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Supplemental Investigation of Embankment Cracking And Interim Dam Safety Measures
Buckeye Flood Retarding Structure No. 1
Flood Control District of Maricopa County
Contract FCD 2003C014
Work Assignment No. 5

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Submitted to:

Flood Control District of Maricopa County
Phoenix, Arizona

Submitted by:

AMEC Earth & Environmental, Inc.
Tempe, Arizona

REGISTERED GEOLOGIST
CERTIFICATE NO.
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RALPH E.
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Date Signed 6/27/05
ARIZONA U.S.A.

June 27, 2005

AMEC Job No. 4-117-001088

June 27, 2005
AMEC Job No. 4-117-001088

Brett A. Howey, P.E.
Project Engineer – Dam Safety
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

Dear Mr. Howey:

Re: Supplemental Investigation of Embankment Cracking and Interim Dam Safety Measures
Buckeye Flood Retarding Structure No. 1
Flood Control District of Maricopa County
Contract FCD 2003C014
Work Assignment No. 5

Transmitted herewith are three copies of the final geotechnical investigation report for the referenced project. This report contains the findings of a supplemental investigation regarding the character of embankment cracking in the vicinity of three areas located at Stations 624+35, 673+50, and 710+47 of the Buckeye Flood Retarding Structure (FRS) No. 1. This document also summarizes the test trenching and backfill operations for the excavated upstream slope that were required to investigate embankment cracking, with these actions being interim dam safety measures for the three subject locations.

Should there be any questions concerning the content of this report, please do not hesitate in contacting the undersigned.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

REGISTERED GEOLOGIST CERTIFICATE NO. 12999 RALPH E. WEEKS Date Signed 6/27/05 ARIZONA U.S.A.

Ralph E. Weeks, P.G.
Senior Geologist

Reviewed by:

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 OVERVIEW OF BUCKEYE FRS 1

3.0 INVESTIGATIVE APPROACH 2
- 3.1 Initial Site Inspections and Geological Reconnaissance 2
- 3.2 Development of Work and Backfill Plans 3
- 3.3 Geophysical Surveys 4
  - 3.3.1 Seismic Refraction and Shear Wave Profiling 4
  - 3.3.2 Resistivity 5
- 3.4 Exploratory Drilling 5
- 3.5 Excavations in the Embankment Slope 6
  - 3.5.1 Upstream Embankment Excavation and Cleaning 6
  - 3.5.2 Embankment Test Trenches 7
- 3.6 Laboratory Testing Program 7

4.0 INTERIM DAM SAFETY MEASURES 7
- 4.1 Selection of Filter Materials 7
- 4.2 Crack Treatment and Backfill Procedure 8
  - 4.2.1 Backfill of Upstream Embankment Excavation 8
  - 4.2.2 Backfill of Embankment Test Trenches 9
- 4.3 Field Documentation of Backfill Procedure 10

5.0 GEOTECHNICAL AND EMBANKMENT CHARACTERIZATION 10
- 5.1 Local Dam Foundation Soil Profile 10
  - 5.1.1 Station 624+50 10
  - 5.1.2 Station 673+50 11
  - 5.1.3 Station 710+47 12
- 5.2 Embankment Discontinuities 13
  - 5.2.1 Station 624+50 13
  - 5.2.2 Station 673+50 14
  - 5.2.3 Station 710+47 15

6.0 DISCUSSION AND RECOMMENDATIONS 15
- 6.1 Crack Treatment and Interim Dam Safety Measures 15
- 6.2 Monitoring Plan for Current Study Areas 16

7.0 REFERENCES 18

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TABLE OF CONTENTS (Continued)

LIST OF FIGURES

Figure 1 - Vicinity Map & Local Geology
Figure 2 - Site Plan & Typical Profile

LIST OF APPENDICES

Appendix A - Hollow-Stem Auger Drilling
Appendix B - Excavations of Upstream Slope
Appendix C - Geophysical Surveys & Interpretations
Appendix D - Laboratory Test Results
Appendix E - Excavation Backfill & Dam Repair

Flood Control District of Maricopa County
Supplemental Investigation of Embankment Cracking
and Interim Dam Safety Measures
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1.0 INTRODUCTION

This report presents the findings of a supplemental geotechnical investigation performed to characterize embankment cracking at three locations along the Buckeye FRS No. 1 embankment. These subject areas are approximately located at Stations 624+35, 673+50, and 710+47 (Figure 1). Descriptions of the interim dam safety measures that were implemented following the geotechnical field program, and a recommended monitoring plan, are also presented herein.

The investigation described herein was authorized by the Flood Control District of Maricopa County (District) during January of 2005 as Work Assignment No. 5 of Contract FCD 2003C014. The investigation involved both field and laboratory test data collection. The goals of the work assignment included the local characterization of the geometry, extent, width and spacing of embankment cracks in the vicinity of the three subject areas, the geotechnical attributes of the underlying foundation soils, and the physical properties of the embankment soils. Field activities included geological mapping, geophysical surveys, drilling, partial excavation of the upstream slope, completion of test pits, surficial cleaning and crack inspection. The laboratory tests included a suite of physical characterization tests of foundation material, embankment material and filter material used on the upstream slope.

The investigation was designed to support the development of recommended interim dam safety measures for Stations 624+35, 673+50 and 710+47. These areas of concern were originally identified during a previous study completed by AMEC Earth & Environmental, Inc. (AMEC, 2001)[1].

2.0 OVERVIEW OF BUCKEYE FRS

In 1999, the District documented transverse and longitudinal cracks on the crest and slopes of Buckeye FRS No. 1. AMEC investigated the cracks at selected locations and prepared two reports on their findings. The reports on the investigations submitted by AMEC to the District are dated March 14, 2001 and May 7, 2002, respectively, titled *Geotechnical Investigation Report Buckeye FRS No. 1* and *Buckeye FRS No. 1 Investigation of Cracking* (AMEC, 2001; AMEC, 2002). Both the 2001 and the 2002 AMEC reports documented seepage emanating from near the upstream toe during the flooding of test pits in the vicinity of Stations 624+35, 673+50 and 721+00, and very high seepage into a crack near Station 710+47. The 2001 AMEC report also recommended a remediation procedure, which was employed at two locations (710+47 and 673+50), to fill any open cracks encountered with ASTM C-33 sand. The 2001 report recommended further investigations of these four locations because of the possible continuity of the cracks, and a potential for seepage erosion through the structure.

[1] References are listed at the end of this report.

In March 2004, the District initiated the investigation of the potential causes of cracking and utilization of interim dam safety measures to backfill the investigation areas in the vicinity of Station 721+00. This effort was completed on June 30, 2004, at which time AMEC delivered a preliminary draft report for District review and comment. District comments were subsequently incorporated into a final draft report that was transmitted to the Natural Resources Conservation Service (NRCS) and the Arizona Department of Water Resources (ADWR) for their review and comment. Review comments provided by NRCS and ADWR where incorporated and the report was finalized in January 2005 (AMEC, 2005b).

The planning of the investigation summarized herein, and the features of the proposed interim dam safety measures for Stations 624+35, 673+50 and 710+47, were developed in consideration of the findings of the previous investigations in the vicinity of Station 721+00, and the successful reconstruction of the dam embankment following those investigations. This information is presented in detail in a final AMEC report submitted to the District on January 7, 2005 titled *Supplemental Investigation of Transverse Cracks – Buckeye FRS No. 1* (AMEC, 2005a).

3.0 INVESTIGATIVE APPROACH

The following discussion summarizes the investigative methods and data sets compiled for this evaluation. The approach included several components: 1) initial site inspection and geologic reconnaissance; 2) development of work and backfill plans; 3) a geophysical program of seismic refraction and shear wave profiling; 4) exploratory drilling; 5) upstream embankment cleaning and excavation; 6) backfill and repair of the embankment slope; and 7) laboratory testing of representative samples.

3.1 Initial Site Inspections and Geological Reconnaissance

An initial site visit and geologic reconnaissance was performed by Ralph Weeks, P.G. and Kenneth Fergason, P.G., both of AMEC, as part of the 2004 investigation. An additional reconnaissance was performed by Mr. Fergason and Michael Rucker, P.E., also of AMEC, in 2005. The length of the dam was traversed by vehicle, and ground reconnaissance was performed at and around Stations 624+35, 673+50 and 710+47. Surficial manifestations of cracking were not evident in the vicinity of 673+50 or 710+47, with the lack of those indications likely due to previous surficial treatment and crack repair efforts. In the vicinity of 624+35, some cracking was evident at the dam crest at about Station 625+10. This consisted of two small potholes on the upstream side of the central filter drain with no further surficial evidence. The local geology was assessed in the field using the published mapping of Demsey (1989).

3.2 Development of Work and Backfill Plans

On January 27, 2005, AMEC submitted an investigation plan for excavation needed for the inspection of embankment cracking and the construction of interim dam safety measures, which included reconstruction of the upstream slope intended to mitigate cracking. This submittal included design plans, special provisions and a construction quality assurance plan for the construction of interim dam safety measures. The investigative approach proposed a field program, geophysical surveys, and embankment excavation to remove the surficial material to a depth of approximately 5.5 feet from the upstream slope of the embankment in the vicinity of Stations 624+35, 673+50 and 710+47 to expose transverse and longitudinal cracks within the upstream shell of the dam. The primary goal of the embankment excavation was to characterize the embankment cracking in the vicinity of the study areas.

The Construction Quality Assurance Plan (CQA Plan) provided for the project addressed the quality control and quality assurance of the construction work. The CQA Plan outlined procedures required to achieve conformance with approved plans and special provisions, specifically field monitoring and documentation of activities. The CQA Plan procedures also provided guidelines for required laboratory testing, field testing and detailed documentation of field activities related to the construction work for this project. The design plans, special provisions and CQA Plans were submitted to ADWR as an application package to perform construction activity at Buckeye FRS No.1 near the vicinity of the study areas. ADWR subsequently approved the plan.

The excavation of the upstream embankment was performed in conformance with the stipulations of an application to alter Buckeye FRS No. 1 approved by the ADWR, dated March 11, 2005. The excavated area at each station varied in width from about 80 to 200 feet. A test pit less than 4 feet in depth (± 9.5 feet below original slope surface) and about 10 feet long also was excavated at Station 673+50 within the excavated portion of the upstream slope.

The excavations revealed the presence of multiple discontinuities in the upstream shell, many of which had measurable aperture within the excavated surface. Condition 3 of ADWR's Approval of Application requires that "...the proposed 1-foot thick filter sand will be placed against closed cracks with no open aperture..." To meet this condition, special treatment of the exposed cracks with aperture was required. A technical memorandum was prepared by AMEC to describe the details of a proposed treatment strategy to fill the aperture of open cracks prior to placement of the filter blanket.

The findings of the ongoing crack investigation were discussed in a meeting held on March 24, 2005 at the site, following a visit of the excavated portion to the upstream shell of the dam at all three locations by representatives of the District, ADWR and AMEC. The following personnel were present during the meeting: Brett Howey, P.E. and Dan Lawrence, P.E. of the District;

Ralph Weeks, P.G., Lawrence A. Hansen, P.E., Bibhuti Panda, P.E. and Ken Ferguson, P.G. of AMEC; and Jon Benoist, P.E. Michael Johnson, P.E. and Chuck Merritt, P.E. of ADWR. The backfill techniques adopted herein, as described in Section 4, were discussed at length during the field meeting. In principle, the treatment strategy recommended was agreeable to all parties present.

The original design of the interim dam safety measures was presented in the cross-section presented on Sheet 2 of the January 27, 2005 report (AMEC, 2005b). The geometry at the crest of the dam section called for the continuation of the filter blanket up and over the central filter drain, with the subsequent placement of the compacted soil cap. Upon excavation of the subject sites, it was observed that placement of the filter material and soil cap to the depths and extent originally proposed was not possible without endangering the integrity of the top of the central filter drain. As depicted in Figure E-1 and described in Section 4, this geometry was modified, with the upstream filter blanket terminating near the upstream brow of the dam crest, and a thinner section of the soil mantle being placed to raise the dam crest back to its original height.

3.3 Geophysical Surveys

3.3.1 Seismic Refraction and Shear Wave Profiling

Twenty-four 120-foot long seismic refraction surveys (Lines 1 through 24) were completed by Michael L. Rucker, P.E., Courtney Cowie, E.I.T. and Ken Fergason, P.G. all with AMEC. Refraction microtremor (ReMi) shear wave (s-wave) surveys were completed at eighteen of these lines along the embankment crest, upstream toe and downstream toe. The purpose of these lines was to assist in characterizing the subsurface geotechnical profile, and to identify the presence or absence of potential discontinuities or fissures in the near vicinity of the study areas. A Geometrics S-12 Smartseis signal enhancement seismograph and geophone array were used. Lines 1 through 4, 13, 14, 18 and 19 were located near FRS Station 624+35. Lines 5 through 8, 15, 16, 21 and 22 were located near FRS Station 673+50. Lines 9 through 12, 17, 18, 23 and 24 were located near FRS Station 710+47. Lines 1, 2, 5, 6, 9 and 10 were positioned along the embankment crest. Lines 3, 4, 7, 8, 11 and 12 were positioned on the upstream slope of the FRS. Lines 13 through 18 were positioned along the upstream toe of the FRS. Lines 19 through 24 were positioned along the downstream toe of the FRS.

A sledgehammer energy source was used to collect compression wave (p-wave) data for seismic refraction analysis. Initially, jogging alongside the geophone array was performed to generate energy for ReMi analysis for a one-dimensional vertical shear wave (s-wave) profile at each seismic line on the embankment crest or toes. When it was determined that ambient noise from the nearby Interstate I-10 interfered with the jogging signals, a field vehicle driven alongside the geophone array was used as the ReMi energy source. The seismic refraction

data and the ReMi data were fully interpreted to provide information regarding the underlying geotechnical profile, including lateral variations in the subsurface materials and within the embankment. The results of the refraction seismic surveys are presented in Appendix C, along with brief descriptions of the seismic refraction equipment and procedures used. Seismic line locations are shown on the site plan presented in Figure 2.

Seismic survey results were used to characterize geotechnical parameters of the embankment and foundation, and to identify the presence or verify the absence of significant discontinuities in the embankment or foundation at the embankment toes. A method of visually examining seismic traces for a sudden decrease in signal amplitude (attenuation) and/or an anomalous increase in arrival time (time offset) of the seismic signal between adjacent geophones was employed for discontinuity detection. The presence of such anomalies in several data sets for each line, such as in both foreshot and backshot trace sets, was considered an indicator of a crack or similar embankment material or soil discontinuity. This method is detailed in Rucker and Keaton (1998) and has been used to identify and trace earth fissures at other sites in Arizona. Interpretation of the absence or presence of anomalies consistent with significant embankment discontinuities or earth fissures was made in the field during the performance of each seismic line. Location(s) of an anomaly interpretation(s) at a seismic line were staked in the field while the seismic line cabling was still deployed on the ground. Anomaly interpretations are included in the seismic interpretations presented in Appendix C.

3.3.2 Resistivity

Surface resistivity soundings were completed at six locations, one location each at the upstream and downstream embankment toe at each station, during the seismic survey. The four-point Wenner array method was used with array spacings of 2.5, 5, 10, 20 and 30 feet. Interpretations were based on a two layer model, where the upper layer was typically in the range of 6,000 to 20,000 ohm-cm, the depth to the second layer was typically 2 to 10 feet, and the lower layer was typically in the range of 3,000 to 8,000 ohm-cm. Resistivity sounding R-1 at Boring B-1 was an exception, where the lower layer was interpreted to have an anomalously high resistivity. A description of the field and interpretation procedures used and the results of the readings and interpretations are included in Appendix C.

3.4 Exploratory Drilling

Six borings (Borings B-1 through B-6, inclusive) were completed at locations adjacent to the upstream toe of the dam to depths of 40 feet below ground surface. Borings B-1 and B-2 were located in the vicinity of Station 624+50, Borings B-3 and B-4 in the vicinity of Station 673+50, and Borings B-5 and B-6 in the vicinity of Station 710+47. The borings were advanced using a CME-75 drill rig utilizing 6-5/8-inch O.D. hollow stem auger, owned and operated by Geomechanics Southwest, Inc. Standard penetration testing and sampling were performed at selected intervals in the borings. The soils encountered during the investigation were

continuously examined, visually classified and logged. Upon completion, the borings were backfilled by the drilling subcontractor with the previously excavated drill cuttings mixed with bentonite chips.

Logs of the test borings are presented in Appendix A, including a brief description of drilling and sampling equipment and procedures. The boring locations are shown in Figure 2. The field investigation was supervised by Mr. Fergason.

3.5 Excavations in the Embankment Slope

Excavation and investigation of the transverse cracking in the upstream embankment proceeded in three stages: 1) excavation of the upstream slope of the dam; 2) cleaning of exposed surfaces; and 3) over-excavation of one crack at Station 673+50.

3.5.1 Upstream Embankment Excavation and Cleaning

At each of the three locations, a section of the embankment was excavated to a depth of approximately 5.5 feet in an area from near the crest to the toe. The edges of the excavations were sloped, and excavation of the crest was limited to about 6 inches. In the vicinity of Station 624+50 the limits of the excavation extended from about Station 623+60 to 625+40, with the area excavated to a depth of 5.5 feet extending from about Station 623+90 to 625+20. In the vicinity of Station 673+50 the limits of the excavation extended from about Station 673+00 to 673+80, with the area excavated to a depth of 5.5 feet extending from about Station 673+20 to 673+70. In the vicinity of Station 710+47 the excavation extended from about Station 710+20 to 711+10, with the area excavated to a depth of 5.5 feet extending from about Station 710+40 to 710+90.

Excavations were performed by District personnel utilizing equipment obtained by the District. The slopes were excavated with a CAT D8N dozer to a depth of about 4 feet, and then excavated to a depth of about 5.5 feet using John Deere 710D and John Deere 710G backhoes. Spoils materials were moved using a CAT 623F scraper, a CAT 140G grader, and a CAT 950G loader. The CAT 623F was used to remove the material at the crest.

Following the excavation of the embankment, the surface was cleaned by District personnel utilizing compressed air from a Sullair 125 cfm compressor. A grid was staked and the cracks were mapped in detail at each of the three locations. Logs showing the location of the discontinuities, the field notes, and a CD with photographs of these locations are presented in Appendix B. The embankment excavation and cleaning was supervised, and crack mapping was completed by Mr. Fergason.

One crack was over excavated to a depth of about 4 feet below the cleaned surface (about 9 feet below the original surface) at about Station 673+35. This trench was 2 to 4 feet wide and

about 20 feet long. The test pit was located on the excavated slope at depth of 10 feet from the crest at approximate elevation 1080 feet. It was excavated by District personnel using a John Deere 710G backhoe. The excavation was supervised by Mr. Fergason and photos can be found on the CD in Appendix B.

3.5.2 Embankment Test Trenches

One test trench was excavated at the downstream toe of the embankment at about Station 672+90. This test trench was excavated at the location of a seismic anomaly identified during the geophysical surveys. The excavation was 15 feet long, 28-inches wide and 4 feet deep. It was excavated by District personnel using a John Deere 710G backhoe. The excavation was supervised by Mr. Fergason and photos can be found on the CD in Appendix B.

3.6 Laboratory Testing Program

The moisture content and dry density of selected soil samples were determined. Results of these tests are shown on the boring logs. Sieve analysis, plasticity index, standard Proctor and consolidation tests were performed on selected samples. The moisture content and dry density of selected samples also were determined. The results of these tests are presented in Appendix B, along with a brief description of laboratory testing procedures. The following table summarizes the number of each laboratory test performed for the current study:

Test Type	Test Designation	No. of Tests
Consolidation	ASTM D2435	13
Density of Ring Sample with Porosity	ASTM D2937	7
Sieve Analysis	ASTM D2487	19
Liquid Limit and Plasticity Index	ASTM D2487	19
Moisture Content	ASTM D2216	11
Standard Procter	ASTM D698A	4

4.0 INTERIM DAM SAFETY MEASURES

4.1 Selection of Filter Materials

A filter analysis was previously performed by AMEC to select a suitable backfill material that would function as a filter for the embankment soil in accordance with NRCS (1994) criteria (AMEC, 2001). NRCS (1994) presents criteria for determining the grain-size distribution (gradation) of sand and gravel filters needed to prevent internal erosion or piping of soil in embankments or foundations of hydraulic structures. These criteria are based on results of an extensive laboratory filter study carried out by NRCS. The laboratory filter study clearly demonstrated that properly graded filters designed in accordance with these criteria are capable

of sealing a crack. The sealing begins when water flows through a crack or opening and carries soil particles eroded from the sides of the opening. The eroded soil particles collect at the face of the filter and seal the crack at the interface. In order to design the filter as a filtering media and drain, both filtration (maximum allowable D15 size of the filter) and permeability requirements (minimum allowable D15 of filter) have been defined by the NRCS criteria. The NRCS criteria define the width of the filter band and maximum (D100) and minimum (D5) particle size criteria to prevent gap-graded filters. The relationship between the maximum D90 and the minimum D10 is also defined by the NRCS criteria to minimize segregation during construction.

The filter analysis performed earlier (AMEC, 2001) was reviewed and a suitable coarse aggregate (Filter Material A) was selected to satisfy the NRCS filter criteria for a base embankment soil representative of the compacted dam fill within the Station 721+00 study area. Filter Material A is a product combining 80 percent ¼-inch minus and 20 percent ⅜-inch washed rock. The grain-size distributions of the embankment soils within the three present study areas for which interim dam safety measures were performed were determined. The grain-size distribution of the sample of Filter Material A collected from stockpiles close to the respective study area was also determined. These grain-size analyses were performed to assure they are similar to embankment soil in the previous study area and that the Filter Material A placed on the upstream slope would perform its intended function (Figure E-2).

4.2 Crack Treatment and Backfill Procedure

4.2.1 Backfill of Upstream Embankment Excavation

The principal intent was to backfill the upstream transverse crack investigation locations utilizing methods that would restore the original as-built geometry to a "better" condition than existed prior to the investigation. The following steps were undertaken to treat those cracks with measurable aperture and subsequently backfill the excavated portions of the upstream slope at Stations 624+35, 673+50 and 710+47:

- The entire excavated surface was cleaned of all loose material and the crack openings were exposed.
- All exposed crack openings on the excavated slope surface were filled with Filter Material A. Filter Material A was placed into the openings of the cracks manually, and the crack was then subjected to the action of a vibratory plate. The vibratory plate was passed three times over the crack opening filled with filter material.

- The shallow test pit located at the upstream slope of the embankment at Station 673+50 was backfilled to the elevation of the surrounding excavated upstream ground surface with moist Filter Material A. The material was densified to a firm and relatively unyielding condition using a vibratory plate compacter.

- A one foot thickness of Filter Material A was carefully placed over the base of the entire excavated area. Filter Material A was placed in a moist uncompacted condition. The area near the crest was filled with filter material thicker than one foot in order to transition to the top of the crest as shown in Figure E-1 and described below.

- The original embankment soils or approved borrow was then placed on the filter material and compacted in 6-inch lifts to backfill the slope up to the original crest of the dam to re-establish the previous grades of the embankment. The soils were free of vegetation and any other deleterious material. The embankment soils were compacted with repeated passes of a rubber-tired front-end loader. The soils were compacted to a minimum of 95 percent of the ASTM D698 maximum dry density, with the moisture content as close as possible to optimum moisture content, but within the range of 1 percent above to 3 percent below optimum moisture content.

- Filter blanket material thicker than one foot was placed on the area close to the crest to transition it to the top of the crest. A one-foot thickness of embankment material was placed on top of the filter blanket to raise the dam crest back to its original height. The embankment material was compacted in the same manner as described above.

4.2.2 Backfill of Embankment Test Trenches

The test pit excavated on the downstream slope of the embankment near station 672+90 was backfilled as follows:

- The test pit was backfilled with moist Filter Material A in 12-inch thick lifts. The test pit was backfilled to within 18 inches of original embankment surface, as measured on the downslope side of the test pit. The material was densified to a firm and relatively unyielding condition using a hand-powered tamper.

- Original embankment soil was then placed on the filter material and compacted in 6-inch lifts to backfill the test pit to re-establish the previous grade of the embankment. The soil was free of vegetation and any other deleterious material. The embankment soils were compacted with repeated passes of a rubber-tired front-end loader and a hand-powered tamper. The soils were compacted to a minimum of 95 percent of the ASTM D698 maximum dry density, with the moisture content as close as possible to optimum moisture content, but within the range of 1 percent above to 3 percent below optimum moisture content.

4.3 Field Documentation of Backfill Procedure

The components of the backfill operation, as described above, were monitored by AMEC representatives. The field activities were recorded and the progress of key activities at the various steps or phases of implementation were observed and documented by photographs. Soil compaction activities were regularly monitored by AMEC field technicians. The thickness of filter blanket and compacted embankment layers were regularly measured. The quantities of the filter material required for infilling the exposed crack openings on the excavated surface were recorded. The field density was measured utilizing a nuclear gauge, and compaction specifications were met. The insitu moisture content also was measured and the specification was met. The daily field observation reports and results of field density and moisture tests are presented in Appendix E, with selected photos of the backfill operation depicted in Figures E-3 to E-6.

5.0 GEOTECHNICAL AND EMBANKMENT CHARACTERIZATION

The following discussions present the findings of this appraisal, beginning with a summary of the relevant efforts of previous investigators. This discussion focuses on the three primary geotechnical features of the facility: the properties of the local alluvial soil profile under the dam, the characteristics of the embankment materials, and the distribution and nature of the discontinuities within the structure.

5.1 Local Dam Foundation Soil Profile

5.1.1 Station 624+50

Holocene alluvial deposits (map unit Qy) are the only unit found exposed in the immediate vicinity of Station 624+50. These deposits are predominantly granular and range from silty to clayey sand. The depths of these deposits are typically 4 feet or less. Deposits are uncemented at the surface but may develop weak cementation (Stage I to I+) below one foot. These deposits are generally soft to firm with N values that are typically less than 30, and often less than 15, and are low to medium in plasticity. These deposits have moisture contents of 5 to 12 percent. The dry density of one sample in this unit was 107 pounds per cubic foot (pcf), at a depth of 2.5 feet. A consolidation/collapse test was performed on a sample from Boring B-2 at 2.5 to 3.5 feet. This test determined consolidation upon inundation of 3 percent with a corresponding dry density of 103.2 pcf.

soils typically are very firm to hard with N values greater than 30 and often over 50. One dry density test was performed within this unit at a depth of 7.5 to 8.5 feet in Boring B-4, determining a value of 105 pcf. Four consolidation tests were performed on samples from this unit at depths of 14.5 to 15.5 feet in Boring B-3 and at 2.5 to 3.5, 7.5 to 8.5, and 12.5 to 13.5 feet in Boring B-4. The resulting volume changes on inundation were 1, 0, 0, and 6 percent, respectively, with corresponding dry densities of 106.3, 92.7, 104.6, and 104.9 pcf, respectively.

Compression wave velocities of the Pleistocene deposits range from about 1,200 to 2,700 f/s to depths of about 10 to 20 feet, and increase to about 2,200 to 3,100 f/s below depths of about 10 to 20 feet. Shear wave velocities of the Pleistocene deposits at depths less than 10 to 20 feet generally range from about 800 to 1,000 f/s, and at depths greater than 10 to 20 feet increase to about 1,300 to 1,600 f/s. Typical resistivities in the upper portion range from about 3,600 to 5,700 ohm-cm.

5.1.3 Station 710+47

Holocene alluvial deposits (map unit Qy) are the only unit found exposed in the immediate vicinity of Station 710+47. These deposits are predominantly granular and consist of silty to clayey sand. The depths of these deposits are typically 2 feet or less. Deposits are uncemented at the surface but may develop weak cementation (Stage I to I+) below one foot. These deposits are generally soft to firm with N values that are typically less than 30, and often less than 15, and are low to medium in plasticity. Compression wave velocities in the surficial Holocene deposits range from about 700 to 1,300 feet per second (f/s). Shear wave velocities in the Holocene deposits are generally less than about 700 f/s. Typical resistivities are in the range of 10,000 to 15,000 ohm-cm.

Pleistocene deposits underlie the Holocene sediments throughout the study area. Generally, Pleistocene deposits begin at about 2 feet below ground surface at Station 710+47. These deposits generally consist of silty or clayey sand inter-bedded with sandy silt and clay, with occasional zones of sand with silt. These deposits are generally weakly to moderately cemented (Stage I to II+). These soils typically are very firm to hard with N values greater than 30 and typically over 50. One dry density test was performed within this unit at a depth of 9.5 to 10.5 feet in Boring B-6, determining a value of 110 pcf. Four consolidation tests were performed on samples from this unit at depths of 7.5 to 8.5 and 24.5 to 25.5 feet in Boring B-5, and at 2.5 to 3.5 and 9.5 to 10.5 feet in Boring B-6. The resulting volume change on inundation was 7, 0, 1, and 0 percent, respectively, with corresponding dry densities of 106.5, 103.5, 96.1, and 102.6 pcf, respectively.

Compression wave velocities of the Pleistocene deposits range from about 1,100 to 2,100 f/s to depths of about 10 to 20 feet, and increase to about 2,500 to 3,300 f/s below depths of about 10 to 20 feet. Shear wave velocities of the Pleistocene deposits at depths less than 10 to 20 feet generally range from about 800 to 1,200 f/s, and at depths greater than 10 to 20 feet increase to about 1,200 to 1,600 f/s. Typical resistivities are in the range of 4,900 to 5,300 ohm-cm.

5.2 Embankment Discontinuities

In general, the discontinuities identified in this investigation resemble the discontinuities observed at Station 721+50, described by AMEC (2005b). The near-surface expression of the cracks observed in all three zones in the excavations of the upstream slope of the embankment is typified by a relatively prominent, dominant discontinuity, flanked by subordinate, smaller fractures. In several cases, the principal feature is segmented, consisting of an en echelon array of cracks. The three areas targeted in this investigation are summarized individually below.

None of the transverse cracks observed in this investigation penetrated into the dam foundation material at the upstream toe of the embankment. Additionally, no seismic anomalies were detected at upstream toe, supporting the above observation, with the exception of the one discussed below at about Station 672+90.

5.2.1 Station 624+50

A detailed map of cracks in the vicinity of Station 624+50 (Figure B-1) is included in Appendix B along with photographs and descriptive notes. The cracking in this area is dominated by a series of cracks located from about Station 624+10 to 624+50 that are arcuate in shape. These cracks are interconnected and have a maximum aperture of 0.5 inches. The aperture ranges from open to filled. A test pit from a previous investigation (AMEC, 2001) was encountered at about Station 624+50. The cracking below the test pit did not appear to be filled with test pit backfill material, and cracking or deflation was not found in the test pit.

Other transverse and longitudinal cracking was present in the vicinity of Station 624+50 (see Figure B-1). Transverse cracks with aperture up to 0.2 inches occur at about Stations 624+80, 625+10, and 625+20. The transverse crack at Station 625+10 is associated with a seismic anomaly on the upstream slope and some surficial evidence was present at the crest of the embankment. The surficial evidence consisted of two small potholes with a diameter of about 2 inches and a depth of several inches located between the central filter drain and the upstream slope on the crest of the embankment.

5.2.2 Station 673+50

A detailed map of cracks in the vicinity of Station 674+50 (Figure B-2) is included in Appendix B, along with photographs and descriptive notes. The most significant observations at Station 674+50 involve the interaction of transverse cracks with test pits from a previous AMEC (2001) investigation. Two test pits from that investigation were encountered, with the larger of the two located near the crest. The transverse crack at this test pit was filled with backfill material to a location several feet below the test pit. Several hairline cracks and deflation features were present in the test pit backfill projecting upwards from the transverse crack. Detailed photographs and descriptions of this can be found in Appendix B. This transverse crack is generally filled and reaches a maximum aperture of 1.5 inches, likely as a result of erosion during flood testing performed as part of the AMEC (2001) investigation and/or from the compressed air cleaning process.

The smaller previous test pit encountered is located at about mid-slope on the upstream embankment. No cracking or deflation was found in the backfill material. The transverse crack associated with this test pit was filled with backfill material to several feet below the test pit location. The maximum aperture of this crack is about 1.8 inches and appears to have been eroded by either previous flood testing and/or from the compressed air cleaning process. The crack is generally filled. It was decided to over excavate this crack to a depth of 4 feet below the cleaned surface, or about 9 feet below the embankment grade. The crack was observed and photographed (CD in Appendix B) periodically during this process. The crack was present to the full depth of the excavation, though the aperture generally decreased with depth and towards the toe of the embankment.

Three other transverse cracks are present and typically have a maximum aperture of about 0.3 inches, with the exception of one location near the crest at about Station 673+30 where an aperture of 1.2 inches was recorded. This aperture appeared to be enhanced by the compressed air cleaning process.

One seismic anomaly was detected at the downstream toe at about station 672+90. A small trench, Test Pit TP-1 (see log in Appendix A), was excavated adjacent to the anomaly. Examination of the trench on several occasions by Mr. Weeks and Mr. Fergason within the first week of excavation did not reveal any discontinuities. Approximately 2 months after the initial excavation the trench was examined again and a discontinuity was found. The discontinuity has a hairline aperture and contains several rootlets. It is present to a depth of about 3 feet below ground surface where it terminates at a gravelly layer. Its orientation is oblique to the dam and trends SE-NW at approximately 345°. The discontinuity does not appear to be an earth fissure, and seems to be primarily related to desiccation. Photos of the trench and discontinuity are on the CD in Appendix B.

5.2.3 Station 710+47

A detailed map of cracks in the vicinity of Station 710+47 (Figure B-3) is included in Appendix B along with photographs and descriptive notes. The most significant observation at Station 710+47 is the number and connectivity of the cracks present. The crack spacing in this area is 5 to 10 feet for cracks with open aperture of 0.2 inches or more, and these cracks range from transverse to oblique to longitudinal in orientation. The spacing for cracking with aperture less than 0.2 inches varies from less than one foot to about 8 feet, with an average in range of 4 to 5 feet.

The transverse crack associated with the AMEC 2001 investigation is located at about Station 710+47. This crack has a maximum eroded aperture of about 5 inches and is filled with backfill material from the test pit. This eroded aperture rapidly decreases to about 0.7 inches away from the test pit. The crack remains filled, but no longer with backfill material from the test pit. No cracking or deflation was found in the test pit backfill material.

Other cracking in the vicinity of Station 710+47 generally has maximum aperture of 0.2 to 0.7 inches, and the cracks are partially filled to open.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Crack Treatment and Interim Dam Safety Measures

The principal goal of the interim dam safety measures is to restore the original as-built geometry of Buckeye FRS No.1 at the vicinity of study areas (Stations 624+35, 673+50 and 710+47) to a "better" condition than existed prior to the investigation. The previous investigation (AMEC, 2001) reported major embankment cracking in the vicinity of the above stations, and toe seepage was reported at those study areas during the flood tests. The current field investigation revealed the presence of multiple cracks, both transverse and longitudinal, in the upstream shell, many of which have measurable aperture within the excavated surface. Hence, the aim of the reconstruction of upstream slope at the vicinities of the subject study areas was to improve the condition of upstream embankment slope on an interim basis. The interim dam safety measures adopted in this investigation work were only applicable to the vicinities of the study areas of Buckeye FRS No.1.

The upper part of the upstream slope to a depth of approximately 5.5 feet was removed from the Buckeye FRS No. 1 embankment in the vicinity of Stations 624+35, 673+50 and 710+47 to expose transverse and longitudinal cracks within the upstream shell of the dam. The slope was reconstructed with a one foot thick filter blanket at the base of the excavated area and approximately 4.5 feet thick of compacted embankment material on top of the filter material.

The crack openings exposed on the excavated area were filled by filter material with the help of a vibratory plate before covering the base with a one-foot thick filter blanket. The infilling of the openings of major cracks with filter material will prevent migration of filter material from the filter blanket to the crack. Thus, the filter blanket layer will not be subjected to any loss of material. Also, the infilling within the crack will prevent the flow of water directly into the crack. A previous test (AMEC, 2001) showed that the seepage was greatly reduced by filling the crack with ASTM C33 sand.

Seepage modeling previously conducted indicates that a wetting front will not reach the base of the 4.5 foot thick soil cap during an extreme flood event (AMEC, 2004). However, if seepage were to occur through future cracks in the overlying upstream shell, the one foot thick filter blanket likely will seal the crack and thus reduce or stop the flow into the cracks located at the base of the filter. The connectivity of remaining transverse cracks below 5.5 feet with the surface of the upstream slope has been lost due to the removal of the upper 5.5 feet segment of all transverse cracks at the upstream slope within the study areas. The upper part of the reconstructed upstream shell has been newly compacted and is devoid of any cracks at present. On an interim basis, the upstream shell above the filter material is now better than the condition of the upstream shell before the investigation. As an interim strategy, the safety measures described above are deemed adequate, in that it is reasonable to assume that new crack formation or any appreciable widening of the covered discontinuities will be minimal over the term of the interim measure, with the treated upstream embankment slope restored to a condition improved over that present prior to the investigation activities.

6.2 Monitoring Plan for Current Study Areas

To augment the construction of the interim dam safety measures (IDSMs), it is understood that the District will establish a plan to periodically monitor the condition of the dam embankment at and in the near vicinities of Stations 624+36, 673+50, 710+47 and 721+00. These four locations have been subjected to IDSMs over the past year. The following outlines the details of a recommended monitoring program.

The four embankment segments of Buckeye FRS No. 1 should receive an elevated level of dam safety monitoring compared to the remainder of the structure. The District should first stake the four subject areas along the embankment crest, using unique signs that identify each as a special monitoring site. The following monitoring and inspection plan should be followed for those four stations:

Quarterly Inspection. A visual walking inspection and ground reconnaissance of the four segments should be made quarterly by qualified District O&M field personnel. Any surface indications of cracking should be reported to a District dam safety engineer for further evaluation.

Annual Inspection. A visual walking inspection and ground reconnaissance of all four ISDM locations should be made annually by a District dam safety engineer.

Event Inspection. After any event that has exceeded 10 percent of the full-pool elevation (6-foot pool stage), a visual walking inspection of all four ISDM locations should be made by qualified District O&M field personnel within one month of the flood event. Any surface indications of cracking should be reported to a District dam safety engineer for further evaluation. An alert level equivalent to 25 percent of the full-pool elevation (9-foot pool stage) should trigger a specific inspection of all four areas by a District dam safety engineer.

During the course of all embankment inspections, mapping and field notes should be developed that locate and describe the characteristics of any potholes or other features indicative of buried embankment discontinuities. This record should be augmented by photographs of each suspected feature.

7.0 REFERENCES

AMEC Earth & Environmental, Inc., 2005b, Supplemental Investigation of Embankment Cracking and Interim Dam Safety Measures Buckeye FRS No.1, AMEC Job No. 4-117-001088, January 27, 2005.

AMEC Earth & Environmental, Inc., 2005a, Supplemental Investigation of Transverse Cracks-Buckeye FRS No.1, AMEC Job No. 4-117-001021, January 7, 2005.

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Natural Resources Conservation Service, 1994, Chapter 26, Gradation Design of Sand and Gravel Filters, Part 633, National Engineering Handbook.

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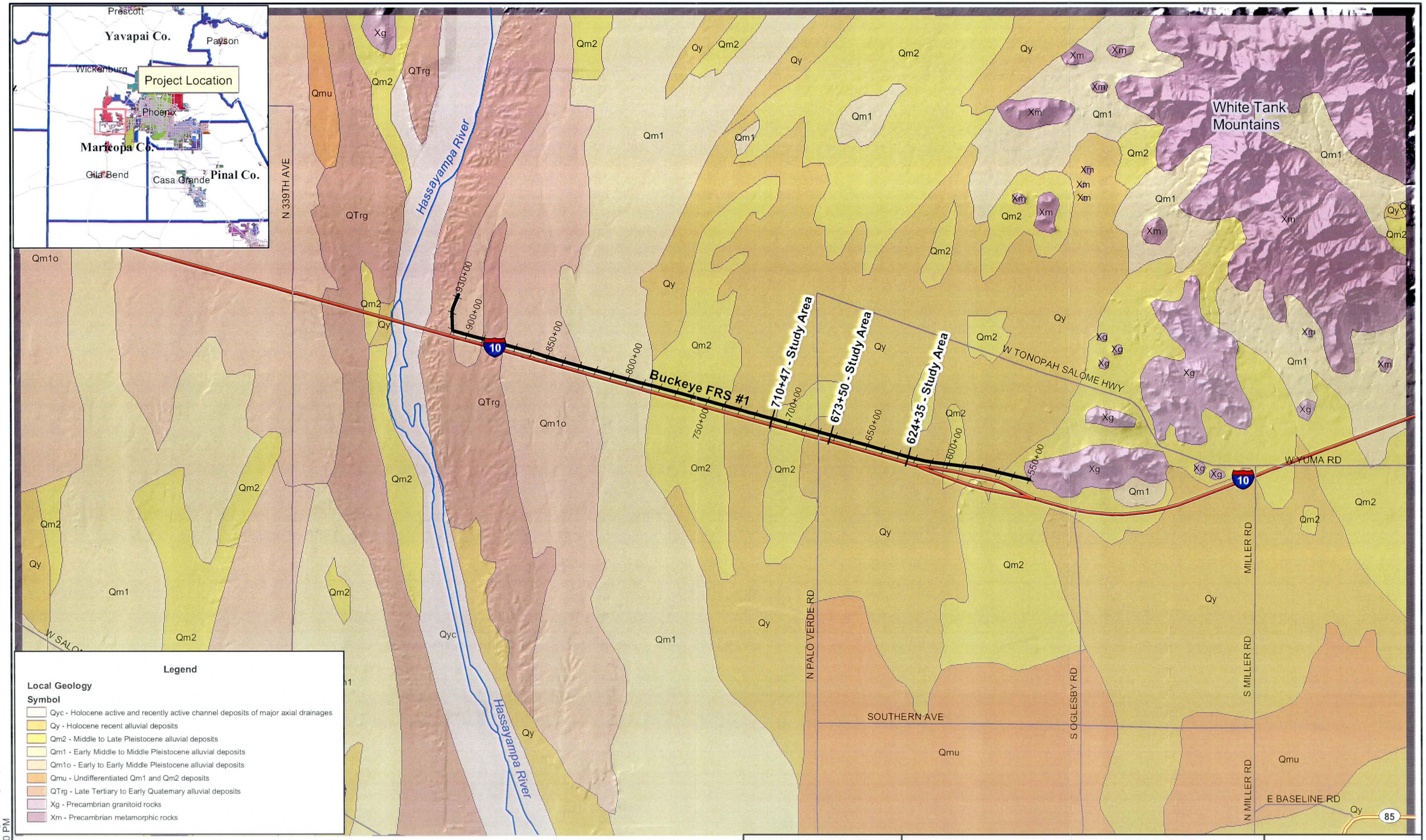
FIGURES



Note: Geologic contacts from Demsey (1989)

1 0.5 0 1 2 Miles

N

JOB NO.:	4-117-001088
DESIGN:	BBP
DRAWN:	EMP
DATE:	05/09/05
SCALE:	1" = 1 mile

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO. 1
CONTRACT FCD2003C014 - WORK ASSIGNMENT NO. 5

VICINITY MAP
& LOCAL GEOLOGY

FIGURE
1

amec

Map Document: (G:\Engineering Department\2004 Projects\4-117-001088 Buckeye Supplemental\GIS\MXD\Buckeye_geology.mxd)
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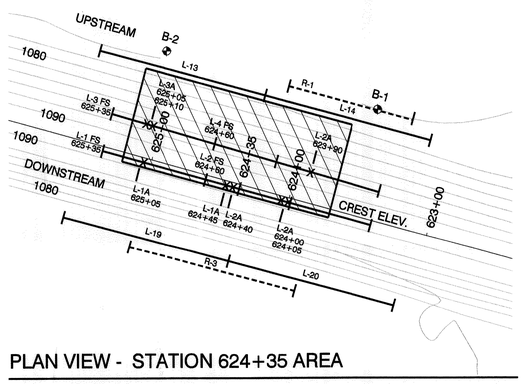
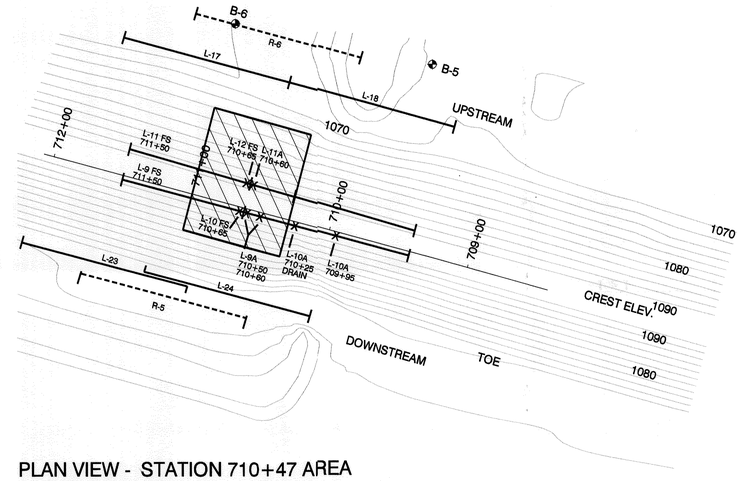


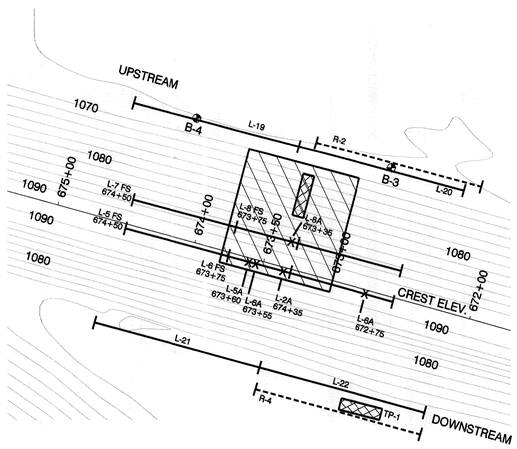
PLAN VIEW - STATION 624+35 AREA

SCALE: 1" = 50'



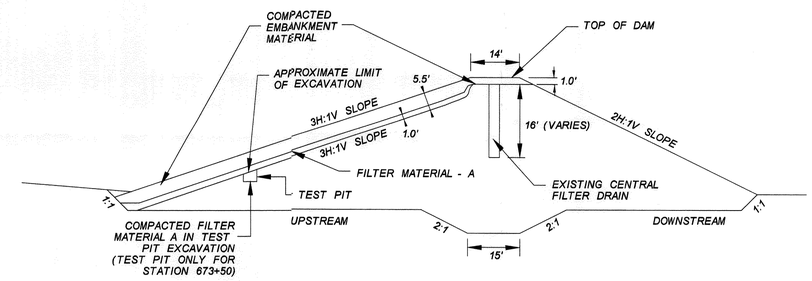
PLAN VIEW - STATION 710+47 AREA

SCALE: 1" = 50'



PLAN VIEW - STATION 673+50 AREA

SCALE: 1" = 50'



INTERIM DAM SAFETY MEASURES TYPICAL CROSS-SECTION

NOT TO SCALE

LEGEND

- HOLLOW STEM AUGER BORING
- SEISMIC REFRACTION/REMI PROFILES
- APPROXIMATE AREA OF SURFICIAL EXCAVATION
- APPROXIMATE AREA OF TEST PIT EXCAVATION
- RESISTIVITY LINE

25 0 25 50
Scale in Feet

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS AND INTERIM DAM SAFETY MEASURES - BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

Registered Professional Engineer (Civil) CERTIFICATE NO. 13872 LAWRENCE A. HANSEN Date Signed 6/27/05 ARIZONA U.S.A.

