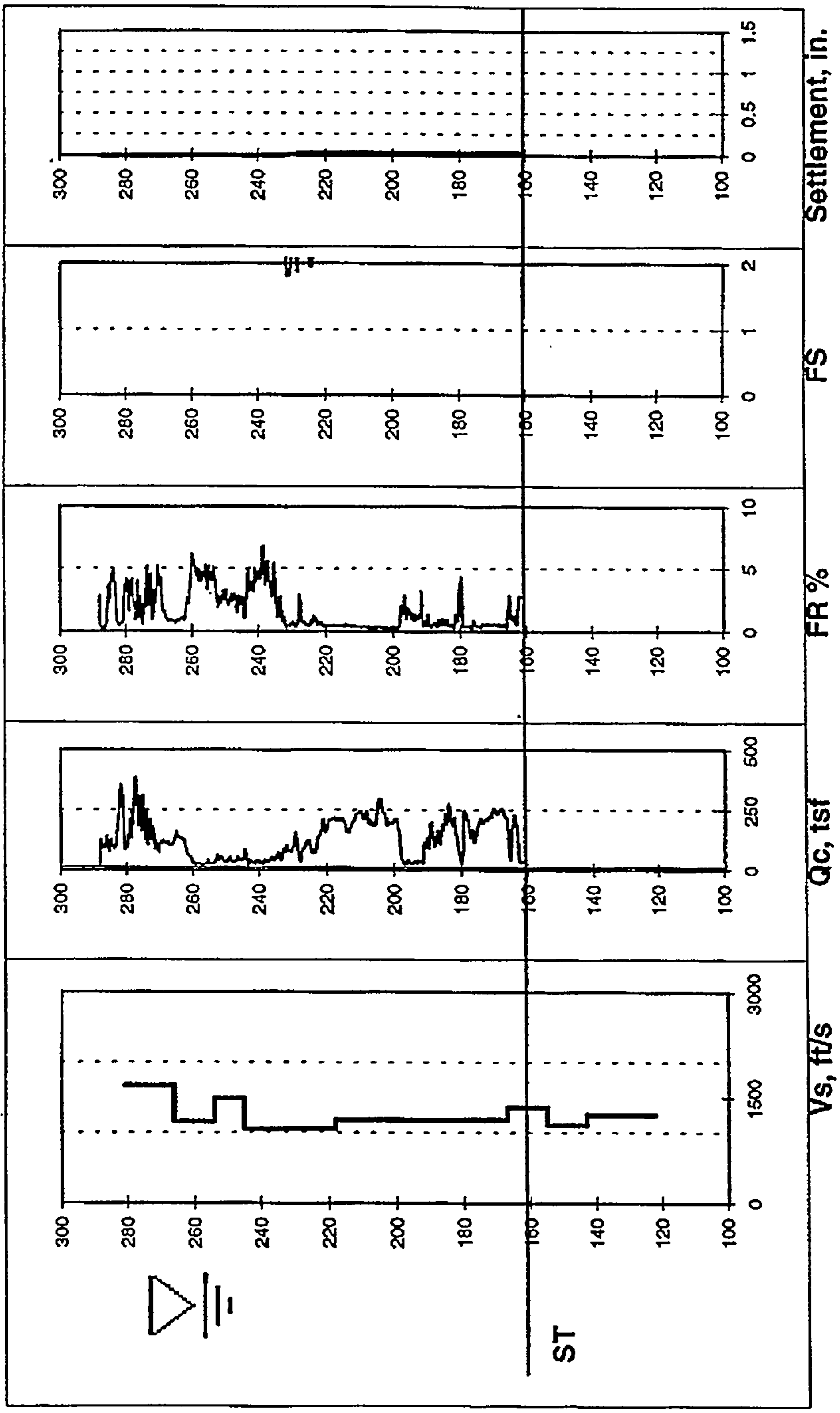
11/13/98,htefc06.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C06



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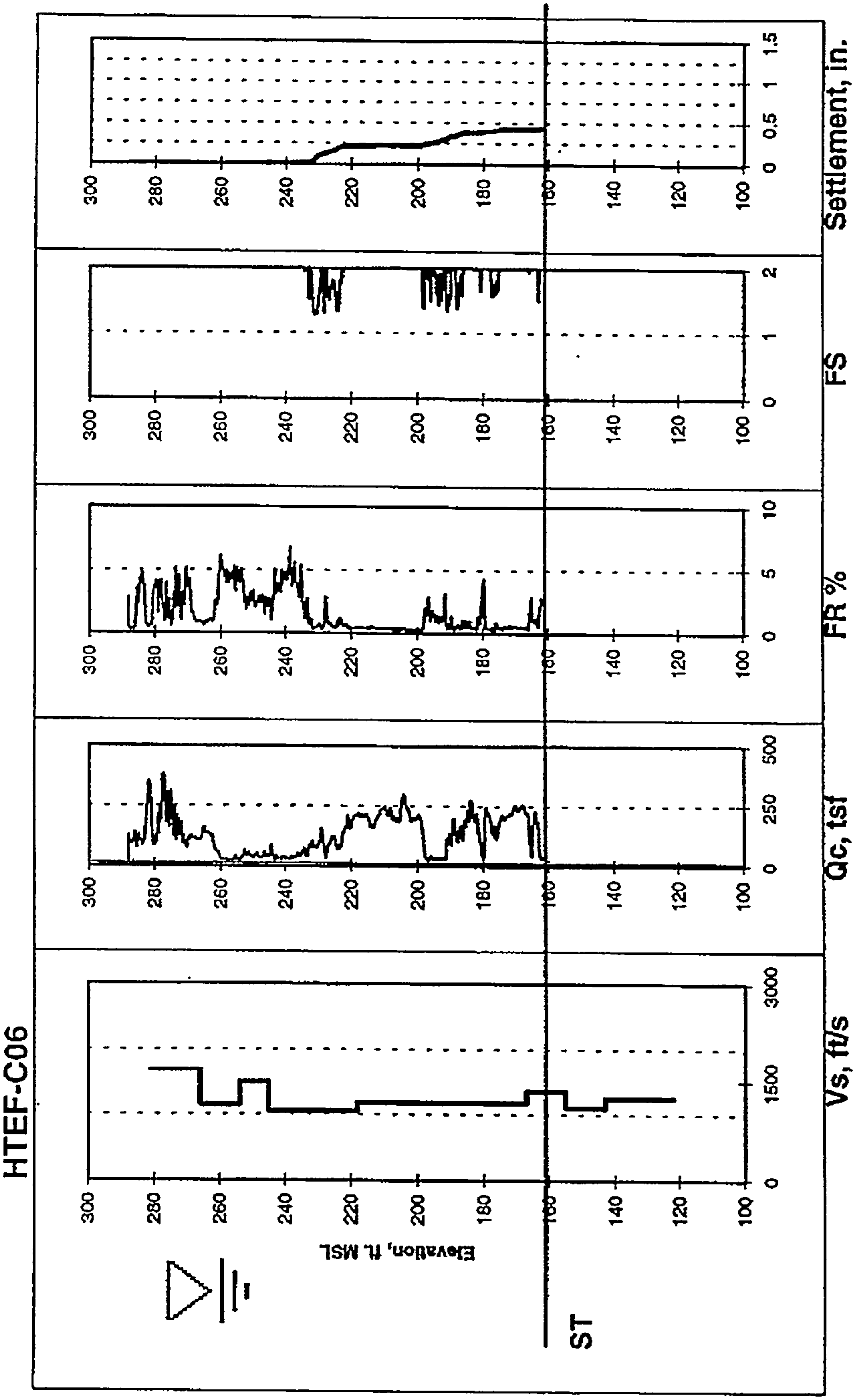
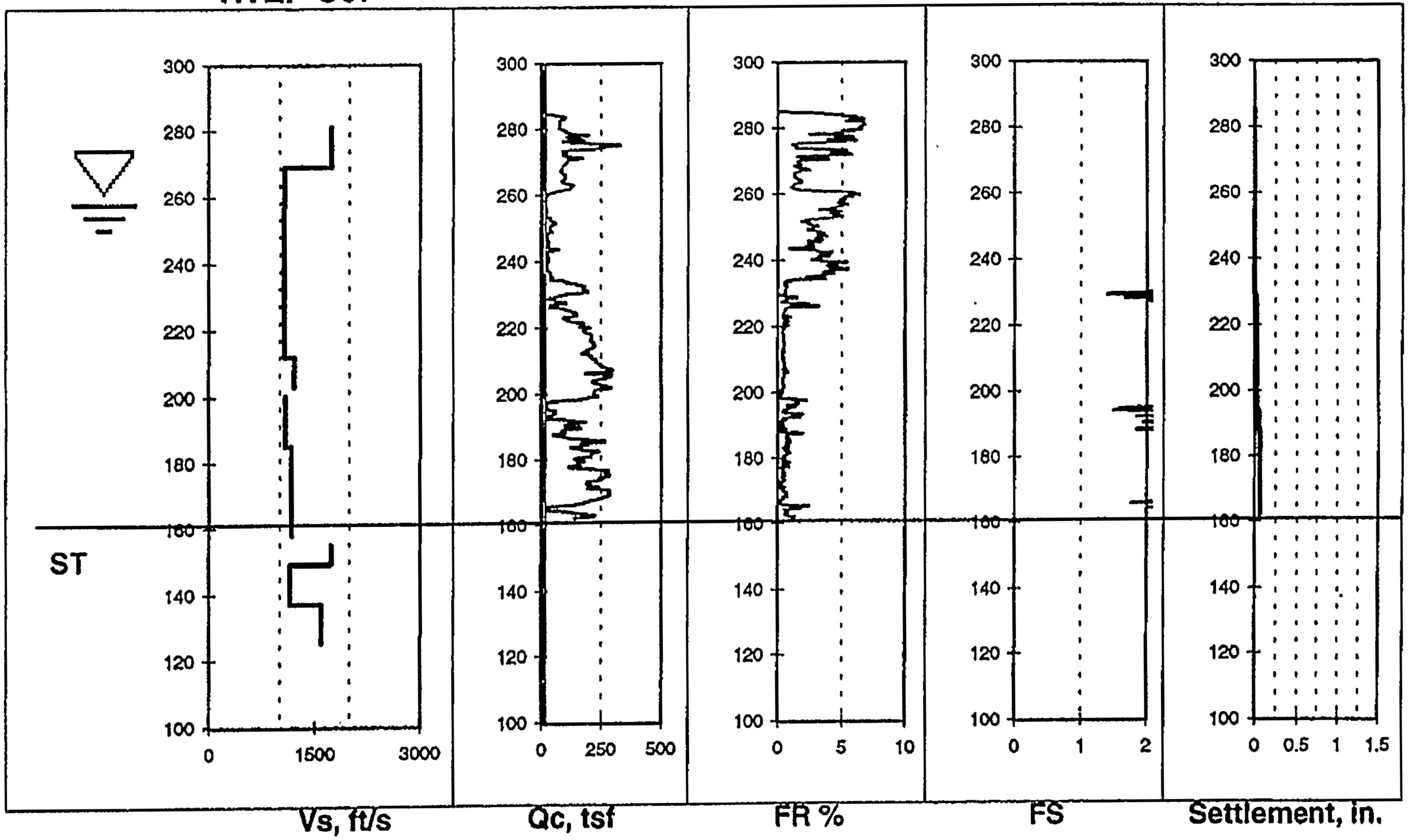
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C06

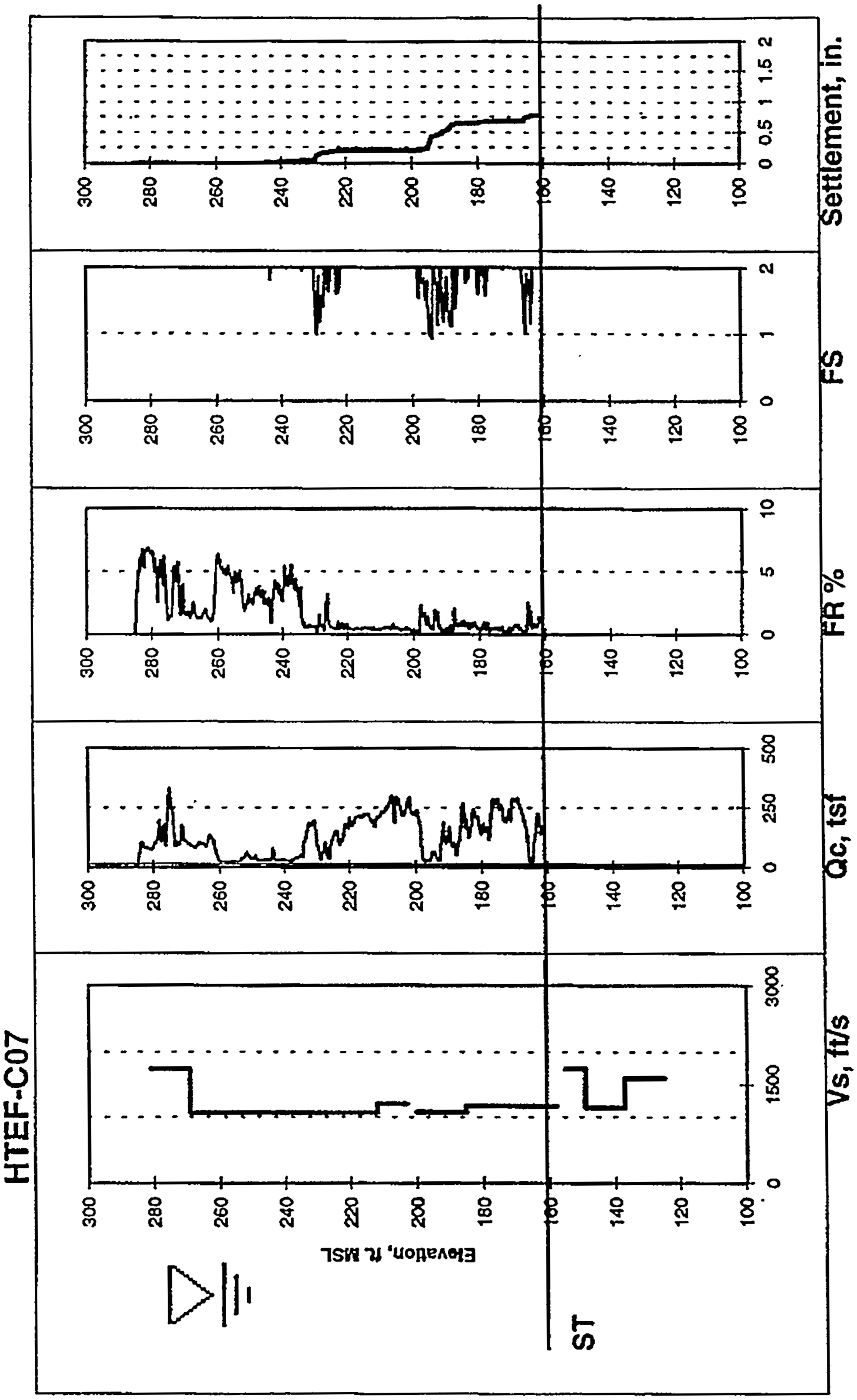


PC3 Ground Motion Earthquake
HTEF-C07



11/13/98,tefc07.XLS,pc3

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C07



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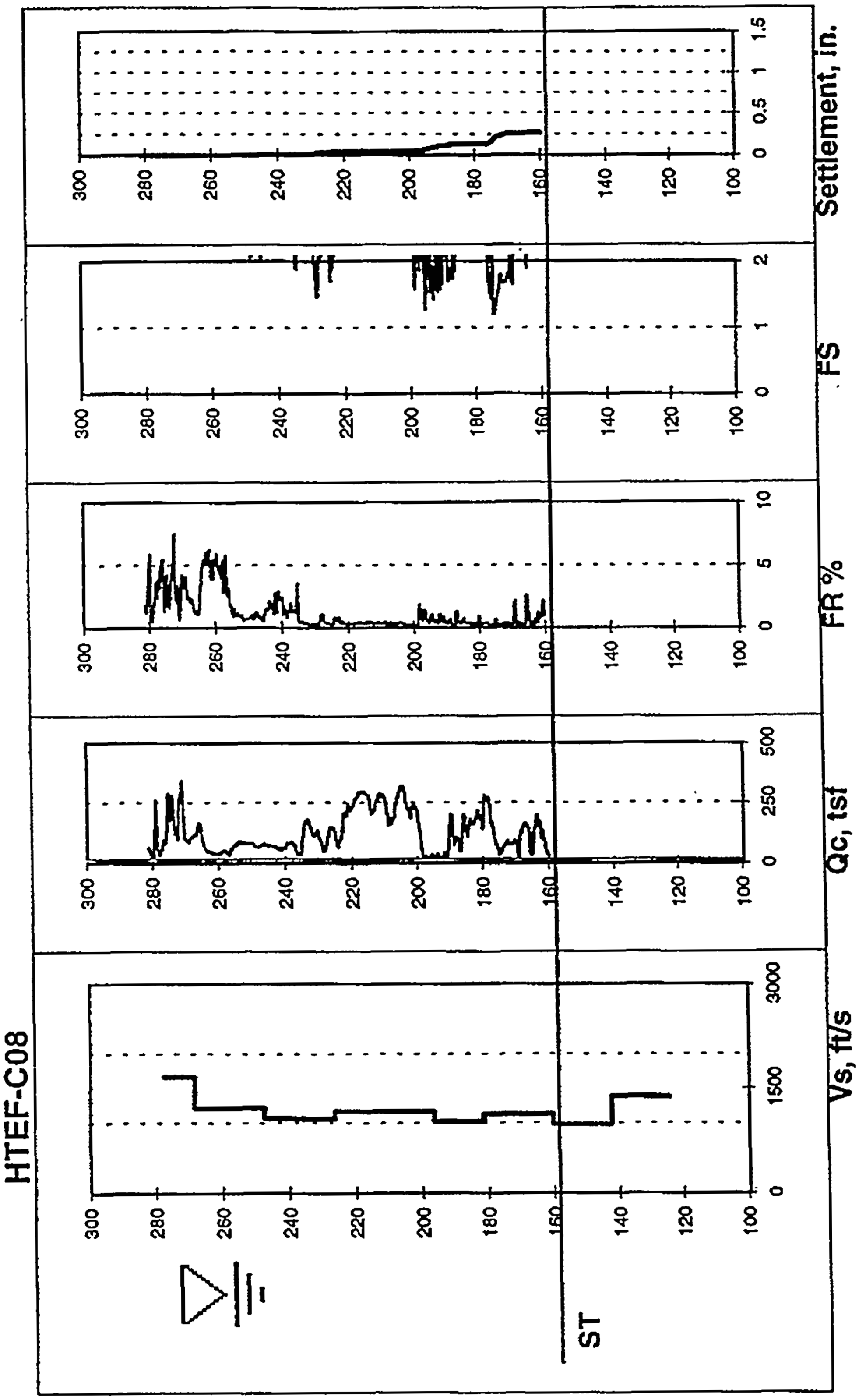
PC3 Ground Motion Earthquake
HTEF-C08



