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16. Abstract

Researchers investigated the bump at the end of the bridge by conducting a literature survey, distributing a questionnaire to the 25 districts of the Texas Department of Transportation, and by investigating two bridge sites in Houston, Texas. Some of the most important conclusions from the surveys are:

1. On the average, 25 percent of all bridges in the USA are affected by the bump problem; this is also the number for Texas bridges,
2. The maintenance cost for the bump problem in the USA is estimated at 100 million dollars per year (1997) and 6.3 million dollars per year in Texas (2001),
3. A tolerable bump has a slope of 1/200 or less,
4. In Texas, the number one reason for the bump is the settlement of the embankment fill followed by the loss of fill by erosion,
5. The problem is worse when the embankment is high and the fill is clay,
6. The problem is minimized when an approach slab is used and the fill behind the abutment is cement stabilized.

The investigations at the two bridge sites with significant bumps indicated that:

1. The soil near the abutment was weaker and wetter than the soil away from the abutment,
2. The soil near the abutment had a relatively high PI for an embankment fill,
3. There were no voids under the pavement.

A bump rating number, BR, and a bump index number, BI, are proposed to document the severity of existing bumps and to evaluate the likelihood of developing a bump at a site, respectively. The recommendations for the soil within 100 ft of the abutment are to:

1. Use controlled quality backfill: PI less than 15, less than 20 percent passing sieve #200, coefficient of uniformity larger than 3,
2. Compact the soil to 95 percent of Modified Proctor controlled by inspection with a measurement every 50 ft2,
3. If such a backfill cannot be achieved, the embankment fill within that 100 ft zone should be cement stabilized.

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CHAPTER 1:
INTRODUCTION

The National Bridge Inventory (1997) shows that there are approximately 600,000 bridges in the United States. Many of them have a problem often called the bump at the end of the bridge. The yearly cost of bump maintenance in Texas is estimated to be about 6.3 million dollars as discussed later. One of the main reasons for this bump is the differential settlement between the bridge abutment and the pavement resting on the embankment fill. This problem has been studied by many departments of transportation and researchers. There are a number of possible causes for this differential settlement at bridge approaches including compression of the fill material, settlement of the natural soil under the embankment, poor construction practices, high traffic loads, poor drainage, poor fill material, loss of fill by erosion, poor joints, and temperature cycles.

Although the problem of the bump at the end of the bridge is quite simple to recognize, identifying the cause of this problem is very complex. Previous work on the bump problem will be described in Chapter 2. Researchers conducted a survey of the districts in Texas to become more familiar with the problems encountered and the solutions used to minimize the bump at the end of the bridge. The result of this survey is summarized in Chapter 3. A series of visual site inspections at several bridges in Houston were accomplished. Chapter 4 explains these surveys. There are some ratings related to the bump at the end of the bridge. Chapter 5 explains these ratings. Chapter 6 gives a background about the two bridges on which field and laboratory tests were conducted. Chapter 7 explains the field tests and results, while Chapter 8 explains the laboratory tests and results. Chapter 9 is the data analysis based on the field and laboratory tests. Conclusions and possible recommendations are described in Chapter 10.

The primary goal of this project is to investigate the settlement at bridge approach slab expansion joint, to identify the reasons for the differential settlement, to define current design and construction problems, and to find a way to minimize the bump at the end of the bridge. This goal is focused on the articulated wide–flange approach slabs, many of which have developed severe dips at the articulation joint with an unacceptable ride comfort index in the Houston area.

CHAPTER 2:
REVIEW OF PREVIOUS WORK

Many reports related to the differential settlement of bridge approach slabs have been published by several departments of transportation and researchers.

While researchers identified many causes, the interaction between the cause and the effect are complex. According to the NCHRP Synthesis 234 (Briaud et al., 1997) the main causes of the differential settlement at bridge approach slabs are:

- settlement of the natural soil under the embankment,
- compression of the embankment fill material due to inadequate compaction of the fill, and
- poor drainage behind the bridge abutment and related erosion of the embankment fill.

Another possible cause suggested by Tadros and Benak (1989) and Bellin (1994) is horizontal forces on the abutments. These horizontal forces are mainly caused by soil pressures (Tadros and Benak 1989) or longitudinal pavement growth (James et al. 1991; Wicke and Stoelhorst 1982). James et al. (1991) state that longitudinal pavement growth generates the horizontal forces and influences the approach roughness; they ranked 131 Texas bridges according to the severity of the bridge approach roughness. They found that bridges with rigid pavements had more severe roughness than those with flexible pavements. Provision for bridge and roadway expansion/contraction may have a significant effect on the degree of roughness at the bridge end.

Void development beneath the approach slab may be another cause of approach settlement. This void can be caused by thermally induced movements of integral abutments that compact the fill (Schaefer and Koch 1992; Hearn 1995) or by the erosion of the fill material aggravated by pumping. Higher embankments experience greater amounts of settlement and therefore have more roughness problems (Laguros et al. 1990). Kramer and Sajer (1991) studied the contributing causes of bump formation. Table 2.1 shows a summary of their findings.

Table 2.1. Causes of Bridge Approach Problems Categorized (after Kramer and Sajer 1991).

Differential Settlement	
Compression of natural soils	Primary consolidation, secondary compression, and creep
Compression of embankment soils	Volume changes and distortional movements/creep of embankment soils
Local compression at bridge/pavement interface	Inadequate compaction at bridge/pavement interface, drainage and erosion problems, rutting/distortion of pavement section, traffic loading, and thermal bridge movements
Movement of Abutments	
Vertical movement	Settlement of soil beneath, downdrag, erosion of soil beneath and around abutment
Horizontal movement	Excessive lateral pressures, thermal movements, swelling pressures from expansive soils, and lateral deformation of embankment and natural soils
Design/Construction Problems	
Engineer-related	Improper materials, lift thickness, and compaction requirements
Contractor-related	Improper equipment, overexcavation for abutment construction, and survey/grade errors
Inspector-related/Poor quality control	Lack of inspection personnel and improper inspection personnel training
Design-related	No provision for bridge expansion/contraction spill-through design resulting in the migration of fill material from behind the abutment

Schaefer and Koch (1992) made specific recommendations for limiting the bump when it was caused by thermally induced movements of integral abutments which compact the backfill. They recommend that:

1. Shoulder areas of approach embankments should be capped with asphaltic concrete.
2. Mudjacking should be performed when a void extends back 3 m from the abutment or if the void reaches a height of 100 mm (50 mm in high traffic areas).
3. The reinforcement of the approach slab should be designed to minimize the transverse cracking that occurs near the abutment/approach slab interface.
4. The slope of the cut made for backfill placement should be changed to measure between 4H:1V and 2H:1V.
5. The gradation of the backfill material should be changed to a slightly finer, more well-graded material, and the requirement of fractured faces should be dropped.
6. The use of the filter wrap should be continued to prevent erosion and raveling of the granular materials and as a separator for future mudjacking.

Zaman et al. (1994) performed a special study for the Oklahoma Department of Transportation in 1994. They made a statistical model that predicts problematic bridge approaches prior to construction. They identify several factors that may affect bridge approach performance, including age of the approach, embankment height, foundation soil thickness, skewness of the approach, traffic volume, embankment, and soil characteristics. The model calculates total bridge approach settlement. Any settlement over 25 mm is considered problematic by this model. Stark et al. (1995) consider that a settlement of 50 to 75 mm would create serious riding discomfort to drivers. They state that gradients of 1/100 or 1/125 create significant riding discomfort and agree with Wahls (1990) that gradients of less than 1/200 are acceptable.

Hearn (1995) gives a very detailed review of the bump problem including a summary of methods available to calculate settlement. According to his review there is basically no difference in the settlement magnitude between abutments on piles and abutments on spread footings. His work is based on the measured settlement of nearly 1,000 structures, including 350 bridges and 50 embankments. He found a difference of only 10 mm between the median settlement of embankments and abutments with the embankments settling more. He indicates that bridges can tolerate more settlement than the present perception and gives a relationship between the differential settlement s_d between adjacent points and the mean total settlement s_m; the ratio s_d/s_m is about one third. His data lead to various relationships on settlement observations.

All studies give similar recommendations for preventing or repairing the bump problem. These recommendations can be classified into three main categories of improvements that correspond to the major causes of the bump at the end of the bridge: improvement of the natural soil, improvement of the fill, and erosion reduction.

CHAPTER 3: QUESTIONNAIRE

As part of this project, a survey of the districts in Texas was performed to become more familiar with the problems encountered and the solutions used to minimize the bump at the end of the bridge. Researchers distributed 25 questionnaires and 16 of them were returned with answers. The summary of this survey is as follows:

1. How many bridges are there in your district?

   Average = 1,462 bridges in each district

   Low = 522 bridges in Wichita Falls District

   High = 3,400 bridges in Ft. Worth District

2. Have you encountered the problem of the bump at the end of the bridge? Please estimate the percentage of bridges in your district that are affected by this condition.

   Yes, average 24.5 percent in each district

3. What is your estimate of total maintenance cost per year in your district for this problem including both internal and contracted maintenance?

   - Estimated total maintenance cost per year: average $ 253,900/year
   - Estimate of percent cost internal: average 82 percent
   - Estimate of percent cost contracted maintenance: average 18 percent

4. Among the bridges that are affected by the bump at the end of the bridge, what percentage has the following characteristics?

   - Type of foundation:
     1) Shallow foundation: 3.3 percent
     2) Deep foundation: 92.3 percent
     3) Unknown: 4.4 percent
   - Type of approach slab:
     1) Rigid approach slab: 50.4 percent
     2) Flexible approach slab: 48.2 percent
     3) Unknown: 1.4 percent
   - Soil actually used as compacted fill:
     1) Clay: 56 percent

2) Silt: 1.5 percent
3) Sand: 4.1 percent
4) Stabilized soil: 18.0 percent
5) Unknown: 19.7 percent

- Foundation soil
  1) Clay: 47.7 percent
  2) Silt: 4.6 percent
  3) Sand: 17.8 percent
  4) Unknown: 30.2 percent
- Height of approach embankment
  1) Less than 10 ft: 31.4 percent
  2) Greater than 10 ft: 68.5 percent
  3) Unknown: 0.1 percent
- Type of terminal joint[1]
  1) Wide-flange steel beam: 7.0 percent
  2) Lug anchor: 35.7 percent
  3) Unknown: 57.3 percent

5. What are the common causes of the problem in your district?

   1 = most common, 2 = frequent, 3 = may be a factor, 4 = never be a factor

   - Settlement of fill: average 1.4
   - Loss of fill by erosion: average 2.5
   - Settlement of natural soil under fill: average 2.7
   - Differential settlement between bridge and fill: 2.7
   - Poor construction practices: average 2.7
   - Temperature cycle: 2.7
   - Settlement of fill under the bridge abutment: average 2.9
   - Poor drainage: average 3.1
   - Pavement growth: 3.1
   - Poor joints: 3.1

[1] Terminal joint is explained in Chapter 6.

- Abutment type: average 3.2
- Poor construction specification: average 3.3
- Bridge type: average 3.3
- Lateral movement of the bridge abutment: average 3.4
- Too rigid a bridge foundation: average 3.5
- Others:
    1) Very few approach slabs in Brownwood District and no concrete pavement
    2) Cracking of riprap around fill allowing erosion of soil
    3) Variation of moisture content due to drought etc.
    4) Bridges with no expansion joints

6. In what cases does the problem appear to be worse?
    - High fill
    - Clay fills
    - Settlement and loss due to erosion
    - Poor compaction
    - Overcompaction
7. In what cases does the problem appear to be minimized?
    - Minimal fills
    - Rocky and sandy fills
    - Shorter structures, newer joint designs, good embankment material (non clay), and proper drainage
    - Fills constructed in advance of construction
8. Was a geotechnical investigation performed for foundation design?

    Yes
9. What methods do you use to detect the problem and how often do you use those methods?

    1 = often, 2 = sometimes, 3 = rarely, 4 = not at all
    - Ridability (subjective): average 1.1

- Visual inspection: average 1.2
- Public complaints: average 2.1
- NDT tests: 2.9
- Ridability (quantitative): average 3.0
- Others

10. What methods were used to investigate cause of the problem?
    - Visual inspection
    - Ground Penetrating Radar (GPR)
    - Soil borings
    - Removal of approach slab
    - Core to locate voids prior to mudjacking
    - Soil boring and drop hammer
11. How and when do you decide to perform maintenance on a bridge with this problem?
    - Subjective
    - Ride becomes unacceptable
12. Please list any other comments you might have regarding the bump at the end of the bridge.
    - Another factor that we feel may contribute is the limited work area and the interrupting of sequenced fill construction due to traffic control. Compaction and the associated quality control are difficult at best in these very constricted work areas.
    - We do not have a problem with our older structures where fill has stabilized, approach slabs, and cement stabilized fill behind abutment seem to be effective in mitigating settlement and preventing the bump.
    - District is currently using a stabilized bridge end backfill standard. Overcompaction concerns have prevailed with flexible pavement approaches. Pavement growth in Continuously Reinforced Concrete Pavement (CRCP) sections is also a major factor.

CHAPTER 4:
SITE SURVEY

Researchers surveyed 18 sites in the TxDOT Houston District. The methodology for this field survey was simple visual inspection. Table 4.1 and Table 4.2 summarize the performance level at each location.

Table 4.1. Poor-Performing Locations.

Highway	Highway Intersection	County	Comment
IH45	Almeda Genoa	Harris	• Both directions treated with Uretech 3 years ago • Approach Embankment: 16′ ~ 17′ • Bump Scale*[2]: 1
BW8	At SH3	Harris	• Eastbound treated with Uretech 3 years ago • Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1
SH99	At Owens Rd.	Ft. Bend	• Approach Embankment: 16′ • Bump Scale*: 0 ~ 1
SH99	At Oyster Ck.	Ft. Bend	• Approach Slab: PCC & 40′ • Approach Embankment: 10′ • Bump Scale*: 0 ~ 1
US59	Before Hillcroft exit ramp	Harris	• Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1
SH225	Center St. and Rohm-Hass	Harris	• Repairs are planned • Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1
IH45	At Parker Rd.	Harris	• Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1

[2] Bump Scale is explained in Chapter 5.

Table 4.1. (Continued).

US59	Saunders/Parker Rd.	Harris	• Repaired but still rough • Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1
SH249	At Grant Rd.	Harris	• Approach Embankment: 16′ ~ 17′ • Bump Scale*: 2
US290	Over FM362	Waller	• Repaired but still rough • Approach Embankment: 16′ ~ 17′ • Bump Scale*: 1 ~ 2

Table 4.2. Good-Performing Locations.

Highway	Highway Intersection	County	Comment
SH6	At Flat Bank Ck.	Ft. Bend	• Approach Slab: PCC & 40′ • Approach Embankment: 10′ • Bump Scale*: 0
FM1876	At A22 Ditch	Ft. Bend	• Approach Slab: PCC & 16′ • Approach Embankment: 10′ • Bump Scale*: 0
FM1876	At Keegans Bayou	Ft. Bend	• Approach Slab: PCC & 16′ • Approach Embankment: 10′ • Bump Scale*: 0
SH99	At Bullhead Slough	Ft. Bend	• Approach Slab: PCC & 16′ • Approach Embankment: 10′ • Bump Scale*: 0
SH99	At Brazos River	Ft. Bend	• Approach Slab: PCC & 17′ • Approach Embankment: 0′ • Bump Scale*: 0
FM3345	East of FM1092	Ft. Bend	• Roadway End of CRCP (not a bridge)

Table 4.2. (Continued).

FM3345	West of FM2234	Ft. Bend	• Roadway End of CRCP (not a bridge)
FM3345	At Stafford Run	Ft. Bend	• Approach Slab: PCC & 16′ • Approach Embankment: 10′ • Bump Scale*: 0

Figure 4.1 and Figure 4.2 show an example of poor performance (SH99 at Oyster Ck.). Examples of good performance, SH99 at Brazos river and FM1876 at A22 ditch, will be found in Figure 4.3 and Figure 4.4.

Figure 4.1. Front View of SH99 at Oyster Ck.

Figure 4.2. Side View of SH99 at Oyster Ck.

Figure 4.3. SH99 at Brazos River.

Figure 4.4. FM1876 at A22 Ditch.

CHAPTER 5:
RATING THE BUMP

Among the 18 sites that were visually investigated, 10 sites were classified as poor performance locations. The primary factor to classify a test site was the 'bump scale' which is judged by visual and drive-by survey. The rating of the bump scale developed for this project ranges from 0 to 4. Table 5.1 shows the ratings of the bump scale and their descriptions.

Table 5.1. Bump Scale Ratings.

Rating	Description	Range
0	No Bump	0
1	Slight Bump	~ 1 inch
2	Moderate Bump - Readily Recognizable	~ 2 inch
3	Significant Bump - Repair Needed	~ 3 inch
4	Large Bump - Safety Hazard	> 3 inch

The bump scales at US290 over FM362 and at SH249 over Grant Rd. are 1 ~ 2 and 2 inches, respectively.

Similar to the bump scale, the 'panel rating' (Carey and Irick 1960) is another method to estimate the road condition. This rating has a range of 0 to 5. A panel of pavement experts make their best evaluation of the condition of the test pavements based on close inspection, the experience of driving over them, and the use of measures taken from several instruments in use at the time. Table 5.2 shows the panel ratings and their descriptions.

Table 5.2. Panel Rating (after Carey and Irick 1960).

Rating	Description
0 ~ 1	Very Poor
1 ~ 2	Poor
2 ~ 3	Fair
3 ~ 4	Good
4 ~ 5	Very Good

The ratings from the panel of experts are processed to assign a single number to each pavement that represents its serviceability. The summary number is called the present serviceability rating (PSR). Non- engineers were asked to rate the pavements. The results were almost the same as those of experts. In addition to the ratings obtained from the panel of experts, several measures were taken of the pavements with instruments in use at the time. Using these measurements, PSR can be estimated using an equation obtained from statistical analyses of the data. The estimate of the PSR is called the present serviceability index (PSI). Carey and Irick (1960) used present serviceability ratings and statistical analyses to find a way of predicting the PSI of roads with a combination of objective measures of pavement condition. They proposed:

$$PSI = 5.03 - 1.91\log(1 + \overline{SV}) - 1.38\overline{RD}^2 - 0.01\sqrt{C + P} \quad (5.1)$$

for flexible pavements,

$$PSI = 5.41 - 1.78\log(1 + \overline{SV}) - 0.09\sqrt{C + P} \quad (5.2)$$

for rigid pavements,

where $\overline{SV}$ = slope variance of road profile,

$\overline{RD}$ = mean rut depth,

C = cracking index, and

P = patching index.

In 1982, the International Road Roughness Experiment (Sayers et al. 1986) was conducted by research teams from Brazil, the United Kingdom, USA, and Belgium to determine the equivalence between various methods of roughness measurement and to propose a measure that may be used by the many devices in current use. Out of this experiment the International Roughness Index (IRI) emerged.

The IRI is a mathematically defined summary statistic of the longitudinal profile in the wheelpath of a traveled road surface. The index is an average rectified slope statistic computed from the absolute profile elevations. It is representative of the vertical motions induced in moving vehicles for the frequency bandwidth which affects both the response of the vehicle and the comfort perceived by occupants.

The IRI describes a scale of roughness which is zero for a true planar surface, increasing to about 6 for moderately rough paved roads, 12 for extremely rough paved roads with potholing and patching, and up to about 20 for extremely rough unpaved roads, as shown in Figure 5.1.

The bump potential index (BPI) was also introduced for this project to quantify the potential for having a bump. The BPI is expressed as

$$BPI = a_1 H_e + a_2 ADT + a_3 t_{life} + a_4 AYP + a_5 \Delta T + a_6 (1 - \frac{R_{ab}}{R_{emb}}) + a_7 s \tag{5.3}$$

where α_i = Rating factor

H_e = Height of embankment

ADT = Average Daily Traffic

t_{life} = Bridge Life

AYP = Average yearly precipitation

ΔT = Temperature cycle

R_{ab} = Resistance of abutment

R_{emb} = Resistance of embankment

s = Gradient of approach.

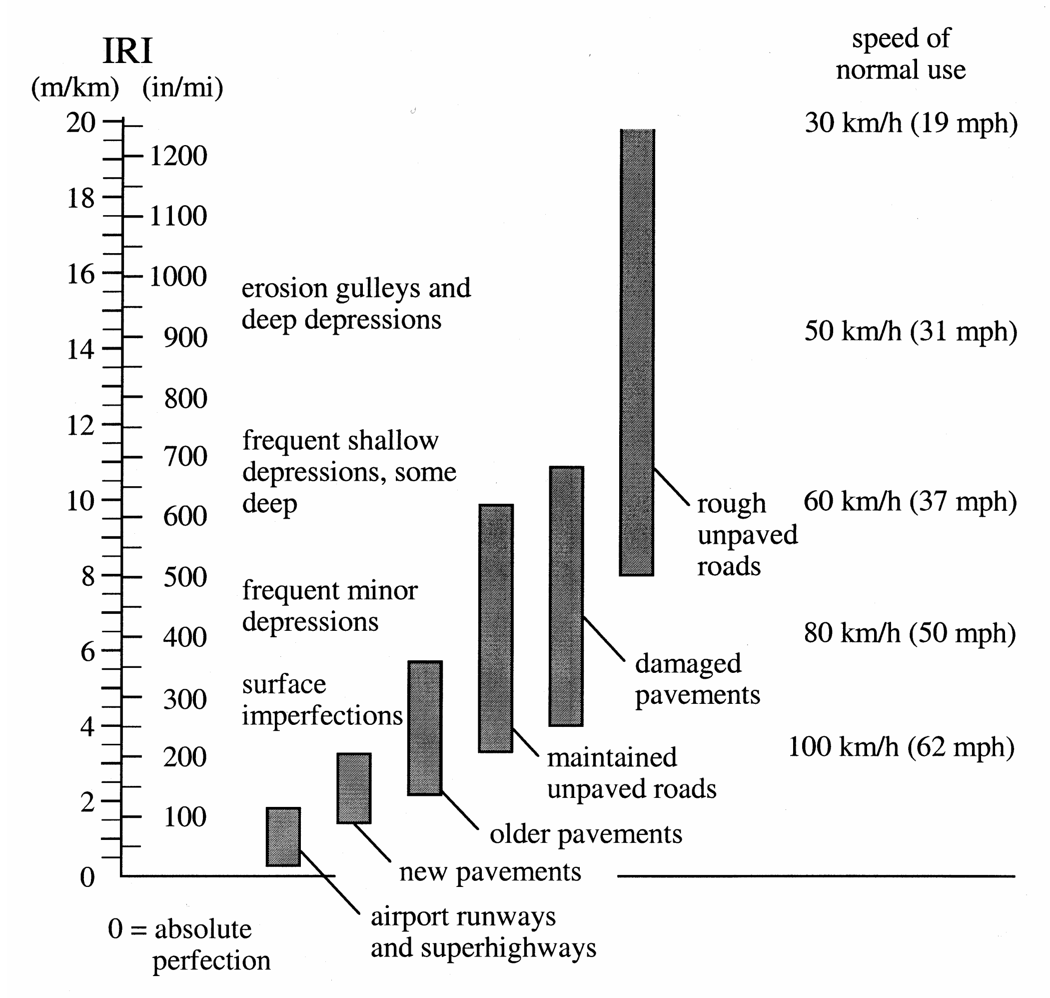


Figure 5.1. Physical Interpretation of the International Roughness Index (IRI) Scale (Sayers et al. 1986).

More work on the BPI .α factors is required to make it more useful. Using all α values equal to 1 can be a starting point.

US290 over FM362 and SH249 at Grand Rd. were chosen by 'bump rating' and other site factors mentioned above.

CHAPTER 6:
SITE DESCRIPTION

Map of Sites

Figure 6.1 shows the location of the two test sites, US290 over FM362 in Waller county and SH249 at Grant Rd. in Harris county.

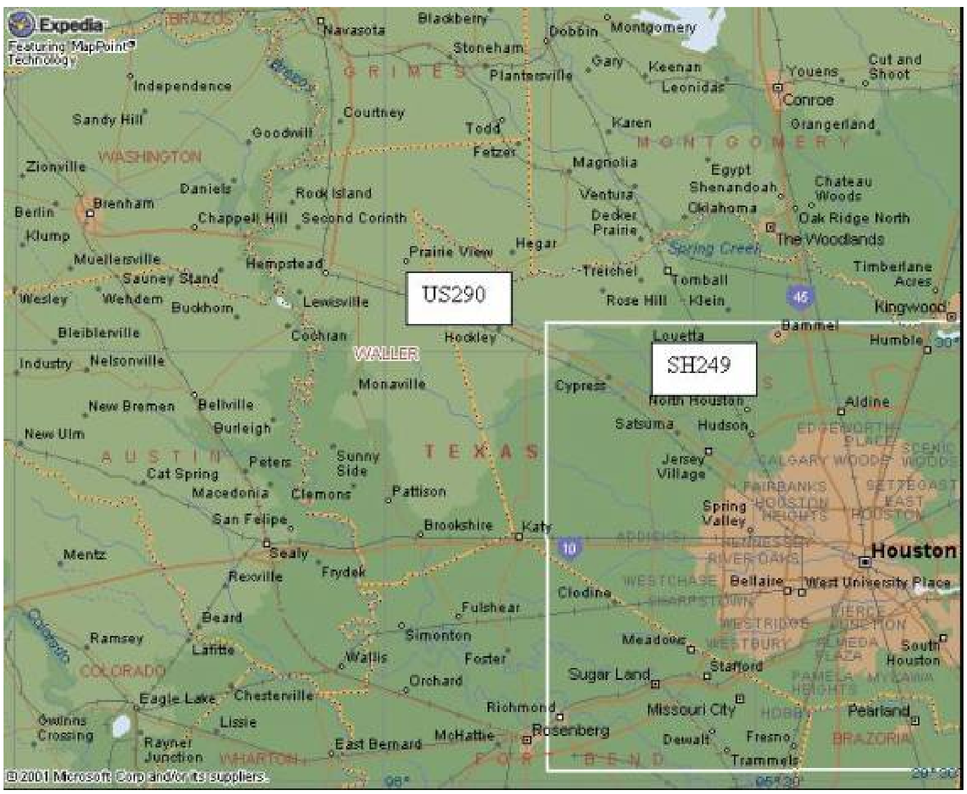


Figure 6.1. Map for the Test Sites.

Average Daily Traffic (ADT)

The average daily traffic is an important factor both to design highways and to analyze the bump problem. The ADT is the total volume of traffic during a given time period (in whole days greater than one day and less than one year) divided by the number of days in that time period. The ADT at the US290 site (1996) is 17,000 vehicles per day, and it is 26,000 vehicles per day at the SH249 (1997).

Weather

As shown in equation 5.3, weather is one factor that affects the settlement of approach slabs. Therefore, it is important to know the local weather of Houston where the test sites are located. According to the internet web site weather.com climatology of Houston, the study of historical weather conditions for a given region, is as shown in Table 6.1.

Table 6.1. Historical Average Weather of Houston.

Month	Low Temperature (°F)	High Temperature (°F)	Rain (inch)
January	41	61	3.9
February	44	66	2.9
March	51	73	3.5
April	58	79	3.6
May	65	85	5.6
June	71	91	5.1
July	73	94	3.4
August	73	93	3.7
September	68	89	4.3
October	59	82	4.7
November	50	72	3.7
December	44	65	3.6
Average	58.0	79.1	4.0

Approach Slab

Approach slabs are reinforced concrete slabs used to span the problematic area between the approach pavement and the bridge abutment. The primary function of the approach slab is to provide a gradual smooth transition. Figure 6.2 shows the plan view of an approach slab, and Figure 6.3 shows a cross section of a typical two-span approach slab with a wide flange. Approach slabs are used in 80 percent of new bridges (Schaefer and Koch 1992). Approach slabs are designed to span a various length, but a typical range is 4 to 7 m (13 to 23 ft). The thickness of approach slabs also varies. Typically they are 225 to 305 mm (9 to 12 inches) thick. The slabs may be supported at both ends; the bridge end support is provided by the abutment and the pavement end support by a sleeper slab or by the roadway embankment. A sleeper slab is a footing that extends the entire width of the roadway.

The intended function of an approach slab is:

- to span the void that may develop below the slab;
- to prevent slab deflection, which could result in settlement near the abutment;
- to provide a ramp for the differential settlement between the embankment and the abutment. This function is affected by the length of the approach slab and the magnitude of the differential settlement; and
- to provide a better seal against water percolation and erosion of the embankment.

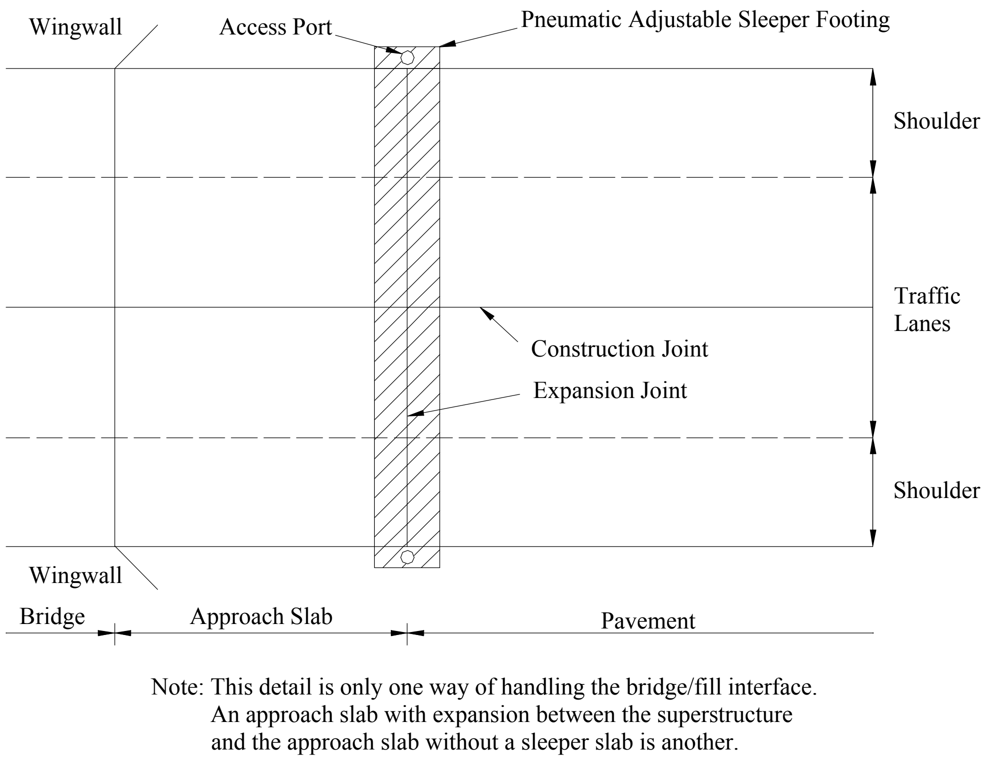


Figure 6.2. Plan View of an Approach System (after Tadros and Benak 1989).

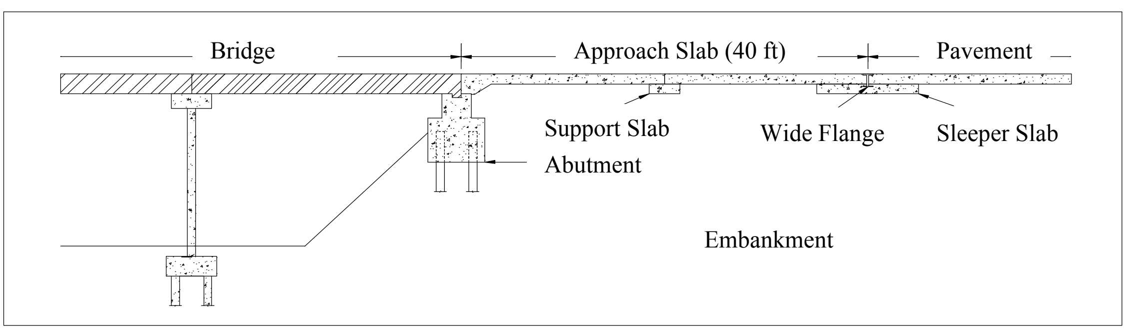


Figure 6.3. Cross Section of a Typical Two-Span Approach Slab with a Wide Flange.

The portion of the embankment under the approach slab is difficult to construct to the same compaction standards as the major portion of the embankment and is more susceptible to live-load induced deformation. The approach slab appears to be the most important component in the bridge for reducing the bump at the approach. Previous surveys confirm this condition with a consensus of respondents mentioning the positive aspects of approach slabs in preventing or minimizing the problem (Briaud, et al., 1997). When to use an approach slab is a difficult question to answer. The decision should be based on the amount of calculated or anticipated differential settlement between the abutment and the embankment, the ability to achieve good compaction, and the ability to prevent erosion or loss of support due to water infiltration. A slope of 1/200 is acceptable from the standpoint of riding comfort (Wahls 1990: Stark et al. 1995).

The approach slabs at both sites are two-span approach slab with a wide-flange beam (Figure 6.4 and 6.5). Figure 6.6 shows the cross sections of US290 and SH249.

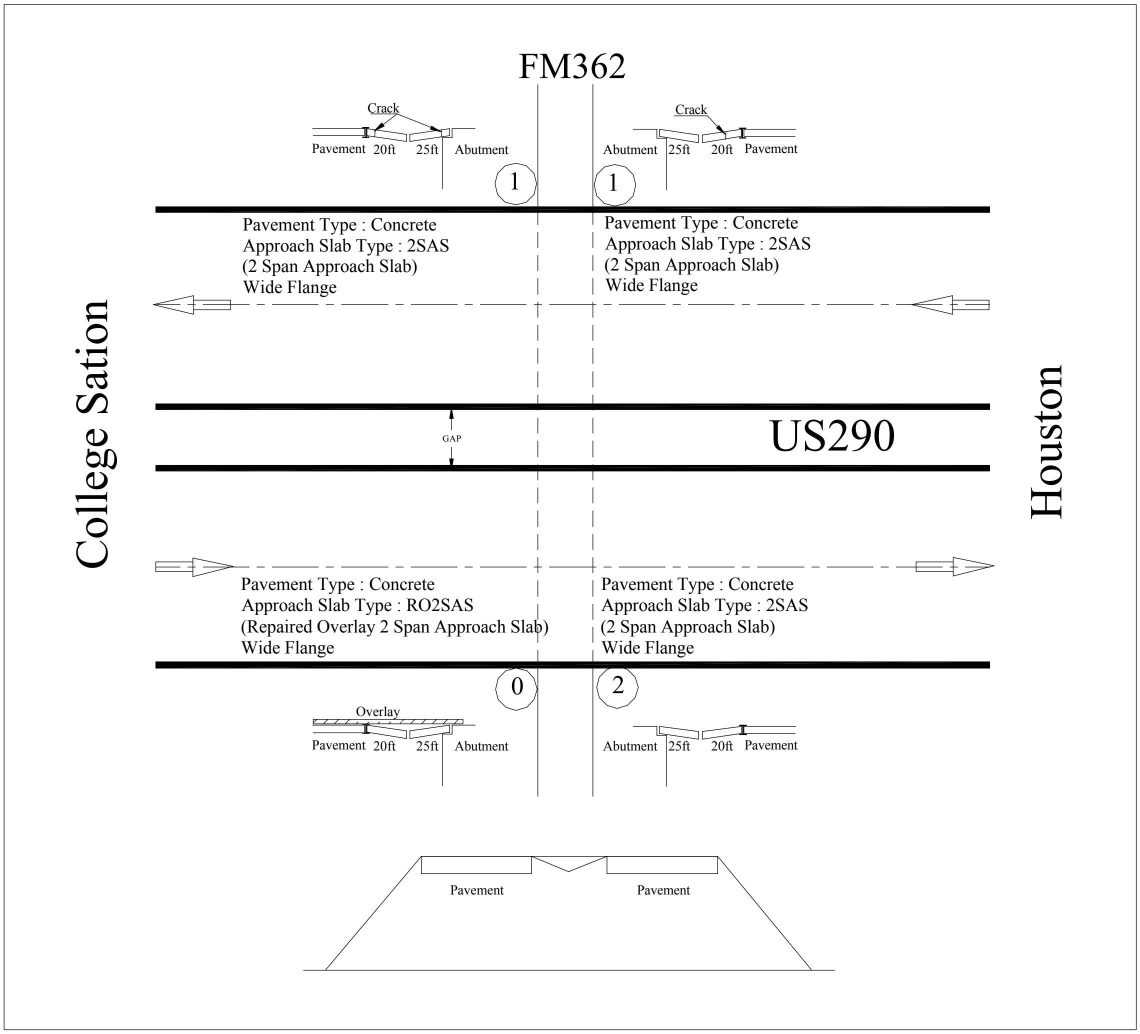


Figure 6.4. Approach Slab Type of US290.

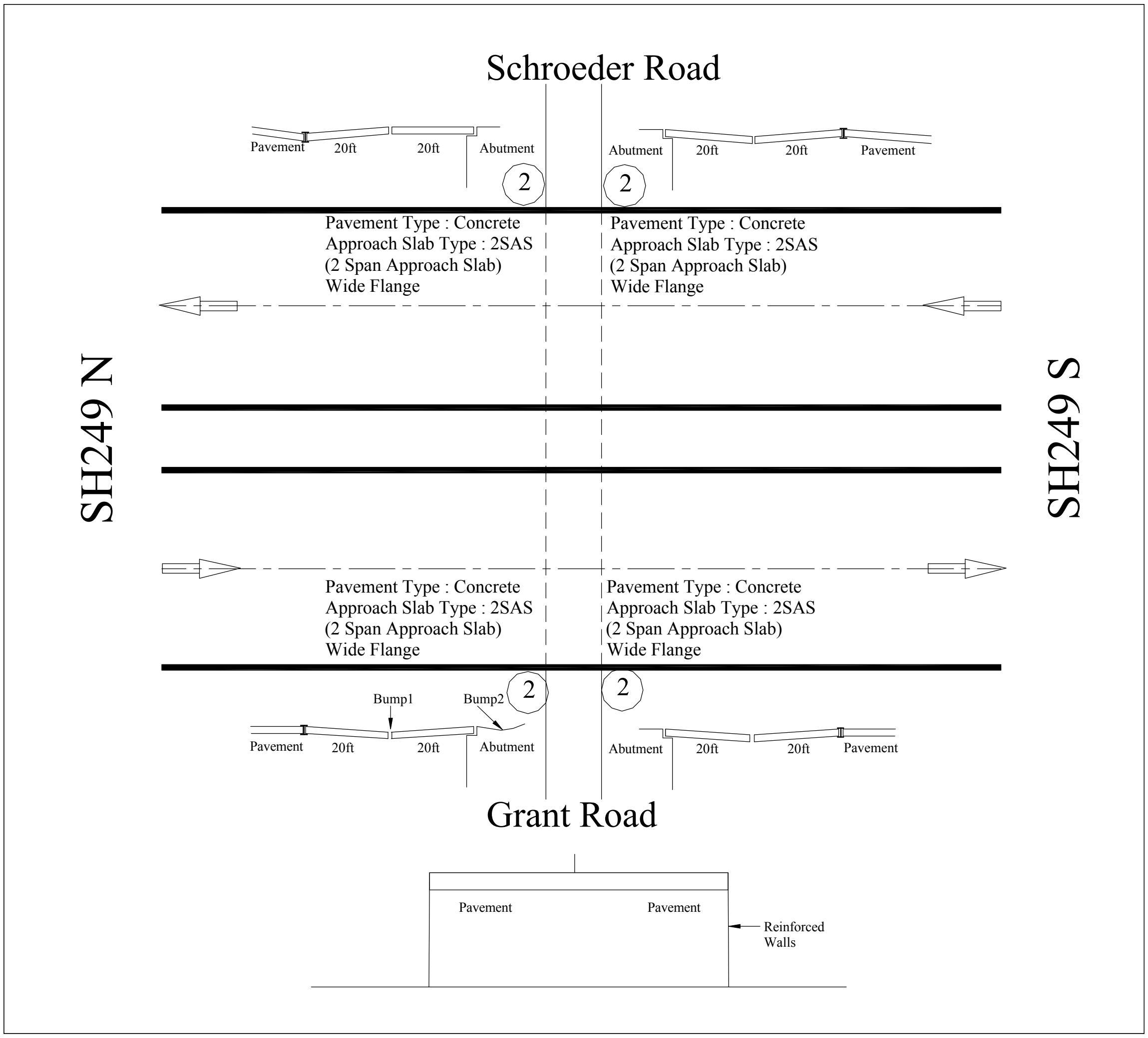
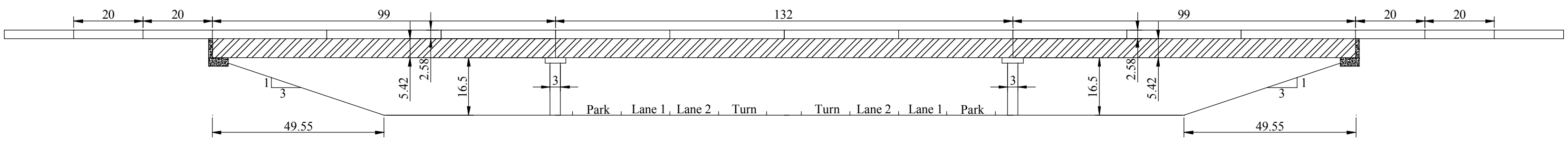
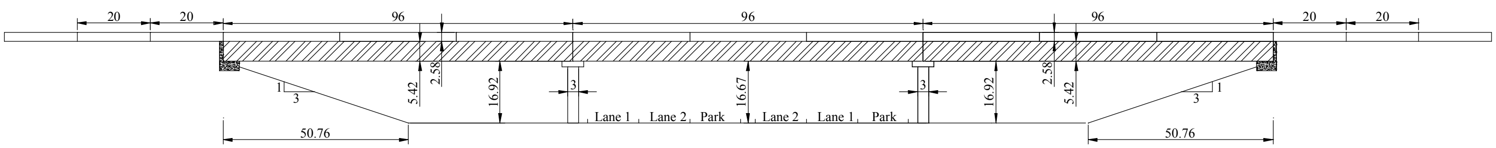


Figure 6.5. Approach Slab Type of SH249.



US290 over FM362



SH249 at Grant Rd

Unit: ft

Figure 6.6. Cross Sections of the Test Sites.

Bridge/Roadway Joint

Expansion Joint

An expansion joint is sometimes used to allow for thermal changes that occur in the bridge and the approach system (Figure 6.2). An expansion joint that is properly maintained will cause few problems. However, if the seal in an expansion joint is allowed to deteriorate or is improperly installed, debris will collect in the joint, and the structure will have no room to expand. Distress to the bridge or the abutment will then occur.

Terminal Joint

The most commonly used terminal treatments are the wide-flange (WF) steel beam which accommodates movement and the lug anchor which restricts movement. The terminal joint at both test sites is the wide-flange steel beam terminal joint.

- Wide-Flange Steel Beam Joint

The wide-flange steel beam joint consists of a WF beam partially set into a reinforced concrete sleeper slab which is approximately 10 ft long and 10 inches thick. The top flange of the beam is flush with the pavement surface. Expansion material, sized to accommodate end movements, is placed on one side of the beam along with a bond-breaker between the pavement and the sleeper slab. In highly corrosive areas the beam should be treated with a corrosion inhibitor. Stud connectors should be welded to the top flange, as shown in Figure 6.7, to prevent premature failures of WF beams where the top flange separates from the beam web.

- Lug Anchor Terminal Joint

The lug anchor terminal treatment generally consists of three to five heavily reinforced rectangular transverse concrete lugs placed in the subgrade to a depth below frost penetration prior to the placement of the pavement. They should be tied to the pavement with reinforcing steel. Since lug anchors restrict approximately 50 percent of the end movement of the pavements an expansion joint is usually needed at a bridge approach. Figure 6.8 shows a typical lug anchor terminal treatment.

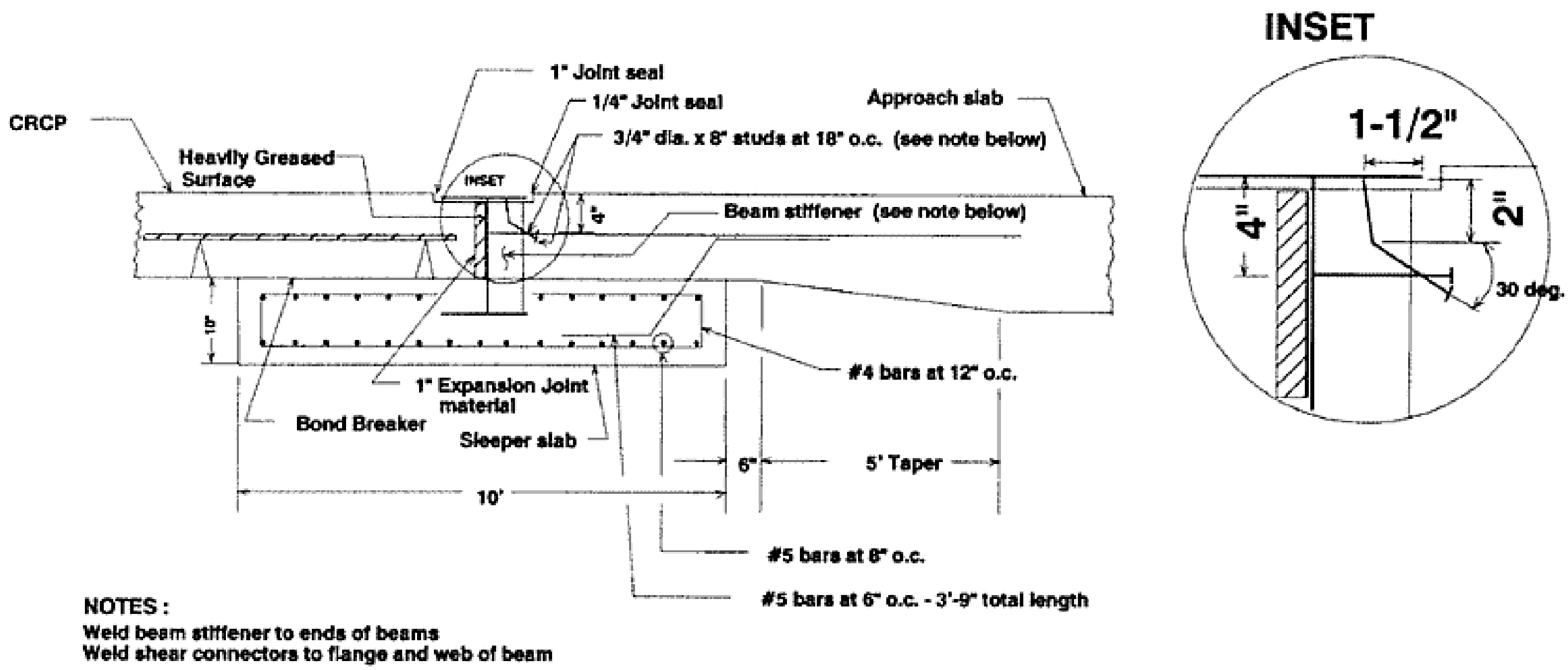


Figure 6.7. Wide-Flange Steel Beam Terminal Joint (http://www.fhwa.dot.gov/legsregs/directives/techadvs/508014a.htm).

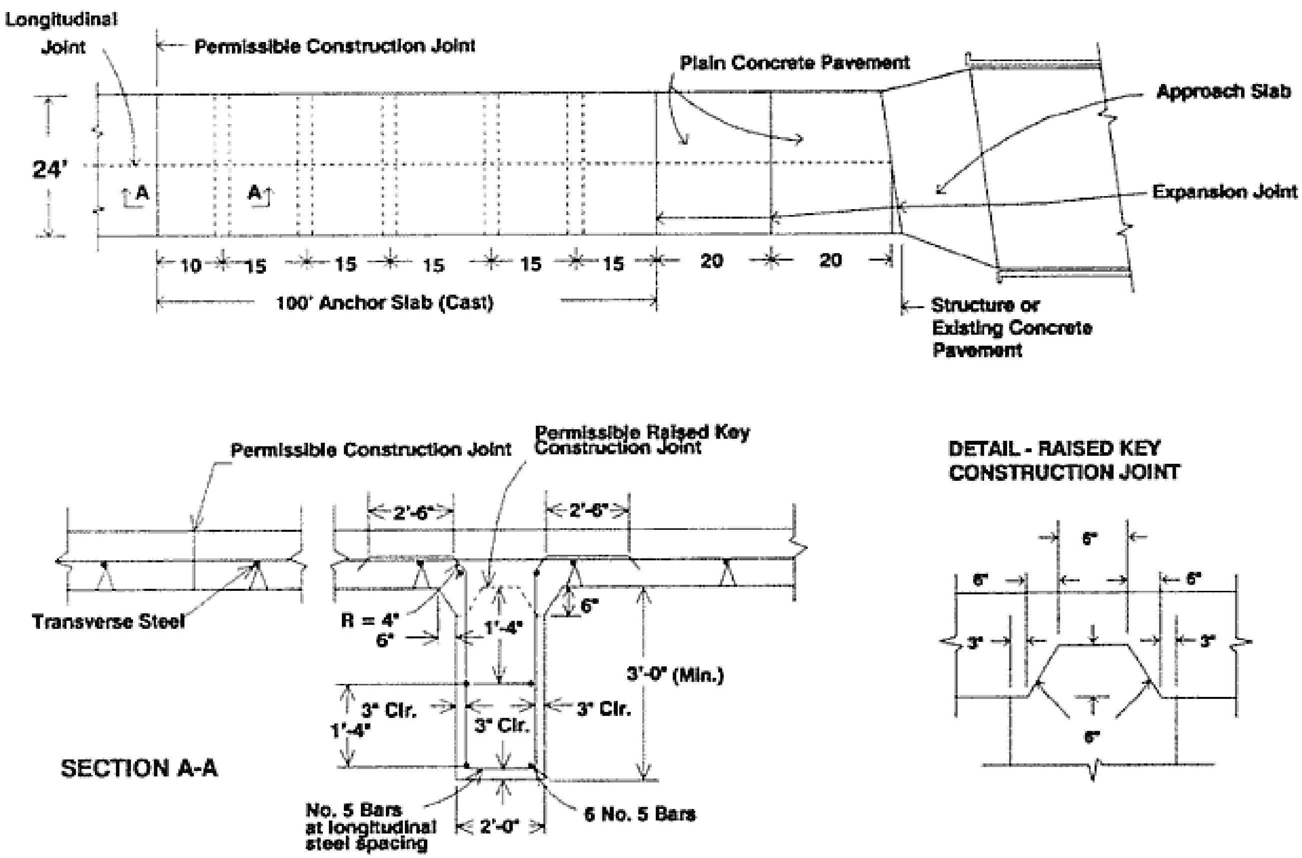


Figure 6.8. Lug Anchor Terminal Joint (http://www.fhwa.dot.gov/legsregs/directives/techadvs/508014b.htm).

Test Locations

Figure 6.9 and Figure 6.10 show the plan view of the test locations and the cross section of the test holes. The depth of all the boreholes was 33 ft except in three sites SH249 NS STS-2 (16 ft), SH249 NN STS-1 (23 ft), and SH249 NN STS-2 (22 ft) (Appendix E).

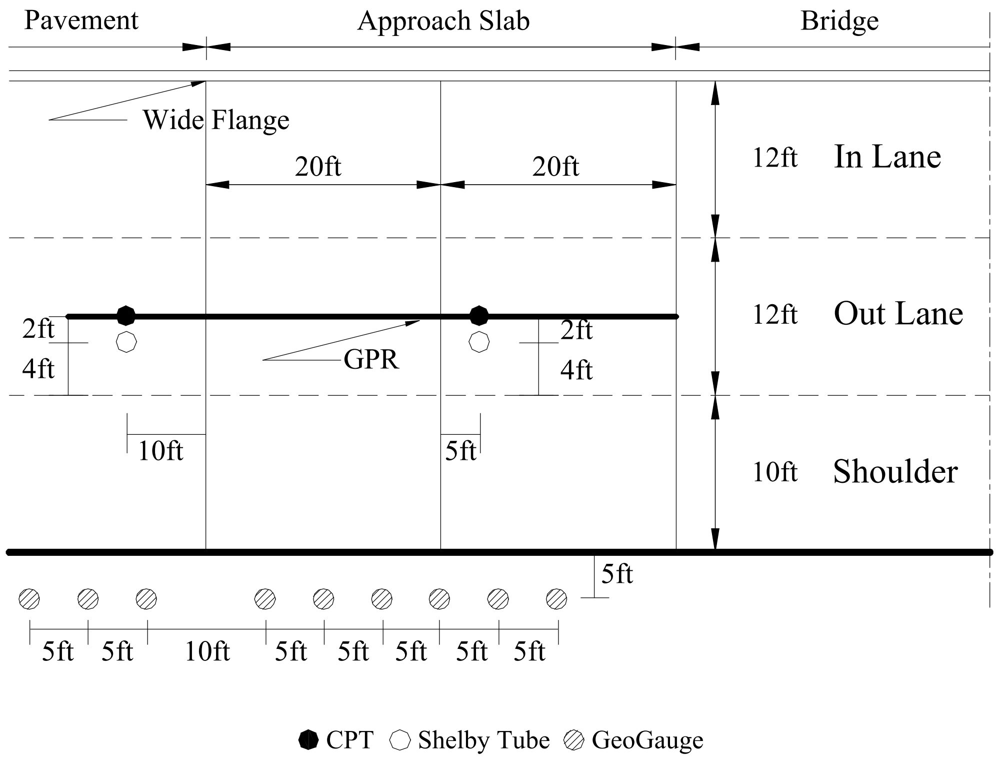


Figure 6.9. Plan View of the Test Locations.

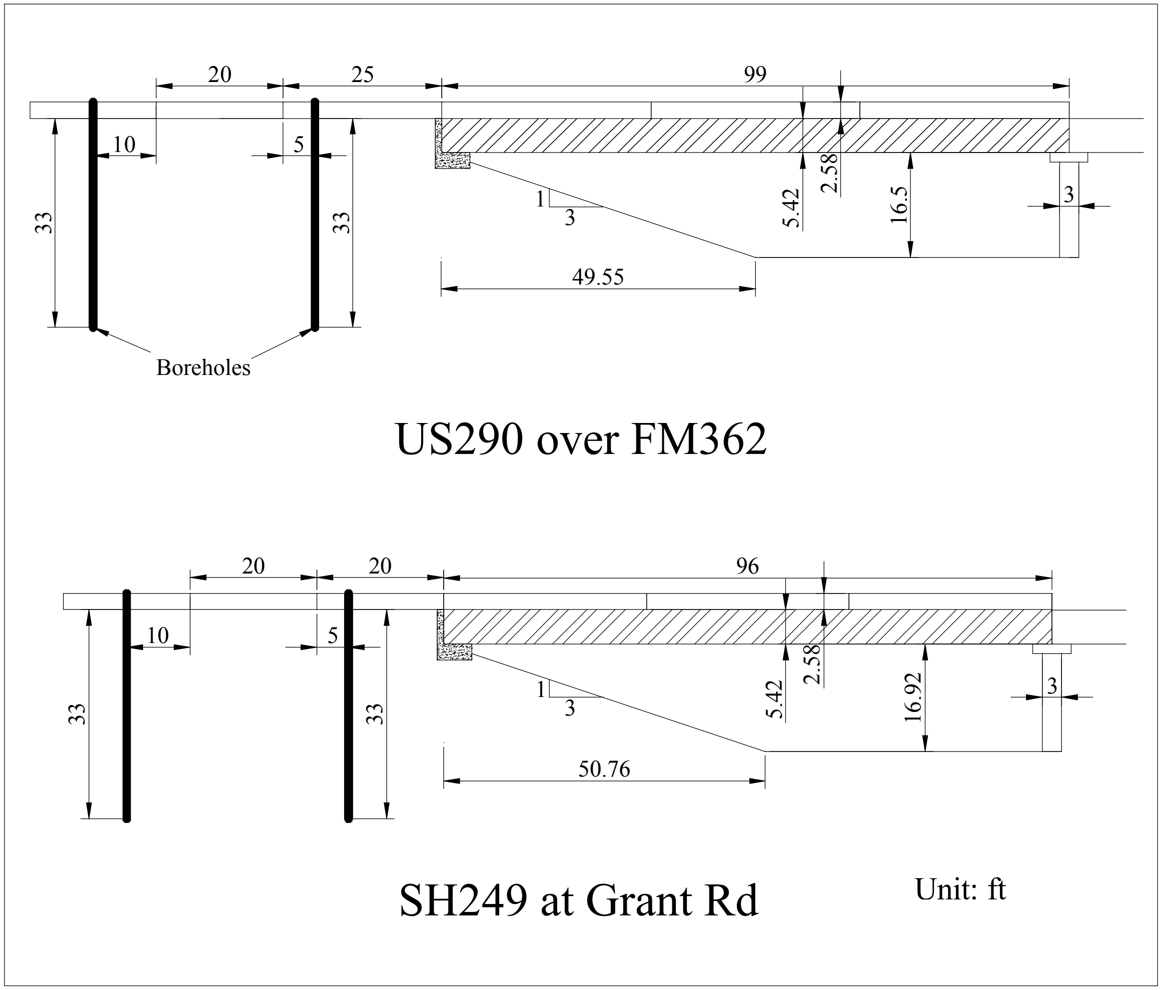


Figure 6.10. Location of Boreholes.

CHAPTER 7:
FIELD TEST AND RESULTS

The data collected and reviewed in previous work were limited to field visits, review of records maintained by the TxDOT, and did not involve any field and/or laboratory testing. Therefore, researchers conducted field and laboratory tests in this project to analyze the problem. Researchers used the following field tests: the profilometer test, the ground penetration radar test, continuous shelby tube sampling, the cone penetrometer test, and the field GeoGauge test.

Before all the field and laboratory tests, the concrete had to be cored. The following tables show the thickness of the pavement at US290 over FM362 and SH249 at Grant Rd. The nomenclature used to refer to a boring is explained with this example:

US290 EW CSTS-1 refers to a test hole done at the US290 over FM362 site, on the bridge going West, at the East end, by Continuous Shelby Tube Sampling in test hole No. 1 (near side from the bridge) (Figure 6.9). CPT stands for Cone Penetrometer Test.

Table 7.1 US290 Coring Thickness

Site	Asphalt Overlay	Concrete	Bond Breaker	Stabilizer	Total
US290 EW CSTS-1		11.75 inches	1.0 inch	5.0 inches	17.75 inches
US290 EW CSTS-2		11.75 inches	1.0 inch	5.5 inches	18.25 inches
US290 EW CPT-1		11.75 inches	1.0 inch	5.0 inches	17.75 inches
US290 EW CPT-2		11.75 inches	1.0 inch	5.0 inches	17.75 inches
US290 WW CSTS-1		11.50 inches	1.0 inch	6.0 inches	18.50 inches
US290 WW CSTS-2		10.25 inches	1.0 inch	5.5 inches	16.75 inches
US290 WW CPT-1		11.50 inches	1.0 inch	6.5 inches	19.00 inches
US290 WW CPT-2		10.25 inches	1.0 inch	5.5 inches	16.75 inches
US290 WE CSTS-1	1.25 inches	11.00 inches	1.0 inch	5.5 inches	18.75 inches
US290 WE CSTS-2	0.75 inches	11.00 inches	1.0 inch	5.5 inches	18.25 inches
US290 WE CPT-1	3.00 inches	11.50 inches	1.0 inch	6.0 inches	21.50 inches
US290 WE CPT-2	0.75 inches	11.00 inches	1.0 inch	5.5 inches	18.25 inches
US290 EE CSTS-1		10.00 inches	1.0 inch	9.0 inches	20.00 inches
US290 EE CSTS-2		10.50 inches	1.0 inch	9.0 inches	20.50 inches
US290 EE CPT-1		10.25 inches	1.0 inch	9.0 inches	20.25 inches
US290 EE CPT-2		10.50 inches	1.0 inch	9.0 inches	20.50 inches

Table 7.2 SH249 Coring Thickness

Site	Asphalt Overlay	Concrete	Bond Breaker	Stabilizer	Total
SH249 NS CSTS-1		12.50 inches	0.0 inch	13.0 inches	26.50 inches
SH249 NS CSTS-2		14.00 inches	1.0 inch	8.0 inches	23.00 inches
SH249 NS CPT-1		13.50 inches	0.0 inch	13.0 inches	34.50 inches
SH249 NS CPT-2		14.50 inches	1.0 inch	8.0 inches	23.50 inches
SH249 SS CSTS-1		17.50 inches	0.0 inch	20.5 inches	38.00 inches
SH249 SS CSTS-2		14.00 inches	1.0 inch	18.0 inches	33.00 inches
SH249 SS CPT-1		18.00 inches	0.0 inch	19.0 inches	37.00 inches
SH249 SS CPT-2		14.00 inches	1.0 inch	19.5 inches	34.50 inches
SH249 SN CSTS-1		14.50 inches	0.0 inch	19.0 inches	33.50 inches
SH249 SN CSTS-2		12.50 inches	1.0 inch	15.5 inches	29.00 inches
SH249 SN CPT-1		14.00 inches	0.0 inch	19.0 inches	33.00 inches
SH249 SN CPT-2		12.50 inches	1.0 inch	15.0 inches	28.50 inches
SH249 NN CSTS-1		16.50 inches	0.0 inch	18.5 inches	35.00 inches
SH249 NN CSTS-2		13.00 inches	1.0 inch	18.0 inches	32.00 inches
SH249 NN CPT-1		16.00 inches	0.0 inch	20.0 inches	36.00 inches
SH249 NN CPT-2		13.00 inches	1.0 inch	15.5 inches	29.50 inches

Profilometer Test

Profiles taken along a line perpendicular to the traffic direction show the super elevation and crown of the road design, plus rutting and other distress. Longitudinal profiles show the design grade, roughness, and texture. The road profile is computed from the difference between the distance from the vehicle to the road and the vertical motion of the vehicle. The vertical motion of the vehicle is measured by first measuring the vertical acceleration of the vehicle and then double integrating this acceleration to obtain vertical motion (Sayers and Karamihas 1998).

Figure 6.1 illustrates an accelerometer which is a sensor that measures acceleration. Data processing algorithms convert the vertical acceleration measure to an inertial reference that defines the instant height of the accelerometer in the host vehicle. The height of the ground relative to the reference is, therefore, the distance between the accelerometer and the ground directly under the accelerometer. This height is measured with a non-contacting sensor such as a laser transducer. The longitudinal distance of the instruments is usually picked up from the vehicle speedometer. Figure 7.2 and Figure 7.3 illustrate a typical profilometer test result and International Roughness Index, respectively. To check the continuance of the bump with time, researchers conducted the profilometer test twice (April 2001 and March 2002). Table 7.3 shows bump range of each site. Appendix C shows profilometer profiles and IRI calculated from the profilometer test. All profiles were obtained by riding at 50 mi/hr. in the middle of the right-hand lane.

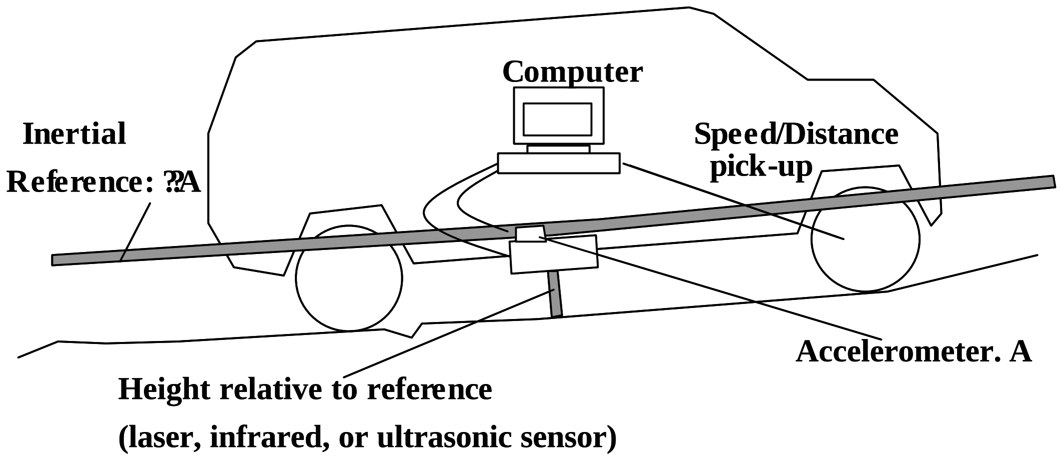


Figure 7.1. Conceptual Drawing of Profilometer (after Sayers and Karamihas 1998).

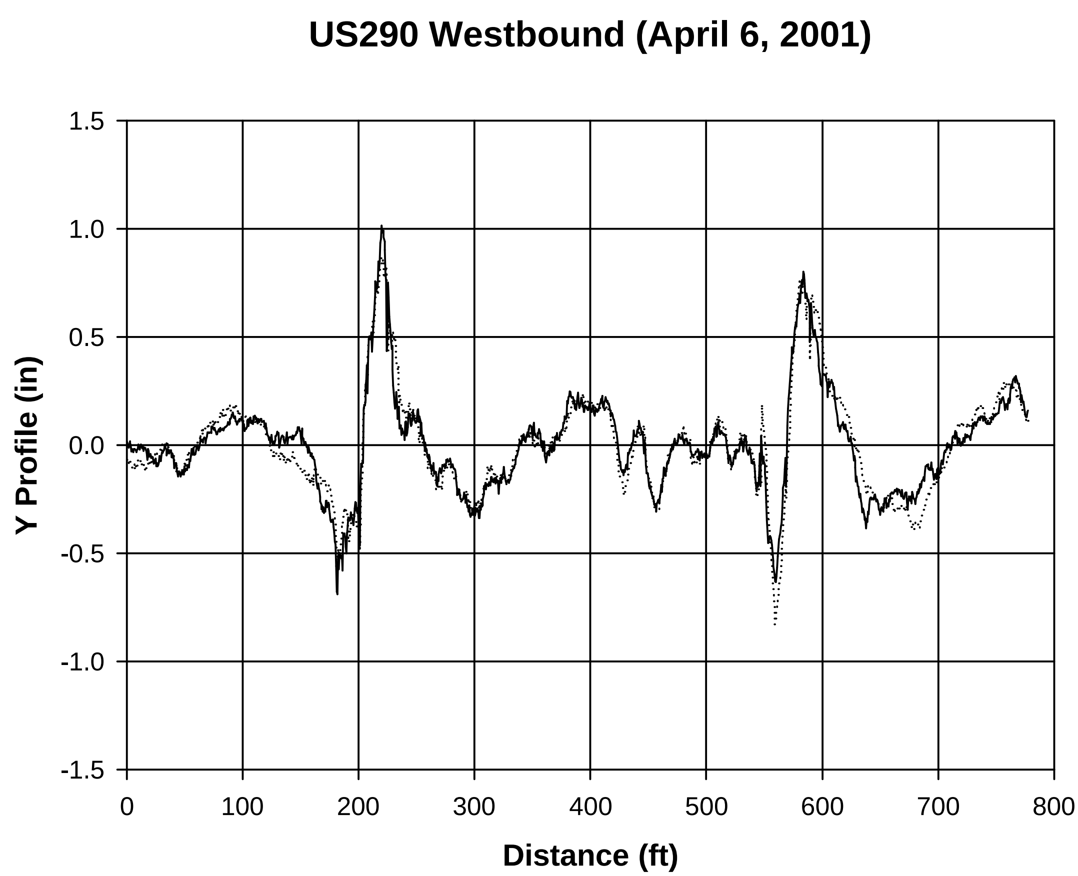


Figure 7.2. Typical Profilometer Test Result (US290 Westbound, April 6, 2001).

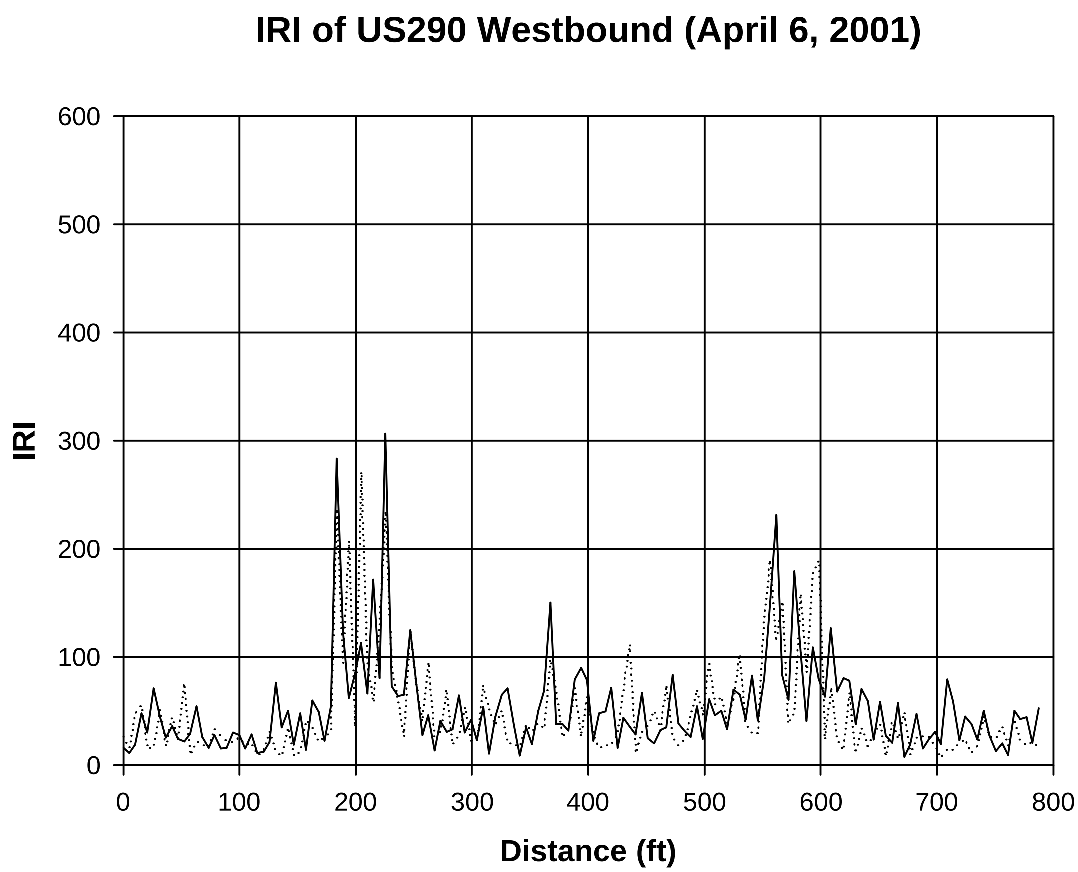


Figure 7.3. Typical International Roughness Index (US290 Westbound, April 6, 2001).

Table 7.3. Bump Range of Each Site.

Test Site	Test Date	
	April,\ 2001	March 2002
US290 WE	1.82	2.09
US290 EE	1.99	0.76
US290 EW	1.58	1.68
US290 WW	1.52	1.71
SH249 NS	1.15	2.12
SH249 SS	1.47	0.99
SH249 SN	2.35	1.52
SH249 NN	1.85	1.17

Ground Penetration Radar Test

The Ground Penetrating Radar is a nondestructive geophysical method that produces a continuous cross-sectional profile or record of subsurface features, without drilling, probing, or digging. GPR profiles are used for evaluating the location and depth of buried objects and investigating the presence and continuity of natural subsurface conditions and features. GPR operates by transmitting pulses of ultra high frequency radio waves (microwave electromagnetic energy) down into the ground through a transducer or antenna. The transmitted energy is reflected from various buried objects or distinct contacts between different earth materials. The antenna then receives the reflected waves and stores them in the digital control unit. Figure 7.4 illustrates a typical example of a GPR result. Figure 7.5 is one of the field test results in this project; it shows that there is no void below the pavement. The line along which the GPR was run is shown in Figure 6.9. Appendix D shows all the GPR results.

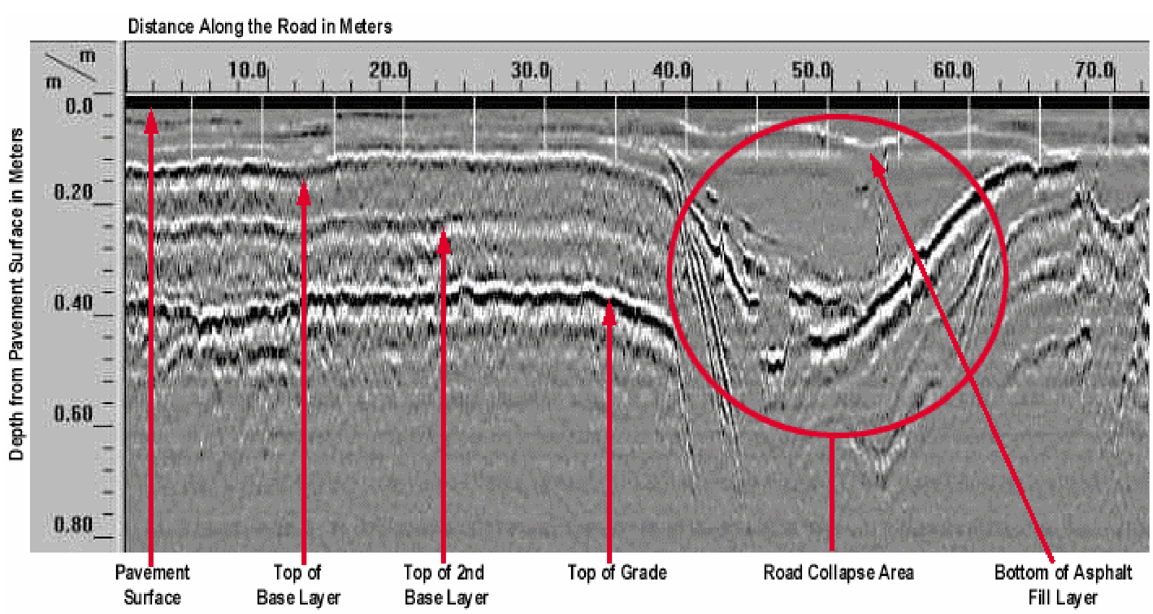


Figure 7.4. Typical Result of GPR Test.

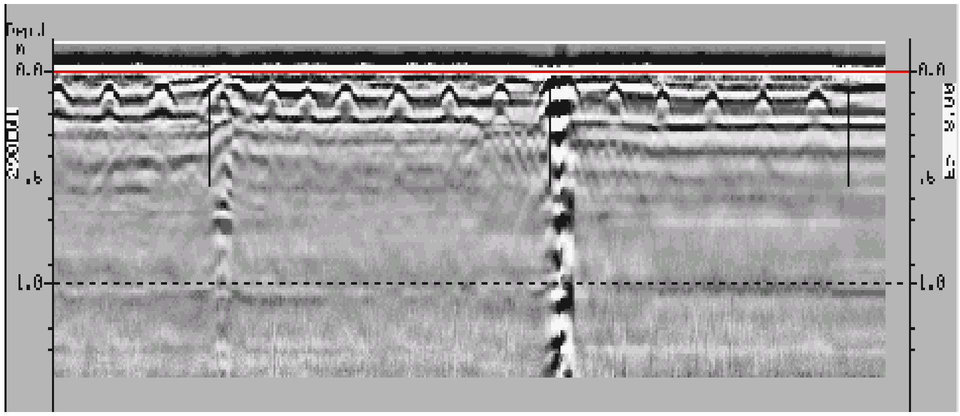


Figure 7.5. One GPR Test Result (US290 EW1).

Continuous Shelby Tube Sampling (CSTS)

Continuous Shelby Tube Sampling (CSTS) was used to obtain soil samples. It can also be used to apparent soil classification. The thin wall steel tubes are made of seamless tubes with outside diameters of 2 inches and 3 in. This project used 3 inch outside diameter tubes. The sampler is attached to a drilling rod and lowered to the bottom of the borehole. The Shelby tube is then pushed into the soil by hydraulic power in one continuous push without rotation. The sampler with the soil is pulled out, sealed, and sent to the laboratory for testing. Figure 7.6 shows a CSTS mounted truck.

Soil samples collected by CSTS can be used in laboratory tests to determine the mechanical properties (triaxial test and consolidation test) as well as physical properties (water content test, unit weight, Atterberg limit test).

Figure 7.7 shows a typical continuous Shelby tube drilling log. Appendix E presents all drilling logs, and Figure 6.9 shows the boring locations.

Figure 7.6. Shelby Tube Sampling Truck.

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ____

County WALLER — Structure BRIDGE — District No. 12

Highway No. US 290 @ FM 362 — Hole No. US 290-EW-STS-2 — Date 6/5/01

Control ______ Station ______ Grd. Elev. ______

Projuct No. ______ Loc. From Centerline Rt. ______ Lt. ______ Grd. Water Elev. ______

Elev. (Ft.)	Depth (Ft.)	Sampl er	Log	THD PEN. TEST No. of Blows 1st 6"	2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
												(3 ~ 5 ft)
						1						Clay w/sand, tan, brown, gray stiff
						2						Sandy clay, tan, brown, gray stiff
						3						Sandy clay, tan, brown, gray w/organic
	5											(5 ~ 7 ft)
						4						Sandy clay, tan, brown, gray w/organic
						5						Clay w/sand, tan, brown, gray stiff
												(9 ~ 11 ft)
						6						Clay w/sand, tan, brown, gray stiff
	10					7						Same as above
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay, dark brown, gray w/red stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Sandy clay, tan, gray w/red stiff
						12						Same as above
	25											
												(26 ~ 28)
						13						Sandy clay, gray, red, stiff
	30											(31 ~ 33)
						14						Sandy clay, red, gray stiff
						15						Same as above

Driller Marco Rodriguez — Logger Pepito Tapado — Title ______

Figure 7.7. Typical CSTS Boring Log.

Cone Penetrometer Test (CPT)

The Cone Penetrometer Test allows engineers to determine the soil strength profile and identify the soils present. These parameters can then be used to evaluate other engineering parameters of the soil and to assess bearing capacity and settlement. The CPT consists of pushing a series of cylindrical rods with a cone at the base into the soil at a constant rate of 20 mm/sec. Continuous measurements of penetration resistance on the cone tip and friction sleeve are recorded during the penetration. The Piezo-cone records pore pressures in addition to point and friction resistance. Figure 7.8 shows the CPT truck, and Figure 7.8 shows the CPT cone right before penetration.

Figure 7.8. CPT Truck.

Figure 7.9. CPT Cone Right before Penetration.

Figure 7.10 is a typical CPT test result which consists of a tip resistance profile, a friction resistance profile, and the ratio of the tip resistance over the friction resistance profile. All the CPT profiles are presented in Appendix F, and their locations are shown in Figure 6.9.

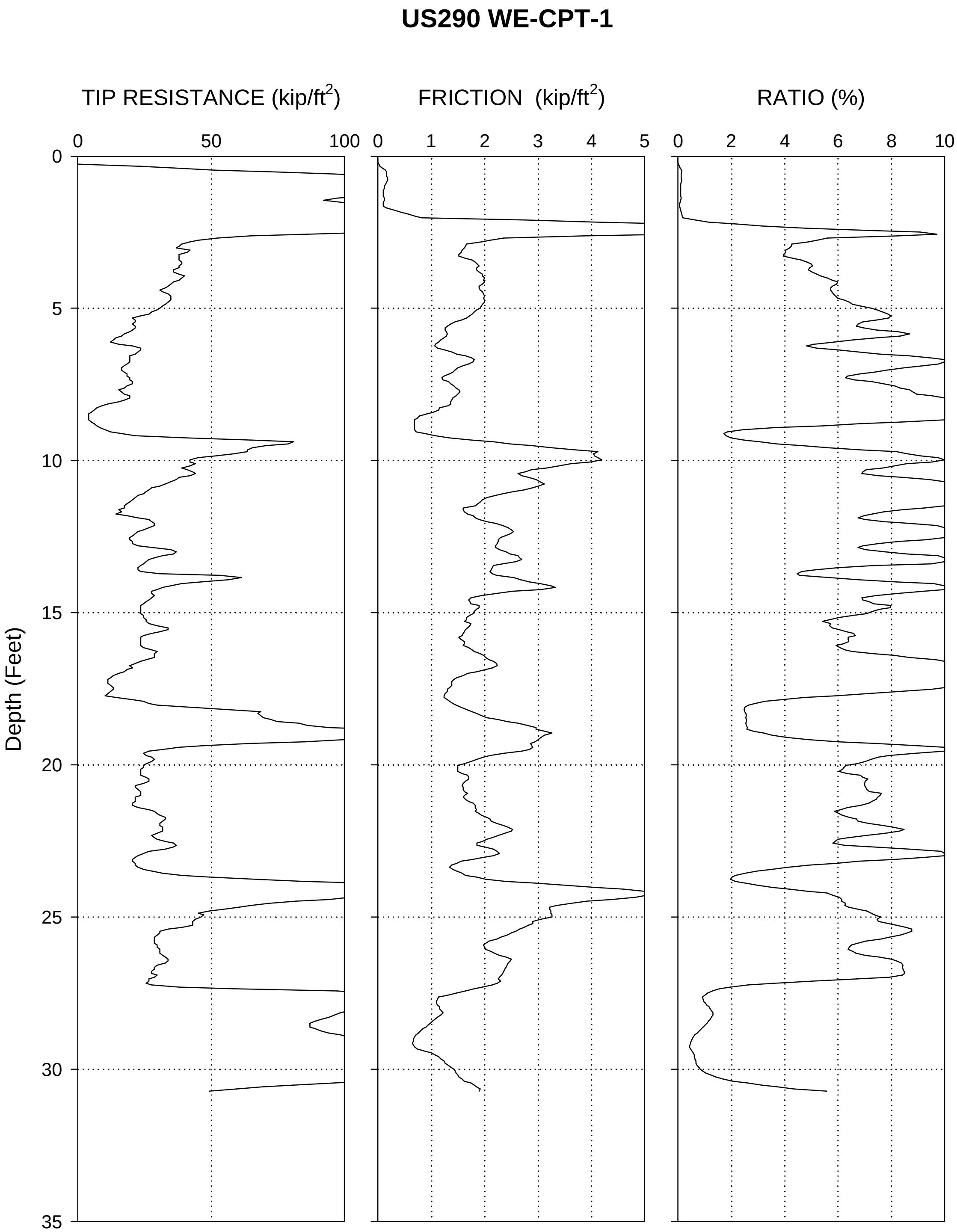


Figure 7.10. Typical CPT Test Result.

Field GeoGauge Test

The GeoGauge is a portable instrument that provides a simple, rapid means of directly measuring the stiffness of a soil close to the surface using steady state vibration. A diagram of the GeoGauge is presented in Figure 7.11. An annular ring foot is attached to the bottom of the GeoGauge. The ring foot is placed by applying slight force or rotation on the soil surface to obtain good contact with the soil tested. The GeoGauge generates a harmonic force excitation. Then, the displacement of the ring foot is recorded by this instrument. The equation for computing the stiffness of the soil used by the GeoGauge is:

$$K_d = F_0 / x_0 = \sqrt{\left(K - Mw^2\right)^2 + C^2 w^2} \tag{7.1}$$

where K_d is the dynamic stiffness (kip/ft), F_0 is the amplitude of the force (kip), x_0 is the amplitude of the dynamic displacement (ft), K is the static stiffness (kip/ft), M is the mass (lb), C is the damping coefficient (kip·s/ft), and ω is the circular frequency (rad/s).

During a GeoGauge test, the instrument imparts a harmonic force at one frequency for a few seconds and records the displacement of the annular ring experienced under this exciting force. Then, the GeoGauge computes the stiffness of the soil by using equation (7.1) and stores it. Then, the GeoGauge moves to a slightly higher frequency and repeats the process. This process goes on until the frequency has reached 200 Hz. The results of one test therefore consist of a number of frequencies between 100 Hz and 200 Hz and the corresponding stiffness according to equation (7.1). Finally an average of all stored stiffness is calculated and displayed on the top of the GeoGauge. All this calculation takes place in one minute. Tables 7.4, 7.5, 7.6, and 7.7 show the GeoGauge test results on the US290 embankment.

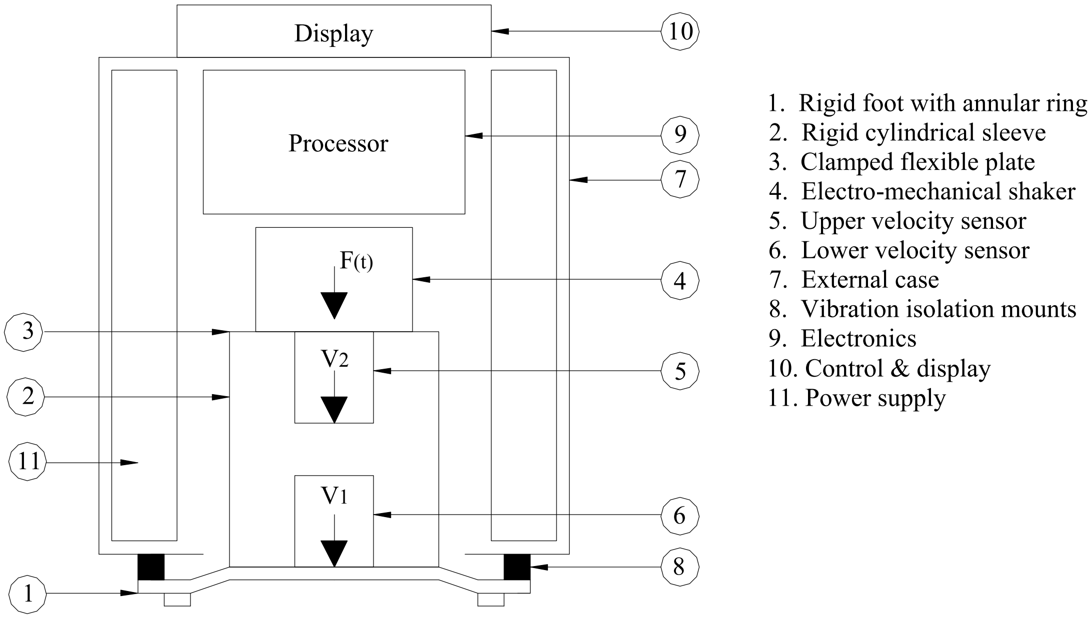


Figure 7.11. Components of the GeoGauge.

Table 7.4. US290 WE Field GeoGauge Test Result.

Test No.	Stiffness	Unit Weight	Water Content	Dry Unit Weight	Distance
	(kip/ft)	(lb/ft^3)	(%)	(lb/ft^3)	(ft)
No. 1	328.24	124.16	15.35	107.64	10
No. 2	285.75	127.76	17.52	108.71	15
No. 3	181.59	113.05	19.96	94.24	20
No. 4	201.12	125.43	20.08	104.46	25
No. 5	215.17	119.44	21.25	98.51	30
No. 6	216.20	126.87	19.12	106.51	35
No. 7	217.57	124.06	19.72	103.62	45
No. 8	180.22	115.40	22.91	93.88	50
No. 9	158.07	127.31	17.68	108.19	55

Table 7.5. US290 EE Field GeoGauge Test Result.

Test No.	Stiffness	Unit Weight	Water Content	Dry Unit Weight	Distance
	(kip/ft)	(lb/ft^3)	(%)	(lb/ft^3)	(ft)
No. 1	669.16	141.54	10.95	127.57	10
No. 2	462.89	122.24	11.02	110.10	15
No. 3	401.22	129.12	11.92	115.37	20
No. 4	525.59	131.81	14.94	114.67	25
No. 5	426.57	122.02	14.08	106.96	30
No. 6	614.68	122.47	12.46	108.91	35
No. 7	629.41	140.41	13.81	123.38	45
No. 8	690.06	128.36	8.34	118.48	50
No. 9	665.04	139.34	10.03	126.65	55

Table 7.6. US290 EW Field GeoGauge Test Result.

Test No.	Stiffness	Unit Weight	Water Content	Dry Unit Weight	Distance
	(kip/ft)	(lb/ft^3)	(%)	(lb/ft^3)	(ft)
No. 1	232.30	128.68	15.34	111.59	10
No. 2	237.44	121.96	15.94	105.19	15
No. 3	263.48	128.17	15.81	110.67	20
No. 4	206.61	109.75	15.80	94.77	25
No. 5	245.32	118.03	22.17	96.61	30
No. 6	371.07	124.34	12.08	110.94	35
No. 7	269.31	118.96	10.15	108.00	45
No. 8	321.39	119.27	11.99	106.50	50
No. 9	276.16	116.68	11.39	104.75	55

Table 7.7. US290 WW Field GeoGauge Test Result.

Test No.	Stiffness	Unit Weight	Water Content	Dry Unit Weight	Distance
	(kip/ft)	(lb/ft^3)	(%)	(lb/ft^3)	(ft)
No. 1	326.87	116.29	28.30	90.64	10
No. 2	525.59	134.55	15.06	116.94	15
No. 3	698.62	129.04	11.26	115.98	20
No. 4	405.67	146.00	13.20	128.97	25
No. 5	388.89	138.52	16.07	119.35	30
No. 6	404.65	144.28	14.92	125.55	35
No. 7	255.26	113.17	33..31	84.89	45
No. 8	275.13	118.82	26.73	93.76	50
No. 9	246.69	119.11	26.27	94.33	55

CHAPTER 8:
LABORATORY TEST AND RESULTS

Water Content Test

Researchers conducted water content tests in the geotechnical laboratory of the Department of Civil Engineering at Texas A&M University. The water content test is a routine laboratory test performed to determine the amount of water present in a soil sample with reference to its dry mass. The water content equation is:

$$w = \frac{M_w}{M_s} \times 100\ (\%) \tag{8.1}$$

where M_w is the mass of water present in the soil mass, and M_s is the mass of soil solids.

Table 8.1 and Table 8.2 show the water content test results. All the results are in Appendix G.

Table 8.1. US290 Water Content (%) Test Result.

Test Site	Depth (ft)						
	4	6	10	16	22	27	32
US290 WE CSTS -1	23.15	15.70	20.24	29.94	19.04	14.85	14.97
US290 WE CSTS -2	N/A	16.99	15.44	33.66	23.16	24.07	15.62
US290 EE CSTS -1	17.34	18.66	12.48	16.27	N/A	11.86	N/A
US290 EE CSTS -2	17.15	13.70	13.71	12.26	17.10	13.41	14.85
US290 EW CSTS -1	25.83	27.16	27.01	14.17	N/A	15.36	24.97
US290 EW CSTS -2	20.92	14.84	30.54	13.02	13.48	17.25	12.30
US290 WW CSTS -1	19.42	20.24	20.87	25.29	19.39	19.61	16.99
US290 WW CSTS -1	18.35	19.55	19.34	19.83	16.51	N/A	15.92

Table 8.2. SH249 Water Content (%) Test Result.

Test Site	Depth (ft)						
	4	6	10	16	22	27	32
SH249 NS CSTS -2	20.46	18.99	26.16	19.33	N/A	N/A	N/A
SH249 SS CSTS -1	18.32	19.40	18.27	23.96	N/A	15.56	18.51
SH249 SS CSTS -2	16.50	24.26	15.17	22.79	15.33	15.64	19.05
SH249 SN CSTS -1	16.29	13.84	17.77	22.59	12.92	15.26	17.78
SH249 SN CSTS -2	14.23	14.37	11.20	24.28	15.40	16.11	19.22
SH249 NN CSTS -1	16.20	16.29	11.73	23.53	12.18	N/A	N/A
SH249 NN CSTS -2	13.45	15.11	13.26	16.20	N/A	N/A	N/A

Unit Weight Test

Researchers performed several unit weight tests from the soil samples obtained by CSTS. Use the following equation to calculate the wet unit weight γ_{wet}:

$$g_{wet} = \frac{W_{ws}}{V_{ws}} \tag{8.2}$$

where W_{ws} is the weight of wet soil, and V_{ws} is the volume of wet soil.

The dry unit weight γ_{dry} can also be calculated after oven-drying using the following equation.

$$g_{dry} = \frac{W_{ds}}{V_{ws}} \tag{8.3}$$

where W_{ds} is the weight of dry soil.

Engineers can decide if the field compaction is acceptable or not by using the unit weights and the laboratory compaction test.

Table 8.3 and Table 8.4 show the dry unit weights obtained in this project. Appendix H shows all the results.

Table 8.3. US290 Dry Unit Weight (lb/ft^3).

Test Site	Depth (ft)						
	4	6	10	16	22	27	32
US290 WE CSTS -1	107.47	114.84	114.91	96.43	110.87	118.27	120.73
US290 WE CSTS -2	N/A	113.81	120.26	92.38	102.78	104.17	118.26
US290 EE CSTS -1	105.50	113.27	119.83	117.73	N/A	122.56	N/A
US290 EE CSTS -2	106.73	122.73	114.90	126.31	109.77	119.76	110.81
US290 EW CSTS -1	103.55	96.71	106.42	122.51	N/A	113.62	101.29
US290 EW CSTS -2	110.51	117.88	97.67	121.30	116.57	113.48	122.89
US290 WW CSTS -1	106.28	106.73	114.55	99.58	109.74	113.07	115.78
US290 WW CSTS -1	111.70	114.34	111.35	111.06	114.09	N/A	119.10

Table 8.4. SH249 Dry Unit Weight (lb/ft^3).

Test Site	Depth (ft)						
	4	6	10	16	22	27	32
SH249 NS CSTS -2	N/A	N/A	91.44	N/A	N/A	N/A	N/A
SH249 SS CSTS -1	N/A	108.66	117.11	98.01	N/A	116.03	110.47
SH249 SS CSTS -2	N/A	100.97	N/A	102.72	N/A	115.51	108.90
SH249 SN CSTS -1	115.59	120.63	105.62	105.29	119.63	112.80	109.87
SH249 SN CSTS -2	115.27	115.30	122.80	100.64	109.03	111.20	113.08
SH249 NN CSTS -1	115.03	112.27	121.93	103.18	117.04	N/A	N/A
SH249 NN CSTS -2	119.77	115.38	122.78	115.20	N/A	N/A	N/A

Atterberg Limit Test

The liquid and plastic limits are used worldwide for soil identification and classification and for correlations. The moisture content at the point of transition from semisolid to plastic state is the plastic limit, and from plastic to liquid state the liquid limit. The plasticity index (PI) is the difference between the liquid limit and the plastic limit of a soil.

$$PI = LL - PL \tag{8.4}$$

Tables 8.5 and 8.6 show the results obtained from the Atterberg limit tests. All the results are in Appendix I.

Table 8.5. US290 Atterberg Limit Test Result.

Test Site	Depth	Water Content	Liquid Limit	Plastic Limit	Plasticity Index
	(ft)	(%)	(%)	(%)	
US290 WE CSTS -1	4	23.15	43.69	14.89	28.80
	27	14.85	30.38	N.P.	
US290 WE CSTS -2	6	16.99	35.94	10.71	25.23
	27	24.07	45.25	15.54	29.71
US290 EE CSTS -1	4	17.34	36.28	12.11	24.17
	27	11.86	36.64	10.53	26.11
US290 EE CSTS -2	6	13.70	36.38	10.79	25.59
	27	13.41	35.90	10.57	25.33
US290 EW CSTS -1	4	25.83	38.88	16.26	22.62
	32	24.97	31.95	13.02	18.93
US290 EW CSTS -2	4	20.92	39.33	15.50	23.83
	27	17.25	37.73	14.82	22.91
Test Site	Depth	Water Content	Liquid Limit	Plastic Limit	Plasticity Index
	(ft)	(%)	(%)	(%)	
US290 WW CSTS -1	4	19.42	35.31	16.10	19.21
	27	19.61	35.57	19.24	16.33
US290 WW CSTS -2	4	18.35	38.88	16.26	22.62
	32	15.92	31.95	13.02	18.93

Table 8.6. SH249 Atterberg Limit Test Result.

Test Site	Depth	Water Content	Liquid Limit	Plastic Limit	Plasticity Index
	(ft)	(%)	(%)	(%)	
SH249 NS CSTS -2	10	25.60	53.97	20.20	33.77
SH249 SS CSTS -1	10	15.37	21.51	10.05	11.46
	27	15.08	35.36	13.23	22.13
SH249 SS CSTS -2	6	24.49	46.42	16.02	30.40
	22	15.33	21.80	13.28	8.52
	32	17.85	39.03	18.99	20.04
SH249 SN CSTS -1	6	13.84	22.44	13.15	9.29
	27	15.26	29.50	13.92	15.58
SH249 SN CSTS -2	6	23.15	40.89	17.59	23.30
	27	16.11	30.69	14.27	16.42
SH249 NN CSTS -1	4	17.87	25.89	12.74	13.15
	16	22.73	42.24	15.75	26.49
SH249 NN CSTS -2	4	12.11	25.90	14.87	11.03
	16	15.59	33.09	15.33	17.76

Sieve Analysis

Sieve analysis is a method used to obtain the particle-size distribution of soil for particle sizes larger than 0.075 mm in diameter. Sieve analysis consists of shaking the soil sample through a set of sieves that have progressively smaller openings. The distribution of particles sizes smaller than 0.075 mm is determined by a sedimentation process using a hydrometer to secure the necessary data. The sieves we used and their openings are as follows:

Table 8.7. U.S. Standard Sieve Sizes.

Sieve No.	Opening (mm)
4	4.750
10	2.000
20	0.850
40	0.425
60	0.250
100	0.150
200	0.075

Tables 8.8, 8.9, and 8.10 summarize of the sieve analysis test results, and Figure 8.1 shows one of the particle size distribution curves. Appendix J lists all the distribution curves.

Table 8.8. Summary of the Sieve Analysis on US290.

Sieve No.	% Passing			
	US290-WE	US290-EE	US290-EW	US290-WW
4	99.9	99.7	99.2	99.6
10	99.0	99.5	98.8	99.4
20	96.1	98.4	97.3	97.1
40	89.9	94.0	94.0	94.0
60	72.9	81.9	84.9	81.1
100	59.1	66.8	78.0	69.5
200	47.9	54.9	69.6	57.2
Pan	0	0	0	0

Table 8.9. Summary of the Sieve Analysis on SH249.

Sieve No.	% Passing			
	SH249-NS	SH249-SS	SH249-SN	SH249-NN
4	99.3	99.5	98.8	100.0
10	98.4	99.3	98.1	100.0
20	96.8	98.5	97.0	98.8
40	93.0	97.7	96.5	97.3
60	83.0	95.8	94.9	95.7
100	69.6	90.1	88.3	90.8
200	55.4	76.5	74.2	78.6
Pan	0	0	0	0

Table 8.10. Summary of the Sieve Analysis on US290 Embankment Soil.

Sieve No.	% Passing			
	US290-WE Embankment	US290-EE Embankment	US290-EW Embankment	US290-WW Embankment
4	99.0	94.6	100.0	98.5
10	97.9	94.0	99.8	97.1
20	96.7	92.6	97.8	96.2
40	92.4	87.7	92.8	93.0
60	80.2	74.3	76.7	85.4
100	66.2	60.0	58.3	75.7
200	54.2	48.3	44.1	64.6
Pan	0	0	0	0

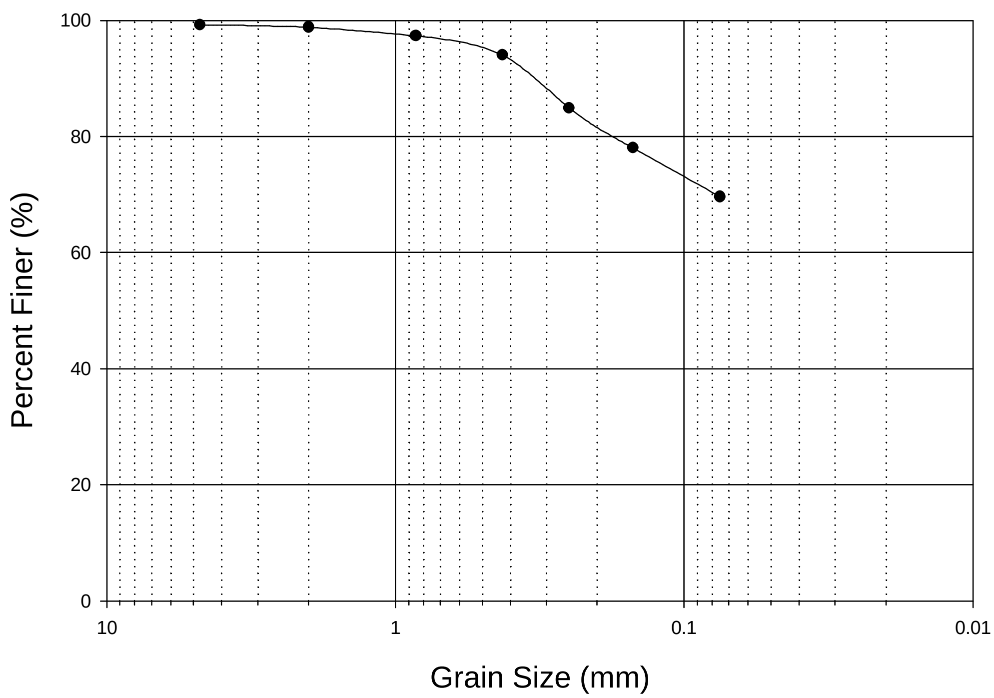


Figure 8.1. US290 EW Particle Size Distribution Curve.

Triaxial Test

Researchers performed unconsolidated undrained triaxial tests (UU test) to obtain the undrained shear strength of the soils and the modulus. A cylindrical specimen of soil is first subjected to an all-round confining pressure, and the specimen is then subjected to a steadily increasing axial load until failure occurs or 15 percent strain occurs. We used specimens with a 1.5 inch diameter and length ranged from 2 to 2.5 times the diameter. No drainage of pore water from the specimen is permitted either during the application of the confining pressure or during axial loading. Load and deformation readings lead to plots of the stress-strain curve from which the maximum stress (or the stress at 15 percent strain) is obtained. The peak value (or the value at 15 percent strain) of the stress-strain curve is the deviator stress of interest. This peak deviator stress is twice the undrained shear strength.

$$c_u = \frac{1}{2}(\sigma_1 - \sigma_3) \tag{8.5}$$

where c_u is the undrained shear strength and is equal to the radius of the Mohr's circle.

Using Hooke's general stress-strain law the vertical principal strain ε_z can be calculated.

$$\varepsilon_z = \frac{1}{E}[\sigma_1 - \nu(\sigma_2 + \sigma_3)] \tag{8.6}$$

where E is the Young's modulus, σ_1 is the vertical stress (major principal stress), σ_2 and σ_3 are intermediate and minor principal stress, and ν is the Poisson's ratio.

The vertical overburden pressure can be calculated with the following equation:

$$\sigma_v = \gamma h \tag{8.7}$$

where γ is the unit weight of the soil and h is the depth of the sample below the surface. If the soil depth is 6 ft below the surface, and the unit weight of the soil is 120 pcf, the overburden pressure is $120 \times 6 = 720$ psf = 5 psi. The confining pressure ($\sigma_2 = \sigma_3$) was taken approximately equal to the overburden pressure.

For the calculation of the secant Modulus, a Poisson's ratio $\nu = 0.35$ was used. The Young's modulus at 25 percent of $(\sigma_1 - \sigma_3)_{max}$ was calculated. Table 8.11 gives typical values of the modulus for several soils.

Table 8.11. Typical Values for the Modulus Es of Selected Soils (after Bowles 1988).

Soil		Es (ksf)
Clay	Very Soft	50 ~ 250
	Soft	100 ~ 500
	Medium	300 ~ 1,000
	Hard	1,000 ~ 2,000
	Sandy	500 ~ 5,000
Glacial Till	Loose	200 ~ 3,200
	Dense	3,000 ~ 15,000
	Very Dense	10,000 ~ 30,000
Loess		300 ~ 1,200
Sand	Silty	150 ~ 450
	Loose	200 ~ 500
	Dense	1,000 ~ 1,700
Sand and Gravel	Loose	1,000 ~ 3,000
	Dense	2,000 ~ 4,000
Soil		Es (ksf)
Shale		3,000 ~ 300,000
Silt		40 ~ 400

Table 8.12 and Table 8.13 give the results of the triaxial tests. The value ε_{25} in the table is the strain at a deviator stress equal to $0.25(\sigma_1 - \sigma_3)_{max}$. All stress strain curves are in Appendix K.

Table 8.12. US290 Triaxial Test Result.

Test Site	Depth (ft)	σ_3 (psi)	$(\sigma_1\text{-}\sigma_3)_{max}$ (psi)	$0.5*(\sigma_1\text{-}\sigma_3)_{max}$ (psi)	$0.25*(\sigma_1\text{-}\sigma_3)_{max}$ (psi)	σ_1 (psi)	ε_{25}	$\sigma_3+0.25*(\sigma_1\text{-}\sigma_3)_{max}$ (psi)	E_{25} (psi)	$E_{25} \div [0.5*(\sigma_1\text{-}\sigma_3)_{max}]$
US290 WE-1	4	5	8.26	4.13	2.07	7.07	0.00101	7.07	3530	855
	27	15	19.77	9.89	4.94	19.94	0.00207	19.94	4562	461
US290 WE-2	6	15	12.62	6.31	3.16	18.16	0.00305	18.16	2510	398
	27	15	18.06	9.03	4.52	19.52	0.00318	19.52	2835	314
US290 EE-1	4	5	16.33	8.17	4.08	9.08	0.00339	9.08	1647	202
	27	15	5.48	2.74	1.37	16.37	0.00061	16.37	9623	3512
US290 EE-2	6	5	51.90	25.95	12.98	17.98	0.00349	17.98	4148	160
	27	15	6.73	3.37	1.68	16.68	0.00254	16.68	2434	723
US290 EW-1	4	5	13.44	6.72	3.36	8.36	0.00148	8.36	3284	489
	32	15	41.95	20.98	10.49	25.49	0.00412	25.49	3638	173
US290 EW-2	4	5	37.93	18.97	9.48	14.48	0.00534	14.48	2057	108
	27	15	37.25	18.63	9.31	24.31	0.00249	24.31	5547	298
US290 WW-1	4	5	12.34	6.17	3.09	8.09	0.00124	8.09	3698	599
	27	15	10.95	5.48	2.74	17.74	0.00268	17.74	2701	493
US290 WW-2	4	5	10.92	5.46	2.73	7.73	0.00123	7.73	3439	630
	32	15	24.61	12.31	6.15	21.15	0.00244	21.15	4366	355

Table 8.13. SH249 Triaxial Test Result.

Test Site	Depth (ft)	σ_3 (psi)	$(\sigma_1-\sigma_3)_{max}$ (psi)	$0.5*(\sigma_1-\sigma_3)_{max}$ (psi)	$0.25*(\sigma_1-\sigma_3)_{max}$ (psi)	σ_1 (psi)	ε_{25}	$\sigma_3+0.25*(\sigma_1-\sigma_3)_{max}$ (psi)	E_{25} (psi)	$E_{25} \div [0.5*(\sigma_1-\sigma_3)_{max}]$
SH249 NS-2	10	8.15	8.10	4.05	2.03	10.18	0.00238	10.18	1880	464
SH249 SS-1	10	5	17.31	8.66	4.33	9.33	0.00136	9.33	4287	495
	27	15	47.42	23.71	11.86	26.86	0.00885	26.86	1849	78
SH249 SS-2	6	5	12.89	6.45	3.22	8.22	0.00092	8.22	5130	796
	22	5	19.92	9.96	4.98	9.98	0.01040	9.98	623	63
	32	5	51.18	25.59	12.80	17.80	0.00283	17.80	5053	197
SH249 SN-1	6	5	80.10	40.05	20.03	25.03	0.02050	25.03	1050	26
	27	15	47.51	23.76	11.88	26.88	0.01185	26.88	1382	58
SH249 SN-2	6	5	30.93	15.47	7.73	12.73	0.00251	12.73	3677	238
	27	15	37.80	18.90	9.45	24.45	0.00681	24.45	2048	108
SH249 NN-1	4	5	15.54	7.77	3.89	8.89	0.00187	8.89	2882	371
	16	15	22.15	11.08	5.54	20.54	0.00998	20.54	1006	91
SH249 NN-2	4	5	81.31	40.66	20.33	25.33	0.00603	25.33	3620	89
	16	15	30.65	15.33	7.66	22.66	0.00581	22.66	2093	137

Compaction Test

In the construction of highway embankments, earth dams, and many other engineering structures, loose soils must be compacted to increase their unit weights and decrease their compressibility. Compaction increases the strength characteristics of soils. Also the amount of undesirable settlement of structures can be decreased by compaction. It can significantly increase the stability of slopes of embankments.

Generally compaction is the densification of soil by removal of air, which requires mechanical energy. The degree of compaction of a soil is measured in terms of its dry unit weight. The standard compaction test was used to obtain the maximum dry unit weight of the soil and the optimum moisture content corresponding to the maximum dry unit weight.

In the standard Proctor test, the soil is compacted in a mold that has a volume of $\frac{1}{30}$ ft^3. The diameter of the mold is 4 inches. The soil is mixed with varying amounts of water and then compacted in three equal layers using a hammer that delivers 25 blows to each layer. The hammer weighs 5.5 lb and has a drop of 12 inches. For each test, the moist unit weight γ can be calculated as

$$\gamma = \frac{W}{V_{(m)}} \tag{8.8}$$

where W = weight of the compacted soil in the mold and

$V_{(m)}$ = volume of the mold.

With the known moisture content ω, the dry unit weight γ_d can be calculated as

$$\gamma_d = \frac{\gamma}{1 + \frac{w(\%)}{100}} \tag{8.9}$$

where w (%) is the percent of moisture content.

The values of γ_d determined from Equation (8.9) can be plotted against the corresponding moisture contents to obtain the maximum dry unit weight and the optimum moisture content for the soil.

The procedure for the standard Proctor test is elaborated in ASTM Test Designation D-698 and AASHTO Test Designation T-99.

Tables 8.14 and 8.15, and Figures 8.2 to 8.5 show the results of the standard Proctor test.

Table 8.14. US290 Standard Proctor Test Result.

		Water Content (%)					
		10	12	14	16	18	20
Dry Unit Weight (pcf)	US290-WE	110.09	113.77	114.86	112.30	108.85	
	US290-EE	108.50	112.09	112.34	109.59	108.13	
	US290-EW		103.29	103.85	104.00	106.24	103.85
	US290-WW	107.82	109.38	111.18	111.29	108.70	

Table 8.15. SH249 Standard Proctor Test Result.

		Water Content (%)					
		6	8	10	12	14	16
Dry Unit Weight (pcf)	SH249-NS	112.08	117.90	116.56	114.53	111.60	
	SH249-SS		110.49	112.81	113.06	113.65	111.34
	SH249-SN		111.34	111.38	113.66	113.59	111.41
	SH249-NN	106.92	114.74	116.34	113.27	112.80	

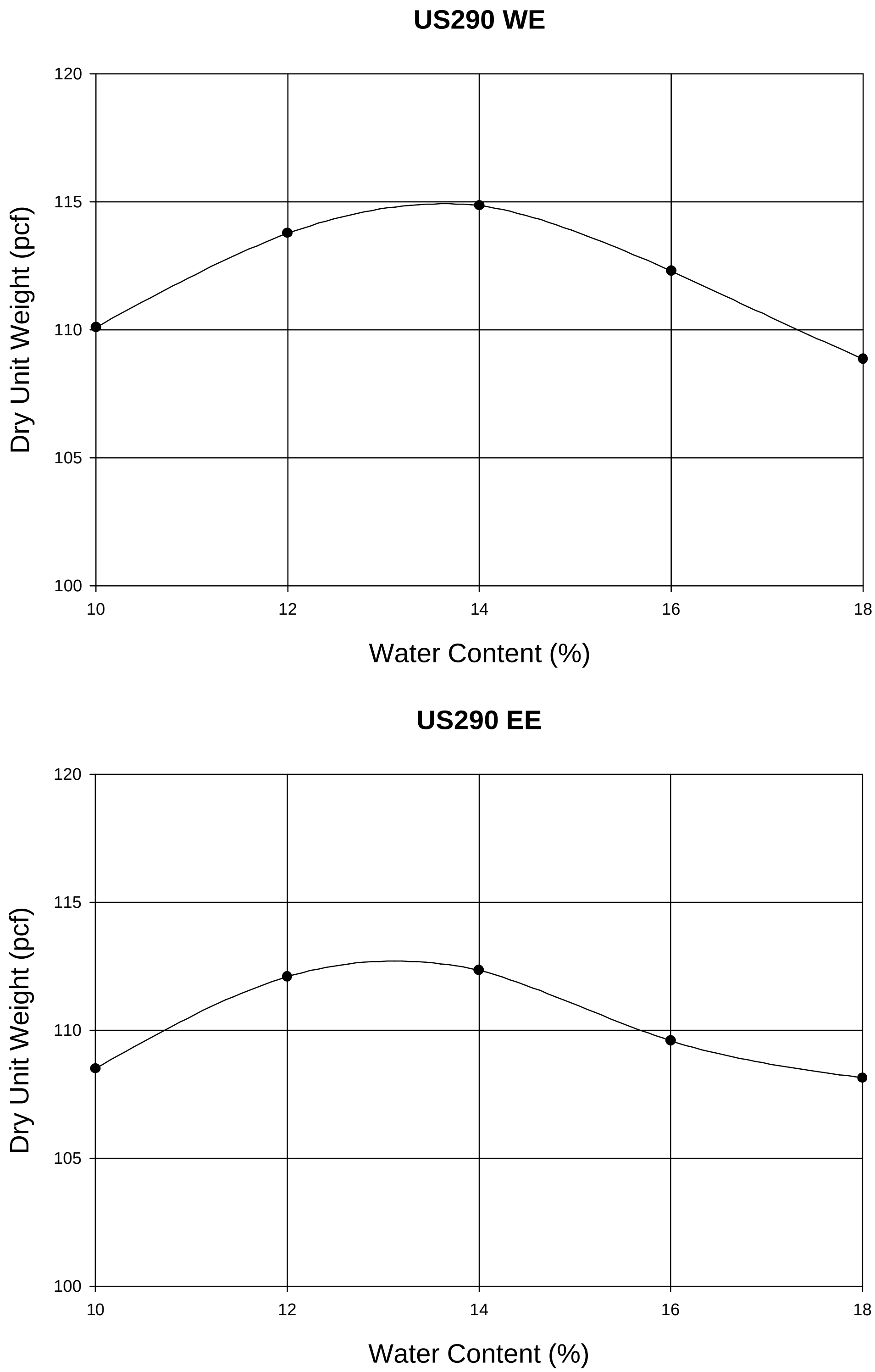
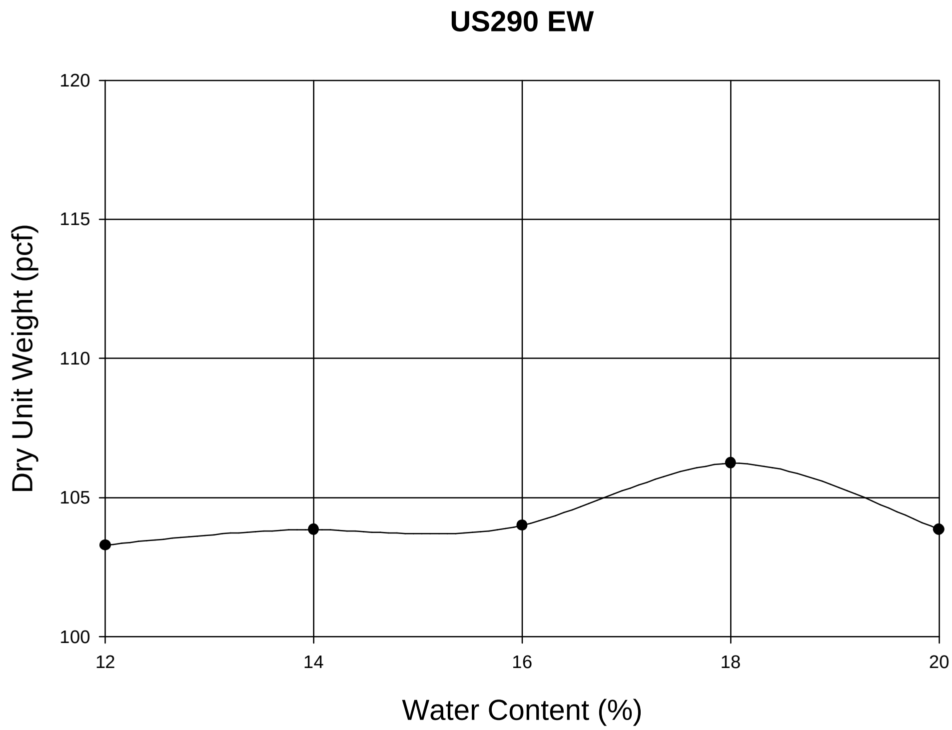


Figure 8.2. US290 WE & EE Standard Compaction Test Result.



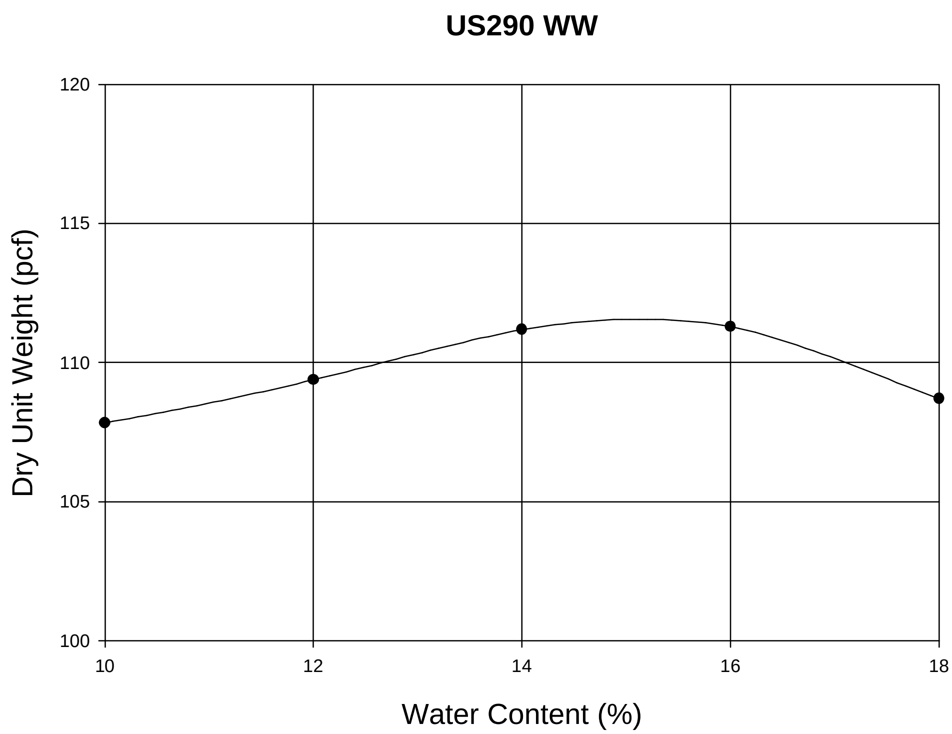


Figure 8.3. US290 EW & WW Standard Compaction Test Result.

