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October 28, 1996

Kennecott

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20850

Subject: **Sohio Western Mining Co.**
L-Bar Uranium Facility, New Mexico
Docket 40-8904
License SUA-1472

Dear Mr. Holonich:

At our recent meeting with your staff, Sohio was asked by Tim Harris to provide a copy of the cone penetrometer test (CPT) data interpretation and tailings fluid trend analysis that was prepared by INTERA. INTERA has not completed their final analysis, but have prepared an interim technical paper which responds to Tim Harris' interest, and we are enclosing a copy together with the CPT data summary.

As noted, these tests were designed to characterize the tailings, and were not intended to address dam stability analysis. During our meeting we did also discuss the stability analysis of the L-Bar tailings dam as it might relate to the seismic risk assessment. In addition to the Shepherd-Miller technical review of the Lawrence Livermore report which we have previously provided, we are enclosing a copy of a report on stability analysis of the reclaimed tailing dam outslope prepared by AK GeoConsult, Inc. In the INTERA report this was incorrectly attributed to Shepherd-Miller.

We believe these enclosures will provide the information needed by Tim Harris for his review. However, if additional data is required, please advise.

Sincerely,

David B. Crouch
On behalf of Sohio Western Mining Co.

130066

NL05/1

Enclosures
cc: R. A. Heig
P. R. Lorello

Add'l Attachments:
CPT Plates 1 and 2
CPT Data Profiles

Technical Explanation

Cone Penetrometer Test Data Interpretation and Tailings Fluid Trend Analyses

L-Bar Uranium Mill Tailings Pile
Seboyeta, New Mexico

It is important to note that the intent of the cone penetration testing was to characterize the *tailings* in terms of stratigraphy and lateral and vertical distribution of gross soil types. The CPT program was not intended to support further dam stability analysis. Further work is currently being performed by INTERA staff on the existing data to better our understanding of the geotechnical properties of the materials. However, the understanding of stratigraphy and material type distribution is greatly improved with the CPT data.

The preliminary results of the characterization appear to fingerprint the areas of greatest concern for additional settlement (the predominantly slimes fractions) with a reasonable degree of confidence due to the distinctive properties of the slimes. This information, combined with laboratory test results on undisturbed soil cores from conventional borings drilled and sampled for correlation to the CPT results, have led to a reasonable understanding of the remaining consolidation to be experienced from the still-saturated materials in the pile.

Additional work on undrained shear strength of the tailings materials has not been performed because the recent stability analysis (Shepherd-Miller, Inc., 1996) indicates that the embankment remains stable under a greater than design-basis seismic event. In other words, we did not consider it necessary to perform detailed material stability analysis of the tailings upstream of the embankment, as any liquefiable materials would be contained within the basin by the dam during a seismic event.

The remaining text in this explanation is excerpted from an investigation in progress regarding all remaining reclamation issues for the site closure. Pagination, figure numbering, and order are as they will appear in the report when it is issued.

Cone Penetrometer Probing and Testing

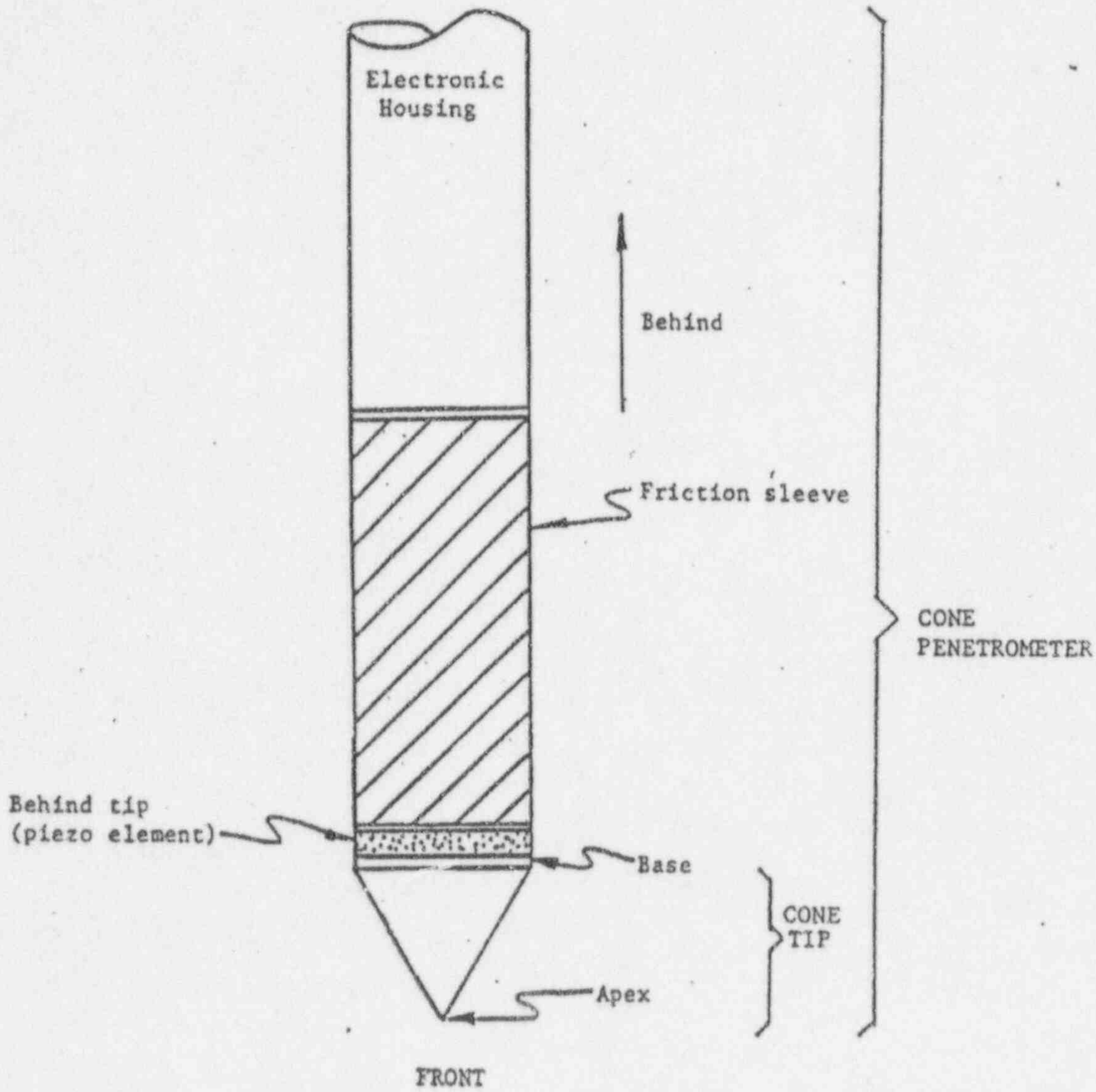
A cone penetrometer testing (CPT) survey was performed as a cost-effective means to characterize the tailings in many locations around the pile. The CPT work was performed from September 11 to September 16, 1995 and consisted of soundings at 26 locations, as presented in Figure 3.2.1, 1995 Cone Penetrometer Test and Profile Locations. The CPT results were calibrated to the three continuously sampled monitor wells (MW-103, 104, and 105) to identify discrete material types. The interpretation of the CPT logs elsewhere in the pile provided information about material distribution in the basin. All CPT data profiles are presented in Appendix B.

Principles and Procedures

The cone penetrometer, as depicted in Figure 3.2.1.1, consists of a 10 cm^2 cone instrumented with strain gauges in its tip and in a sleeve immediately behind the tip, and a piezo element between the tip and sleeve hydraulically coupled to a pressure transducer. The cone is pushed through the soil at a constant rate and values of tip and sleeve resistance are measured at 2 cm intervals, and the tip resistance, sleeve friction, and the ratio of the sleeve friction to tip resistance (defined as the friction ratio) is plotted. Pore pressure measurements are also taken both during the penetration and after penetration is stopped. The values of each parameter and combinations of each differ for different soil types, and the results of the data can be used to interpret the soil stratigraphy.

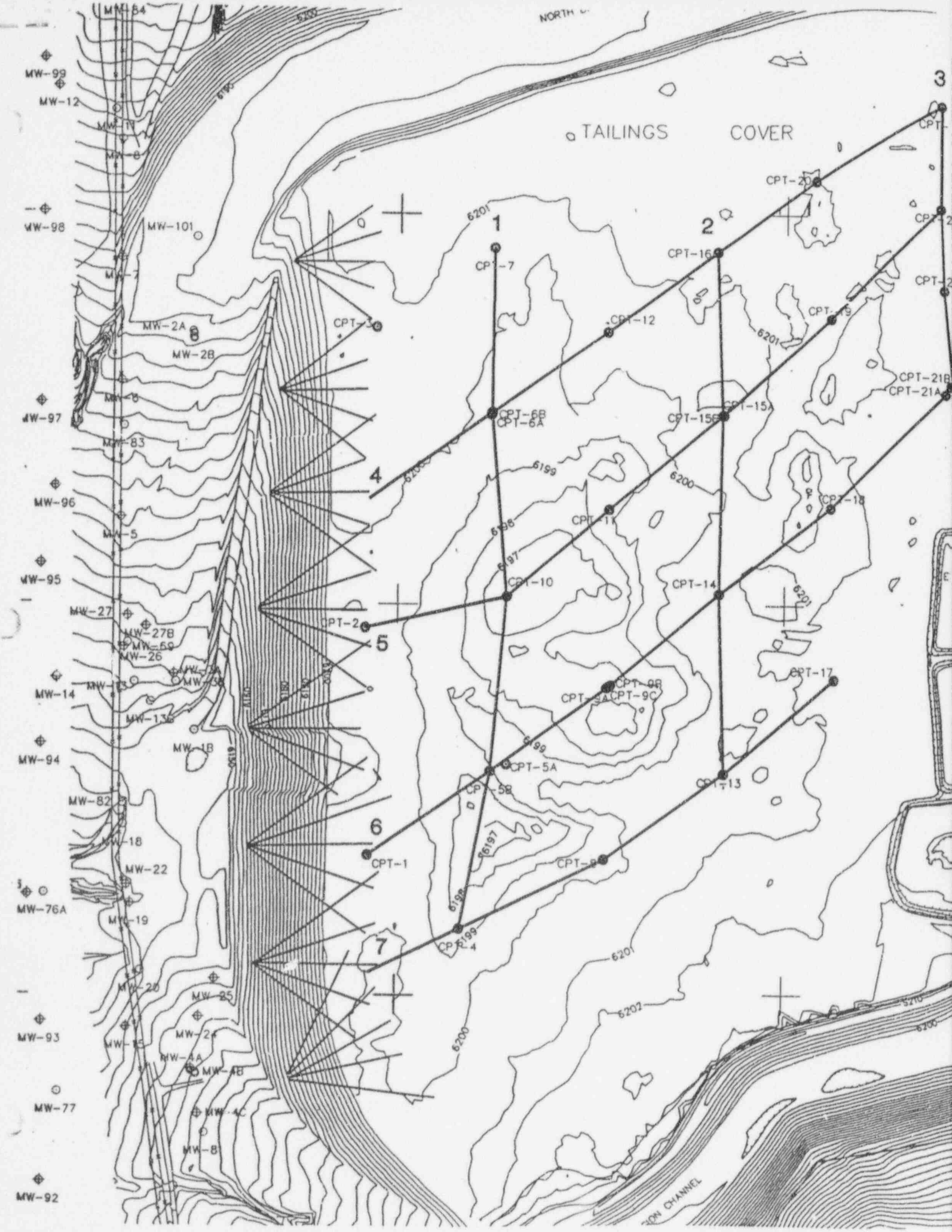
To gain an understanding of what the values of tip resistance and sleeve friction mean in terms of L-Bar's tailings, several CPT pushes were performed at the same location as the continuous sampling from the monitor well installation. The known stratigraphy from the borings were then compared to the values obtained from the CPT plot to establish what the CPT data represented for each material type in the pile. The more cost-effective CPT was then used at many locations around the site to determine the stratigraphy of the tailings and depth to Mancos shale bedrock. In lieu of a lengthy discussion of CPT data interpretation in this report, the reader is referred to Robertson and Campanella, 1989.

For our purposes and given the known soil types at the site, high tip resistance (defined as greater than 30 tons per square foot or tsf) coupled with low friction ratio (defined as less than 2%) indicates coarse-grained fill or sand. Low tip resistance (<30 tsf) and high friction ratio (>2%)



NOT TO SCALE

DATE: 10/16/95 REF: 1060-012	Electric Piezocone Configuration	
INTERA	L-BAR MINE TAILINGS HYDROLOGIC CHARACTERIZATION	Figure 3.2.1.1



TAILINGS COVER
NORTH
1
2
3
4
5
6
7
CPT-7
CPT-12
CPT-16
CPT-20
CPT-19
CPT-3
CPT-6B
CPT-6A
CPT-15B
CPT-15A
CPT-21B
CPT-21A
CPT-11
CPT-18
CPT-10
CPT-14
CPT-2
CPT-9B
CPT-9C
CPT-17
CPT-5A
CPT-5B
CPT-13
CPT-1
CPT-4
MW-99
MW-12
MW-98
MW-101
MW-7
MW-2A
MW-2B
MW-97
MW-83
MW-96
MW-5
MW-95
MW-27
MW-27B
MW-26
MW-14
MW-13B
MW-1B
MW-94
MW-82
MW-18
MW-22
MW-76A
MW-19
MW-25
MW-93
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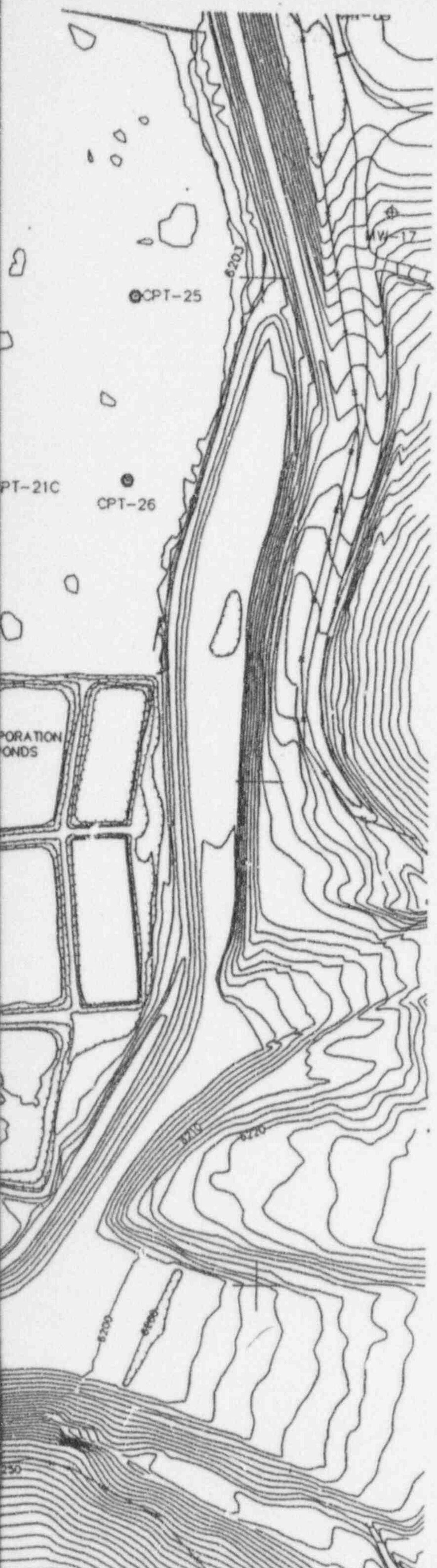
6201
6200
6199
6198
6197
6202
CHANNEL



ANSTEC APERTURE CARD

Also Available on Aperture Card

LEGEND

- CPT-4 ⊙ PIEZOCONE PROBE LOCATION
- ⊕ MONITORING WELL
- ◈ PIEZOMETER
- ⊙ SETTLEMENT GAUGE
- ▣ POINT-OF-COMPLIANCE WELL
- ● PUMPING WELL
- ◘ ALLUVIUM MONITORING WELL (SHALLOW)
- ▣ 2nd TRES HERMANOS MONITORING WELL (DEEP)
- —×— PERIMETER FENCE
- ⇐ EXISTING HORIZONTAL DRAINS (1981)

0 150 300

APPROXIMATE SCALE IN FEET

NOTE: 1 FOOT TOPOGRAPHIC CONTOUR INTERVAL SHOWN ON TAILINGS COVER.

1995 Cone Penetration Test and Profile Locations

L-BAR RECLAMATION

INTERA

Date: 10/16/95
Project No. 1060-012
Revision No: 0
Checked By: Kelly Tilford

Figure 3.2.1

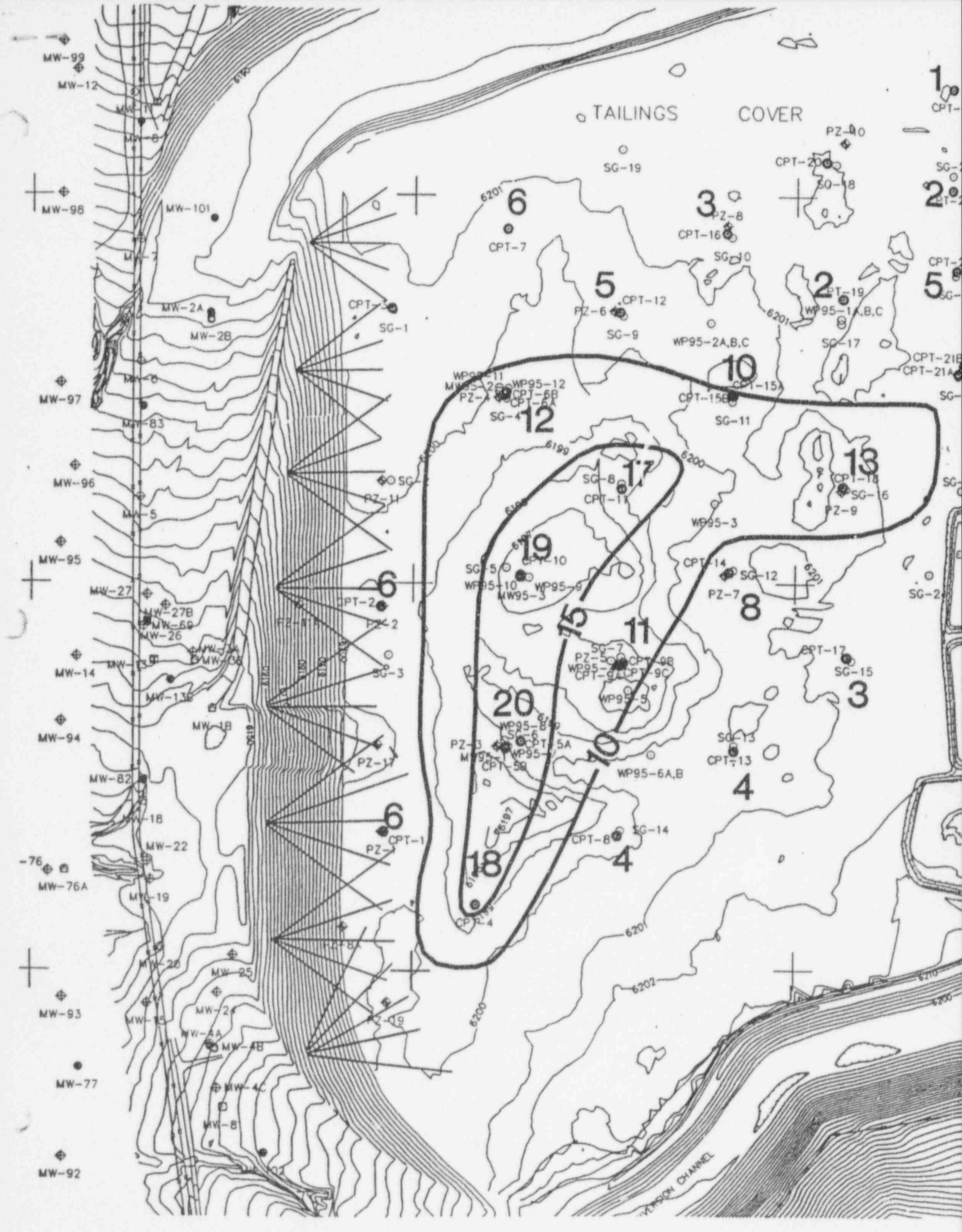
9611140304-01

indicates slimes. Other combinations of tip and friction resistance indicate a mixture of sand and slimes, or other miscellaneous fill materials. High tip resistance and high friction ratio is interpreted as Mancos shale or consolidated colluvial materials.

Cone Penetrometer Test Results

The L-Bar tailings pile proved to be an excellent site for application of the cone penetrometer because the finer-grained tailings materials allowed the penetrometer to progress smoothly and the different tailings material types produced distinct penetrometer signatures. Based on the results of the soundings, the CPT data appear to be especially useful for defining the areas of highest slimes concentrations. The actual profiles and the tailings stratigraphic interpretations are included as Plates 1 and 2, attached with this report. Individual cone data logs are presented in Appendix B. The hydrocyclone tailings deposition method used during milling operations creates alternating sand/slime beaches as the cyclone is moved around the perimeter of the basin. This concentrates the coarser material around the sides and pushes the fines to the center of the pile. Figure 3.2.2.1 presents the plan view of slimes thickness as interpreted from the CPT investigation. The slimes are represented in red on the plates, and are fingerprinted on the data profiles by zones of low tip resistance and high friction ratio. The thickest pocket of slimes in the east-west direction occurs along profile 5 in the area between CPT-2 and CPT-10 and extends to between CPT-15B and CPT-19. This lens varies between 10 to 18 feet in thickness, and likely pinches out at the upstream and downstream ends. In the north-south direction, along profile 1, the slimes extend from CPT-6B to some distance south of CPT-4. This pattern of alternating sequence of beach sands and slimes, as represented by cyclic denser and looser zones, is strongly evident in the profiles from CPT-1, -2, -10, -14, and 15B. The interpreted elevation of the Mancos shale correlates reasonably well with elevations defined by the earlier Woodward-Clevenger study of the tailings basin.

Active pore pressure plots were obtained during probing. This parameter is highly dependent on the grain size distribution and plasticity of the soils. This parameter was omitted from further analysis. However, the field data plots of dissipation are presented in Appendix E-7 for information.



TAILINGS COVER
DIVERSION CHANNEL
MW-99
MW-12
MW-98
MW-101
MW-7
MW-2A
MW-2B
MW-97
MW-83
MW-96
MW-5
MW-95
MW-27
MW-27B
MW-69
MW-26
MW-14
MW-13B
MW-1B
MW-94
MW-82
MW-18
MW-22
MW-76A
MW-19
MW-93
MW-25
MW-4A
MW-4B
MW-4C
MW-77
MW-8
MW-92
CPT-3
SG-1
CPT-2
PZ-2
SG-3
PZ-11
PZ-17
CPT-1
PZ-19
CPT-7
SG-19
PZ-8
CPT-16
SG-10
PZ-10
CPT-20
SG-18
PZ-6
CPT-12
SG-9
WP95-2A,B,C
CPT-19
WP95-1A,B,C
SG-17
CPT-21A
WP95-12
PZ-4
CPT-6B
SG-4
CPT-15A
CPT-15B
SG-11
SG-8
CPT-11
WP95-3
CPT-18
SG-16
PZ-9
SG-5
CPT-10
WP95-10
WP95-9
MW95-3
CPT-14
SG-12
PZ-7
SG-7
PZ-5
CPT-9B
CPT-9C
WP95-5
CPT-17
SG-15
PZ-3
WP95-8
CPT-5A
CPT-5B
WP95-6A,B
SG-13
CPT-13
CPT-8
SG-14
CPT-4
6201
6200
6202
6199
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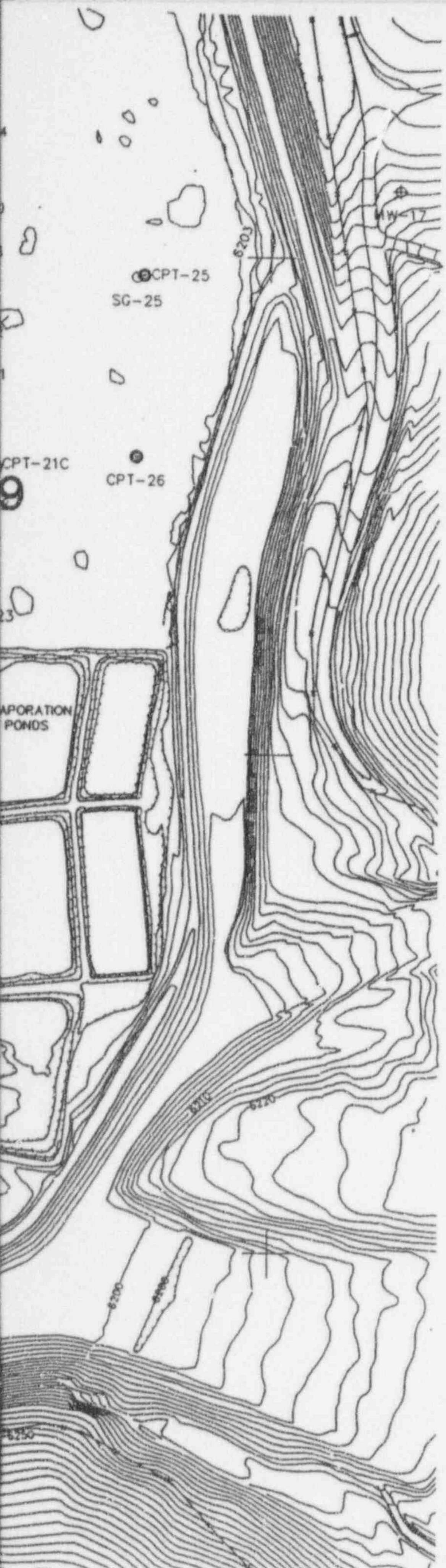


LEGEND

CURRENT ACTIVITIES

- MW95-1 ○ MONITOR WELL INSTALLATION
- SS-13 ○ COVER SOIL SAMPLE
- WP95-1 ○ WELL POINT LOCATION
- CPT-4 ○ PIEZOCONE PROBE LOCATION

PREVIOUSLY EXISTING FEATURES

- ⊕ MONITORING WELL
- ✦ PIEZOMETER
- ⊙ SETTLEMENT GAUGE
- □ POINT-OF-COMPLIANCE WELL
- ● PUMPING WELL
- ◘ ALLUVIUM MONITORING WELL (SHALLOW)
- ◙ 2nd TRES HERMANOS MONITORING WELL (DEEP)
- —•— PERIMETER FENCE
- ⋞ EXISTING HORIZONTAL DRAINS (1981)
- 0 APPROXIMATE SLIMES THICKNESS CONTOUR

NOTE: 1 FOOT TOPOGRAPHIC CONTOUR INTERVAL SHOWN ON TAILINGS COVER.