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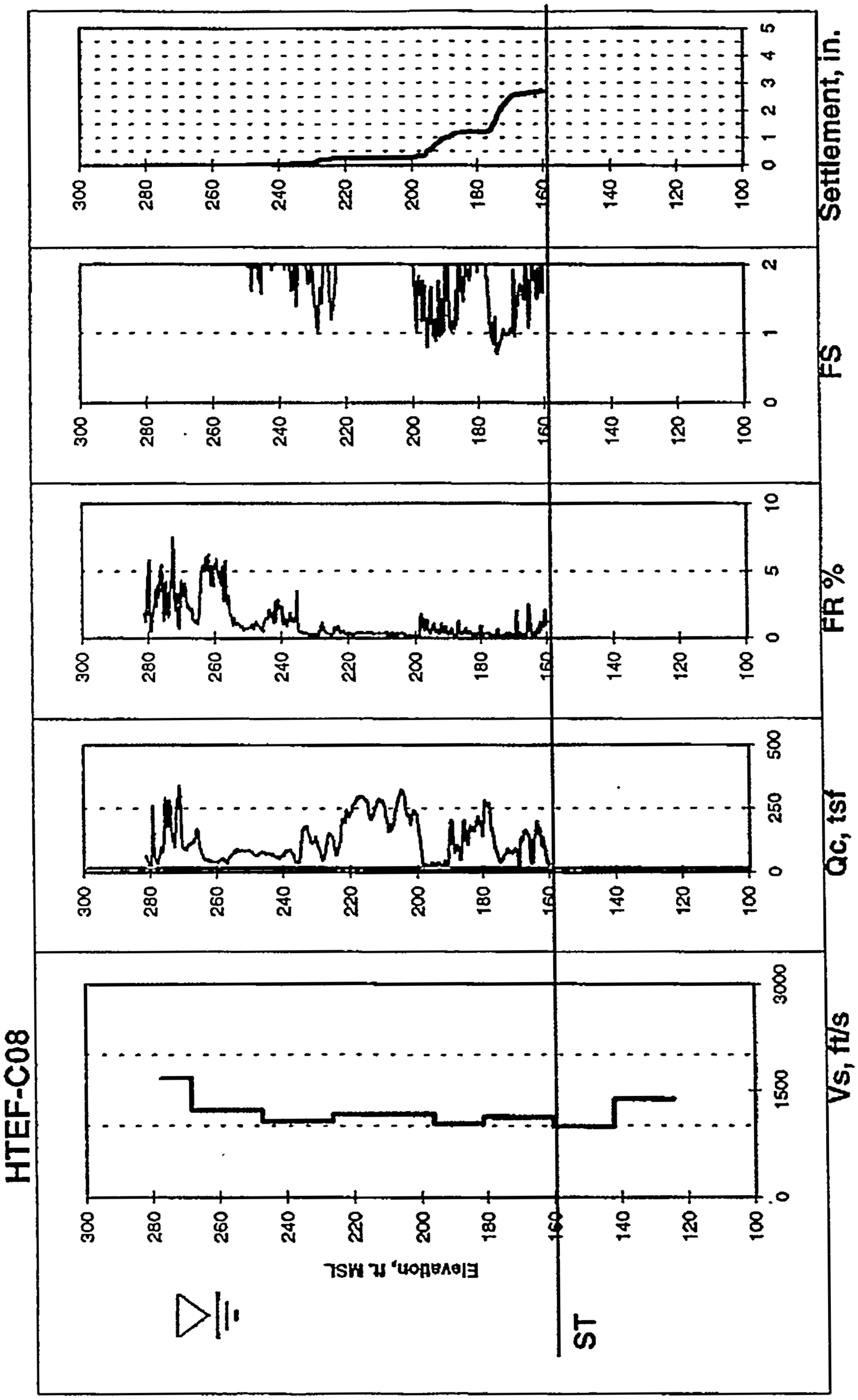
Charleston 50th Percentile Ground Motion Earthquake

HTEF-C08

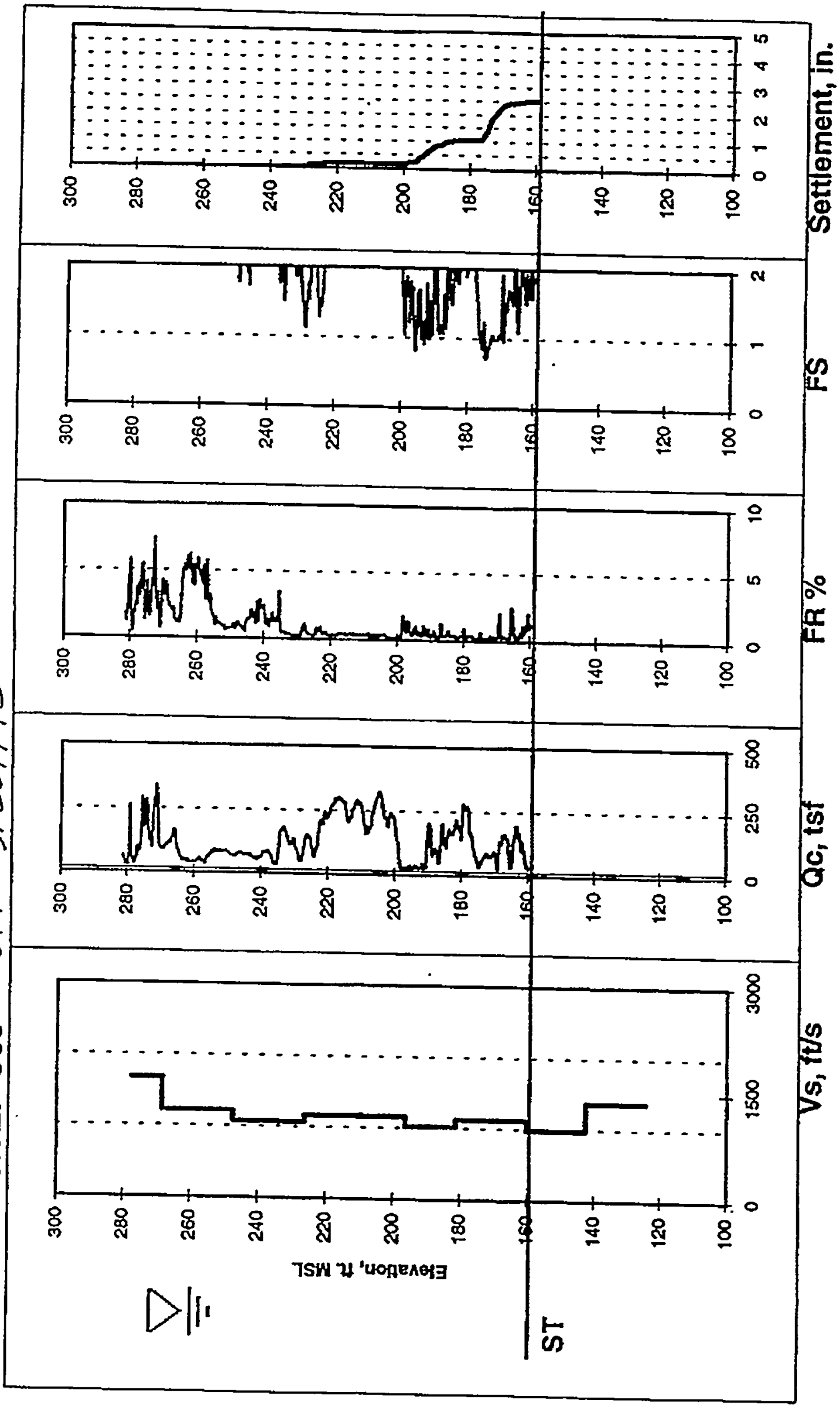


11/13/98,tefc08.XLS,c50

D-17

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C08

CPT SPECIFIC



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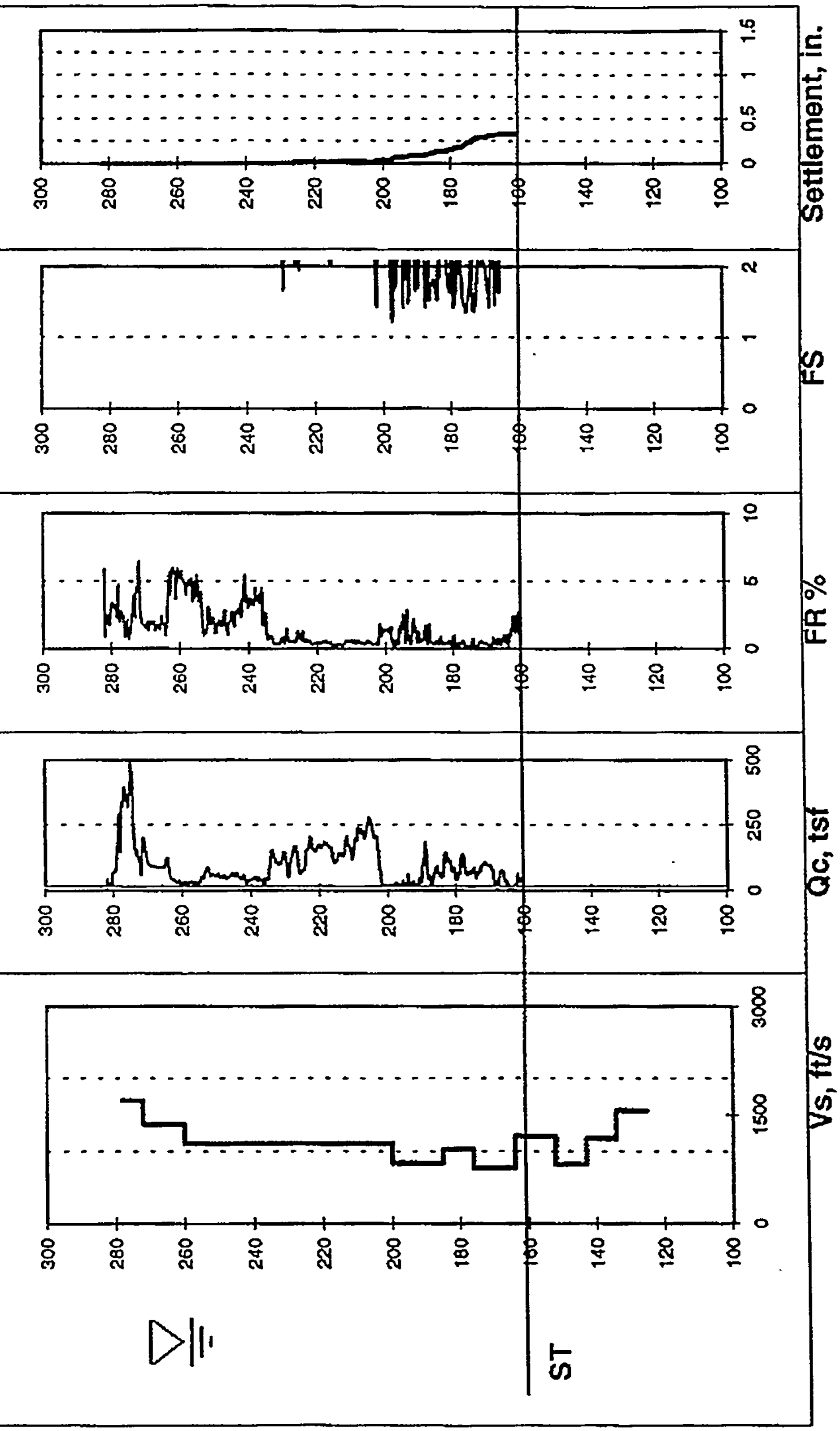
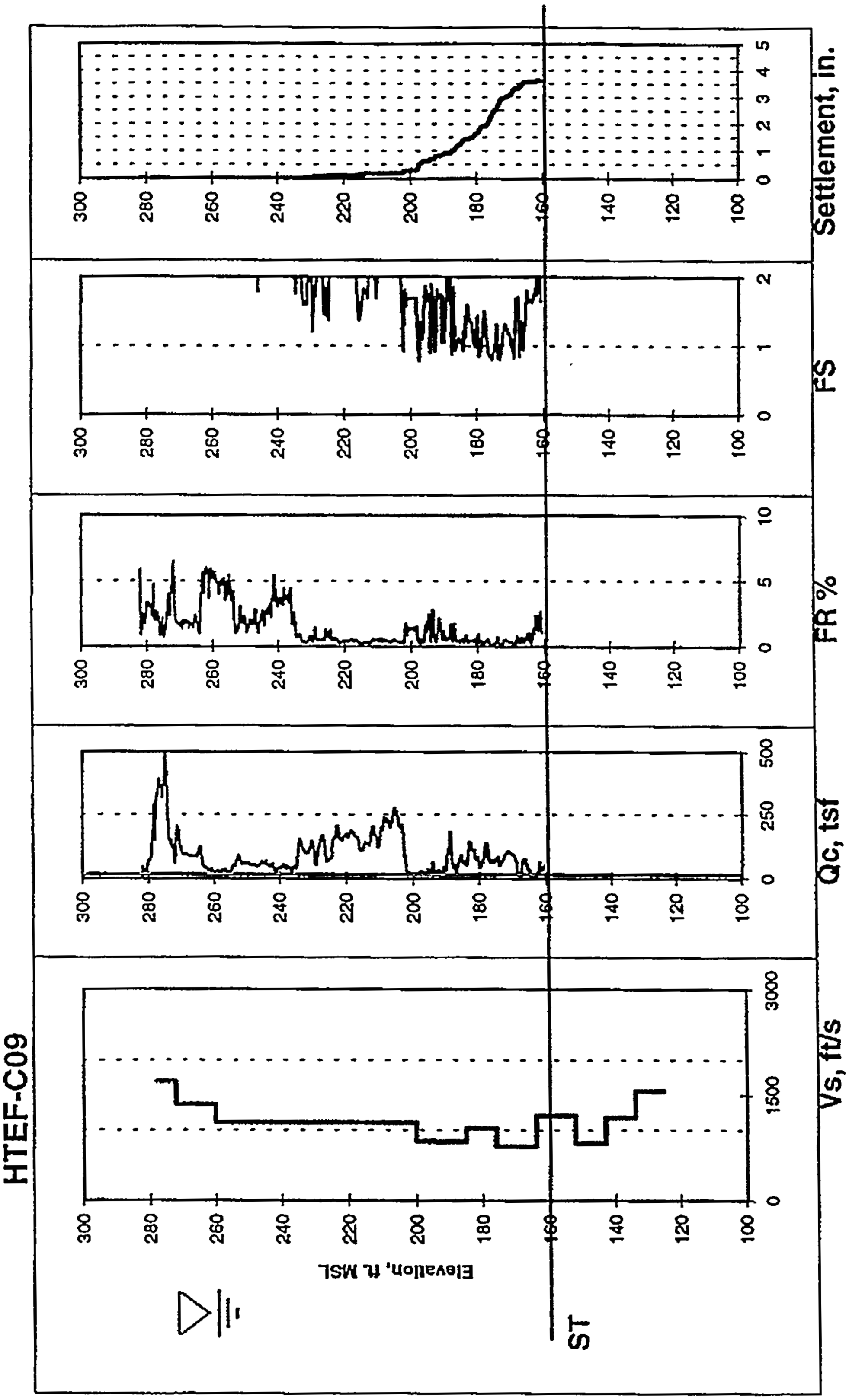
11/13/98,tefc09.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C09