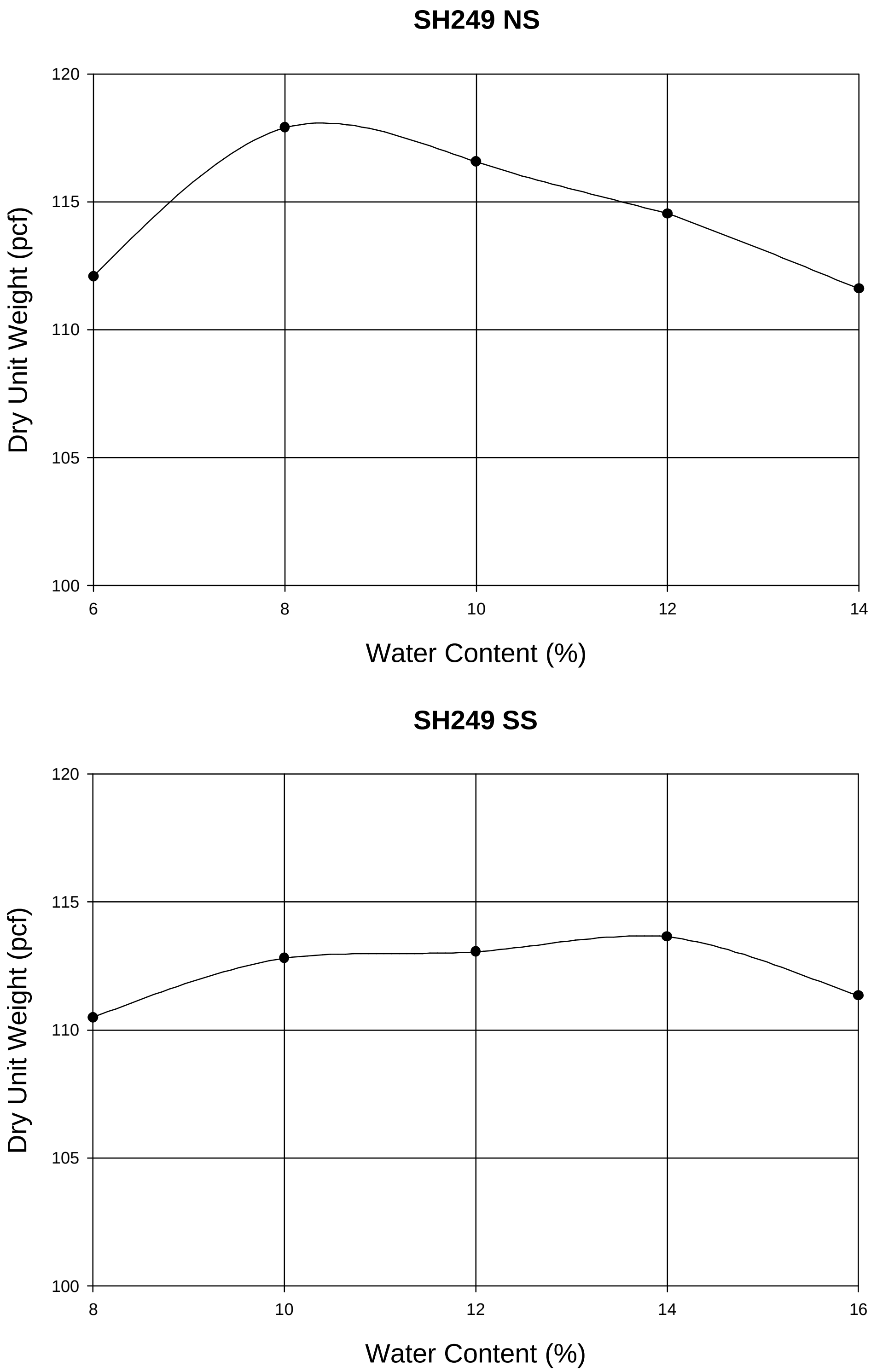
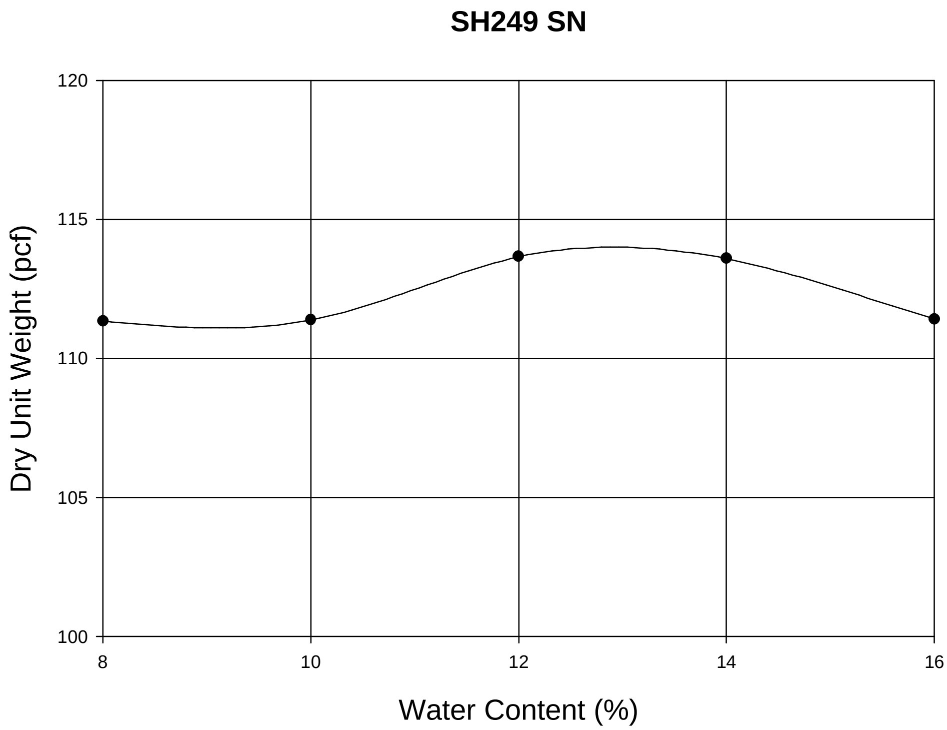


Figure 8.4. SH249 NS & SS Standard Compaction Test Result.



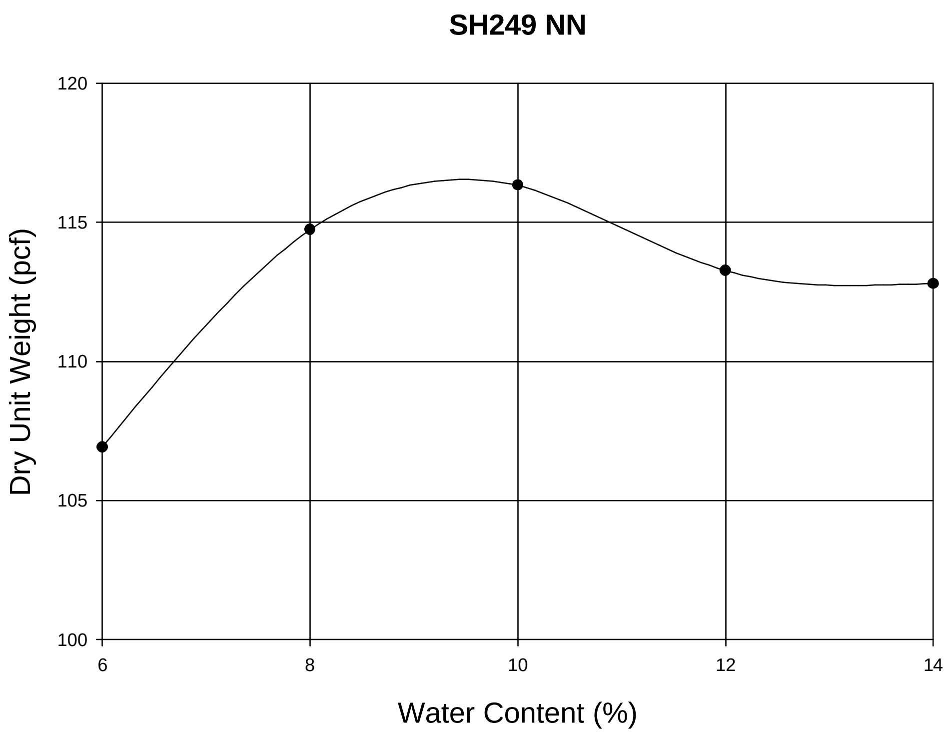


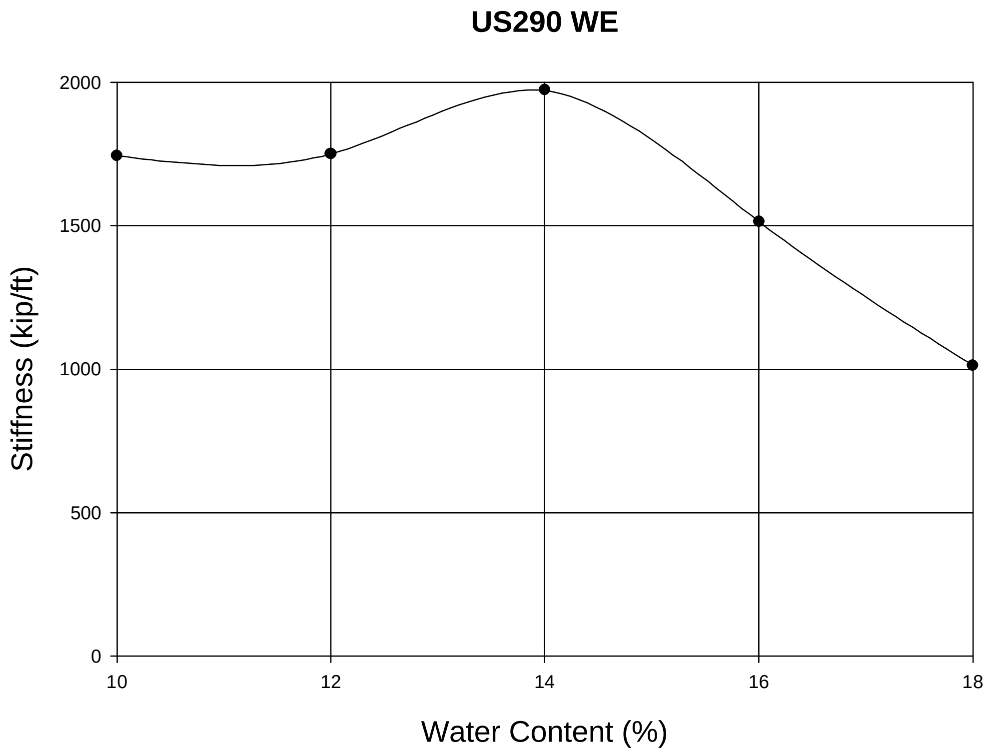
Figure 8.5. SH249 SN & NN Standard Compaction Test Result.

Laboratory GeoGauge Test

The test procedure, used in this project, was as follows:

Following compaction of the last layer of the compaction test, the extension collar is removed, and the sample is carefully trimmed flush with the top of the mold. Any holes in the top surface are filled with unused soil or trimmed soil from the specimen. Then, with the mold and base plate on a solid surface (i.e., concrete floor), a 5.75 inch. diameter and 0.25 inch. thick metal plate is firmly attached to the bottom of the GeoGauge and placed onto the top of the soil surface. Any contact between the plate and the side-wall of the mold is avoided. The GeoGauge test is performed, and the GeoGauge stiffness K is read. All the steps are repeated to get a second GeoGauge stiffness.

Figures 8.6 to 8.9 show the plot of the GeoGauge modulus stiffness K versus water content curve.



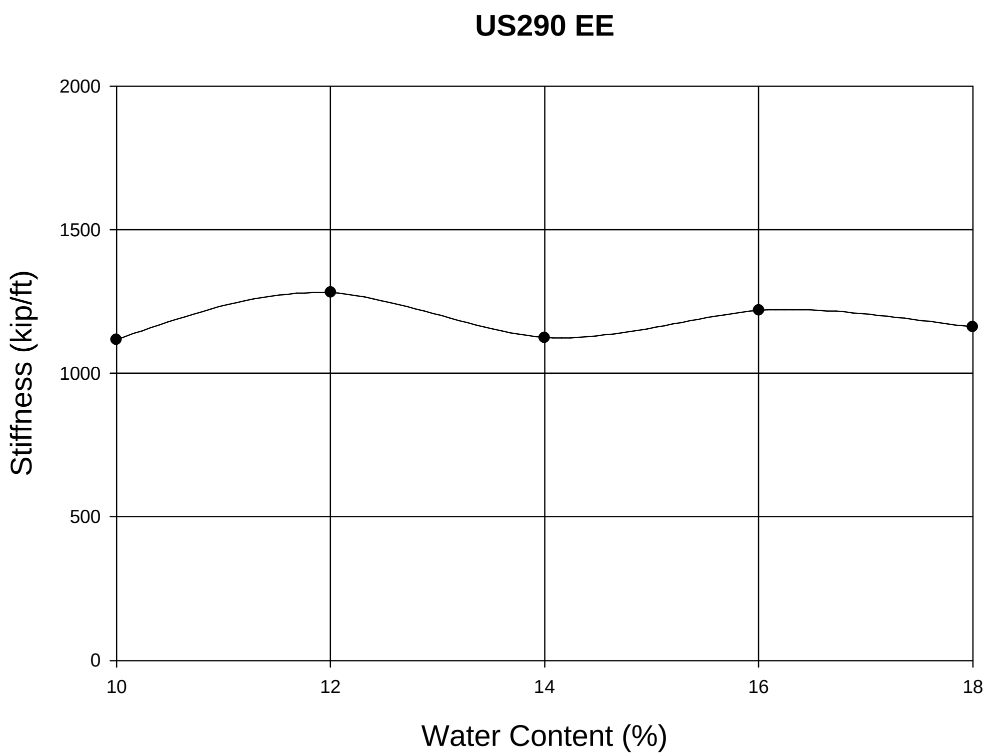


Figure 8.6. US290 WE & EE Laboratory GeoGauge Test Result.

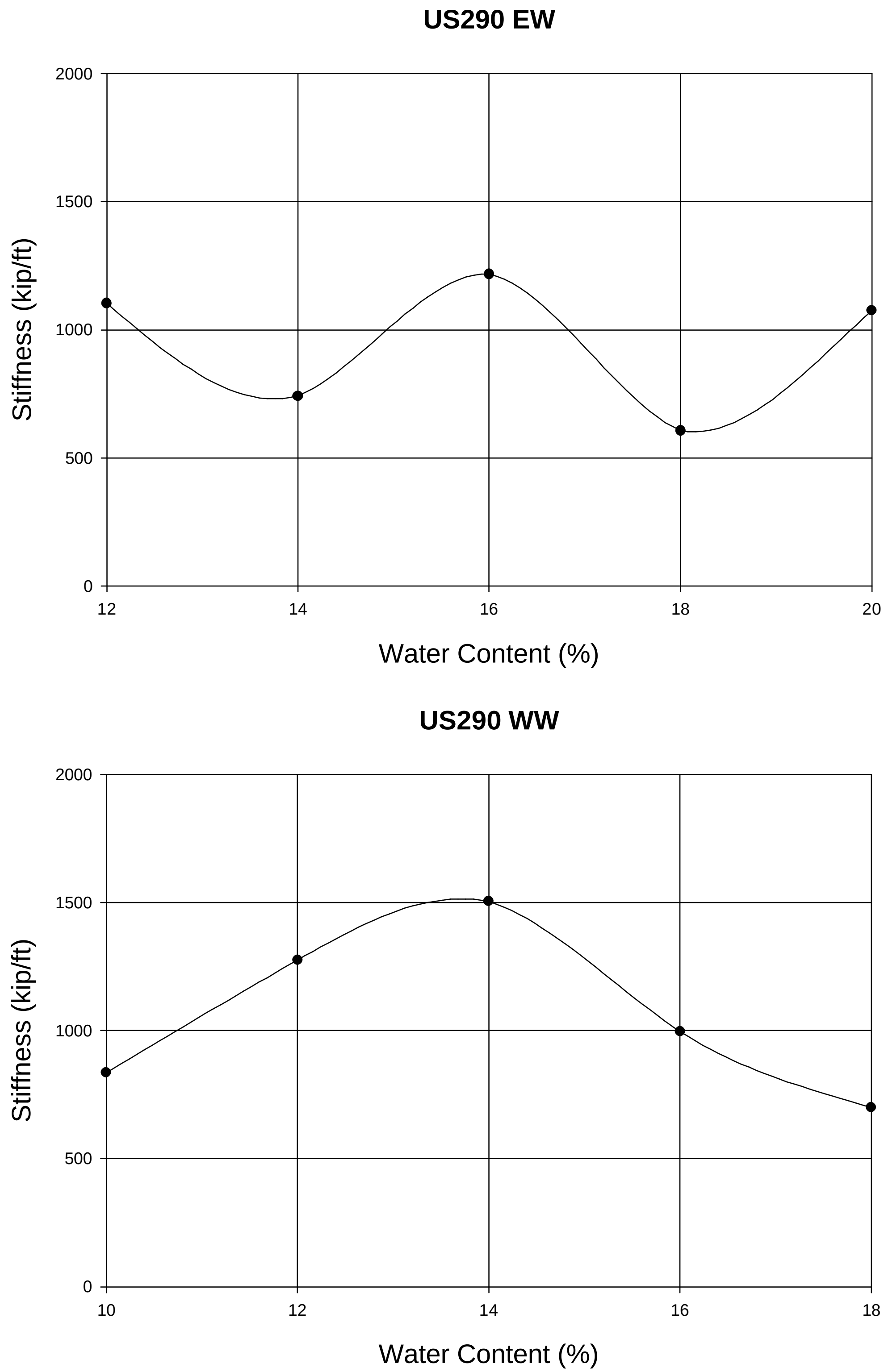
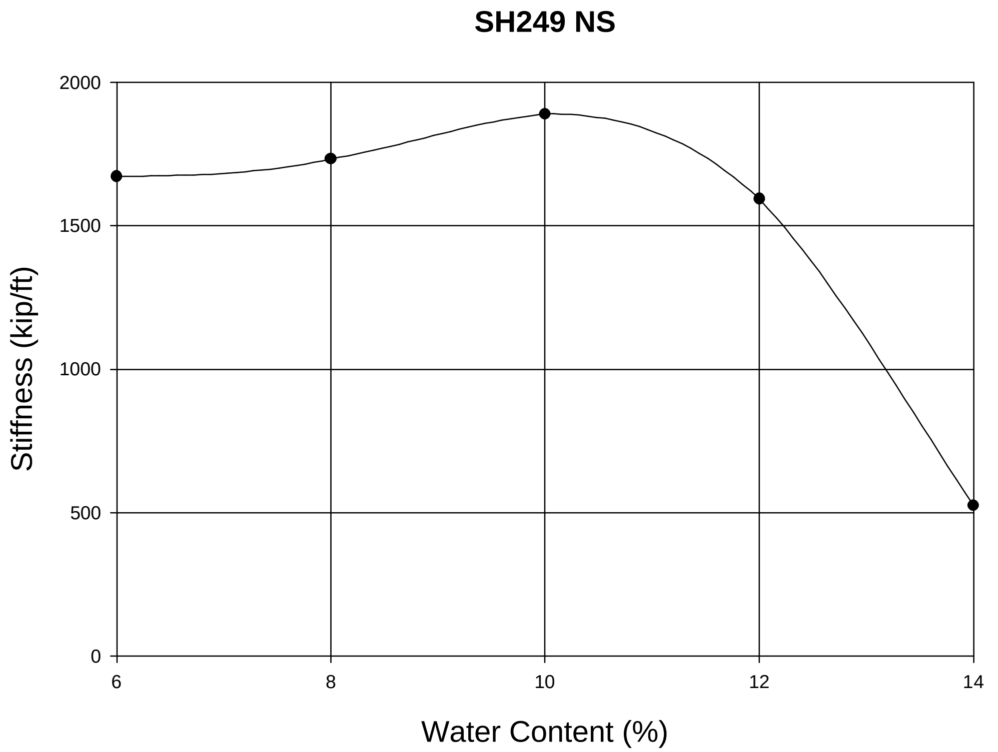


Figure 8.7. US290 EW & WW Laboratory GeoGauge Test Result.



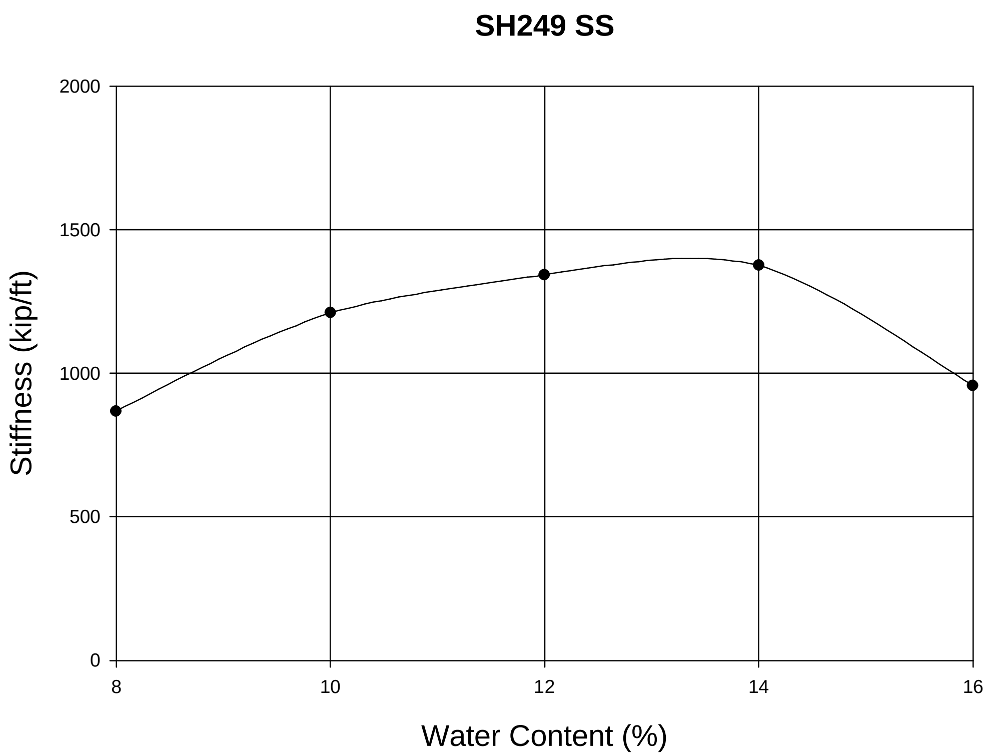


Figure 8.8. SH249 NS & SS Laboratory GeoGauge Test Result.

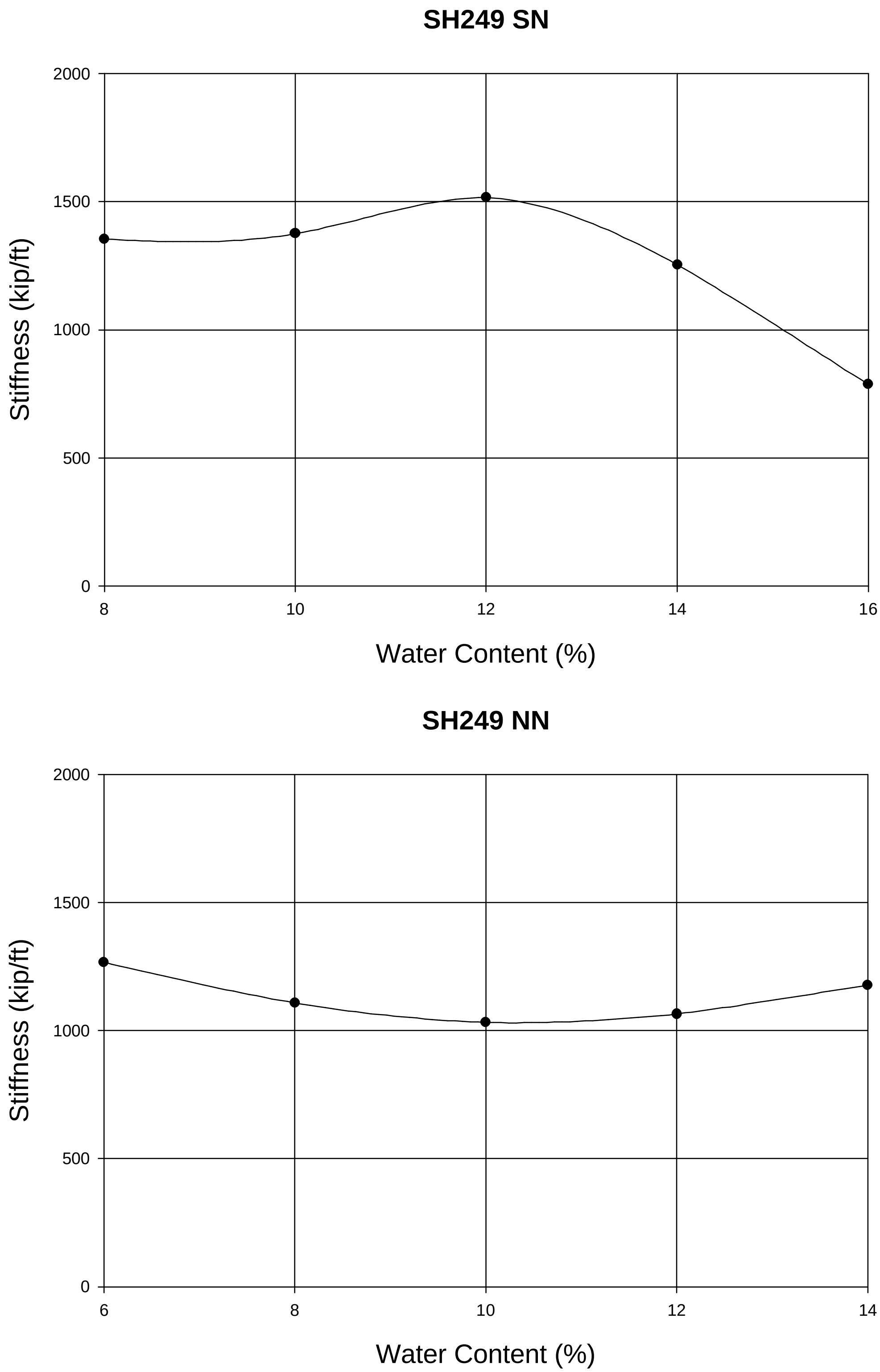


Figure 8.9. SH249 SN & NN Laboratory GeoGauge Test Result.

CHAPTER 9: DATA ANALYSIS

Profilometer Test

The results of the profilometer test (Appendix C) show the profile of the bump at the end of bridge. Figure 7.2 indicates that the bump size is about 1.5 inches both on US290 EW (going west, east end) and US290 WW (going west, west end). All the sites investigated have bumps ranging from 1.15 inches to 2.35 inches on April 2001 and from 0.76 inches to 2.12 inches on March 2002. The International Roughness Index and the Present Serviceability Index data (Appendix C) indicate that:

- the range of pavement condition on US290 and SH249 is from "older pavements" to "damaged pavements" on April 2001 and from "older pavement" to "rough unpaved roads" on March 2002,
- the speed of normal use in the bump zone should be limited to 50 mph, and
- the serviceability of the pavement is very poor.

These conclusions seem exaggerated compared to what is experienced by the driver riding over these approaches. All the profilometer test data are attached in Appendix C.

Ground Penetration Radar Test

Voids, large or not, could play a big role in pavement settlement. The GPR test result shows that there are no voids below the pavement of the embankment. Therefore, we can assess that the approach slab settlement at our research sites would not be caused by voids (Appendix D).

Continuous Shelby Tube Sampling

Using Shelby tube samples, engineers can give a visual classification of the soils at the site. Appendix E shows the drilling log descriptions and shows that the soil is classified as sandy clay and silty clay. In a later section, the USCS soil classification will be given. The samples collected by CSTS were used for other laboratory tests as well (Appendix E).

Cone Penetrometer Test

The Cone Penetrometer Test results show the profile of soil resistance, both tip resistance and shaft resistance (skin friction) as a function of depth (Appendix F).

Since the concern of our study is mainly dealing with the embankment soil, we used the average CPT data between below the pavement surface and 20 feet below the pavement surface.

Table 9.1 and Table 9.2 show the average tip resistance and shaft resistance obtained by CPT tests. Figures 9.1, 9.2, 9.3, and 9.4 visually show these averages.

Table 9.1. US290 Average Tip and Shaft Resistance.

	WE-1	WE-2	EE-1	EE-2	EW-1	EW-2	WW-1	WW-2
Tip (kip/ft^2)	31.63	64.28	31.84	46.31	47.63	78.82	29.75	62.12
Shaft (kip/ft^2)	1.98	3.89	1.88	2.59	2.12	3.18	2.35	4.46

Table 9.2. SH249 Average Tip and Shaft Resistance.

	NS-1	NS-2	SS-1	SS-2	SN-1	SN-2	NN-1	NN-2
Tip (kip/ft^2)	23.88	31.59	25.43	42.28	36.70	48.52	50.29	54.56
Shaft (kip/ft^2)	0.86	1.10	0.86	2.10	1.82	2.21	1.94	2.28

From Table 9.1 and 9.2 we recognize that every CPT resistance near the bridge is smaller than the CPT resistance away from the bridge. The ratio of the near tip resistance to the far away tip resistance ranges from 0.49 to 0.69 on US290 and from 0.60 to 0.92 on SH249.

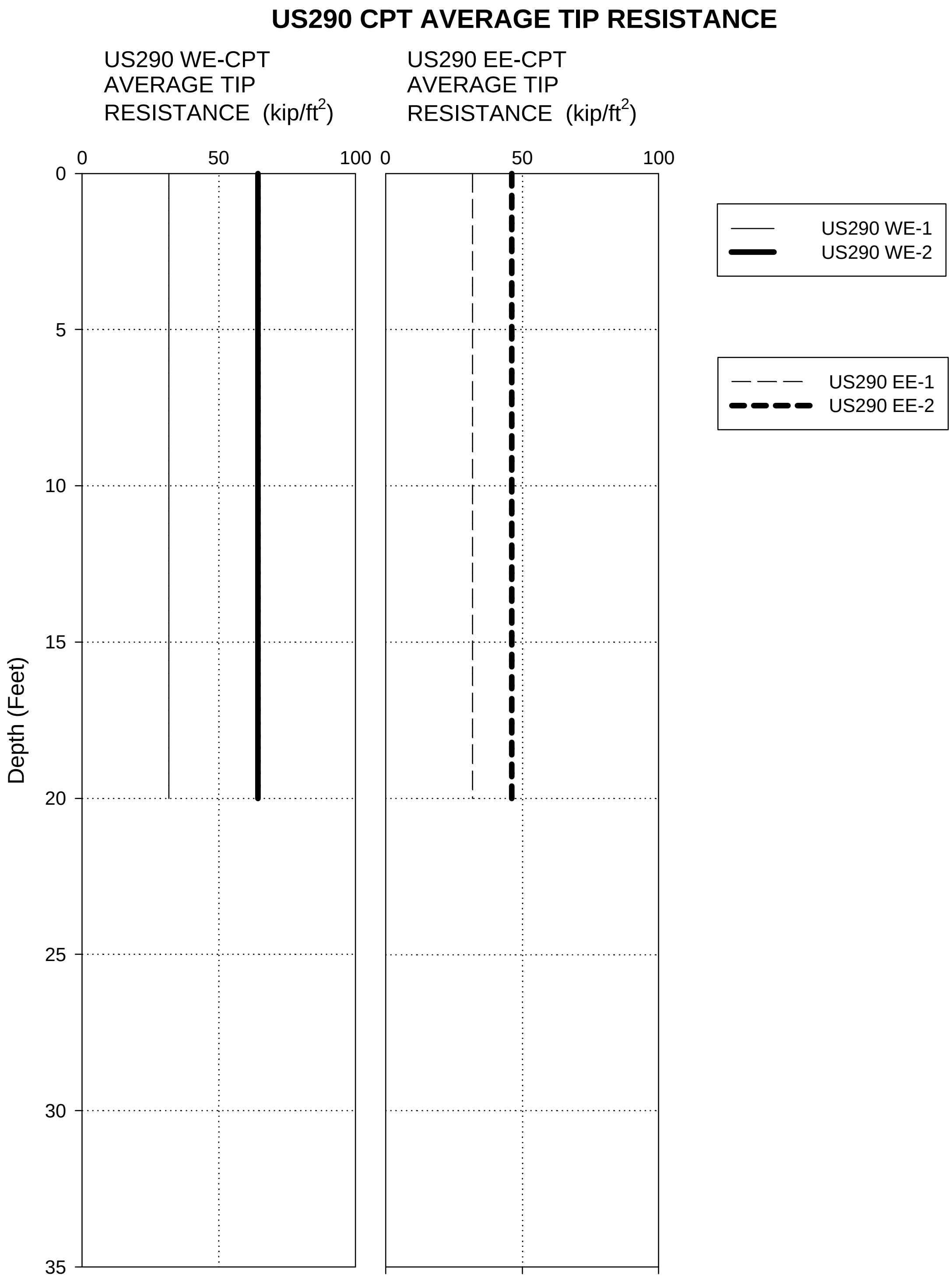


Figure 9.1. US290 WE & EE CPT Average Tip Resistance.

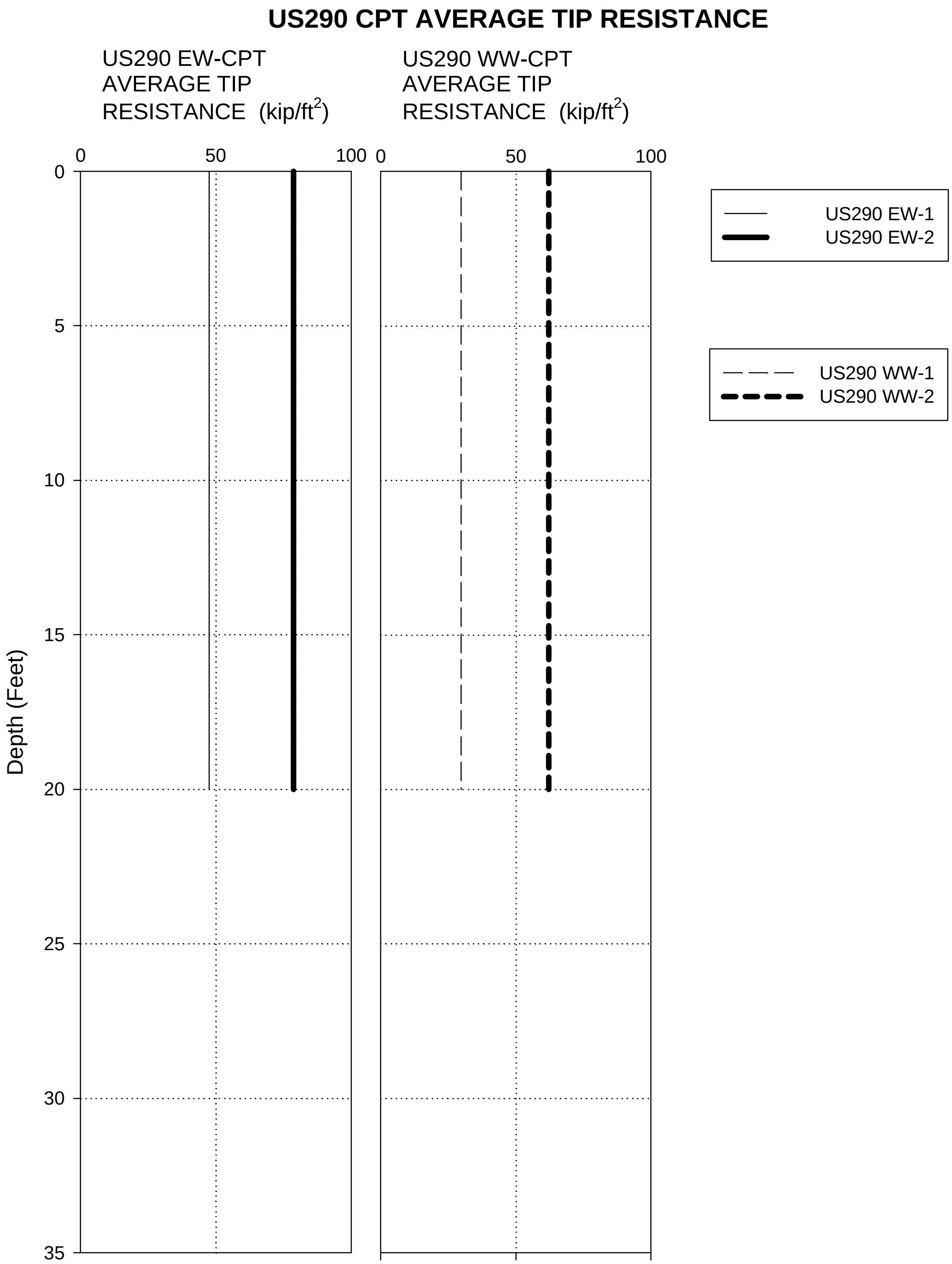


Figure 9.2. US290 EW & WW CPT Average Tip Resistance.

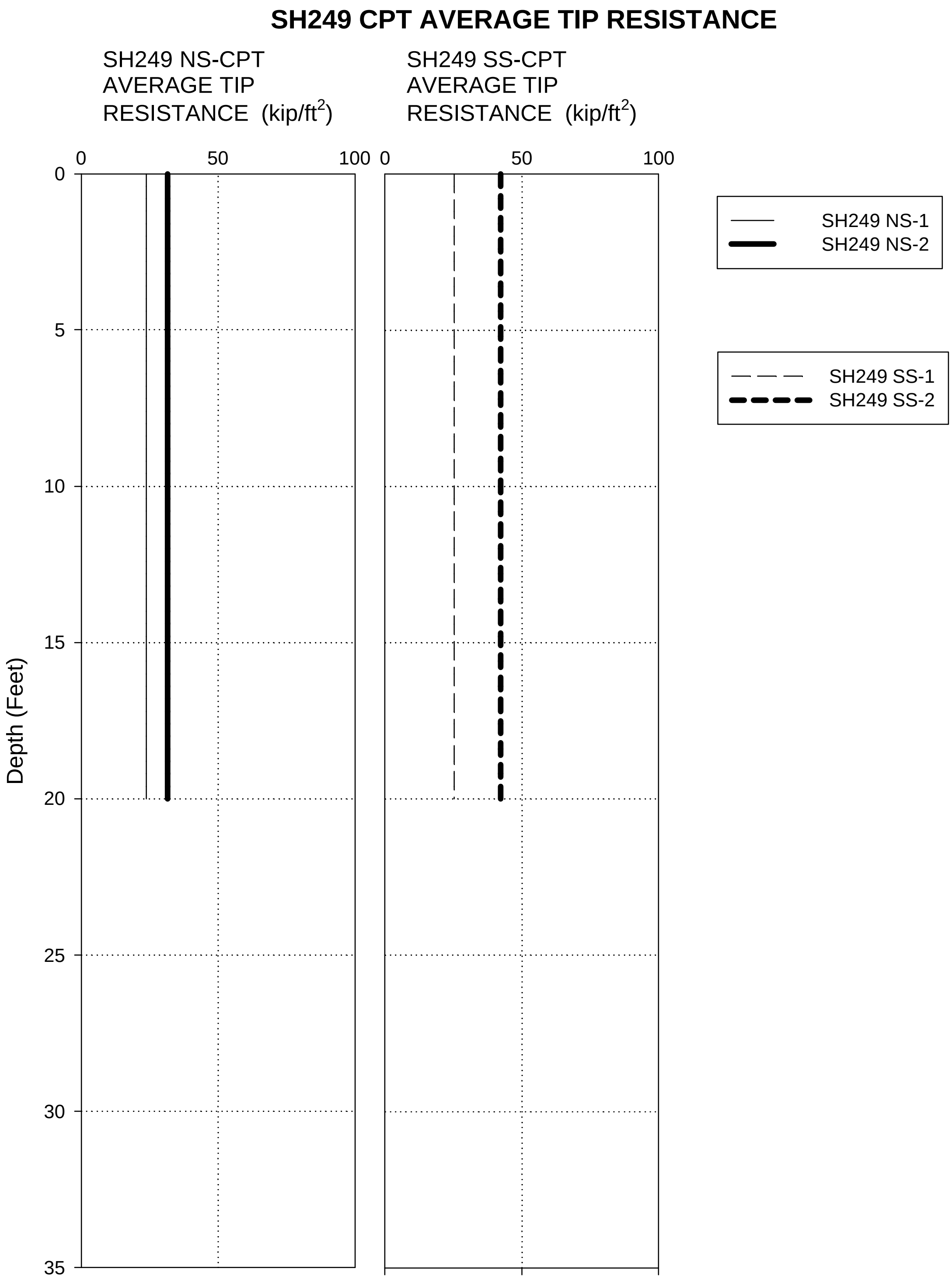


Figure 9.3. SH249 NS & SS CPT Average Tip Resistance.

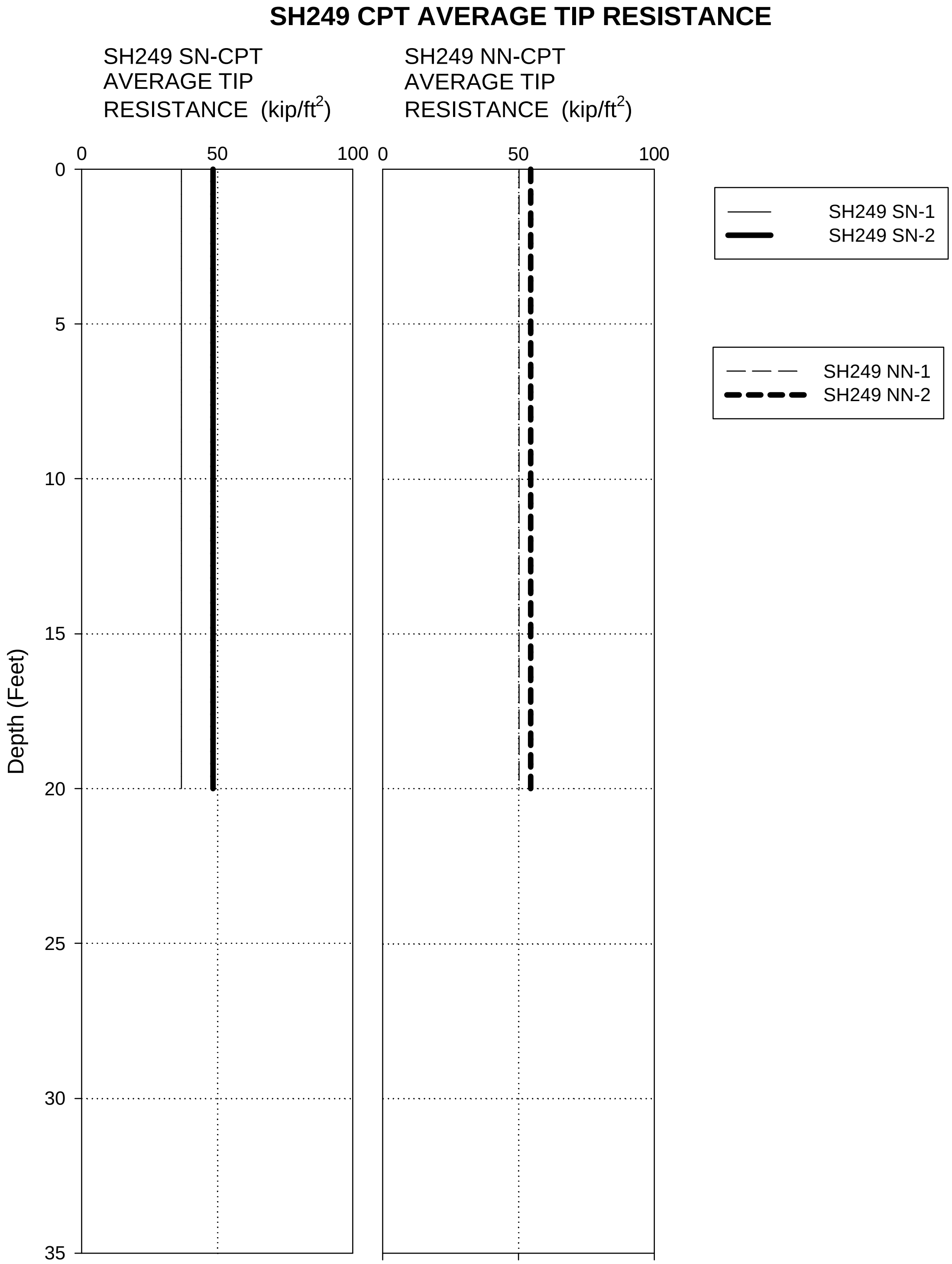


Figure 9.4. SH249 SN & NN CPT Average Tip Resistance.

Field GeoGauge Test

Researchers measured the soil stiffness of the bridge embankment at US290 using the GeoGauge (Tables 7.3, 7.4, 7.5, and 7.6). But there are no special features in the test results to help us analyze the settlement of the bridge approach slab. Further ongoing research on an FHWA project may shed some light on those tests.

Water Content Test

The water content of the soil was determined at different depths using the soil samples obtained by CSTS. Appendix G lists the complete set of results. Figures 9.5, 9.6, 9.7, and 9.8 show the average water content at each site. From these figures we can recognize that every test point near the bridge has a higher water content value than the point away from the bridge.

Unit Weight Test

The unit weight was measured at different depths using the soil samples of CSTS (Appendix H). Figures 9.9, 9.10, 9.11, and 9.12 show average dry unit weight at each site. From these figures we can see that every test point near the bridge has a higher dry unit weight value than the point away from the bridge except for SH249 southbound sites.

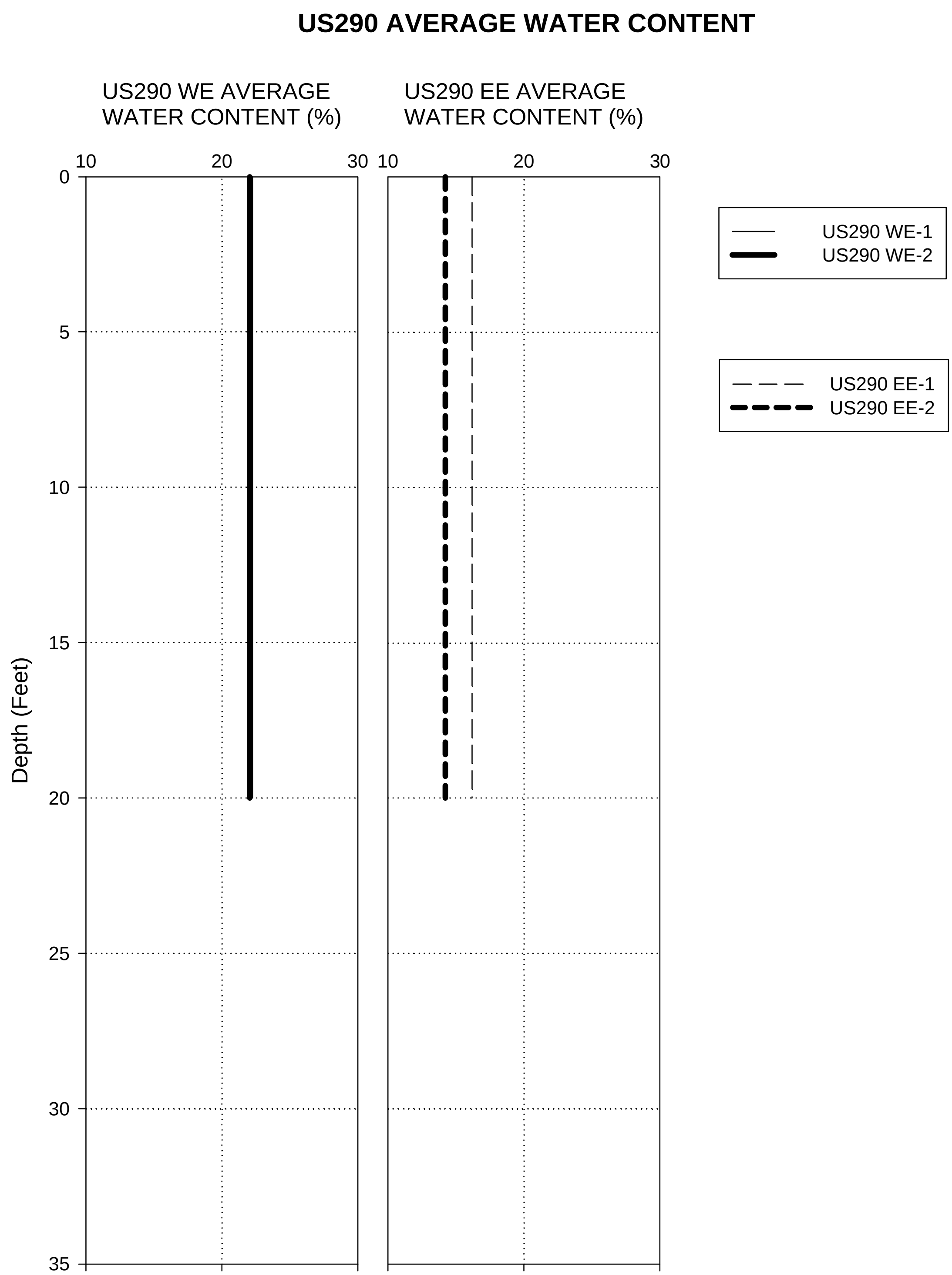


Figure 9.5. US290 WE & EE Average Water Content.

US290 AVERAGE WATER CONTENT

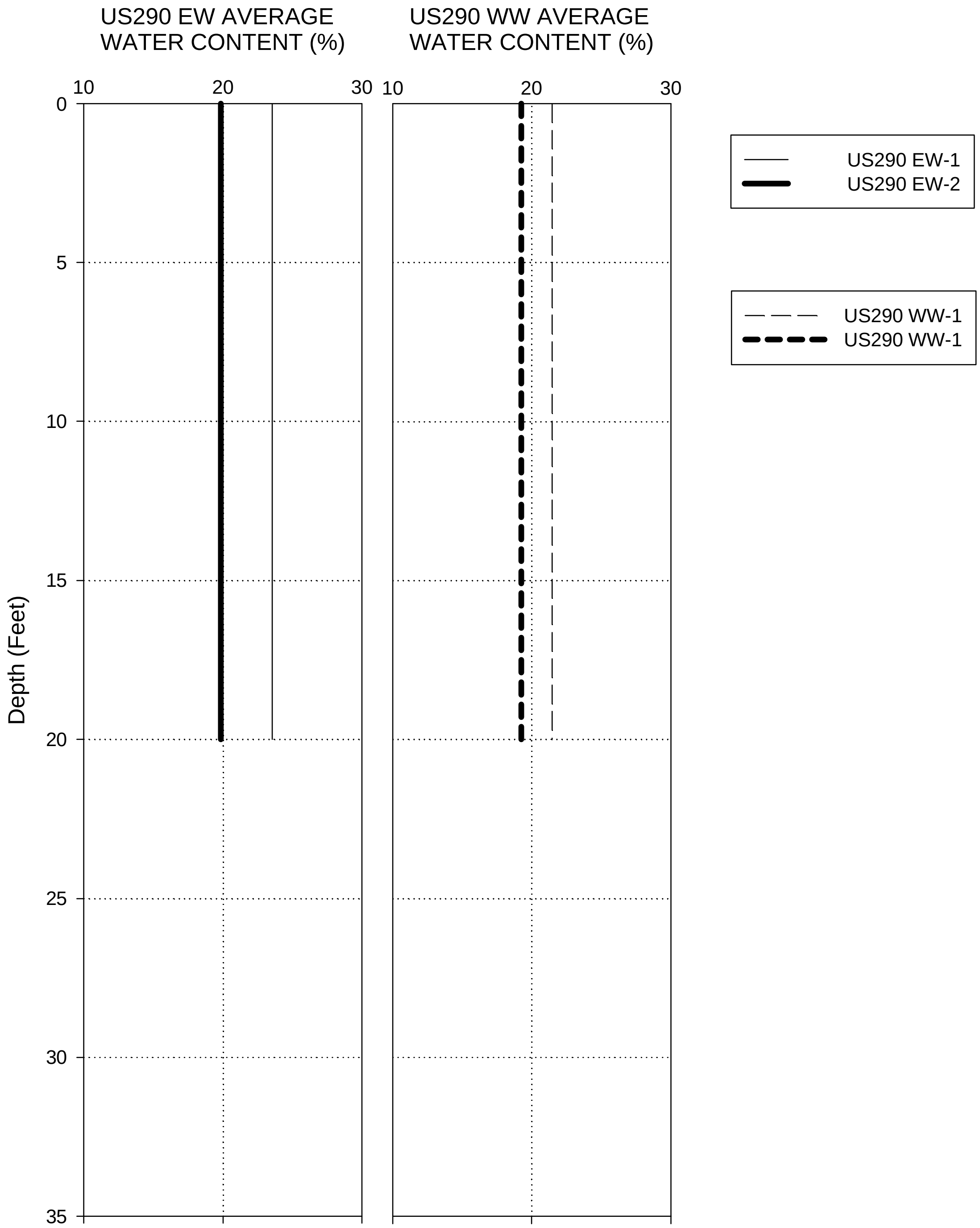


Figure 9.6. US290 EW & WW Average Water Content.

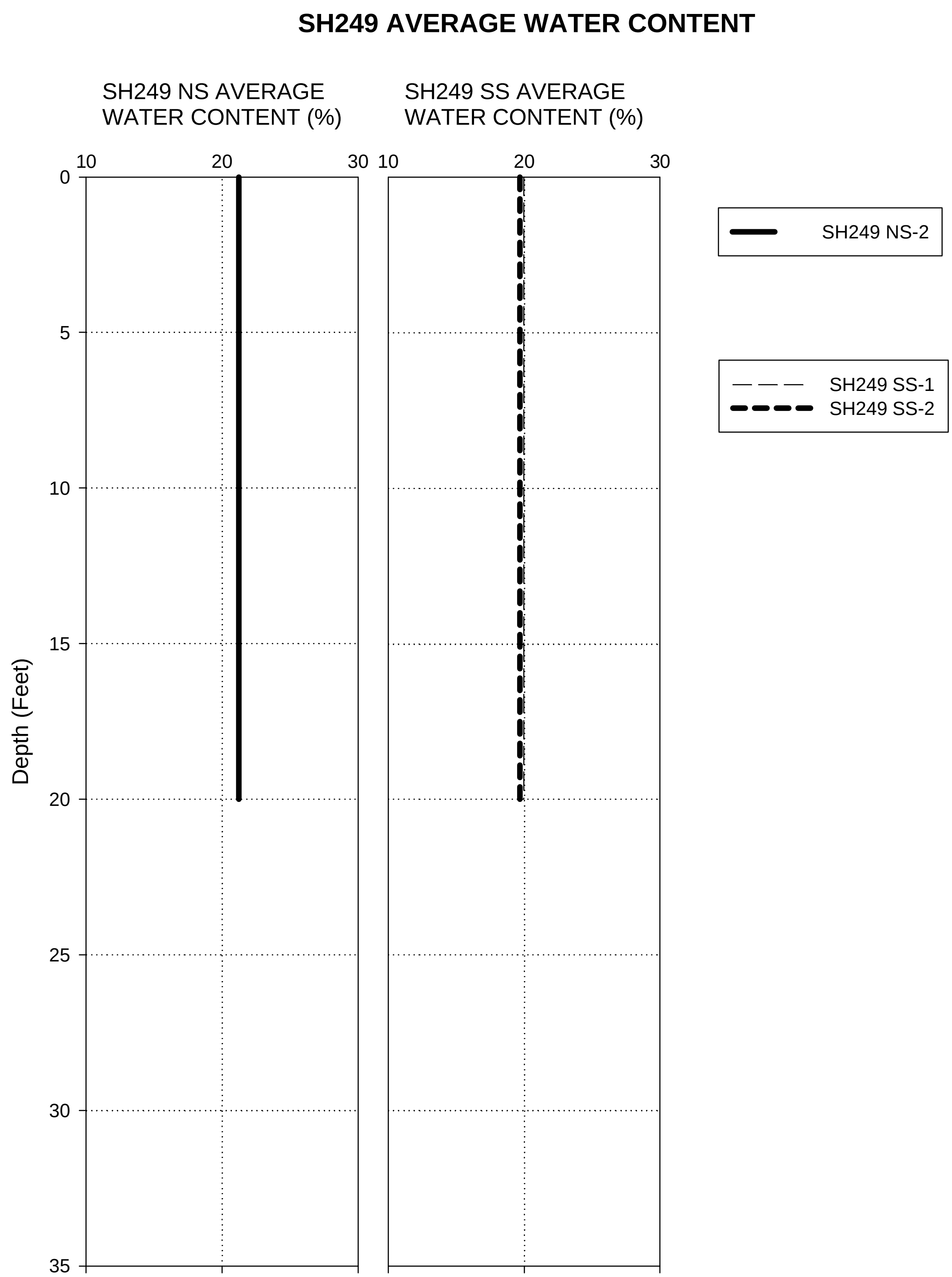


Figure 9.7. SH249 NS & SS Average Water Content.

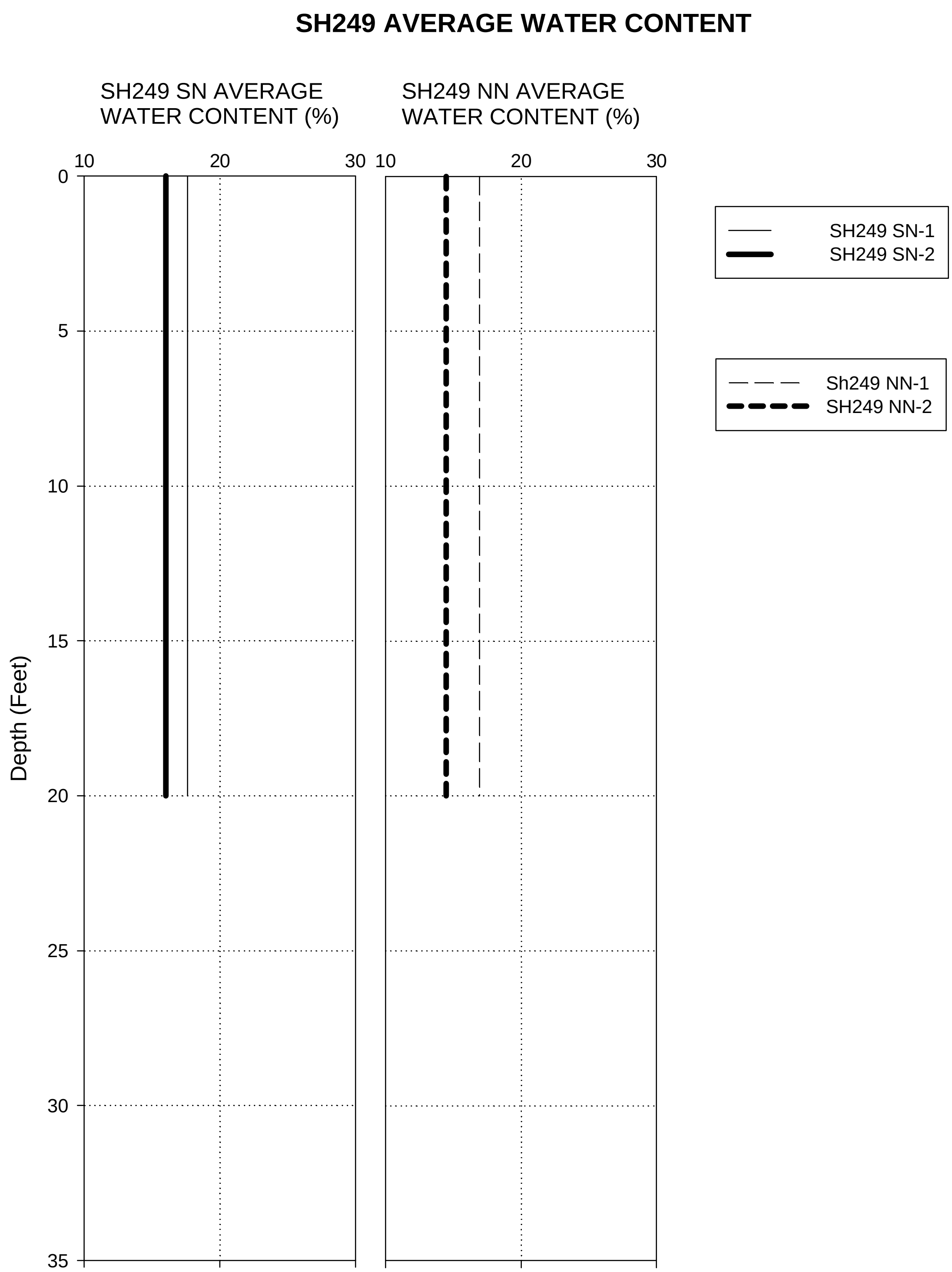


Figure 9.8. SH249 SN & NN Average Water Content.

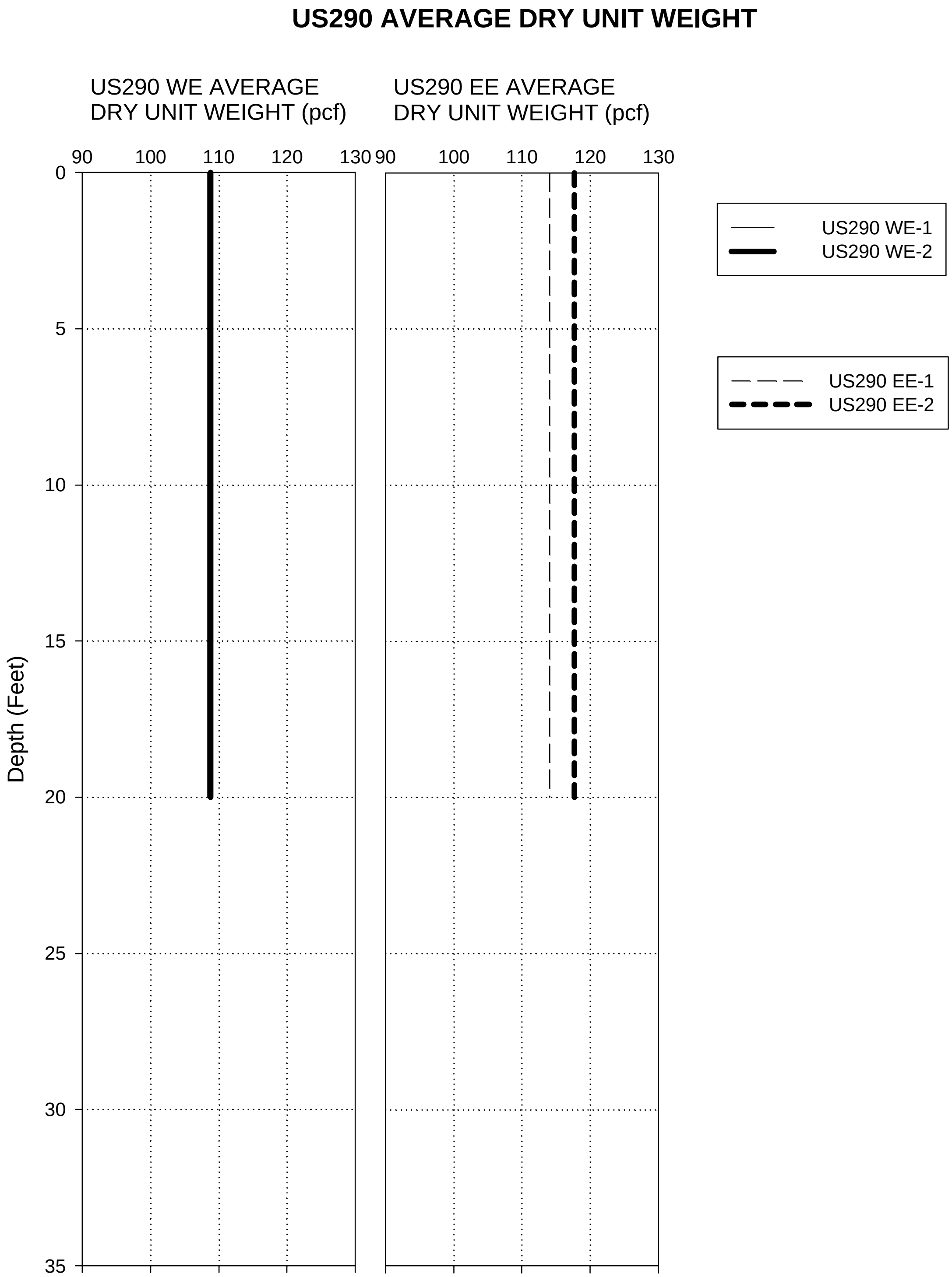


Figure 9.9. US290 WE & EE Average Dry Unit Weight.

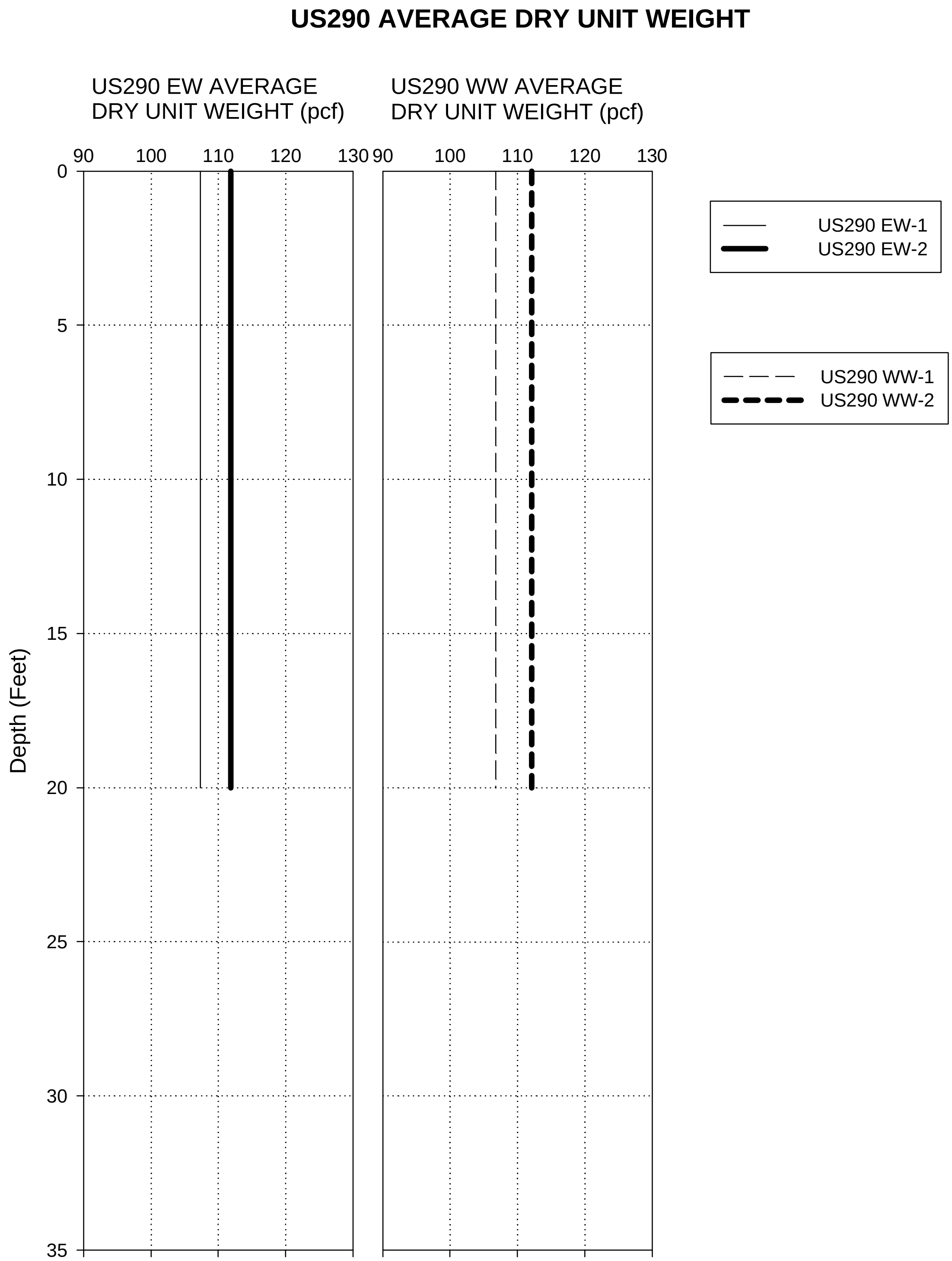


Figure 9.10. US290 EW & WW Average Dry Unit Weight.

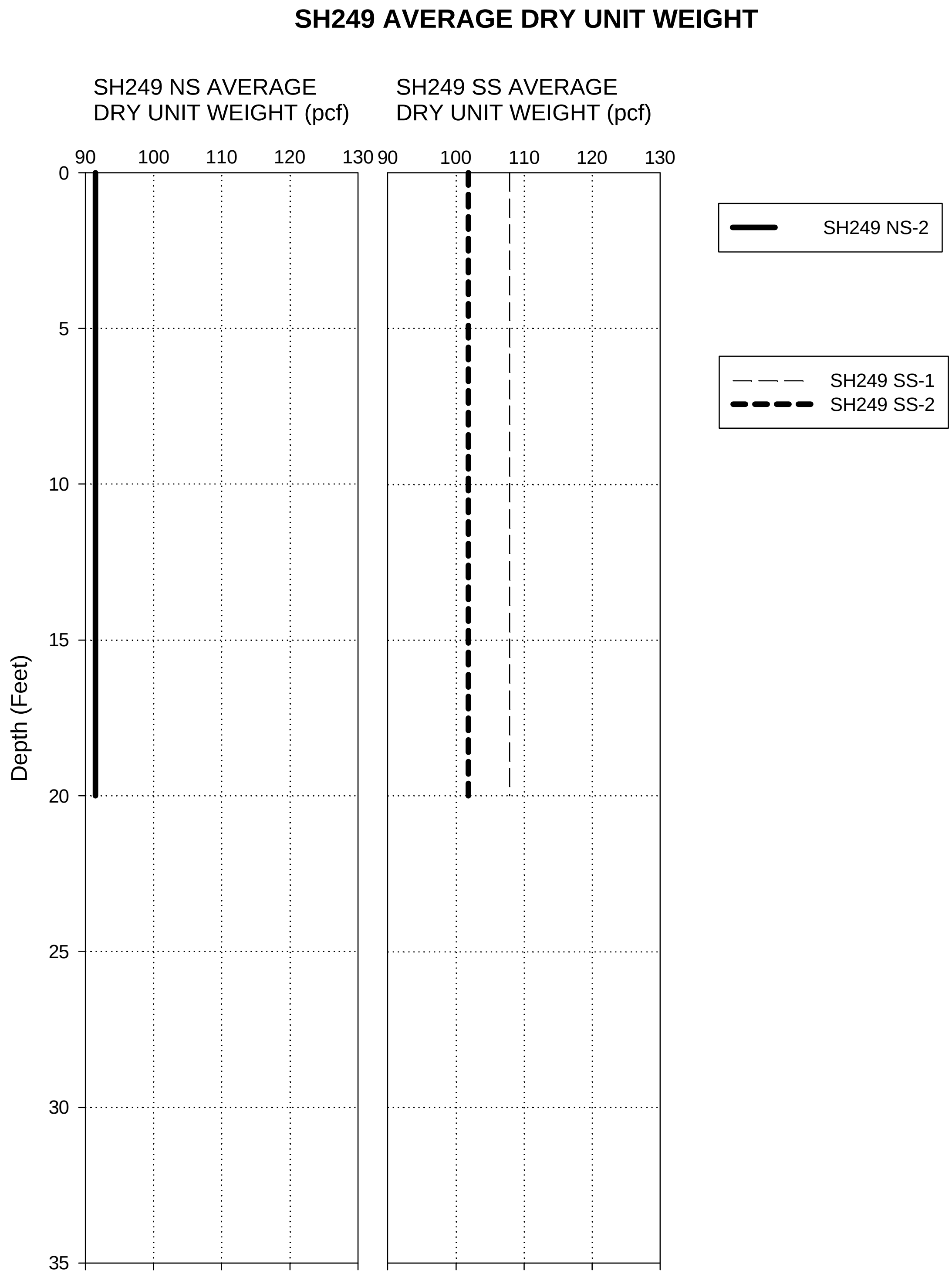


Figure 9.11. SH249 NS & SS Average Dry Unit Weight.

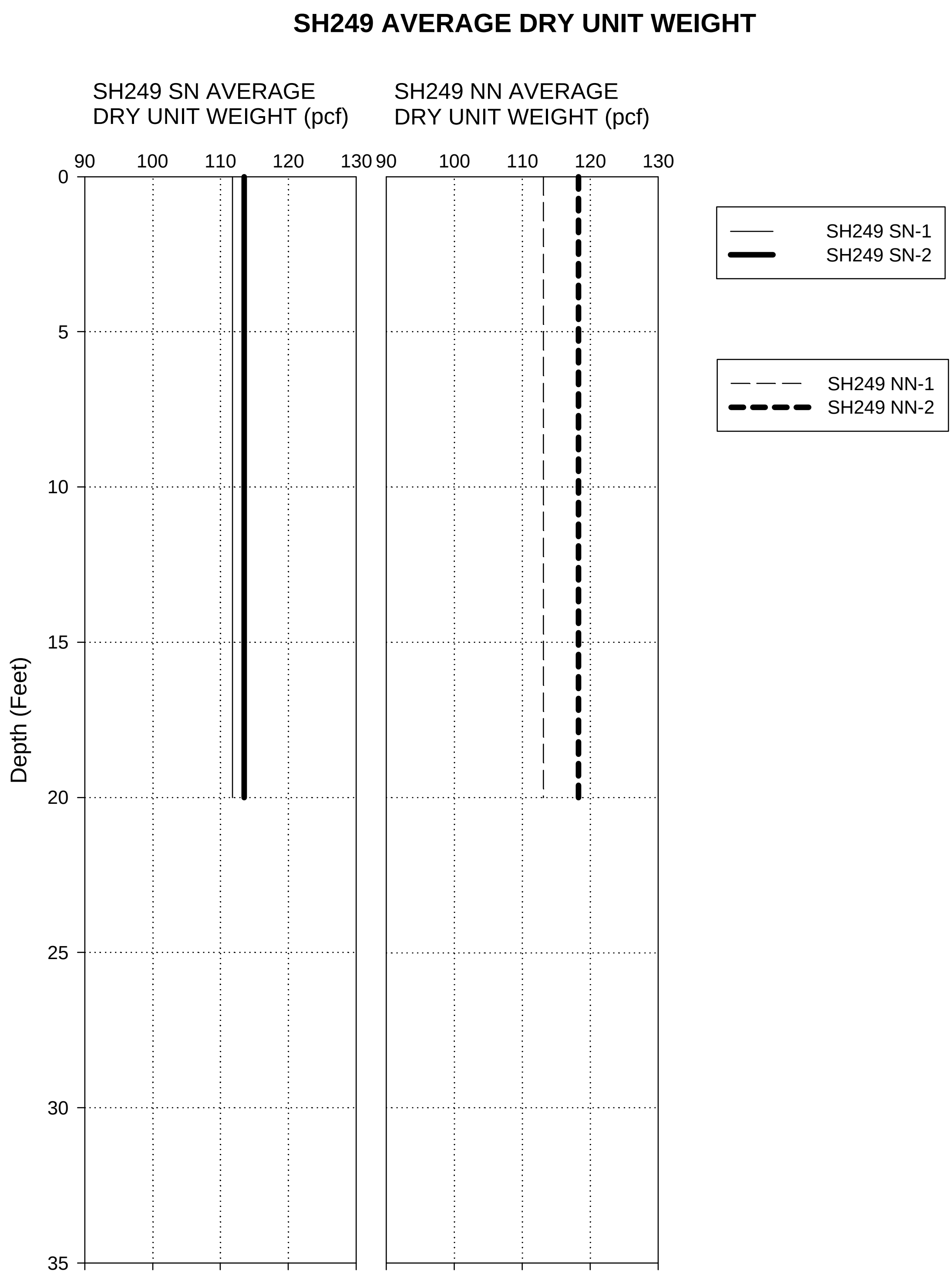


Figure 9.12. SH249 SN & NN Average Dry Unit Weight.

Atterberg Limit Test

Researchers measured the liquid limit, plastic limit, and plasticity index from the Atterberg limit test (see Appendix I). According to the TxDOT "Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges" suitable materials for roadway embankment construction shall meet the following requirements:

- The liquid limit shall not exceed 45 percent.
- The plasticity index shall not exceed 15 percent.

All US290 samples have a plasticity index over 15 percent, and 64 percentages of the SH249 samples also have a plasticity index over 15 percent. Therefore the fill material of US290 and SH249 does not meet these specifications for highways embankment construction. The specifications for these two jobs may have been different from the ones mentioned above.

Sieve Analysis

Appendix J shows the sieve analysis results. All the samples are fine-grained soils (except US290 WE) since over 50 percent of the sample weight passes through the No. 200 sieve. Tables 9.3 and 9.4 show the USCS classifications obtained by combining tables 8.6, 8.7, 8.8, 8.9 and using the plasticity chart.

Table 9.3. Soil Classification of US290 by USCS.

	WE-1	WE-2	EE-1	EE-2	EW-1	EW-2	WW-1	WW-2
Fill Material	SC	SC	CL	CL	CL	CL	CL	CL
Natural Ground	N.P.	SC	CL	CL	CL	CL	CL	CL

Table 9.4. Soil Classification of SH249 by USCS.

	NS-1	NS-2	SS-1	SS-2	SN-1	SN-2	NN-1	NN-2
Fill Material	N/A	CH	CL	CL	CL	CL	CL	CL
Natural Ground	N/A	N/A	CL	CL	CL	CL	CL	CL

Triaxial Test

The average values of $(\sigma_1\text{-}\sigma_3)_{max}$ for the US290 and SH249 fill material 20 ft below the pavement surface are 20.47 psi and 33.22 psi, respectively. The average US290 and SH249 Young's moduli (secant modulus at 25 percent of the peak deviator stress in a UU test) of the fill material are 3,039 psi and 2,847 psi, respectively.

According to the Table 8.11, the fill material at both sites falls into the category of soft to medium clay. Appendix K details these results.

Compaction Test

Laboratory compaction test results can be compared with the measured field dry unit weight. Table 9.5 shows the average dry unit weight in the field and the maximum dry unit weight from the laboratory Standard Proctor tests.

Table 9.5. Field and Laboratory Dry Density.

Test Site	Field Dry Unit Weight	Lab. Dry Unit Weight (using Standard Proctor)
	(pcf)	(pcf)
US290 WE	108.45	114.86
US290 EE	115.88	112.34
US290 EW	109.57	106.24
Test Site	Field Dry Unit Weight	Lab. Dry Unit Weight (using Standard Proctor)
	(pcf)	(pcf)
US290 WW	109.45	111.29
SH249 NS	91.44	117.90
SH249 SS	107.43	113.65
SH249 SN	112.64	113.66
SH249 NN	115.69	116.34
Average	108.82	113.28

Average laboratory maximum unit weights are higher than the field dry unit weight. Note that we did not carry out Modified Proctor compaction tests but Standard Proctor compaction tests. On the average, the field unit weight represents 96 percent of the Standard Proctor Maximum unit weight. Tables 8.14 and 8.15 list all the results.

CHAPTER 10: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Researchers investigated the bump at the end of the bridge by conducting a literature survey, by distributing a questionnaire to the 25 districts of the Texas DOT, and by investigating two bridge sites in Houston, Texas.

The literatures surveyed lead to the following conclusions:

1. On the average, 25 percent of all bridges in the USA are affected by the bump problem.
2. The maintenance cost for the bump problem in the USA is estimated at 100 million dollars per year (1997).
3. The main reasons for the development of a bump are the settlement of the embankment due to a weak natural soil or to the compression of the embankment fill, voids under the pavement due to erosion, and abutment displacement due to pavement growth, slope instability or temperature cycles.
4. The bump is more severe with a high embankment, an abutment on piles, high average daily traffic, soft natural soil, intense rain storms, extreme temperature cycles, and steep approach gradients.
5. The bump is less severe when there is an approach slab, appropriate fill material, good compaction or stabilization, effective drainage, good construction practice and inspection, and adequate waiting period between fill placement and paving.
6. A tolerable bump has a slope of 1/200 or less.

The best approach recommended in the literature is:

1. Treat the bump problem as a stand-alone design issue, and prevention as a design goal.
2. Assign the responsibility of this design issue to an engineer.
3. Stress teamwork and open-mindedness among the geotechnical, structural, pavements, construction, and maintenance engineers.

4. Carry out proper settlement versus time calculations.
5. If differential settlement is excessive, design an approach slab.
6. Provide for expansion/contraction between the structure and the approach roadway (fabric reinforcement, flow fill).
7. Design a proper drainage and erosion protection system.
8. Use and enforce proper specifications.
9. Choose knowledgeable inspectors especially for geotechnical aspects.
10. Perform a joint inspection including joints, grade specifications, and drainage.

The questionnaire results lead to the following conclusions:

1. On the average, 24.5 percent of the bridges in Texas have a bump problem.
2. The maintenance cost for the bump problem in Texas is estimated at 6.3 million dollars per year (2001).
3. The number one reason for the bump is the settlement of the embankment fill followed by the loss of fill by erosion.
4. The problem is worse when the embankment is high and the fill is clay.
5. The problem is minimized when an approach slab is used and the fill behind the abutment is cement stabilized.

Researchers conducted a detailed investigation of two bridge overpass sites on major highways in Houston. Both bridge sites had articulated two-span approach slabs with a wide-flange beam. The investigation lead to the following conclusions:

1. The profilometer gave bump amplitudes varying from 1.15 to 2.35 inches on April 2001 and from 0.76 to 2.12 on March 2002, transition slopes as steep as 1/100, international roughness indices as high as 820 indicating a rough unpaved road condition, and present serviceability indices of 0.00 indicating really poor condition.
2. The profilometer test performed one year after later indicated that some of the bumps had decreased and some had stayed the same while the others had increased. Therefore, bumps are dynamic features that may be tied to the

weather through the shrink-swell nature of some soils used for embankment fills.

3. Close to the bridge abutment, the cone penetrometer resistance was 33.8 percent lower on the average and the water content was 10.5 percent higher on the average than the values away from the abutment.
4. The compaction level within the embankment below the bump averaged 96 percent of the Standard Proctor maximum dry unit weight.
5. The soil of the embankment fill had a PI varying from 8.52 to 33.77 with an average equal to 20.96.
6. The ground penetrating radar indicated that there were no voids under the pavement.

The data seem to indicate that the soil near the abutment is more exposed to water than the soil away from the abutment. A higher water content leads to a lower strength and therefore a higher compressibility of the soil; this leads to a bump.

A bump rating number BR and a bump index BI were developed as part of this project. The bump rating goes from 0 for no bump to 4 for a dangerous bump and is typically obtained by guessing at the BR number after riding over the pavement at full speed. The number refers to the differential settlement in inches between the low and high point of the bump. The bump ratings at the two sites investigated ranged from 0 to 2. The bump index gives an estimate for the likelihood that a bump will develop for a given situation. The equation giving the bump index includes the height of embankment, the average daily traffic, bridge life, average yearly precipitation, temperature cycle, resistance of abutment, resistance of embankment, and gradient of approach. Further research is needed if the coefficients involved in that equation are to be determined.

Recommendations

The following recommendations are made for the zone located within 100 ft from the abutment:

1. Use quality backfill: PI less than 15, less than 20 percent passing sieve #200, coefficient of uniformity larger than 3.

2. Compact the soil to 95 percent of Modified Proctor controlled by inspection with a measurement every 50 ft^2.

If such a quality backfill cannot be achieved, the embankment fill within that 100 ft zone should be cement stabilized.

REFERENCES

Bellin, J. (November 28, 1994). "Bridge Approaches." Oregon Department of Transportation, Bridge Section, Salem, 13 pp.

Bowels, J. E. (1988). "Foundation Analysis and Design, 4th-ed." McGraw-Hill Co., New York, USA, 1004 pp.

Briaud, J-L., James, R. W., and Hoffman, S. B. (1997). "NCHRP Synthesis 234: Settlement of Bridge Approaches (The Bump at the End of the Bridge)." Transportation Research Board, National Research Council, Washington, D.C., 75 pp.

Carey, W. N. and Irick, P. E. (1960). "The Pavement Serviceability-Performance Concept." Highway Research Board Bulletin 250, 40-58 pp.

Federal Highway Administration. (1990, June 5). "Technical Advisory: Continuously Reinforced Concrete Pavement." [Press release posted on the World Wide Web]. Retrieved June 15, 2002 from the World Wide Web: http://www.fhwa.dot.gov/legsregs/directives/ techadvs/t508014.htm

Hearn, G. (October 1995). "Faulted Pavements at Bridge Abutments." Colorado Transportation Institute Synthesis, University of Colorado at Boulder, 181 pp.

James, R. W., Zhang, H., Zollinger, D. G., Thompson, L. J., Bruner, R. F., and Xin, D. (December 1991). "A Study of Bridge Approach Roughness." Report No. FHWA/TX-91/1213-1F, Texas Department of Transportation, Austin, 116 pp.

Kramer, S. L. and Sajer, P. (December 1991). "Bridge Approach Slab Effectiveness." Report No. WA-RD 227.1, Washington State Department of Transportation, Olympia, 223 pp.

Laguros, J. G., Zaman, M., and Mahmood, I. U. (January 1990). "Evaluation of Causes of Excessive Settlements of Pavements Behind Bridge Abutments and Their Remedies—Phase II (Executive Summary)." Report No. FHWA/OK 89 (07), Oklahoma Department of Transportation, Oklahoma City, 20 pp.

National Bridge Inventory. (1997). Bridge Management Branch, Federal Highway Administration, Washington, D.C.

Sayers, M. W., Gillespie, T. D., and Paterson, W. D. O. (1986). "Guidelines for Conducting and Calibrating Road Roughness Measurements." World Bank Technical Paper No. 46, Washington, D.C.

Sayers, M. W., Gillespie, T. D., and Queiroz, C. A. V. (1986). "International Road Roughness Experiment: Establishing for Correlation and a Calibration Standard for Measurements." World Bank Technical Paper No. 45, Washington, D.C.

Sayers, M. W. and Karamihas, S. M. (1998, Sep. 18). “The Little Book of Profiling.” [Press release posted on the World Wide Web]. Retrieved June 15, 2002 from the World Wide Web: http://www.umtri.umich.edu/erd/roughness/lit_book.pdf

Schaefer, V. R. and Koch, J. C. (November 1992). “Void Development Under Bridge Approaches.” Report No. SD90-03, South Dakota Department of Transportation, Pierre, 147 pp.

Stark, T. D., Olson, S. M., and Long, J. H. (April 1995). “Differential Movement at the Embankment/Structure Interface—Mitigation and Rehabilitation.” Report No. IAB-H1, FY 93, Illinois Department of Transportation, Springfield, Illinois, 297 pp.

Tadros, M. K. and Benak, J. V. (December 1989). “Bridge Abutment and Approach Slab Settlement (Phase 1).” Nebraska Department of Roads, Lincoln, Nebraska, 89 pp.

Wahls, H. E. (1990). “NCHRP Synthesis 159: Design and Construction of Bridge Approaches.” Transportation Research Board, National Research Council, Washington, D.C. 45 pp.

Wicke, M. and Stoelhorst, D. (1982). “Problems Associated with the Design and Construction of Concrete Pavements on Approach Embankments.” Transport and Road Research Laboratory, IRRD 267166, London, England, 15 pp.

Zaman, M., Laguros, J. G., and Jha, R. K. (February 1994). “Statistical Models for Identification of Problematic Bridge Sites and Estimation of Approach Settlements.” Report for Study 2188, Oklahoma Department of Transportation, Oklahoma City, 122 pp.and Appendices volume.

APPENDIX A SURVEY QUESTIONNAIRE

TEXAS DEPARTMENT OF TRANSPORTATION RESEARCH PROGRAM

Project No. 04147

Performed by Texas Transportation Institute

Investigation of Settlement at Bridge Approach Slab Expansion Joint

QUESTIONNAIRE

Name of respondent : ______________________

Title : ______________________

Phone No. : ______________________

Fax No. : ______________________

E-mail Address : ______________________

I. GENERAL INFORMATION

1. How many bridges are there in your district? ______________________

2. Have you encountered the problem of the bump at the end of the bridge? please estimate the percentage of bridges in your district that are affected by this condition:

   ❑ 0% ❑ 10% ❑ 20% ❑ 30% ❑ 40% ❑ 50% ❑ OTHER _____%

3. What is your estimate of the total maintenance cost per year in your district for this problem including both internal and contracted maintenance?

   a) Estimated Total Maintenance Cost (per year): $______________________
   b) Estimate of Percent Cost Internal: ______________________%
   c) Estimate of Percent Cost Contracted Maintenance: ______________________%

4. Among the bridges that are affected by the bump at the end of the bridge, what percentages have the following characteristics?

a) Type of Bridge Foundation

Shallow foundation	________
Deep foundation	________
Unknown	________
Total	100%

b) Type of Approach Slab

Rigid approach slab	________
Flexible approach slab	________
Unknown	________
Total	100%

c) Soil Used as Compacted Fill

Clay	________
Silt	________
Sand	________
Stabilized soil	________
Unknown	________
Total	100%

d) Foundation Soil

Clay	________
Silt	________
Sand	________
Unknown	________
Total	100%

e) Height of Approach Embankment

Less than 10 ft high	________
Greater than 10ft high	________
Unknown	________
Total	100%

f) Type of Terminal Joints Treatment

Wide-flange steel Beam	________
Lug Anchor	________
Unknown	________
Total	100%

II. CONDITIONAL INFORMATION

5. What are the common causes of the problem in your district?

Please rank using: 1=most common, 2=frequent, 3=may be a factor, 4=never a factor

a) Settlement of fill ____________________
b) Loss of fill by erosion ____________________
c) Poor drainage ____________________
d) Settlement of natural soil under the fill ____________________
e) Settlement of natural soil under the bridge abutment ____________________
f) Too rigid a bridge foundation ____________________
g) Differential settlement between bridge and fill ____________________
h) Poor construction specifications ____________________

i) Poor construction practices ____________________
j) Lateral movement of the bridge abutment ____________________
k) Bridge type ____________________
l) Abutment type ____________________
m) Pavement growth ____________________
n) Poor joints ____________________
o) Temperature cycle ____________________
p) Other **If other, please explain**: ____________________

6. In what cases does the problem appear to be worse? **Please comment**:

____
____
____

7. In what cases does the problem appear to be minimized? **Please comment**:

____
____
____

III. OPERATIONAL IFORMATION

8. What methods do you use to detect the problem and how often do you use those methods?

Please use the following scale: 1=often, 2=sometimes, 3=rarely, 4=not at all

a) Visual inspection ____________________
b) Ridability (subjective) ____________________
c) Ridability (quantitative) ____________________
d) Public complains ____________________
e) Non-destructive tests(NDT) ____________________
please explain the test(s) used:

____
____

f) Other; if other, please explain:

____
____

9. How and when do you decide to perform maintenance on a bridge with this problem?

____

____

____

10. Please list any other comments you might have regarding the bump at the end of the bridge.

____

____

____

THANK YOU FOR YOUR ASSISTANCE!

Please send your response to:

Professor J.-L. Briaud
Department of Civil Engineering
Texas A&M University
College Station, TX 77843-3136

If you have any question, please call Professor Briaud at **(979) 845-3795** or contact him by E-mail at **BRIAUD@TAMU.EDU**. If you would like to submit your questionnaire response by facsimile, please do so at **(979) 845-6554**

We would appreciate your response by November 31, 2000

APPENDIX B SUMMARY OF SURVEY RESPONSES

Districts who responded to the survey.

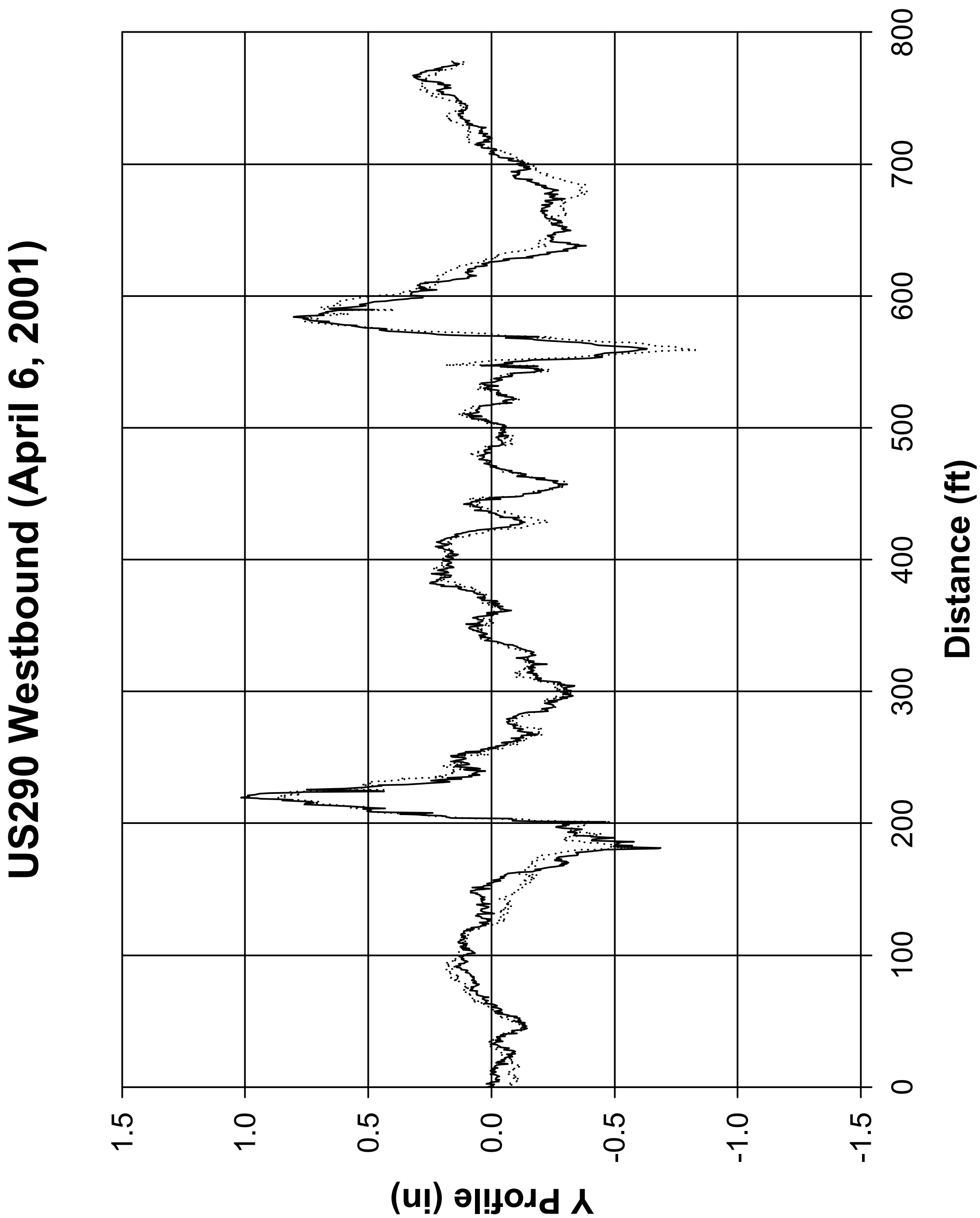
1. Beaumont
2. Brownwood
3. Bryan
4. Childress
5. Corpus Christi
6. Ft. Worth
7. Houston
8. Laredo
9. Odessa
10. San Antonio
11. Waco
12. Wichita Falls
13. Yoakum

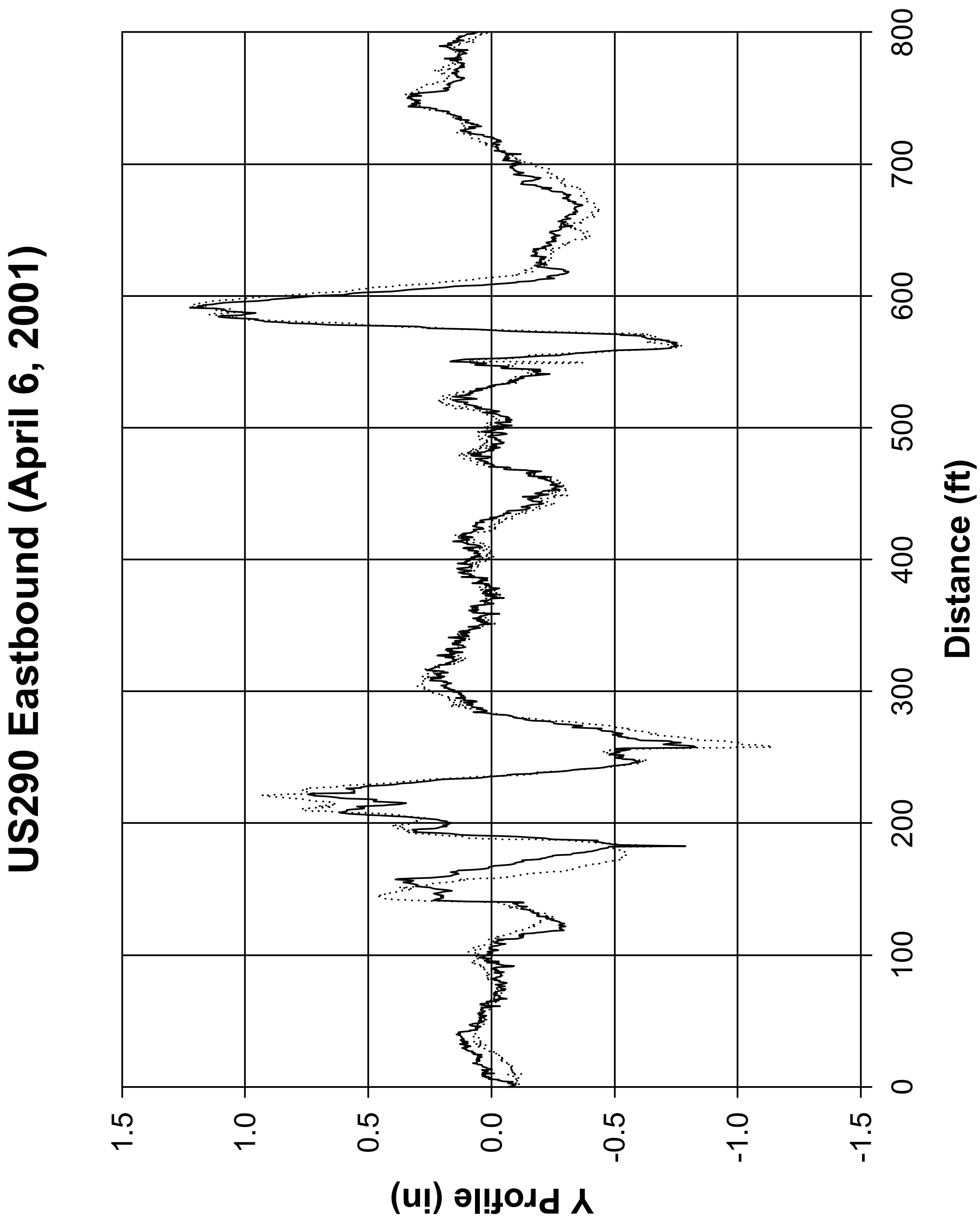
District	Q1	Q2	Q3			Q4													
			a)	b)	c)	a)				b)				c)					
						1)	2)	3)	sum	1)	2)	3)	sum	1)	2)	3)	4)	5)	sum
Beaumont	1,055	40	N/A	N/A	N/A	0	100	0	100	100	0	0	100	100	0	0	0	0	100
Brownwood	894	30	25,000	100	0	20	80	0	100	10	90	0	100	80	0	10	0	10	100
Bryan	687	20	100,000	100	0	5	95	0	100	50	50	0	100	50	0	0	10	40	100
Childress	900	10	N/A	N/A	N/A	0	98	2	100	80	20	0	100	0	0	0	80	20	100
Corpus Christi	1,245	50	10,000	95	5	0	100	0	100	100	0	0	100	80	20	0	0	0	100
Ft. Worth	3,400	20	750,000	70	30	0	100	0	100	100	0	0	100	90	0	10	0	0	100
Houston	2,659	18	1,300,000	18	82	6	42	52	100	76	5	19	100	35	0	1	32	32	100
Laredo	630	20	100,000	40	60	0	100	0	100	5	95	0	100	0	0	20	80	0	100
Odessa	1,051	0	N/A	N/A	N/A	0	0	0	100	0	0	0	100	0	0	0	0	0	100
San Antonio	2,419	20	250,000	100	0	0	100	0	100	2	98	0	100	0	0	0	0	100	100
Waco 1	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A	100	N/A	N/A	N/A	100	N/A	N/A	N/A	N/A	N/A	100
Waco 2	1,617	10	N/A	N/A	N/A	0	100	0	100	25	75	0	100	N/A	N/A	N/A	N/A	N/A	100
Waco 3	1,617	30	65,000	100	0	N/A	N/A	N/A	100	30	70	0	100	90	0	0	10	0	100
Waco 4	1,617	30	50,000	100	0	0	100	0	100	40	60	0	100	80	0	0	20	0	100
Wichita Falls	522	40	40,000	100	0	12	85	3	100	78	22	0	100	82	0	12	2	4	100
Yoakum	1,622	20	102,500	80	20	0	100	0	100	10	90	0	100	50	0	0	0	50	100
Average	1,462	24.533	253,864	82	18	3.3	92.3	4.4	100	50.4	48.2	1.4	100	56.7	1.5	4.1	18.0	19.7	100
Total	22,342																		

District	Q4													Q5							
	d)					e)				f)				a)	b)	c)	d)	e)	f)	g)	h)
	1)	2)	3)	4)	sum	1)	2)	3)	sum	1)	2)	3)	sum								
Beaumont	0	0	100	0	100	50	50	0	100	0	100	0	100	1	4	4	2	4	4	3	3
Brownwood	10	0	10	80	100	40	60	0	100	0	0	100	100	1	3	3	3	4	3	3	3
Bryan	60	0	5	35	100	50	50	0	100	0	40	60	100	1	1	2	3	3	3	2	3
Childress	33	0	33	33	100	25	75	0	100	N/A	N/A	N/A	100	2	1	3	3	3	4	4	4
Corpus Christi	70	20	10	0	100	0	100	0	100	0	0	100	100	3	2	3	0	0	0	3	3
Ft. Worth	40	40	20	0	100	20	80	0	100	0	10	90	100	1	3	3	3	3	4	2	3
Houston	38	0	3	59	100	27	71	2	100	45	32	23	100	2	3	3	3	3	3	3	3
Laredo	60	0	40	0	100	20	80	0	100	0	0	100	100	1	1	4	4	4	4	1	4
Odessa	0	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	0	0	0	0	0
San Antonio	0	0	0	100	100	5	95	0	100	N/A	N/A	N/A	100	1	3	3	4	4	3	1	3
Waco 1	N/A	N/A	N/A	N/A	100	N/A	N/A	N/A	100	N/A	N/A	N/A	100	1	2	3	3	3	4	4	4
Waco 2	N/A	N/A	N/A	N/A	100	25	75	0	100	0	0	100	100	1	4	3	3	3	4	2	3
Waco 3	90	0	0	10	100	45	55	0	100	N/A	N/A	N/A	100	1	3	4	1	1	4	3	4
Waco 4	80	0	0	20	100	30	70	0	100	N/A	N/A	N/A	100	1	3	3	2	2	4	3	3
Wichita Falls	85	0	10	5	100	77	23	0	100	25	75	0	100	1	2	3	3	3	4	2	3
Yoakum	50	0	0	50	100	25	75	0	100	0	100	0	100	3	3	3	4	4	4	4	3
Average	47.4	4.6	17.8	30.2	100	31.4	68.5	0.1	100	7.0	35.7	57.3	100	1.4	2.5	3.1	2.7	2.9	3.5	2.7	3.3
Total																					

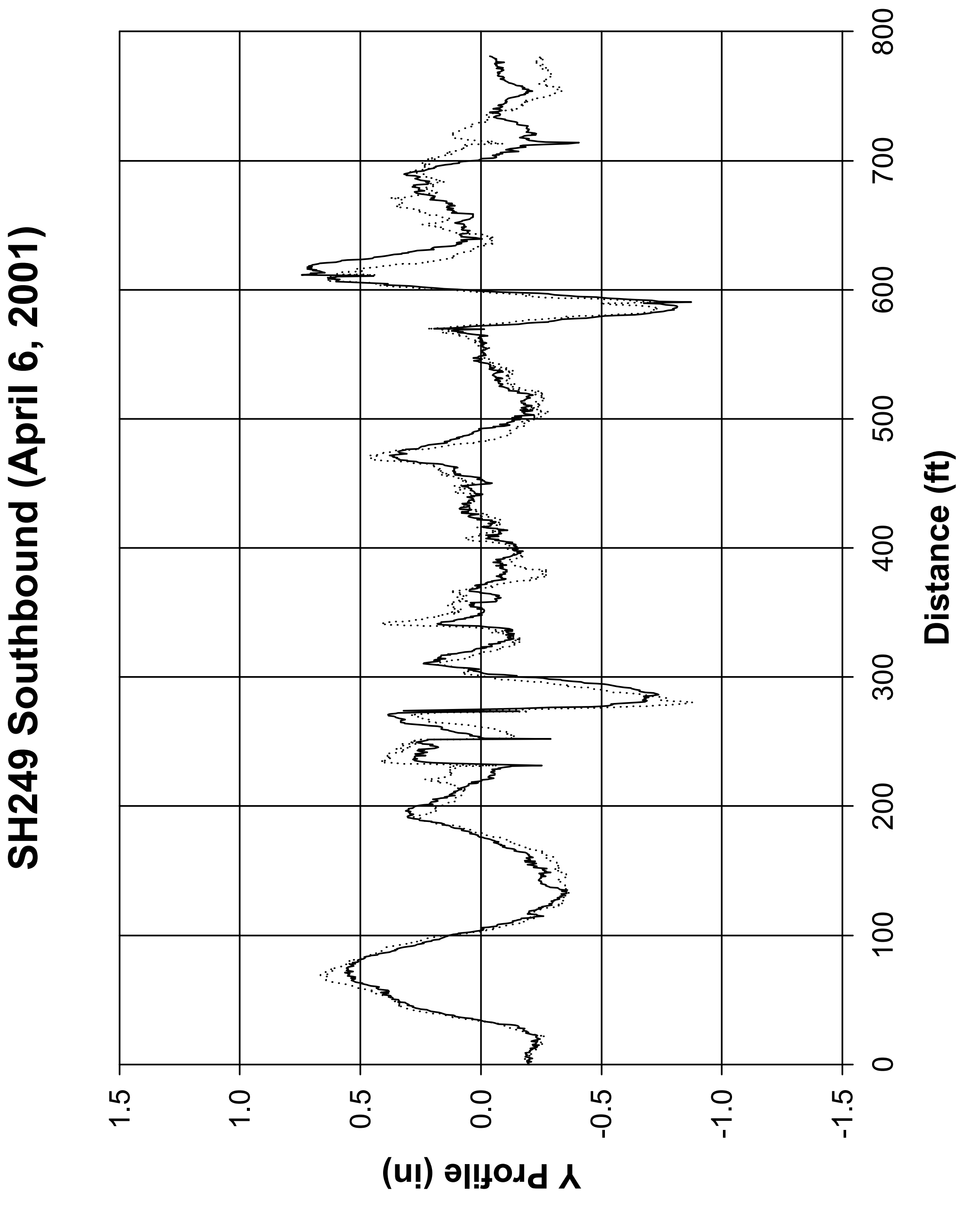
District	Q5								Q6	Q7	Q8	Q9						Q10	Q11	Q12
	I)	j)	k)	l)	m)	n)	o)	p)				a)	b)	c)	d)	e)	f)			
Beaumont	2	4	3	4	3	3	3	N/A	Ans	Ans	Yes	1	1	3	3	4	N/A	N/A	Ans	N/A
Brownwood	2	4	4	4	4	3	3	Ans	Ans	Ans	Yes	1	1	3	2	0	N/A	Ans	Ans	Ans
Bryan	3	4	3	3	2	2	2	Ans	Ans	Ans	No	1	1	4	1	4	N/A	Ans	Ans	Ans
Childress	3	4	N/A	N/A	4	4	3	N/A	Ans	N/A	Yes	1	1	N/A	2	4	N/A	Ans	Ans	Ans
Corpus Christi	3	0	0	0	0	0	2	N/A	Ans	Ans	Yes	1	2	2	2	2	N/A	Ans	Ans	N/A
Ft. Worth	1	3	3	3	3	3	3	N/A	Ans	Ans	Yes	1	1	3	2	4	N/A	Ans	Ans	Ans
Houston	3	3	3	3	3	3	3	Ans	Ans	Ans	Yes	1	1	2	2	4	N/A	Ans	Ans	Ans
Laredo	3	3	3	4	3	4	3	N/A	Ans	N/A	Yes	1	1	4	2	N/A	N/A	Ans		
Odessa	0	0	0	0	0	0	0	N/A	N/A	N/A	Yes	2	1	0	3	0	N/A	N/A	N/A	N/A
San Antonio	1	3	4	2	4	3	3	N/A	Ans	Ans	Yes	1	1	3	2	4	N/A	Ans	Ans	Ans
Waco 1	3	4	4	4	4	4	4	N/A	Ans	N/A	Yes	1	1	3	4	4	N/A	N/A	Ans	Ans
Waco 2	3	4	4	4	2	3	3	N/A	Ans	Ans	Yes	1	1	3	2	4	N/A	N/A	N/A	Ans
Waco 3	4	4	4	3	3	3	1	Ans	Ans	Ans	Yes	1	1	4	1	4	N/A	Ans	Ans	N/A
Waco 4	3	4	4	4	3	4	3	N/A	Ans	Ans	Yes	1	1	3	2	4	N/A	Ans	Ans	N/A
Wichita Falls	3	3	3	3	3	2	3	N/A	Ans	Ans	Yes	1	1	4	1	4	N/A	Ans	Ans	Ans
Yoakum	3	4	4	4	2	2	2	N/A	Ans	Ans	Yes	3	1	4	3	0	N/A	Ans	Ans	Ans
Average	2.7	3.4	3.3	3.2	3.1	3.1	2.7					1.2	1.1	3.0	2.1	2.9				
Total																				

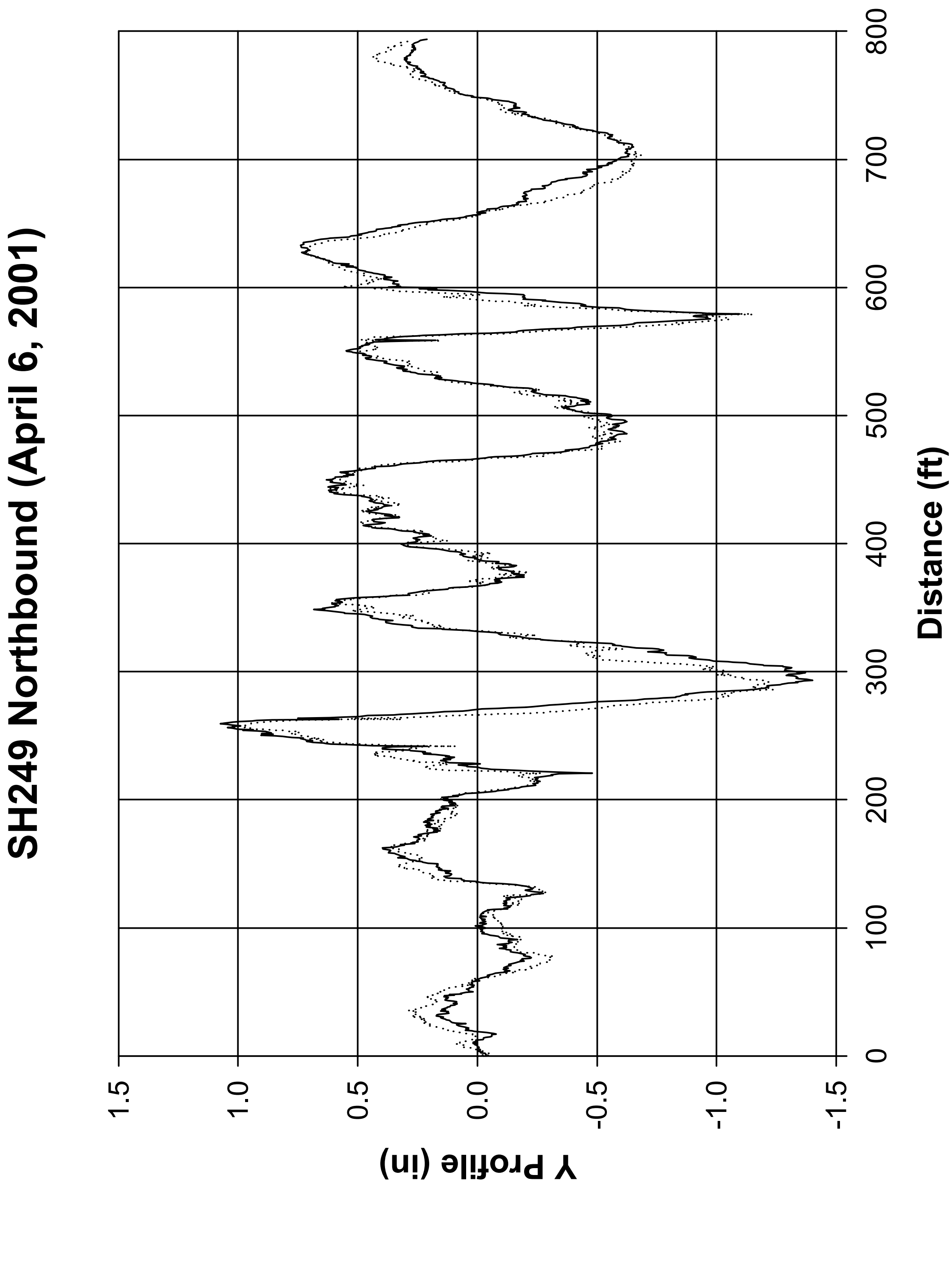
APPENDIX C PROFILOMETER TEST DATA

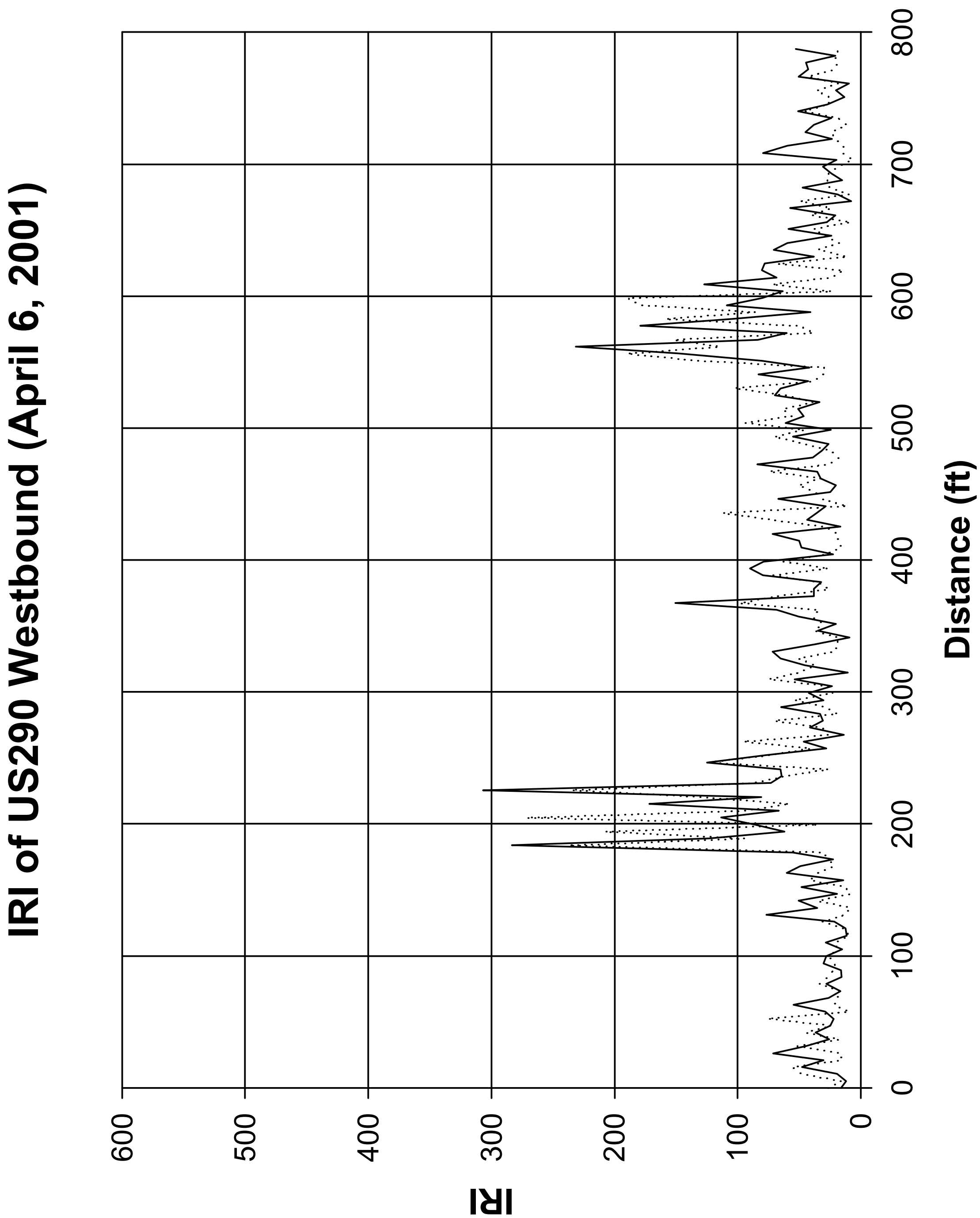

US290 Westbound (April 6, 2001)
Y Profile (in)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Distance (ft)
0
100
200
300
400
500
600
700
800