	BY	DATE
DESIGNED	LAH	5/2005
DRAWN	GWH	5/2005
CHECKED	LAH	5/2005

amec

AS BUILT OF EMBANKMENT REPAIR

FIGURE 2

APPENDIX A

HOLLOW – STEM AUGER DRILLING

TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or "river-run" material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT & PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

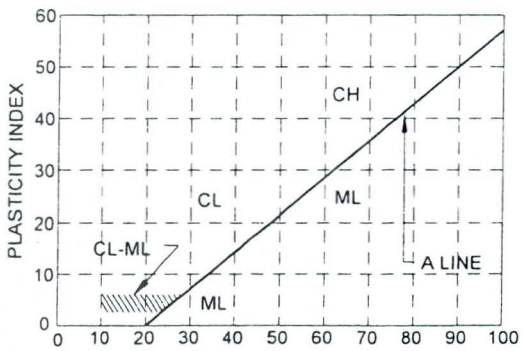
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the United Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see " The Unified Soil Classification System " ASTM Designation: D2487

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
					GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixture.
			Limits plot below "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot below "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid limit less than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid limit more than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid limit more than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5 % to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in)
Cobbles	300mm to 75mm (12in to 3in)
Gravel	75mm (3in) to No 4 sieve
Coarse gravel	75mm to 19mm (3in to 3/4in)
Fine gravel	19mm (3/4in) to No 4 sieve
Sand	No 4 to No 200
Coarse	No 4 to No 10
Medium	No 10 to No 40
Fine	No 40 to No 200
Fines (silt or clay)	Below No 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 623+60, 70' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	3-8-6			SM/SC	moist moderately firm to firm	**SILTY TO CLAYEY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate, medium plasticity, light brown
				U	36					note: weakly lime cemented below 4' (Stage II - II+)
5				U	37	106	12			note: moisture content decrease below 7'
				S	7-15-14					
10				U	34	98	11	SC	moist firm	**CLAYEY SAND,** some fine grained gravel, well graded, subangular to angular, weakly lime cemented (Stage I+), medium to high plasticity, light brown
								ML/CL	slightly moist to moist firm to hard	**SANDY SILT TO SANDY CLAY,** trace of fine grained gravel, weakly lime cemented (Stage II), low plasticity, light brown note: occasional lense of SM (<6" thick)
				S	9-12-15					
15				U	76					
								SM	slightly moist very firm	**SILTY SAND,** trace of clay, trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage II - II+), low plasticity, light brown note: occasional zone SP-SM (<6" thick)
				S	16-20-24					
								ML		note: occasional zone ML
20				S	23-38-50/5"				slightly moist hard	**SANDY SILT,** trace of clay, predominantly medium to fine grained sand, weakly to moderately lime cemented (Stage II - II+), low plasticity, light brown note: occasional lense of SM/SP-SM (<6" thick)
25				S	24-40-50/4"					

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-1

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 623+60, 70' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								ML	slightly moist hard	**SANDY SILT,** continued
								CL	slightly moist hard	**SANDY CLAY,** trace of silt, predominantly fine to medium grained sand, moderately lime cemented (Stage III), medium plasticity, light brown
30				U	100/9" NR					
35				S	40-50/3"					
								SM/ML	slightly moist to moist hard	**SILTY SAND TO SANDY SILT,** predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage I+ - II), low plasticity, light brown
40				S	38-48-45					
										Stopped Auger at 39'6" Stopped Sampler at 41'
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-1

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 625+10, 70' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	6-7-7			SM	moist moderately firm	**SILTY SAND,** trace fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate, low plasticity to nonplastic, light brown
				U	57	107	5	CL/SC	slightly moist very firm to hard	**CLAYEY SAND TO SANDY CLAY,** some silt, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage II+), low to medium plasticity, light brown
5				S	17-28-32					
				U	56					note: occasional lense (~6" thick) of SP-SM/SM at 8' & 9'6"
10				S	24-28-36					
				U	100/10"			SC	slightly moist to moist hard	**CLAYEY SAND,** trace of silt, predominantly fine to medium grained sand, subangular to subrounded, weakly lime cemented (Stage I+ - II), medium plasticity, reddish-brown
15				S	20-25-29					
				U	100/11"			SM/ML	slightly moist to moist hard	**SILTY SAND TO SANDY SILT,** trace of predominantly fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage II+), low plasticity, light brown
20				S	24-40-48			SM	slightly moist hard	**SANDY SILT,** trace of clay, predominantly medium to fine grained sand, weakly to moderately lime cemented (Stage II - II+), low plasticity, light brown note: occasional zone of well graded sand
25				U	100/10"					

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-2

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 625+10, 70' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								SM	slightly moist hard	**SANDY SILT,** continued
30				S	24-43-40					note: increase in silt content at 30'
								ML	slightly moist hard	**SANDY SILT,** predominantly medium to fine grained sand, weakly to moderately lime cemented (Stage II - II+), low plasticity, light brown
35				S	32-50/4"					
				S	50/4"					
40										Stopped Auger at 39'6" Sampler refused at 39'10"
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-2

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 672+75, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	7-9-7			SM/ML	moist moderately firm	**SILTY SAND TO SANDY SILT,** trace of fine grained gravel, predominantly medium to fine grained, subangular to subrounded, trace of calcium carbonate, low plasticity, light brown
				U	100/10"			SM/ML	slightly moist hard	**SILTY SAND TO SANDY SILT,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly to moderately lime cemented (Stage II+ - III), low plasticity, light brown to light grayish-brown
5				U	100/3"					
				S	29-25-25			SM	slightly moist hard	**SILTY SAND,** trace to some fine grained gravel, well graded, subangular to subrounded, weakly lime cemented, (Stage I+ - II), low plasticity to nonplastic, light brown
				U	86					
10				S	27-24-18			ML	slightly moist to moist very firm	**SANDY SILT,** predominantly medium to fine grained sand, weakly lime cemented (Stage II - II+), low plasticity, light grayish-brown
15				U	33			SM	slightly moist to moist dense	**SILTY SAND,** trace of predominantly fine grained gravel, predominantly medium to fine grained sand, weakly lime cemented (Stage II), nonplastic, light grayish-brown
				S	23-50/5"			ML	slightly moist hard	**SANDY SILT,** predominantly fine to medium grained sand, weakly lime cemented (Stage II), low plasticity, light grayish-brown
20				S	24-23-34			SP-SM /SM	slightly moist to moist hard	**SAND WITH SILT TO SILTY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage I+), nonplastic to low plasticity, light brown note: occasional zone with well graded sand
25				S	40-50/5 1/2"					

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-3

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/24/05

LOCATION Sta. 672+75, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								SP-SM /SM	slightly moist to moist hard	**SAND WITH SILT TO SILTY SAND,** continued
30				U	100/8"					
35				S	35-50/5"					
								ML	slightly moist hard	**SANDY SILT,** moderately lime cemented (Stage II), low plasticity, light brown
40				S	50/5 1/2"					Stopped Auger at 36'6" Sampler refused at 40'
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-3

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 674+25, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	7-6-5			SC	moist moderately firm	**CLAYEY SAND,** trace of silt, trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate, medium plasticity, brown
				U	38					
								ML	moist firm	**SANDY SILT,** weakly lime cemented (Stage II), low plasticity, light grayish-brown
5				S	5-5-5			SM	moist moderately firm	**SILTY SAND,** predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate (Stage II), low plasticity, grayish-brown
								SC/CL		
				U	32	105	8		moist firm	**CLAYEY SAND TO SANDY CLAY,** trace of silt, predominantly medium to fine grained sand, weakly lime cemented (Stage I+ - II), medium plasticity, light brown
10				S	8-13-12					
				U	25					
								SM	moist firm	**SILTY SAND,** trace of fine grained gravel, well graded, subangular to subrounded, trace of calcium carbonate (Stage I - I+), nonplastic, light brown note: occasional thin lense of ML
15				S	9-15-12					
								SP-SM /SM	moist very firm	**SAND WITH SILT TO SILTY SAND,** trace to some fine grained gravel, well graded to predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate (Stage I - I+), nonplastic to low plasticity, light brown
				U	40					
20				S	14-15-17					
								SP-SM	moist medium dense to dense	**SAND WITH SILT,** trace to some fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, noncemented, nonplastic, brown
25				U	35					

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-4

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 674+25, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								SP-SM	moist medium dense to dense	**SAND WITH SILT,** continued
								SM	moist very firm to hard	**SILTY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage I+), nonplastic to low plasticity, light brown
30				S	14-16-20					
35				S	23-50/5 1/2"					note: thin (~6" thick) lense of GP-GM at 35'
								SP-SM /SM	moist very dense	**SAND WITH SILT TO SILTY SAND,** rare fine grained gravel, predominantly fine grained sand, subangular to subrounded, noncemented, nonplastic, brown
40				S	23-27-32					
										Stopped Auger at 39'6" Stopped Sampler at 41'
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-4

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 709+72, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	3-12-30			SM/SC	moist	**SILTY TO CLAYEY SAND,** predominantly fine to medium grained sand, subangular to subrounded, trace of calcium carbonate, low plasticity, brown
								SP-SM /SM	moderately firm	
				U	100/10"			ML	slightly moist hard	**SAND WITH SILT TO SILTY SAND,** trace to some fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented, (Stage II - II+), low plasticity to nonplastic, light brown
5				S	17-30-49				slightly moist hard	**SANDY SILT,** trace of clay, predominantly fine to medium grained sand, weakly to moderately lime cemented (Stage II+ - III), low plasticity, light grayish-brown
				U	48			SC/CL	slightly moist very firm	**CLAYEY SAND TO SANDY CLAY,** trace of silt, predominantly fine grained sand, weakly lime cemented (II - II+), low to medium plasticity, light grayish-brown
10				S	21-19-15					
				U	58			SM	slightly moist hard	**SILTY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, weakly lime cemented (Stage II - II+), low plasticity, light grayish-brown
15				S	10-25-40			SP-SM	slightly moist dense	**SAND WITH SILT,** some fine grained gravel, well graded, subangular to subrounded, weakly lime cemented (Stage I), nonplastic, light brown
				U	100/11"			ML/SM	slightly moist hard	**SANDY SILT TO SILTY SAND,** trace of fine grained gravel, trace of clay, predominantly fine to medium grained sand, moderately lime cemented (Stage II+), low plasticity to nonplastic, light brown
20				S	25-50/5 1/2"					
25				U	89	98	8			note: weakly lime cemented, Stage II at 25'

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-5

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 709+72, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								ML/SM	slightly moist hard	**SANDY SILT TO SILTY SAND,** continued
30				U	100/10"					
								CL/SC	slightly moist hard	**SANDY CLAY TO CLAYEY SAND,** trace of silt, predominantly fine to medium grained sand, subangular to subrounded, weakly to moderately lime cemented (Stage I+ - II), low plasticity, brown
35				S	24-40-50/4"					
								SP-SM	moist very dense	**SAND WITH SILT,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, noncemented to weakly lime cemented (Stage I), nonplastic, light brown
40				S	27-29-32					
										Stopped Auger at 39'6" Stopped Sampler at 41'
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-5

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 711+22, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	3-3-3			SC/SM	slightly moist to moist	**SILTY TO CLAYEY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, trace of calcium carbonate, low plasticity, light brown
				A						
								ML/SM	soft	**SANDY SILT TO SILTY SAND,** predominantly fine to medium grained sand, weakly lime cemented (Stage II - II+), low plasticity to nonplastic, light grayish-brown
				U	50				slightly moist	
									very firm to hard	
5				U	65					
				S	24-30-35			SM	slightly moist	**SILTY SAND,** trace to some fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly lime cemented (Stage I+ - II+), low plasticity, light brown
10				U	70	110	3		hard	
								ML/SM	slightly moist	**SANDY SILT TO SILTY SAND,** trace of fine grained gravel, predominantly medium to fine grained sand, weakly to moderately lime cemented (Stage II - II+), low plasticity, light grayish-brown
				U	35-50/6"				hard	note: occasional zone (<6" thick) of SM
15				S	100/7"					
				S	35-40-44					
20				U	100/5" NR					
				S	17-50/4"					
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-6

PROJECT Buckeye FRS No. 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 **DATE** 1/25/05

LOCATION Sta. 711+22, 90' R of Crest

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs per Cubic ft	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								ML/SM	slightly moist hard	**SANDY SILT TO SILTY SAND,** continued
30				S	35- 50/5"					note: some clay at 30'
35				S	50/ 5 1/2"					note: increase in sand content at 40'
				S	50/3"					Stopped Auger at 39'6" Sampler refused at 39'9"
40										
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-6

APPENDIX B

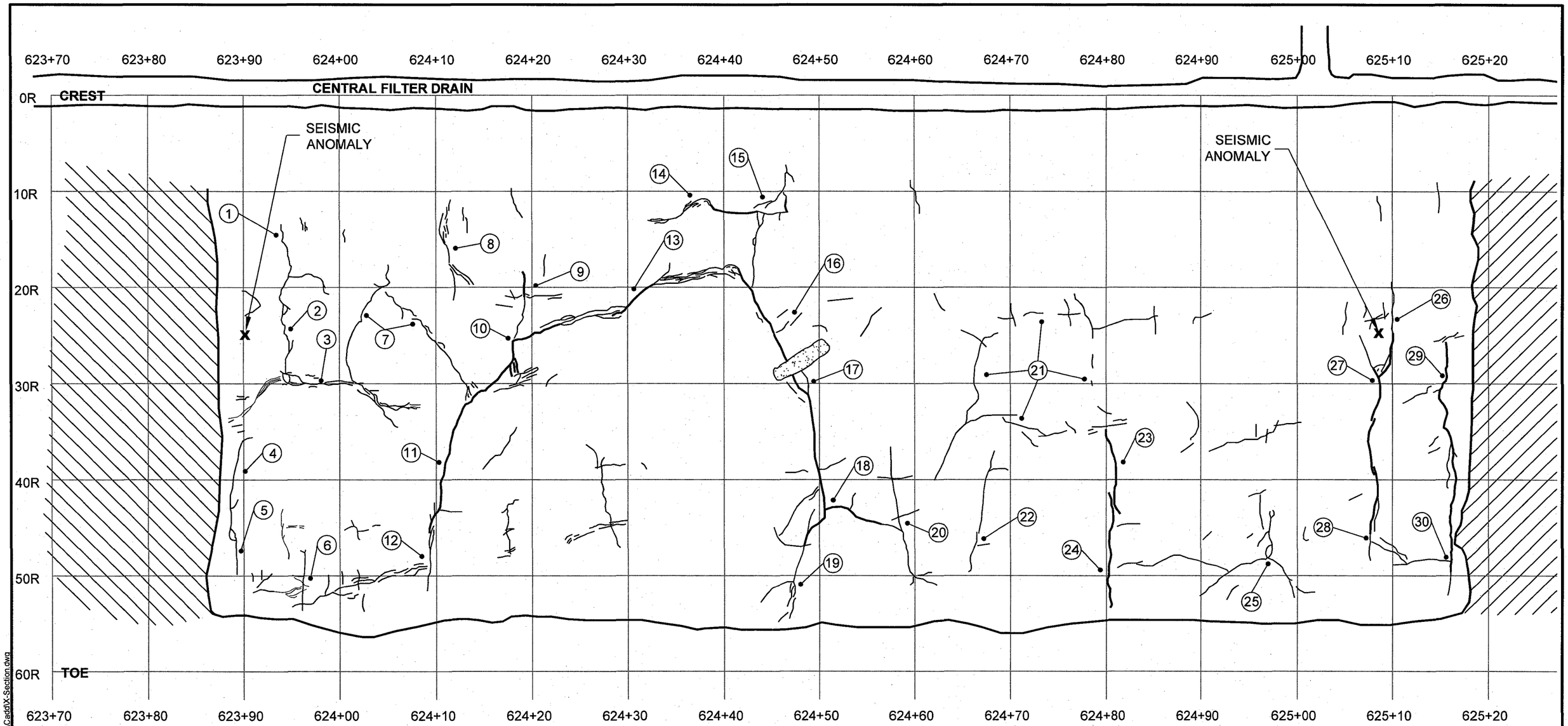
EXCAVATIONS OF UPSTREAM SLOPE

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive 1-inch high 2.5-inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inch per minute. The machine is designed to receive one of the 1-inch high 2.42-inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.



KEY

- LIMIT OF DEEPER EXCAVATION OR SPOILS PILE
- DISTINCT CRACK
- (1) NOTE STATION
- BACKFILL OF TEST PIT FROM PREVIOUS INVESTIGATION

0 5 10 20

JOB NO.	4-117-001088
DESIGN:	KCF
DRAWN:	GWH
DATE:	4/2005
SCALE:	1" = 10'

SURFICIAL CRACK MAPPING
STATION 624+50

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS AND INTERIM DAM SAFETY MEASURES - BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO.5

FIGURE
B-1

amec

G:\Engineering Department\2004 Projects\4-117-001088 Buckeye Supplemental\Cadd\X-Section.dwg

Field Notes for Station 624+50

1. Aperture is 0.1 inches or less, open to partially filled, stepped to wavy with common rootlets. Photo 624_1a.

2. Aperture is 0.1 inches or less, open to partially filled, stepped to wavy with common rootlets. Photo 624_2a.

3. Aperture is 0.1 inches or less, open, and stepped to wavy. Photos 624_3a and 624_3b.

4. Aperture is 0.05 inches or less, open to partially filled, stepped to wavy with common rootlets. Photo 624_4a.

5. Aperture is 0.15 inches or less, partially open to partially filled, stepped. Photo 624_5a.

6. Aperture is 0.1 inches or less, open to partially filled, stepped with occasional rootlets. Photo 624_6a.

7. Aperture is 0.05 inches or less, partially open to filled, stepped to wavy with occasional rootlets. Photo 624_7a.

8. Aperture is 0.2 inches or less, open to partially filled, stepped to wavy with common rootlets. Photo 624_8a.

9. Aperture is 0.15 inches or less, open to partially filled, stepped with occasional rootlets. Photo 624_9a.

10. Aperture is 0.2 inches or less, open to partially filled, stepped. Photos 624_10a and 624_10b.

11. Aperture is approximately 0.4 inches, open to partially filled, stepped with occasional rootlets. Photos 624_11a, 624_11b, 624_11c, and 624_11d.

12. Aperture is 0.2 inches or less, open to partially filled, stepped. Photos 624_12a and 624_12b.

13. Aperture is 0.3 to 0.4 inches, open, stepped. Photos 624_13a and 624_13b.

14. Aperture is 0.15 inches or less, open to partially filled, stepped to wavy with common rootlets. Photo 624_14a.

15. Longitudinal crack has an aperture of 0.2 inches or less, open to partially filled, stepped to wavy with common rootlets. Transverse crack has an aperture of 0.1 inches or less, partially filled, and wavy. Photo 624_15a.

16. Aperture is 0.2 to 0.5 inches, open to partially open, stepped with occasional rootlets. Photos 624_16a and 624_16b.

17. Aperture is approximately 0.2 inches, filled, stepped. Photos 624_17a and 624_17b.

18. Transverse crack has an aperture of 0.3 inches or less, filled to partially open. Longitudinal crack has an aperture of approximately 0.2 inches, partially filled to partially open, stepped to wavy. Photos 624_18a, 624_18b, 624_18c, and 624_18d.

19. Aperture is 0.2 inches or less and decreases downslope, filled to partially open, stepped to wavy. Photos 624_19a and 624_19b.

20. Transverse crack has an aperture of hairline to 0.05 inches, typically hairline, filled to tight, stepped. Longitudinal crack has an aperture of 0.1 to 0.2 inches, open to partially open, stepped to wavy with common rootlets. Photos 624_20a and 624_20b.

21. Crack apertures are 0.05 inches or less, typically hairline, tight to partially open, stepped to wavy with occasional to common rootlets. No photo.

22. Aperture s 0.05 inches or less, filled to partially open, stepped to wavy with common rootlets. Photo 624_22a.

23. Aperture is approximately 0.2 inches, open to partially filled, stepped with occasional rootlets. Photo 624_23a.

24. Aperture is 0.1 inches or less and decreases downslope, open to partially filled, stepped to wavy with occasional rootlets. Photo 624_24a.

25. Crack apertures are 0.1 inches or less, open to partially filled, stepped to wavy with common rootlets. Photos 624_25a and 624_25b.

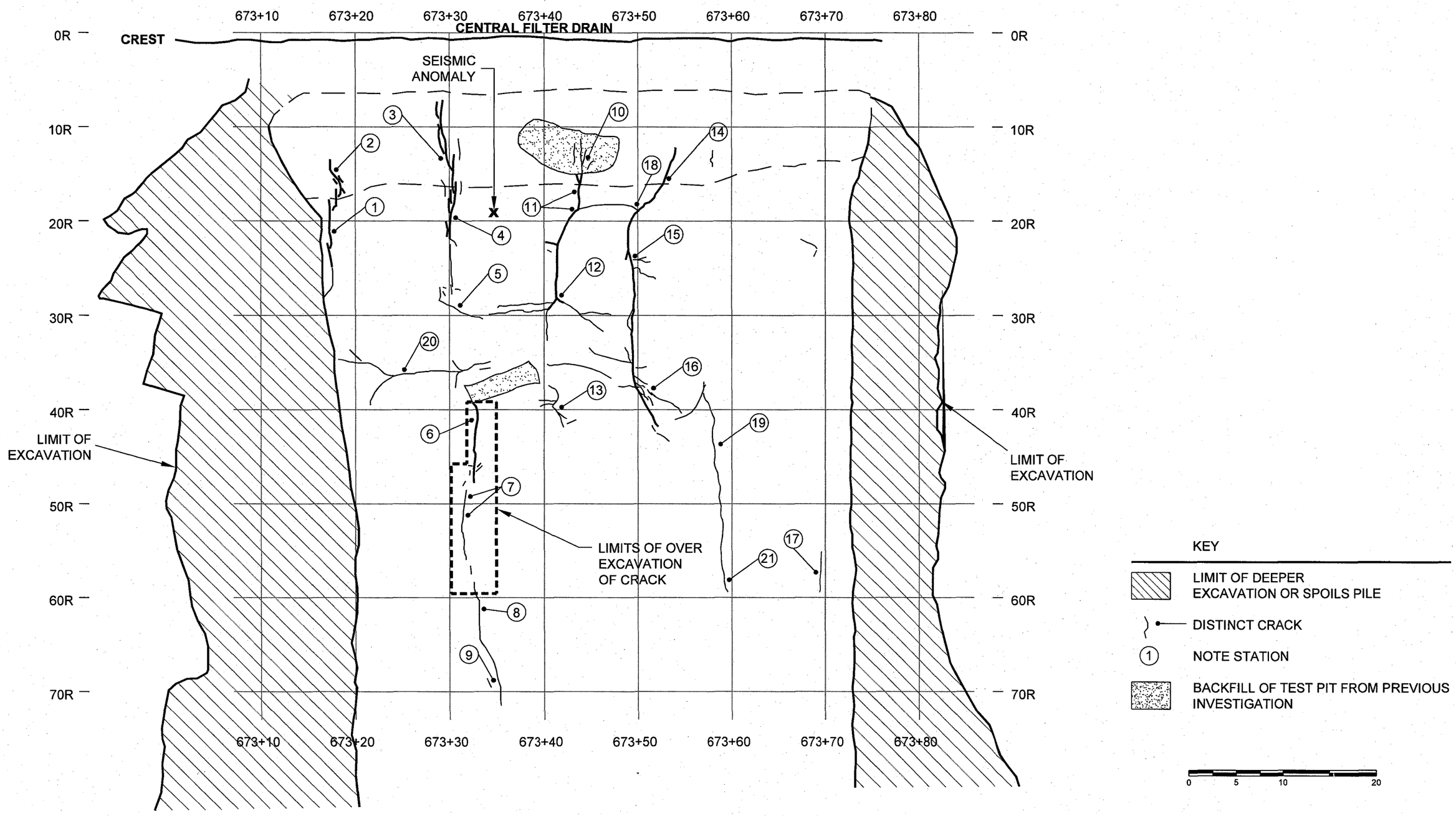
26. Aperture is 0.2 inches or less, open to partially filled, stepped to wavy with occasional rootlets. Photos 624_26a and 624_26b.

27. Aperture is approximately 0.3 inches, open, stepped. Photo 624_27a.

28. Aperture is 0.15 inches or less and decreases downslope, open to partially filled, stepped. Photo 624_28a.

29. Aperture is 0.05 to 0.1 inches, open, stepped to wavy. Photo 624_29a.

30. Aperture is 0.1 to 0.2 inches, open to occasionally partially filled, stepped with common rootlets. Photo 624_30a.



JOB NO.	4-117-001088
DESIGN:	KCF
DRAWN:	GWH
DATE:	3/2005
SCALE:	1" = 10'

SURFICIAL CRACK MAPPING
STATION 673+50

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
AND INTERIM DAM SAFETY MEASURES - BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO.5

FIGURE
B-2

amec

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Field Notes for Station 673+50

1. Crack has up to 0.4 inches aperture for a length of less than 1 foot. Typical aperture is 0.1 inches or less. Crack is open to partially filled and stepped. Photo 673_1a.

2. Crack is ~0.1 inches to hairline open. Crack is open to partially filled and stepped. Photo 673_2a.

3. Crack has a maximum eroded aperture of 1.2 inches, which is possibly enhanced by the compressed air cleaning activities. Typical aperture is 0.2 to 0.4 inches. Crack is open with rare partial filling and occasional rootlets are present. The crack is stepped and forms wedges that are up to 4 inches wide. Photo 673_3a.

4. Crack has 0.1 to 0.3 inches aperture. It is open to partially filled and stepped. The crack becomes tight to filled with a maximum aperture of 0.1 inches and is typically less than 0.02 inches down slope from this location. Photo 673_4a.

5. Crack has 0.02 to 0.04 inches aperture. It is open to partially filled and has several rootlets. Photo 673_5a.

6. Crack has an eroded aperture up to 1.5 inches, and typical aperture of ~0.75 inches. It is partially open to filled with sand from test pit backfill. Several roots up to 0.4 inches diameter and rootlets are present. Photos 673_6a and 673_6b.

7. Crack has an eroded aperture of 0.7 to 1.8 inches and is typically less than 1 inch. It is partially open to filled with sand from test pit backfill. Test pit backfill filling is not present down slope from this location and aperture decreases to 0.02 inches or less. Photo 673_7a.

8. Air eroded aperture of up to 0.6 inches, typically aperture is less than 0.5 inches. Zone of aperture greater than 0.02 inches is approximately 2 feet in length, with aperture upslope and down slope of 0.02 inches or less. Crack is filled with debris and from test pit backfill sand. Photo 673_8a.

9. Healed crack. No aperture, ~1 foot long. Other crack is hairline with no aperture. Photo 673_9a.

10. Crack propagates through test pit backfill. No aperture. Photos 673_10a and 673_10b.

11. Eroded aperture of up to 1.5 inches. Filled with sand backfill from test pit. Crack is stepped. Sand test pit backfill does not extend down slope from this location. Photos 673_11a, 673_11b, and 673_11c.

12. Eroded aperture is up to 1 inch, with uneroded aperture typically less than 0.1 inches. Crack is stepped and typically filled and occasionally partially open with occasional rootlets. The shorter longitudinal cracks are partially filled with and aperture of 0.1 inches or less. Photo 673_12a.

13. Partially filled cracks with aperture of 0.1 inches or less. Photo 673_13a.

14. Partially filled to filled crack with aperture up to 0.3 inches and typical aperture of 0.1 to 0.2 inches. The crack is stepped. Photo 673_14a.

15. Partially open to filled crack with maximum eroded aperture of 0.5 inches, and a typical aperture that is ~0.1 inches. The crack is stepped with common rootlets. Photo 673_15a.

16. Generally open to partially filled crack with a maximum aperture of 0.5 inches and a typical aperture of ~0.2 inches. The crack is stepped with many splays and common rootlets. Aperture decreases down slope from this location. Photo 673_16a.

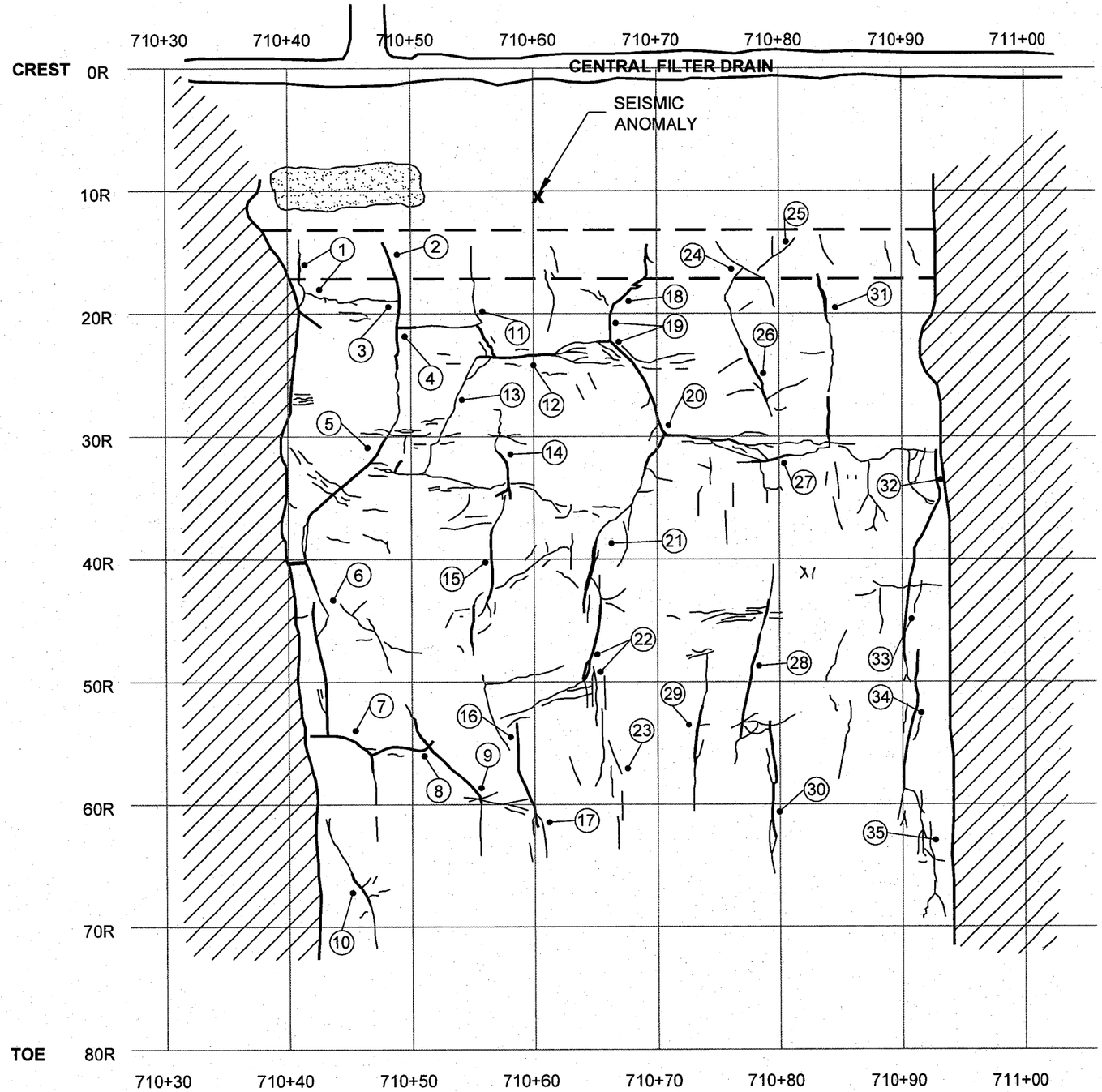
17. Open to partially filled crack with an aperture of ~0.1 inches. The crack has common rootlets and aperture decreases to hairline down slope. Photo 673_17a.

18. Longitudinal crack with 0.2 to 0.3 inches diameter. Partially filled to filled. Photo 673_18a.

19. Up to 0.2 inches aperture, with a typical aperture of 0.1 inches or less. Partially filled to open, stepped, and common rootlets. Photo 673_19a.

20. Longitudinal cracks with aperture 0.05 inches or less. Open to filled with occasional rootlet. Photo 673_20a.

21. Hairline to 0.02 inches aperture and filled to open. Photo 673_21a.



KEY

- LIMIT OF DEEPER EXCAVATION OR SPOILS PILE
- DISTINCT CRACK
- (1) NOTE STATION
- BACKFILL OF TEST PIT FROM PREVIOUS INVESTIGATION

0 5 10 20

JOB NO.	4-117-001088
DESIGN:	KCF
DRAWN:	GWH
DATE:	4/2005
SCALE:	1" = 10'

SURFICIAL CRACK MAPPING
STATION 710+47

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS AND INTERIM DAM SAFETY MEASURES - BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO.5

FIGURE
B-3

amec

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Field Notes for Station 710+48

1. Transverse crack has a maximum aperture of 0.14 inches, and is typically 0.1 inches or less. Open to partially filled with occasional rootlets. Longitudinal crack has an aperture of 0.02 inches or less, typically hairline, occasional open zones, generally tight, stepped. Photos 710_1a and 710_1b.

2. Eroded aperture up to 5 inches just below test pit from previous investigation, typically eroded aperture is approximately 1.5 inches. Filled with sand from test pit backfill. Photos 710_2a and 710_2b.

3. Maximum eroded aperture of approximately 0.7 inches. Filled with sand from test pit backfill, downslope from this point the crack is no longer filled with sand from test pit backfill, but is filled with other filling. Photos 710_3a, 710_3b, and 710_3c.

4. Transverse crack has an eroded aperture of approximately 0.7 inches, filled, parallel cracks often from wedges up to several inches wide. Longitudinal crack has an aperture up to 0.7 inches, filled. Photo 710_4a.

5. Aperture of approximately 1 inch, filled, and oblique in orientation. Longitudinal cracks are hairline to 0.02 inches in aperture. Photo 710_5a.

6. Up to 1 inch aperture with some zones with no aperture, filled, stepped. Photo 710_6a.

7. Aperture of approximately 1 inch, filled, stepped, oblique in orientation. Photo 710_7a.

8. Longitudinal crack with approximately 1 inch aperture, filled. Photo 710_8a.

9. Oblique crack with 0.1 to hairline aperture, filled, stepped. Photo 710_9a.

10. Aperture of approximately 0.2 inches that decreases to hairline upslope and downslope, partially filled to filled, stepped. 710_10a.

11. Transverse crack with aperture of 0.1 inches or less, partially filled to open, stepped. Longitudinal crack has aperture of 0.2 inches or less, filled. Photo 710_11a.

12. Longitudinal crack with approximately 0.7 inches aperture, filled to partially open. Photo 710_12a.

13. Aperture of hairline to 0.2 inches, filled, stepped. Photo 710_13a.

14. Aperture of 0.2 to 0.4 inches, open to partially filled, stepped. Photo 710_14a.

15. Aperture of 0.1 to 0.5 inches, typically approximately 0.2 inches, partially filled, stepped. Photo 710_15a.

16. Longitudinal cracks with aperture of 0.1 to 0.3 inches, filled to partially open, stepped. 710_16a.

17. Aperture is 0.1 inches or less, filled, stepped. Photo 710_17a.

18. Aperture is 0.1 to 0.2 inches, open, stepped. Photo 710_18a.

19. Transverse crack has an aperture up to 0.7 inches, typically approximately 0.5 inches, typically open, occasionally partially filled, stepped. Longitudinal crack has an aperture of 0.02 to 0.1 inches, open to partially filled, stepped. Photo 710_19a.

20. Transverse crack has an aperture of 0.2 to 0.7 inches, typically open, occasionally partially filled, stepped. Longitudinal crack has an aperture of 0.2 to 0.4 inches, typically open, occasionally partially filled, stepped to wavy. Photo 710_20a.

21. Aperture is approximately 0.4 inches, open to partially filled, stepped. Photo 710_21a.

22. En echelon cracks with 0.2 to 0.4 inches aperture, open to partially filled, stepped. Photo 710_22a.

23. Up to 0.2 inches aperture, open to partially filled, stepped. Photo 710_23a.

24. Aperture of 0.1 to 0.2 inches, open to partially filled, stepped. Photo 710_24a.

25. Oblique crack with aperture of approximately 0.1 inches, open, stepped. Photos 710_25a and 710_25b.

26. Aperture is approximately 0.2 inches, open, stepped. Photo 710_26a.

27. Longitudinal crack with 0.2 to 0.5 inches aperture, open to partially filled, stepped to wavy. Photos 710_27a and 710_27b.

28. Aperture of 0.2 to 0.5 inches, open to partially filled, stepped. Photo 710_28a.

29. Aperture of 0.2 to 0.3 inches, open to partially filled, stepped. Photo 710_29a.

30. Aperture of 0.2 to 0.4 inches, filled to partially open, stepped. Photo 710_30a.

31. Aperture of approximately 0.3 inches which decreases to 0.01 inches or less downslope, open with occasional partially filled zones, stepped. Photo 710_31a.

32. Aperture of approximately 0.5 inches, open, stepped, forms wedges up to several inches across. Photos 710_32a and 710_32b.

33. Aperture of 0.5 to 0.7 inches, open, stepped. Photos 710_33a and 710_33b.

34. Aperture of 0.2 to 0.5 inches, open to partially filled, stepped. Downslope crack is filled to partially open. Photo 710_34a.

35. En echelon cracks with a maximum aperture of 0.1 inches, typically approximately 0.05 inches, stepped to wavy. Photo 710_35a.

PROJECT Buckeye FRS No 1
Supplemental Investigation of Embankment
Cracking & Interim Dam Safety Measures

JOB NO. 4-117-001088 DATE 3/22/05

BACKHOE TYPE John Deere 710G
LOCATION Sta 673+35
SURFACE ELEV.
DATUM

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist moderately firm to firm	**SILTY SAND,** trace of clay, trace of fine grained gravel, predominantly medium to fine grained sand, subangular to subrounded, noncemented (Stage I), low plasticity to nonplastic, light brown
					SM/GM	slightly moist very firm	**SILTY SAND & GRAVEL,** well graded sand, predominantly fine grained gravel, subangular to subrounded, weakly lime cemented (Stage I+ - II), low plasticity to nonplastic, light brown
5							Stopped Backhoe at 5'
10							
15							
20							
25							

SAMPLE TYPE
B - Undisturbed Bulk Sample
D - Disturbed Bulk Sample
U - 3" O D 2.42" I D tube sample
A - Drill Cuttings
G - Grab sample

LOG OF TEST PIT NO. TP-1

APPENDIX C

GEOPHYSICAL SURVEYS & INTERPRETATIONS

REFRACTION SEISMIC EQUIPMENT & PROCEDURES

Refraction seismic surveys are performed in general conformance with the guidelines presented in ASTM D5777-95 Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation for refraction surveys using compression waves (p-waves). ASTM D5777 does not address shear wave (s-wave) surveys; standard practice is followed for refraction surveys using s-waves. In some investigations, such as seeking and tracing earth fissures or other significant discontinuities (Rucker and Keaton, 1998), non-standard procedures and analyses, such as signal amplitude analysis, are used as part of the investigation process.

Seismic Equipment - Refraction seismic surveys are performed using a Geometrics ES-1225 or Smartseis S-12 signal enhancement seismograph. These instruments have the capability to simultaneously record 12 channels of geophone data and produce hard copies of that data. The Smartseis also has the capability of digitally storing geophone data. Signal enhancement capability permits the use of a sledgehammer as the seismic energy source. A timing sensor is attached to the hammer, and for p-waves, a metal plate is set securely on the ground surface and struck. Generating horizontally polarized s-waves typically involves setting the plate against the end of a wooden plank or railroad tie oriented perpendicular to the axis of the geophone array and striking with a horizontal motion of the sledgehammer. A truck is usually driven onto the plank or tie to effectively couple the plank or tie to the ground.

Because of the signal enhancement capability, signals from several or many strikes can be added together to increase the total signal available relative to noise to obtain the seismic record. Although explosives can also be used as a p-wave seismic energy source, a sledgehammer does not require licenses or permits, or involve special limitations, regulations and liabilities. Explosive energy sources may be needed for long geophone arrays. Geophone cables with 12 geophone takeouts at 10-foot, 20-foot or 20-meter spacings are presently used. Vertical geophones are used to obtain p-wave data and horizontal geophones are used to obtain s-wave data. The seismograph system is extremely portable. In areas where vehicular access is not possible, the equipment can be mobilized by various means, including backpacking, packhorse, helicopter and canoe.

Field Procedures - The field operations are directed by our experienced engineer or geologist, who operates the equipment, prepares the records and examines the data in the field. Refraction seismic lines are generally laid out using the standard spacings on the geophone cables. A maximum depth of investigation of about 75 to 100 feet may be possible using a 300-foot array. For shorter lines with improved near-surface resolution, 10-foot spacings between geophones with a 120-foot array have a maximum depth of investigation of about 30 to 40 feet. Other geophone spacings can also be used. To improve the resolution of near-surface interfaces, energy source positions generally are set at 12.5 feet from the ends of a 25-foot spacing geophone array or at 5 feet from the ends of a 10-foot geophone spacing array. Several shots locations are utilized along the length of an array. When three shots are obtained, there is a foreshot and a backshot at the array ends and a midshot at the array center. The midshot is usually placed midway between the two centermost geophones. When five shots are obtained, the additional shotpoints are located midway between the foreshot-midshot and the midshot-backshot. These multiple shot points permit interpretation of near-surface interfaces at various locations along the array as well as near the endpoints for variable subsurface profiles, and permits more refined overall interpretations of shallow and mid-depth subsurface velocities and interfaces. In cases when both enhanced depth of investigation and improved shallow resolution are needed, multiple 12-geophone arrays are completed end to end and combined into longer composite 24- or more geophone arrays with greater depths of investigation. Additional energy shotpoints are then, at a minimum, performed at the midpoint and far endpoint of each adjacent 12-geophone array to provide seismic energy travel path coverage over the extended array.

REFRACTION SEISMIC EQUIPMENT & PROCEDURES (Cont.)

P-wave data are recorded for general exploration work. S-wave data are also recorded when dynamic subsurface material properties are desired. An s-wave arrival is verified by obtained two sets of horizontal data that are 180 degrees out of phase. The phase reversal is obtained by either reversing the horizontal geophone orientation or reversing the hammer impact direction. Hard copy printouts of all field data are made and inspected as the information is collected. Field notes, including line number and orientation, topographic variations and other notes as appropriate are made on the hard copy printout. Locations and other notes are made on site maps and in notebooks as appropriate. Initial first arrival picks are made in the field and array endpoint arrival times are checked for immediate data adequacy verification as part of the quality control process.

Interpretation - Although preliminary or quality control initial refraction seismic data interpretations may sometimes be performed in the field, full interpretations are completed in the office. At the present time, two interpretation methods are being used; the intercept time method (ITM) and an optimization software routine based on finite difference optimization software. ITM breaks an interpretation into several distinct layers. It is simple, can be performed with a calculator, and can provide excellent interpretations of near surface layer depths and velocities. Optimization provides a continuously variable velocity interpretation through a discrete grid. Interpretations using optimization also indicate zones where interpretation has occurred, thus providing quality control on the depths to which the interpretation can be relied upon. However, the discrete grid used by optimization results in a low resolution near surface interpretation. The combination of both ITM and, when appropriate, optimization methods provides two separate interpretations with complimentary strengths and cross-checking capability. These interpretation methods are applied as appropriate to a particular project.

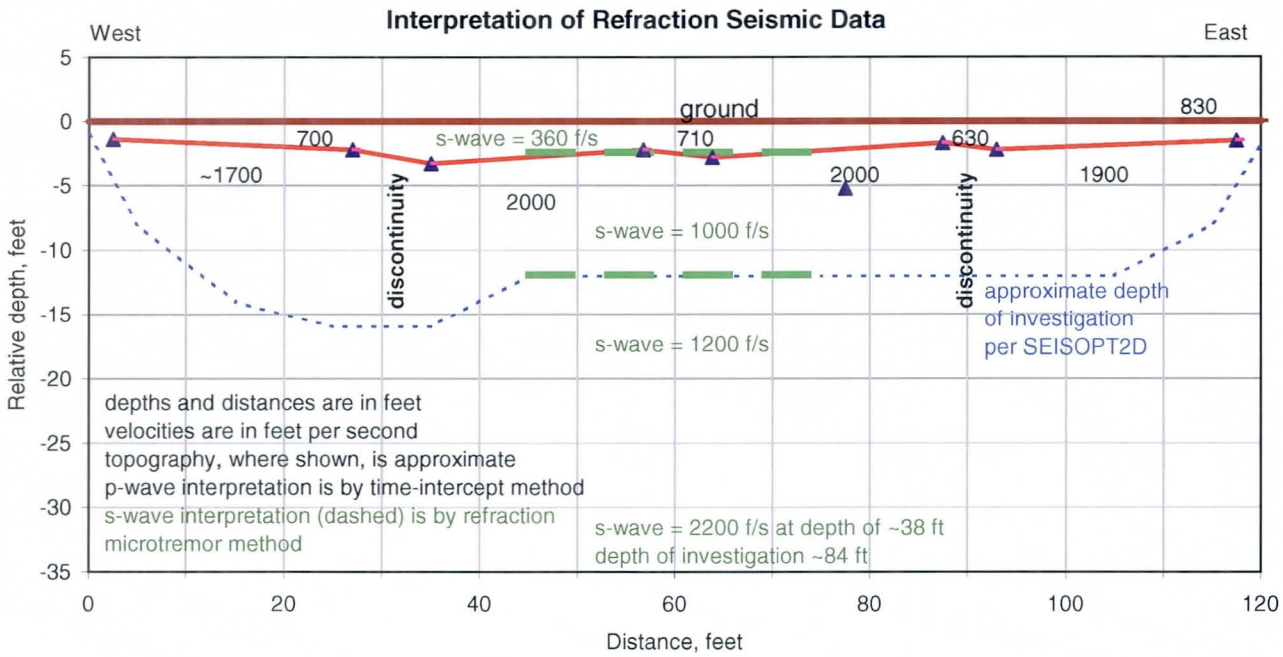
Refraction seismic data interpretation using the intercept time method is detailed by Mooney (1973). A personal computer spreadsheet is used to perform the necessary calculations to obtain depths and layer velocities, and print out time-distance plots and depth interpretations. This method is used for interpretations of up to three layers. It is considered that more than three layers cannot be effectively interpreted using twelve geophone data points. Interpretations are then completed manually to produce a final interpreted geologic profile and layer depths.

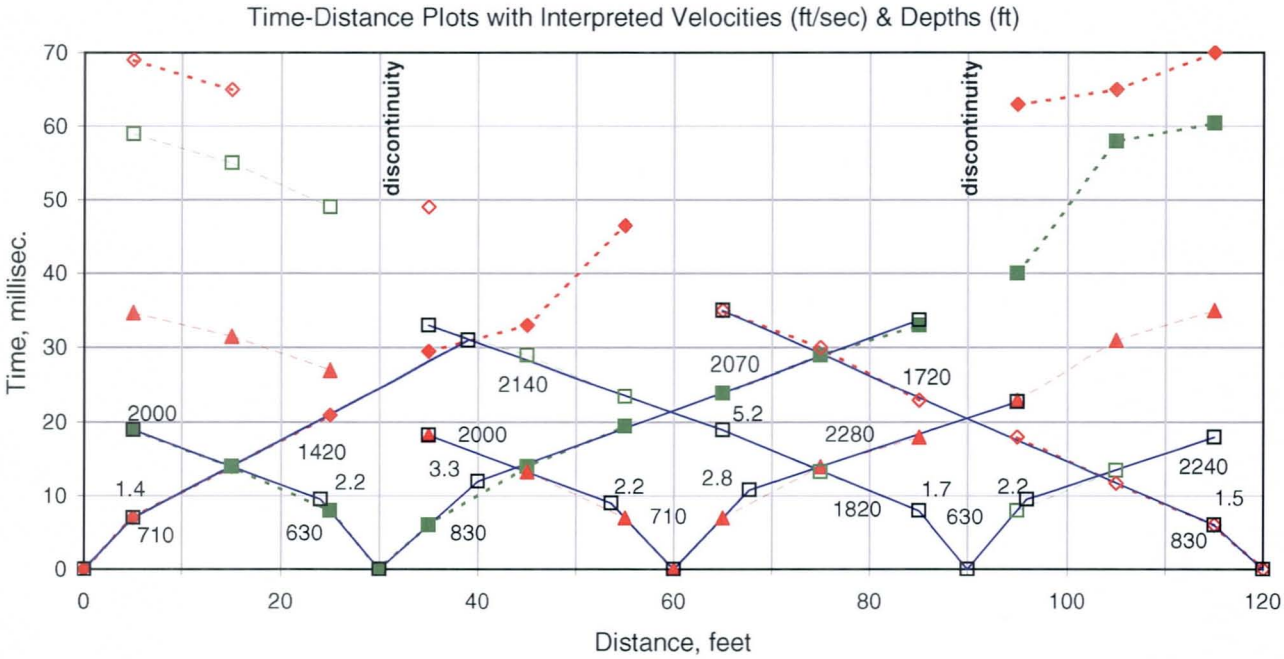
Refraction seismic data interpretation using optimization is performed using the SeisOpt2D software package by Optim, L.L.C., 1999, of Reno, Nevada. Energy source and geophone receiver locations and elevations, and first arrival times are entered into the software package, and first arrival travel times are optimized through a process of repeated (typically 10,000 to 100,000) iterations. Multiple seismic lines combined end to end into a longer composite line can be effectively interpreted using this software. Model grid dimensions and element sizes are selected, with larger grids containing smaller elements providing greater potential resolution. However, very large grids containing small elements may become unstable, and several runs may need to be made to obtain stable, robust interpretations. Once a robust interpretation has been obtained, the resulting seismic velocity profile is printed out with varying colors indicating the interpreted velocities.