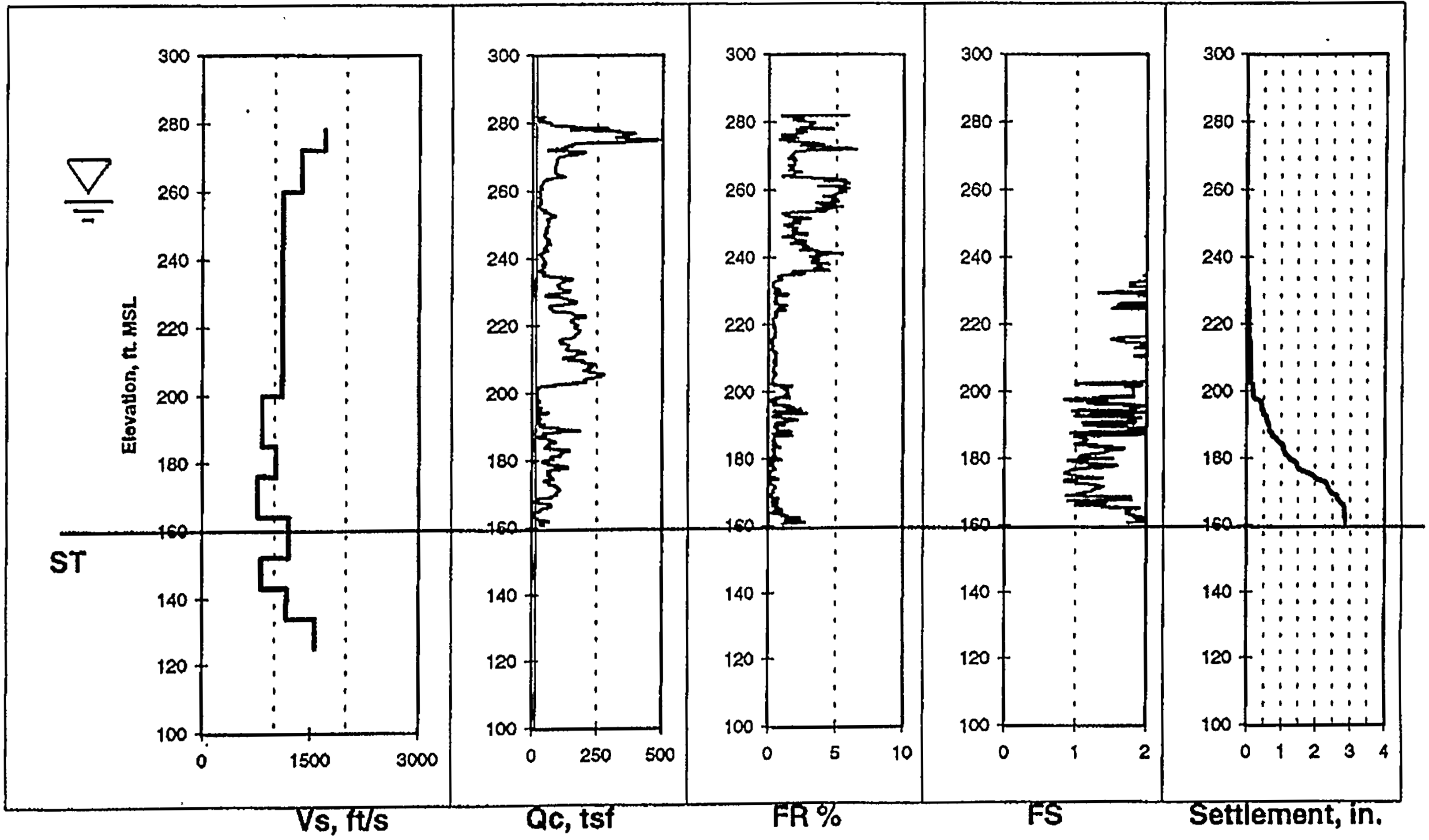
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C09



11/13/98,tefc09.XLS,c50

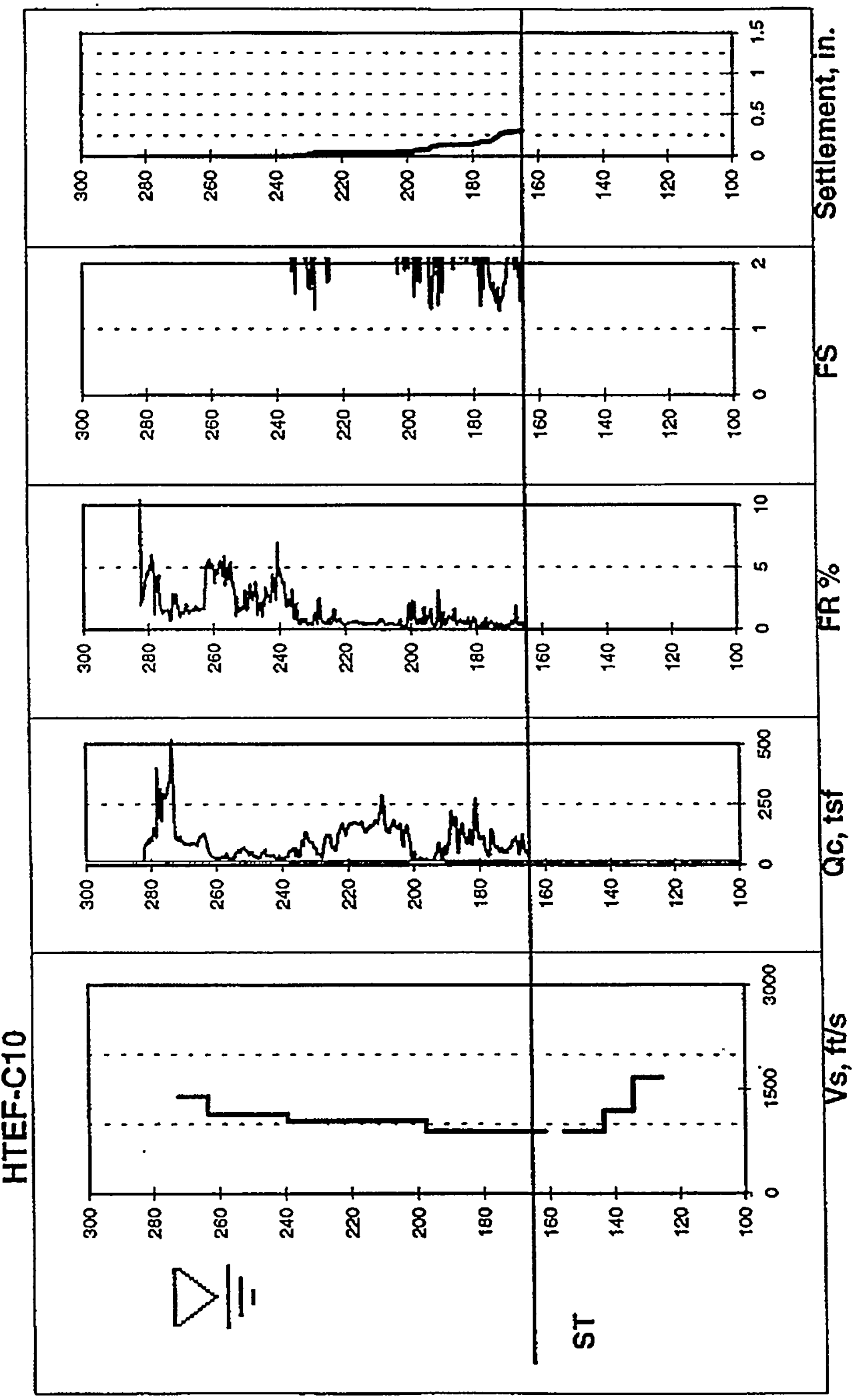
D-20

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C09 CPT SPECIFIC CURVE



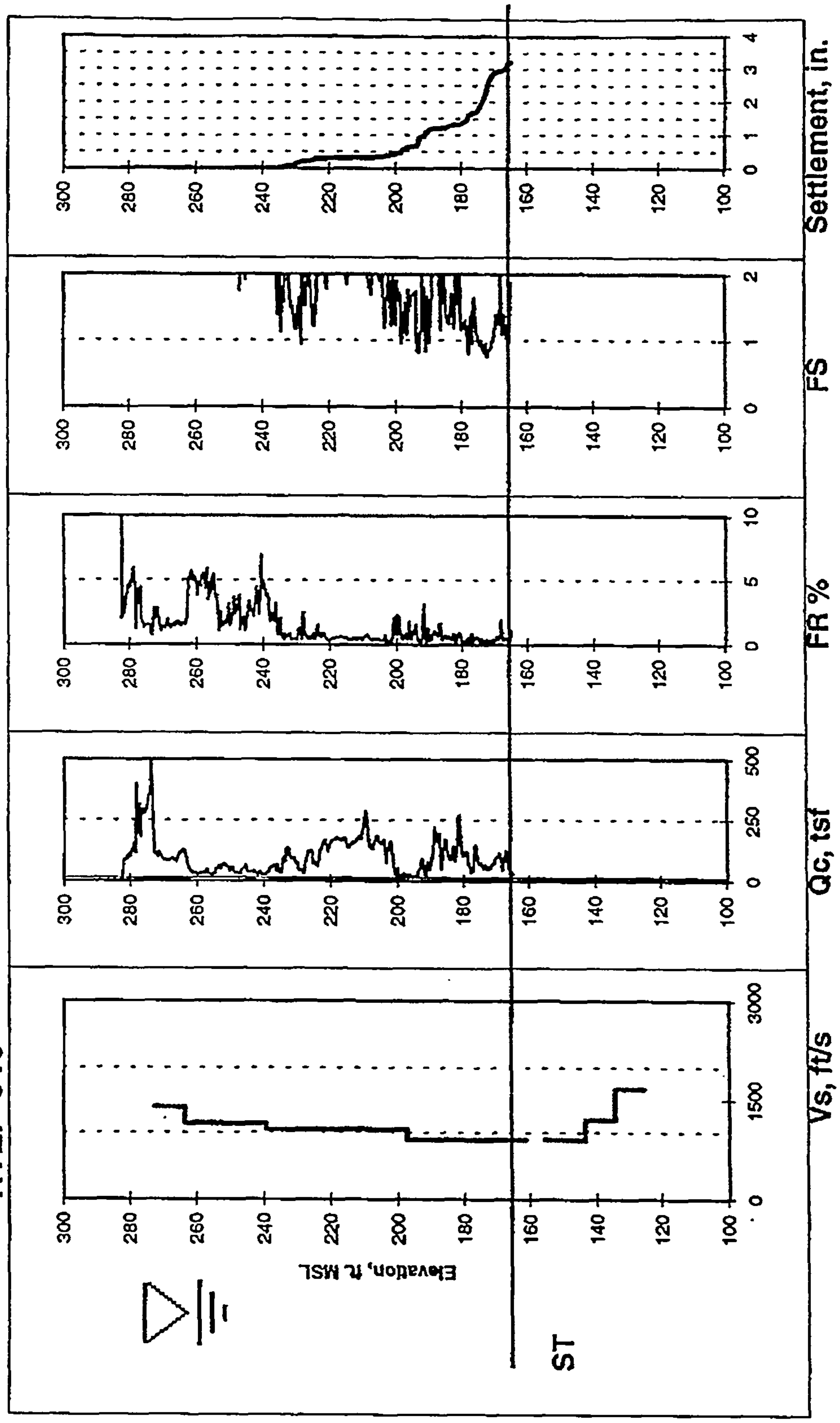
11/13/98,tefc09 new curve.XLS,c50

PC3 Ground Motion Earthquake
HTEF-C10



11/13/98,htefc10.XLS,pc3

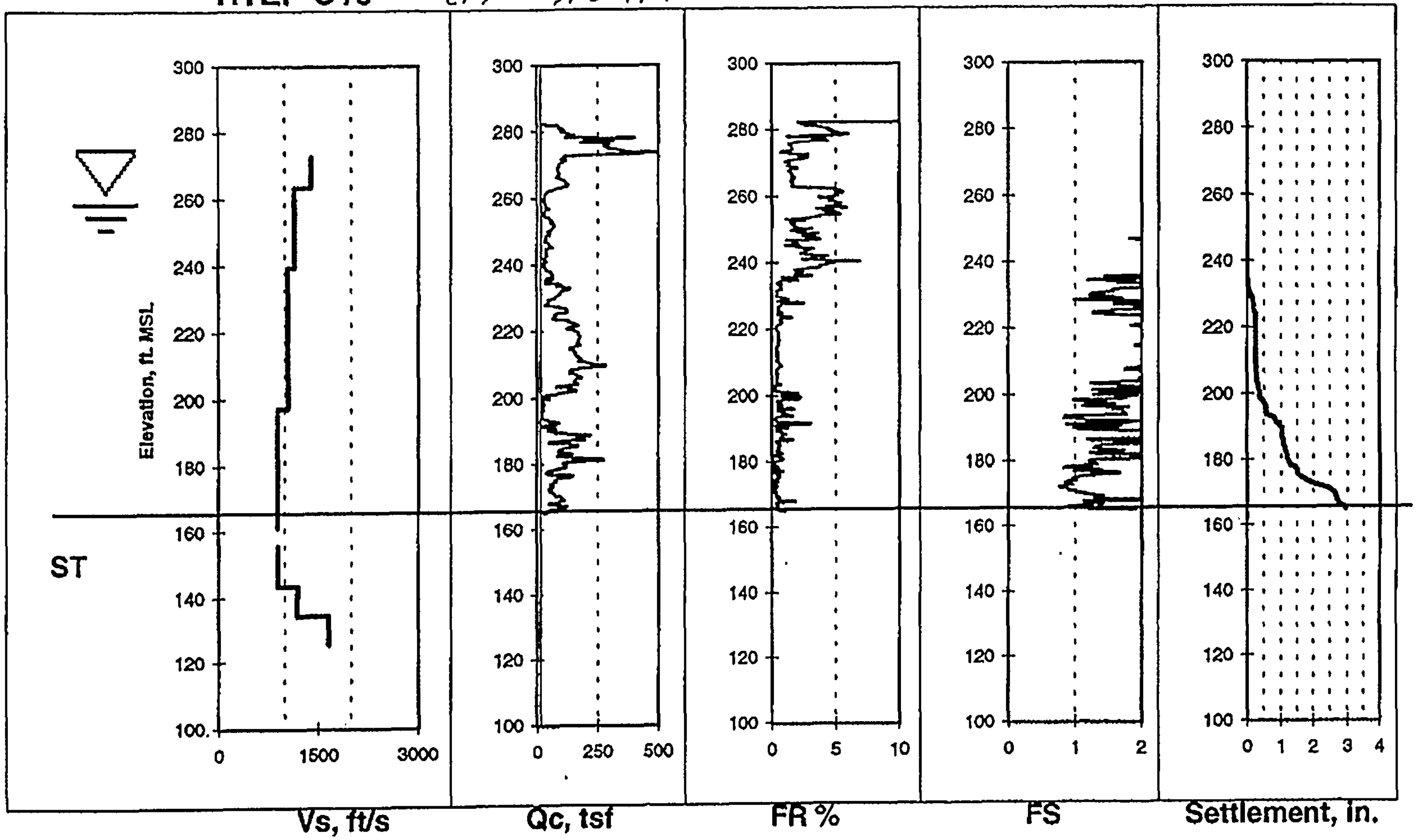
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C10