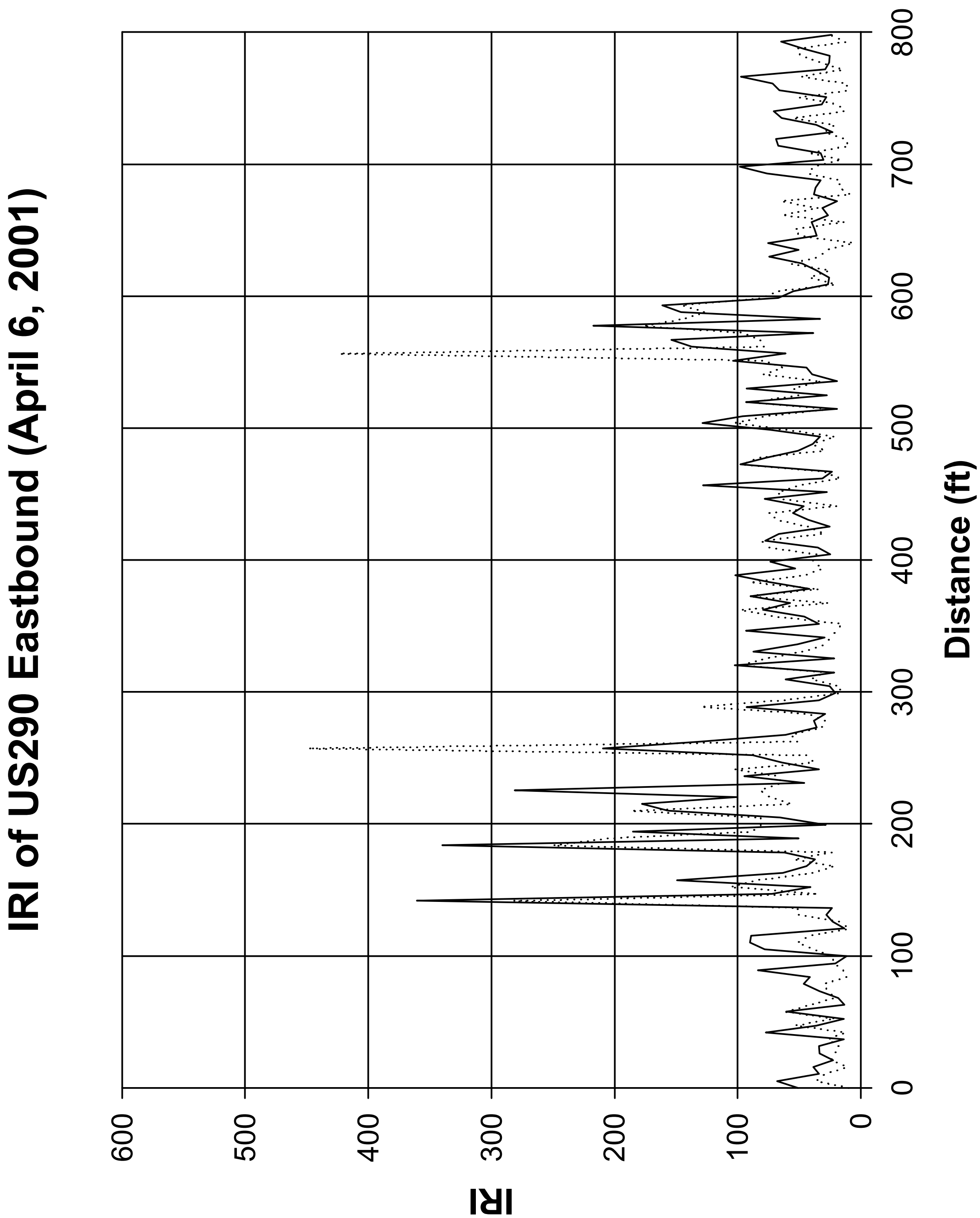


US290 Eastbound (April 6, 2001)
Distance (ft)
Y Profile (in)
0
100
200
300
400
500
600
700
800
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5

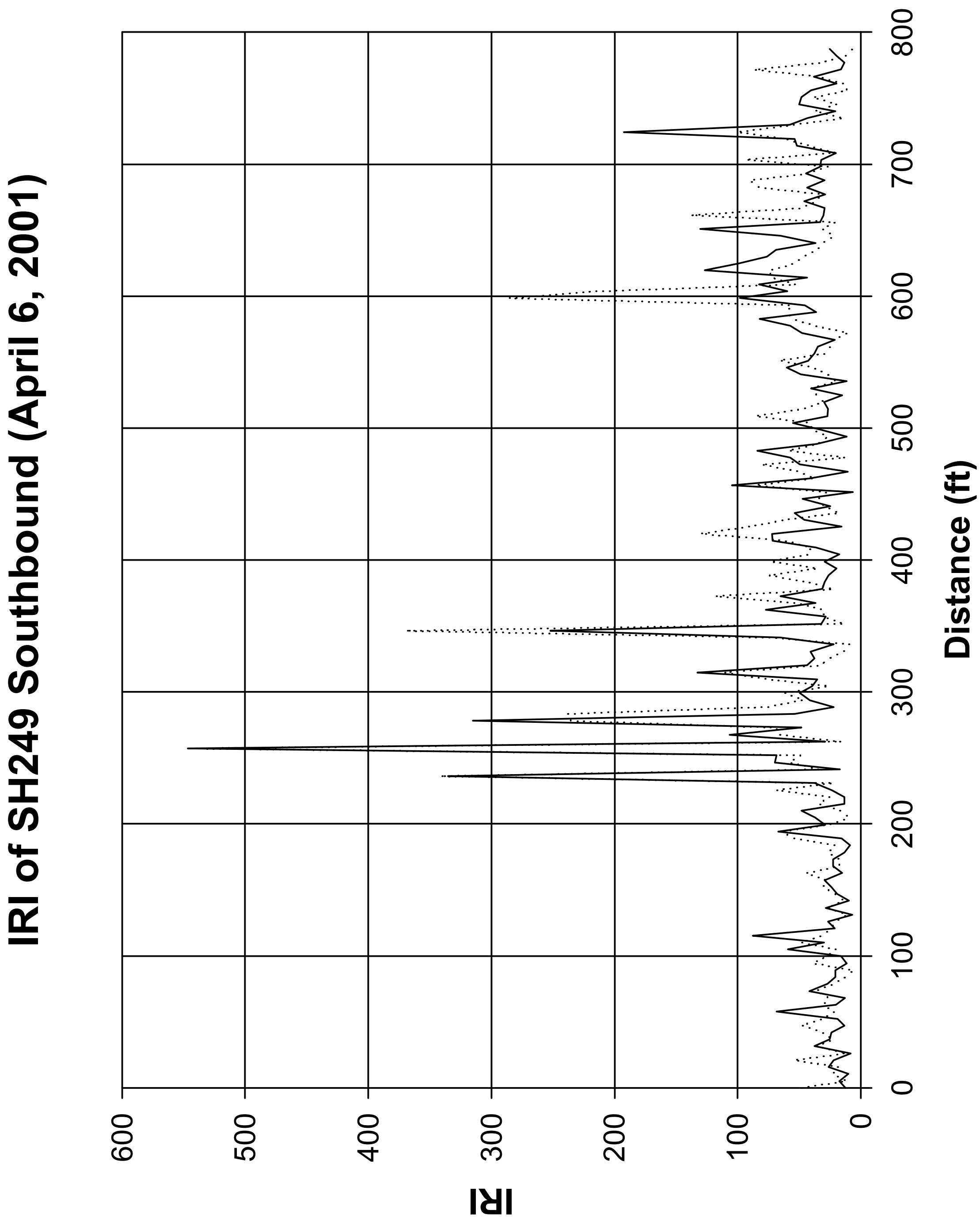

SH249 Southbound (April 6, 2001)
Y Profile (in)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Distance (ft)
0
100
200
300
400
500
600
700
800

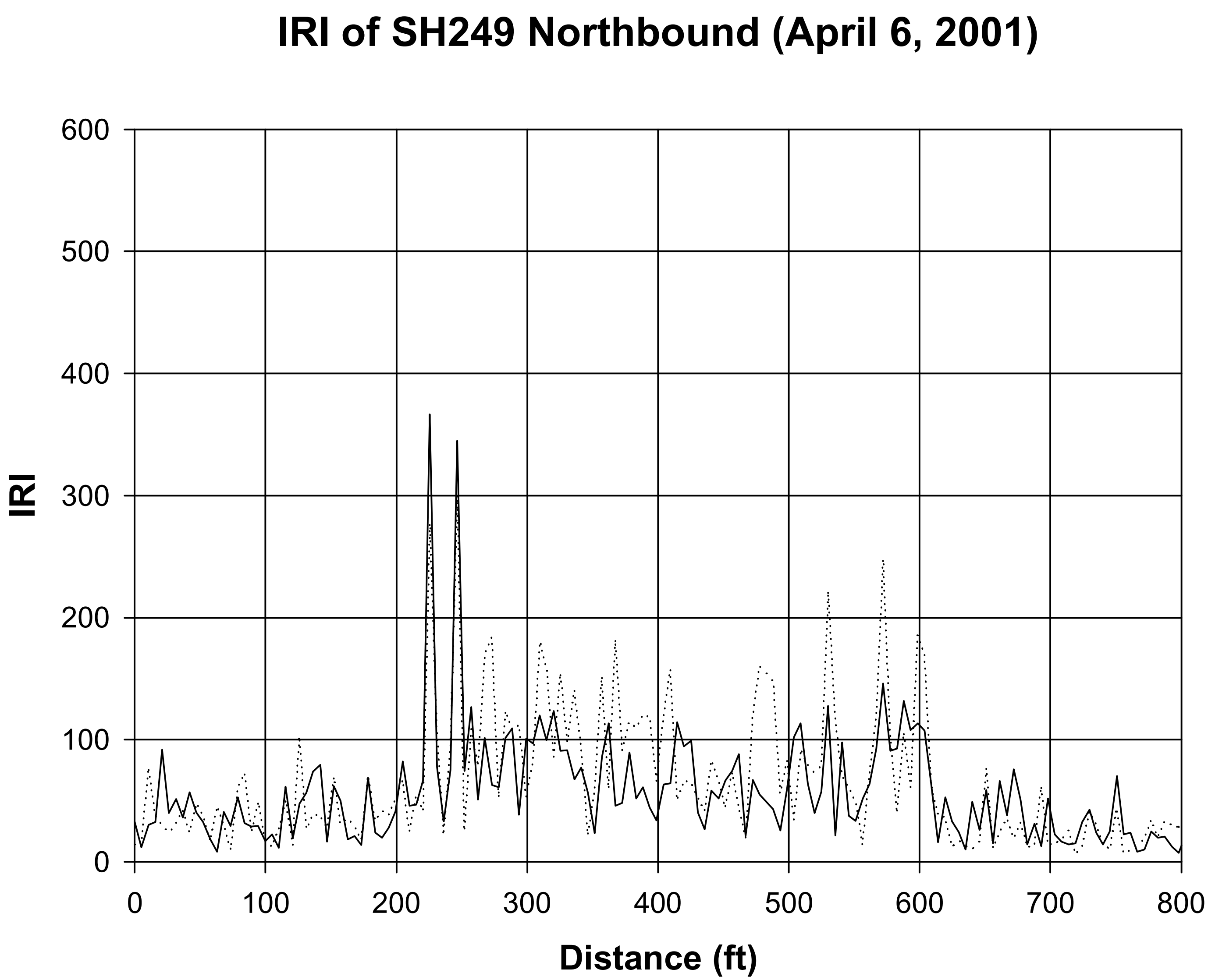

SH249 Northbound (April 6, 2001)
Y Profile (in)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Distance (ft)
0
100
200
300
400
500
600
700
800

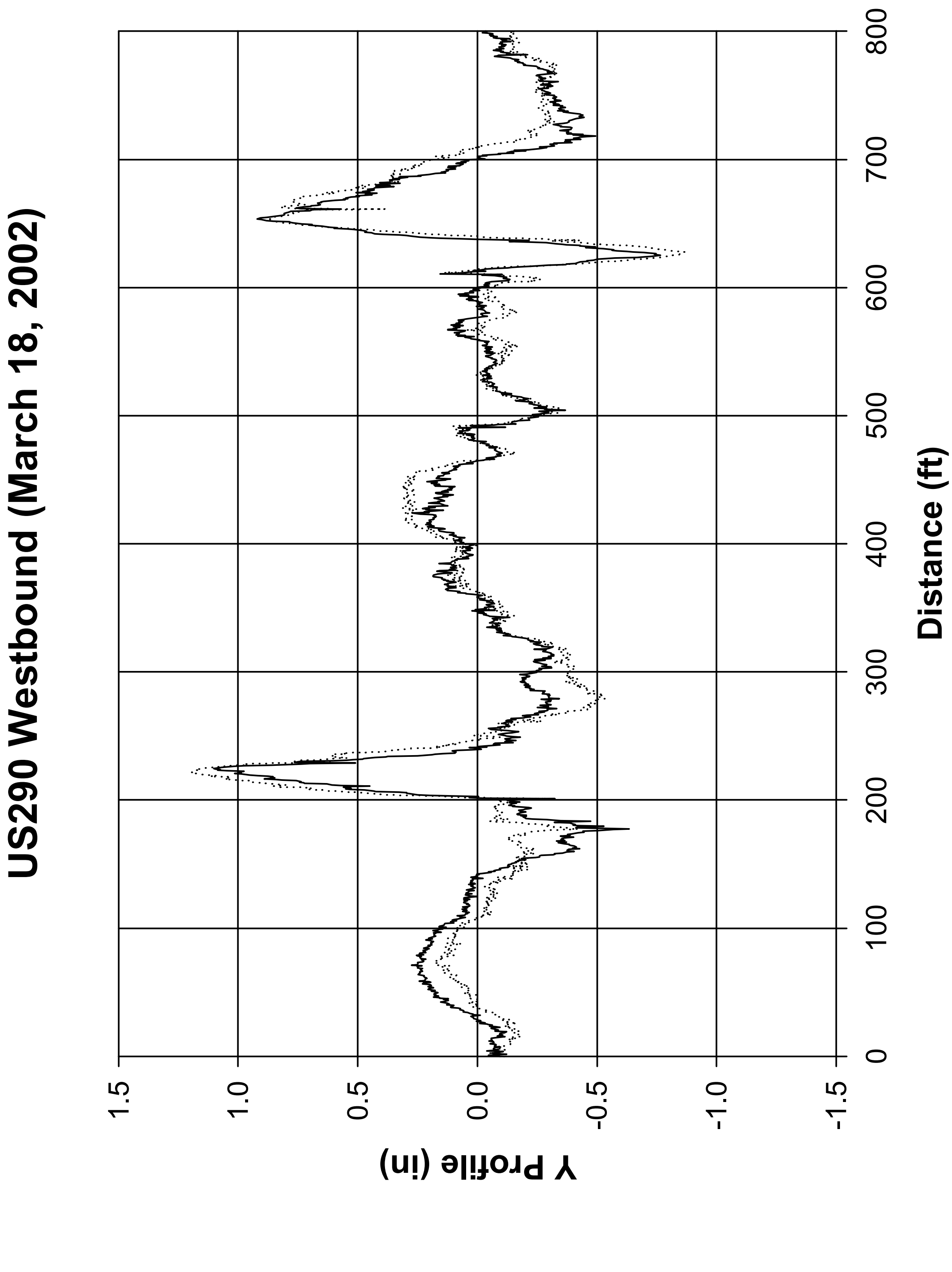

IRI of US290 Westbound (April 6, 2001)
IRI
0
100
200
300
400
500
600
Distance (ft)
0
100
200
300
400
500
600
700
800

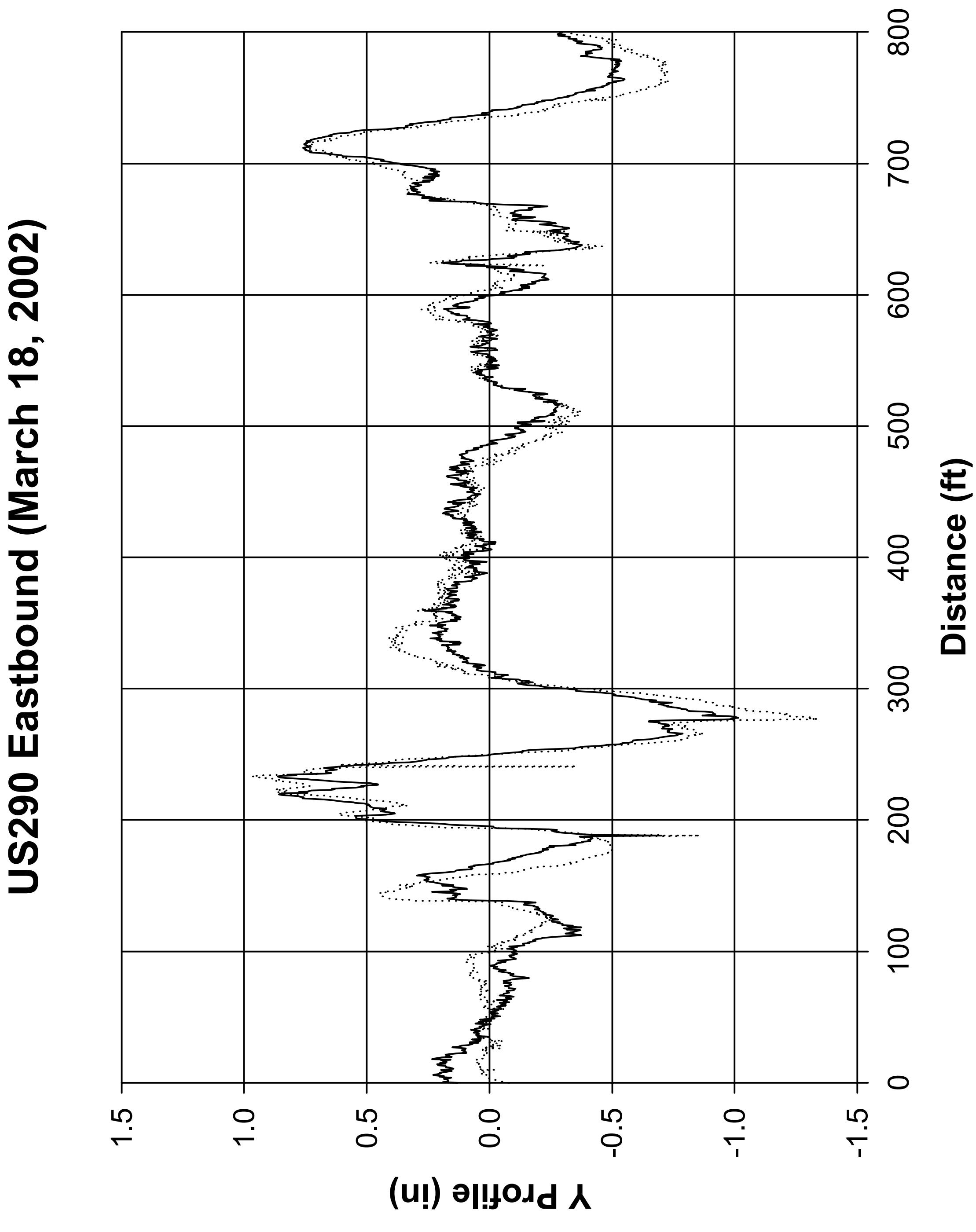


IRI of US290 Eastbound (April 6, 2001)
IRI
Distance (ft)
0
100
200
300
400
500
600
700
800

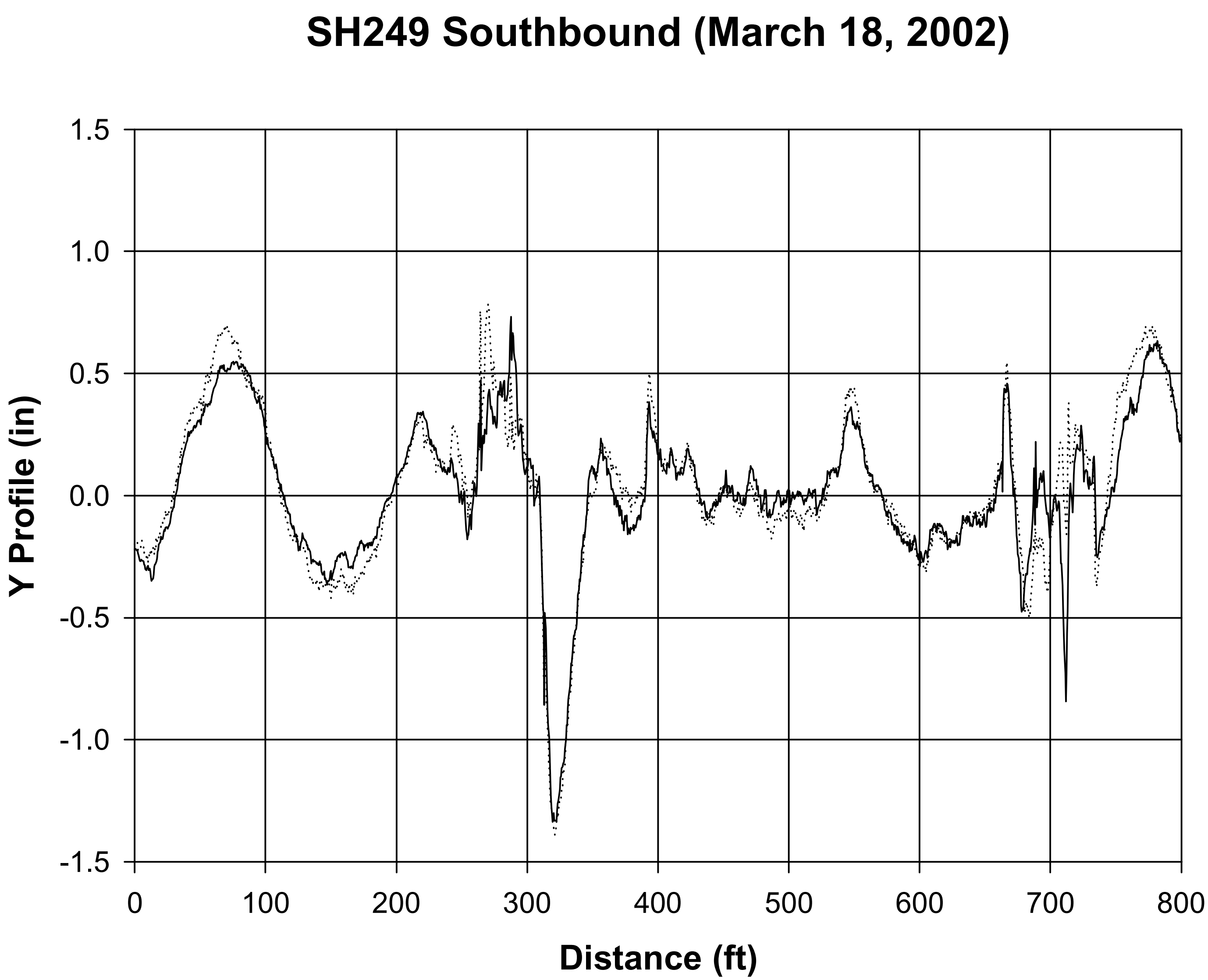

IRI of SH249 Southbound (April 6, 2001)
IRI
0
100
200
300
400
500
600
Distance (ft)
0
100
200
300
400
500
600
700
800

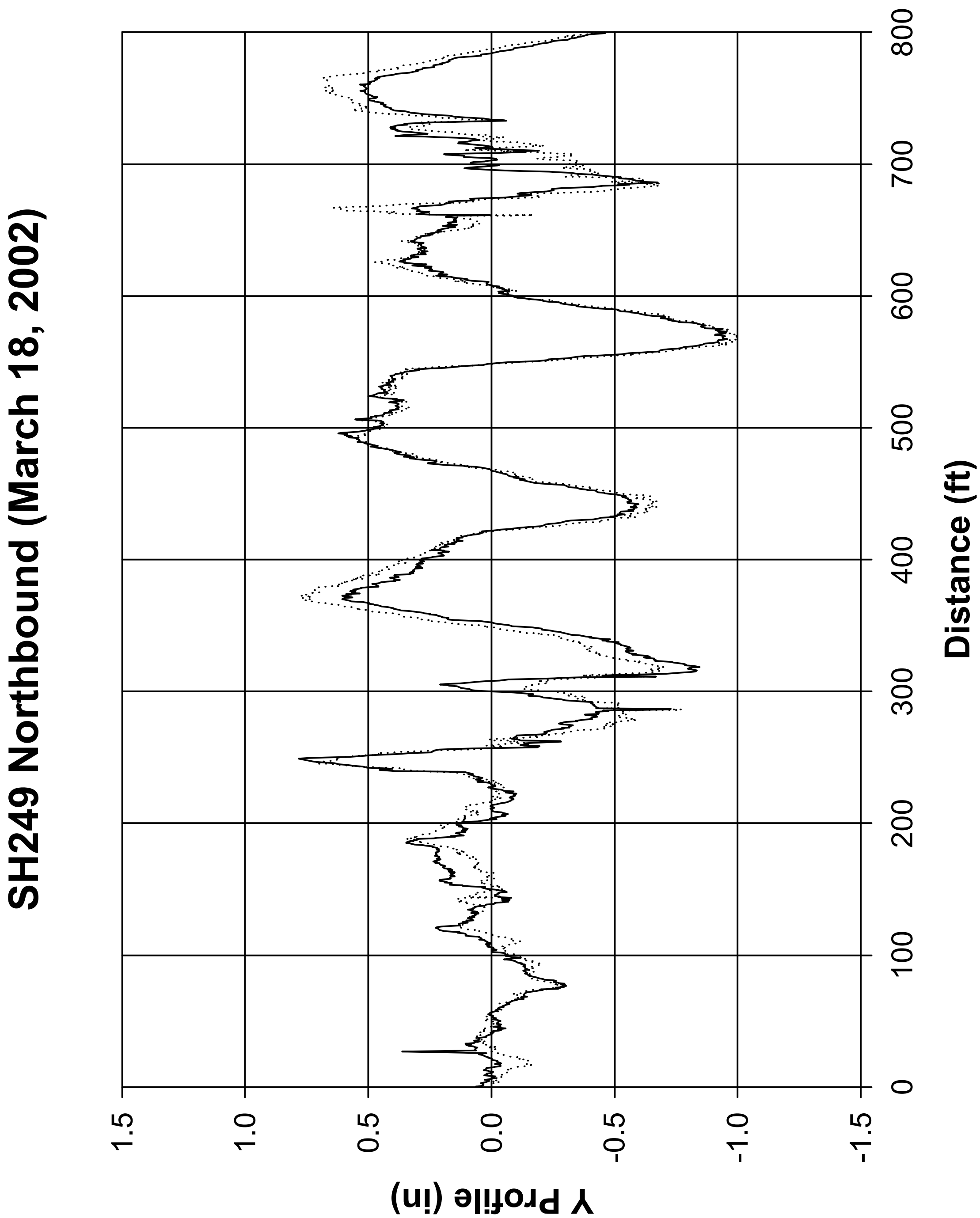

IRI of SH249 Northbound (April 6, 2001)
IRI
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
Distance (ft)

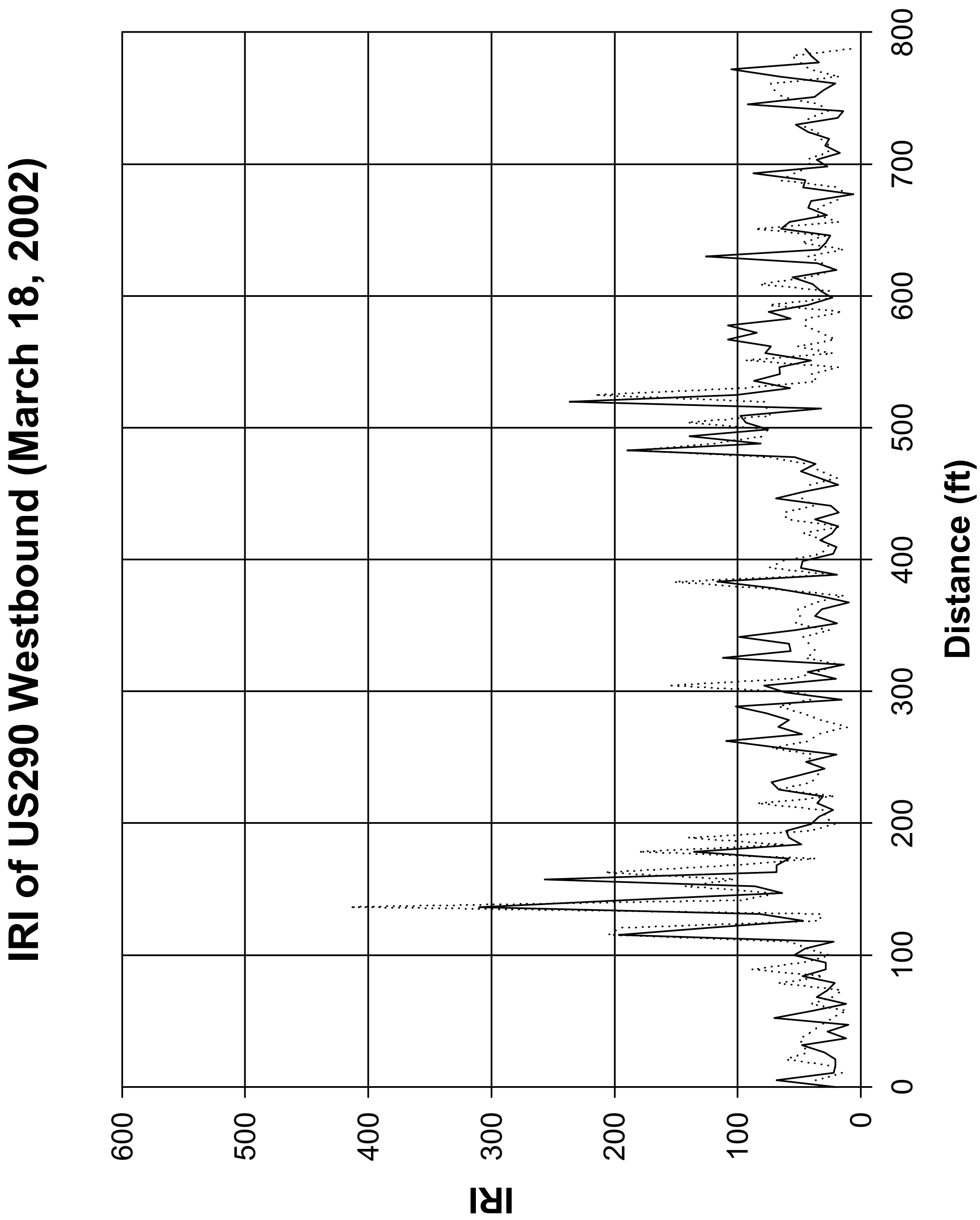

US290 Westbound (March 18, 2002)
Y Profile (in)
Distance (ft)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
100
200
300
400
500
600
700
800

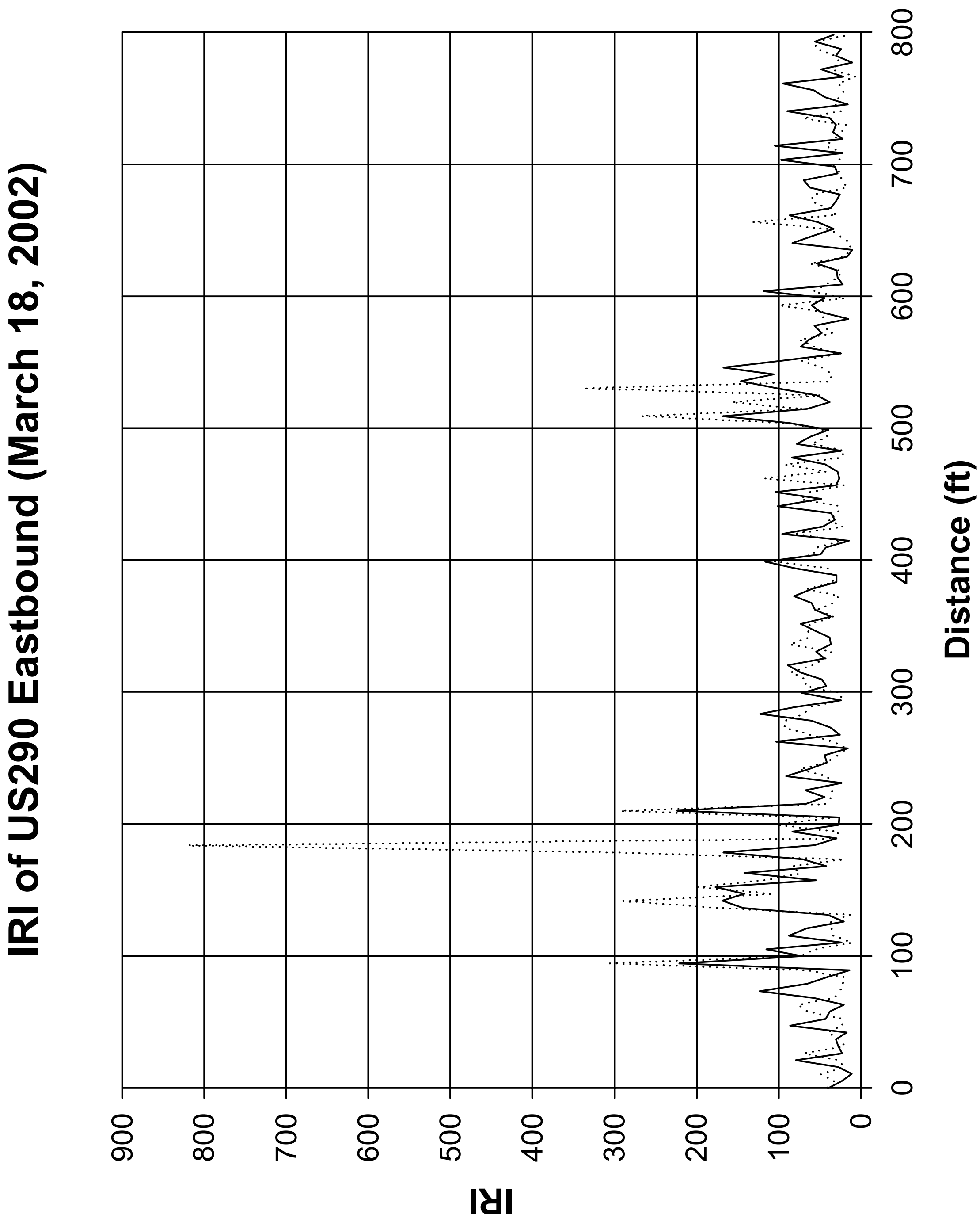


US290 Eastbound (March 18, 2002)
Y Profile (in)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Distance (ft)
0
100
200
300
400
500
600
700
800

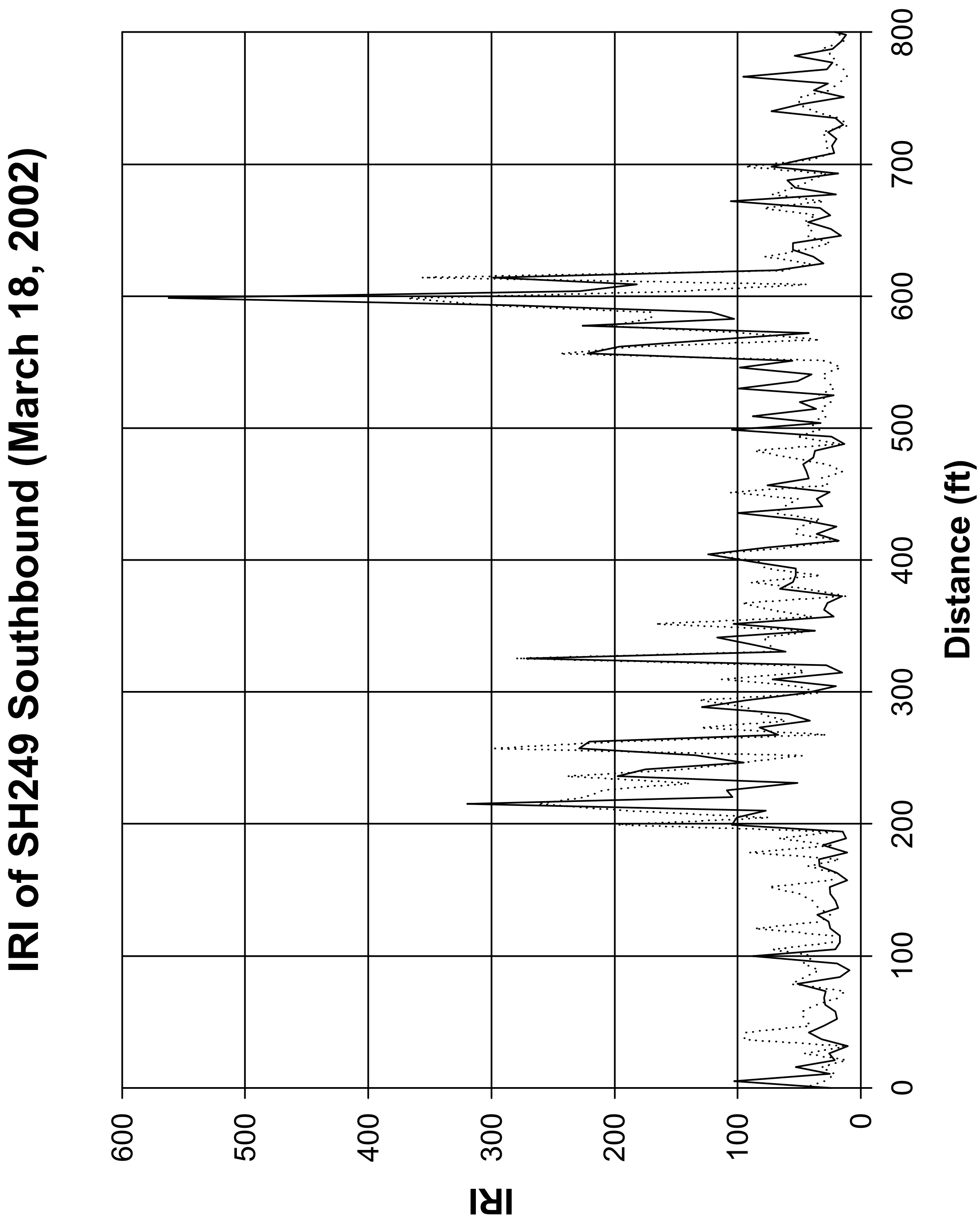

SH249 Southbound (March 18, 2002)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Y Profile (in)
0
100
200
300
400
500
600
700
800
Distance (ft)


SH249 Northbound (March 18, 2002)
Y Profile (in)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Distance (ft)
0
100
200
300
400
500
600
700
800

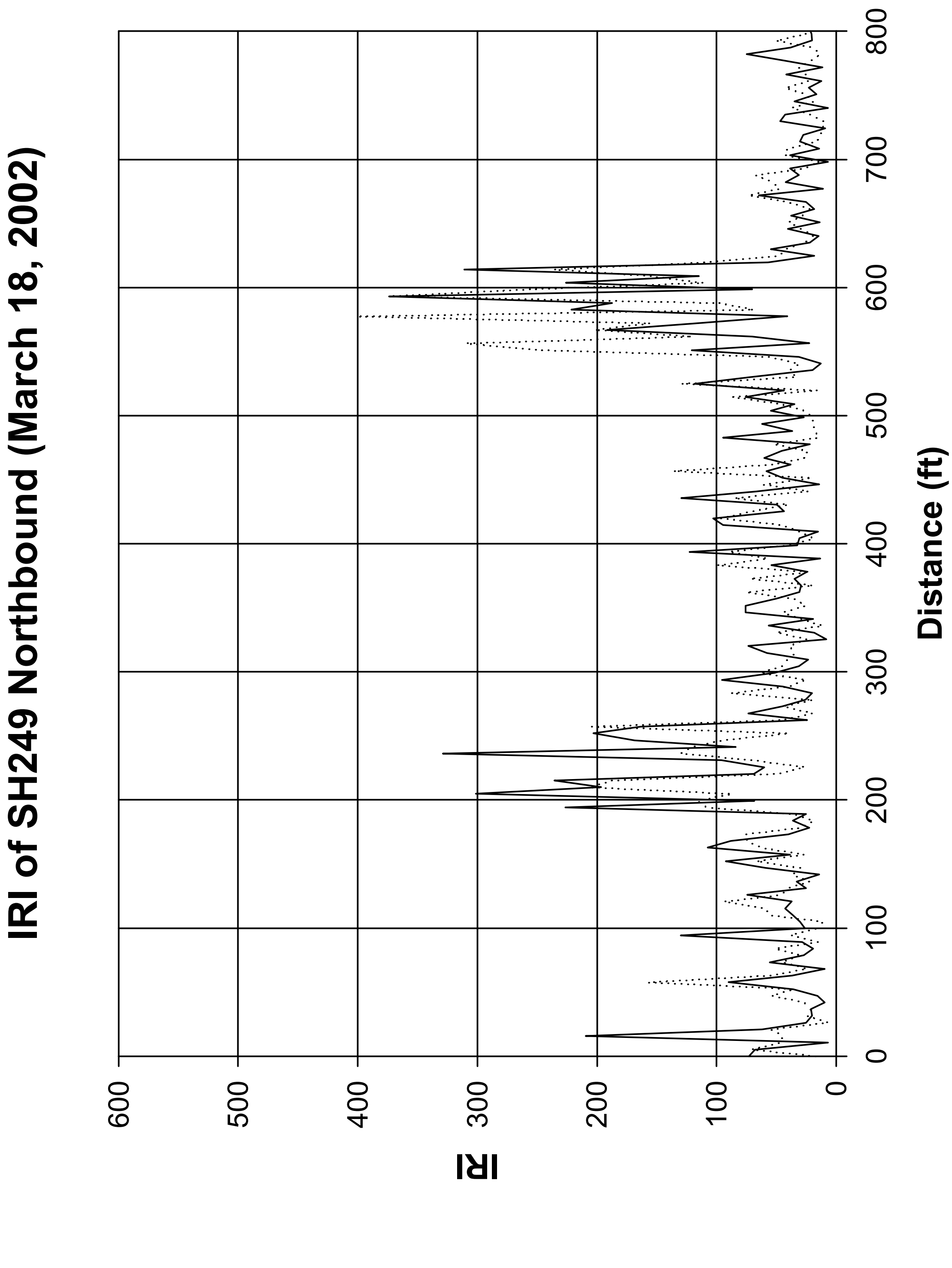

IRI of US290 Westbound (March 18, 2002)
IRI
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
Distance (ft)



IRI of US290 Eastbound (March 18, 2002)
IRI
900
800
700
600
500
400
300
200
100
0
Distance (ft)
0
100
200
300
400
500
600
700
800



IRI of SH249 Southbound (March 18, 2002)
IRI
0
100
200
300
400
500
600
Distance (ft)
0
100
200
300
400
500
600
700
800


IRI of SH249 Northbound (March 18, 2002)
IRI
Distance (ft)
0
100
200
300
400
500
600
700
800

IRI & BUMP Calculations

US290 Eastbound (April 6, 2001)

ProView(v8.25) Report - TxDOT

========== I M P O R T   D A T A F I L E =========

Input file: d:\SH290\SH290EB2.PRO

Number of profiles loaded: 2

--Header Lines

HEAD3,04062001,12,102,SH290EB,0000 +00.000,R1

CMET3,FORD AEROSTAR MINI VAN, S232, 6362km, 293475G, mi,
1FMDA31U7VZA11903, 09142000

KPRF01 mil LR 0.1572 m 0.000 mi

SH290 EB R1

--Header Lines

Metric units input - english output. Converted 0.1572 meters to 0.5157 feet.

Data record count: 2317   Total distance: 0.226 miles

Min/Max profile values: -1.142/1.233 inches

Average value(bias) for all profiles: 0.000 inches

===== I R I & B U M P   C A L C U L A T I O N =====

Distance	Description		
00.0010	IRI(L): 027.09	IRI(2): 038.01	PSI = 04.70
00.0020	IRI(L): 029.36	IRI(2): 046.80	PSI = 04.70
00.0030	IRI(L): 030.89	IRI(2): 006.68	PSI = 04.70
00.0040	IRI(L): 023.96	IRI(2): 048.25	PSI = 04.70
00.0050	IRI(L): 032.04	IRI(2): 053.86	PSI = 04.70
00.0060	IRI(L): 014.54	IRI(2): 045.96	PSI = 04.70
00.0070	IRI(L): 032.05	IRI(2): 026.96	PSI = 04.70
00.0080	IRI(L): 095.43	IRI(2): 030.18	PSI = 04.44
00.0090	IRI(L): 051.57	IRI(2): 040.53	PSI = 04.70
00.0100	IRI(L): 019.11	IRI(2): 030.91	PSI = 04.70
00.0110	IRI(L): 042.10	IRI(2): 034.87	PSI = 04.70
00.0120	IRI(L): 037.02	IRI(2): 029.50	PSI = 04.70
00.0130	IRI(L): 033.67	IRI(2): 022.56	PSI = 04.70
00.0140	IRI(L): 065.70	IRI(2): 049.40	PSI = 04.57
00.0150	IRI(L): 099.98	IRI(2): 057.83	PSI = 04.07
00.0160	IRI(L): 012.04	IRI(2): 082.46	PSI = 04.70
00.0170	IRI(L): 069.87	IRI(2): 017.08	PSI = 04.70
00.0180	IRI(L): 059.23	IRI(2): 013.17	PSI = 04.70
00.0190	IRI(L): 034.11	IRI(2): 014.05	PSI = 04.70
00.0200	IRI(L): 028.10	IRI(2): 029.99	PSI = 04.70
00.0210	IRI(L): 058.90	IRI(2): 034.16	PSI = 04.70

00.0210	IRI(L): 083.74	IRI(2): 034.30	PSI = 04.54
00.0220	IRI(L): 049.81	IRI(2): 027.82	PSI = 04.70
00.0230	IRI(L): 036.12	IRI(2): 016.57	PSI = 04.70
00.0240	IRI(L): 133.88	IRI(2): 023.35	PSI = 04.08
00.0250	IRI(L): 032.05	IRI(2): 034.35	PSI = 04.70
00.0260	IRI(L): 029.13	IRI(2): 025.49	PSI = 04.70
00.0270	IRI(L): 093.74	IRI(2): 055.76	PSI = 04.16
00.0280	IRI(L): 018.91	IRI(2): 030.93	PSI = 04.70
00.0290	IRI(L): 035.06	IRI(2): 025.29	PSI = 04.70
00.0300	IRI(L): 045.94	IRI(2): 054.17	PSI = 04.70
00.0310	IRI(L): 039.86	IRI(2): 049.94	PSI = 04.70
00.0320	IRI(L): 036.93	IRI(2): 024.64	PSI = 04.70
00.0330	IRI(L): 059.26	IRI(2): 013.61	PSI = 04.70
00.0340	IRI(L): 049.31	IRI(2): 042.02	PSI = 04.70
00.0350	IRI(L): 104.18	IRI(2): 023.58	PSI = 04.41
00.0360	IRI(L): 029.96	IRI(2): 020.17	PSI = 04.70
00.0370	IRI(L): 028.36	IRI(2): 017.96	PSI = 04.70
00.0380	IRI(L): 045.29	IRI(2): 025.68	PSI = 04.70
00.0390	IRI(L): 083.11	IRI(2): 019.71	PSI = 04.70
00.0400	IRI(L): 041.05	IRI(2): 020.74	PSI = 04.70
00.0410	IRI(L): 026.87	IRI(2): 037.01	PSI = 04.70
00.0420	IRI(L): 073.96	IRI(2): 017.85	PSI = 04.70
00.0430	IRI(L): 036.99	IRI(2): 039.56	PSI = 04.70

00.0440	IRI(L): 008.69	IRI(2): 019.84	PSI = 04.70
00.0450	IRI(L): 040.70	IRI(2): 017.43	PSI = 04.70
00.0460	IRI(L): 056.13	IRI(2): 024.46	PSI = 04.70
00.0470	IRI(L): 022.11	IRI(2): 012.96	PSI = 04.70
00.0480	IRI(L): 060.59	IRI(2): 016.49	PSI = 04.70
00.0490	IRI(L): 047.00	IRI(2): 026.35	PSI = 04.70
00.0500	IRI(L): 017.97	IRI(2): 037.34	PSI = 04.70
00.0510	IRI(L): 037.19	IRI(2): 024.33	PSI = 04.70
00.0520	IRI(L): 036.33	IRI(2): 024.61	PSI = 04.70
00.0530	IRI(L): 058.48	IRI(2): 044.00	PSI = 04.70
00.0540	IRI(L): 020.31	IRI(2): 023.91	PSI = 04.70
00.0550	IRI(L): 015.28	IRI(2): 024.95	PSI = 04.70
00.0560	IRI(L): 030.12	IRI(2): 025.32	PSI = 04.70
00.0570	IRI(L): 017.09	IRI(2): 021.33	PSI = 04.70
00.0580	IRI(L): 024.96	IRI(2): 019.69	PSI = 04.70
00.0590	IRI(L): 031.37	IRI(2): 010.38	PSI = 04.70
00.0600	IRI(L): 029.19	IRI(2): 017.58	PSI = 04.70
00.0610	IRI(L): 013.41	IRI(2): 024.39	PSI = 04.70
00.0620	IRI(L): 043.01	IRI(2): 041.41	PSI = 04.70
00.0630	IRI(L): 026.05	IRI(2): 038.19	PSI = 04.70
00.0630	IRI(L): 025.47	IRI(2): 015.67	PSI = 04.70
00.0640	IRI(L): 105.46	IRI(2): 041.23	PSI = 04.19
00.0650	IRI(L): 048.23	IRI(2): 028.50	PSI = 04.70

00.0660	IRI(L): 021.35	IRI(2): 036.85	PSI = 04.70
00.0670	IRI(L): 050.79	IRI(2): 010.19	PSI = 04.70
00.0680	IRI(L): 067.88	IRI(2): 036.39	PSI = 04.70
00.0690	IRI(L): 033.99	IRI(2): 028.99	PSI = 04.70
00.0700	IRI(L): 038.46	IRI(2): 011.36	PSI = 04.70
00.0710	IRI(L): 022.72	IRI(2): 024.34	PSI = 04.70
00.0720	IRI(L): 033.43	IRI(2): 020.88	PSI = 04.70
00.0730	IRI(L): 034.12	IRI(2): 017.69	PSI = 04.70
00.0740	IRI(L): 013.96	IRI(2): 027.14	PSI = 04.70
00.0750	IRI(L): 076.91	IRI(2): 012.59	PSI = 04.70
00.0760	IRI(L): 036.40	IRI(2): 053.19	PSI = 04.70
00.0770	IRI(L): 013.85	IRI(2): 021.19	PSI = 04.70
00.0780	IRI(L): 060.78	IRI(2): 060.62	PSI = 04.49
00.0790	IRI(L): 013.07	IRI(2): 041.09	PSI = 04.70
00.0800	IRI(L): 018.46	IRI(2): 020.60	PSI = 04.70
00.0810	IRI(L): 033.69	IRI(2): 027.21	PSI = 04.70
00.0820	IRI(L): 046.50	IRI(2): 029.95	PSI = 04.70
00.0830	IRI(L): 041.33	IRI(2): 011.86	PSI = 04.70
00.0840	IRI(L): 083.50	IRI(2): 014.21	PSI = 04.70
00.0850	IRI(L): 020.90	IRI(2): 022.02	PSI = 04.70
00.0860	IRI(L): 011.68	IRI(2): 023.11	PSI = 04.70
00.0870	IRI(L): 077.93	IRI(2): 038.74	PSI = 04.55
00.0880	IRI(L): 089.86	IRI(2): 051.48	PSI = 04.25

00.0890	IRI(L): 089.28	IRI(2): 041.75	PSI = 04.37
00.0900	IRI(L): 013.11	IRI(2): 009.77	PSI = 04.70
00.0910	IRI(L): 022.81	IRI(2): 016.90	PSI = 04.70
00.0920	IRI(L): 028.24	IRI(2): 051.53	PSI = 04.70
00.0930	IRI(L): 023.33	IRI(2): 051.38	PSI = 04.70
00.0940	IRI(L): 360.59	IRI(2): 282.16	PSI = 01.04
00.0950	IRI(L): 072.20	IRI(2): 034.93	PSI = 04.68
00.0960	IRI(L): 040.74	IRI(2): 106.04	PSI = 04.19
00.0970	IRI(L): 149.14	IRI(2): 083.97	PSI = 03.37
00.0980	IRI(L): 063.24	IRI(2): 039.98	PSI = 04.70
00.0990	IRI(L): 043.99	IRI(2): 021.43	PSI = 04.70
00.1000	IRI(L): 036.93	IRI(2): 054.28	PSI = 04.70
00.1010	IRI(L): 061.83	IRI(2): 023.81	PSI = 04.70
00.1020	IRI(L): 339.77	IRI(2): 250.14	PSI = 01.27
00.1030	IRI(L): 050.56	IRI(2): 206.26	PSI = 03.19
00.1040	IRI(L): 184.86	IRI(2): 088.98	PSI = 03.06
00.1050	IRI(L): 028.59	IRI(2): 080.86	PSI = 04.65
00.1050	IRI(L): 065.57	IRI(2): 081.16	PSI = 04.19
00.1060	IRI(L): 156.59	IRI(2): 186.57	PSI = 02.58
00.1070	IRI(L): 177.79	IRI(2): 056.44	PSI = 03.37
00.1080	IRI(L): 101.22	IRI(2): 074.24	PSI = 03.89
00.1090	IRI(L): 281.16	IRI(2): 081.73	PSI = 02.46
00.1100	IRI(L): 046.02	IRI(2): 064.26	PSI = 04.64

00.1110	IRI(L): 094.63	IRI(2): 067.35	PSI = 04.03
00.1120	IRI(L): 033.80	IRI(2): 101.90	PSI = 04.32
00.1130	IRI(L): 063.67	IRI(2): 038.13	PSI = 04.70
00.1140	IRI(L): 087.62	IRI(2): 043.40	PSI = 04.38
00.1150	IRI(L): 209.26	IRI(2): 448.84	PSI = 00.97
00.1160	IRI(L): 130.58	IRI(2): 051.00	PSI = 03.83
00.1170	IRI(L): 060.93	IRI(2): 056.92	PSI = 04.54
00.1180	IRI(L): 035.64	IRI(2): 031.98	PSI = 04.70
00.1190	IRI(L): 038.14	IRI(2): 029.04	PSI = 04.70
00.1200	IRI(L): 028.91	IRI(2): 042.42	PSI = 04.70
00.1210	IRI(L): 092.54	IRI(2): 129.79	PSI = 03.46
00.1220	IRI(L): 034.10	IRI(2): 062.80	PSI = 04.70
00.1230	IRI(L): 020.55	IRI(2): 016.32	PSI = 04.70
00.1240	IRI(L): 025.11	IRI(2): 017.29	PSI = 04.70
00.1250	IRI(L): 061.23	IRI(2): 040.27	PSI = 04.70
00.1260	IRI(L): 021.53	IRI(2): 030.48	PSI = 04.70
00.1270	IRI(L): 102.40	IRI(2): 096.99	PSI = 03.67
00.1280	IRI(L): 021.49	IRI(2): 077.49	PSI = 04.70
00.1290	IRI(L): 087.14	IRI(2): 046.70	PSI = 04.34
00.1300	IRI(L): 051.28	IRI(2): 029.81	PSI = 04.70
00.1310	IRI(L): 029.45	IRI(2): 024.25	PSI = 04.70
00.1320	IRI(L): 093.08	IRI(2): 019.76	PSI = 04.60
00.1330	IRI(L): 033.79	IRI(2): 015.11	PSI = 04.70

00.1340	IRI(L): 046.12	IRI(2): 067.35	PSI = 04.59
00.1350	IRI(L): 079.27	IRI(2): 097.71	PSI = 03.88
00.1360	IRI(L): 057.42	IRI(2): 026.61	PSI = 04.70
00.1370	IRI(L): 089.40	IRI(2): 091.08	PSI = 03.84
00.1380	IRI(L): 041.97	IRI(2): 034.33	PSI = 04.70
00.1390	IRI(L): 074.32	IRI(2): 089.96	PSI = 04.01
00.1400	IRI(L): 101.98	IRI(2): 045.56	PSI = 04.19
00.1410	IRI(L): 053.36	IRI(2): 031.19	PSI = 04.70
00.1420	IRI(L): 073.30	IRI(2): 039.33	PSI = 04.61
00.1430	IRI(L): 024.65	IRI(2): 036.01	PSI = 04.70
00.1440	IRI(L): 034.79	IRI(2): 074.12	PSI = 04.66
00.1450	IRI(L): 077.42	IRI(2): 080.55	PSI = 04.07
00.1460	IRI(L): 066.76	IRI(2): 029.79	PSI = 04.70
00.1470	IRI(L): 025.32	IRI(2): 043.00	PSI = 04.70
00.1470	IRI(L): 042.77	IRI(2): 067.77	PSI = 04.63
00.1480	IRI(L): 055.35	IRI(2): 075.01	PSI = 04.38
00.1490	IRI(L): 046.24	IRI(2): 019.72	PSI = 04.70
00.1500	IRI(L): 078.17	IRI(2): 064.01	PSI = 04.25
00.1510	IRI(L): 027.67	IRI(2): 067.66	PSI = 04.70
00.1520	IRI(L): 128.00	IRI(2): 049.23	PSI = 03.88
00.1530	IRI(L): 031.12	IRI(2): 016.49	PSI = 04.70
00.1540	IRI(L): 023.24	IRI(2): 031.05	PSI = 04.70
00.1550	IRI(L): 098.04	IRI(2): 096.03	PSI = 03.71

00.1560	IRI(L): 076.16	IRI(2): 082.92	PSI = 04.06
00.1570	IRI(L): 050.99	IRI(2): 029.60	PSI = 04.70
00.1580	IRI(L): 039.14	IRI(2): 039.13	PSI = 04.70
00.1590	IRI(L): 033.12	IRI(2): 021.12	PSI = 04.70
00.1600	IRI(L): 073.67	IRI(2): 060.77	PSI = 04.33
00.1610	IRI(L): 128.74	IRI(2): 102.71	PSI = 03.39
00.1620	IRI(L): 096.16	IRI(2): 076.10	PSI = 03.92
00.1630	IRI(L): 019.32	IRI(2): 026.77	PSI = 04.70
00.1640	IRI(L): 093.23	IRI(2): 088.22	PSI = 03.83
00.1650	IRI(L): 027.77	IRI(2): 050.61	PSI = 04.70
00.1660	IRI(L): 092.71	IRI(2): 054.73	PSI = 04.19
00.1670	IRI(L): 019.49	IRI(2): 032.34	PSI = 04.70
00.1680	IRI(L): 039.70	IRI(2): 079.31	PSI = 04.52
00.1690	IRI(L): 044.23	IRI(2): 063.45	PSI = 04.67
00.1700	IRI(L): 103.78	IRI(2): 079.46	PSI = 03.82
00.1710	IRI(L): 061.12	IRI(2): 423.49	PSI = 01.78
00.1720	IRI(L): 137.41	IRI(2): 078.56	PSI = 03.52
00.1730	IRI(L): 153.95	IRI(2): 082.13	PSI = 03.35
00.1740	IRI(L): 038.73	IRI(2): 095.58	PSI = 04.34
00.1750	IRI(L): 217.29	IRI(2): 176.77	PSI = 02.27
00.1760	IRI(L): 033.16	IRI(2): 144.10	PSI = 03.88
00.1770	IRI(L): 146.29	IRI(2): 126.65	PSI = 03.06
00.1780	IRI(L): 161.38	IRI(2): 145.62	PSI = 02.82

00.1790	IRI(L): 067.14	IRI(2): 080.35	PSI = 04.19
00.1800	IRI(L): 054.75	IRI(2): 068.60	PSI = 04.47
00.1810	IRI(L): 026.64	IRI(2): 020.65	PSI = 04.70
00.1820	IRI(L): 025.86	IRI(2): 041.79	PSI = 04.70
00.1830	IRI(L): 036.29	IRI(2): 025.57	PSI = 04.70
00.1840	IRI(L): 047.65	IRI(2): 057.32	PSI = 04.70
00.1850	IRI(L): 074.57	IRI(2): 033.91	PSI = 04.66
00.1860	IRI(L): 050.68	IRI(2): 028.02	PSI = 04.70
00.1870	IRI(L): 075.33	IRI(2): 006.19	PSI = 04.70
00.1880	IRI(L): 035.96	IRI(2): 049.68	PSI = 04.70
00.1890	IRI(L): 037.60	IRI(2): 053.66	PSI = 04.70
00.1890	IRI(L): 039.93	IRI(2): 013.58	PSI = 04.70
00.1900	IRI(L): 026.52	IRI(2): 064.33	PSI = 04.70
00.1910	IRI(L): 031.48	IRI(2): 034.93	PSI = 04.70
00.1920	IRI(L): 019.23	IRI(2): 064.62	PSI = 04.70
00.1930	IRI(L): 037.99	IRI(2): 008.46	PSI = 04.70
00.1940	IRI(L): 036.77	IRI(2): 017.81	PSI = 04.70
00.1950	IRI(L): 032.72	IRI(2): 017.11	PSI = 04.70
00.1960	IRI(L): 076.06	IRI(2): 042.69	PSI = 04.53
00.1970	IRI(L): 098.52	IRI(2): 038.50	PSI = 04.30
00.1980	IRI(L): 030.48	IRI(2): 015.84	PSI = 04.70
00.1990	IRI(L): 032.51	IRI(2): 042.72	PSI = 04.70
00.2000	IRI(L): 067.20	IRI(2): 009.65	PSI = 04.70

00.2010	IRI(L): 068.69	IRI(2): 012.86	PSI = 04.70
00.2020	IRI(L): 022.81	IRI(2): 029.43	PSI = 04.70
00.2030	IRI(L): 036.51	IRI(2): 021.47	PSI = 04.70
00.2040	IRI(L): 064.19	IRI(2): 055.13	PSI = 04.52
00.2050	IRI(L): 070.90	IRI(2): 012.83	PSI = 04.70
00.2060	IRI(L): 031.67	IRI(2): 019.02	PSI = 04.70
00.2070	IRI(L): 028.00	IRI(2): 049.87	PSI = 04.70
00.2080	IRI(L): 066.06	IRI(2): 010.60	PSI = 04.70
00.2090	IRI(L): 071.49	IRI(2): 011.67	PSI = 04.70
00.2100	IRI(L): 097.25	IRI(2): 048.60	PSI = 04.20
00.2110	IRI(L): 029.15	IRI(2): 014.53	PSI = 04.70
00.2120	IRI(L): 025.67	IRI(2): 031.41	PSI = 04.70
00.2130	IRI(L): 025.05	IRI(2): 048.90	PSI = 04.70
00.2140	IRI(L): 045.87	IRI(2): 051.60	PSI = 04.70
00.2150	IRI(L): 064.54	IRI(2): 012.58	PSI = 04.70
00.2160	IRI(L): 023.70	IRI(2): 024.29	PSI = 04.70
00.2170	IRI(L): 029.70	IRI(2): 017.42	PSI = 04.70
00.2180	IRI(L): 035.57	IRI(2): 012.36	PSI = 04.70
00.2190	IRI(L): 036.57	IRI(2): 035.92	PSI = 04.70
00.2200	IRI(L): 092.60	IRI(2): 033.09	PSI = 04.44
00.2210	IRI(L): 043.63	IRI(2): 010.31	PSI = 04.70
00.2220	IRI(L): 034.77	IRI(2): 096.43	PSI = 04.37
00.2230	IRI(L): 022.30	IRI(2): 039.00	PSI = 04.70

00.2240	IRI(L): 100.68	IRI(2): 079.77	PSI = 03.84
00.2250	IRI(L): 024.34	IRI(2): 098.75	PSI = 04.47
00.2260	IRI(L): 044.66	IRI(2): 104.09	PSI = 04.17

IRI values in in/mile

Bumps detected using filtered profile: 0

Bumps with negative heights are depressions.

IRI & BUMP Calculations

US290 Westbound (April 6, 2001)

ProView(v8.25) Report - TxDOT

========== I M P O R T   D A T A F I L E =========

Input file: d:\SH290\SH290WB1.PRO

Number of profiles loaded: 2

---Header Lines

HEAD3,04062001,12,102,SH290WB,0000 +00.000,L1

CMET3,FORD AEROSTAR MINI VAN, S232, 6362km, 293475G, mi, 1FMDA31U7VZA11903, 09142000

KPRF01 mil LR 0.1572 m 0.000 mi

SH290WB R1

---Header Lines

Metric units input - english output. Converted 0.1572 meters to 0.5157 feet.

Data record count: 2091   Total distance: 0.204 miles

Min/Max profile values: -0.828/1.017 inches

Average value(bias) for all profiles: 0.004 inches

===== I R I & B U M P   C A L C U L A T I O N =====

Distance	Description		
00.0010	IRI(L): 024.42	IRI(2): 021.32	PSI = 04.70
00.0020	IRI(L): 034.11	IRI(2): 018.43	PSI = 04.70
00.0030	IRI(L): 055.42	IRI(2): 033.56	PSI = 04.70
00.0040	IRI(L): 036.07	IRI(2): 013.06	PSI = 04.70
00.0050	IRI(L): 039.99	IRI(2): 040.62	PSI = 04.70
00.0060	IRI(L): 109.68	IRI(2): 007.72	PSI = 04.54
00.0070	IRI(L): 006.79	IRI(2): 013.59	PSI = 04.70
00.0080	IRI(L): 023.23	IRI(2): 014.92	PSI = 04.70
00.0090	IRI(L): 014.74	IRI(2): 016.89	PSI = 04.70
00.0100	IRI(L): 019.52	IRI(2): 025.50	PSI = 04.70
00.0110	IRI(L): 025.01	IRI(2): 017.72	PSI = 04.70
00.0120	IRI(L): 014.49	IRI(2): 034.63	PSI = 04.70
00.0130	IRI(L): 004.86	IRI(2): 036.41	PSI = 04.70
00.0140	IRI(L): 030.74	IRI(2): 065.77	PSI = 04.70
00.0150	IRI(L): 060.52	IRI(2): 008.03	PSI = 04.70
00.0160	IRI(L): 030.45	IRI(2): 008.99	PSI = 04.70
00.0170	IRI(L): 017.72	IRI(2): 013.99	PSI = 04.70
00.0180	IRI(L): 037.63	IRI(2): 045.87	PSI = 04.70
00.0190	IRI(L): 022.25	IRI(2): 027.39	PSI = 04.70
00.0200	IRI(L): 032.06	IRI(2): 006.61	PSI = 04.70
00.0210	IRI(L): 028.84	IRI(2): 020.11	PSI = 04.70

00.0210	IRI(L): 025.73	IRI(2): 030.10	PSI = 04.70
00.0220	IRI(L): 013.66	IRI(2): 009.95	PSI = 04.70
00.0230	IRI(L): 027.36	IRI(2): 008.68	PSI = 04.70
00.0240	IRI(L): 046.03	IRI(2): 040.57	PSI = 04.70
00.0250	IRI(L): 025.67	IRI(2): 010.37	PSI = 04.70
00.0260	IRI(L): 049.21	IRI(2): 027.73	PSI = 04.70
00.0270	IRI(L): 014.17	IRI(2): 023.71	PSI = 04.70
00.0280	IRI(L): 023.27	IRI(2): 013.35	PSI = 04.70
00.0290	IRI(L): 009.27	IRI(2): 018.49	PSI = 04.70
00.0300	IRI(L): 018.20	IRI(2): 014.58	PSI = 04.70
00.0310	IRI(L): 027.23	IRI(2): 033.66	PSI = 04.70
00.0320	IRI(L): 017.32	IRI(2): 034.66	PSI = 04.70
00.0330	IRI(L): 063.79	IRI(2): 068.22	PSI = 04.36
00.0340	IRI(L): 034.82	IRI(2): 044.82	PSI = 04.70
00.0350	IRI(L): 018.01	IRI(2): 017.25	PSI = 04.70
00.0360	IRI(L): 019.25	IRI(2): 023.42	PSI = 04.70
00.0370	IRI(L): 033.62	IRI(2): 024.20	PSI = 04.70
00.0380	IRI(L): 034.37	IRI(2): 023.43	PSI = 04.70
00.0390	IRI(L): 025.23	IRI(2): 005.29	PSI = 04.70
00.0400	IRI(L): 052.50	IRI(2): 050.11	PSI = 04.70
00.0410	IRI(L): 049.23	IRI(2): 017.45	PSI = 04.70
00.0420	IRI(L): 020.39	IRI(2): 010.15	PSI = 04.70
00.0430	IRI(L): 015.64	IRI(2): 014.86	PSI = 04.70

00.0440	IRI(L): 108.21	IRI(2): 009.86	PSI = 04.54
00.0450	IRI(L): 021.26	IRI(2): 029.58	PSI = 04.70
00.0460	IRI(L): 048.76	IRI(2): 011.51	PSI = 04.70
00.0470	IRI(L): 037.54	IRI(2): 031.41	PSI = 04.70
00.0480	IRI(L): 045.91	IRI(2): 038.34	PSI = 04.70
00.0490	IRI(L): 021.71	IRI(2): 011.65	PSI = 04.70
00.0500	IRI(L): 010.62	IRI(2): 017.13	PSI = 04.70
00.0510	IRI(L): 030.72	IRI(2): 013.29	PSI = 04.70
00.0520	IRI(L): 052.53	IRI(2): 039.43	PSI = 04.70
00.0530	IRI(L): 078.62	IRI(2): 018.52	PSI = 04.70
00.0540	IRI(L): 038.92	IRI(2): 042.23	PSI = 04.70
00.0550	IRI(L): 043.47	IRI(2): 028.71	PSI = 04.70
00.0560	IRI(L): 026.67	IRI(2): 050.98	PSI = 04.70
00.0570	IRI(L): 041.06	IRI(2): 015.07	PSI = 04.70
00.0580	IRI(L): 015.88	IRI(2): 026.59	PSI = 04.70
00.0590	IRI(L): 011.77	IRI(2): 016.23	PSI = 04.70
00.0600	IRI(L): 019.25	IRI(2): 048.31	PSI = 04.70
00.0610	IRI(L): 047.91	IRI(2): 055.55	PSI = 04.70
00.0620	IRI(L): 030.51	IRI(2): 015.62	PSI = 04.70
00.0630	IRI(L): 071.01	IRI(2): 016.95	PSI = 04.70
00.0630	IRI(L): 044.79	IRI(2): 051.36	PSI = 04.70
00.0640	IRI(L): 025.51	IRI(2): 017.65	PSI = 04.70
00.0650	IRI(L): 036.55	IRI(2): 044.38	PSI = 04.70

00.0660	IRI(L): 024.73	IRI(2): 024.35	PSI = 04.70
00.0670	IRI(L): 022.24	IRI(2): 075.77	PSI = 04.70
00.0680	IRI(L): 029.08	IRI(2): 009.70	PSI = 04.70
00.0690	IRI(L): 054.87	IRI(2): 021.81	PSI = 04.70
00.0700	IRI(L): 026.00	IRI(2): 019.02	PSI = 04.70
00.0710	IRI(L): 016.34	IRI(2): 017.02	PSI = 04.70
00.0720	IRI(L): 027.85	IRI(2): 033.82	PSI = 04.70
00.0730	IRI(L): 015.41	IRI(2): 027.11	PSI = 04.70
00.0740	IRI(L): 015.93	IRI(2): 021.98	PSI = 04.70
00.0750	IRI(L): 030.49	IRI(2): 021.15	PSI = 04.70
00.0760	IRI(L): 028.03	IRI(2): 026.19	PSI = 04.70
00.0770	IRI(L): 015.35	IRI(2): 019.08	PSI = 04.70
00.0780	IRI(L): 028.40	IRI(2): 020.57	PSI = 04.70
00.0790	IRI(L): 011.26	IRI(2): 009.31	PSI = 04.70
00.0800	IRI(L): 012.33	IRI(2): 013.46	PSI = 04.70
00.0810	IRI(L): 021.78	IRI(2): 031.07	PSI = 04.70
00.0820	IRI(L): 076.77	IRI(2): 012.48	PSI = 04.70
00.0830	IRI(L): 035.30	IRI(2): 008.56	PSI = 04.70
00.0840	IRI(L): 050.59	IRI(2): 034.88	PSI = 04.70
00.0850	IRI(L): 019.14	IRI(2): 008.36	PSI = 04.70
00.0860	IRI(L): 048.14	IRI(2): 012.81	PSI = 04.70
00.0870	IRI(L): 014.18	IRI(2): 041.96	PSI = 04.70
00.0880	IRI(L): 060.04	IRI(2): 034.91	PSI = 04.70

00.0890	IRI(L): 049.10	IRI(2): 021.67	PSI = 04.70
00.0900	IRI(L): 022.73	IRI(2): 026.28	PSI = 04.70
00.0910	IRI(L): 054.96	IRI(2): 030.54	PSI = 04.70
00.0920	IRI(L): 283.59	IRI(2): 237.09	PSI = 01.59
00.0930	IRI(L): 122.88	IRI(2): 094.62	PSI = 03.51
00.0940	IRI(L): 062.13	IRI(2): 207.78	PSI = 03.09
00.0950	IRI(L): 085.23	IRI(2): 035.37	PSI = 04.50
00.0960	IRI(L): 113.32	IRI(2): 271.40	PSI = 02.32
00.0970	IRI(L): 066.36	IRI(2): 095.01	PSI = 04.04
00.0980	IRI(L): 171.91	IRI(2): 058.09	PSI = 03.40
00.0990	IRI(L): 080.87	IRI(2): 129.97	PSI = 03.56
00.1000	IRI(L): 306.97	IRI(2): 235.06	PSI = 01.49
00.1010	IRI(L): 073.09	IRI(2): 088.17	PSI = 04.04
00.1020	IRI(L): 064.17	IRI(2): 061.20	PSI = 04.44
00.1030	IRI(L): 065.02	IRI(2): 026.65	PSI = 04.70
00.1040	IRI(L): 124.94	IRI(2): 124.28	PSI = 03.24
00.1050	IRI(L): 077.42	IRI(2): 075.57	PSI = 04.13
00.1050	IRI(L): 028.28	IRI(2): 040.75	PSI = 04.70
00.1060	IRI(L): 046.63	IRI(2): 095.39	PSI = 04.25
00.1070	IRI(L): 013.92	IRI(2): 026.25	PSI = 04.70
00.1080	IRI(L): 041.29	IRI(2): 031.62	PSI = 04.70
00.1090	IRI(L): 030.98	IRI(2): 070.34	PSI = 04.70
00.1100	IRI(L): 033.12	IRI(2): 019.19	PSI = 04.70

00.1110	IRI(L): 064.83	IRI(2): 028.81	PSI = 04.70
00.1120	IRI(L): 030.48	IRI(2): 053.88	PSI = 04.70
00.1130	IRI(L): 042.27	IRI(2): 022.71	PSI = 04.70
00.1140	IRI(L): 023.46	IRI(2): 026.66	PSI = 04.70
00.1150	IRI(L): 053.87	IRI(2): 074.35	PSI = 04.41
00.1160	IRI(L): 010.82	IRI(2): 049.69	PSI = 04.70
00.1170	IRI(L): 045.44	IRI(2): 037.25	PSI = 04.70
00.1180	IRI(L): 065.04	IRI(2): 050.51	PSI = 04.57
00.1190	IRI(L): 071.42	IRI(2): 021.25	PSI = 04.70
00.1200	IRI(L): 037.02	IRI(2): 019.16	PSI = 04.70
00.1210	IRI(L): 009.31	IRI(2): 017.92	PSI = 04.70
00.1220	IRI(L): 034.97	IRI(2): 037.90	PSI = 04.70
00.1230	IRI(L): 019.95	IRI(2): 030.86	PSI = 04.70
00.1240	IRI(L): 050.52	IRI(2): 039.50	PSI = 04.70
00.1250	IRI(L): 068.62	IRI(2): 033.63	PSI = 04.70
00.1260	IRI(L): 150.72	IRI(2): 098.25	PSI = 03.25
00.1270	IRI(L): 038.20	IRI(2): 066.67	PSI = 04.70
00.1280	IRI(L): 038.29	IRI(2): 025.95	PSI = 04.70
00.1290	IRI(L): 032.02	IRI(2): 035.05	PSI = 04.70
00.1300	IRI(L): 079.31	IRI(2): 071.20	PSI = 04.15
00.1310	IRI(L): 089.93	IRI(2): 026.35	PSI = 04.56
00.1320	IRI(L): 079.00	IRI(2): 063.01	PSI = 04.25
00.1330	IRI(L): 022.41	IRI(2): 028.78	PSI = 04.70

00.1340 IRI(L): 048.08 IRI(2): 016.11 PSI = 04.70

00.1350 IRI(L): 049.93 IRI(2): 018.20 PSI = 04.70

00.1360 IRI(L): 071.69 IRI(2): 019.81 PSI = 04.70

00.1370 IRI(L): 016.46 IRI(2): 028.37 PSI = 04.70

00.1380 IRI(L): 043.73 IRI(2): 072.89 PSI = 04.55

00.1390 IRI(L): 035.98 IRI(2): 111.87 PSI = 04.18

00.1400 IRI(L): 028.47 IRI(2): 011.34 PSI = 04.70

00.1410 IRI(L): 067.26 IRI(2): 031.21 PSI = 04.70

00.1420 IRI(L): 024.89 IRI(2): 037.22 PSI = 04.70

00.1430 IRI(L): 020.17 IRI(2): 050.65 PSI = 04.70

00.1440 IRI(L): 032.61 IRI(2): 032.68 PSI = 04.70

00.1450 IRI(L): 035.41 IRI(2): 074.34 PSI = 04.64

00.1460 IRI(L): 083.89 IRI(2): 026.42 PSI = 04.64

00.1470 IRI(L): 038.92 IRI(2): 017.88 PSI = 04.70

00.1470 IRI(L): 031.52 IRI(2): 024.46 PSI = 04.70

00.1480 IRI(L): 026.06 IRI(2): 046.19 PSI = 04.70

00.1490 IRI(L): 054.97 IRI(2): 070.20 PSI = 04.45

00.1500 IRI(L): 024.39 IRI(2): 046.06 PSI = 04.70

00.1510 IRI(L): 061.08 IRI(2): 093.80 PSI = 04.11

00.1520 IRI(L): 046.58 IRI(2): 056.20 PSI = 04.70

00.1530 IRI(L): 050.82 IRI(2): 063.79 PSI = 04.58

00.1540 IRI(L): 033.40 IRI(2): 039.04 PSI = 04.70

00.1550 IRI(L): 069.87 IRI(2): 061.82 PSI = 04.37

00.1560	IRI(L): 065.41	IRI(2): 102.60	PSI = 03.97
00.1570	IRI(L): 042.52	IRI(2): 038.95	PSI = 04.70
00.1580	IRI(L): 082.97	IRI(2): 030.41	PSI = 04.60
00.1590	IRI(L): 041.64	IRI(2): 029.72	PSI = 04.70
00.1600	IRI(L): 080.46	IRI(2): 135.19	PSI = 03.52
00.1610	IRI(L): 147.87	IRI(2): 189.87	PSI = 02.62
00.1620	IRI(L): 231.58	IRI(2): 114.66	PSI = 02.56
00.1630	IRI(L): 083.63	IRI(2): 151.91	PSI = 03.35
00.1640	IRI(L): 060.37	IRI(2): 038.35	PSI = 04.70
00.1650	IRI(L): 179.40	IRI(2): 049.70	PSI = 03.41
00.1660	IRI(L): 104.34	IRI(2): 158.67	PSI = 03.14
00.1670	IRI(L): 041.00	IRI(2): 085.99	PSI = 04.42
00.1680	IRI(L): 108.97	IRI(2): 178.59	PSI = 02.96
00.1690	IRI(L): 080.05	IRI(2): 189.36	PSI = 03.09
00.1700	IRI(L): 063.56	IRI(2): 023.81	PSI = 04.70
00.1710	IRI(L): 126.99	IRI(2): 072.13	PSI = 03.67
00.1720	IRI(L): 068.50	IRI(2): 023.60	PSI = 04.70
00.1730	IRI(L): 080.57	IRI(2): 014.17	PSI = 04.70
00.1740	IRI(L): 078.03	IRI(2): 067.27	PSI = 04.21
00.1750	IRI(L): 037.98	IRI(2): 011.19	PSI = 04.70
00.1760	IRI(L): 070.59	IRI(2): 034.64	PSI = 04.70
00.1770	IRI(L): 059.68	IRI(2): 017.78	PSI = 04.70
00.1780	IRI(L): 024.06	IRI(2): 029.57	PSI = 04.70

00.1790	IRI(L): 059.05	IRI(2): 038.62	PSI = 04.70
00.1800	IRI(L): 027.63	IRI(2): 008.57	PSI = 04.70
00.1810	IRI(L): 020.87	IRI(2): 040.66	PSI = 04.70
00.1820	IRI(L): 057.45	IRI(2): 024.47	PSI = 04.70
00.1830	IRI(L): 007.91	IRI(2): 048.87	PSI = 04.70
00.1840	IRI(L): 018.97	IRI(2): 009.79	PSI = 04.70
00.1850	IRI(L): 047.32	IRI(2): 025.56	PSI = 04.70
00.1860	IRI(L): 015.27	IRI(2): 026.93	PSI = 04.70
00.1870	IRI(L): 023.79	IRI(2): 026.28	PSI = 04.70
00.1880	IRI(L): 030.67	IRI(2): 018.45	PSI = 04.70
00.1890	IRI(L): 019.78	IRI(2): 006.84	PSI = 04.70
00.1890	IRI(L): 079.46	IRI(2): 014.94	PSI = 04.70
00.1900	IRI(L): 059.65	IRI(2): 014.03	PSI = 04.70
00.1910	IRI(L): 023.21	IRI(2): 021.14	PSI = 04.70
00.1920	IRI(L): 045.24	IRI(2): 024.07	PSI = 04.70
00.1930	IRI(L): 037.90	IRI(2): 011.44	PSI = 04.70
00.1940	IRI(L): 023.65	IRI(2): 018.27	PSI = 04.70
00.1950	IRI(L): 050.72	IRI(2): 045.77	PSI = 04.70
00.1960	IRI(L): 027.25	IRI(2): 026.20	PSI = 04.70
00.1970	IRI(L): 013.10	IRI(2): 025.27	PSI = 04.70
00.1980	IRI(L): 020.21	IRI(2): 035.95	PSI = 04.70
00.1990	IRI(L): 009.40	IRI(2): 018.67	PSI = 04.70
00.2000	IRI(L): 050.37	IRI(2): 042.87	PSI = 04.70

00.2010	IRI(L): 042.91	IRI(2): 022.32	PSI = 04.70
00.2020	IRI(L): 044.57	IRI(2): 018.63	PSI = 04.70
00.2030	IRI(L): 020.88	IRI(2): 021.56	PSI = 04.70
00.2040	IRI(L): 052.77	IRI(2): 016.99	PSI = 04.70

IRI values in in/mile

Bumps detected using filtered profile: 0

Bumps with negative heights are depressions.

IRI & BUMP Calculations

SH249 Northbound (April 6, 2001)

ProView(v8.25) Report - TxDOT

========== I M P O R T D A T A F I L E =========

Input file: d:\SH249\SH249NB2.PRO

Number of profiles loaded: 2

--Header Lines

HEAD3,04062001,12,102,SH249NB,0000 +00.000,L4

CMET3,FORD AEROSTAR MINI VAN, S232, 6362km, 293475G, mi, 1FMDA31U7VZA11903, 09142000

KPRF01 mil LR 0.1572 m 0.000 mi

SH249NB 2

--Header Lines

Metric units input - english output. Converted 0.1572 meters to 0.5157 feet.

Data record count: 1734 Total distance: 0.169 miles

Min/Max profile values: -1.402/1.075 inches

Average value(bias) for all profiles: -0.003 inches

===== I R I & B U M P C A L C U L A T I O N =====

Distance	Description		
00.0010	IRI(L): 003.06	IRI(2): 047.93	PSI = 04.70
00.0020	IRI(L): 041.41	IRI(2): 013.43	PSI = 04.70
00.0030	IRI(L): 017.26	IRI(2): 005.80	PSI = 04.70
00.0040	IRI(L): 033.45	IRI(2): 006.51	PSI = 04.70
00.0050	IRI(L): 058.13	IRI(2): 013.29	PSI = 04.70
00.0060	IRI(L): 023.64	IRI(2): 011.91	PSI = 04.70
00.0070	IRI(L): 028.40	IRI(2): 063.26	PSI = 04.70
00.0080	IRI(L): 038.49	IRI(2): 055.66	PSI = 04.70
00.0090	IRI(L): 017.97	IRI(2): 073.17	PSI = 04.70
00.0100	IRI(L): 033.80	IRI(2): 015.28	PSI = 04.70
00.0110	IRI(L): 032.18	IRI(2): 071.95	PSI = 04.70
00.0120	IRI(L): 034.26	IRI(2): 042.68	PSI = 04.70
00.0130	IRI(L): 026.90	IRI(2): 030.13	PSI = 04.70
00.0140	IRI(L): 061.62	IRI(2): 054.23	PSI = 04.56
00.0150	IRI(L): 033.50	IRI(2): 020.02	PSI = 04.70
00.0160	IRI(L): 035.30	IRI(2): 032.21	PSI = 04.70
00.0170	IRI(L): 031.41	IRI(2): 038.90	PSI = 04.70
00.0180	IRI(L): 021.15	IRI(2): 025.47	PSI = 04.70
00.0190	IRI(L): 050.92	IRI(2): 021.79	PSI = 04.70
00.0200	IRI(L): 033.24	IRI(2): 014.10	PSI = 04.70
00.0210	IRI(L): 012.16	IRI(2): 014.31	PSI = 04.70

00.0210	IRI(L): 030.48	IRI(2): 077.21	PSI = 04.67
00.0220	IRI(L): 032.45	IRI(2): 038.37	PSI = 04.70
00.0230	IRI(L): 091.69	IRI(2): 029.52	PSI = 04.50
00.0240	IRI(L): 039.85	IRI(2): 023.88	PSI = 04.70
00.0250	IRI(L): 051.67	IRI(2): 031.49	PSI = 04.70
00.0260	IRI(L): 036.31	IRI(2): 042.22	PSI = 04.70
00.0270	IRI(L): 056.94	IRI(2): 024.39	PSI = 04.70
00.0280	IRI(L): 040.27	IRI(2): 048.16	PSI = 04.70
00.0290	IRI(L): 032.80	IRI(2): 037.99	PSI = 04.70
00.0300	IRI(L): 018.57	IRI(2): 017.21	PSI = 04.70
00.0310	IRI(L): 008.49	IRI(2): 045.69	PSI = 04.70
00.0320	IRI(L): 040.74	IRI(2): 029.40	PSI = 04.70
00.0330	IRI(L): 029.30	IRI(2): 010.01	PSI = 04.70
00.0340	IRI(L): 052.75	IRI(2): 061.14	PSI = 04.59
00.0350	IRI(L): 031.55	IRI(2): 072.96	PSI = 04.70
00.0360	IRI(L): 028.87	IRI(2): 024.57	PSI = 04.70
00.0370	IRI(L): 029.54	IRI(2): 049.27	PSI = 04.70
00.0380	IRI(L): 016.81	IRI(2): 017.41	PSI = 04.70
00.0390	IRI(L): 022.42	IRI(2): 012.36	PSI = 04.70
00.0400	IRI(L): 011.44	IRI(2): 028.13	PSI = 04.70
00.0410	IRI(L): 061.75	IRI(2): 050.47	PSI = 04.61
00.0420	IRI(L): 019.56	IRI(2): 013.97	PSI = 04.70
00.0430	IRI(L): 047.57	IRI(2): 102.86	PSI = 04.15

00.0440	IRI(L): 056.36	IRI(2): 027.14	PSI = 04.70
00.0450	IRI(L): 073.90	IRI(2): 038.90	PSI = 04.60
00.0460	IRI(L): 079.27	IRI(2): 038.23	PSI = 04.54
00.0470	IRI(L): 016.67	IRI(2): 027.71	PSI = 04.70
00.0480	IRI(L): 062.13	IRI(2): 069.50	PSI = 04.37
00.0490	IRI(L): 050.07	IRI(2): 030.59	PSI = 04.70
00.0500	IRI(L): 018.09	IRI(2): 036.28	PSI = 04.70
00.0510	IRI(L): 021.05	IRI(2): 029.75	PSI = 04.70
00.0520	IRI(L): 013.84	IRI(2): 018.04	PSI = 04.70
00.0530	IRI(L): 069.13	IRI(2): 070.70	PSI = 04.27
00.0540	IRI(L): 024.10	IRI(2): 033.58	PSI = 04.70
00.0550	IRI(L): 019.78	IRI(2): 041.61	PSI = 04.70
00.0560	IRI(L): 027.90	IRI(2): 038.34	PSI = 04.70
00.0570	IRI(L): 041.25	IRI(2): 052.48	PSI = 04.70
00.0580	IRI(L): 082.23	IRI(2): 067.00	PSI = 04.17
00.0590	IRI(L): 045.99	IRI(2): 025.18	PSI = 04.70
00.0600	IRI(L): 046.92	IRI(2): 054.56	PSI = 04.70
00.0610	IRI(L): 066.41	IRI(2): 041.80	PSI = 04.67
00.0620	IRI(L): 366.47	IRI(2): 277.37	PSI = 01.04
00.0630	IRI(L): 077.76	IRI(2): 108.43	PSI = 03.79
00.0630	IRI(L): 033.03	IRI(2): 021.95	PSI = 04.70
00.0640	IRI(L): 075.54	IRI(2): 095.64	PSI = 03.94
00.0650	IRI(L): 344.91	IRI(2): 300.26	PSI = 01.03

00.0660	IRI(L): 074.57	IRI(2): 025.38	PSI = 04.70
00.0670	IRI(L): 126.79	IRI(2): 108.74	PSI = 03.35
00.0680	IRI(L): 050.78	IRI(2): 078.46	PSI = 04.40
00.0690	IRI(L): 101.66	IRI(2): 171.06	PSI = 03.07
00.0700	IRI(L): 062.82	IRI(2): 183.93	PSI = 03.26
00.0710	IRI(L): 061.21	IRI(2): 052.99	PSI = 04.59
00.0720	IRI(L): 101.50	IRI(2): 123.71	PSI = 03.44
00.0730	IRI(L): 109.21	IRI(2): 108.22	PSI = 03.51
00.0740	IRI(L): 038.55	IRI(2): 112.16	PSI = 04.15
00.0750	IRI(L): 101.02	IRI(2): 053.26	PSI = 04.11
00.0760	IRI(L): 096.94	IRI(2): 082.83	PSI = 03.85
00.0770	IRI(L): 120.08	IRI(2): 180.60	PSI = 02.86
00.0780	IRI(L): 099.80	IRI(2): 158.38	PSI = 03.18
00.0790	IRI(L): 123.66	IRI(2): 086.34	PSI = 03.57
00.0800	IRI(L): 090.69	IRI(2): 154.92	PSI = 03.27
00.0810	IRI(L): 091.35	IRI(2): 098.54	PSI = 03.75
00.0820	IRI(L): 067.43	IRI(2): 140.70	PSI = 03.59
00.0830	IRI(L): 077.02	IRI(2): 095.72	PSI = 03.92
00.0840	IRI(L): 056.29	IRI(2): 022.12	PSI = 04.70
00.0850	IRI(L): 023.57	IRI(2): 060.17	PSI = 04.70
00.0860	IRI(L): 085.87	IRI(2): 151.92	PSI = 03.34
00.0870	IRI(L): 113.32	IRI(2): 060.11	PSI = 03.91
00.0880	IRI(L): 045.69	IRI(2): 182.10	PSI = 03.42

00.0890	IRI(L): 048.19	IRI(2): 091.52	PSI = 04.27
00.0900	IRI(L): 089.72	IRI(2): 114.92	PSI = 03.62
00.0910	IRI(L): 051.70	IRI(2): 109.72	PSI = 04.04
00.0920	IRI(L): 060.92	IRI(2): 120.65	PSI = 03.83
00.0930	IRI(L): 044.34	IRI(2): 118.52	PSI = 04.02
00.0940	IRI(L): 034.01	IRI(2): 066.42	PSI = 04.70
00.0950	IRI(L): 063.13	IRI(2): 119.47	PSI = 03.82
00.0960	IRI(L): 064.37	IRI(2): 157.69	PSI = 03.47
00.0970	IRI(L): 114.46	IRI(2): 050.58	PSI = 04.00
00.0980	IRI(L): 094.42	IRI(2): 066.75	PSI = 04.04
00.0990	IRI(L): 099.36	IRI(2): 064.58	PSI = 04.01
00.1000	IRI(L): 040.51	IRI(2): 052.43	PSI = 04.70
00.1010	IRI(L): 026.49	IRI(2): 041.83	PSI = 04.70
00.1020	IRI(L): 058.23	IRI(2): 083.41	PSI = 04.25
00.1030	IRI(L): 051.95	IRI(2): 067.12	PSI = 04.52
00.1040	IRI(L): 066.69	IRI(2): 044.39	PSI = 04.63
00.1050	IRI(L): 074.58	IRI(2): 073.37	PSI = 04.18
00.1050	IRI(L): 088.05	IRI(2): 043.30	PSI = 04.37
00.1060	IRI(L): 021.18	IRI(2): 020.06	PSI = 04.70
00.1070	IRI(L): 067.26	IRI(2): 120.38	PSI = 03.78
00.1080	IRI(L): 054.91	IRI(2): 160.40	PSI = 03.52
00.1090	IRI(L): 049.14	IRI(2): 154.65	PSI = 03.63
00.1100	IRI(L): 043.22	IRI(2): 147.85	PSI = 03.74

00.1110	IRI(L): 025.86	IRI(2): 056.27	PSI = 04.70
00.1120	IRI(L): 060.06	IRI(2): 083.06	PSI = 04.23
00.1130	IRI(L): 102.03	IRI(2): 034.92	PSI = 04.31
00.1140	IRI(L): 113.68	IRI(2): 092.47	PSI = 03.61
00.1150	IRI(L): 064.04	IRI(2): 079.44	PSI = 04.23
00.1160	IRI(L): 039.77	IRI(2): 072.97	PSI = 04.60
00.1170	IRI(L): 057.25	IRI(2): 078.84	PSI = 04.32
00.1180	IRI(L): 127.79	IRI(2): 222.00	PSI = 02.54
00.1190	IRI(L): 021.44	IRI(2): 117.82	PSI = 04.28
00.1200	IRI(L): 097.85	IRI(2): 070.50	PSI = 03.96
00.1210	IRI(L): 037.66	IRI(2): 060.90	PSI = 04.70
00.1220	IRI(L): 033.63	IRI(2): 048.78	PSI = 04.70
00.1230	IRI(L): 051.81	IRI(2): 014.25	PSI = 04.70
00.1240	IRI(L): 063.78	IRI(2): 073.71	PSI = 04.30
00.1250	IRI(L): 093.00	IRI(2): 118.77	PSI = 03.56
00.1260	IRI(L): 145.98	IRI(2): 247.87	PSI = 02.27
00.1270	IRI(L): 090.76	IRI(2): 106.72	PSI = 03.68
00.1280	IRI(L): 092.60	IRI(2): 040.16	PSI = 04.35
00.1290	IRI(L): 131.84	IRI(2): 105.87	PSI = 03.34
00.1300	IRI(L): 108.16	IRI(2): 061.25	PSI = 03.95
00.1310	IRI(L): 113.66	IRI(2): 185.61	PSI = 02.87
00.1320	IRI(L): 107.53	IRI(2): 170.51	PSI = 03.03
00.1330	IRI(L): 062.99	IRI(2): 062.78	PSI = 04.44

00.1340	IRI(L): 016.03	IRI(2): 038.38	PSI = 04.70
00.1350	IRI(L): 053.02	IRI(2): 036.77	PSI = 04.70
00.1360	IRI(L): 032.90	IRI(2): 012.23	PSI = 04.70
00.1370	IRI(L): 024.49	IRI(2): 017.67	PSI = 04.70
00.1380	IRI(L): 010.01	IRI(2): 013.26	PSI = 04.70
00.1390	IRI(L): 049.09	IRI(2): 010.46	PSI = 04.70
00.1400	IRI(L): 026.41	IRI(2): 016.53	PSI = 04.70
00.1410	IRI(L): 058.76	IRI(2): 076.69	PSI = 04.32
00.1420	IRI(L): 014.96	IRI(2): 011.36	PSI = 04.70
00.1430	IRI(L): 066.32	IRI(2): 024.89	PSI = 04.70
00.1440	IRI(L): 037.97	IRI(2): 035.61	PSI = 04.70
00.1450	IRI(L): 075.57	IRI(2): 019.53	PSI = 04.70
00.1460	IRI(L): 051.08	IRI(2): 032.31	PSI = 04.70
00.1470	IRI(L): 014.33	IRI(2): 012.03	PSI = 04.70
00.1470	IRI(L): 031.15	IRI(2): 013.66	PSI = 04.70
00.1480	IRI(L): 012.74	IRI(2): 062.24	PSI = 04.70
00.1490	IRI(L): 051.91	IRI(2): 014.22	PSI = 04.70
00.1500	IRI(L): 022.75	IRI(2): 015.00	PSI = 04.70
00.1510	IRI(L): 016.58	IRI(2): 018.51	PSI = 04.70
00.1520	IRI(L): 014.41	IRI(2): 025.88	PSI = 04.70
00.1530	IRI(L): 015.21	IRI(2): 006.16	PSI = 04.70
00.1540	IRI(L): 032.76	IRI(2): 013.20	PSI = 04.70
00.1550	IRI(L): 042.79	IRI(2): 041.56	PSI = 04.70

00.1560 IRI(L): 023.79 IRI(2): 031.50 PSI = 04.70

00.1570 IRI(L): 014.49 IRI(2): 014.02 PSI = 04.70

00.1580 IRI(L): 024.86 IRI(2): 010.68 PSI = 04.70

00.1590 IRI(L): 070.09 IRI(2): 044.12 PSI = 04.59

00.1600 IRI(L): 022.50 IRI(2): 007.75 PSI = 04.70

00.1610 IRI(L): 023.92 IRI(2): 009.66 PSI = 04.70

00.1620 IRI(L): 008.03 IRI(2): 013.47 PSI = 04.70

00.1630 IRI(L): 010.32 IRI(2): 018.87 PSI = 04.70

00.1640 IRI(L): 024.74 IRI(2): 034.32 PSI = 04.70

00.1650 IRI(L): 019.59 IRI(2): 020.37 PSI = 04.70

00.1660 IRI(L): 020.47 IRI(2): 033.33 PSI = 04.70

00.1670 IRI(L): 012.19 IRI(2): 030.13 PSI = 04.70

00.1680 IRI(L): 007.25 IRI(2): 028.76 PSI = 04.70

00.1690 IRI(L): 022.44 IRI(2): 022.25 PSI = 04.70

IRI values in in/mile

Bumps detected using filtered profile: 0

Bumps with negative heights are depressions.

IRI & BUMP Calculations

SH249 Southbound (April 6, 2001)

ProView(v8.25) Report - TxDOT

========== I M P O R T   D A T A F I L E =========

Input file: d:\SH249\SH249SB2.PRO

Number of profiles loaded: 2

--Header Lines

HEAD3,04062001,12,102,SH249SB,0000 +00.000,R1

CMET3,FORD AEROSTAR MINI VAN, S232, 6362km, 293475G, mi, 1FMDA31U7VZA11903, 09142000

KPRF01 mil LR 0.1572 m 0.000 mi

SH249SB 2

--Header Lines

Metric units input - english output. Converted 0.1572 meters to 0.5157 feet.

Data record count: 2097   Total distance: 0.205 miles

Min/Max profile values: -0.879/0.743 inches

Average value(bias) for all profiles: 0.004 inches

===== I R I & B U M P   C A L C U L A T I O N =====

Distance	Description		
00.0010	IRI(L): 016.67	IRI(2): 042.91	PSI = 04.70
00.0020	IRI(L): 021.53	IRI(2): 017.56	PSI = 04.70
00.0030	IRI(L): 022.31	IRI(2): 018.42	PSI = 04.70
00.0040	IRI(L): 034.85	IRI(2): 030.89	PSI = 04.70
00.0050	IRI(L): 052.41	IRI(2): 016.34	PSI = 04.70
00.0060	IRI(L): 013.40	IRI(2): 030.27	PSI = 04.70
00.0070	IRI(L): 010.09	IRI(2): 017.73	PSI = 04.70
00.0080	IRI(L): 034.58	IRI(2): 032.02	PSI = 04.70
00.0090	IRI(L): 030.56	IRI(2): 024.21	PSI = 04.70
00.0100	IRI(L): 018.29	IRI(2): 037.31	PSI = 04.70
00.0110	IRI(L): 015.82	IRI(2): 030.47	PSI = 04.70
00.0120	IRI(L): 036.46	IRI(2): 019.05	PSI = 04.70
00.0130	IRI(L): 023.12	IRI(2): 032.52	PSI = 04.70
00.0140	IRI(L): 033.84	IRI(2): 027.37	PSI = 04.70
00.0150	IRI(L): 035.18	IRI(2): 010.79	PSI = 04.70
00.0160	IRI(L): 016.20	IRI(2): 029.70	PSI = 04.70
00.0170	IRI(L): 050.14	IRI(2): 006.87	PSI = 04.70
00.0180	IRI(L): 065.76	IRI(2): 021.94	PSI = 04.70
00.0190	IRI(L): 028.51	IRI(2): 011.67	PSI = 04.70
00.0200	IRI(L): 028.97	IRI(2): 024.78	PSI = 04.70
00.0210	IRI(L): 005.90	IRI(2): 004.60	PSI = 04.70

00.0210	IRI(L): 018.79	IRI(2): 013.81	PSI = 04.70
00.0220	IRI(L): 022.62	IRI(2): 027.79	PSI = 04.70
00.0230	IRI(L): 045.85	IRI(2): 023.84	PSI = 04.70
00.0240	IRI(L): 025.44	IRI(2): 039.60	PSI = 04.70
00.0250	IRI(L): 027.34	IRI(2): 044.24	PSI = 04.70
00.0260	IRI(L): 055.90	IRI(2): 022.56	PSI = 04.70
00.0270	IRI(L): 029.15	IRI(2): 031.13	PSI = 04.70
00.0280	IRI(L): 061.44	IRI(2): 048.98	PSI = 04.64
00.0290	IRI(L): 046.68	IRI(2): 039.19	PSI = 04.70
00.0300	IRI(L): 031.92	IRI(2): 041.90	PSI = 04.70
00.0310	IRI(L): 034.86	IRI(2): 019.51	PSI = 04.70
00.0320	IRI(L): 072.46	IRI(2): 014.58	PSI = 04.70
00.0330	IRI(L): 042.56	IRI(2): 027.00	PSI = 04.70
00.0340	IRI(L): 036.76	IRI(2): 023.27	PSI = 04.70
00.0350	IRI(L): 012.33	IRI(2): 020.32	PSI = 04.70
00.0360	IRI(L): 010.87	IRI(2): 008.12	PSI = 04.70
00.0370	IRI(L): 068.91	IRI(2): 038.69	PSI = 04.67
00.0380	IRI(L): 041.87	IRI(2): 010.40	PSI = 04.70
00.0390	IRI(L): 034.77	IRI(2): 031.59	PSI = 04.70
00.0400	IRI(L): 037.66	IRI(2): 017.71	PSI = 04.70
00.0410	IRI(L): 013.26	IRI(2): 067.55	PSI = 04.70
00.0420	IRI(L): 022.42	IRI(2): 028.31	PSI = 04.70
00.0430	IRI(L): 058.41	IRI(2): 021.28	PSI = 04.70

00.0440	IRI(L): 007.88	IRI(2): 023.32	PSI = 04.70
00.0450	IRI(L): 012.80	IRI(2): 016.35	PSI = 04.70
00.0460	IRI(L): 040.52	IRI(2): 048.05	PSI = 04.70
00.0470	IRI(L): 020.90	IRI(2): 005.05	PSI = 04.70
00.0480	IRI(L): 028.97	IRI(2): 026.74	PSI = 04.70
00.0490	IRI(L): 033.59	IRI(2): 022.90	PSI = 04.70
00.0500	IRI(L): 025.81	IRI(2): 027.63	PSI = 04.70
00.0510	IRI(L): 050.43	IRI(2): 022.17	PSI = 04.70
00.0520	IRI(L): 012.77	IRI(2): 023.70	PSI = 04.70
00.0530	IRI(L): 047.29	IRI(2): 022.57	PSI = 04.70
00.0540	IRI(L): 036.26	IRI(2): 034.16	PSI = 04.70
00.0550	IRI(L): 029.79	IRI(2): 034.01	PSI = 04.70
00.0560	IRI(L): 011.11	IRI(2): 027.23	PSI = 04.70
00.0570	IRI(L): 019.60	IRI(2): 016.88	PSI = 04.70
00.0580	IRI(L): 012.66	IRI(2): 047.88	PSI = 04.70
00.0590	IRI(L): 017.27	IRI(2): 011.66	PSI = 04.70
00.0600	IRI(L): 010.25	IRI(2): 023.05	PSI = 04.70
00.0610	IRI(L): 026.08	IRI(2): 017.79	PSI = 04.70
00.0620	IRI(L): 022.06	IRI(2): 054.16	PSI = 04.70
00.0630	IRI(L): 008.40	IRI(2): 011.71	PSI = 04.70
00.0630	IRI(L): 037.75	IRI(2): 036.23	PSI = 04.70
00.0640	IRI(L): 025.16	IRI(2): 022.57	PSI = 04.70
00.0650	IRI(L): 024.07	IRI(2): 031.62	PSI = 04.70

00.0660	IRI(L): 013.41	IRI(2): 048.06	PSI = 04.70
00.0670	IRI(L): 018.83	IRI(2): 031.12	PSI = 04.70
00.0680	IRI(L): 068.22	IRI(2): 021.48	PSI = 04.70
00.0690	IRI(L): 020.00	IRI(2): 030.40	PSI = 04.70
00.0700	IRI(L): 012.87	IRI(2): 026.08	PSI = 04.70
00.0710	IRI(L): 041.70	IRI(2): 036.33	PSI = 04.70
00.0720	IRI(L): 027.18	IRI(2): 022.60	PSI = 04.70
00.0730	IRI(L): 020.78	IRI(2): 012.22	PSI = 04.70
00.0740	IRI(L): 020.83	IRI(2): 006.02	PSI = 04.70
00.0750	IRI(L): 011.39	IRI(2): 039.08	PSI = 04.70
00.0760	IRI(L): 015.99	IRI(2): 027.49	PSI = 04.70
00.0770	IRI(L): 059.17	IRI(2): 020.15	PSI = 04.70
00.0780	IRI(L): 029.98	IRI(2): 048.37	PSI = 04.70
00.0790	IRI(L): 087.77	IRI(2): 031.26	PSI = 04.52
00.0800	IRI(L): 021.39	IRI(2): 024.82	PSI = 04.70
00.0810	IRI(L): 026.67	IRI(2): 020.79	PSI = 04.70
00.0820	IRI(L): 006.95	IRI(2): 011.24	PSI = 04.70
00.0830	IRI(L): 028.50	IRI(2): 027.44	PSI = 04.70
00.0840	IRI(L): 009.38	IRI(2): 014.00	PSI = 04.70
00.0850	IRI(L): 019.17	IRI(2): 020.80	PSI = 04.70
00.0860	IRI(L): 023.73	IRI(2): 030.58	PSI = 04.70
00.0870	IRI(L): 029.45	IRI(2): 028.31	PSI = 04.70
00.0880	IRI(L): 015.05	IRI(2): 044.47	PSI = 04.70

00.0890	IRI(L): 022.39	IRI(2): 017.68	PSI = 04.70
00.0900	IRI(L): 022.38	IRI(2): 017.16	PSI = 04.70
00.0910	IRI(L): 013.53	IRI(2): 026.90	PSI = 04.70
00.0920	IRI(L): 008.64	IRI(2): 020.43	PSI = 04.70
00.0930	IRI(L): 015.66	IRI(2): 054.27	PSI = 04.70
00.0940	IRI(L): 067.24	IRI(2): 063.75	PSI = 04.38
00.0950	IRI(L): 028.84	IRI(2): 025.79	PSI = 04.70
00.0960	IRI(L): 037.34	IRI(2): 010.00	PSI = 04.70
00.0970	IRI(L): 048.19	IRI(2): 015.30	PSI = 04.70
00.0980	IRI(L): 013.49	IRI(2): 034.25	PSI = 04.70
00.0990	IRI(L): 013.42	IRI(2): 025.26	PSI = 04.70
00.1000	IRI(L): 023.42	IRI(2): 068.61	PSI = 04.70
00.1010	IRI(L): 037.85	IRI(2): 022.56	PSI = 04.70
00.1020	IRI(L): 335.13	IRI(2): 341.58	PSI = 00.90
00.1030	IRI(L): 017.08	IRI(2): 034.64	PSI = 04.70
00.1040	IRI(L): 069.84	IRI(2): 058.09	PSI = 04.41
00.1050	IRI(L): 068.29	IRI(2): 049.22	PSI = 04.54
00.1050	IRI(L): 546.61	IRI(2): 543.85	PSI = 00.00
00.1060	IRI(L): 028.79	IRI(2): 015.93	PSI = 04.70
00.1070	IRI(L): 106.57	IRI(2): 066.48	PSI = 03.92
00.1080	IRI(L): 048.15	IRI(2): 069.15	PSI = 04.55
00.1090	IRI(L): 315.11	IRI(2): 235.34	PSI = 01.45
00.1100	IRI(L): 053.71	IRI(2): 237.84	PSI = 02.93

00.1110	IRI(L): 022.09	IRI(2): 075.35	PSI = 04.70
00.1120	IRI(L): 041.20	IRI(2): 046.85	PSI = 04.70
00.1130	IRI(L): 049.68	IRI(2): 061.52	PSI = 04.62
00.1140	IRI(L): 039.52	IRI(2): 026.18	PSI = 04.70
00.1150	IRI(L): 035.32	IRI(2): 076.46	PSI = 04.62
00.1160	IRI(L): 132.78	IRI(2): 110.69	PSI = 03.29
00.1170	IRI(L): 043.70	IRI(2): 032.84	PSI = 04.70
00.1180	IRI(L): 037.59	IRI(2): 025.66	PSI = 04.70
00.1190	IRI(L): 040.68	IRI(2): 014.26	PSI = 04.70
00.1200	IRI(L): 021.86	IRI(2): 009.18	PSI = 04.70
00.1210	IRI(L): 065.31	IRI(2): 072.00	PSI = 04.30
00.1220	IRI(L): 252.33	IRI(2): 370.10	PSI = 01.13
00.1230	IRI(L): 032.15	IRI(2): 013.44	PSI = 04.70
00.1240	IRI(L): 028.37	IRI(2): 030.39	PSI = 04.70
00.1250	IRI(L): 077.13	IRI(2): 030.43	PSI = 04.67
00.1260	IRI(L): 036.87	IRI(2): 052.06	PSI = 04.70
00.1270	IRI(L): 065.22	IRI(2): 118.03	PSI = 03.82
00.1280	IRI(L): 031.04	IRI(2): 022.40	PSI = 04.70
00.1290	IRI(L): 029.48	IRI(2): 042.01	PSI = 04.70
00.1300	IRI(L): 026.11	IRI(2): 074.80	PSI = 04.70
00.1310	IRI(L): 019.80	IRI(2): 035.28	PSI = 04.70
00.1320	IRI(L): 029.31	IRI(2): 073.57	PSI = 04.70
00.1330	IRI(L): 017.50	IRI(2): 042.58	PSI = 04.70

00.1340	IRI(L): 036.16	IRI(2): 040.53	PSI = 04.70
00.1350	IRI(L): 071.74	IRI(2): 061.48	PSI = 04.35
00.1360	IRI(L): 071.87	IRI(2): 130.12	PSI = 03.64
00.1370	IRI(L): 015.48	IRI(2): 091.77	PSI = 04.68
00.1380	IRI(L): 045.75	IRI(2): 061.54	PSI = 04.68
00.1390	IRI(L): 053.53	IRI(2): 017.61	PSI = 04.70
00.1400	IRI(L): 024.92	IRI(2): 029.98	PSI = 04.70
00.1410	IRI(L): 047.27	IRI(2): 034.64	PSI = 04.70
00.1420	IRI(L): 006.61	IRI(2): 028.23	PSI = 04.70
00.1430	IRI(L): 104.94	IRI(2): 085.35	PSI = 03.75
00.1440	IRI(L): 042.02	IRI(2): 037.71	PSI = 04.70
00.1450	IRI(L): 010.56	IRI(2): 050.92	PSI = 04.70
00.1460	IRI(L): 049.61	IRI(2): 080.66	PSI = 04.38
00.1470	IRI(L): 057.29	IRI(2): 012.82	PSI = 04.70
00.1470	IRI(L): 084.06	IRI(2): 058.90	PSI = 04.24
00.1480	IRI(L): 035.69	IRI(2): 034.73	PSI = 04.70
00.1490	IRI(L): 011.44	IRI(2): 026.94	PSI = 04.70
00.1500	IRI(L): 032.13	IRI(2): 039.48	PSI = 04.70
00.1510	IRI(L): 055.24	IRI(2): 042.07	PSI = 04.70
00.1520	IRI(L): 027.31	IRI(2): 085.47	PSI = 04.60
00.1530	IRI(L): 026.60	IRI(2): 047.66	PSI = 04.70
00.1540	IRI(L): 029.96	IRI(2): 030.16	PSI = 04.70
00.1550	IRI(L): 015.20	IRI(2): 035.75	PSI = 04.70

00.1560	IRI(L): 040.31	IRI(2): 040.52	PSI = 04.70
00.1570	IRI(L): 011.22	IRI(2): 019.70	PSI = 04.70
00.1580	IRI(L): 048.86	IRI(2): 026.96	PSI = 04.70
00.1590	IRI(L): 060.37	IRI(2): 039.13	PSI = 04.70
00.1600	IRI(L): 042.76	IRI(2): 066.01	PSI = 04.66
00.1610	IRI(L): 037.86	IRI(2): 029.65	PSI = 04.70
00.1620	IRI(L): 034.71	IRI(2): 024.62	PSI = 04.70
00.1630	IRI(L): 021.25	IRI(2): 022.20	PSI = 04.70
00.1640	IRI(L): 047.68	IRI(2): 010.65	PSI = 04.70
00.1650	IRI(L): 057.53	IRI(2): 037.22	PSI = 04.70
00.1660	IRI(L): 082.16	IRI(2): 054.95	PSI = 04.30
00.1670	IRI(L): 036.17	IRI(2): 060.59	PSI = 04.70
00.1680	IRI(L): 045.33	IRI(2): 056.20	PSI = 04.70
00.1690	IRI(L): 098.28	IRI(2): 285.67	PSI = 02.33
00.1700	IRI(L): 059.53	IRI(2): 217.21	PSI = 03.04
00.1710	IRI(L): 082.93	IRI(2): 053.15	PSI = 04.32
00.1720	IRI(L): 043.45	IRI(2): 072.48	PSI = 04.56
00.1730	IRI(L): 126.85	IRI(2): 074.64	PSI = 03.65
00.1740	IRI(L): 099.20	IRI(2): 054.05	PSI = 04.12
00.1750	IRI(L): 076.36	IRI(2): 047.01	PSI = 04.47
00.1760	IRI(L): 069.06	IRI(2): 035.40	PSI = 04.70
00.1770	IRI(L): 036.71	IRI(2): 030.97	PSI = 04.70
00.1780	IRI(L): 065.12	IRI(2): 022.05	PSI = 04.70

00.1790	IRI(L): 130.37	IRI(2): 031.49	PSI = 04.03
00.1800	IRI(L): 032.89	IRI(2): 020.68	PSI = 04.70
00.1810	IRI(L): 030.18	IRI(2): 137.91	PSI = 03.97
00.1820	IRI(L): 029.32	IRI(2): 049.58	PSI = 04.70
00.1830	IRI(L): 045.68	IRI(2): 036.48	PSI = 04.70
00.1840	IRI(L): 028.92	IRI(2): 031.84	PSI = 04.70
00.1850	IRI(L): 043.69	IRI(2): 082.54	PSI = 04.43
00.1860	IRI(L): 029.29	IRI(2): 090.41	PSI = 04.51
00.1870	IRI(L): 044.47	IRI(2): 044.04	PSI = 04.70
00.1880	IRI(L): 033.18	IRI(2): 026.91	PSI = 04.70
00.1890	IRI(L): 032.32	IRI(2): 093.72	PSI = 04.44
00.1890	IRI(L): 020.12	IRI(2): 020.85	PSI = 04.70
00.1900	IRI(L): 051.74	IRI(2): 041.84	PSI = 04.70
00.1910	IRI(L): 053.92	IRI(2): 061.79	PSI = 04.57
00.1920	IRI(L): 192.65	IRI(2): 100.38	PSI = 02.92
00.1930	IRI(L): 057.83	IRI(2): 056.78	PSI = 04.58
00.1940	IRI(L): 042.96	IRI(2): 014.05	PSI = 04.70
00.1950	IRI(L): 020.88	IRI(2): 037.41	PSI = 04.70
00.1960	IRI(L): 049.85	IRI(2): 019.49	PSI = 04.70
00.1970	IRI(L): 048.20	IRI(2): 038.87	PSI = 04.70
00.1980	IRI(L): 040.57	IRI(2): 010.72	PSI = 04.70
00.1990	IRI(L): 019.69	IRI(2): 014.12	PSI = 04.70
00.2000	IRI(L): 038.00	IRI(2): 035.37	PSI = 04.70

00.2010	IRI(L): 016.19	IRI(2): 086.69	PSI = 04.70
00.2020	IRI(L): 013.29	IRI(2): 032.71	PSI = 04.70
00.2030	IRI(L): 019.79	IRI(2): 012.14	PSI = 04.70
00.2040	IRI(L): 025.08	IRI(2): 006.76	PSI = 04.70

IRI values in in/mile

Bumps detected using filtered profile: 0

Bumps with negative heights are depressions.