Estimated Slimes Thickness from CPT Data

L-BAR RECLAMATION

INTERA

Date: 10/20/95
Project No. 1060-012
Revision No: 0
Checked By: Kelly Tilford

Figure 3.2.2.1

9611140304-02

Zones of reworked or mixed tailings and fill materials were also identified from the CPT program. As documented in the reclamation plan, these materials included waste ore, windblown soils scraped from the hillsides, and scattered pond access ramp fill. As interpreted along profile 1, this type of material extends the full length of the basin, as indicated on Plate 1. However, the ability to distinguish between alternating slimes and sand lenses or reworked fill or tailings materials is limited. There is strong evidence of beach-type deposition from CPT-2 in the east-west direction, but less of a definite trend in the north-south direction. For the purpose of this study, we can say that these upper zones are not distinctly sands or slimes.

Tailings Fluid Level Historical Behavior

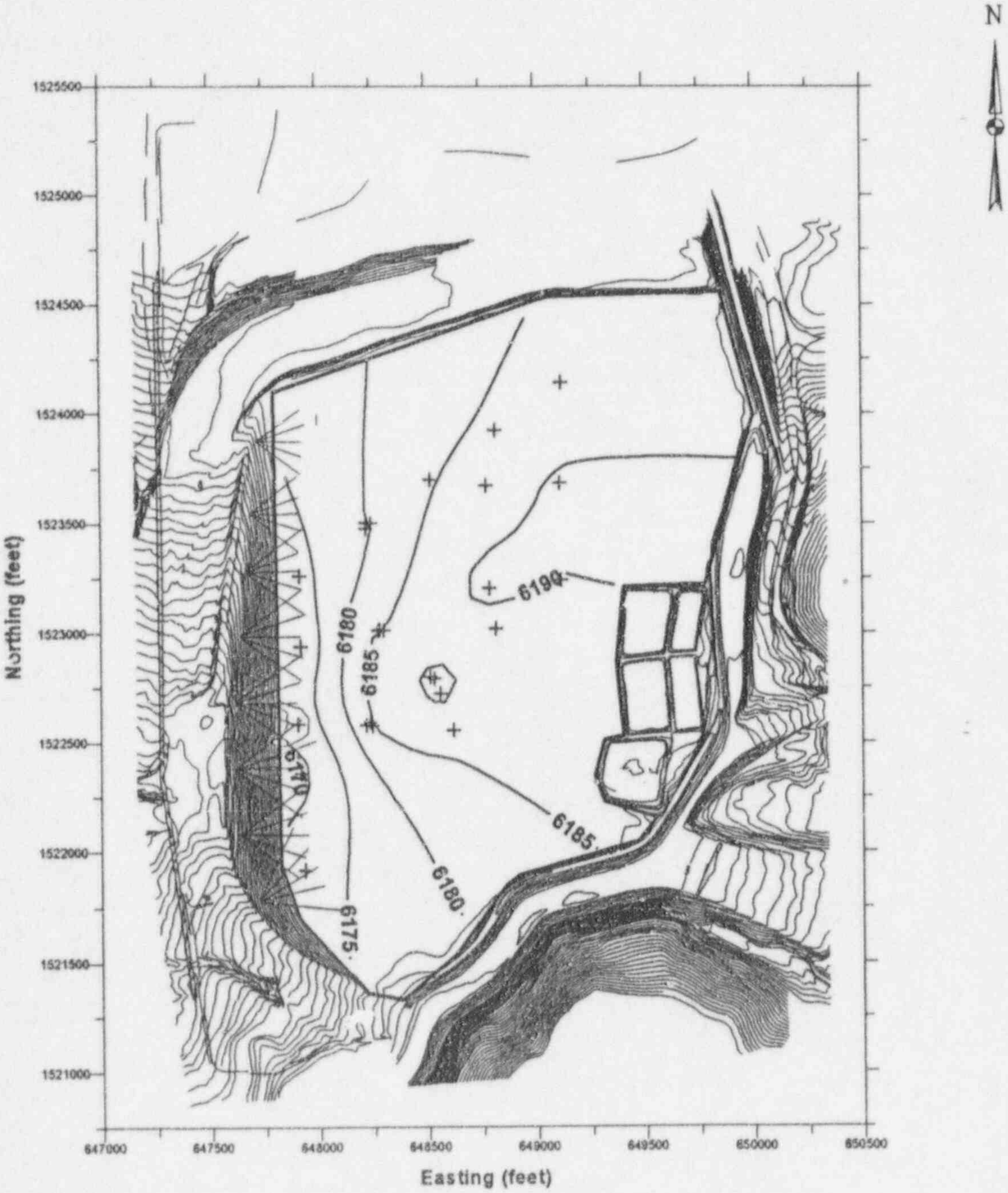
The tailings fluid has been monitored continually since completion of the reclamation in 1989. This monitoring includes the fluid level decline observed in the piezometers completed within the tailings during the reclamation and flow monitoring from the horizontal drains. Several other types of monitoring components were installed in the tailings during the 1995 and 1996 investigations. These included the three monitor wells installed in the deepest slimes sections of the tailings (MW-103 to -105, Section 3.3.2) numerous well-points to assess lateral continuity of the tailings fluid surface (WP-1 to WP-12, Section 3.3.1), and observation well-points adjacent to the First Tres Hermanos wells (MW-106 to -109, Section 3.4.2).

The tailings fluid levels have continued to decline across the entire site, with several of the peripheral piezometers near the embankment drains going dry since reclamation. Trend plots for all the piezometers are presented in Appendix H, Tailings Piezometer Trend Plots. These plots appear to show two types of drainage. There is an overall drainage trend across the full areal extent of the pile, indicating that the tailings fluid is indeed draining into the subsurface at all the monitoring locations. There is also a significant drop in potentiometric level near the embankment drains, indicating localized preferential flow out the drains.

Figures 6.1.1.3.1 and 6.1.1.3.2 present the tailings fluid potentiometric surfaces for 1989 and 1996, respectively. These figures show the exaggerated influence of the horizontal drain arrays on tailings dewatering, with localized drawdowns greater than 20 feet in these areas.

89tlsfld.srf

INTERA A Duke Engineering & Services Company	1989 Tailings Fluid Potentiometric Surface	Figure 6.1.1.3.1



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INTERA	1996 Tailings Fluid Potentiometric Surface	Figure 6.1.1.3.2

This drainage seems to be continuing. Table 6.1.1.3.1 presents the results of recent fluid level monitoring surveys from all available tailings pile features in October 1995 and May 1996. With the exception of PZ-1, PZ-2, PZ-11, and MW-103, all fluid levels have experienced continued drawdown.

Table 6.1.1.3.1 Tailings Fluid Levels

Well-Point Number	Fluid Elevation 10/11/95	Fluid Elevation 5/14/96	Fluid Elevation Difference 10/95-5/96
WP-1A	Dry	Dry	
WP-1B	6190.68	6189.11	-1.57
WP-1C	Dry	Dry	
WP-2A	6185.91	6185.55	-0.36
WP-2B	6188.90	6186.96	-1.94
WP-2C	Dry	Dry	
WP-3A	6192.24	6190.40	-1.84
WP-3B	6192.34	6190.83	-1.51
WP-3C	6191.55	6190.80	-0.75
WP-4	6193.84	6190.86	-2.99
WP-5	6194.96	6191.35	-3.61
WP-6A	6187.12	6185.74	-1.38
WP-6B	Dry	Dry	
WP-7	6186.93	6184.96	-1.97
WP-8	6187.51	6185.90	-1.61
WP-9	6187.45	6185.94	-1.51
WP-10	6186.61	6185.16	-1.44
WP-11	6180.12	6179.85	-0.26
WP-12	6180.65	6180.23	-0.43
1995 Monitor Wells			
MW-103	6179.27	6179.43	0.16
MW-104	6186.74	6185.76	-0.98
MW-105	6183.45	6182.60	-0.85
Piezometers			
PZ-1	6167.68	6167.98	0.30
PZ-2	6170.13	6170.53	0.40

Well-Point Number	Fluid Elevation 10/11/95	Fluid Elevation 5/14/96	Fluid Elevation Difference 10/95-5/96
PZ-3	6181.90	6180.98	-0.92
PZ-4	6179.24	6178.91	-0.33
PZ-6	Dry	Dry	
PZ-7	6185.44	6184.23	-1.21
PZ-8	6186.23	6185.74	-0.49
PZ-9	6190.07	6188.52	-1.55
PZ-10	6187.04	6186.48	-0.56
PZ-11	6173.19	6173.36	0.17
PZ-17	Dry	Dry	
PZ-19	Dry	Dry	

The three piezometers showing a fluid level increase are completed within the embankment along the west side of the tailings basin and within the area significantly influenced by the horizontal drains. It is likely that these small fluctuations are the result of uneven transient flow to the deeper drains. Monitor well MW-103 also showed an insignificant fluid level increase and is located in a deep section of slimes. The fluid level in this well is interpreted as having remained constant during this short monitoring period.

Existing Drain Performance

The performance of the existing drains can be used to evaluate the horizontal flow from the pile nearest the drains. The existing drains were designed to reduce the phreatic surface on the upstream side of the starter dam embankment, and performed acceptably (D'Appolonia, 1981). The perforated section of drains ranges from 90 feet to 220 feet in length and operation of the drains rapidly reduced the fluid levels in the tailings near the upstream face of the dam. An evaluation of drain performance is presented in Table 6.1.1.4.1 and 6.1.1.4.2 below.

Table 6.1.1.4.1 Total Perforated Drain Length

Station	Cumulative Drain Lengths	Total
5 + 00	220+190+170+180+220	980
8 + 00	210+160+160+160+190	880
11 + 00	130+160+150+160+180	780
14 + 00	170+140+140+140+110	700
Total North Drains		**3,340 LF Perf. Pipe**
17 + 00	180+160+160+150+180	830
20 + 00	170+175+140+150+150	785
23 + 00	250+240+220+220+90	1020
Total South Drains		**2,635 LF Perf. Pipe**

Table 6.1.1.4.2 Initial Discharge Trends

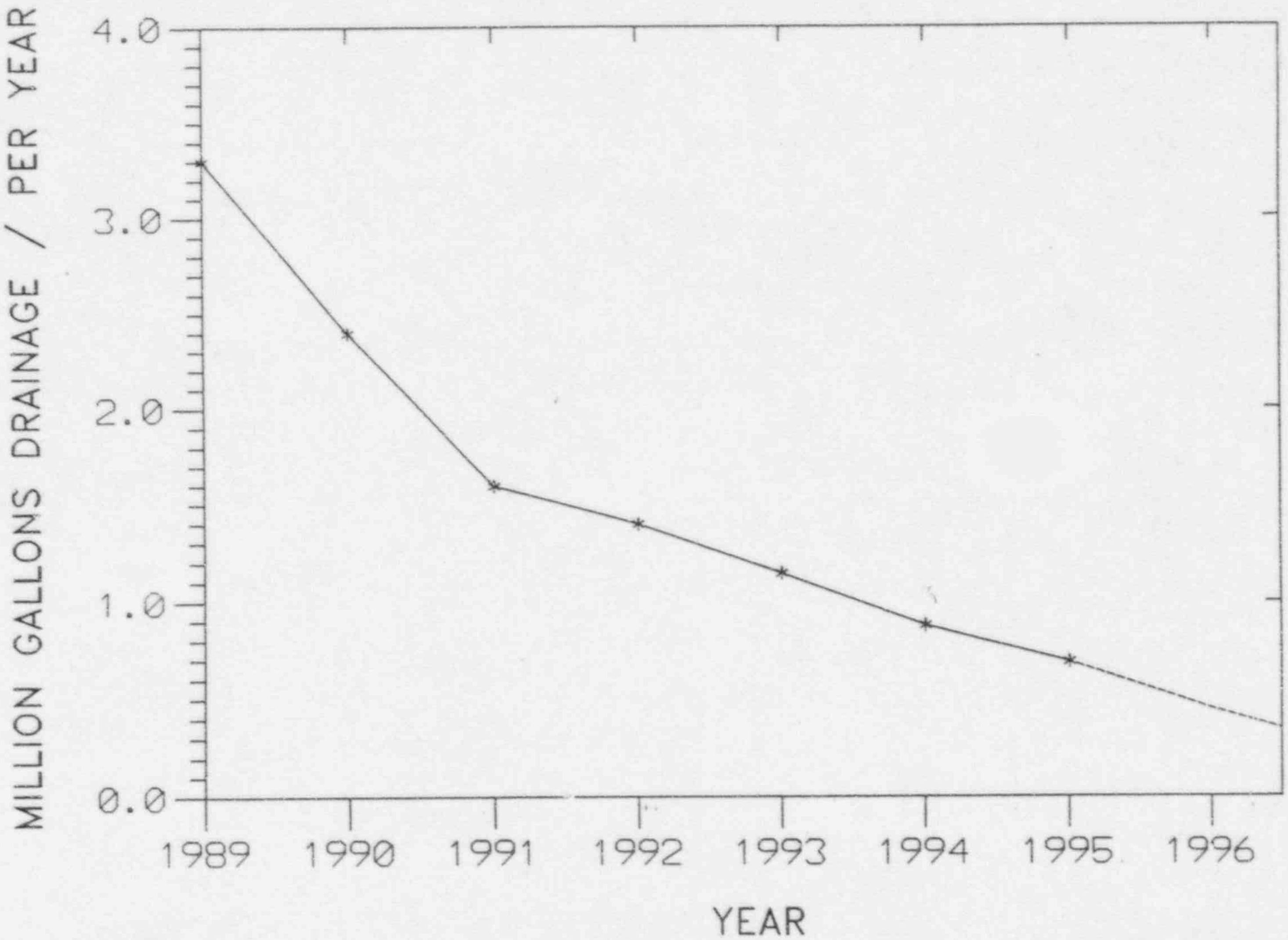
Date	Initial Flow
5/21/81	All drains installed
5/26/81 Flows	N = 29.8 gpm, S = 18 gpm
	Annualized = 25,123,680 gals/yr
Calculated unit flow on 5/26/81	**N = 8.9 x 10^{-3} gpm/ft., S = 6.8 x 10^{-3} gpm/ft**
Note: North array produced nearly twice as much stable flow: 29.8 gpm vs. 18 gpm	
6/28/81 Flows	N = 21.1 gpm, S = 12.5 gpm
	Annualized = 17,660,160 gals/yr
Calculated Unit Flow on 6/28/81	**N = 6.3 x 10^{-3} gpm/ft, S = 4.7 x 10^{-3} gpm/ft**

The drains have been in operation since 1981, and fluid disposal in the pond ceased in 1986. No record of horizontal drain flow is available for 1981 through 1989.

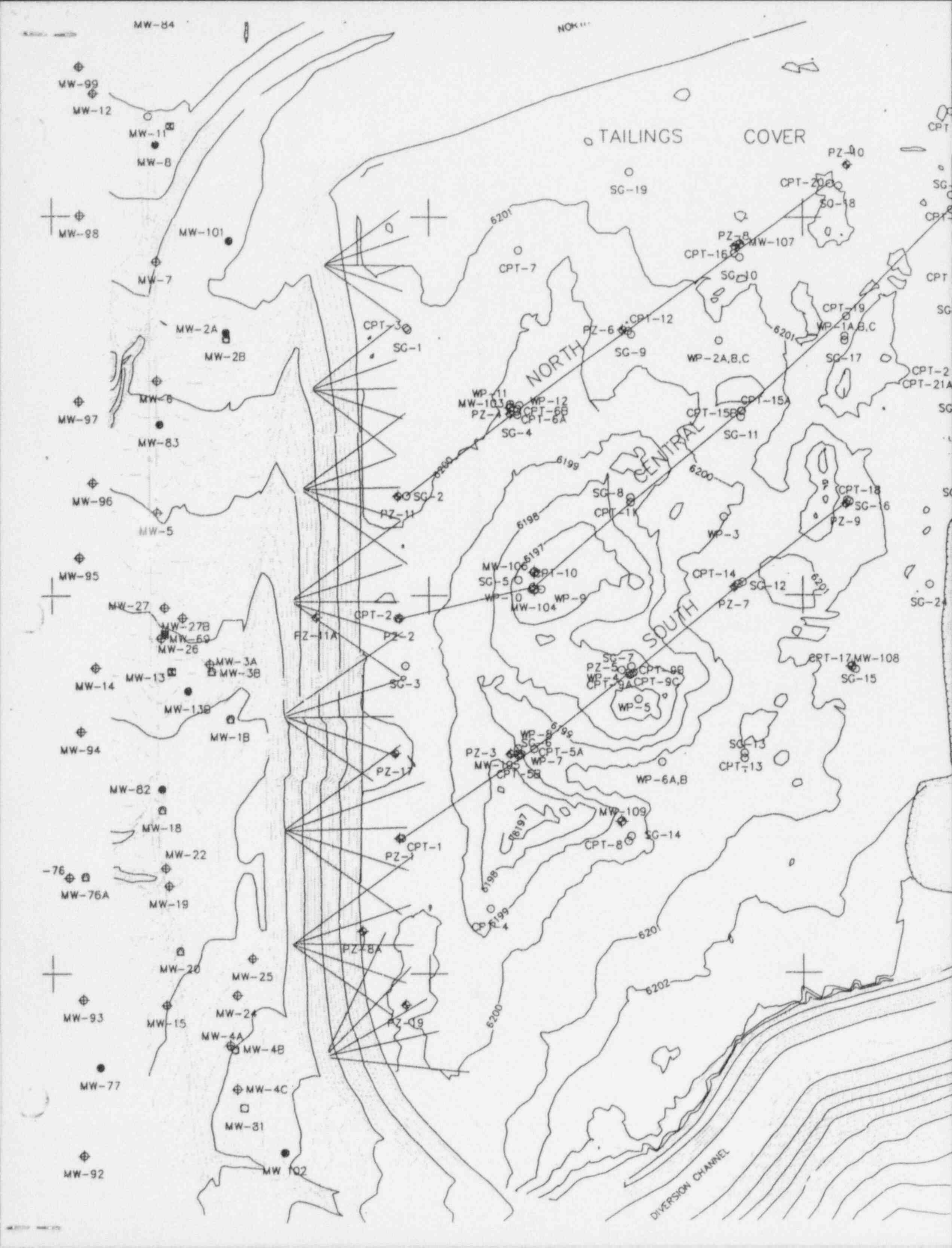
The drains were closed during the reclamation work in 1988, reopened in 1989, and records of flow have been kept since that time, as shown on Figure 6.1.1.4.1, Tailings Fluid Drainage from Toe Drains. We can see from the shape of the curve that drain flow performance is substantially reducing with time. In fact, the initial higher flows may have resulted from accumulation of fluid

near the drains while they were shut off, or may have been a reflection of consolidation from the surcharge of waste ore, windblown materials, and clay cover during the reclamation. It is likely that these initial flows represent some influence by both factors. The drains are not presently contributing a major portion of the tailings dewatering.

As discussed in the D'Appolonia report, the predominant materials on the upstream side of the embankment are primarily sands. This is also supported by the results of the recent CPT investigation. We assume that these sands are the most easily drained soil type in the tailings pile, and that the percentage of predominantly-sand decreases with distance away from the embankment. The locations of the cross sections are shown on Figure 6.1.1.4.2, and the tailings fluid levels are depicted on Figures 6.1.1.4.3, 6.1.1.4.4, and 6.1.1.4.5, the north, central, and south piezometer line cross sections, respectively. The central cross section contains the most detailed information about fluid levels and has been drawn to scale with a 10:1 vertical exaggeration including the previous starter dam configuration and approximate spatial relationship to the nearest horizontal drain. As shown on this figure, over 17 feet of hydraulic head difference was observed between MW-104 and PZ-2, with a lateral separation of only 350 feet. The lateral radius influence distance of the drains appears to lie between these two features, but we were unable to determine the exact distance. It is apparent that the fluid levels at MW-104 and upstream in the basin are not influenced by the horizontal drains. However continued widespread drawdown in the upper reaches of the basin seem to indicate significant vertical downward migration of tailings fluid, as discussed in Section 6.2.



INTERA | Tailings Fluid Drainage from Horizontal Drains | Figure 6.1.1.4.1



TAILINGS COVER
NORTH
CENTRAL
SOUTH
DIVERSION CHANNEL
MW-84
MW-99
MW-12
MW-11
MW-8
MW-98
MW-101
MW-7
MW-2A
MW-2B
MW-6
MW-97
MW-83
MW-96
MW-5
MW-95
MW-27
MW-27B
MW-69
MW-26
MW-3A
MW-3B
MW-14
MW-13
MW-13B
MW-1B
MW-94
MW-82
MW-18
MW-22
MW-76A
MW-19
MW-20
MW-25
MW-93
MW-15
MW-24
MW-4A
MW-4B
MW-4C
MW-77
MW-81
MW-92
MW 102
PZ-10
CPT-20
SG-18
SG-19
PZ-8
MW-107
CPT-16
SG-10
CPT-7
CPT-3
SG-1
PZ-6
CPT-12
SG-9
WP-2A,B,C
CPT-19
WP-1A,B,C
SG-17
WP-11
MW-103
WP-12
CPT-6B
PZ-4
CPT-6A
SG-4
CPT-15B
CPT-15A
SG-11
SG-2
PZ-11
SG-8
CPT-11
CPT-18
SG-16
PZ-9
WP-3
MW-106
CPT-10
SG-5
WP-10
WP-9
MW-104
CPT-14
SG-12
PZ-7
CPT-2
PZ-2
PZ-11A
SG-3
SG-7
PZ-5
WP-4
CPT-9A
CPT-9B
CPT-9C
WP-5
CPT-17
MW-108
SG-15
PZ-17
WP-8
SG-6
PZ-3
CPT-5A
MW-105
WP-7
CPT-5B
SG-13
CPT-13
WP-6A,B
MW-109
SG-14
CPT-8
CPT-1
PZ-1
CPT-4
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SG-24
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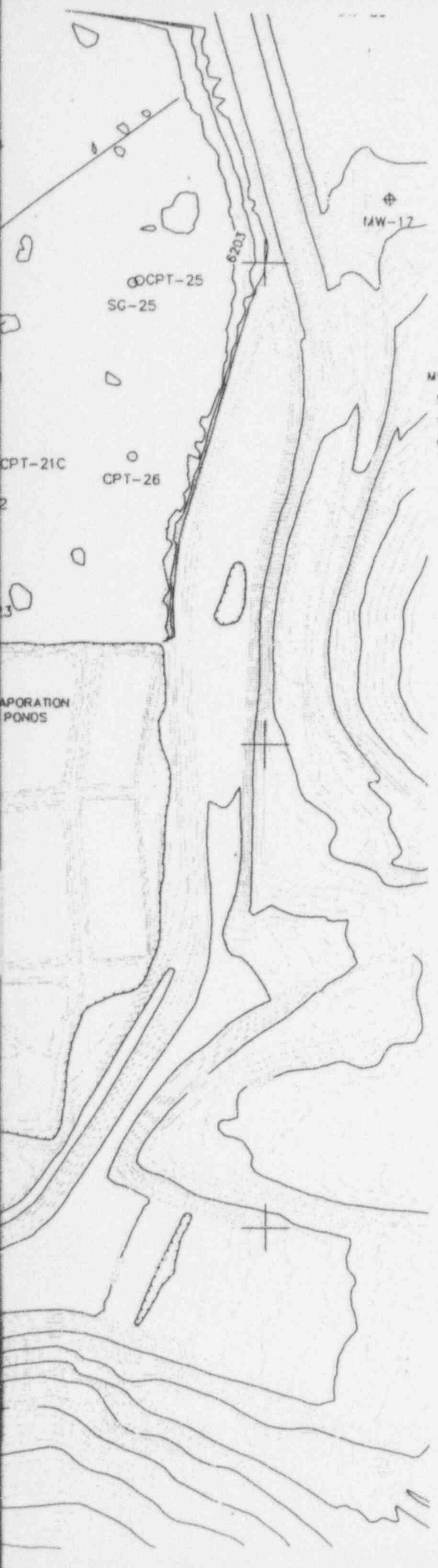


LEGEND

CURRENT ACTIVITIES

- MW-104 ◈ MONITOR WELL INSTALLATION
- SS-13 ○ COVER SOIL SAMPLE
- WP-1 ○ WELL POINT LOCATION
- CPT-4 ○ PIEZOCONE PROBE LOCATION
- ◈ 1996 FIRST TRES HERMANOS WELLS

PREVIOUSLY EXISTING FEATURES

- ⊕ MONITORING WELL
- ◈ PIEZOMETER
- ○ SETTLEMENT GAUGE
- □ POINT-OF-COMPLIANCE WELL
- ● PUMPING WELL
- ▣ ALLUVIUM MONITORING WELL (SHALLOW)
- ▣ 2nd TRES HERMANOS MONITORING WELL (DEEP)
- PERIMETER FENCE
- EXISTING HORIZONTAL DRAINS (1981)

NOTE: 1 FOOT TOPOGRAPHIC CONTOUR INTERVAL SHOWN ON TAILINGS COVER.