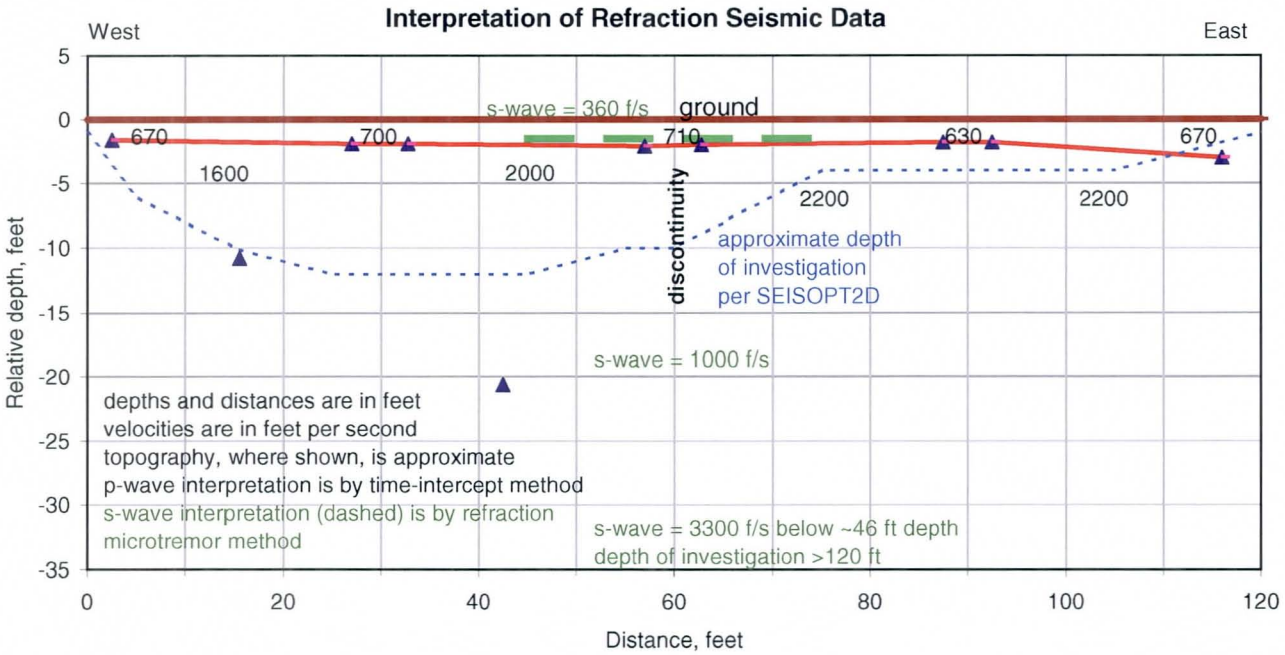
References:

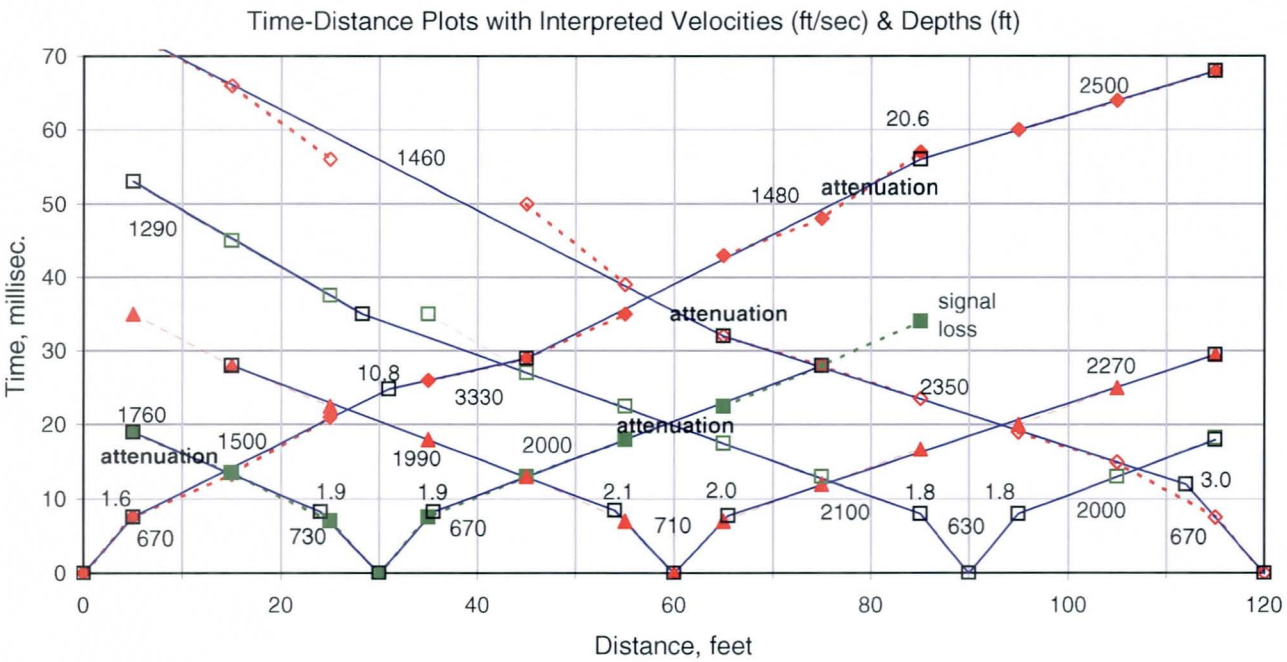
Mooney, H.M., 1973, Engineering Seismology Using Refraction Methods, Bison Instruments, Inc., Minneapolis, Minnesota.

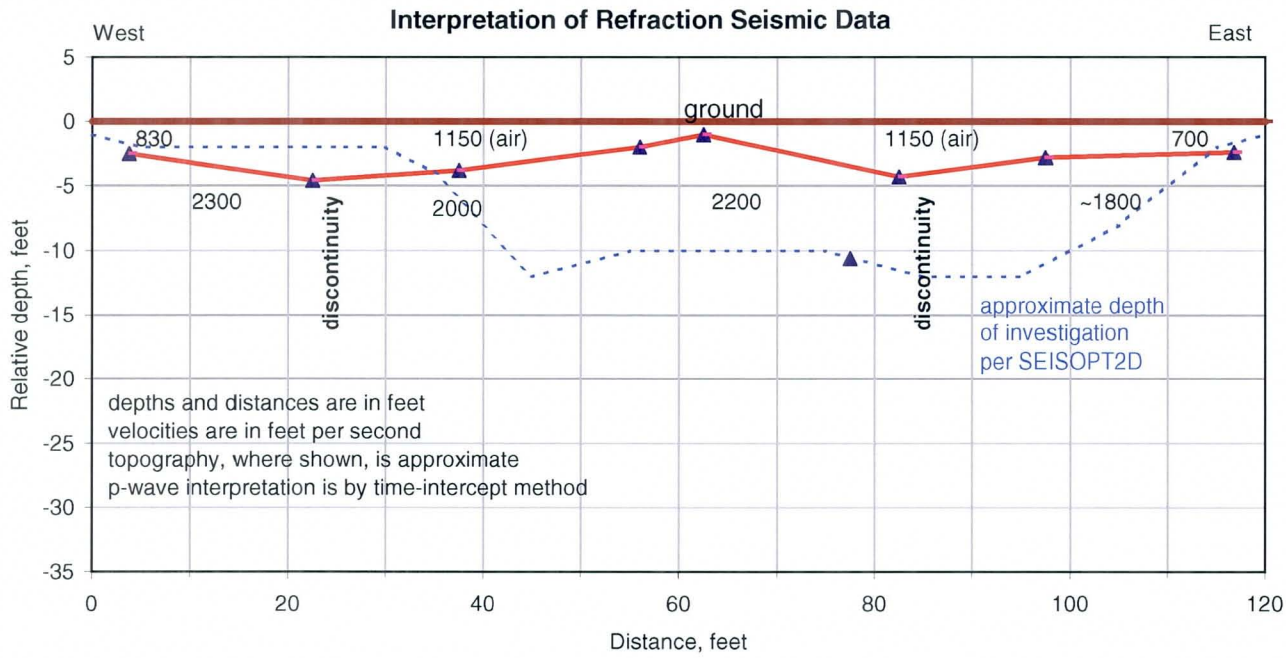
Rucker, M.L. and Keaton, J.R., 1998, Tracing an Earth Fissure Using Seismic-Refraction Methods with Physical Verification, in Land Subsidence Case Studies and Current Research: Proceedings of the Dr. Joseph F. Poland Symposium on Land Subsidence, Edited by Borchers, J.W., Special Publication No. 8, Association of Engineering Geologists, Star Publishing Company, Belmont, California, p. 207-216.

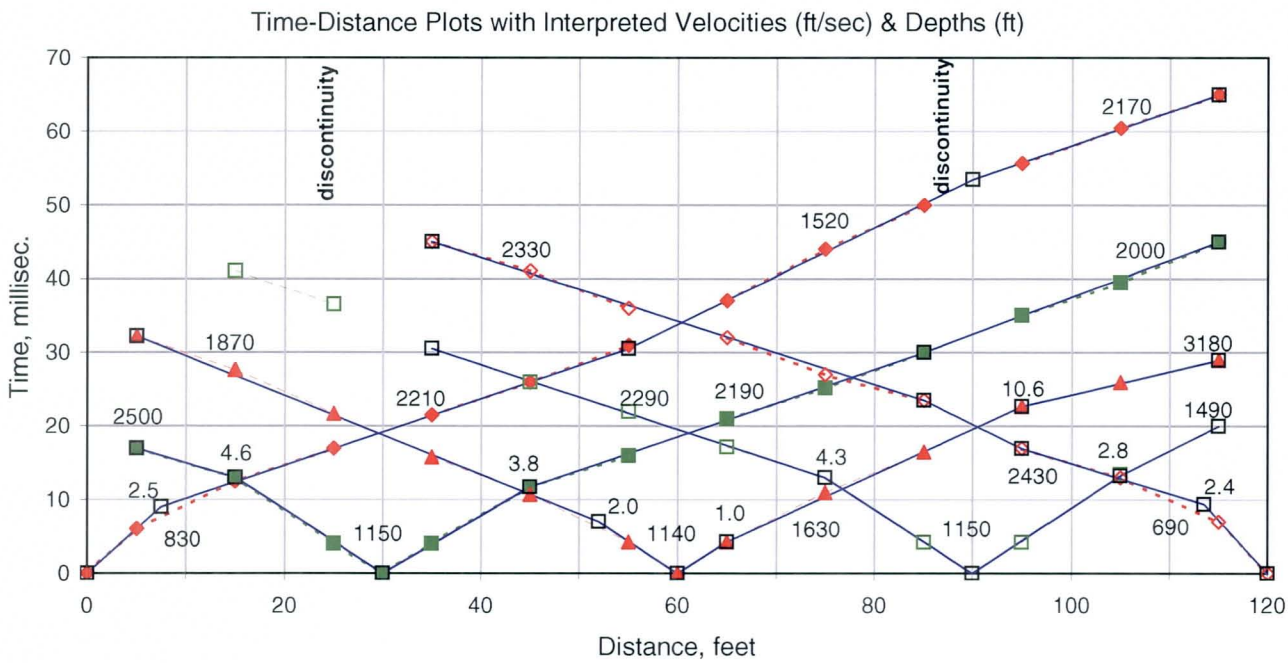

Interpretation of Refraction Seismic Data
West
East
ground
700
710
630
830
~1700
2000
1900
s-wave = 360 f/s
s-wave = 1000 f/s
s-wave = 1200 f/s
discontinuity
discontinuity
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 2200 f/s at depth of ~38 ft
depth of investigation ~84 ft
Relative depth, feet
Distance, feet

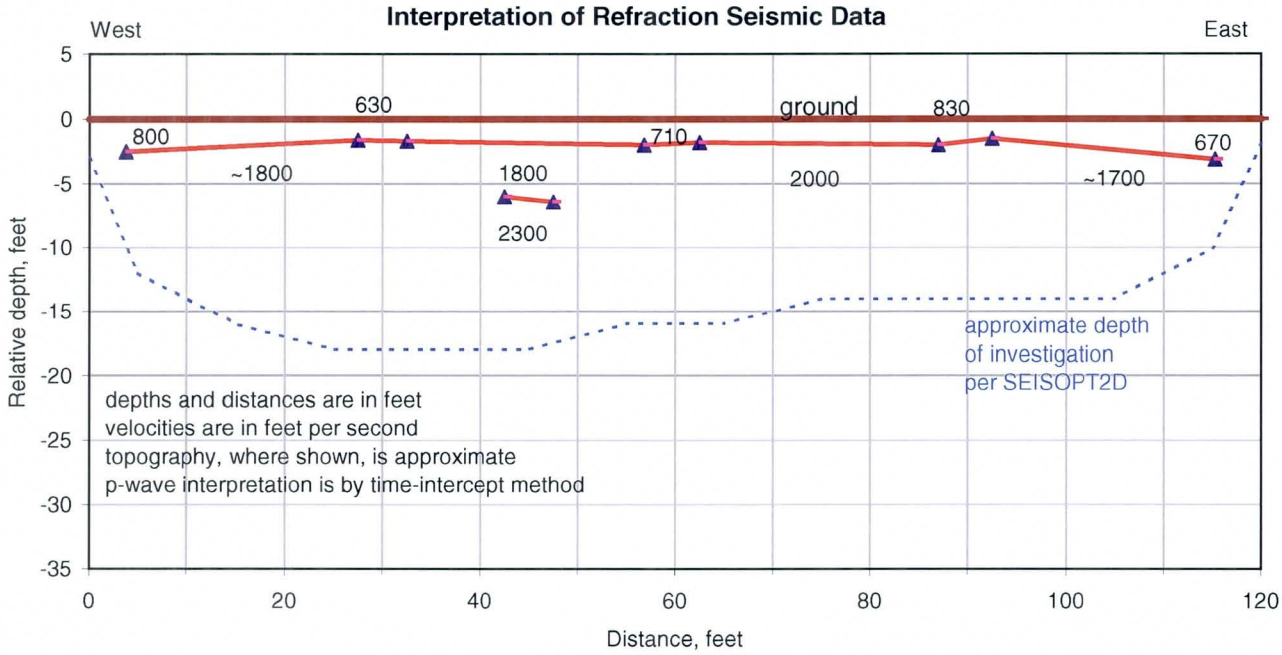

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
discontinuity
discontinuity
2000
1.4
710
1420
2.2
630
2000
3.3
830
2140
2.2
710
2070
5.2
2.8
2280
1720
1.7
1820
630
2.2
2240
1.5
830
Time, millisec.
Distance, feet

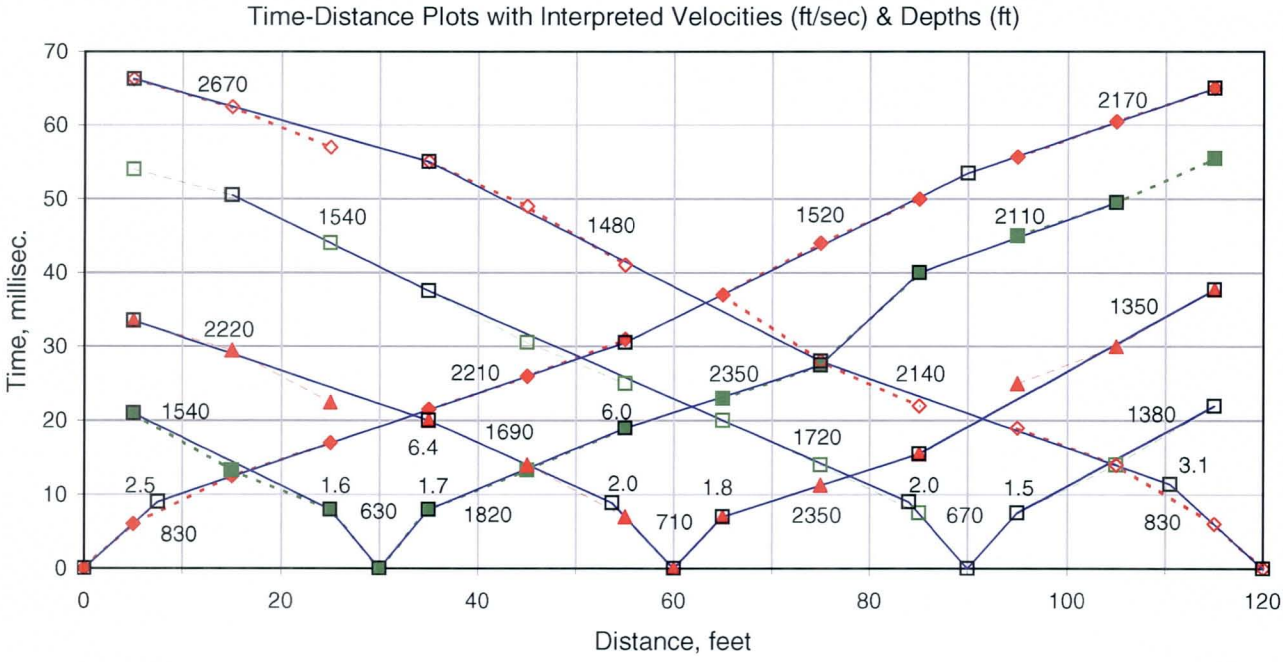

Interpretation of Refraction Seismic Data
West
East
s-wave = 360 f/s
ground
670
700
710
630
670
1600
2000
2200
2200
discontinuity
approximate depth
of investigation
per SEISOPT2D
s-wave = 1000 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
s-wave = 3300 f/s below ~46 ft depth
depth of investigation >120 ft
Relative depth, feet
Distance, feet

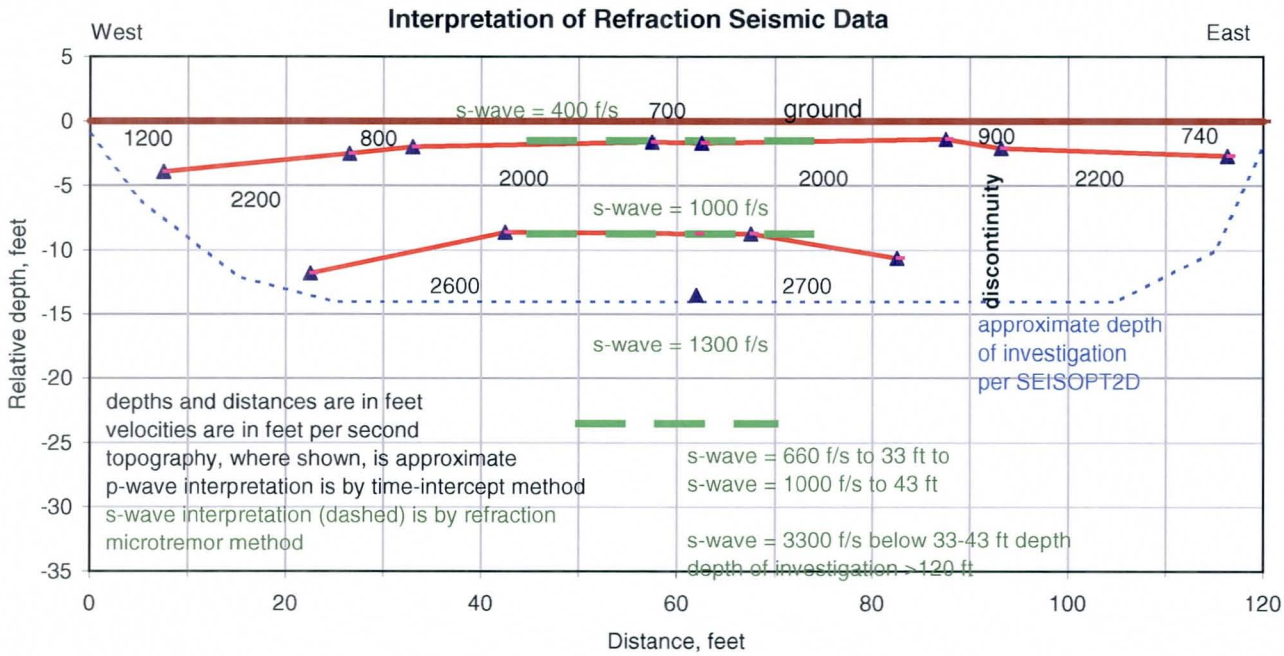

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
1460
1290
1480
attenuation
20.6
2500
attenuation
signal
loss
10.8
3330
2350
2270
1760
1500
attenuation
1990
2000
attenuation
1.6
670
1.9
730
1.9
670
2.1
710
2.0
2100
1.8
630
1.8
2000
3.0
670
Time, millisec.
Distance, feet

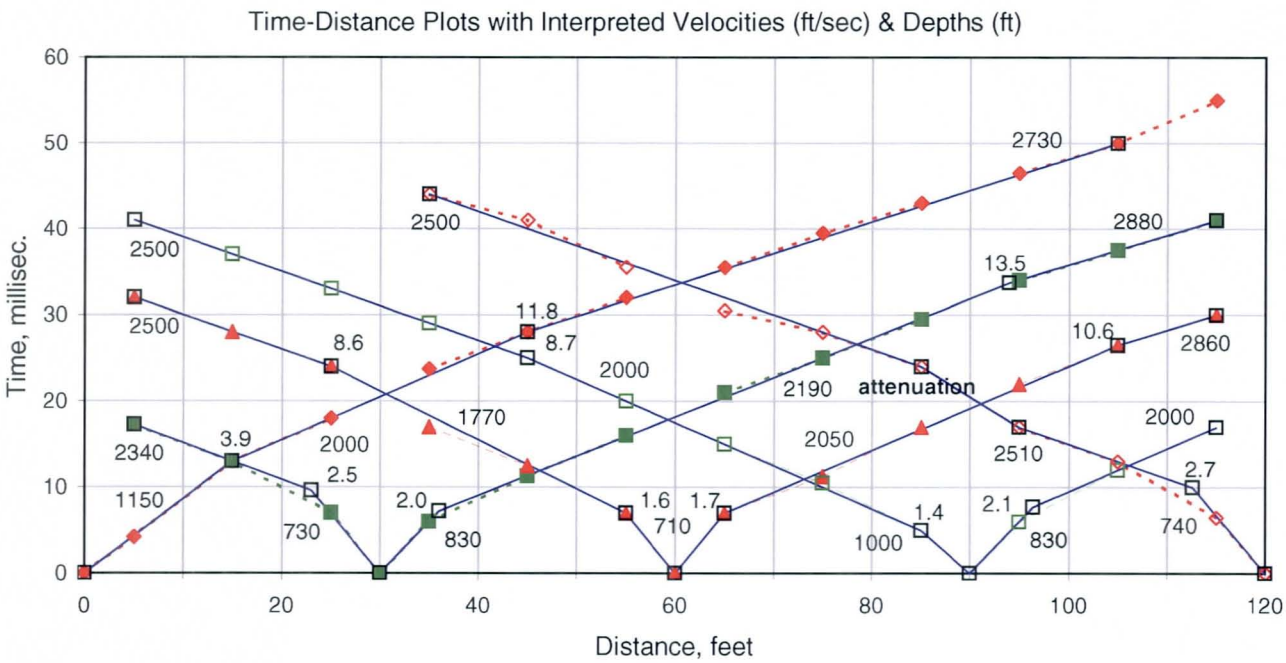

Interpretation of Refraction Seismic Data
West
East
ground
830
1150 (air)
1150 (air)
700
2300
2000
2200
~1800
discontinuity
discontinuity
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
Relative depth, feet
Distance, feet

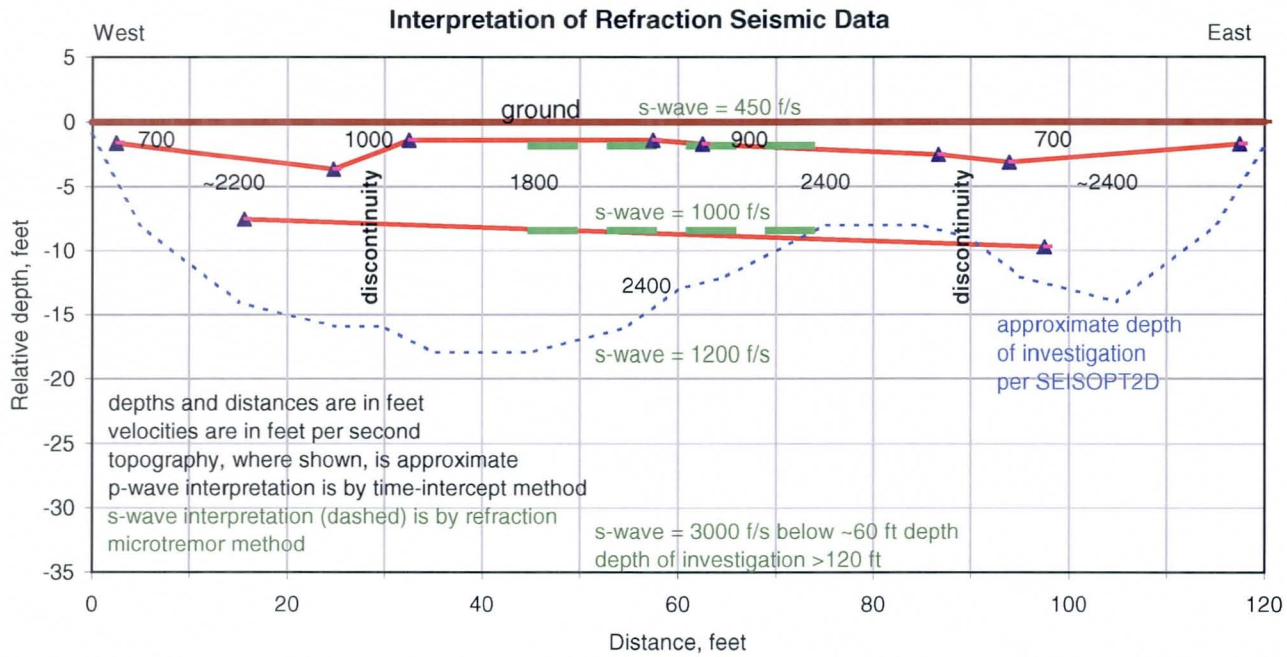

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
discontinuity
discontinuity
2170
1520
2330
2000
1870
3180
2210
2290
2190
10.6
2500
1490
4.6
3.8
4.3
2.8
2.5
2430
2.4
2.0
1.0
830
1150
1140
1630
1150
690
Time, millisec.
Distance, feet

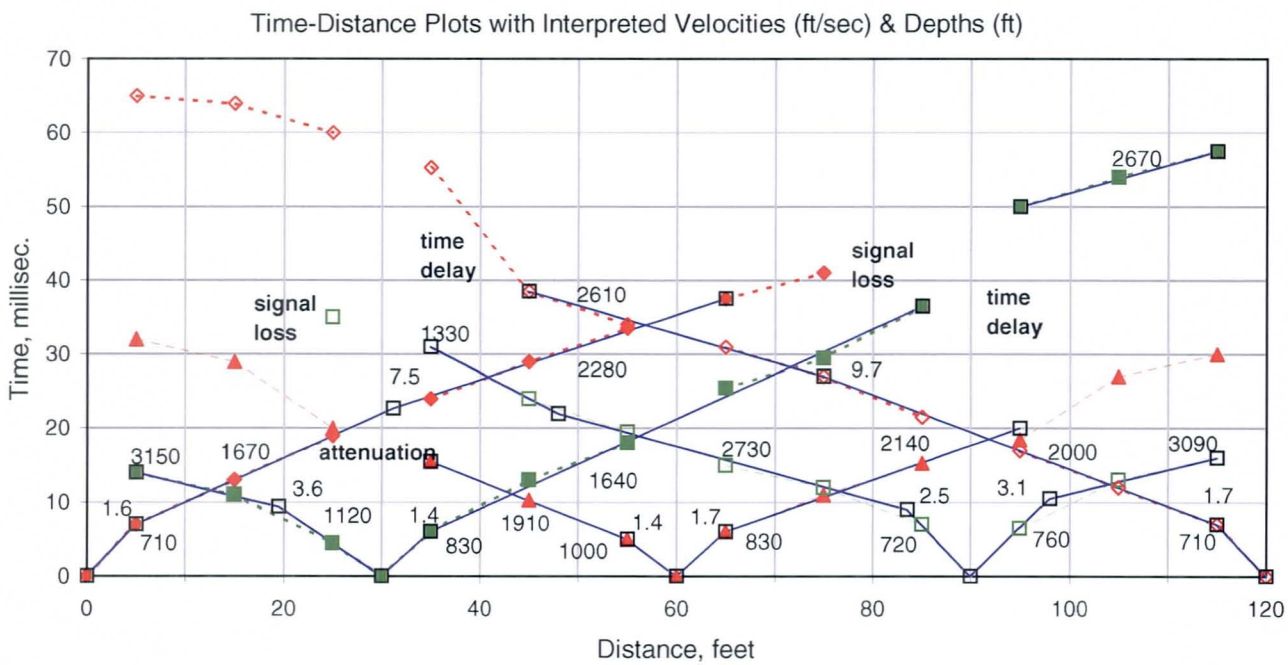

Interpretation of Refraction Seismic Data
West
East
ground
800
630
710
830
670
~1800
1800
2300
2000
~1700
approximate depth
of investigation
per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
Relative depth, feet
Distance, feet

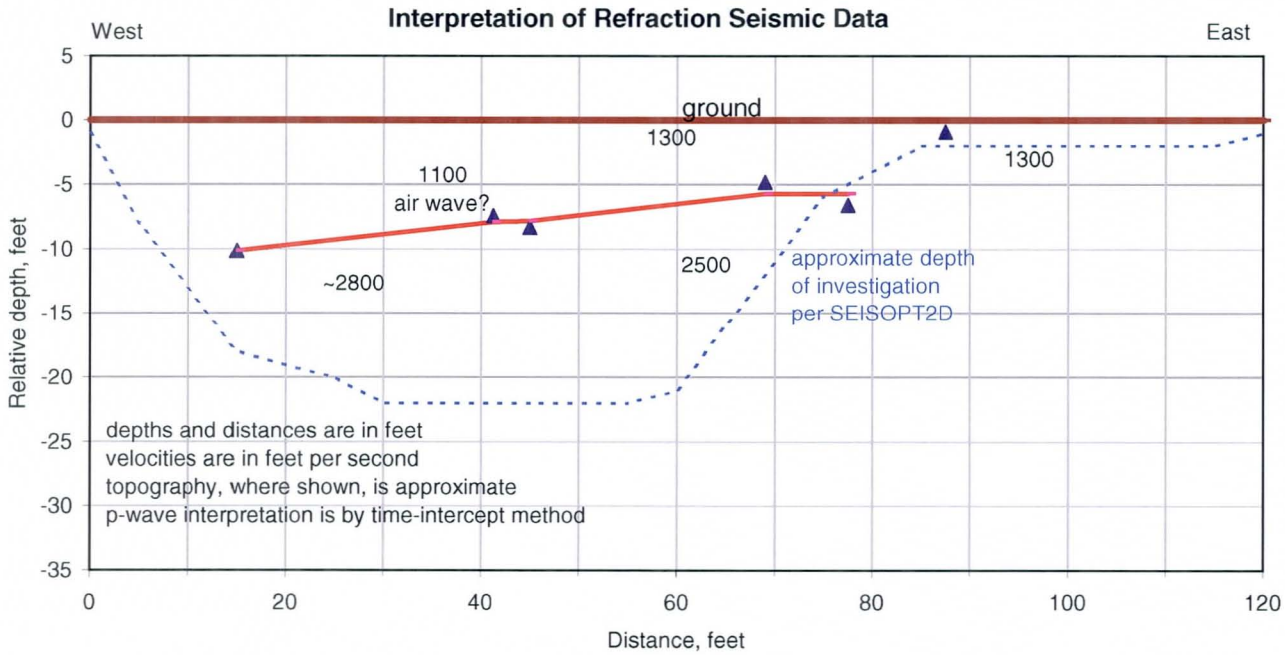

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2670
1540
1480
1520
2170
2110
2220
2210
2350
2140
1350
1540
6.0
6.4
1690
1720
1380
2.5
1.6
1.7
2.0
1.8
2.0
1.5
3.1
830
630
1820
710
2350
670
830
Time, millisec.
Distance, feet

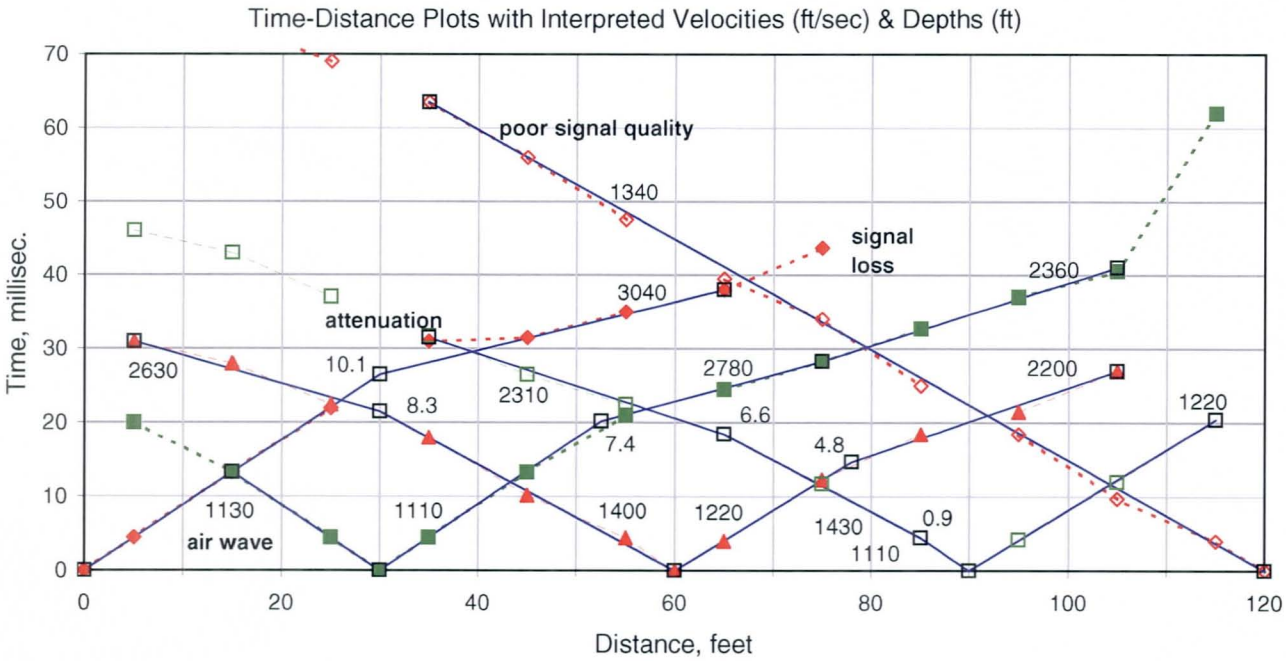

Interpretation of Refraction Seismic Data
West
East
Relative depth, feet
Distance, feet
s-wave = 400 f/s
700
ground
1200
800
900
740
2200
2000
2000
2200
s-wave = 1000 f/s
2600
2700
discontinuity
s-wave = 1300 f/s
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 660 f/s to 33 ft to
s-wave = 1000 f/s to 43 ft
s-wave = 3300 f/s below 33-43 ft depth
depth of investigation >120 ft

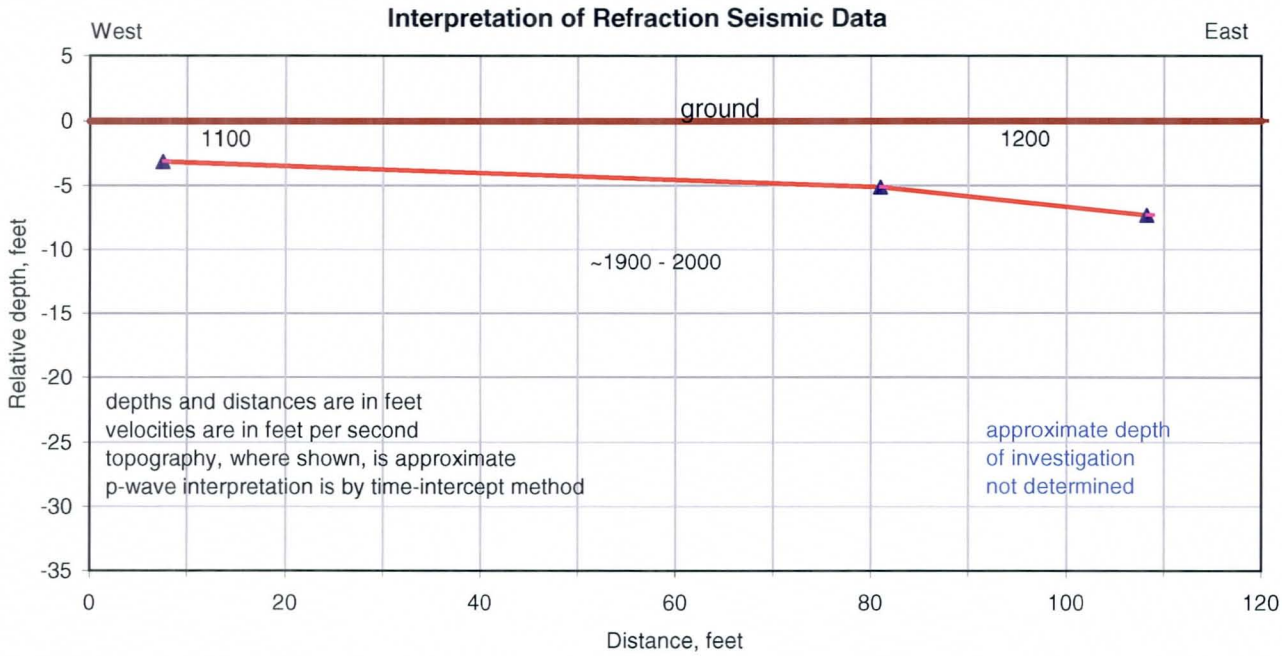

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
2730
2500
2880
2500
13.5
2500
11.8
8.6
8.7
10.6
2860
2000
2190
attenuation
1770
2000
2340
3.9
2000
2050
2510
2.5
2.7
1150
2.0
1.6
1.7
1.4
2.1
730
830
710
1000
830
740

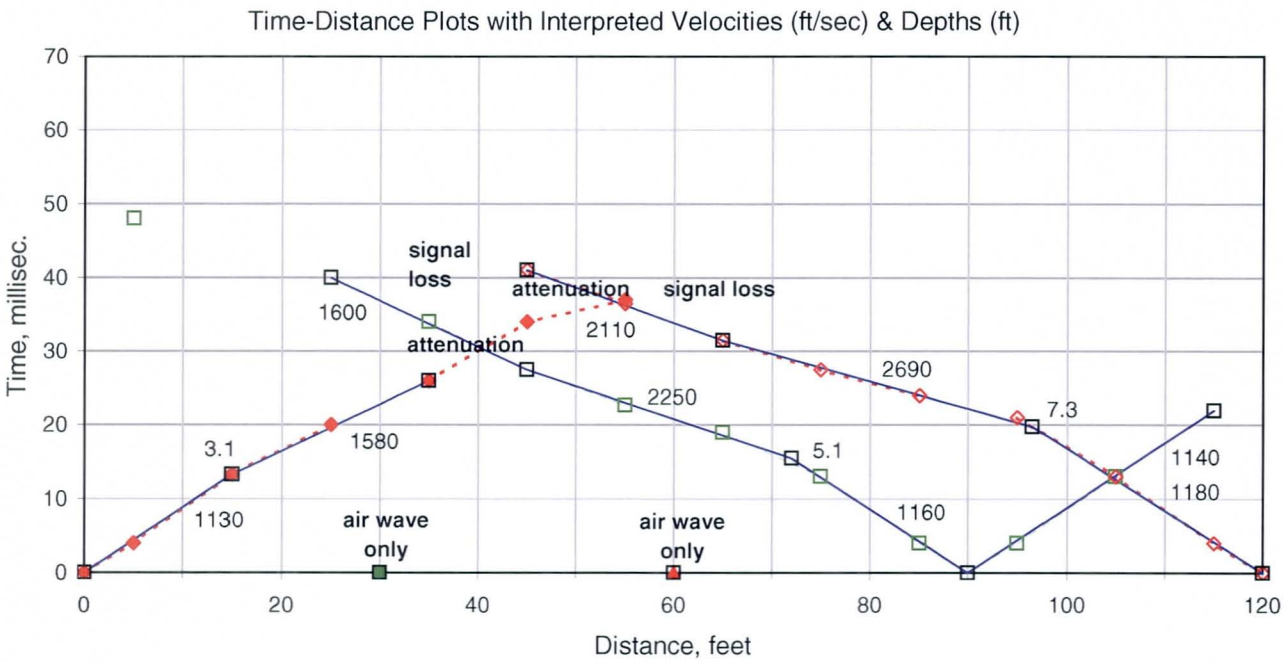

Interpretation of Refraction Seismic Data
West
East
ground
s-wave = 450 f/s
700
1000
900
700
~2200
1800
2400
~2400
s-wave = 1000 f/s
discontinuity
discontinuity
2400
s-wave = 1200 f/s
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 3000 f/s below ~60 ft depth
depth of investigation >120 ft
Relative depth, feet
Distance, feet

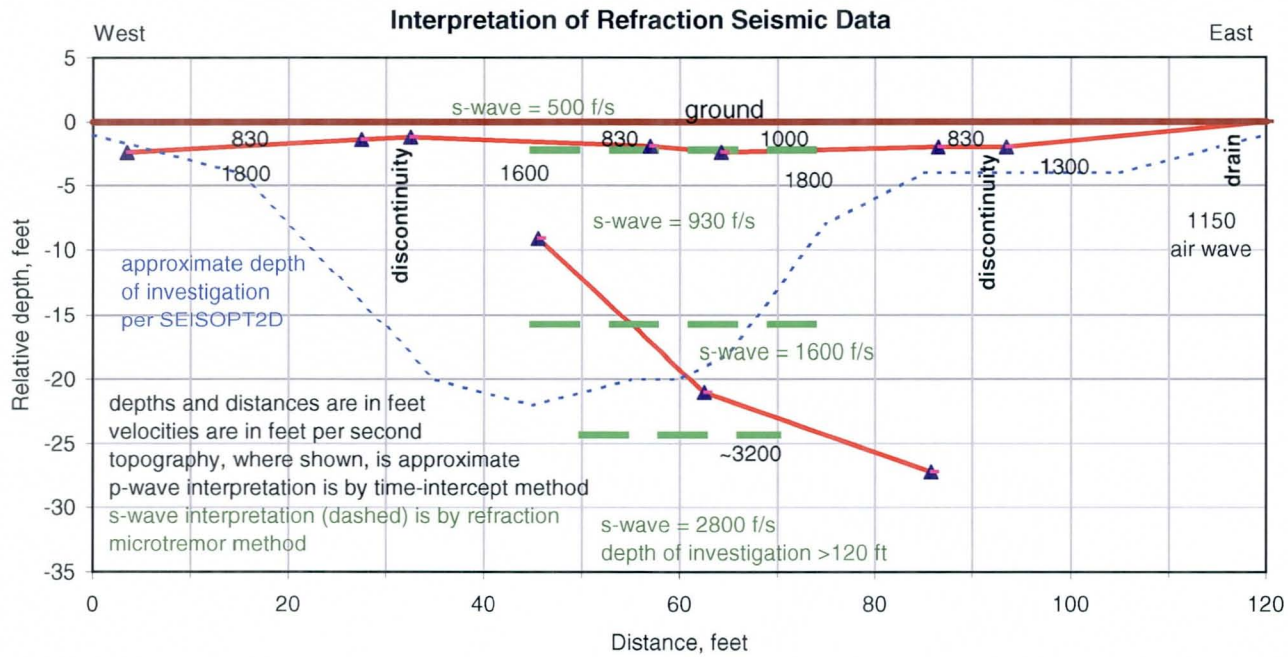

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
signal loss
time delay
signal loss
time delay
attenuation
3150
1670
710
1330
2610
2280
7.5
9.7
2670
3.6
1120
1.4
830
1910
1000
1640
1.4
1.7
830
2730
2140
720
2.5
2000
3.1
760
3090
710
1.7
1.6

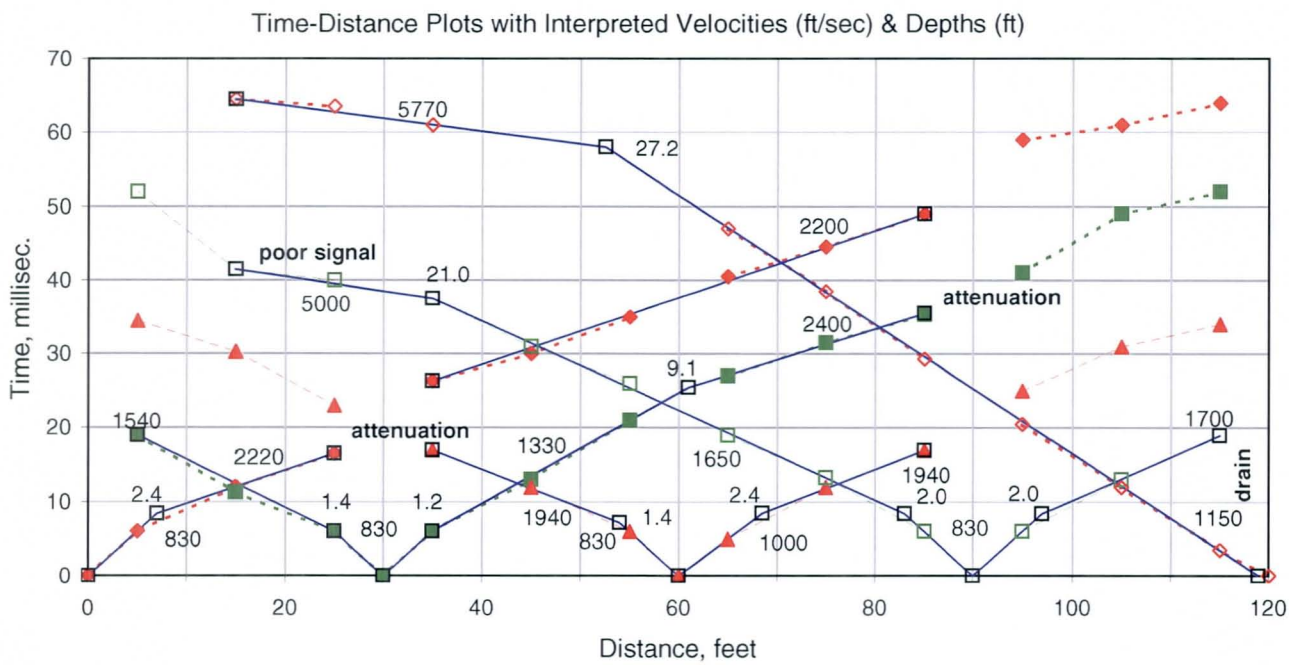

Interpretation of Refraction Seismic Data
West
East
ground
1300
1300
1100
air wave?
~2800
2500
approximate depth
of investigation
per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
Relative depth, feet
Distance, feet

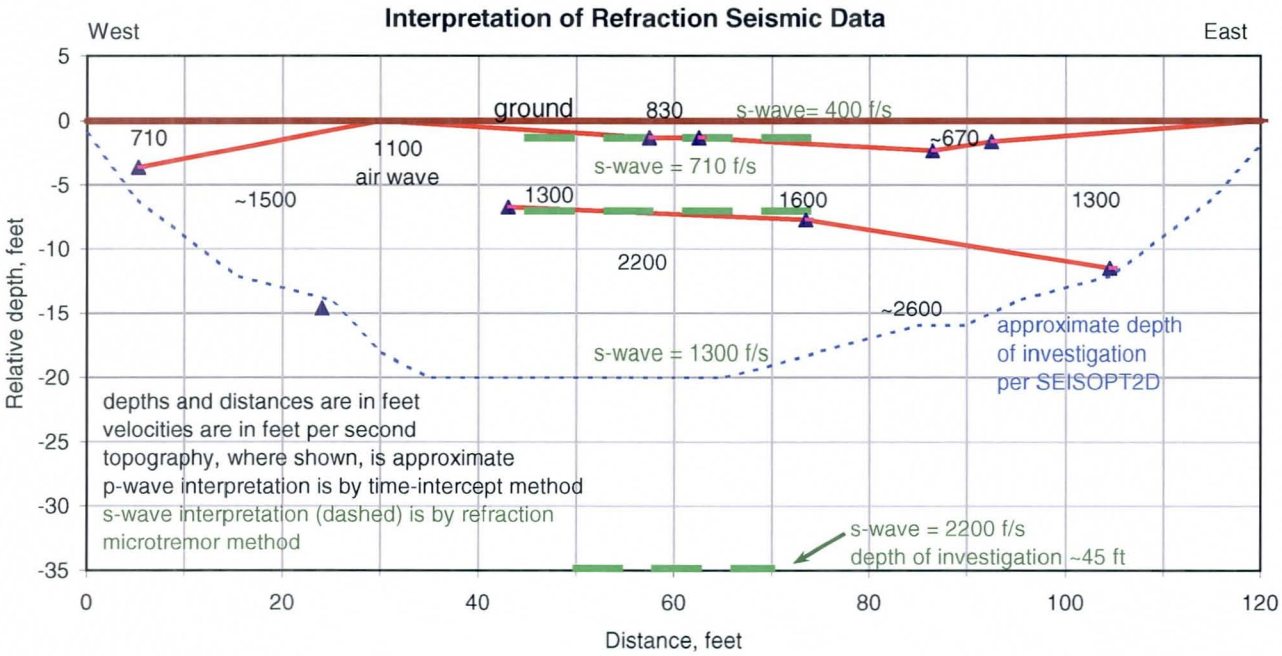

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
poor signal quality
1340
signal
loss
3040
2360
attenuation
2630
10.1
8.3
2310
2780
6.6
2200
1220
7.4
4.8
1130
air wave
1110
1400
1220
1430
1110
0.9
Time, millisec.
Distance, feet