IRI & BUMP Calculations

US290 Eastbound (March 18, 2002)

========== I M P O R T   D A T A F I L E =========

Input file: d:_MY PROFILER FY2002\APROACH SLABS 2\DATA REPORTS\US290_R1_4.pro

---Header Lines

HEAD3,03182002,12,237,US0290,002,R1

CMET3,GMC_Safari gas minivan, RS232, 12100MI, 293240F, mi, 1GKDM19WXSB560669,07262001

KPRF01 mil LR 5.236 i 0.100 mi (profileID,elev_units,profiles/L=left/R=right/,samp_intv,inches,rpt_intv,miles)

English units input - english output. No conversion required.

Number of profiles loaded: 2

Data record count: 2437   Total distance: 0.201 miles

Min/Max profile values: -1.340/0.970 inches

Average value(bias) for all profiles: 0.001 inches

===== I R I & B U M P C A L C U L A T I O N =====

IRI values in in/mile

Distance	PSI	IRI(L)	IRI(R)	Avg IRI
00.0010	4.67	075.47	032.63	054.05
00.0020	3.98	132.03	034.68	083.35
00.0030	4.84	030.18	054.61	042.40
00.0040	5.00	021.97	036.82	029.39
00.0050	4.91	021.31	053.69	037.50
00.0060	4.95	031.48	037.48	034.48
00.0070	4.98	037.32	027.95	032.63
00.0080	4.11	071.54	082.49	077.02
00.0090	4.76	061.73	033.66	047.69
00.0100	5.00	014.13	033.94	024.04
00.0110	4.82	067.48	018.96	043.22
00.0120	4.95	023.65	046.37	035.01
00.0130	4.73	020.71	080.17	050.44
00.0140	4.74	048.10	050.35	049.23
00.0150	4.93	037.14	034.63	035.89
00.0160	4.90	032.40	043.19	037.79
00.0170	4.75	063.25	033.77	048.51
00.0180	4.76	072.36	023.13	047.75
00.0190	5.00	019.97	024.60	022.29

00.0200	5.00	039.65	019.46	029.56
00.0210	4.76	037.37	057.94	047.66
00.0220	5.00	032.96	027.75	030.35
00.0230	4.92	058.05	015.22	036.63
00.0240	5.00	049.31	013.55	031.43
00.0250	4.87	039.24	040.27	039.76
00.0260	5.00	023.30	032.60	027.95
00.0270	5.00	011.14	048.77	029.96
00.0280	5.00	027.48	019.98	023.73
00.0290	4.69	079.15	027.06	053.10
00.0300	4.79	022.82	068.93	045.87
00.0310	5.00	027.75	020.14	023.95
00.0320	5.00	030.55	025.41	027.98
00.0330	5.00	017.08	040.51	028.80
00.0340	4.66	086.34	022.46	054.40
00.0350	4.97	042.95	024.15	033.55
00.0360	4.72	037.52	064.09	050.81
00.0370	4.75	020.42	076.70	048.56
00.0380	4.80	057.29	032.60	044.94
00.0390	4.17	123.52	025.48	074.50
00.0400	4.82	065.56	021.84	043.70
00.0410	5.00	040.48	020.62	030.55
00.0420	4.86	013.65	067.27	040.46

00.0430	1.55	221.08	309.73	265.40
00.0440	4.21	071.37	073.90	072.64
00.0450	3.94	114.88	056.27	085.57
00.0460	5.00	023.50	011.43	017.46
00.0470	4.49	087.60	033.89	060.74
00.0480	4.72	065.83	035.83	050.83
00.0490	5.00	020.37	036.84	028.60
00.0500	5.00	040.29	013.35	026.82
00.0500	2.75	143.38	174.47	158.93
00.0510	1.91	168.92	289.45	229.18
00.0520	3.25	142.27	106.61	124.44
00.0530	2.37	176.99	199.52	188.25
00.0540	3.93	054.21	117.39	085.80
00.0550	3.52	142.16	073.71	107.94
00.0560	4.44	041.98	084.07	063.02
00.0570	4.79	070.68	021.36	046.02
00.0580	1.84	167.41	303.65	235.53
00.0590	0.15	056.24	819.79	438.01
00.0600	5.00	029.66	027.95	028.80
00.0610	4.62	083.17	028.03	055.60
00.0620	4.36	026.99	105.41	066.20
00.0630	4.99	026.50	038.49	032.50
00.0640	1.61	224.15	292.70	258.43

00.0650	4.65	066.76	042.80	054.78
00.0660	4.87	044.04	036.14	040.09
00.0670	4.72	067.83	034.38	051.11
00.0680	5.00	023.32	034.25	028.79
00.0690	4.35	091.27	041.74	066.50
00.0700	4.28	064.18	074.93	069.56
00.0710	4.85	041.27	041.83	041.55
00.0720	4.93	043.85	028.28	036.07
00.0730	5.00	016.05	017.00	016.52
00.0740	4.30	103.38	034.08	068.73
00.0750	4.82	025.81	061.52	043.66
00.0760	4.39	037.36	092.73	065.05
00.0770	4.12	060.31	092.84	076.58
00.0780	3.74	122.56	069.17	095.86
00.0790	4.24	080.70	061.75	071.23
00.0800	5.00	023.85	022.83	023.34
00.0810	4.75	071.35	025.61	048.48
00.0820	4.66	042.04	066.68	054.36
00.0830	4.57	047.43	068.05	057.74
00.0840	4.07	073.14	085.17	079.15
00.0850	4.17	088.93	060.26	074.60
00.0860	4.82	044.38	042.79	043.59
00.0870	4.80	054.41	035.52	044.96

00.0880	4.47	036.48	086.58	061.53
00.0890	4.72	037.76	064.58	051.17
00.0900	4.51	056.10	063.89	060.00
00.0910	4.33	072.90	062.17	067.53
00.0920	4.95	036.73	032.50	034.61
00.0930	4.64	055.52	054.86	055.19
00.0940	4.78	059.64	033.75	046.70
00.0950	4.67	081.18	026.66	053.92
00.0960	4.46	059.12	064.98	062.05
00.0970	5.00	029.54	033.68	031.61
00.0980	4.98	029.81	036.35	033.08
00.0990	4.53	079.28	039.52	059.40
00.1000	3.47	116.37	105.16	110.77
00.1010	4.68	048.81	058.51	053.66
00.1020	4.75	042.94	054.25	048.59
00.1030	5.00	014.47	024.24	019.36
00.1040	3.87	096.04	081.93	088.98
00.1050	4.96	046.41	021.92	034.16
00.1060	4.93	031.78	040.15	035.97
00.1070	4.99	036.54	027.50	032.02
00.1080	4.40	101.44	027.21	064.33
00.1090	4.49	048.13	073.91	061.02
00.1100	3.99	103.78	062.02	082.90

00.1110	5.00	030.50	021.01	025.75
00.1120	4.23	026.50	117.22	071.86
00.1130	4.94	028.12	042.64	035.38
00.1140	4.33	043.32	091.75	067.53
00.1150	4.66	084.28	024.28	054.28
00.1160	5.00	024.10	019.91	022.01
00.1170	4.29	077.71	060.29	069.00
00.1180	4.72	061.33	040.62	050.97
00.1190	4.83	039.59	045.86	042.72
00.1200	3.88	086.80	090.08	088.44
00.1210	2.04	168.28	266.97	217.63
00.1220	4.31	065.17	071.67	068.42
00.1230	3.71	037.51	156.91	097.21
00.1240	4.71	053.59	049.68	051.64
00.1250	2.02	100.68	338.42	219.55
00.1260	3.81	145.64	038.40	092.02
00.1270	4.26	106.38	034.57	070.48
00.1280	3.52	167.59	047.74	107.66
00.1290	3.96	096.78	071.94	084.36
00.1300	5.00	023.95	027.99	025.97
00.1310	4.39	073.00	056.95	064.98
00.1320	4.29	063.40	074.64	069.02
00.1330	4.86	047.54	034.18	040.86

00.1340	4.71	056.52	046.95	051.73
00.1350	5.00	015.15	046.48	030.82
00.1360	4.77	049.18	045.32	047.25
00.1370	4.05	060.15	099.47	079.81
00.1380	4.99	044.07	020.08	032.07
00.1390	3.89	118.17	057.62	087.90
00.1400	4.98	021.79	043.48	032.63
00.1410	5.00	028.33	027.43	027.88
00.1420	5.00	029.60	024.49	027.04
00.1430	4.56	053.56	062.20	057.88
00.1440	5.00	016.41	019.73	018.07
00.1450	5.00	010.08	012.47	011.28
00.1460	4.76	083.53	013.22	048.37
00.1470	4.84	057.68	026.13	041.90
00.1480	4.94	033.10	037.20	035.15
00.1490	3.81	052.65	131.66	092.16
00.1500	4.56	086.95	029.40	058.18
00.1510	4.89	036.32	041.33	038.82
00.1520	4.80	030.59	060.04	045.31
00.1530	4.85	025.50	057.66	041.58
00.1540	4.88	062.09	016.51	039.30
00.1550	4.78	069.77	023.63	046.70
00.1560	5.00	028.57	024.01	026.29

00.1570	4.98	031.78	033.96	032.87
00.1580	4.46	097.22	026.60	061.91
00.1590	5.00	022.23	022.64	022.44
00.1600	4.18	104.74	042.93	073.83
00.1610	5.00	022.16	032.08	027.12
00.1620	5.00	033.77	023.55	028.66
00.1630	5.00	030.35	017.58	023.97
00.1640	4.66	037.85	070.40	054.12
00.1650	4.59	089.36	024.12	056.74
00.1660	5.00	016.11	031.28	023.69
00.1670	4.94	044.03	027.10	035.56
00.1680	4.89	056.87	019.75	038.31
00.1690	4.47	094.72	028.37	061.54
00.1690	5.00	021.20	006.53	013.87
00.1700	4.85	047.83	035.23	041.53
00.1710	5.00	010.31	025.41	017.86
00.1720	5.00	030.21	030.86	030.53
00.1730	4.88	023.89	054.20	039.04
00.1740	4.61	055.65	056.52	056.09
00.1750	5.00	032.80	016.05	024.43
00.1760	4.19	103.27	044.08	073.67
00.1770	5.00	036.98	016.26	026.62
00.1780	4.87	029.33	050.75	040.04

00.1790	4.87	032.40	047.76	040.08
00.1800	5.00	026.41	011.85	019.13
00.1810	5.00	020.49	029.53	025.01
00.1820	4.79	040.28	051.12	045.70
00.1830	4.61	056.29	055.88	056.08
00.1840	4.72	073.26	028.69	050.97
00.1850	5.00	028.46	032.27	030.37
00.1860	4.88	053.96	024.64	039.30
00.1870	4.53	080.23	038.11	059.17
00.1880	5.00	035.88	020.12	028.00
00.1890	4.62	059.95	051.92	055.93
00.1900	4.82	022.29	064.89	043.59
00.1910	4.94	024.42	045.90	035.16
00.1920	4.63	053.32	057.18	055.25
00.1930	5.00	028.98	032.20	030.59
00.1940	5.00	027.36	014.56	020.96
00.1950	4.93	037.43	033.98	035.71
00.1960	3.85	166.05	014.22	090.14
00.1970	4.89	028.69	048.09	038.39
00.1980	4.92	044.18	029.77	036.97
00.1990	4.71	023.72	079.81	051.76
00.2000	5.00	018.03	029.62	023.82
00.2010	5.00	029.29	018.49	023.89

IRI & BUMP Calculations

US290 Westbound (March 18, 2002)

==========I M P O R T   D A T A F I L E =========

Input file: d:_MY PROFILER FY2002\APROACH SLABS 2\DATA REPORTS\US290_L1_1.pro

---Header Lines

HEAD3,03182002,12,237,US0290,003,L1

CMET3,GMC_Safari gas minivan, RS232, 12100MI, 293240F, mi, 1GKDM19WXSB560669,07262001

KPRF01 mil LR 5.236 i 0.100 mi (profileID,elev_units,profiles/L=left/R=right/,samp_intv,inches,rpt_intv,miles)

English units input - english output. No conversion required.

Number of profiles loaded: 2

Data record count: 2436   Total distance: 0.201 miles

Min/Max profile values: -0.868/1.199 inches

Average value(bias) for all profiles: -0.002 inches

===== I R I & B U M P C A L C U L A T I O N =====

IRI values in in/mile

Distance	PSI	IRI(L)	IRI(R)	Avg IRI
00.0010	4.96	025.89	042.78	034.34
00.0020	5.00	036.20	012.08	024.14
00.0030	5.00	047.90	013.56	030.73
00.0040	4.81	024.60	064.48	044.54
00.0050	5.00	025.73	011.67	018.70
00.0060	5.00	020.33	027.56	023.95
00.0070	5.00	013.77	022.36	018.06
00.0080	5.00	028.22	019.35	023.79
00.0090	5.00	017.86	023.23	020.55
00.0100	4.99	030.94	034.14	032.54
00.0110	5.00	019.68	018.50	019.09
00.0120	4.90	046.34	029.88	038.11
00.0130	4.80	044.56	045.38	044.97
00.0140	5.00	020.13	035.36	027.74
00.0150	5.00	025.36	026.39	025.87
00.0160	4.97	021.20	046.06	033.63
00.0170	5.00	028.48	017.68	023.08
00.0180	4.79	043.91	047.98	045.95
00.0190	4.51	080.29	040.02	060.15

00.0200	3.88	146.91	029.71	088.31
00.0210	4.86	032.29	049.01	040.65
00.0220	4.86	036.75	044.97	040.86
00.0230	4.75	062.89	034.36	048.63
00.0240	5.00	017.44	022.10	019.77
00.0250	5.00	033.39	019.80	026.60
00.0260	5.00	044.13	010.66	027.39
00.0270	5.00	013.06	021.56	017.31
00.0280	4.94	017.83	053.37	035.60
00.0290	5.00	016.20	021.37	018.78
00.0300	5.00	027.06	030.33	028.70
00.0310	5.00	035.54	027.29	031.42
00.0320	4.74	073.56	025.79	049.68
00.0330	4.93	010.42	061.07	035.74
00.0340	4.97	049.44	017.55	033.49
00.0350	4.88	036.25	042.59	039.42
00.0360	4.87	041.03	038.93	039.98
00.0370	5.00	014.80	014.44	014.62
00.0380	5.00	020.55	033.90	027.23
00.0390	4.70	068.35	036.78	052.56
00.0400	5.00	022.20	015.42	018.81
00.0410	5.00	020.69	021.99	021.34
00.0420	4.86	020.64	060.65	040.64

00.0430	4.92	029.18	043.58	036.38
00.0440	4.77	047.66	046.90	047.28
00.0450	5.00	011.69	049.75	030.72
00.0460	4.97	027.25	039.58	033.41
00.0470	5.00	010.24	032.00	021.12
00.0480	4.78	070.16	023.28	046.72
00.0490	5.00	038.62	011.67	025.15
00.0500	5.00	011.70	040.40	026.05
00.0500	5.00	035.72	022.78	029.25
00.0510	5.00	027.30	015.53	021.41
00.0520	4.81	021.23	066.62	043.93
00.0530	4.88	047.23	031.06	039.15
00.0540	4.55	028.36	088.58	058.47
00.0550	4.90	028.53	047.04	037.79
00.0560	4.87	054.07	025.58	039.82
00.0570	4.81	045.28	043.18	044.23
00.0580	4.87	021.96	057.85	039.91
00.0590	2.22	196.73	205.15	200.94
00.0600	2.75	120.74	195.92	158.33
00.0610	4.87	046.72	033.74	040.23
00.0620	4.59	082.32	031.83	057.07
00.0630	0.70	309.95	415.22	362.59
00.0640	2.99	186.60	095.92	141.26

00.0650	4.35	063.69	069.10	066.39
00.0660	3.41	086.00	142.75	114.37
00.0670	2.48	256.65	102.95	179.80
00.0680	3.04	068.46	207.64	138.05
00.0690	3.89	068.57	107.60	088.08
00.0700	4.76	058.56	036.97	047.76
00.0710	2.76	135.41	180.42	157.92
00.0720	4.64	048.04	061.70	054.87
00.0730	3.68	058.18	140.18	099.18
00.0740	4.72	060.88	041.44	051.16
00.0750	5.00	040.38	021.15	030.77
00.0760	5.00	034.17	029.39	031.78
00.0770	5.00	022.31	029.51	025.91
00.0780	4.52	035.47	084.12	059.79
00.0790	5.00	030.81	021.48	026.14
00.0800	4.34	066.48	067.08	066.78
00.0810	4.60	072.80	040.13	056.46
00.0820	4.82	050.35	036.22	043.28
00.0830	5.00	029.33	029.83	029.58
00.0840	4.81	044.62	043.77	044.19
00.0850	5.00	019.93	039.00	029.46
00.0860	4.29	066.02	072.45	069.24
00.0870	4.15	109.25	041.42	075.33

00.0880	4.85	047.65	035.68	041.66
00.0890	4.88	066.84	011.31	039.08
00.0900	4.80	058.13	032.16	045.14
00.0910	4.46	076.46	047.35	061.90
00.0920	3.96	101.67	066.84	084.25
00.0930	5.00	015.85	040.78	028.32
00.0940	4.66	061.33	047.24	054.28
00.0950	3.36	078.56	156.43	117.49
00.0960	4.90	020.06	055.47	037.77
00.0970	4.88	043.04	035.29	039.17
00.0980	5.00	013.83	017.28	015.56
00.0990	4.08	112.09	045.12	078.61
00.1000	4.78	056.88	036.81	046.84
00.1010	4.73	058.44	042.20	050.32
00.1020	4.20	098.73	047.22	072.97
00.1030	4.88	053.19	025.72	039.46
00.1040	4.93	019.25	053.04	036.15
00.1050	4.82	037.20	049.25	043.23
00.1060	4.85	031.78	050.89	041.33
00.1070	5.00	009.75	037.00	023.37
00.1080	5.00	034.39	013.99	024.19
00.1090	4.20	069.63	076.92	073.27
00.1100	3.10	116.52	151.39	133.96

00.1110	5.00	019.20	024.25	021.73
00.1120	4.47	048.91	074.32	061.62
00.1130	4.63	047.24	063.89	055.56
00.1140	5.00	022.41	033.26	027.84
00.1150	5.00	019.72	025.94	022.83
00.1160	5.00	033.19	030.44	031.82
00.1170	4.95	023.40	046.65	035.02
00.1180	5.00	018.92	016.05	017.48
00.1190	4.75	037.19	059.93	048.56
00.1200	4.87	018.03	062.40	040.22
00.1210	5.00	024.60	038.25	031.42
00.1220	4.55	068.96	047.88	058.42
00.1230	4.79	046.11	045.69	045.90
00.1240	5.00	018.33	041.18	029.75
00.1250	5.00	033.44	019.44	026.44
00.1260	4.86	048.91	032.61	040.76
00.1270	4.86	036.74	044.08	040.41
00.1280	4.41	053.65	074.27	063.96
00.1290	2.38	189.51	185.52	187.51
00.1300	3.66	081.19	119.15	100.17
00.1310	3.49	139.05	080.34	109.70
00.1320	4.15	075.19	075.22	075.21
00.1330	3.36	093.49	140.95	117.22

00.1340	3.94	097.86	073.24	085.55
00.1350	4.66	032.27	076.57	054.42
00.1360	2.77	236.70	078.25	157.48
00.1370	2.75	100.91	216.14	158.53
00.1380	4.15	057.48	093.40	075.44
00.1390	4.48	086.81	035.68	061.24
00.1400	4.68	065.77	041.19	053.48
00.1410	4.84	065.99	018.54	042.27
00.1420	4.34	040.32	093.75	067.04
00.1430	4.73	077.80	023.07	050.43
00.1440	4.46	073.12	051.02	062.07
00.1450	4.40	108.13	021.09	064.61
00.1460	4.55	084.47	032.79	058.63
00.1470	4.11	108.02	046.01	077.01
00.1480	4.73	057.12	044.34	050.73
00.1490	4.80	074.90	015.38	045.14
00.1500	4.54	043.26	074.55	058.91
00.1510	5.00	023.15	023.24	023.19
00.1520	5.00	032.81	025.87	029.34
00.1530	4.50	039.16	081.78	060.47
00.1540	4.74	055.45	043.45	049.45
00.1550	5.00	019.62	022.30	020.96
00.1560	4.97	035.49	031.16	033.33

00.1570	3.96	125.65	042.64	084.15
00.1580	5.00	034.01	014.05	024.03
00.1590	4.90	028.56	048.04	038.30
00.1600	5.00	024.71	029.30	027.00
00.1610	4.15	064.94	085.81	075.37
00.1620	4.90	058.08	018.22	038.15
00.1630	5.00	027.74	035.27	031.50
00.1640	4.89	042.62	034.71	038.67
00.1650	5.00	040.56	020.93	030.74
00.1660	5.00	006.03	012.00	009.02
00.1670	4.97	046.94	019.52	033.23
00.1680	4.65	044.92	064.63	054.77
00.1690	4.24	087.43	054.97	071.20
00.1690	4.97	027.14	040.21	033.67
00.1700	4.87	035.91	043.96	039.94
00.1710	5.00	017.12	026.95	022.04
00.1720	5.00	029.07	025.61	027.34
00.1730	5.00	025.59	032.95	029.27
00.1740	4.88	042.70	035.42	039.06
00.1750	4.72	052.65	049.26	050.96
00.1760	5.00	018.90	041.68	030.29
00.1770	5.00	014.44	026.52	020.48
00.1780	4.44	091.76	033.98	062.87

00.1790	4.73	037.43	062.90	050.16
00.1800	4.73	030.35	070.14	050.24
00.1810	4.78	020.72	072.91	046.82
00.1820	4.84	065.94	017.68	041.81
00.1830	4.20	105.45	041.11	073.28
00.1840	4.84	034.16	049.41	041.78
00.1850	4.76	040.48	055.96	048.22
00.1860	5.00	044.94	008.25	026.59
00.1870	5.00	020.46	037.62	029.04
00.1880	5.00	029.49	029.58	029.53
00.1890	4.55	040.19	076.78	058.49
00.1900	5.00	040.06	023.32	031.69
00.1910	5.00	029.95	029.09	029.52
00.1920	4.92	045.87	026.98	036.42
00.1930	5.00	041.21	014.20	027.70
00.1940	5.00	017.43	040.86	029.15
00.1950	5.00	032.63	029.28	030.96
00.1960	4.76	059.43	037.11	048.27
00.1970	5.00	016.25	018.64	017.45
00.1980	4.02	066.85	096.21	081.53
00.1990	5.00	023.31	037.51	030.41
00.2000	4.82	053.98	033.19	043.59

IRI & BUMP Calculations

SH249 Northbound (March 18, 2002)

========== I M P O R T   D A T A F I L E =========

Input file: d:_MY PROFILER FY2002\APROACH SLABS 2\DATA REPORTS\SH249_L1_4.pro

--Header Lines

HEAD3,03182002,12,102,SH0249,004,L1

CMET3,GMC_Safari gas minivan, RS232, 12100MI, 293240F, mi, 1GKDM19WXSB560669,07262001

KPRF01 mil LR 5.236 i 0.100 mi

(profileID,elev_units,profiles/L=left/R=right/,samp_intv,inches,rpt_intv,miles)

English units input - english output. No conversion required.

Number of profiles loaded: 2

Data record count: 2416   Total distance: 0.200 miles

Min/Max profile values: -1.007/0.782 inches

Average value(bias) for all profiles: -0.007 inches

===== I R I & B U M P C A L C U L A T I O N =====

IRI values in in/mile

Distance	PSI	IRI(L)	IRI(R)	Avg IRI
00.0010	5.00	047.72	011.40	029.56
00.0020	5.00	019.51	044.22	031.87
00.0030	5.00	017.70	030.74	024.22
00.0040	5.00	022.85	039.65	031.25
00.0050	4.75	033.82	063.39	048.61
00.0060	4.81	036.29	051.90	044.09
00.0070	3.50	161.52	056.68	109.10
00.0080	4.92	057.43	016.51	036.97
00.0090	5.00	019.74	027.94	023.84
00.0100	4.80	072.99	017.33	045.16
00.0110	4.28	068.16	070.66	069.41
00.0120	5.00	007.02	046.77	026.90
00.0130	3.21	209.29	044.90	127.10
00.0140	4.56	062.11	054.37	058.24
00.0150	5.00	025.28	006.78	016.03
00.0160	5.00	019.98	024.33	022.15
00.0170	5.00	021.30	021.41	021.36
00.0180	5.00	009.67	026.88	018.27
00.0190	4.95	015.65	054.08	034.86

00.0200	4.94	035.59	035.42	035.51
00.0210	3.26	089.89	157.32	123.61
00.0220	4.79	036.86	055.28	046.07
00.0230	5.00	009.42	024.70	017.06
00.0240	4.73	055.59	045.40	050.49
00.0250	5.00	026.88	028.95	027.92
00.0260	4.95	019.23	050.83	035.03
00.0270	5.00	028.38	015.74	022.06
00.0280	3.97	130.02	038.24	084.13
00.0290	5.00	026.20	016.88	021.54
00.0300	5.00	030.39	011.32	020.86
00.0310	4.78	036.22	056.03	046.12
00.0320	4.72	042.59	059.51	051.05
00.0330	4.38	036.98	093.82	065.40
00.0340	4.51	074.52	045.87	060.19
00.0350	4.98	025.10	040.52	032.81
00.0360	5.00	033.10	022.55	027.83
00.0370	5.00	014.42	037.03	025.72
00.0380	4.80	059.43	030.12	044.78
00.0390	4.06	092.39	066.81	079.60
00.0400	4.98	038.67	027.13	032.90
00.0410	3.95	107.37	062.28	084.82
00.0420	4.02	088.31	074.57	081.44

00.0430	4.56	040.01	075.93	057.97
00.0440	5.00	022.70	029.44	026.07
00.0450	5.00	036.54	019.11	027.83
00.0460	5.00	025.45	035.25	030.35
00.0470	2.63	226.45	108.31	167.38
00.0480	3.81	068.47	115.83	092.15
00.0490	2.30	301.29	087.36	194.32
00.0500	2.22	196.60	206.54	201.57
00.0500	2.10	235.80	187.51	211.66
00.0510	4.55	069.08	047.83	058.46
00.0520	4.82	060.06	026.54	043.30
00.0530	4.00	095.84	068.72	082.28
00.0540	1.91	329.04	129.97	229.51
00.0550	3.62	084.05	120.71	102.38
00.0560	3.14	168.64	094.58	131.61
00.0570	3.29	203.21	039.71	121.46
00.0580	2.42	163.39	204.73	184.06
00.0590	4.96	024.27	043.98	034.13
00.0600	4.78	073.65	020.03	046.84
00.0610	4.80	045.13	044.43	044.78
00.0620	5.00	025.69	019.55	022.62
00.0630	4.67	020.30	087.65	053.97
00.0640	4.84	044.64	039.70	042.17

00.0650	4.50	095.72	025.14	060.43
00.0660	4.57	051.53	063.88	057.70
00.0670	4.90	031.21	045.07	038.14
00.0680	4.99	023.30	040.81	032.05
00.0690	4.79	057.98	034.16	046.07
00.0700	4.61	073.32	039.31	056.32
00.0710	5.00	008.49	025.06	016.77
00.0720	4.96	018.31	049.74	034.03
00.0730	4.96	056.55	011.44	033.99
00.0740	5.00	019.49	029.75	024.62
00.0750	4.51	075.72	044.41	060.06
00.0760	4.73	075.74	025.59	050.67
00.0770	4.83	050.05	035.18	042.61
00.0780	4.70	030.69	075.20	052.94
00.0790	5.00	029.17	019.55	024.36
00.0800	4.68	034.87	071.91	053.39
00.0810	5.00	024.39	022.15	023.27
00.0820	4.12	054.18	099.54	076.86
00.0830	4.94	013.34	057.48	035.41
00.0840	3.55	122.50	089.81	106.15
00.0850	4.93	032.68	039.45	036.07
00.0860	5.00	030.66	018.71	024.68
00.0870	5.00	014.89	030.65	022.77

00.0880	4.26	094.87	046.08	070.48
00.0890	3.67	102.75	096.43	099.59
00.0900	4.58	043.44	071.40	057.42
00.0910	4.80	049.54	040.40	044.97
00.0920	3.53	129.37	085.42	107.40
00.0930	4.80	067.20	023.44	045.32
00.0940	4.91	014.22	060.88	037.55
00.0950	4.98	045.10	020.66	032.88
00.0960	3.71	058.21	136.17	097.19
00.0970	4.79	038.39	052.43	045.41
00.0980	4.83	060.10	025.94	043.02
00.0990	4.95	045.65	024.13	034.89
00.1000	4.91	022.04	052.32	037.18
00.1010	4.65	094.75	014.72	054.74
00.1020	5.00	036.74	017.38	027.06
00.1030	4.86	061.81	020.01	040.91
00.1040	5.00	026.90	019.66	023.28
00.1050	4.86	054.77	026.81	040.79
00.1060	4.86	034.85	047.00	040.92
00.1070	4.03	075.65	086.74	081.20
00.1080	5.00	043.51	016.07	029.79
00.1090	3.25	118.71	129.31	124.01
00.1100	4.70	072.49	033.14	052.81

00.1110	5.00	019.86	039.45	029.65
00.1120	5.00	012.98	031.01	022.00
00.1130	4.82	031.44	056.15	043.80
00.1140	2.41	120.92	248.96	184.94
00.1150	2.65	022.46	309.59	166.03
00.1160	3.75	070.16	120.60	095.38
00.1170	2.27	191.49	201.97	196.73
00.1180	3.06	117.62	155.75	136.68
00.1190	2.00	040.73	400.68	220.70
00.1200	2.94	221.24	069.01	145.12
00.1210	2.97	187.49	098.05	142.77
00.1220	0.61	373.64	374.63	374.14
00.1230	2.66	070.36	260.85	165.60
00.1240	2.62	225.91	111.23	168.57
00.1250	3.08	114.82	155.67	135.24
00.1260	1.47	310.95	235.89	273.42
00.1270	3.95	056.95	112.52	084.74
00.1280	4.98	018.51	047.61	033.06
00.1290	4.75	054.82	042.95	048.89
00.1300	5.00	021.97	026.00	023.99
00.1310	5.00	014.53	019.27	016.90
00.1320	4.95	040.35	028.92	034.63
00.1330	5.00	013.77	039.73	026.75

00.1340	4.98	037.65	028.27	032.96
00.1350	5.00	018.50	022.39	020.45
00.1360	4.98	025.40	040.22	032.81
00.1370	4.29	064.60	073.45	069.03
00.1380	5.00	011.05	047.16	029.10
00.1390	4.76	042.40	053.72	048.06
00.1400	4.74	031.20	067.33	049.26
00.1410	4.98	038.69	026.99	032.84
00.1420	5.00	006.93	014.23	010.58
00.1430	4.86	038.54	043.24	040.89
00.1440	5.00	014.19	040.45	027.32
00.1450	5.00	030.07	016.10	023.08
00.1460	5.00	027.34	013.21	020.28
00.1470	5.00	009.16	011.07	010.12
00.1480	5.00	047.12	010.33	028.73
00.1490	5.00	042.71	020.99	031.85
00.1500	5.00	006.94	037.09	022.01
00.1510	5.00	035.17	018.79	026.98
00.1520	5.00	016.54	025.52	021.03
00.1530	4.99	022.79	042.31	032.55
00.1540	5.00	012.30	023.74	018.02
00.1550	4.97	041.87	025.62	033.74
00.1560	5.00	011.44	031.26	021.35

00.1570	4.99	042.83	021.66	032.24
00.1580	4.81	074.90	013.24	044.07
00.1590	5.00	038.27	019.37	028.82
00.1600	4.94	020.07	050.42	035.24
00.1610	5.00	020.87	025.68	023.27
00.1620	5.00	022.36	034.18	028.27
00.1630	4.87	043.14	036.94	040.04
00.1640	4.81	047.21	041.43	044.32
00.1650	4.77	039.34	054.45	046.89
00.1660	5.00	016.77	036.21	026.49
00.1670	5.00	033.30	030.29	031.80
00.1680	5.00	015.79	040.71	028.25
00.1690	5.00	038.93	024.77	031.85
00.1690	5.00	016.75	018.41	017.58
00.1700	5.00	038.08	015.24	026.66
00.1710	5.00	015.54	021.54	018.54
00.1720	5.00	026.49	027.36	026.93
00.1730	5.00	018.49	038.77	028.63
00.1740	4.71	075.16	029.40	052.28
00.1750	5.00	018.18	010.22	014.20
00.1760	5.00	024.48	036.91	030.69
00.1770	4.76	039.82	056.43	048.13
00.1780	4.96	051.40	016.71	034.05

00.1790	5.00	014.95	011.63	013.29
00.1800	5.00	020.17	012.26	016.22
00.1810	5.00	012.89	036.49	024.69
00.1820	4.98	046.30	019.80	033.05
00.1830	4.81	011.48	076.53	044.00
00.1840	5.00	039.32	023.51	031.42
00.1850	5.00	027.83	009.11	018.47
00.1860	4.96	037.17	031.25	034.21
00.1870	4.97	019.27	047.33	033.30
00.1880	4.90	013.46	062.29	037.88
00.1890	5.00	013.55	007.05	010.30
00.1900	4.85	062.43	019.93	041.18
00.1910	4.82	033.16	054.11	043.64
00.1920	5.00	027.78	027.13	027.46
00.1930	4.92	038.19	035.67	036.93
00.1940	5.00	013.25	040.97	027.11
00.1950	5.00	016.27	014.40	015.34
00.1960	5.00	020.48	016.53	018.50
00.1970	4.92	048.02	025.89	036.95
00.1980	5.00	010.53	006.77	008.65
00.1990	4.74	055.41	043.10	049.26

IRI & BUMP Calculations

SH249 Southbound (March 18, 2002)

========== I M P O R T   D A T A F I L E =========

Input file: d:_MY PROFILER FY2002\APROACH SLABS 2\DATA REPORTS\SH249_R1_1.pro

--Header Lines

HEAD3,03182002,12,102,SH0249,001,R1

CMET3,GMC_Safari gas minivan, RS232, 12100MI, 293240F, mi, 1GKDM19WXSB560669,07262001

KPRF01 mil LR 5.236 i 0.100 mi (profileID,elev_units,profiles/L=left/R=right/,samp_intv,inches,rpt_intv,miles)

English units input - english output. No conversion required.

Number of profiles loaded: 2

Data record count: 2427   Total distance: 0.201 miles

Min/Max profile values: -1.389/0.784 inches

Average value(bias) for all profiles: 0.003 inches

===== I R I & B U M P   C A L C U L A T I O N =====

IRI values in in/mile

Distance	PSI	IRI(L)	IRI(R)	Avg IRI
00.0010	5.00	035.78	008.45	022.11
00.0020	4.48	070.49	052.24	061.36
00.0030	4.86	050.78	031.14	040.96
00.0040	4.93	028.91	043.19	036.05
00.0050	5.00	032.96	020.82	026.89
00.0060	5.00	016.73	016.48	016.60
00.0070	4.85	012.97	070.44	041.70
00.0080	5.00	015.31	014.06	014.69
00.0090	4.95	034.84	034.35	034.59
00.0100	4.94	024.45	046.24	035.34
00.0110	4.35	103.08	029.95	066.51
00.0120	5.00	025.08	020.77	022.92
00.0130	4.84	052.61	032.24	042.42
00.0140	5.00	021.19	011.89	016.54
00.0150	4.93	025.57	046.00	035.78
00.0160	5.00	010.45	011.10	010.77
00.0170	4.43	031.81	094.83	063.32
00.0180	4.31	042.37	093.99	068.18
00.0190	4.94	029.92	040.62	035.27

00.0200	4.98	019.10	046.20	032.65
00.0210	4.95	020.91	048.11	034.51
00.0220	4.99	028.71	036.12	032.41
00.0230	5.00	029.84	018.29	024.07
00.0240	5.00	028.51	013.15	020.83
00.0250	4.67	051.54	056.58	054.06
00.0260	5.00	017.12	045.66	031.39
00.0270	5.00	009.13	034.19	021.66
00.0280	4.97	019.52	047.37	033.45
00.0290	4.45	087.89	036.82	062.35
00.0300	4.79	020.58	071.28	045.93
00.0310	5.00	016.77	023.53	020.15
00.0320	5.00	016.86	023.24	020.05
00.0330	4.63	024.71	086.28	055.49
00.0340	5.00	026.10	034.07	030.08
00.0350	5.00	035.33	024.74	030.04
00.0360	5.00	018.22	034.84	026.53
00.0370	5.00	020.79	038.97	029.88
00.0380	4.91	024.68	049.48	037.08
00.0390	4.73	025.23	074.79	050.01
00.0400	5.00	011.00	023.85	017.42
00.0410	5.00	019.41	020.85	020.13
00.0420	4.90	033.61	042.81	038.21

00.0430	5.00	034.06	017.68	025.87
00.0440	4.73	011.17	090.26	050.71
00.0450	5.00	030.74	022.48	026.61
00.0460	4.88	011.90	066.75	039.33
00.0470	5.00	014.78	022.52	018.65
00.0480	2.85	104.93	197.69	151.31
00.0490	3.89	100.54	075.50	088.02
00.0500	3.12	076.94	187.93	132.43
00.0500	1.30	319.82	262.67	291.24
00.0510	2.68	104.21	223.57	163.89
00.0520	2.75	108.70	209.08	158.89
00.0530	3.75	051.28	138.90	095.09
00.0540	2.03	197.69	238.94	218.32
00.0550	2.73	174.76	145.58	160.17
00.0560	3.75	095.28	095.16	095.22
00.0570	3.82	134.59	048.08	091.34
00.0580	1.56	228.80	299.79	264.29
00.0590	2.13	220.36	198.10	209.23
00.0600	4.76	067.19	028.13	047.66
00.0610	3.55	082.40	130.19	106.30
00.0620	4.72	041.54	060.97	051.26
00.0630	4.27	058.79	081.43	070.11
00.0640	3.46	129.25	093.43	111.34

00.0650	3.45	093.13	131.24	112.18
00.0660	4.88	044.52	033.67	039.09
00.0670	4.94	020.25	050.71	035.48
00.0680	3.80	071.84	113.03	092.44
00.0690	5.00	015.30	045.57	030.44
00.0700	4.84	027.86	056.86	042.36
00.0710	1.45	271.63	280.27	275.95
00.0720	4.34	061.17	072.46	066.81
00.0730	4.02	089.00	073.69	081.35
00.0740	3.70	116.80	079.12	097.96
00.0750	4.90	036.99	038.78	037.89
00.0760	3.09	103.15	166.81	134.98
00.0770	5.00	021.85	039.72	030.79
00.0780	4.72	029.67	072.75	051.21
00.0790	4.47	026.85	096.62	061.73
00.0800	5.00	014.97	012.42	013.69
00.0810	4.67	065.69	042.21	053.95
00.0820	4.22	055.24	089.13	072.18
00.0830	4.83	052.91	032.72	042.81
00.0840	4.38	052.57	077.74	065.16
00.0850	3.94	088.48	082.38	085.43
00.0860	3.25	123.83	124.17	124.00
00.0870	4.30	076.38	060.68	068.53

00.0880	5.00	017.93	016.82	017.38
00.0890	4.80	035.81	054.01	044.91
00.0900	4.95	019.91	050.10	035.01
00.0910	4.87	047.83	032.64	040.23
00.0920	3.95	100.32	069.65	084.99
00.0930	4.78	031.06	062.02	046.54
00.0940	4.82	035.66	050.94	043.30
00.0950	4.37	024.99	106.30	065.64
00.0960	4.72	075.86	026.68	051.27
00.0970	4.91	042.12	032.32	037.22
00.0980	5.00	044.04	014.85	029.44
00.0990	4.92	046.65	026.65	036.65
00.1000	4.76	038.51	057.66	048.09
00.1010	4.46	037.35	086.48	061.91
00.1020	5.00	013.51	017.56	015.53
00.1030	4.90	024.02	052.37	038.20
00.1040	4.29	104.88	033.52	069.20
00.1050	4.91	032.37	042.09	037.23
00.1060	4.57	087.74	027.43	057.58
00.1070	4.95	036.08	032.82	034.45
00.1080	4.92	049.52	024.24	036.88
00.1090	5.00	022.00	034.63	028.32
00.1100	4.50	099.35	021.25	060.30

00.1110	4.88	051.30	027.88	039.59
00.1120	4.94	039.79	031.55	035.67
00.1130	4.58	098.44	016.13	057.28
00.1140	4.84	055.72	028.33	042.02
00.1150	1.87	222.03	244.59	233.31
00.1160	2.34	196.07	185.76	190.91
00.1170	4.11	121.05	033.61	077.33
00.1180	4.33	042.18	093.06	067.62
00.1190	2.04	226.01	208.28	217.15
00.1200	3.06	103.09	170.81	136.95
00.1210	2.93	121.48	169.77	145.63
00.1220	1.28	282.24	304.77	293.50
00.1230	0.00	562.05	367.97	465.01
00.1240	2.36	228.80	149.54	189.17
00.1250	3.43	181.81	044.26	113.03
00.1260	0.99	298.44	356.65	327.54
00.1270	4.37	068.32	063.32	065.82
00.1280	4.93	030.18	041.28	035.73
00.1290	4.56	038.51	077.94	058.22
00.1300	4.72	055.18	046.68	050.93
00.1310	4.87	054.99	024.94	039.97
00.1320	5.00	016.12	044.11	030.12
00.1330	5.00	024.38	039.00	031.69

00.1340	4.81	042.61	046.45	044.53
00.1350	5.00	024.67	036.37	030.52
00.1360	4.61	033.05	078.90	055.98
00.1370	4.32	105.55	030.38	067.97
00.1380	4.78	020.22	072.03	046.12
00.1390	4.68	053.47	054.00	053.73
00.1400	4.73	059.66	041.06	050.36
00.1410	5.00	018.39	028.04	023.21
00.1420	3.98	072.74	093.79	083.27
00.1430	4.80	048.97	040.38	044.67
00.1440	5.00	021.51	023.83	022.67
00.1450	5.00	023.60	029.03	026.32
00.1460	5.00	019.76	027.20	023.48
00.1470	5.00	026.48	031.42	028.95
00.1480	5.00	014.27	010.49	012.38
00.1490	5.00	020.60	017.53	019.07
00.1500	4.63	072.46	038.65	055.56
00.1510	4.74	049.56	050.28	049.92
00.1520	4.99	013.90	050.28	032.09
00.1530	4.99	038.33	025.90	032.11
00.1540	5.00	026.79	018.32	022.55
00.1550	4.69	095.46	011.01	053.24
00.1560	5.00	027.53	014.12	020.82

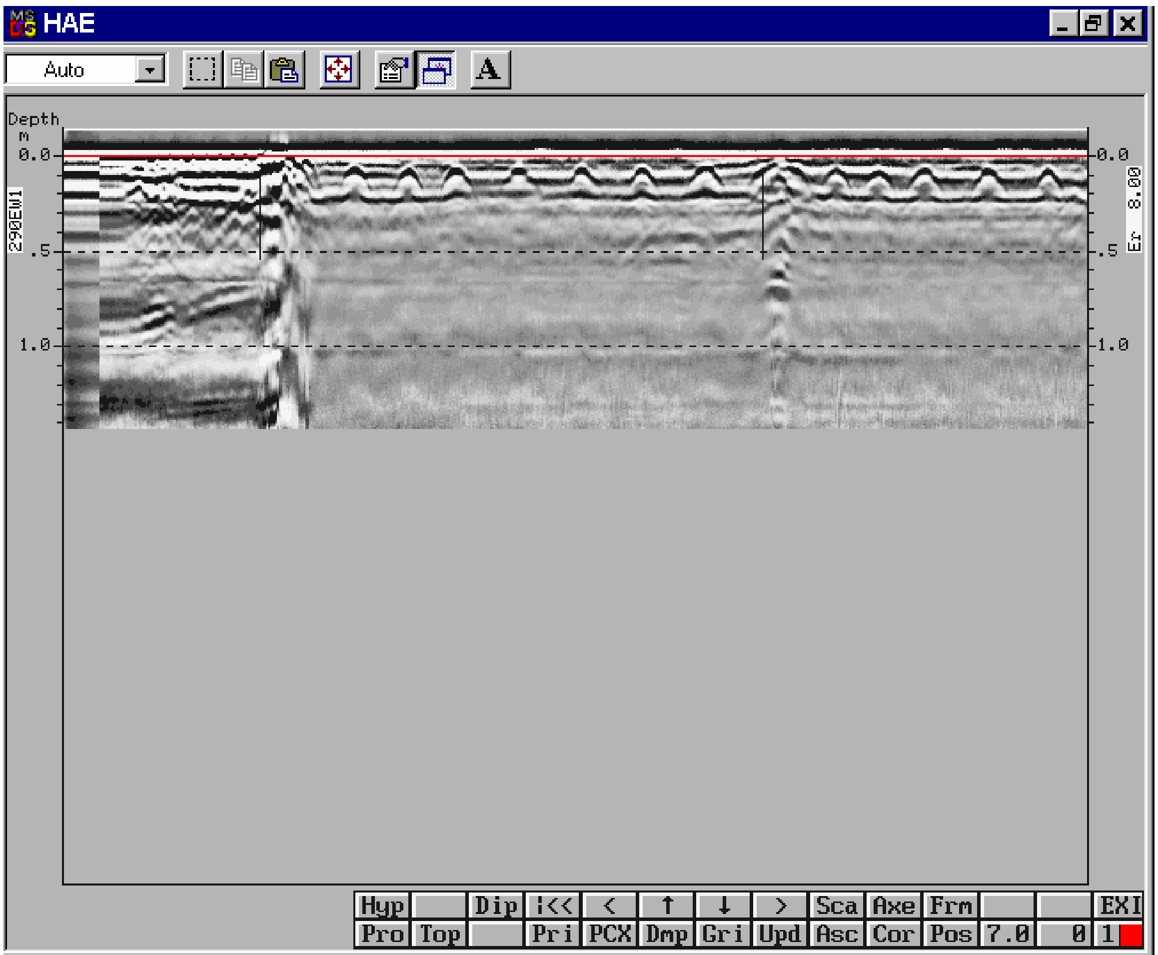
00.1570	5.00	023.08	021.70	022.39
00.1580	4.90	053.68	022.25	037.97
00.1590	5.00	022.86	032.70	027.78
00.1600	5.00	016.10	013.60	014.85
00.1610	5.00	011.79	017.41	014.60
00.1620	4.97	035.41	031.10	033.26
00.1630	4.91	040.02	035.19	037.60
00.1640	5.00	026.83	032.67	029.75
00.1650	5.00	023.02	025.57	024.30
00.1660	5.00	021.33	029.74	025.53
00.1670	4.59	057.89	056.07	056.98
00.1680	4.95	024.04	045.58	034.81
00.1690	4.85	049.72	033.00	041.36
00.1690	4.38	062.88	068.07	065.48
00.1700	4.11	117.85	036.16	077.01
00.1710	4.83	047.40	037.67	042.54
00.1720	4.97	040.03	027.37	033.70
00.1730	4.86	055.72	025.07	040.40
00.1740	3.98	052.91	113.48	083.20
00.1750	4.78	048.71	044.98	046.84
00.1760	4.80	030.03	059.96	044.99
00.1770	4.79	055.55	036.45	046.00
00.1780	5.00	026.53	029.97	028.25

00.1790	4.90	033.19	042.42	037.80
00.1800	4.37	076.54	054.54	065.54
00.1810	4.96	009.74	058.75	034.25
00.1820	5.00	009.18	045.16	027.17
00.1830	5.00	015.84	039.11	027.47
00.1840	4.55	019.68	097.16	058.42
00.1850	4.02	032.29	130.98	081.63
00.1860	5.00	020.00	020.31	020.15
00.1870	4.77	053.23	041.68	047.46
00.1880	4.37	109.15	022.62	065.89
00.1890	4.79	053.64	037.26	045.45
00.1900	4.28	070.78	068.17	069.47
00.1910	4.86	020.09	061.08	040.58
00.1920	4.65	061.27	047.87	054.57
00.1930	4.66	019.60	088.66	054.13
00.1940	4.74	031.67	067.41	049.54
00.1950	4.87	052.11	028.30	040.20
00.1960	4.37	049.74	081.70	065.72
00.1970	4.77	019.60	075.27	047.44
00.1980	4.84	031.95	051.65	041.80
00.1990	4.59	076.91	036.77	056.84
00.2000	3.95	040.16	129.48	084.82