11/13/98,htefc10.XLS,c50

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C10

CPT SPECIFIC CURVE

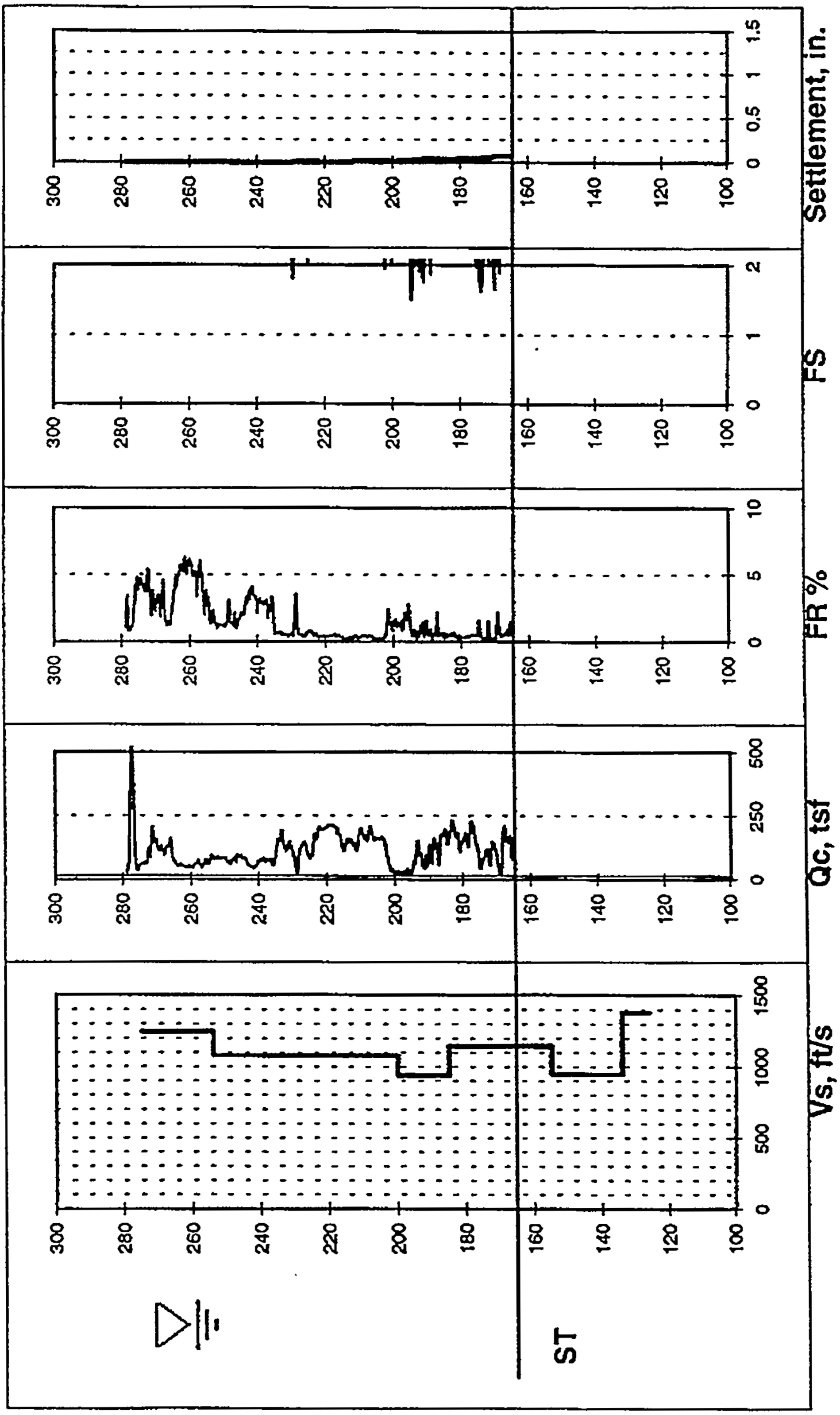


11/13/98,htefc10 new curve.XLS,c50

D-24

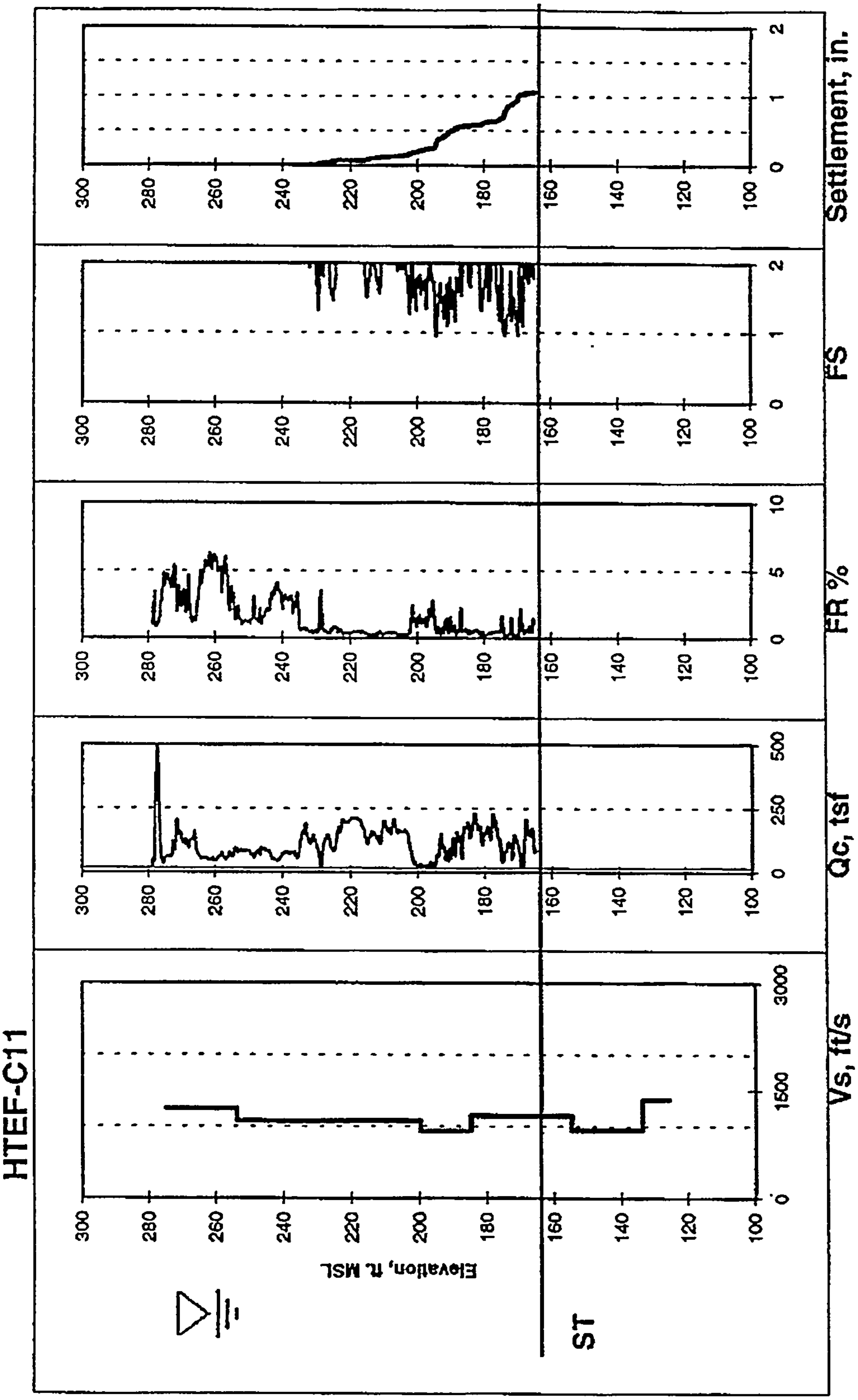
11/13/98,tefc11.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C11



Charleston 50th Percentile Ground Motion Earthquake

HTEF-C11



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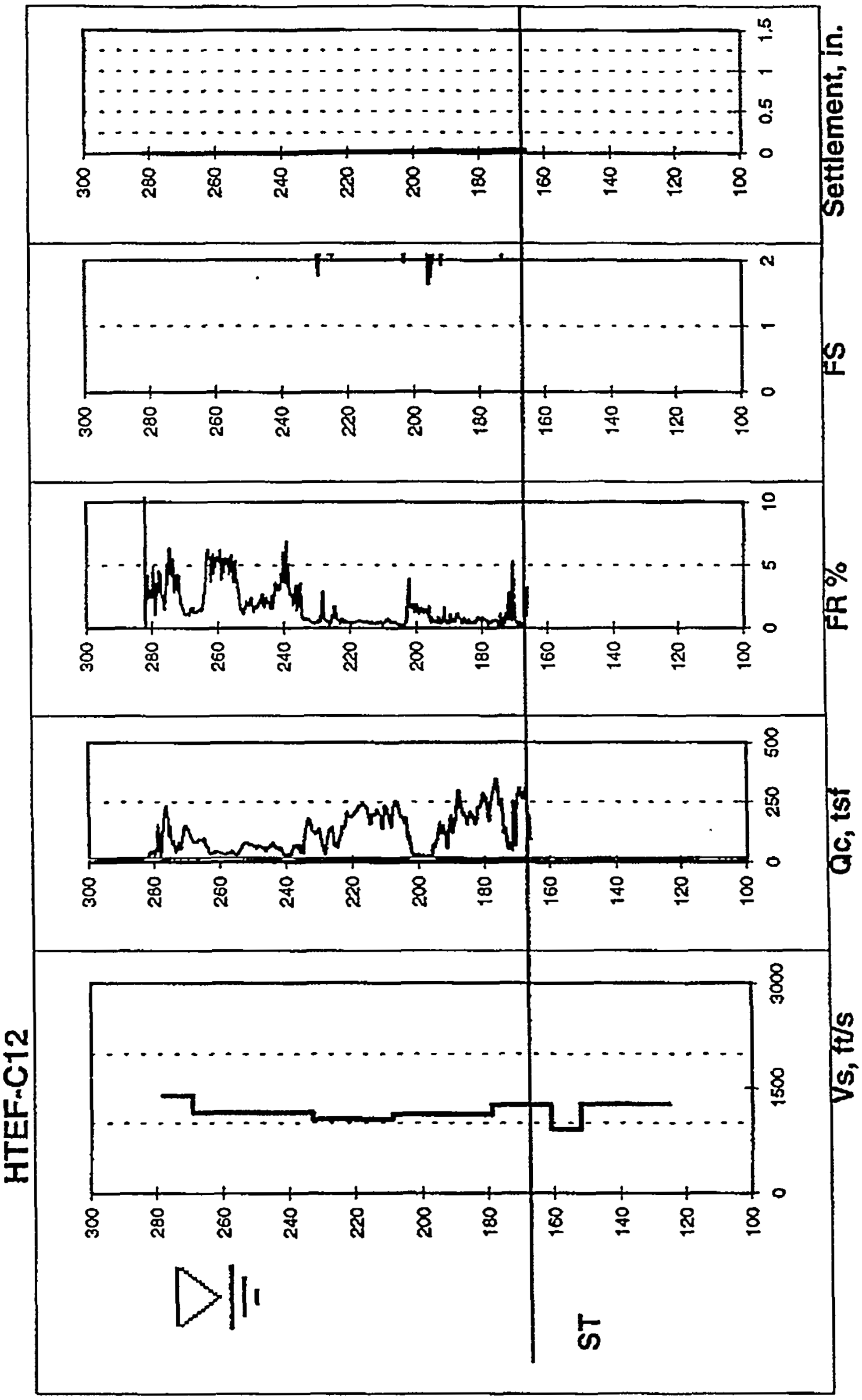
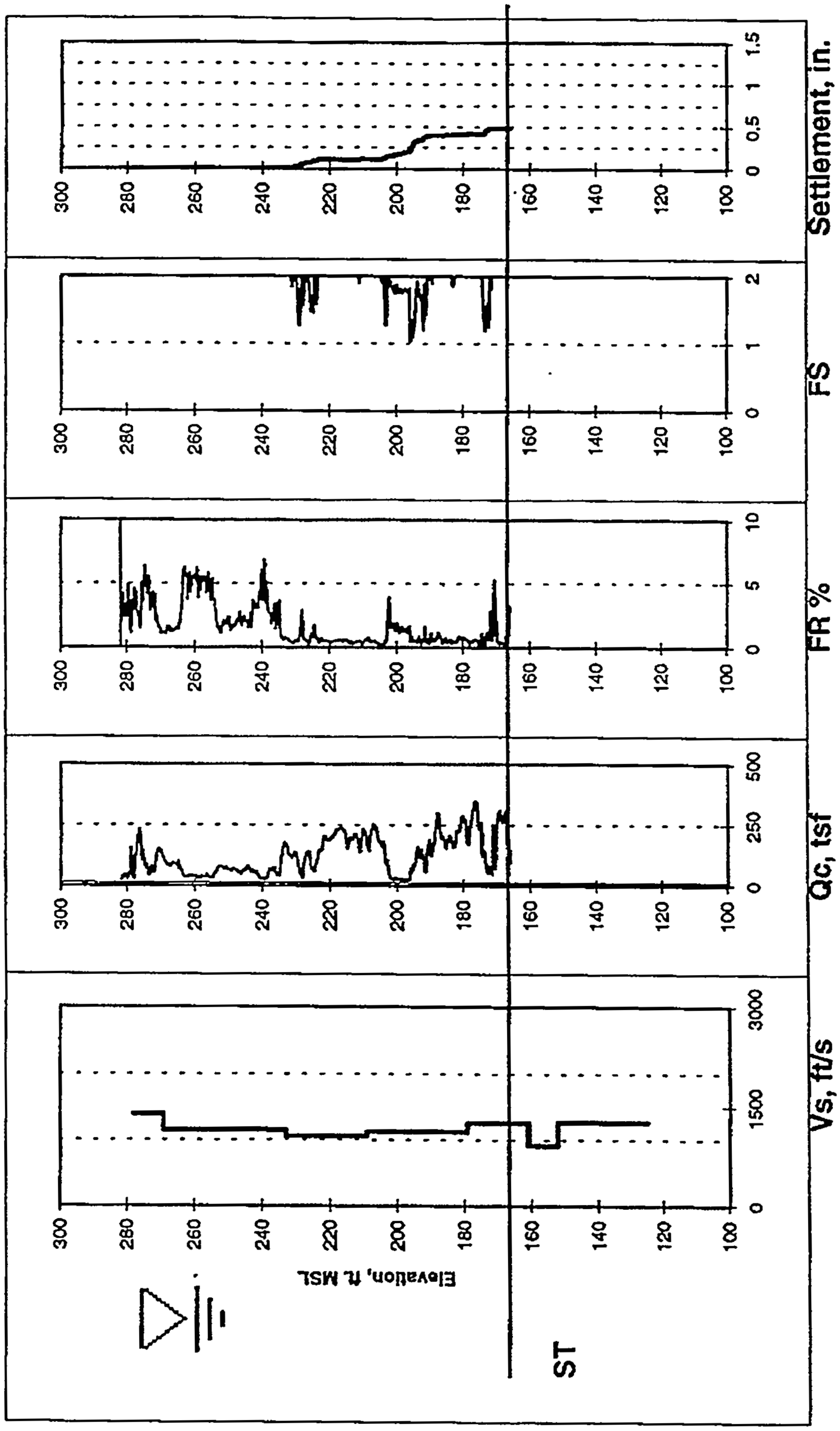
D-26



PC3 Ground Motion Earthquake
HTEF-C12

11/13/98,tefc12.XLS,pc3

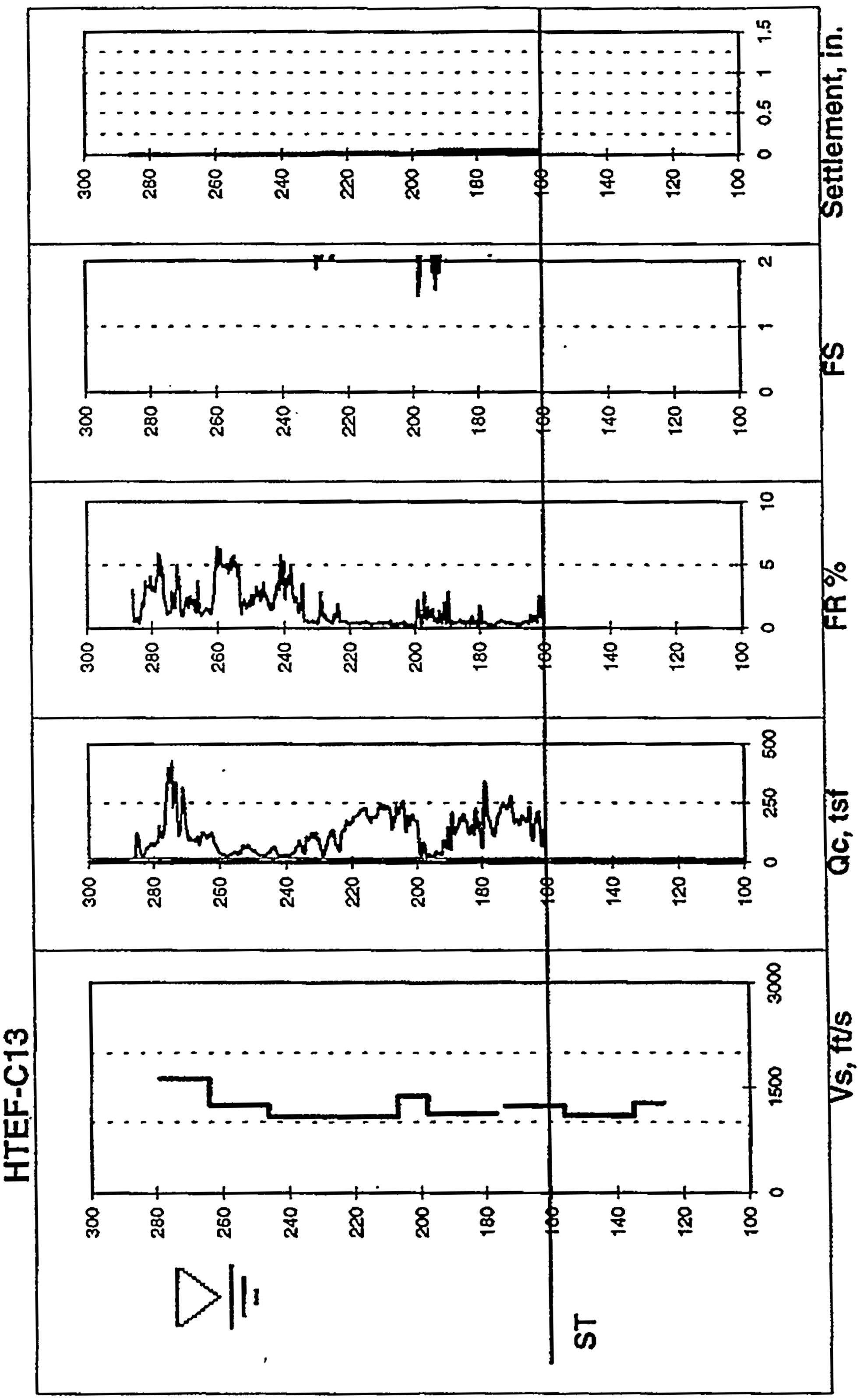
Charleston 50th Percentile Ground Motion Earthquake
HTEF-C12