Piezometer Cross Section Locations

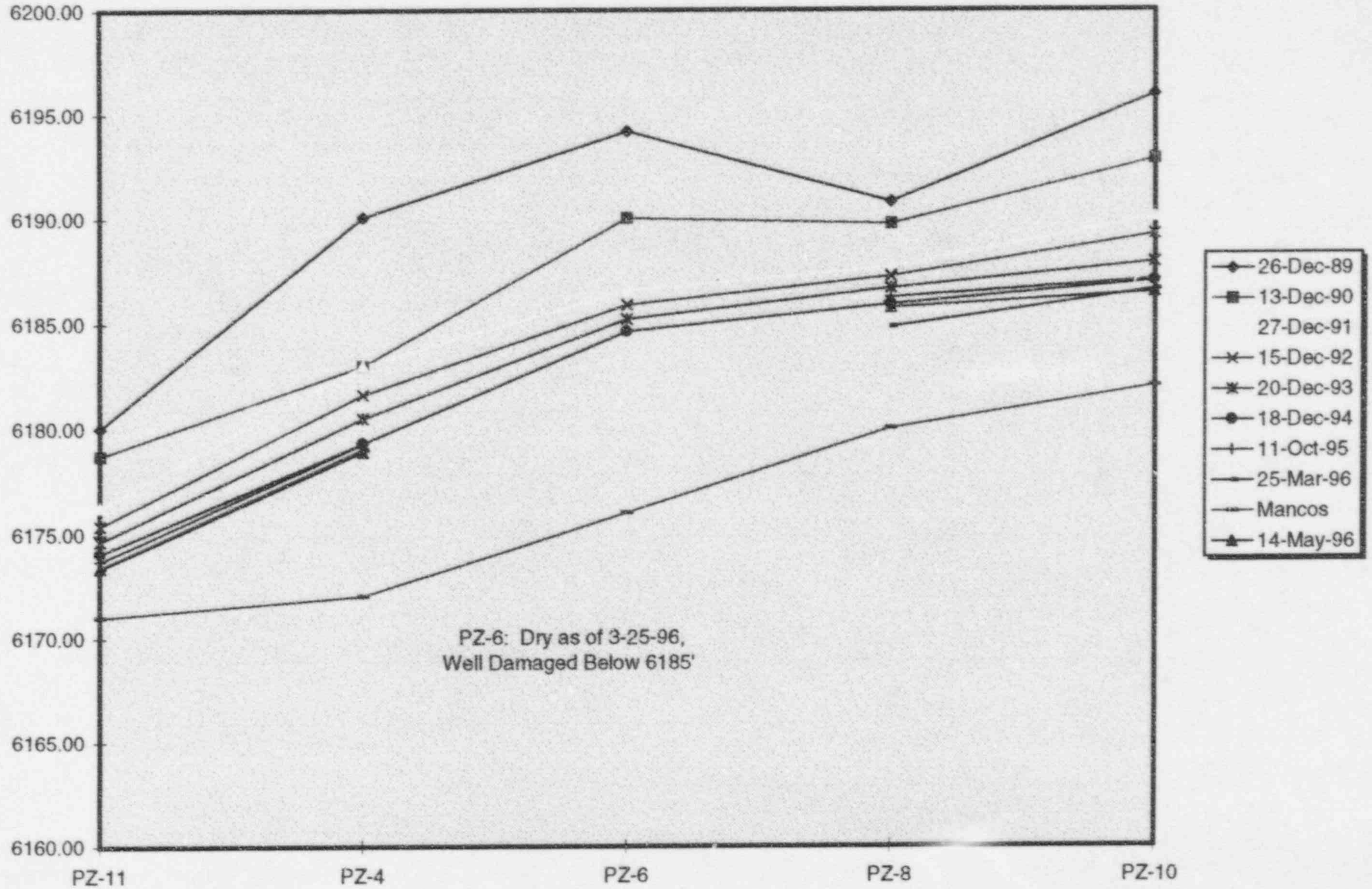
L-BAR RECLAMATION

INTERA

Date:	10/20/95
Project No.	1060-012
Revision No:	0
Checked By:	Kelly Tilford

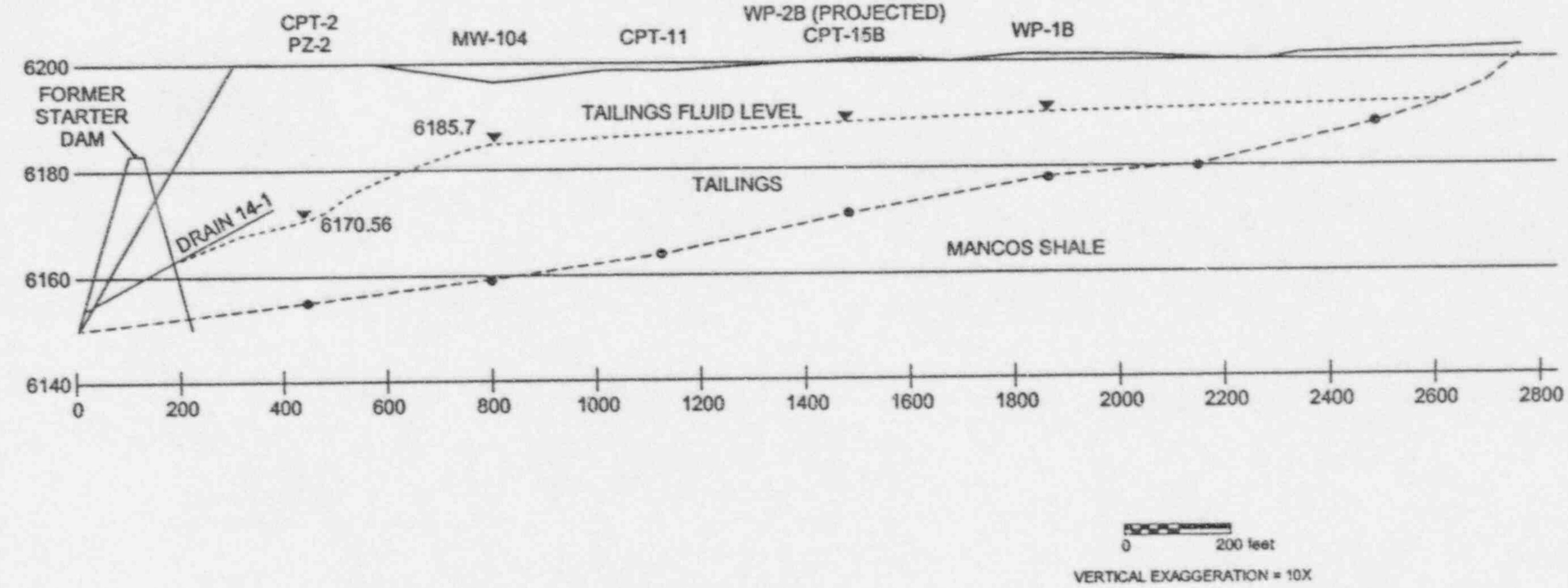
Figure 6.1.1.4.2

9611140304-03



npzline.xls

Figure 6.1.1.4.3
North Piezometer Line Cross Section



DATE: 8/4/96
REF: 1060-012
FILE: XS.xar
INTERA

CENTRAL PIEZOMETER CROSS SECTION

L-BAR RECLAMATION

Figure 6.1.1.4.4

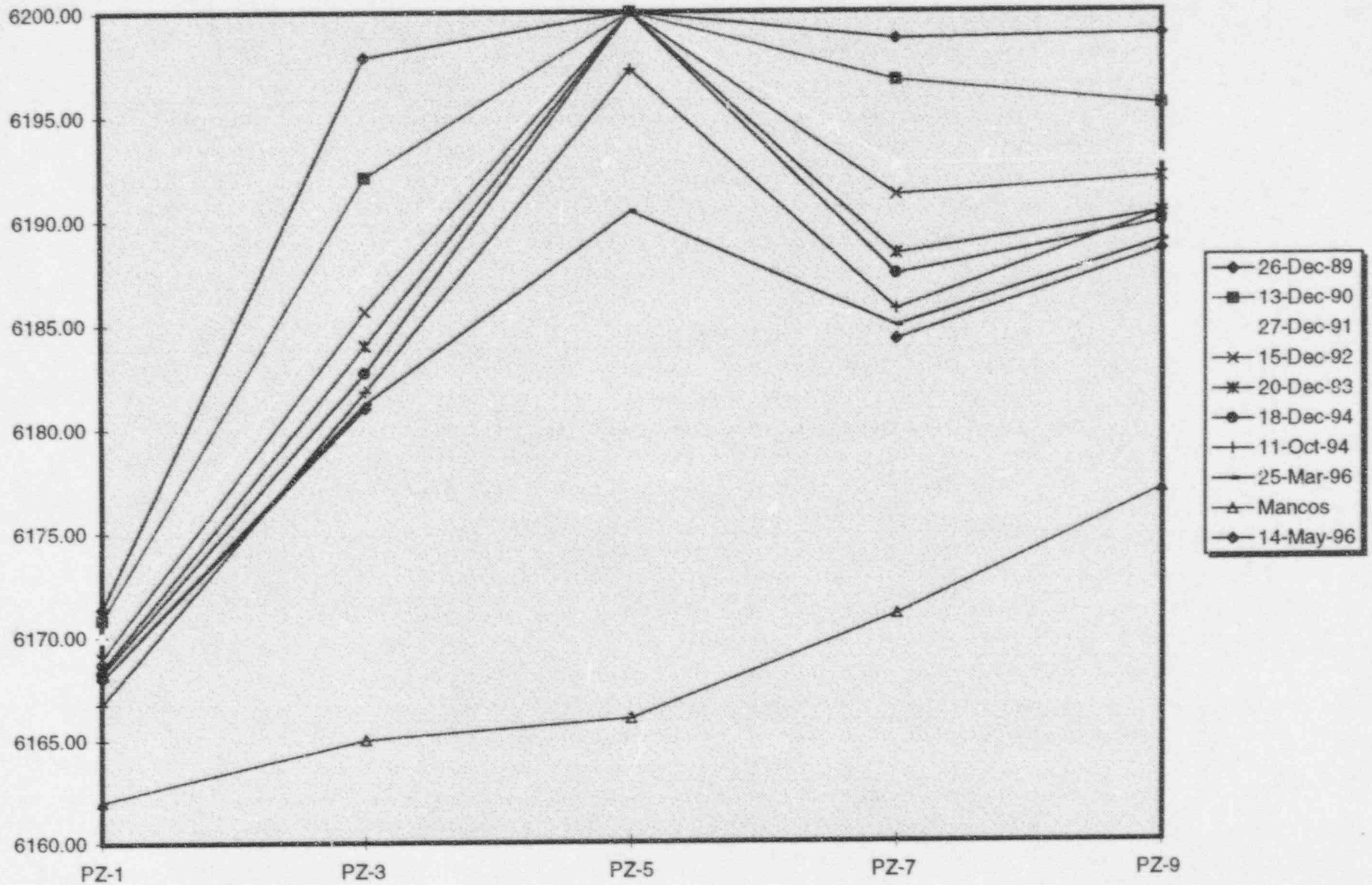


Figure 6.1.1.4.5
South Piezometer Cross Section

spzline.xls

OVERSIZE
DOCUMENT
PAGE(S) PULLED

SEE APERTURE CARD FILES

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05

APPENDIX B

- CPT-01
- CPT-02
- CPT-03B
- CPT-05
- CPT-5B
- CPT-06
- CPT-06B
- CPT-07
- CPT-08
- CPT-09
- CPT-09B
- CPT-09C
- CPT-10
- CPT-11
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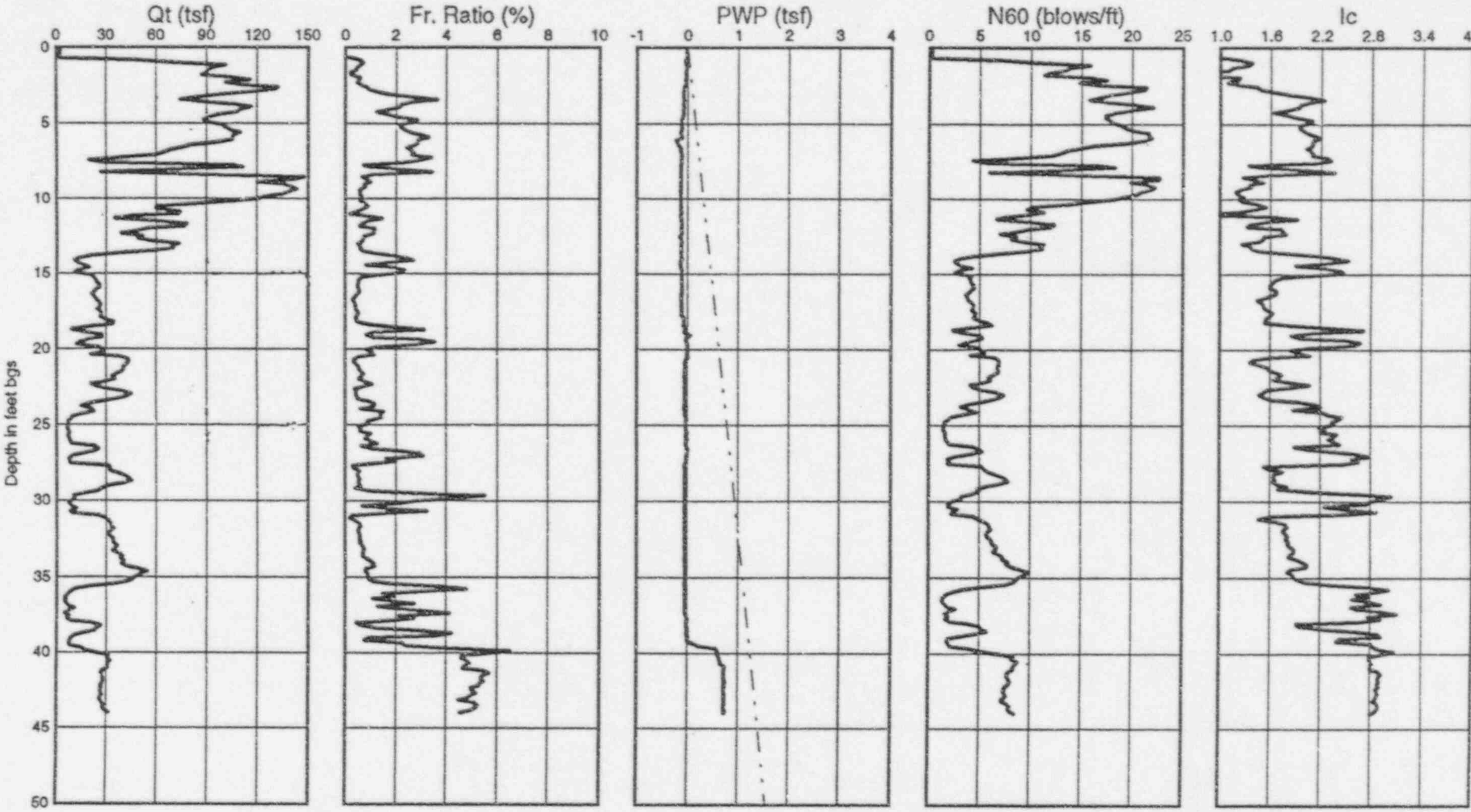
- CPT-20B
- CPT-21
- CPT-21B
- CPT-21C
- CPT-22
- CPT-23
- CPT-24
- CPT-25
- CPT-26

Cone Penetration Test - CPT-01

Test Date : Sep 12, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

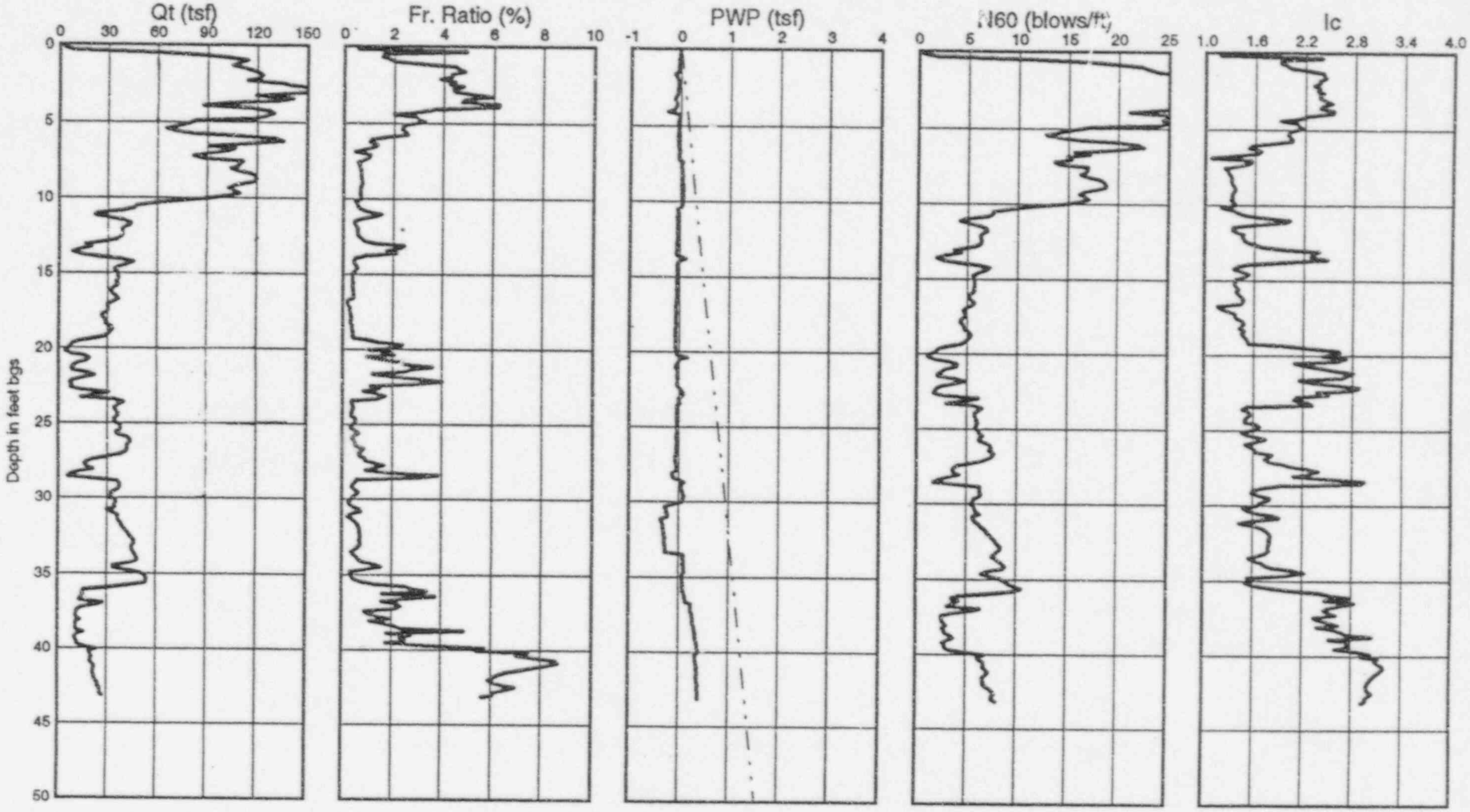
INTERA Inc.

Cone Penetration Test - CPT-02

Test Date : Sep 12, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Fr/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: S[illegible]mber 23, 1995 DRAWN BY: Keith Brown

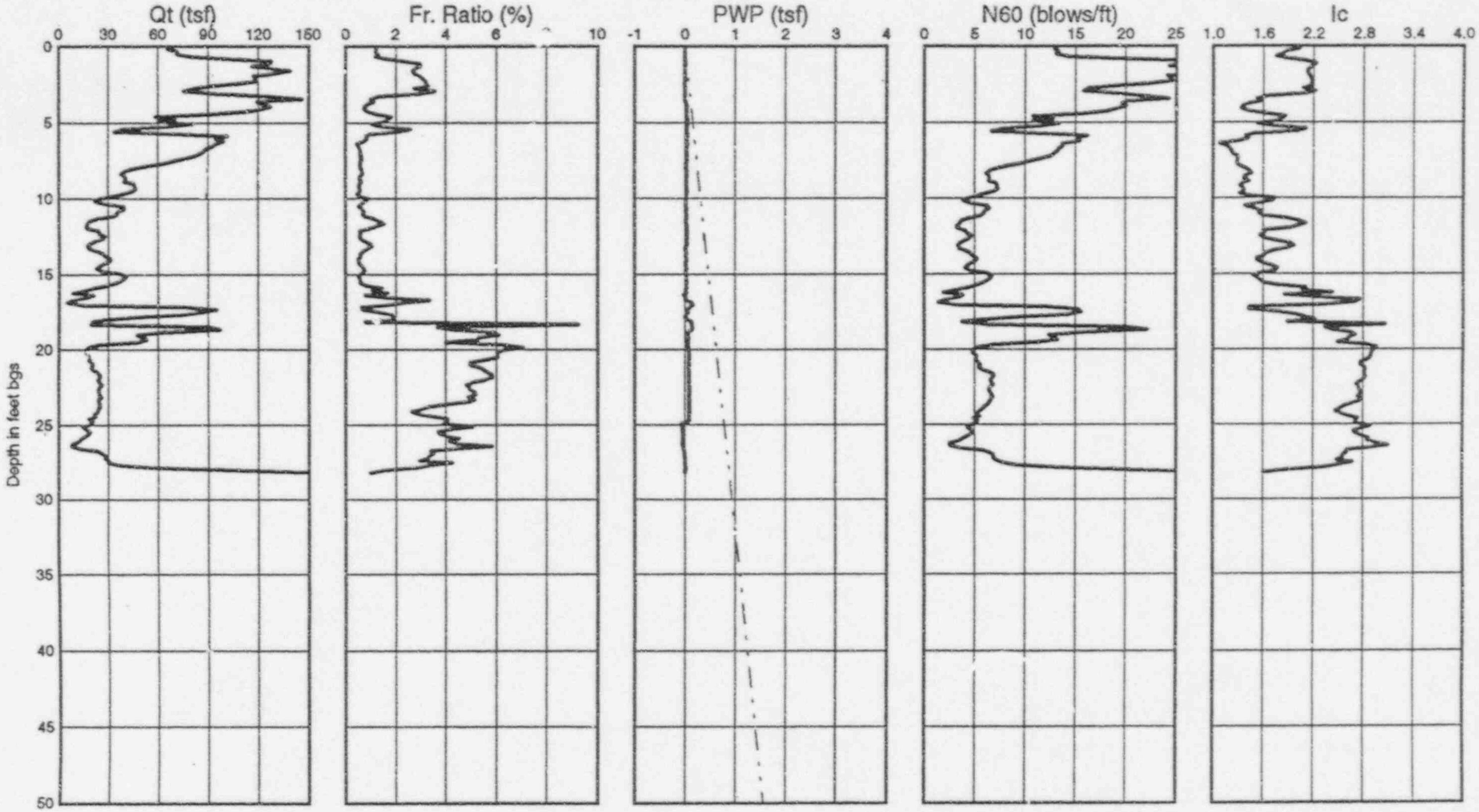
INTERA Inc.

Cone Penetration Test - CPT-03B

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

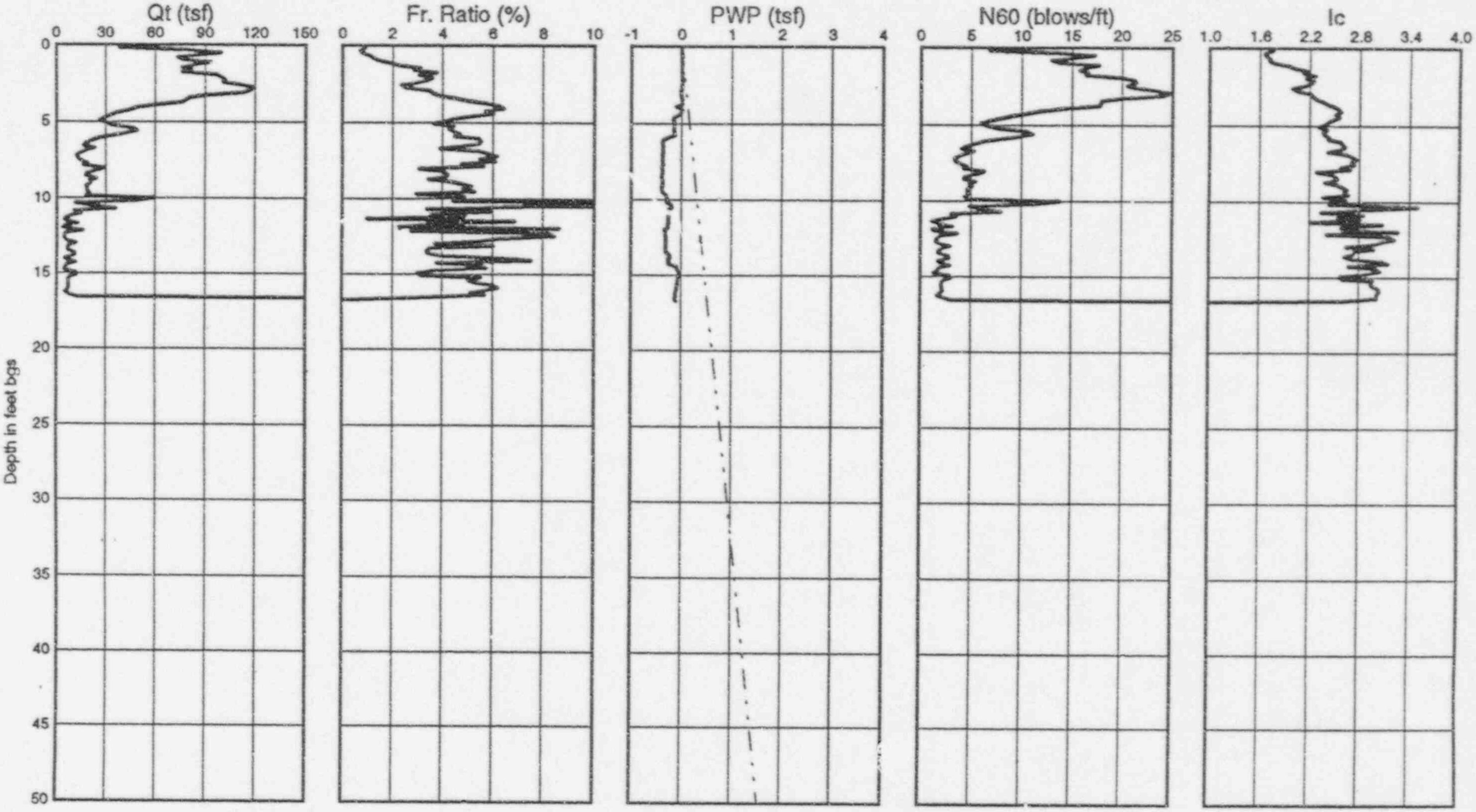
INTERA Inc.