APPENDIX D GROUND PENETRATION RADAR TEST

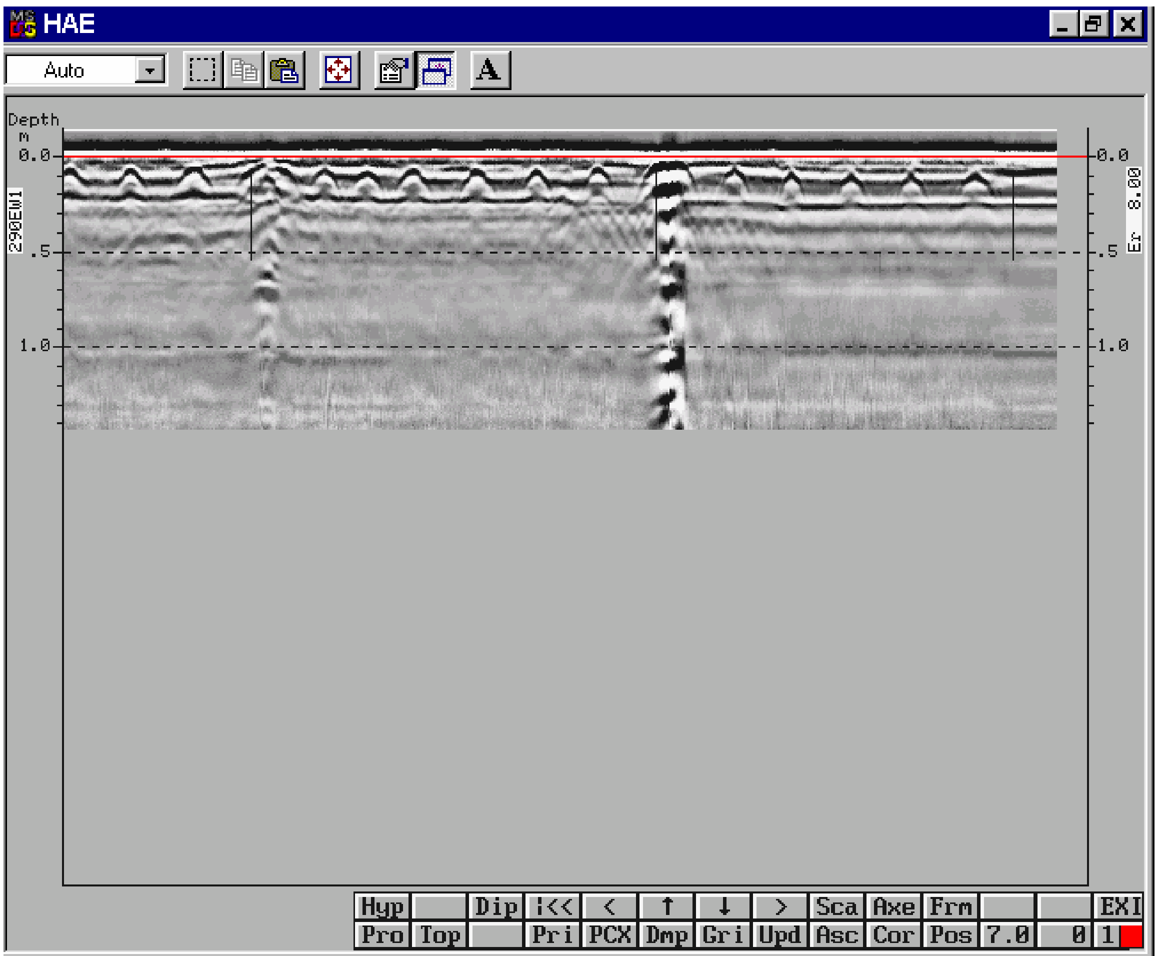
US290 West Bound

US290 EW1



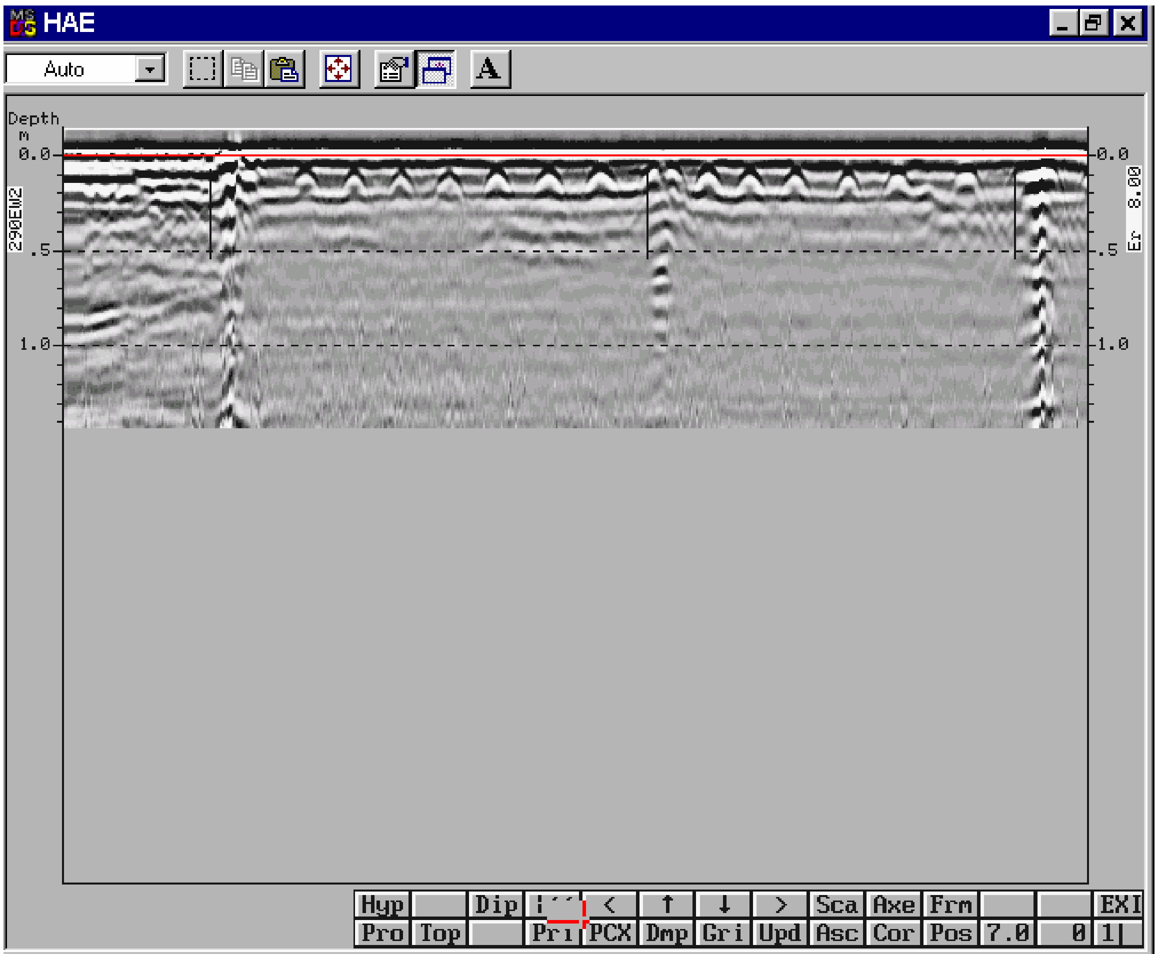
US290 West Bound

US290 EW1



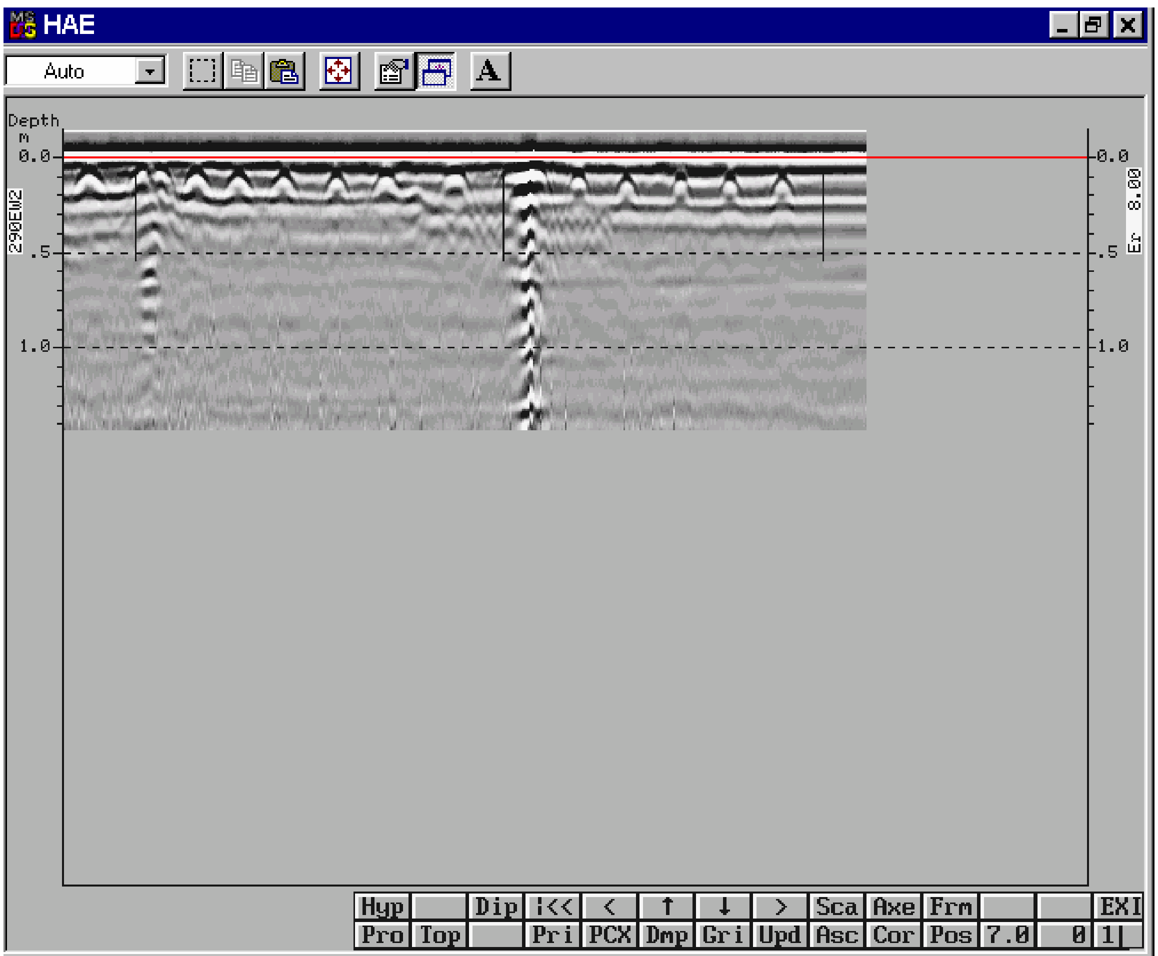
US290 West Bound

US290 EW2



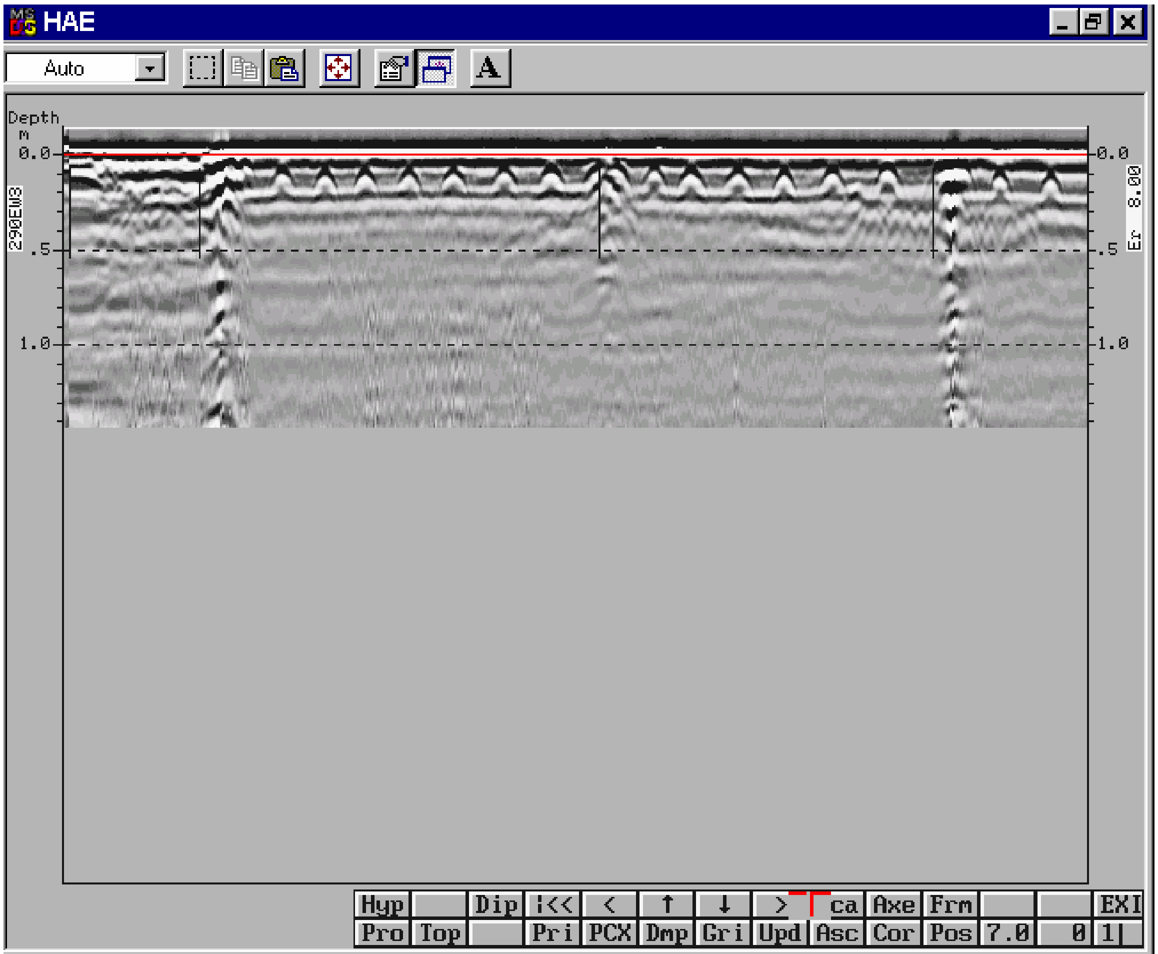
US290 West Bound

US290 EW2



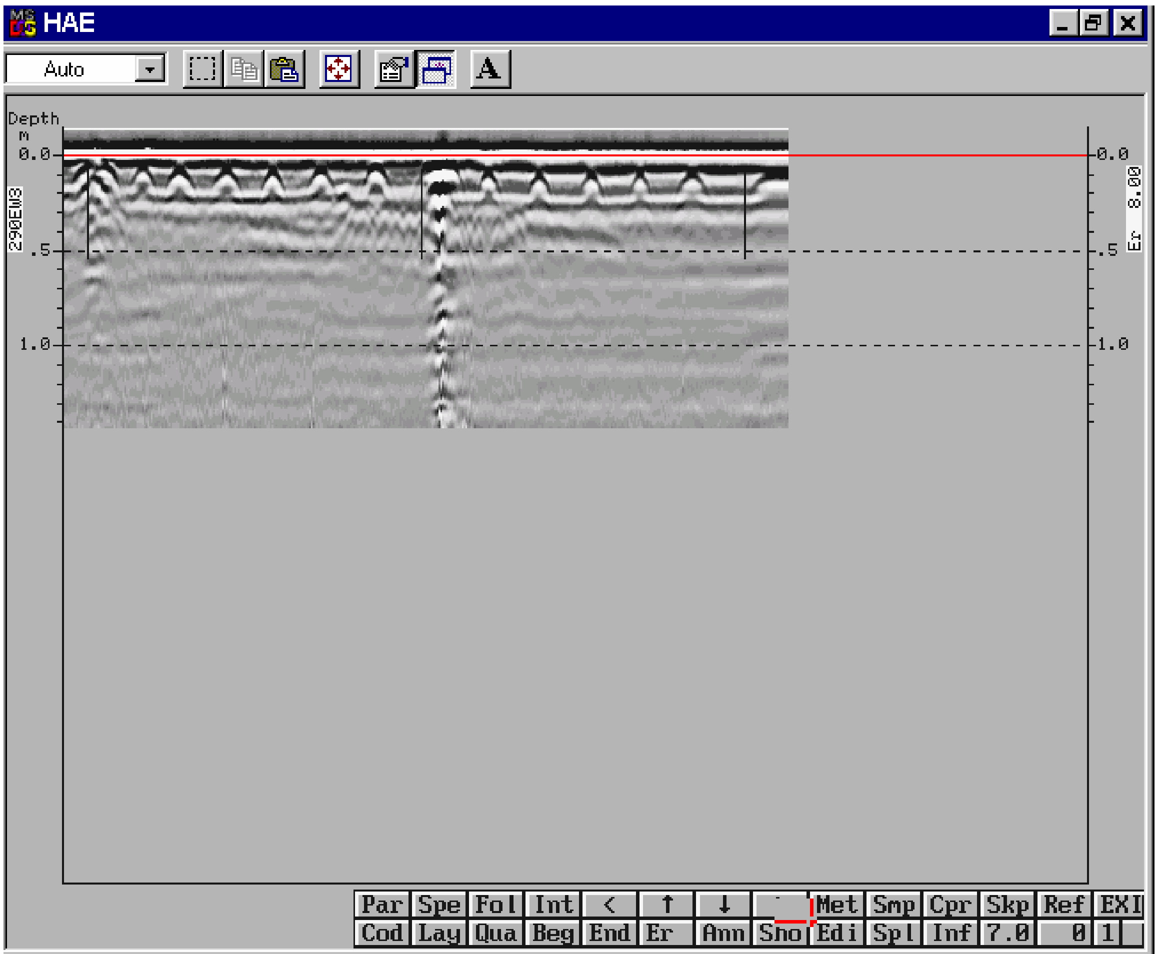
US290 West Bound

US290 EW3



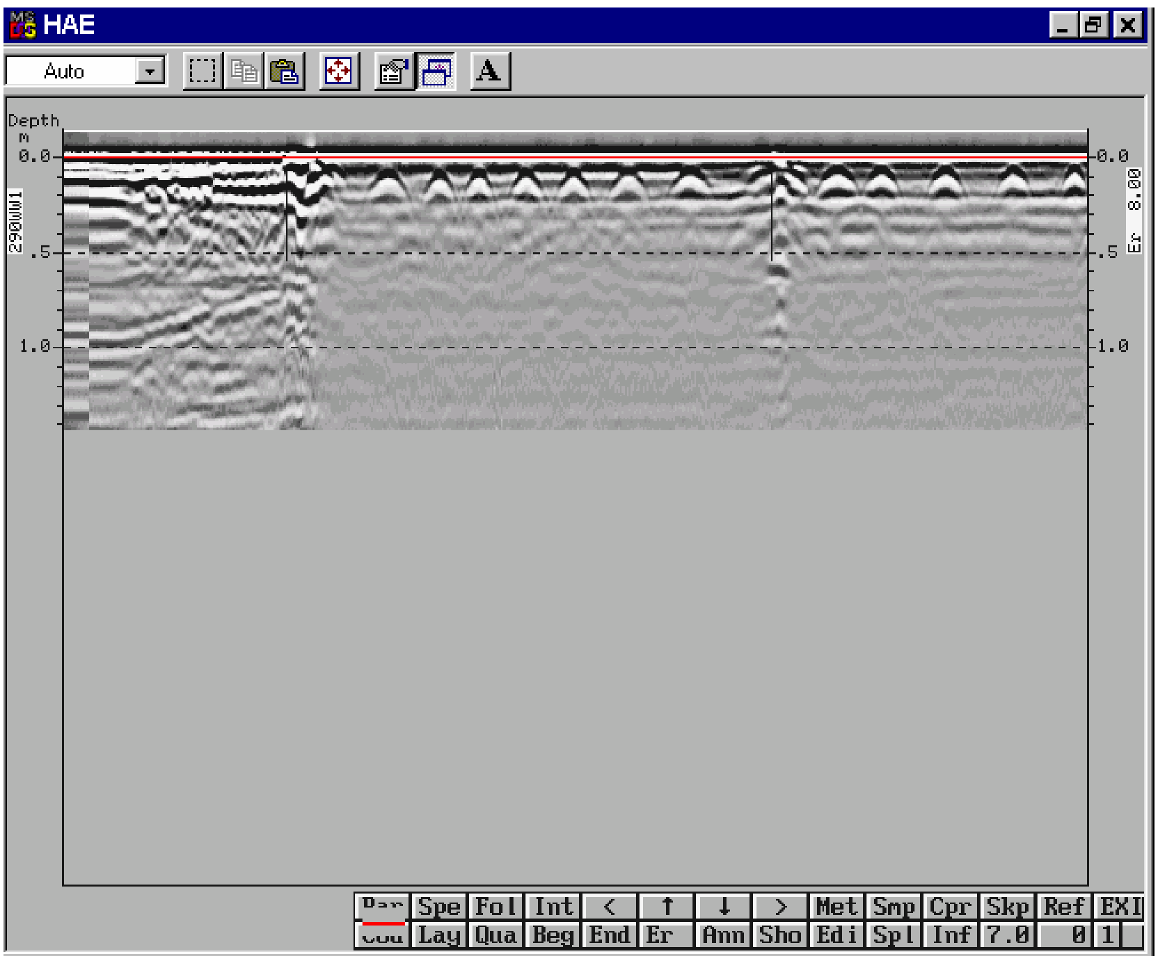
US290 West Bound

US290 EW3



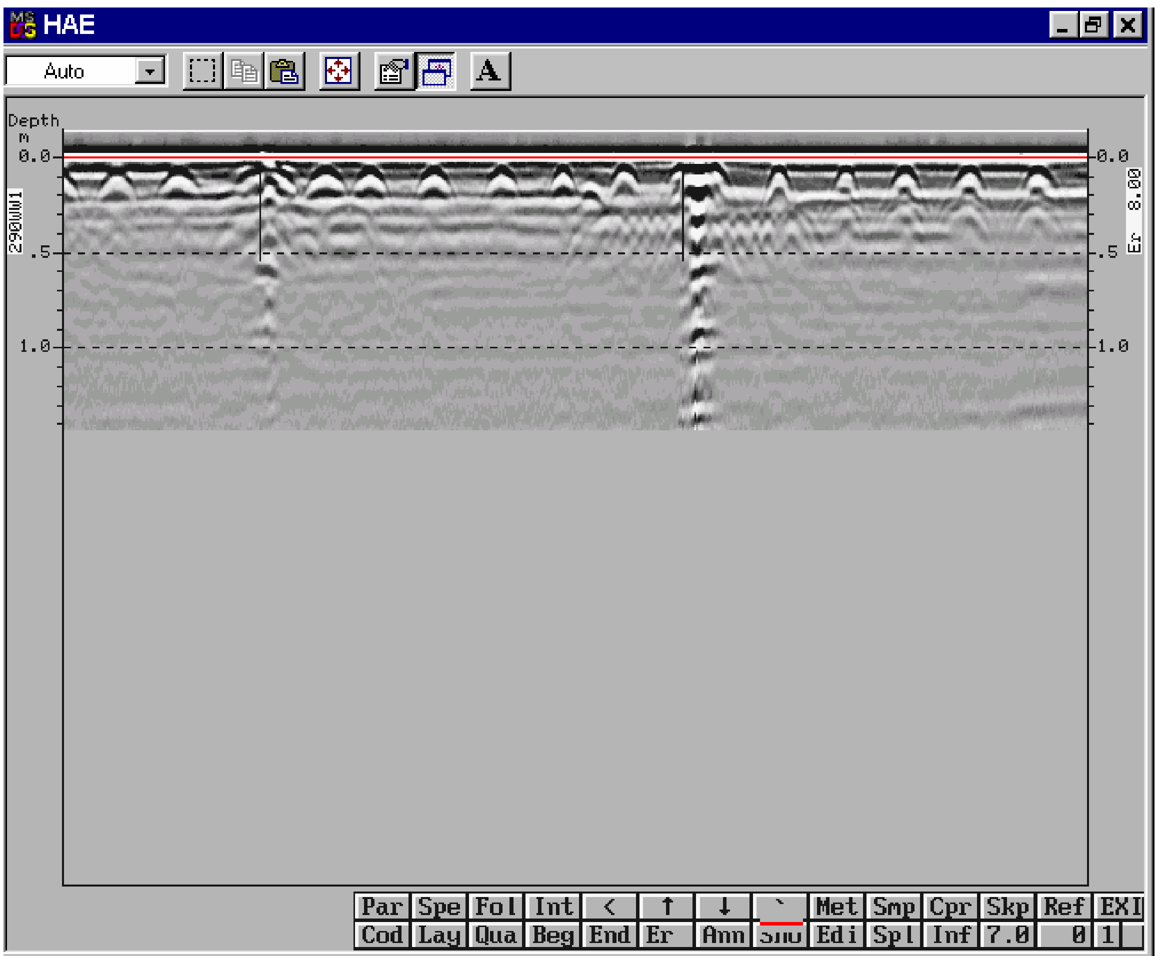
US290 West Bound

US290 WW1



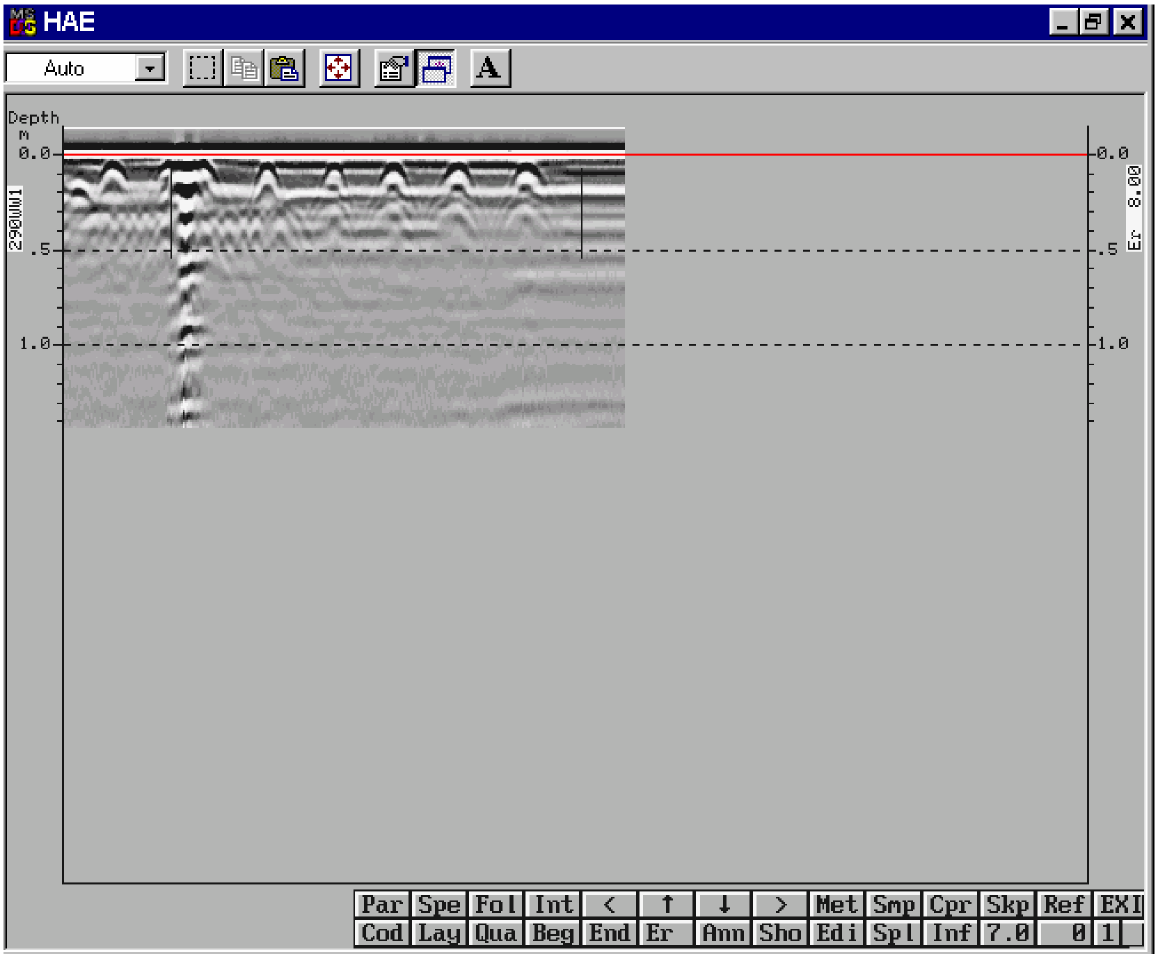
US290 West Bound

US290 WW1



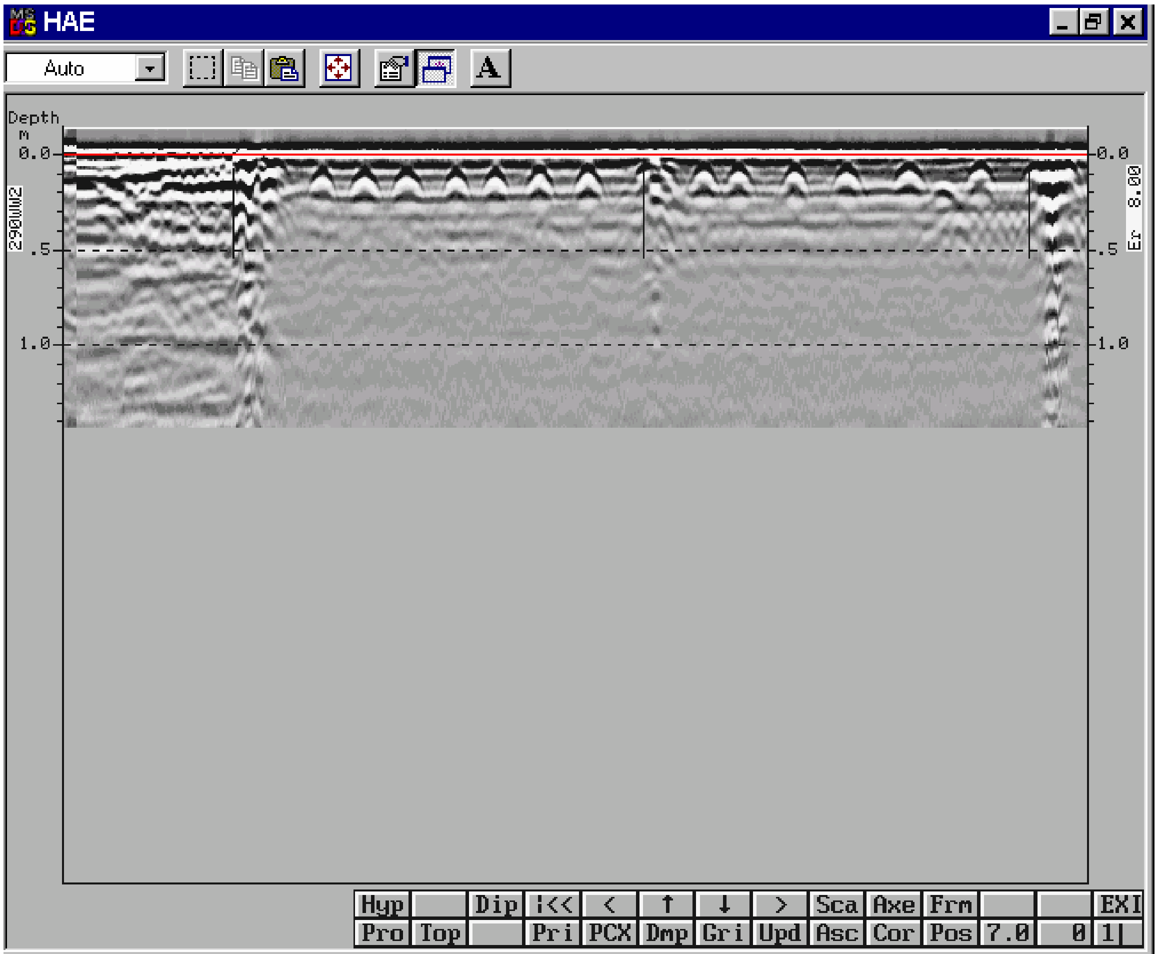
US290 West Bound

US290 WW1



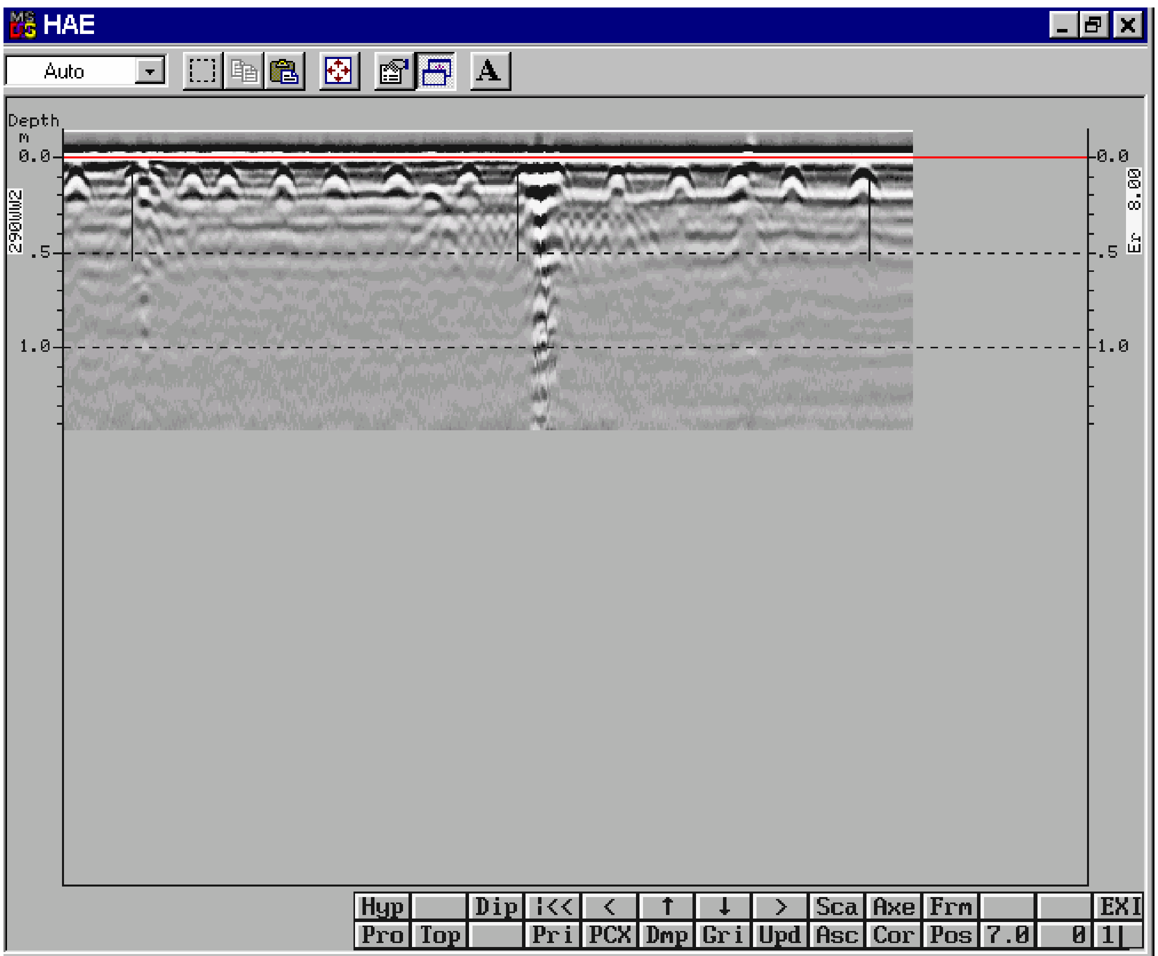
US290 West Bound

US290 WW2



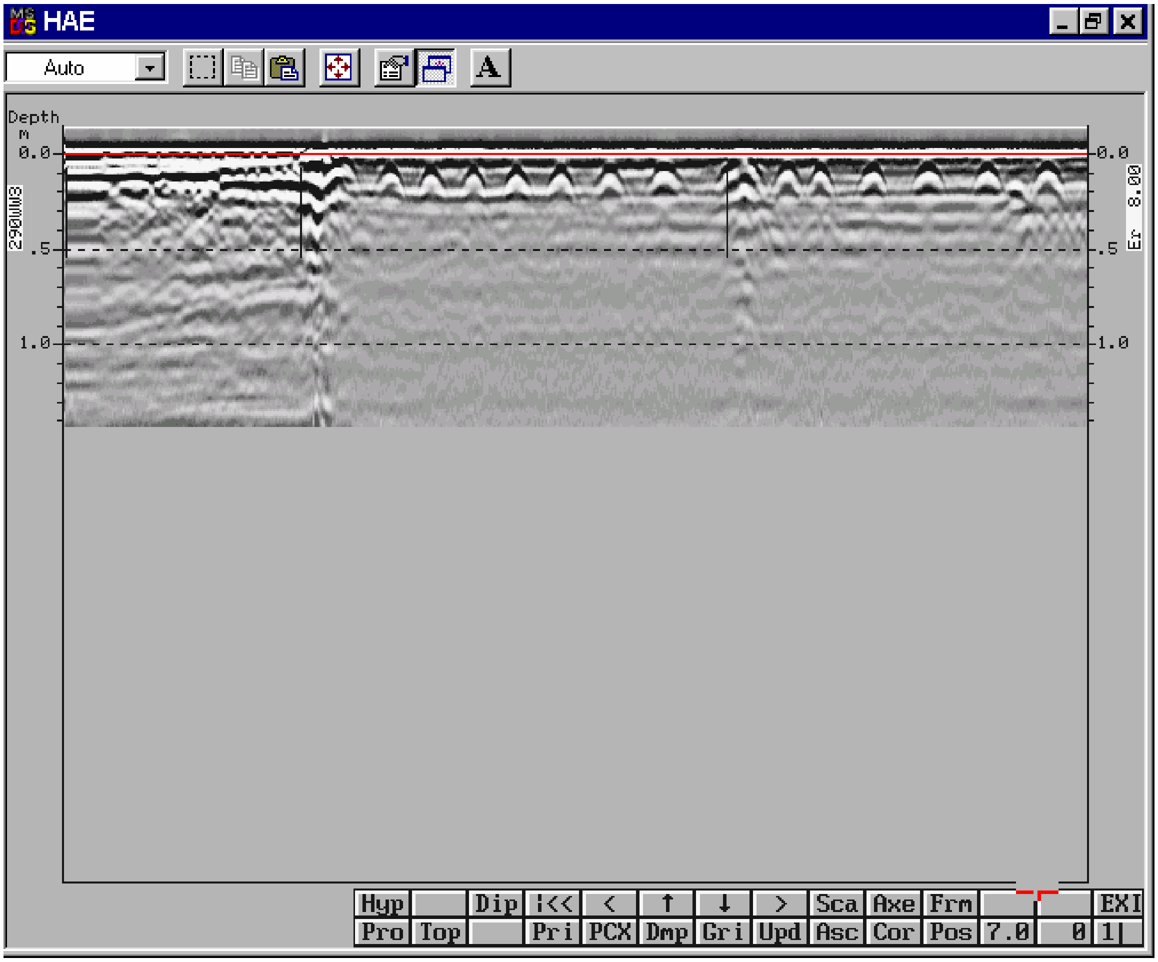
US290 West Bound

US290 WW2



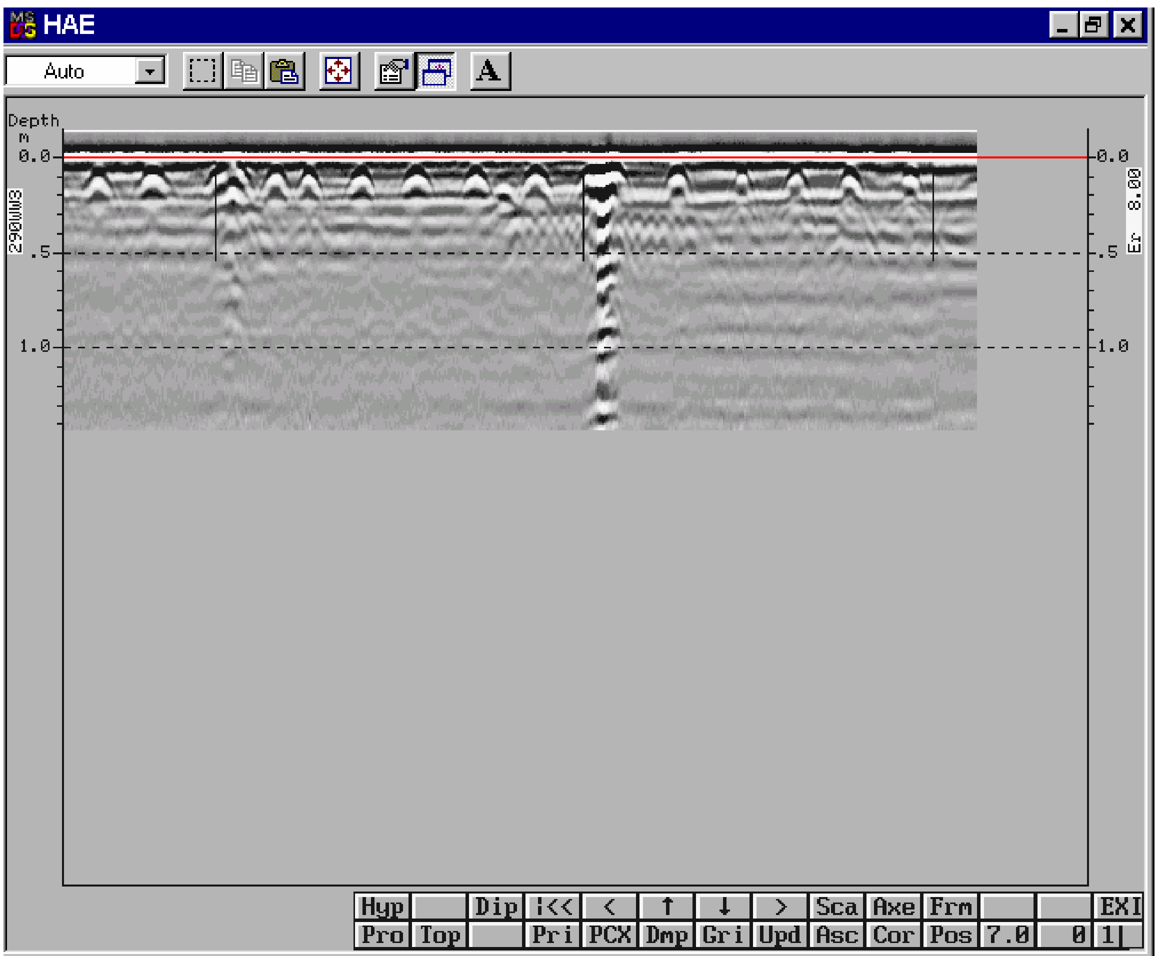
US290 West Bound

US290 WW3



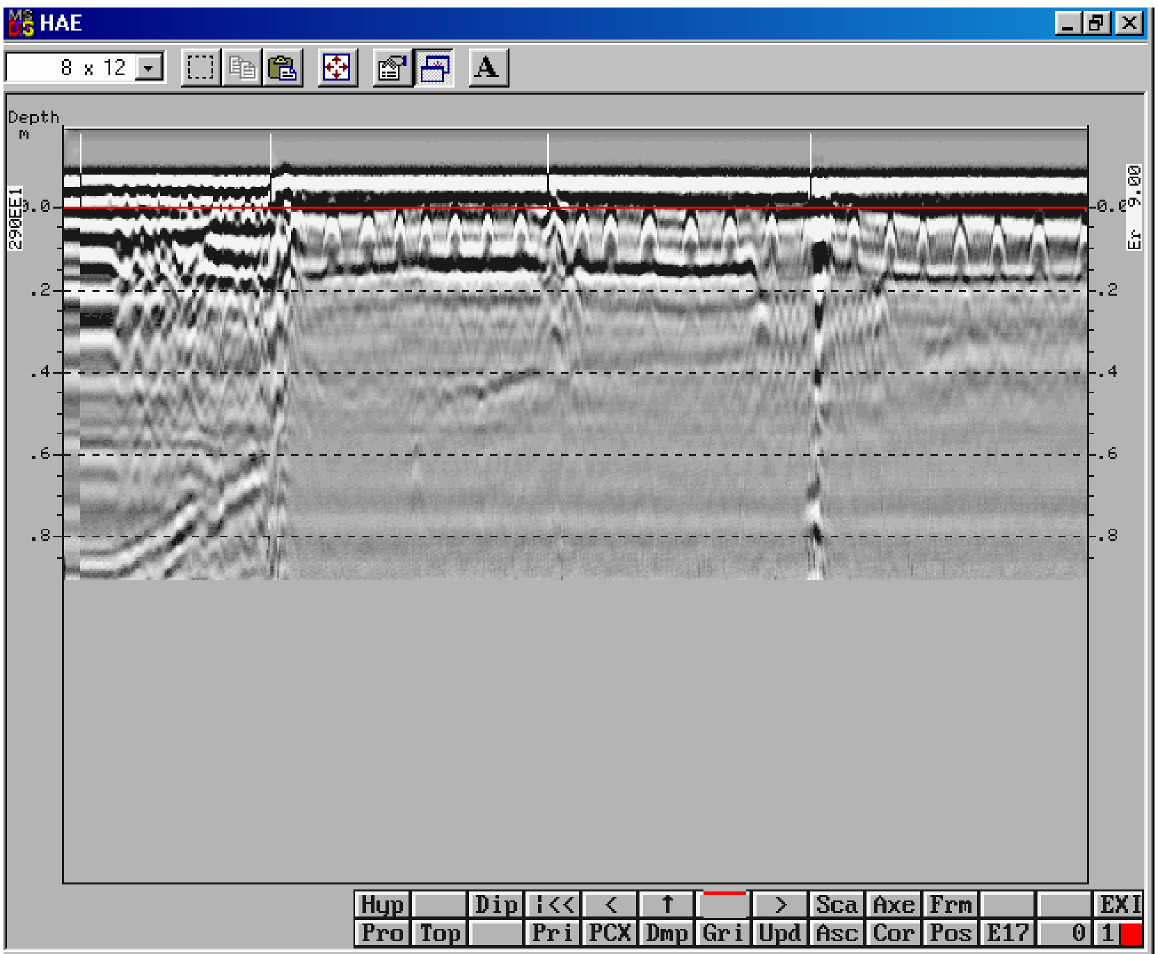
US290 West Bound

US290 WW3



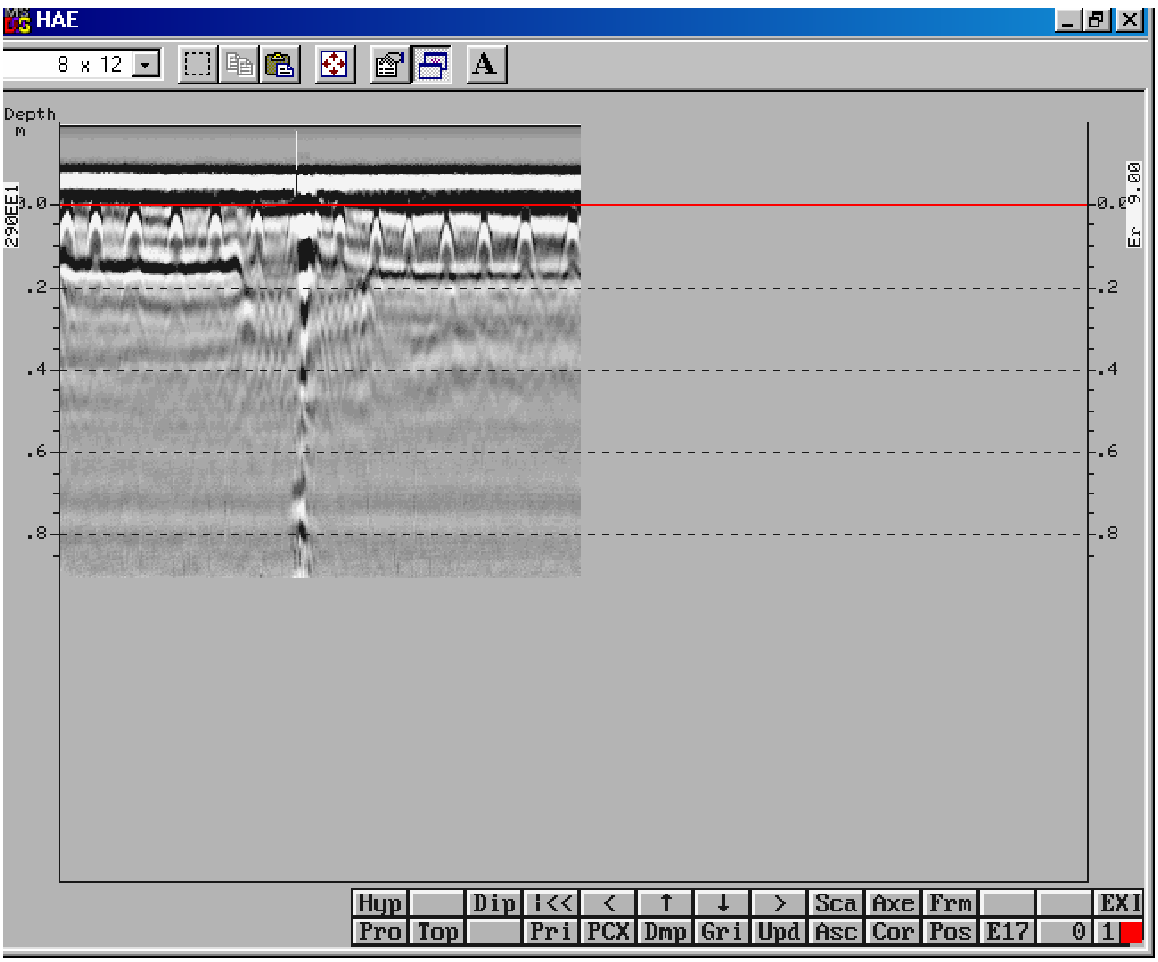
US290 East Bound

US290 EE1



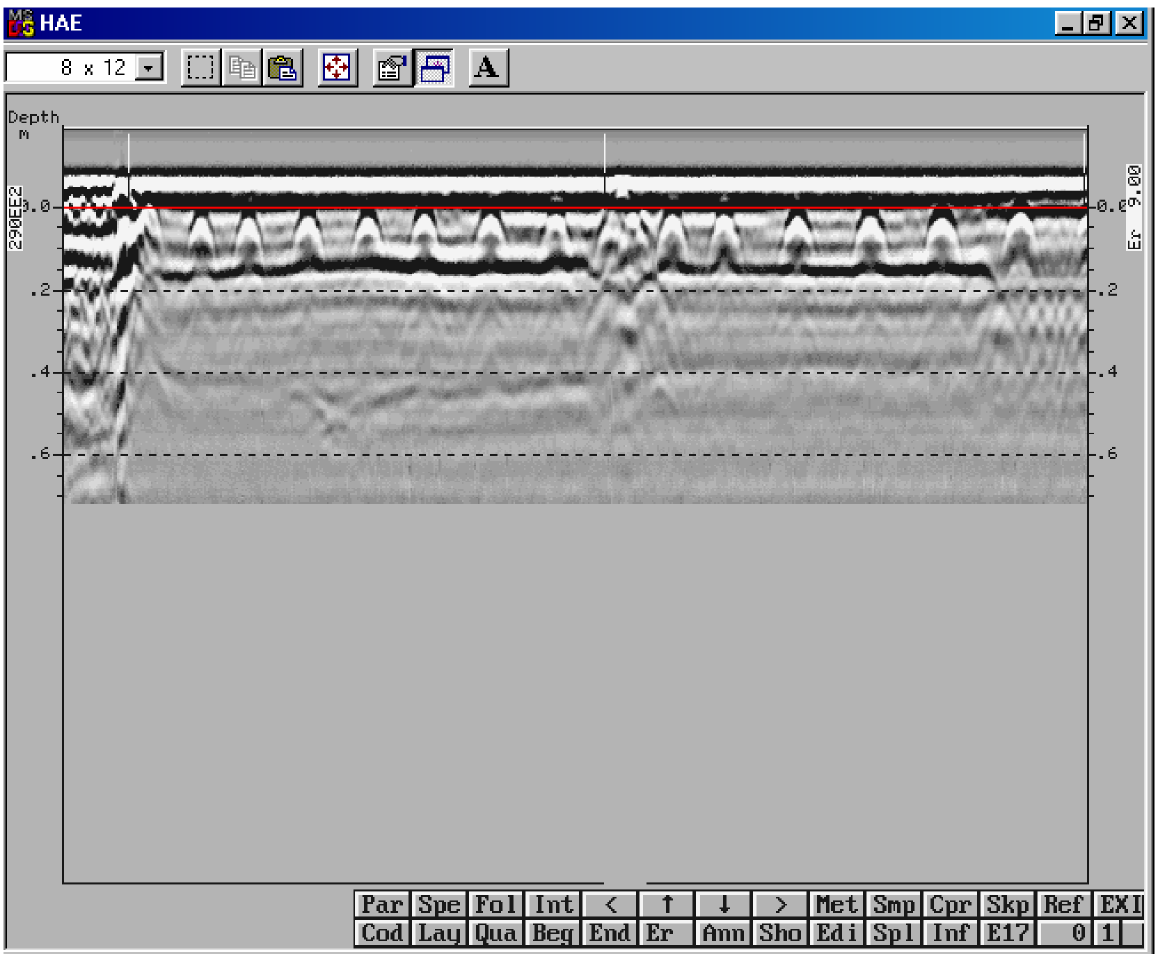
US290 East Bound

US290 EE1



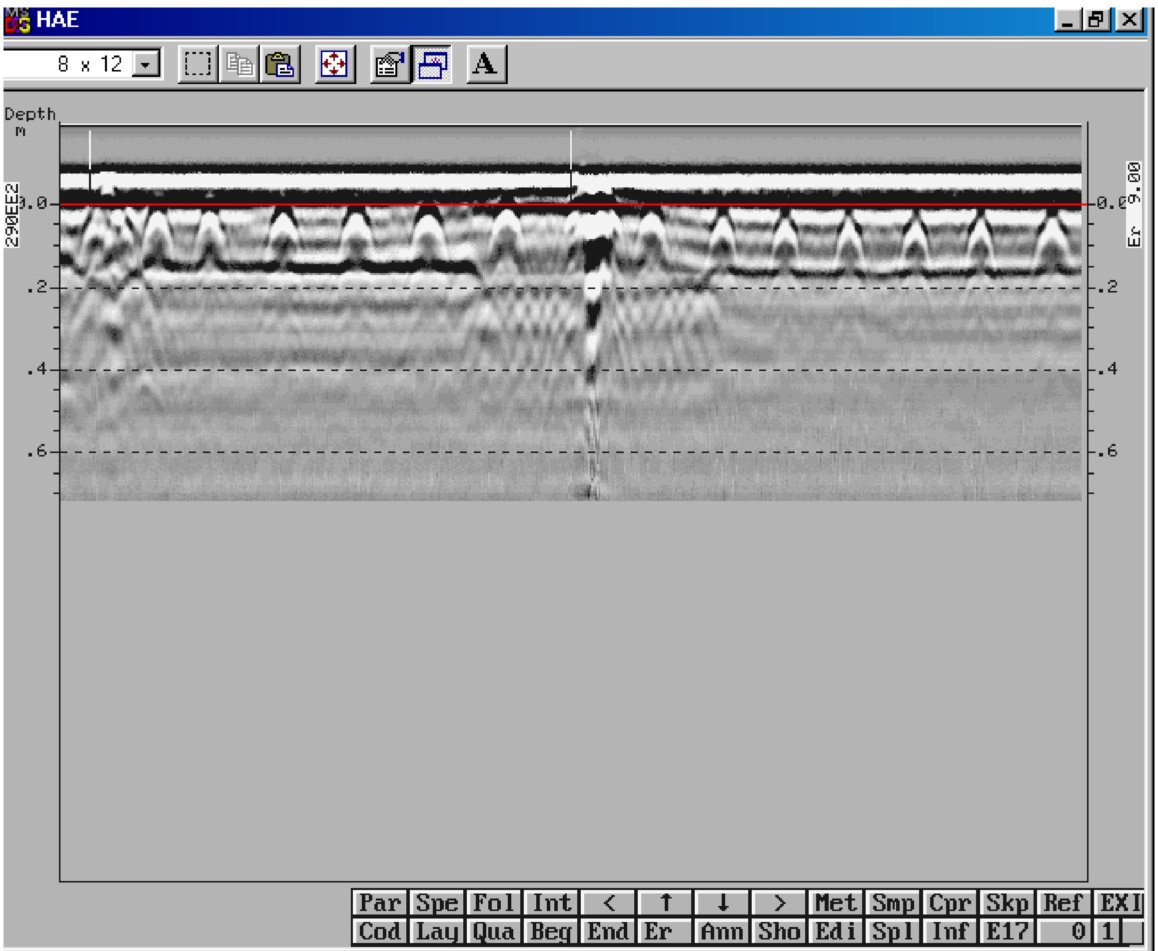
US290 East Bound

US290 EE2



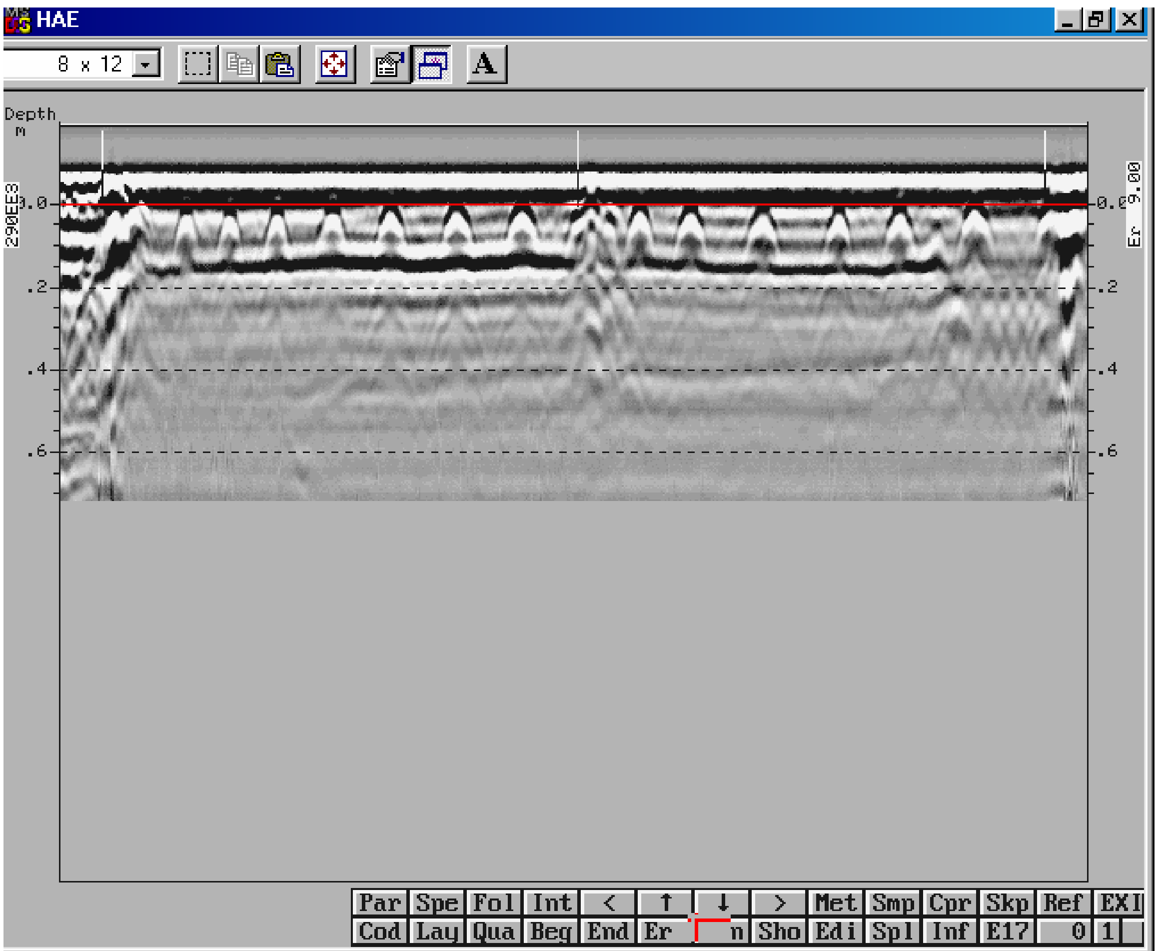
US290 East Bound

US290 EE2



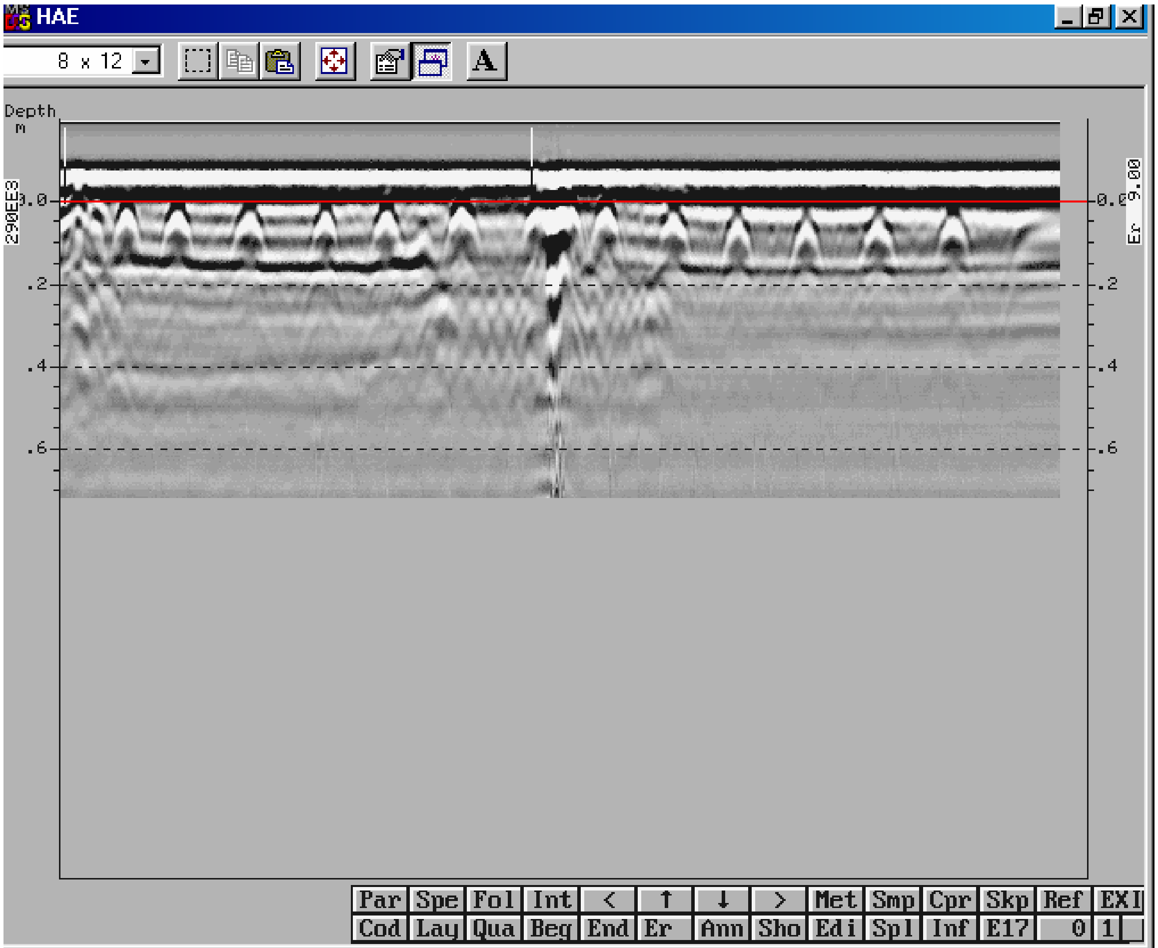
US290 East Bound

US290 EE3



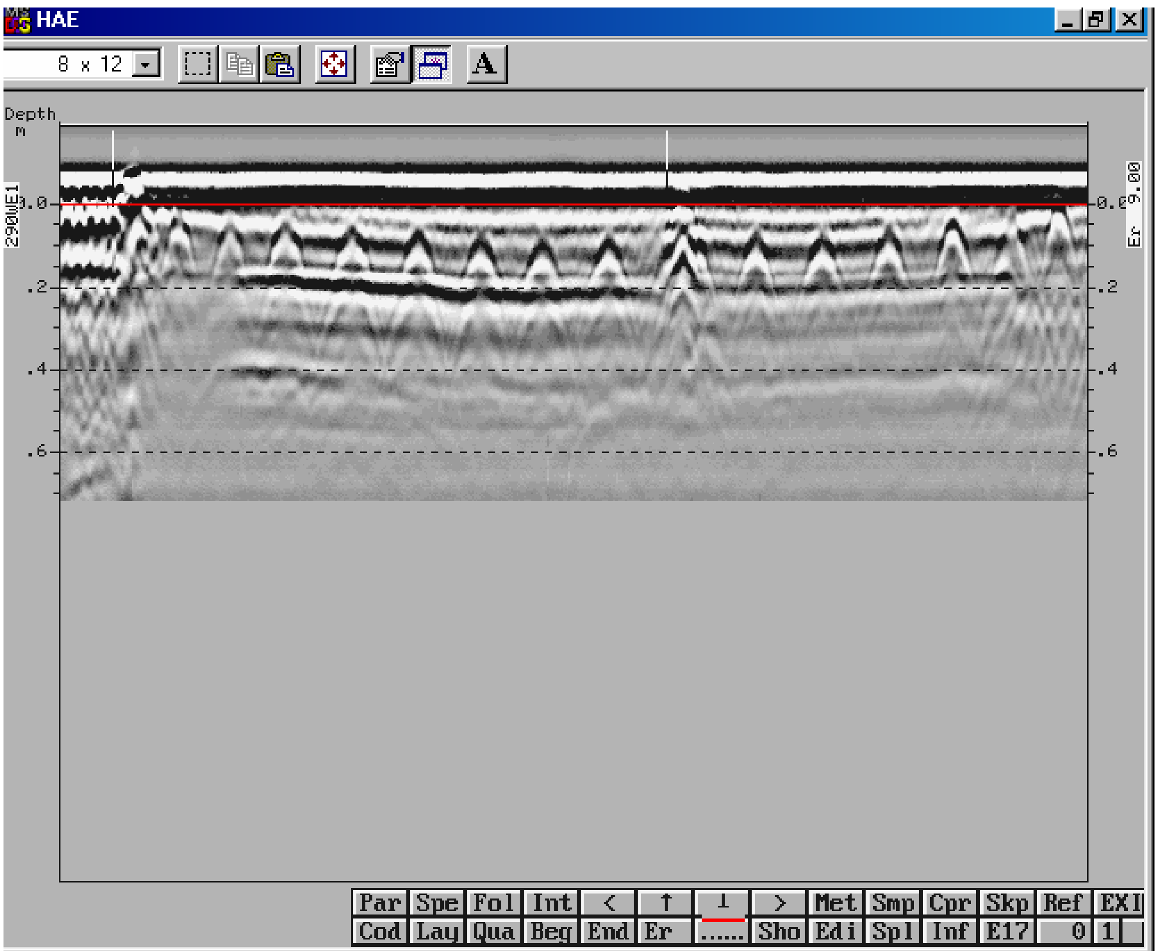
US290 East Bound

US290 EE3



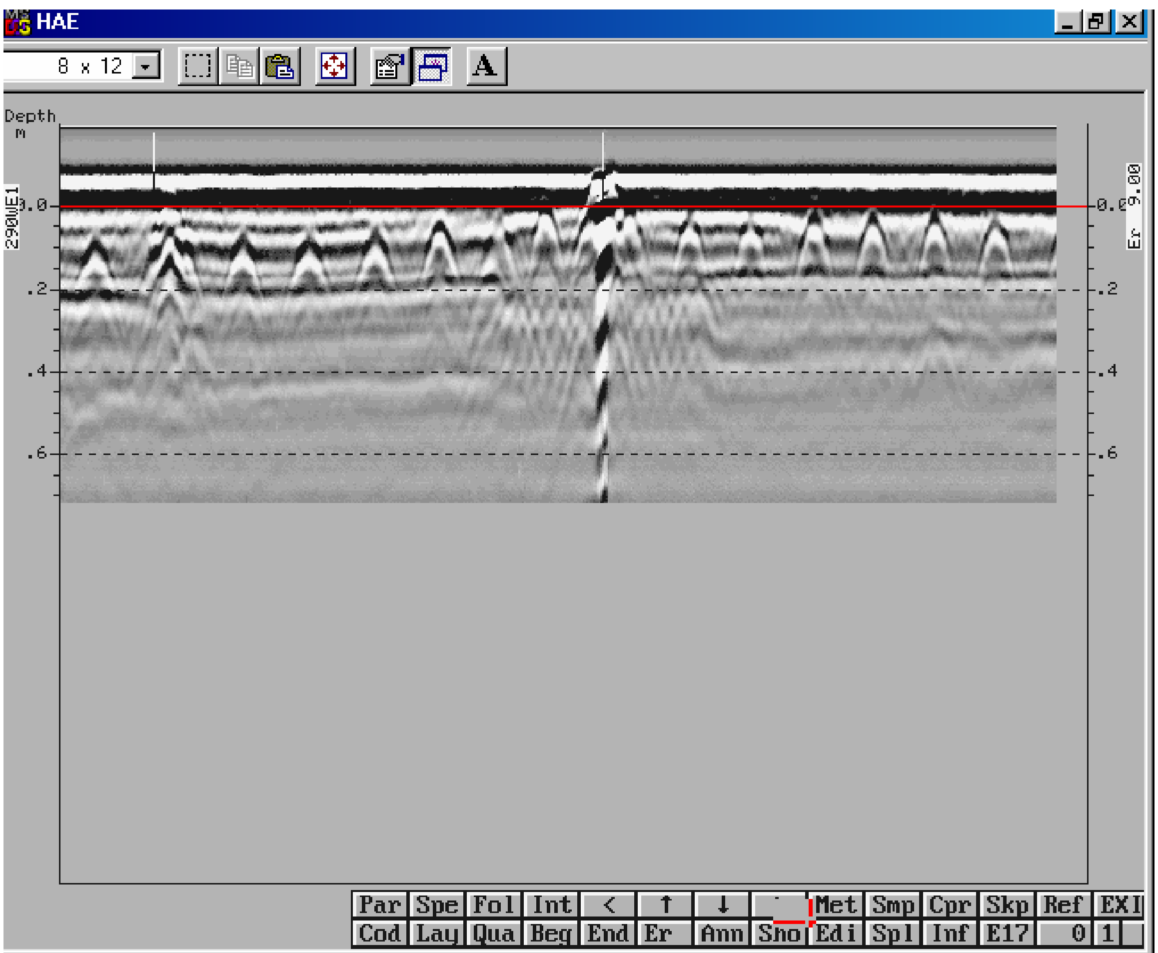
US290 East Bound

US290 WE1



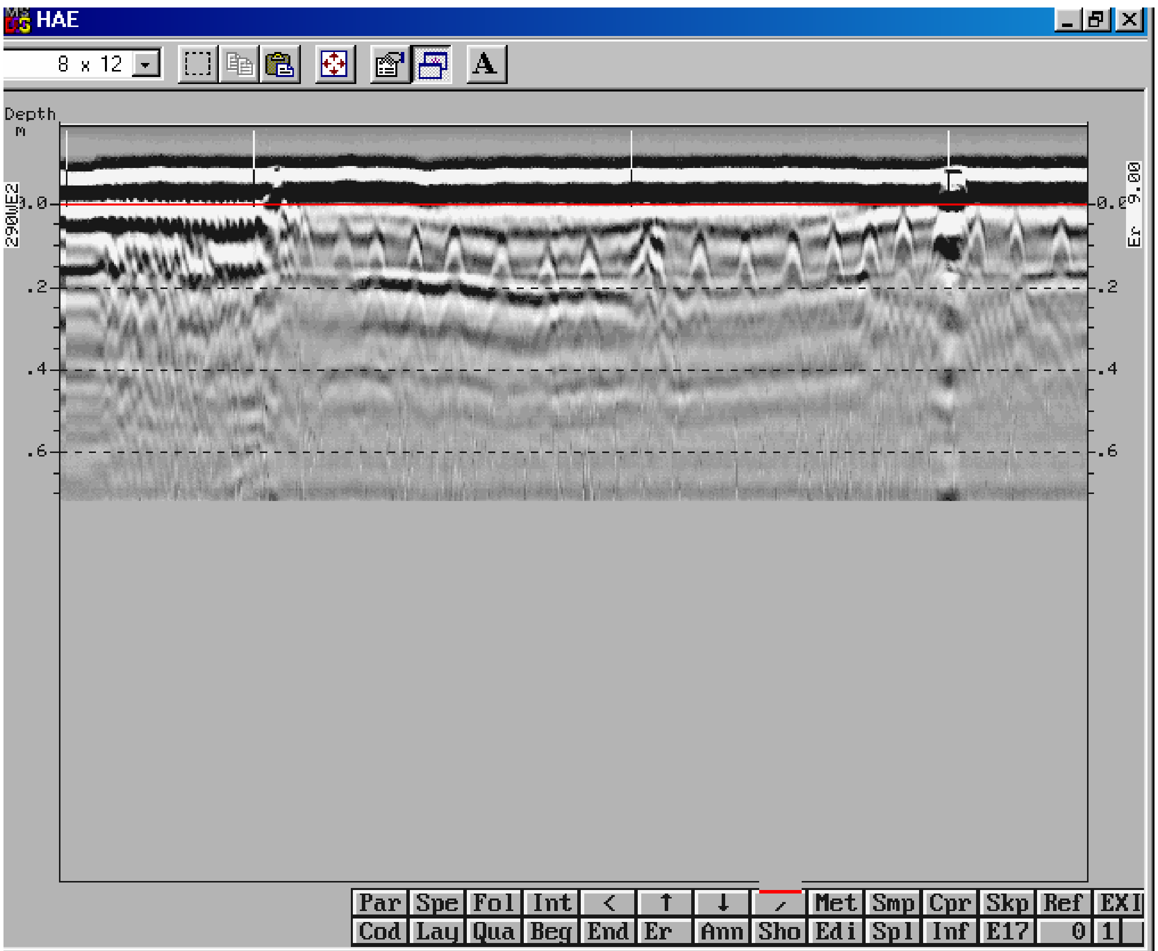
US290 East Bound

US290 WE1



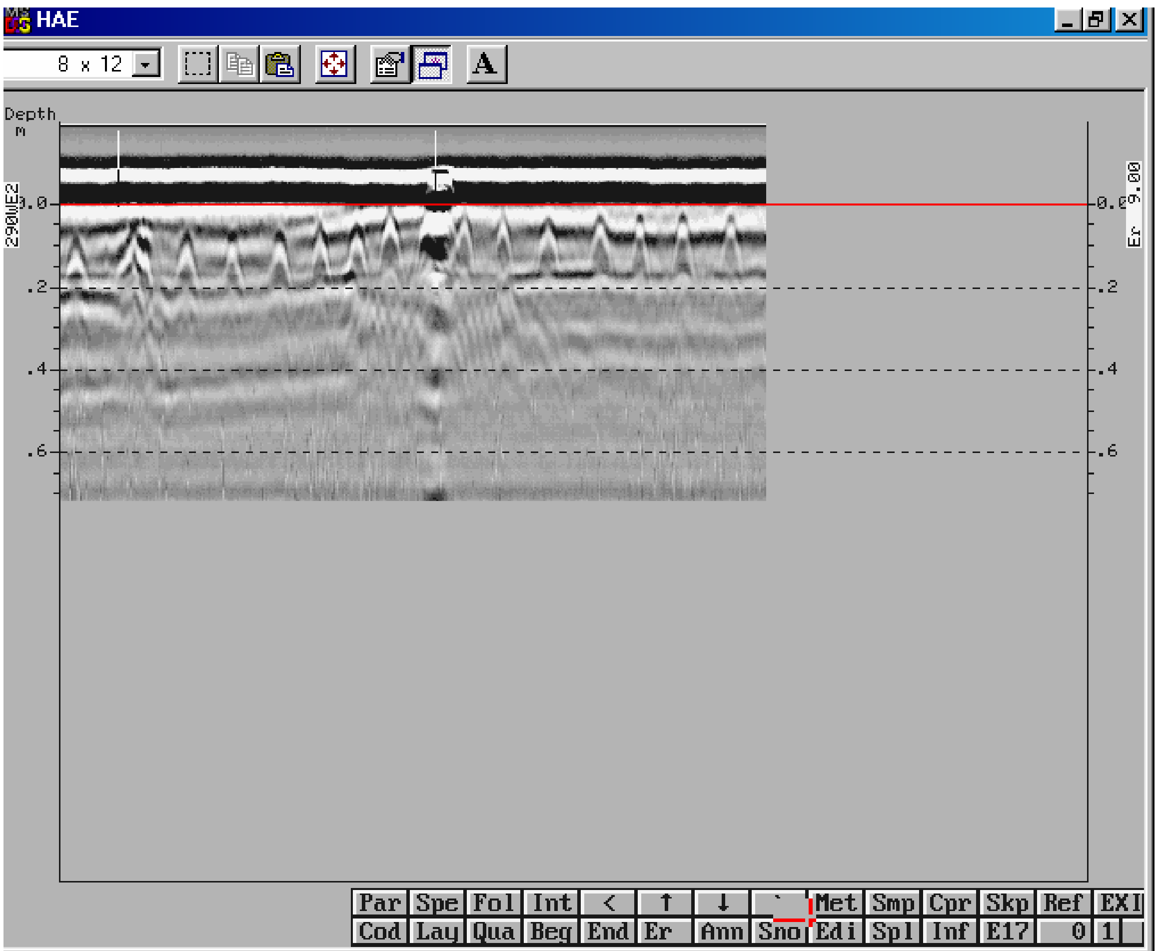
US290 East Bound

US290 WE2



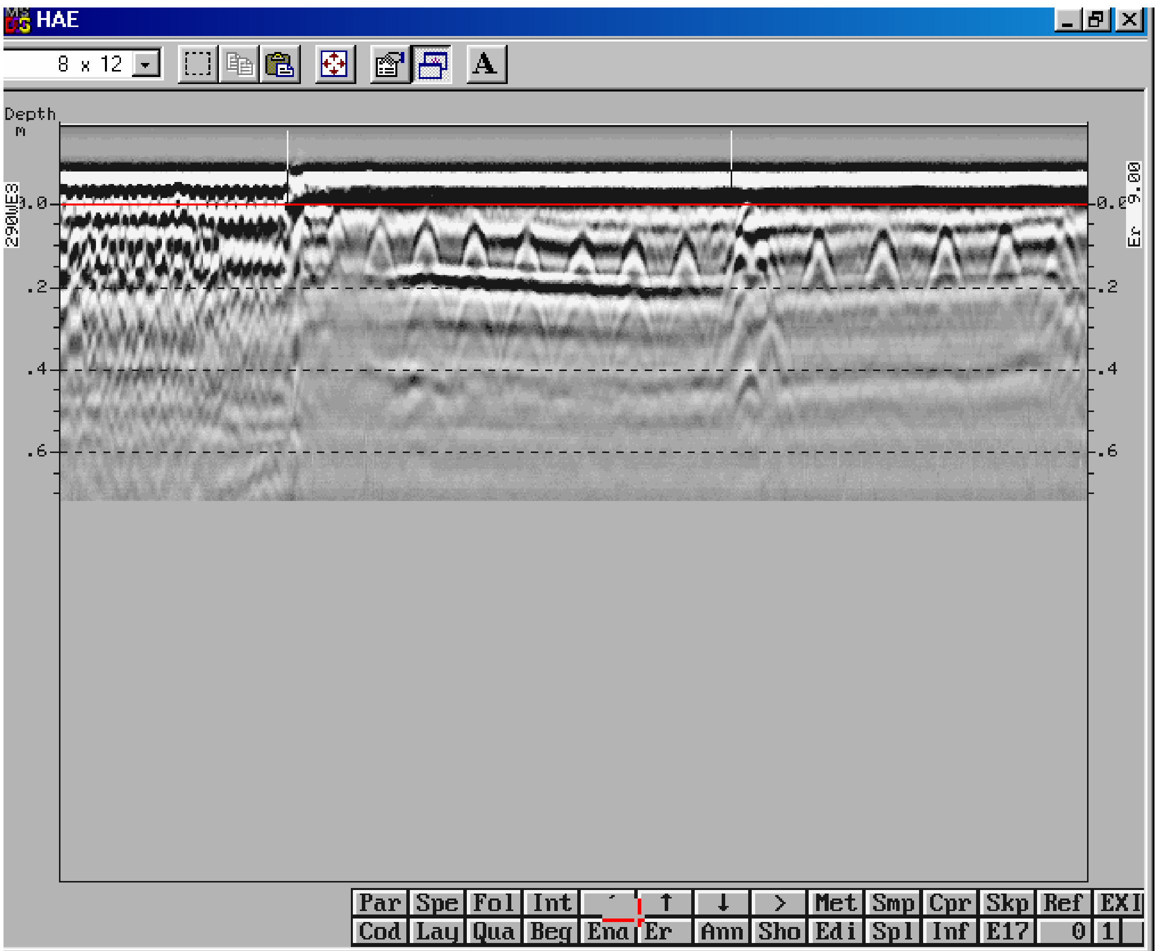
US290 East Bound

US290 WE2



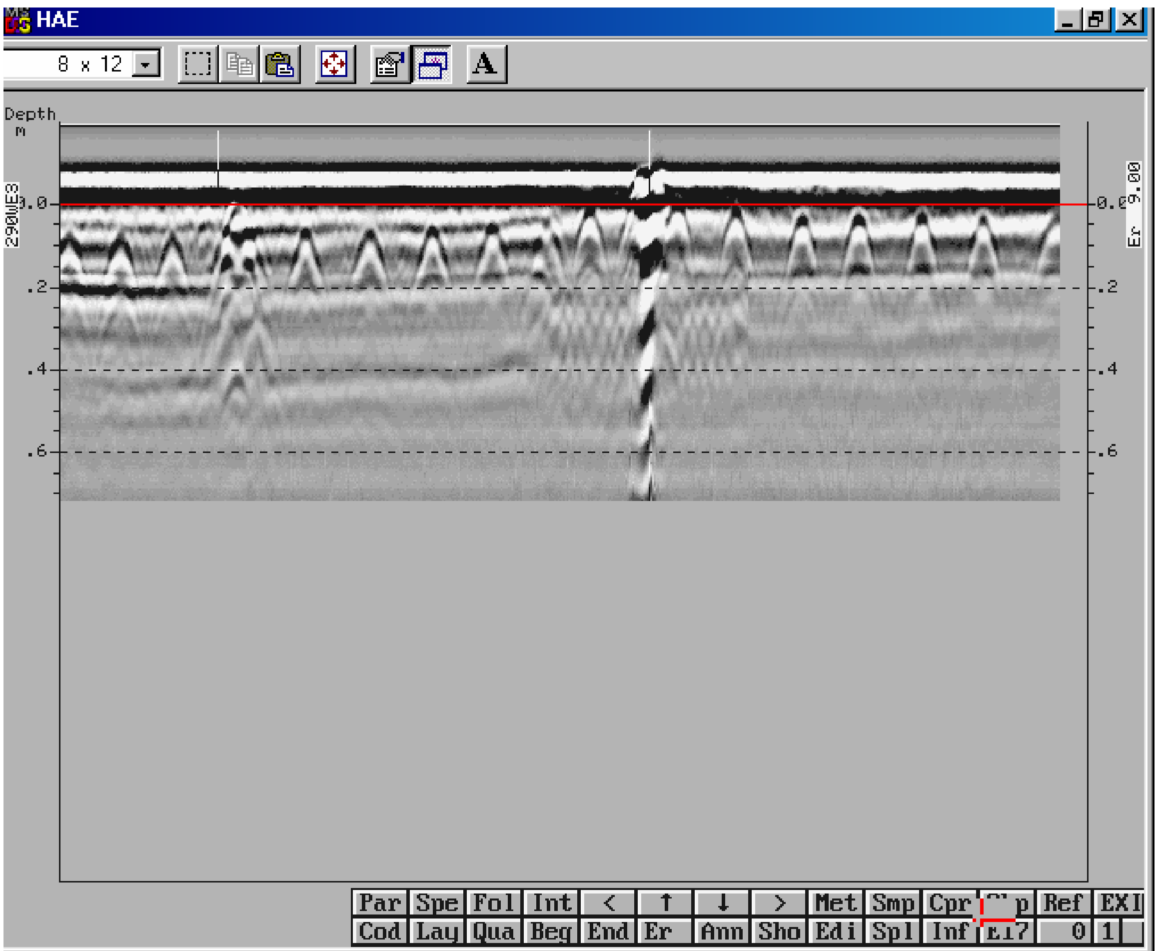
US290 East Bound

US290 WE3



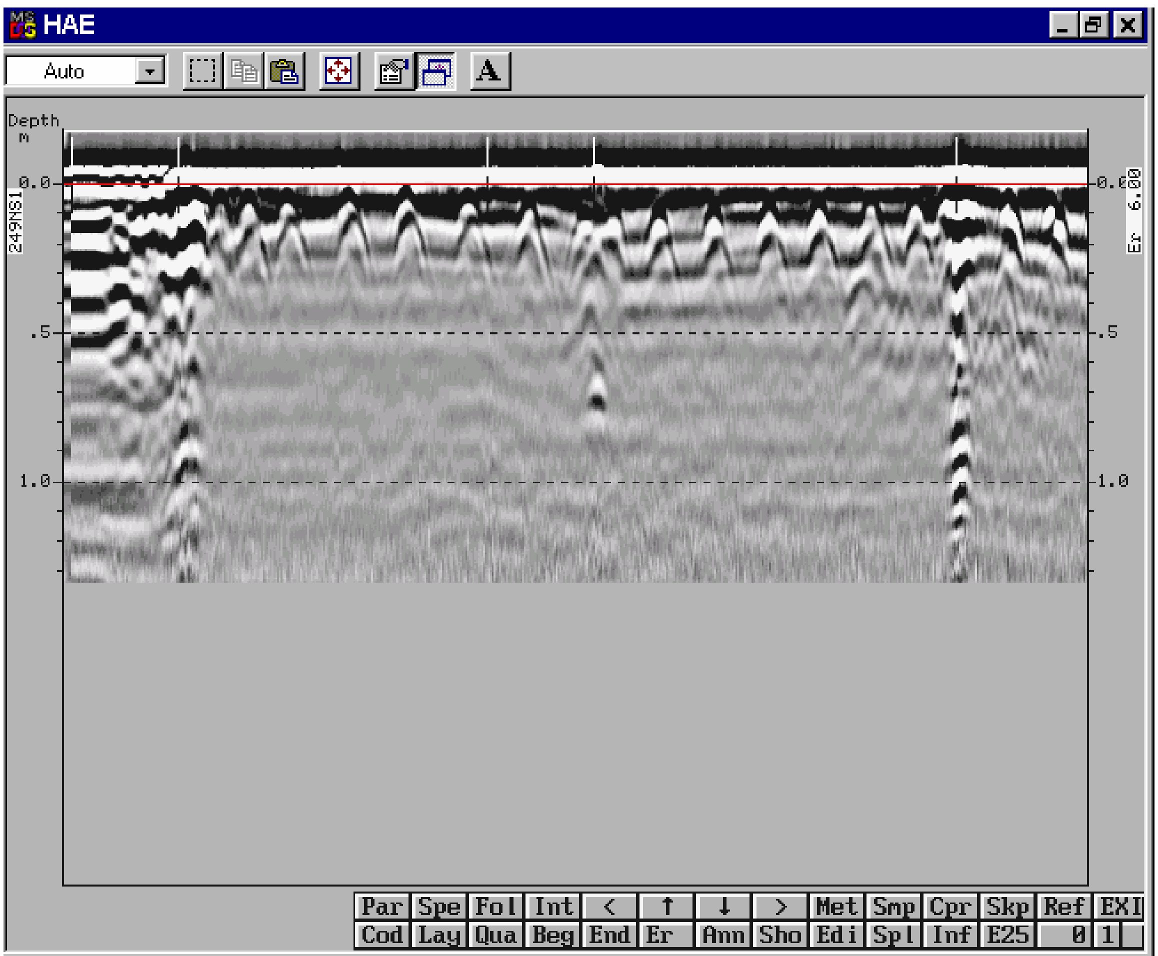
US290 East Bound

US290 WE3



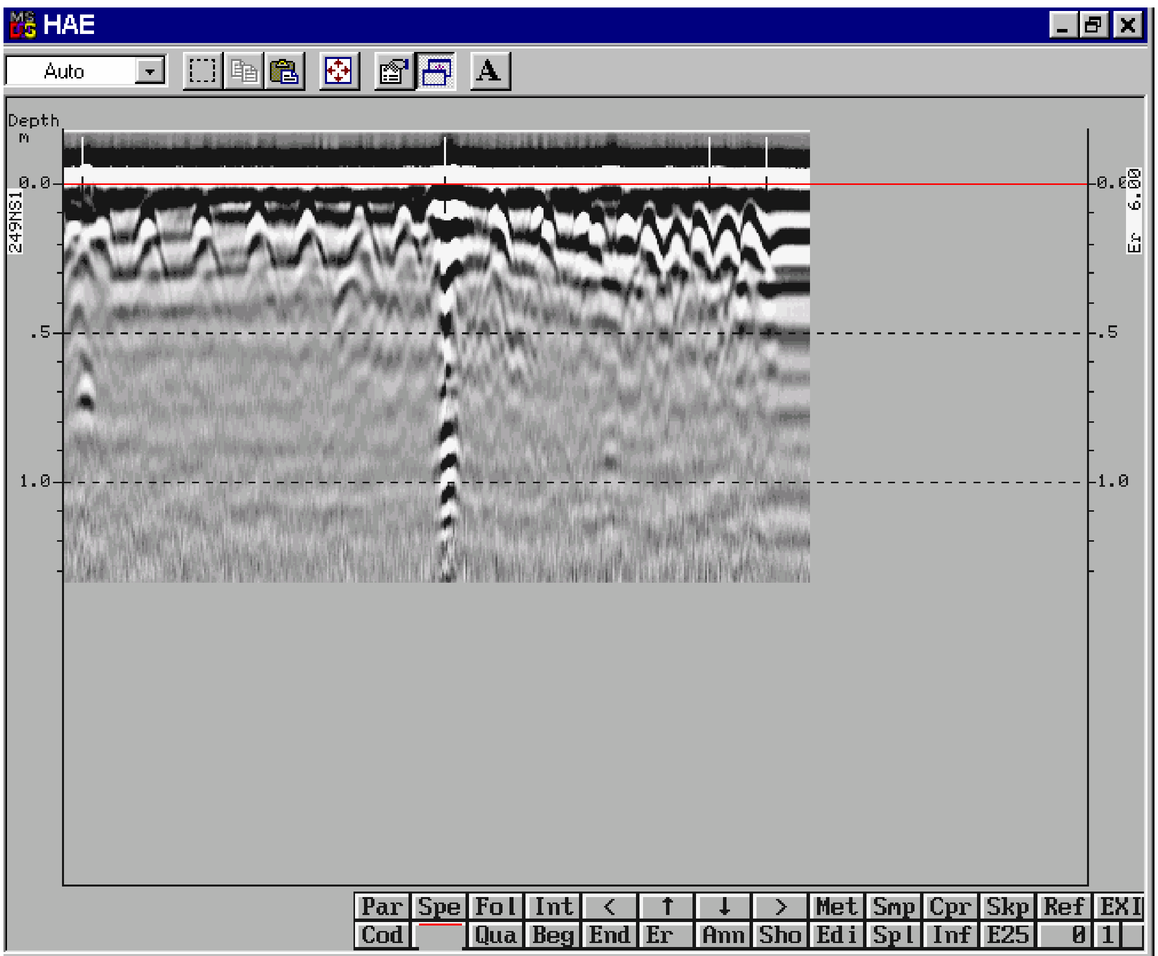
SH249 South Bound

SH249NS1



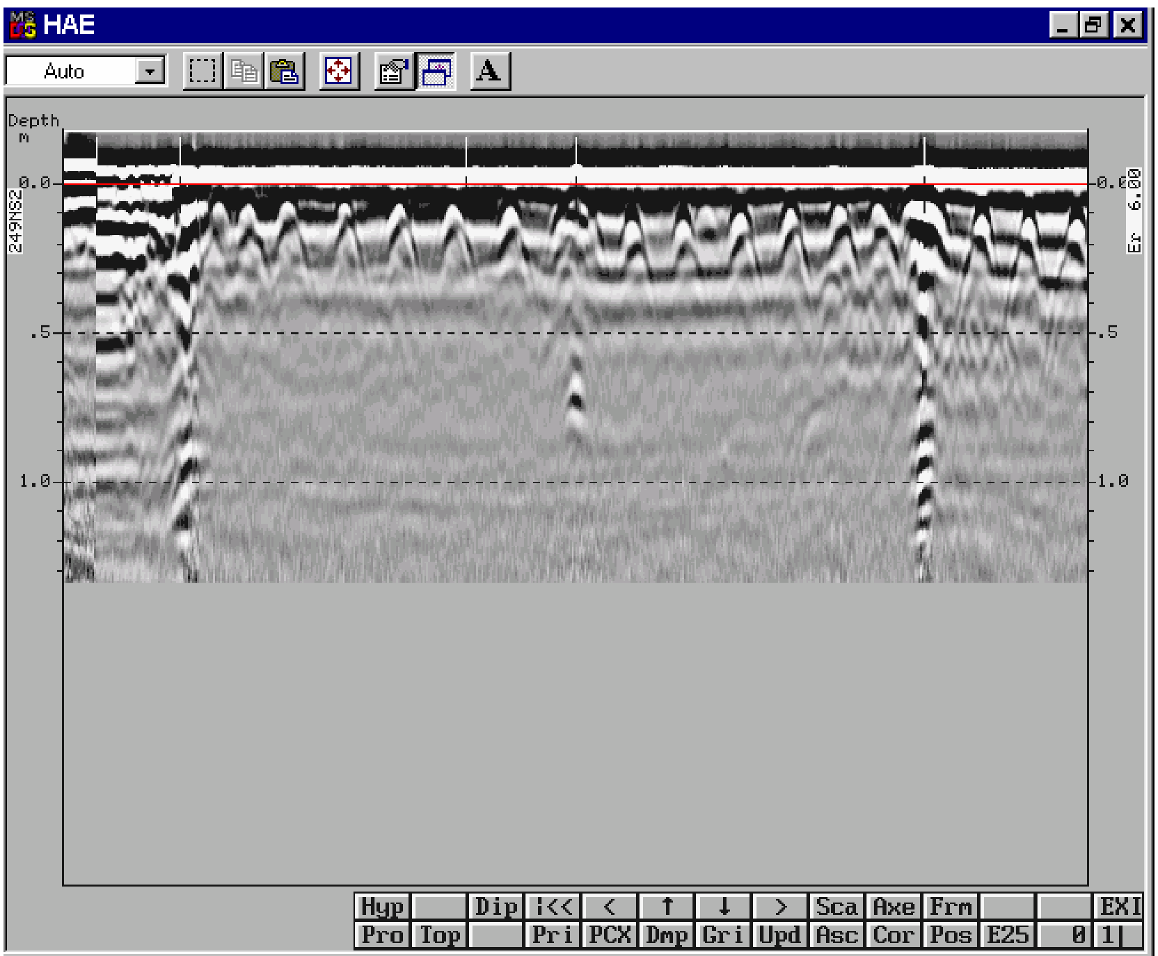
SH249 South Bound

SH249NS1



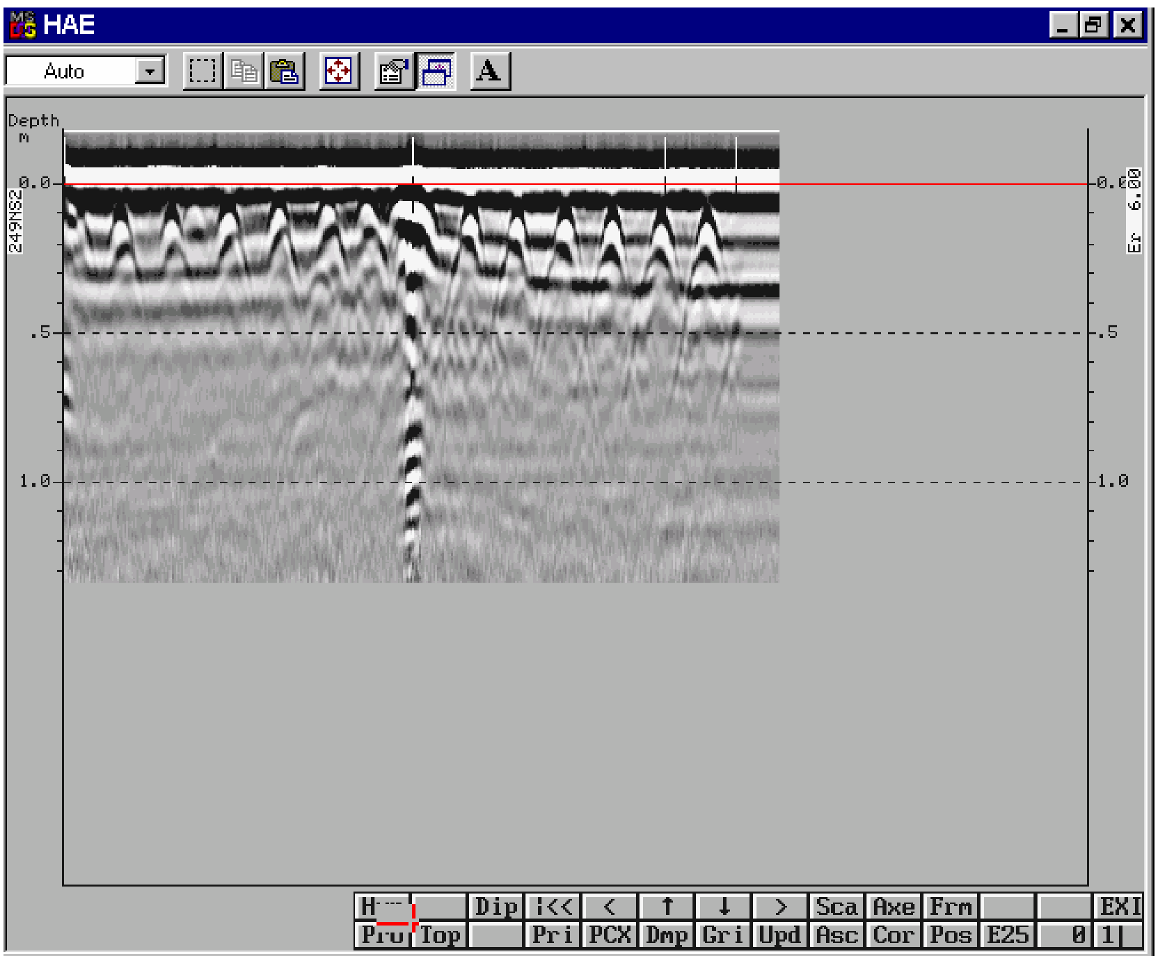
SH249 South Bound

SH249NS2



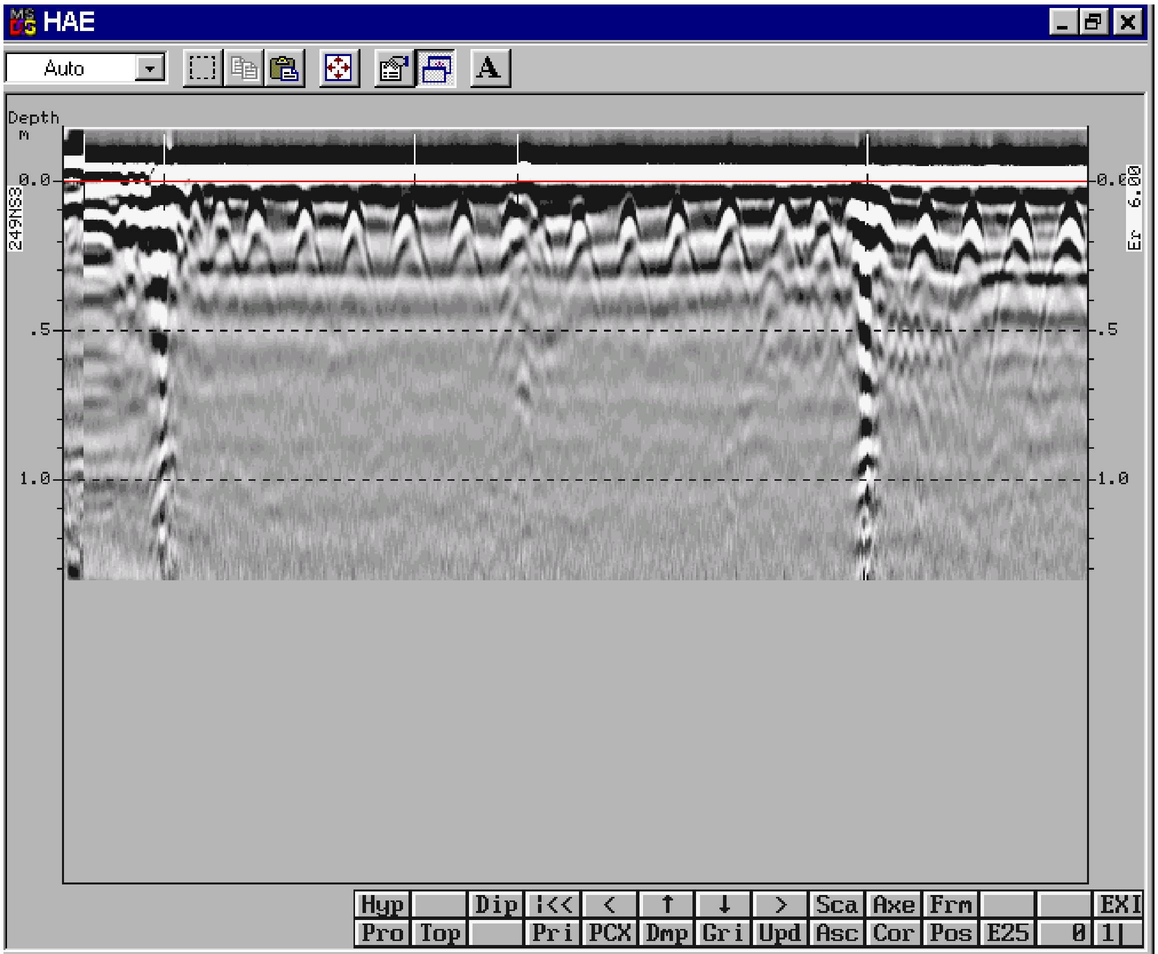
SH249 South Bound

SH249NS2



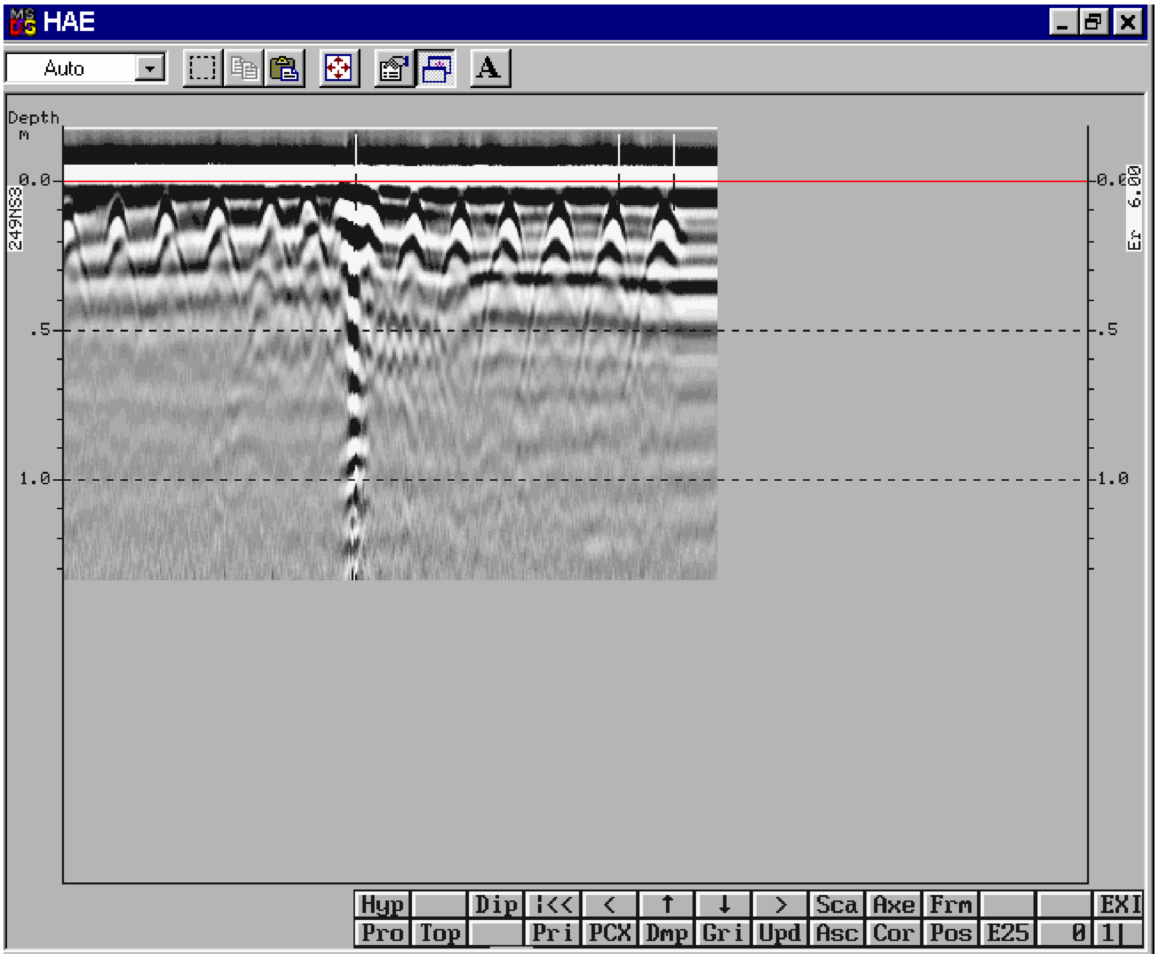
SH249 South Bound

SH249NS3



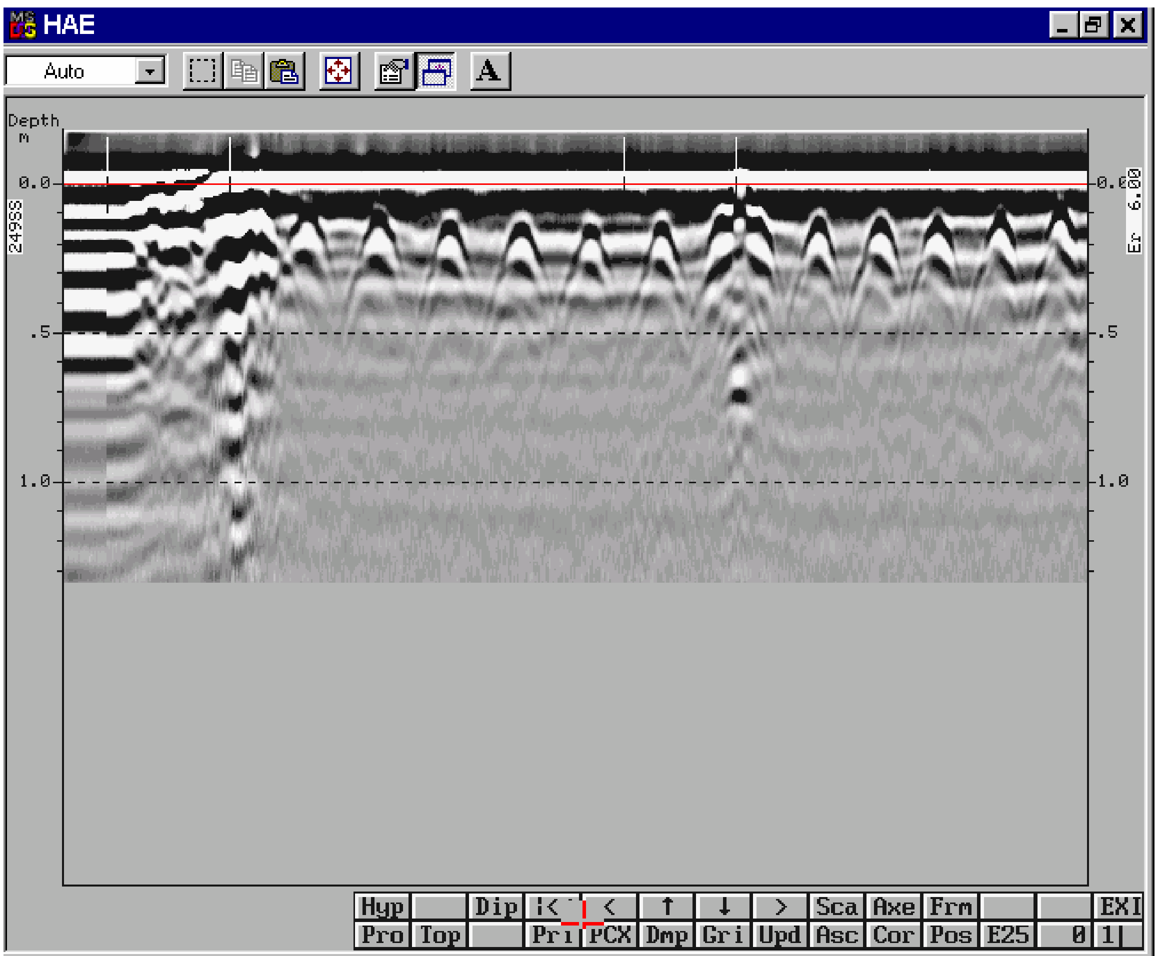
SH249 South Bound

SH249NS3



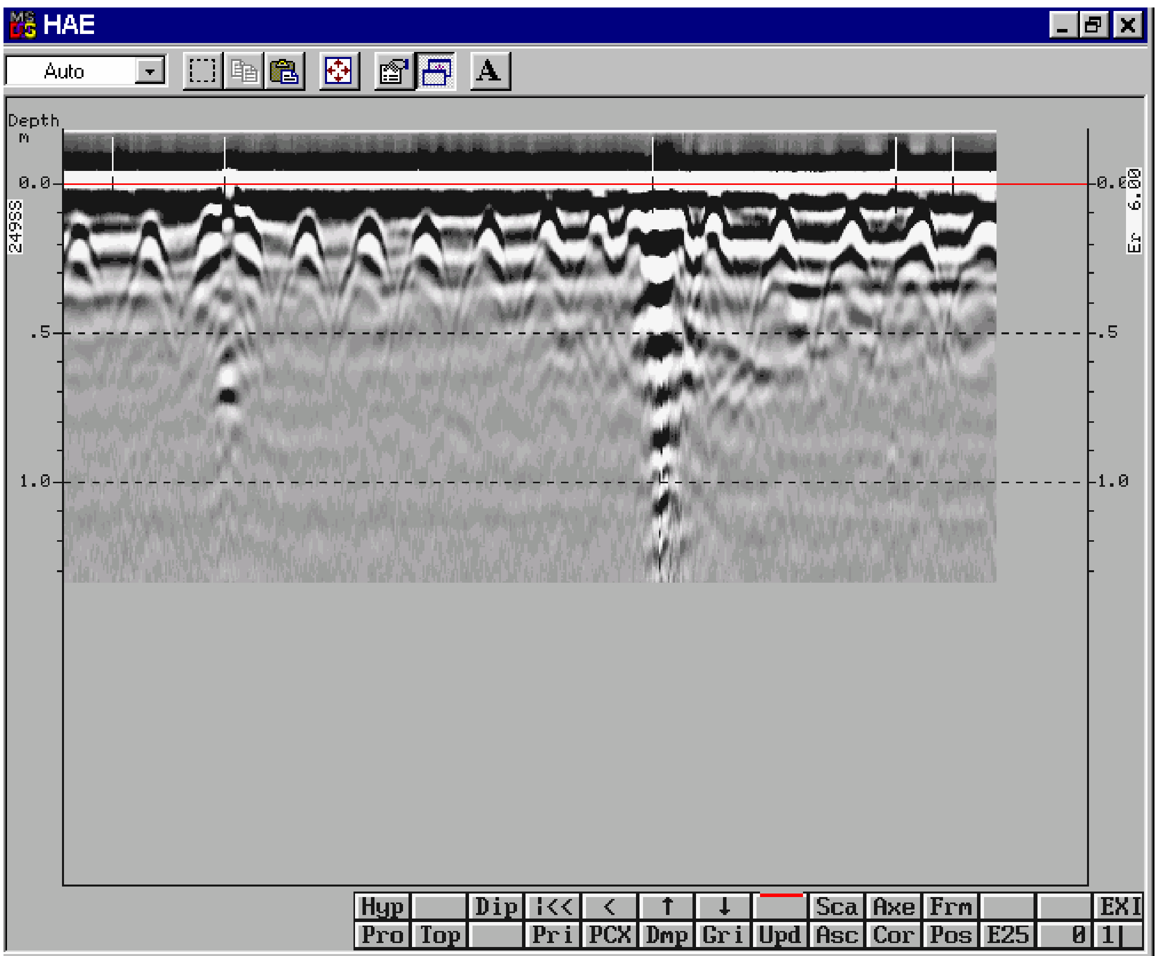
SH249 South Bound

SH249SS1



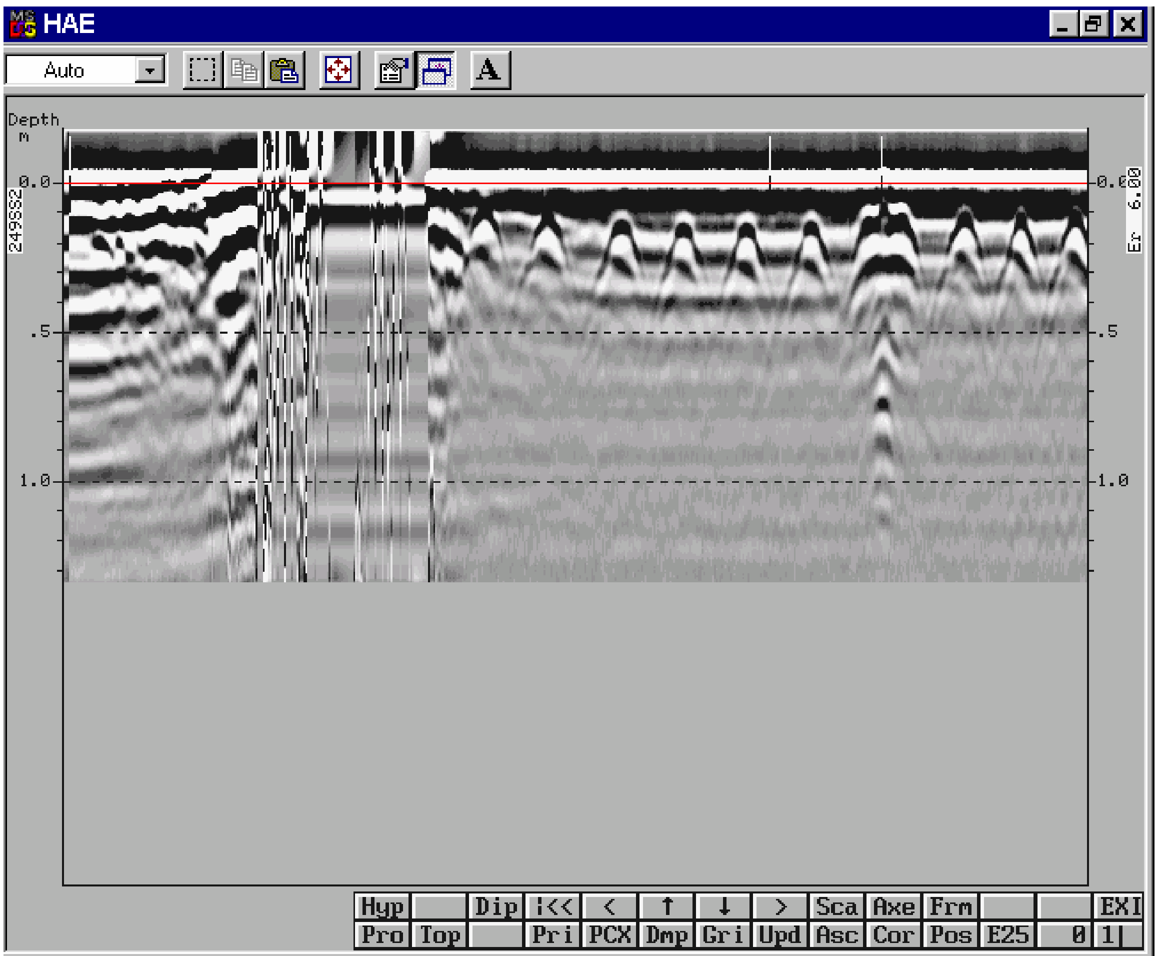
SH249 South Bound

SH249SS1



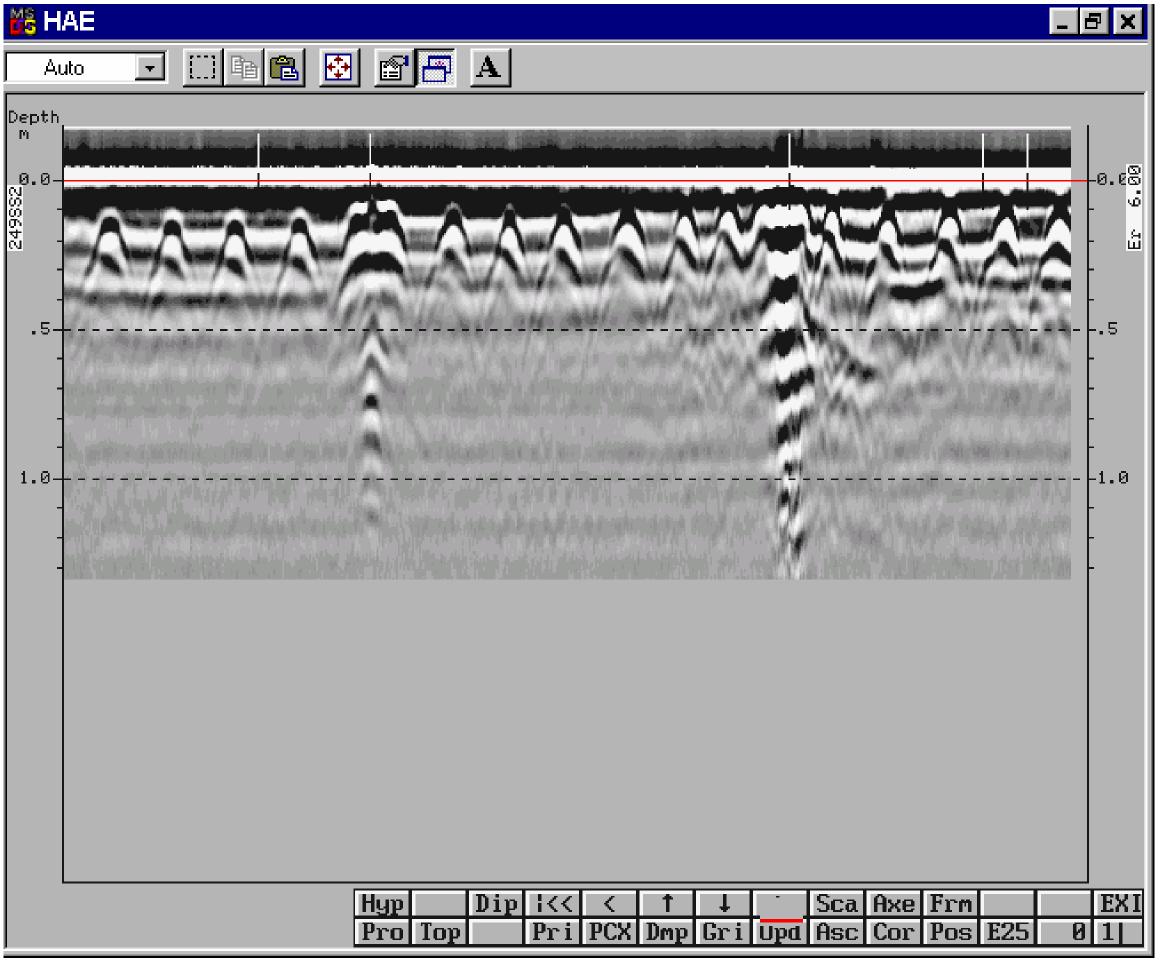
SH249 South Bound

SH249SS2



SH249 South Bound

SH249SS2



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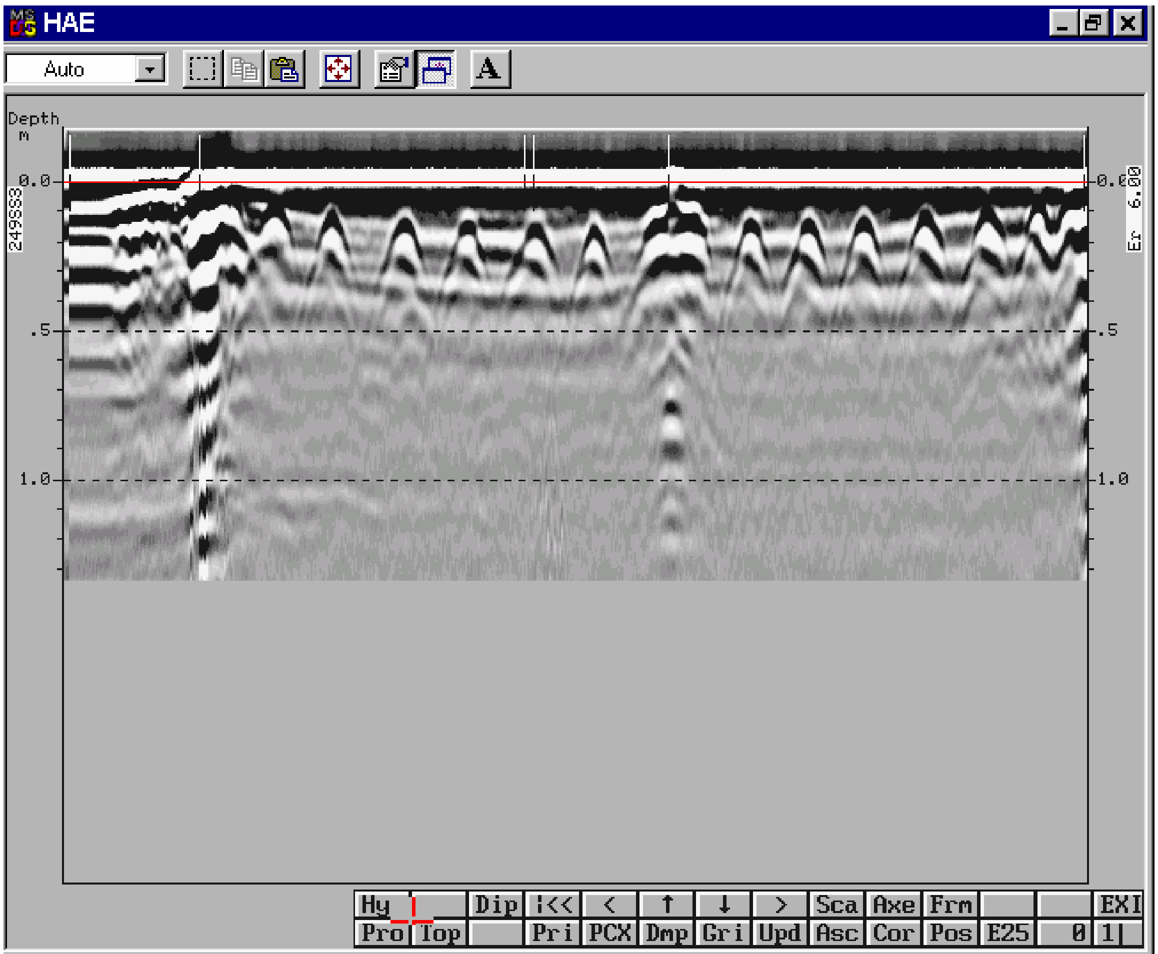

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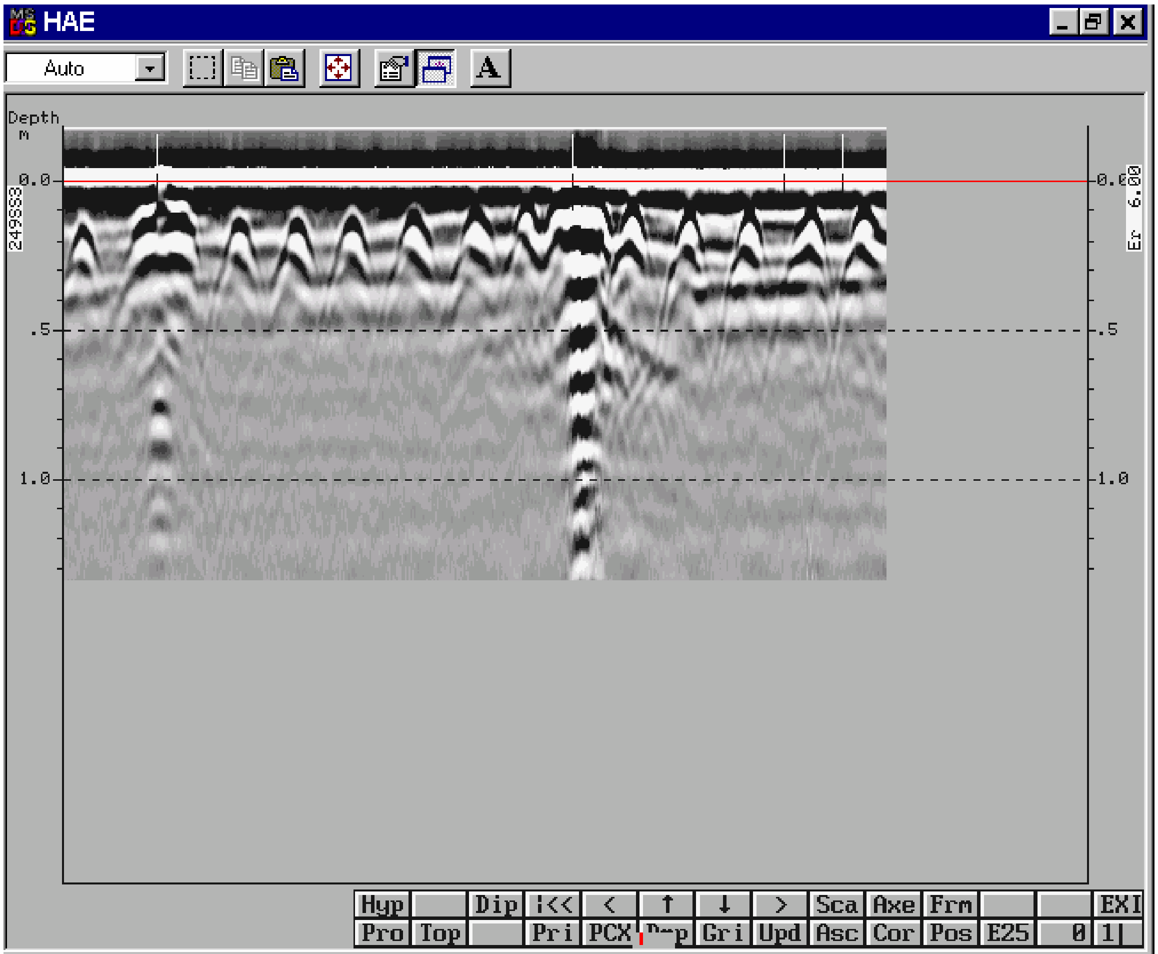
SH249SS3



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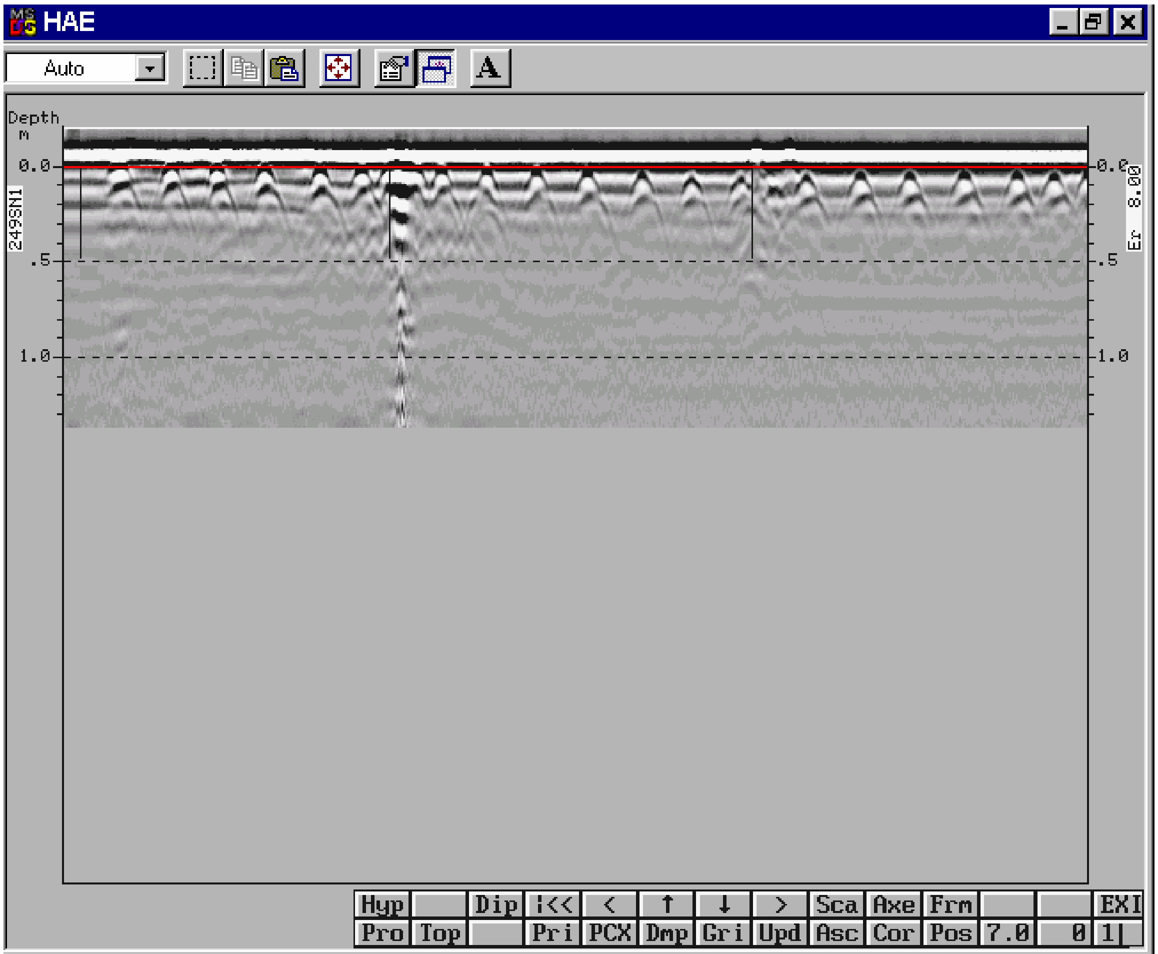
SH249SN1



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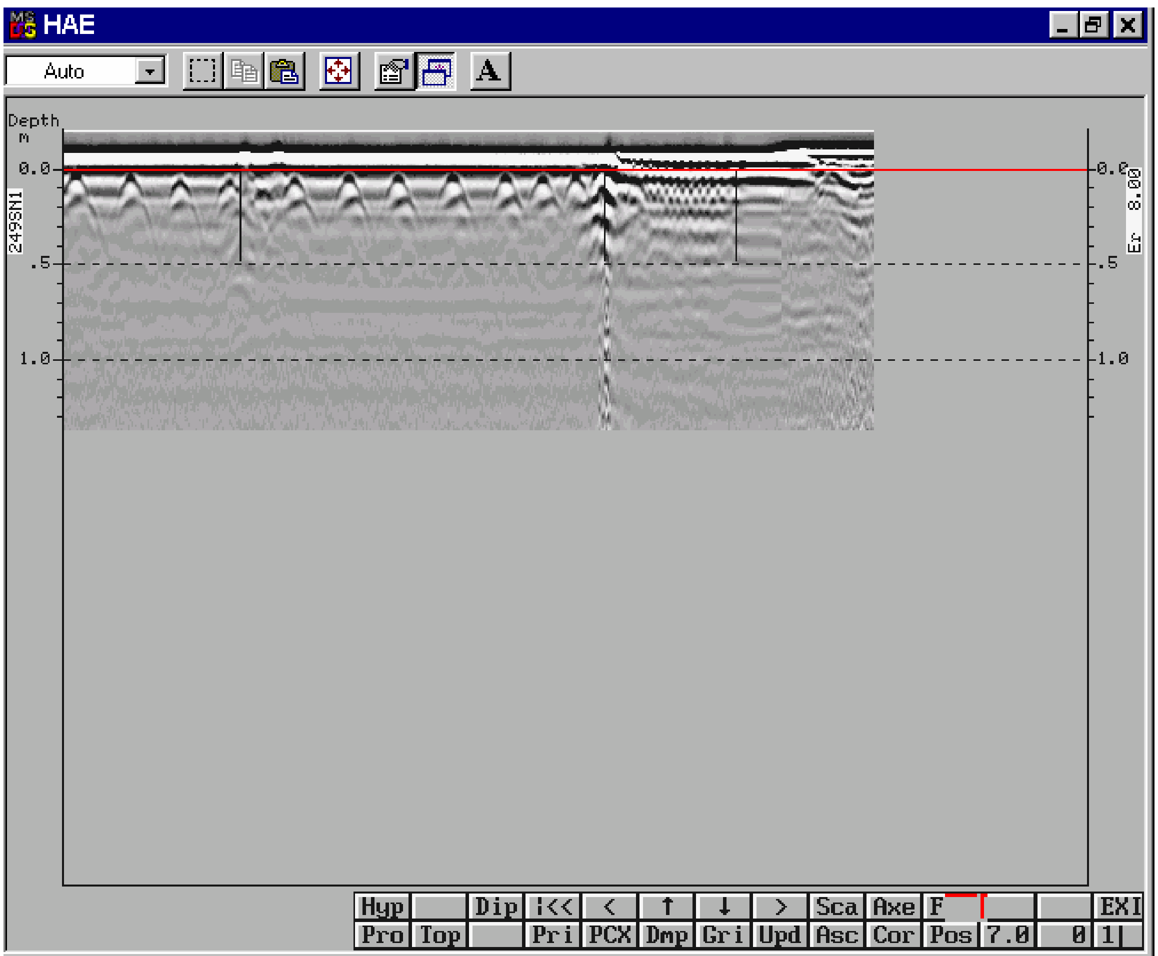
SH249SN1



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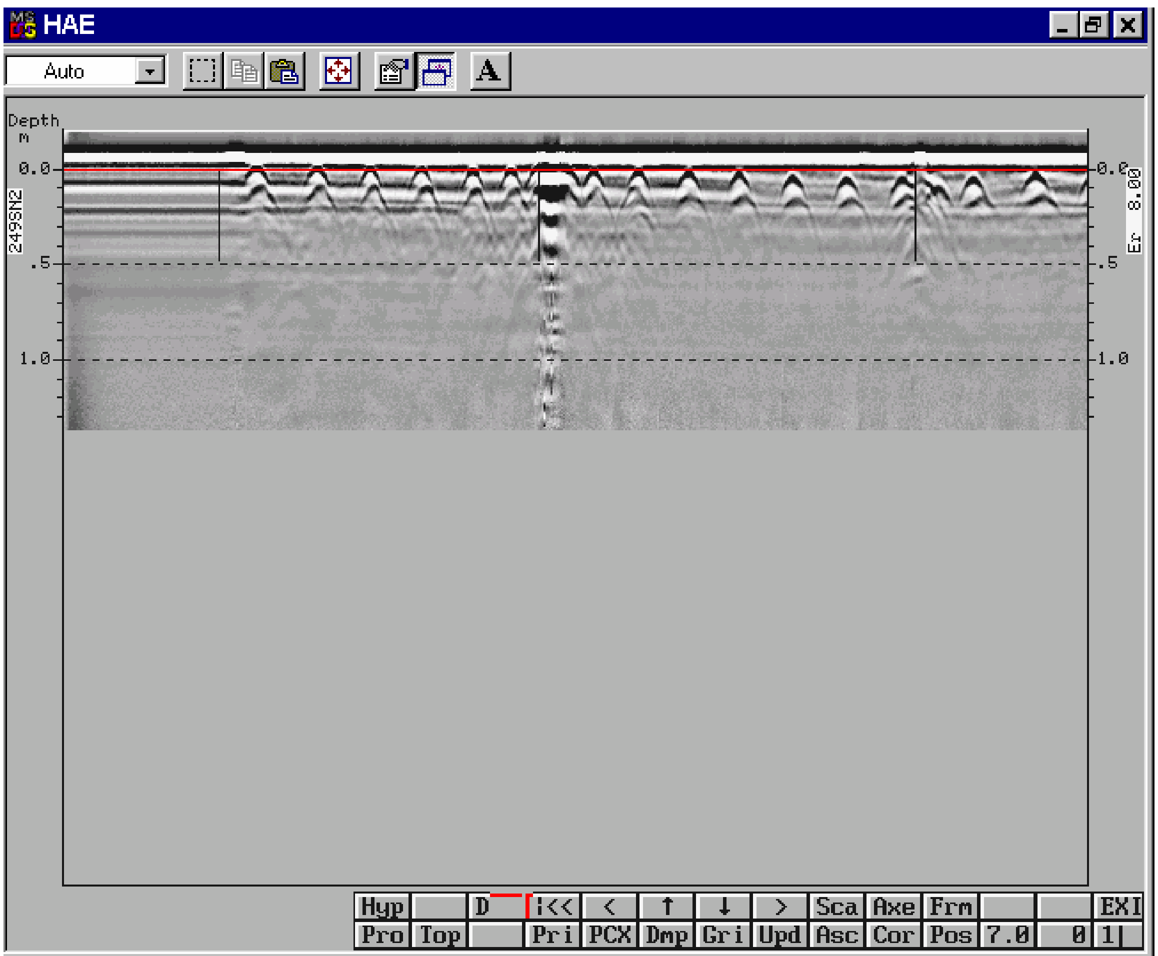
SH249SN2



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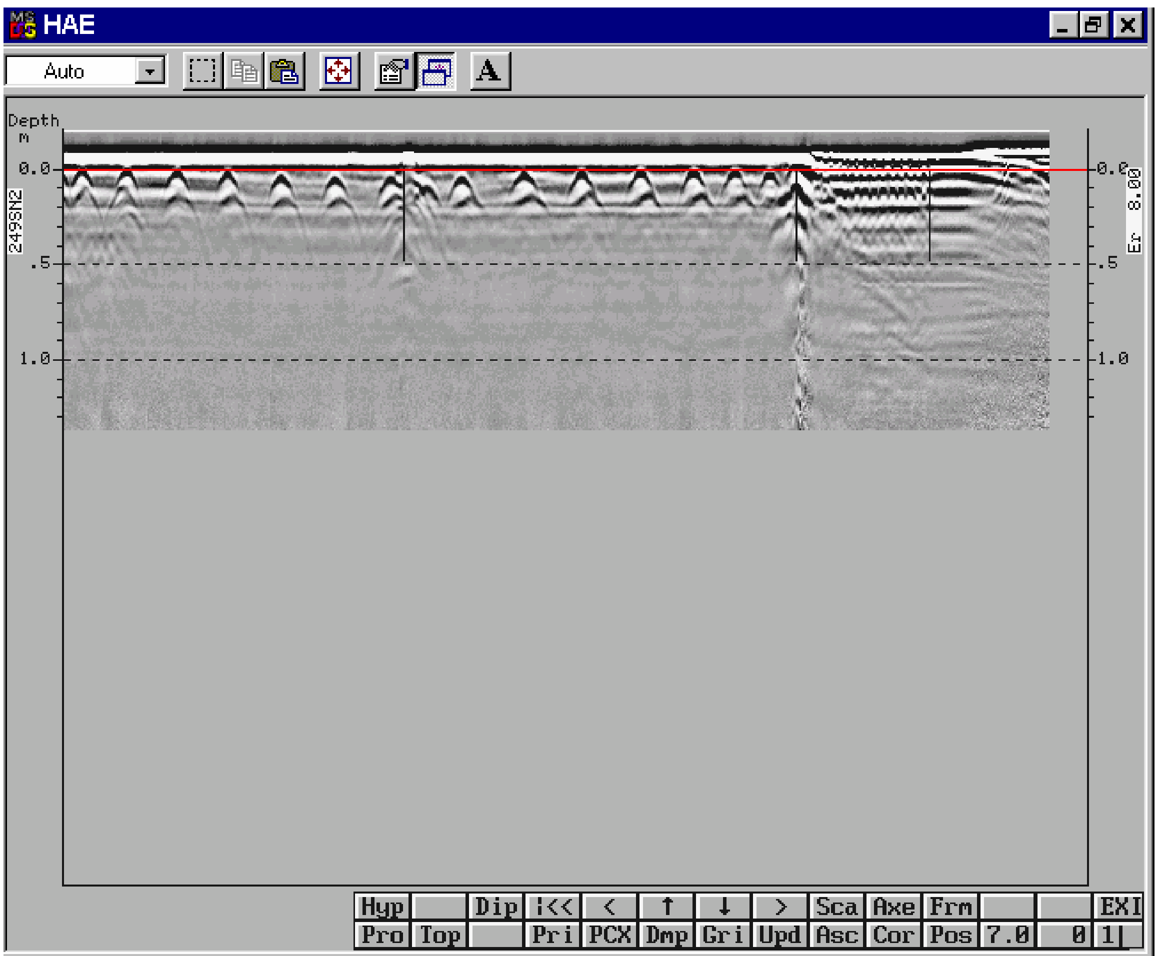

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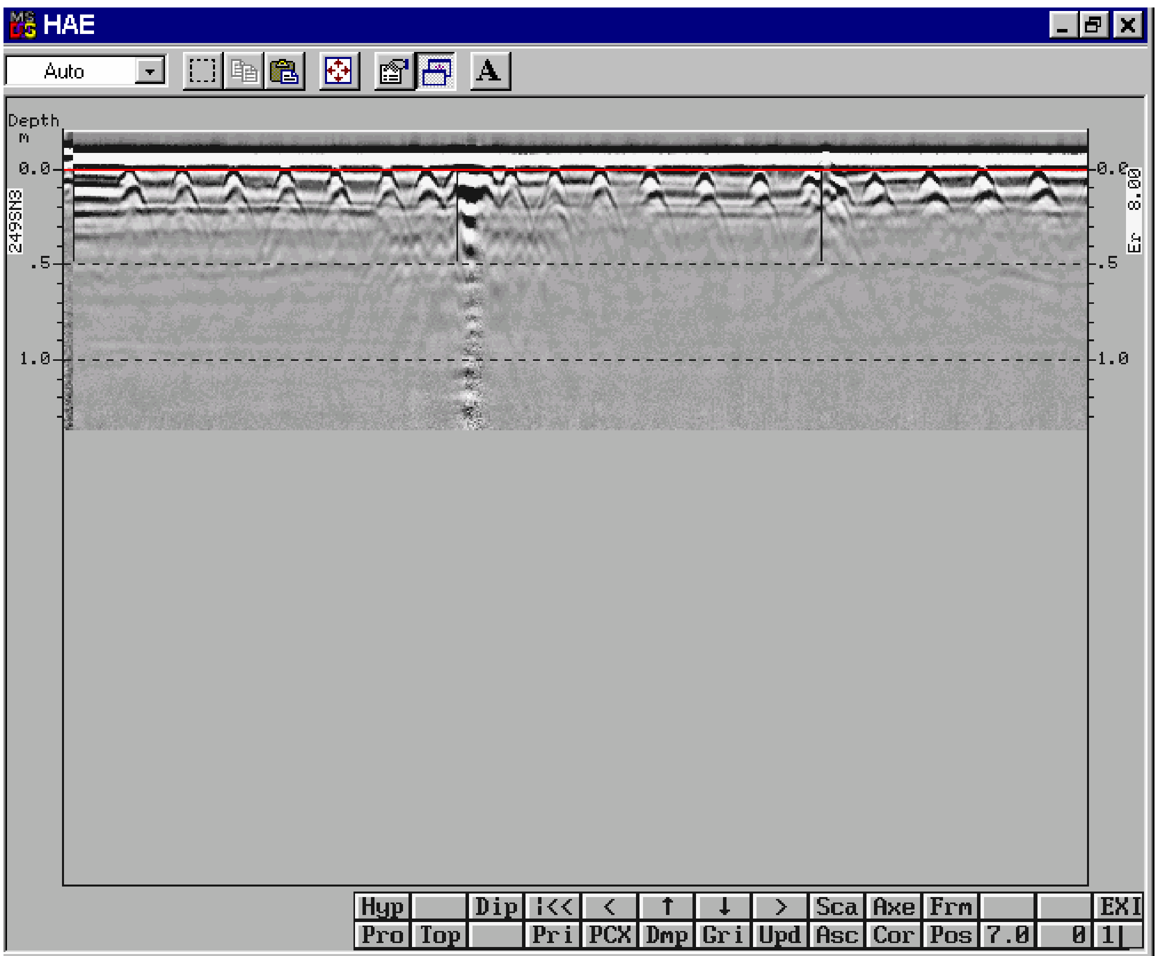
SH249SN3



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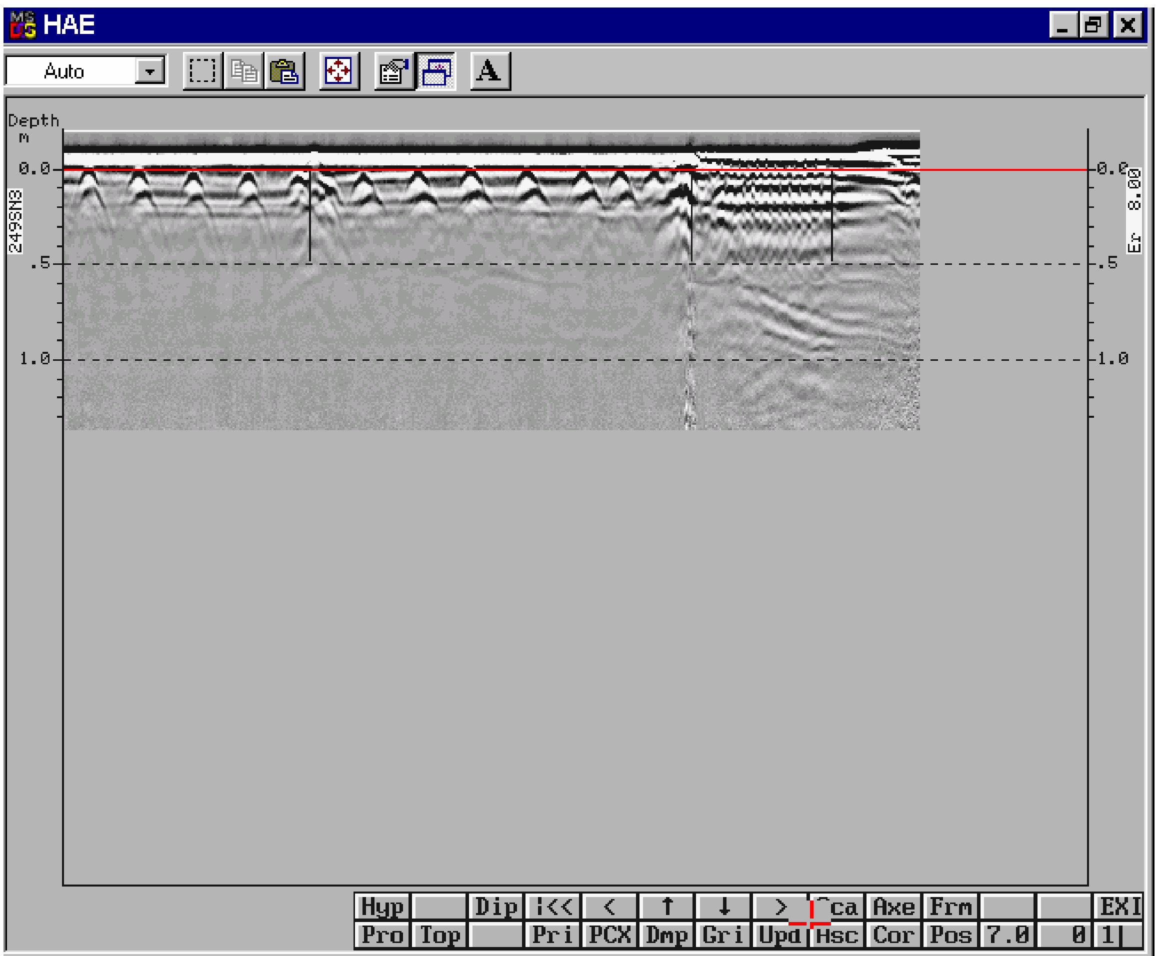
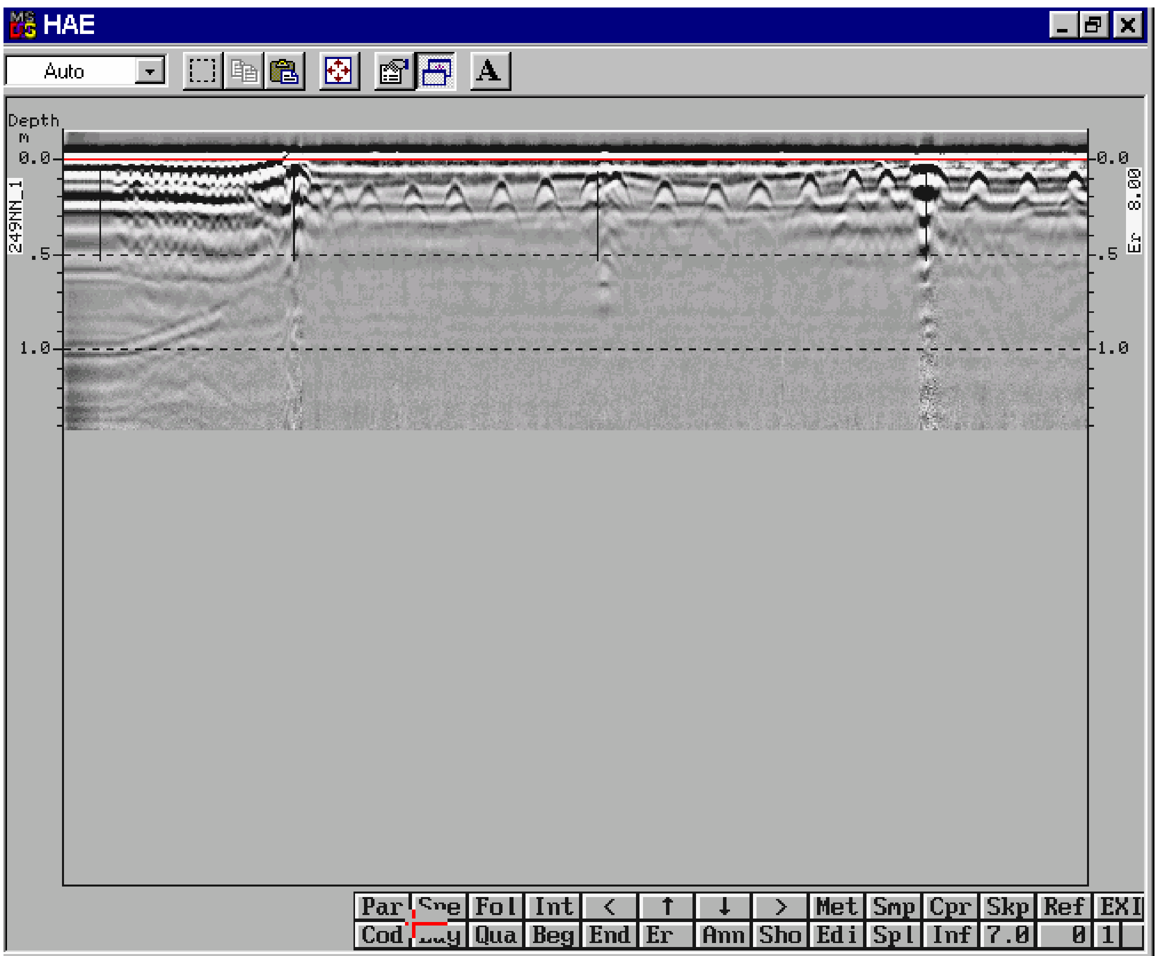
SH249SN3



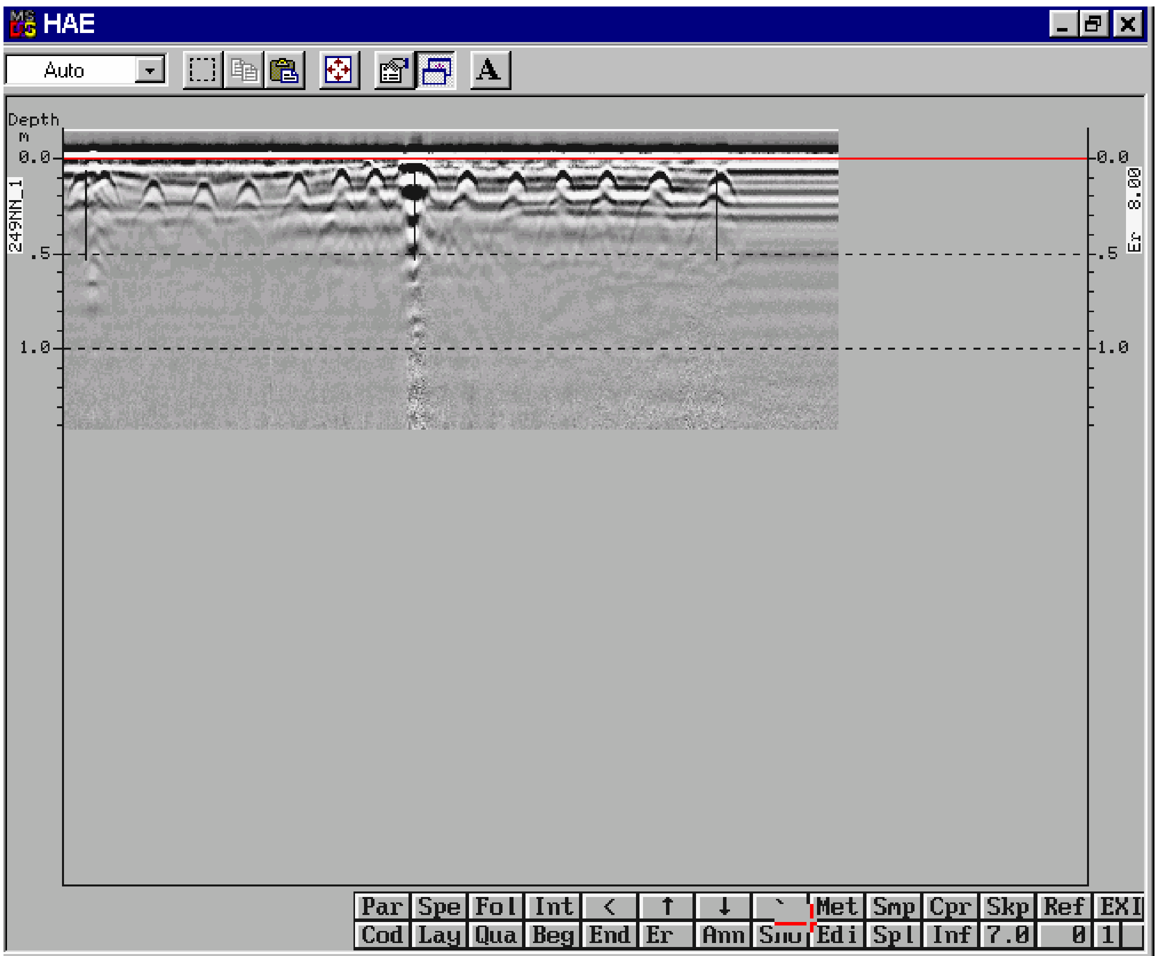
SH249 North Bound

SH249NN1



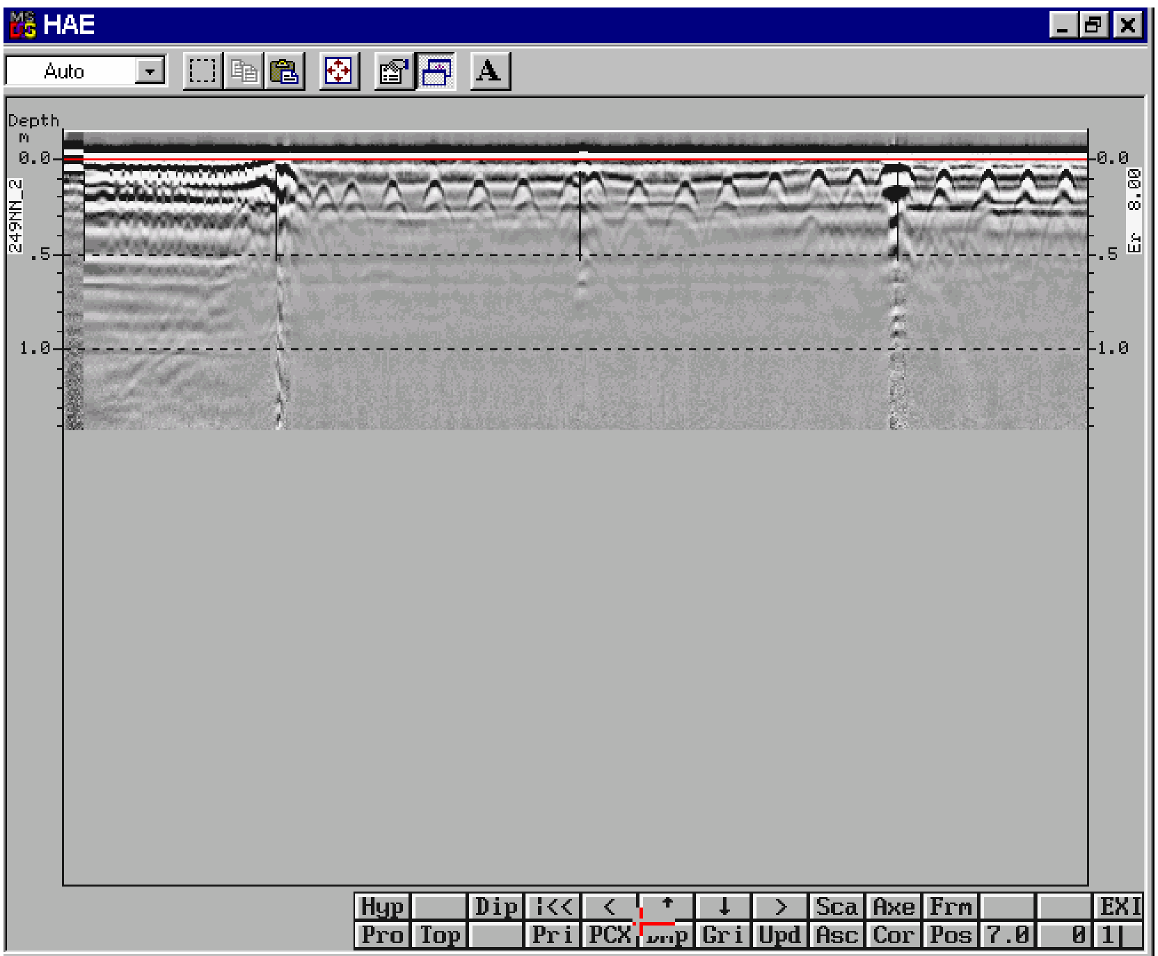
SH249 North Bound

SH249NN1



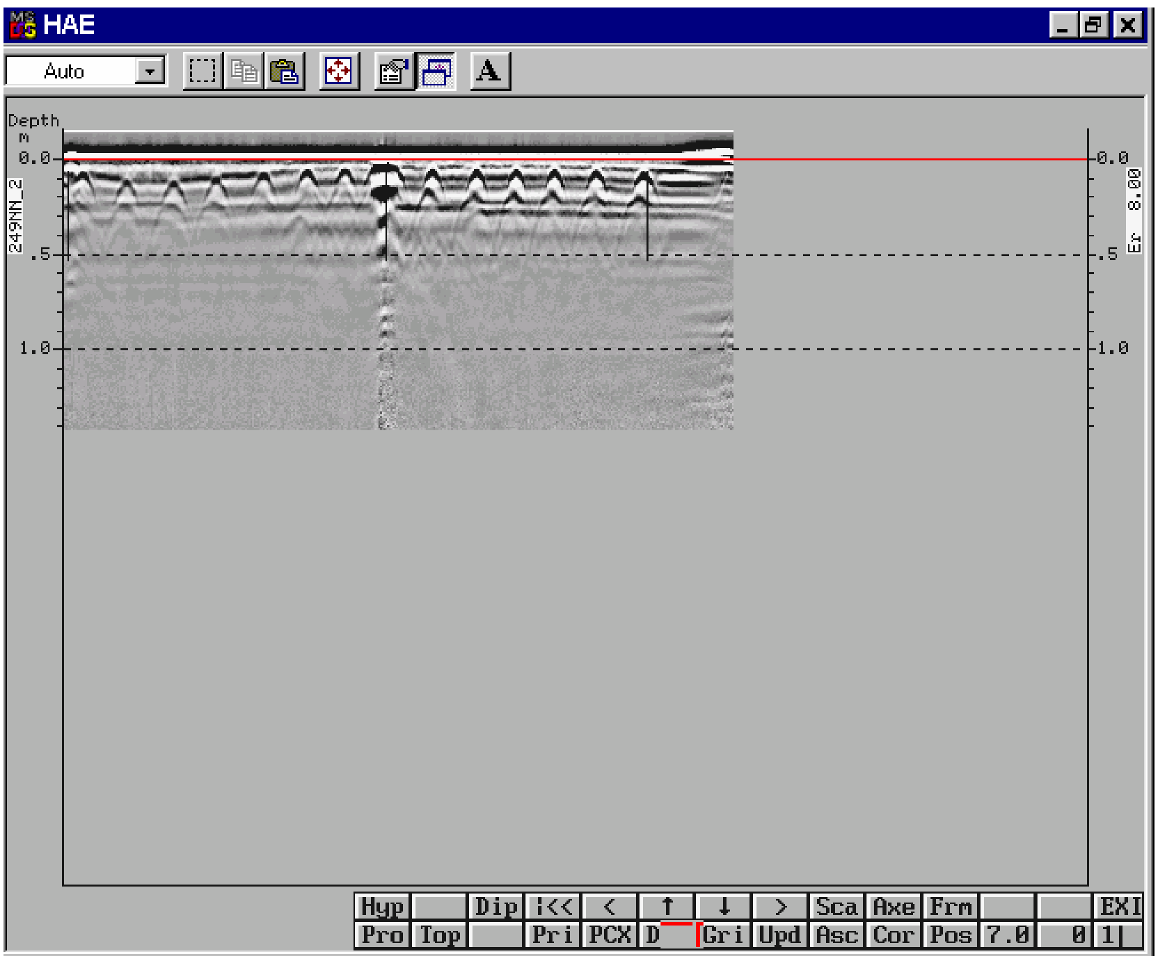
SH249 North Bound

SH249NN2



SH249 North Bound

SH249NN2



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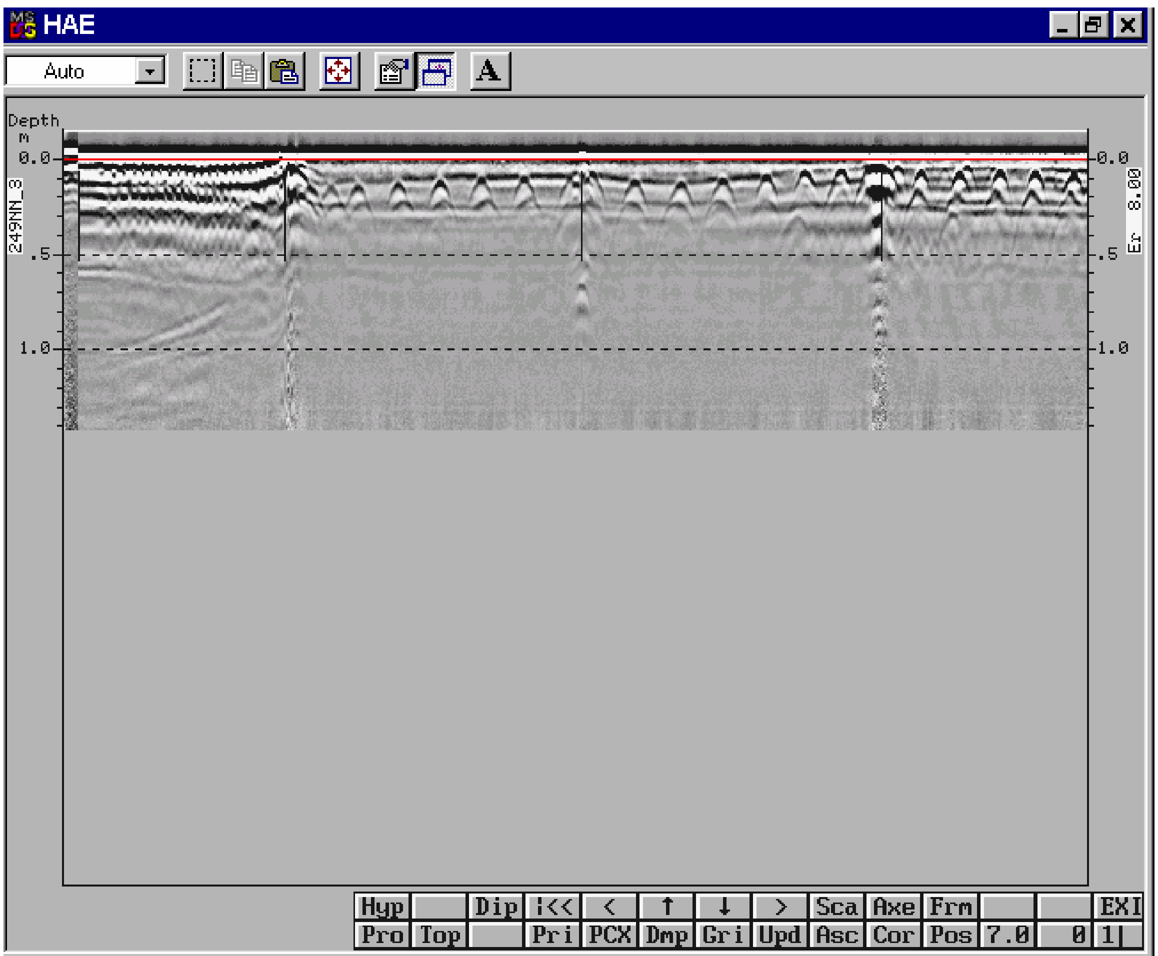
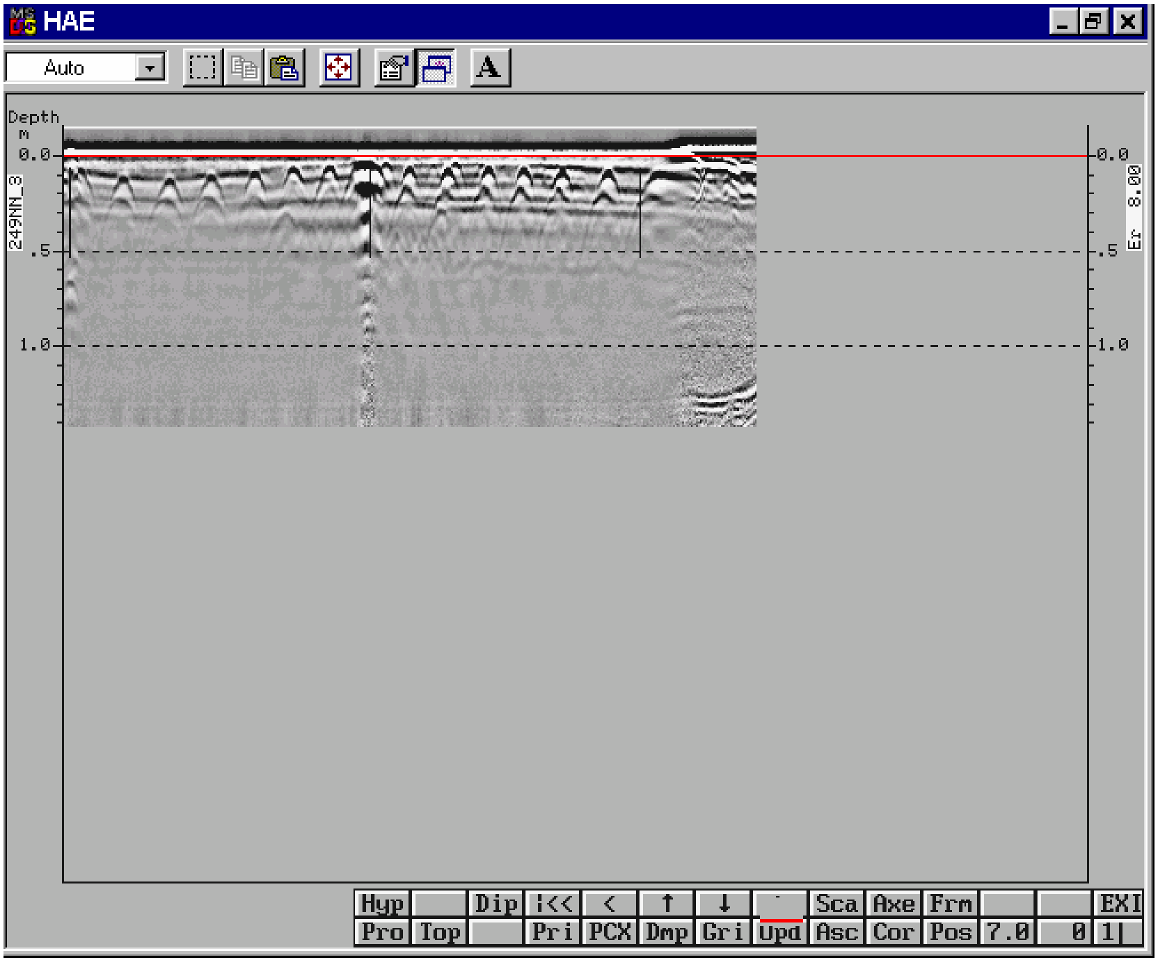
SH249NN3



SH249 North Bound

SH249NN3



APPENDIX E CONTINUOUS SHELBY TUBE SAMPLE

DRILLING REPORT

sheet ___ of ___

(For use with Undisturbed Sampling & Testing)

County WALLER | Structure BRIDGE | District No. 12

Highway No. US 290 @ FM 362 | Hole No. US 290-EW-STS-1 | Date 06/05/01 & 06/26/01

Control | Station | Grd. Elev.

Projuct No. | Loc. From Centerline Rt. Lt. | Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
												(3 ~ 5 ft)
						1						Sandy clay, dark gray, w/organic stiff
						2						Sandy clay, dark gray, tan, brown, stiff
						3						Same as above
	5											(5 ~ 7 ft)
						4						Clay, tan, brown, gray stiff
						5						Same as above
												(9 ~ 11 ft)
						6						Sandy clay, tan, brown, gray stiff
	10					7						
						8						
	15											(15 ~ 17)
						9						Sandy clay, tan, brown, dark gray w/ organic stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Hot mix
						12						
	25											
												(26 ~ 28)
						13						Sandy clay, red, light gray, tan stiff
	30											(31 ~ 33)
						14						Sandy clay, light gray, some red and tan stiff
						15						Same as above

Driller Marco Rodriguez | Logger L. Hall | Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS | Structure BRIDGE | District No. 12

Highway No. US 290 @ FM 362 | Hole No. US 290-EW-STS-2 | Date 06/05/01

Control ___ | Station ___ | Grd. Elev. ___

Projuct No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
						1						Clay w/sand, tan, brown, gray stiff
						2						Sandy clay, tan, brown, gray stiff
						3						Sandy clay, tan, brown, gray w/organic
	5											(5 ~ 7 ft)
						4						Sandy clay, tan, brown, gray w/organic
						5						Clay w/sand, tan, brown, gray stiff
												(9 ~ 11 ft)
						6						Clay w/sand, tan, brown, gray stiff
	10					7						Same as above
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay, dark brown, gray w/red stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Sandy clay, tan, gray w/red stiff
						12						Same as above
	25											
												(26 ~ 28)
						13						Sandy clay, gray, red, stiff
	30											(31 ~ 33)
						14						Sandy clay, red, gray stiff
						15						Same as above

Driller Marco Rodriguez | Logger Pepito Tapado | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County WALLER | Structure BRIDGE | District No. 12

Highway No. US 290 @ FM 362 | Hole No. US 290-WW-STS-1 | Date 06/26/01

Control 0014-14-746 | Station ___ | Grd. Elev. ___

Projuct No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
						1						
						2						Sandy clay, reddish tan gray stiff
						3						Same as above
	5											(5 ~ 7 ft)
						4						Sandy clay, reddish tan stiff
						5						Sandy clay, reddish tan brown stiff
												(9 ~ 11 ft)
						6						
	10					7						Sandy clay, red gray tan stiff
						8						
	15											(15 ~ 17)
						9						Sandy clay, red tan gray stiff
						10						Sandy clay to sand, red tan gray (gray sand) stiff
	20											
												(21 ~ 23)
						11						Sandy clay, tan red gray stiff
						12						Sandy clay, tan gray stiff
												Sandy clay with sand layer, gray red tan stiff
	25											
												(26 ~ 28)
						13						Sandy clay, gray tan stiff
												Same as above
												Same as above
	30											(31 ~ 33)
						14						Sandy clay, gray tan stiff
						15						Same as above

Driller Marco Rodriguez | Logger L. Hall | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County WALLER | Structure BRIDGE | District No. 12

Highway No. US 290 @ FM 362 | Hole No. US 290-WW-STS-2 | Date 06/26/01

Control 0014-14-746 | Station ___ | Grd. Elev. ___

Projuct No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	THD PEN. TEST No. of Blows 2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
												(3 ~ 5 ft)
						1						Sandy clay, red gray stiff
						2						Same as above
						3						Same as above
	5											(5 ~ 7 ft)
						4						Same as above
						5						Sandy clay, red gray brown stiff
												(9 ~ 11 ft)
						6						
	10					7						Sandy clay, brown tan gray red stiff
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay, trd tan gray stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Silty clay, red brown gray stiff
						12						Same as above
	25											
												(26 ~ 28)
						13						Push through
												No recovery sand @ 26-28 ft.
	30											(31 ~ 33)
						14						Sandy clay, tan gray stif
						15						Same as above
												Same as above

Driller Marco Rodriguez | Logger L. Hall | Title ___

DRILLING REPORT
(For use with Undisturbed Sampling & Testing)

County WALLER | Structure BRIDGE | District No. 12
Highway No. US 290 @ FM 362 | Hole No. US 290-EE-STS-1 | Date 07/09/01
Control 0014-14-746 | Station ___ | Grd. Elev. ___
Project No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
						1						
						2						Sandy clay, tan gray stiff
						3						Same as above
	5											(5 ~ 7 ft)
						4						Sandy clay, gray tan stiff
						5						Same as above
												(9 ~ 11 ft)
						6						
	10					7						Sandy clay, tan gray stiff
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay, gray tan stiff
						10						Same as above
												Sandy clay, gray tan brown w/ organic stiff
	20											
												(21 ~ 23)
						11						Sandy clay, brown tan stiff
						12						Same as above
	25											
												(26 ~ 28)
						13						Sandy clay, gray red tan stiff
												Same as above
	30											(31 ~ 33)
						14						31' - 33' push sand no recovery
						15						

Driller Marco Rodriguez | Logger L. Hall | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County: WALLER | Structure: BRIDGE | District No.: 12

Highway No.: US 290 @ FM 362 | Hole No.: US 290-EE-STS-2 | Date: 07/09/01

Control: 0014-14-746 | Station: | Grd. Elev.:

Project No.: | Loc. From Centerline Rt.: Lt.: | Grd. Water Elev.:

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
												(3 ~ 5 ft)
						1						Sandy clay, tan red gray stiff
						2						Same as above
						3						Sandy clay, tan gray slightly red stiff
	5											(5 ~ 7 ft)
						4						Same as above
						5						Same as above
												(9 ~ 11 ft)
						6						
	10					7						Sandy clay, gray tan red stiff
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay, brown red tan stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Silty clay, multi-colors compact moist w/ ferrous and gravel
						12						Same as above
	25											
												(26 ~ 28)
						13						Sandy clay, red tan gray stiff
	30											(31 ~ 33)
						14						
						15						Sandy clay, tan red gray stiff

Driller: Marco Rodriguez | Logger: L. Hall | Title:

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County WALLER | Structure BRIDGE | District No. HOUSTON

Highway No. US 290 @ FM 362 | Hole No. US 290-WE-STS-1 | Date 06/28/01

Control 0014-14-746 | Station ___ | Grd. Elev. ___

Projuct No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
						1						Sandy clay, red gray tan stiff
						2						Same as above
						3						Same as above
	5											(5 ~ 7 ft)
						4						Sandy clay, red tan gray stiff
						5						Same as above
												(9 ~ 11 ft)
						6						
	10					7						Sandy clay, gray red tan stiff
						8						Same as above
	15											(15 ~ 17)
						9						Sandy clay with sand layer, gray red tan stiff
						10						Same as above
	20											
												(21 ~ 23)
						11						Silty clay, tan red gray stiff
						12						Silty clay tan red gray brown stiff
	25											
												(26 ~ 28)
						13						Sandy clay, gray tan red stiff
												Same as above
	30											(31 ~ 33)
						14						Sandy clay, gray tan stiff
						15						Same as above
												Same as above

Driller Marco Rodriguez | Logger L. Hall | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County WALLER | Structure BRIDGE | District No. HOUSTON

Highway No. US 290 @ FM 362 | Hole No. US 290-WE-STS-2 | Date 06/28/01

Control 0014-14-746 | Station | Grd. Elev.

Projuct No. | Loc. From Centerline Rt. Lt. | Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
						1						
						2						
						3						
	5											(5 ~ 7 ft)
						4						Sandy clay, tan red gray stiff
						5						Sandy clay, tan gray slightly red stiff
												(9 ~ 11 ft)
						6						Sandy clay, red gray tan stiff
	10					7						Sandy clay, red gray tan stiff
						8						Sandy clay, red gray tan brown stiff
	15											(15 ~ 17)
						9						Sandy clay, gray tan stiff
						10						Sandy clay, gray tan red stiff
												Sandy clay, gray tan red stiff
	20											
												(21 ~ 23)
						11						Sandy clay, gray red tan stiff
						12						Same as above
												Same as above
	25											
												(26 ~ 28)
						13						Silty to sandy clay, gray red tan stiff
												Silty sand brown
	30											(31 ~ 33)
						14						Sandy clay, gray tan stiff
						15						Same as above
												Sandy clay, gray tan brown stiff

Driller Marco Rodriguez | Logger L. Hall | Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS
Structure BRIDGE
District No. HOUSTON

Highway No. SH 249 @ GRANT
Hole No. SH 249-NS-STS-2
Date 03/23/01

Control 0014 - 14 - 746
Station
Grd. Elev.

Projuct No.
Loc. From Centerline Rt. ___ Lt. ___
Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
	0											
	1											Cored 14 inches Concrete
	2											1 inch Bond Breaker, 9 inches Stabilizer
	3											had to drill to 4 ft, could not push
	4											
	5					1, 2						Sand & Clay mixture appeared
	6											poorly mixed
	7					3						poor redovery
	8					4, 5						
	9											
	10											
	11					6, 7						
	12											
	13											
	14											
	15											
	16					8, 9						

Driller Marco Rodriguez
Logger Clinton Mighty
Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS | Structure BRIDGE | District No. HOUSTON

Highway No. SH 249 @ GRANT | Hole No. SH 249-SS-STS-1 | Date 04/06/01

Control 0014 - 14 - 746 | Station ___ | Grd. Elev. ___

Projuct No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
												(3 ~ 5 ft)
	5					1						Clay, blackish-yellow-blue
												(5 ~ 7 ft)
						2						Clay, calc., black streaks, blue
						3						Clay, calc., black streaks, blue
												(9 ~ 11 ft)
	10					4						Clay, calc., blueish, gray, soft
						5						
	15											(15 ~ 17)
						6						Clay, approaching sand bed, gray, hard
	20											
												(21 ~ 23)
												Sand, no recovery
	25											
												(26 ~ 28)
						7						Clay, Iron nodules, gray w/steaks of orange
						8						Same as above
	30											(31 ~ 33)
						9						Clay, slightly silty, gray, w/streaks of yellow
						10						Same as above

Driller Marco Rodriguez | Logger Clinton Mighty | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS | Structure BRIDGE | District No. HOUSTON

Highway No. SH 249 @ GRANT | Hole No. SH 249-SS-STS-2 | Date 04/06/01

Control 0014 - 14 - 746 | Station | Grd. Elev.

Project No. | Loc. From Centerline Rt. Lt. | Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	THD PEN. TEST No. of Blows 2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
												(3 ~ 5 ft)
	5					1						Clay, gray-yellow, calc.
												(5 ~ 7 ft)
						2						Clay, blue-yellow, black, organic
						3						Clay, blue-yellow, black, organic
												(9 ~ 11 ft)
	10					4						Sand, w/ silt, clay, gray, organic
	15											(15 ~ 17)
						5						Clay, slightly sandy, red-gray
						6						Clay, slightly sandy, red-gray
	20											(21 ~ 23)
						7						Clay, slightly silty, black
	25											(26 ~ 28)
						8						Clay, organic, gray-yellow
						9						Clay, yellow, gray
						10						Clay, gray
	30											(31 ~ 33)
						11						Clay, gray, organic
						12						Clay, gray, organic

Driller Marco Rodriguez | Logger Clinton Mighty | Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

County HARRIS
Structure BRIDGE
District No. HOUSTON

Highway No. SH 249 @ GRANT
Hole No. SH 249-SN-STS-1
Date 05/11/01

Control 0014 - 14 - 746
Station
Grd. Elev.

Projuct No.
Loc. From Centerline Rt. ____ Lt. ____
Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	THD PEN. TEST No. of Blows 2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
						1						Silty Clay, Gray/Black, Stiff
	5					2						Same as above
						3						Silty Clay, Tan, Stiff
						4						Same as above
						5						Silty Clay, Tan, Stiff
	10					6						Same as above
						7						Silty Clay, Tan with Calcareous, Stiff
	15											
						8						Silty Clay, Brown/Gray, Stiff
						9						Silty Clay, Brown/Red, Stiff
	20					10						Silty Clay, Gray/Tan, Stiff
	25											
						11						Silty Clay, Gray, Stiff
						12						Silty Clay, Tan, Stiff
	30											
						13						Silty Clay, Tan, Stiff
						14						Same as above
						15						Same as above

Driller Marco Rodriguez
Logger L. Hall
Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS | Structure BRIDGE | District No. HOUSTON

Highway No. SH 249 @ GRANT | Hole No. SH 249-SN-STS-2 | Date 05/11/01

Control 0014 - 14 - 746 | Station | Grd. Elev.

Project No. | Loc. From Centerline Rt. Lt. | Grd. Water Elev.