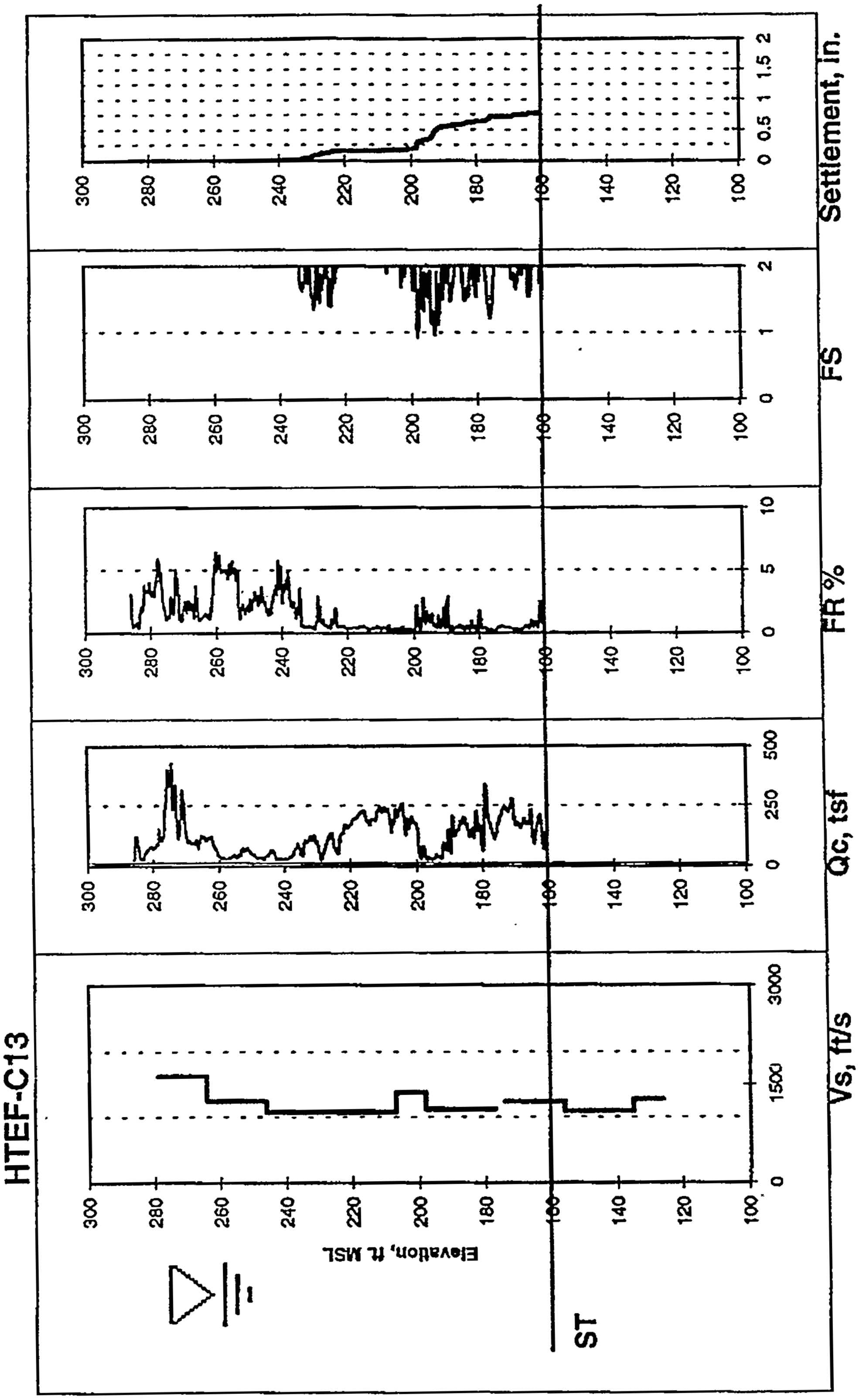
11/13/98,tefc12.XLS,c50

11/13/98,tefc13.XLS,pc3

PC3 Ground Motion Earthquake
HTEF-C13



Charleston 50th Percentile Ground Motion Earthquake
HTEF-C13



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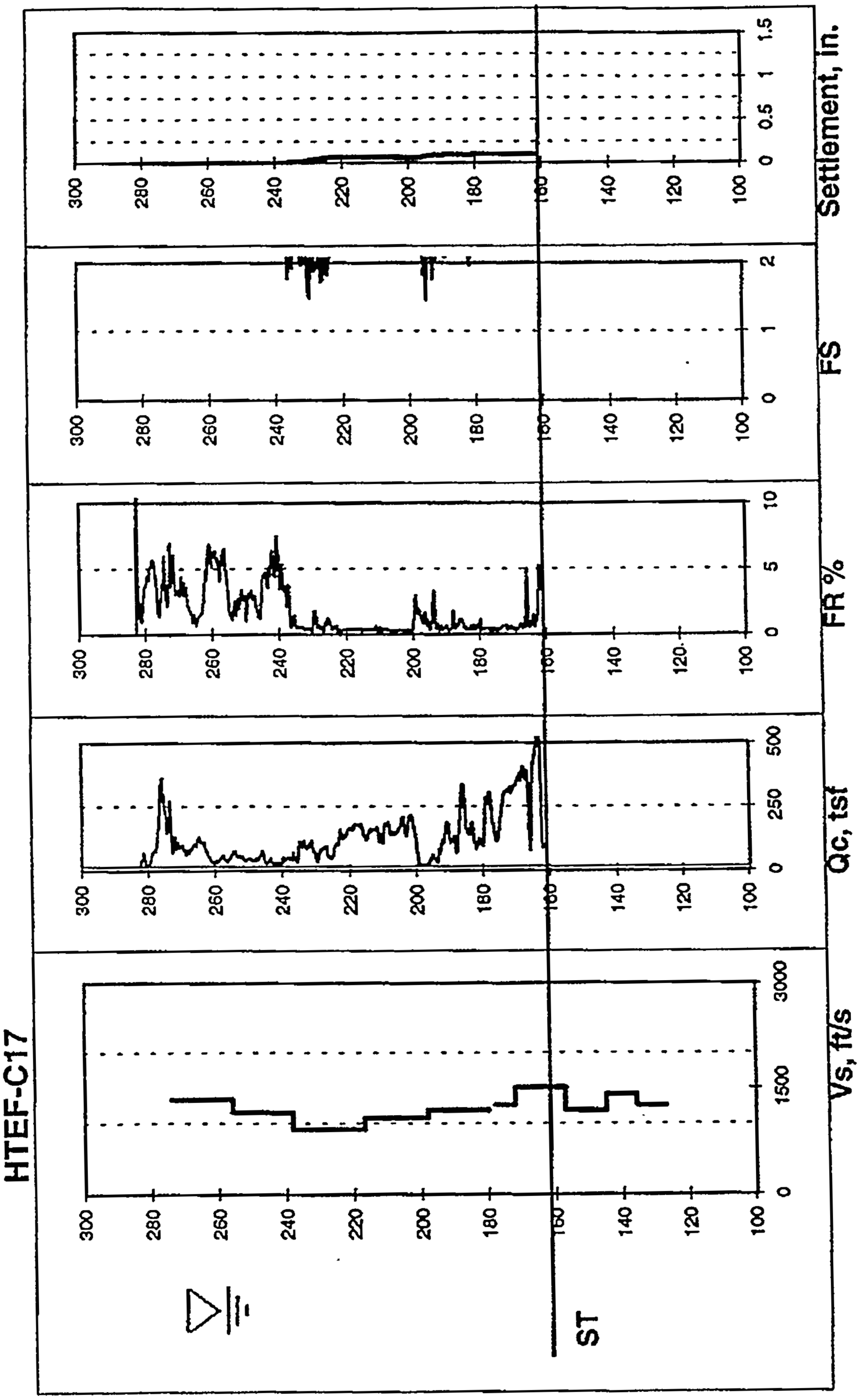
D-30

PC3 Ground Motion Earthquake
HTEF-C17



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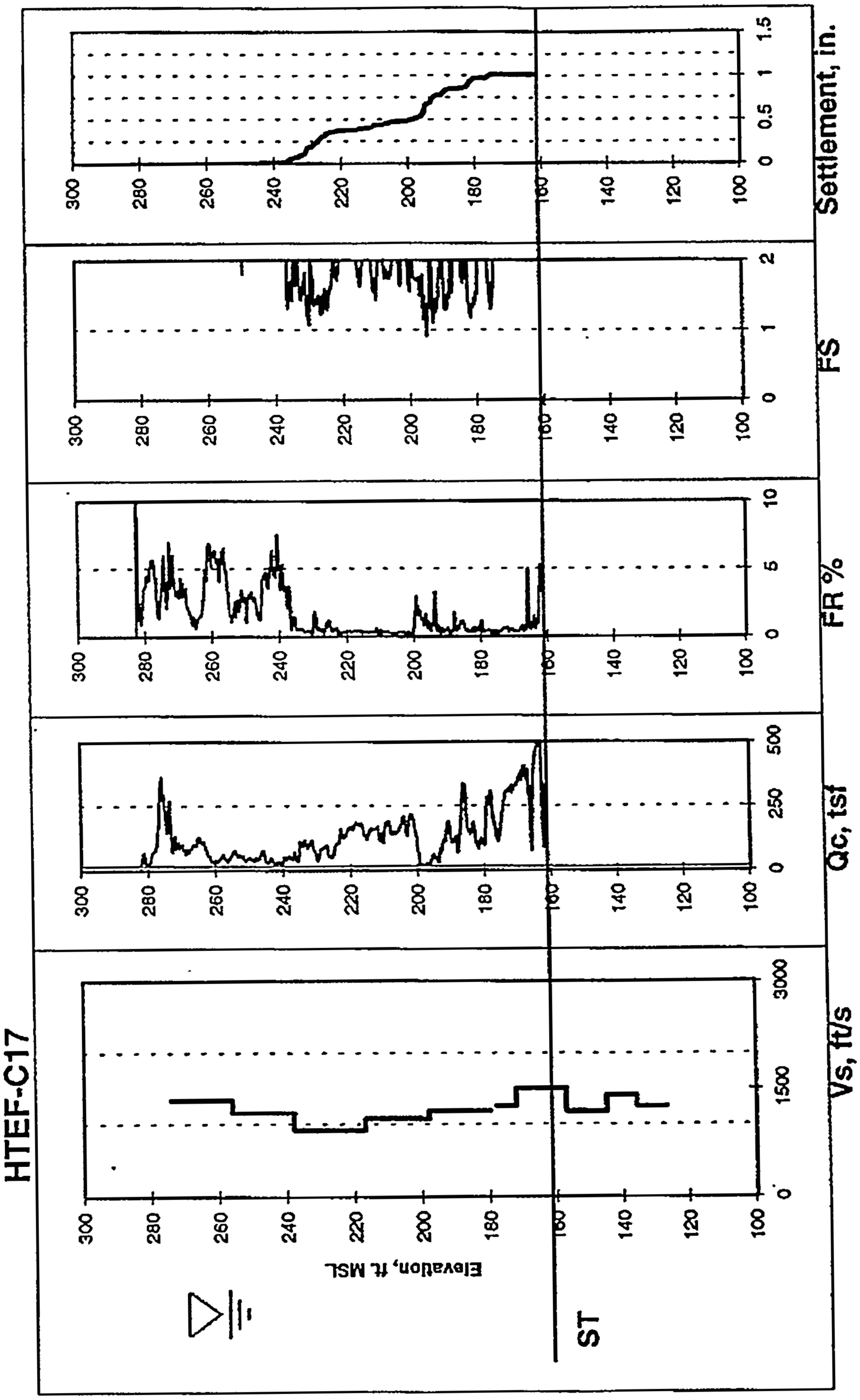
11/13/98,tefc17.XLS,c50

Charleston 50th Percentile Ground Motion Earthquake
HTEF-C17

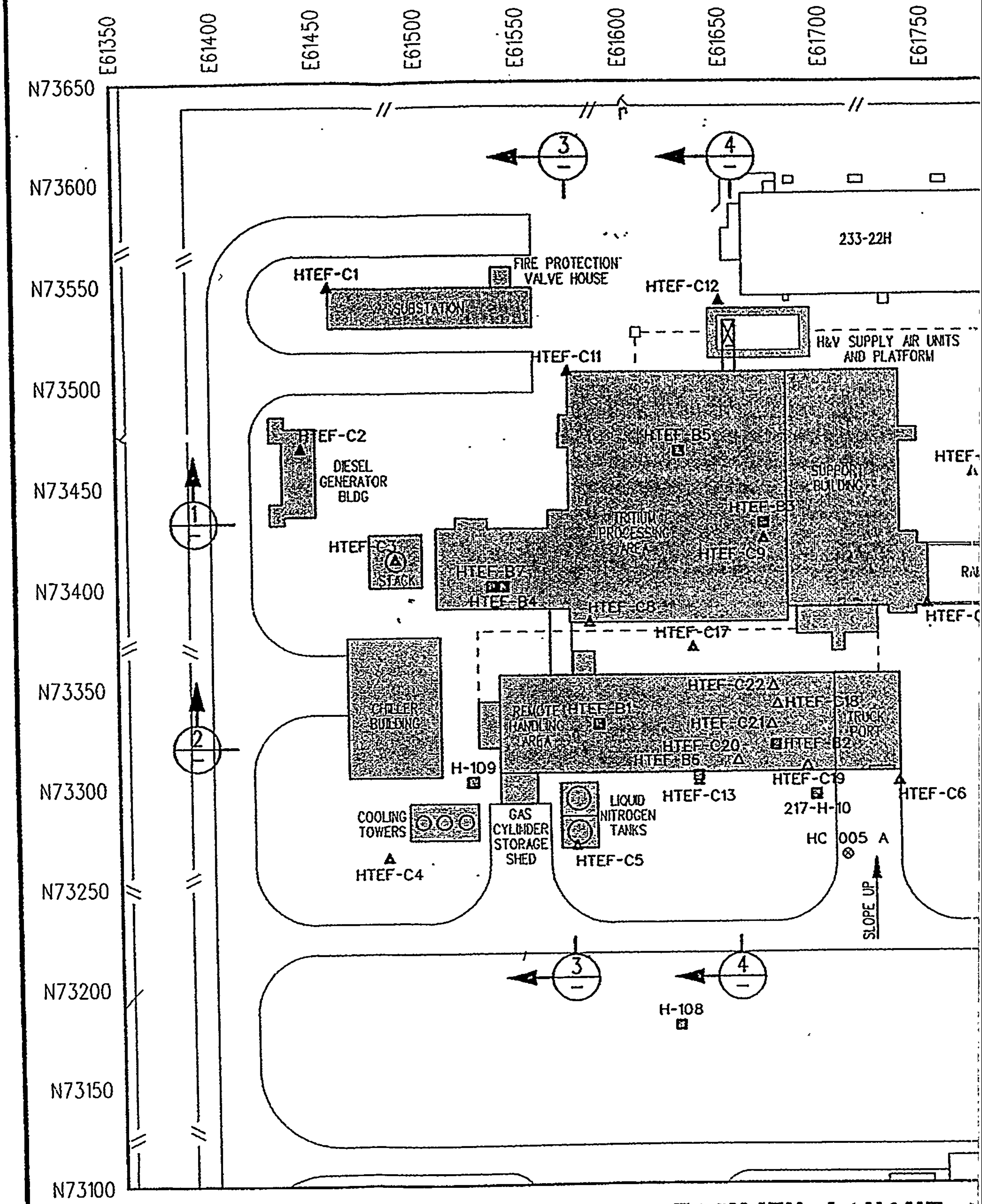


Appendix E

Facility Layout and Exploration Location Plan

and

Subsurface Cross-Sections

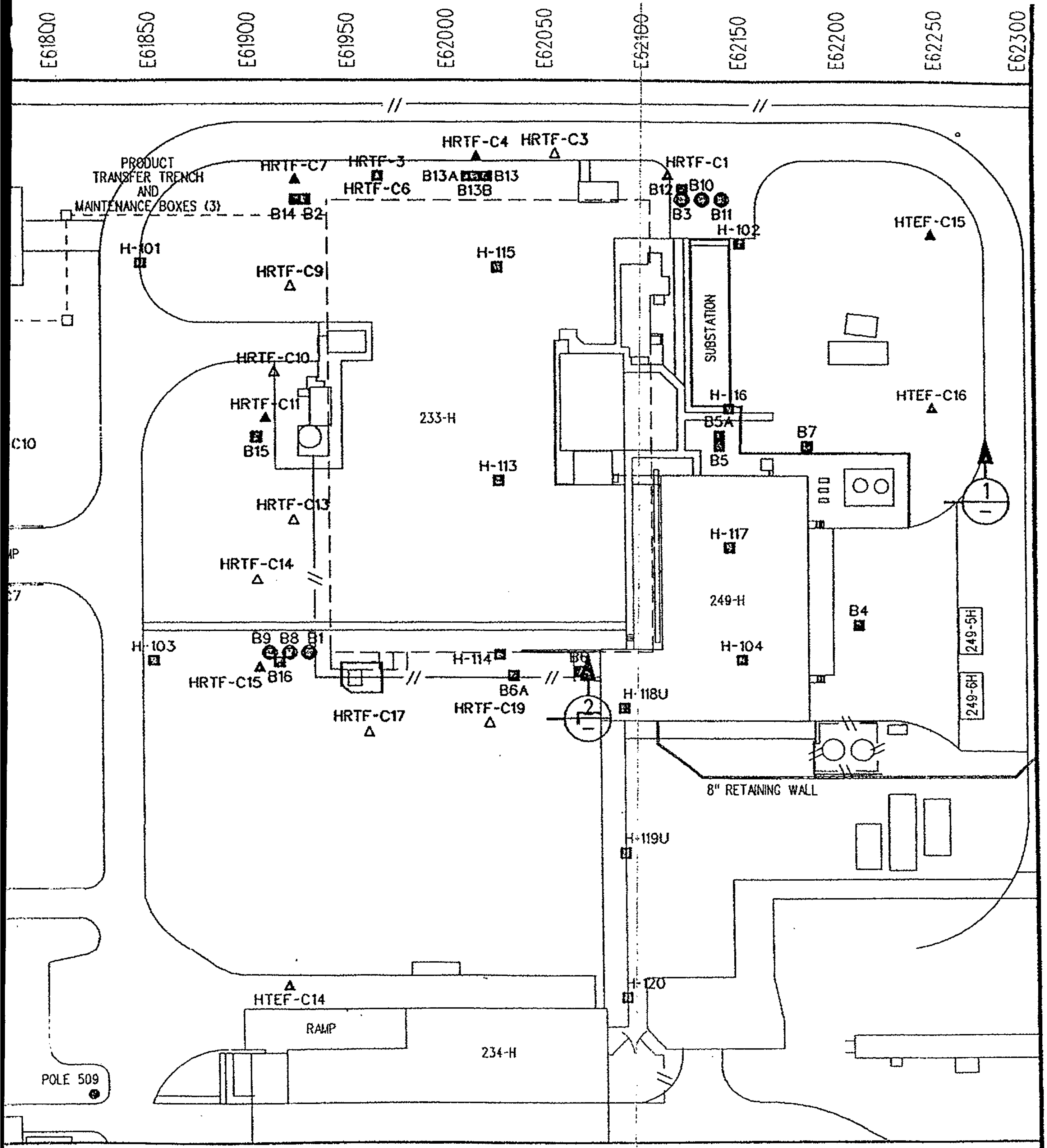


FACILITY LAYOUT A

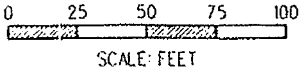
LEGEND

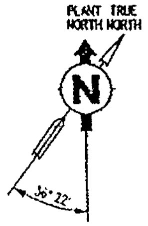
- ▲ SEISMIC PIEZOCONE PENETRATION TEST SOUNDING (22)
- △ PIEZOCONE PENETRATION TEST SOUNDING (13)
- ⊗ MONITOR WELL (1)
- ▣ BORING (38)
- ○ CROSS-HOLE GEOPHYSICAL SURVEY (6)