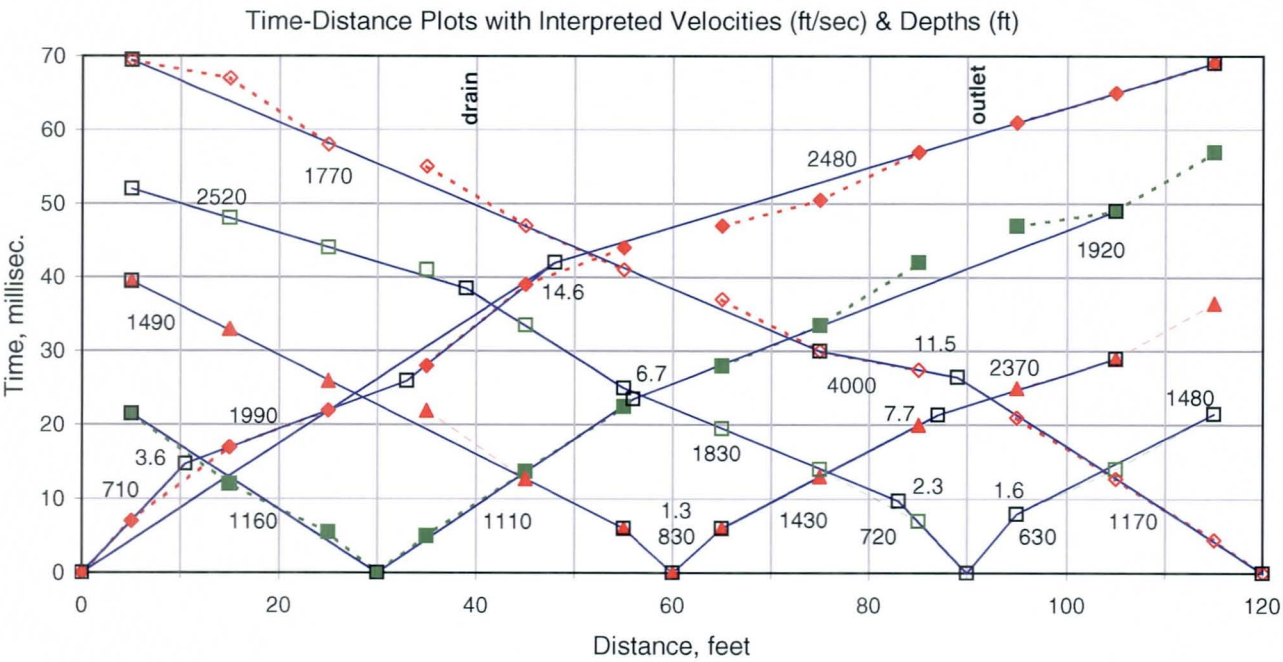

Interpretation of Refraction Seismic Data
West
East
ground
1100
1200
~1900 - 2000
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
approximate depth
of investigation
not determined
Relative depth, feet
Distance, feet
5
0
-5
-10
-15
-20
-25
-30
-35
0
20
40
60
80
100
120

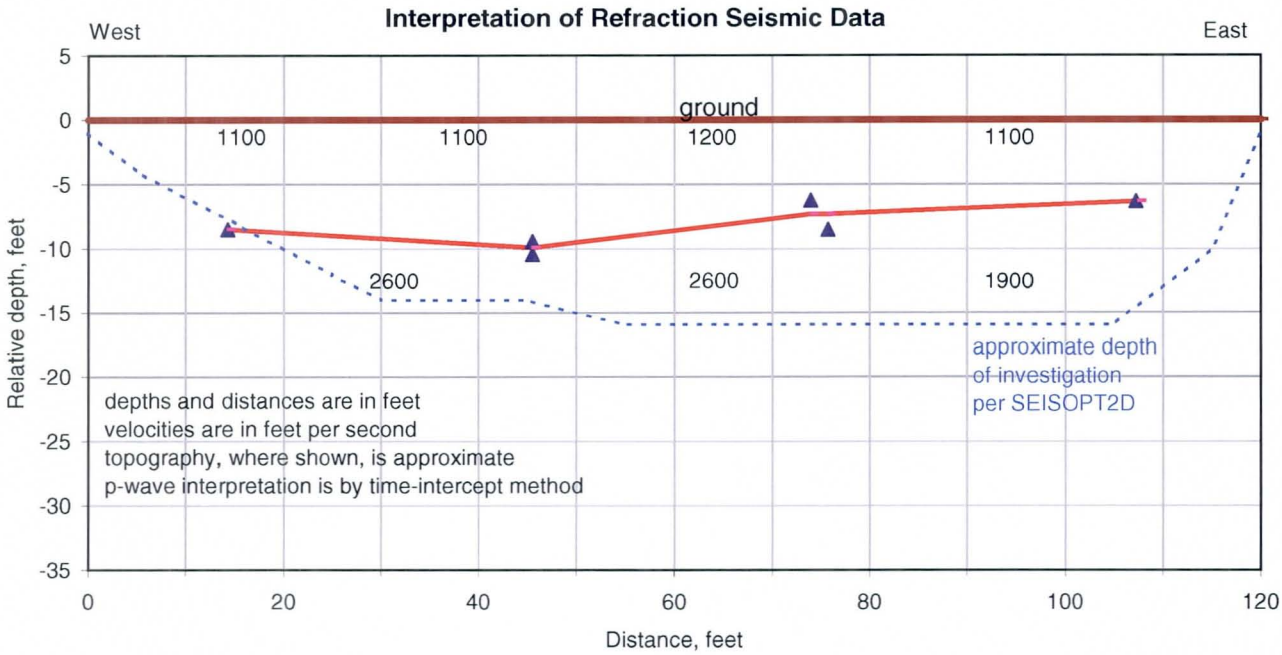

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
signal
loss
attenuation
signal loss
attenuation
1600
2110
2690
2250
7.3
3.1
1580
5.1
1140
1180
1130
1160
air wave
only
air wave
only
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120

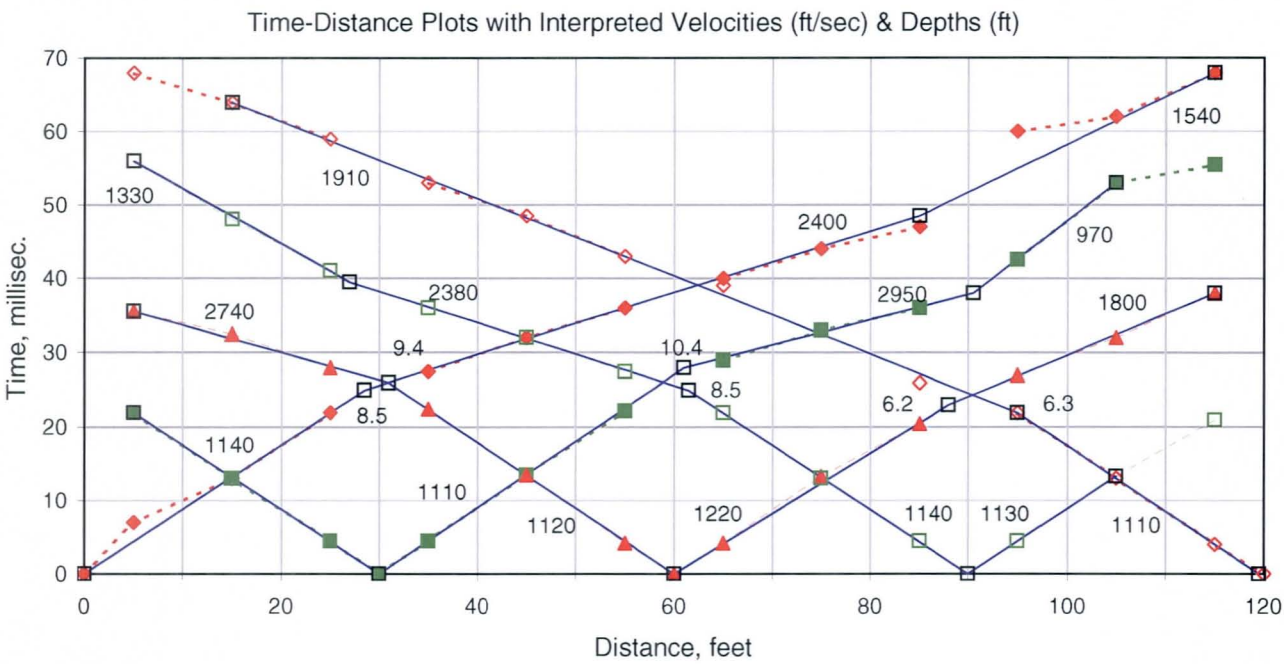

Interpretation of Refraction Seismic Data
West
East
s-wave = 500 f/s
ground
830
1800
1600
830
1000
1800
830
1300
drain
discontinuity
discontinuity
s-wave = 930 f/s
1150
air wave
approximate depth
of investigation
per SEISOPT2D
s-wave = 1600 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
~3200
s-wave = 2800 f/s
depth of investigation >120 ft
Relative depth, feet
Distance, feet

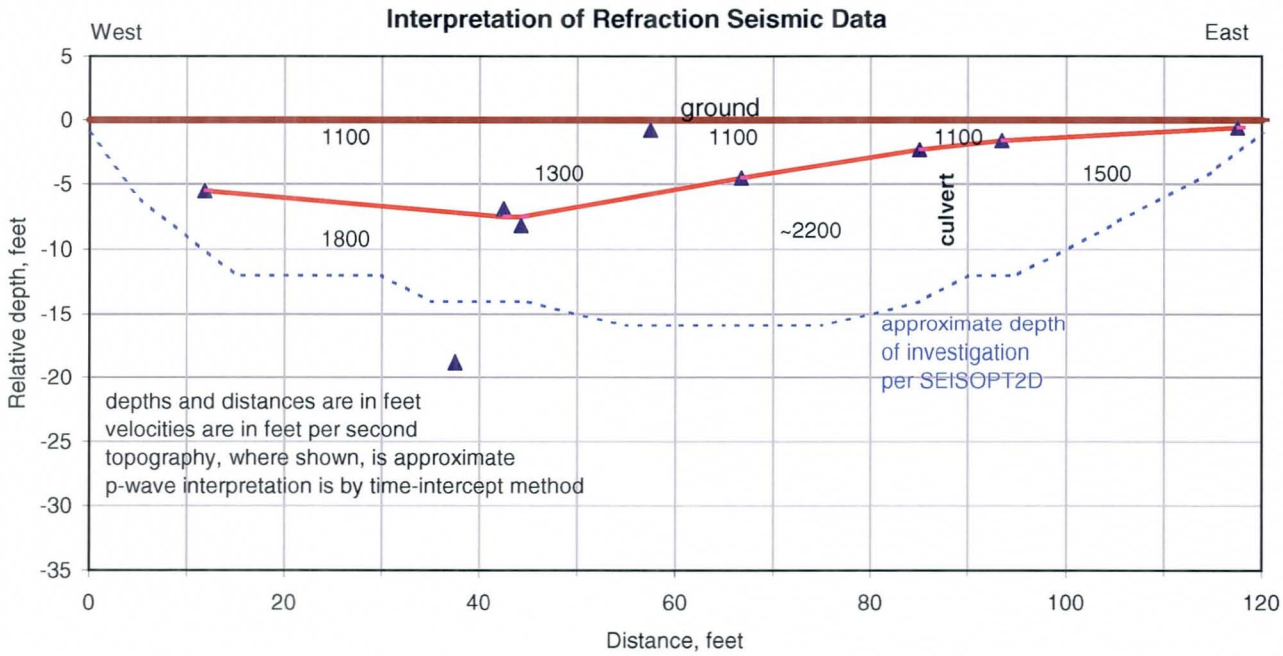

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
5770
27.2
2200
poor signal
21.0
5000
attenuation
2400
9.1
1540
attenuation
2220
1330
1650
1940
1700
drain
2.4
830
1.4
830
1.2
1940
830
1.4
2.4
1000
2.0
830
2.0
1150
Time, millisec.
Distance, feet

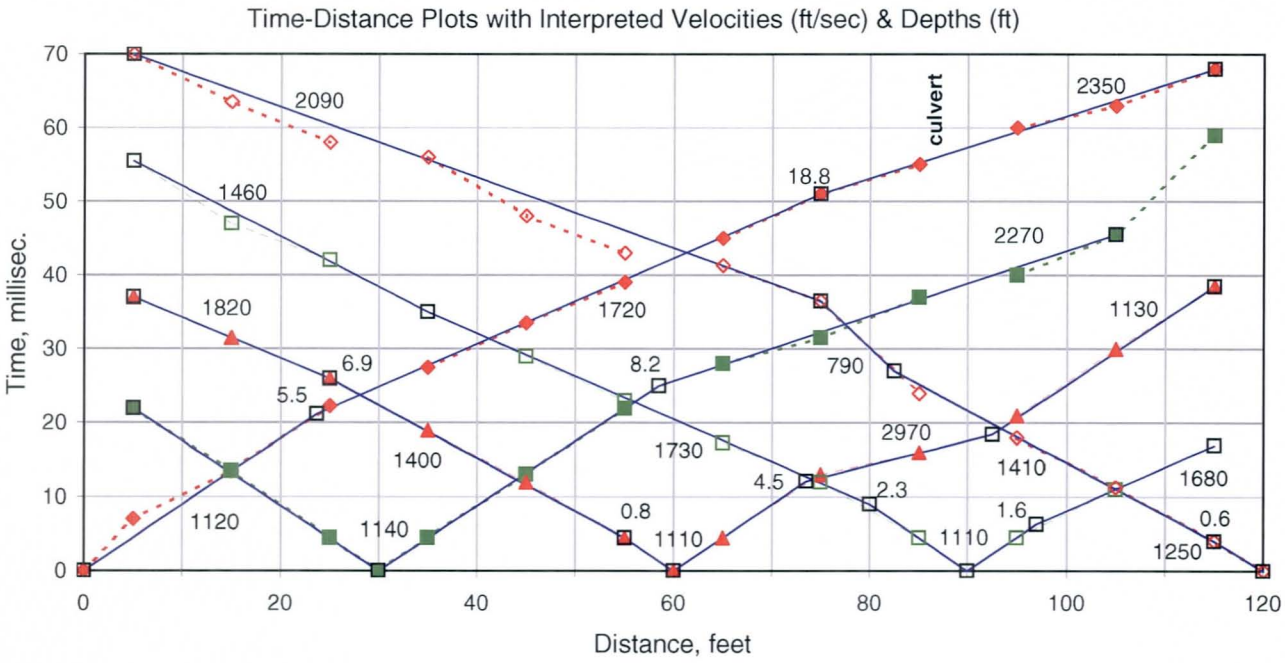

Interpretation of Refraction Seismic Data
West
East
ground
830
s-wave= 400 f/s
710
1100
air wave
~670
s-wave = 710 f/s
~1500
1300
1600
1300
2200
~2600
approximate depth
of investigation
per SEISOPT2D
s-wave = 1300 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
s-wave = 2200 f/s
depth of investigation ~45 ft
Relative depth, feet
Distance, feet

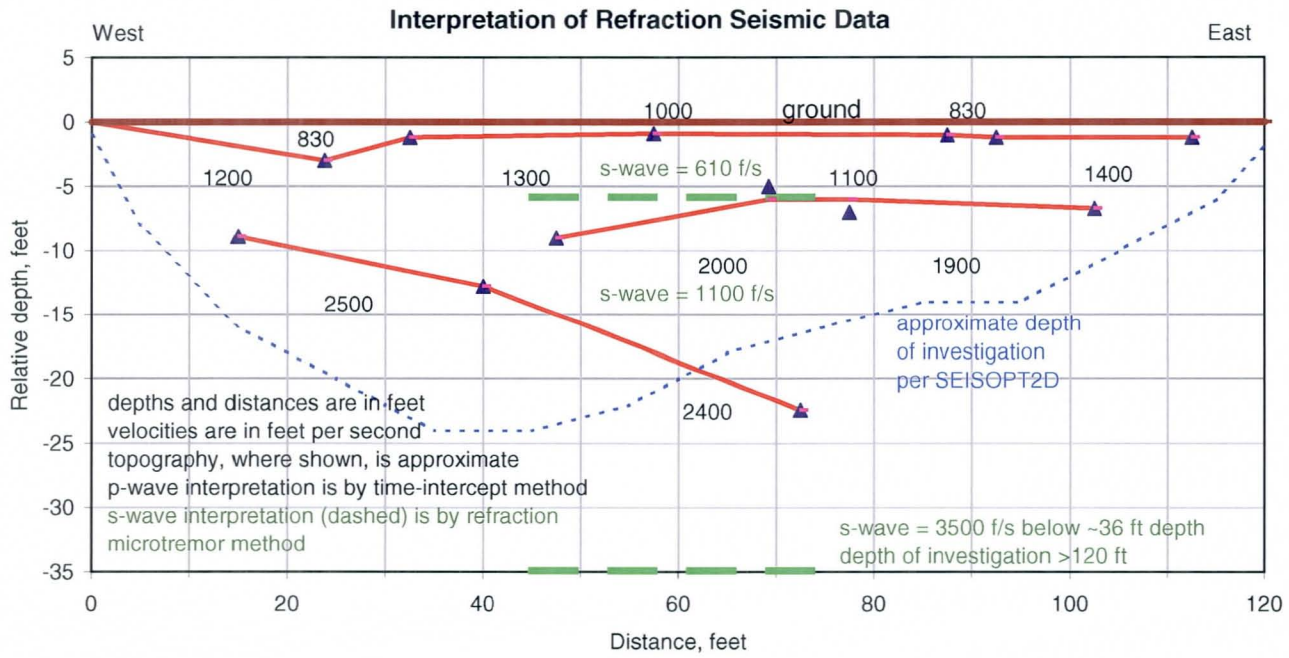

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
drain
outlet
1770
2520
2480
1920
14.6
1490
11.5
6.7
2370
4000
1990
7.7
1480
3.6
1830
710
2.3
1.6
1.3
1160
1110
830
1430
720
630
1170
Time, millisec.
Distance, feet

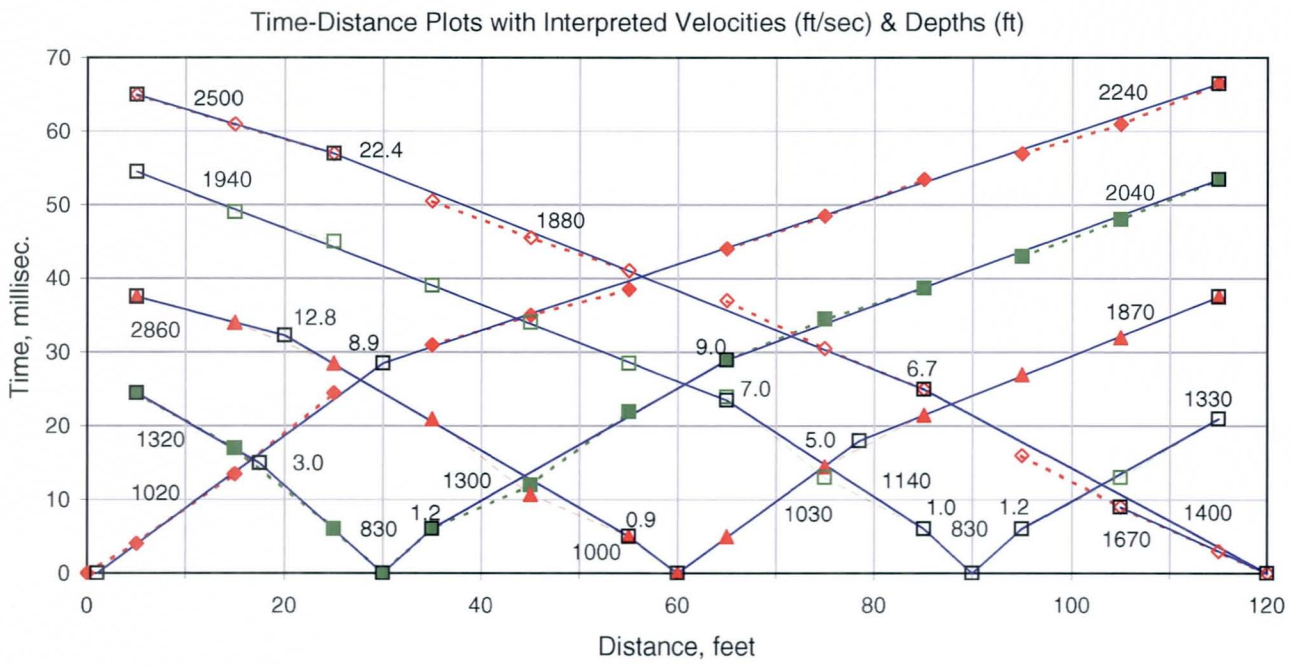

Interpretation of Refraction Seismic Data
West
East
ground
1100
1100
1200
1100
2600
2600
1900
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
Relative depth, feet
Distance, feet

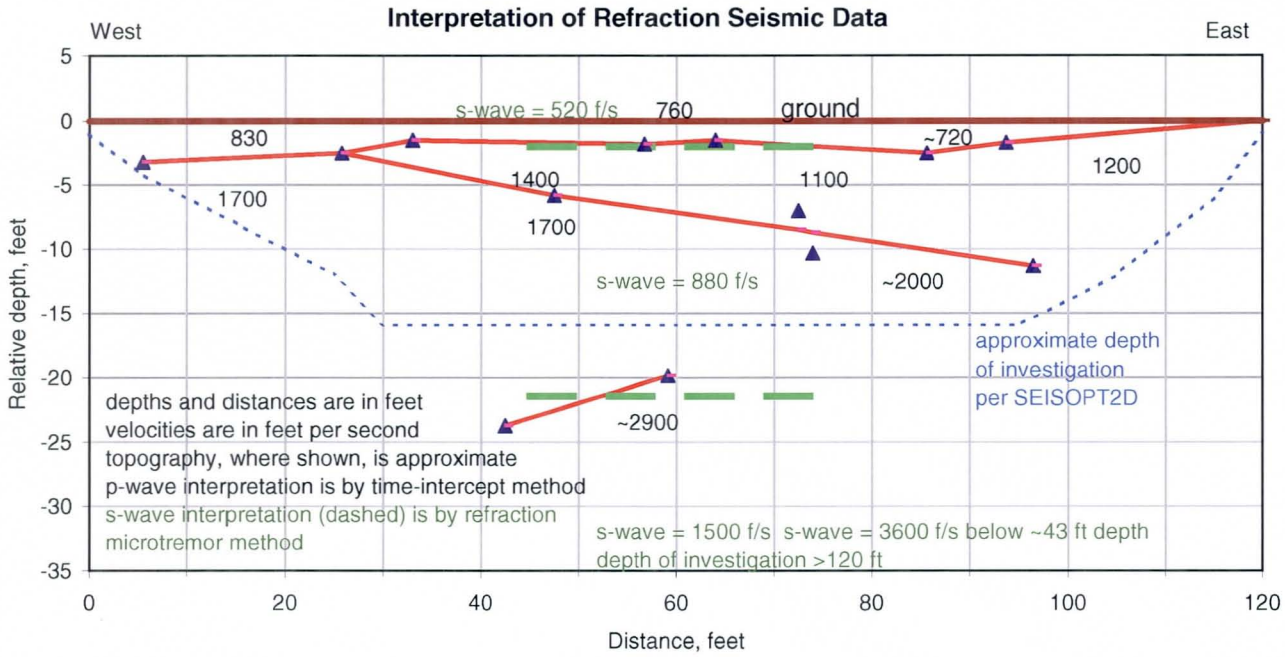

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
1910
1330
2380
2740
1140
1110
1120
1220
1140
1130
1110
2400
2950
1540
970
1800
9.4
8.5
10.4
8.5
6.2
6.3
Time, millisec.
Distance, feet

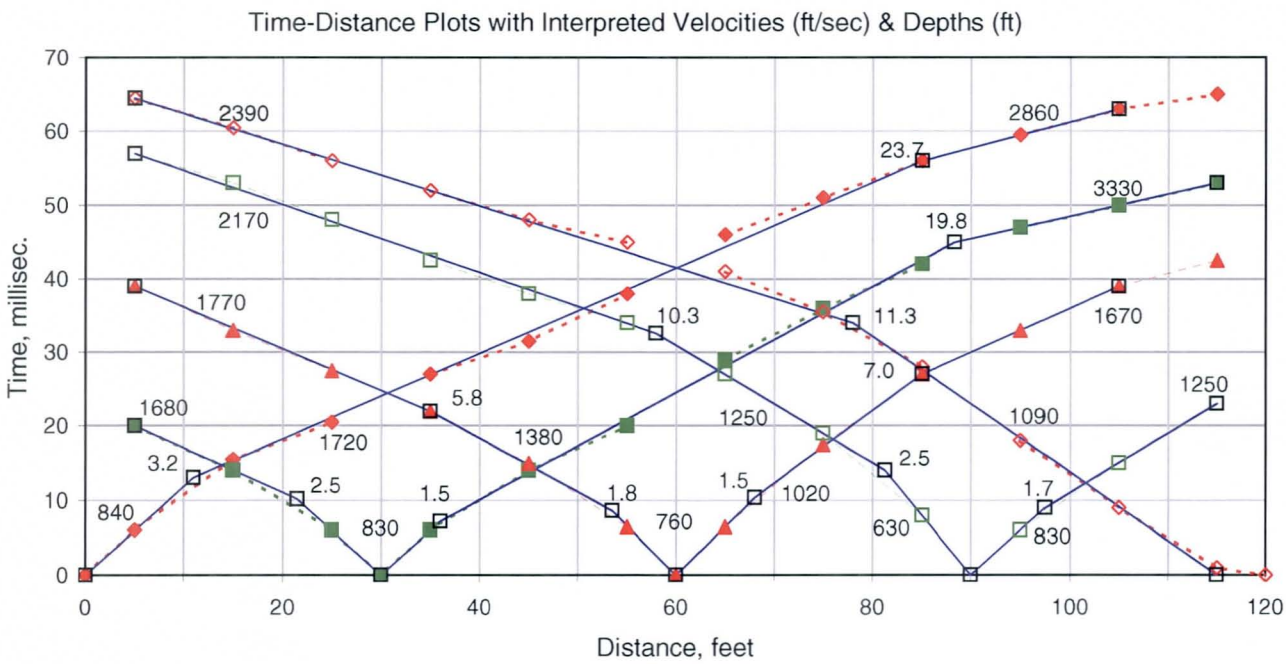

Interpretation of Refraction Seismic Data
West
East
ground
1100
1100
1100
1300
1500
1800
~2200
culvert
approximate depth
of investigation
per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
Relative depth, feet
Distance, feet

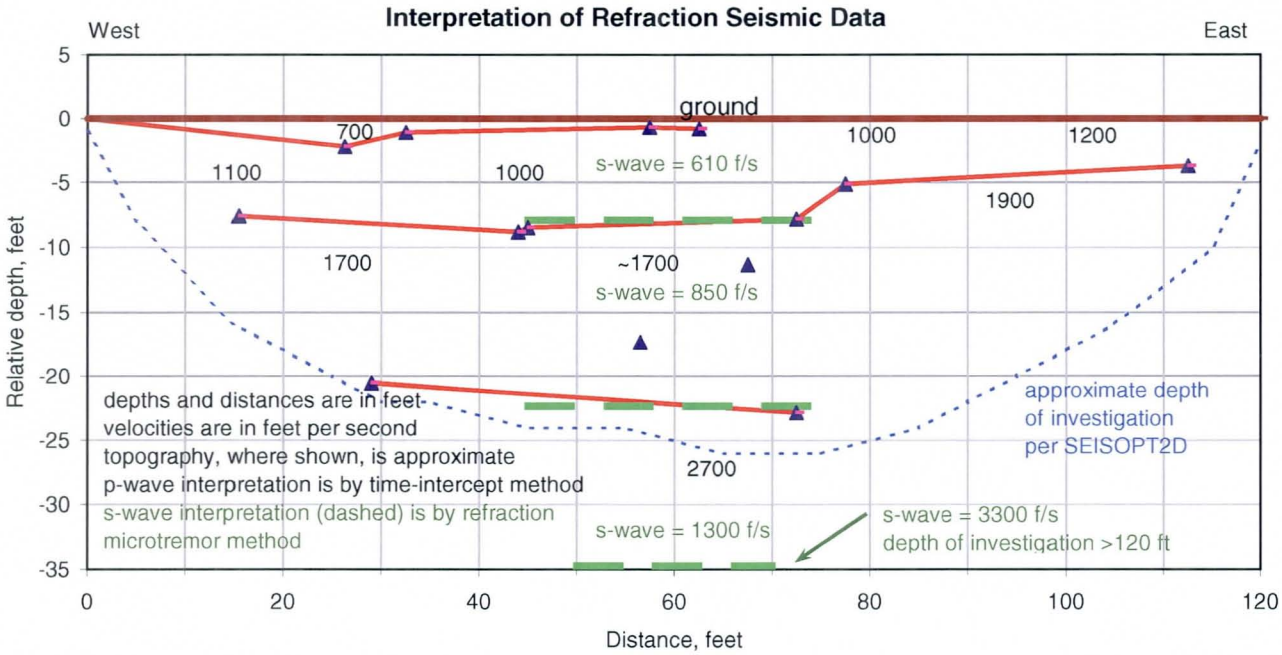

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2090
1460
1820
1120
1140
1400
1720
1730
1110
790
2970
1410
1130
1680
1250
2350
2270
culvert
18.8
6.9
5.5
8.2
4.5
2.3
1.6
0.8
0.6
Time, millisec.
Distance, feet

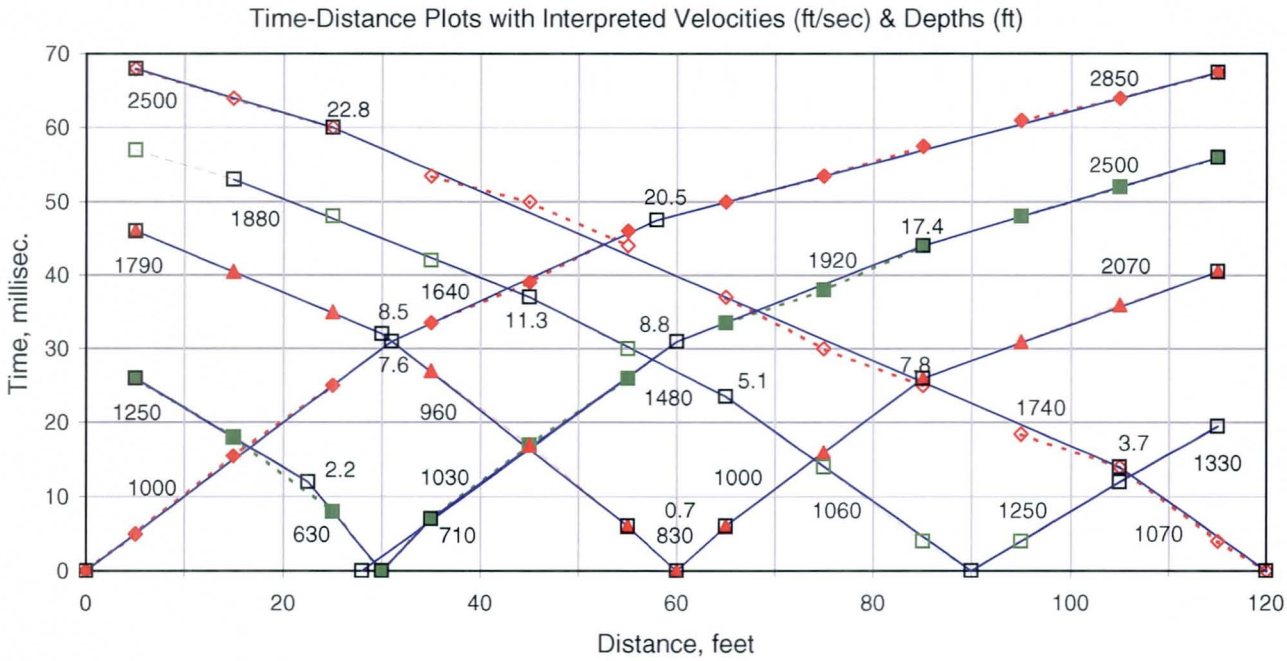

Interpretation of Refraction Seismic Data
West
East
ground
1000
830
830
1200
1300
s-wave = 610 f/s
1100
1400
2000
1900
2500
s-wave = 1100 f/s
approximate depth
of investigation
per SEISOPT2D
2400
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
s-wave = 3500 f/s below ~36 ft depth
depth of investigation >120 ft
Relative depth, feet
Distance, feet

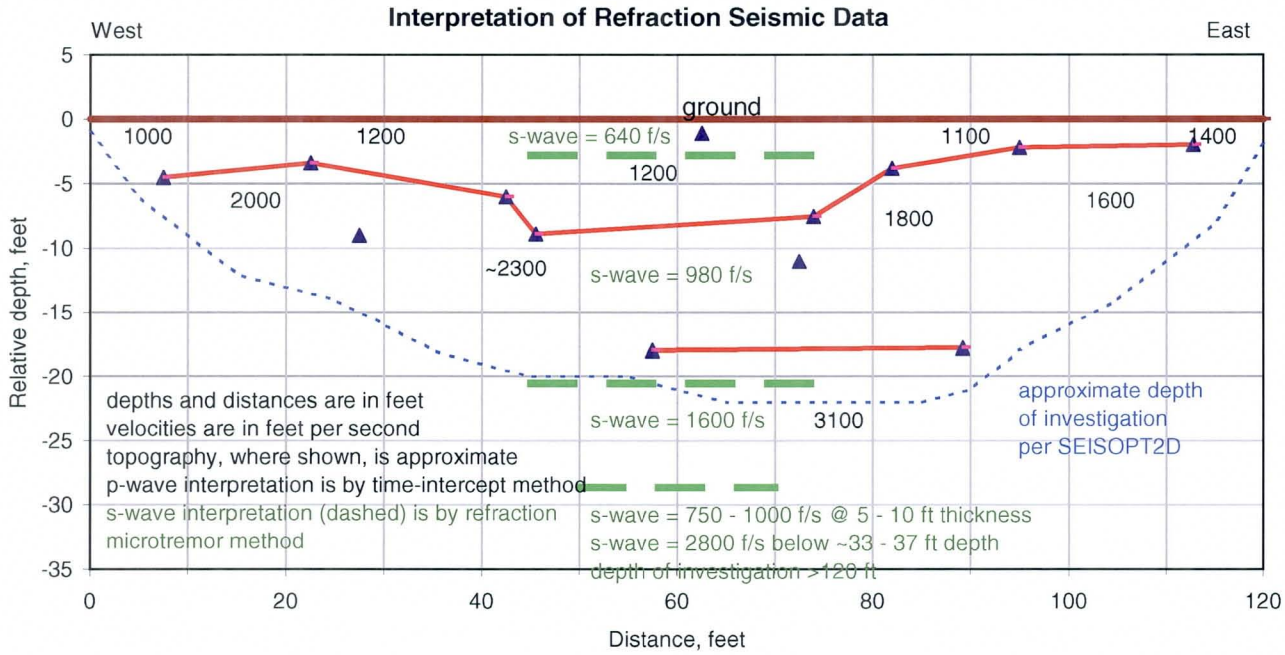

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2500
22.4
1940
1880
2240
2040
2860
12.8
8.9
9.0
7.0
6.7
1870
1330
1320
3.0
5.0
1020
1300
1140
830
1.2
0.9
1030
1.0
830
1.2
1400
1000
1670
Time, millisec.
Distance, feet

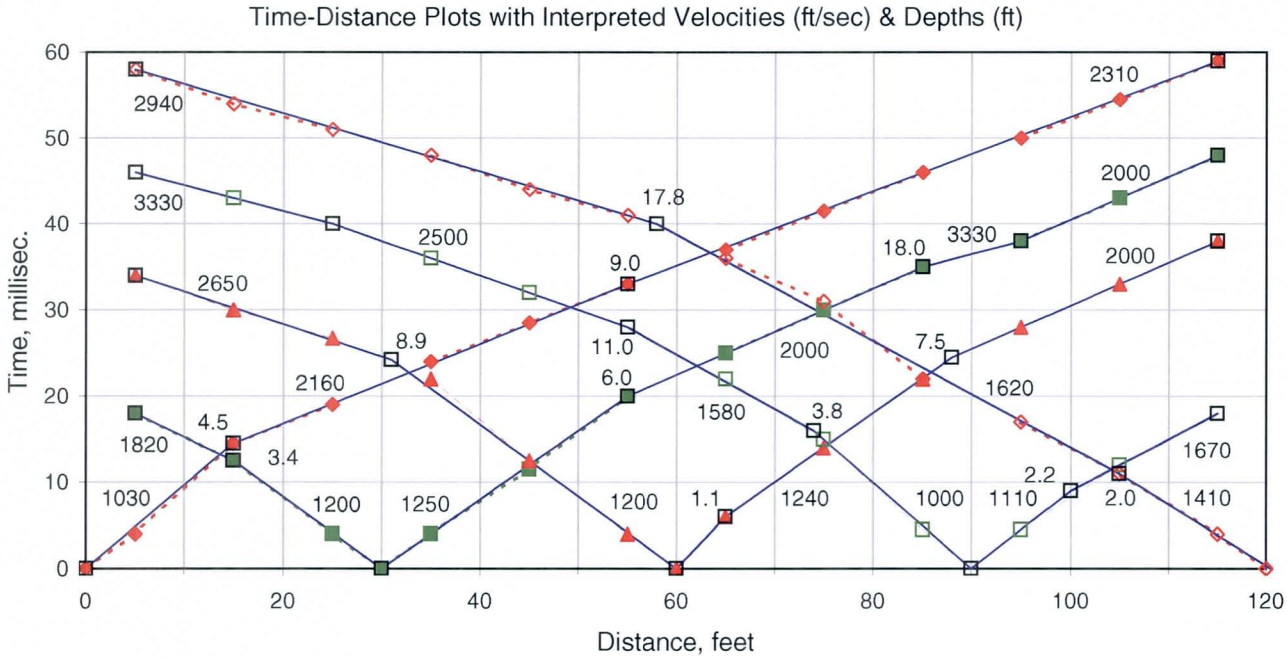

Interpretation of Refraction Seismic Data
West
East
ground
s-wave = 520 f/s
760
830
~720
1200
1400
1100
1700
1700
s-wave = 880 f/s
~2000
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
~2900
s-wave = 1500 f/s
s-wave = 3600 f/s below ~43 ft depth
depth of investigation >120 ft
Relative depth, feet
Distance, feet

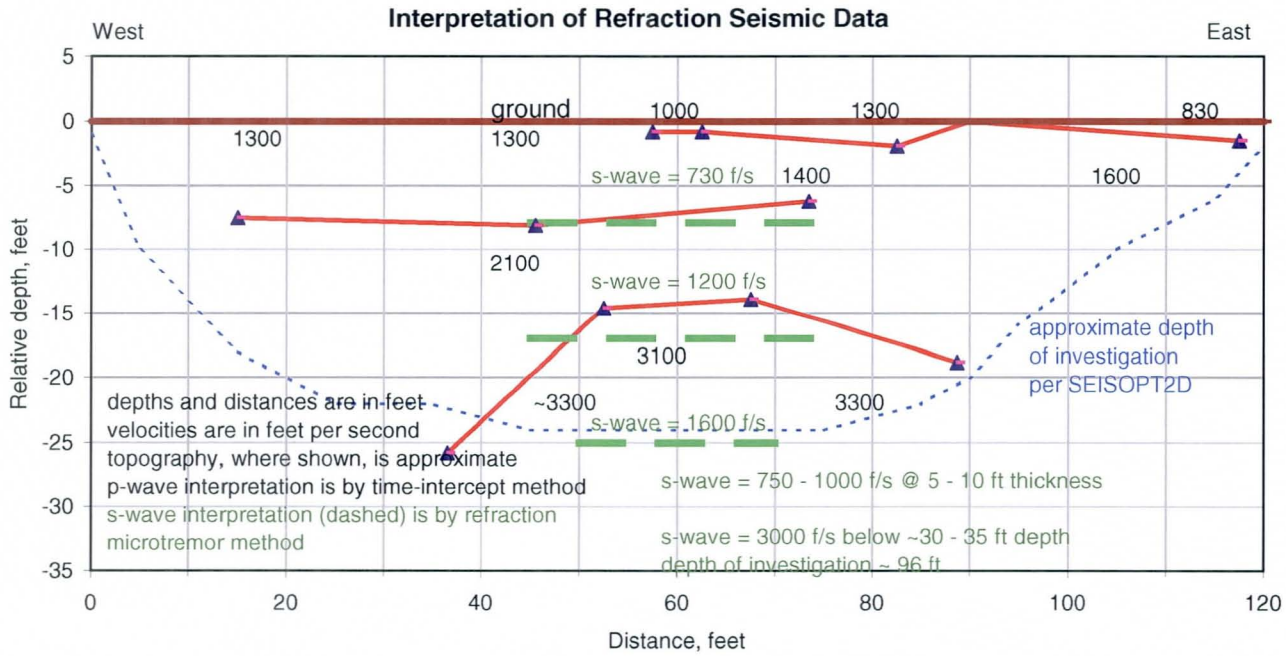

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2390
2860
23.7
3330
2170
19.8
1770
10.3
11.3
1670
7.0
1680
5.8
1250
1250
1090
1720
1380
3.2
2.5
2.5
1.5
1.8
1.5
1020
1.7
840
830
760
630
830
Time, millisec.
Distance, feet

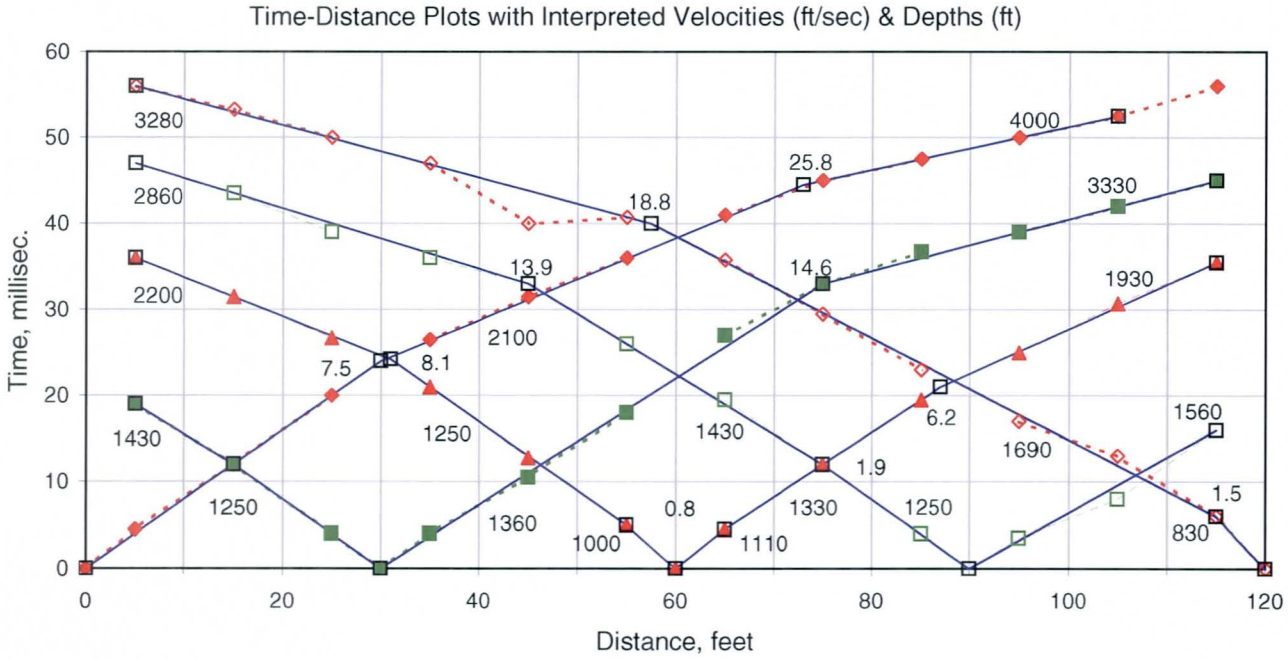

Interpretation of Refraction Seismic Data
West
East
ground
700
1000
1200
1100
1000
s-wave = 610 f/s
1900
1700
~1700
s-wave = 850 f/s
depths and distances are in feet-
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
2700
s-wave = 1300 f/s
s-wave = 3300 f/s
depth of investigation >120 ft
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

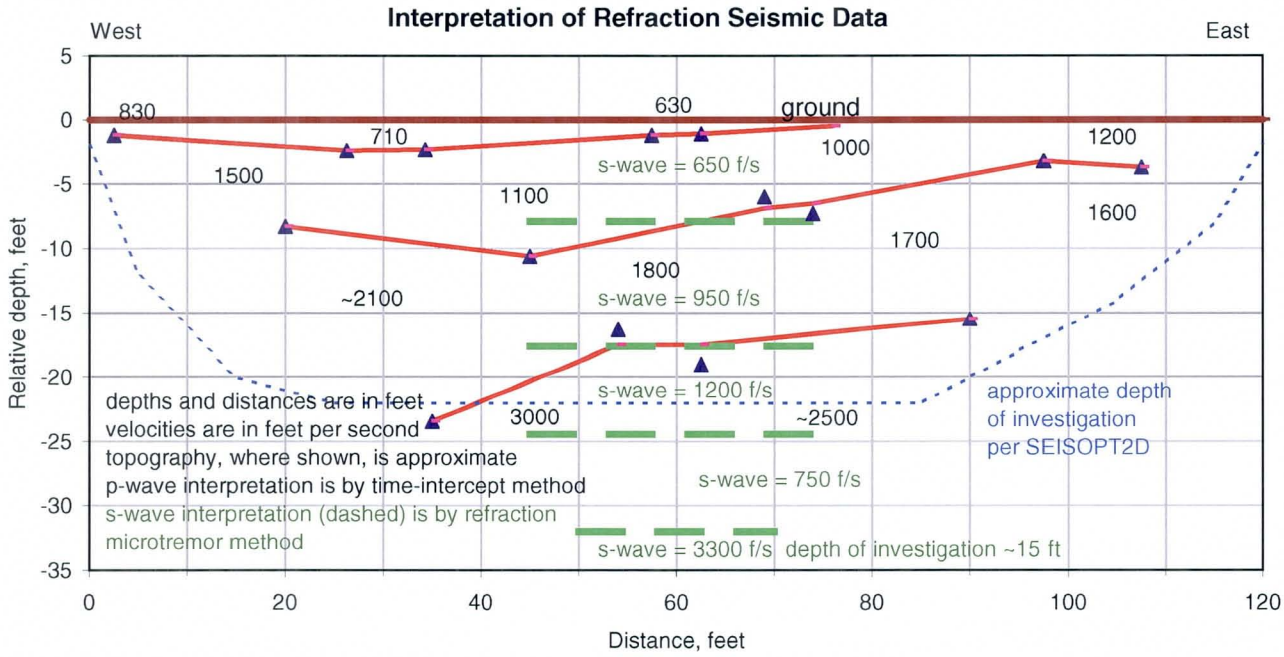

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2500
22.8
2850
1880
20.5
2500
17.4
1790
1920
2070
1640
8.5
11.3
8.8
7.6
7.8
5.1
1250
960
1480
1740
3.7
1330
2.2
1030
1000
1000
0.7
1060
1250
630
710
830
1070
Time, millisec.
Distance, feet

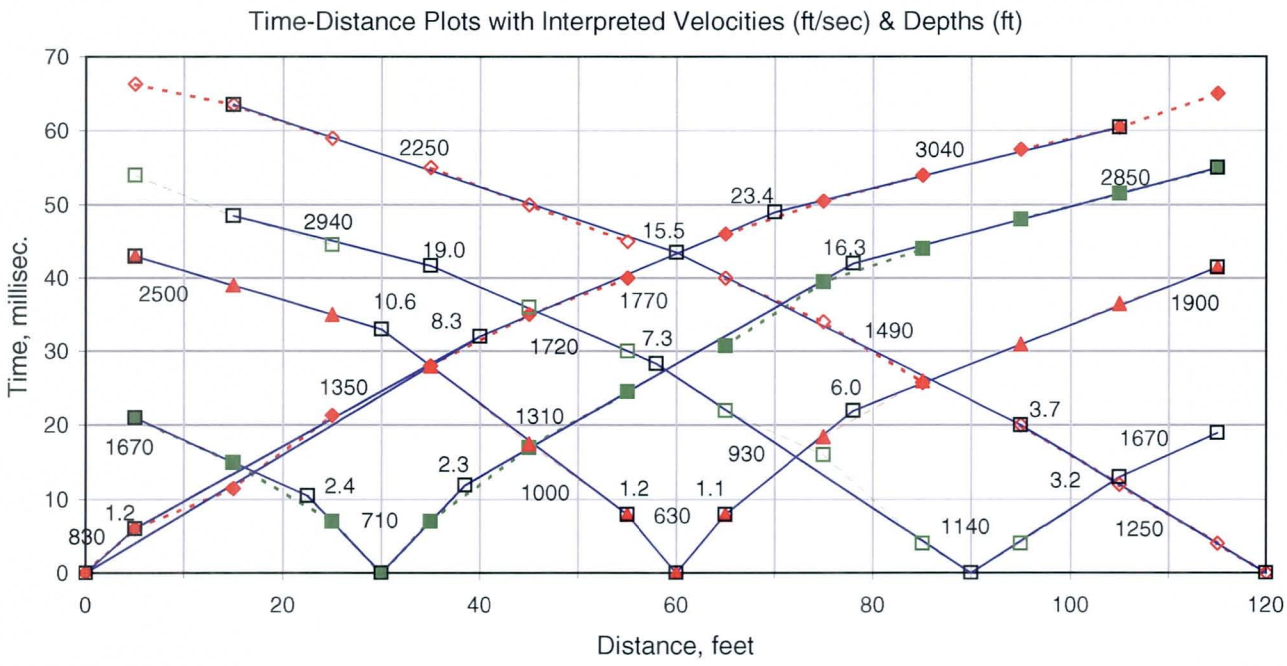

Interpretation of Refraction Seismic Data
West
East
ground
1000
1200
1100
1400
2000
1200
1800
1600
~2300
s-wave = 640 f/s
s-wave = 980 f/s
s-wave = 1600 f/s
3100
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 750 - 1000 f/s @ 5 - 10 ft thickness
s-wave = 2800 f/s below ~33 - 37 ft depth
depth of investigation >120 ft
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