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
						1						Silty Clay with Calc., Tan/Brown, Stiff
	5											
						2						Slightly Silty Clay, Tan/Brown/Black, Stiff
						3						Same as above
						4						Silty Clay, Gray/Black, Stiff
	10											
						5						Same as above
	15					6						Clay, Brown, Stiff
						7						Clay with Sand, Brown, Stiff
	20											
						8						Clay, Tan with Organic, Stiff
	25											
						9						Silty Clay, Gray/Tan, Stiff
						10						Same as above
						11						Same as above
	30											
						12						Silty Clay, Tan/Brown/Red, Stiff
						13						Same as above
						14						Same as above

Driller Marco Rodriguez | Logger L. Hall | Title

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

sheet ___ of ___

County HARRIS | Structure BRIDGE | District No. 12

Highway No. SH 249 @ GRANT | Hole No. SH 249-NN-STS-1 | Date 05/15/01

Control 0014 - 14 - 746 | Station ___ | Grd. Elev. ___

Project No. ___ | Loc. From Centerline Rt. ___ Lt. ___ | Grd. Water Elev. ___

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows		Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
				1st 6"	2nd 6"							
						1						Clay, Dark Gray, Light Gray, Tan, Stiff
						2						Same as above
	5					3						Same as above
						4						Sandy Clay, Tan Gray Mix w/aggregate stiff
						5						Same as above
	10											
						6						Sandy Clay, Dark Gray, Tan, Stiff
	15											
						7						Sandy Clay, Tan Gray, Stiff
						8						Same as above
	20											
						9						Sandy Clay, Dark Gray, Stiff
	25											
	30											

Driller Marco Rodriguez | Logger Pepito Tapado | Title ___

DRILLING REPORT

(For use with Undisturbed Sampling & Testing)

County HARRIS | Structure BRIDGE | District No. 12

Highway No. SH 249 @ GRANT | Hole No. SH 249-NN-STS-2 | Date 05/15/01

Control 0014 - 14 - 746 | Station ______ | Grd. Elev. ______

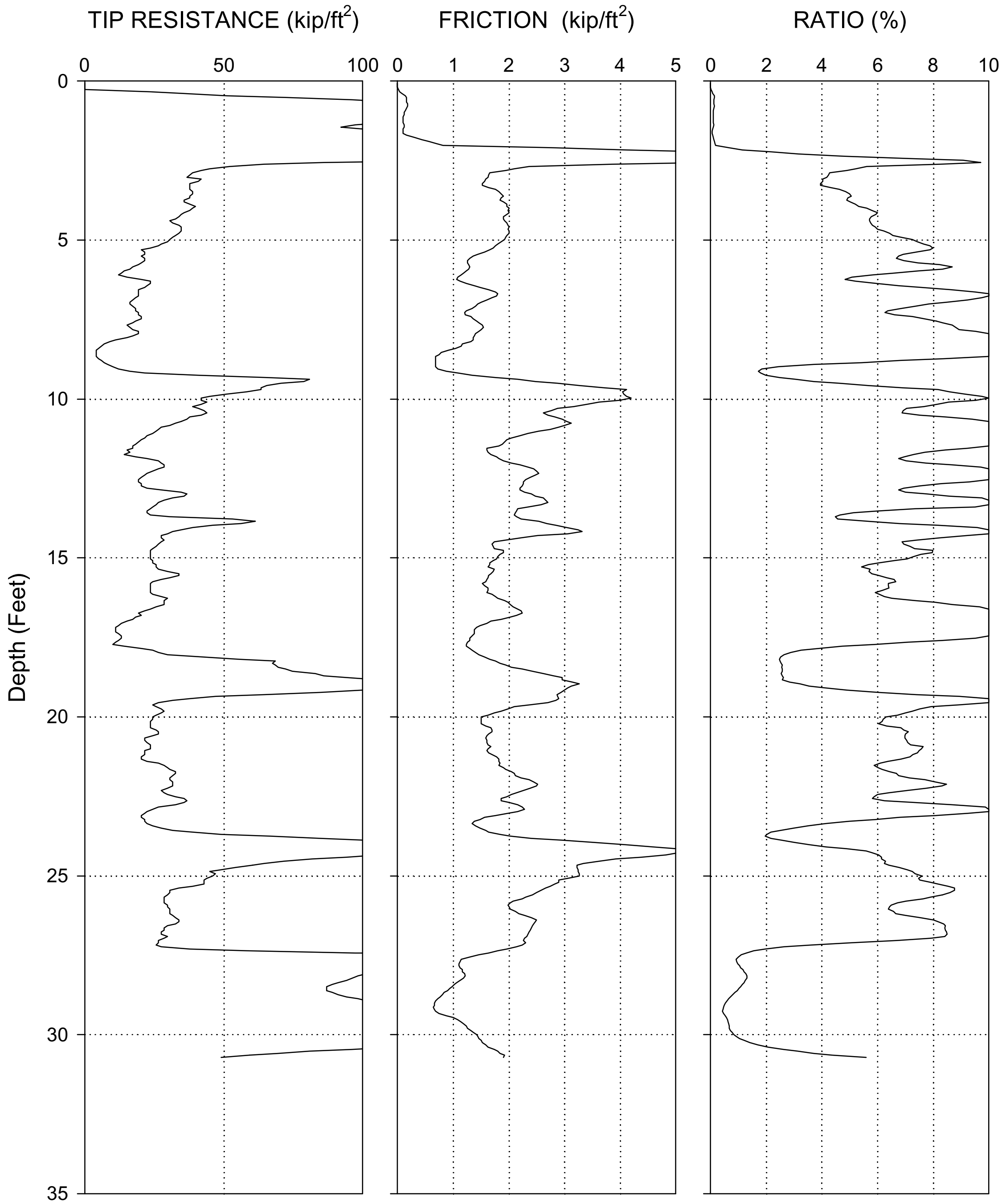
Projuct No. ______ | Loc. From Centerline Rt. ______ Lt. ______ | Grd. Water Elev. ______

Elev. (Ft.)	Depth (Ft.)	Sampler	Log	THD PEN. TEST No. of Blows 1st 6"	2nd 6"	Sample Number	Lat. Pressure & Ult. Stress (psi)	Wet Density (psf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	DESCRIPTION OF MATERIAL AND REMARKS
						1						Sandy Clay, Dark Gray, Tan, Red, Stiff
						2						Same as above
	5					3						Same as above
						4						Sandy Clay, Dark Gray, Tan, Red, Stiff
						5						Same as above
						6						Same as above
	10											
						7						Sandy Clay, Dark Gray, Tan, Red, Stiff
	15					8						Sandy Clay, Red, Gray, Stiff
						9						Same as above
						10						Same as above
	20											
												Stone Layer @ 22'
	25											
	30											

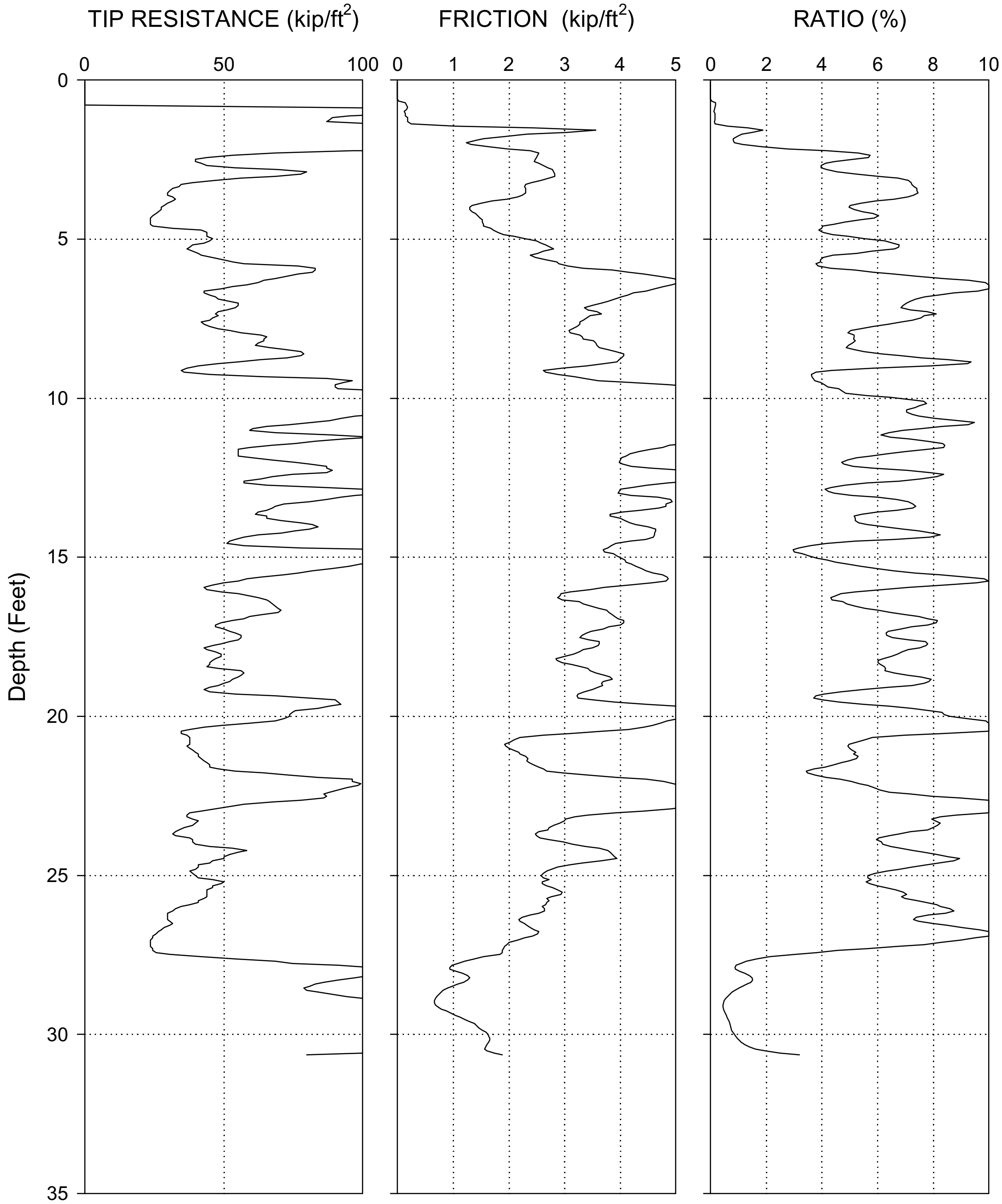
Driller Marco Rodriguez | Logger Pepito Tapado | Title ______

APPENDIX F CONE PENETROMETER TEST

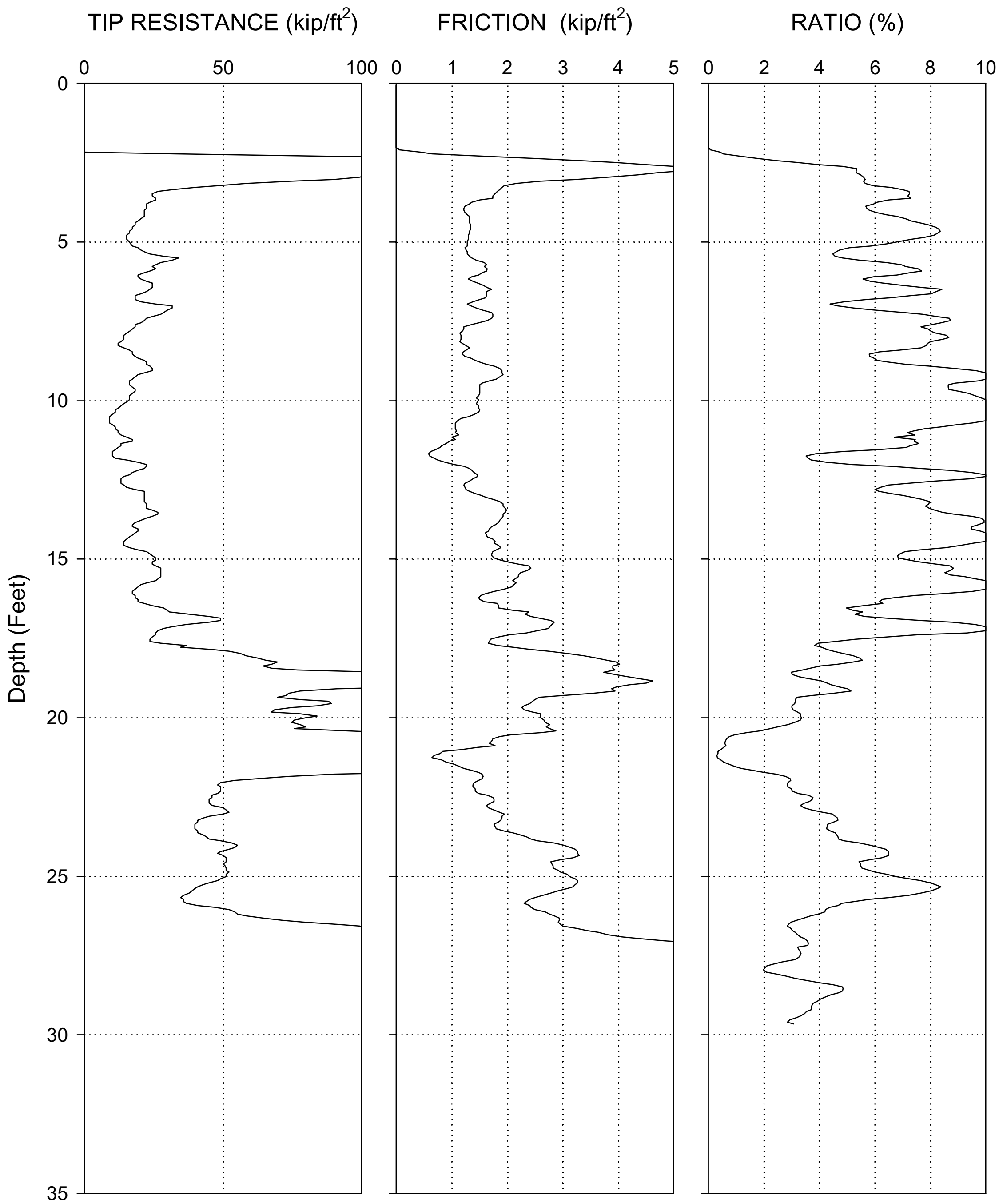
US290 WE-CPT-1



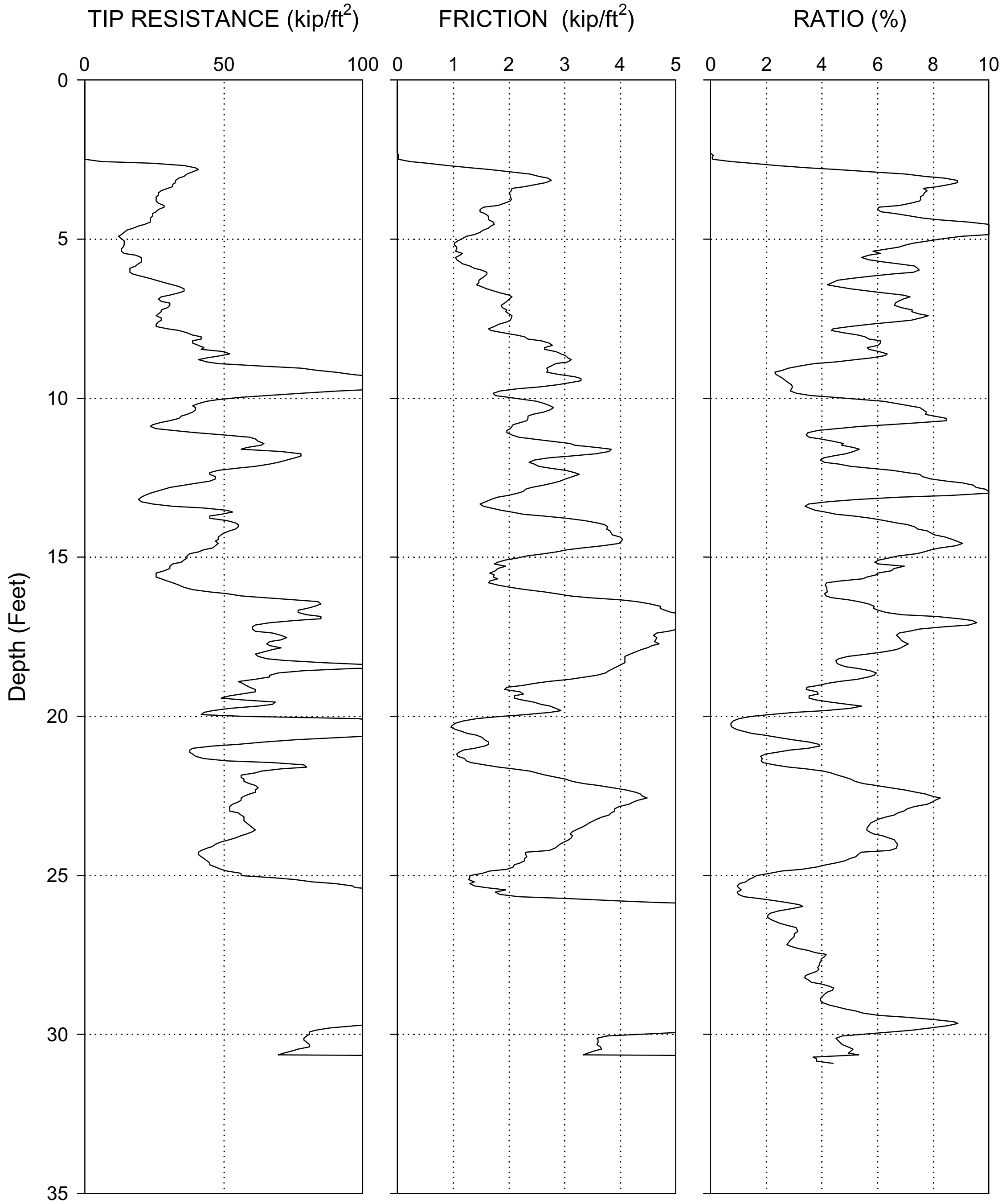
US290 WE-CPT-2



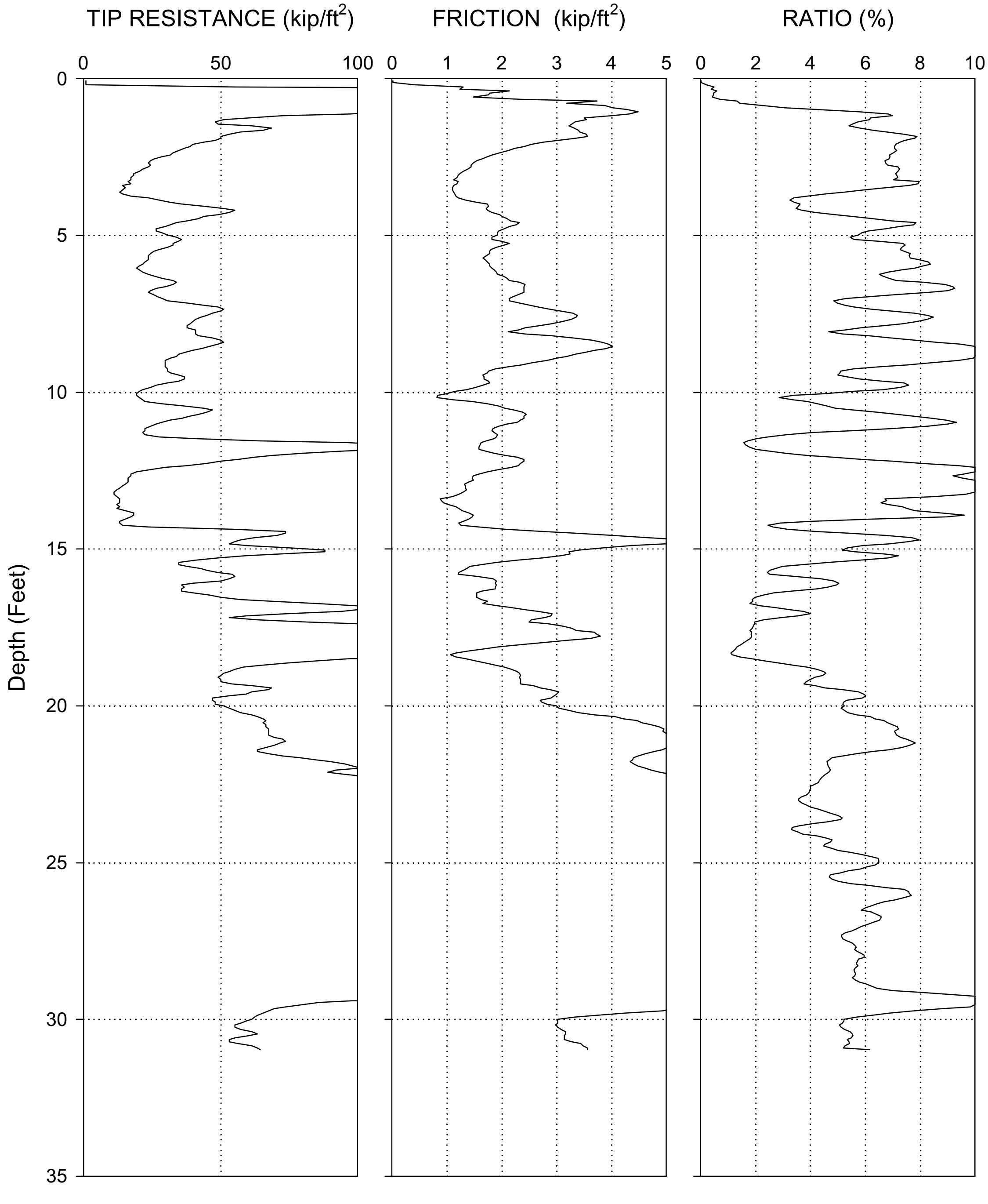
US290 EE-CPT-1



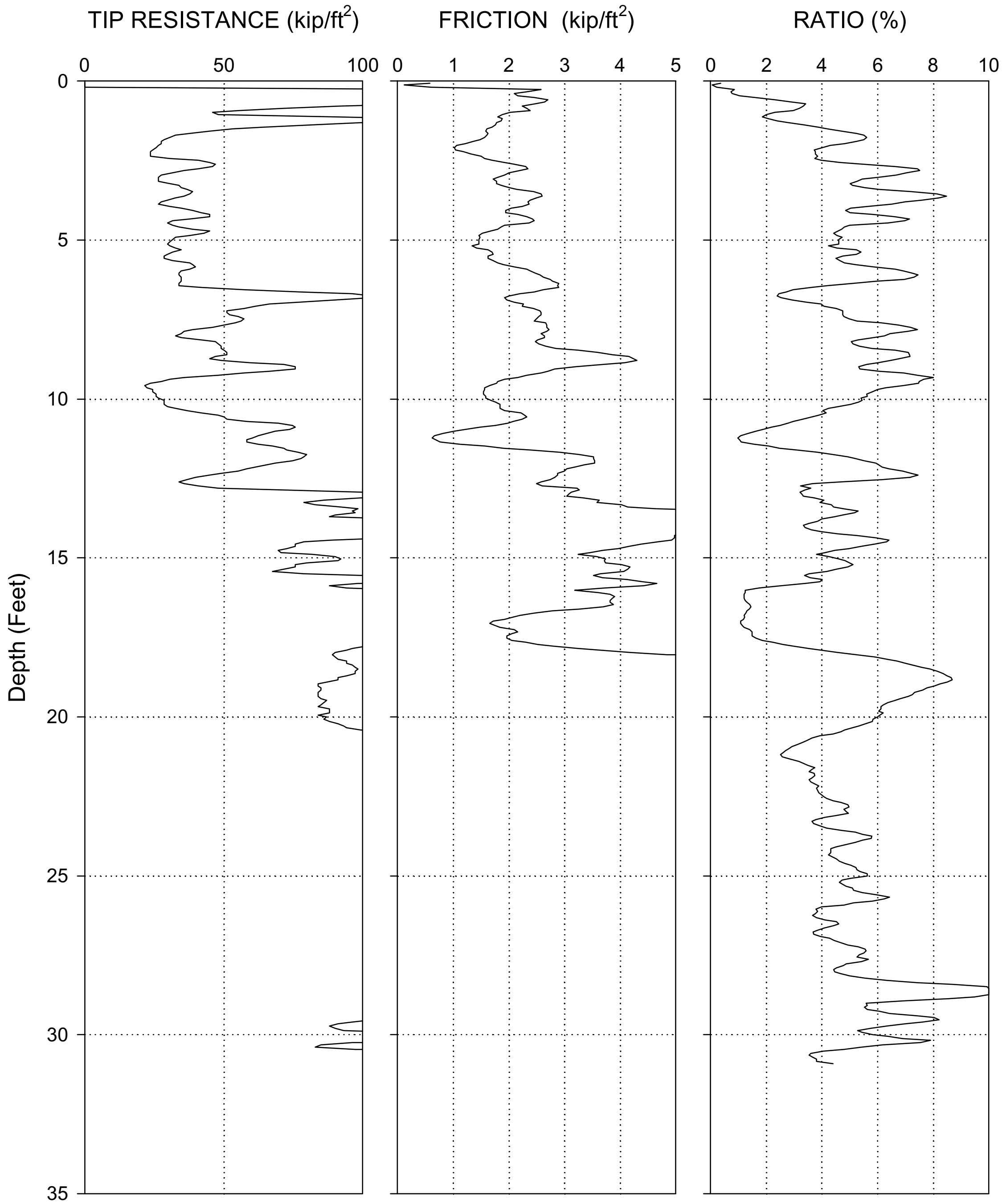
US290 EE-CPT-2



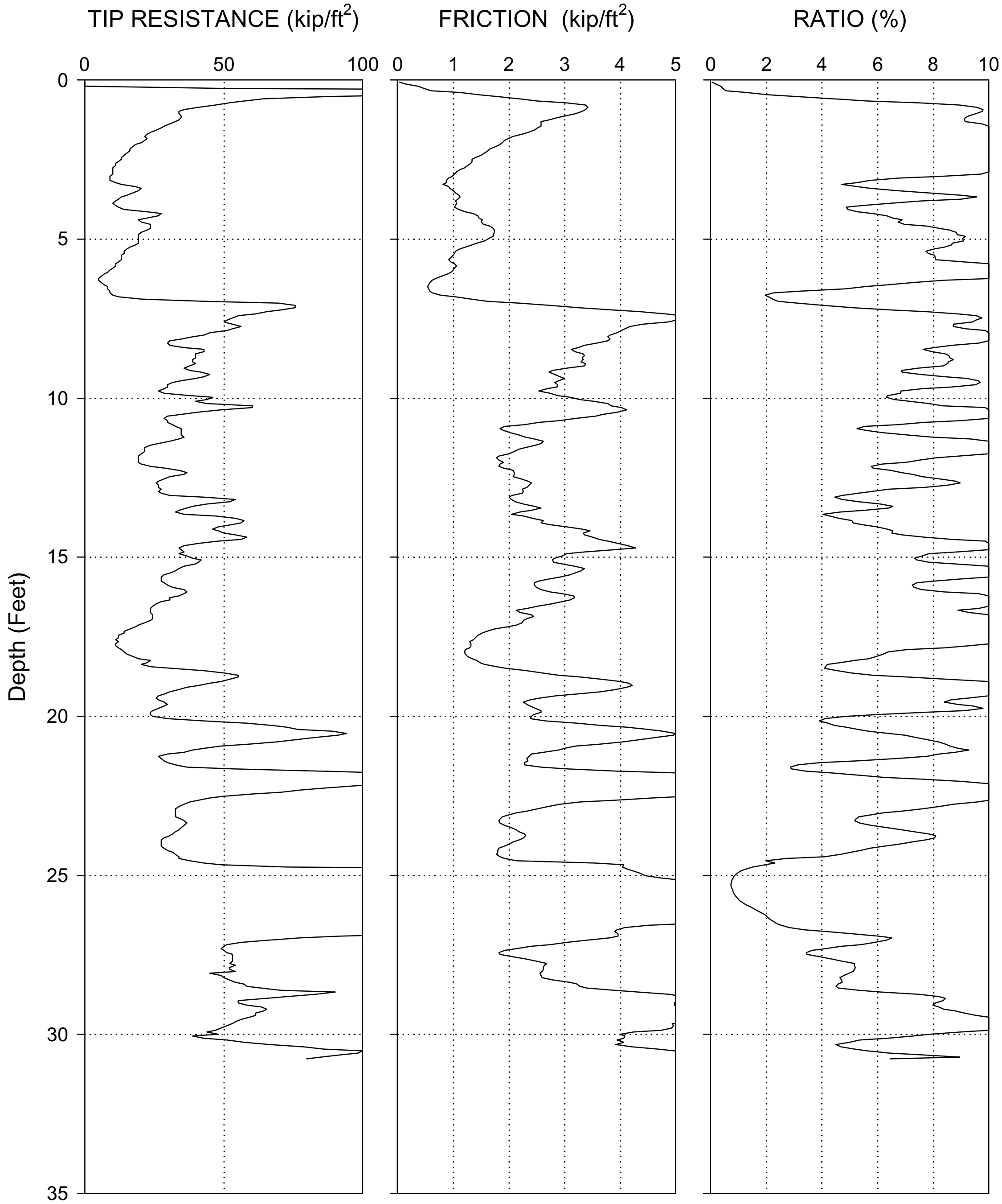
US290 EW-CPT-1



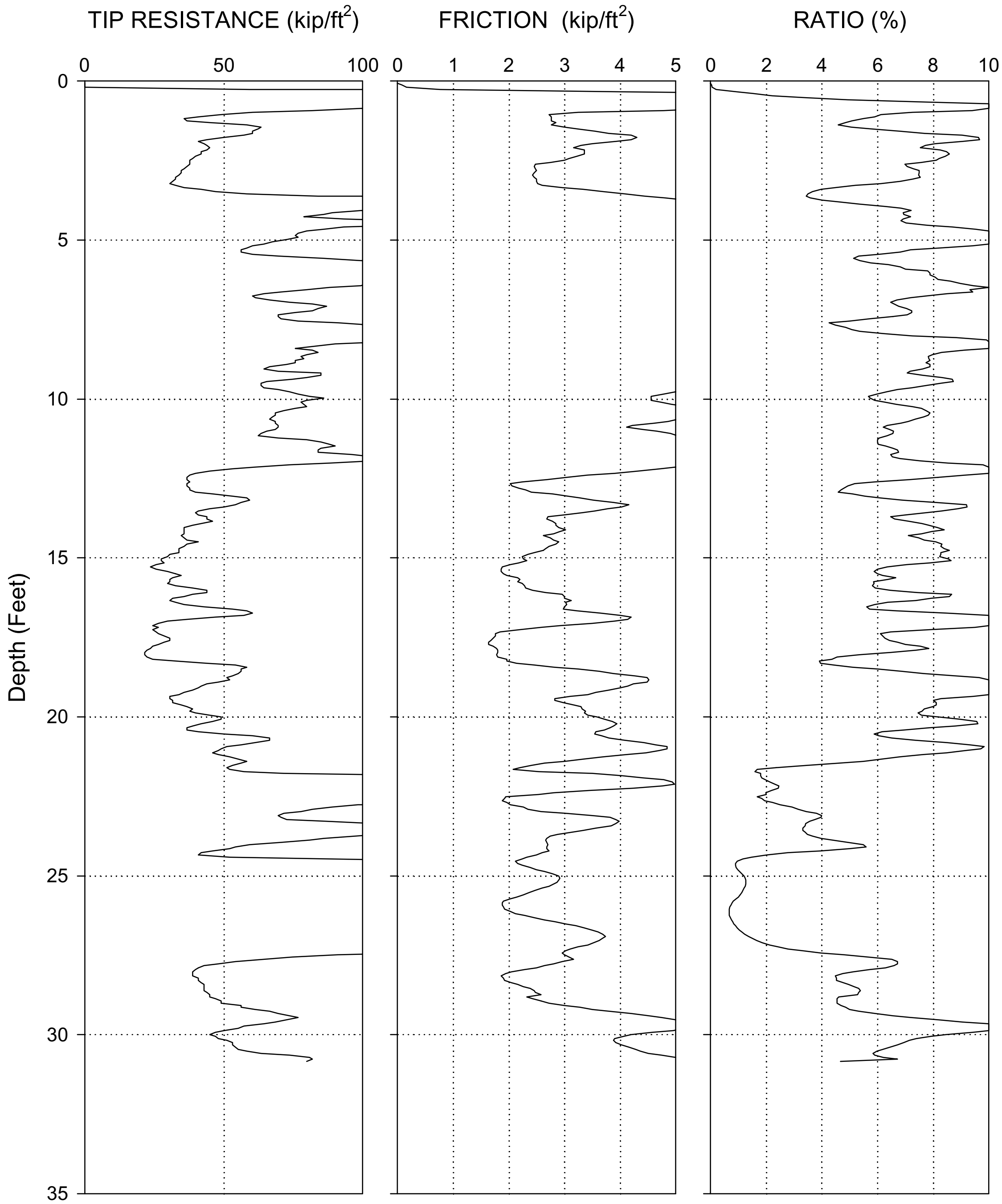
US290 EW-CPT-2



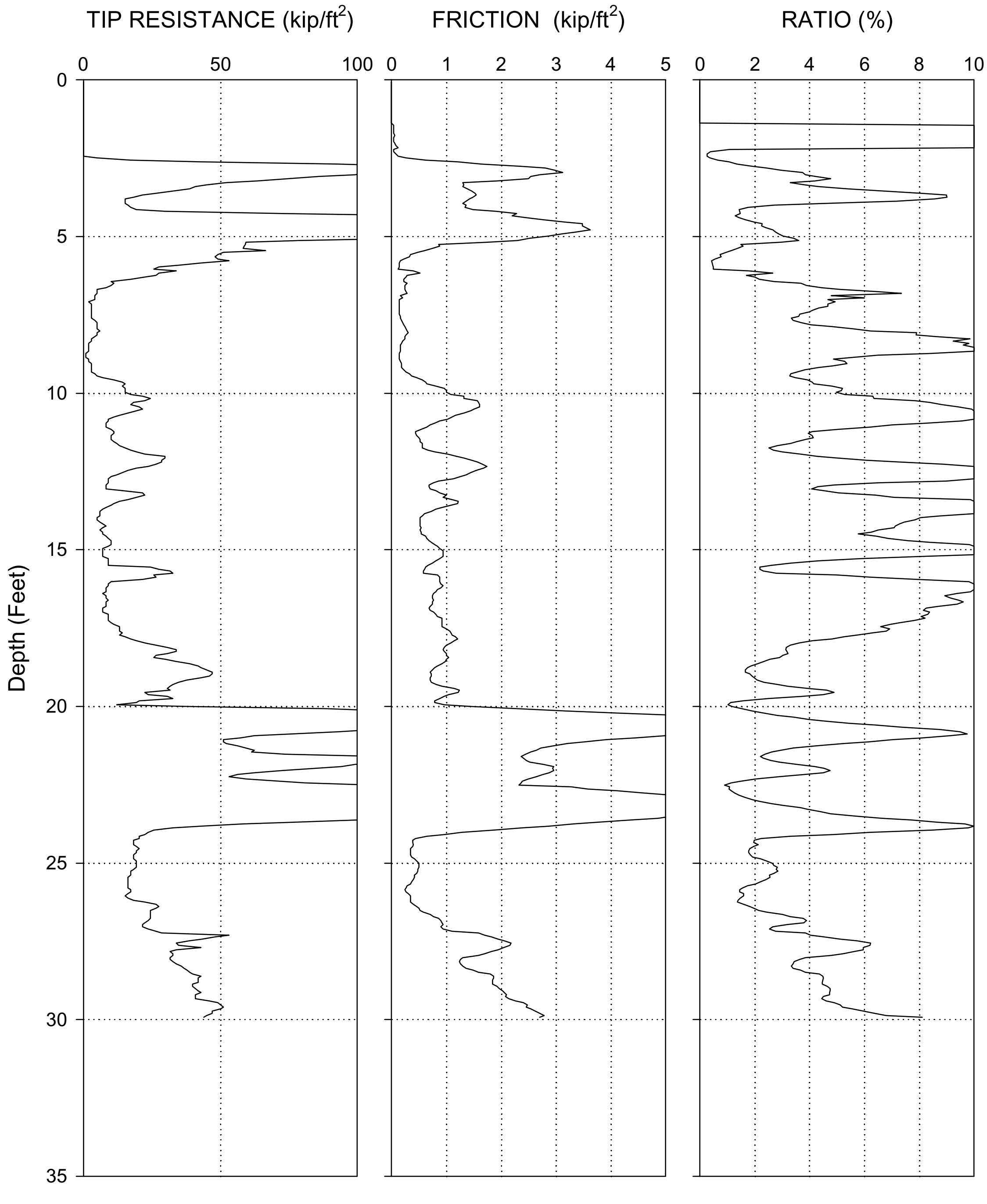
US290 WW-CPT-1



US290 WW-CPT-2



SH249 NS-CPT-1



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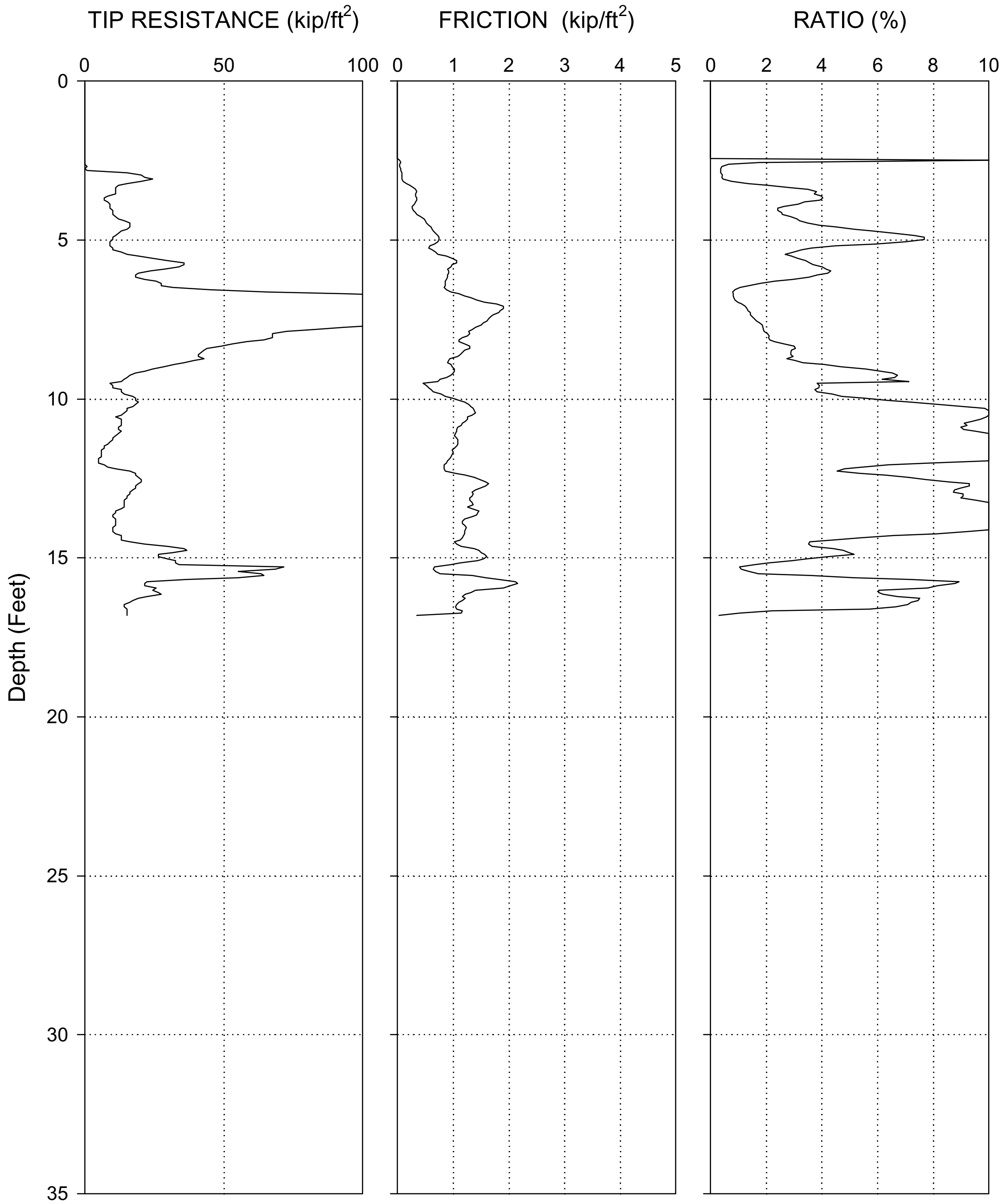

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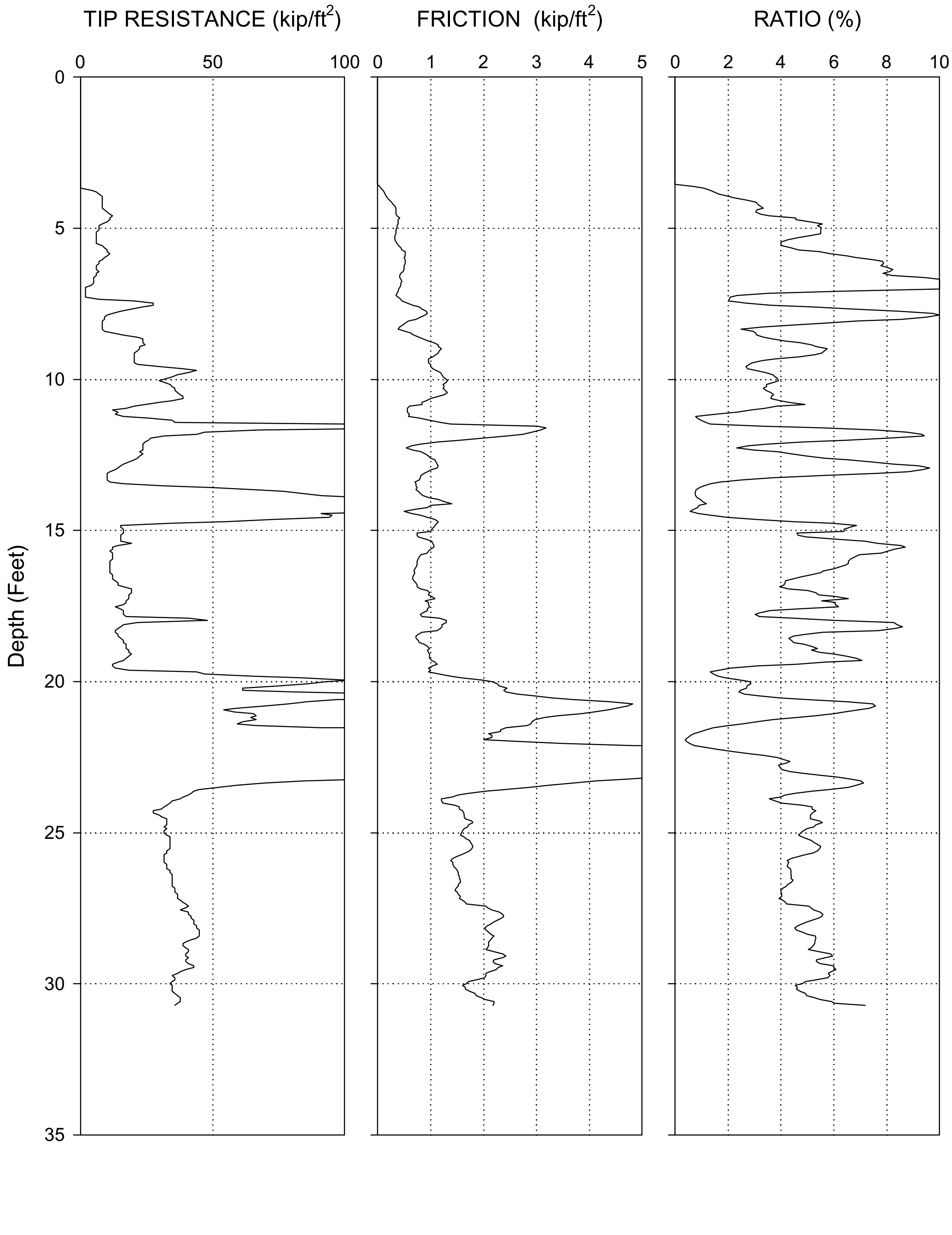

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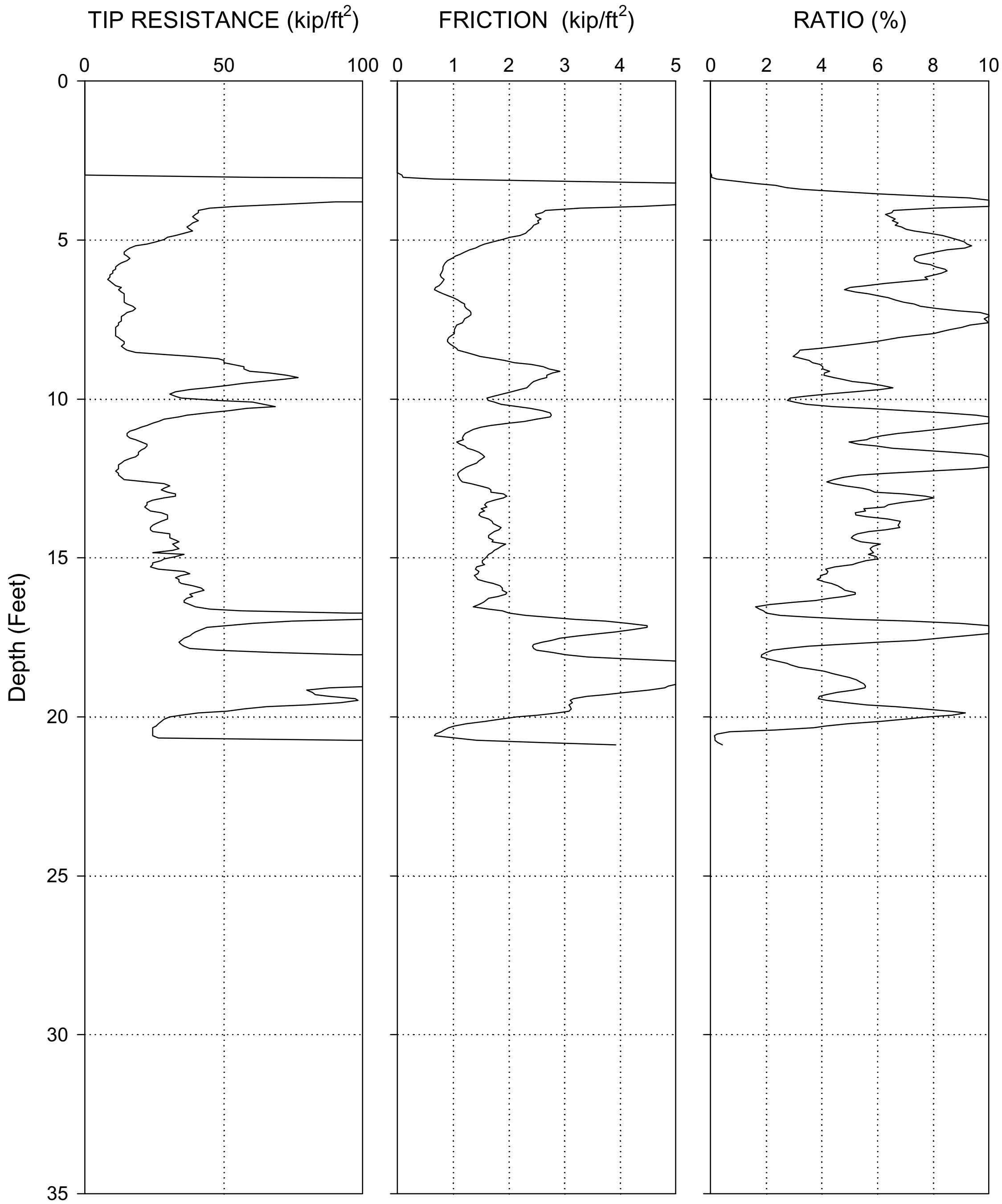

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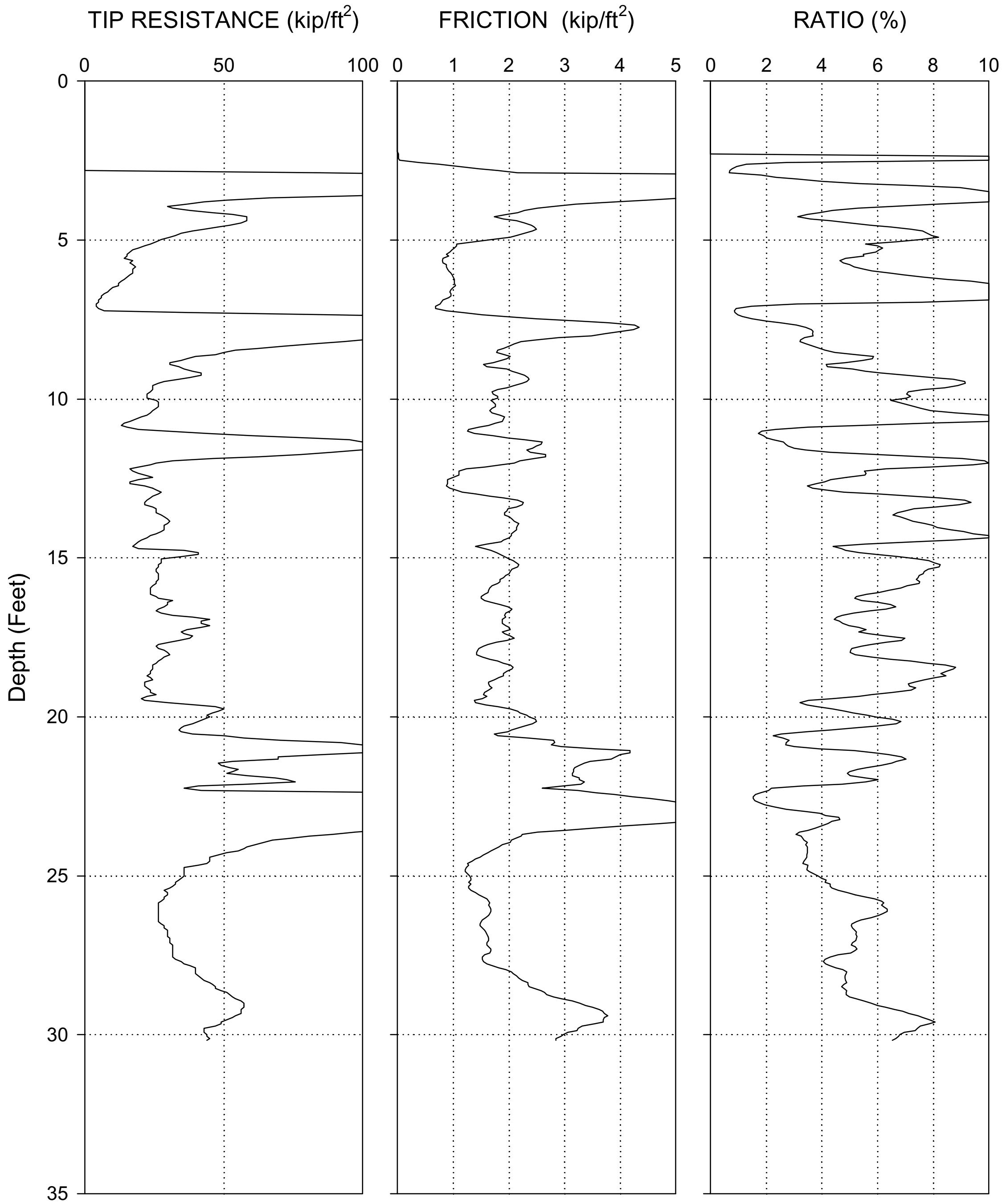

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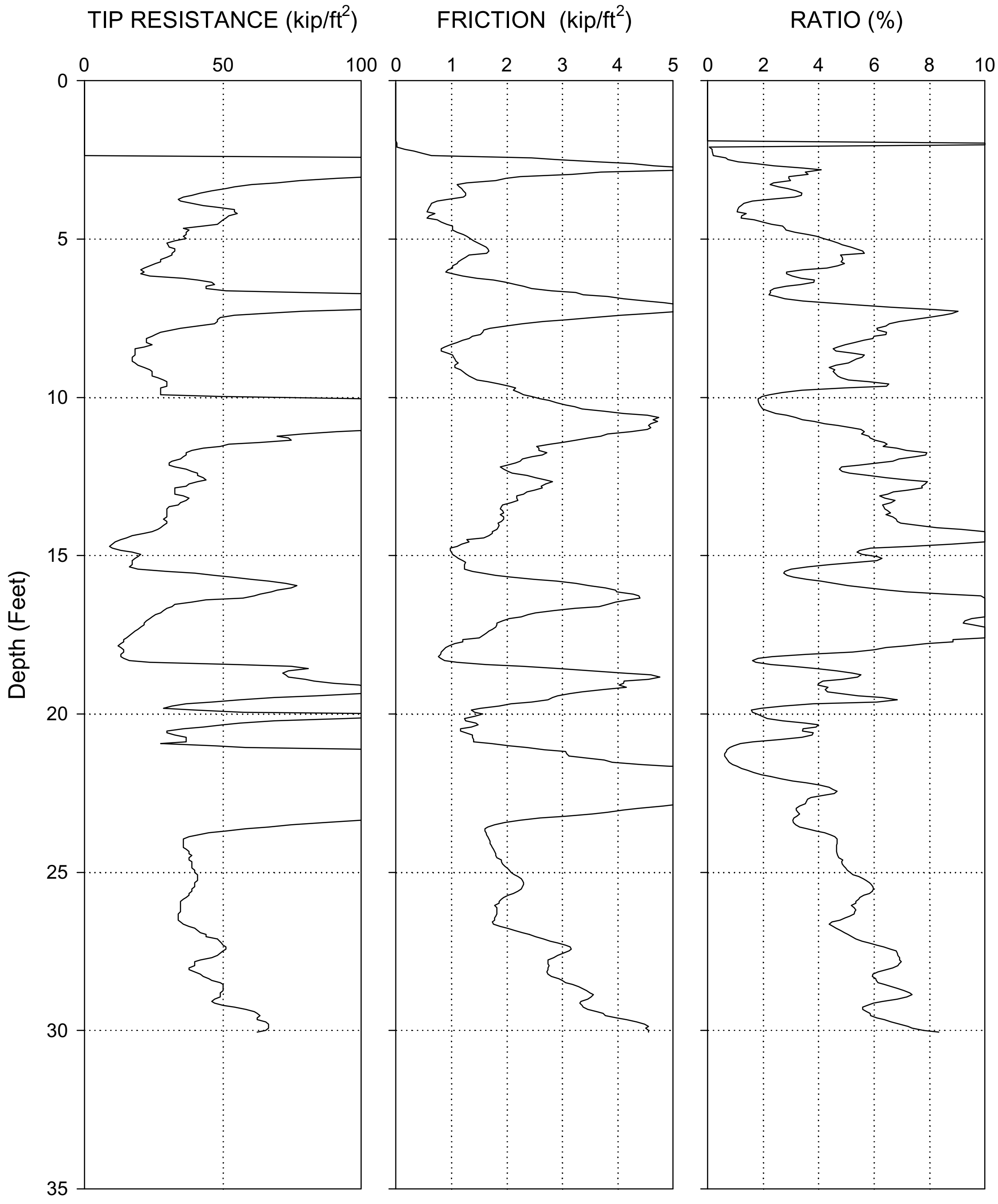

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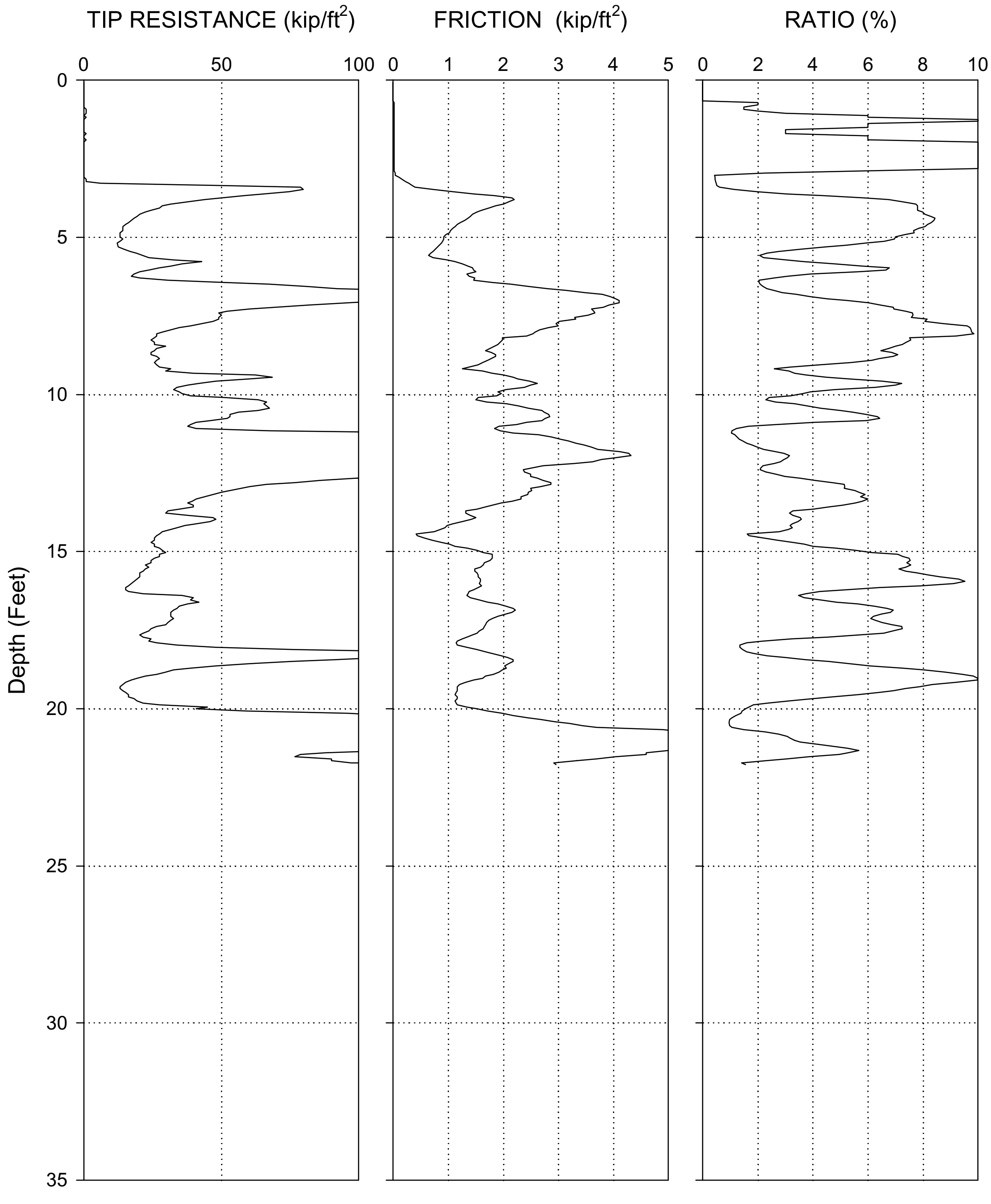

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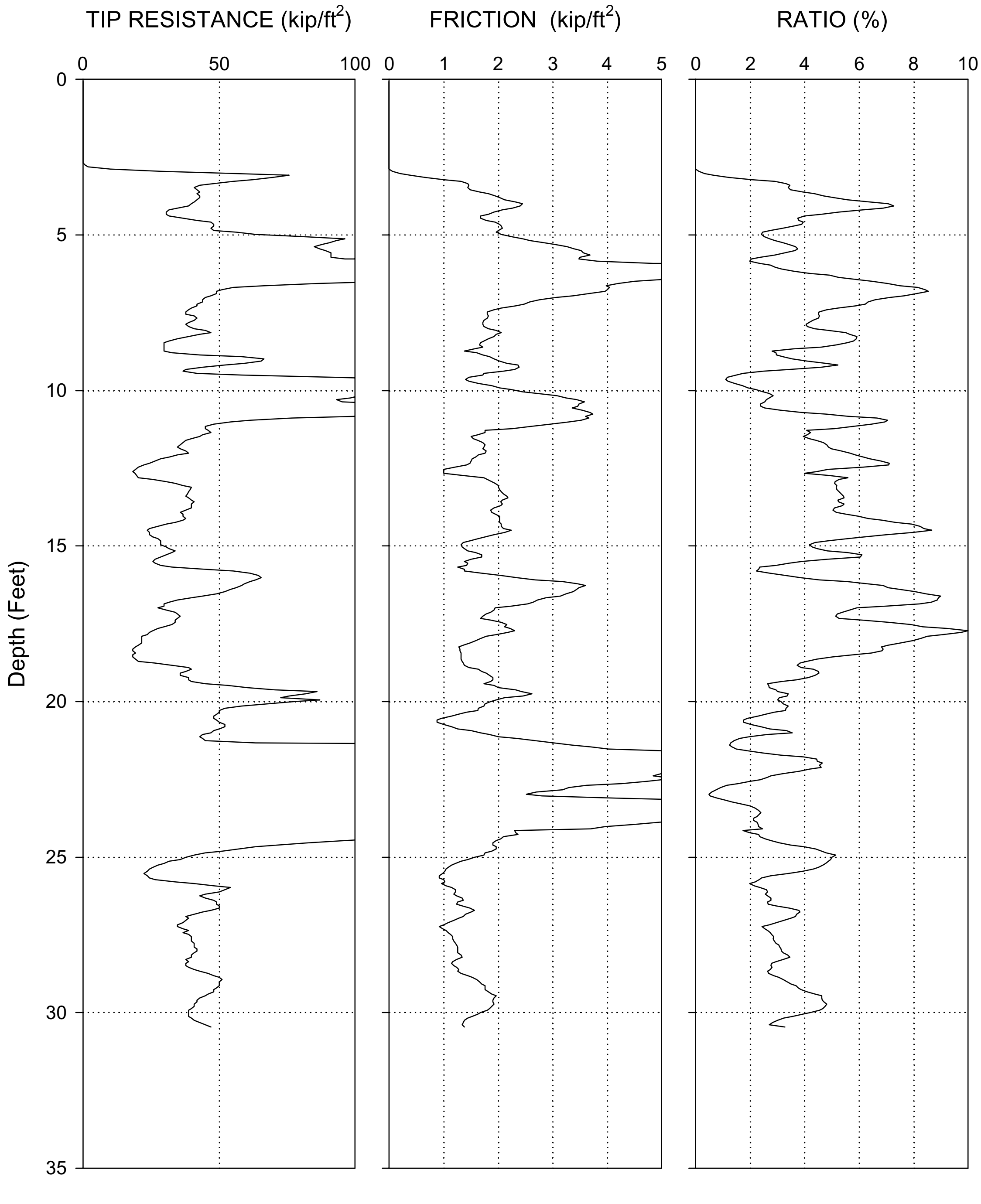


APPENDIX G WATER CONTENT TEST

US290-EE-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	3'-5'	1.00	25.09	21.53	3.56	20.53	**17.34**
No.4	5'-7'	1.00	22.62	19.22	3.4	18.22	**18.66**
No.6	9'-11'	1.00	30.65	27.36	3.29	26.36	**12.48**
No.8	15'-17'	1.00	33.52	28.97	4.55	27.97	**16.27**
No.13	26'-28'	1.00	26.00	23.35	2.65	22.35	**11.86**

US290-EE-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	3'-5'	1.00	32.15	27.59	4.56	26.59	**17.15**
No.5	5'-7'	1.00	31.37	27.71	3.66	26.71	**13.70**
No.7	9'-11'	1.00	27.88	24.64	3.24	23.64	**13.71**
No.9	15'-17'	1.00	33.68	30.11	3.57	29.11	**12.26**
No.11	21'-23'	1.00	21.06	18.13	2.93	17.13	**17.10**
No.12	26'-28'	1.00	37.20	32.92	4.28	31.92	**13.41**
No.13	31'-33'	1.00	21.96	19.25	2.71	18.25	**14.85**

US290-EW-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	3'-5'	1.00	29.35	23.53	5.82	22.53	**25.83**
No.5	5'-7'	1.00	25.77	20.48	5.29	19.48	**27.16**
No.7	9'-11'	1.00	26.77	21.29	5.48	20.29	**27.01**
No.8	15'-17'	1.00	22.83	20.12	2.71	19.12	**14.17**
No.11	26'-28'	1.00	33.98	29.59	4.39	28.59	**15.36**
No.12	31'-33'	1.00	37.29	30.04	7.25	29.04	**24.97**

US290-EW-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	3'-5'	1.00	34.41	28.63	5.78	27.63	**20.92**
No.4	5'-7'	1.00	28.62	25.05	3.57	24.05	**14.84**
No.7	9'-11'	1.00	33.36	25.79	7.57	24.79	**30.54**
No.9	15'-17'	1.00	31.55	28.03	3.52	27.03	**13.02**
No.12	21'-23'	1.00	37.45	33.12	4.33	32.12	**13.48**
No.13	26'-28'	1.00	27.10	23.26	3.84	22.26	**17.25**
No.15	31'-33'	1.00	27.56	24.65	2.91	23.65	**12.30**

US290-WE-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	3'-5'	1.00	33.40	27.31	6.09	26.31	**23.15**
No.4	5'-7'	1.00	29.59	25.71	3.88	24.71	**15.70**
No.6	9'-11'	1.00	34.03	28.47	5.56	27.47	**20.24**
No.8	15'-17'	1.00	31.99	24.85	7.14	23.85	**29.94**
No.10	21'-23'	1.00	38.26	32.30	5.96	31.3	**19.04**
No.13	26'-28'	1.00	29.54	25.85	3.69	24.85	**14.85**
No.15	31'-33'	1.00	35.72	31.20	4.52	30.2	**14.97**

US290-WE-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.2	5'-7'	1.00	35.08	30.13	4.95	29.13	**16.99**
No.5	9'-11'	1.00	39.43	34.29	5.14	33.29	**15.44**
No.8	15'-17'	1.00	28.16	21.32	6.84	20.32	**33.66**
No.11	21'-23'	1.00	29.72	24.32	5.4	23.32	**23.16**
No.14	26'-28'	1.00	16.26	13.30	2.96	12.3	**24.07**
No.16	31'-33'	1.00	29.27	25.45	3.82	24.45	**15.62**

US290-WW-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	23.20	19.59	3.61	18.59	**19.42**
No.3	5'-7'	1.00	38.01	31.78	6.23	30.78	**20.24**
No.5	9'-11'	1.00	43.45	36.12	7.33	35.12	**20.87**
No.7	15'-17'	1.00	22.90	18.48	4.42	17.48	**25.29**
No.9	21'-23'	1.00	21.69	18.33	3.36	17.33	**19.39**
No.12	26'-28'	1.00	55.60	46.65	8.95	45.65	**19.61**
No.15	31'-33'	1.00	34.60	29.72	4.88	28.72	**16.99**

US290-WW-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	26.48	22.53	3.95	21.53	**18.35**
No.4	5'-7'	1.00	33.90	28.52	5.38	27.52	**19.55**
No.6	9'-11'	1.00	22.78	19.25	3.53	18.25	**19.34**
No.9	15'-17'	1.00	41.60	34.88	6.72	33.88	**19.83**
No.11	21'-23'	1.00	31.48	27.16	4.32	26.16	**16.51**
No.13	31'-33'	1.00	50.80	43.96	6.84	42.96	**15.92**

SH249-NS-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	0.98	14.51	11.57	2.94	10.59	**27.76**
No.2	3'-5'	1.00	15.27	13.61	1.66	12.61	**13.16**
No.3	5'-7'	0.94	36.02	29.48	6.54	28.54	**22.92**
No.4	5'-7'	0.98	24.81	20.39	4.42	19.41	**22.77**
No.5	5'-7'	0.98	20.51	18.53	1.98	17.55	**11.28**
No.6	9'-11'	0.99	18.11	14.50	3.61	13.51	**26.72**
No.7	9'-11'	0.96	27.21	21.86	5.35	20.9	**25.60**
No.8	15'-17'	1.00	37.26	31.96	5.30	30.96	**17.12**
No.9	15'-17'	1.01	31.99	26.50	5.49	25.49	**21.54**

SH249-SS-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.02	29.31	24.93	4.38	23.91	**18.32**
No.2	5'-7'	1.02	39.26	33.04	6.22	32.02	**19.43**
No.3	5'-7'	1.02	37.75	31.79	5.96	30.77	**19.37**
No.4	9'-11'	1.02	15.51	13.58	1.93	12.56	**15.37**
No.5	9'-11'	1.02	32.10	26.67	5.43	25.65	**21.17**
No.6	15'-17'	1.02	34.34	27.90	6.44	26.88	**23.96**
No.7	26'-28'	1.02	28.44	24.65	3.79	23.63	**16.04**
No.8	26'-28'	1.02	40.55	35.37	5.18	34.35	**15.08**
No.9	31'-33'	1.02	31.10	26.41	4.69	25.39	**18.47**
No.10	31'-33'	1.02	19.87	16.92	2.95	15.9	**18.55**

SH249-SS-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.02	28.06	24.23	3.83	23.21	**16.50**
No.2	5'-7'	1.02	33.53	27.23	6.30	26.21	**24.04**
No.3	5'-7'	1.02	23.39	18.99	4.40	17.97	**24.49**
No.4	9'-11'	1.02	39.13	34.11	5.02	33.09	**15.17**
No.5	15'-17'	1.02	30.59	25.30	5.29	24.28	**21.79**
No.6	15'-17'	1.02	25.32	20.65	4.67	19.63	**23.79**
No.7	21'-23'	1.02	32.70	28.49	4.21	27.47	**15.33**
No.8	26'-28'	1.02	29.41	25.14	4.27	24.12	**17.70**
No.9	26'-28'	1.02	29.96	26.16	3.80	25.14	**15.12**
No.10	26'-28'	1.02	21.23	18.73	2.50	17.71	**14.12**
No.11	31'-33'	1.02	31.65	27.01	4.64	25.99	**17.85**
No.12	31'-33'	1.02	31.48	26.35	5.13	25.33	**20.25**

SH249-SN-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	43.40	37.46	5.94	36.46	**16.29**
No.3	5'-7'	1.00	32.59	28.75	3.84	27.75	**13.84**
No.6	9'-11'	1.00	37.25	31.78	5.47	30.78	**17.77**
No.9	15'-17'	1.00	23.63	19.46	4.17	18.46	**22.59**
No.10	21'-23'	1.00	43.31	38.47	4.84	37.47	**12.92**
No.12	26'-28'	1.00	44.82	39.02	5.8	38.02	**15.26**
No.14	31'-33'	1.00	43.32	36.93	6.39	35.93	**17.78**

SH249-SN-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	32.86	28.89	3.97	27.89	**14.23**
No.2	5'-7'	1.00	63.31	55.48	7.83	54.48	**14.37**
No.4	9'-11'	1.00	38.64	34.85	3.79	33.85	**11.20**
No.6	15'-17'	1.00	41.90	33.91	7.99	32.91	**24.28**
No.8	21'-23'	1.00	40.04	34.83	5.21	33.83	**15.40**
No.10	26'-28'	1.00	26.59	23.04	3.55	22.04	**16.11**
No.13	31'-33'	1.00	40.21	33.89	6.32	32.89	**19.22**

SH249-NN-STS-1
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	35.56	30.32	5.24	29.32	**17.87**
No.3	3'-5'	1.00	26.95	23.66	3.29	22.66	**14.52**
No.5	5'-7'	1.00	42.84	36.98	5.86	35.98	**16.29**
No.6	9'-11'	1.00	22.63	20.36	2.27	19.36	**11.73**
No.7	15'-17'	1.00	29.41	23.85	5.56	22.85	**24.33**
No.8	15'-17'	1.00	24.76	20.36	4.4	19.36	**22.73**
No.9	21'-23'	1.00	48.16	43.04	5.12	42.04	**12.18**

SH249-NN-STS-2
Water Content

Sample No.	Depth (ft)	Cup Weight	Cup+Wet Soil	Cup+Dry Soil	Water Wt.	Soil Wt.	**W/C**
No.1	3'-5'	1.00	24.24	21.73	2.51	20.73	**12.11**
No.2	3'-5'	1.00	27.23	23.85	3.38	22.85	**14.79**
No.5	5'-7'	1.00	27.20	23.38	3.82	22.38	**17.07**
No.6	5'-7'	1.00	24.33	21.62	2.71	20.62	**13.14**
No.7	9'-11'	1.00	28.68	25.44	3.24	24.44	**13.26**
No.8	15'-17'	1.00	30.72	26.44	4.28	25.44	**16.82**
No.10	15'-17'	1.00	26.29	22.88	3.41	21.88	**15.59**

APPENDIX H UNIT WEIGHT TEST

US290-EE-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	2.99	3.02	3.01	3.005	5.480	5.488	5.368	5.445	38.62	1255.0	2.7668	123.80	17.34	105.50
No.4	3.01	2.96	2.99	2.987	4.691	4.742	4.721	4.718	33.07	1166.7	2.5721	134.41	18.66	113.27
No.6	3.03	3.01	2.99	3.009	4.111	3.962	4.026	4.033	28.67	1014.5	2.2366	134.79	12.48	119.83
No.8	3.00	3.01	2.98	2.997	5.557	5.504	5.492	5.518	38.92	1398.6	3.0834	136.88	16.27	117.73
No.13	3.00	3.02	3.02	3.014	4.573	4.567	4.536	4.559	32.52	1170.4	2.5803	137.09	11.86	122.56

US290-EE-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.03	3.01	3.03	3.022	3.727	3.728	3.755	3.737	26.80	879.5	1.9389	125.04	17.15	106.73
No.5	3.00	3.00	2.99	2.995	4.536	4.582	4.610	4.576	32.25	1181.2	2.6041	139.55	13.70	122.73
No.7	3.01	3.00	3.00	3.003	3.355	3.388	3.391	3.378	23.93	820.5	1.8089	130.64	13.71	114.90
No.9	3.00	2.96	3.00	2.987	4.764	4.784	4.812	4.787	33.53	1248.2	2.7518	141.80	12.26	126.31
No.11	2.97	2.98	2.91	2.956	4.663	4.708	4.681	4.684	32.14	1084.4	2.3907	128.54	17.10	109.77
No.12	3.00	3.00	3.02	3.003	4.348	4.428	4.385	4.387	31.07	1107.8	2.4423	135.82	13.41	119.76
No.13	2.98	3.02	3.02	3.006	3.364	3.411	3.289	3.355	23.81	795.3	1.7533	127.26	14.85	110.81

US290-EW-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.00	2.97	2.98	2.983	4.200	4.160	4.140	4.167	29.13	996.2	2.1962	130.29	25.83	103.55
No.5	3.01	3.02	3.00	3.010	4.690	4.710	4.690	4.697	33.42	1078.8	2.3783	122.97	27.16	96.71
No.7	3.00	3.06	3.03	3.030	4.140	4.190	4.150	4.160	30.00	1064.3	2.3463	135.16	27.01	106.42
No.8	2.98	2.96	2.99	2.977	2.820	2.810	2.840	2.823	19.65	721.4	1.5904	139.88	14.17	122.51
No.11	3.00	3.03	3.00	3.011	2.405	2.465	2.457	2.442	17.39	598.2	1.3188	131.07	15.36	113.62
No.12	3.02	3.03	3.01	3.022	5.326	5.347	5.292	5.322	38.16	1268.0	2.7954	126.58	24.97	101.29

US290-EW-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.00	2.99	2.99	2.993	4.375	4.366	4.345	4.362	30.69	1076.5	2.3733	133.63	20.92	110.51
No.4	2.99	3.00	3.00	2.997	3.810	3.810	3.780	3.800	26.80	952.4	2.0997	135.38	14.84	117.88
No.7	2.95	2.97	3.00	2.973	4.390	4.380	4.360	4.377	30.39	1017.1	2.2422	127.50	30.54	97.67
No.9	2.97	2.98	2.98	2.977	3.660	3.690	3.700	3.683	25.63	922.5	2.0337	137.10	13.02	121.30
No.12	2.99	3.00	2.99	2.993	4.610	4.680	4.630	4.640	32.65	1133.8	2.4996	132.28	13.48	116.57
No.13	2.99	2.98	3.00	2.990	4.230	4.240	4.230	4.233	29.72	1038.2	2.2887	133.05	17.25	113.48
No.15	2.98	2.99	3.01	2.993	4.560	4.590	4.590	4.580	32.23	1167.7	2.5742	138.02	12.30	122.89

US290-WE-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.01	3.01	3.03	3.017	4.683	4.632	4.623	4.646	33.22	1154.1	2.5443	132.34	23.15	107.47
No.4	2.97	2.99	3.00	2.985	4.517	4.520	4.449	4.495	31.47	1097.5	2.4195	132.87	15.70	114.84
No.6	3.00	3.00	3.03	3.011	4.598	4.632	4.580	4.603	32.78	1188.8	2.6208	138.17	20.24	114.91
No.8	3.00	3.01	3.03	3.012	4.758	4.797	4.878	4.811	34.29	1127.7	2.4861	125.30	29.94	96.43
No.10	2.99	2.98	3.03	3.000	4.853	4.890	4.949	4.897	34.61	1199.0	2.6433	131.98	19.04	110.87
No.13	3.00	3.00	3.02	3.008	4.698	4.660	4.644	4.667	33.17	1182.9	2.6078	135.83	14.85	118.27
No.15	3.02	3.02	3.00	3.013	5.960	5.839	5.799	5.866	41.82	1523.9	3.3596	138.80	14.97	120.73

US290-WE-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.02	3.00	3.00	3.005	4.303	4.365	4.284	4.317	30.62	1070.2	2.3594	133.15	16.99	113.81
No.5	2.99	3.01	2.98	2.996	5.081	5.091	5.058	5.077	35.78	1303.9	2.8746	138.82	15.44	120.26
No.8	2.85	2.98	2.82	2.885	2.431	2.466	2.460	2.452	16.03	519.5	1.1453	123.48	33.66	92.38
No.11	3.01	3.02	2.99	3.008	5.497	5.525	5.398	5.473	38.89	1292.1	2.8486	126.58	23.16	102.78
No.14	3.03	3.02	3.00	3.016	4.325	4.300	4.281	4.302	30.73	1042.7	2.2987	129.24	24.07	104.17
No.16	3.02	3.01	3.01	3.016	6.017	6.033	6.045	6.032	43.08	1546.3	3.4090	136.73	15.62	118.26

US290-WW-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	2.93	2.77	2.86	2.853	3.870	3.900	3.820	3.863	24.70	823.0	1.8144	126.92	19.42	106.28
No.3	3.05	2.97	3.03	3.017	4.659	4.775	4.719	4.718	33.73	1136.1	2.5046	128.33	20.24	106.73
No.5	3.00	2.98	2.99	2.987	5.270	5.315	5.187	5.257	36.85	1339.3	2.9526	138.46	20.87	114.55
No.7	3.02	2.99	3.00	3.003	4.170	4.240	4.180	4.197	29.73	973.6	2.1464	124.75	25.29	99.58
No.9	2.99	2.93	2.95	2.956	4.975	4.971	4.936	4.961	34.04	1170.8	2.5811	131.01	19.39	109.74
No.12	3.01	3.01	3.00	3.007	5.080	5.060	5.070	5.070	36.00	1277.9	2.8173	135.24	19.61	113.07
No.15	2.99	2.99	3.01	2.997	5.360	5.330	5.340	5.343	37.69	1340.0	2.9542	135.46	16.99	115.78

US290-WW-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	3.01	3.02	3.01	3.013	3.911	3.935	3.913	3.920	27.95	970.0	2.1385	132.19	18.35	111.70
No.4	3.02	3.02	3.04	3.027	4.220	4.210	4.220	4.217	30.34	1088.6	2.3999	136.70	19.55	114.34
No.6	3.01	3.03	3.03	3.022	3.921	3.908	3.929	3.919	28.12	980.8	2.1623	132.88	19.34	111.35
No.9	2.96	2.90	2.96	2.940	4.550	4.530	4.540	4.540	30.82	1076.7	2.3737	133.08	19.83	111.06
No.11	3.02	2.91	3.02	2.981	4.705	4.714	4.760	4.726	32.98	1150.8	2.5371	132.93	16.51	114.09
No.13	3.01	3.01	3.02	3.013	5.240	5.260	5.260	5.253	37.46	1357.7	2.9932	138.06	15.92	119.10

SH249-NS-STS-2
Unit Weight

	Diameter (in.)				Ave. Dia.	Height (in.)		Ave. Ht.	Volume	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top 1	Top 2	Buttom 1	Buttom 2	(in.)	H1	H2	(in.)	(in.^3)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.6	3.06	3.04	3.01	3.006	3.029	2.653	2.786	2.719	19.59	1.3	113.3672	26.72	89.46
No.7	2.99	3.01	2.98	2.989	2.994	4.187	4.171	4.179	29.41	2.0	117.3305	25.60	93.42

SH249-SS-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	3.00	2.98	2.97	2.983	4.552	4.607	4.598	4.586	32.05	1101.7	2.4287	130.94	19.43	109.64
No.3	2.98	2.95	2.93	2.954	4.547	4.572	4.554	4.558	31.23	1053.7	2.3229	128.53	19.37	107.67
No.4	2.98	2.98	3.00	2.985	4.584	4.507	4.593	4.561	31.91	1131.8	2.4951	135.11	15.37	117.11
No.6	2.97	2.98	2.97	2.976	4.962	5.044	5.003	5.003	34.80	1109.7	2.4463	121.49	23.96	98.01
No.7	3.01	3.00	3.01	3.007	4.585	4.531	4.541	4.552	32.34	1139.3	2.5117	134.22	16.04	115.67
No.8	3.03	3.01	2.99	3.006	4.848	4.850	4.846	4.848	34.42	1210.1	2.6678	133.95	15.08	116.40
No.10	2.99	2.99	2.98	2.987	5.072	5.076	5.031	5.060	35.46	1219.1	2.6876	130.97	18.55	110.47

SH249-SS-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.2	2.97	2.99	3.01	2.990	5.205	5.301	5.241	5.249	36.87	1196.0	2.6366	123.58	24.04	99.63
No.3	2.93	2.99	2.98	2.966	4.812	4.864	4.813	4.830	33.37	1115.4	2.4589	127.35	24.49	102.30
No.5	3.01	3.01	3.00	3.007	4.973	4.939	4.972	4.961	35.22	1166.7	2.5721	126.19	21.79	103.61
No.6	3.02	3.01	3.03	3.018	4.668	4.651	4.614	4.644	33.22	1099.1	2.4232	126.06	23.79	101.83
No.8	2.99	2.99	3.01	2.999	4.937	4.926	5.012	4.958	35.03	1209.2	2.6658	131.52	17.70	111.74
No.9	3.00	2.99	2.97	2.987	5.289	5.338	5.299	5.309	37.20	1325.2	2.9215	135.73	15.12	117.90
No.10	3.02	3.01	3.00	3.011	5.020	5.021	5.104	5.048	35.96	1258.9	2.7754	133.38	14.12	116.88
No.11	3.01	2.99	3.00	3.000	5.085	5.054	5.079	5.073	35.86	1251.9	2.7599	132.99	17.85	112.84
No.12	3.02	2.98	3.01	3.002	5.286	5.319	5.273	5.293	37.47	1241.6	2.7372	126.22	20.25	104.97

SH249-SN-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	2.96	2.97	2.97	2.966	3.072	3.043	3.124	3.080	21.27	750.5	1.6546	134.42	16.29	115.59
No.3	3.01	3.02	3.02	3.015	4.834	4.874	4.861	4.856	34.67	1249.6	2.7549	137.32	13.84	120.63
No.6	3.00	3.00	2.96	2.990	4.823	4.815	4.779	4.805	33.73	1101.3	2.4279	124.39	17.77	105.62
No.9	2.99	3.00	3.01	3.000	5.430	5.452	5.440	5.440	38.44	1302.5	2.8715	129.07	22.59	105.29
No.10	3.02	3.00	3.00	3.007	3.919	3.936	3.928	3.927	27.89	989.1	2.1806	135.09	12.92	119.63
No.12	3.03	3.05	3.03	3.036	5.438	5.468	5.419	5.441	39.40	1344.5	2.9641	130.00	15.26	112.80
No.14	3.04	3.01	3.01	3.018	5.130	5.130	5.146	5.135	36.74	1248.1	2.7516	129.41	17.78	109.87

SH249-SN-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	3.00	3.00	2.98	2.992	4.549	4.545	4.489	4.528	31.83	1100.3	2.4257	131.67	14.23	115.27
No.2	3.00	2.99	2.99	2.993	4.444	4.449	4.483	4.458	31.36	1085.6	2.3933	131.88	14.37	115.30
No.4	3.01	2.96	3.01	2.995	5.127	5.071	5.103	5.100	35.93	1287.9	2.8393	136.55	11.20	122.80
No.6	2.99	3.01	3.01	3.004	5.292	5.295	5.232	5.273	37.36	1226.7	2.7044	125.08	24.28	100.64
No.8	3.05	3.03	3.02	3.035	5.008	5.045	4.997	5.017	36.28	1198.4	2.6420	125.82	15.40	109.03
No.10	3.03	3.03	3.03	3.033	5.422	5.474	5.487	5.461	39.46	1337.3	2.9482	129.11	16.11	111.20
No.13	3.00	3.00	3.01	3.004	5.329	5.306	5.345	5.326	37.75	1336.0	2.9453	134.81	19.22	113.08

SH249-NN-STS-1
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	3.00	3.00	3.00	3.000	3.870	3.920	3.810	3.867	27.33	919.7	2.0276	128.19	17.87	108.75
No.3	3.00	3.00	3.01	3.003	3.830	3.740	3.780	3.783	26.80	977.3	2.1546	138.91	14.52	121.30
No.5	3.00	3.00	3.00	3.000	3.940	3.930	3.880	3.917	27.69	948.8	2.0917	130.56	16.29	112.27
No.6	3.01	2.99	3.00	3.000	3.920	3.880	3.860	3.887	27.47	982.4	2.1658	136.22	11.73	121.93
No.7	3.00	3.00	3.00	3.000	3.900	3.880	3.890	3.890	27.50	919.6	2.0274	127.41	24.33	102.47
No.8	3.02	3.00	3.00	3.007	4.510	4.500	4.500	4.503	31.97	1070.1	2.3591	127.50	22.73	103.89
No.9	3.01	3.00	2.99	3.000	2.060	2.060	2.070	2.063	14.58	502.7	1.1081	131.29	12.18	117.04

SH249-NN-STS-2
Unit Weight

	Diameter (in.)			Ave. Dia.	Height (in.)			Ave. Ht.	Volume	Weight	Weight	Unit Wt.	W/C	Dry Unit Wt.
	Top	Middle	Buttom	(in.)	H1	H2	H3	(in.)	(in.^3)	(g)	(lb)	(lb/ft^3)	(%)	(lb/ft^3)
No.1	3.00	3.00	3.00	3.000	3.940	3.900	3.900	3.913	27.66	1012.6	2.2324	139.45	12.11	124.39
No.2	3.00	3.00	3.00	3.000	3.600	3.620	3.590	3.603	25.47	883.7	1.9482	132.17	14.79	115.14
No.5	3.00	3.00	3.00	3.000	3.010	3.010	3.030	3.017	21.32	750.5	1.6546	134.08	17.07	114.53
No.6	3.00	3.00	3.00	3.000	3.940	3.960	3.880	3.927	27.76	958.2	2.1124	131.51	13.14	116.24
No.7	3.00	3.00	3.00	3.000	2.800	2.840	2.870	2.837	20.05	731.9	1.6135	139.05	13.26	122.78
No.8	3.00	3.00	3.00	3.000	4.130	4.120	4.120	4.123	29.15	1029.3	2.2692	134.53	16.82	115.16
No.10	3.00	3.00	3.00	3.000	4.460	4.420	4.420	4.433	31.34	1095.7	2.4156	133.20	15.59	115.24

APPENDIX I ATTERBERG LIMIT TEST

US290-EE-STS-1-No. 2-Atterberg Limit Test

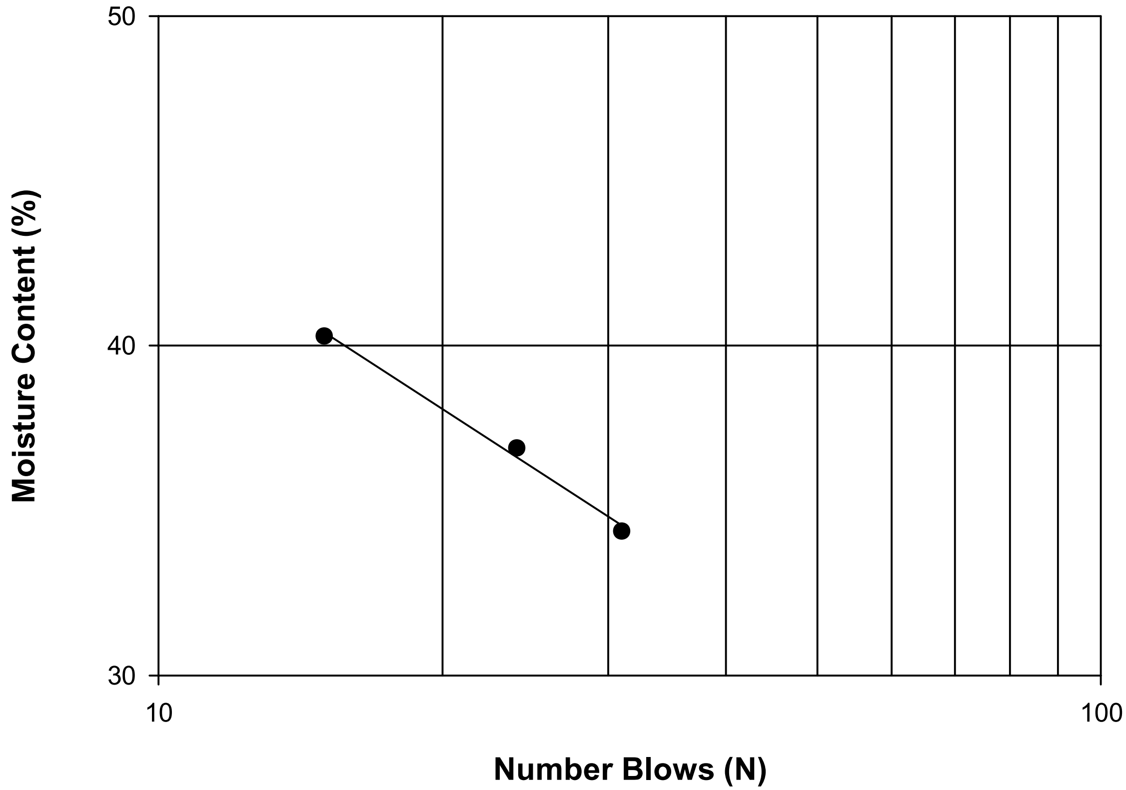
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 2	3' - 5'	1.00	10.07	7.75	2.32	6.75	31	**34.37**
		1.00	10.39	7.86	2.53	6.86	24	**36.88**
		1.00	10.54	7.80	2.74	6.80	15	**40.29**
Liquid Limit								**36.28**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 2	3' - 5'	0.99	2.35	2.21	0.14	1.22		**11.48**
		0.98	2.13	2.00	0.13	1.02		**12.75**
Plastic Limit								**12.11**

US290-EE-STS-1-No. 2 LIQUID LIMIT TEST



US290-EE-STS-1-No. 13-Atterberg Limit Test

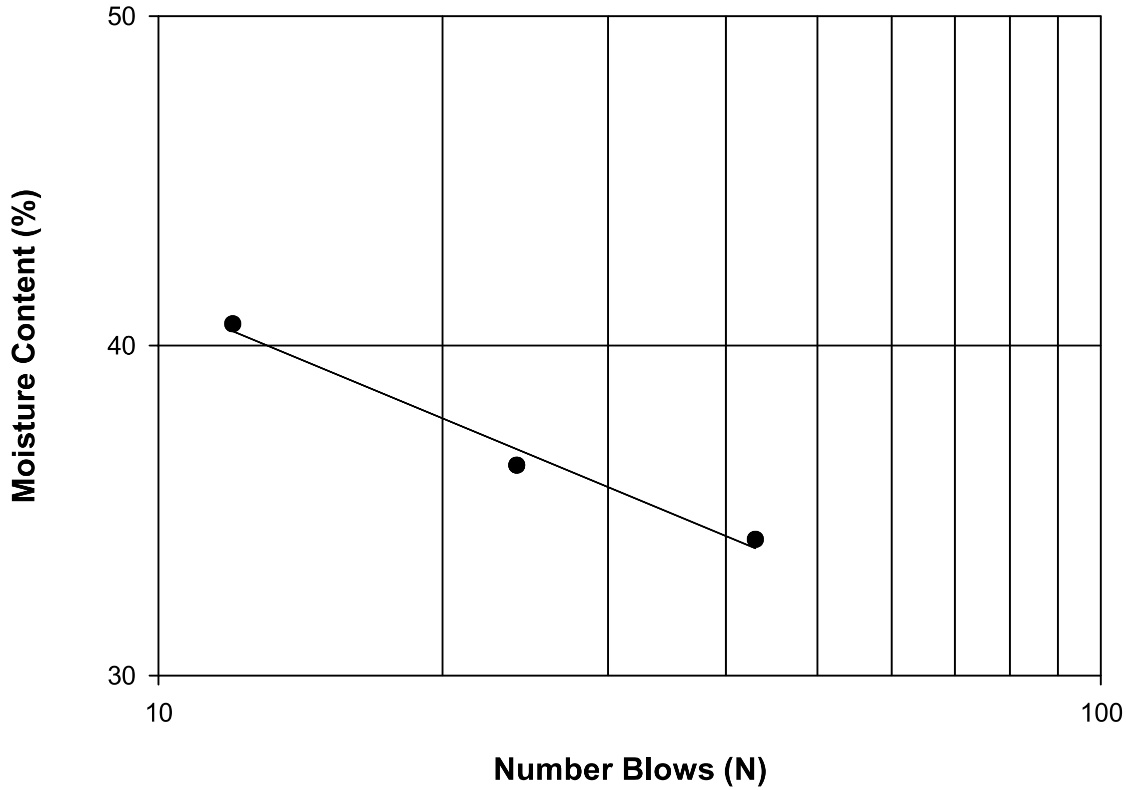
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	8.05	6.17	1.88	5.17	24	**36.36**
		1.00	8.75	6.51	2.24	5.51	12	**40.65**
		1.00	8.43	6.54	1.89	5.54	43	**34.12**
Liquid Limit								**36.64**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	2.64	2.47	0.17	1.47		**11.56**
		1.00	2.50	2.37	0.13	1.37		**9.49**
Plastic Limit								**10.53**

US290-EE-STS-1-No. 13 LIQUID LIMIT TEST



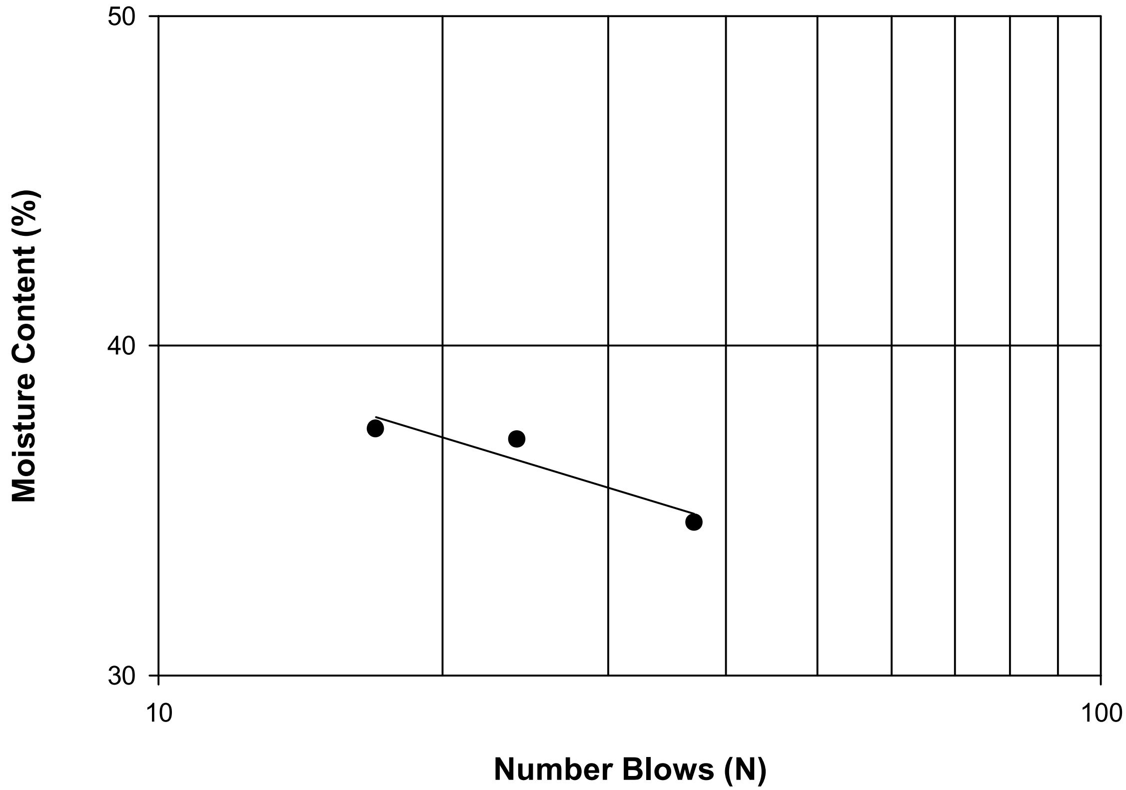
US290-EE-STS-2-No. 5-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 5	3' - 5'	1.00	9.63	7.41	2.22	6.41	37	**34.63**
		1.00	10.93	8.24	2.69	7.24	24	**37.15**
		1.00	8.85	6.71	2.14	5.71	17	**37.48**
Liquid Limit								**36.38**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 5	3' - 5'	0.99	2.33	2.22	0.11	1.23		**8.94**
		0.98	1.96	1.85	0.11	0.87		**12.64**
Plastic Limit								**10.79**

US290-EE-STS-2-No. 5 LIQUID LIMIT TEST



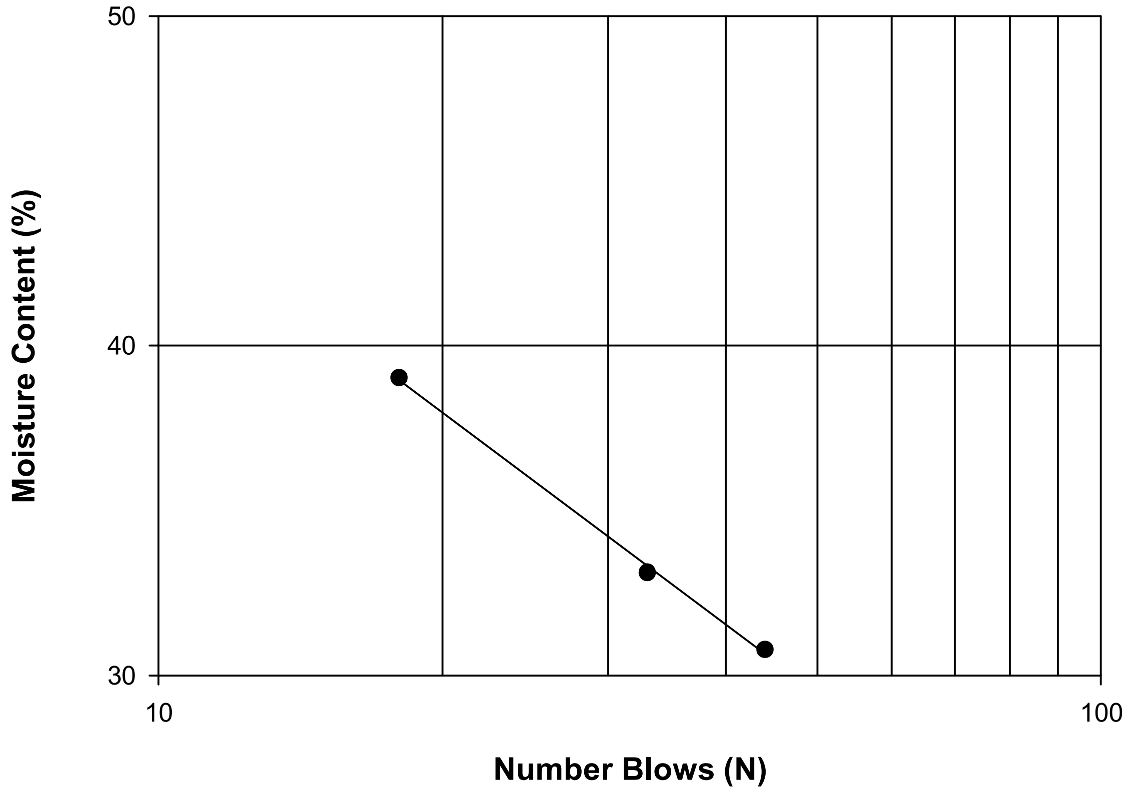
US290-EE-STS-2-No. 12-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	9.03	7.14	1.89	6.14	44	**30.78**
		1.00	8.80	6.86	1.94	5.86	33	**33.11**
		1.00	10.94	8.15	2.79	7.15	18	**39.02**
Liquid Limit								**35.90**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	2.66	2.50	0.16	1.5		**10.67**
		1.00	2.16	2.05	0.11	1.05		**10.48**
Plastic Limit								**10.57**

US290-EE-STS-2-No. 12 LIQUID LIMIT TEST



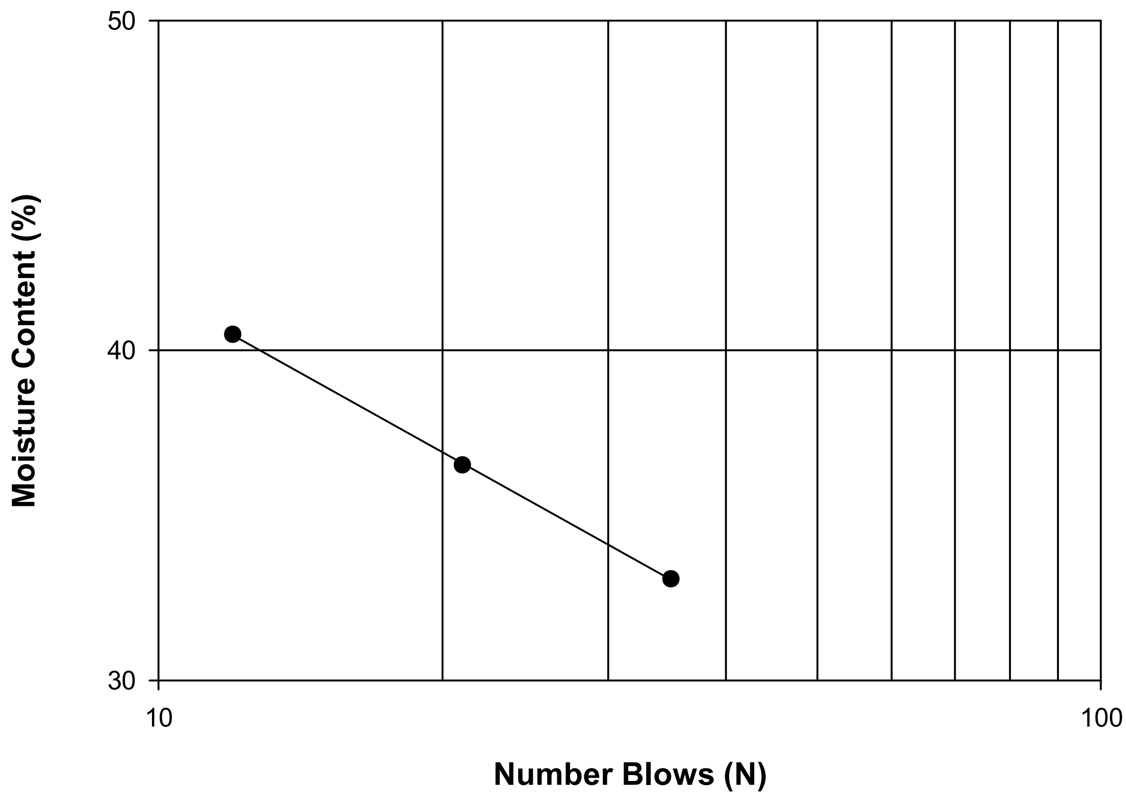
US290-EW-STS-1-No. 1-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	10.94	8.47	2.47	7.47	35	**33.07**
		1.00	9.75	7.41	2.34	6.41	21	**36.51**
		1.00	10.06	7.45	2.61	6.45	12	**40.47**
Liquid Limit								**38.88**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	0.99	2.41	2.22	0.19	1.23		**15.45**
		0.98	2.42	2.21	0.21	1.23		**17.07**
Plastic Limit								**16.26**

US290-EW-STS-1-No. 1 LIQUID LIMIT TEST



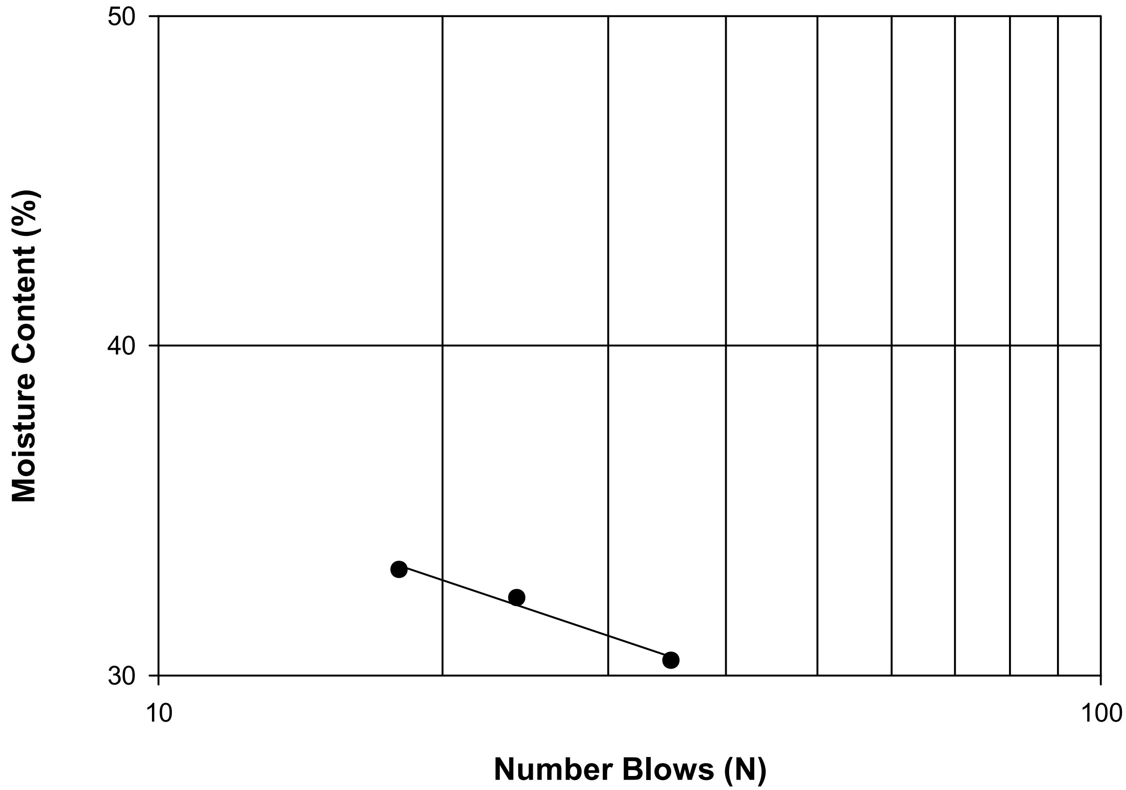
US290-EW-STS-1-No. 13-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	10.04	7.93	2.11	6.93	35	**30.45**
		1.00	13.07	10.12	2.95	9.12	24	**32.35**
		1.00	10.67	8.26	2.41	7.26	18	**33.20**
Liquid Limit								**31.95**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	2.37	2.23	0.14	1.23		**11.38**
		1.00	2.80	2.57	0.23	1.57		**14.65**
Plastic Limit								**13.02**

US290-EW-STS-1-No. 13 LIQUID LIMIT TEST



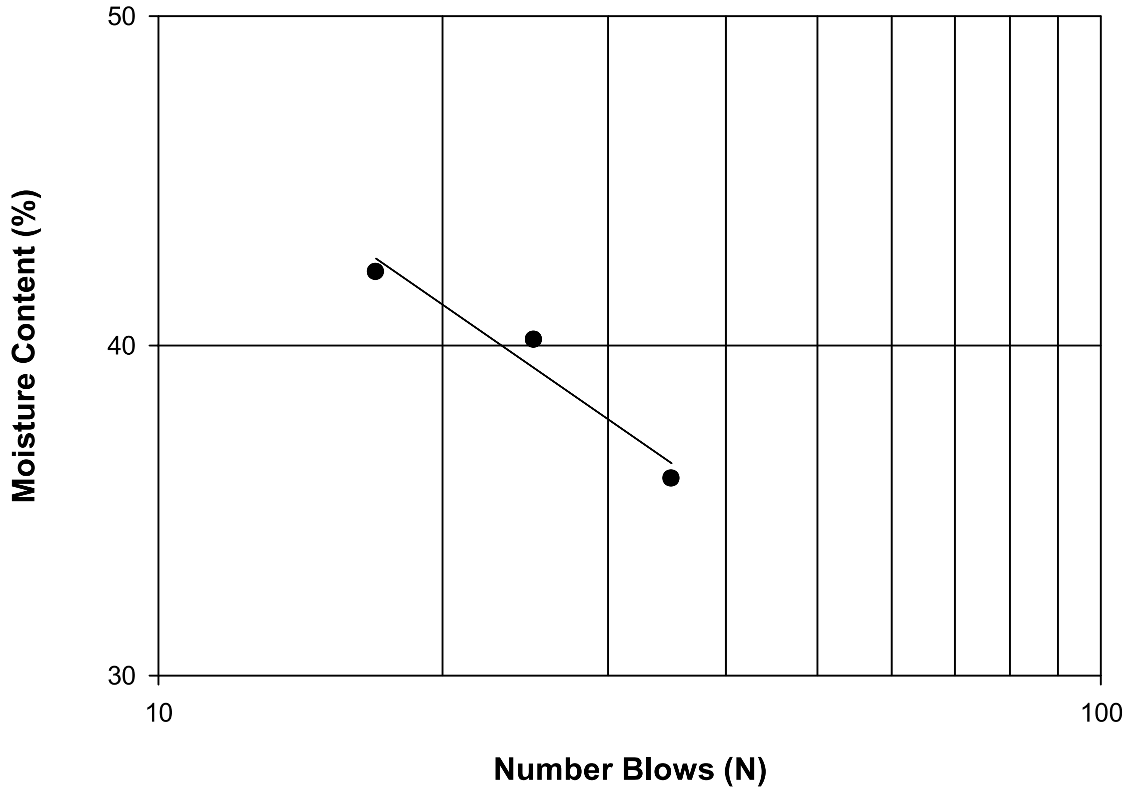
US290-EW-STS-2-No. 2-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	1.00	11.28	8.56	2.72	7.56	35	**35.98**
		1.00	10.21	7.57	2.64	6.57	25	**40.18**
		1.00	12.82	9.31	3.51	8.31	17	**42.24**
Liquid Limit								**39.33**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	0.99	2.44	2.25	0.19	1.26		**15.08**
		0.98	2.29	2.11	0.18	1.13		**15.93**
Plastic Limit								**15.50**

US290-EW-STS-2-No. 2 LIQUID LIMIT TEST



US290-EW-STS-2-No. 13-Atterberg Limit Test

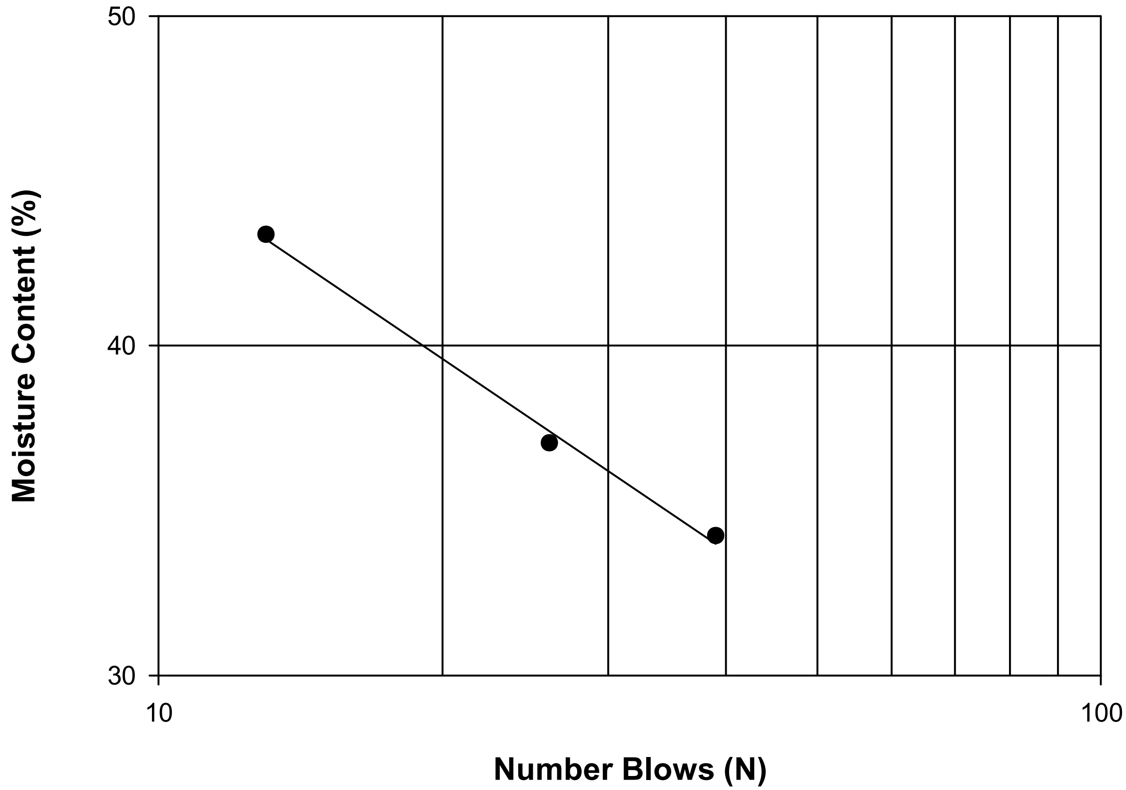
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	8.77	6.67	2.1	5.67	26	**37.04**
		1.00	10.02	7.72	2.30	6.72	39	**34.23**
		1.00	9.20	6.72	2.48	5.72	13	**43.36**
Liquid Limit								**37.73**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 13	26' - 28'	1.00	1.94	1.82	0.12	0.82		**14.63**
		1.00	1.69	1.60	0.09	0.60		**15.00**
Plastic Limit								**14.82**

US290-EW-STS-2-No. 13 LIQUID LIMIT TEST



US290-WE-STS-1-No. 2-Atterberg Limit Test

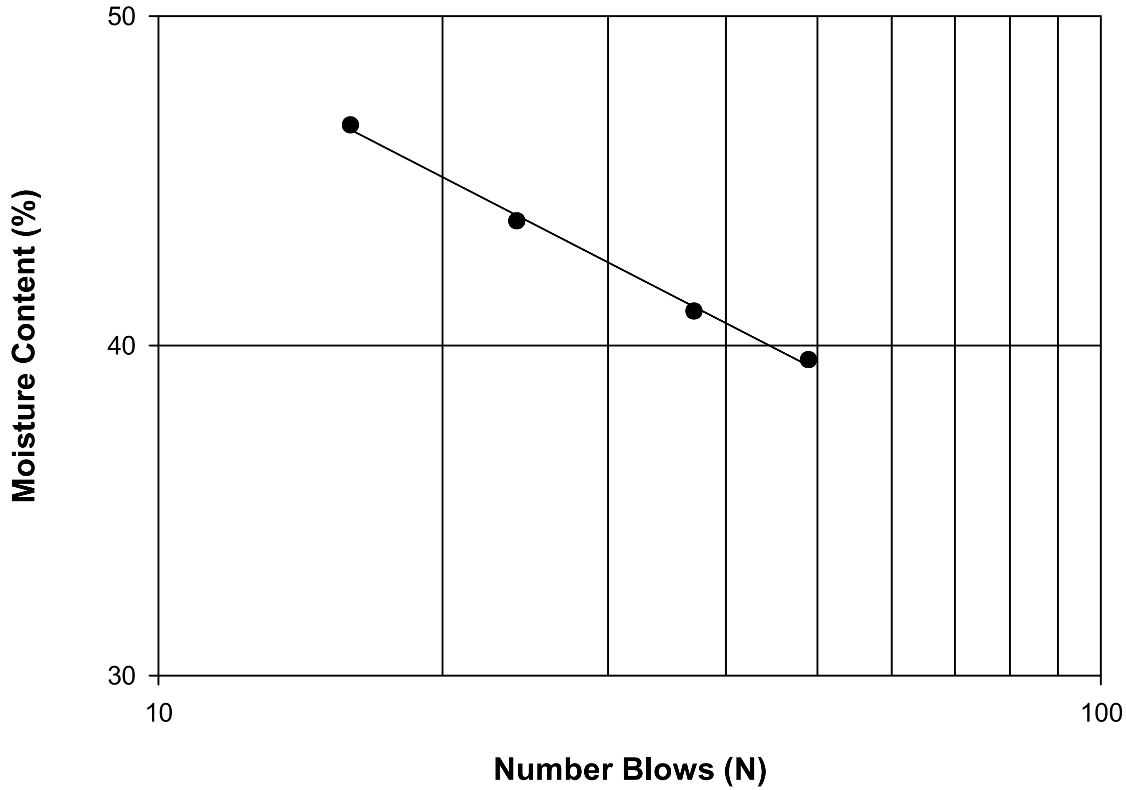
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	1.00	8.02	6.03	1.99	5.03	49	**39.56**
		1.00	8.32	6.19	2.13	5.19	37	**41.04**
		1.00	8.85	6.46	2.39	5.46	24	**43.77**
		1.00	8.54	6.14	2.40	5.14	16	**46.69**
Liquid Limit								**43.69**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	0.99	3.65	3.29	0.36	2.3		**15.65**
		0.98	3.16	2.89	0.27	1.91		**14.14**
Plastic Limit								**14.89**

US290-WE-STS-1-No. 2 LIQUID LIMIT TEST



US290-WE-STS-1-No. 13-Atterberg Limit Test

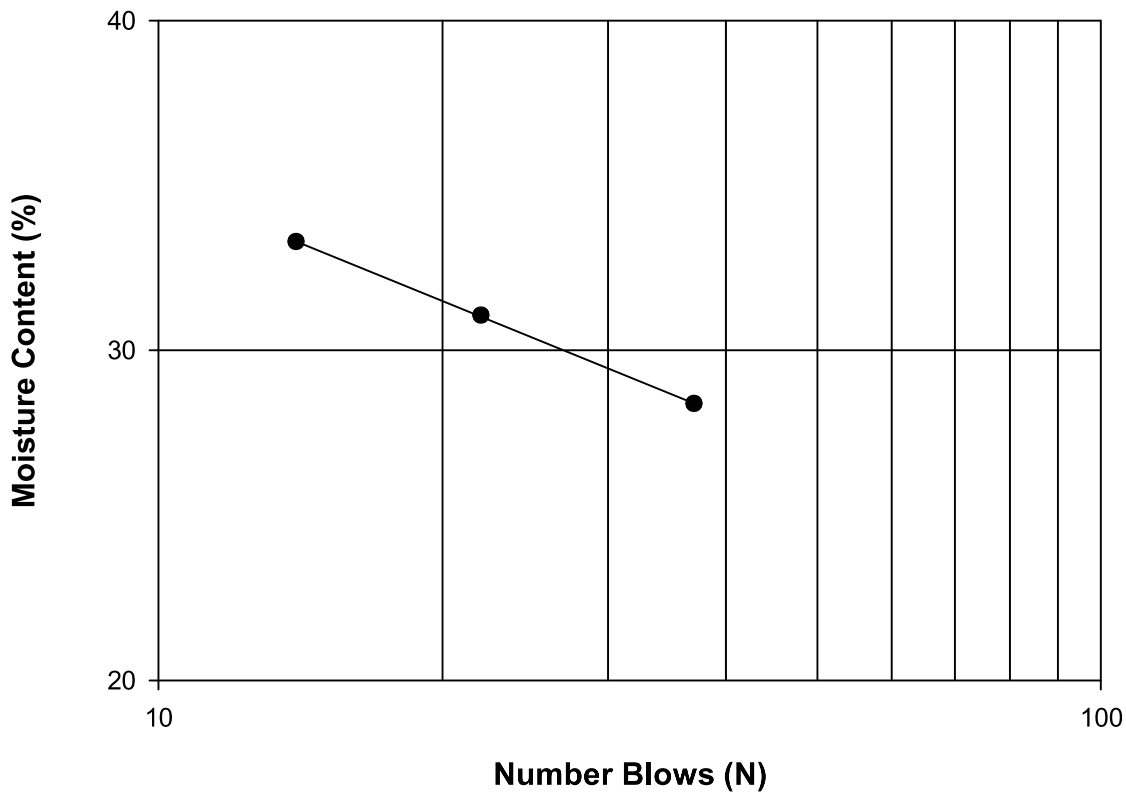
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 13	26' - 28'	1.00	11.36	9.07	2.29	8.07	37	**28.38**
		1.00	12.10	9.47	2.63	8.47	22	**31.05**
		1.00	12.53	9.65	2.88	8.65	14	**33.29**
Liquid Limit								**30.38**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 13	26' - 28'	1.00	N/A	N/A				
		1.00	N/A	N/A				
Plastic Limit								**Non Plastic**