Cone Penetration Test - CPT-05

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Q-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

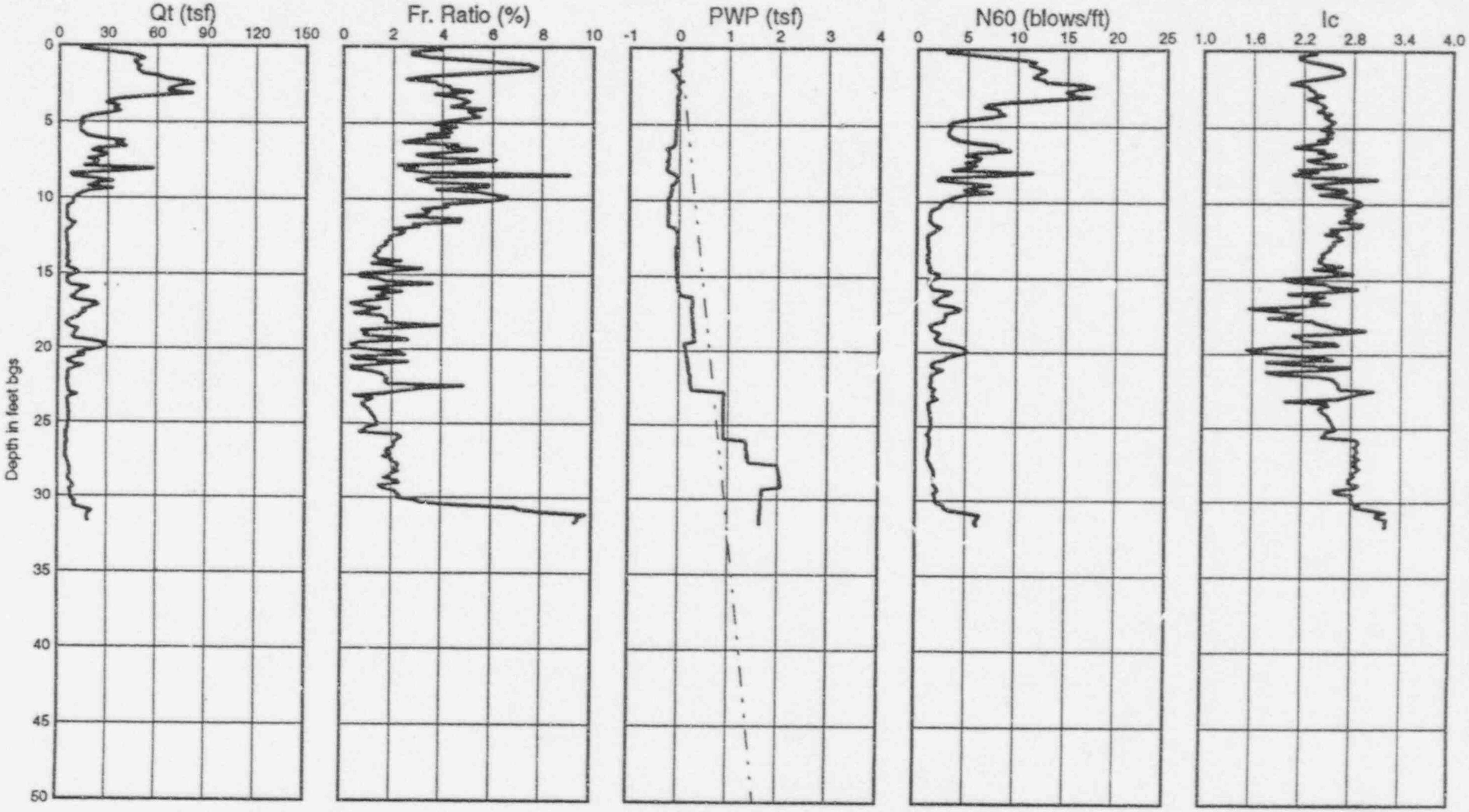
INTERA Inc.

Cone Penetration Test - CPT-5B

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

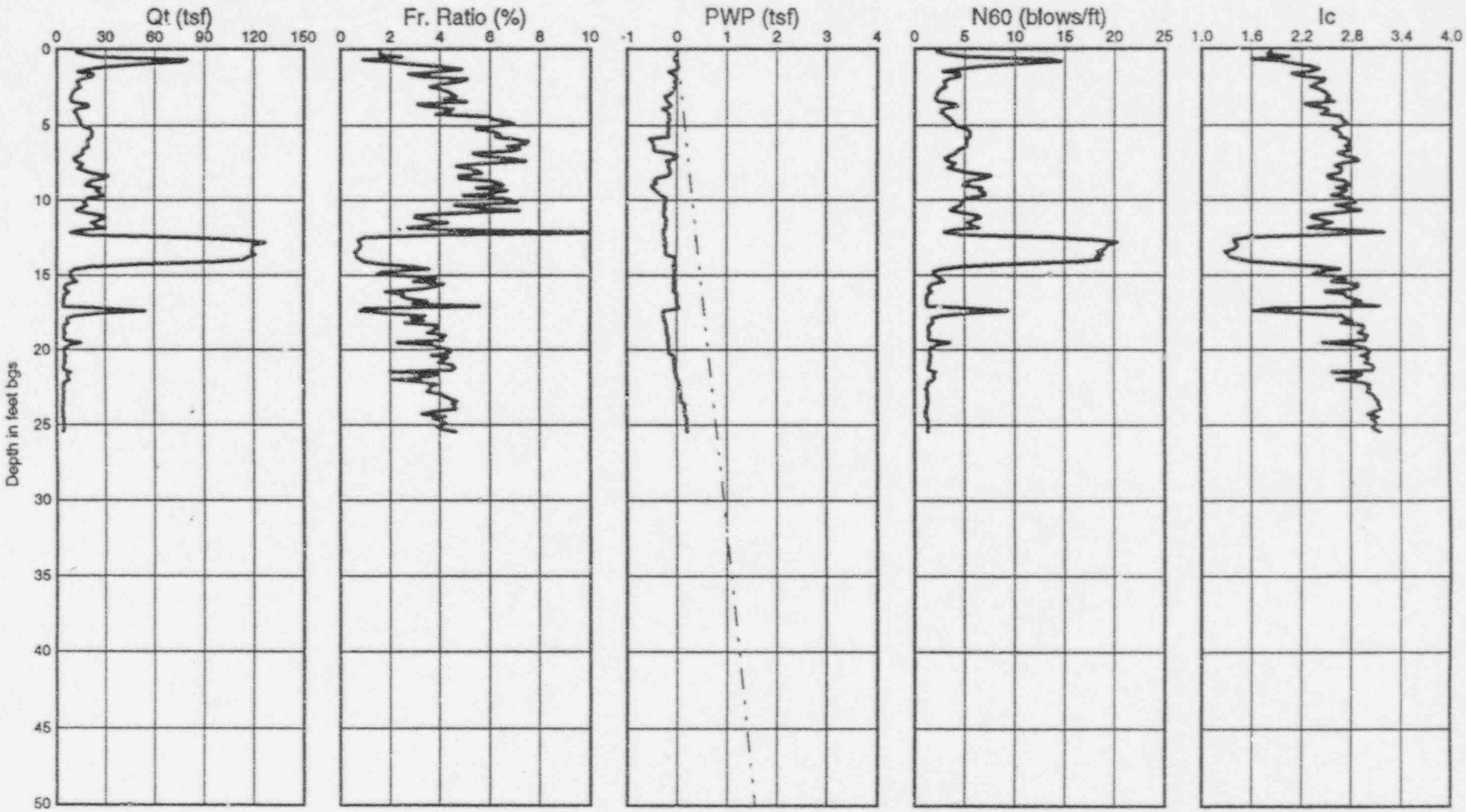
INTERA Inc.

Cone Penetration Test - CPT-06

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

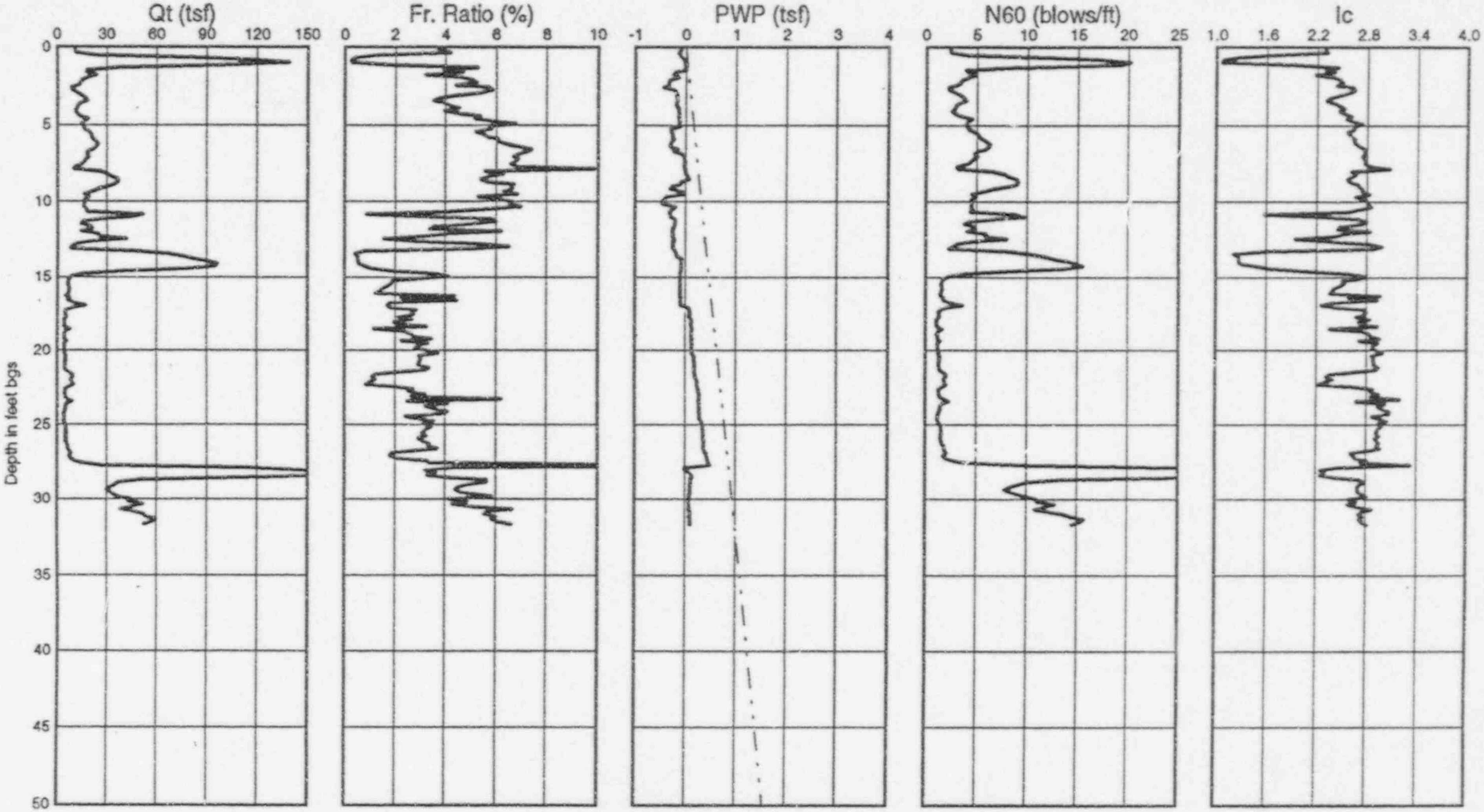
INTERA Inc.

Cone Penetration Test - CPT-06B

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Fs/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

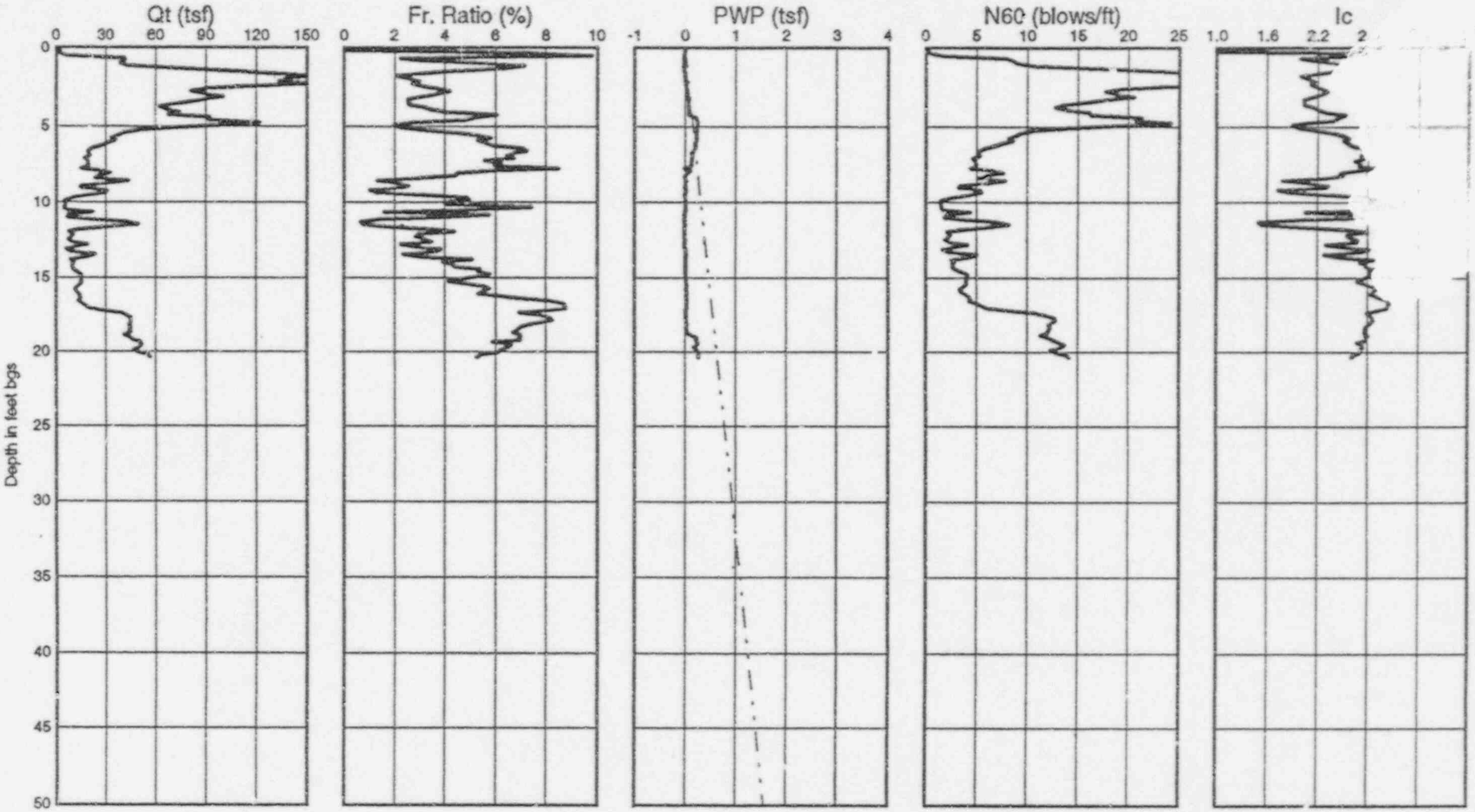
INTERA Inc.

Cone Penetration Test - CPT-07

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

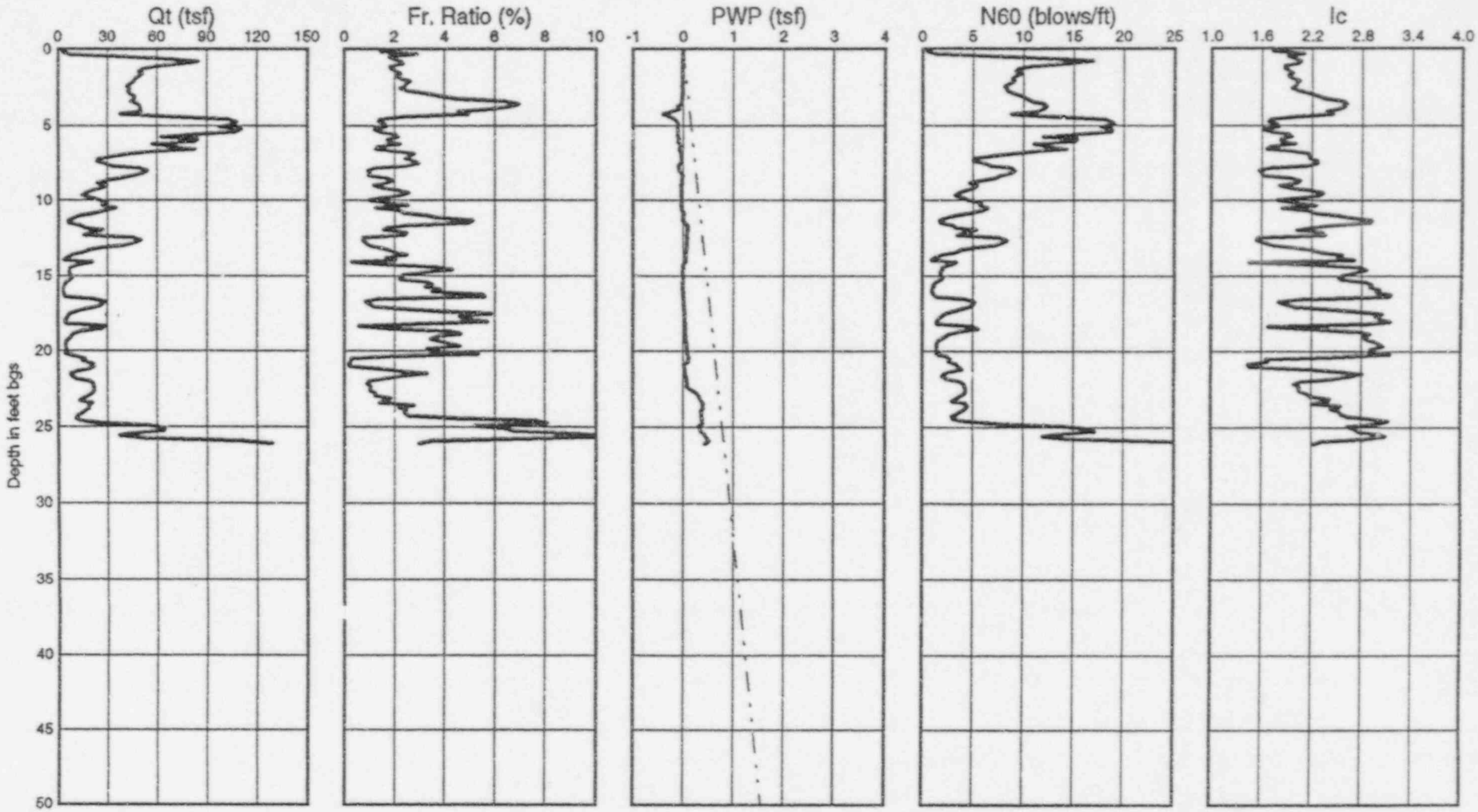
INTERA Inc.

Cone Penetration Test - CPT-08

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

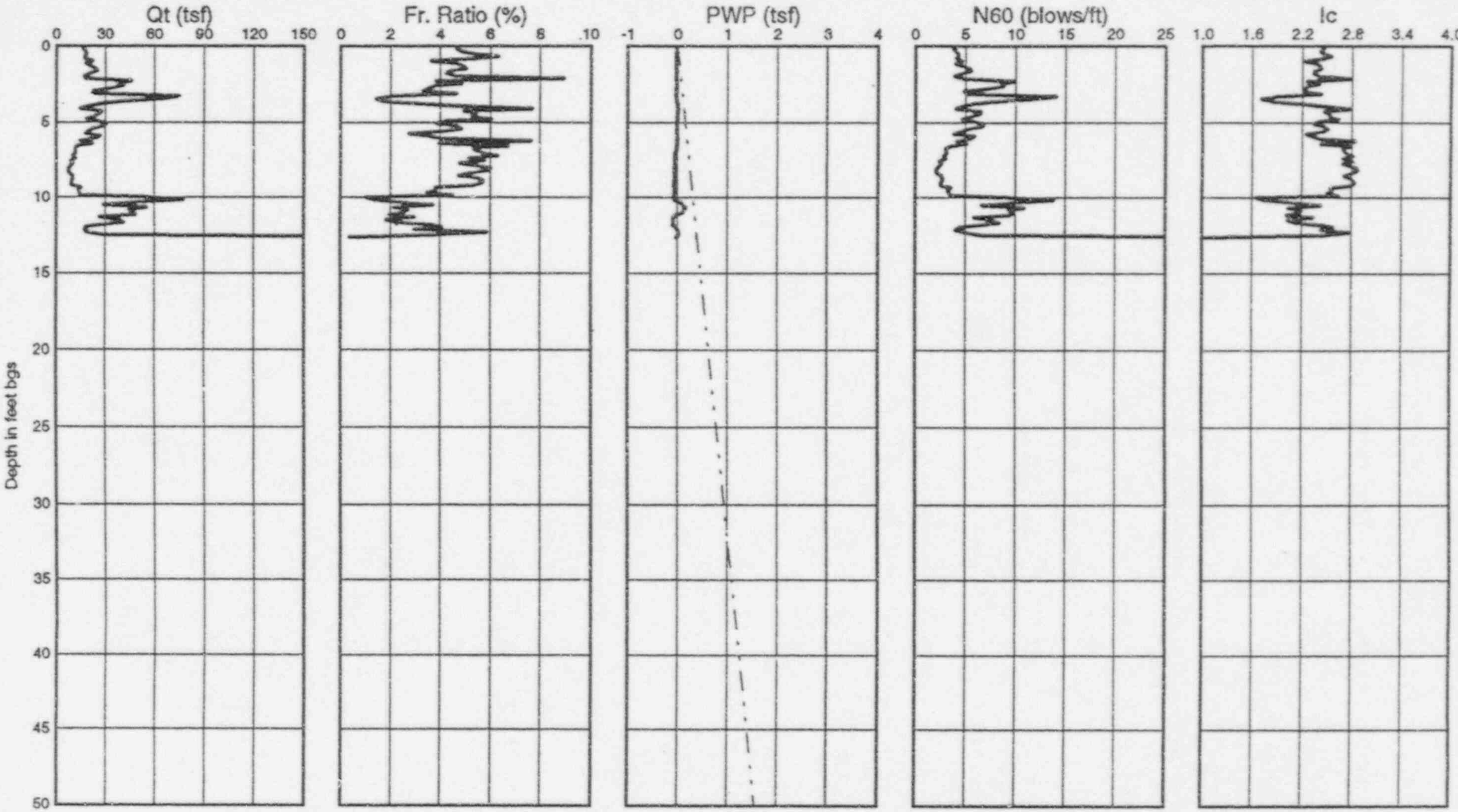
INTERA Inc.

Cone Penetration Test - CPT-09

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

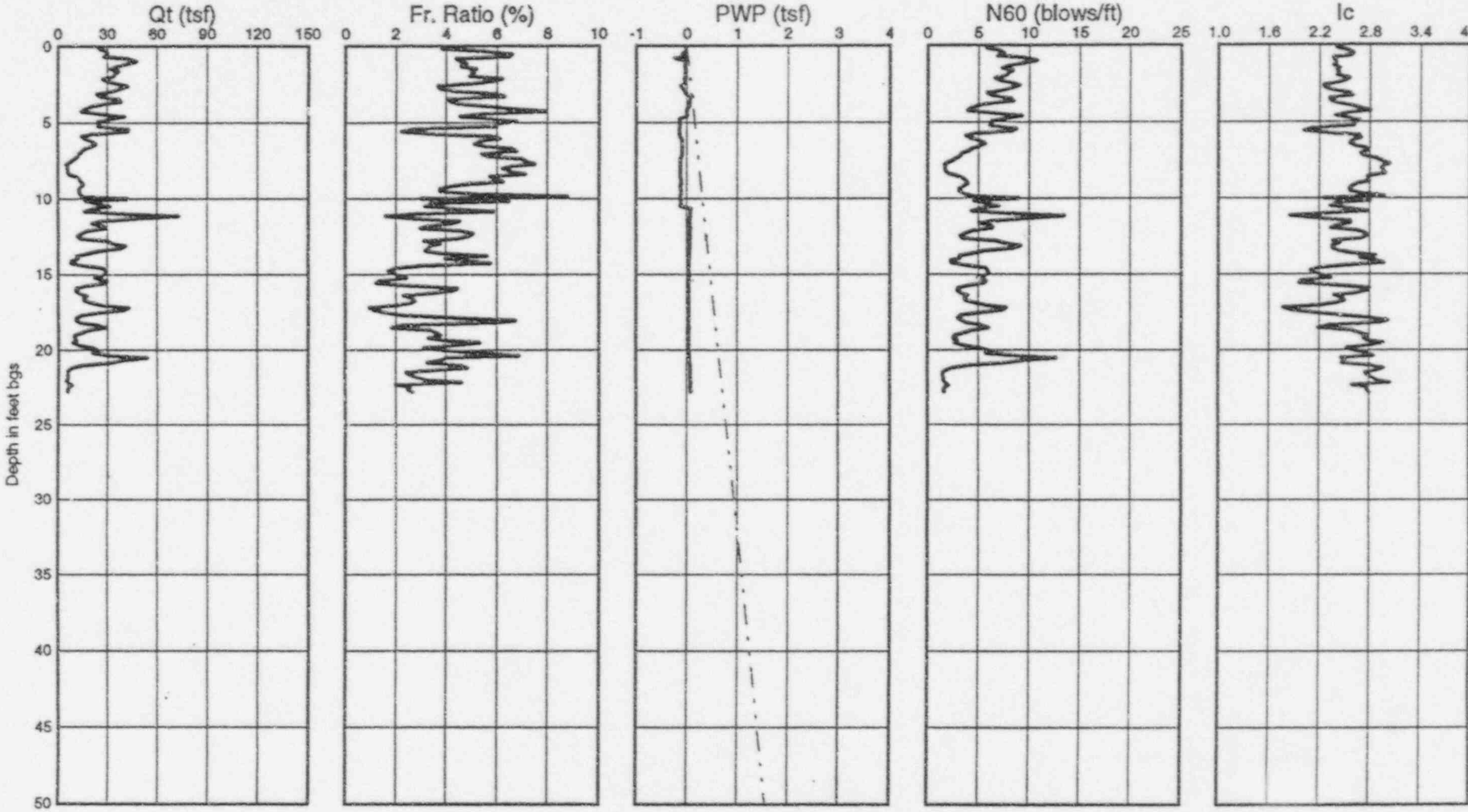
INTERA Inc.