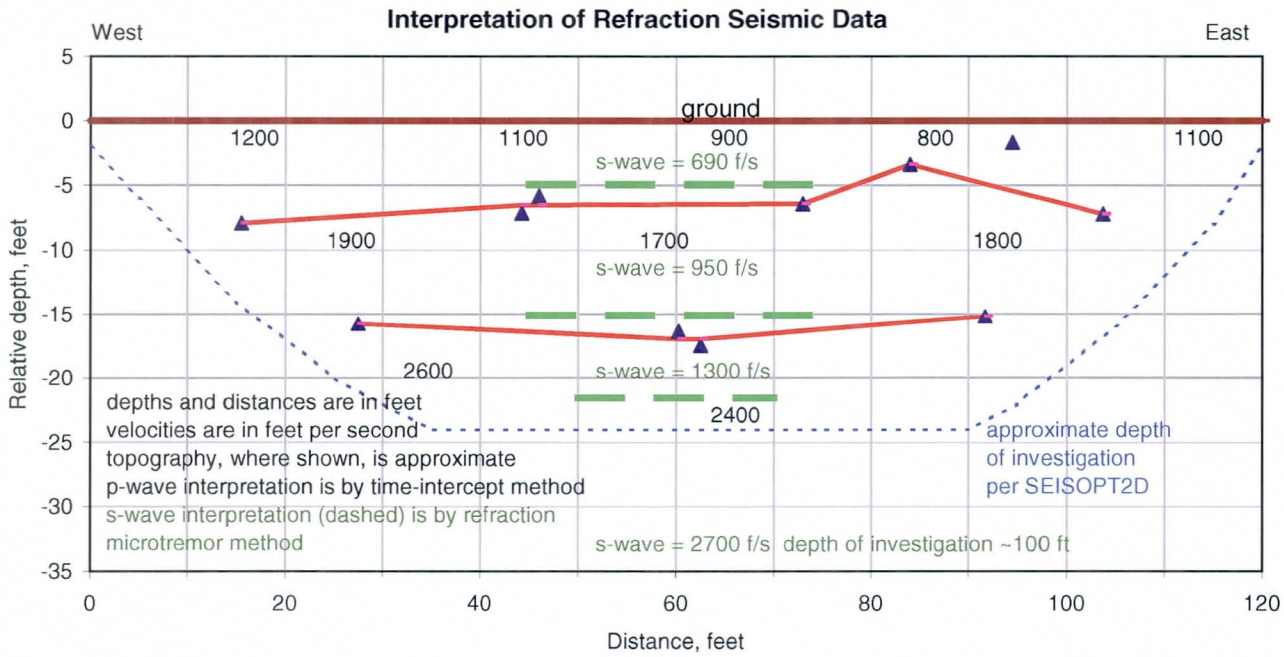

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2940
2310
3330
17.8
2000
2500
9.0
18.0
3330
2650
2000
8.9
11.0
2000
7.5
2160
6.0
1620
4.5
1580
3.8
1820
3.4
1670
2.2
1030
1200
1250
1200
1.1
1240
1000
1110
2.0
1410
Time, millisec.
Distance, feet

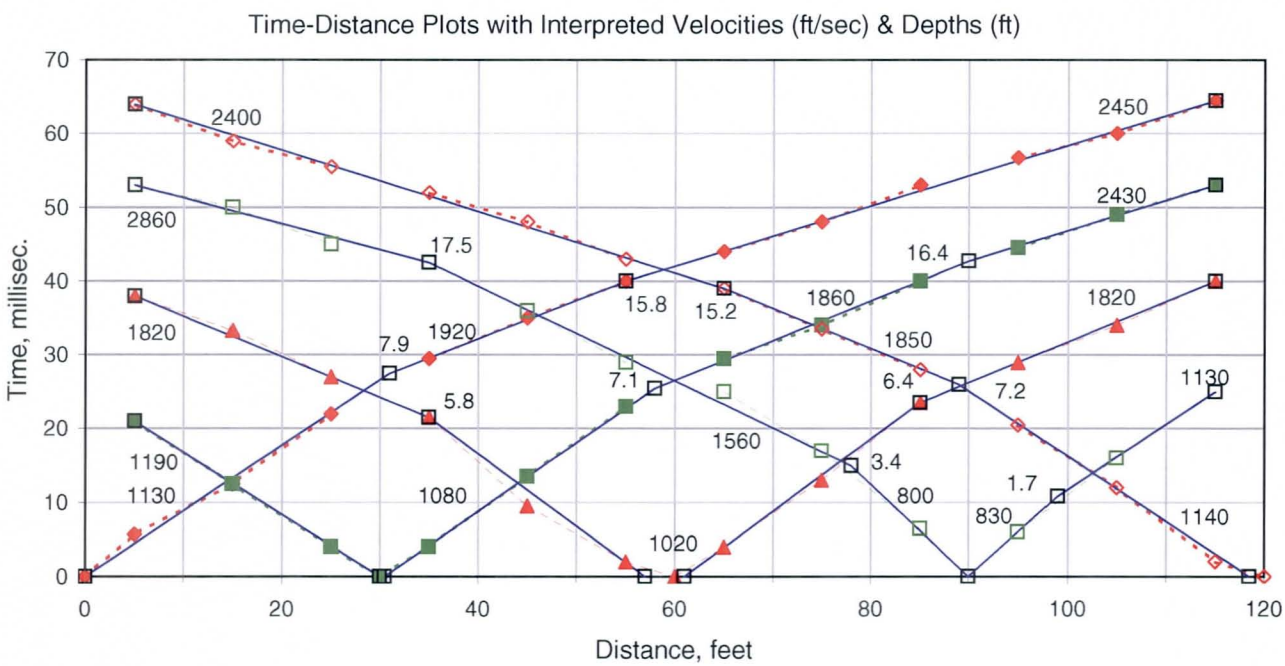

Interpretation of Refraction Seismic Data
West
East
ground
1300
1000
1300
830
1300
s-wave = 730 f/s
1400
1600
2100
s-wave = 1200 f/s
3100
approximate depth of investigation per SEISOPT2D
~3300
3300
s-wave = 1600 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 750 - 1000 f/s @ 5 - 10 ft thickness
s-wave = 3000 f/s below ~30 - 35 ft depth
depth of investigation ~ 96 ft
Relative depth, feet
Distance, feet

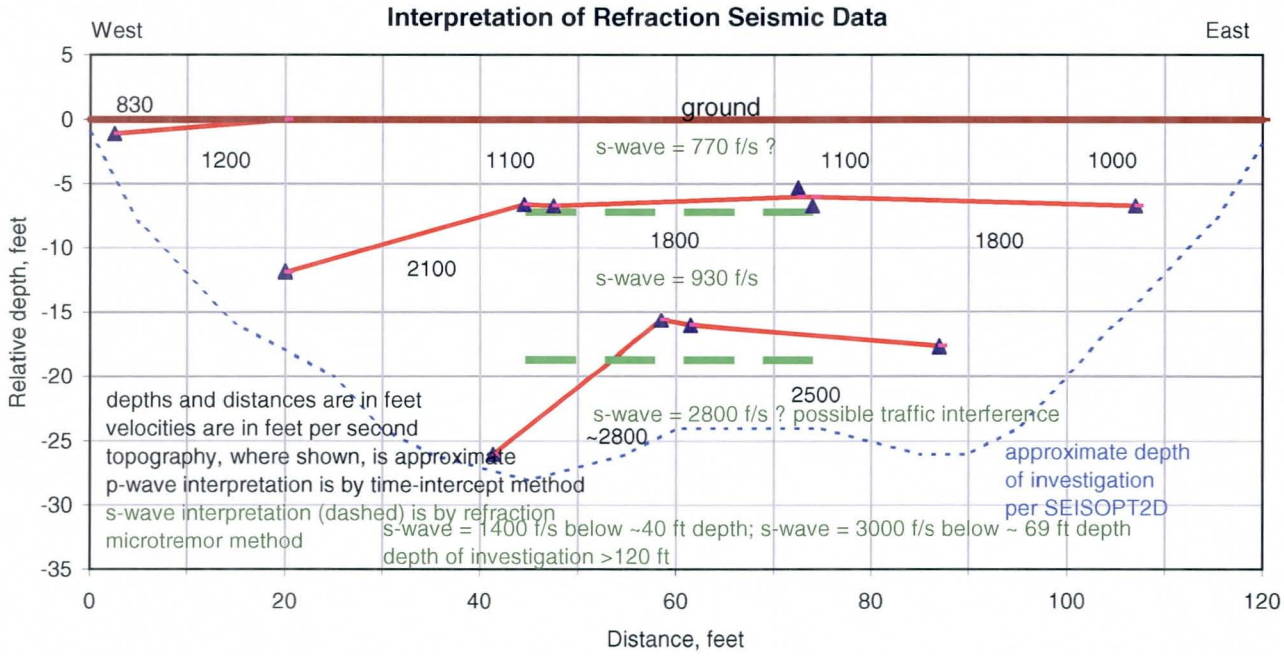

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3280
2860
2200
1430
1250
7.5
8.1
2100
1250
1360
13.9
18.8
1000
0.8
1430
25.8
14.6
1110
1330
1.9
6.2
1250
4000
1690
3330
1930
1560
1.5
830
Time, millisec.
Distance, feet

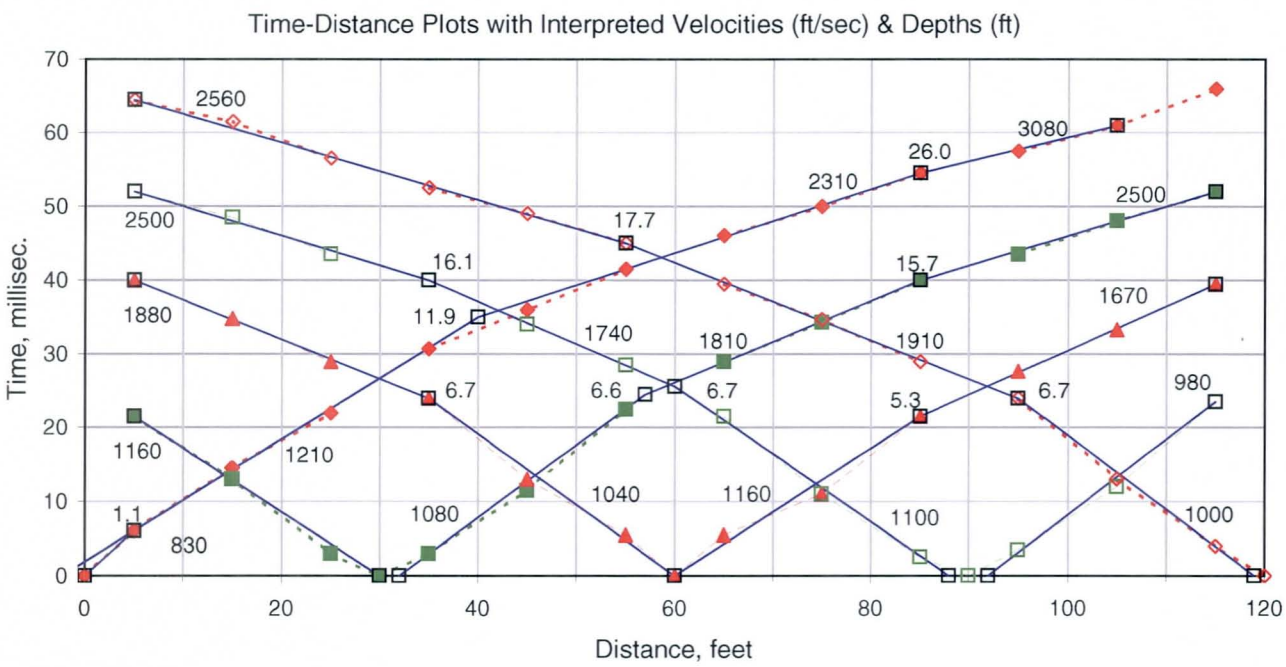

Interpretation of Refraction Seismic Data
West
East
ground
830
710
630
1000
1200
1500
1100
1600
1700
1800
~2100
3000
~2500
s-wave = 650 f/s
s-wave = 950 f/s
s-wave = 1200 f/s
s-wave = 750 f/s
s-wave = 3300 f/s depth of investigation ~15 ft
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

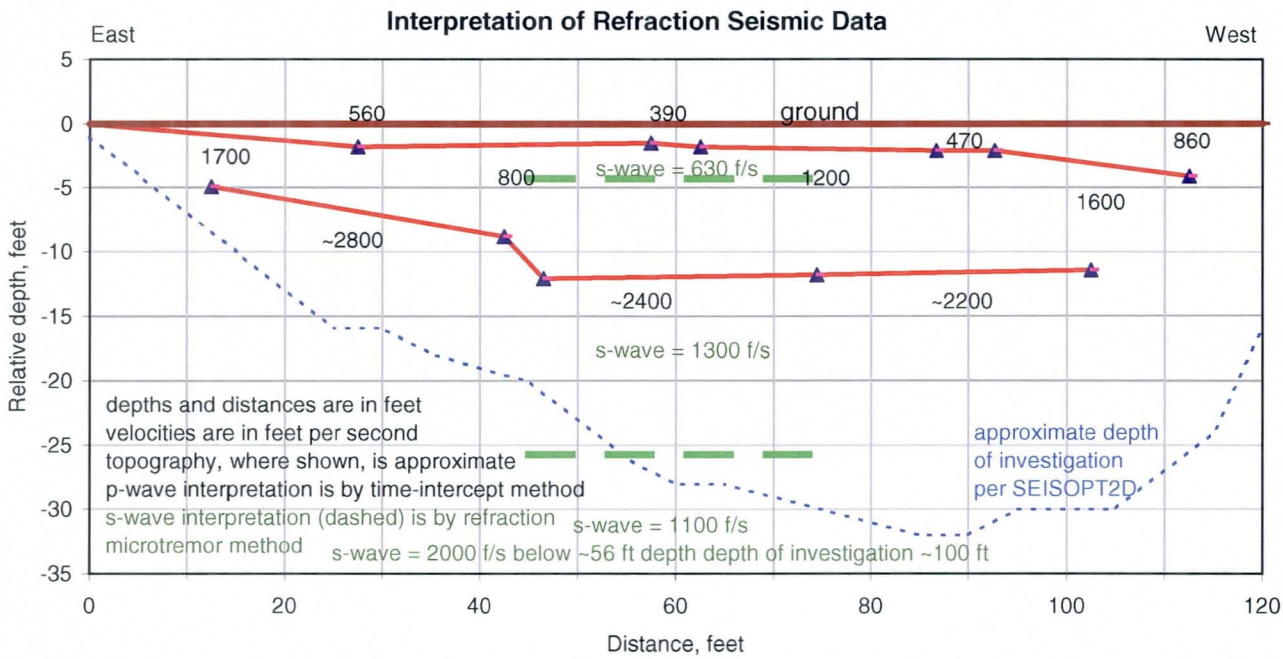

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
2250
3040
2850
2940
23.4
15.5
19.0
16.3
2500
10.6
8.3
1770
1490
1900
1720
7.3
1350
6.0
3.7
1310
1670
930
1670
2.3
2.4
1000
1.2
1.1
3.2
1.2
710
630
1140
1250
830

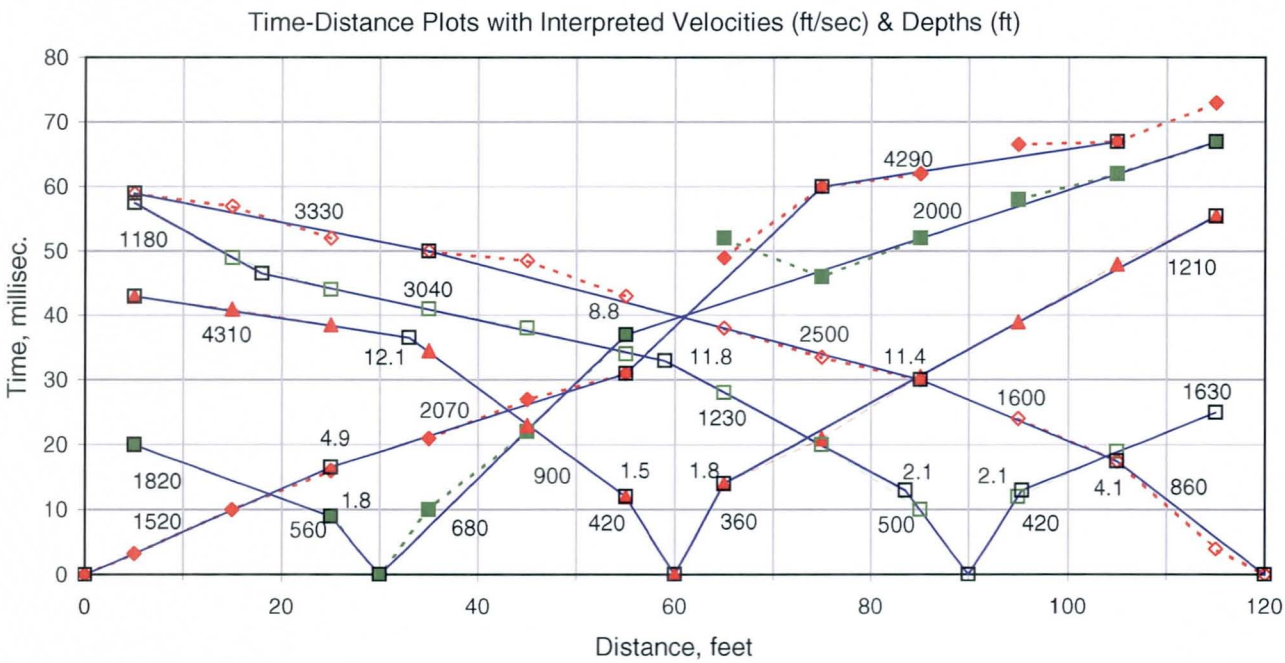

Interpretation of Refraction Seismic Data
West
East
ground
1200
1100
900
800
1100
s-wave = 690 f/s
1900
1700
1800
s-wave = 950 f/s
2600
s-wave = 1300 f/s
2400
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
s-wave = 2700 f/s depth of investigation ~100 ft
Relative depth, feet
Distance, feet

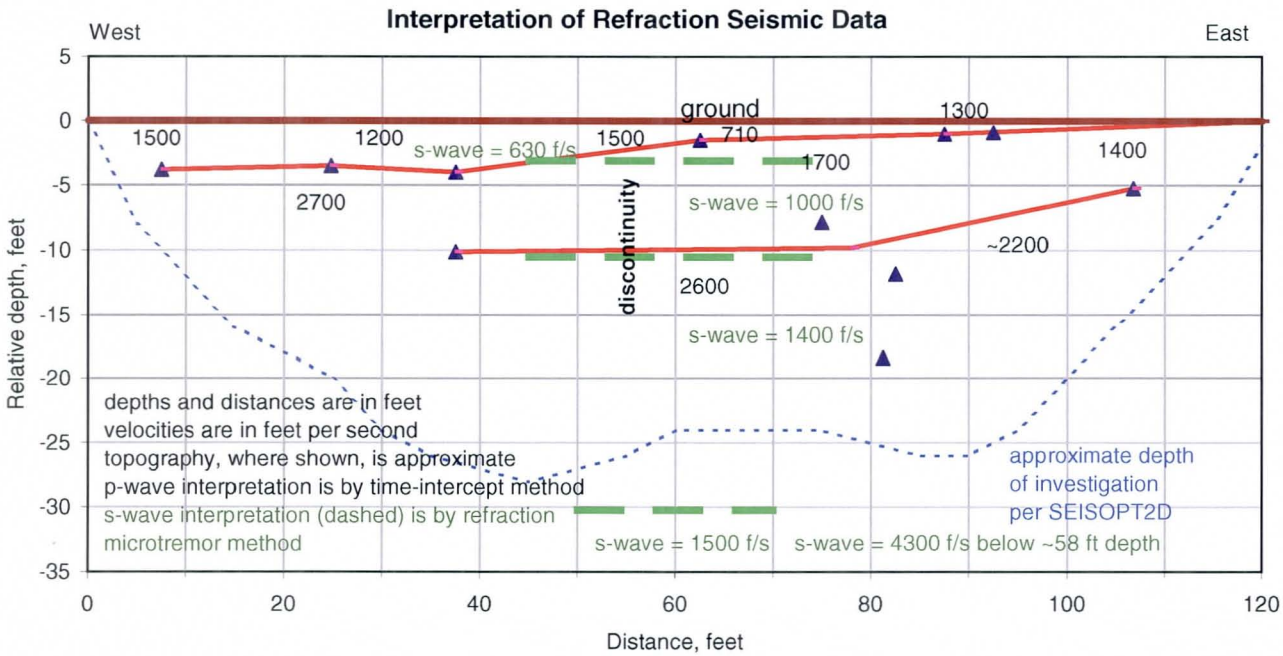

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2400
2450
2860
2430
17.5
16.4
15.8
15.2
1860
1820
1820
7.9
1920
1850
7.1
6.4
7.2
1130
5.8
1560
3.4
1190
1130
1080
800
1.7
830
1140
1020
Time, millisec.
Distance, feet

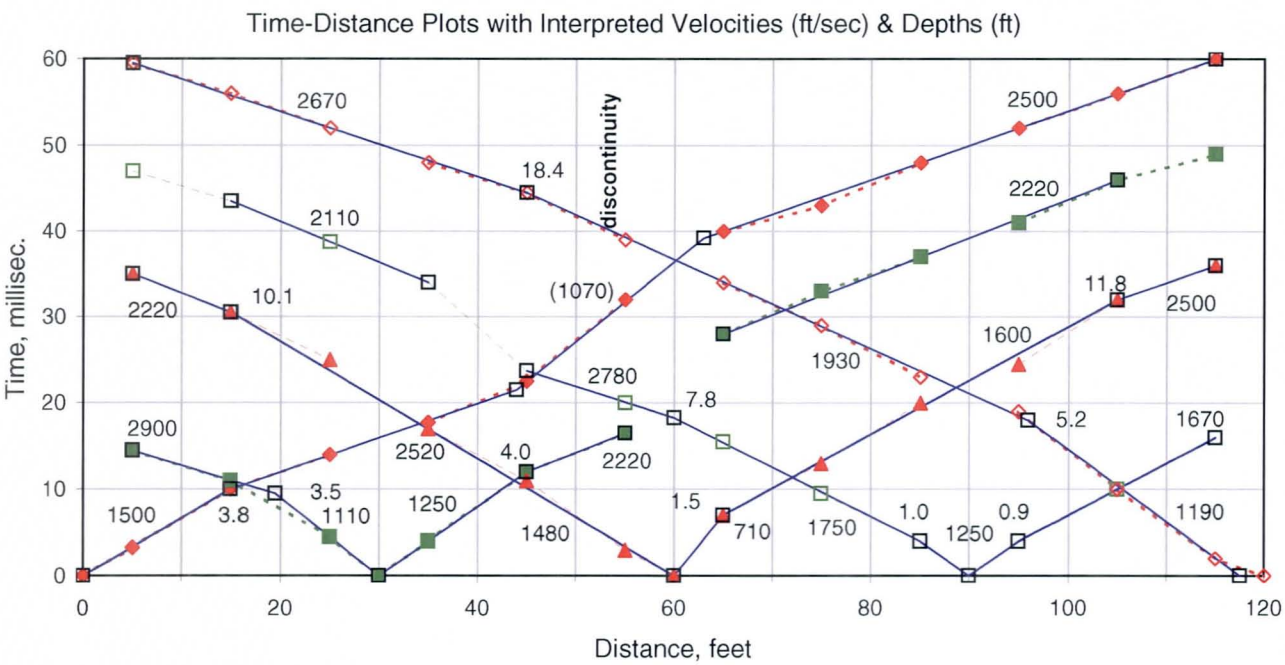

Interpretation of Refraction Seismic Data
West
East
ground
830
1200
1100
1100
1000
s-wave = 770 f/s ?
2100
1800
1800
s-wave = 930 f/s
2500
~2800
s-wave = 2800 f/s ? possible traffic interference
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 1400 f/s below ~40 ft depth; s-wave = 3000 f/s below ~ 69 ft depth
depth of investigation >120 ft
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

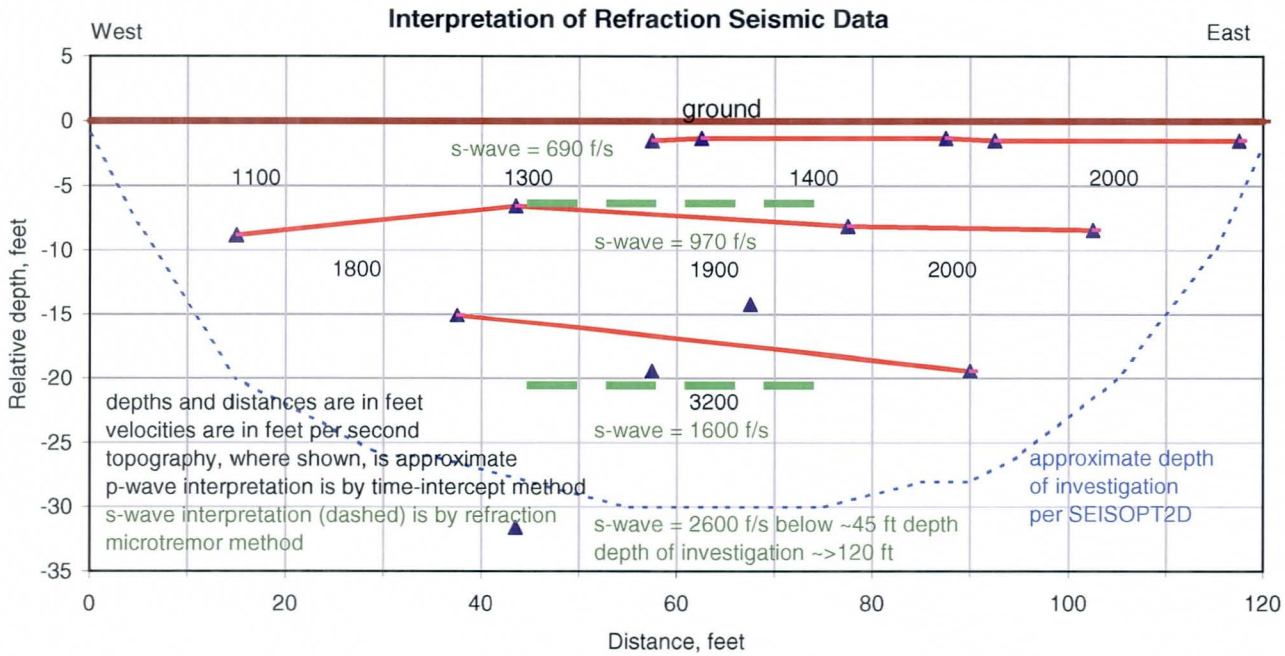

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2560
2500
1880
1160
830
1.1
1210
16.1
11.9
6.7
1080
17.7
1740
6.6
1040
2310
1810
6.7
1160
26.0
15.7
1910
5.3
1100
3080
2500
1670
6.7
980
1000
Time, millisec.
Distance, feet

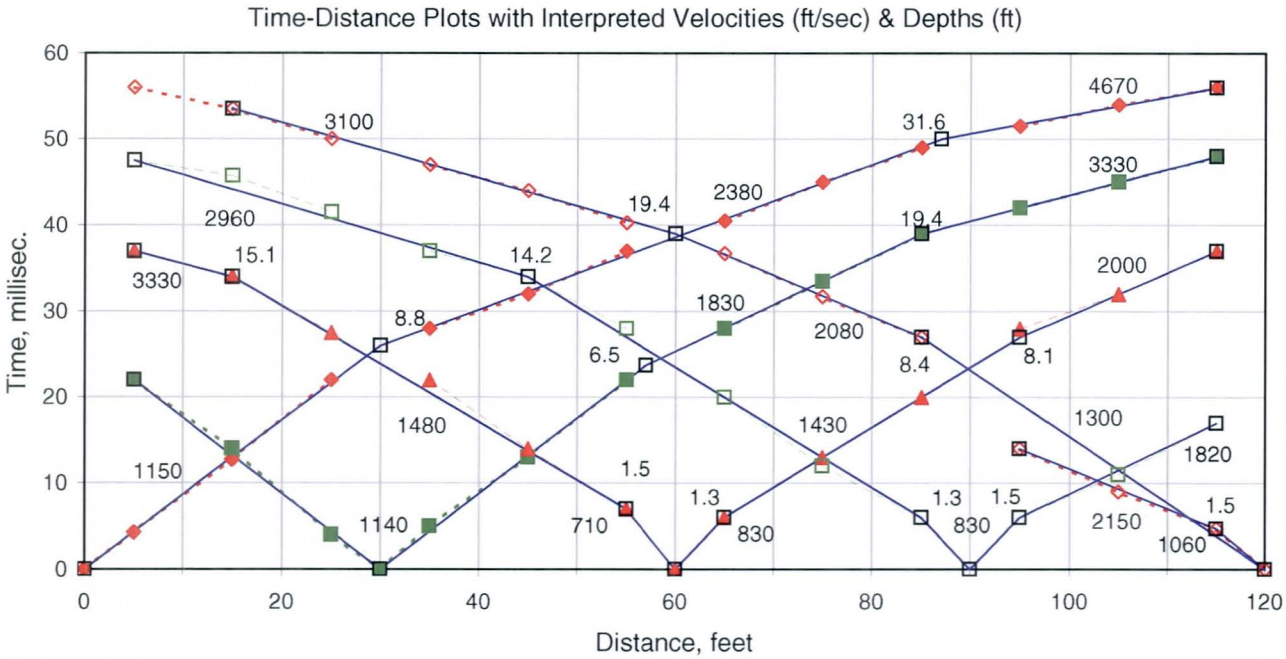

Interpretation of Refraction Seismic Data
East
West
ground
560
390
470
860
1700
800
s-wave = 630 f/s
1200
1600
~2800
~2400
~2200
s-wave = 1300 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 1100 f/s
s-wave = 2000 f/s below ~56 ft depth depth of investigation ~100 ft
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

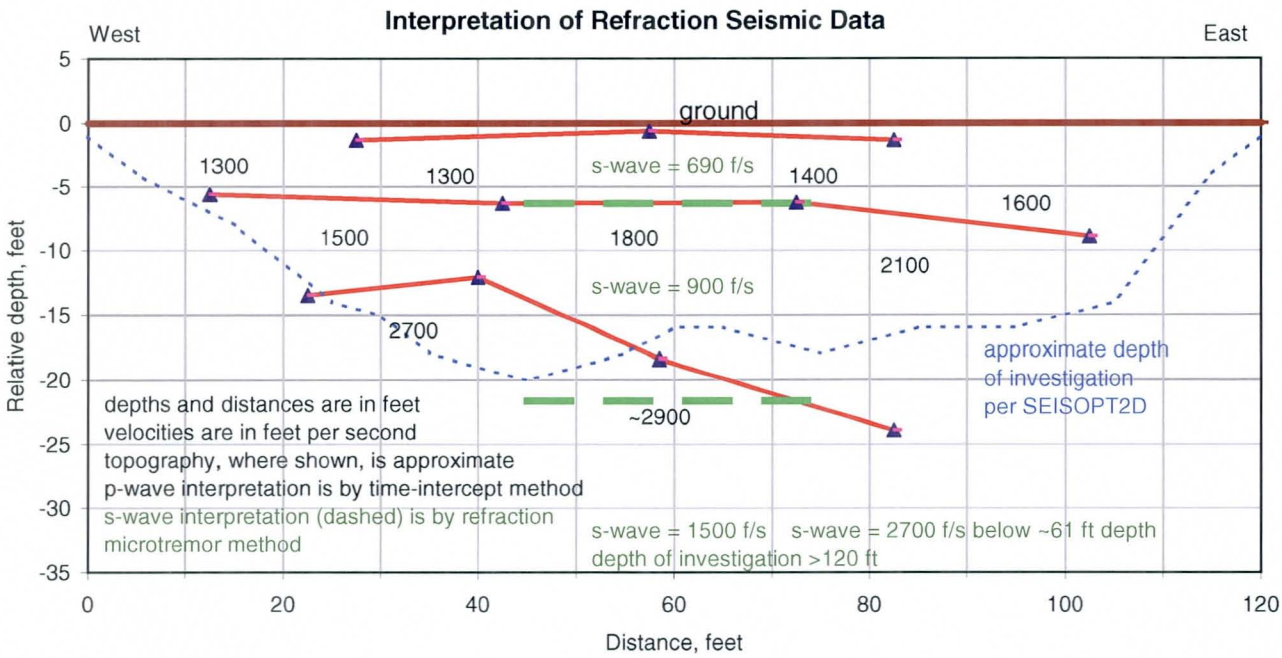

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
4290
3330
2000
1180
3040
1210
8.8
4310
2500
12.1
11.8
11.4
1600
1630
2070
1230
4.9
1820
900
1.5
1.8
2.1
2.1
4.1
860
1.8
1520
560
680
420
360
500
420

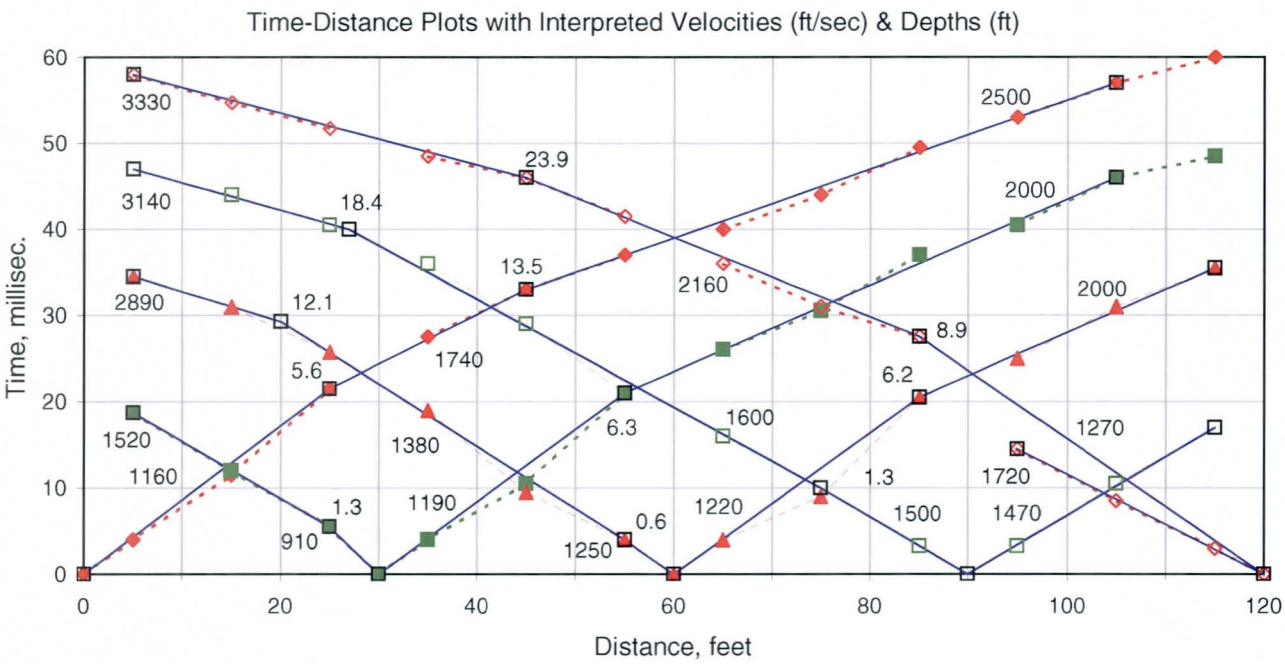

Interpretation of Refraction Seismic Data
West
East
ground
1500
1200
1500
710
1300
1400
1700
2700
2600
~2200
s-wave = 630 f/s
s-wave = 1000 f/s
s-wave = 1400 f/s
s-wave = 1500 f/s
s-wave = 4300 f/s below ~58 ft depth
discontinuity
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
discontinuity
2670
18.4
2500
2110
2220
10.1
(1070)
11.8
2500
2220
1930
1600
2780
7.8
5.2
1670
2900
2520
4.0
2220
3.5
1500
3.8
1110
1250
1480
1.5
710
1750
1.0
1250
0.9
1190
Time, millisec.
Distance, feet

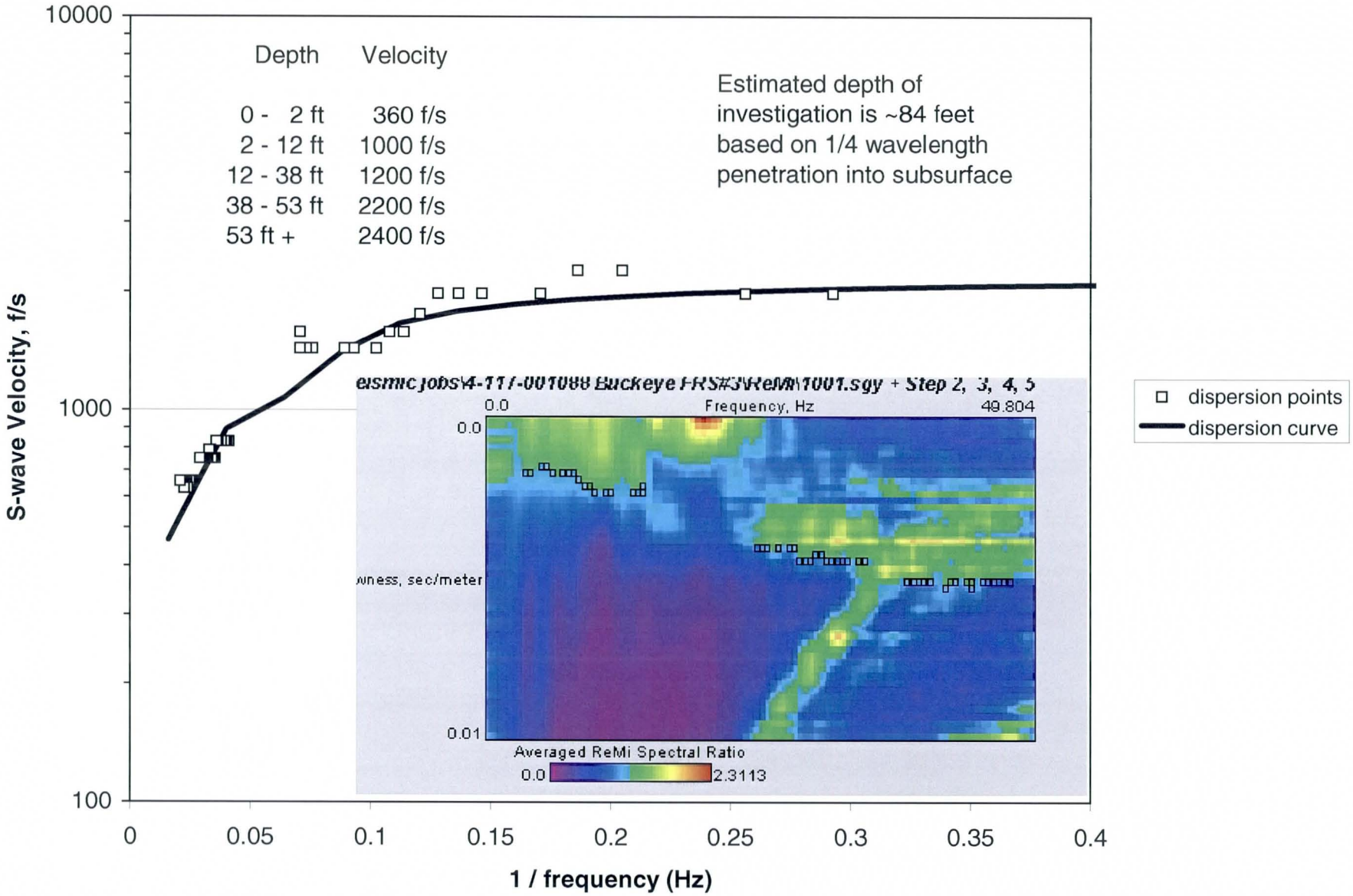

Interpretation of Refraction Seismic Data
West
East
ground
s-wave = 690 f/s
1100
1300
1400
2000
s-wave = 970 f/s
1800
1900
2000
3200
s-wave = 1600 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 2600 f/s below ~45 ft depth
depth of investigation ~>120 ft
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet

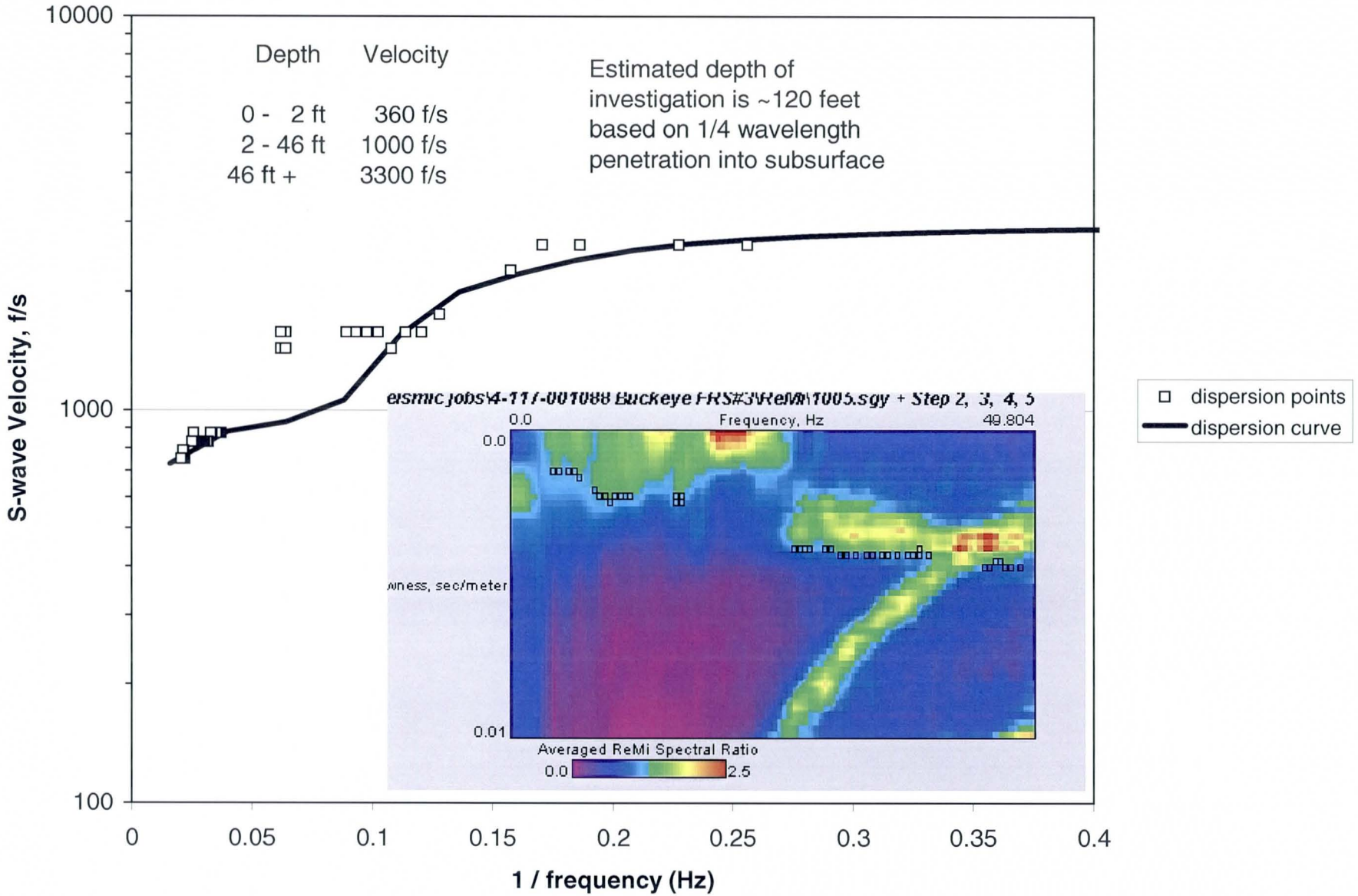

Interpretation of Refraction Seismic Data
West
East
ground
1300
1300
s-wave = 690 f/s
1400
1600
1500
1800
2100
s-wave = 900 f/s
2700
approximate depth of investigation per SEISOPT2D
~2900
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 1500 f/s
s-wave = 2700 f/s below ~61 ft depth
depth of investigation >120 ft
Relative depth, feet
Distance, feet

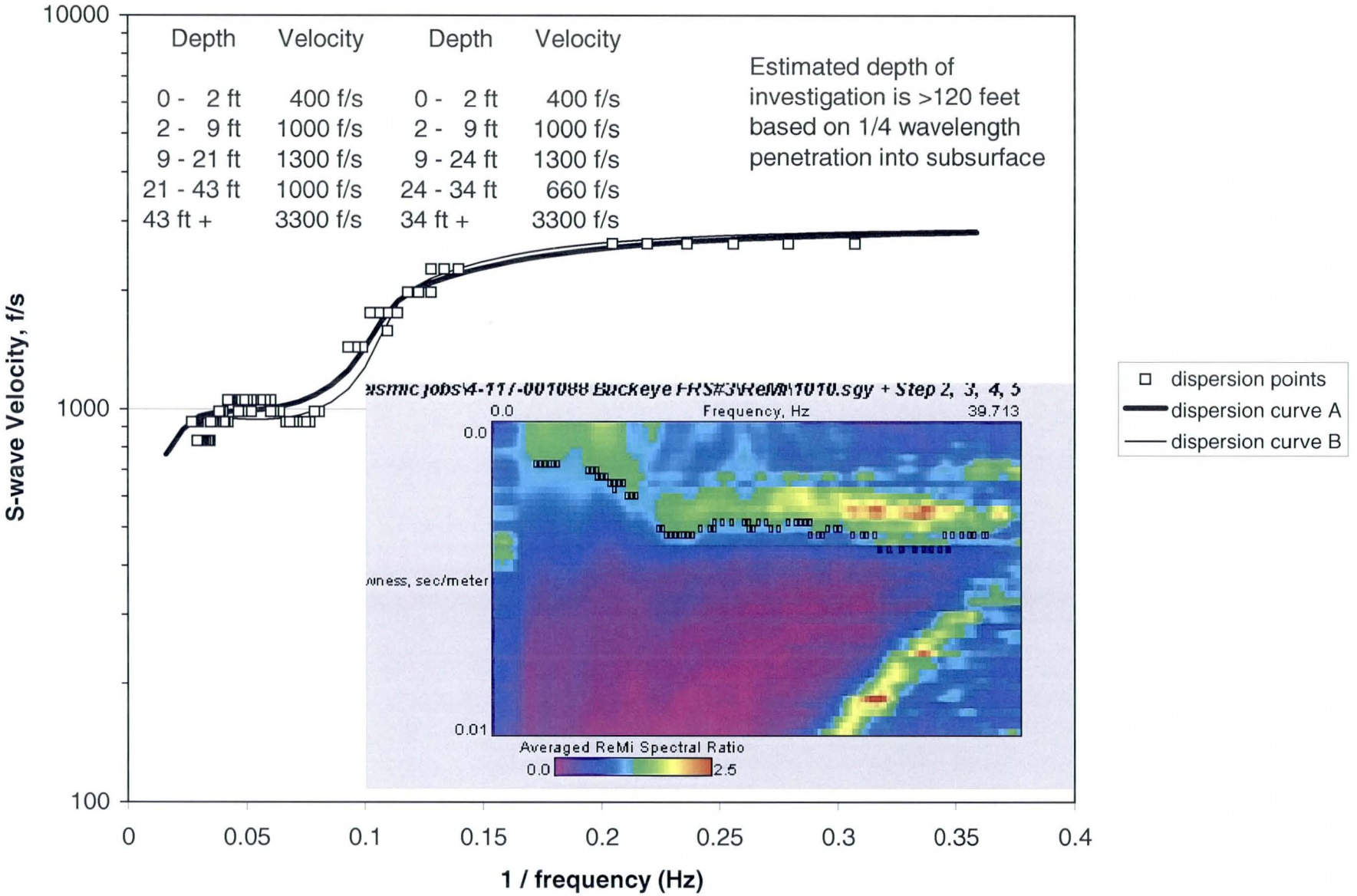

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3330
23.9
2500
3140
18.4
2000
13.5
2160
2890
12.1
2000
8.9
1740
5.6
6.2
1520
6.3
1600
1270
1380
1160
1.3
1720
1190
1.3
1220
0.6
1500
1470
910
1250
Time, millisec.
Distance, feet

Refraction Microtremor S-wave Interpretation **Line 1** AMEC Job No. 4-117-001088



Refraction Microtremor S-wave Interpretation **Line 2** AMEC Job No. 4-117-001088