US290-WE-STS-1-No. 13 LIQUID LIMIT TEST



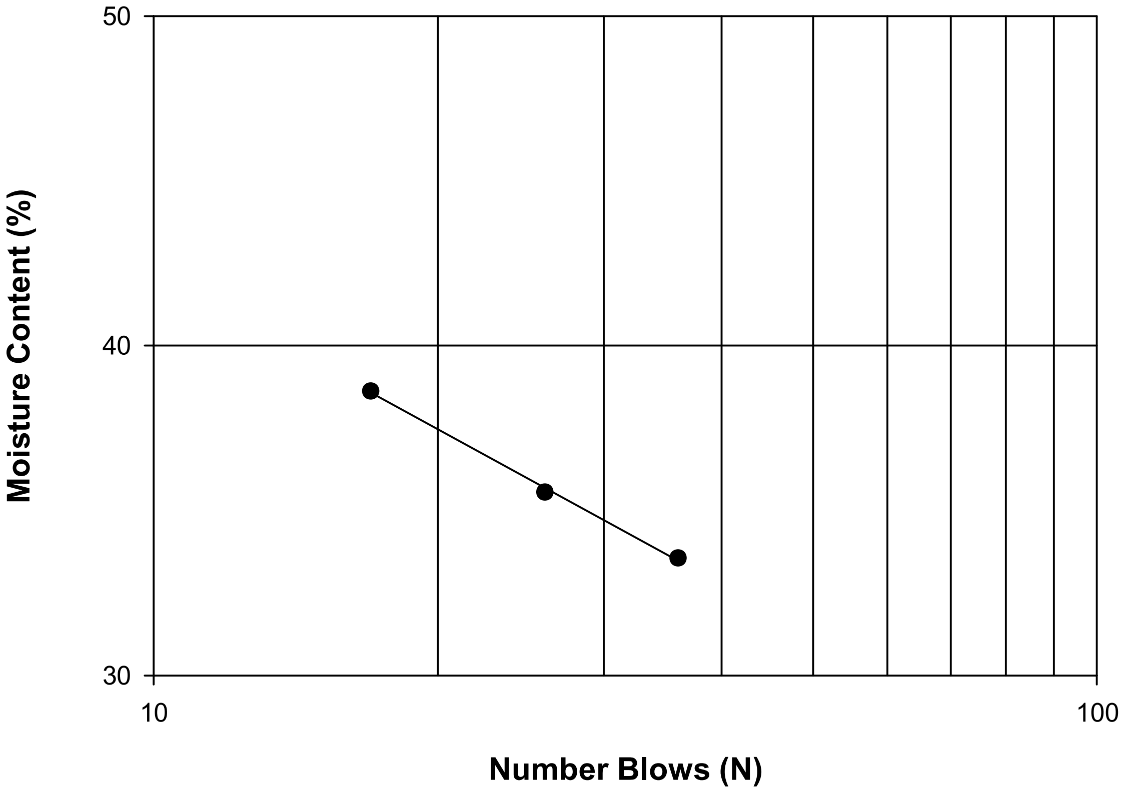
US290-WE-STS-2-No. 2-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	1.00	9.64	7.47	2.17	6.47	36	**33.54**
		1.00	9.81	7.50	2.31	6.50	26	**35.54**
		1.00	11.41	8.51	2.90	7.51	17	**38.62**
Liquid Limit								**35.94**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 2	3' - 5'	0.99	1.91	1.83	0.08	0.84		**9.52**
		0.98	1.92	1.82	0.10	0.84		**11.90**
Plastic Limit								**10.71**

US290-WE-STS-2-No. 2 LIQUID LIMIT TEST



US290-WE-STS-2-No. 14-Atterberg Limit Test

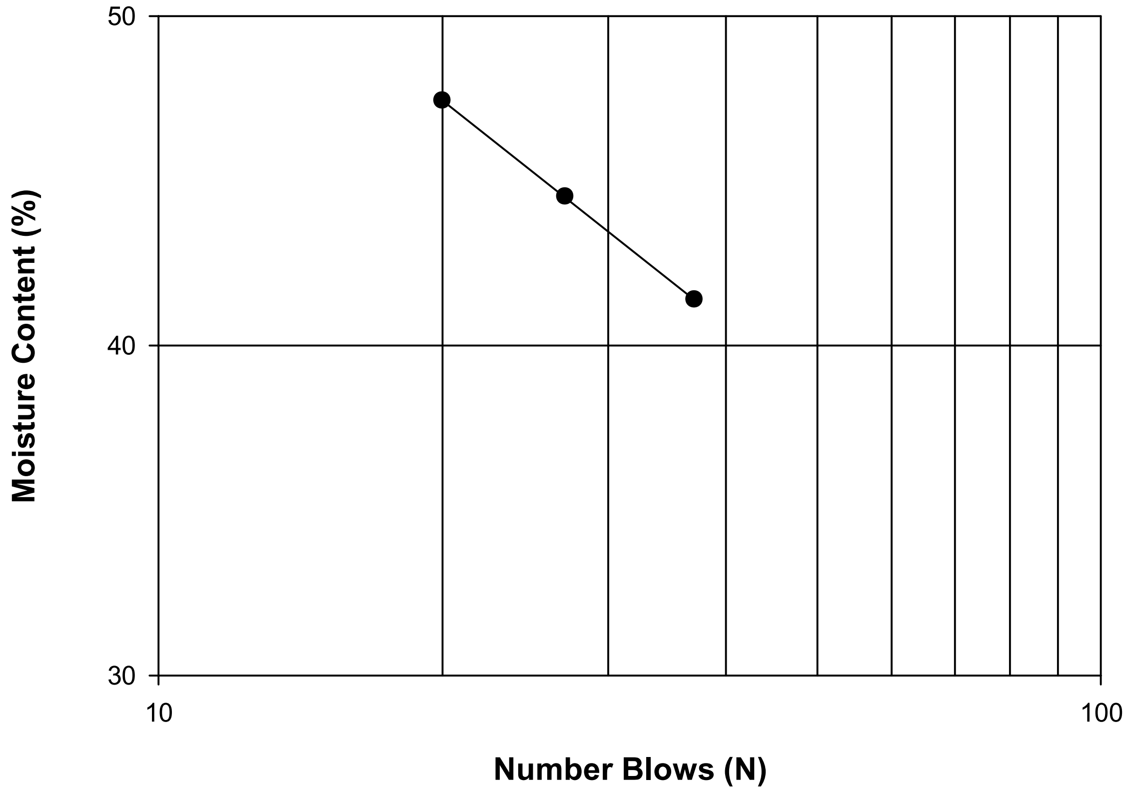
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 14	26' - 28'	1.00	9.88	7.28	2.6	6.28	37	**41.40**
		1.00	9.31	6.75	2.56	5.75	27	**44.52**
		1.00	14.18	9.94	4.24	8.94	20	**47.43**
Liquid Limit								**45.25**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 14	26' - 28'	1.00	2.47	2.26	0.21	1.26		**16.67**
		1.00	2.19	2.04	0.15	1.04		**14.42**
Plastic Limit								**15.54**

US290-WE-STS-2-No. 14 LIQUID LIMIT TEST



US290-WW-STS-1-No. 1-Atterberg Limit Test

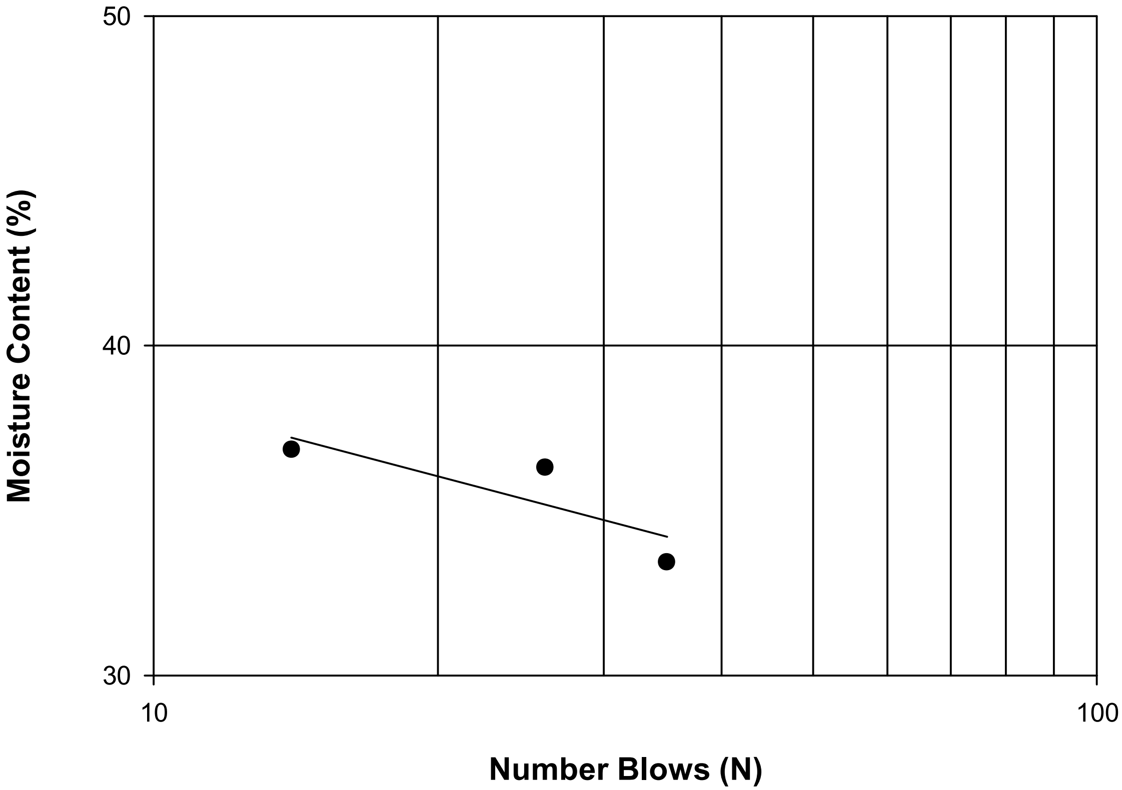
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	9.18	7.13	2.05	6.13	35	**33.44**
		1.00	17.03	12.76	4.27	11.76	26	**36.31**
		1.00	14.74	11.04	3.70	10.04	14	**36.85**
Liquid Limit								**35.31**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	0.99	2.77	2.54	0.23	1.55		**14.84**
		0.98	4.09	3.63	0.46	2.65		**17.36**
Plastic Limit								**16.10**

US290-WW-STS-1-No. 1 LIQUID LIMIT TEST



US290-WW-STS-1-No. 12-Atterberg Limit Test

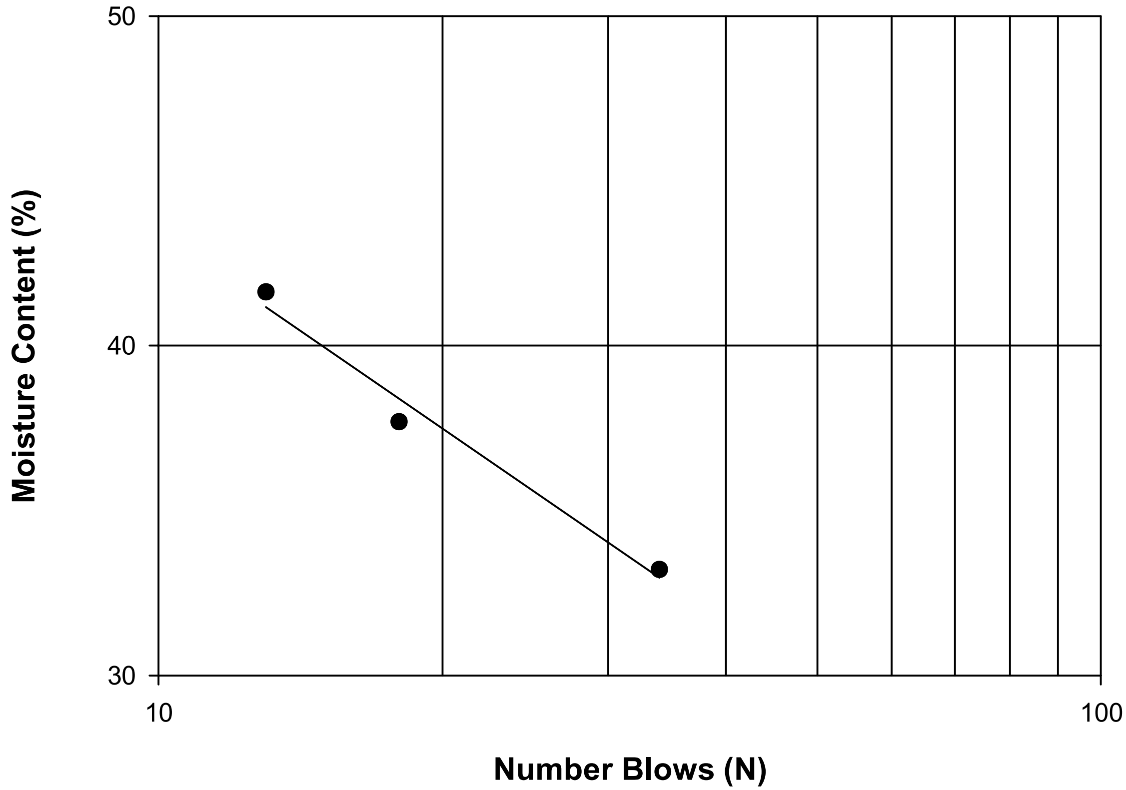
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	13.00	10.01	2.99	9.01	34	**33.19**
		1.00	10.61	7.98	2.63	6.98	18	**37.68**
		1.00	13.76	10.01	3.75	9.01	13	**41.62**
Liquid Limit								**35.57**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	2.27	2.07	0.20	1.07		**18.69**
		1.00	3.24	2.87	0.37	1.87		**19.79**
Plastic Limit								**19.24**

US290-WW-STS-1-No. 12 LIQUID LIMIT TEST



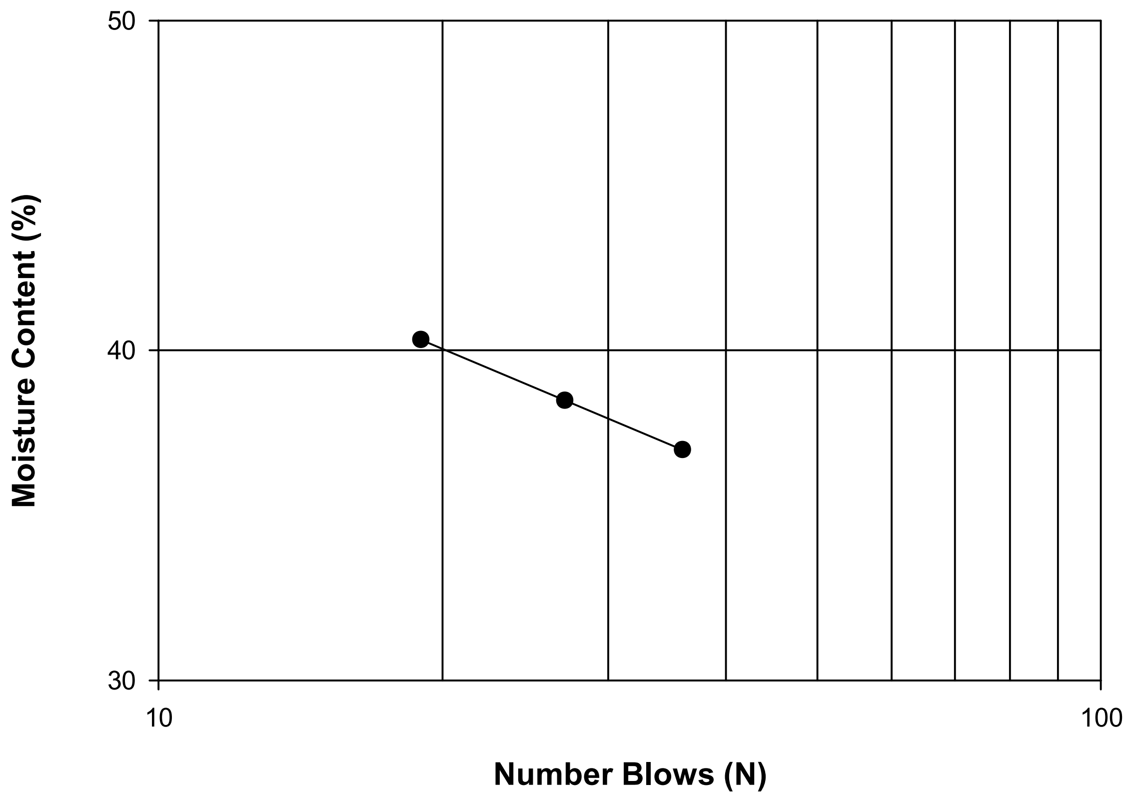
US290-WW-STS-2-No. 1-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	10.26	7.76	2.5	6.76	36	**36.98**
		1.00	12.59	9.37	3.22	8.37	27	**38.47**
		1.00	10.71	7.92	2.79	6.92	19	**40.32**
Liquid Limit								**38.88**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	0.99	2.41	2.22	0.19	1.23		**15.45**
		0.98	2.42	2.21	0.21	1.23		**17.07**
Plastic Limit								**16.26**

US290-WW-STS-2-No. 1 LIQUID LIMIT TEST



US290-WW-STS-2-No. 13-Atterberg Limit Test

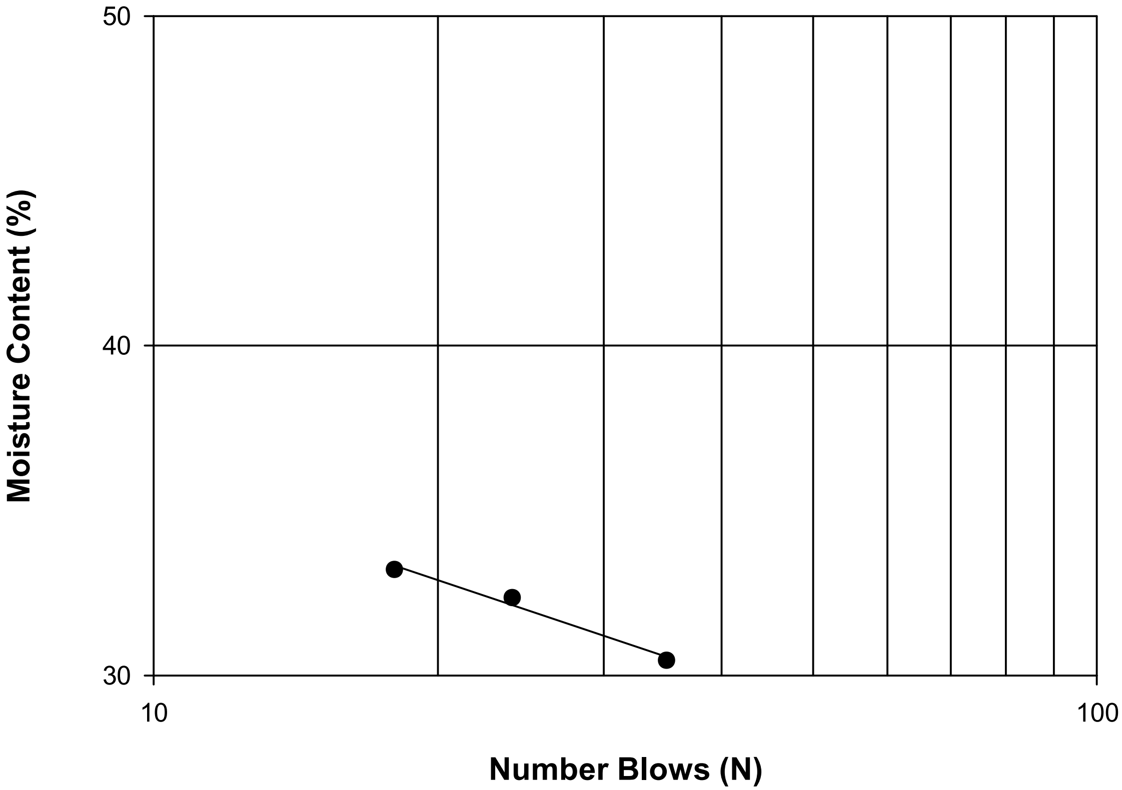
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 13	26' - 28'	1.00	10.04	7.93	2.11	6.93	35	**30.45**
		1.00	13.07	10.12	2.95	9.12	24	**32.35**
		1.00	10.67	8.26	2.41	7.26	18	**33.20**
Liquid Limit								**31.95**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 13	26' - 28'	1.00	2.37	2.23	0.14	1.23		**11.38**
		1.00	2.80	2.57	0.23	1.57		**14.65**
Plastic Limit								**13.02**

US290-WW-STS-2-No. 13 LIQUID LIMIT TEST



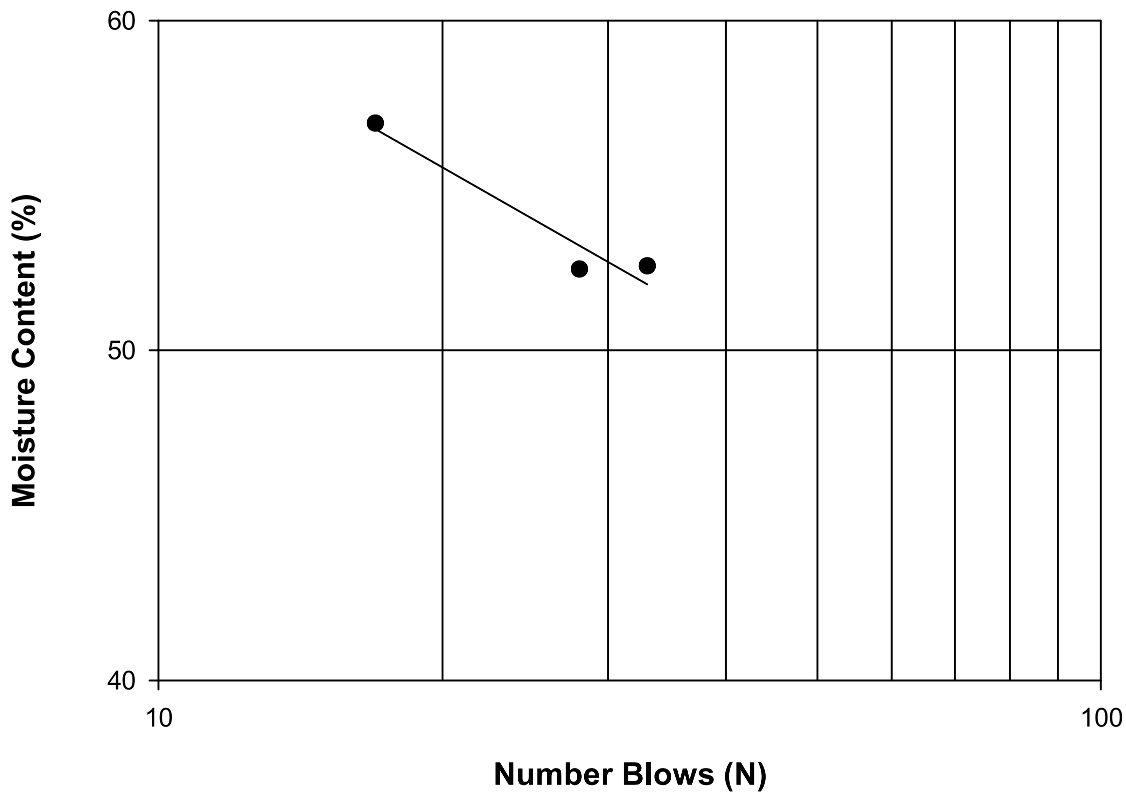
SH249-NS-STS-2-No. 7-Atterberg Limit Test
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 7	9' - 11'	1.00	9.39	6.50	2.89	5.5	33	**52.55**
		1.00	11.26	7.73	3.53	6.73	28	**52.45**
		1.00	12.28	8.19	4.09	7.19	17	**56.88**
Liquid Limit								**53.97**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 7	9' - 11'	1.00	1.76	1.66	0.10	0.66		**15.15**
		1.00	2.29	2.03	0.26	1.03		**25.24**
Plastic Limit								**20.20**

SH249-NS-STS-2-No. 7 LIQUID LIMIT TEST



SH249-SS-STS-1-No. 4-Atterberg Limit Test

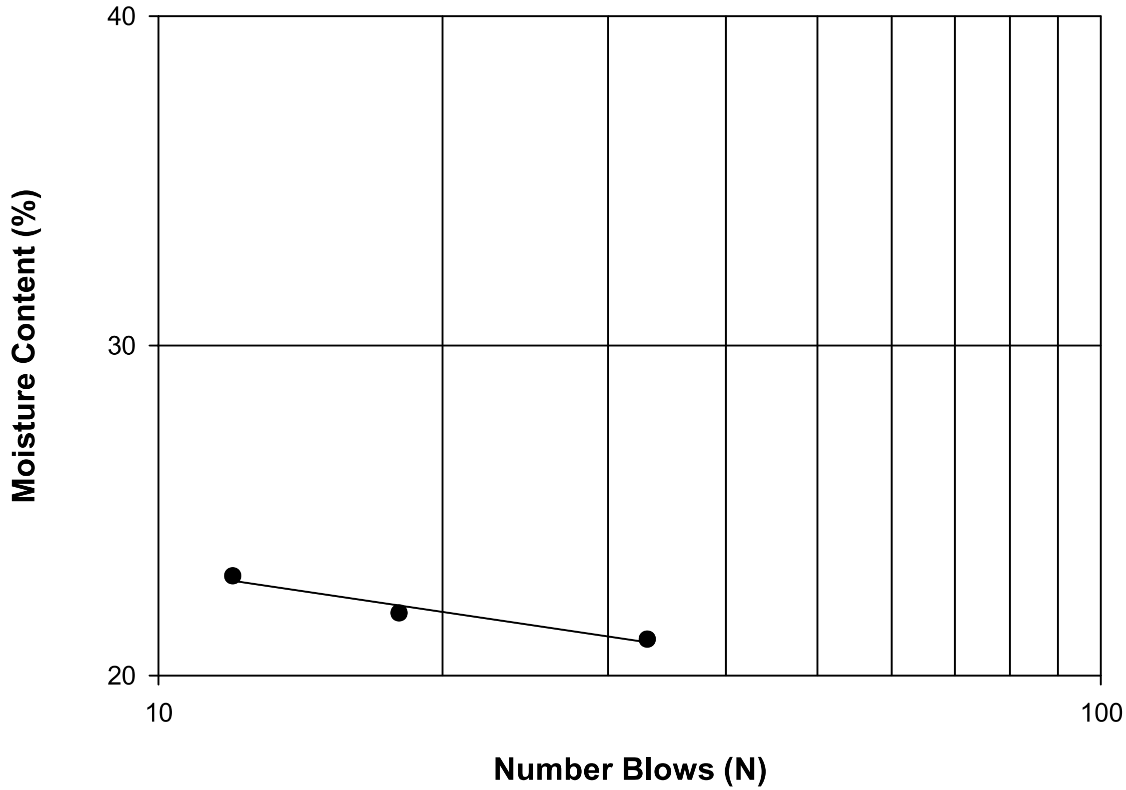
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 4	9' - 11'	1.00	12.31	10.34	1.97	9.34	33	**21.09**
		1.00	9.19	7.72	1.47	6.72	18	**21.88**
		1.00	12.23	10.13	2.10	9.13	12	**23.00**
Liquid Limit								**21.51**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 4	9' - 11'	1.00	1.52	1.48	0.04	0.48		**8.33**
		1.00	1.38	1.34	0.04	0.34		**11.76**
Plastic Limit								**10.05**

SH249-SS-STS-1-No. 4 LIQUID LIMIT TEST



SH249-SS-STS-1-No. 8-Atterberg Limit Test

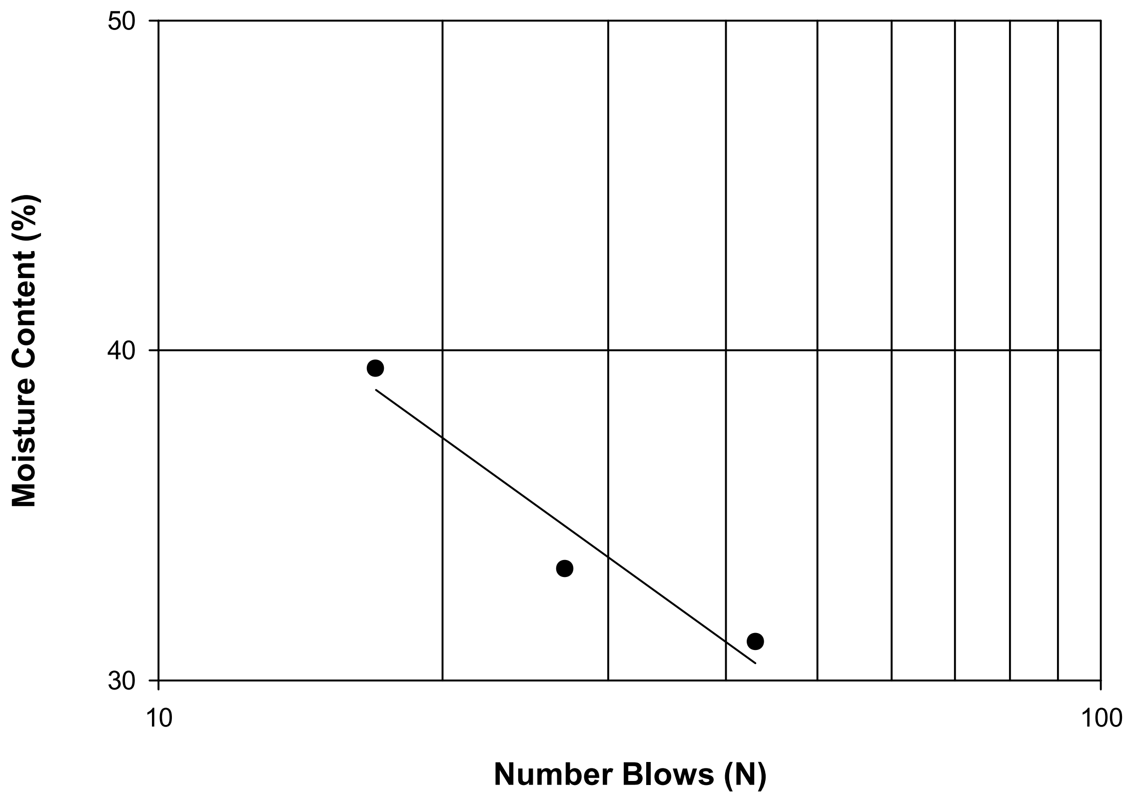
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 8	26' - 28'	1.00	9.95	7.71	2.24	6.71	27	**33.38**
		1.00	9.63	7.58	2.05	6.58	43	**31.16**
		1.00	11.50	8.53	2.97	7.53	17	**39.44**
Liquid Limit								**35.36**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 8	26' - 28'	1.00	2.11	1.98	0.13	0.98		**13.27**
		1.00	2.03	1.91	0.12	0.91		**13.19**
Plastic Limit								**13.23**

SH249-SS-STS-1-No. 8 LIQUID LIMIT TEST



SH249-SS-STS-2-No. 3-Atterberg Limit Test

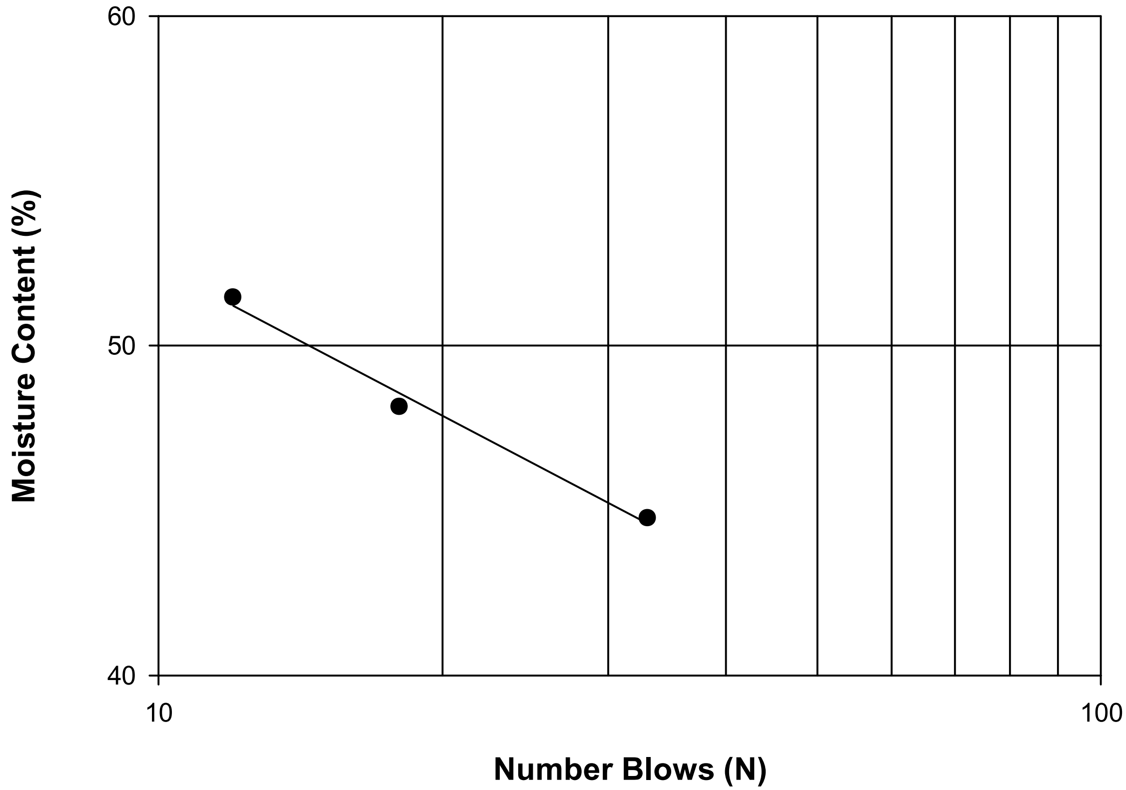
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 3	5' - 7'	1.00	11.80	8.46	3.34	7.46	33	**44.77**
		1.00	10.54	7.44	3.10	6.44	18	**48.14**
		1.00	9.74	6.77	2.97	5.77	12	**51.47**
Liquid Limit								**46.42**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 3	5' - 7'	1.00	1.92	1.78	0.14	0.78		**17.95**
		1.00	1.81	1.71	0.10	0.71		**14.08**
Plastic Limit								**16.02**

SH249-SS-STS-2-No. 3 LIQUID LIMIT TEST



SH249-SS-STS-2-No. 5-Atterberg Limit Test

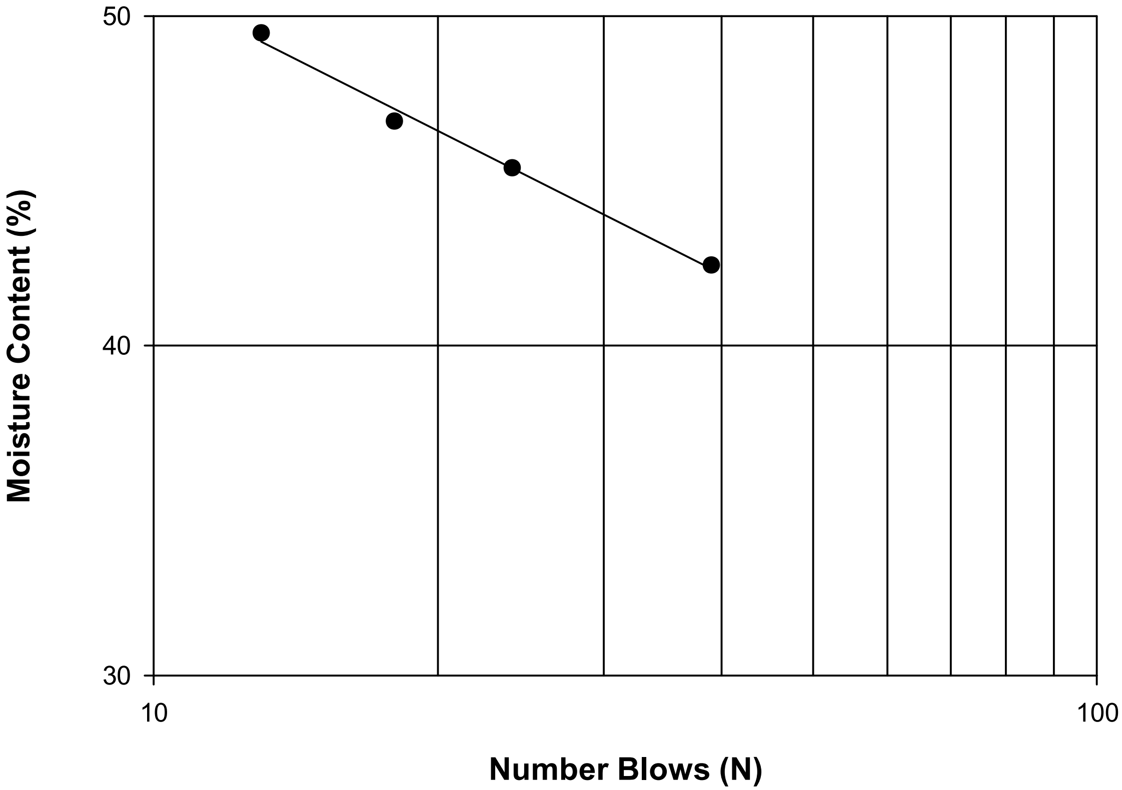
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 5	15' - 17'	1.00	10.88	7.61	3.27	6.61	13	**49.47**
		1.00	15.68	11.00	4.68	10	18	**46.80**
		1.00	12.18	8.69	3.49	7.69	24	**45.38**
		1.00	10.60	7.74	2.86	6.74	39	**42.43**
Liquid Limit								**45.12**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 5	15' - 17'	1.00	2.08	1.92	0.16	0.92		**17.39**
		1.00	2.34	2.15	0.19	1.15		**16.52**
		1.00	2.61	2.36	0.25	1.36		**18.38**
Plastic Limit								**17.43**

SH249-SS-STS-2-No. 5 LIQUID LIMIT TEST



SH249-SS-STS-2-No. 7-Atterberg Limit Test

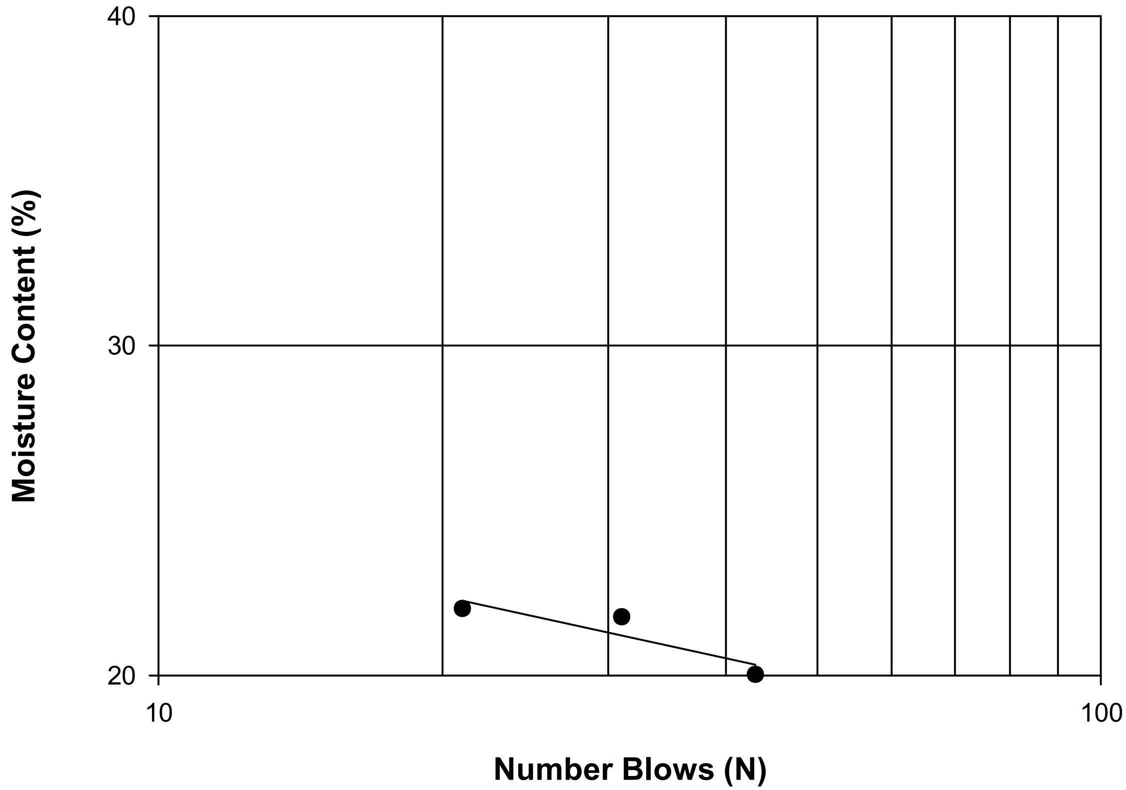
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 7	21' - 23'	1.00	11.31	9.59	1.72	8.59	43	**20.02**
		1.00	10.06	8.44	1.62	7.44	31	**21.77**
		1.00	11.42	9.54	1.88	8.54	21	**22.01**
Liquid Limit								**21.80**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 7	21' - 23'	1.00	1.64	1.57	0.07	0.57		**12.28**
		1.00	1.64	1.56	0.08	0.56		**14.29**
Plastic Limit								**13.28**

SH249-SS-STS-2-No. 7 LIQUID LIMIT TEST



SH249-SS-STS-2-No. 11-Atterberg Limit Test

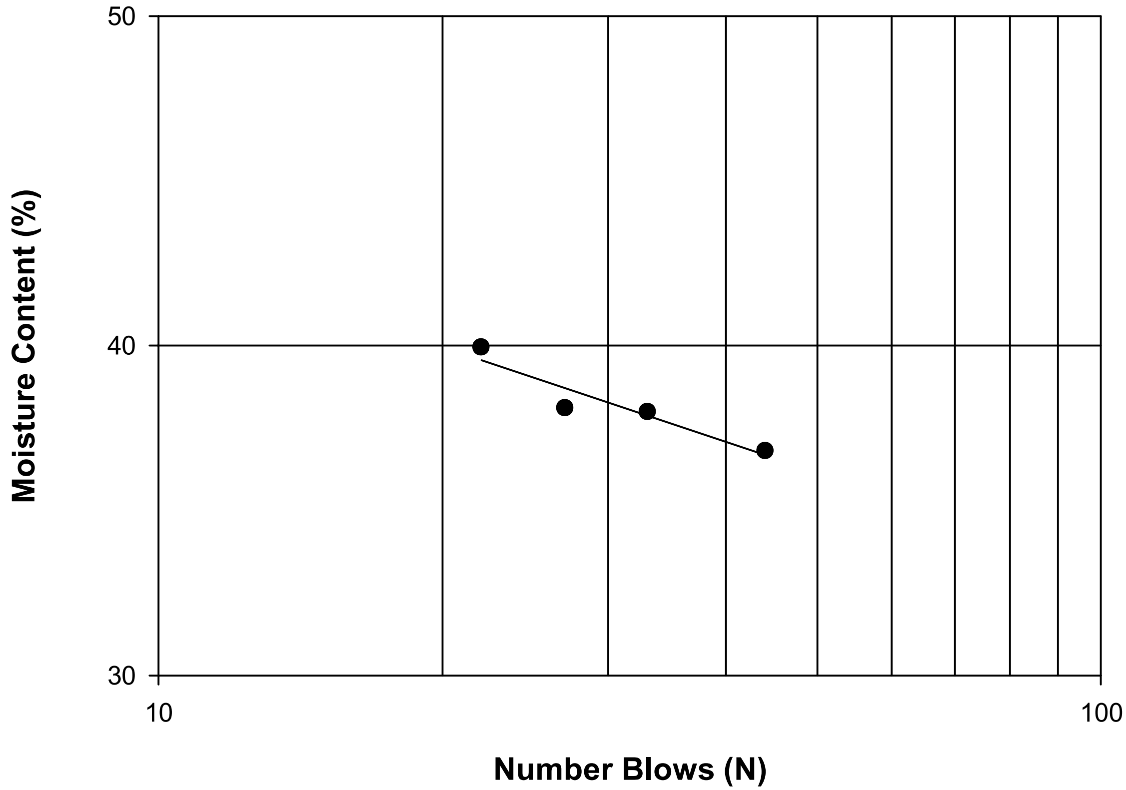
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 11	31' - 33'	1.00	10.44	7.90	2.54	6.9	44	**36.81**
		1.00	10.77	8.08	2.69	7.08	33	**37.99**
		1.00	7.96	6.04	1.92	5.04	27	**38.10**
		1.00	11.72	8.66	3.06	7.66	22	**39.95**
Liquid Limit								**39.03**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 11	31' - 33'	1.00	1.71	1.59	0.12	0.59		**20.34**
		1.00	1.80	1.68	0.12	0.68		**17.65**
Plastic Limit								**18.99**

SH249-SS-STS-2-No. 11 LIQUID LIMIT TEST



SH249-SN-STS-1-No. 3-Atterberg Limit Test

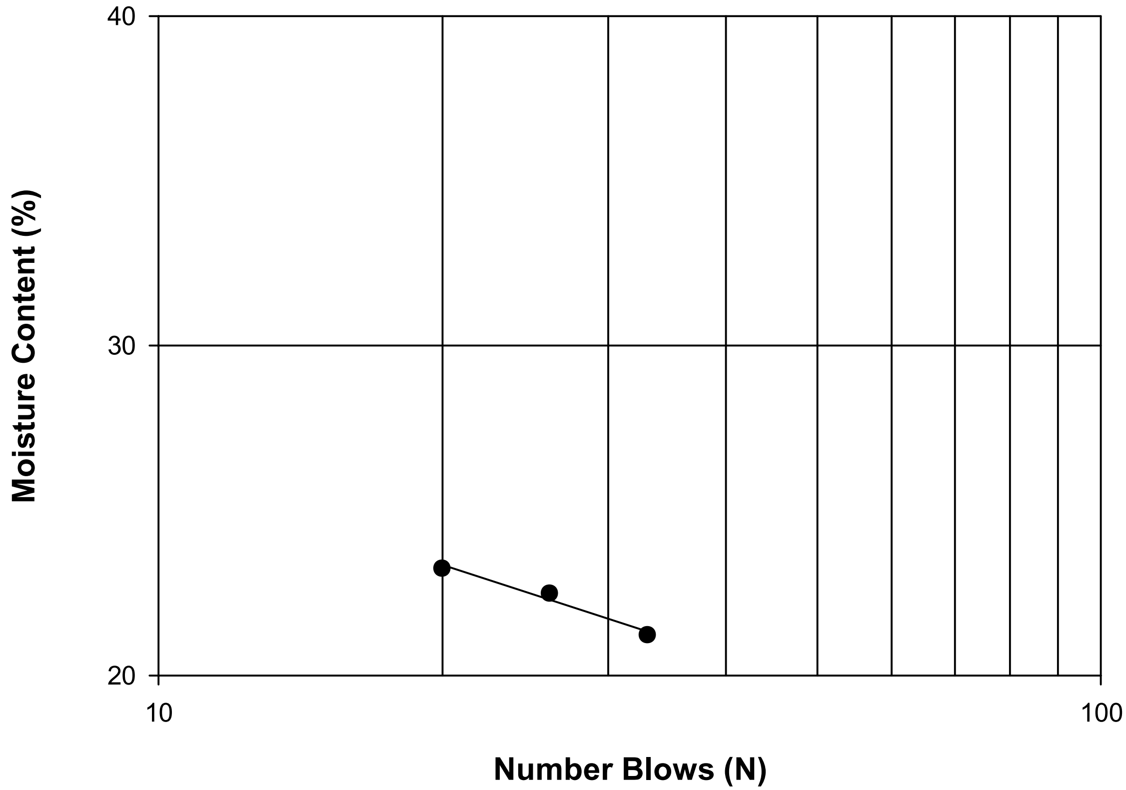
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 3	5' - 7'	1.00	9.74	8.21	1.53	7.21	33	**21.22**
		1.00	11.51	9.58	1.93	8.58	26	**22.49**
		1.00	11.13	9.22	1.91	8.22	20	**23.24**
Liquid Limit								**22.44**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 3	5' - 7'	1.00	2.10	1.99	0.11	0.99		**11.11**
		1.00	2.82	2.58	0.24	1.58		**15.19**
Plastic Limit								**13.15**

SH249-SN-STS-1-No. 3 LIQUID LIMIT TEST



SH249-SN-STS-1-No. 12-Atterberg Limit Test

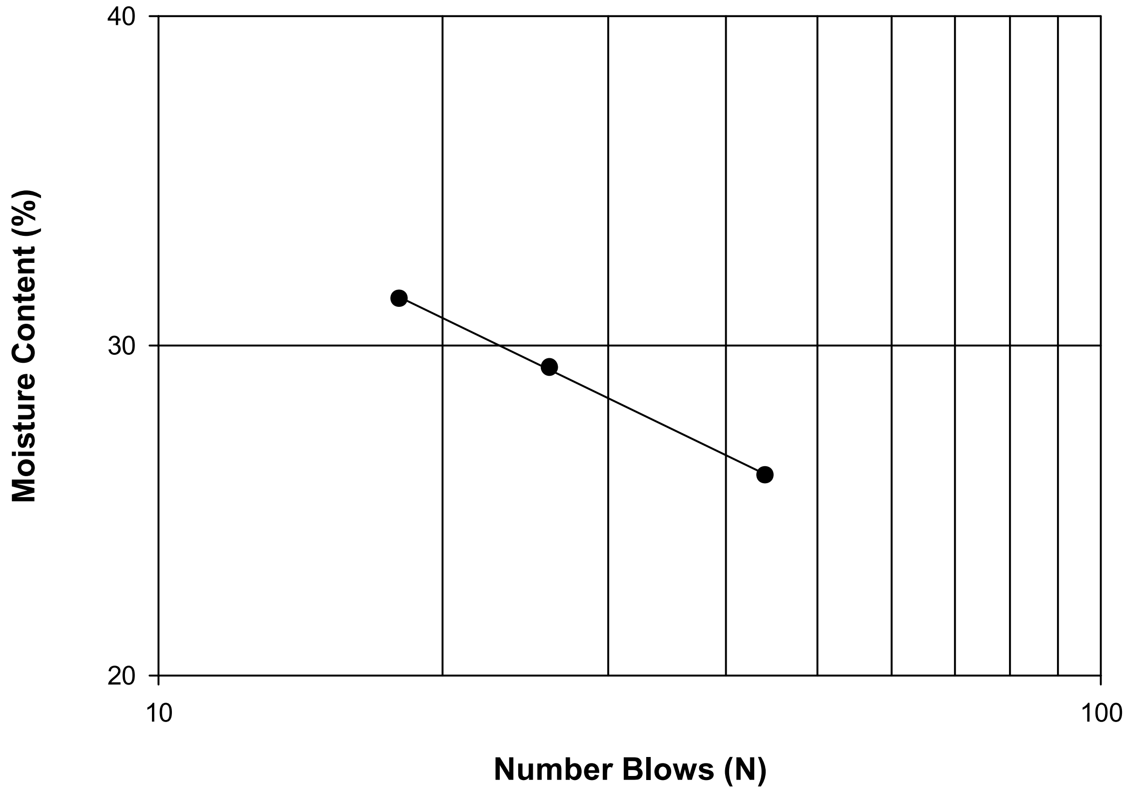
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	7.72	6.33	1.39	5.33	44	**26.08**
		1.00	13.08	10.34	2.74	9.34	26	**29.34**
		1.00	12.25	9.56	2.69	8.56	18	**31.43**
Liquid Limit								**29.50**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 12	26' - 28'	1.00	2.67	2.48	0.19	1.48		**12.84**
		1.00	3.99	3.60	0.39	2.60		**15.00**
Plastic Limit								**13.92**

SH249-SN-STS-1-No. 12 LIQUID LIMIT TEST



SH249-SN-STS-2-No. 2-Atterberg Limit Test

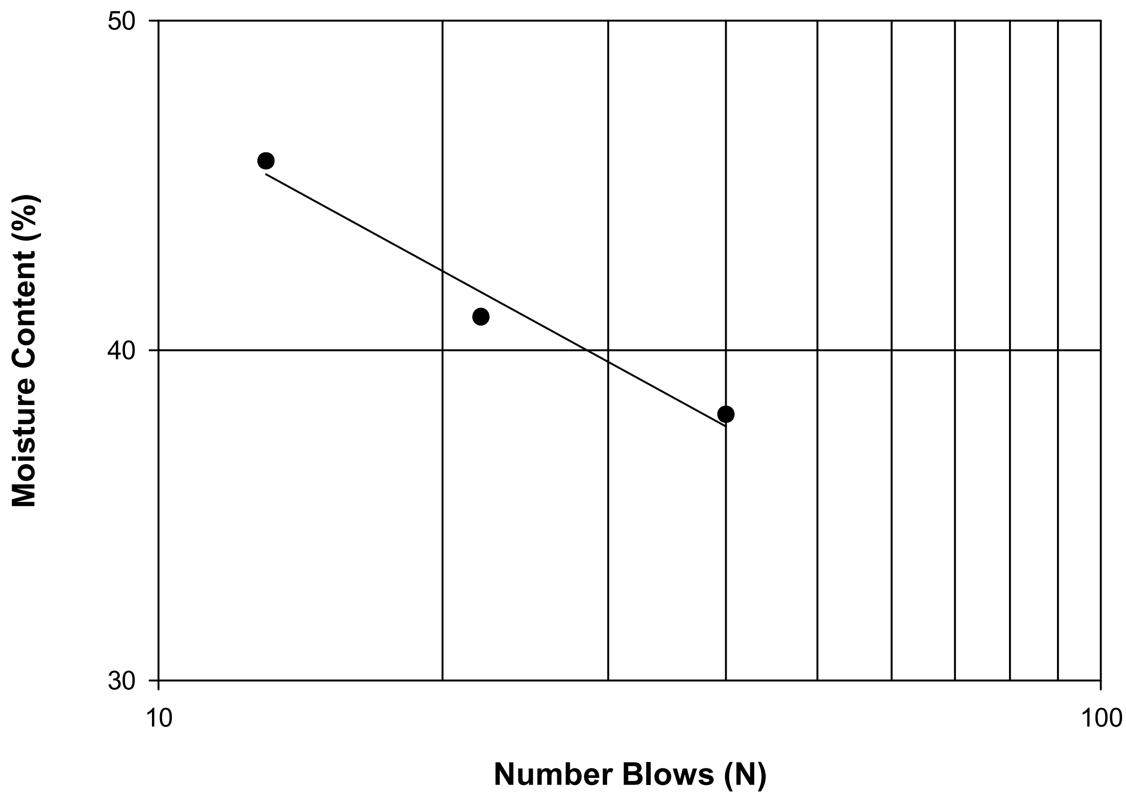
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 2	5' - 7'	1.00	7.64	5.81	1.83	4.81	40	**38.05**
		1.00	8.84	6.56	2.28	5.56	22	**41.01**
		1.00	9.22	6.64	2.58	5.64	13	**45.74**
Liquid Limit								**40.89**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 2	5' - 7'	1.00	1.90	1.79	0.11	0.79		**13.92**
		1.00	3.11	2.74	0.37	1.74		**21.26**
Plastic Limit								**17.59**

SH249-SN-STS-2-No. 2 LIQUID LIMIT TEST



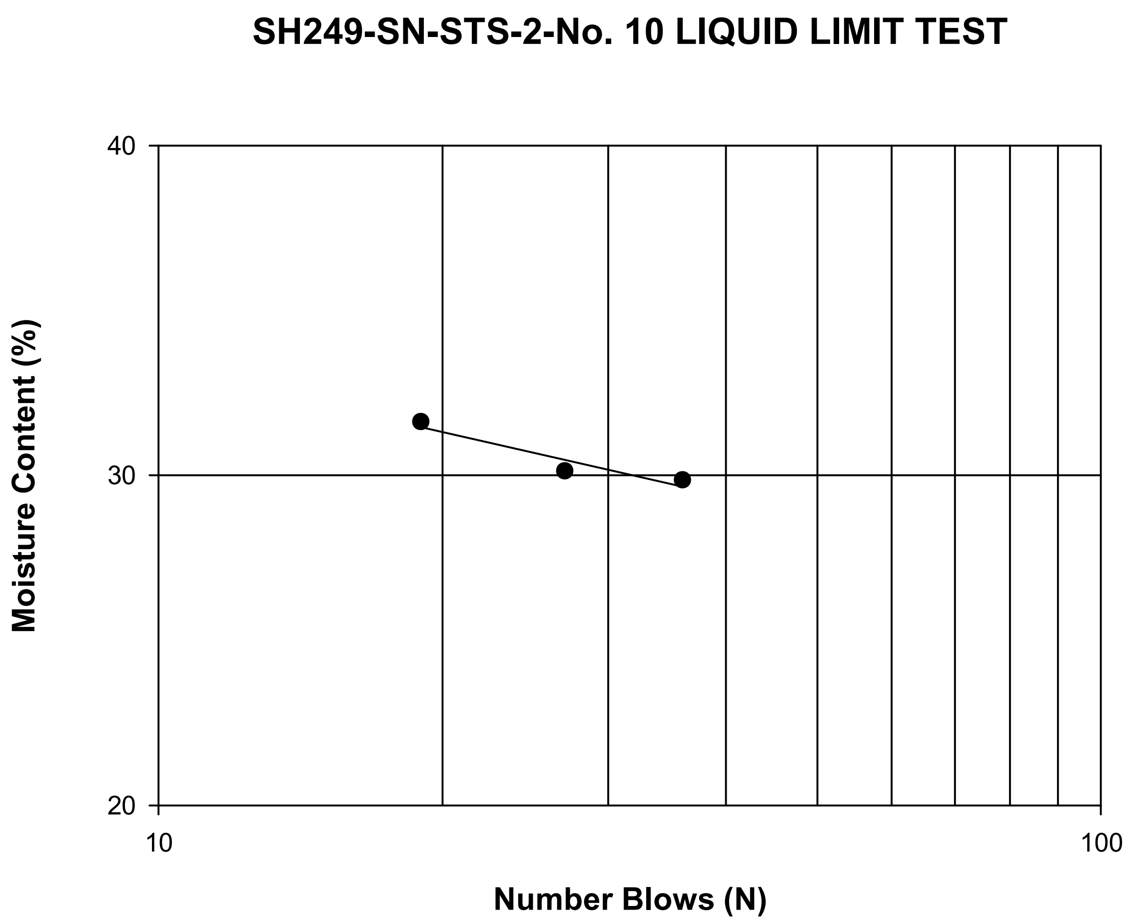
SH249-SN-STS-2-No. 10-Atterberg Limit Test

Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 10	26' - 28'	1.00	9.95	7.80	2.15	6.8	19	**31.62**
		1.00	8.17	6.51	1.66	5.51	27	**30.13**
		1.00	10.31	8.17	2.14	7.17	36	**29.85**
Liquid Limit								**30.69**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 10	26' - 28'	1.00	2.40	2.23	0.17	1.23		**13.82**
		1.00	2.48	2.29	0.19	1.29		**14.73**
Plastic Limit								**14.27**


SH249-SN-STS-2-No. 10 LIQUID LIMIT TEST
40
30
20
Moisture Content (%)
10
100
Number Blows (N)

SH249-NN-STS-1-No. 1-Atterberg Limit Test

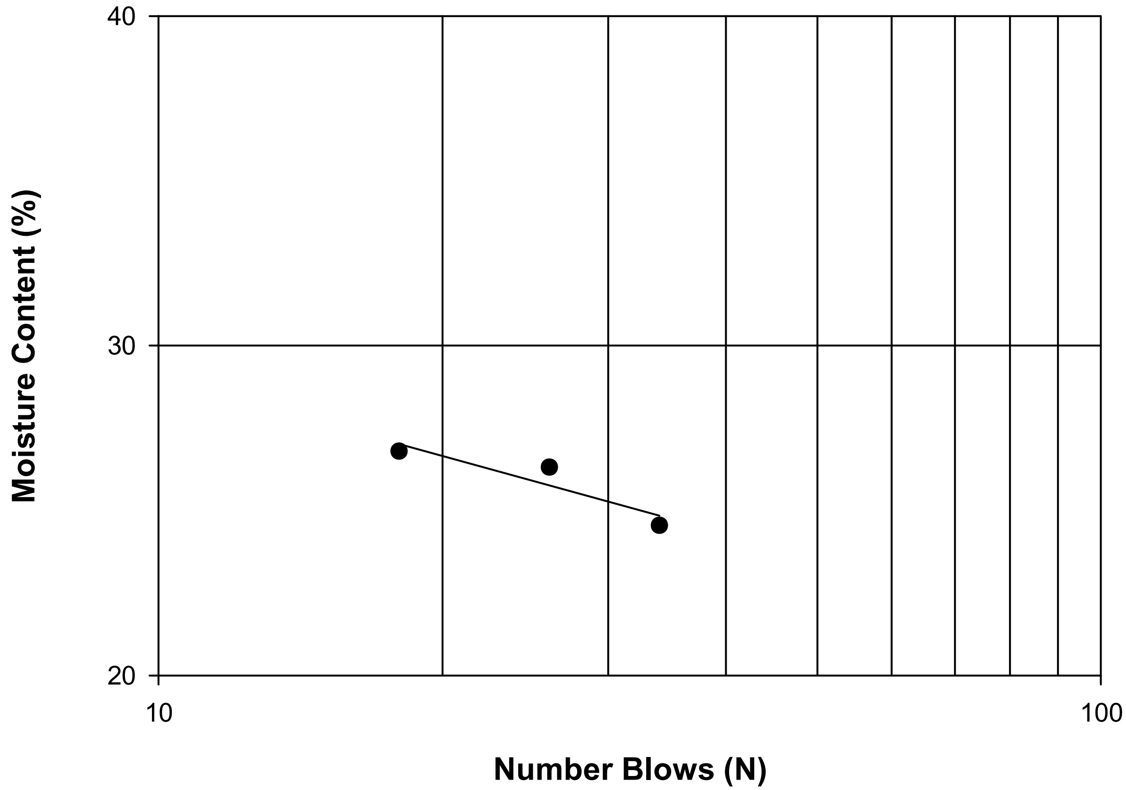
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	11.51	9.44	2.07	8.44	34	**24.53**
		1.00	12.62	10.20	2.42	9.2	26	**26.30**
		1.00	12.69	10.22	2.47	9.22	18	**26.79**
Liquid Limit								**25.89**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	2.62	2.41	0.21	1.41		**14.89**
		1.00	1.94	1.85	0.09	0.85		**10.59**
Plastic Limit								**12.74**

SH249-NN-STS-1-No. 1 LIQUID LIMIT TEST



SH249-NN-STS-1-No. 8-Atterberg Limit Test

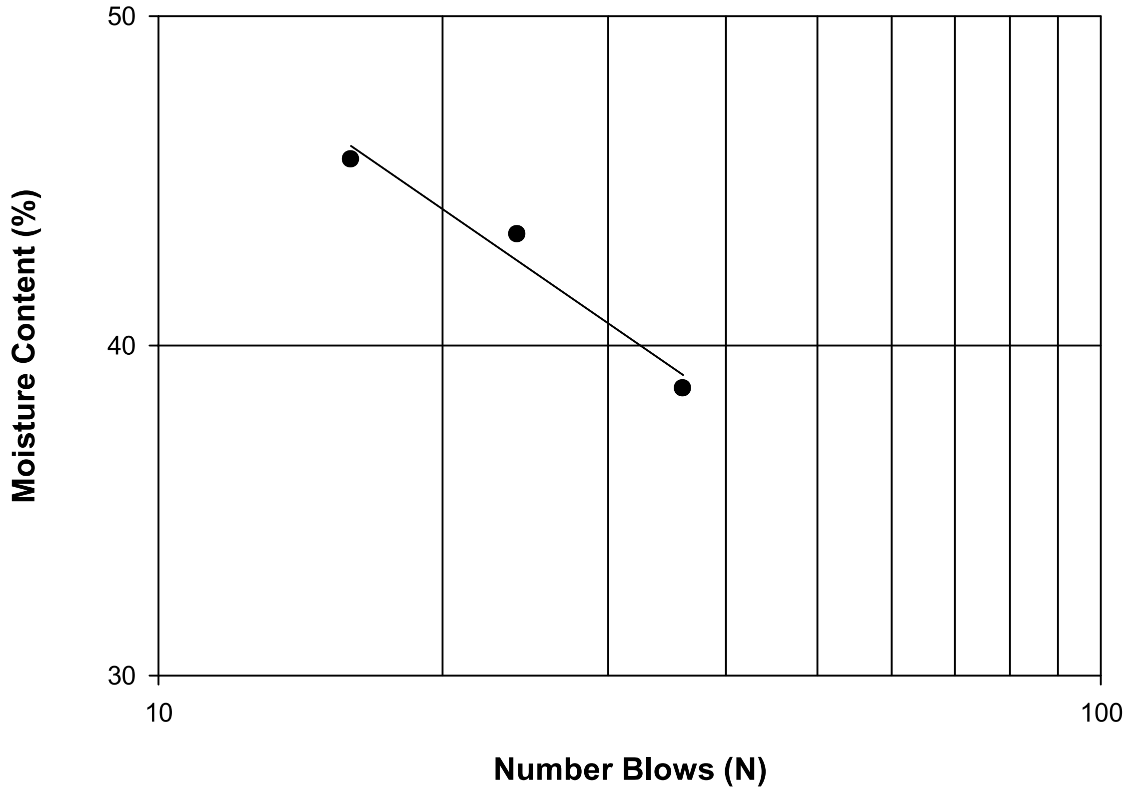
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 8	15' - 17'	1.00	9.42	7.07	2.35	6.07	36	**38.71**
		1.00	9.79	7.13	2.66	6.13	24	**43.39**
		1.00	10.54	7.55	2.99	6.55	16	**45.65**
Liquid Limit								**42.24**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 8	15' - 17'	1.00	2.59	2.38	0.21	1.38		**15.22**
		1.00	3.00	2.72	0.28	1.72		**16.28**
Plastic Limit								**15.75**

SH249-NN-STS-1-No. 8 LIQUID LIMIT TEST



SH249-NN-STS-2-No. 1-Atterberg Limit Test

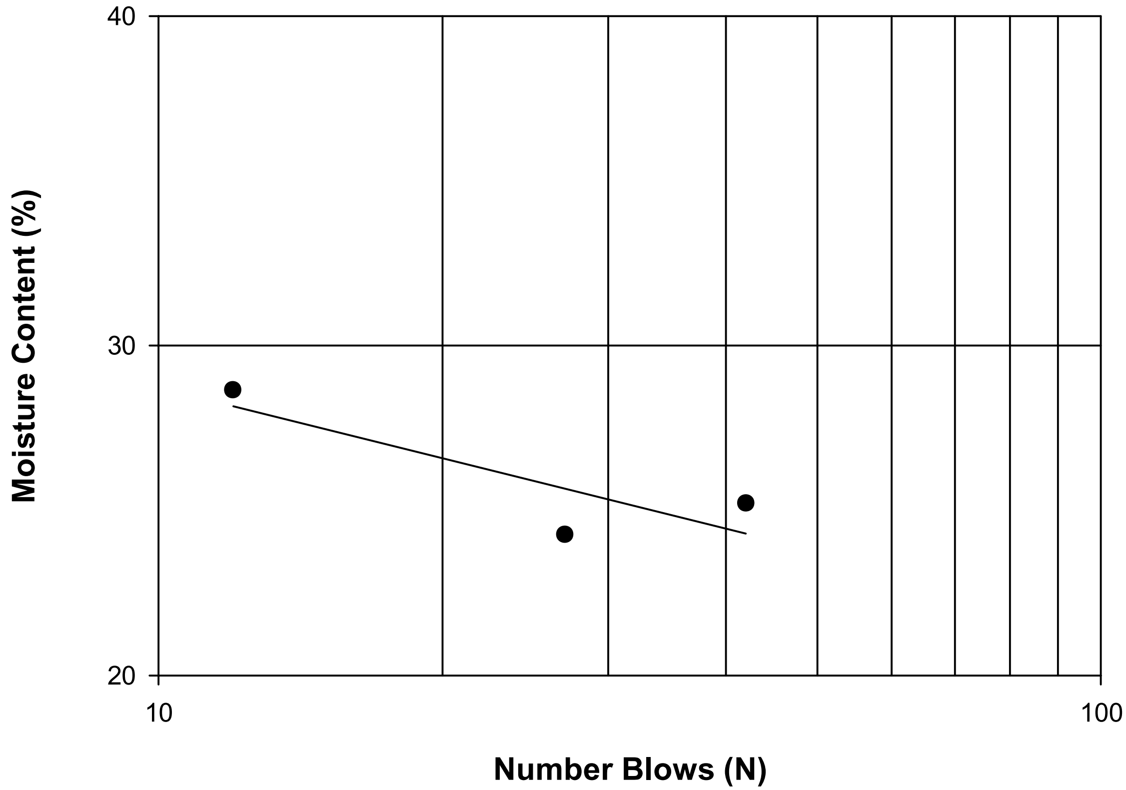
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	8.68	7.18	1.5	6.18	27	**24.27**
		1.00	9.89	7.91	1.98	6.91	12	**28.65**
		1.00	9.94	8.14	1.80	7.14	42	**25.21**
Liquid Limit								**25.90**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	W/C (%)
No. 1	3' - 5'	1.00	2.32	2.15	0.17	1.15		**14.78**
		1.00	2.23	2.07	0.16	1.07		**14.95**
Plastic Limit								**14.87**

SH249-NN-STS-2-No. 1 LIQUID LIMIT TEST



SH249-NN-STS-2-No. 10-Atterberg Limit Test

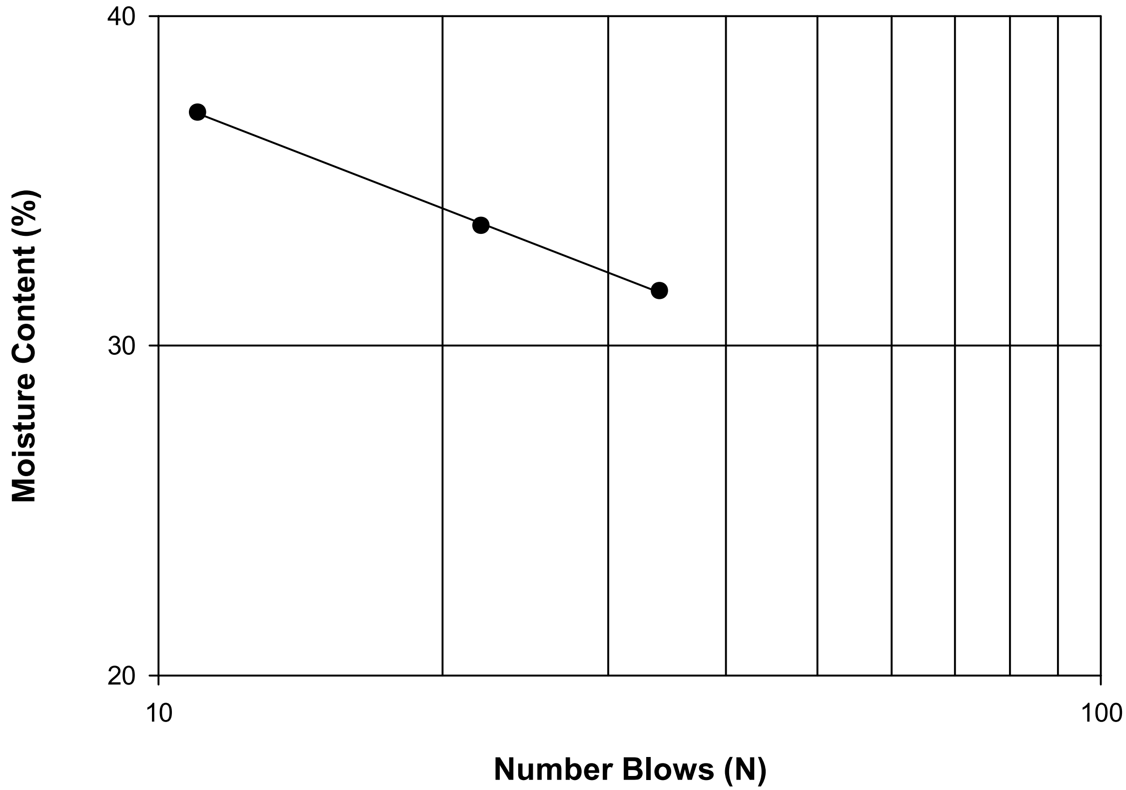
Liquid Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 10	15' - 17'	1.00	9.15	7.19	1.96	6.19	34	**31.66**
		1.00	8.55	6.65	1.9	5.65	22	**33.63**
		1.00	9.69	7.34	2.35	6.34	11	**37.07**
Liquid Limit								**33.09**

Plastic Limit

Sample No.	Depth (ft)	Cup Weight (g)	Cup+Wet Soil (g)	Cup+Dry Soil (g)	Water Wt. (g)	Soil Wt. (g)	Blows (N)	**W/C (%)**
No. 10	15' - 17'	1.00	2.96	2.69	0.27	1.69		**15.98**
		1.00	2.64	2.43	0.21	1.43		**14.69**
Plastic Limit								**15.33**

SH249-NN-STS-2-No. 10 LIQUID LIMIT TEST



APPENDIX J SIEVE ANALYSIS TEST

US290 EE Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	608.9	608.4	0.5	179.1	0.3	99.7
10	533.5	533.1	0.4	178.7	0.2	99.5
20	370.9	369.0	1.9	176.8	1.1	98.4
40	401.4	393.5	7.9	168.9	4.4	94.0
60	538.5	516.7	21.8	147.1	12.1	81.9
100	524.5	497.4	27.1	120.0	15.1	66.8
200	319.7	298.3	21.4	98.6	11.9	54.9
pan	408.5	309.9	98.6	0.0	54.9	0.0
Total:	3705.9	3526.3	179.6			

US290 WE Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	608.6	608.4	0.2	227.4	0.1	99.9
10	535.1	533.1	2.0	225.4	0.9	99.0
20	375.6	369.0	6.6	218.8	2.9	96.1
40	407.7	393.5	14.2	204.6	6.2	89.9
60	555.4	516.7	38.7	165.9	17.0	72.9
100	528.9	497.4	31.5	134.4	13.8	59.1
200	323.6	298.3	25.3	109.1	11.1	47.9
pan	419.0	309.9	109.1	0.0	47.9	0.0
Total:	3753.9	3526.3	227.6			

US290 EW Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	609.9	608.4	1.5	192.6	0.8	99.2
10	533.9	533.1	0.8	191.8	0.4	98.8
20	372.0	369.0	3.0	188.8	1.5	97.3
40	399.8	393.5	6.3	182.5	3.2	94.0
60	534.5	516.7	17.8	164.7	9.2	84.9
100	510.7	497.4	13.3	151.4	6.9	78.0
200	314.6	298.3	16.3	135.1	8.4	69.6
pan	445.0	309.9	135.1	0.0	69.6	0.0
Total:	3720.4	3526.3	194.1			

US290 WW Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	609.1	608.4	0.7	190.8	0.4	99.6
10	533.5	533.1	0.4	190.4	0.2	99.4
20	373.5	369.0	4.5	185.9	2.3	97.1
40	399.3	393.5	5.8	180.1	3.0	94.0
60	541.4	516.7	24.7	155.4	12.9	81.1
100	519.7	497.4	22.3	133.1	11.6	69.5
200	321.8	298.3	23.5	109.6	12.3	57.2
pan	419.5	309.9	109.6	0.0	57.2	0.0
Total:	3717.8	3526.3	191.5			

SH249 NS Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	611.0	608.6	2.4	319.1	0.7	99.3
10	536.7	533.8	2.9	316.2	0.9	98.4
20	374.2	369.3	4.9	311.3	1.5	96.8
40	406.5	394.3	12.2	299.1	3.8	93.0
60	549.0	516.7	32.3	266.8	10.0	83.0
100	540.6	497.7	42.9	223.9	13.3	69.6
200	344.4	298.5	45.9	178.0	14.3	55.4
pan	487.8	309.8	178.0	0.0	55.4	0.0
Total:	3850.2	3528.7	321.5			

SH249 SS Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	609.8	608.6	1.2	257.7	0.5	99.5
10	534.5	533.8	0.7	257.0	0.3	99.3
20	371.4	369.3	2.1	254.9	0.8	98.5
40	396.3	394.3	2.0	252.9	0.8	97.7
60	521.5	516.7	4.8	248.1	1.9	95.8
100	512.5	497.7	14.8	233.3	5.7	90.1
200	333.8	298.5	35.3	198.0	13.6	76.5
pan	507.8	309.8	198.0	0.0	76.5	0.0
Total:	3787.6	3528.7	258.9			

SH249 SN Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	614.3	608.6	5.7	488.5	1.2	98.8
10	537.7	533.8	3.9	484.6	0.8	98.1
20	374.5	369.3	5.2	479.4	1.1	97.0
40	396.9	394.3	2.6	476.8	0.5	96.5
60	524.5	516.7	7.8	469.0	1.6	94.9
100	530.3	497.7	32.6	436.4	6.6	88.3
200	368.3	298.5	69.8	366.6	14.1	74.2
pan	676.4	309.8	366.6	0.0	74.2	0.0
Total:	4022.9	3528.7	494.2			

SH249 NN Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	608.6	608.6	0.0	337.4	0.0	100.0
10	533.9	533.8	0.1	337.3	0.0	100.0
20	373.2	369.3	3.9	333.4	1.2	98.8
40	399.3	394.3	5.0	328.4	1.5	97.3
60	522.1	516.7	5.4	323.0	1.6	95.7
100	514.3	497.7	16.6	306.4	4.9	90.8
200	339.7	298.5	41.2	265.2	12.2	78.6
pan	575.0	309.8	265.2	0.0	78.6	0.0
Total:	3866.1	3528.7	337.4			

US290 EE Embankment Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	620.0	608.4	11.6	203.9	5.4	94.6
10	534.5	533.1	1.4	202.5	0.6	94.0
20	371.9	369.0	2.9	199.6	1.3	92.6
40	404.2	393.5	10.7	188.9	5.0	87.7
60	545.4	516.7	28.7	160.2	13.3	74.3
100	528.2	497.4	30.8	129.4	14.3	60.0
200	323.7	298.3	25.4	104.0	11.8	48.3
pan	413.9	309.9	104.0	0.0	48.3	0.0
Total:	3741.8	3526.3	215.5			

US290 WE Embankment Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	610.2	608.4	1.8	171.5	1.0	99.0
10	535.0	533.1	1.9	169.6	1.1	97.9
20	371.1	369.0	2.1	167.5	1.2	96.7
40	400.8	393.5	7.3	160.2	4.2	92.4
60	537.9	516.7	21.2	139.0	12.2	80.2
100	521.7	497.4	24.3	114.7	14.0	66.2
200	319.0	298.3	20.7	94.0	11.9	54.2
pan	403.9	309.9	94.0	0.0	54.2	0.0
Total:	3699.6	3526.3	173.3			

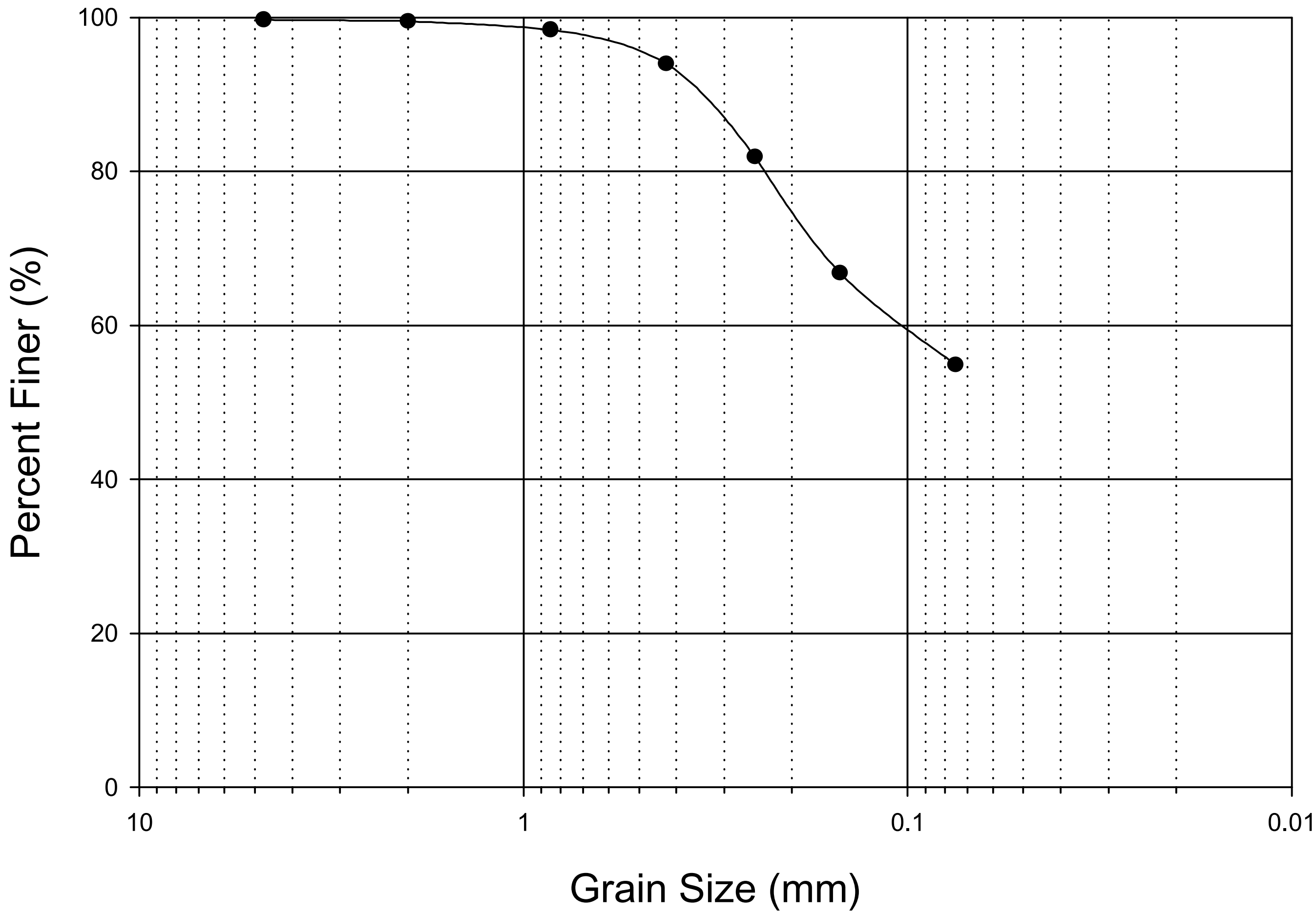
US290 EW Embankment Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	608.4	608.4	0.0	182.5	0.0	100.0
10	533.5	533.1	0.4	182.1	0.2	99.8
20	372.7	369.0	3.7	178.4	2.0	97.8
40	402.6	393.5	9.1	169.3	5.0	92.8
60	546.0	516.7	29.3	140.0	16.1	76.7
100	531.0	497.4	33.6	106.4	18.4	58.3
200	324.3	298.3	26.0	80.4	14.2	44.1
pan	390.3	309.9	80.4	0.0	44.1	0.0
Total:	3708.8	3526.3	182.5			

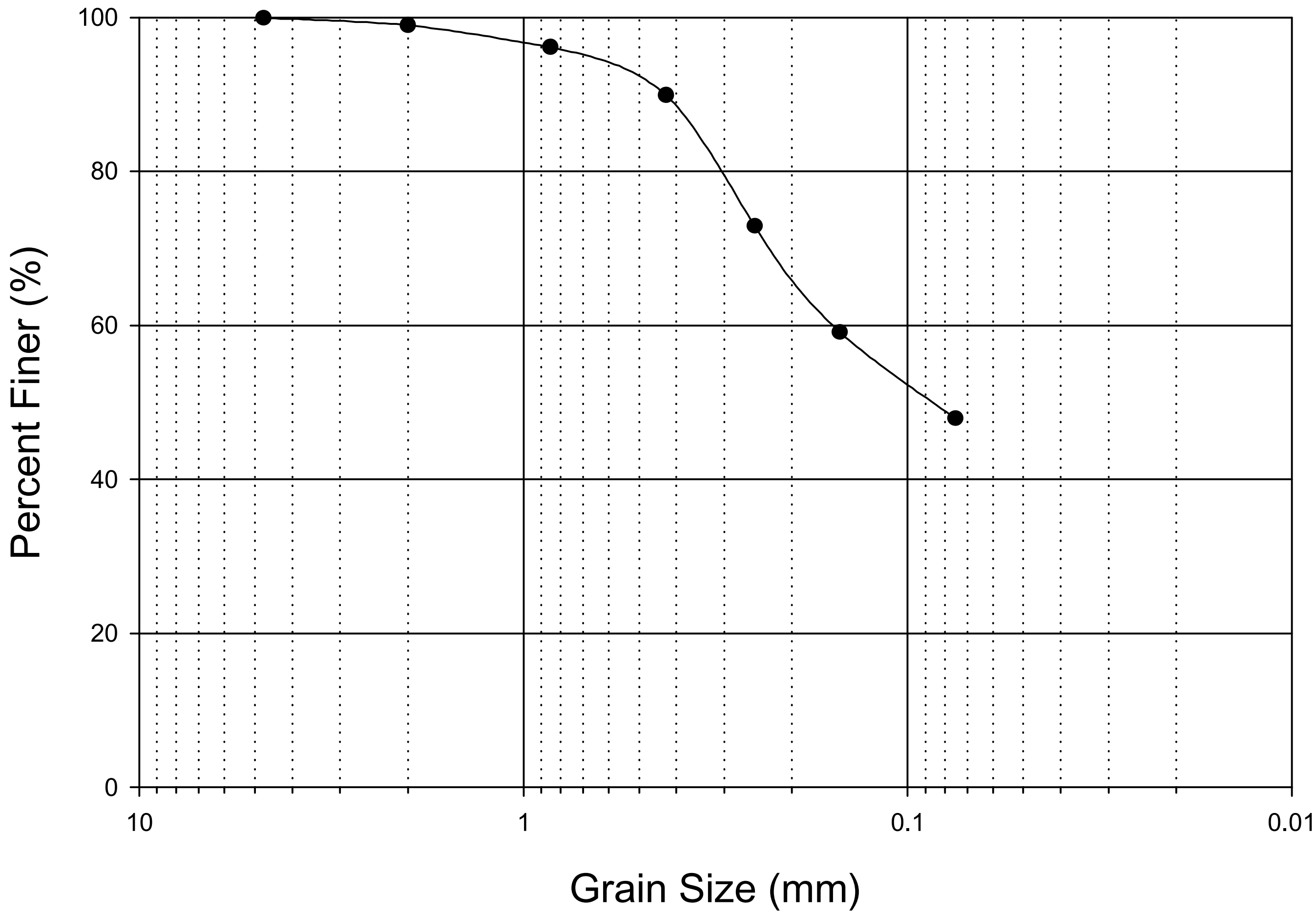
US290 WW Embankment Sieve Analysis

Sieve Number	Retained (g)	Sieve Mass(g)	Soil retained(g)	Passing (g)	% Retained	%Passing
4	610.9	608.4	2.5	168.9	1.5	98.5
10	535.5	533.1	2.4	166.5	1.4	97.1
20	371.0	369.0	2.0	164.5	1.2	96.0
40	398.6	393.5	5.1	159.4	3.0	93.0
60	529.7	516.7	13.0	146.4	7.6	85.4
100	514.0	497.4	16.6	129.8	9.7	75.7
200	317.4	298.3	19.1	110.7	11.1	64.6
pan	420.6	309.9	110.7	0.0	64.6	0.0
Total:	3697.7	3526.3	171.4			

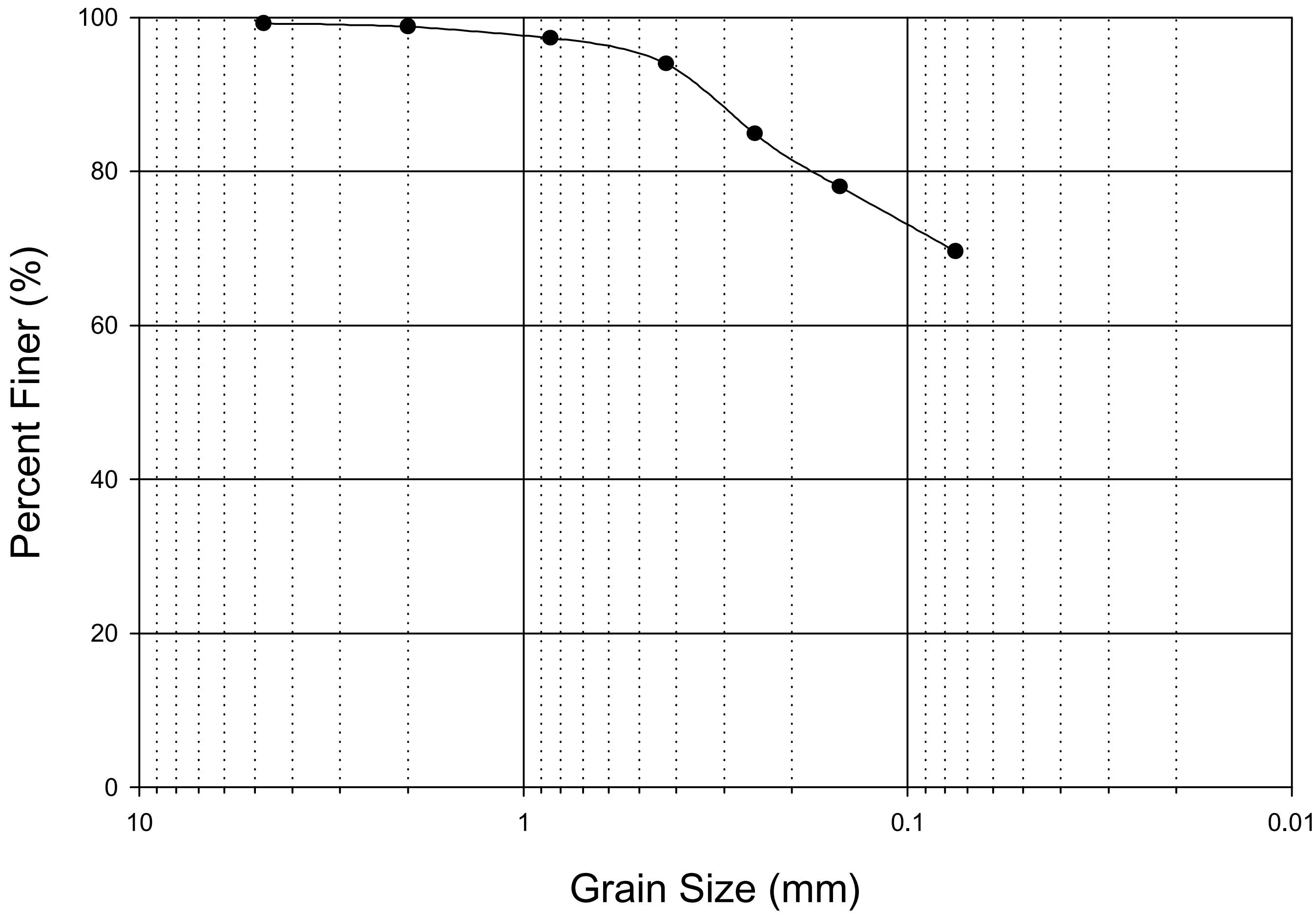
US290 EE Particle Size Distribution Curve



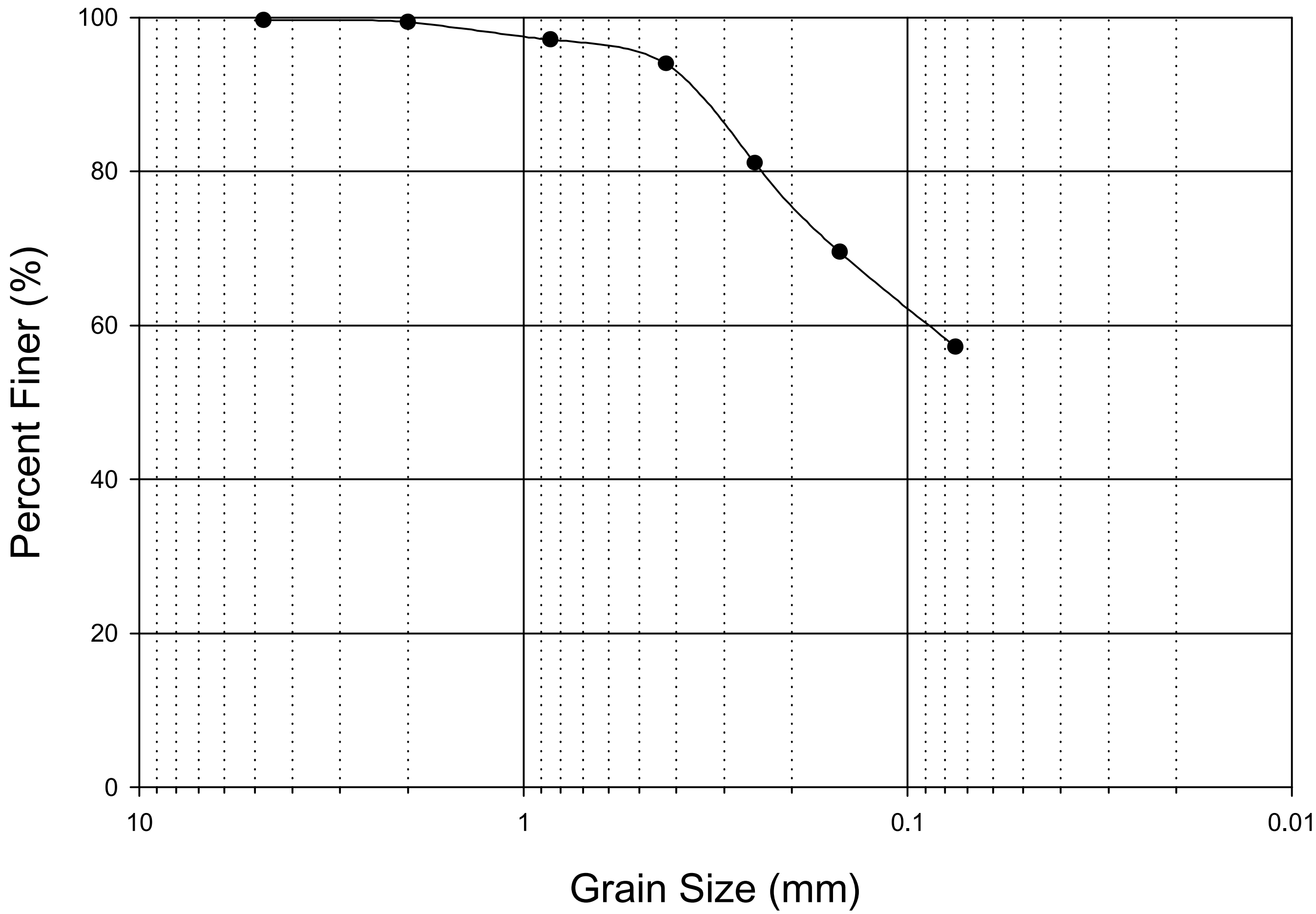
US290 WE Particle Size Distribution Curve



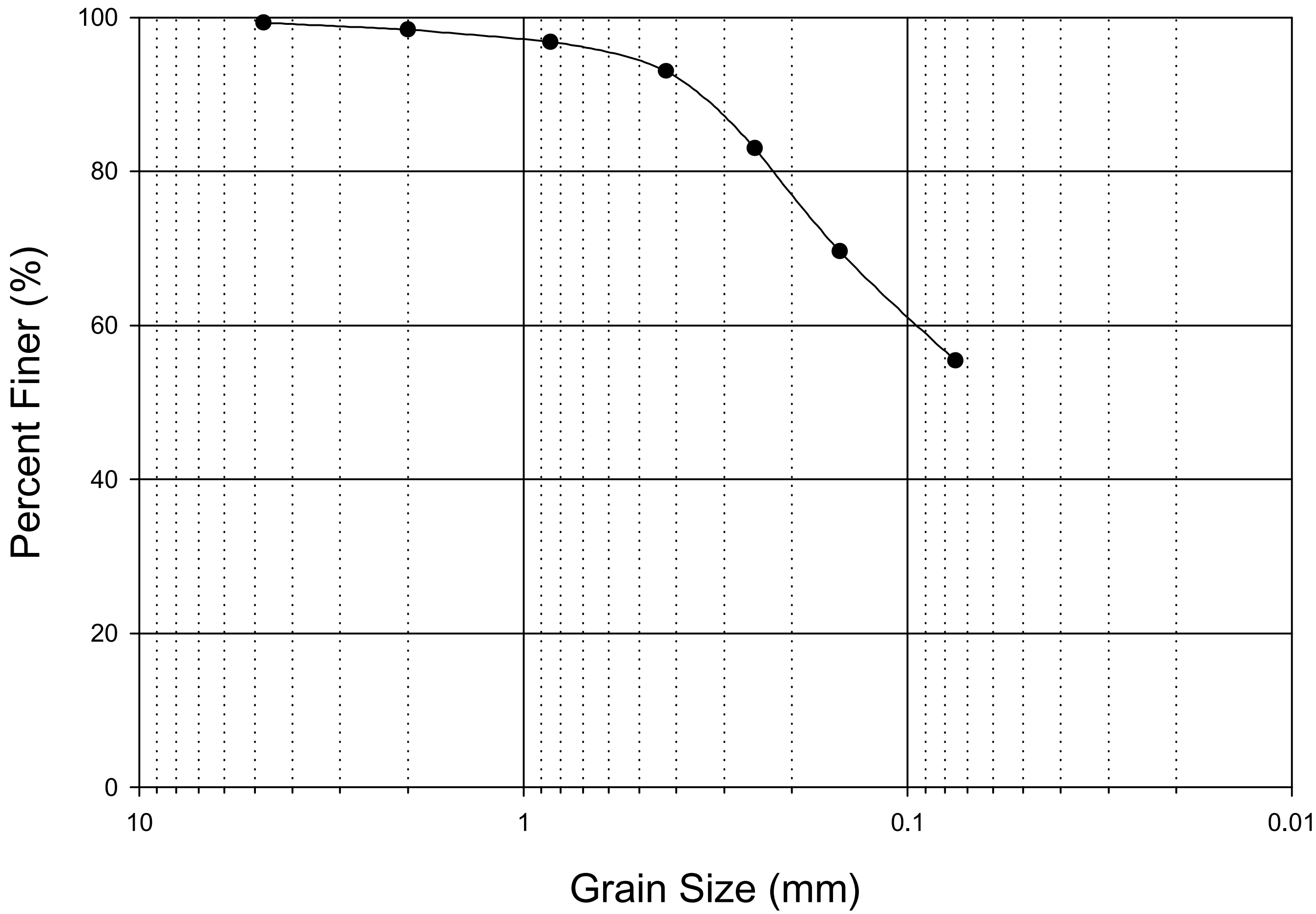
US290 EW Particle Size Distribution Curve



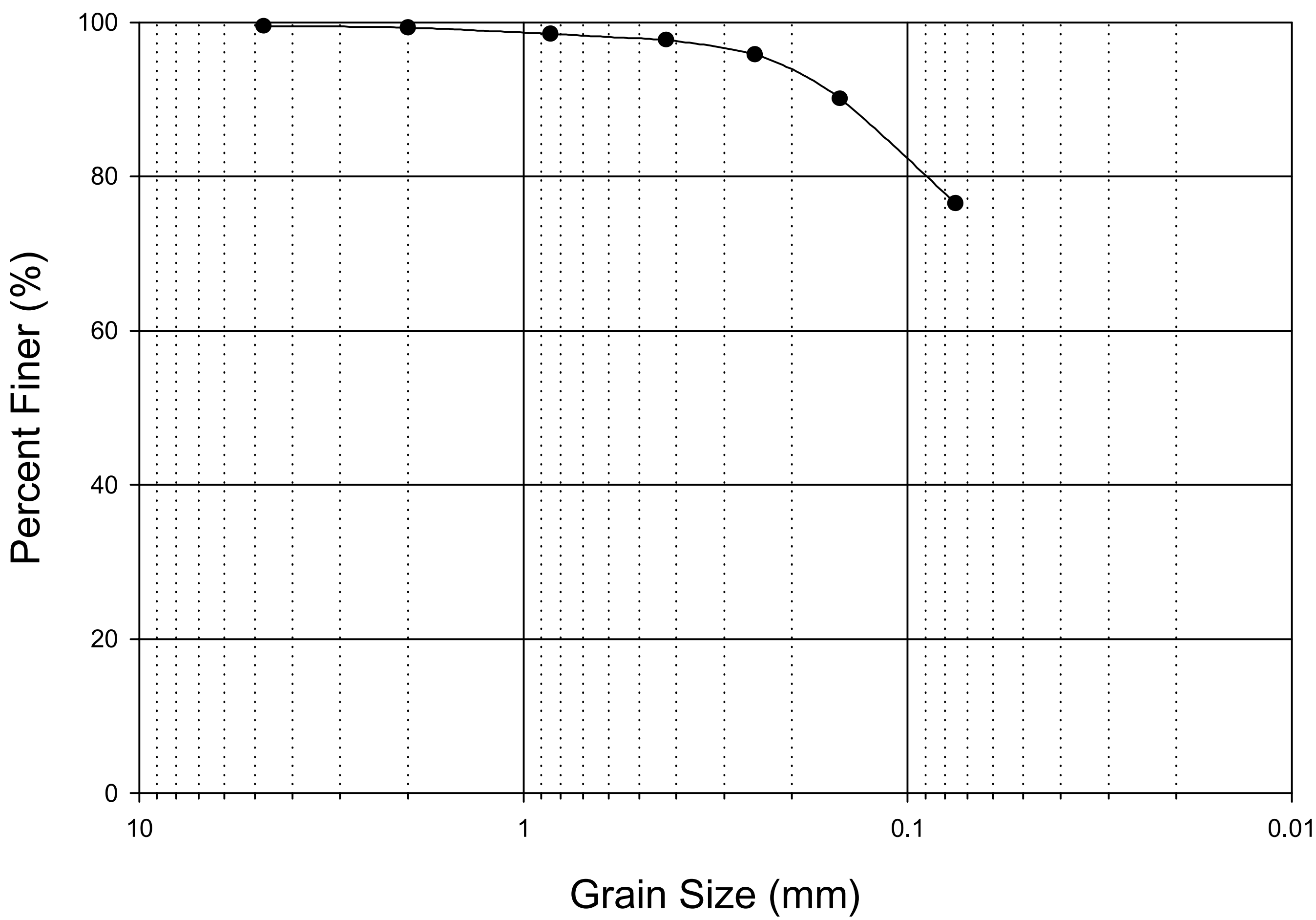
US290 WW Particle Size Distribution Curve



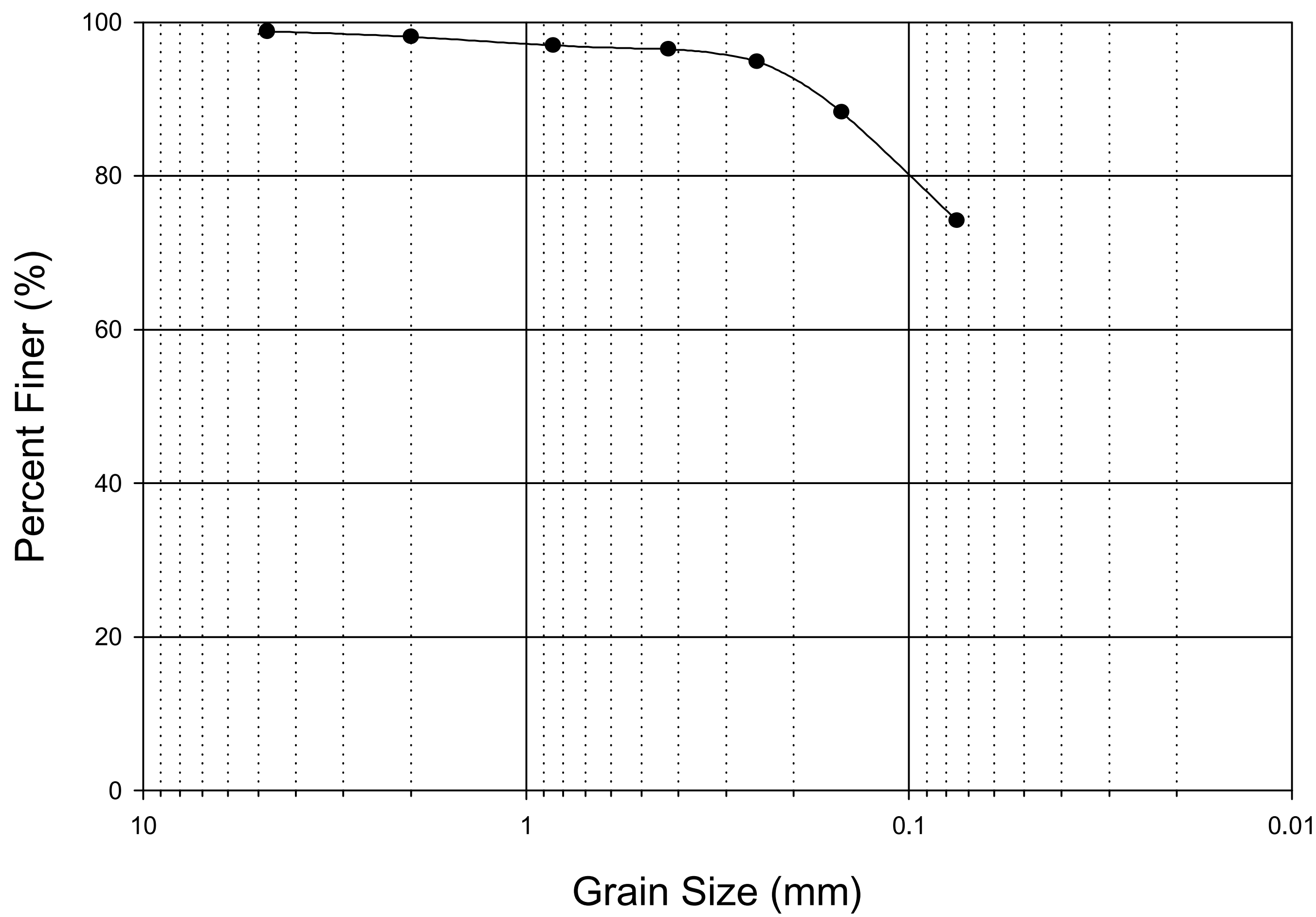
SH249 NS Particle Size Distribution Curve



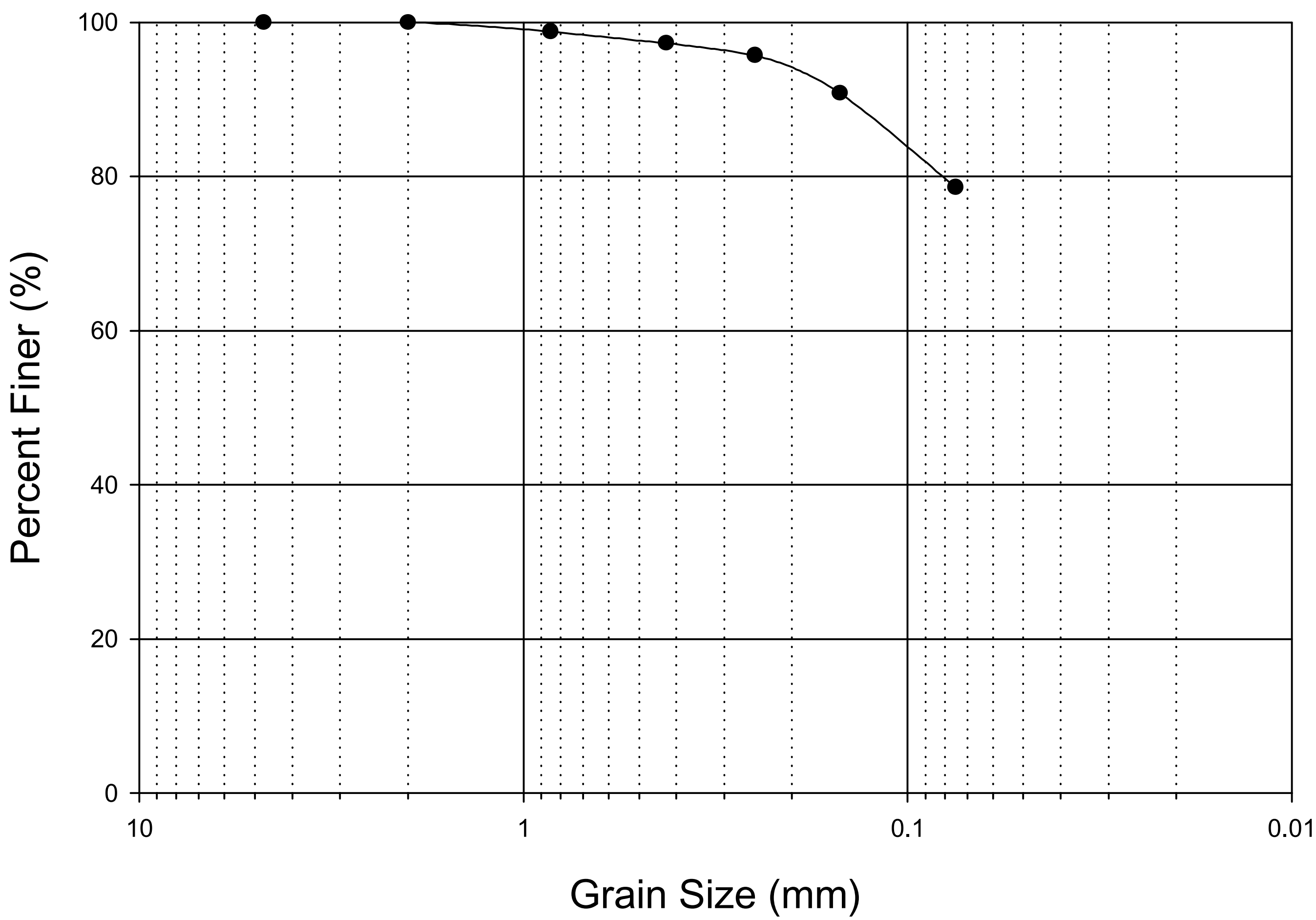
SH249 SS Particle Size Distribution Curve



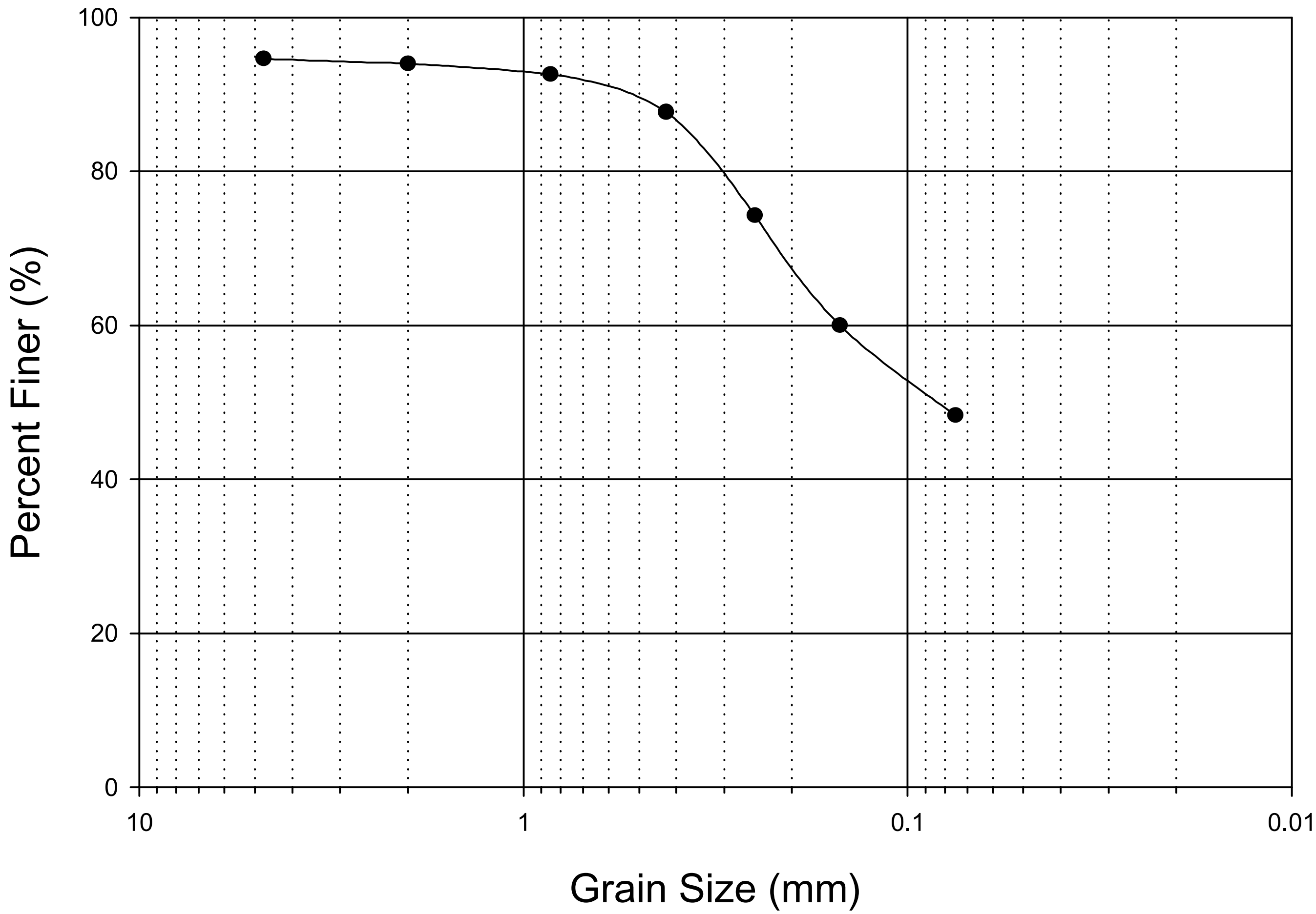
SH249 SN Particle Size Distribution Curve



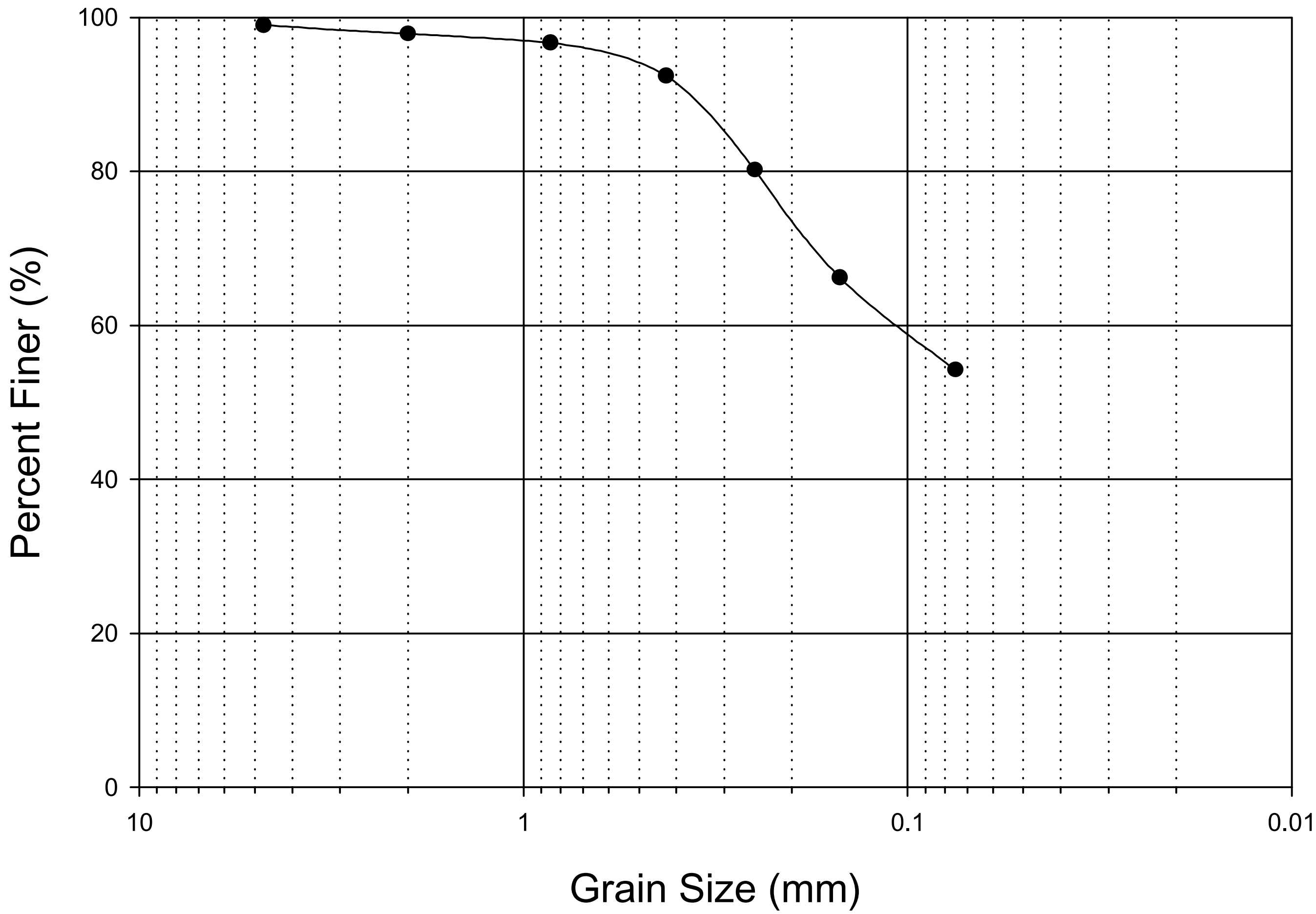
SH249 NN Particle Size Distribution Curve