Cone Penetration Test - CPT-09B

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Ff/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

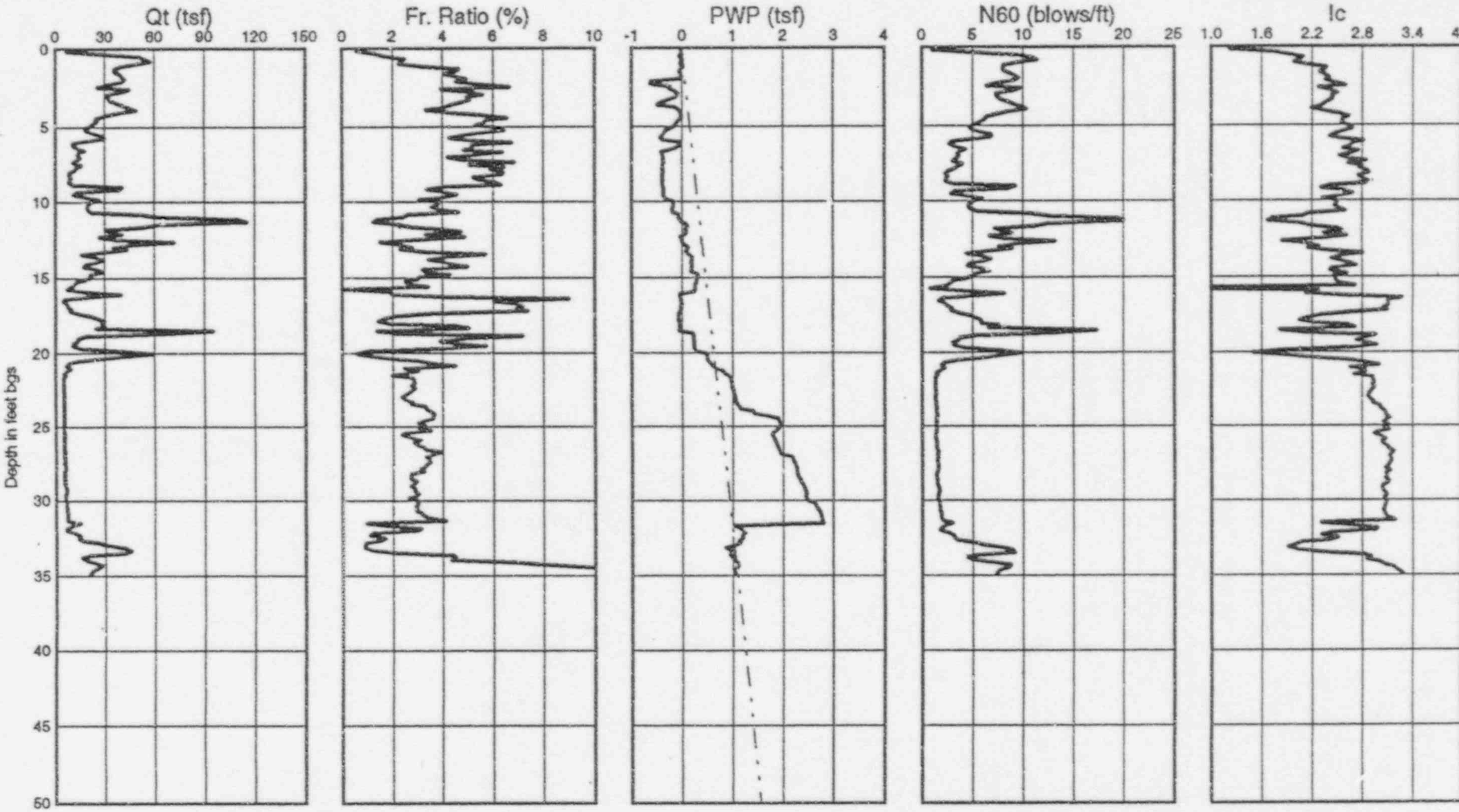
INTERA Inc.

Cone Penetration Test - CPT-09C

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012   DATE: September 23, 1995   DRAWN BY: Keith Brown

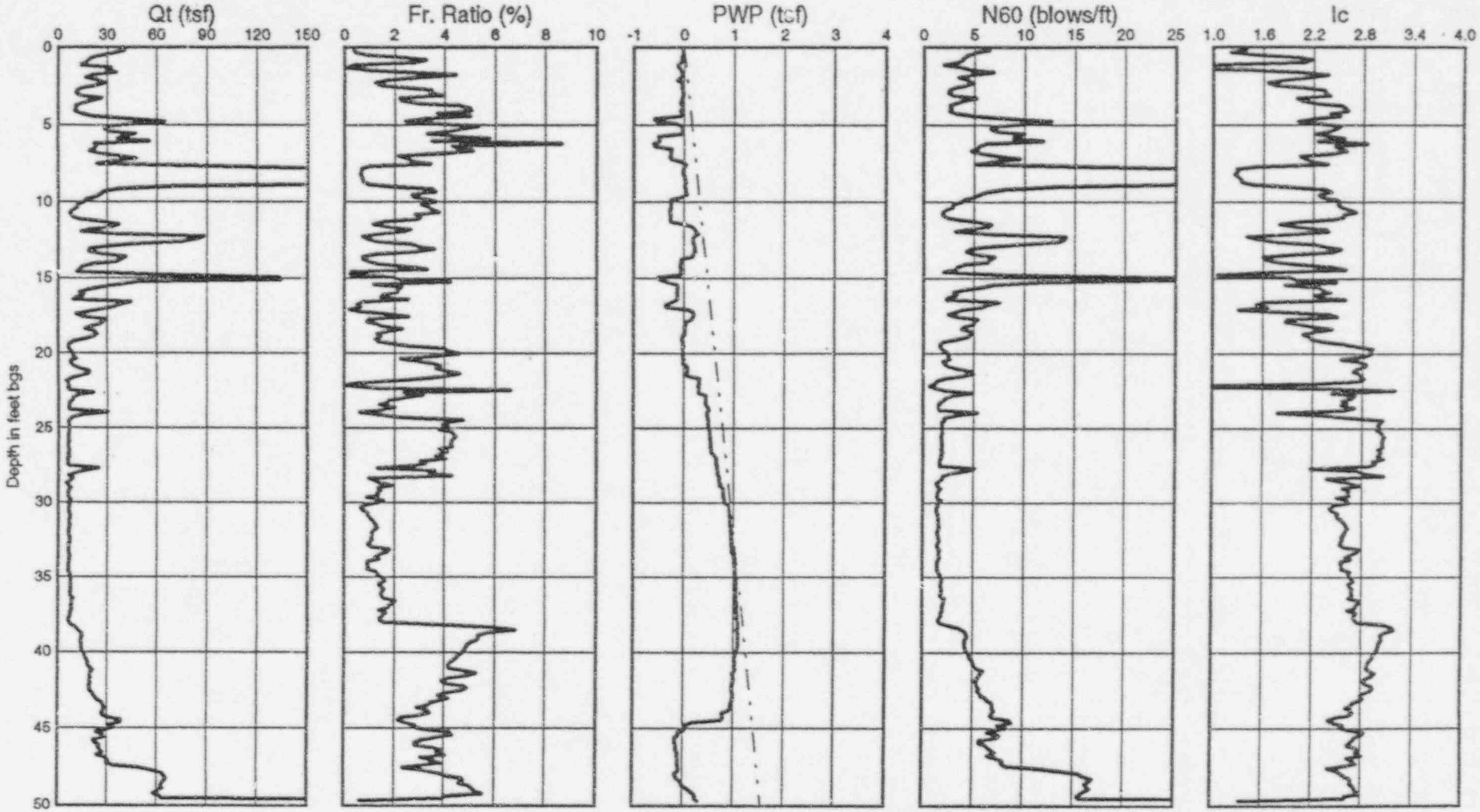
INTERA Inc.

Cone Penetration Test - CPT-10

Test Date : Sep 12, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

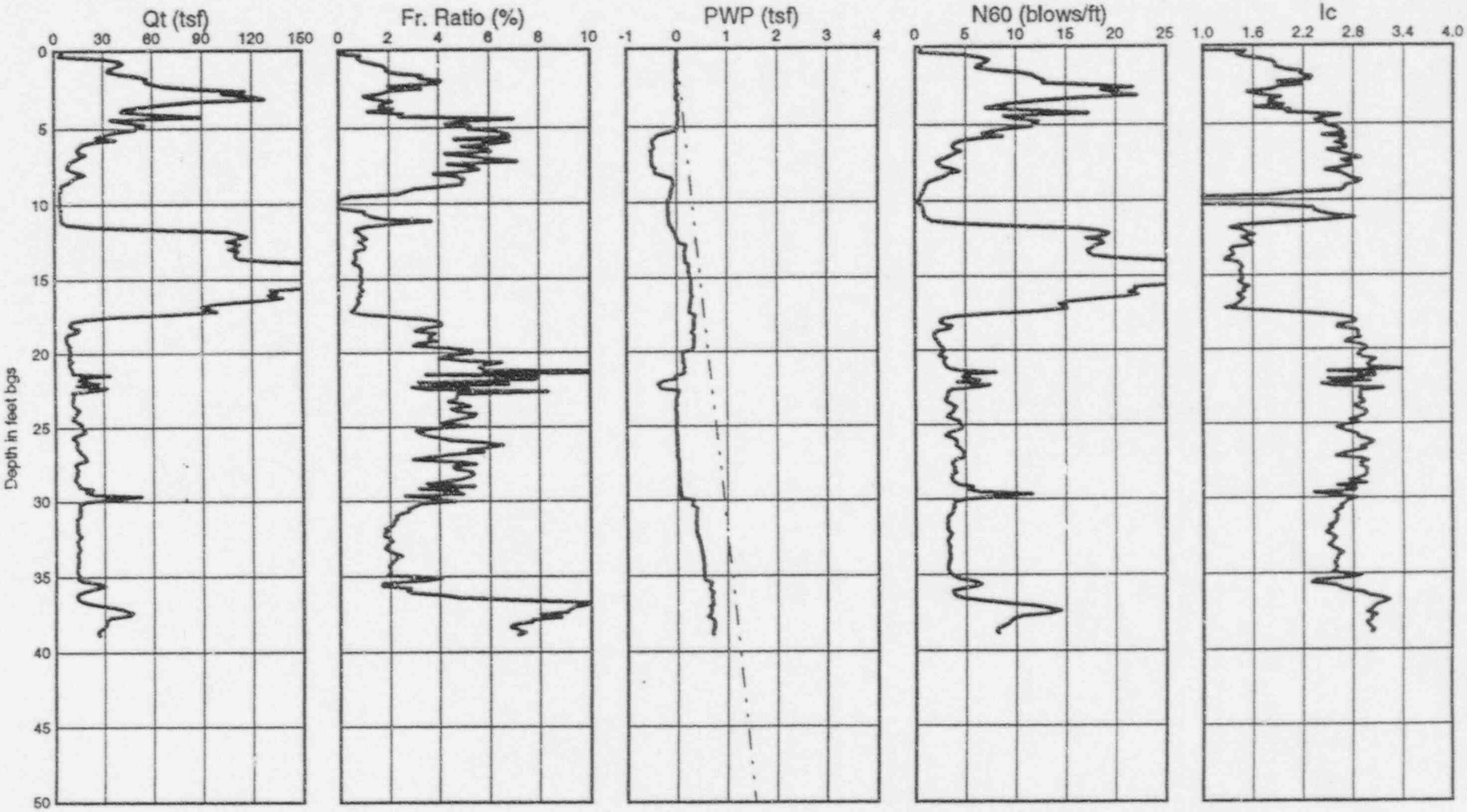
INTERA Inc.

Cone Penetration Test - CPT-11

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

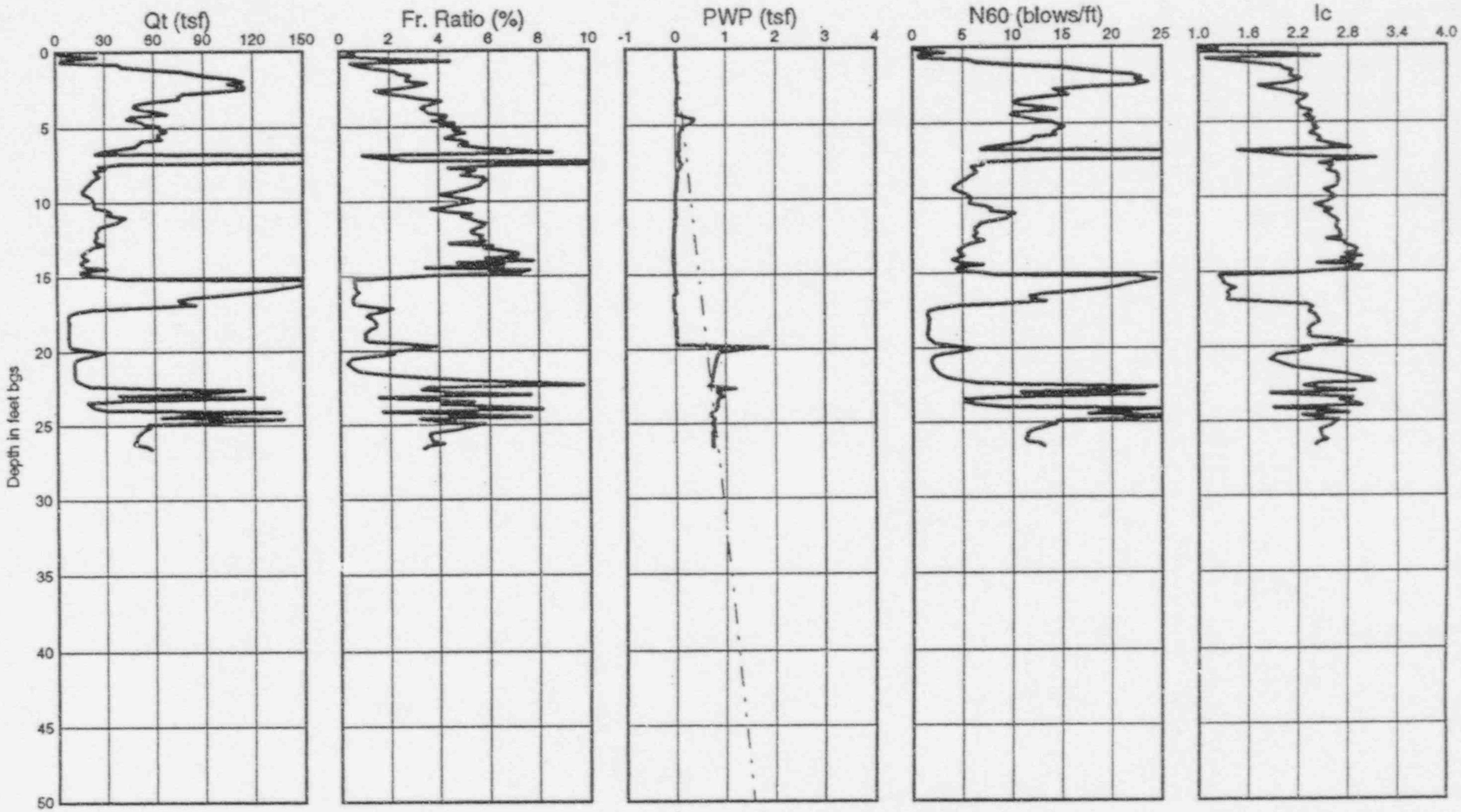
INTERA Inc.

Cone Penetration Test - CPT-12

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*Ff/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

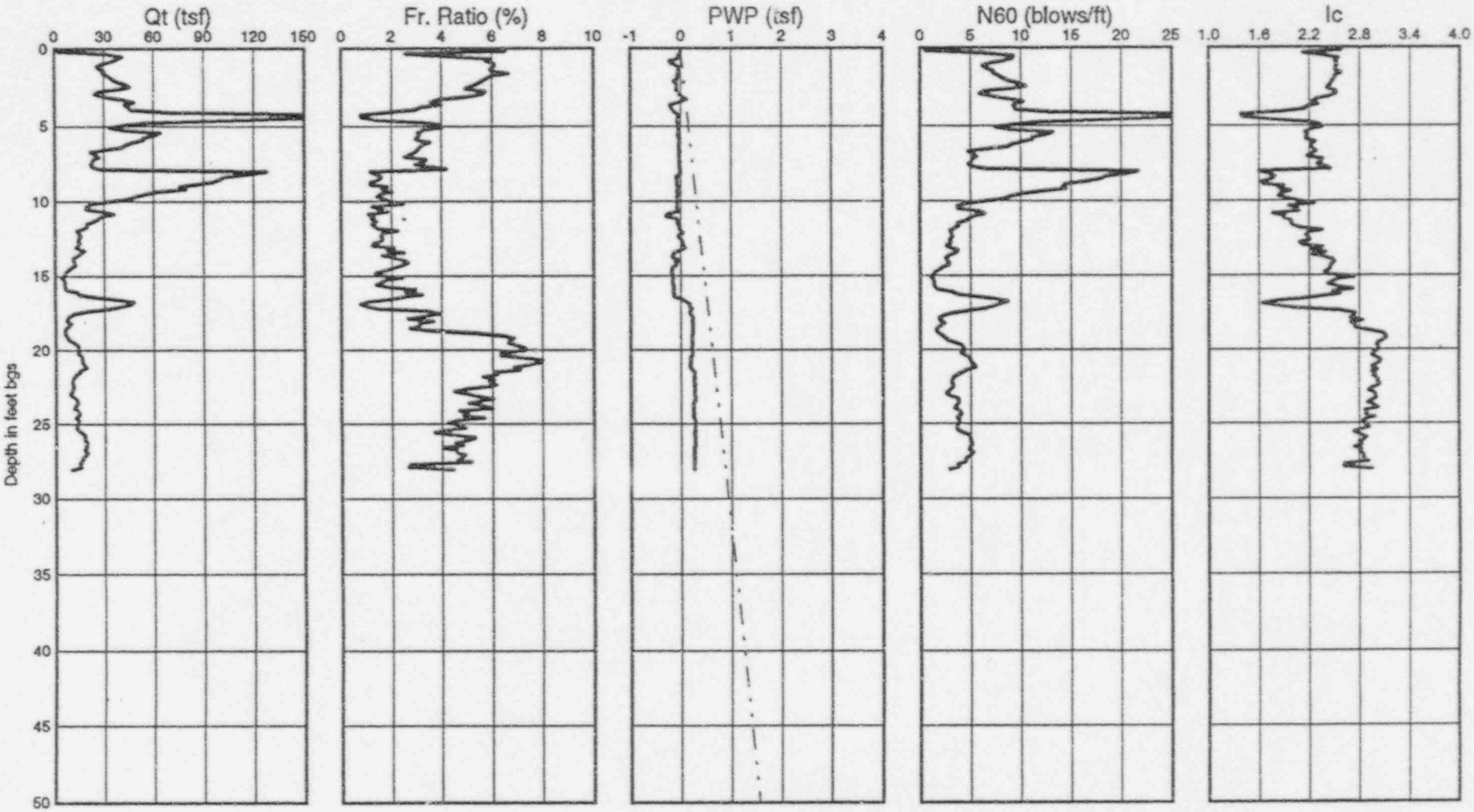
INTERA Inc.

Cone Penetration Test - CPT-13

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

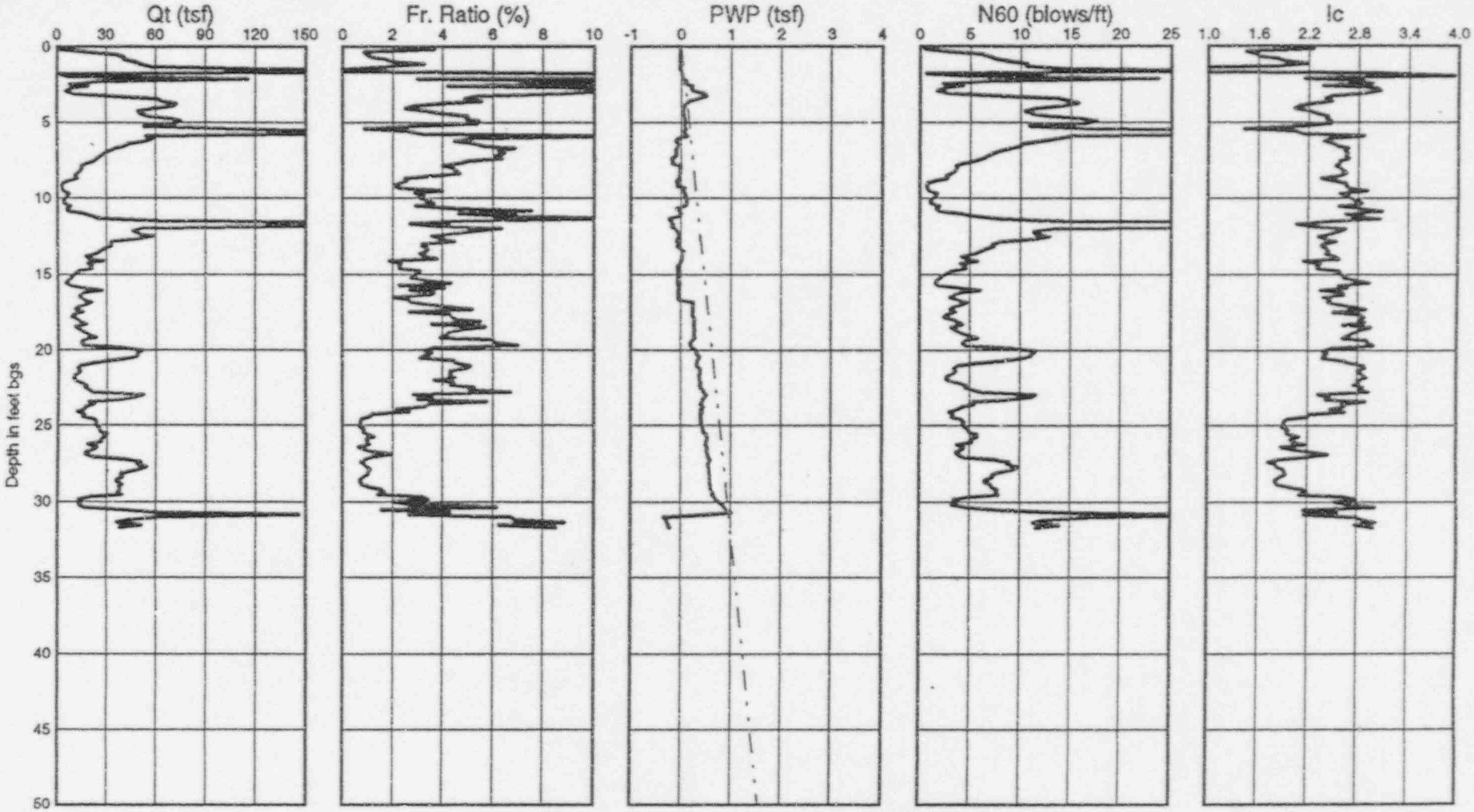
INTERA Inc.