Note: Layout is based on Referer



ND EXPLORATION LOCATION PLAN





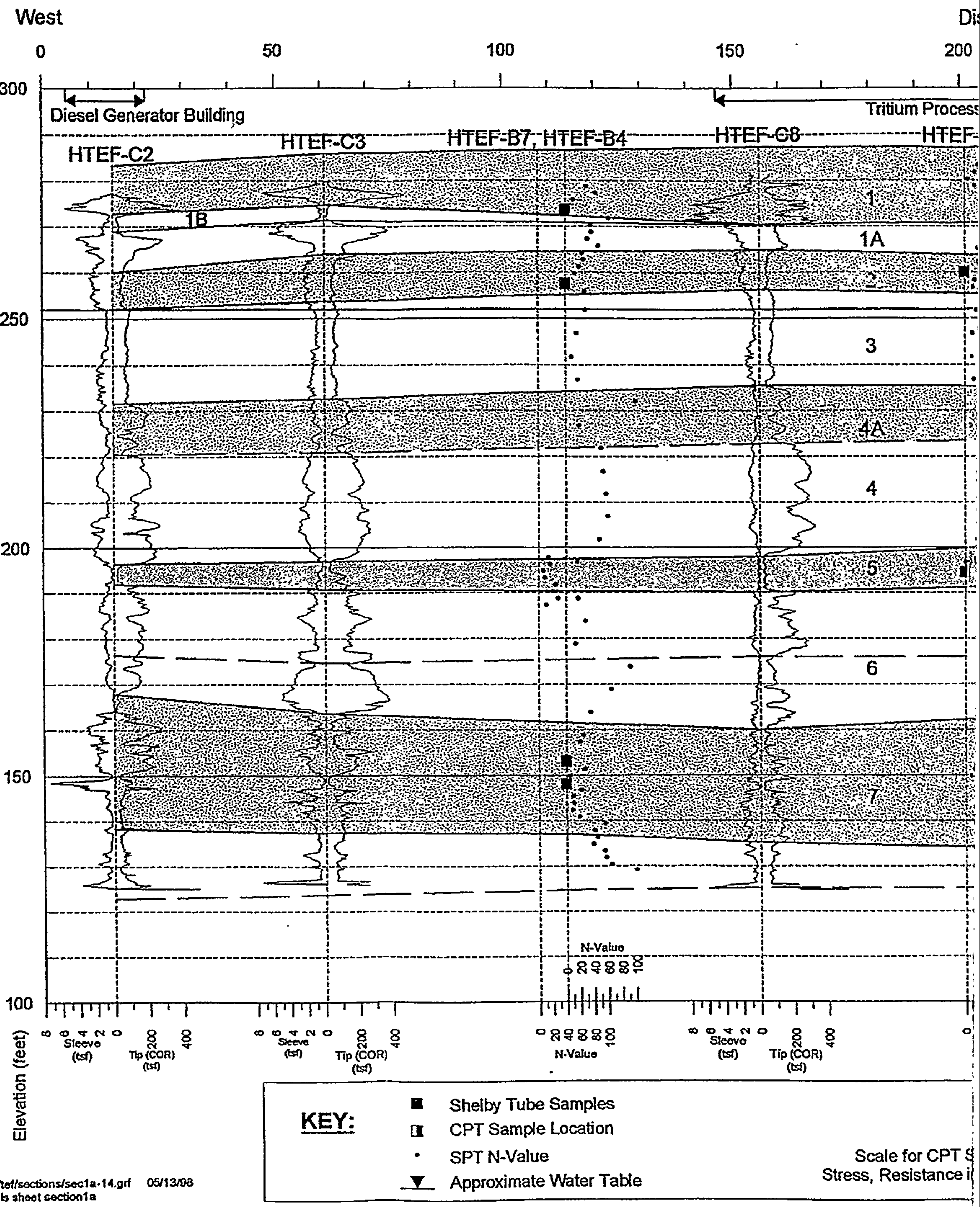
nce 1.1 and subject to change during the design process.

MLH5000

E-

Prepared By: Robert F. Gelinas Checked By:

Approved By: Revision: Rev 0 Date: 05/13/98



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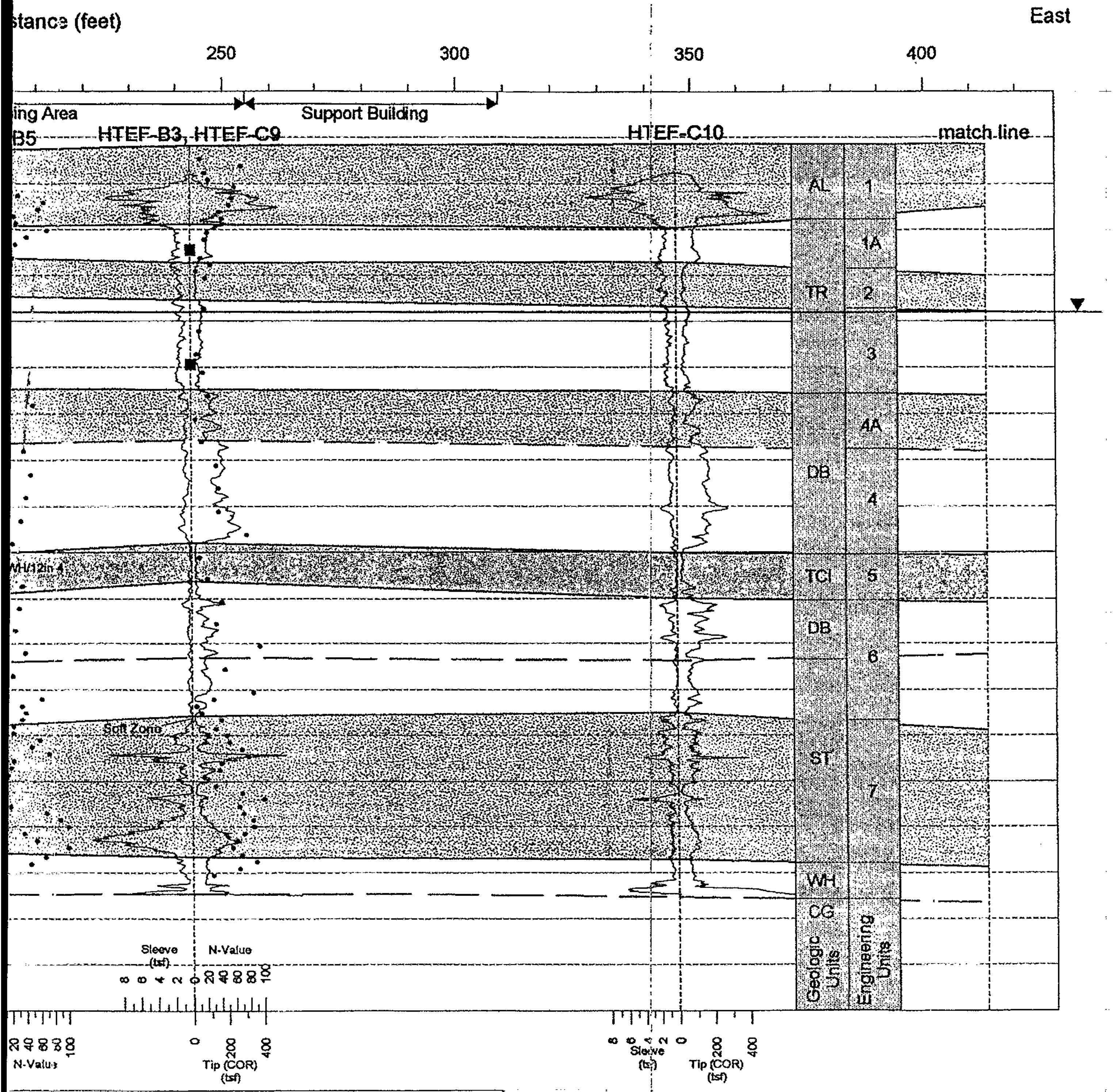
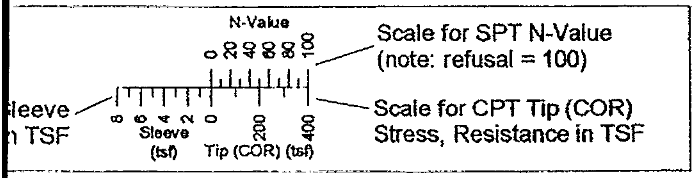
uses tefsect.xls sheet section1a

TEF Section Line 1a



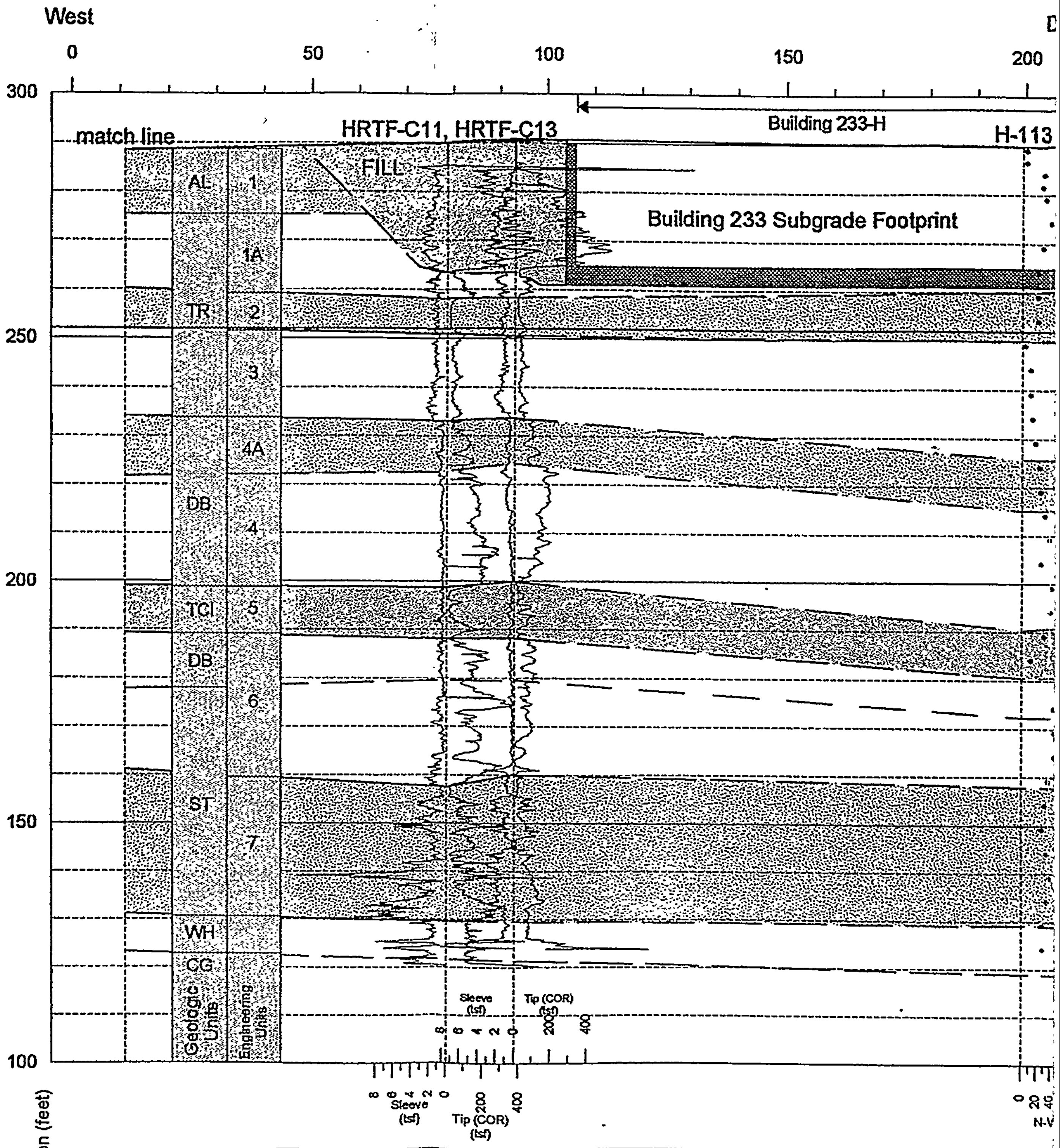


NOTES:

1. All CPT and SPT Borings Projected to E-W line at N73443.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

E-.

Prepared By: Robert F. Gelinas
Checked By:
Approved By:
Revision: Rev 0
Date: 05/13/98



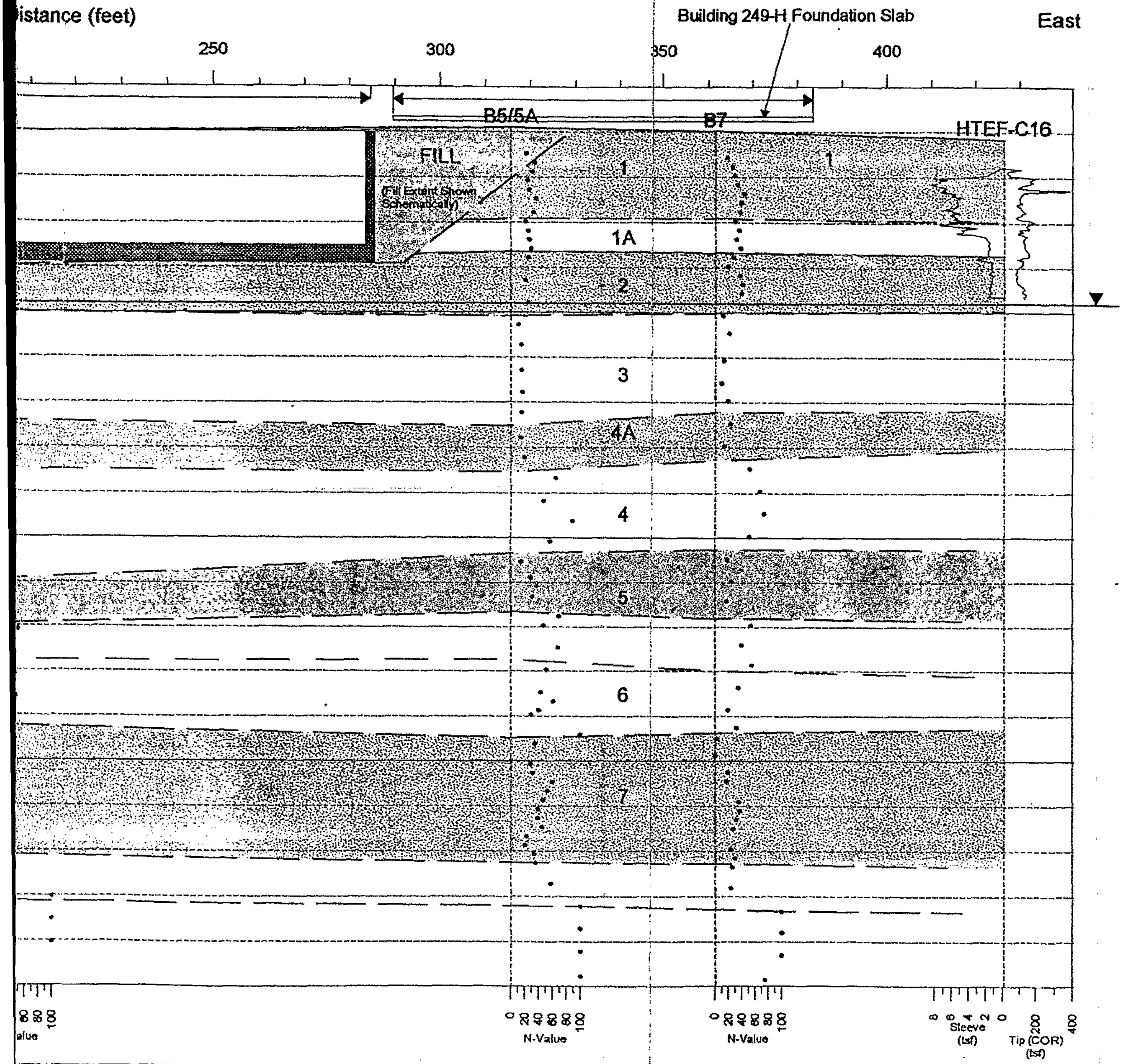
KEY:

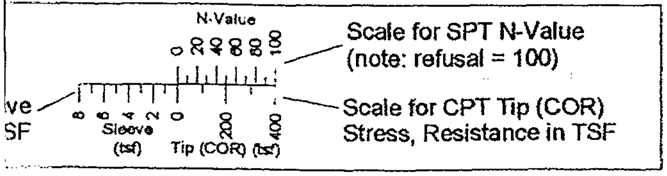
- ■ Shelby Tube Samples
- ◨ CPT Sample Location
- • SPT N-Value
- ▼ Approximate Water Table

Scale for CPT Slee
Stress, Resistance in T

d:/gelinas/cpt/tef/sections/sec1b-15.grf 05/13/98
uses tefsect.xls sheet section1b

TEF Section Line 1b





Scale for SPT N-Value (note: refusal = 100)

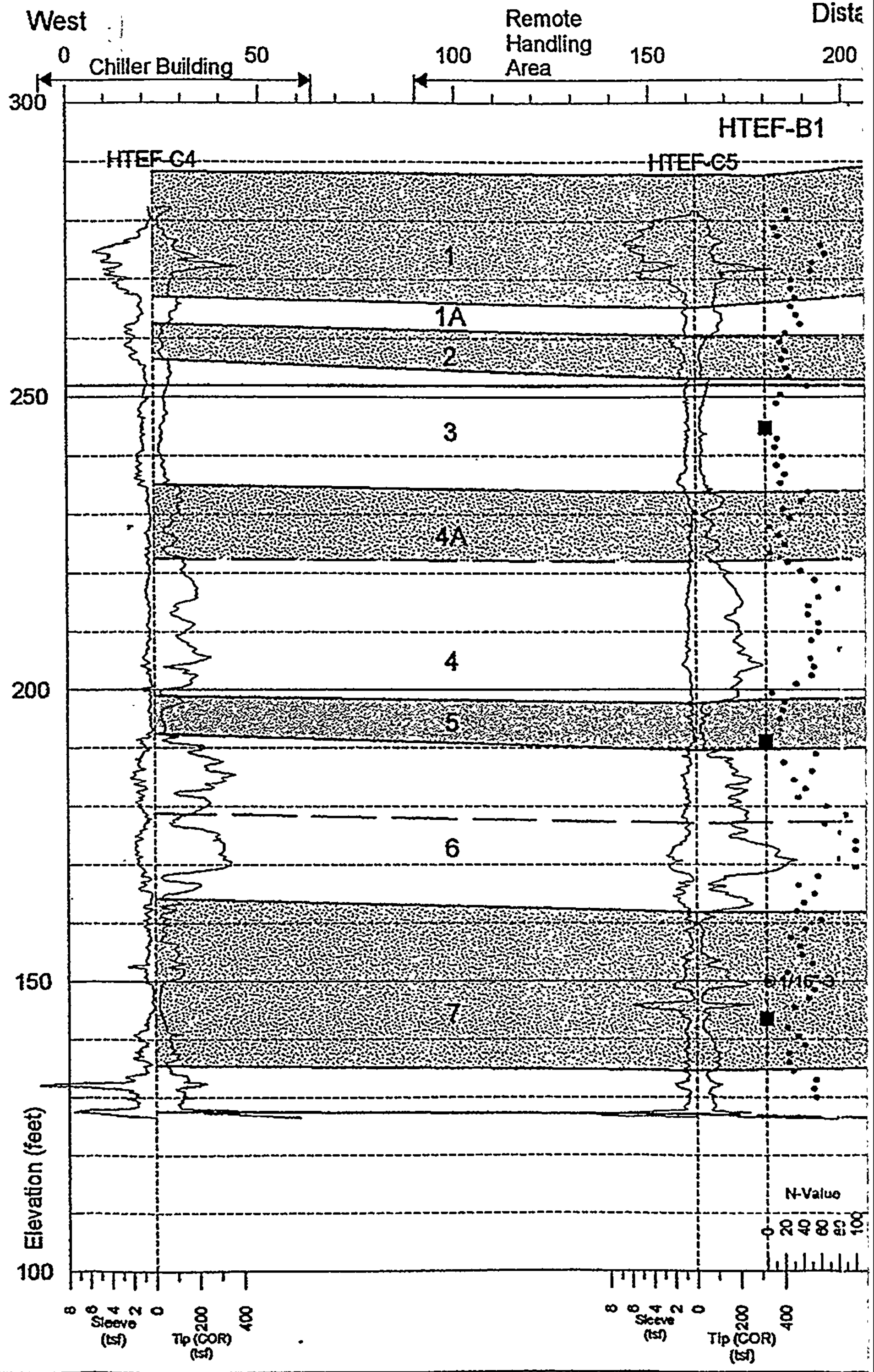
Scale for CPT Tip (COR) Stress, Resistance in TSF

NOTES:

1. All CPT and SPT Borings Projected to E-W line at N734432.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

Prepared By: Robert F. Gelinas Checked By:

Approved By: Revision: Rev 0 Date: 05/13/98



KEY:

■ Shelby Tube Samples

◨ CPT Sample Location

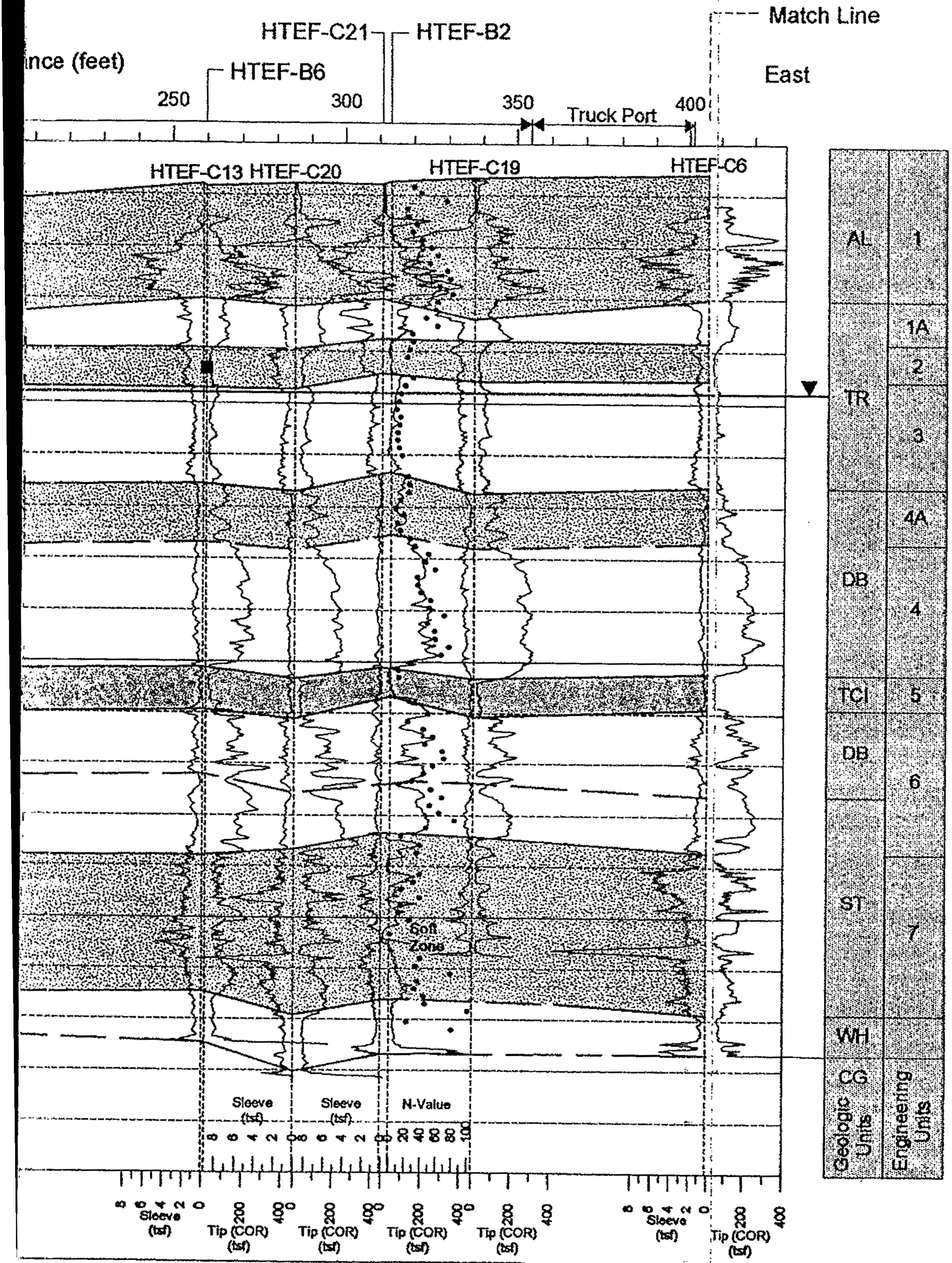
• SPT N-Value

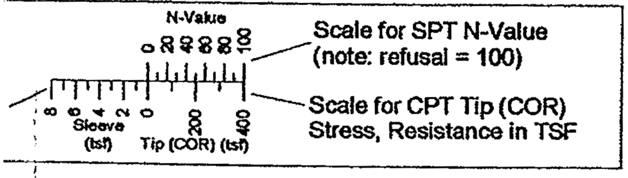
▼ Approximate Water Table

Scale for CPT Sleeve
Stress, Resistance in TSF

d:/gelinas/cpt/tef/sections/sec2a-15.grf 05/13/98
uses tefsect.xls sheet section2a

TEF Section Line 2a





Scale for SPT N-Value (note: refusal = 100)

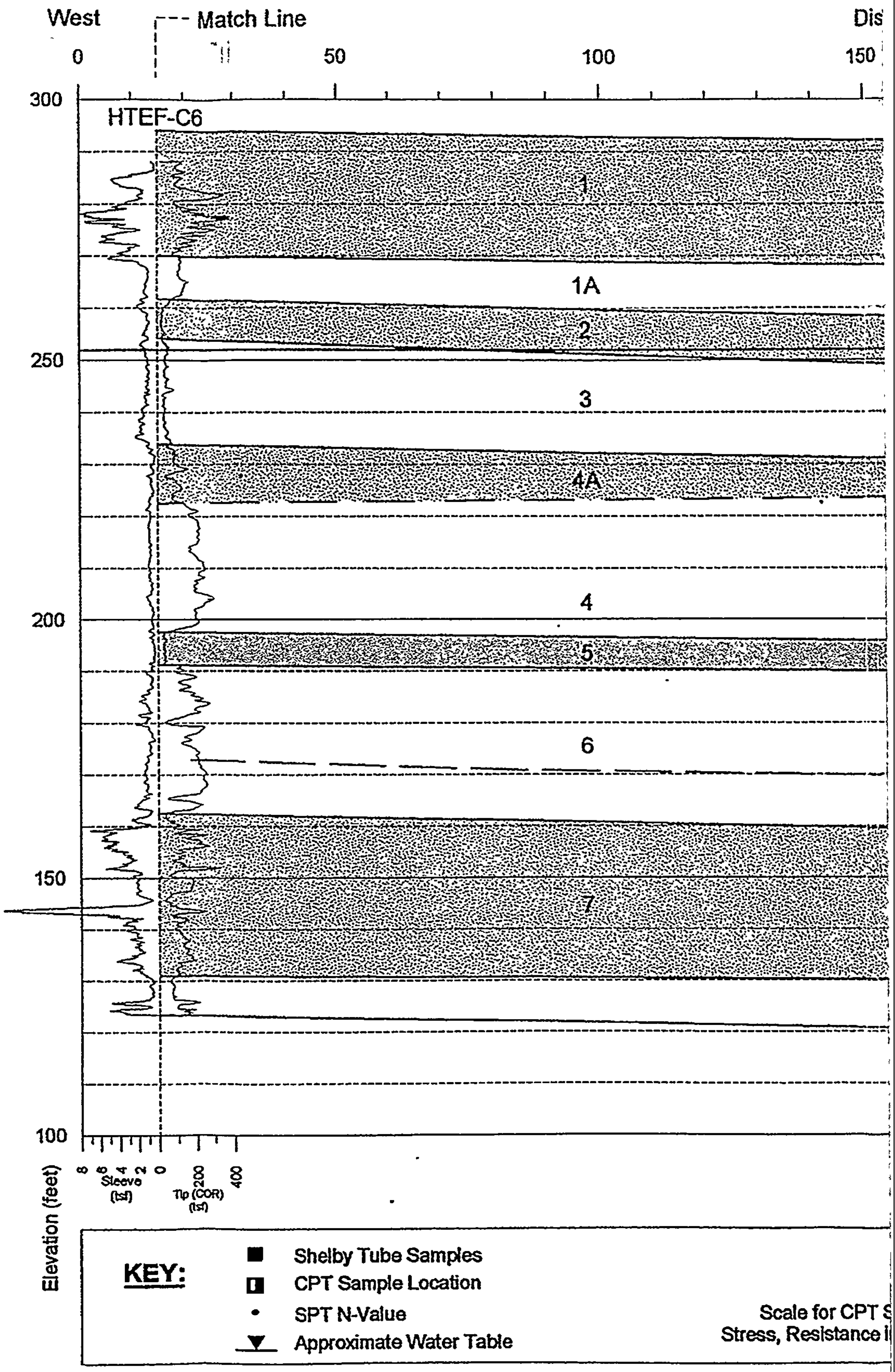
Scale for CPT Tip (COR) Stress, Resistance in TSF

NOTES:

1. All CPT and SPT Borings Projected to E-W line at N73320.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

Prepared By: Robert F. Gelinas Checked By:

Approved By: Revision: Rev 0 Date: 05/13/98



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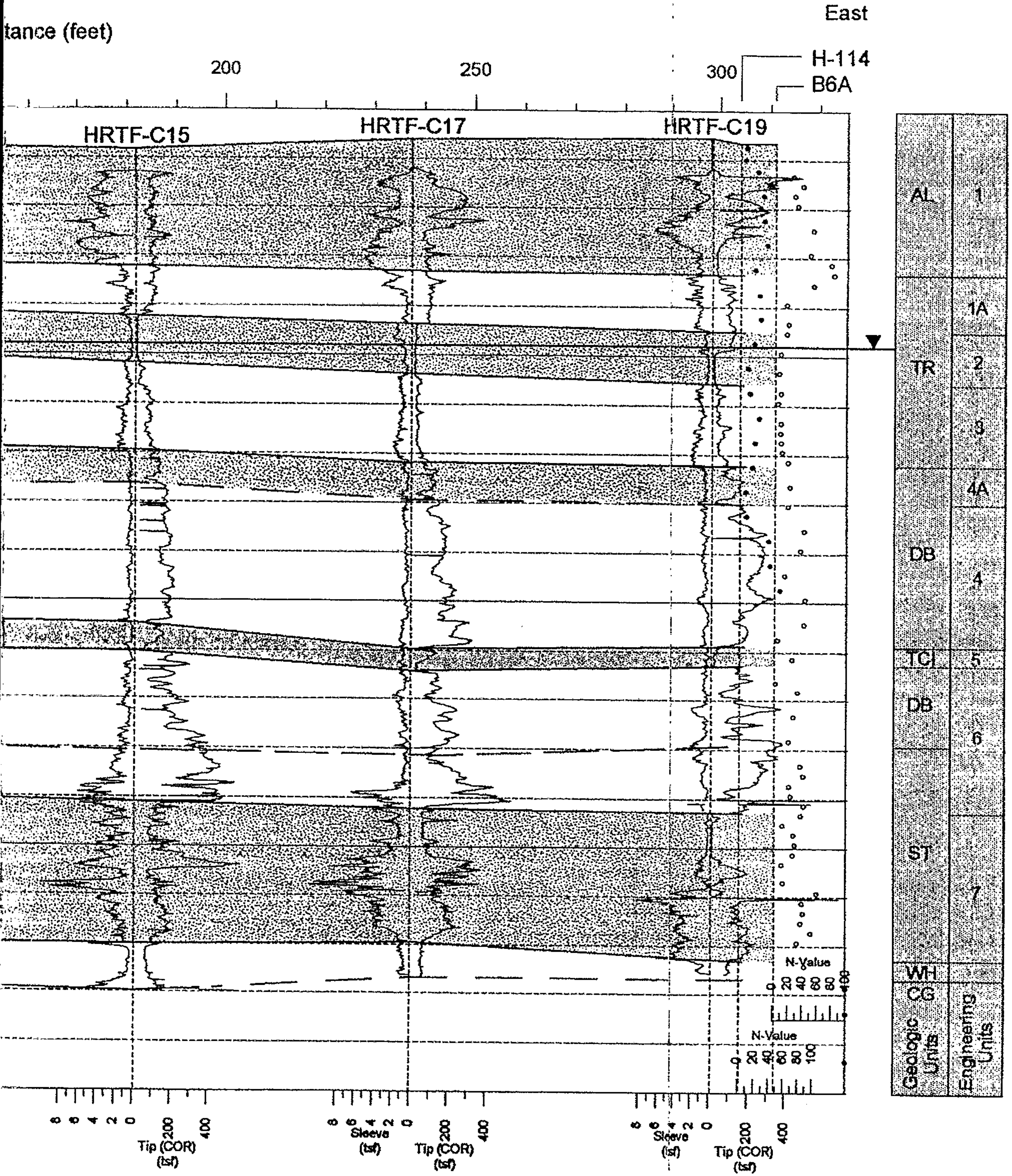
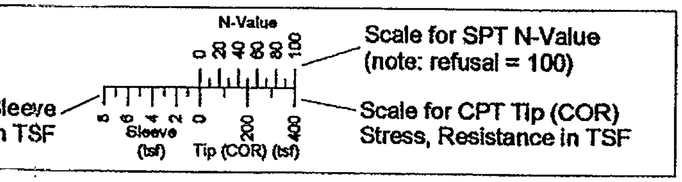
uses tefsect.xls sheet section2b