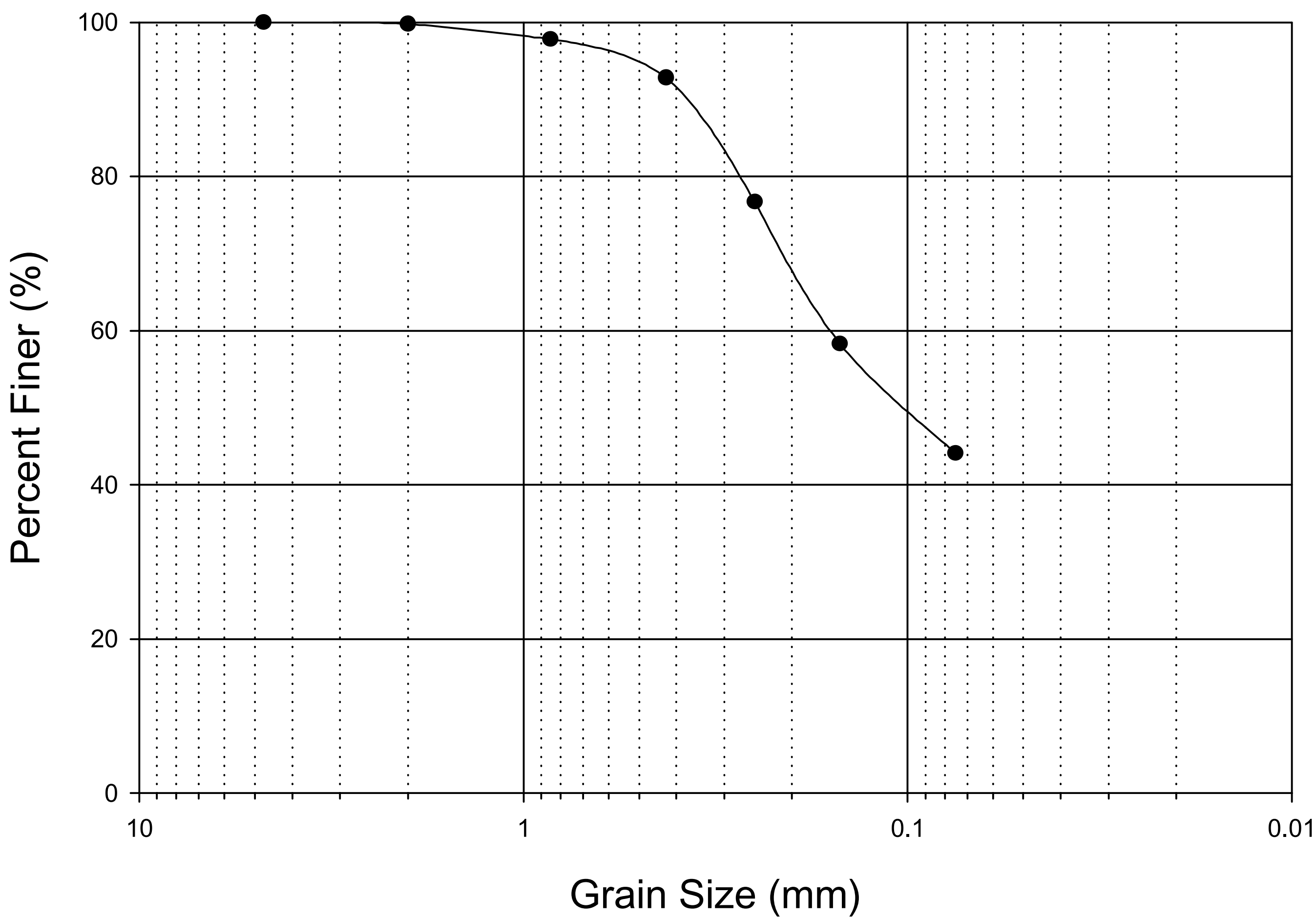
US290 EE Embankment Particle Size Distribution Curve



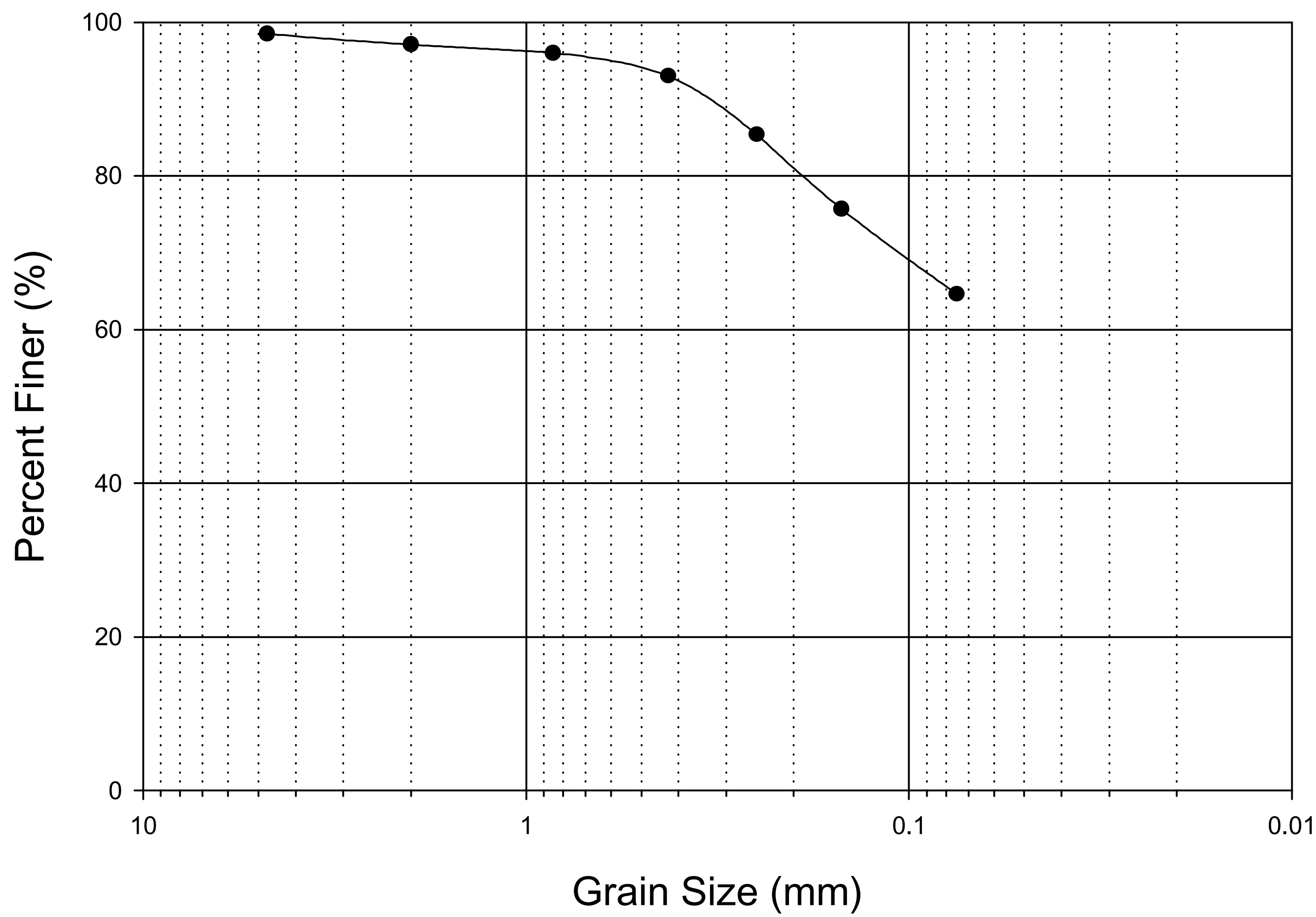
US290 WE Embankment Particle Size Distribution Curve



US290 EW Embankment Particle Size Distribution Curve

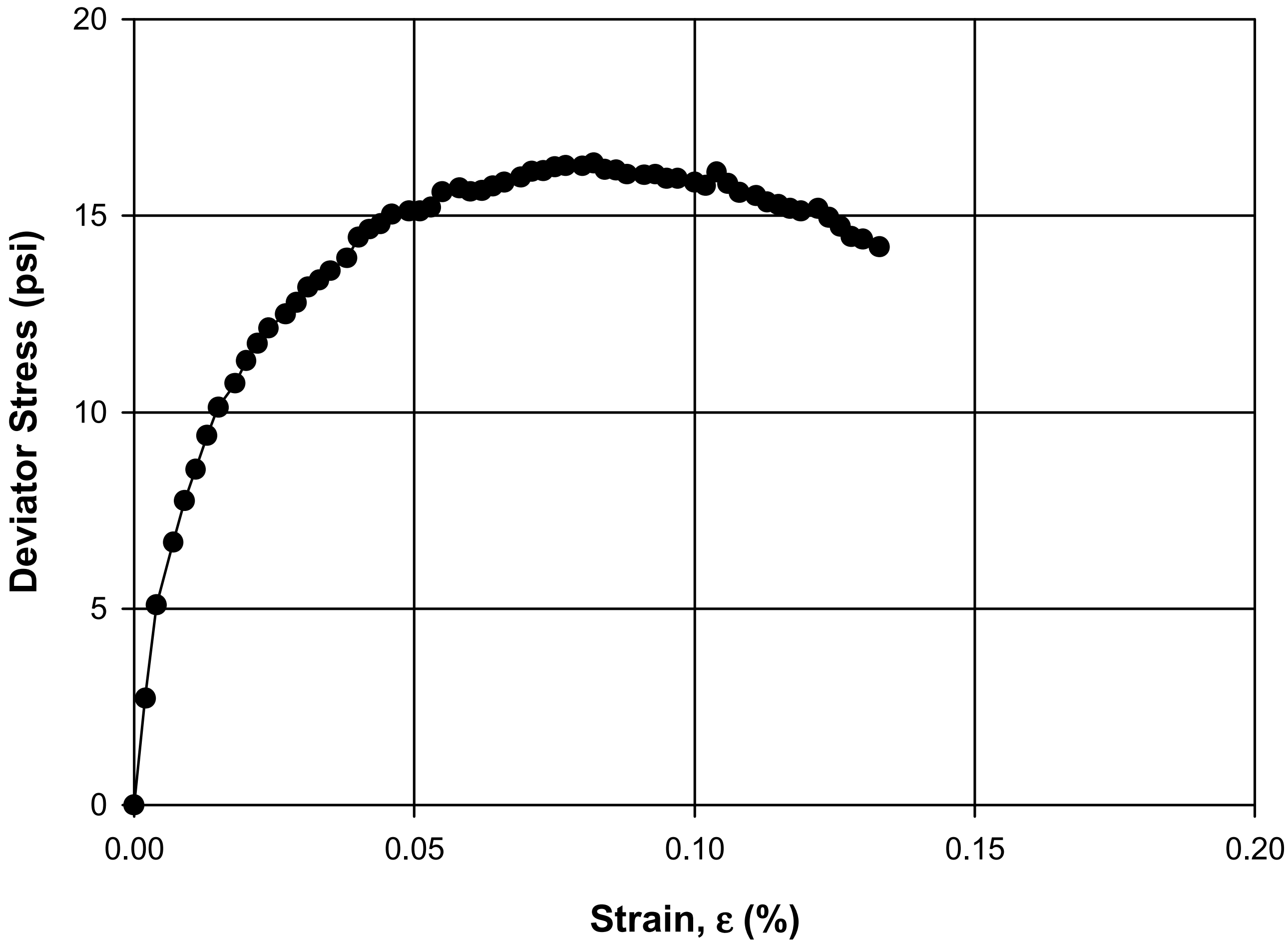


US290 WW Embankment Particle Size Distribution Curve

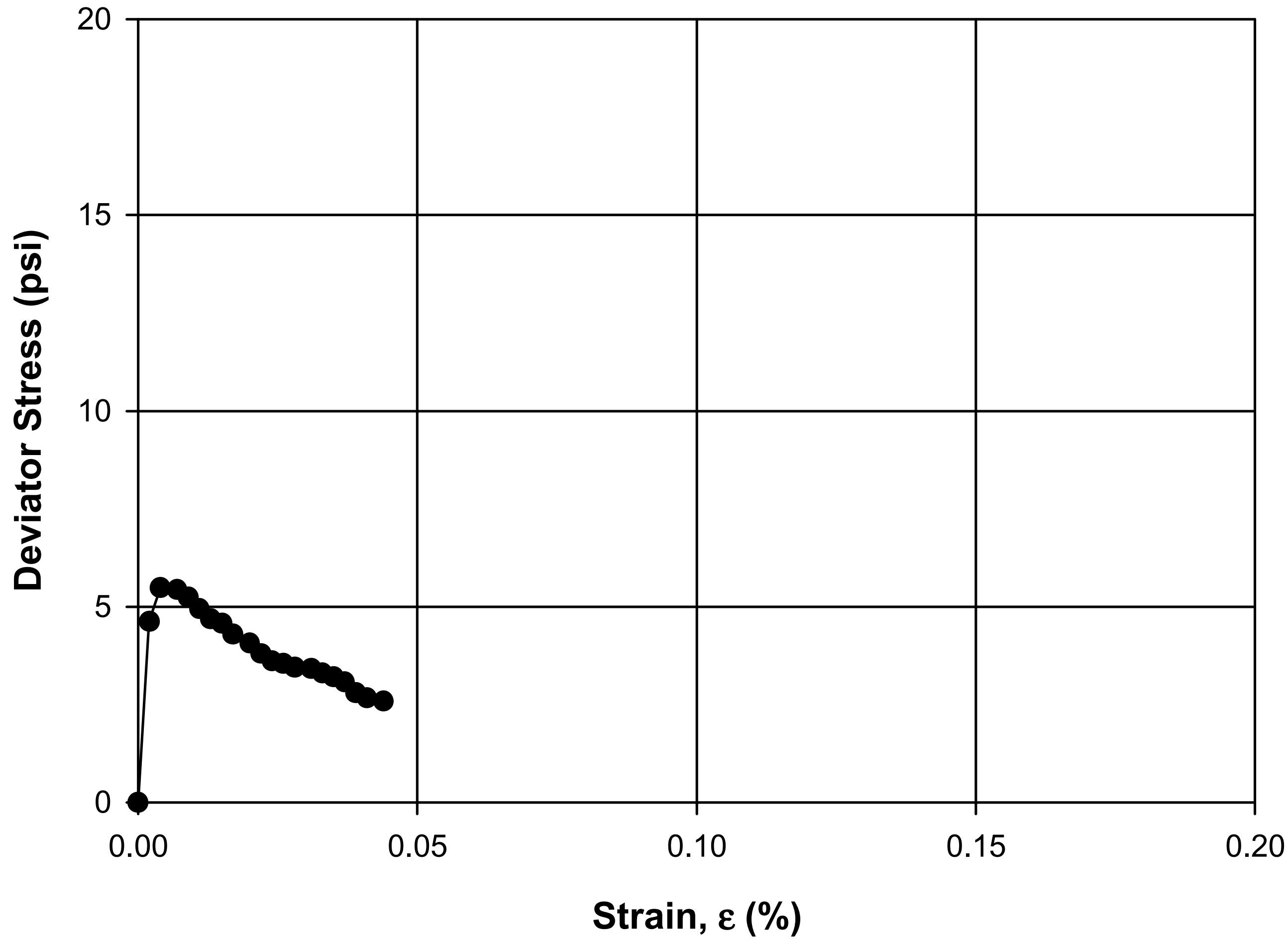


APPENDIX K TRIAXIAL TEST

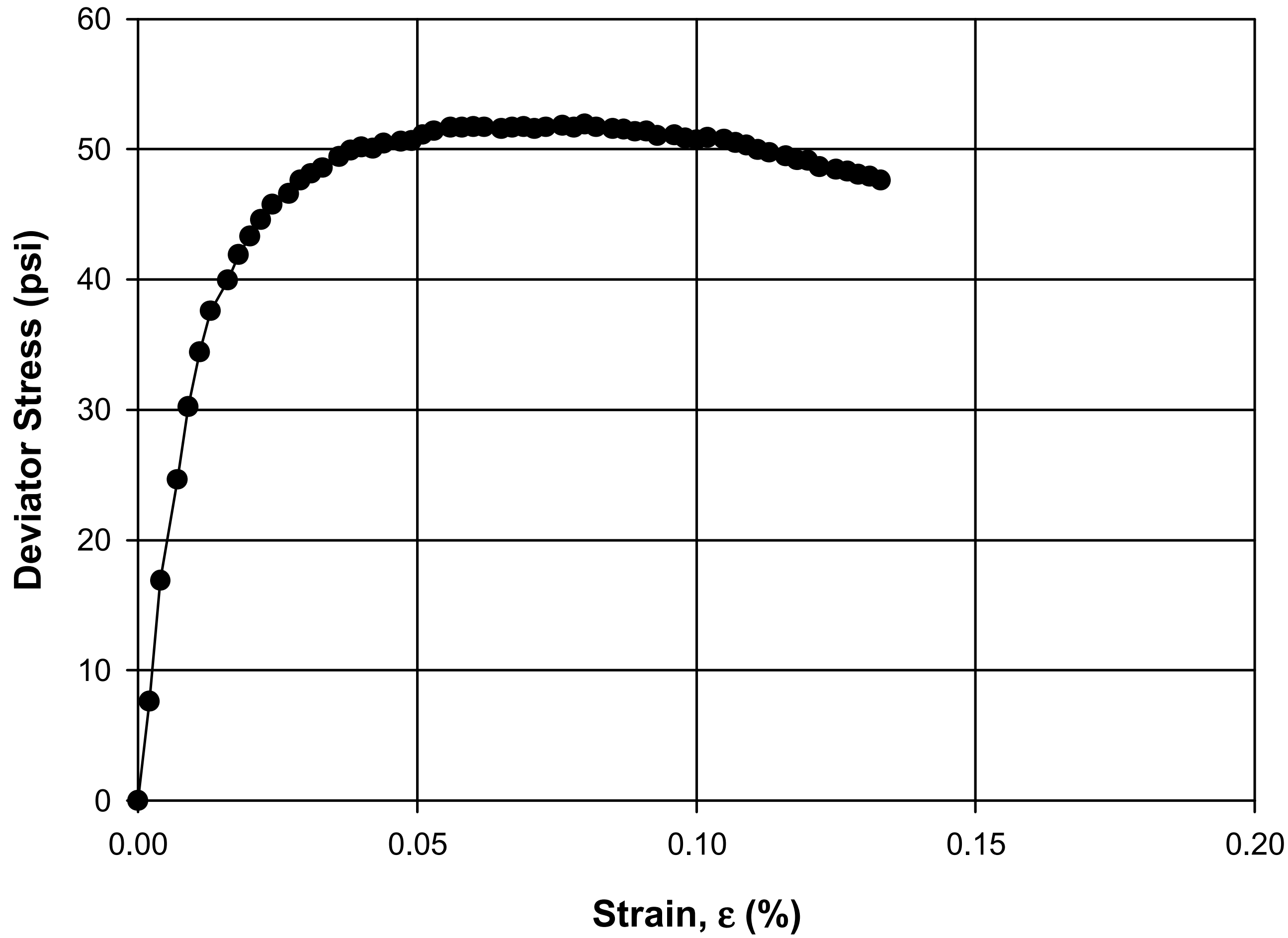
US290-EE-STS-1-No. 2 TRIAXIAL TEST



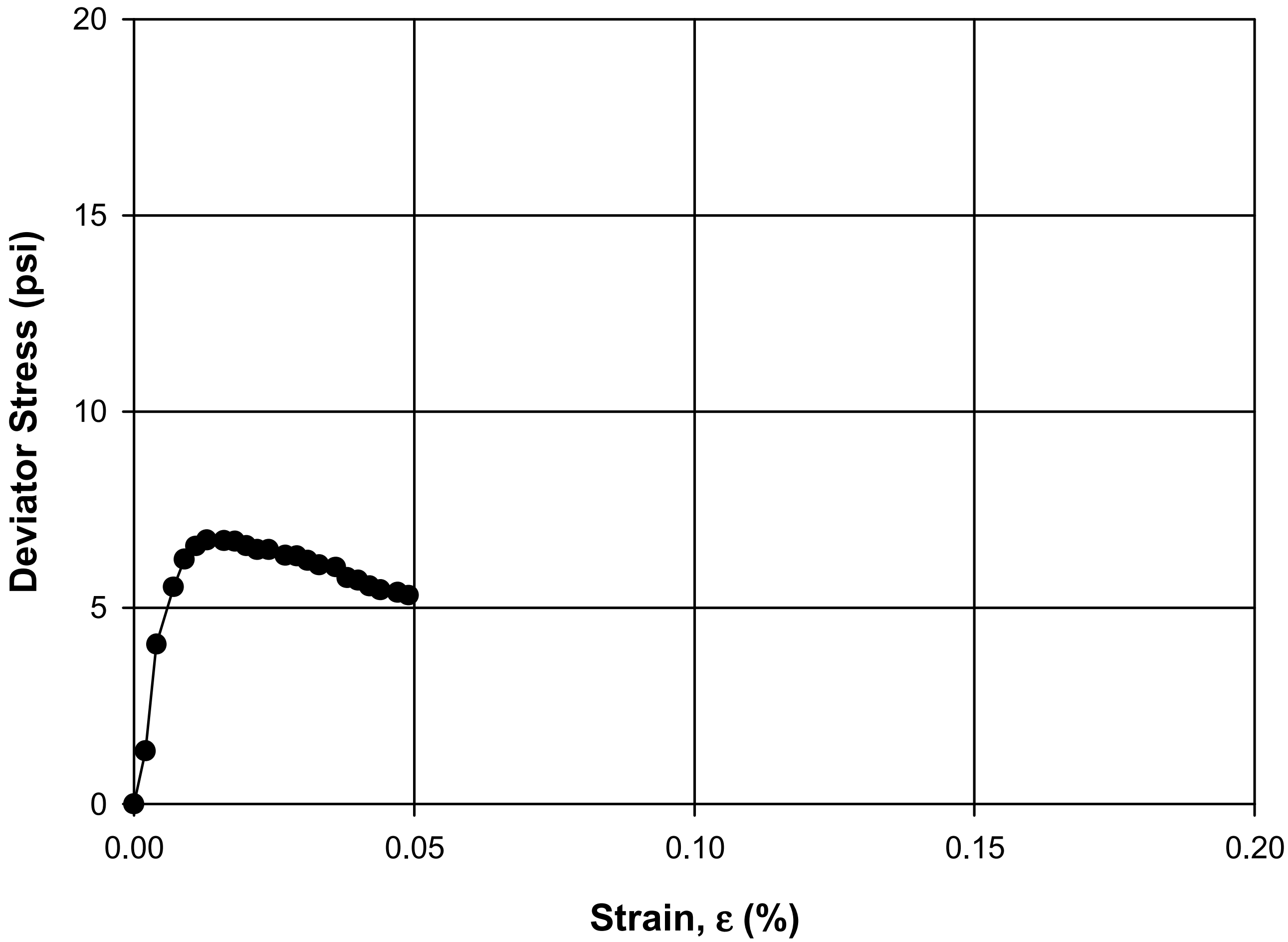
US290-EE-STS-1-No. 13 TRIAXIAL TEST



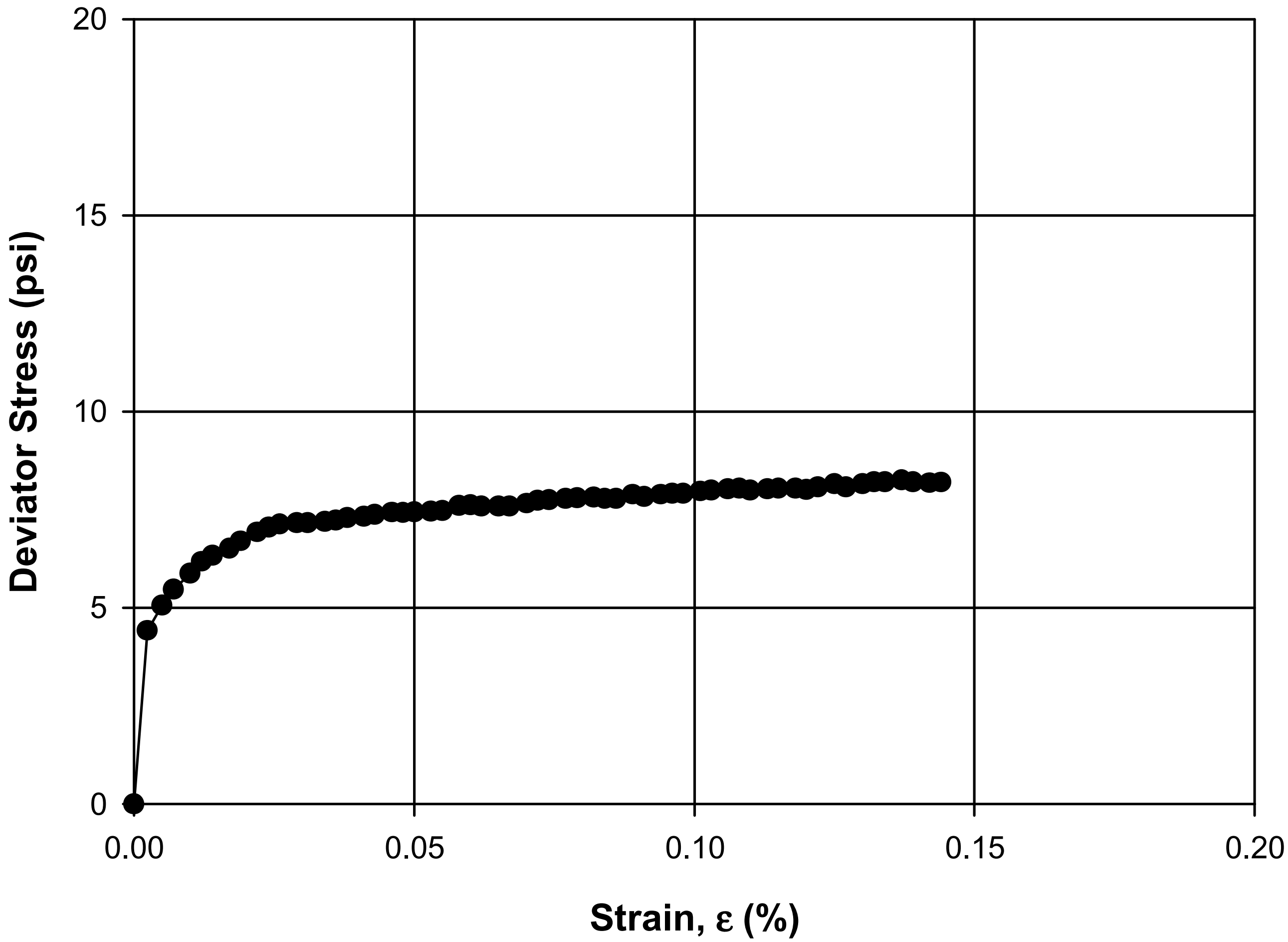
US290-EE-STS-2-No. 5 TRIAXIAL TEST



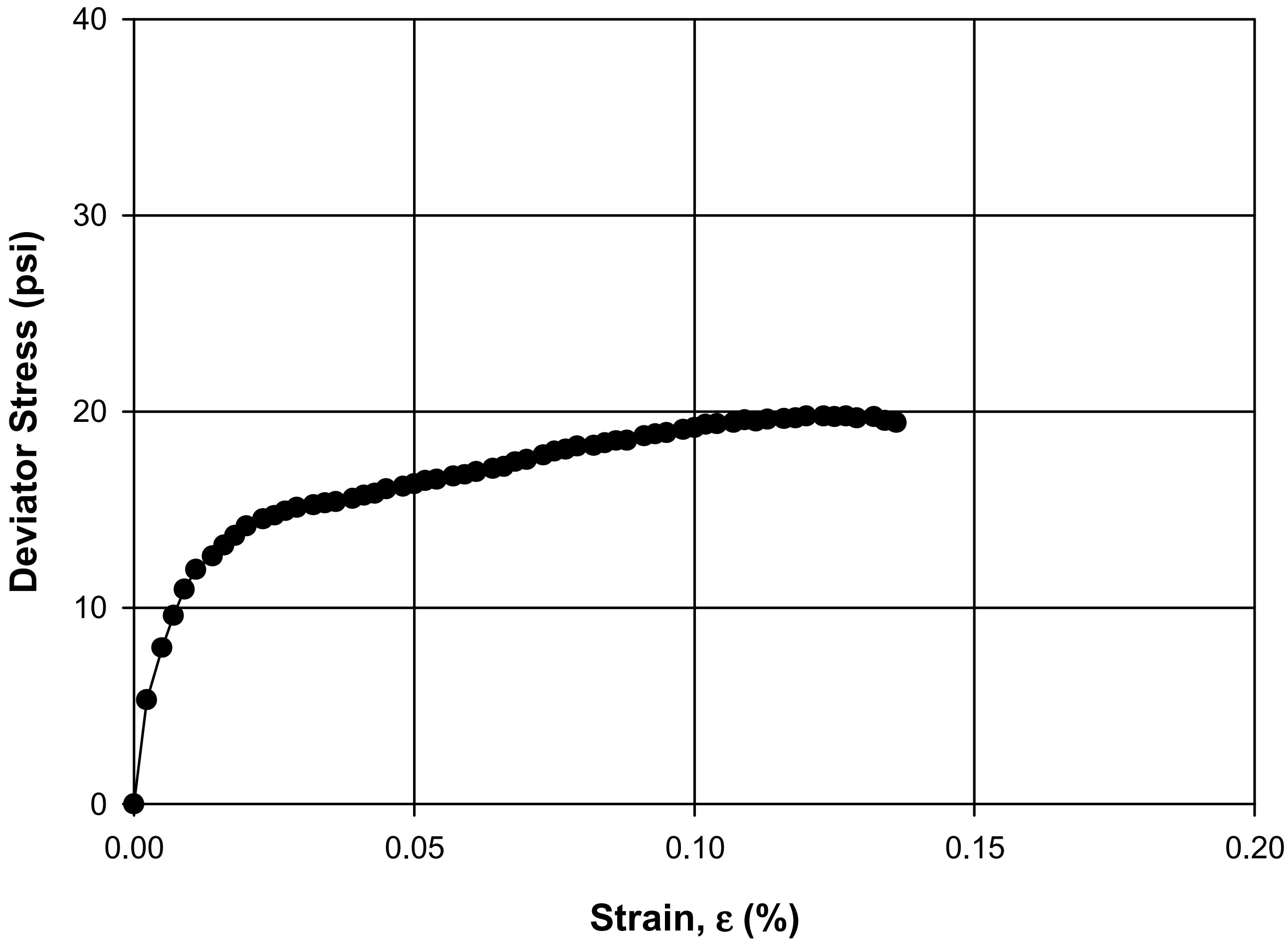
US290-EE-STS-2-No. 12 TRIAXIAL TEST

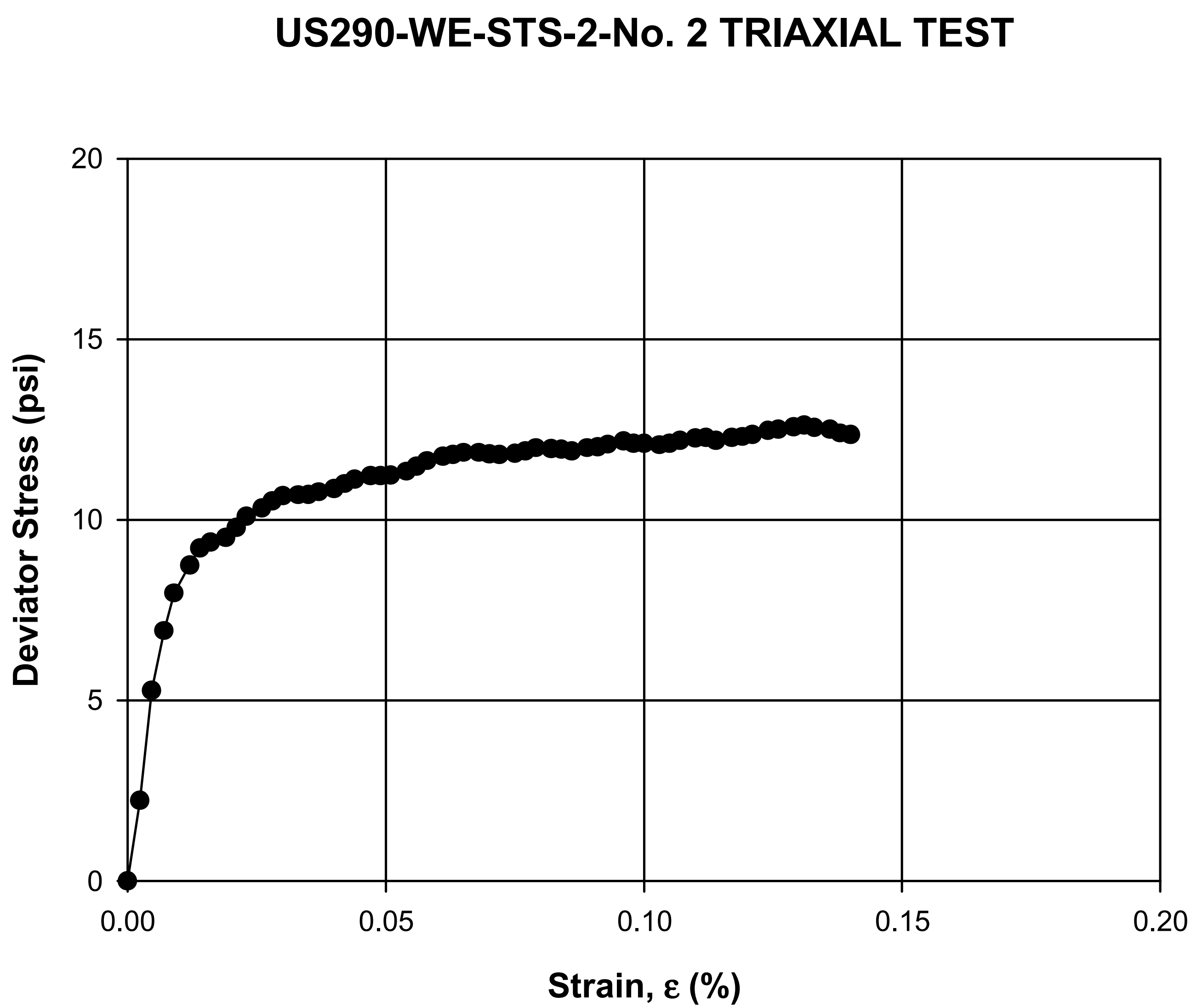


US290-WE-STS-1-No. 2 TRIAXIAL TEST

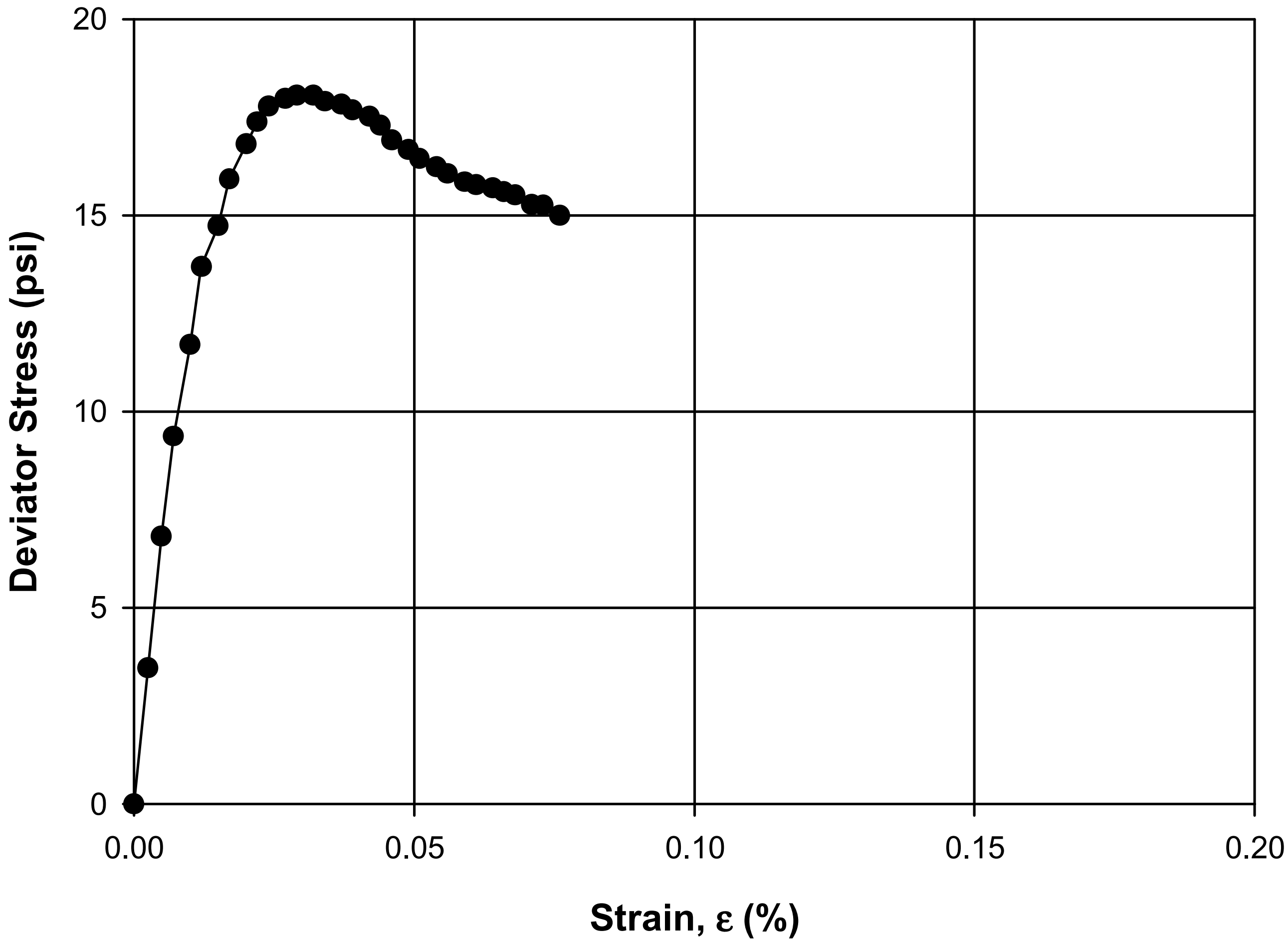


US290-WE-STS-1-No. 13 TRIAXIAL TEST

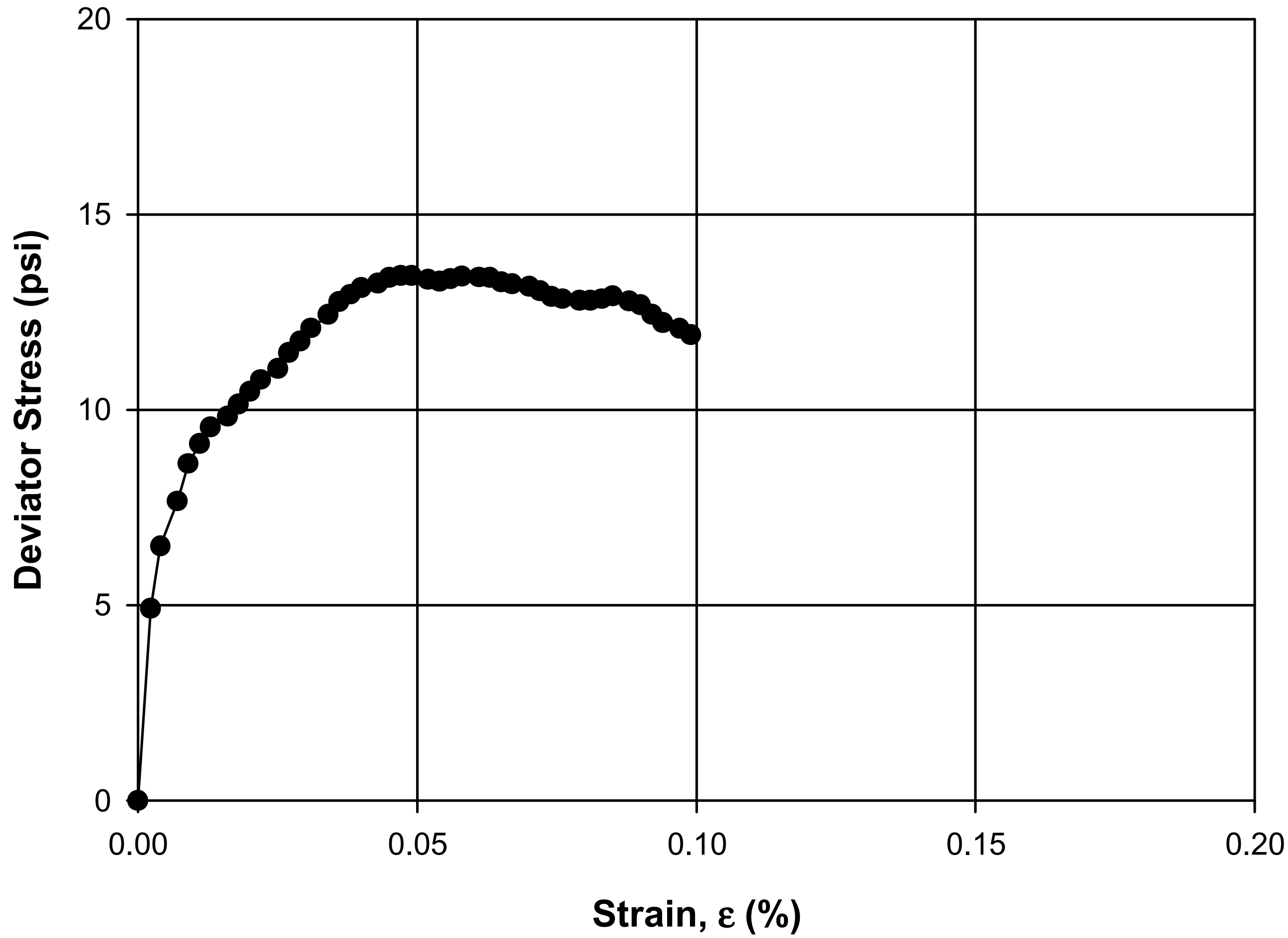



US290-WE-STS-2-No. 2 TRIAXIAL TEST
Deviator Stress (psi)
20
15
10
5
0
0.00
0.05
0.10
0.15
0.20
Strain, ε (%)

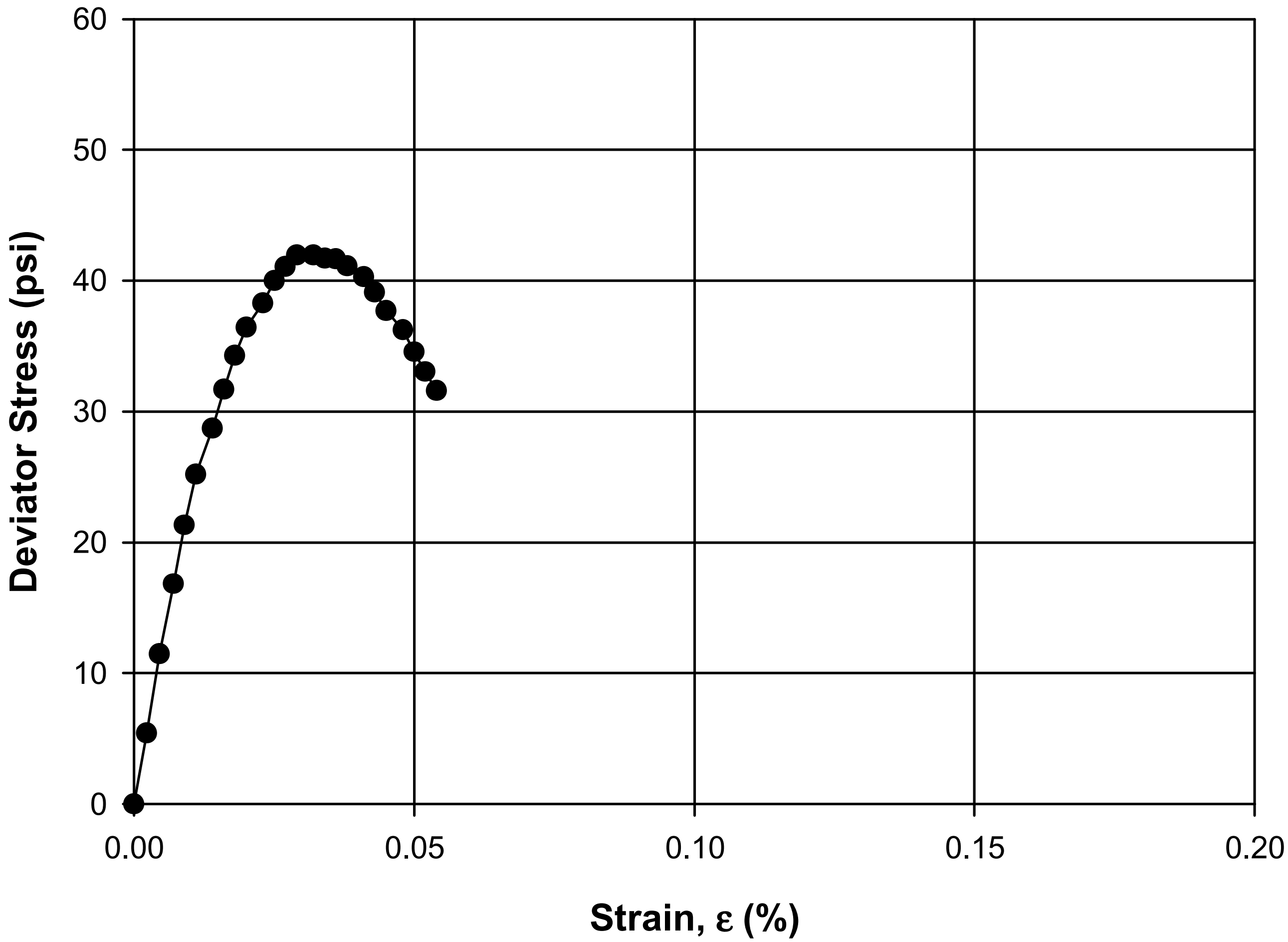
US290-WE-STS-2-No. 14 TRIAXIAL TEST

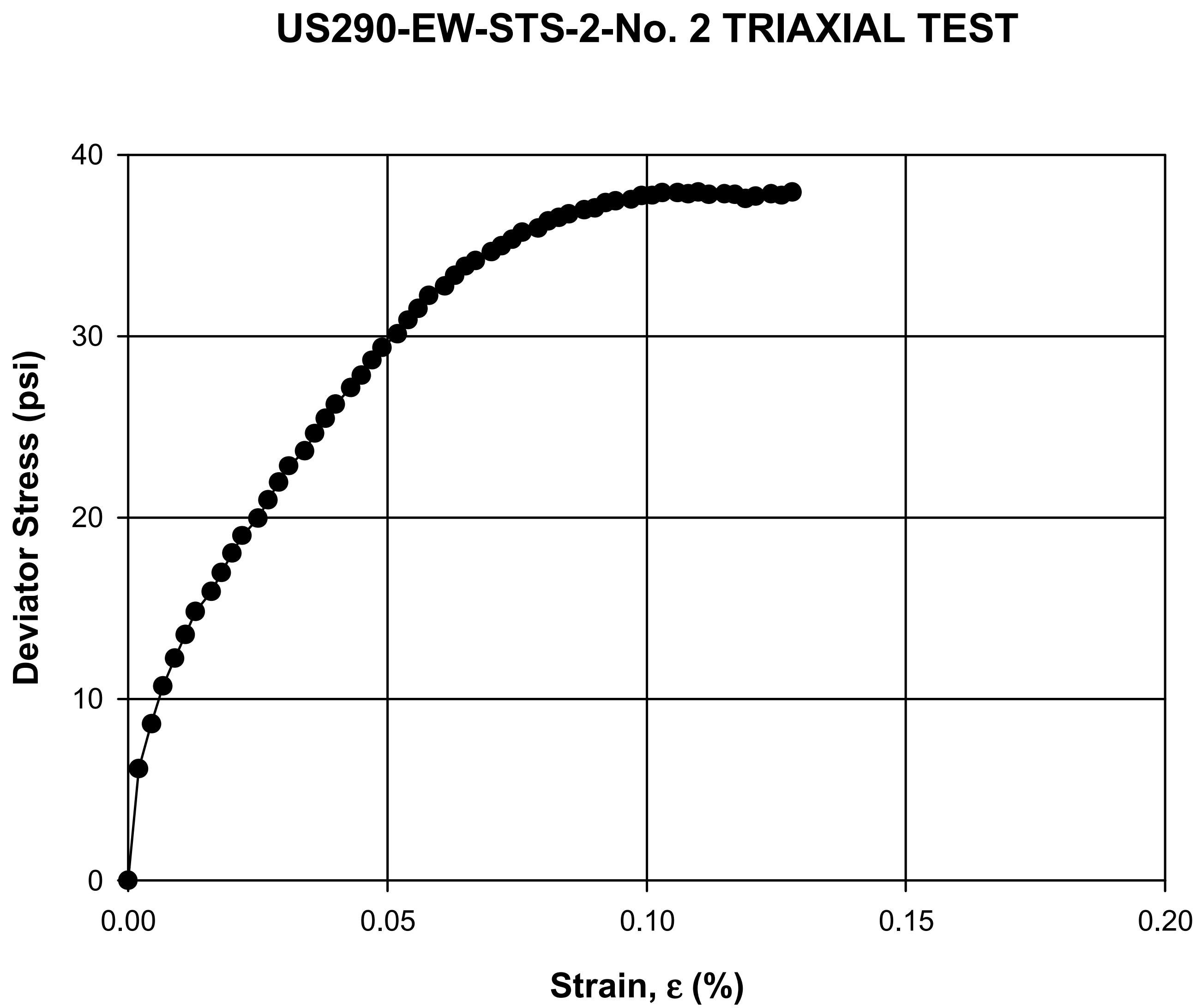


US290-EW-STS-1-No. 3 TRIAXIAL TEST

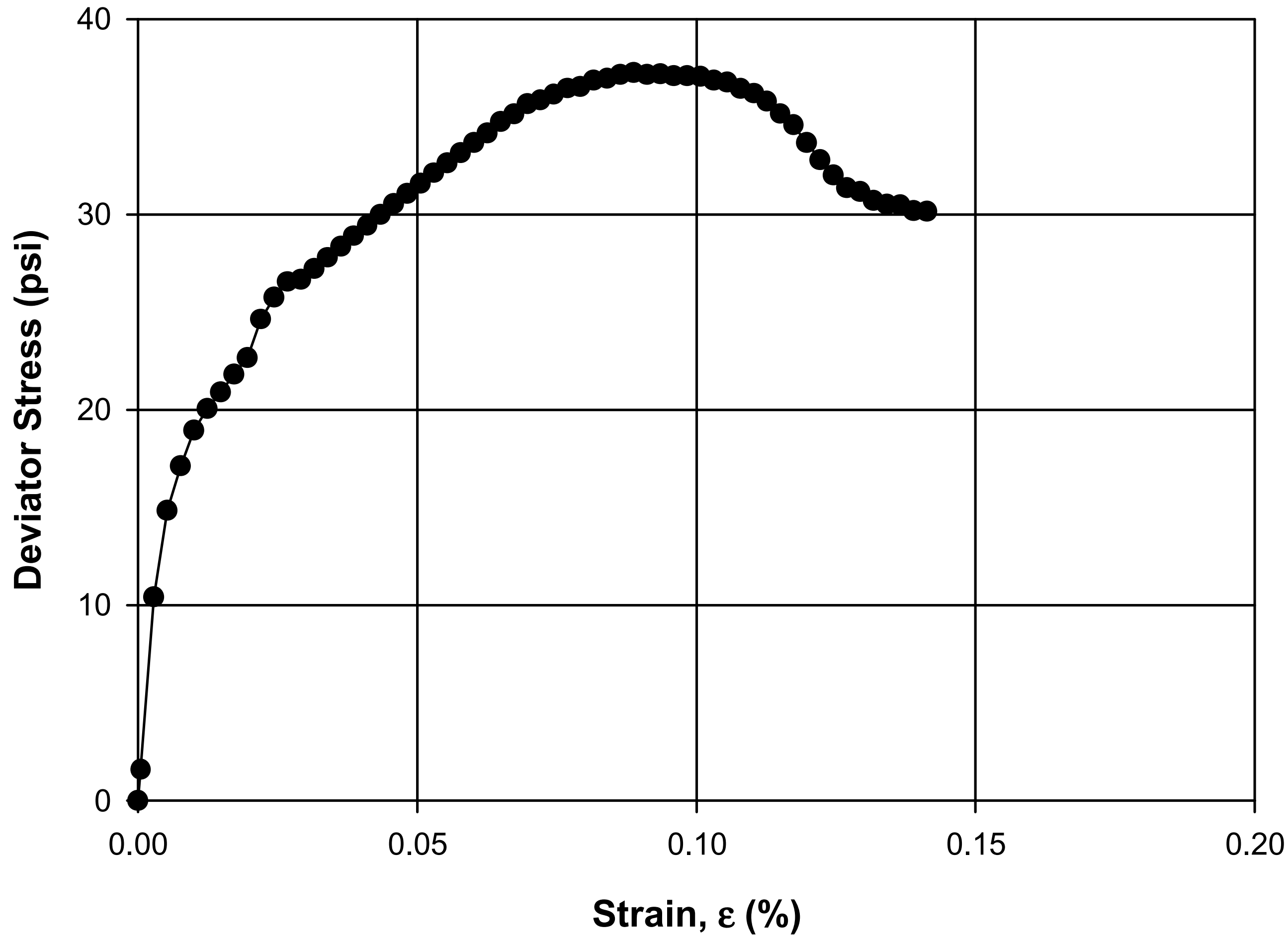


US290-EW-STS-1-No. 13 TRIAXIAL TEST

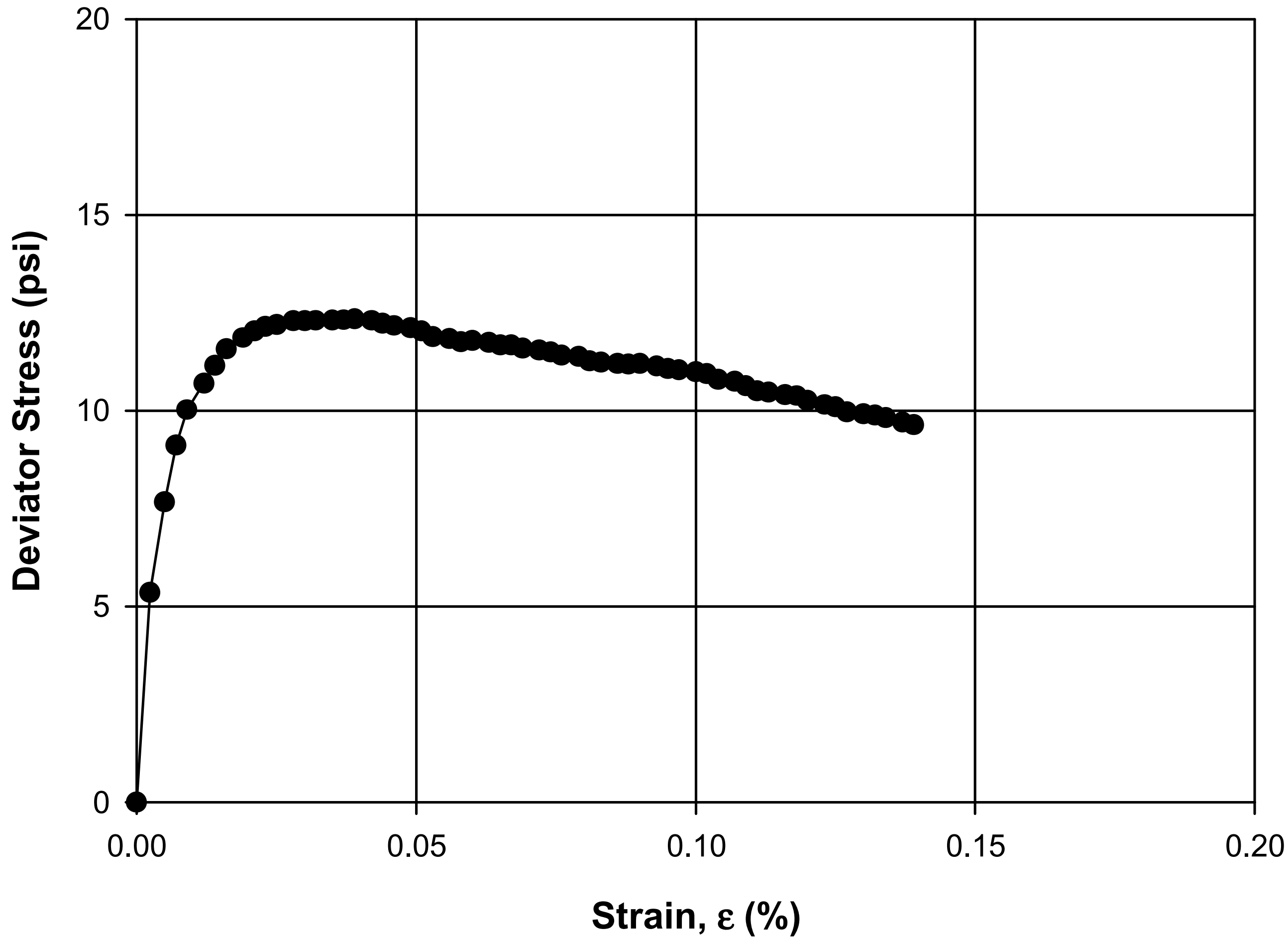



US290-EW-STS-2-No. 2 TRIAXIAL TEST
Deviator Stress (psi)
40
30
20
10
0
0.00
0.05
0.10
0.15
0.20
Strain, ε (%)

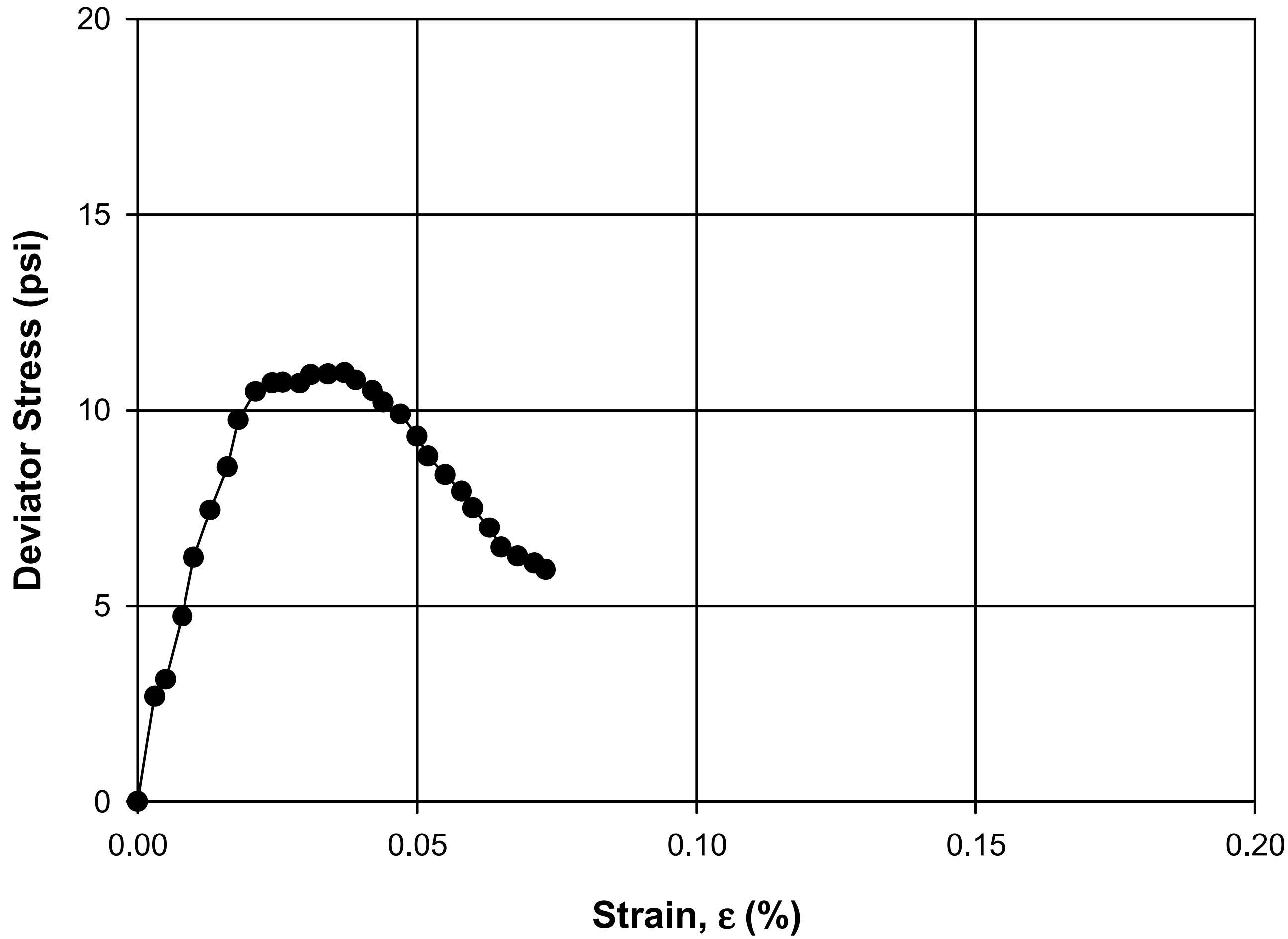
US290-EW-STS-2-No. 13 TRIAXIAL TEST



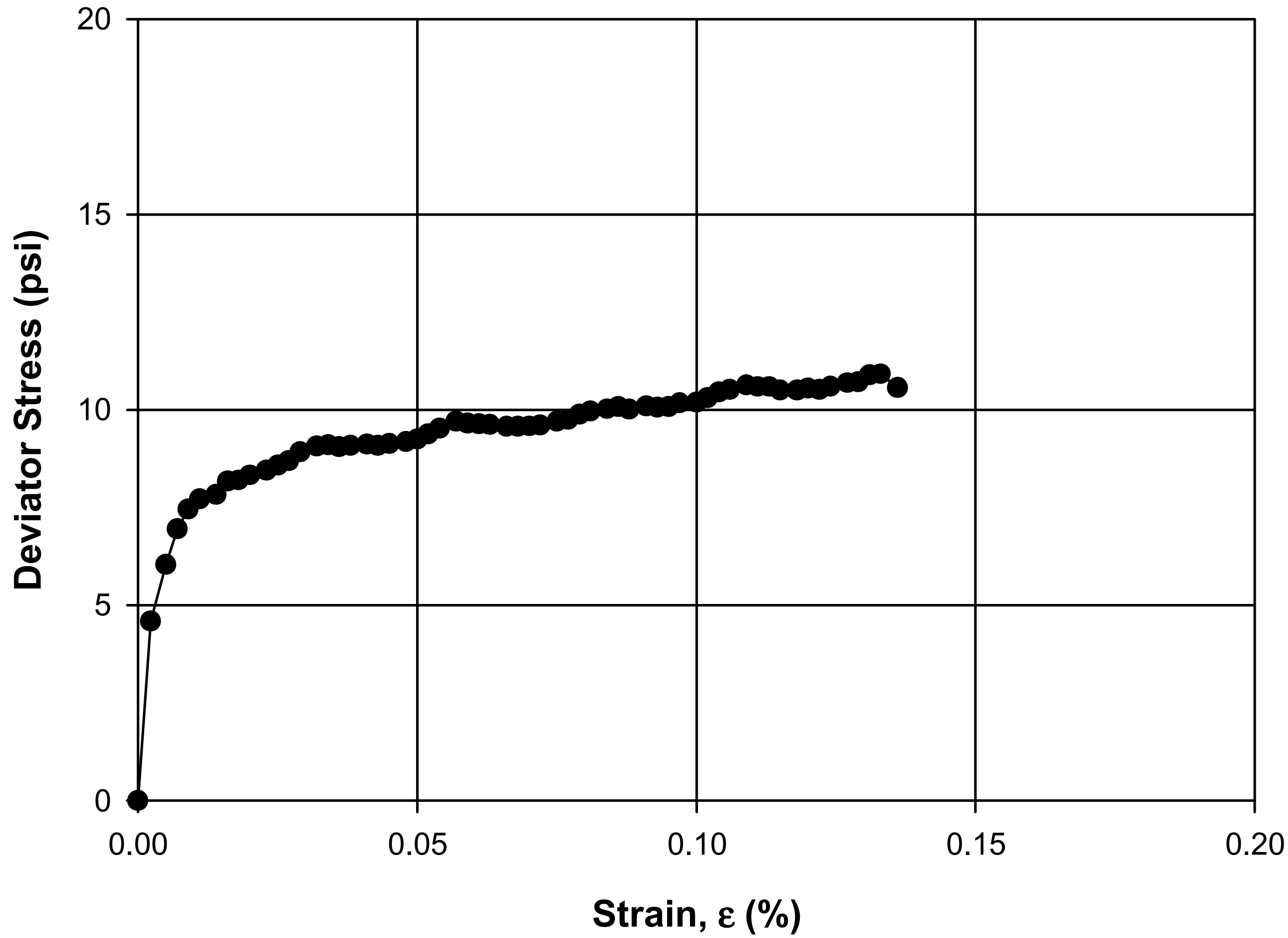
US290-WW-STS-1-No. 1 TRIAXIAL TEST



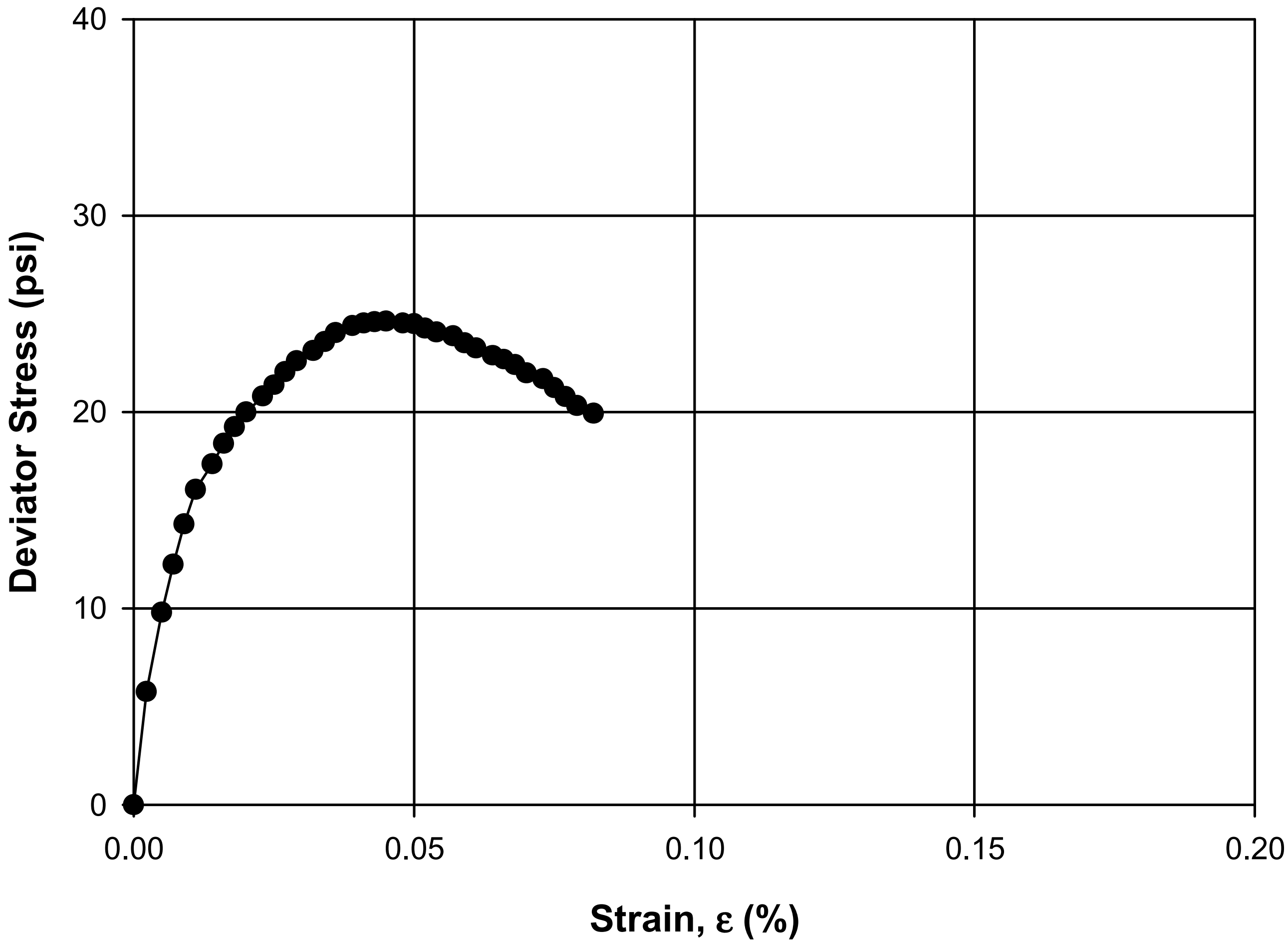
US290-WW-STS-1-No. 12 TRIAXIAL TEST



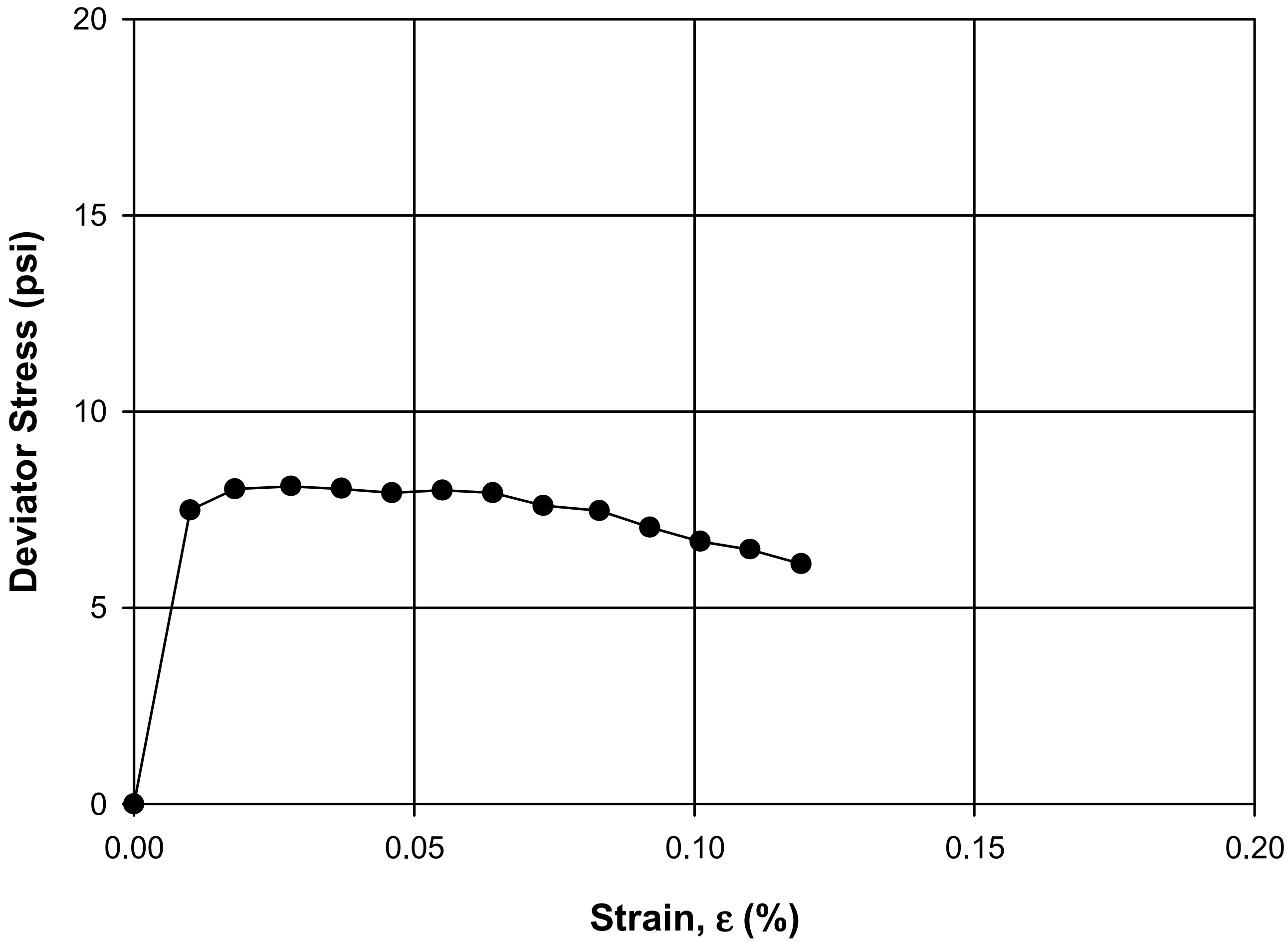
US290-WW-STS-2-No. 1 TRIAXIAL TEST



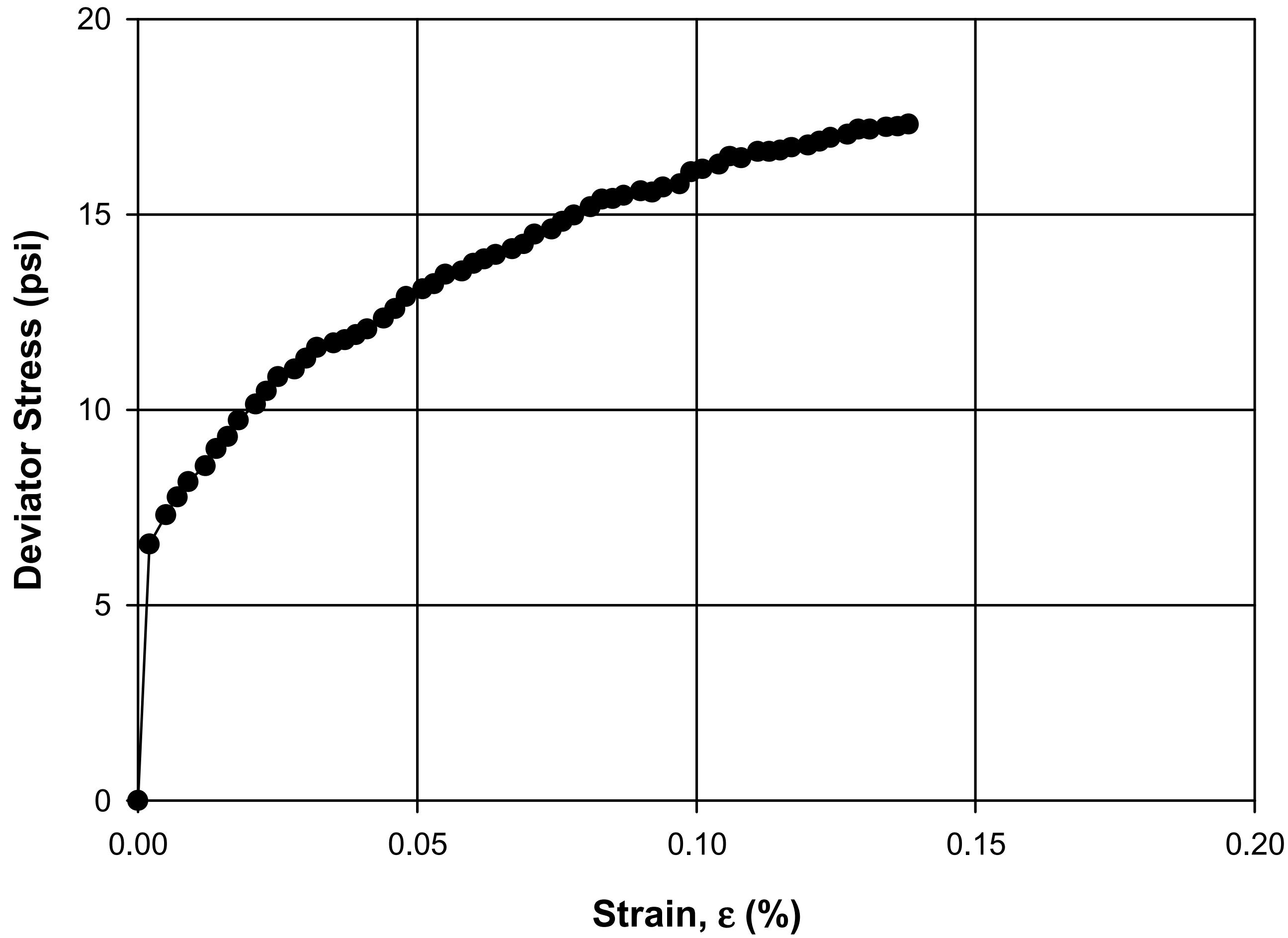
US290-WW-STS-2-No. 13 TRIAXIAL TEST



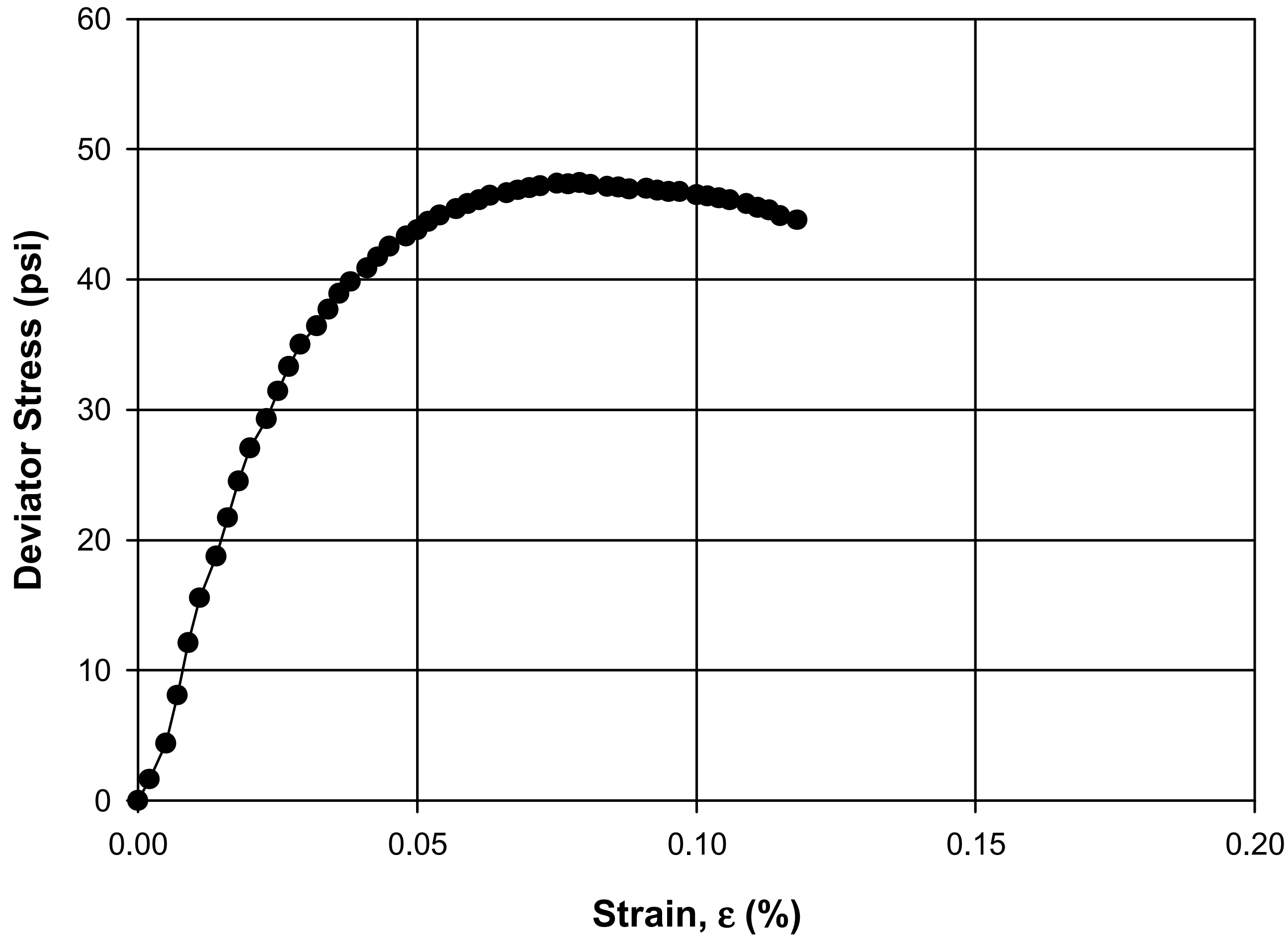
SH249-NS-STS-2-No. 7 TRIAXIAL TEST



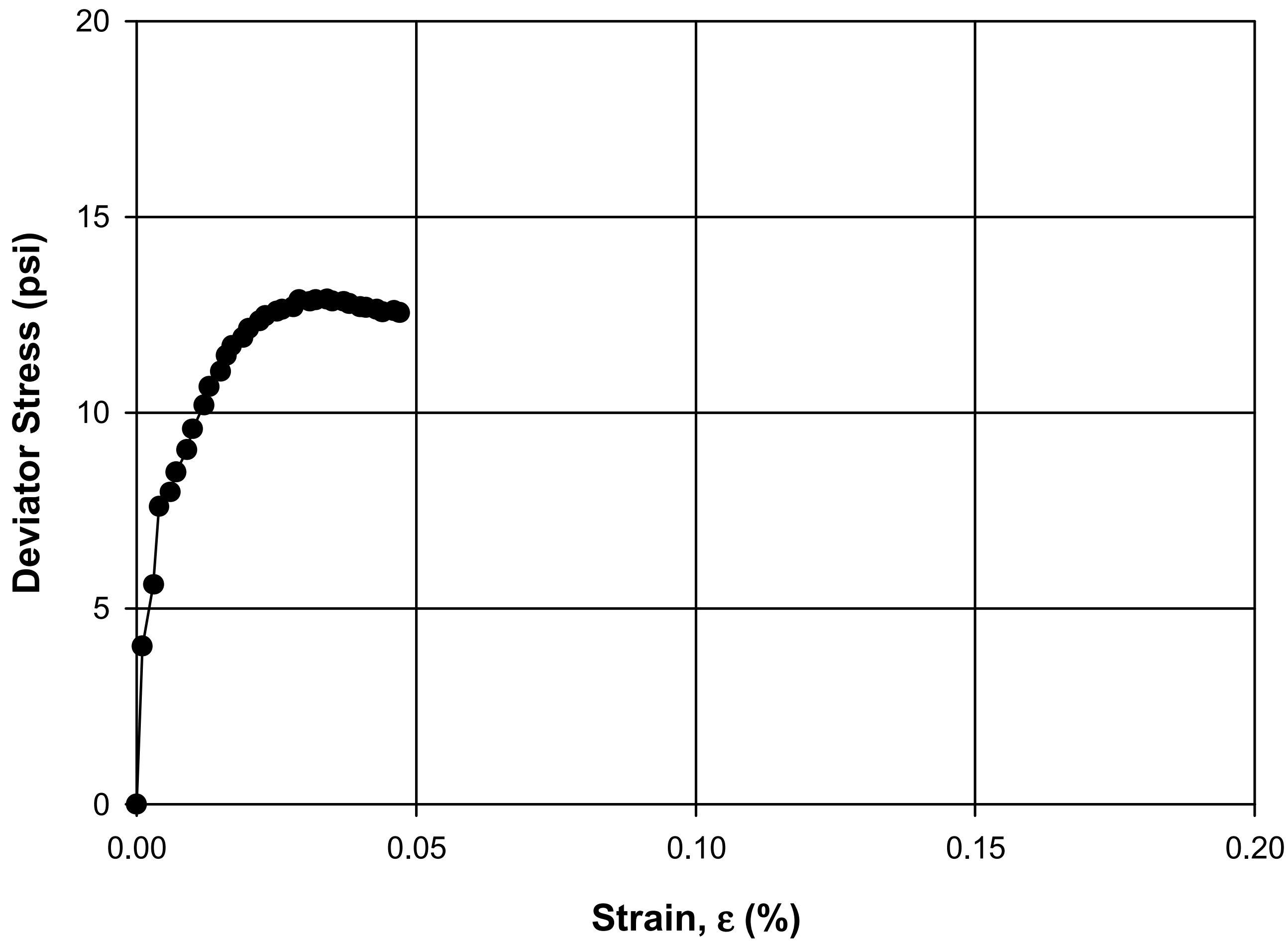
SH249-SS-STS-1-No. 4 TRIAXIAL TEST



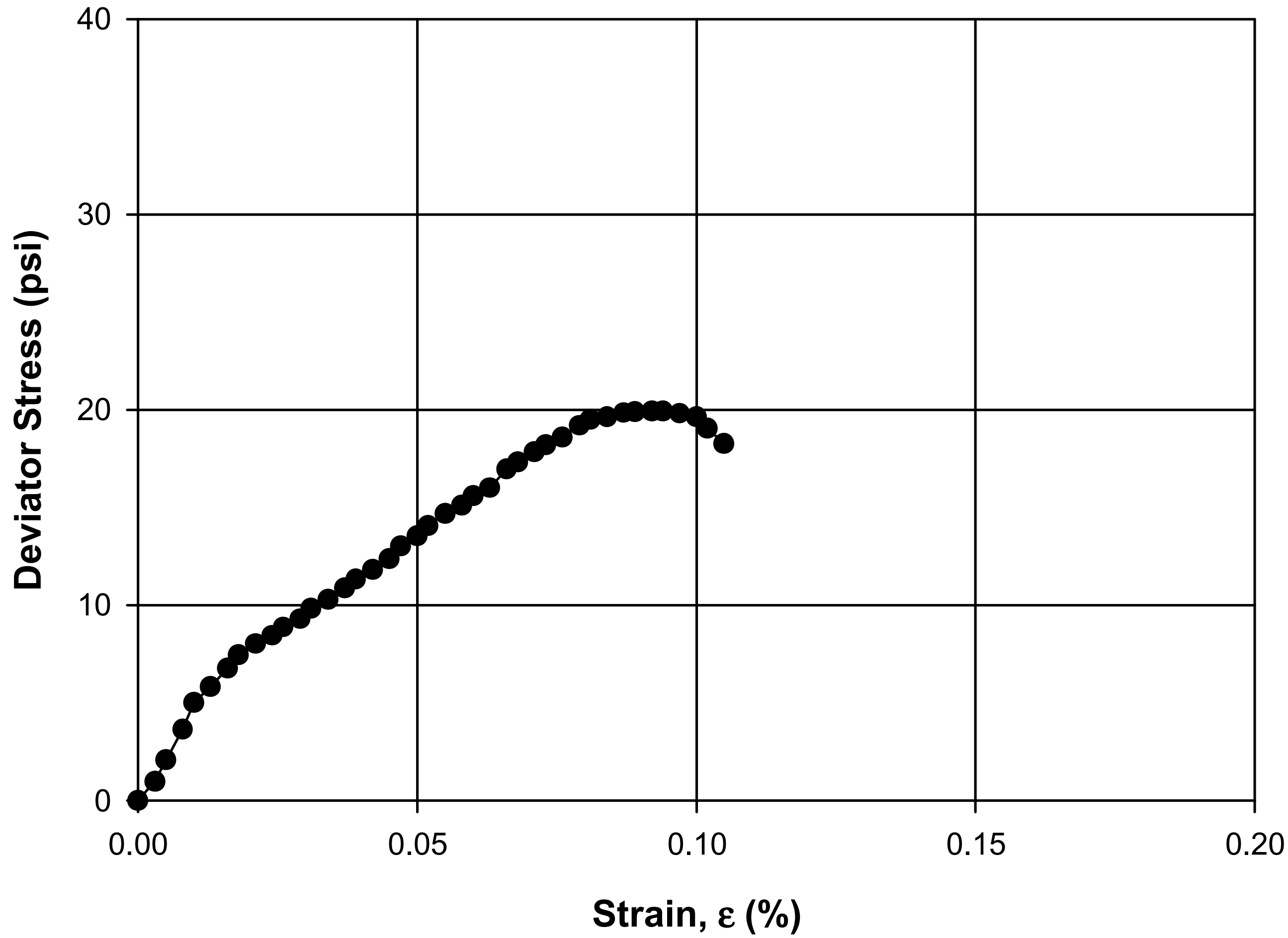
SH249-SS-STS-1-No. 8 TRIAXIAL TEST

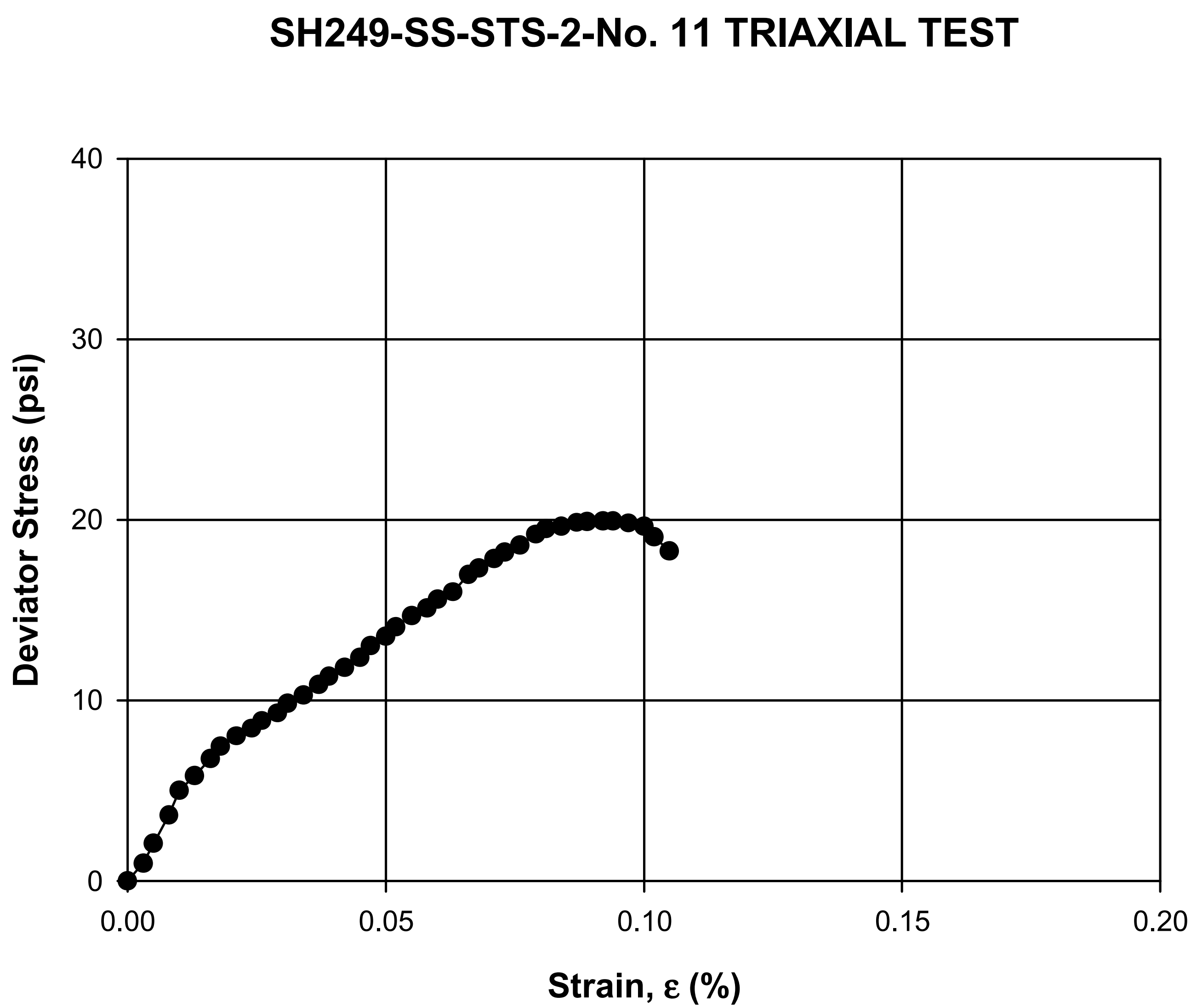


SH249-SS-STS-2-No. 3 TRIAXIAL TEST

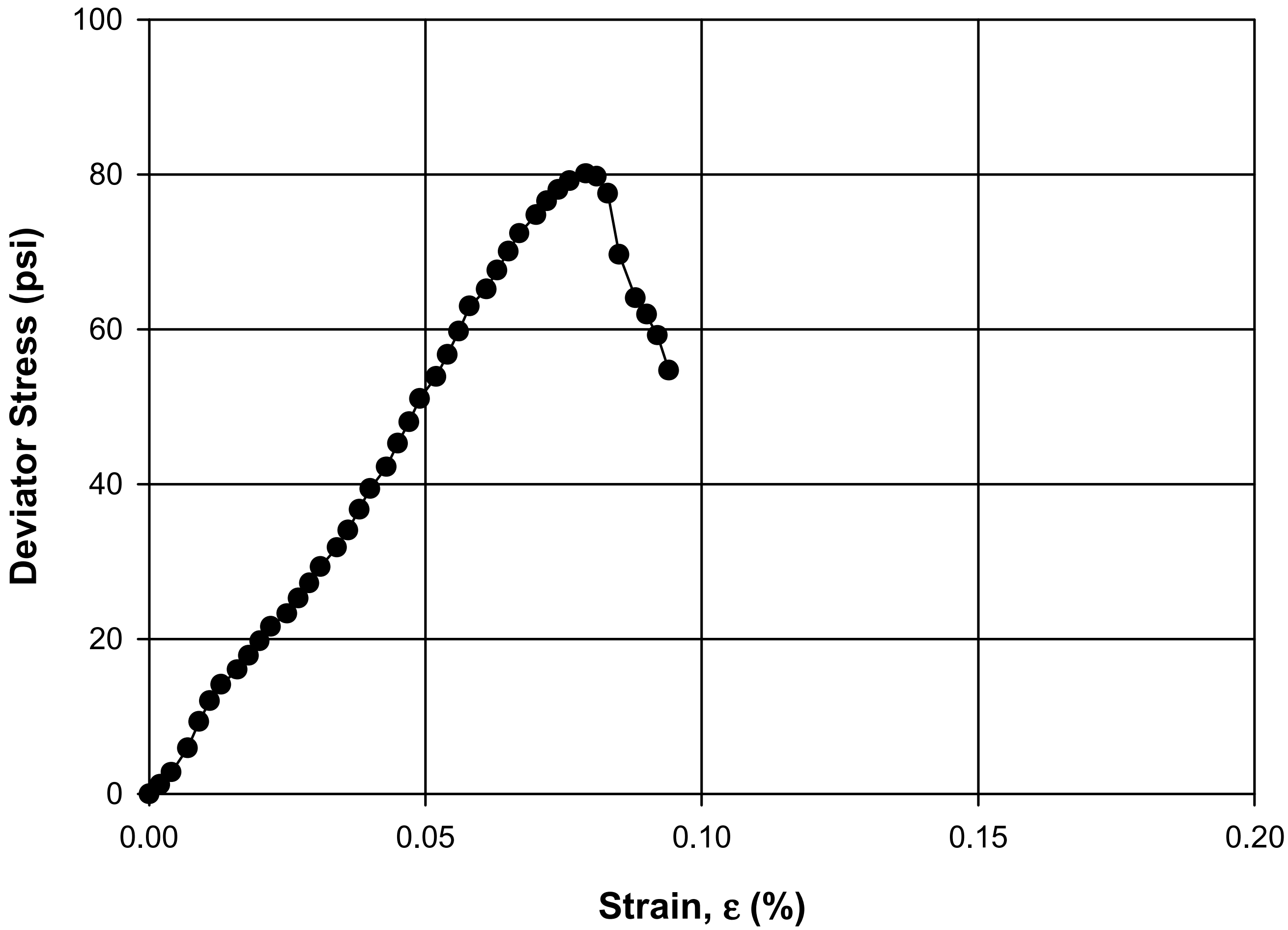


SH249-SS-STS-2-No. 7 TRIAXIAL TEST

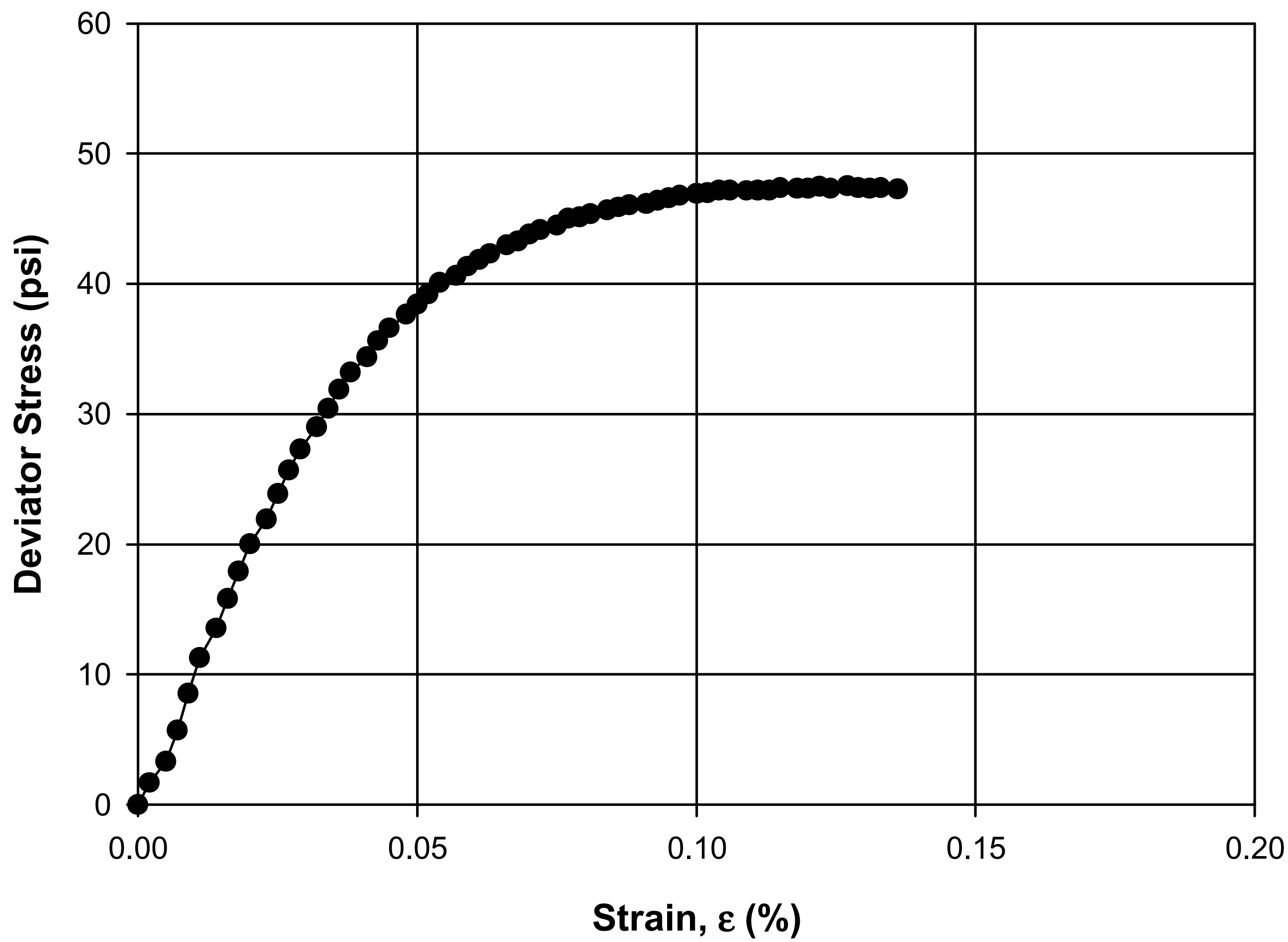



SH249-SS-STS-2-No. 11 TRIAXIAL TEST
Deviator Stress (psi)
0
10
20
30
40
0.00
0.05
0.10
0.15
0.20
Strain, ε (%)

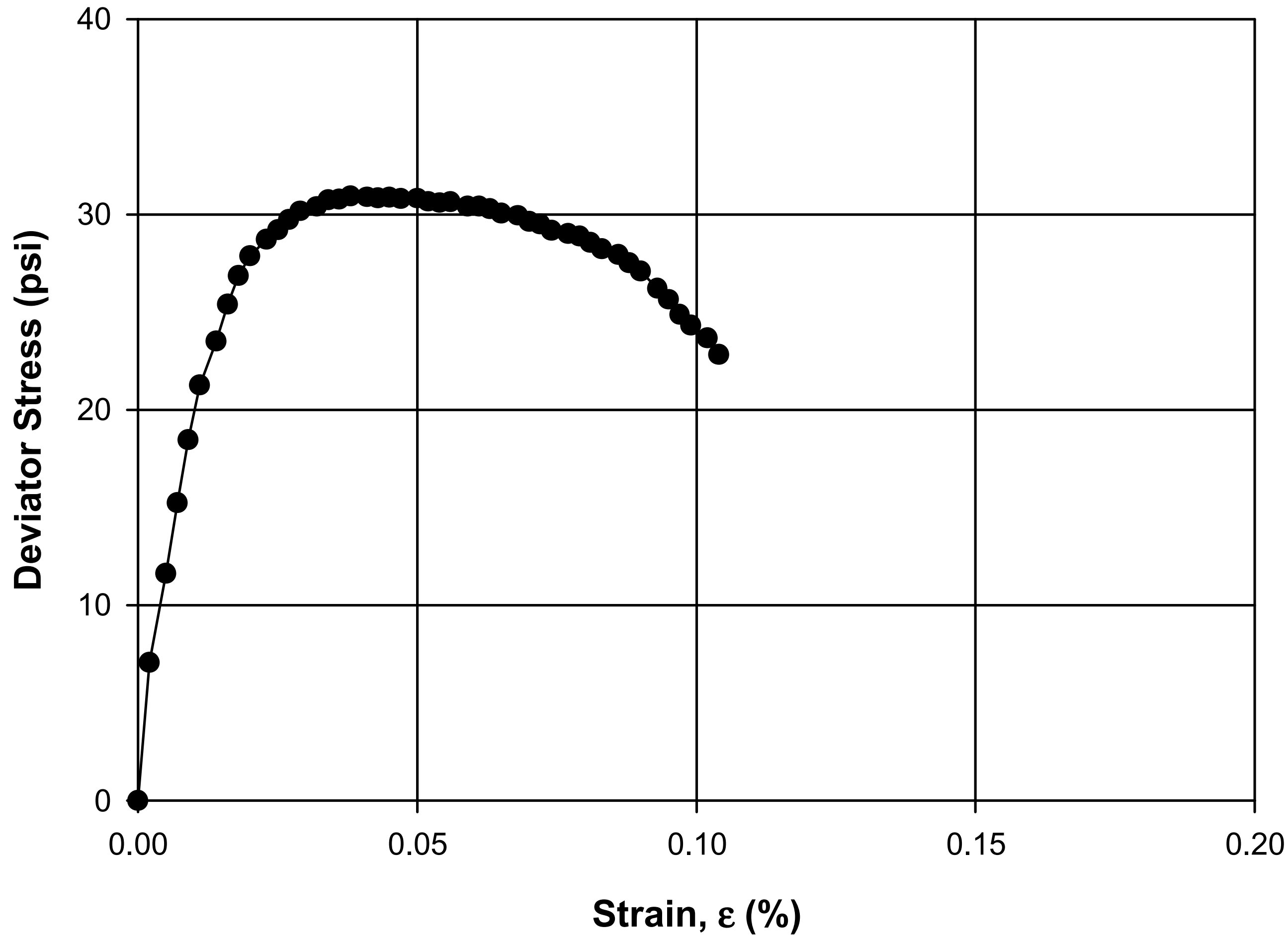
SH249-SN-STS-1-No. 3 TRIAXIAL TEST

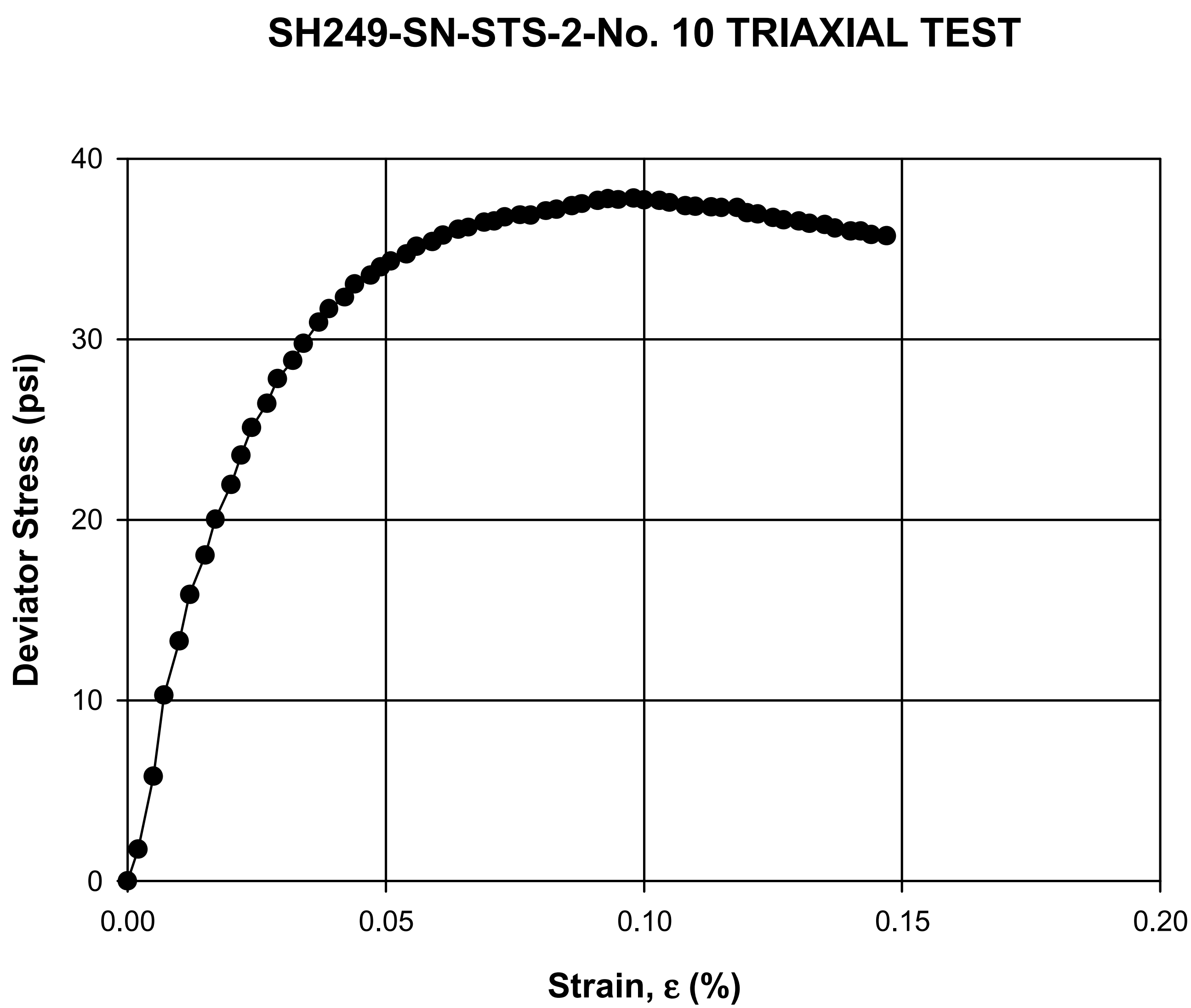


SH249-SN-STS-1-No. 12 TRIAXIAL TEST

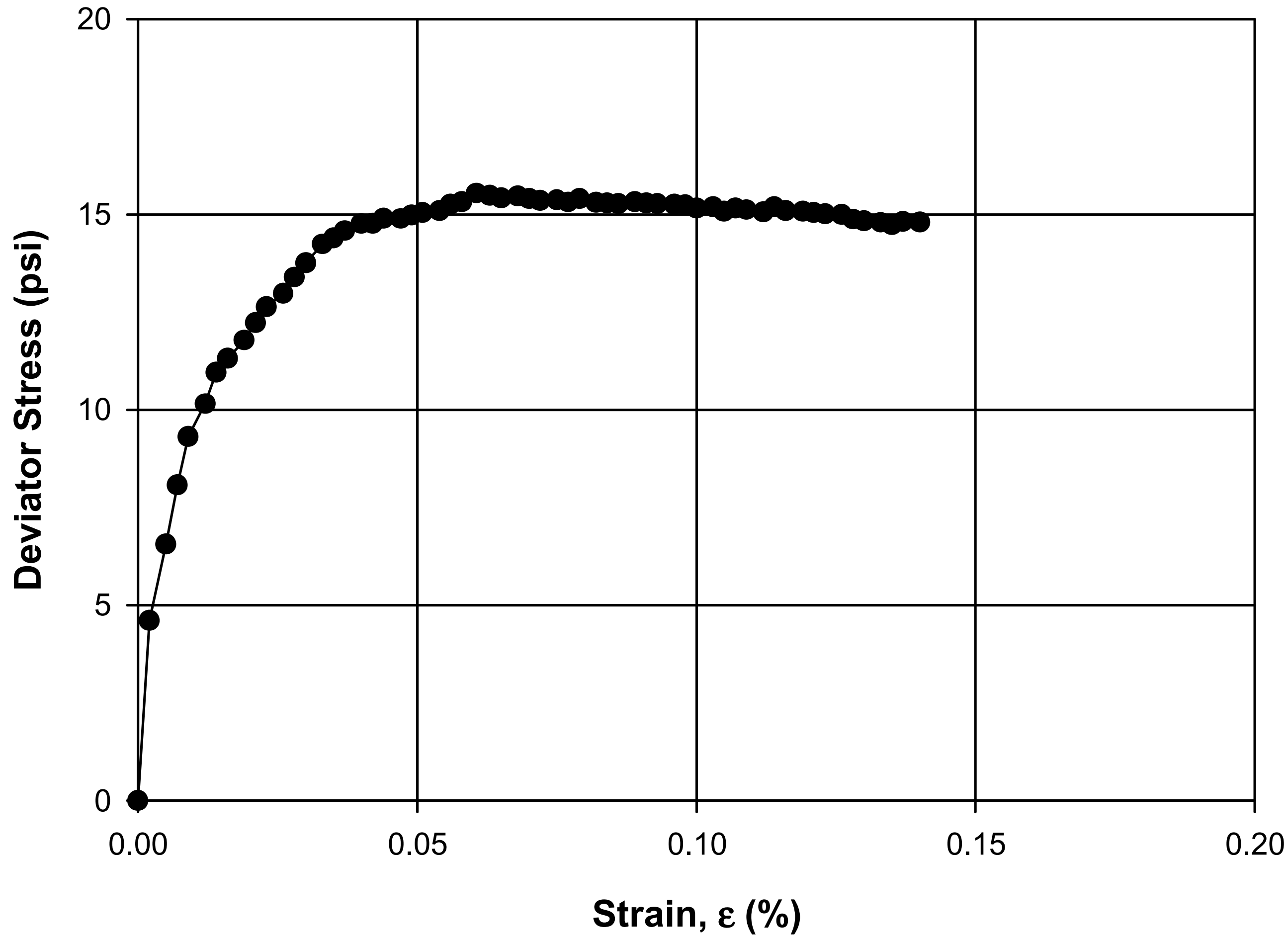


SH249-SN-STS-2-No. 2 TRIAXIAL TEST

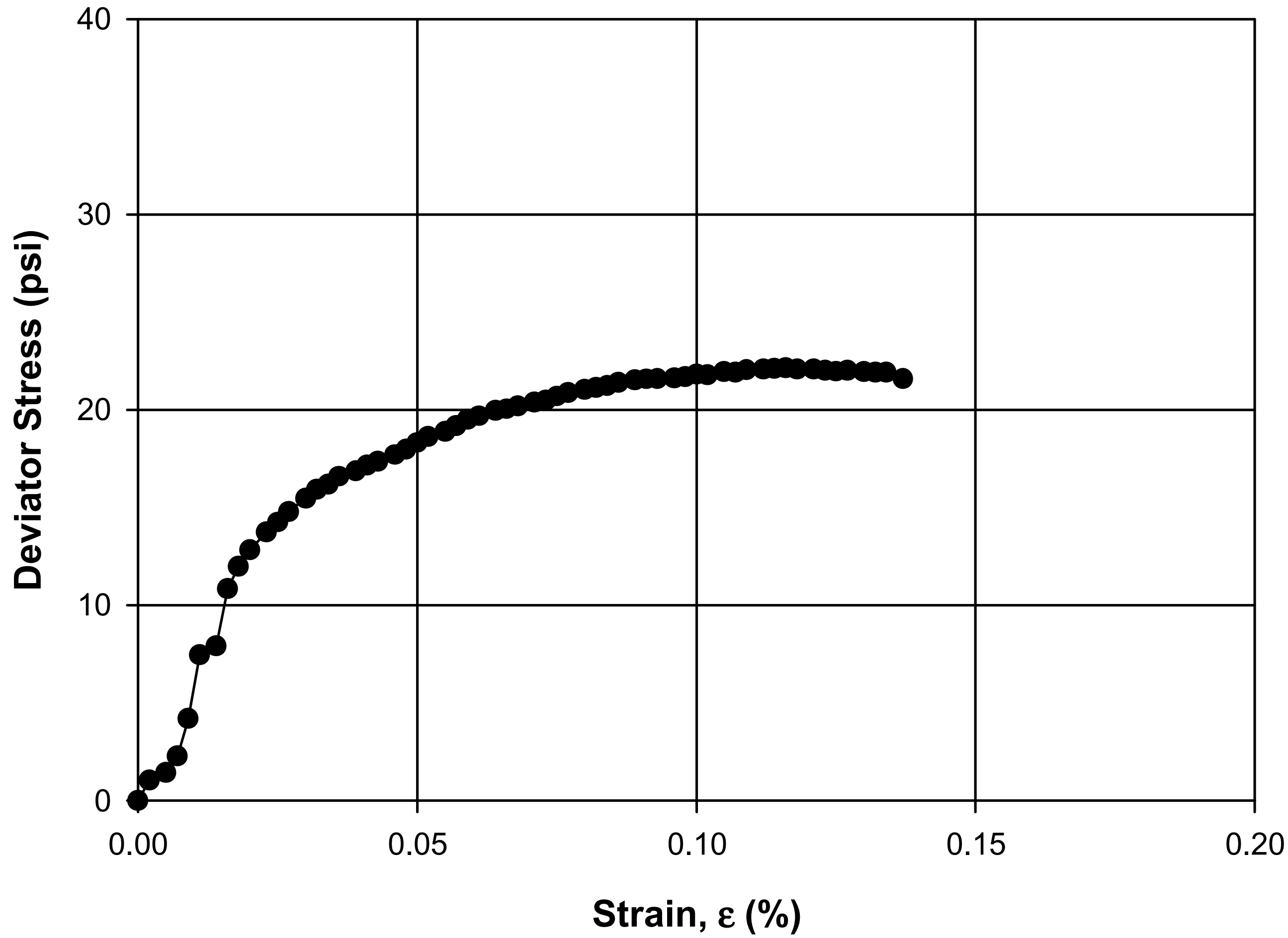



SH249-SN-STS-2-No. 10 TRIAXIAL TEST
Deviator Stress (psi)
0
10
20
30
40
0.00
0.05
0.10
0.15
0.20
Strain, ε (%)

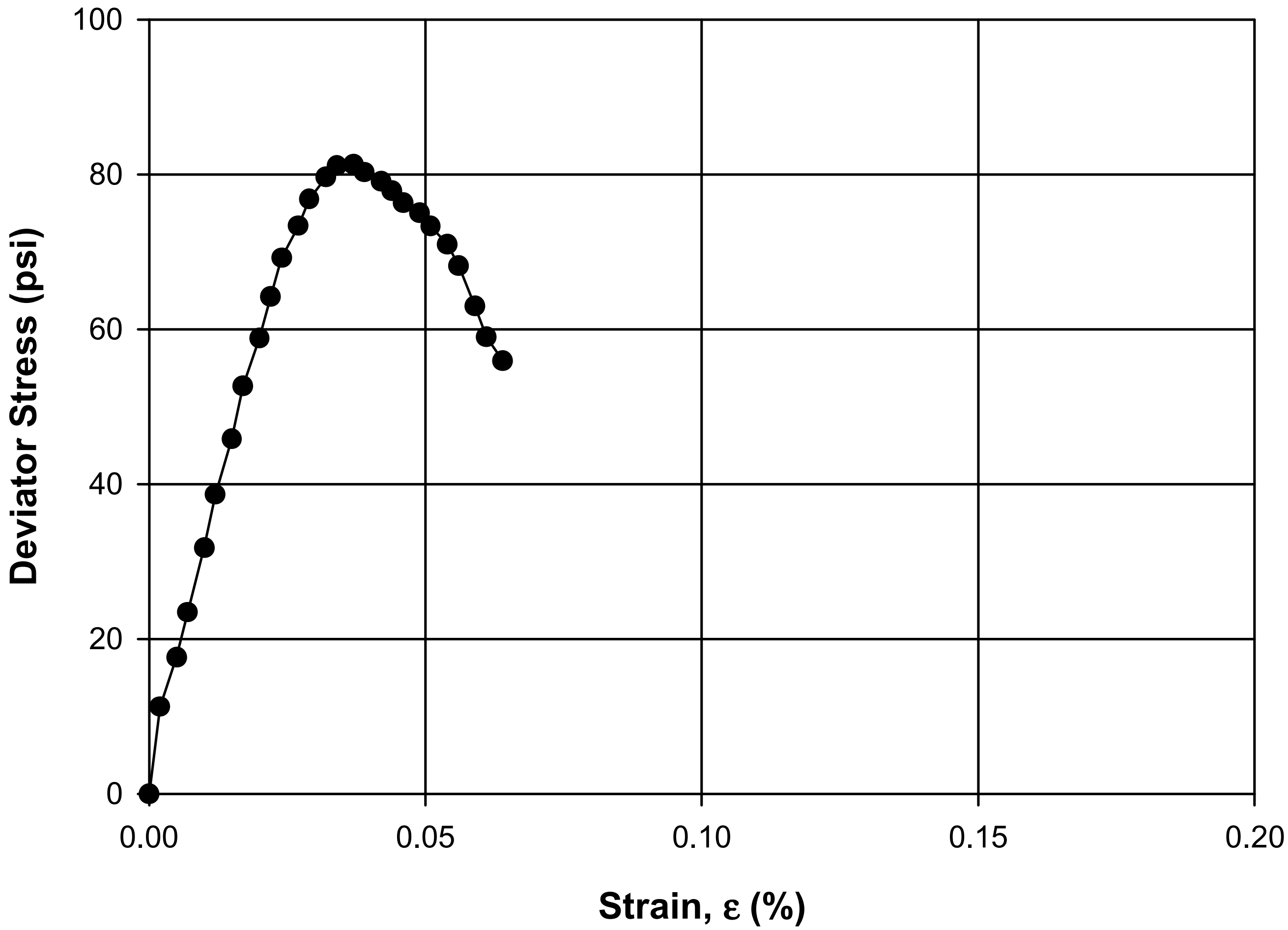
SH249-NN-STS-1-No. 1 TRIAXIAL TEST



SH249-NN-STS-1-No. 8 TRIAXIAL TEST



SH249-NN-STS-2-No. 1 TRIAXIAL TEST



SH249-NN-STS-2-No. 10 TRIAXIAL TEST