Cone Penetration Test - CPT-14

Test Date : Sep 13, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Fs/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

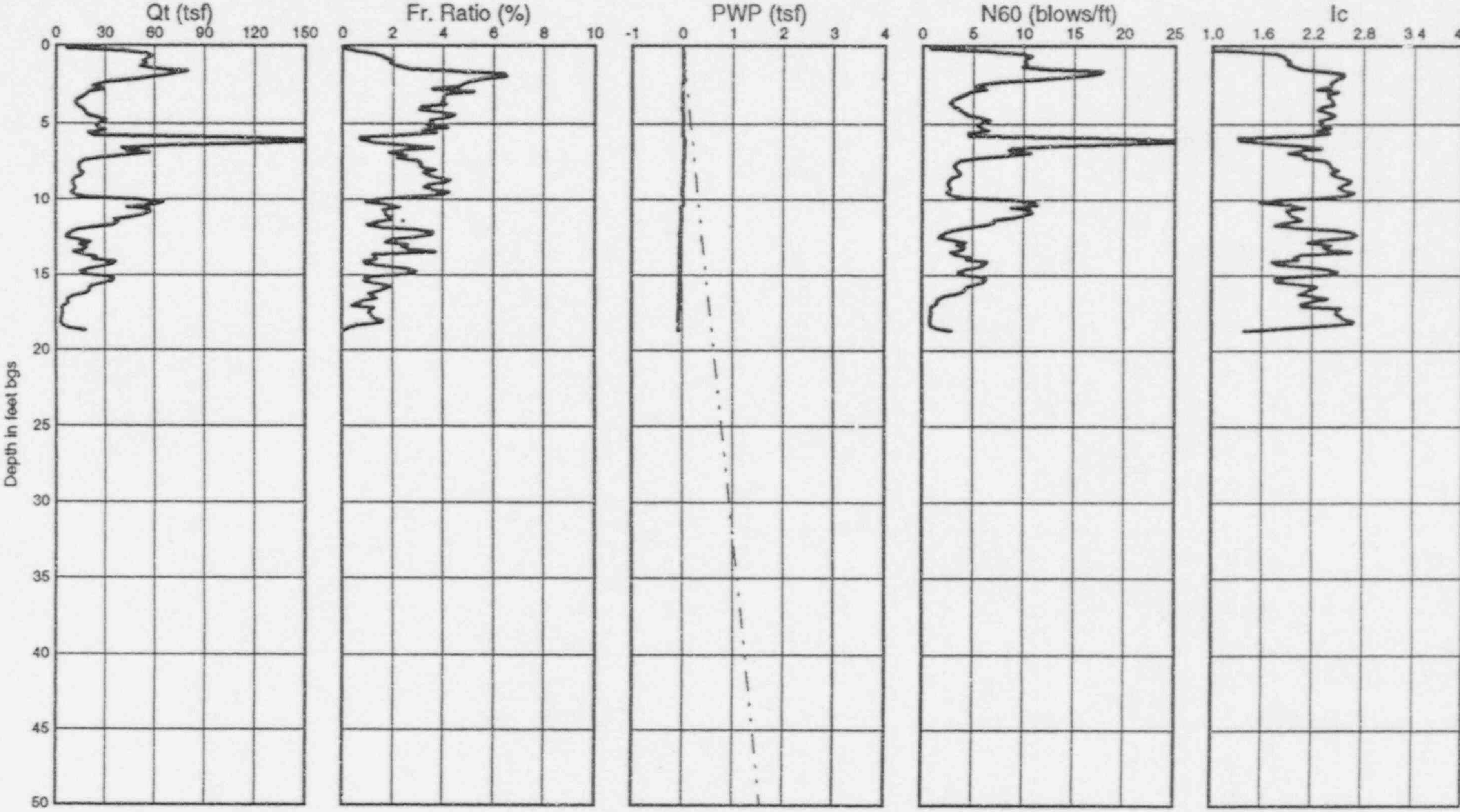
INTERA Inc.

Cone Penetration Test - CPT-15

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

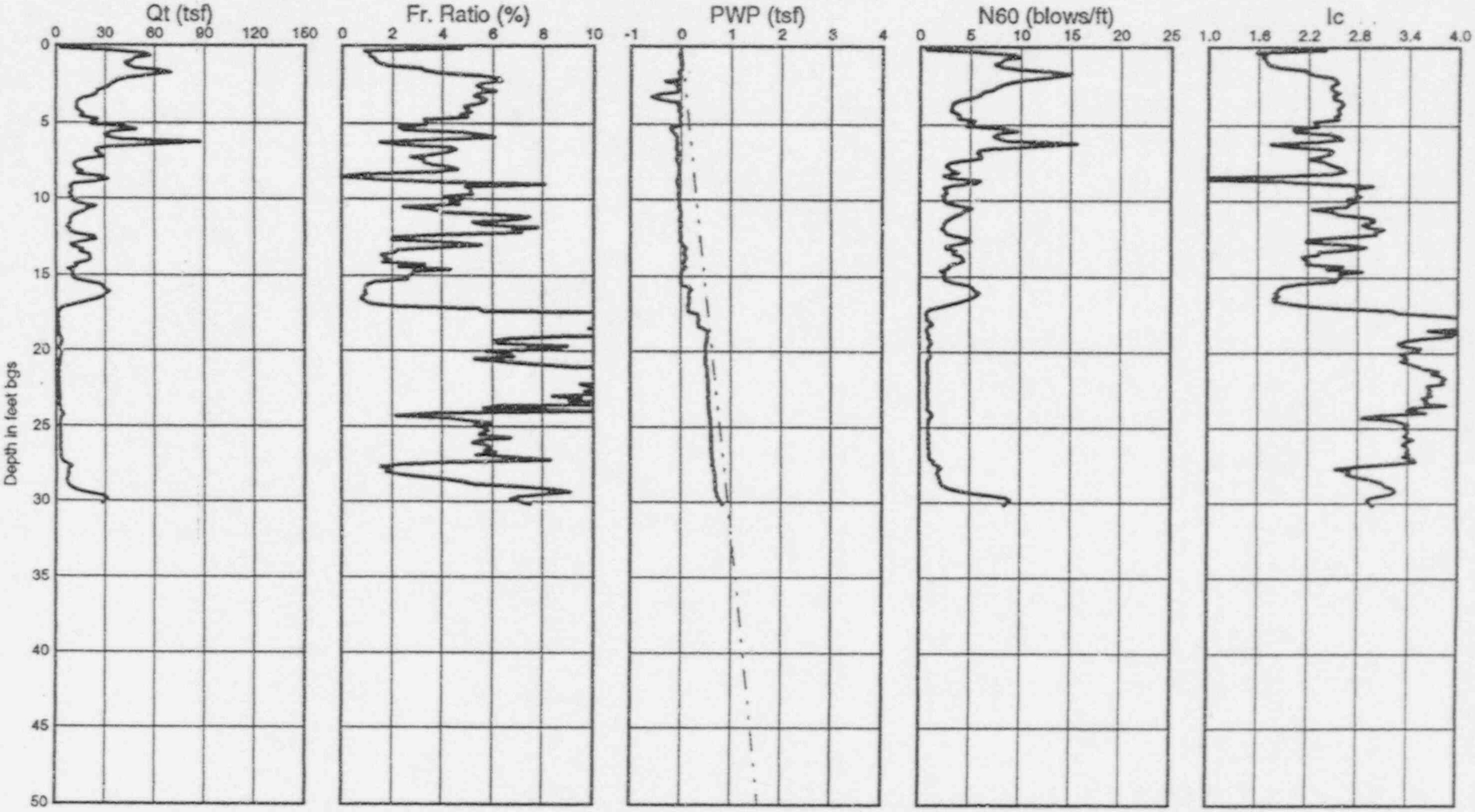
INTERA Inc.

Cone Penetration Test - CPT-15B

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

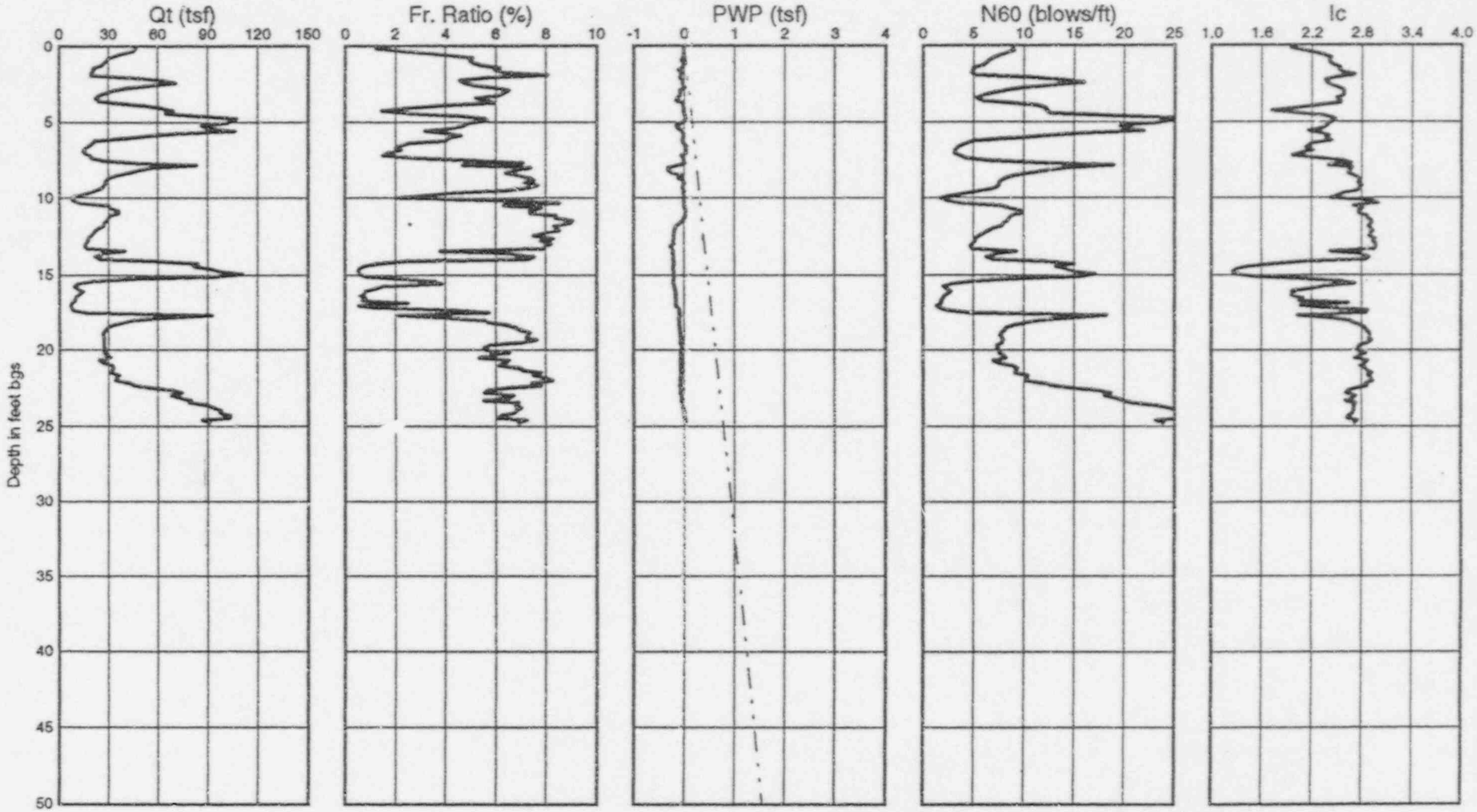
INTERA Inc.

Cone Penetration Test - CPT-16

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

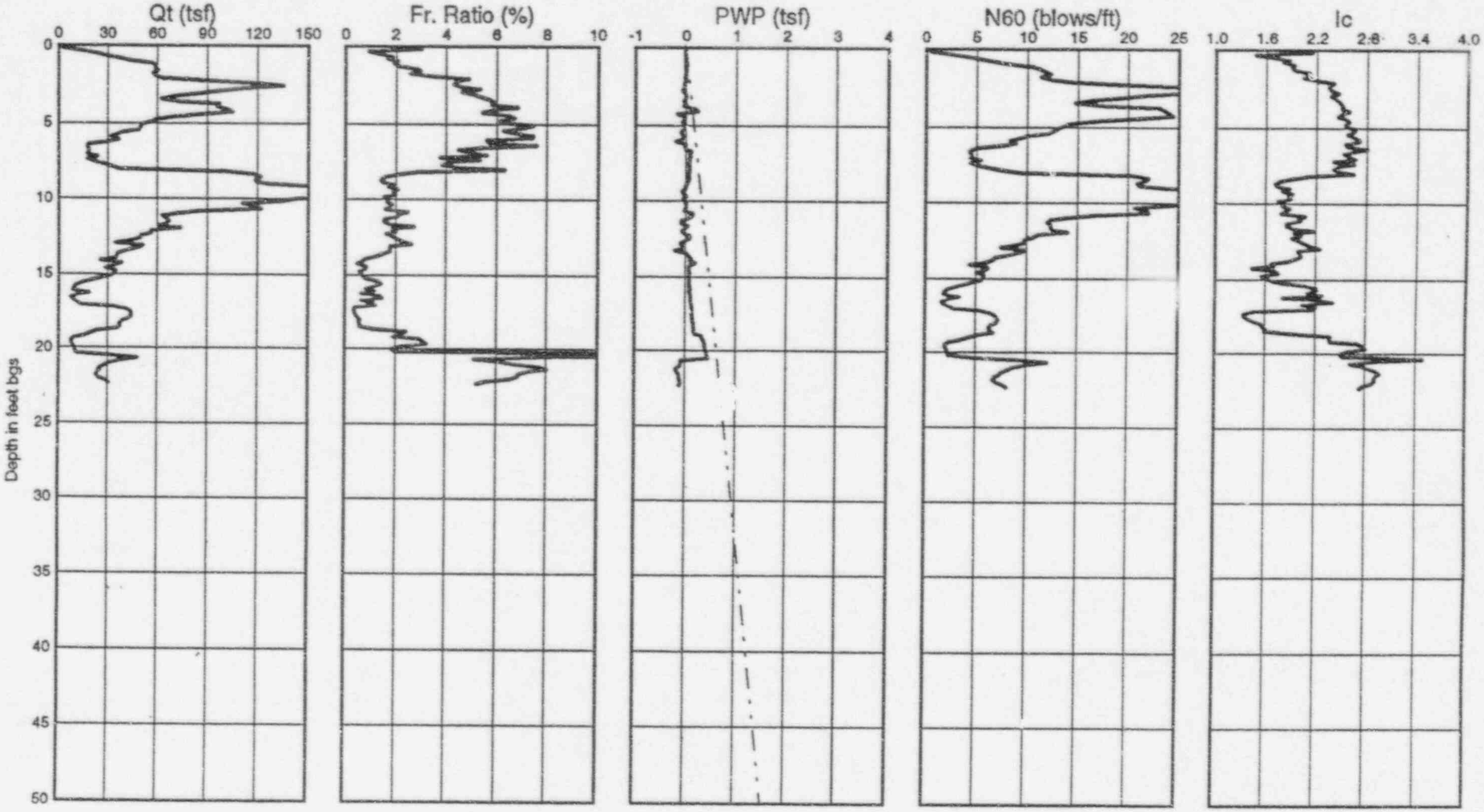
INTERA Inc.

Cone Penetration Test - CPT-17

Test Date : Sep 15, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

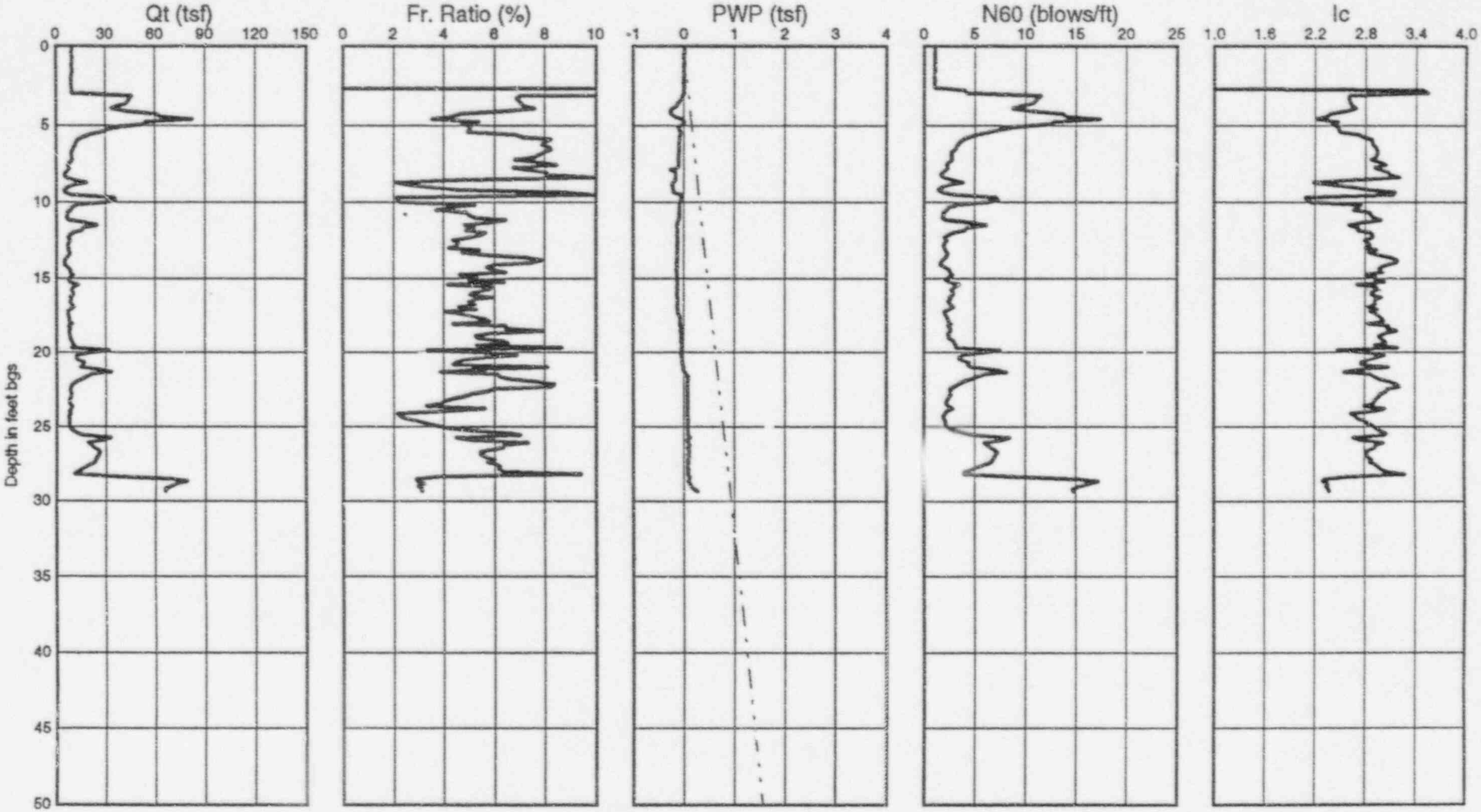
INTERA Inc.

Cone Penetration Test - CPT-18

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Ff/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

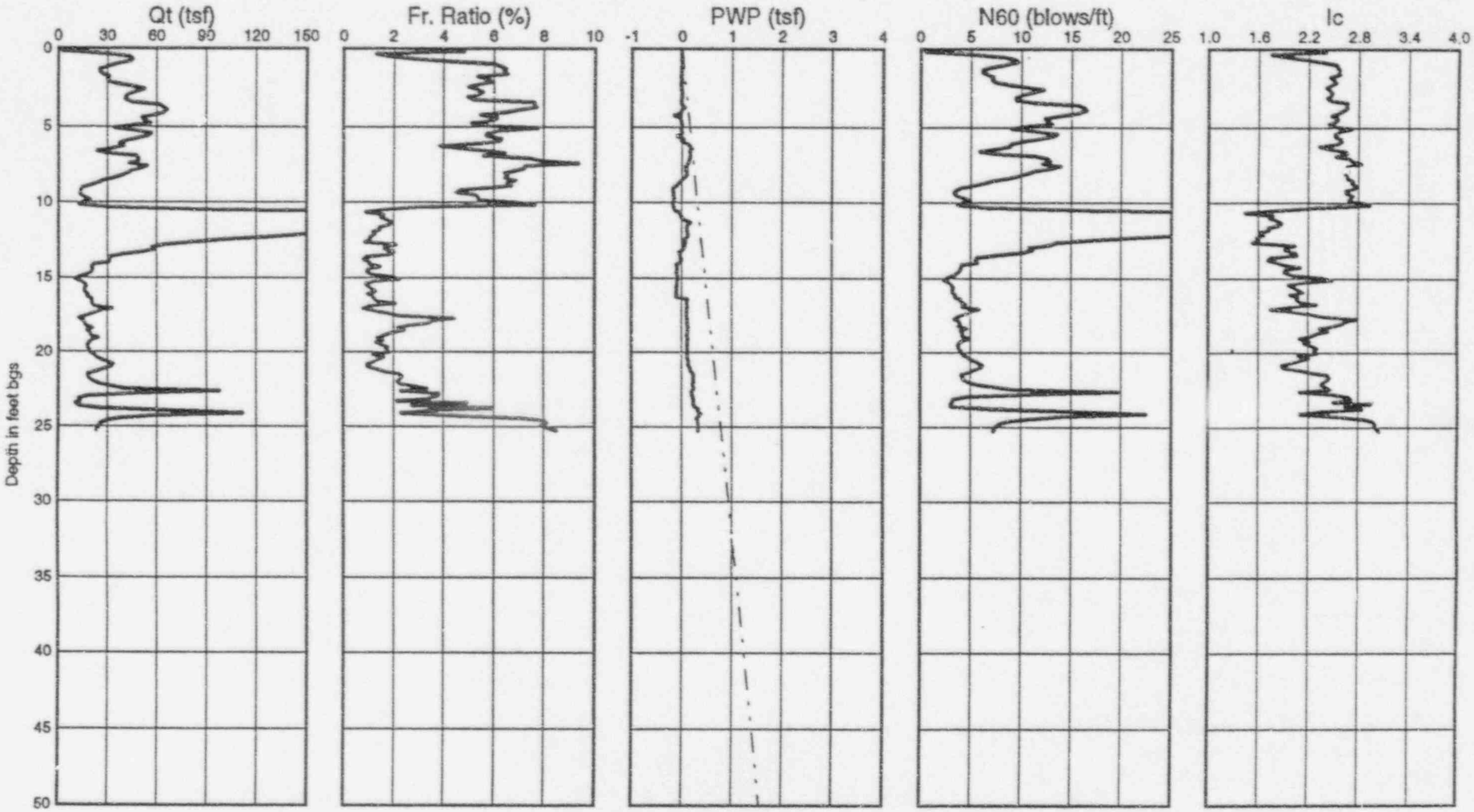
INTERA Inc.

Cone Penetration Test - CPT-19

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

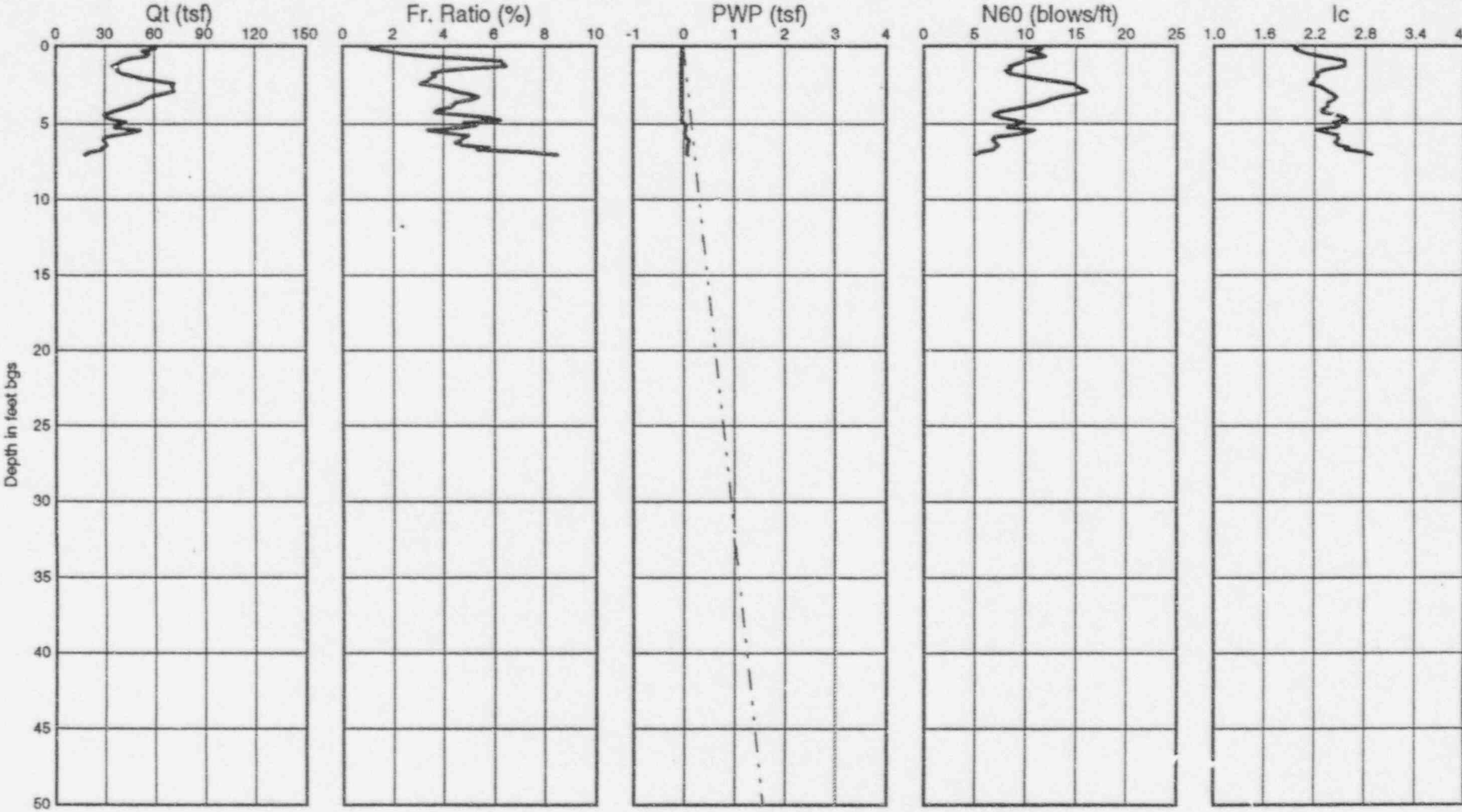
INTERA Inc.