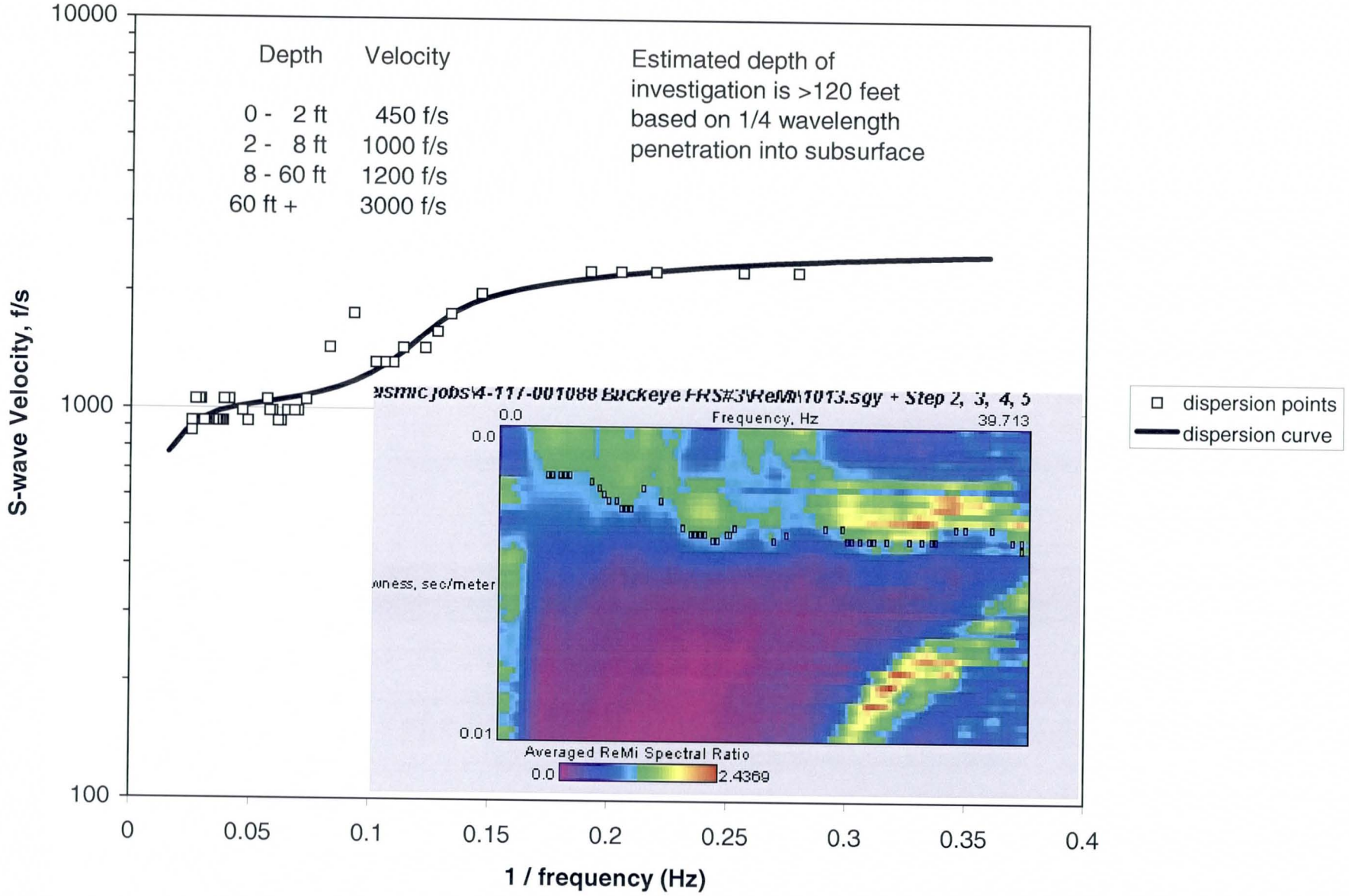


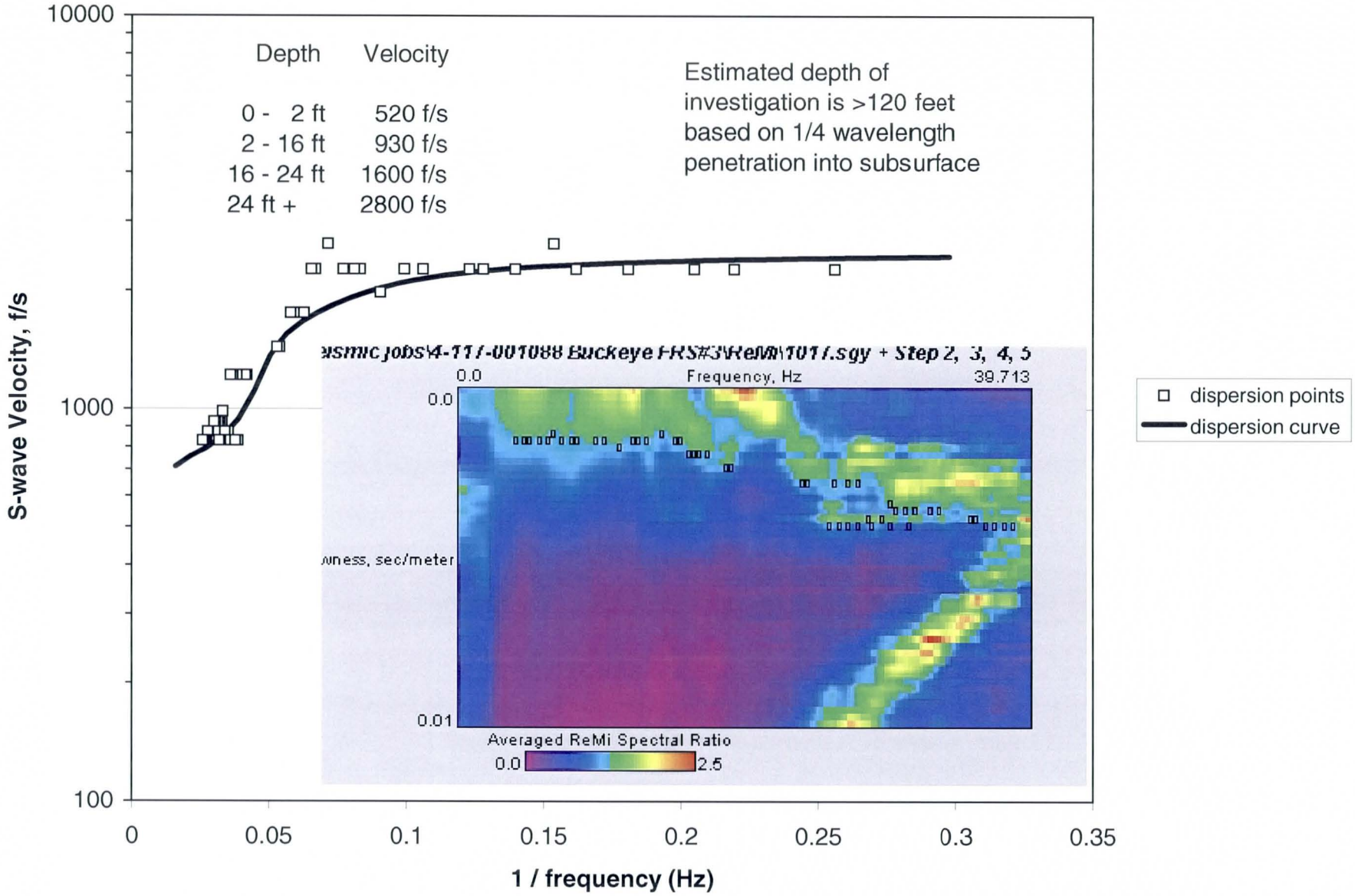

Depth Velocity Depth Velocity
0 - 2 ft 400 f/s 0 - 2 ft 400 f/s
2 - 9 ft 1000 f/s 2 - 9 ft 1000 f/s
9 - 21 ft 1300 f/s 9 - 24 ft 1300 f/s
21 - 43 ft 1000 f/s 24 - 34 ft 660 f/s
43 ft + 3300 f/s 34 ft + 3300 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve A
dispersion curve B
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
0.0
2.5

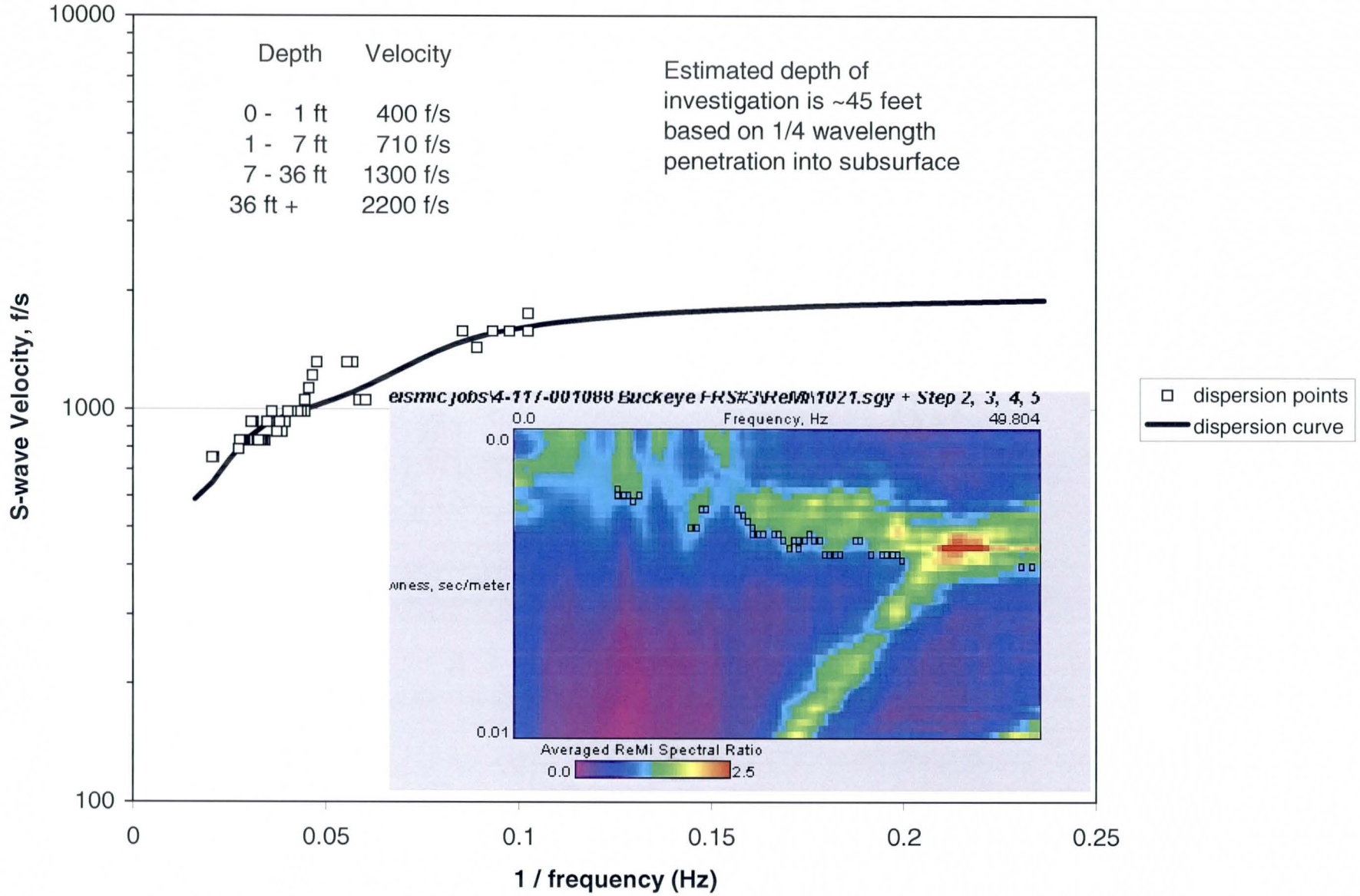
Refraction Microtremor S-wave Interpretation

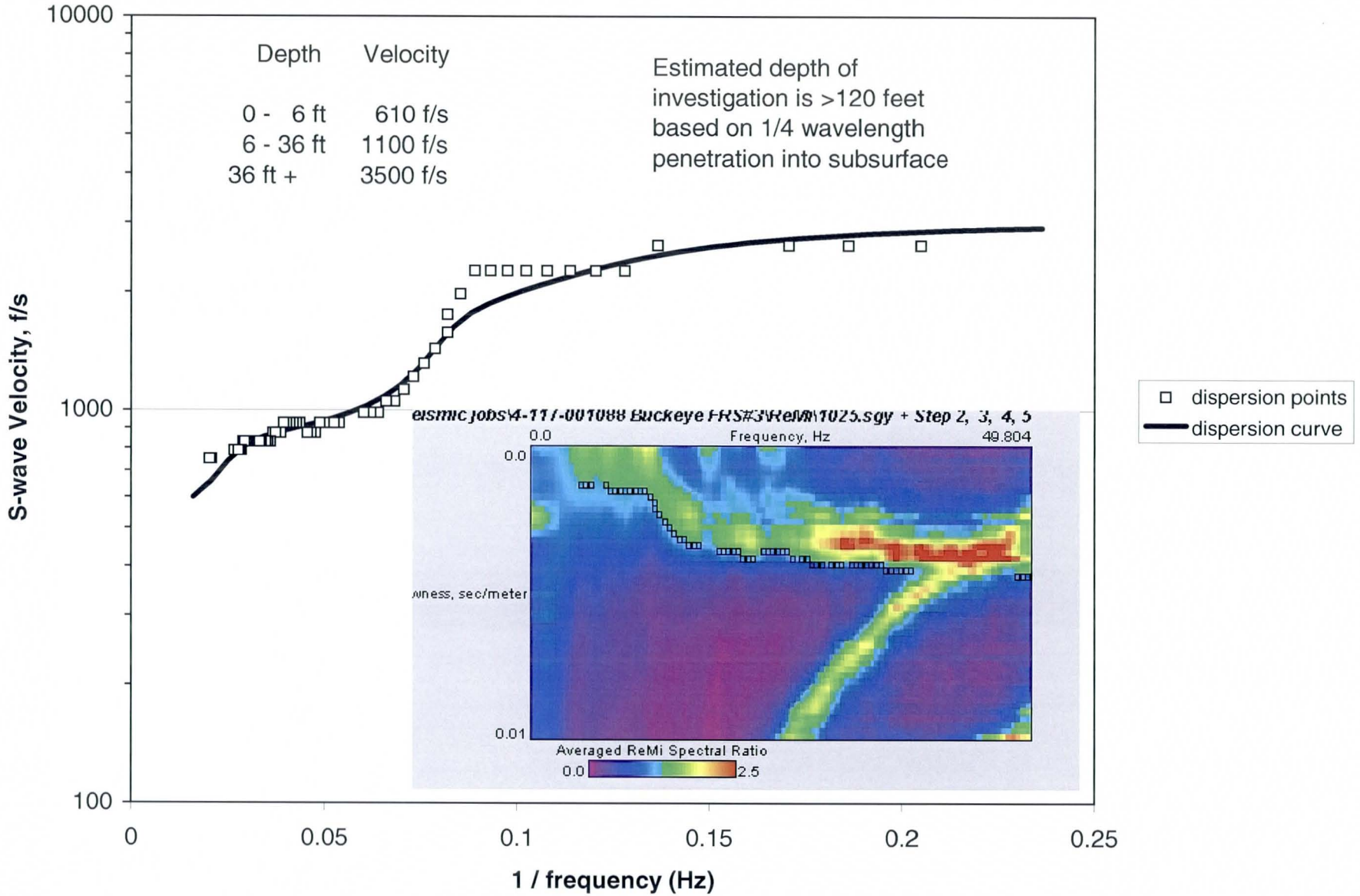
Line 6

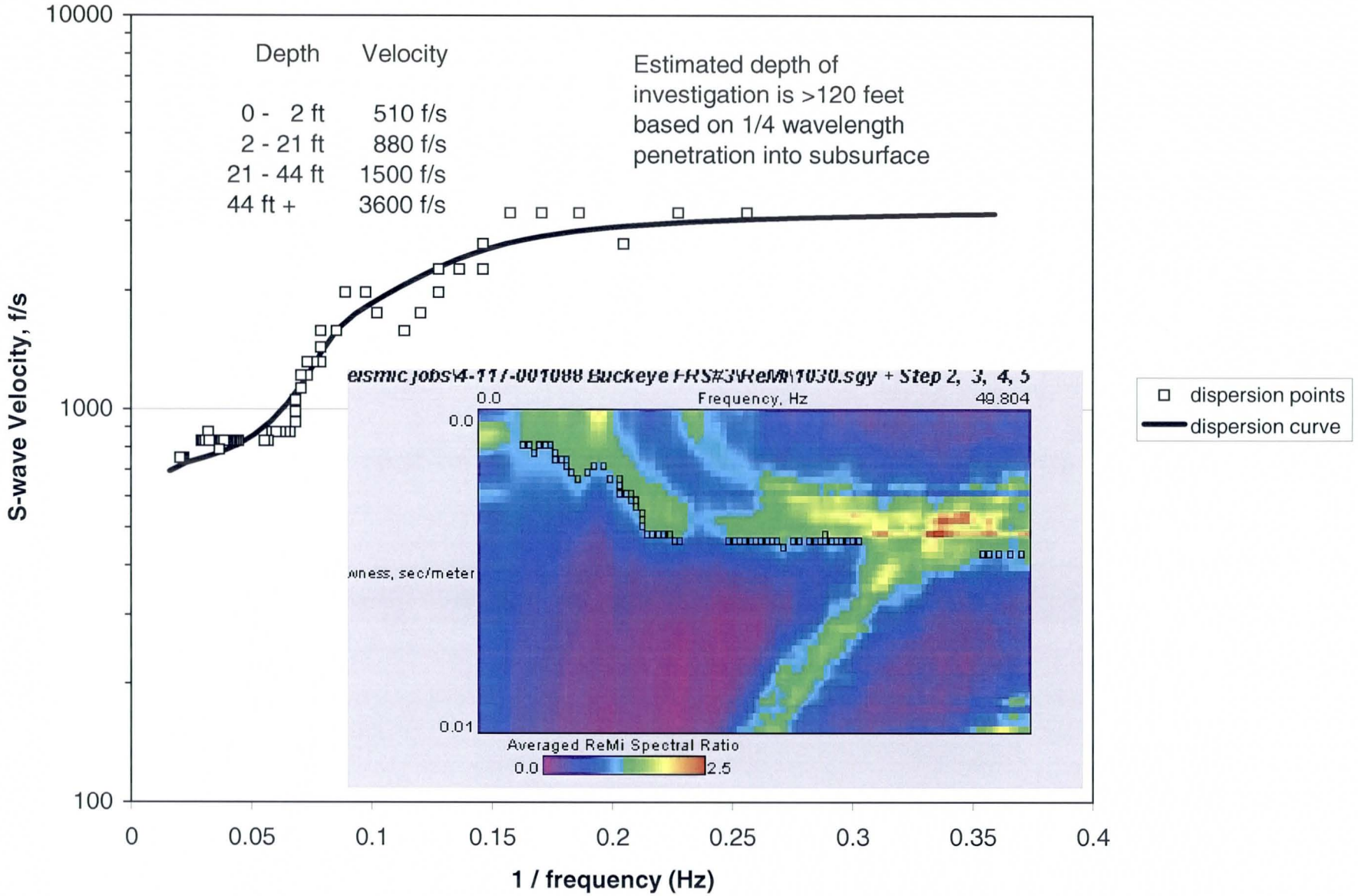
AMEC Job No. 4-117-001088

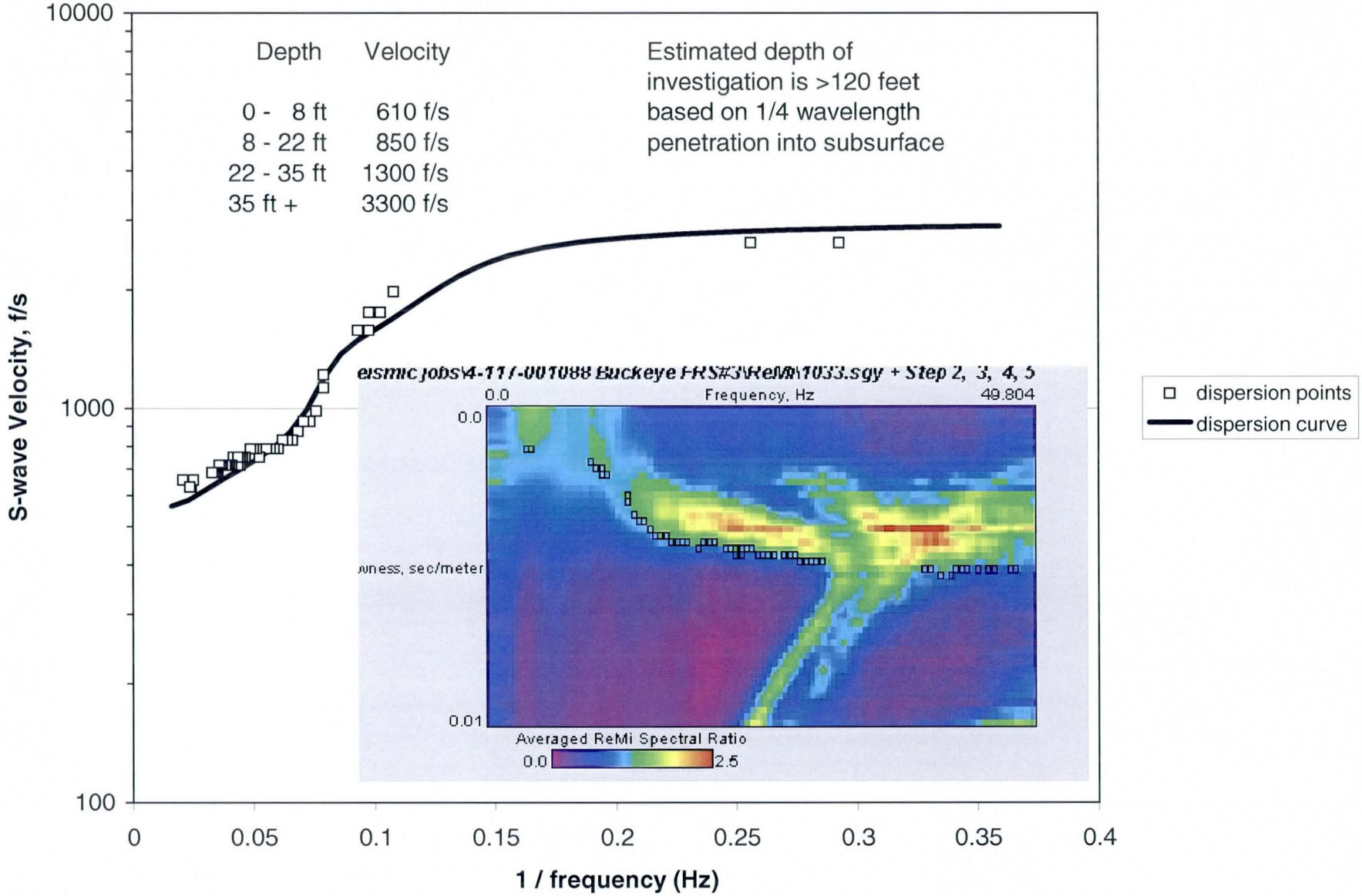



Depth Velocity
0 - 2 ft 520 f/s
2 - 16 ft 930 f/s
16 - 24 ft 1600 f/s
24 ft + 2800 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
1 / frequency (Hz)
0.0
Frequency, Hz
39.713
0.0
0.01
Averaged ReMi Spectral Ratio
0.0
2.5
dispersion points
dispersion curve


Depth Velocity
0 - 1 ft 400 f/s
1 - 7 ft 710 f/s
7 - 36 ft 1300 f/s
36 ft + 2200 f/s
Estimated depth of investigation is ~45 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5

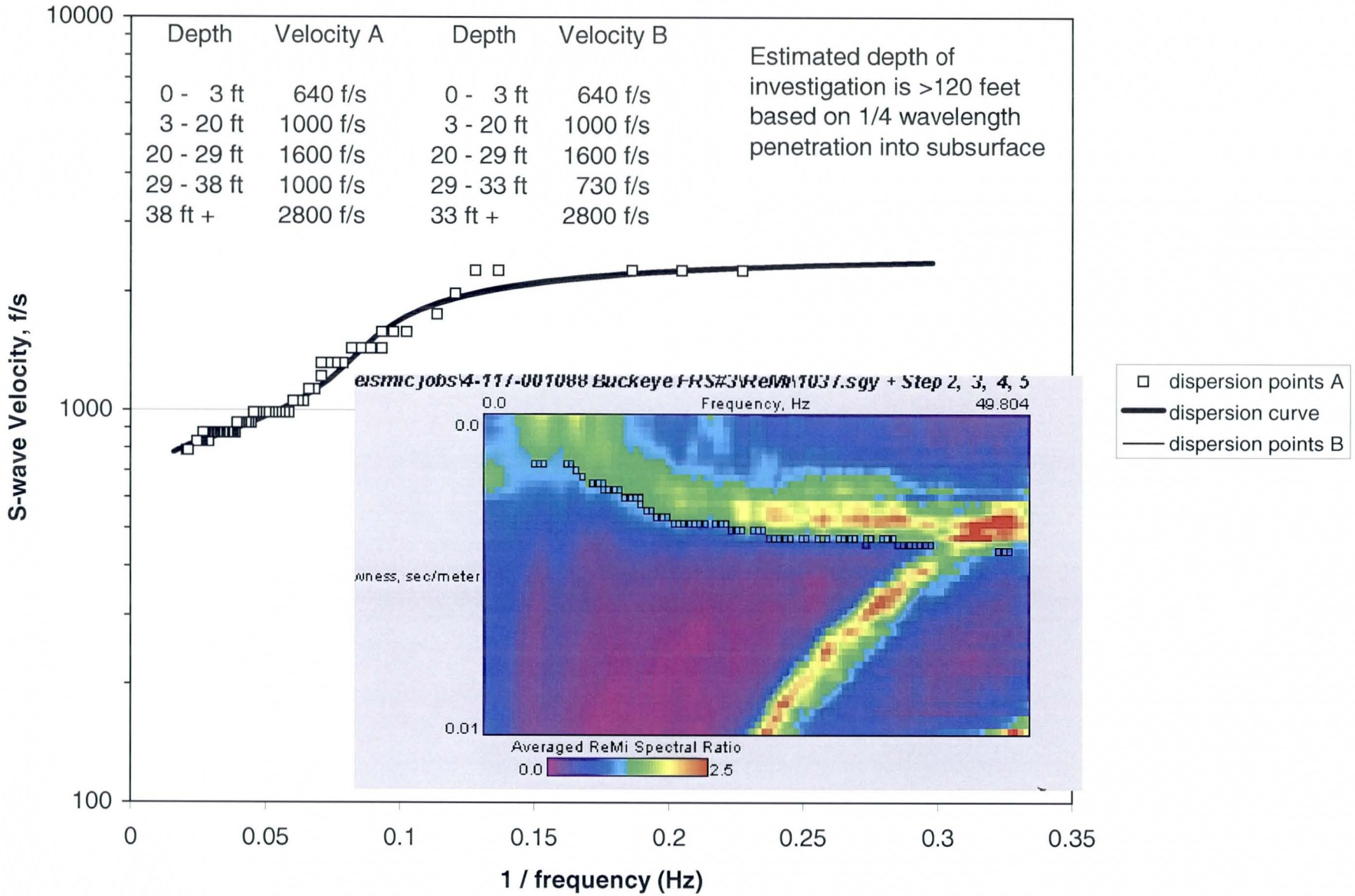

Depth Velocity
0 - 6 ft 610 f/s
6 - 36 ft 1100 f/s
36 ft + 3500 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5

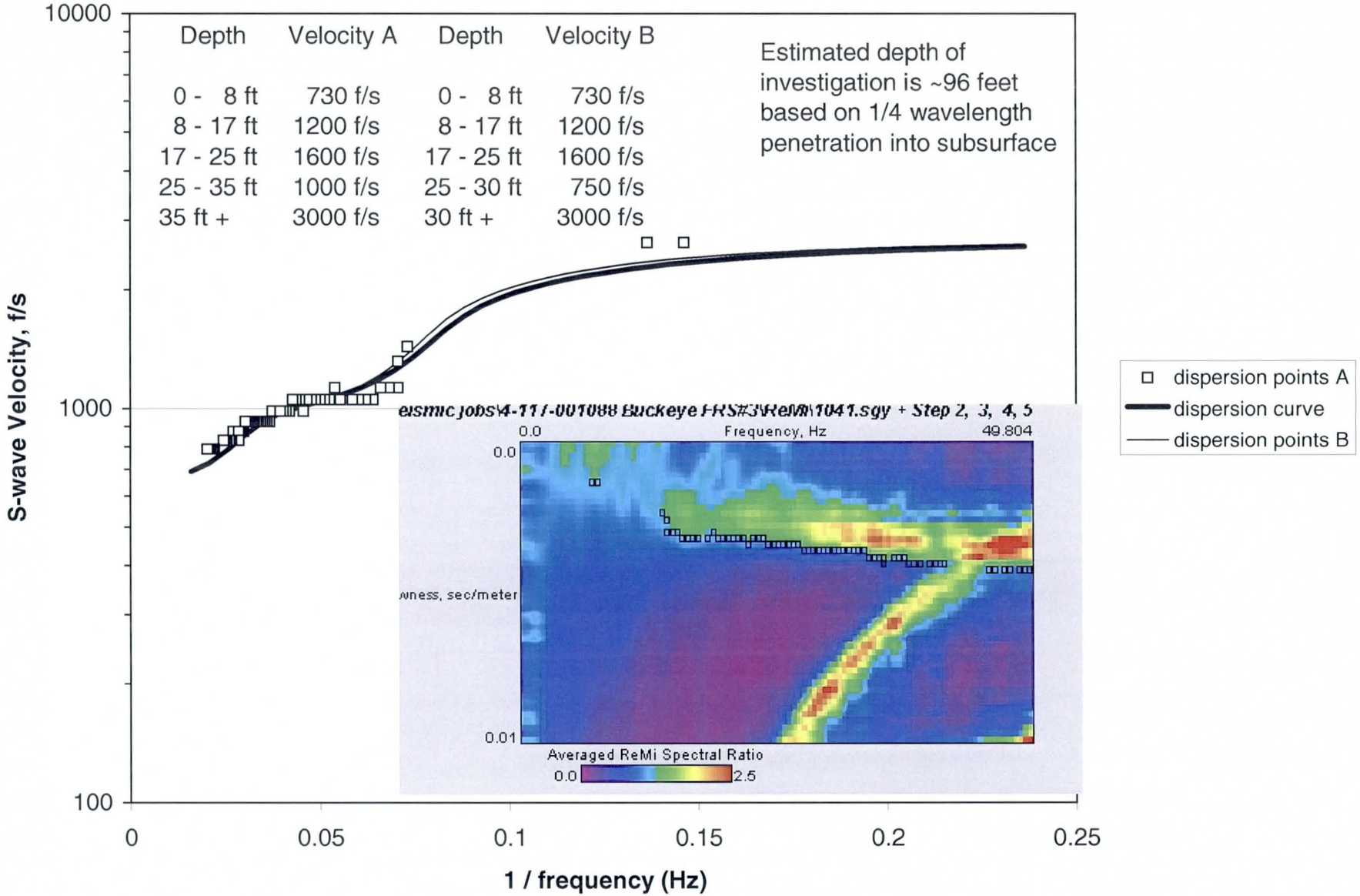

Depth Velocity
0 - 2 ft 510 f/s
2 - 21 ft 880 f/s
21 - 44 ft 1500 f/s
44 ft + 3600 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.5
dispersion points
dispersion curve

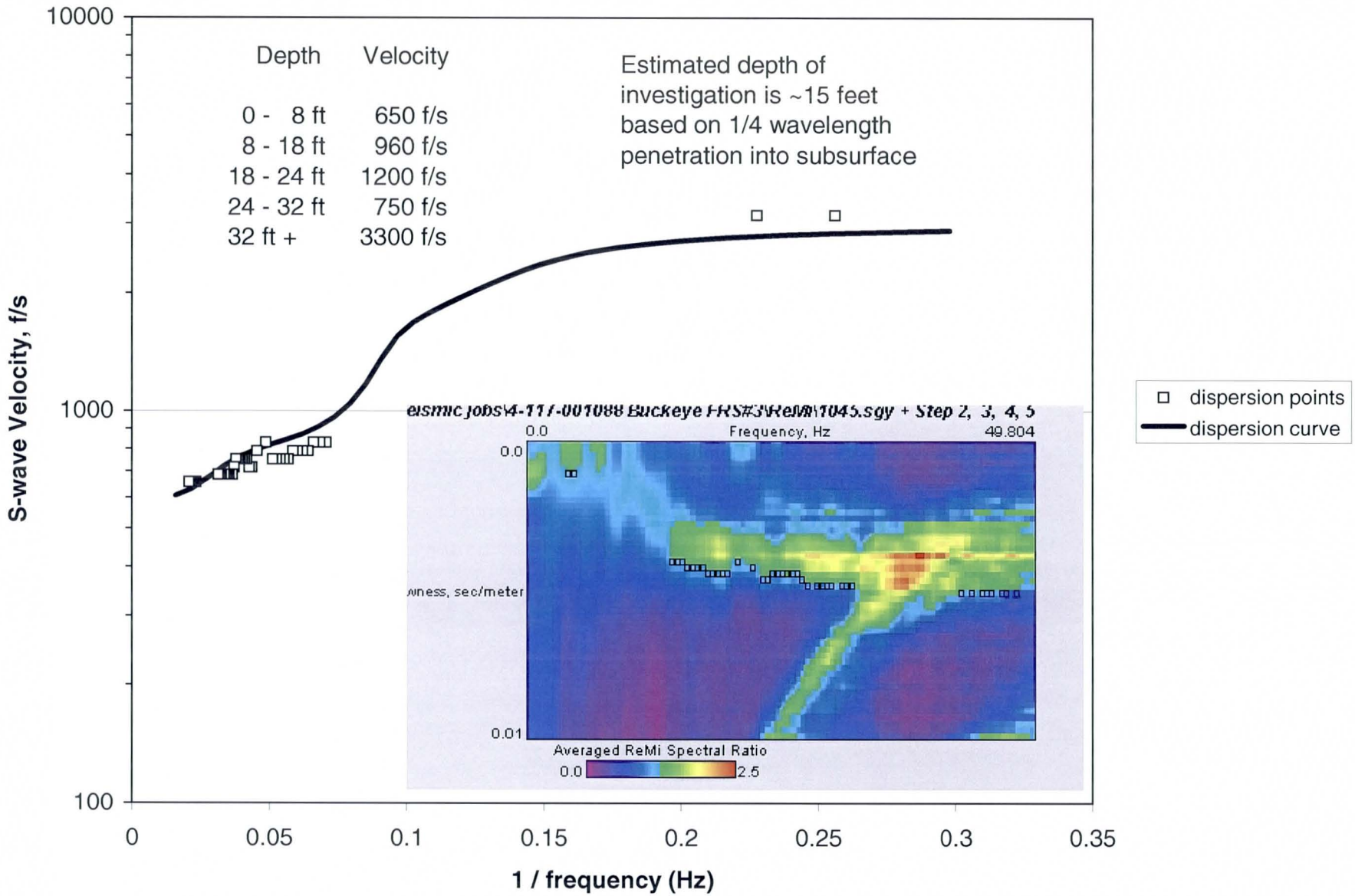

Depth Velocity
0 - 8 ft 610 f/s
8 - 22 ft 850 f/s
22 - 35 ft 1300 f/s
35 ft + 3300 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.5
dispersion points
dispersion curve

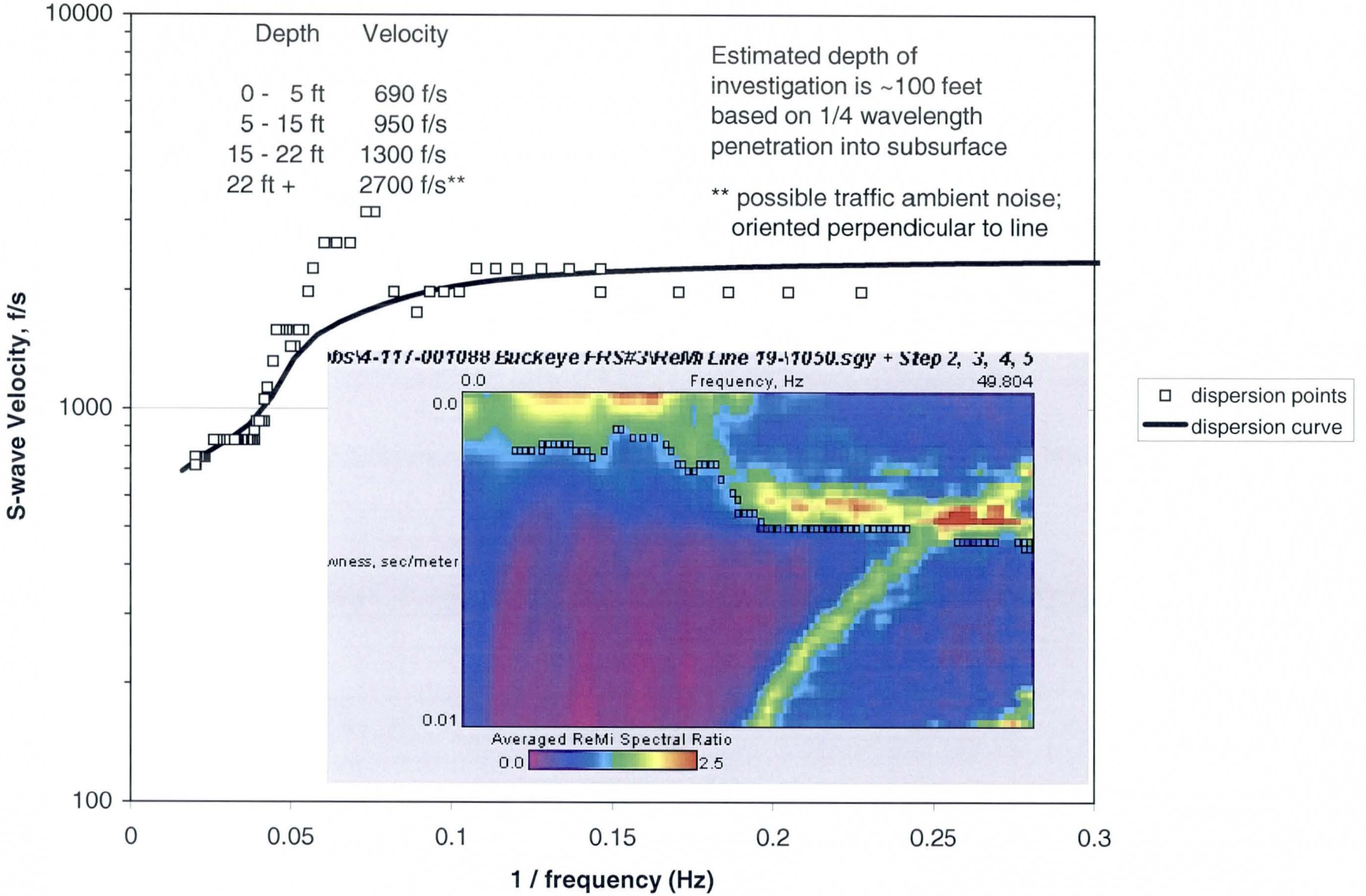
Depth	Velocity A	Depth	Velocity B
0 - 3 ft	640 f/s	0 - 3 ft	640 f/s
3 - 20 ft	1000 f/s	3 - 20 ft	1000 f/s
20 - 29 ft	1600 f/s	20 - 29 ft	1600 f/s
29 - 38 ft	1000 f/s	29 - 33 ft	730 f/s
38 ft +	2800 f/s	33 ft +	2800 f/s

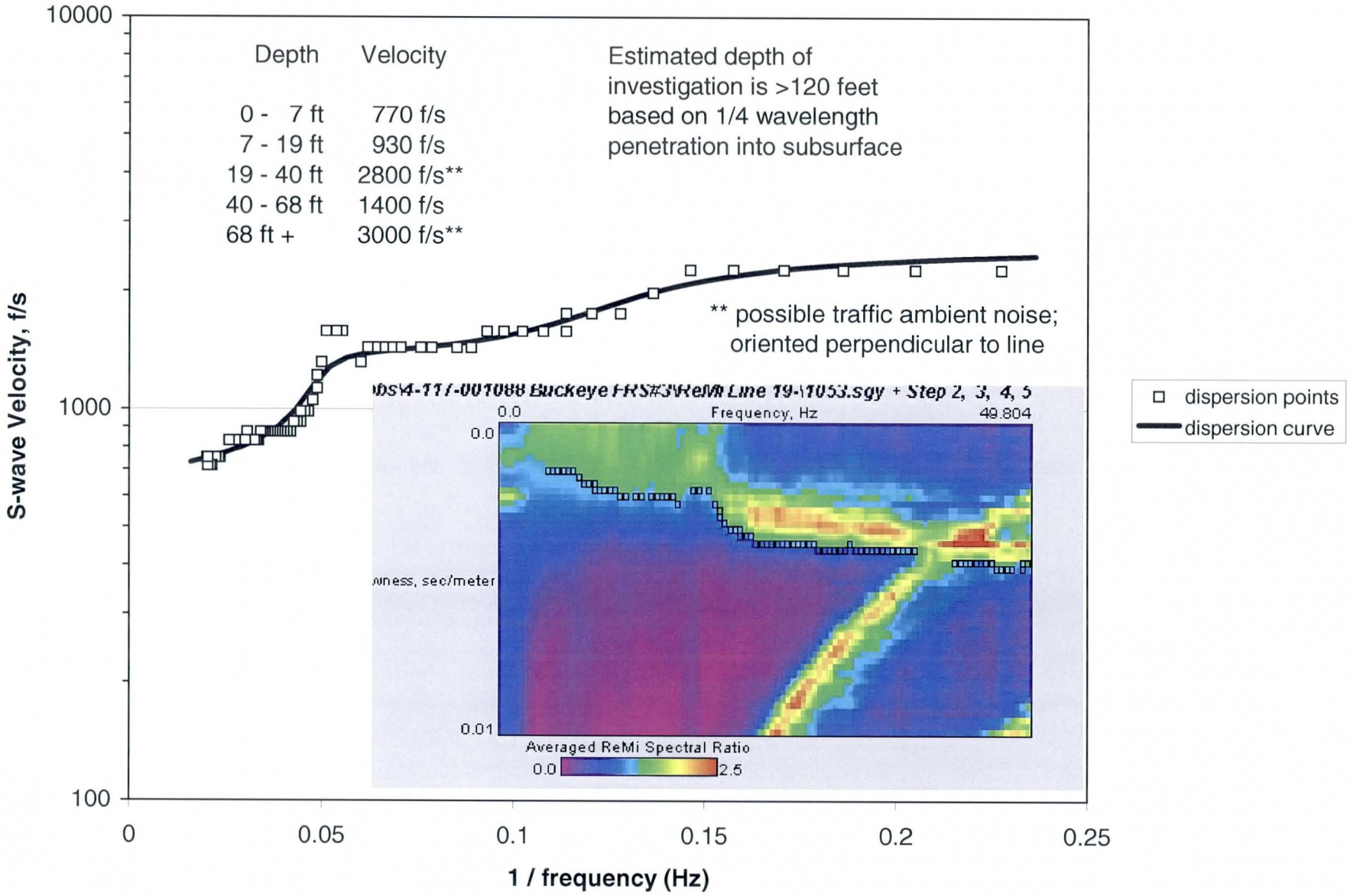
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface

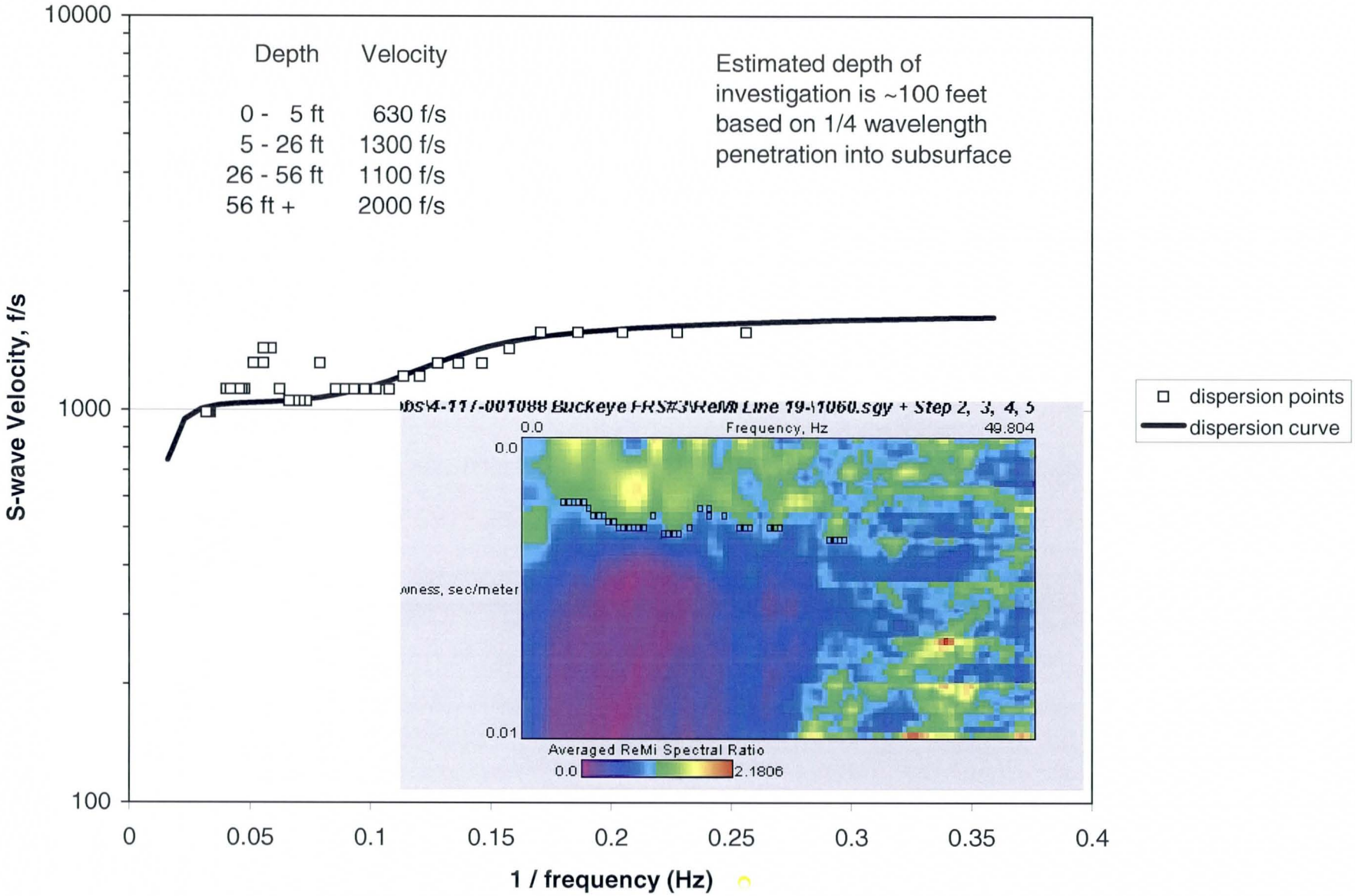


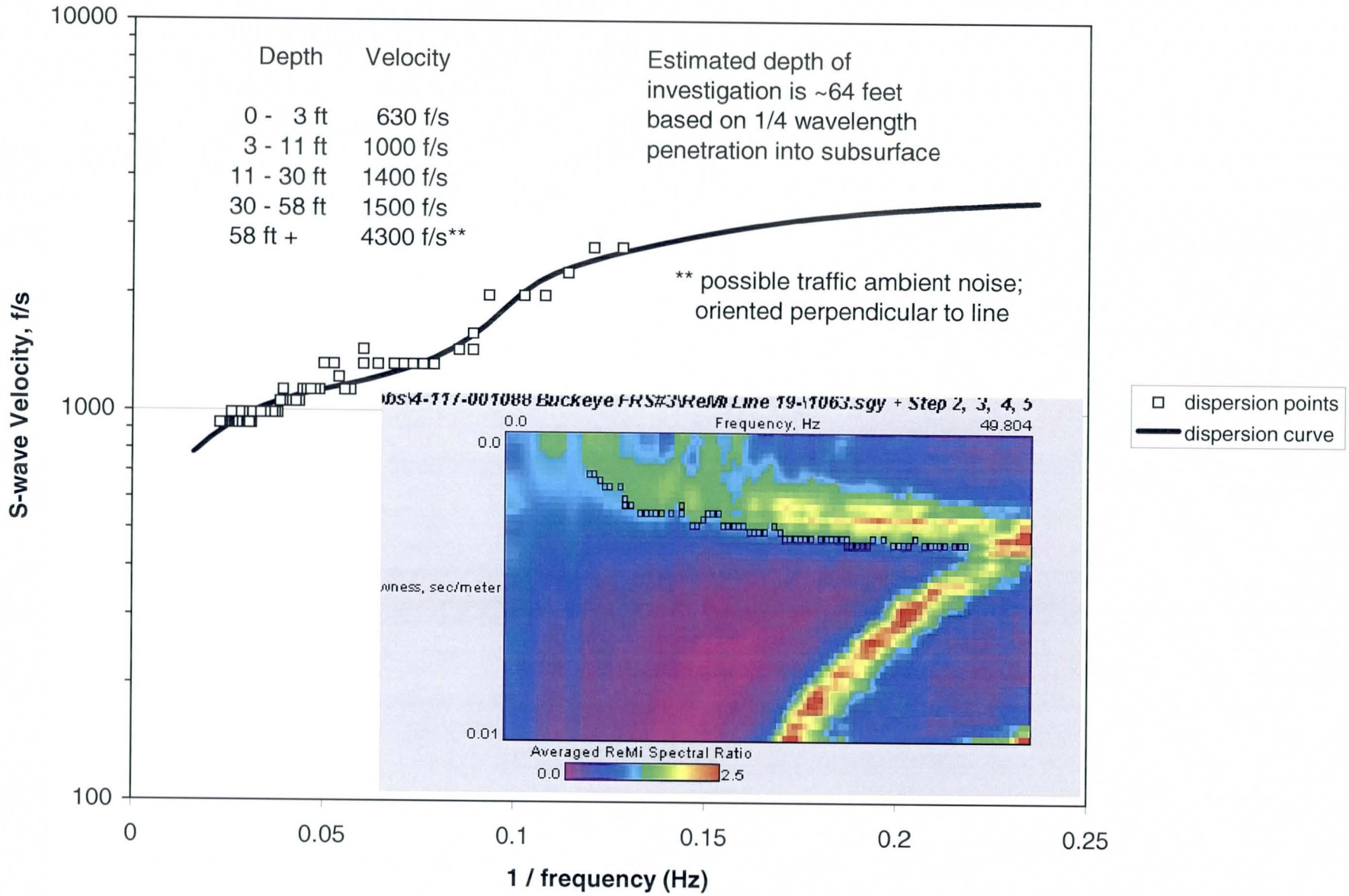

Depth Velocity A Depth Velocity B
0 - 8 ft 730 f/s 0 - 8 ft 730 f/s
8 - 17 ft 1200 f/s 8 - 17 ft 1200 f/s
17 - 25 ft 1600 f/s 17 - 25 ft 1600 f/s
25 - 35 ft 1000 f/s 25 - 30 ft 750 f/s
35 ft + 3000 f/s 30 ft + 3000 f/s
Estimated depth of investigation is ~96 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
1 / frequency (Hz)
dispersion points A
dispersion curve
dispersion points B
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.5