TEF Section Line 2b



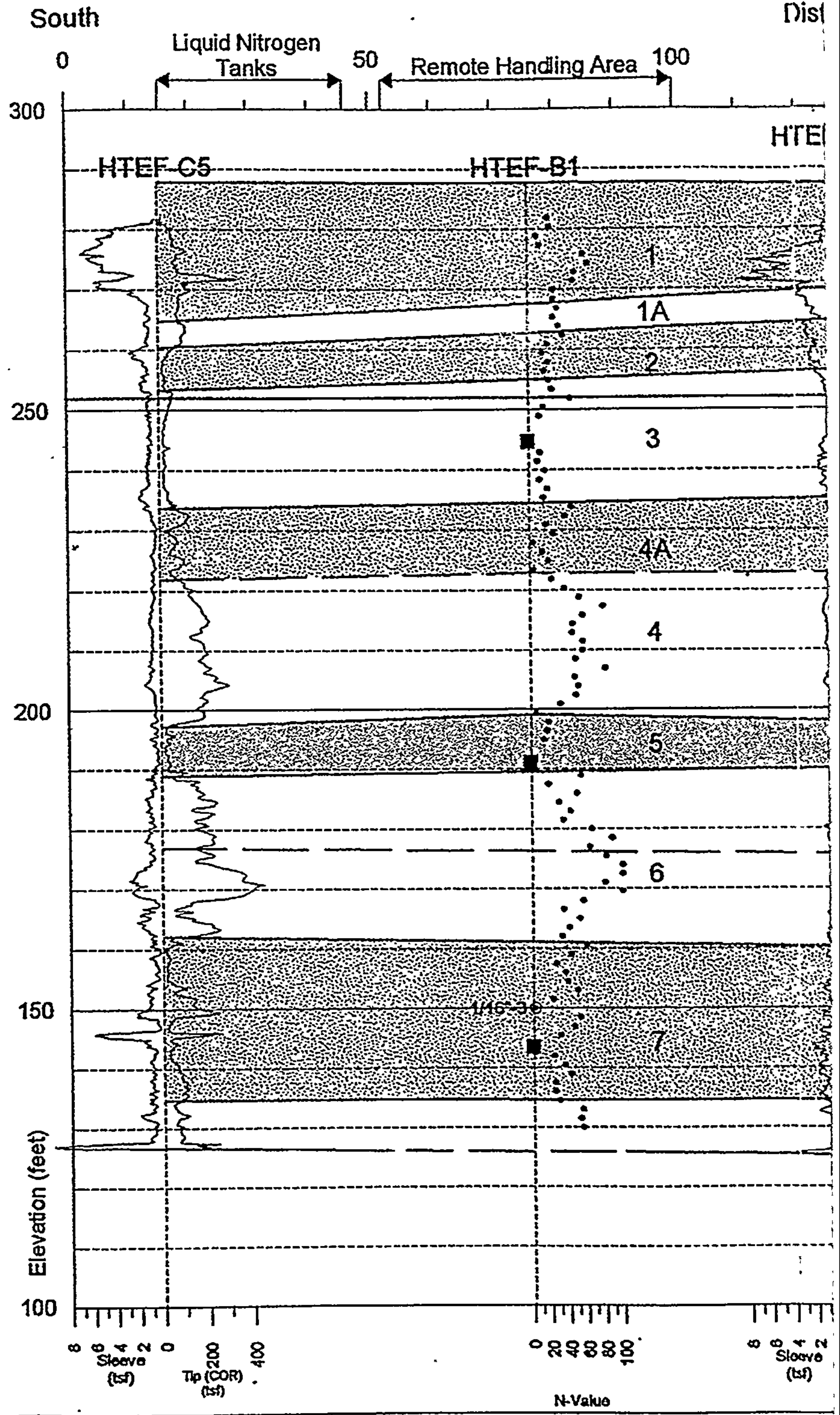


NOTES:

1. All CPT and SPT Borings Projected to E-W line at N73320.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

E-6

Prepared By: Robert F. Gelinas	Checked By:		
Approved By:	Revision: Rev 0	Date: 05/13/98	



KEY:

■ Shelby Tube Samples

◨ CPT Sample Location

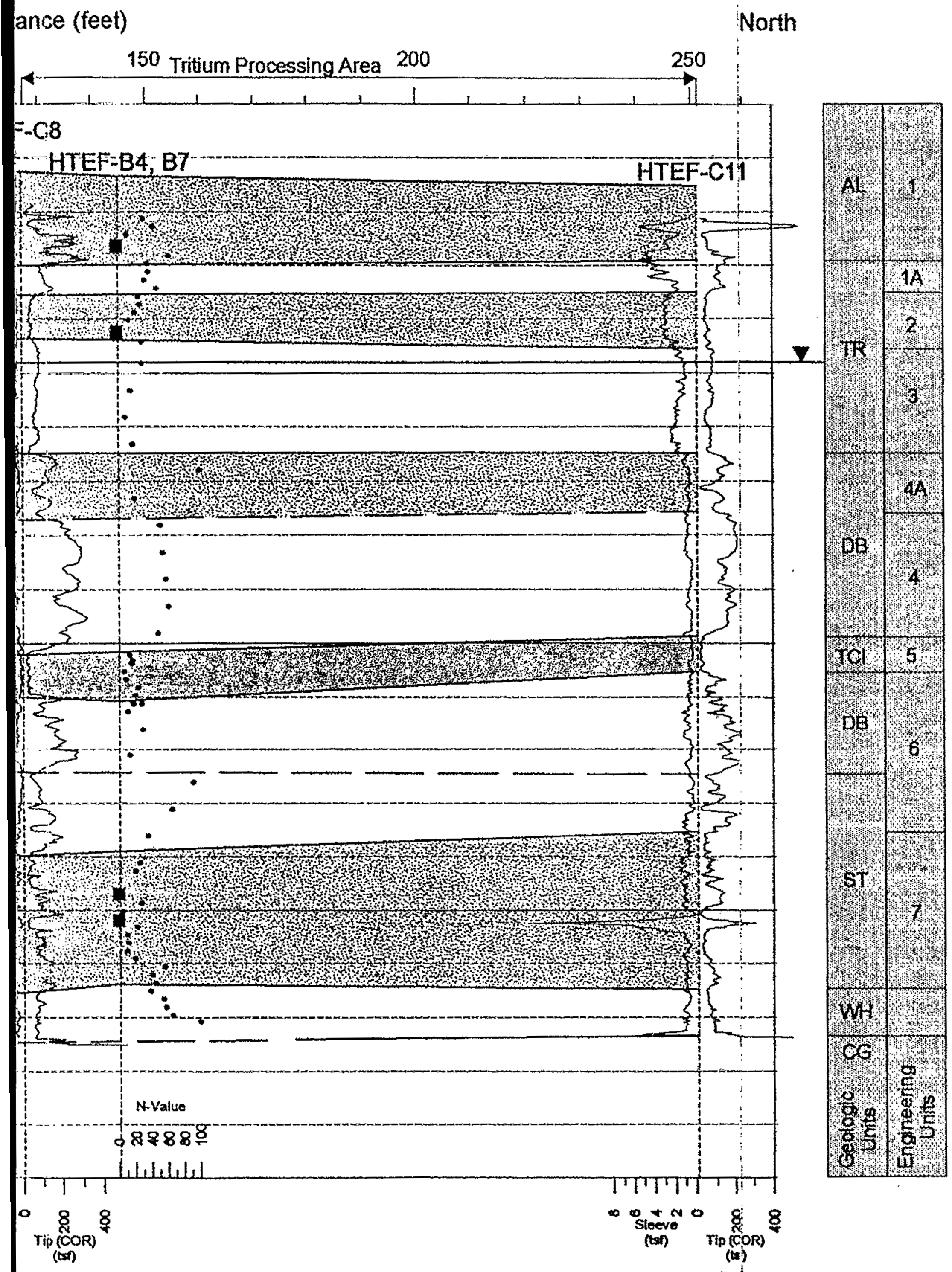
• SPT N-Value

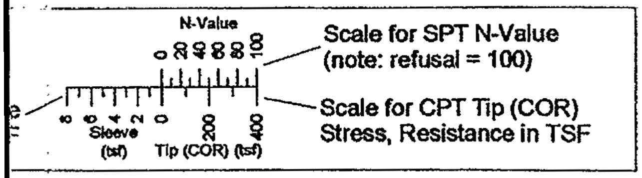
▼ Approximate Water Table

Scale for CPT Sleev
Stress, Resistance in TS

d:/gelinas/cpt/tef/sections/sec3-14.grf 05/13/98
uses tefsect.xls sheet section3

TEF Section Line 3





NOTES:

1. All CPT and SPT Borings Projected to N-S line at E61573.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

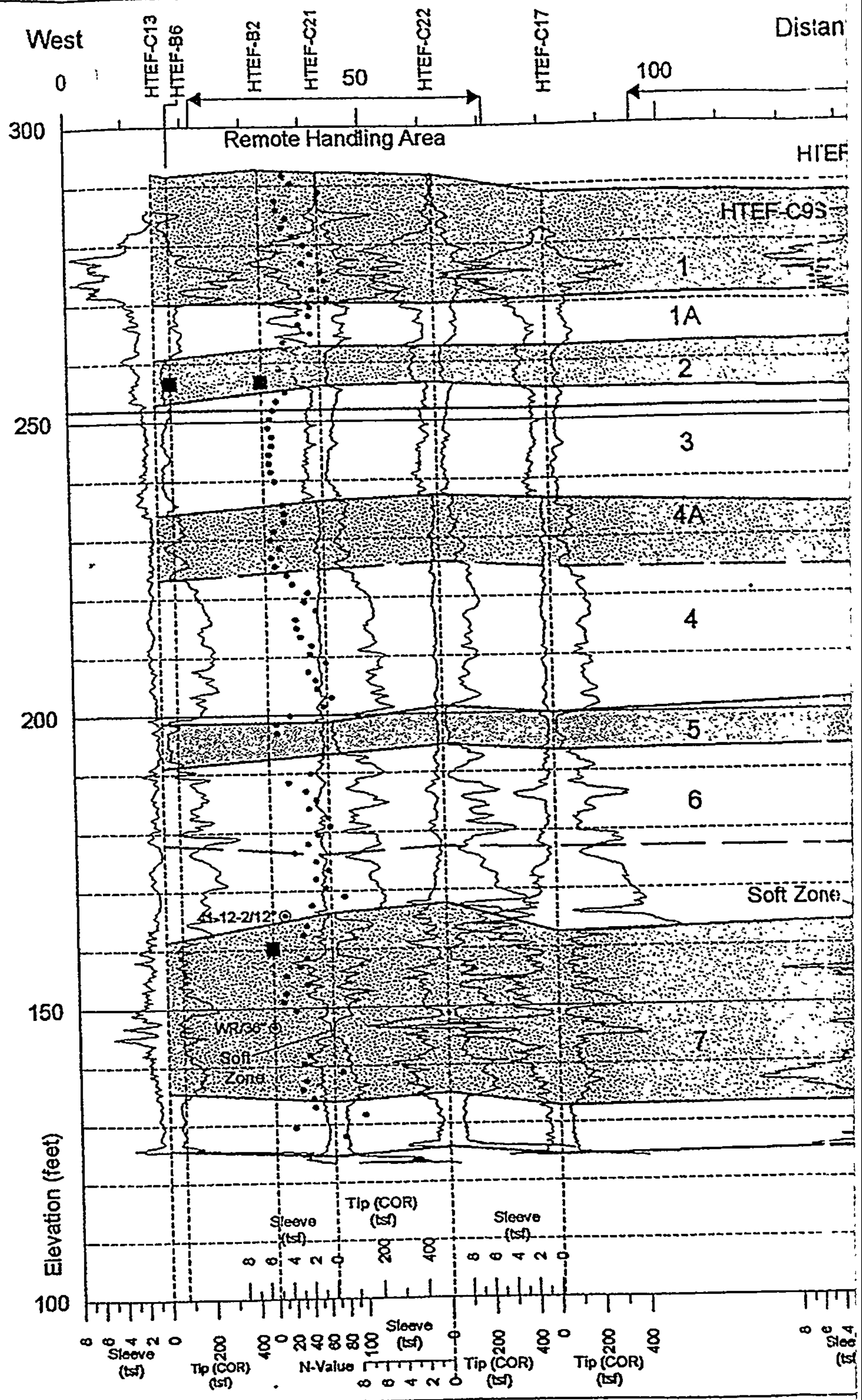
Prepared By: Robert F. Gelinas

Checked By:

Approved By:

Revision: Rev 0

Date: 05/13/98



KEY:

■ Shelby Tube Samples

▮ CPT Sample Location

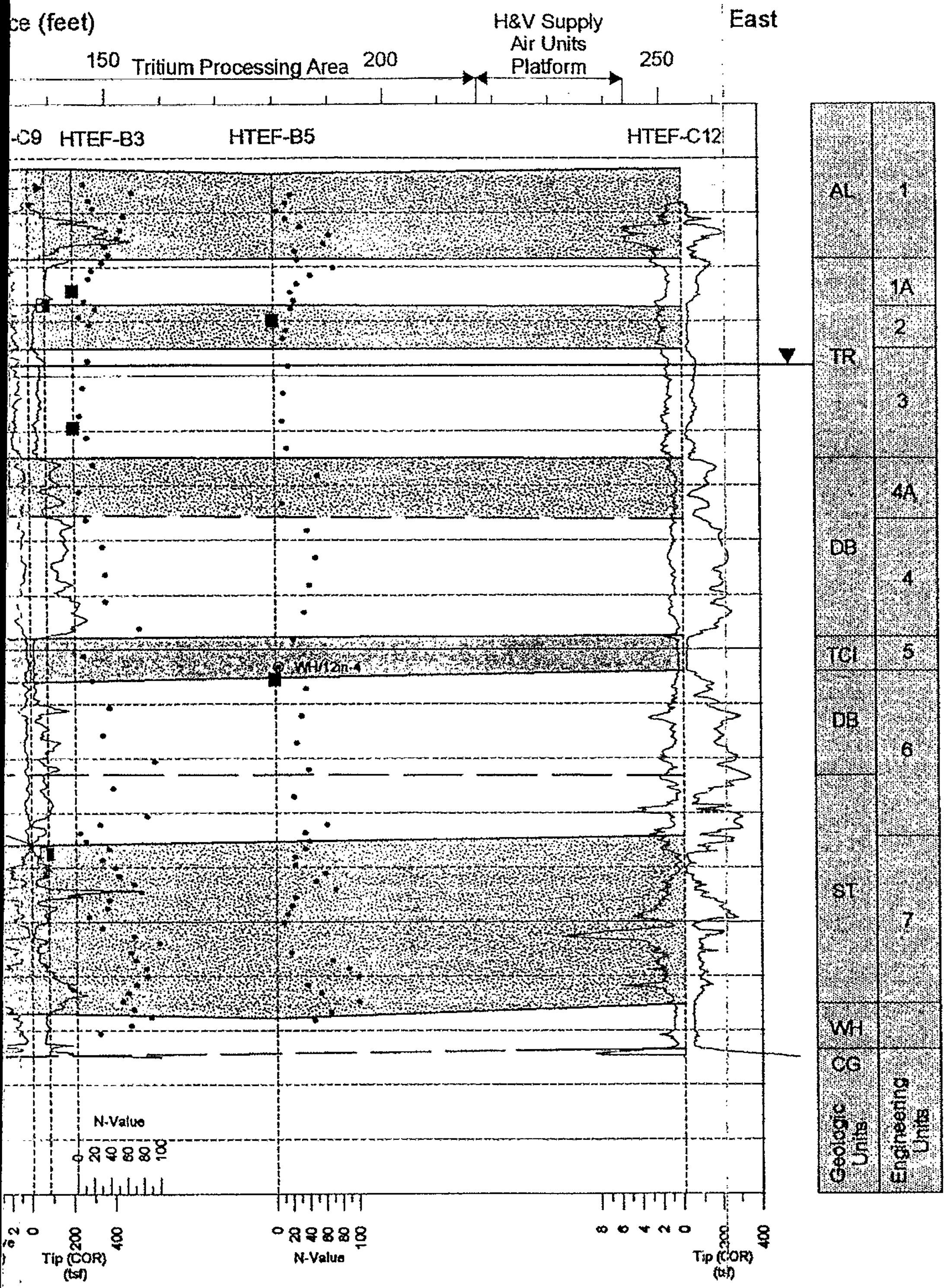
• SPT N-Value

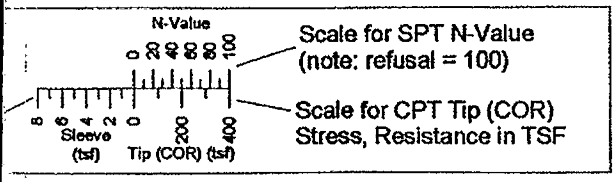
▼ Approximate Water Table

Scale for CPT Sleeve Stress, Resistance in TSF

d:/gelinas/cpt/tef/sections/sec4-15.grf 05/13/98
uses tefsect.xls sheet section4

TEF Section Line 4





NOTES:

1. All CPT and SPT Borings Projected to N-S line at E61656.
2. The subsurface section shown represents our evaluation of the most probable conditions based upon interpretation of presently available data. Some variation from these conditions must be expected.
3. The discussion in the text of the report is necessary for a proper understanding of the nature of the subsurface material.
4. The use of the geologic formation designation of soils encountered is used for ease of description and should not be interpreted as a textural or engineering description.

E-8