Cone Penetration Test - CPT-20

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

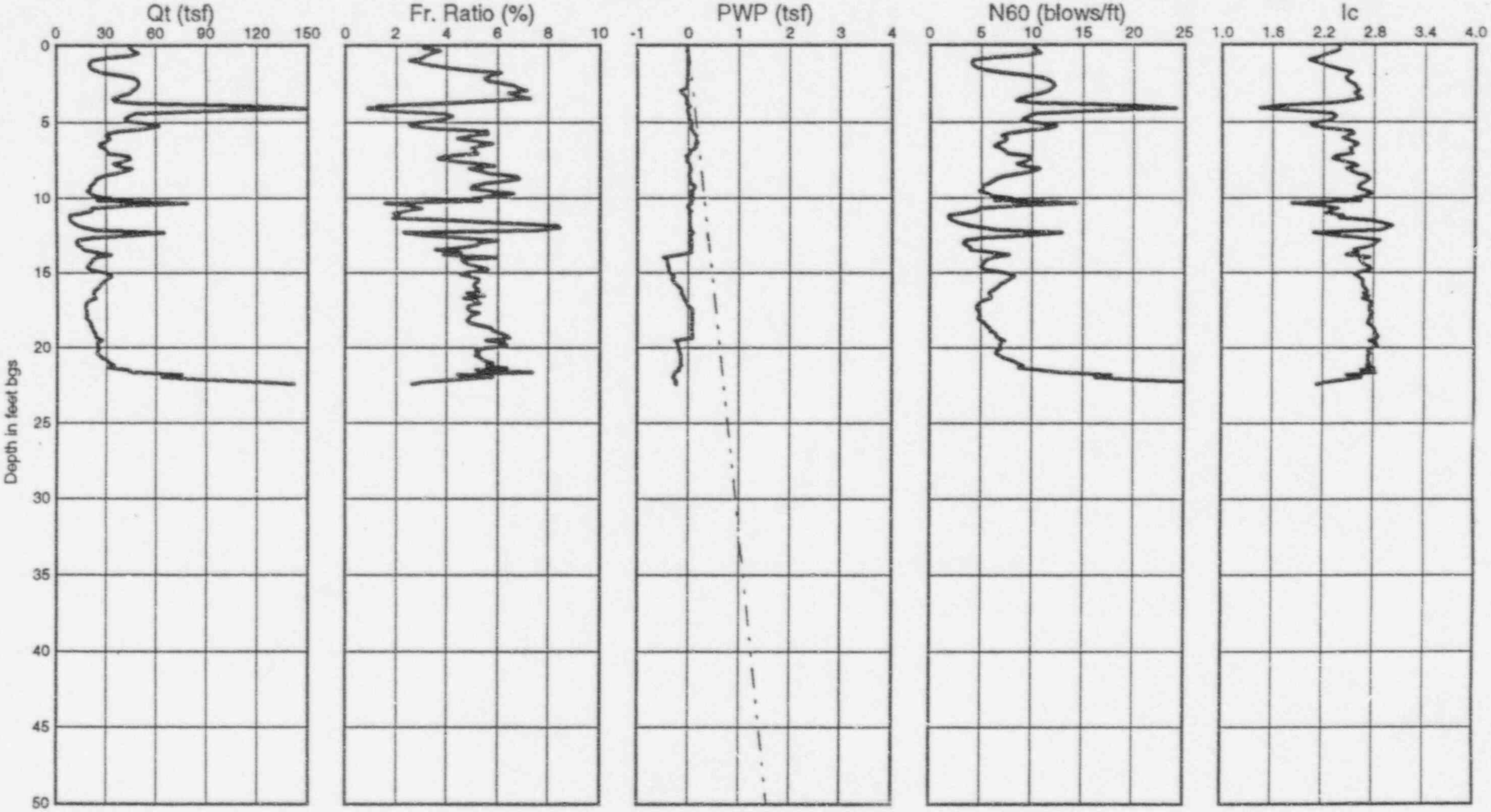
INTERA Inc.

Cone Penetration Test - CPT-20B

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

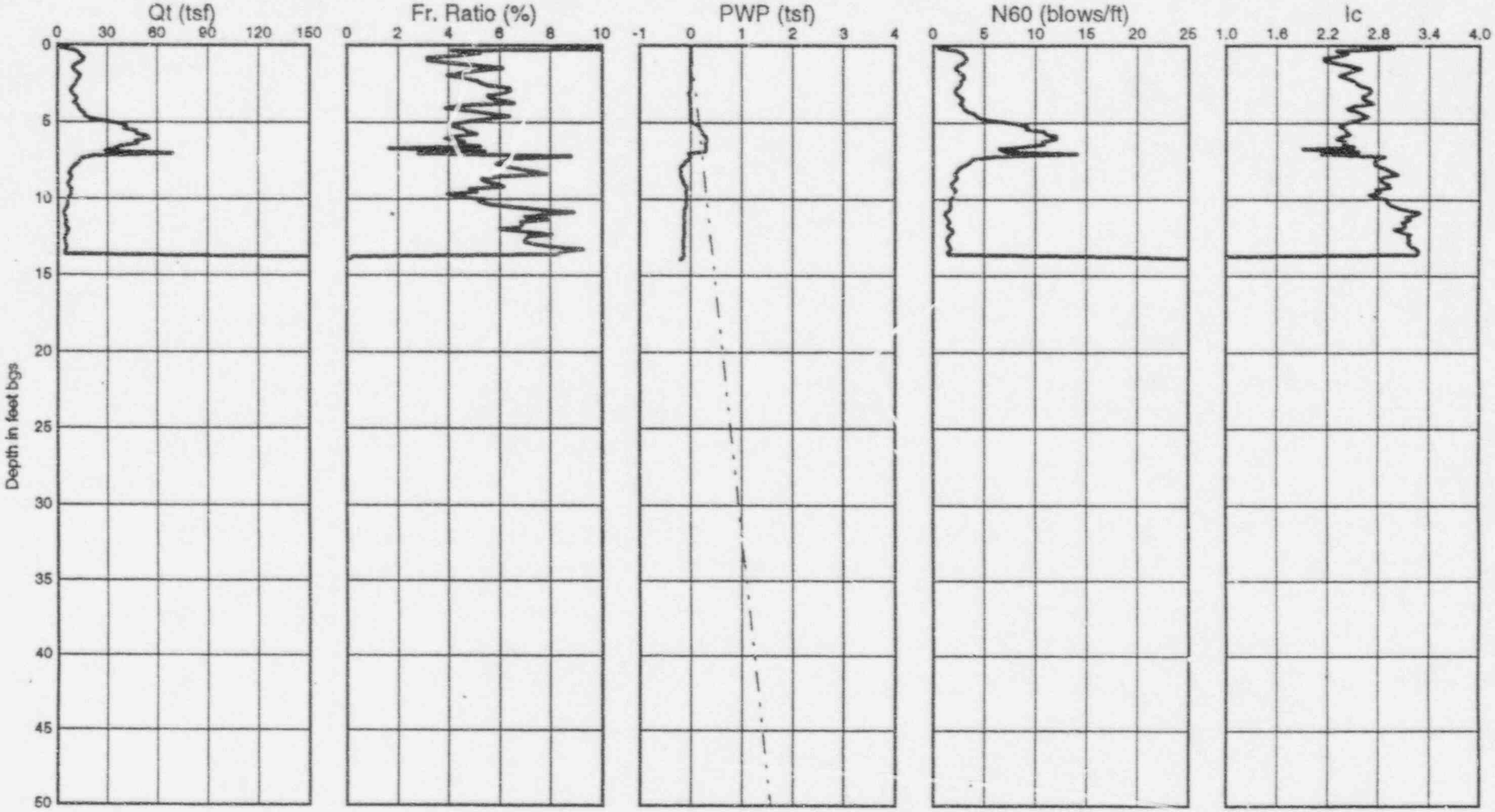
INTERA Inc.

Cone Penetration Test - CPT-21

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Ff/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

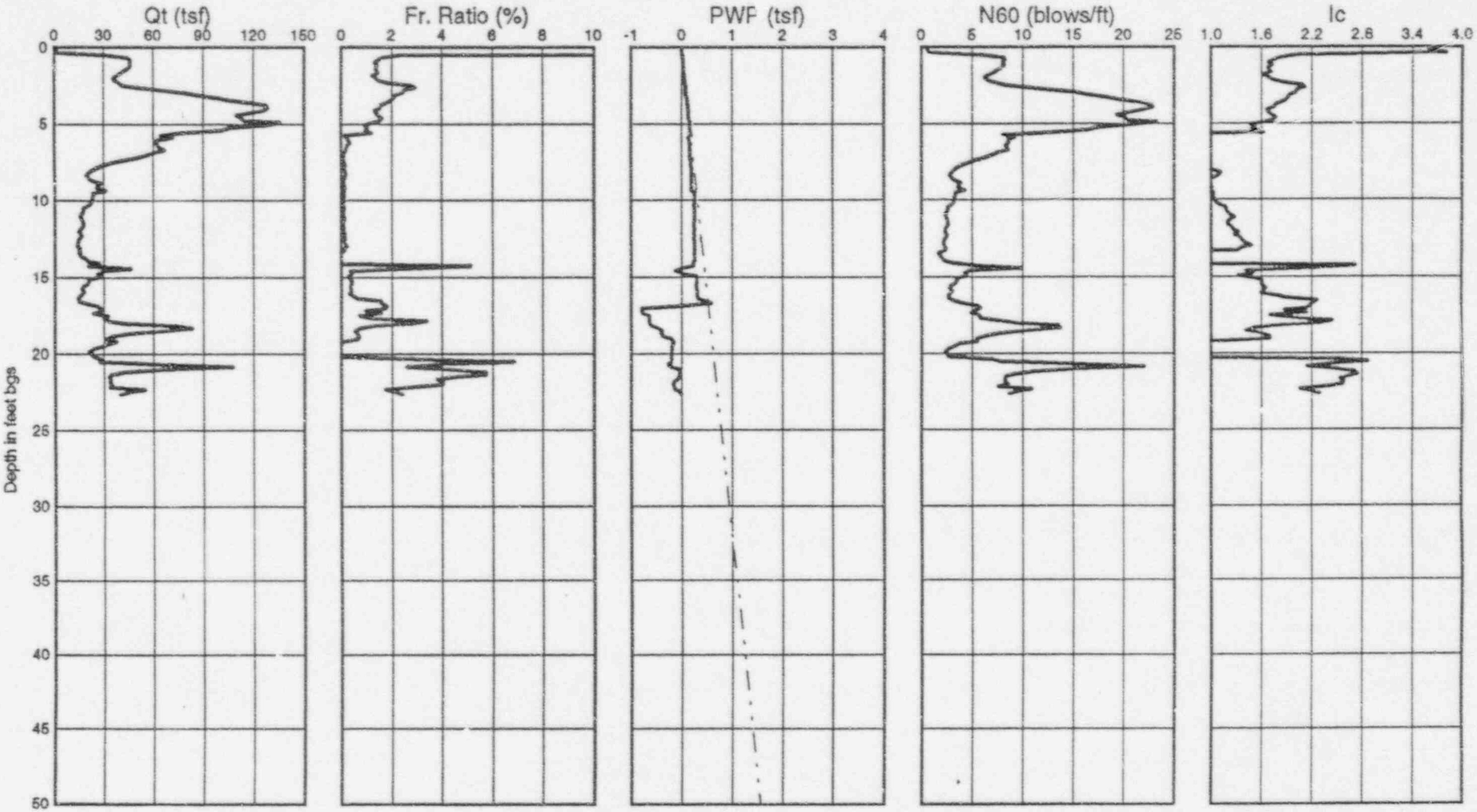
INTERA Inc.

Cone Penetration Test - CPT-21B

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

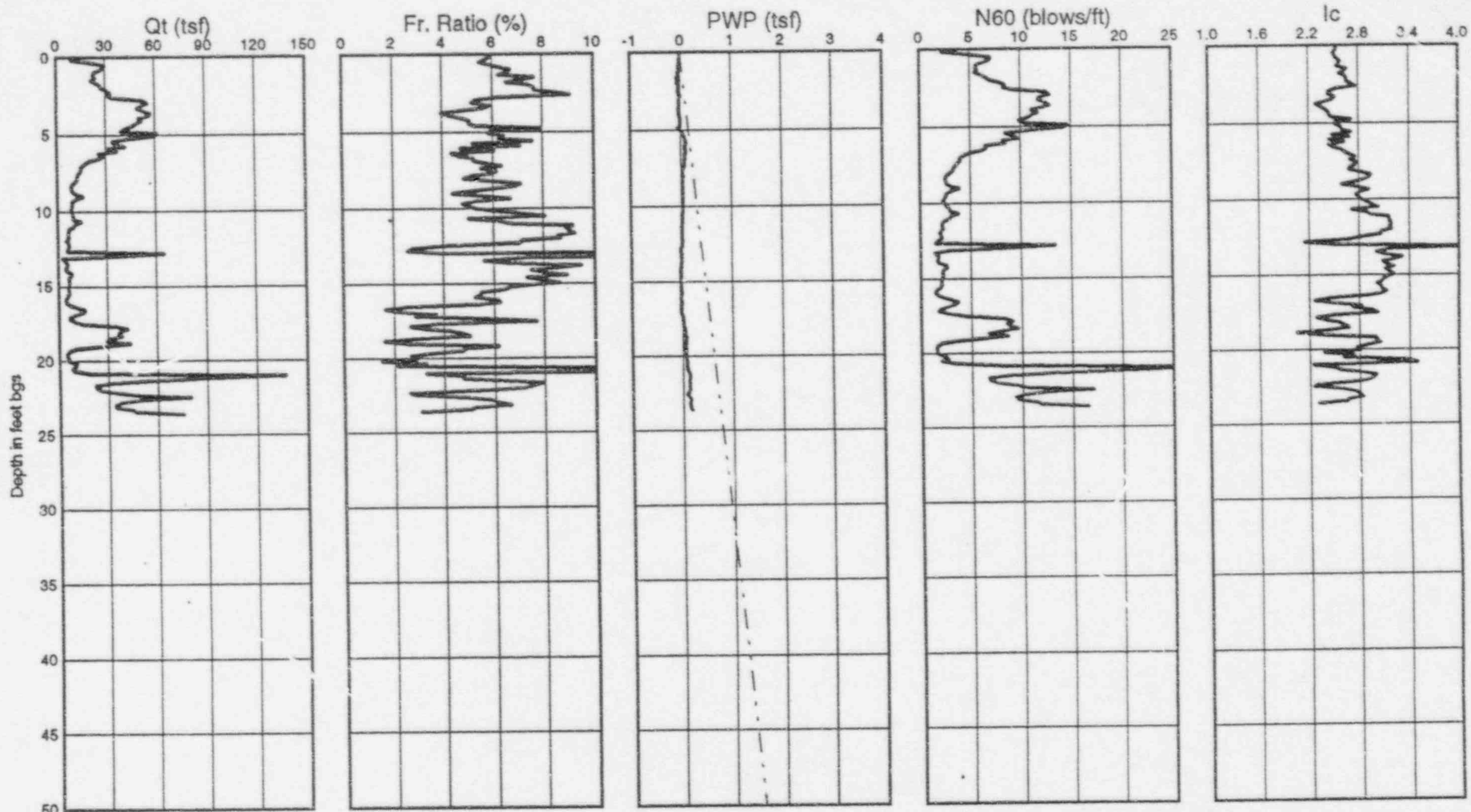
INTERA Inc.

Cone Penetration Test - CPT-21C

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

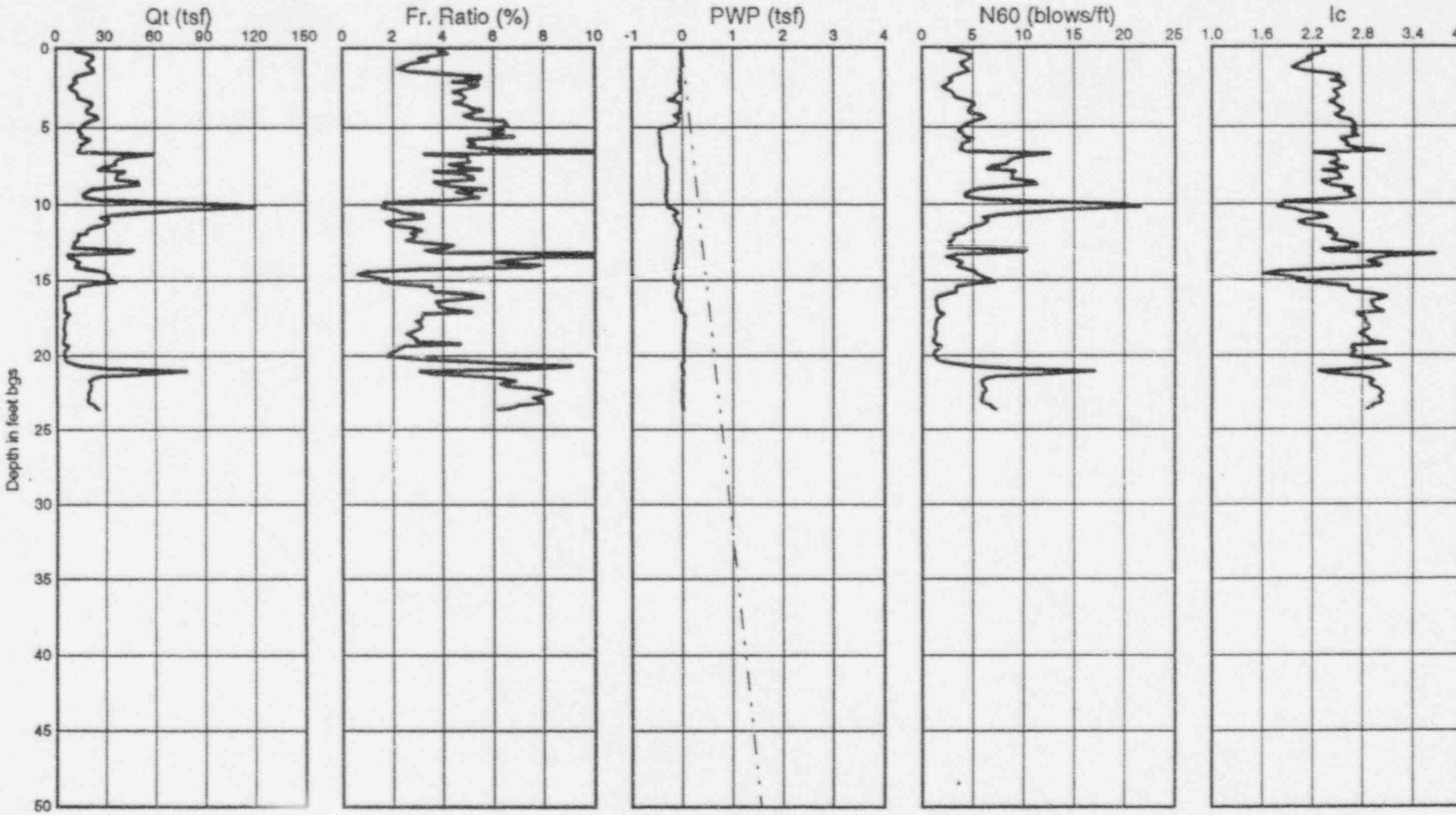
INTERA Inc.

Cone Penetration Test - CPT-22

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

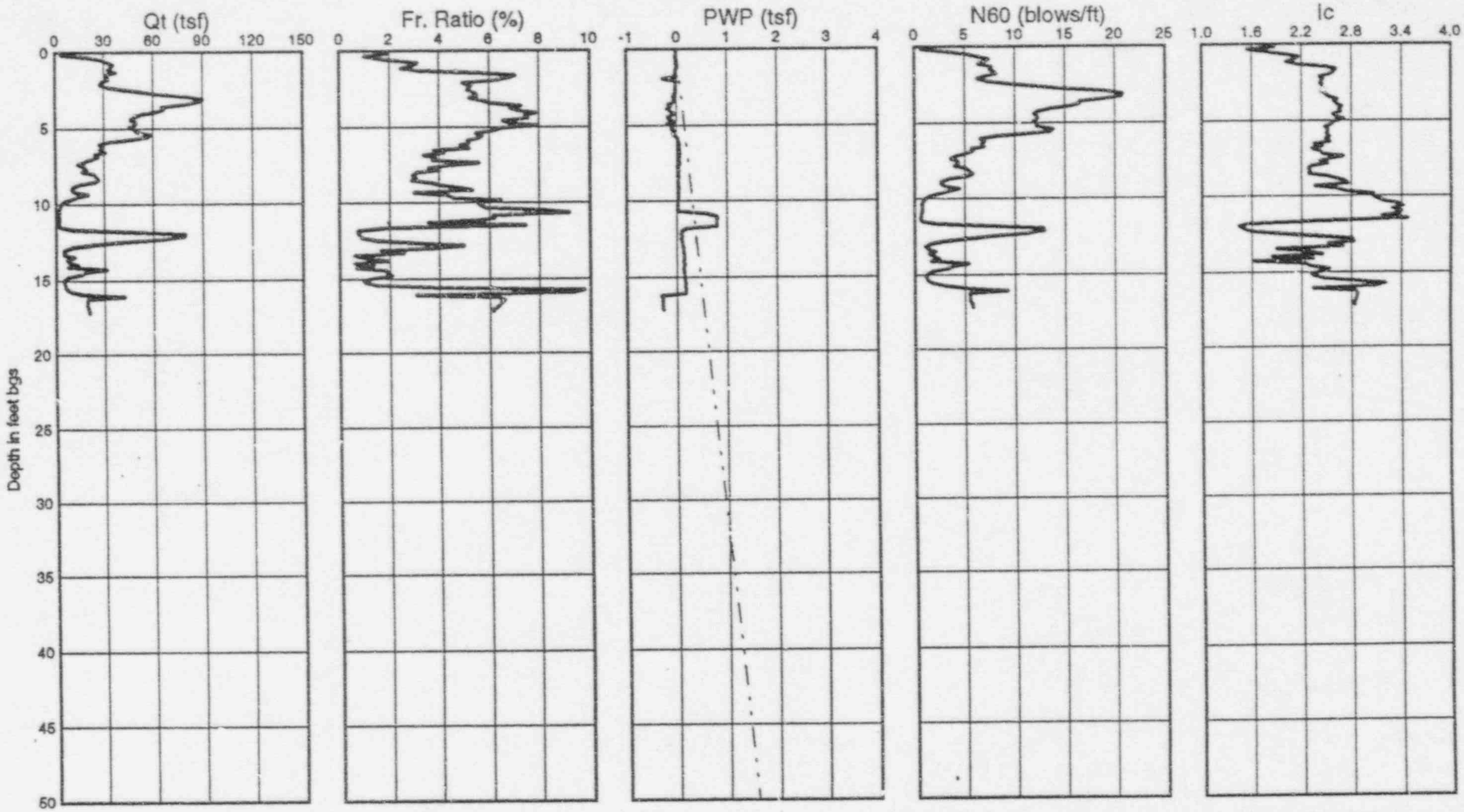
INTERA Inc.

Cone Penetration Test - CPT-23

Test Date : Sep 14, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*Fs/(Qt-Signav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

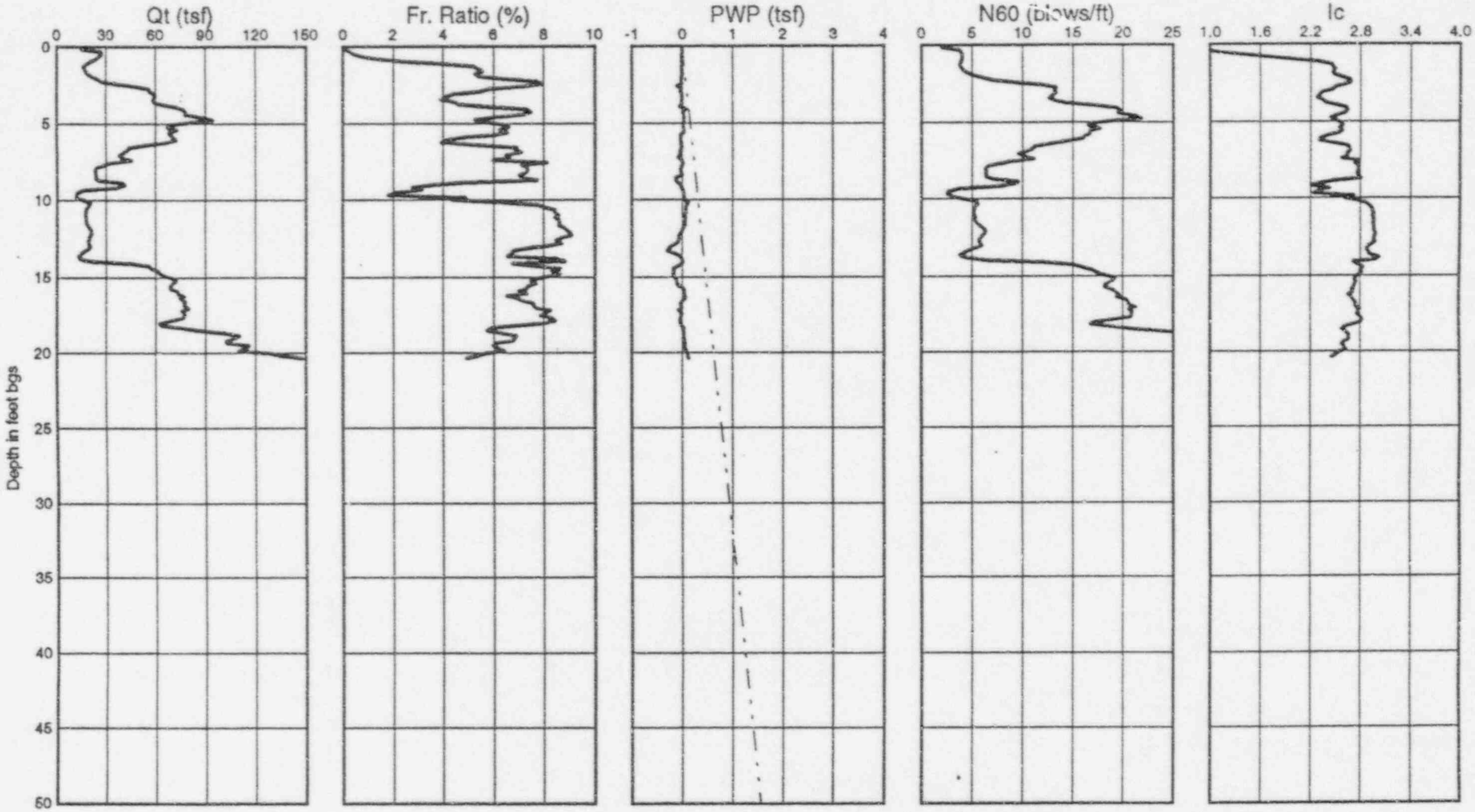
INTERA Inc.