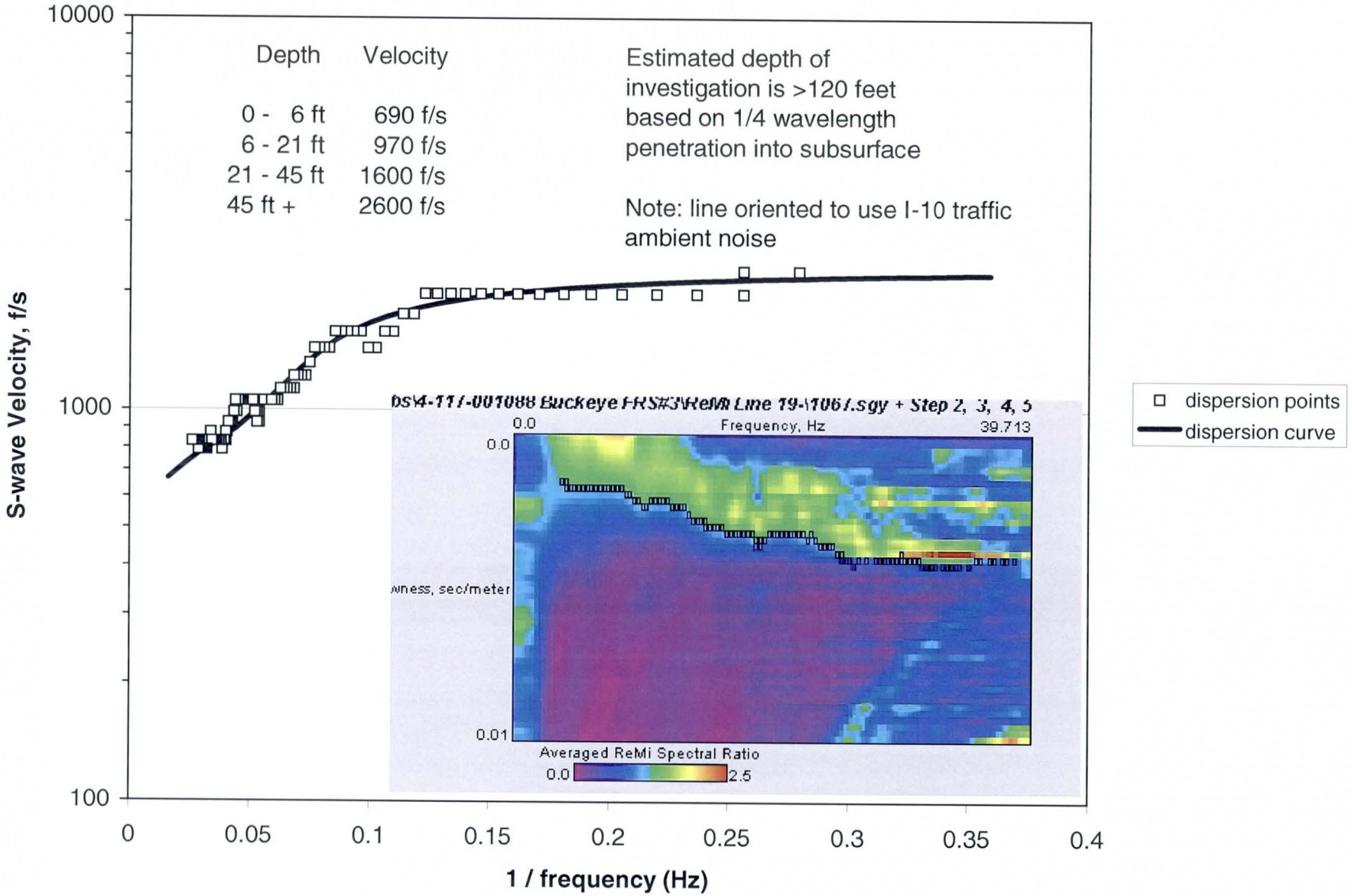

Depth Velocity
0 - 8 ft 650 f/s
8 - 18 ft 960 f/s
18 - 24 ft 1200 f/s
24 - 32 ft 750 f/s
32 ft + 3300 f/s
Estimated depth of investigation is ~15 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5

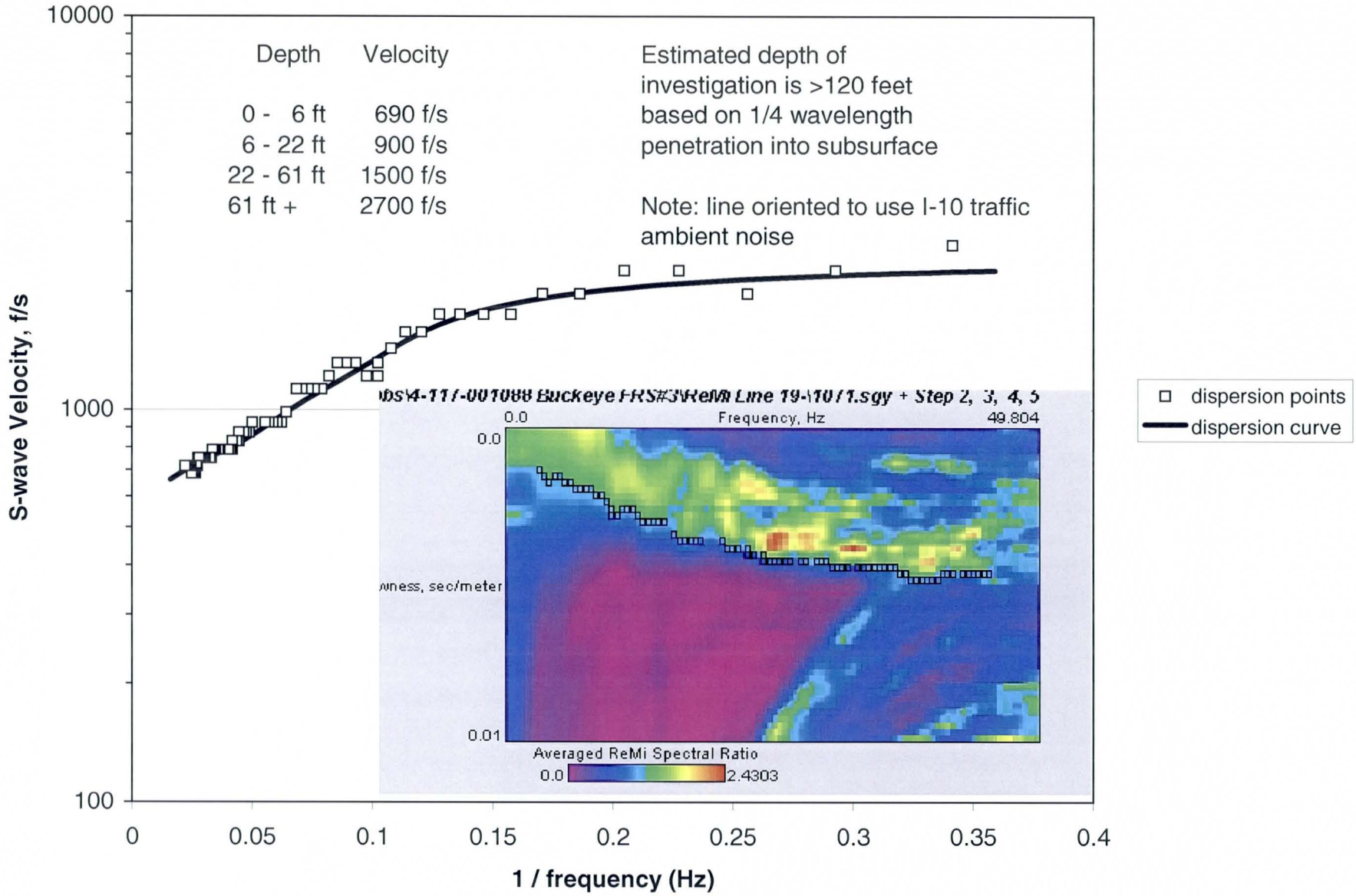

Depth Velocity
0 - 5 ft 690 f/s
5 - 15 ft 950 f/s
15 - 22 ft 1300 f/s
22 ft + 2700 f/s**
Estimated depth of investigation is ~100 feet based on 1/4 wavelength penetration into subsurface
** possible traffic ambient noise; oriented perpendicular to line
dispersion points
dispersion curve
S-wave Velocity, f/s
1 / frequency (Hz)
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.5


Depth Velocity
0 - 7 ft 770 f/s
7 - 19 ft 930 f/s
19 - 40 ft 2800 f/s**
40 - 68 ft 1400 f/s
68 ft + 3000 f/s**
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
** possible traffic ambient noise; oriented perpendicular to line
dispersion points
dispersion curve
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
1 / frequency (Hz)


Depth Velocity
0 - 5 ft 630 f/s
5 - 26 ft 1300 f/s
26 - 56 ft 1100 f/s
56 ft + 2000 f/s
Estimated depth of investigation is ~100 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.1806


Depth Velocity
0 - 3 ft 630 f/s
3 - 11 ft 1000 f/s
11 - 30 ft 1400 f/s
30 - 58 ft 1500 f/s
58 ft + 4300 f/s**
Estimated depth of investigation is ~64 feet based on 1/4 wavelength penetration into subsurface
** possible traffic ambient noise; oriented perpendicular to line
dispersion points
dispersion curve
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
1 / frequency (Hz)
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5


Depth Velocity
0 - 6 ft 690 f/s
6 - 21 ft 970 f/s
21 - 45 ft 1600 f/s
45 ft + 2600 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
Note: line oriented to use I-10 traffic ambient noise
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
0.0
2.5


Depth Velocity
0 - 6 ft 690 f/s
6 - 22 ft 900 f/s
22 - 61 ft 1500 f/s
61 ft + 2700 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
Note: line oriented to use I-10 traffic ambient noise
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.4303

APPENDIX D

LABORATORY TEST RESULTS

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	1
SAMPLE SOURCE:	SEE BELOW	DATE ASSIGNED:	2/14/05

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	6"	Lab #

PERCENT PASSING BY WEIGHT

B-6 @ 2.5-3.5'	SM	NV	NP	31	44	58	65	72	83	91	93	99	100	100	100	100	100	100	100	100	100	100	73
B-6 @ 9.5-10.5'	SM	NV	NP	15	24	37	46	56	71	80	83	92	93	95	97	100	100	100	100	100	100	100	76

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PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	1
SAMPLE SOURCE:	SEE BELOW	DATE ASSIGNED:	2/14/05

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	6"	Lab #
PERCENT PASSING BY WEIGHT																							
B-1 @ 4.5-5.5'	SC	42	21	34	43	53	59	64	74	82	84	88	89	89	91	95	100	100	100	100	100	100	4
B-1 @ 9.5-10.5'	SC	52	30	31	40	52	59	67	82	91	93	98	99	99	100	100	100	100	100	100	100	100	6
B-2 @ 2.5-3.5'	SC	36	14	40	52	67	74	82	92	96	97	99	100	100	100	100	100	100	100	100	100	100	17
B-2 @ 7.5-8.5'	SP-SM	NV	NP	11	18	31	40	52	71	84	87	97	98	100	100	100	100	100	100	100	100	100	19
B-3 @ 14.5-15.5'	SM	NV	NP	17	23	33	43	54	74	86	90	97	99	100	100	100	100	100	100	100	100	100	36
B-4 @ 2.5-3.5'	SC	37	13	44	54	64	69	74	84	90	92	96	97	98	98	100	100	100	100	100	100	100	45
B-4 @ 7.5-8.5'	SC	46	25	48	60	73	79	85	94	98	99	100	100	100	100	100	100	100	100	100	100	100	47
B-4 @ 12.5-13.5'	SM	NV	NP	31	41	53	60	68	81	90	92	97	98	100	100	100	100	100	100	100	100	100	49
B-5 @ 7.5-8.5'	SC	33	13	25	38	53	61	68	79	86	89	95	97	99	100	100	100	100	100	100	100	100	61
B-5 @ 24.5-25.5'	SM	NV	NP	36	56	72	77	82	88	91	92	96	97	99	100	100	100	100	100	100	100	100	67

AASHTO R18

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amec

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	1
MATERIAL:	SOIL	LAB NO:	SEE BELOW
SAMPLE SOURCE:	SEE BORING	DATE ASSIGNED:	2/14/05

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD(ASTM D2937)

LAB #	BORING	MOISTURE WET WT. (g)	MOISTURE DRY WT. (g)	MOISTURE MOISTURE CONTENT	NUMBER OF RINGS	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
4	B-1 @ 4.5-5.5'	270.4	241.1	12.1%	2.0	375.1	89.2	105.6
6	B-1 @ 9.5-10.5'	266.7	240.2	11.0%	4.0	701.3	177.8	97.6
17	B-2 @ 2.5-3.5'	340.4	325.8	4.5%	3.0	542.6	136.2	107.4
36	B-3 @ 14.5-15.5'	296.3	289.0	2.5%	3.0	581.7	136.3	119.9
47	B-4 @ 7.5-8.5'	404.7	375.9	7.7%	4.0	727.0	181.3	104.9
67	B-5 @ 24.5-25.5'	270.6	251.6	7.6%	4.0	716.8	207.3	98.0
76	B-6 @ 9.5-10.5'	294.5	285.1	3.3%	4.0	730.9	183.0	109.8

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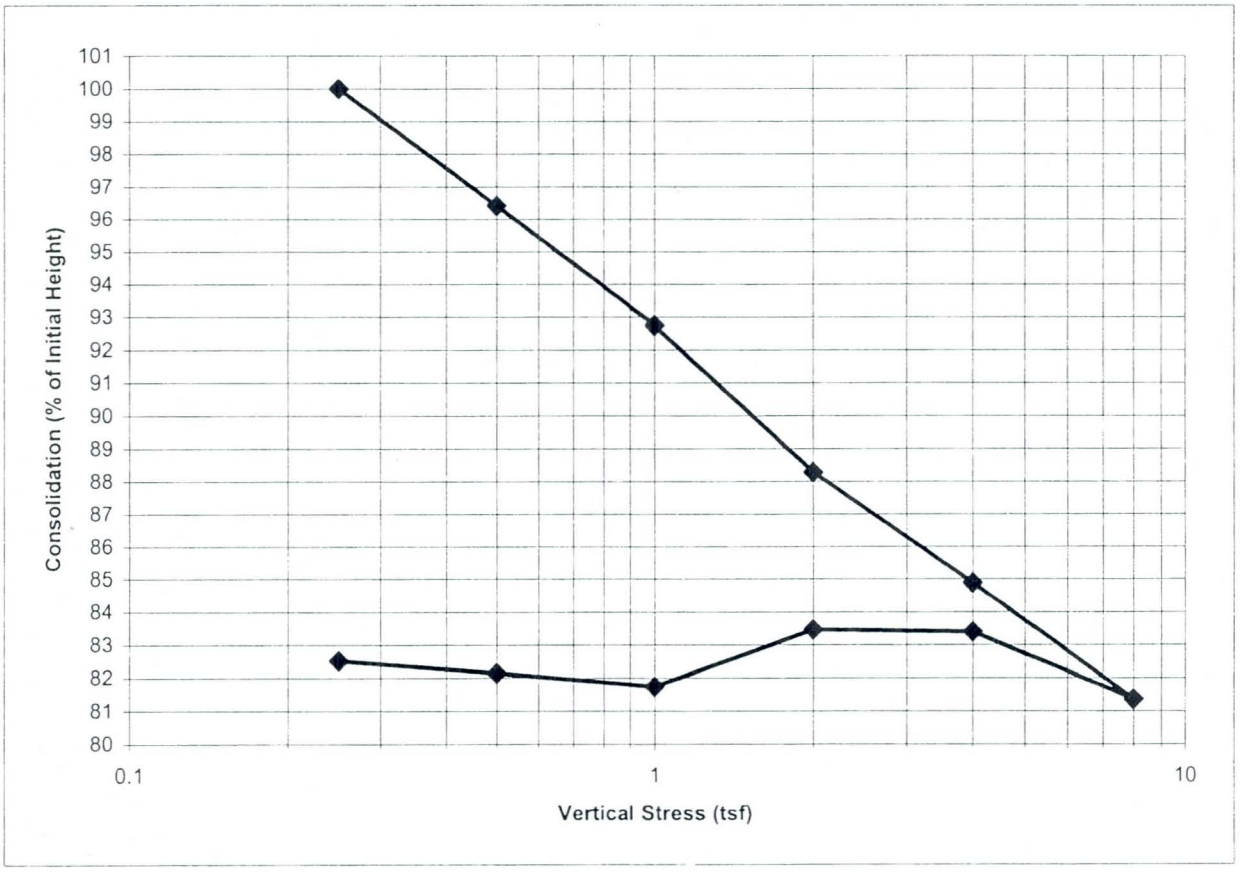
PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	4
SAMPLE SOURCE:	B-1 @ 4.5-5.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.74
INITIAL MOISTURE CONTENT	9.0%	FINAL MOISTURE CONTENT	16.3%
INITIAL DRY DENSITY(pcf)	97.6	FINAL DRY DENSITY(pcf)	119.5
INITIAL DEGREE OF SATURATION	33%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.75	FINAL VOID RATIO	0.42
ESTIMATED SPECIFIC GRAVITY	2.725	SATURATED AT	1 tsf



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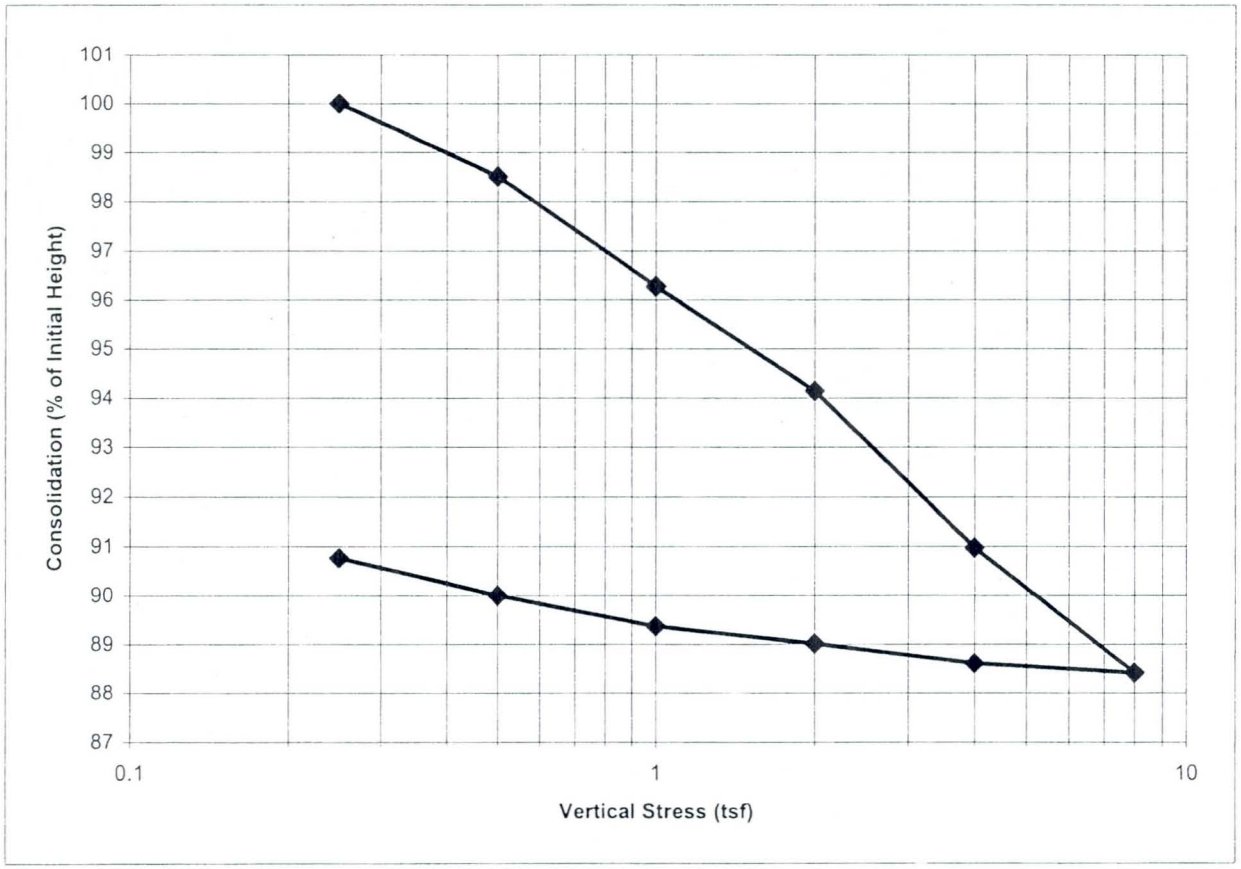
REVIEWED BY CG

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	6
SAMPLE SOURCE:	B-1 @ 9.5-10.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.07
INITIAL MOISTURE CONTENT	12.5%	FINAL MOISTURE CONTENT	17.2%
INITIAL DRY DENSITY(pcf)	110.8	FINAL DRY DENSITY(pcf)	124.9
INITIAL DEGREE OF SATURATION	55%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.68	FINAL VOID RATIO	0.49
ESTIMATED SPECIFIC GRAVITY	2.975	SATURATED AT	1 tsf



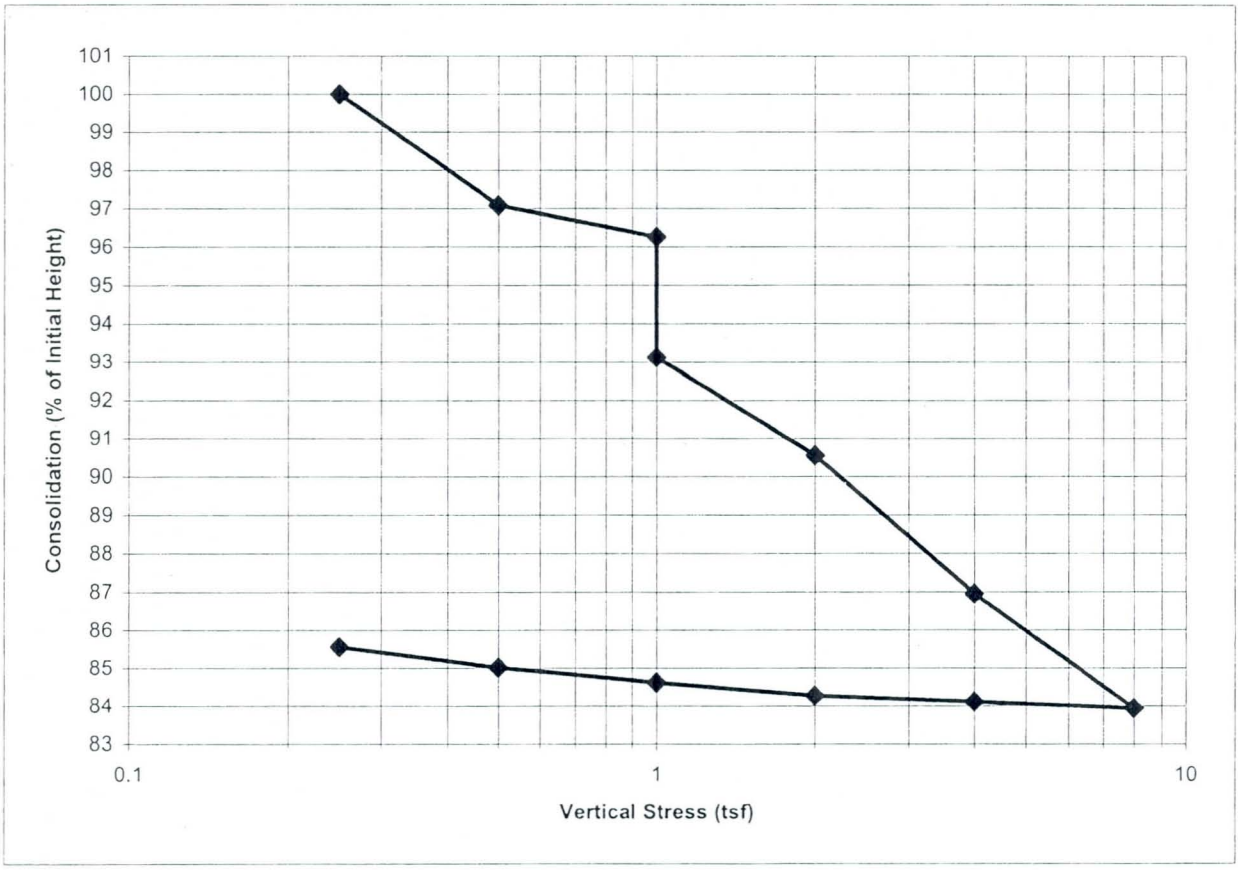
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	17
SAMPLE SOURCE:	B-2 @ 2.5-3.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.86
INITIAL MOISTURE CONTENT	4.6%	FINAL MOISTURE CONTENT	16.6%
INITIAL DRY DENSITY(pcf)	103.2	FINAL DRY DENSITY(pcf)	122.5
INITIAL DEGREE OF SATURATION	18%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.73	FINAL VOID RATIO	0.45
ESTIMATED SPECIFIC GRAVITY	2.851	SATURATED AT	1 tsf



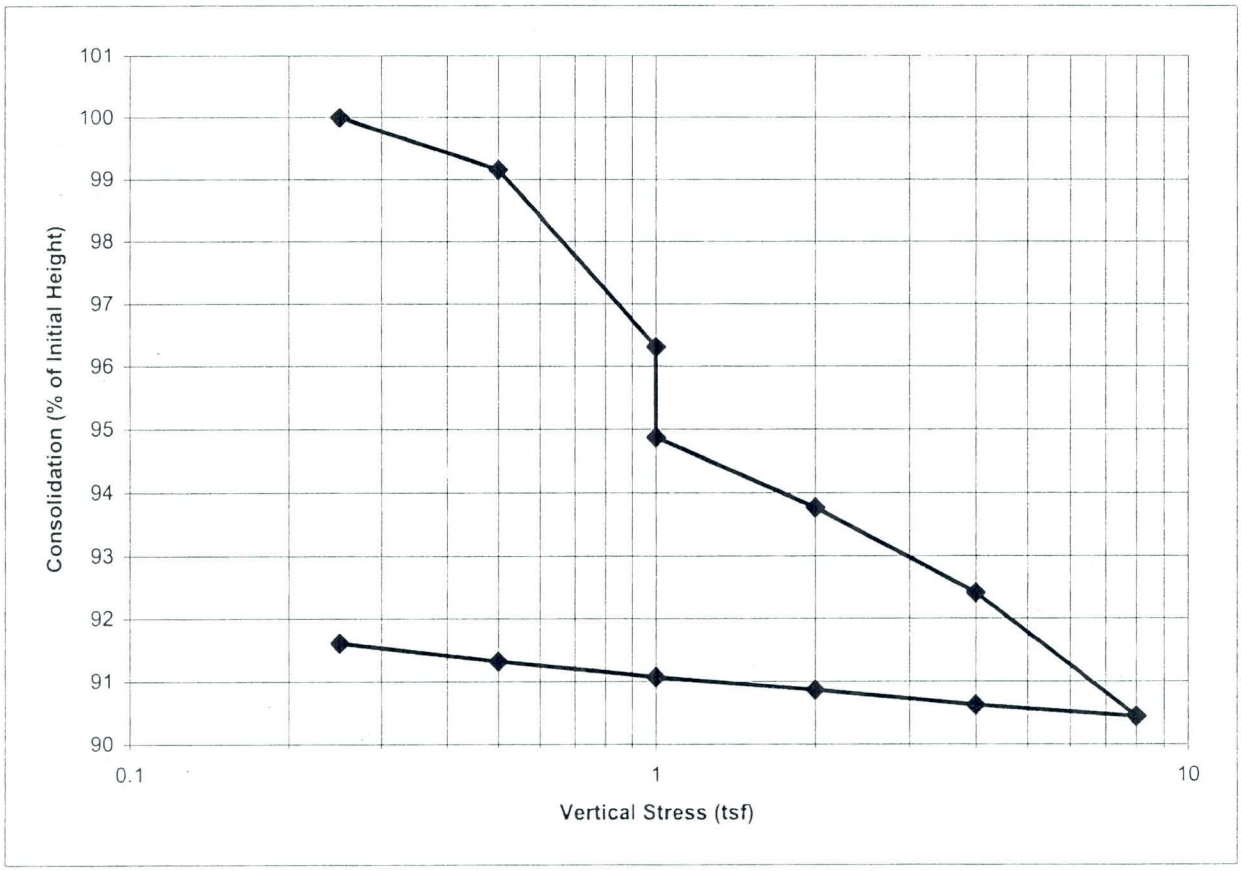
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SP-SM	**LAB NO:**	19
SAMPLE SOURCE:	B-2 @ 7.5-8.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.16
INITIAL MOISTURE CONTENT	4.0%	FINAL MOISTURE CONTENT	16.6%
INITIAL DRY DENSITY(pcf)	114.5	FINAL DRY DENSITY(pcf)	126.1
INITIAL DEGREE OF SATURATION	19%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.63	FINAL VOID RATIO	0.47
ESTIMATED SPECIFIC GRAVITY	2.975	SATURATED AT	1 tsf



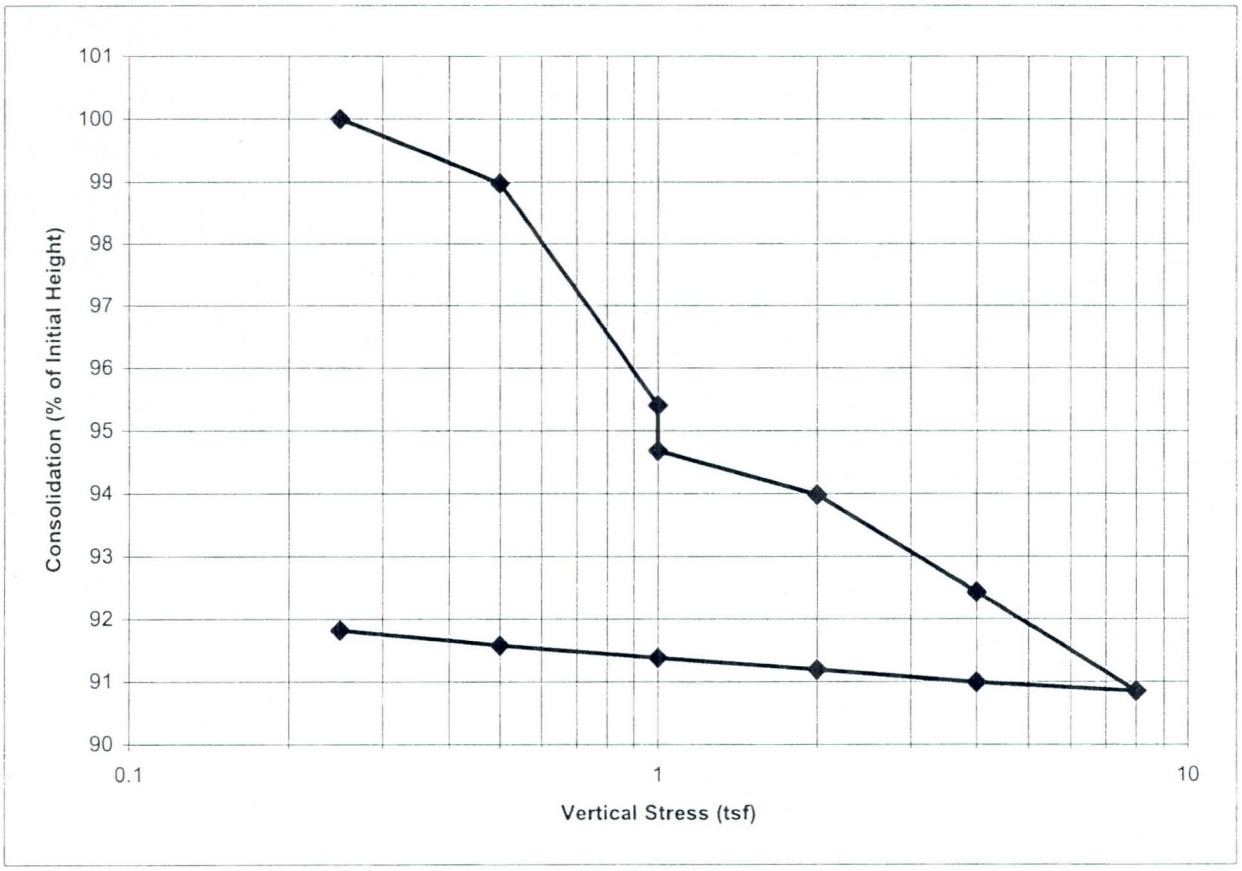
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SM	**LAB NO:**	36
SAMPLE SOURCE:	B-3 @ 14.5-15.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.18
INITIAL MOISTURE CONTENT	11.5%	FINAL MOISTURE CONTENT	21.6%
INITIAL DRY DENSITY(pcf)	106.3	FINAL DRY DENSITY(pcf)	116.5
INITIAL DEGREE OF SATURATION	44%	FINAL DEGREE OF SATURATION	104%
INITIAL VOID RATIO	0.80	FINAL VOID RATIO	0.63
ESTIMATED SPECIFIC GRAVITY	3.050	SATURATED AT	1 tsf



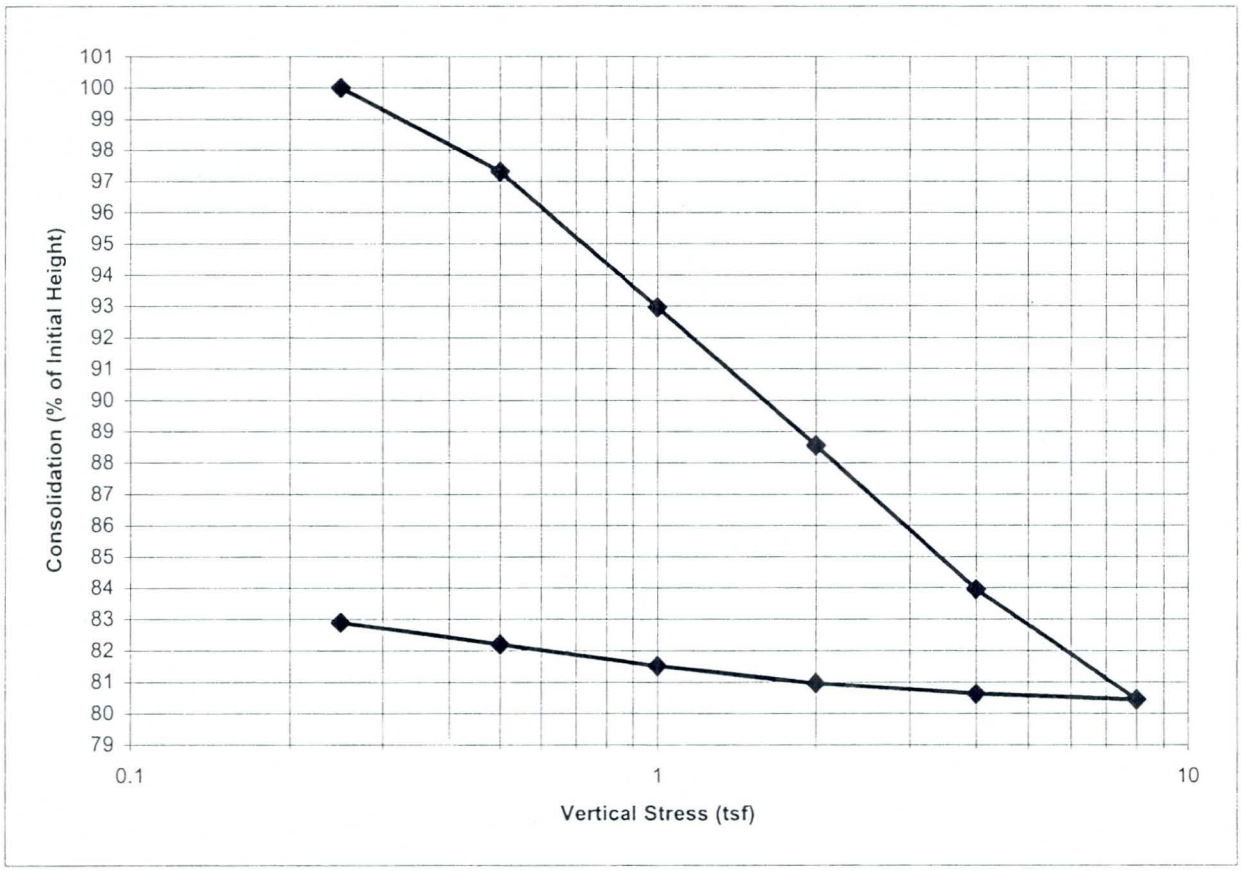
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	45
SAMPLE SOURCE:	B-4 @ 2.5-3.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.70
INITIAL MOISTURE CONTENT	11.6%	FINAL MOISTURE CONTENT	19.2%
INITIAL DRY DENSITY(pcf)	92.7	FINAL DRY DENSITY(pcf)	114.9
INITIAL DEGREE OF SATURATION	37%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.87	FINAL VOID RATIO	0.51
ESTIMATED SPECIFIC GRAVITY	2.775	SATURATED AT	1 tsf



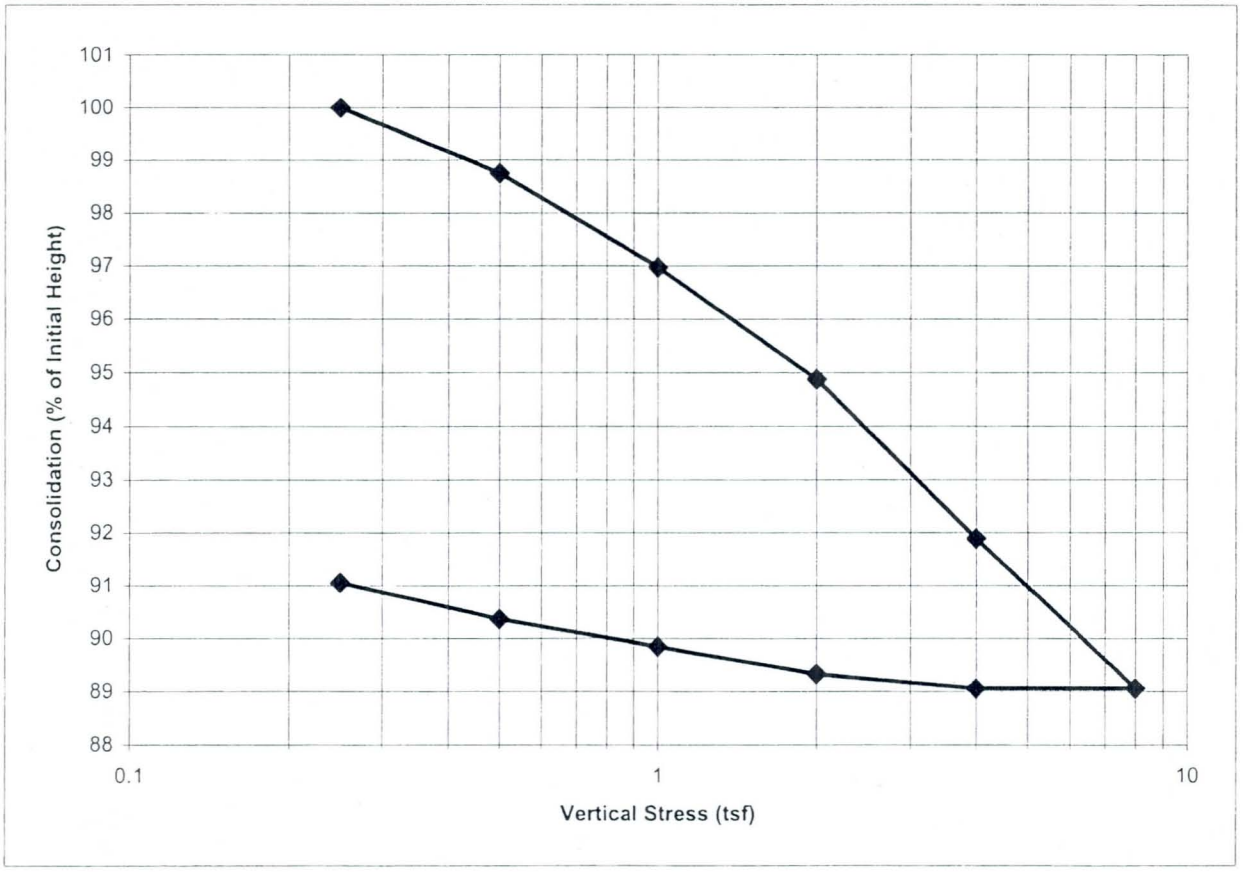
AASHTO R18

REVIEWED BY CG

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	47
SAMPLE SOURCE:	B-4 @ 7.5-8.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.10
INITIAL MOISTURE CONTENT	13.9%	FINAL MOISTURE CONTENT	17.9%
INITIAL DRY DENSITY(pcf)	104.6	FINAL DRY DENSITY(pcf)	117.0
INITIAL DEGREE OF SATURATION	59%	FINAL DEGREE OF SATURATION	104%
INITIAL VOID RATIO	0.66	FINAL VOID RATIO	0.48
ESTIMATED SPECIFIC GRAVITY	2.775	SATURATED AT	1 tsf



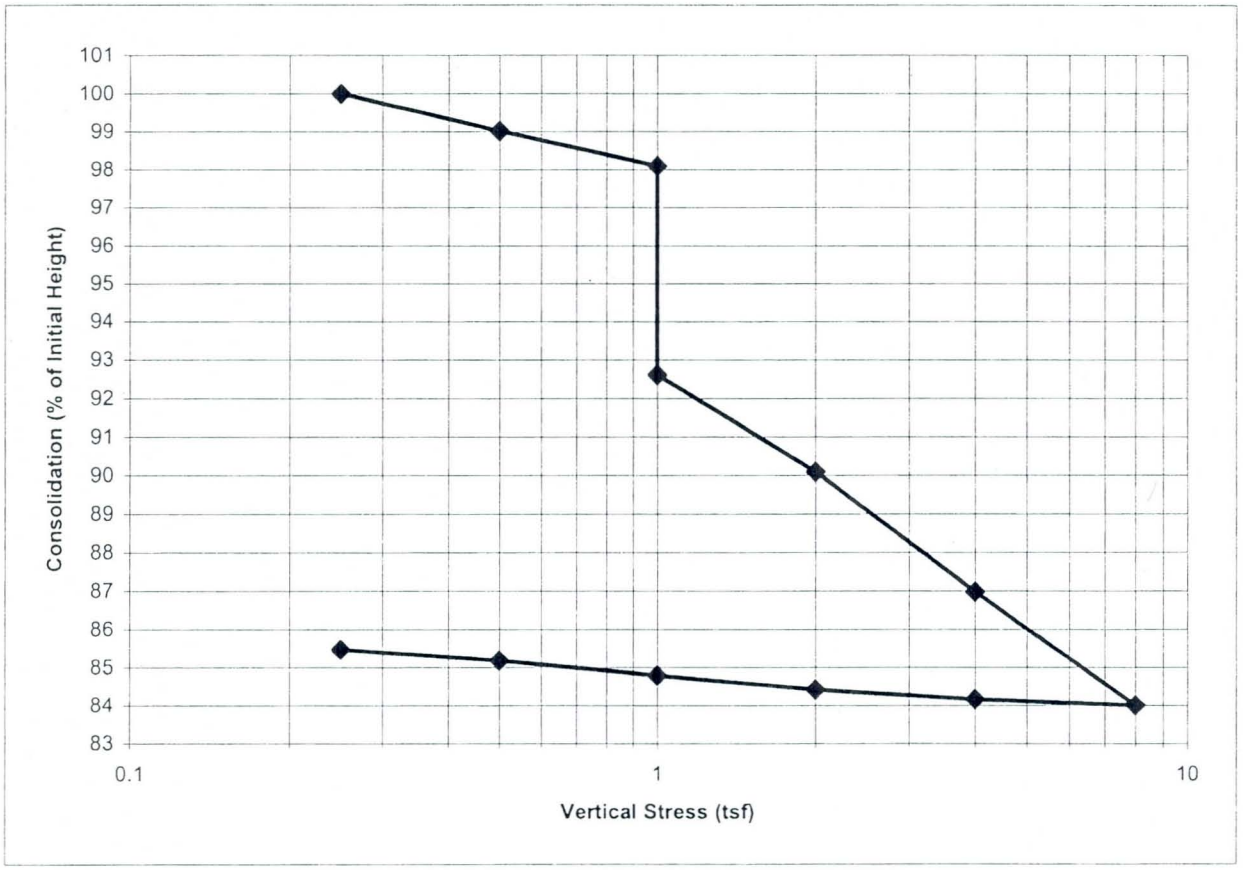
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SM	**LAB NO:**	49
SAMPLE SOURCE:	B-4 @ 12.5-13.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.86
INITIAL MOISTURE CONTENT	8.6%	FINAL MOISTURE CONTENT	13.7%
INITIAL DRY DENSITY(pcf)	104.9	FINAL DRY DENSITY(pcf)	124.4
INITIAL DEGREE OF SATURATION	38%	FINAL DEGREE OF SATURATION	102%
INITIAL VOID RATIO	0.63	FINAL VOID RATIO	0.37
ESTIMATED SPECIFIC GRAVITY	2.725	SATURATED AT	1 tsf