Cone Penetration Test - CPT-24

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

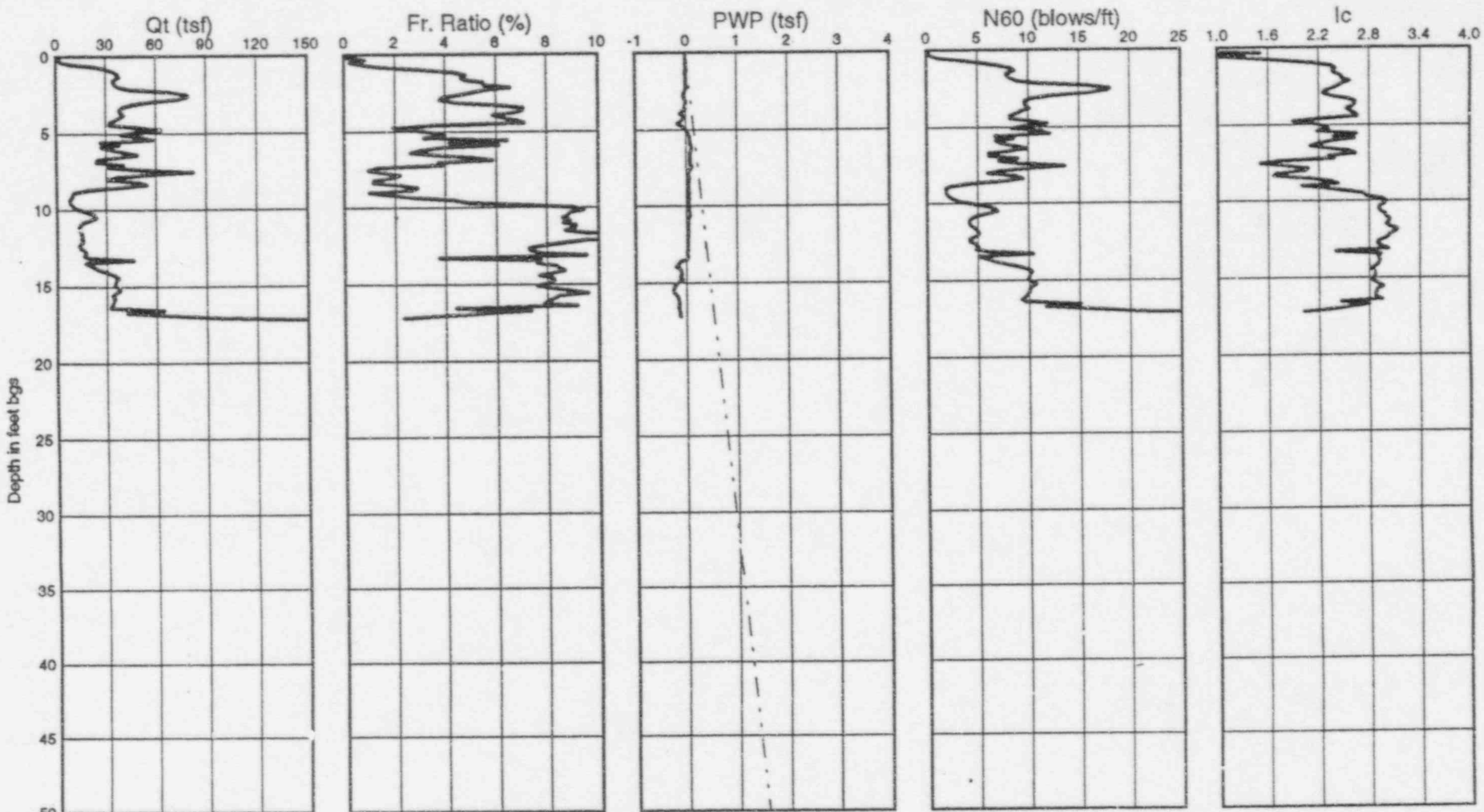
INTERA Inc.

Cone Penetration Test - CPT-25

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

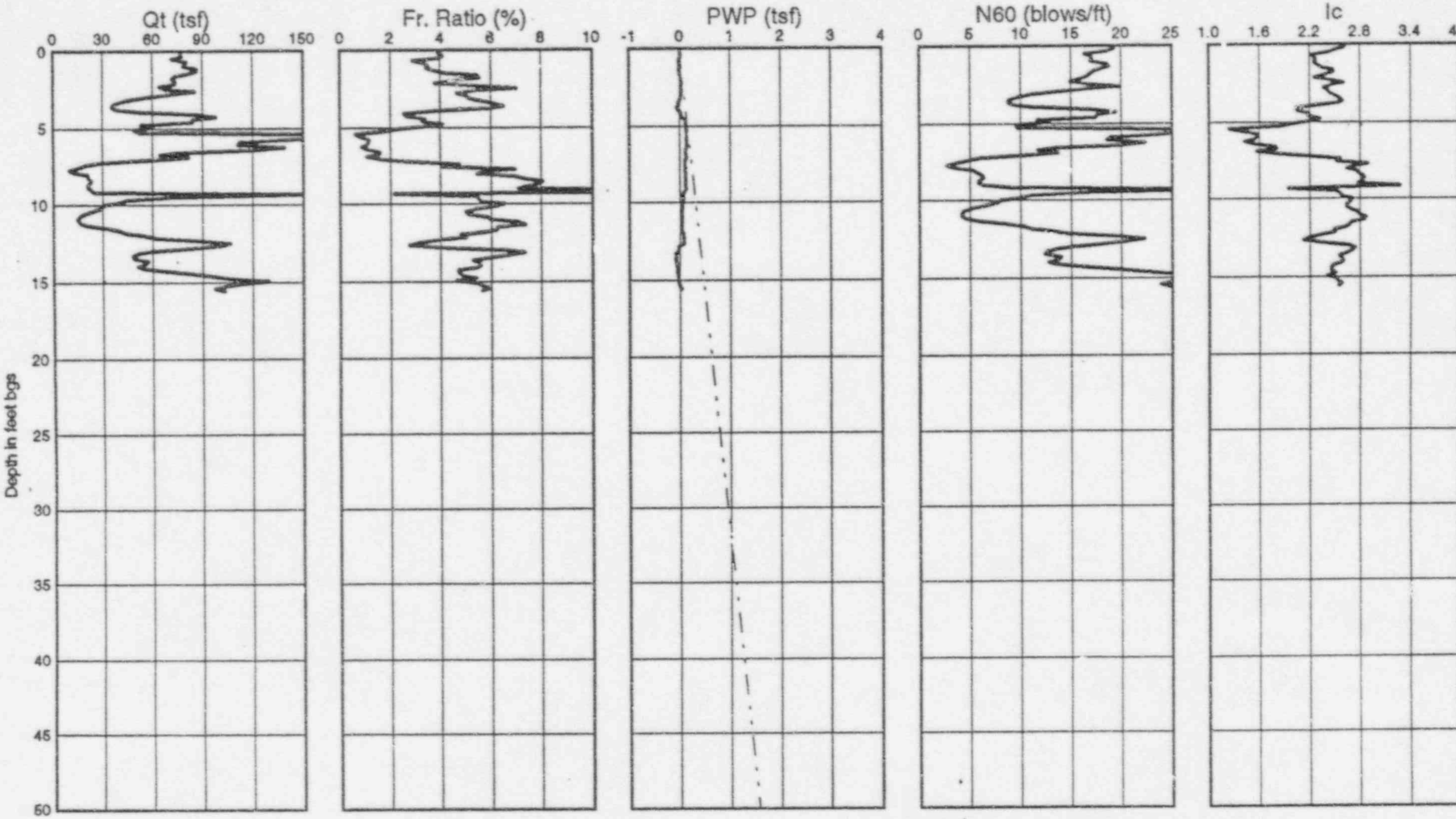
INTERA Inc.

Cone Penetration Test - CPT-26

Test Date : Sep 16, 1995
Location : L-Bar Mine Tailings Investigation

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 0.00
Water Table Depth : 0.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 110 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 1060-012 DATE: September 23, 1995 DRAWN BY: Keith Brown

INTERA Inc.

AK GeoConsult, Inc. Geotechnical and Geoenvironmental Engineering
13212 Manitoba Drive, NE Albuquerque, NM 87111-2955 505 275 8410 Fax 505 298 9839

August 26, 1996 9641

Mr. P.J. Quinton
INTERA Inc.
6850 Austin Center Blvd., Suite 300
Austin, TX 78731

REPORT ON STABILITY ANALYSES OF RECLAIMED L-BAR TAILING DAM OUTSLOPE

Dear Jim:

As requested by your letter of August 14, 1996 I have performed analyses of pseudostatic stability (structural stability under earthquake-equivalent static load conditions) for the outslope of the reclaimed L-Bar Uranium Operations tailing dam under several conditions. The input and output files for these analyses are attached to this letter.

The most critical cross section, through the swale centerline at the highest part of the dam, was used in the analyses. The input data for the analyses included:

- the critical cross section geometry (Fig. 4-5 of the Reclamation Plan)
- 1996 potentiometric surface according to Fig.6.1.1.3.2 and tabulated data from your file 96TLWL
- physical properties of tailings, soil, and rock from investigations by D'Appolonia, 1981 and design calculations 84103.C6 and 84103.H6

The stability analyses were performed using the computer code SB-SLOPE Version 3.0 (Geosystems, 1993). This code uses the Simplified Bishop form of analysis, one of several widely used forms of limiting equilibrium analysis. This code gives results that are equivalent to those of the STABL5 code used in the original anaylses for reclamation design. For each stability analysis a range of initiation and termination points and maximum failure surface depth were chosen to evaluate those failure surfaces (a total of 9878 surfaces in each analysis) that would affect the long-term function of the dam - containment of the tailings. Surfaces that would affect only the outslope to shallow depths but not breach containment were excluded from the analyses.

Your letter posed several questions for which these analyses were performed:

1) "What g force is the dam, as presently constructed with 1996 water levels, capable of withstanding?"

Analyses LBAR96 and LBAR96E were run to address this question, and the input and output are attached. With the 1996 potentiometric surface and the design peak ground acceleration (g) of 0.1, the pseudostatic factor of safety of the dam is 1.37 (versus 1.0 for minimum stability). With the 1996 potentiometric surface, the dam could withstand an earthquake with g = 0.17 (factor of safety = 1.014 with a seismic coefficient, or g value, of 0.17).

2) "At what water level would the dam cease to have the required factor of safety given a g force of 0.1?"

Analysis LBARMXPL was performed to answer this question. It shows that even if the potentiometric surface were to rise to ground surface, causing the tailings dam, and downstream ground to be fully saturated, the factor of safety would be 1.15, well above the minimum of 1.0 required for stability.

3) "(At what water level would the dam cease to have the required factor of safety given a g force of) 0.43?"

Analyses LBAR9643, performed to determine the factor of safety for the dam with the 1996 water levels and g = 0.43, shows that the dam would be unstable (FS = 0.427) under these load conditions. Analysis LBARMN43 applied the load from g = 0.43 to the dam with the water level (potentiometric surface) at natural ground level, below the dam structure and all tailings. This represents a condition of the tailings and dam being completely dewatered but underlain by saturated natural ground. Even under these latter conditions, the factor of safety would be just 0.44, only slightly higher than that for the 1996 water levels.

By telcon today you posed another question for analysis:

4) What would be the maximum tolerable g value (giving a factor of safety of 1.0) if the water level were in the flow zone of the Tres Hermanos sandstone, about 18 feet below natural ground?

Analysis LBAR20TH shows that with a g value of 0.20, the factor of safety would be 1.02.

These analyses show that, in the present configuration, the stability of the dam is very sensitive to the seismic coefficient, or g value, but relatively insensitive to the water level. The water level could rise to the highest possible level (LBARMXPL) and still maintain a safety factor well above 1.0 under g = 0.1 conditions. However, even if the dam and tailings were completely dewatered (LBARMN43), a g = 0.43 earthquake event would lead to dam failure; i.e., there would be no safe water level. Furthermore, a reduction of water level to the Tres Hermanos would allow an increase of only 0.03 in tolerable g value.

According to the New Mexico State Engineer's Office (Larry Ferns, oral communication this date), the design g value for dams is still 0.1 for the area of the L-Bar, which is in or near seismic zone 2. The 1994 Uniform Building Code (UBC) gives a zone rating of 2A or 2B to the L-Bar area, for which the listed g value is 0.15 to 0.20. For pseudostatic calculations like those in the SB-SLOPE code those g values should be reduced to about 85% of the listed values. It should be noted that the UBC values are intended for use in designing inhabited structures where lives are directly at risk, not earthen dams.

A g = 0.43 seismic event is far greater that any historic or anticipated event in or near the Rio Grande Rift. Such an event would have a recurrence interval of well over 1000 years (the required protection period for 10 CFR 40 byproduct materials) anywhere in the world, not to mention a zone 2 location. Therefore, a g = 0.43 value for stability analysis is excessive.

Please contact me if you have any questions regarding these analyses.

Yours truly,

Alan K. Kuhn, PhD, PE

ALAN K. KUHN
NEW MEXICO
6798
REGISTERED PROFESSIONAL ENGINEER

AKK/kmk

attachments

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Project: L-BAR URANIUM OPERATIONS RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBAR96   Description:

ANALYSIS DATA:

Point No.	Coordinates X	Y
1	500.0	6150.0
2	569.0	6150.0
3	572.0	6147.5
4	587.2	6150.0
5	587.2	6147.5
6	600.0	6150.0
7	721.8	6173.9
8	725.6	6172.7
9	735.6	6172.7
10	830.0	6197.7
11	832.0	6195.2
12	832.0	6191.1
13	900.0	6198.4
14	900.0	6196.9
15	900.0	6192.8
16	968.0	6200.0
17	967.0	6198.5
18	1019.0	6200.1
19	978.0	6195.6
20	1019.0	6196.0
21	1019.0	6156.0
22	754.0	6151.0
23	762.0	6158.0
24	937.0	6170.0
25	1019.0	6173.0

Line No.	Left Point	Right Point	Soil No.	Phreatic Line
1	1	2	1	Y
2	2	4	2	Y
3	2	3	1	N
4	3	5	1	N
5	5	6	1	N
6	4	10	2	N
7	6	7	3	N
8	7	8	3	N
9	8	9	3	N
10	9	12	4	N
11	7	11	5	N
12	10	13	2	N
13	11	14	5	N
14	12	15	4	N
15	13	16	2	N
16	14	17	5	N
17	15	19	4	N
18	17	16	5	N
19	16	18	5	N
20	19	20	4	N
21	24	25	4	Y
22	23	24	4	Y
23	22	23	4	Y
24	6	22	1	Y
25	22	21	1	N
26	4	6	2	Y

Soil No.	Density pcf	Cohesion psf	Phi Deg
1	129.0	1000	10.0
2	178.9	0	40.0
3	116.0	2400	12.0
4	110.0	0	20.0
5	106.0	2400	12.0

Seismic coefficient, horizontal = 0.150
vertical = 0.150

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	5.0
right x	830.0	1000.0	5.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 700.9, y = 6434.9, r = 332.2, FS = 1.371

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Project: L-BAR URANIUM OPERATIONS RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBAR96E Description: 1996 GWT WITH EQ=0.17

ANALYSIS DATA:

Point No.	Coordinates X	Y
1	500.0	6150.0
2	569.0	6150.0
3	572.0	6147.5
4	587.2	6150.0
5	587.2	6147.5
6	600.0	6150.0
7	721.8	6173.9
8	725.6	6172.7
9	735.6	6172.7
10	830.0	6197.7
11	832.0	6195.2
12	832.0	6191.1
13	900.0	6198.4
14	900.0	6196.9
15	900.0	6192.8
16	968.0	6200.0
17	967.0	6198.5
18	1019.0	6200.1
19	978.0	6195.6
20	1019.0	6196.0
21	1019.0	6156.0
22	754.0	6151.0
23	762.0	6158.0
24	937.0	6170.0
25	1019.0	6173.0

Line No.	Left Point	Right Point	Soil No.	Phreatic Line
1	1	2	1	Y
2	2	4	2	Y
3	2	3	1	N
4	3	5	1	N
5	5	6	1	N
6	4	10	2	N
7	6	7	3	N
8	7	8	3	N
9	8	9	3	N
10	9	12	4	N
11	7	11	5	N
12	10	13	2	N
13	11	14	5	N
14	12	15	4	N
15	13	16	2	N
16	14	17	5	N
17	15	19	4	N
18	17	16	5	N
19	16	18	5	N
20	19	20	4	N
21	24	25	4	Y
22	23	24	4	Y
23	22	23	4	Y
24	6	22	1	Y
25	22	21	1	N
26	4	6	2	Y

Soil No.	Density pcf	Cohesion psf	Phi Deg
1	129.0	1000	10.0
2	178.9	0	40.0
3	116.0	2400	12.0
4	110.0	0	20.0
5	106.0	2400	12.0

Seismic coefficient, horizontal = 0.170
vertical = 0.170

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	5.0
right x	830.0	1000.0	5.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 720.5, y = 6553.9, r = 450.9, FS = 1.014 - low FS

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Project: L-BAR RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBARMXPL Description: RECLAIMED DAM STABILITY WITH GWT AT SURFACE

ANALYSIS DATA:

Point No.	Coordinates X	Y	Line No.	Left Point	Right Point	Soil No.	Phreatic Line
1	500.0	6150.0	1	1	2	1	Y
2	569.0	6150.0	2	2	4	2	Y
3	572.0	6147.5	3	2	3	1	N
4	587.2	6150.0	4	3	5	1	N
5	587.2	6147.5	5	5	6	1	N
6	600.0	6150.0	6	4	10	2	Y
7	721.8	6173.9	7	6	7	3	N
8	725.6	6172.7	8	7	8	3	N
9	735.6	6172.7	9	8	9	3	N
10	830.0	6197.7	10	9	12	4	N
11	832.0	6195.2	11	7	11	5	N
12	832.0	6191.1	12	10	13	2	Y
13	900.0	6198.4	13	11	14	5	N
14	900.0	6196.9	14	12	15	4	N
15	900.0	6192.8	15	13	16	2	Y
16	968.0	6200.0	16	14	17	5	N
17	967.0	6198.5	17	15	19	4	N
18	1019.0	6200.1	18	17	16	5	N
19	978.0	6195.6	19	16	18	5	Y
20	1019.0	6196.0	20	19	20	4	N
21	1019.0	6156.0	21	24	25	4	N
22	754.0	6151.0	22	23	24	4	N
23	762.0	6158.0	23	22	23	4	N
24	937.0	6170.0	24	6	22	1	N
25	1019.0	6173.0	25	22	21	1	N
			26	4	6	2	N

Soil No.	Density pcf	Cohesion psf	Phi Deg
1	129.0	1000	10.0
2	178.9	0	40.0
3	116.0	2400	12.0
4	110.0	0	20.0
5	106.0	2400	12.0

Seismic coefficient, horizontal = 0.100
vertical = 0.100

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	10.0
right x	830.0	1000.0	10.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 734.5, y = 6414.0, r = 311.0, FS = 1.154 - low FS

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Prcject: L-BAR URANIUM OPERATIONS RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBAR9643 Description: 1996 GWT WITH EQ=0.43

ANALYSIS DATA:

Point No.	Coordinates X	Y	Line No.	Left Point	Right Point	Soil No.	Phreatic Line
1	500.0	6150.0	1	1	2	1	Y
2	569.0	6150.0	2	2	4	2	Y
3	572.0	6147.5	3	2	3	1	N
4	587.2	6150.0	4	3	5	1	N
5	587.2	6147.5	5	5	6	1	N
6	600.0	6150.0	6	4	10	2	N
7	721.8	6173.9	7	6	7	3	N
8	725.6	6172.7	8	7	8	3	N
9	735.6	6172.7	9	8	9	3	N
10	830.0	6197.7	10	9	12	4	N
11	832.0	6195.2	11	7	11	5	N
12	832.0	6191.1	12	10	13	2	N
13	900.0	6198.4	13	11	14	5	N
14	900.0	6196.9	14	12	15	4	N
15	900.0	6192.8	15	13	16	2	N
16	968.0	6200.0	16	14	17	5	N
17	967.0	6198.5	17	15	19	4	N
18	1019.0	6200.1	18	17	16	5	N
19	978.0	6195.6	19	16	18	5	N
20	1019.0	6196.0	20	19	20	4	N
21	1019.0	6156.0	21	24	25	4	Y
22	754.0	6151.0	22	23	24	4	Y
23	762.0	6158.0	23	22	23	4	Y
24	937.0	6170.0	24	6	22	1	Y
25	1019.0	6173.0	25	22	21	1	N
			26	4	6	2	Y

Soil No.	Density pcf	Cohesion psf	Phi Deg
1	129.0	1000	10.0
2	178.9	0	40.0
3	116.0	2400	12.0
4	110.0	0	20.0
5	106.0	2400	12.0

Seismic coefficient, horizontal = 0.430
vertical = 0.430

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	5.0
right x	830.0	1000.0	5.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 750.3, y = 6472.7, r = 369.7, FS = 0.427 - very low FS

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Project: L-BAR URANIUM OPERATIONS RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBARMN43   Description: MINIMUM GWT WITH EQ=.43

ANALYSIS DATA:

Point No.	Coordinates X	Y	Line No.	Left Point	Right Point	Soil No.	Phreatic Line
1	500.0	6150.0	1	1	2	1	Y
2	569.0	6150.0	2	2	4	2	Y
3	572.0	6147.5	3	2	3	1	N
4	587.2	6150.0	4	3	5	1	N
5	587.2	6147.5	5	5	6	1	N
6	600.0	6150.0	6	4	10	2	N
7	721.8	6173.9	7	6	7	3	N
8	725.6	6172.7	8	7	8	3	N
9	735.6	6172.7	9	8	9	3	N
10	830.0	6197.7	10	9	12	4	N
11	832.0	6195.2	11	7	11	5	N
12	832.0	6191.1	12	10	13	2	N
13	900.0	6198.4	13	11	14	5	N
14	900.0	6196.9	14	12	15	4	N
15	900.0	6192.8	15	13	16	2	N
16	968.0	6200.0	16	14	17	5	N
17	967.0	6198.5	17	15	19	4	N
18	1019.0	6200.1	18	17	16	5	N
19	978.0	6195.6	19	16	18	5	N
20	1019.0	6196.0	20	19	20	4	N
21	1019.0	6156.0	21	24	25	4	N
22	754.0	6151.0	22	23	24	4	N
23	762.0	6158.0	23	22	23	4	N
24	937.0	6170.0	24	6	22	1	Y
25	1019.0	6173.0	25	22	21	1	Y
			26	4	6	2	Y

Soil No.	Density pcf	Cohesion psf	Phi Deg
1	129.0	1000	10.0
2	178.9	0	40.0
3	116.0	2400	12.0
4	110.0	0	20.0
5	106.0	2400	12.0

Seismic coefficient, horizontal = 0.430
vertical = 0.430

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	5.0
right x	830.0	1000.0	5.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 750.3, y = 6472.7, r = 369.7, FS = 0.443 - very low FS

GEOSYSTEM SLOPE STABILITY PROGRAM
SB-SLOPE

PROJECT DATA:
Project: L-BAR URANIUM OPERATIONS RECLAIMED TAILING DAM OUTSLOPE
Location: SEBOYETA, NM
Filename: LBAR20TH   Description: GWT AT TRES HERMANOS, EQ=.20

ANALYSIS DATA:

Point No.	Coordinates X	Y	Line No.	Left Point	Right Point	Soil No.	Phreatic Line	Soil No.	Density pcf	Cohesion psf	Phi Deg
1	500.0	6150.0	1	1	2	1	N	1	129.0	1000	10.0
2	569.0	6150.0	2	2	4	2	N	2	178.9	0	40.0
3	572.0	6147.5	3	2	3	1	N	3	116.0	2400	12.0
4	587.2	6150.0	4	3	5	1	N	4	110.0	0	20.0
5	587.2	6147.5	5	5	6	1	N	5	106.0	2400	12.0
6	600.0	6150.0	6	4	10	2	N				
7	721.8	6173.9	7	6	7	3	N				
8	725.6	6172.7	8	7	8	3	N				
9	735.6	6172.7	9	8	9	3	N				
10	830.0	6197.7	10	9	12	4	N				
11	832.0	6195.2	11	7	11	5	N				
12	832.0	6191.1	12	10	13	2	N				
13	900.0	6198.4	13	11	14	5	N				
14	900.0	6196.9	14	12	15	4	N				
15	900.0	6192.8	15	13	16	2	N				
16	968.0	6200.0	16	14	17	5	N				
17	967.0	6198.5	17	15	19	4	N				
18	1019.0	6200.1	18	17	16	5	N				
19	978.0	6195.6	19	16	18	5	N				
20	1019.0	6196.0	20	19	20	4	N				
21	1019.0	6156.0	21	24	25	4	N				
22	754.0	6151.0	22	23	24	4	N				
23	762.0	6158.0	23	22	23	4	N				
24	937.0	6170.0	24	6	22	1	N				
25	1019.0	6173.0	25	22	21	1	N				
26	500.0	6132.0	26	4	6	2	N				
27	1019.0	6138.0	27	26	27	1	Y				

Seismic coefficient, horizontal = 0.200
vertical = 0.200

Range search; initial parameters:

	min	max	increment
left x	500.0	700.0	5.0
right x	830.0	1000.0	5.0

radius increment is 10.0
minimum perpendicular depth is 20.0
limit at elevation 6100.0
OVERALL MINIMUM: x = 720.5, y = 6553.9, r = 450.9, FS = 1.021 - low FS