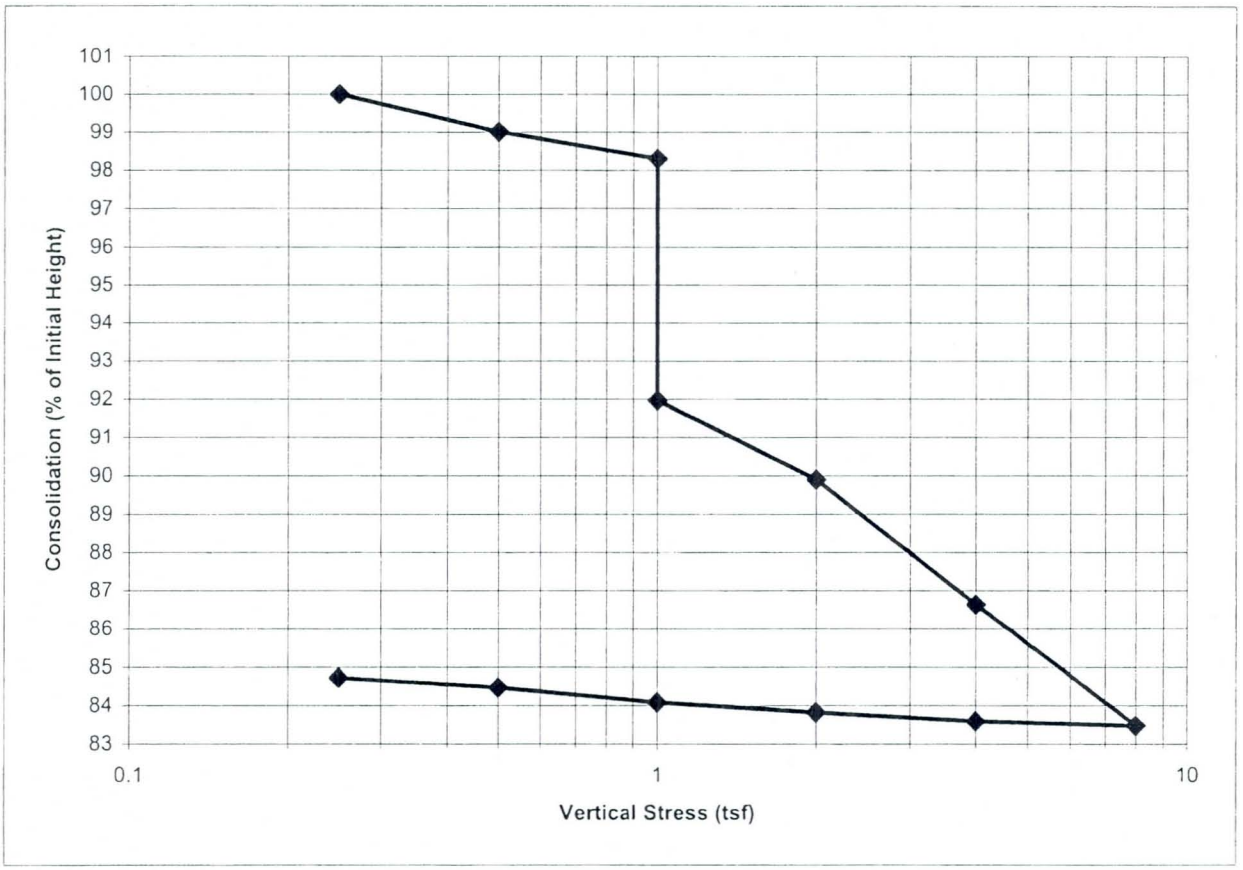
AASHTO R18

REVIEWED BY CG

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SC	**LAB NO:**	61
SAMPLE SOURCE:	B-5 @ 7.5-8.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.84
INITIAL MOISTURE CONTENT	0.7%	FINAL MOISTURE CONTENT	13.9%
INITIAL DRY DENSITY(pcf)	106.5	FINAL DRY DENSITY(pcf)	127.0
INITIAL DEGREE OF SATURATION	3%	FINAL DEGREE OF SATURATION	104%
INITIAL VOID RATIO	0.64	FINAL VOID RATIO	0.37
ESTIMATED SPECIFIC GRAVITY	2.795	SATURATED AT	1 tsf



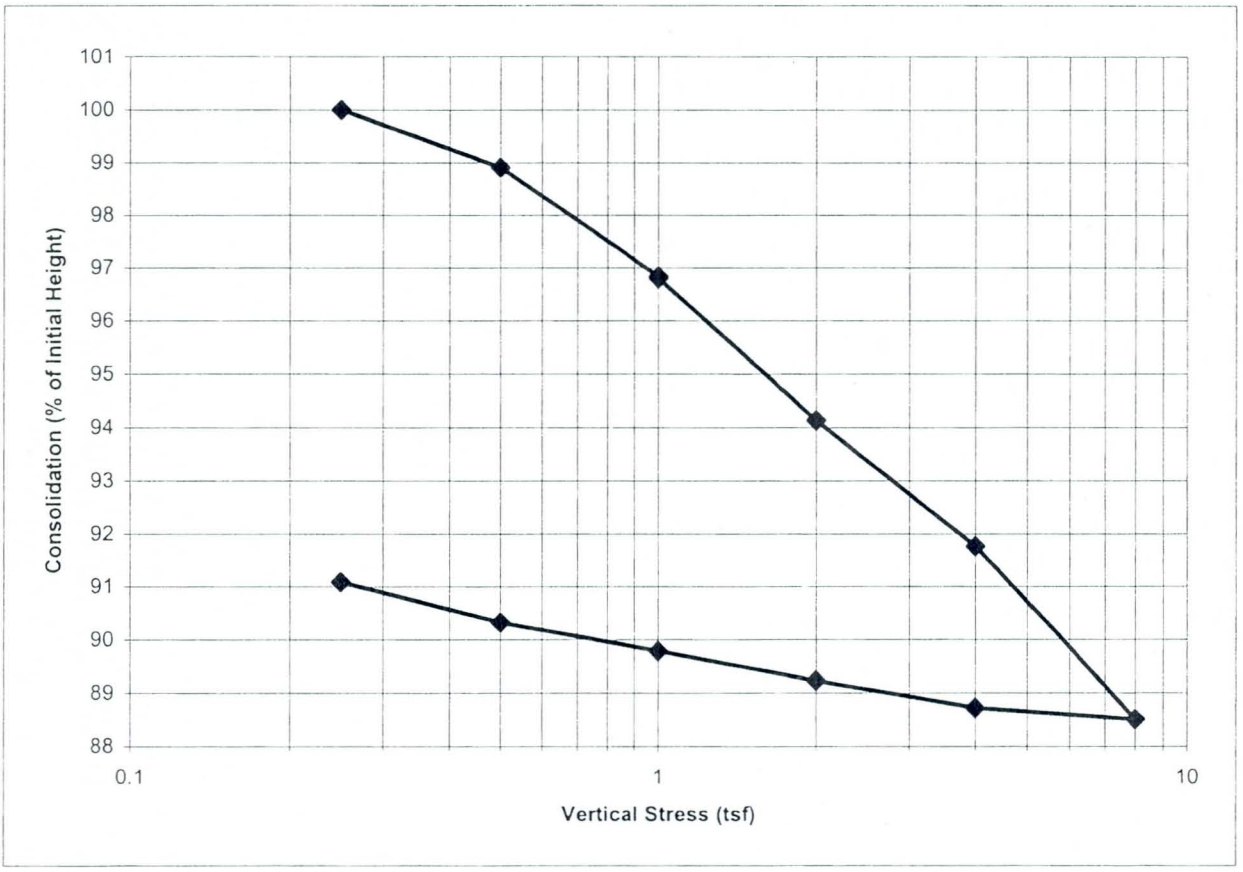
AASHTO R18

REVIEWED BY

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SM	**LAB NO:**	67
SAMPLE SOURCE:	B-5 @ 24.5-25.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.07
INITIAL MOISTURE CONTENT	7.8%	FINAL MOISTURE CONTENT	18.6%
INITIAL DRY DENSITY(pcf)	103.5	FINAL DRY DENSITY(pcf)	116.5
INITIAL DEGREE OF SATURATION	32%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.69	FINAL VOID RATIO	0.50
ESTIMATED SPECIFIC GRAVITY	2.795	SATURATED AT	1 tsf



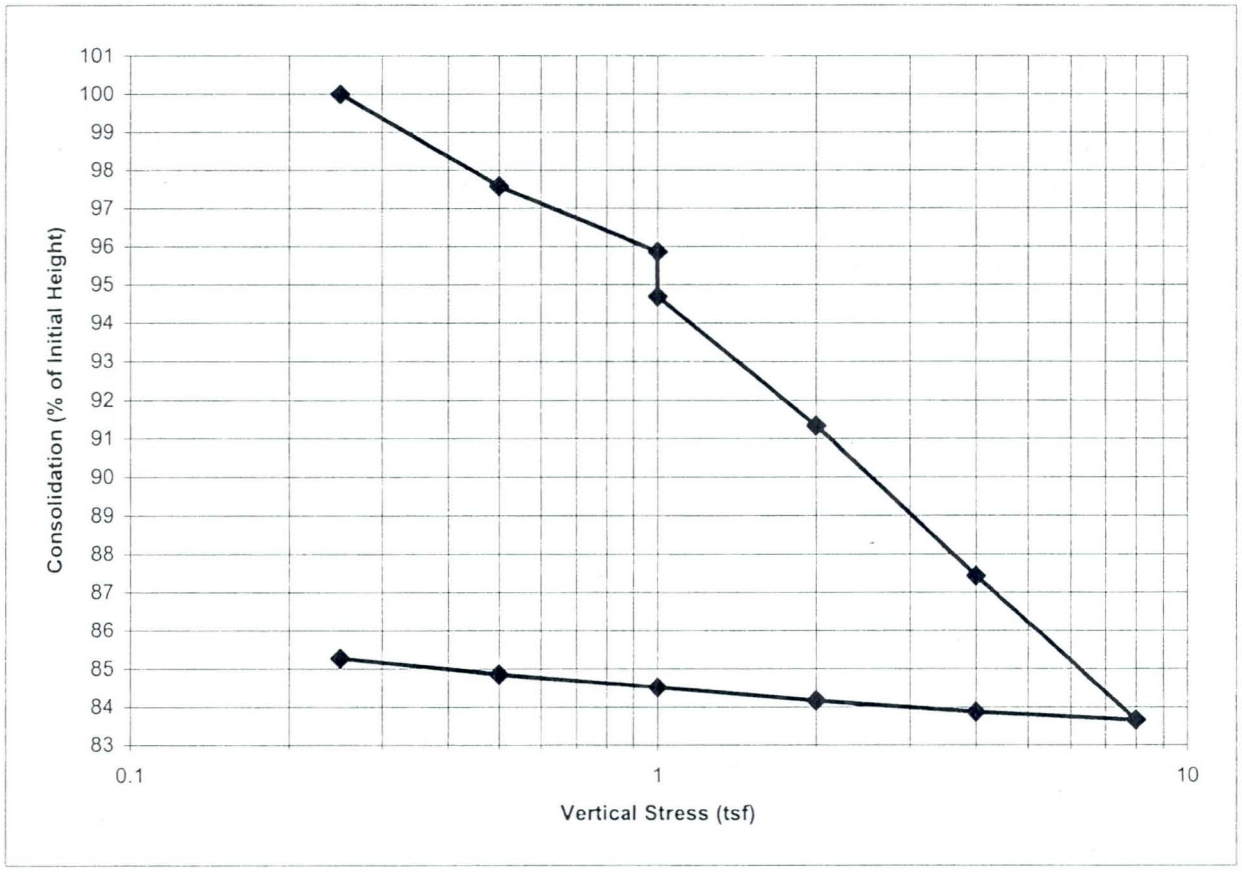
AASHTO R18

REVIEWED BY Cy

PROJECT:	BUCKEYE FRS NO. 1	**JOB NO:**	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	**WORK ORDER NO:**	1
MATERIAL:	SM	**LAB NO:**	73
SAMPLE SOURCE:	B-6 @ 2.5-3.5'	**DATE SAMPLED:**	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.85
INITIAL MOISTURE CONTENT	4.5%	FINAL MOISTURE CONTENT	17.2%
INITIAL DRY DENSITY(pcf)	96.1	FINAL DRY DENSITY(pcf)	114.4
INITIAL DEGREE OF SATURATION	17%	FINAL DEGREE OF SATURATION	103%
INITIAL VOID RATIO	0.73	FINAL VOID RATIO	0.45
ESTIMATED SPECIFIC GRAVITY	2.651	SATURATED AT	1 tsf



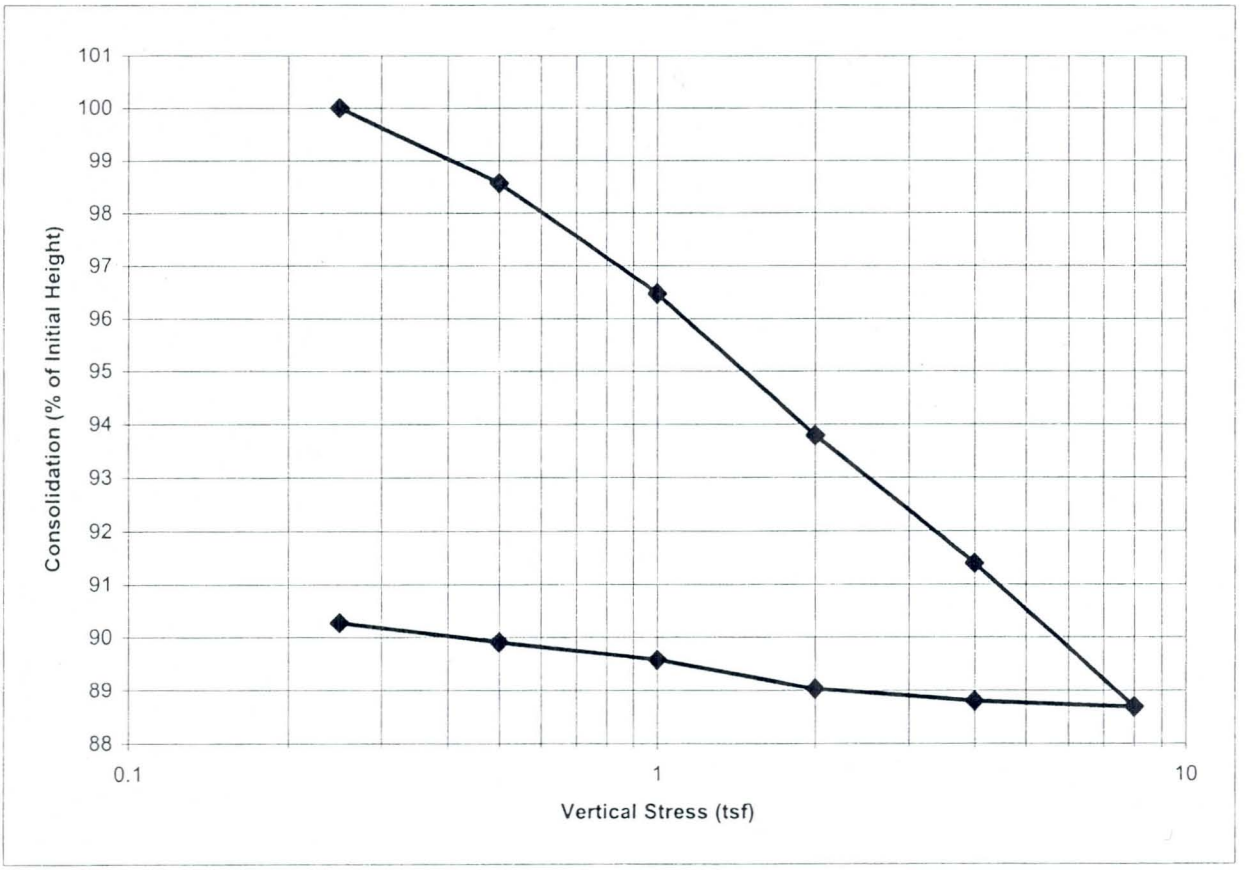
AASHTO R18

REVIEWED BY CG

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	1
MATERIAL:	SM	LAB NO:	76
SAMPLE SOURCE:	B-6 @ 9.5-10.5'	DATE SAMPLED:	2/14/05
SAMPLE PREP:	IN-SITU		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.08
INITIAL MOISTURE CONTENT	1.1%	FINAL MOISTURE CONTENT	14.4%
INITIAL DRY DENSITY(pcf)	102.6	FINAL DRY DENSITY(pcf)	115.3
INITIAL DEGREE OF SATURATION	5%	FINAL DEGREE OF SATURATION	97%
INITIAL VOID RATIO	0.56	FINAL VOID RATIO	0.38
ESTIMATED SPECIFIC GRAVITY	2.551	SATURATED AT	1 tsf



AASHTO R18

REVIEWED BY CG

AMEC Job No. 4-117-001088

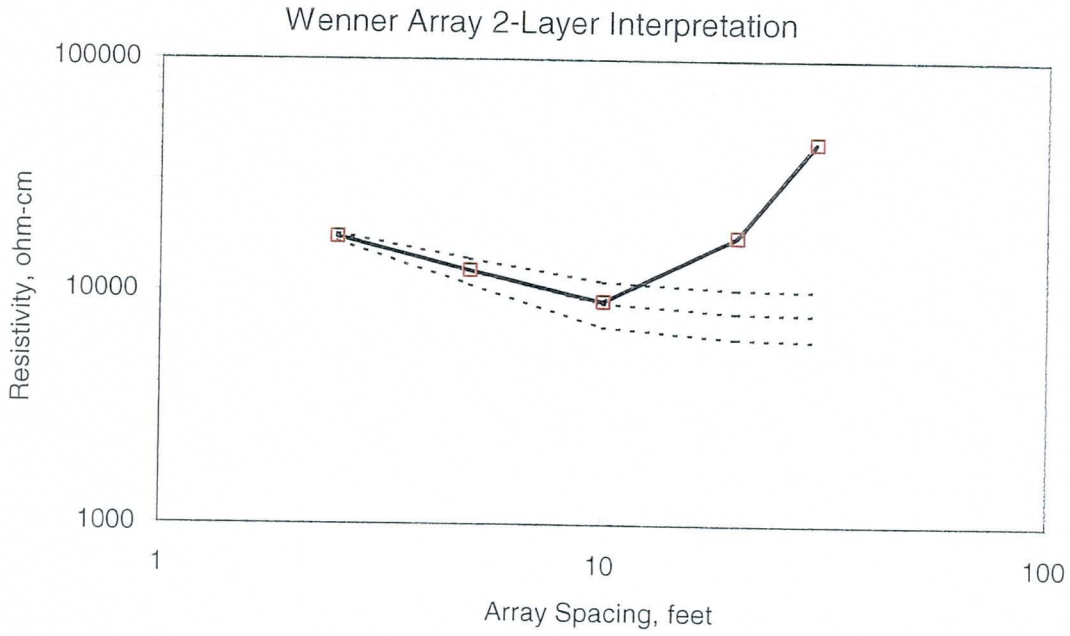
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-1 at Boring B-1 shallow

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	35.81	479	17146
5	12.84	958	12296
10	4.76	1915	9115
20	4.50	3830	17254
30	7.67	5745	44038

RESULTS OF 2-LAYER INTERPRETATION Q2 = -0.43

Layer 1 (surface)	20000	ohm-cm
Interface depth	2.5	feet
Layer 2 (deep)	7972	ohm-cm



AMEC Job No. 4-117-001088

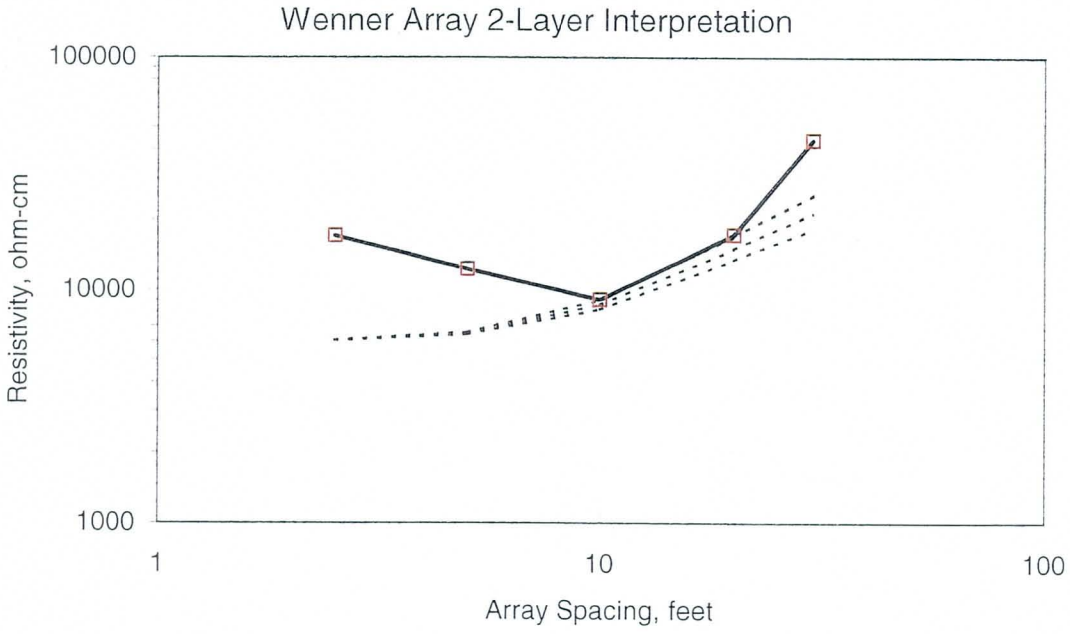
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-1 at Boring B-1 deep

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	35.81	479	17146
5	12.84	958	12296
10	4.76	1915	9115
20	4.50	3830	17254
30	7.67	5745	44038

RESULTS OF 2-LAYER INTERPRETATION Q2 = 0.92

Layer 1 (surface)	6000	ohm-cm
Interface depth	10	feet
Layer 2 (deep)	144000	ohm-cm



AMEC Job No. 4-117-001088

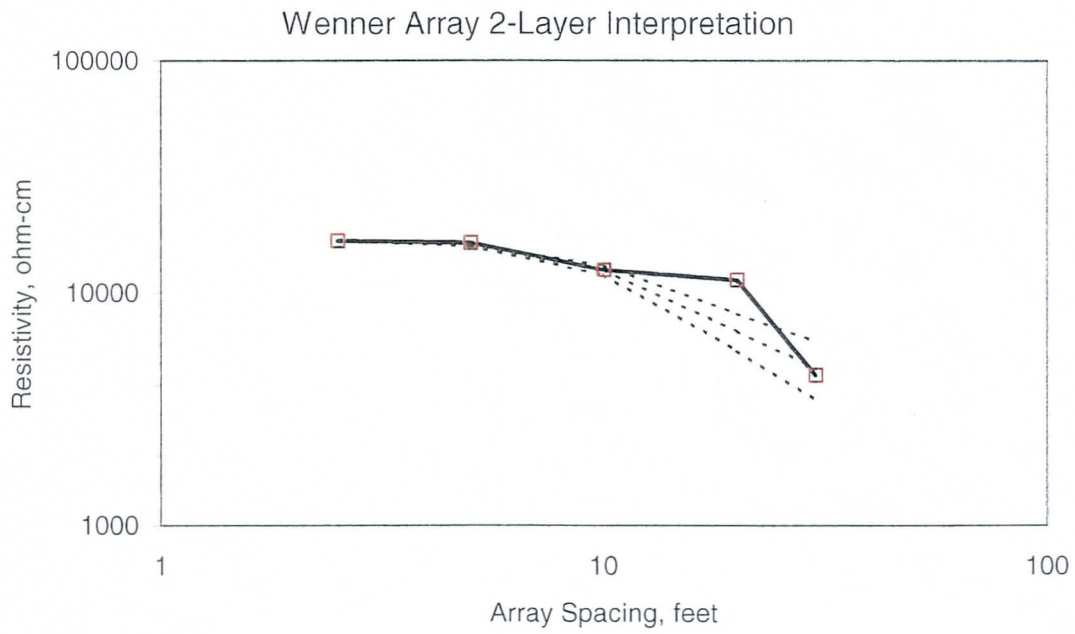
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-2 at Boring B-3

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	34.86	479	16690
5	17.15	958	16424
10	6.55	1915	12537
20	2.97	3830	11362
30	0.77	5745	4447

RESULTS OF 2-LAYER INTERPRETATION Q2 = -0.65

Layer 1 (surface)	17000	ohm-cm
Interface depth	9	feet
Layer 2 (deep)	3606	ohm-cm



AMEC Job No. 4-117-001088

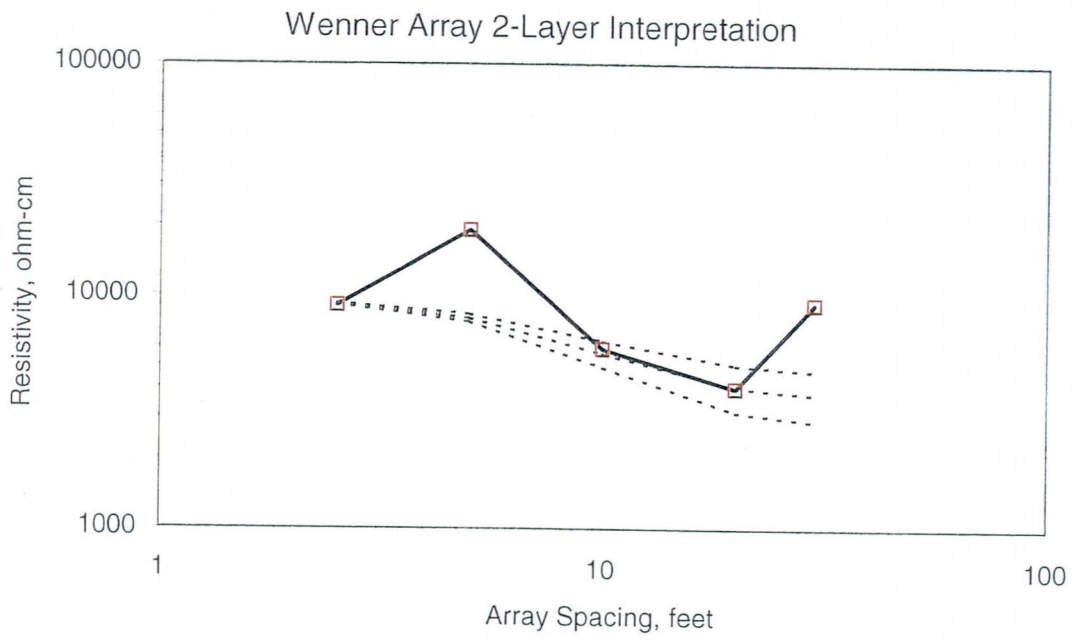
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-3 at Station 624 downstream toe

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	18.92	479	9059
5	19.89	958	19049
10	3.10	1915	5936
20	1.05	3830	4024
30	1.61	5745	9239

RESULTS OF 2-LAYER INTERPRETATION Q2 = -0.45

Layer 1 (surface)	9500	ohm-cm
Interface depth	5	feet
Layer 2 (deep)	3603	ohm-cm



AMEC Job No. 4-117-001088

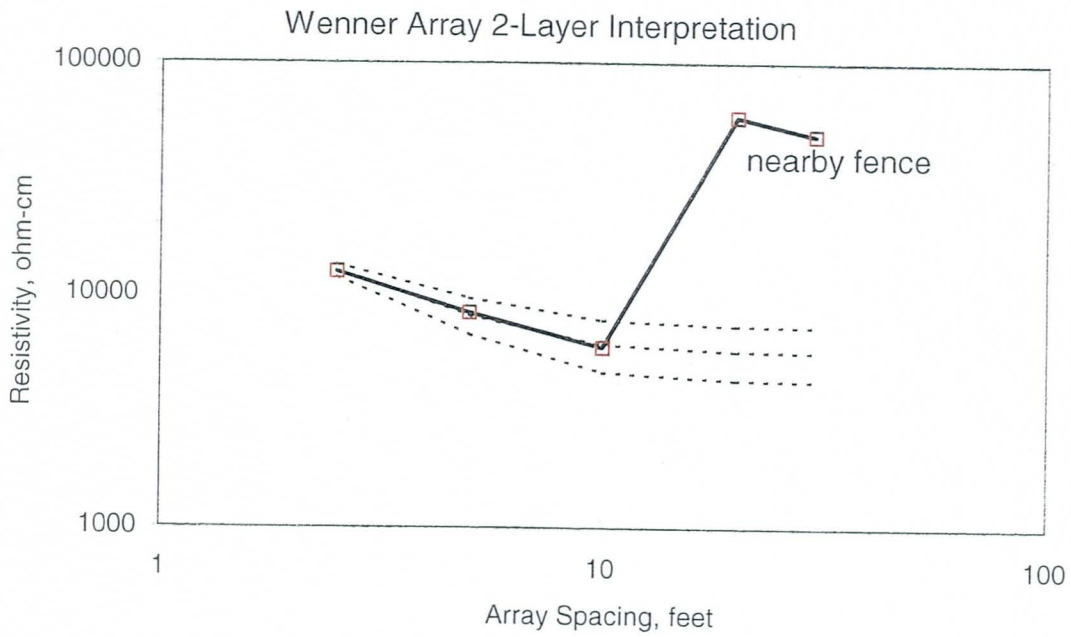
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-4 at Station 673 downstream toe

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	26.24	479	12564
5	8.75	958	8376
10	3.11	1915	5953
20	15.28	3830	58537
30	8.51	5745	48884

RESULTS OF 2-LAYER INTERPRETATION Q2 = -0.5

Layer 1 (surface)	17000	ohm-cm
Interface depth	2	feet
Layer 2 (deep)	5667	ohm-cm



AMEC Job No. 4-117-001088

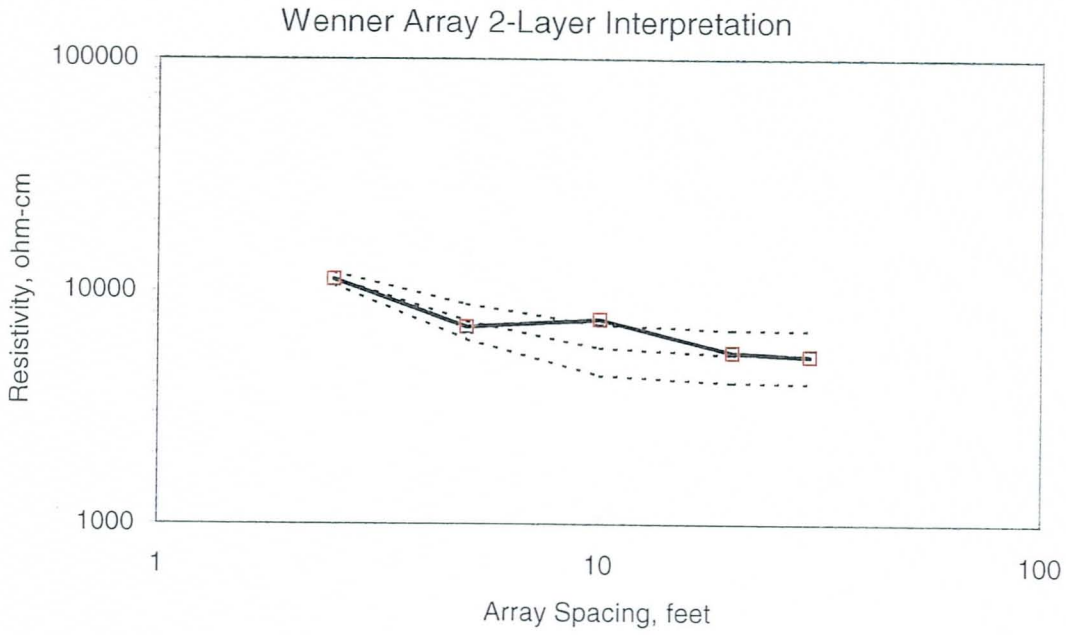
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-5 at Sta 710 downstream toe

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	23.46	479	11233
5	7.33	958	7014
10	3.94	1915	7553
20	1.43	3830	5463
30	0.91	5745	5255

RESULTS OF 2-LAYER INTERPRETATION Q2 = -0.48

Layer 1 (surface)	15000	ohm-cm
Interface depth	2	feet
Layer 2 (deep)	5270	ohm-cm



AMEC Job No. 4-117-001088

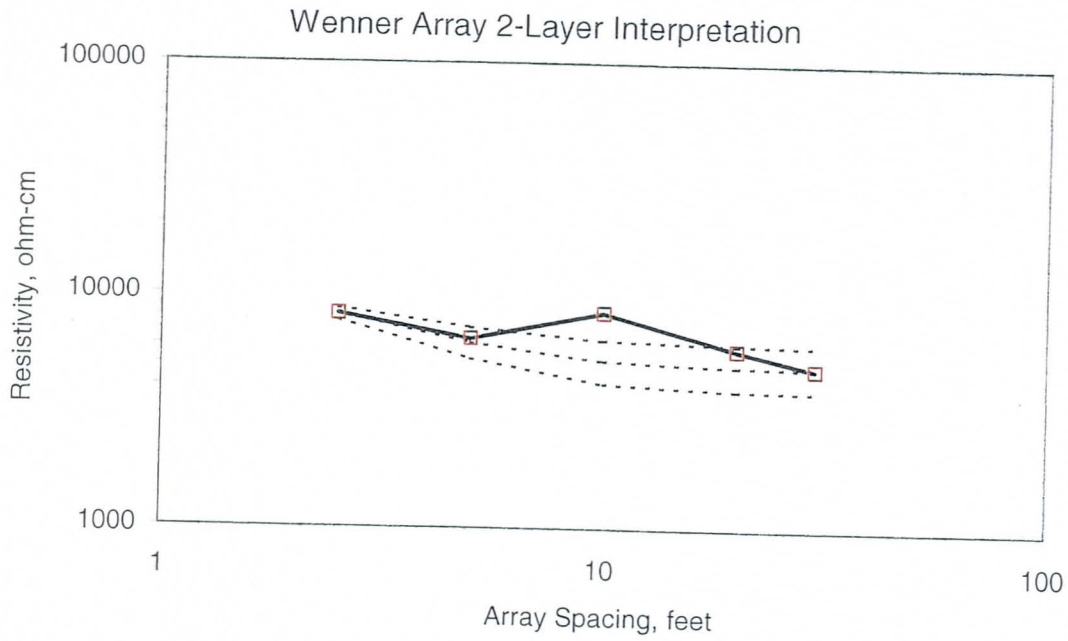
FIELD RESISTIVITY - FOUR POINT WENNER ARRAY METHOD

R-6 at Station 710 upstream toe

Spacing Feet	Resistance ohms	multiplier	Resistivity ohm-cm
2.5	17.20	479	8234
5	6.76	958	6477
10	4.40	1915	8422
20	1.54	3830	5888
30	0.85	5745	4910

RESULTS OF 2-LAYER INTERPRETATION

Layer 1 (surface)	10000	ohm-cm	Q2 =	-0.34
Interface depth	2	feet		
Layer 2 (deep)	4925	ohm-cm		



PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	2
MATERIAL:	SOIL	LAB NO:	85
SAMPLE SOURCE:	MESA MATERIALS	DATE SAMPLED:	3/30/05

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL ANALYSIS

SIEVE SIZE	% PASSING
6in.	100
4in.	100
3in.	100
2in.	100
1 1/2in.	100
1 1/4in.	100
1in.	100
3/4in.	100
1/2in.	100
3/8in.	98
1/4in.	80
#4	75
#8	65
#10	62
#16	52
#30	30
#40	17
#50	10
#100	3
#200	1.9

AASHTO R18

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	3
SAMPLE SOURCE:	SEE BELOW	DATE ASSIGNED:	4/7/05

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

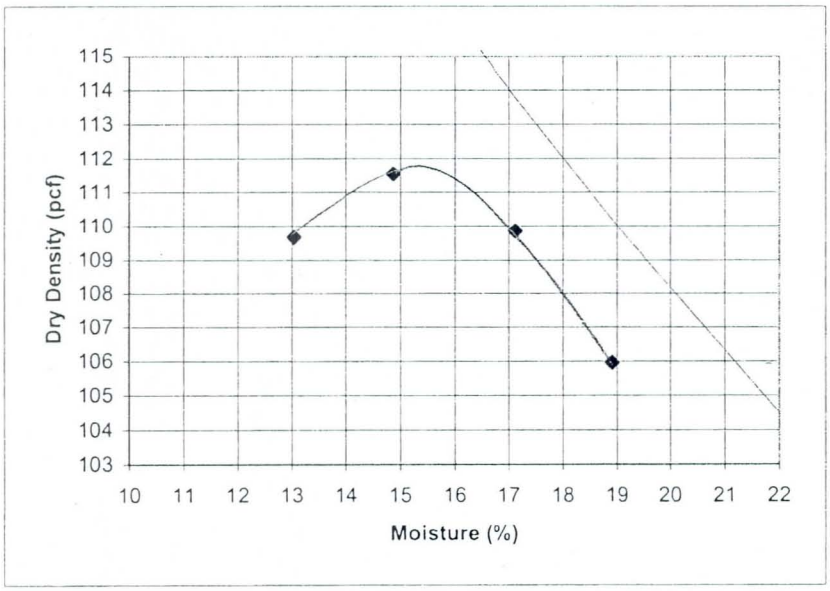
				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	6"	Lab #
PERCENT PASSING BY WEIGHT																							
M-1 @ 624+35				2.6	4	9	16	26	47	59	62	82	91	100	100	100	100	100	100	100	100	100	86
M-2 @ 673+50				2.9	5	11	17	28	49	62	66	83	91	99	100	100	100	100	100	100	100	100	87
M-3 @ 710+47				3.6	6	11	18	28	49	62	66	84	91	100	100	100	100	100	100	100	100	100	88
F-1 @ @ 624+35	SC	27	8	17	26	39	46	53	66	73	75	81	85	94	99	100	100	100	100	100	100	100	89
F-2 @ 673+50	SC	28	8	32	41	52	59	65	76	84	86	93	94	96	97	98	100	100	100	100	100	100	90
F-3 @ 710+47	SC	35	13	40	49	59	65	70	79	85	87	93	94	96	96	97	98	98	100	100	100	100	91
B-1 @ BORROW PIT	SM	37	12	41	50	59	64	69	78	85	87	94	95	97	98	99	99	100	100	100	100	100	92

AASHTO R18

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	3
MATERIAL:	SOIL	LAB NO:	92
SAMPLE SOURCE:	B-1 @ BORROW PIT	SAMPLE DATE:	4/7/05

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	111.7
OPTIMUM MOISTURE (%):	15.3



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	100
1 1/4"	100
1"	99
3/4"	99
1/2"	98
3/8"	97
1/4"	95
#4	94
#8	87
#10	85
#16	78
#30	69
#40	64
#50	59
#100	50
#200	41

ATTERBERG LIMITS

LL:	37
PL:	25
PI:	12
USCS:	SM

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

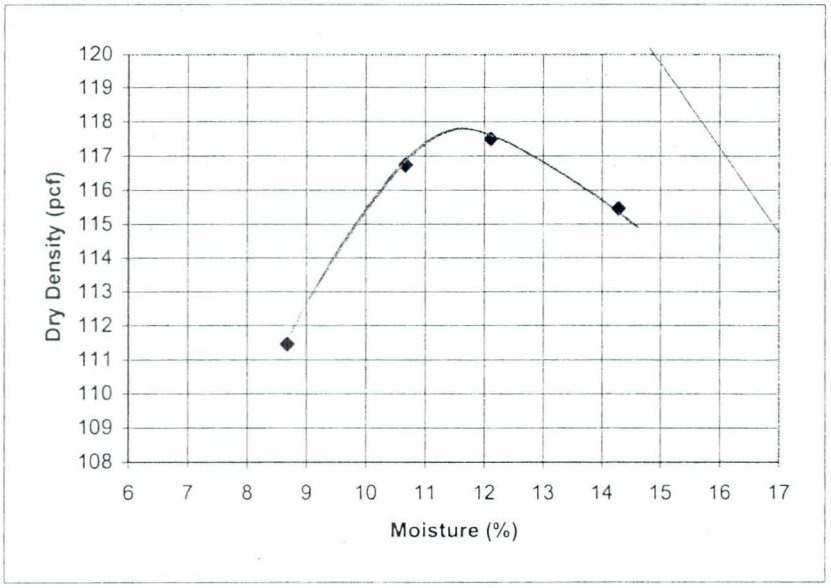
THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	3
MATERIAL:	SOIL	LAB NO:	91
SAMPLE SOURCE:	F-3 @ 710+47	SAMPLE DATE:	4/7/05

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	117.8
OPTIMUM MOISTURE (%):	11.6



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	100
1 1/4"	98
1"	98
3/4"	97
1/2"	96
3/8"	96
1/4"	94
#4	93
#8	87
#10	85
#16	79
#30	70
#40	65
#50	59
#100	49
#200	40

ATTERBERG LIMITS

LL:	35
PL:	22
PI:	13
USCS:	SC

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.675 ASSUMED.

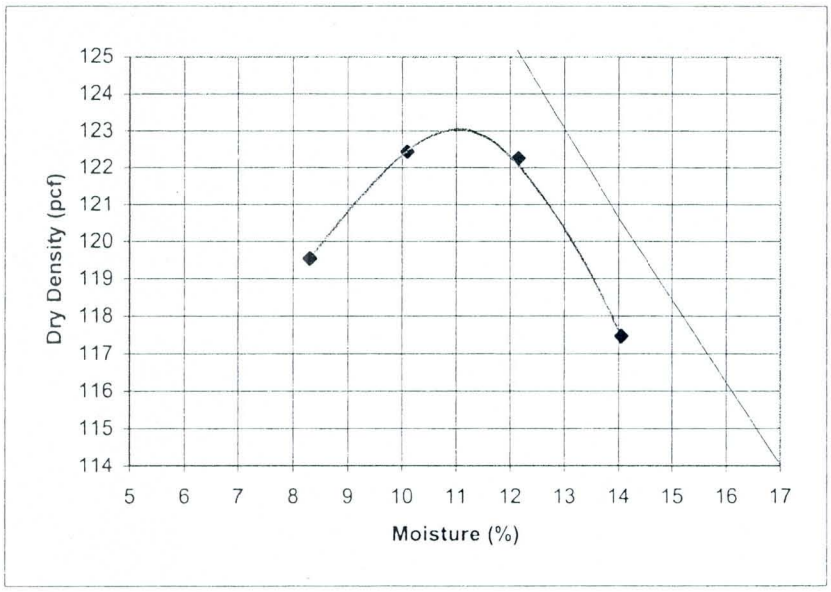
THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	3
MATERIAL:	SOIL	LAB NO:	90
SAMPLE SOURCE:	F-2 @ 673+50	SAMPLE DATE:	4/7/05

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	123.0
OPTIMUM MOISTURE (%):	11.1



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2".	100
1 1/2"	100
1 1/4"	100
1"	100
3/4"	98
1/2"	97
3/8"	96
1/4"	94
#4	93
#8	86
#10	84
#16	76
#30	65
#40	59
#50	52
#100	41
#200	32

ATTERBERG LIMITS

LL:	28
PL:	20
PI:	8
USCS:	SC

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

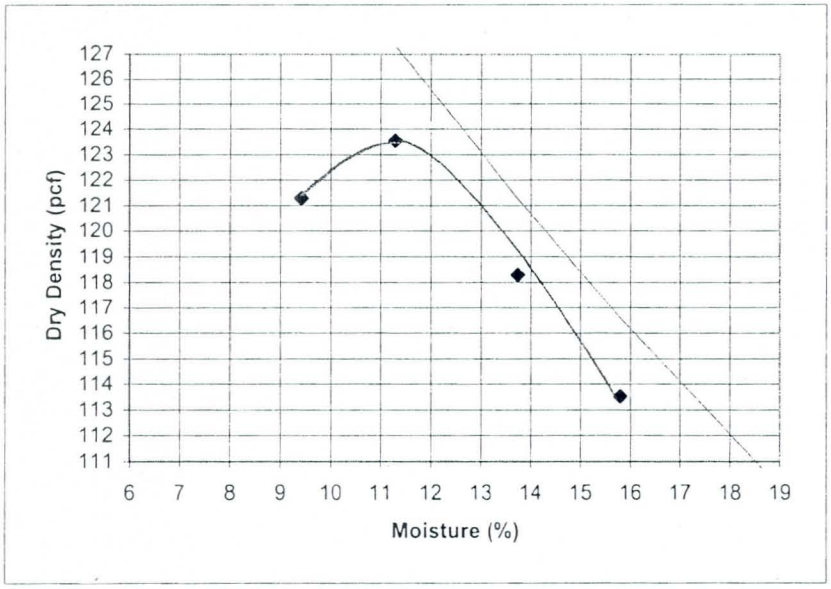
THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

PROJECT:	BUCKEYE FRS NO. 1	JOB NO:	4-117-001088
LOCATION:	MARICOPA COUNTY, ARIZONA	WORK ORDER NO:	3
MATERIAL:	SOIL	LAB NO:	89
SAMPLE SOURCE:	F-1 @ @ 624+35	SAMPLE DATE:	4/7/05

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	123.6
OPTIMUM MOISTURE (%):	11.3



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	100
1 1/4"	100
1"	100
3/4"	100
1/2"	99
3/8"	94
1/4"	85
#4	81
#8	75
#10	73
#16	66
#30	53
#40	46
#50	39
#100	26
#200	17

ATTERBERG LIMITS

LL:	27
PL:	19
PI:	8
USCS:	SC

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

APPENDIX E

EXCAVATION BACKFILL & DAM REPAIR

April 19, 2005
AMEC Job No. 4-117-001088
Report No. 1

County of Maricopa
Flood Control District
2801 West Durango Street
Phoenix, Arizona 85009

Attention: Brett A. Howey, P.E.

RE: BUCKEYE FRS NO. 1
MARICOPA COUNTY, ARIZONA

Transmitted herewith are Daily Progress Reports on observations performed at the above-referenced project over the period of April 11-14, 2005.

Should you have any questions concerning this report, please do not hesitate to call.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

COPY

Marty Verquer
Field Supervisor

G:\Materials\Projects\2004\41171088\Field Reports\Report No 1.doc

AMEC Earth & Environmental, Inc.
1405 West Auto Drive
Tempe, Arizona 85284-1016
Tel +1 (480) 940-2320
Fax +1 (480) 785-0970

amec

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	1		
Project Name	Buckeye Frs. No. 1	Date:	04/11/05	Time:	6:30am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation of Embankment Cracking	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
446B Cat Rubber Tire Backhoe
140G CAT Blade
Vibratory Plate (see attached photos)
Water Truck
(4) Operators
(4) Laborers

SCOPE:

FCD crews prepped for work. Met with crews to discuss procedures for the project. Cleaning of area 710+47 took all of the day. Brett Howey with MCFCD was out to observe progress. Cleaning of the slope was done manually with brooms and shovels. FCD crews also mixed native material, moisture contents tested within specifications of -3 to +1 of optimum moisture. Pictures were taken of progress. Cracks No. 22-23) were filled with sand filter material (2 buckets (5 gals.)), and a vibratory plate over the cracks 3 times. Will resume tomorrow.

RESULTS:

NOTIFICATION:

Notes/Comments: Weather was in the high 70s, slight breeze and sunny.

AMEC Representative: Matt Manthey/B.B. Panda

amec

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	2		
Project Name	Buckeye Frs. No. 1	Date:	04/12/05	Time:	7:00am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation of Embankment Cracking	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Water Truck
(3) Operators
(7) Laborers

SCOPE:

FCD crews continued to clean slope of embankment for crack filling. Finished filling cracks at 11:00 am. Pictures were taken and filter blanket was started at 10:30 am. Total forty-five, 5-gallon buckets of sand were placed in the cracks for area 710+47. Laborer crew moved to next section to begin cleaning process. Loader finished placement of filter blanket, depth checked periodically within 12 inches +1- an inch. Material was placed from top of dam down. Pictures were taken. Blade (140G Cat) continued blending native material for backfill. Labor crew continued cleaning in area 670+53. Toe of dam - roadway area backfill began, only a few loads placed before end of shift at 2:00 pm.

RESULTS:

NOTIFICATION:

Notes/Comments: Weather was in the low 80s, calm breeze and sunny.

AMEC Representative: Matt Manthey

amec

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	**4-117-001088**	Report No:	**3**		
Project Name	**Buckeye Frs. No. 1**	Date:	**04/13/05**	Time:	**6:30am**
Project Location	**I-10 and Sun Valley Parkway**				
Services Requested	**Observation of Embankment Cracking**	By:	**MCFCD**		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Water Truck
(3) Operators
(8) Laborers

SCOPE:

FCD crews continued on area 710+47 backfill. Test was taken on toe of dam to check rolling pattern. Blade operator notified of moisture needed and it will be taken care of. Backfill continued throughout the day. Four insitu density tests were taken with nuclear gauge. Pictures were taken. Cleaning crew finished area 670+35. Moved to area 624+53 and began cleaning. Bill W./MCFCD was out to observe activities.

RESULTS:

Test met specifications with exception of moisture @ 4% of optimum. Density tests met project specifications.

NOTIFICATION:

Notes/Comments:

Weather was in the high 80s, slight breeze and clear.

AMEC Representative: Matt Manthey

amec

Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	04/13/05
		Report Number	3

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	Sta. 710+47, Toe of Dam	04/13/05	-2'	0	114.3	7.8	117.8	7.8	**97**	**95**	F-3
2	Sta. 710+47, Toe of Dam	"	-2'	0	113.9	8.9	117.8	8.9	**97**	**95**	F-3
3	Sta. 710+47/Toe/Slope of Dam	"	-1'	0	112.2	7.6	117.8	7.6	**95**	**95**	F-3
4	Sta. 710+47, Slope of Dam	"	0'	0	115.6	10.8	117.8	10.8	**98**	**95**	F-3

* DEPTH OF REFERENCE POINT: Existing Embankment

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	4		
Project Name	Buckeye Frs. No. 1	Date:	04/14/05	Time:	9:00am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation of Embankment Cracking	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Water Truck
(3) Operators
(8) Laborers

SCOPE:

FCD crews continued to work on embankment repair at Station 710+47. Backfill operation continued. Two insitu density tests were performed with nuclear gauge. Pictures were taken at Station 624+35. Crew continued to clean surface of debris and will possibly finish on Monday 4/18/05. Dan Michael/MCFCD was out to check on progress.

RESULTS:

Tests met specifications.

NOTIFICATION:

Notes/Comments:

AMEC Representative: Matt Manthey

amec

Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	04/18/05
		Report Number	4

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	710+47, Slope of Dam, Lift @ -3' 1/2 Way Up Dam	04/14/05	-3'	0	113.0	7.9	117.8	7.9	**96**	**95**	F-3
2	710+47, Slope of Dam, Lift @ -2' 1/2 Way Up Dam	"	-2'	0	118.1	8.1	117.8	8.1	**100+**	**95**	F-3

* DEPTH OF REFERENCE POINT: Existing Grade and Dam

amec

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	5		
Project Name	Buckeye Frs. No. 1	Date:	04/18/05	Time:	9:00am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation of Dam Crack Repair	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Vibratory Plate (see attached photo)
Water Truck
(3) Operators
(8) Laborers

SCOPE:

Met with Frank/AMEC who is taking over the observation duties on this project. He was briefed on procedures and introduced to the MCFCD team. Pictures were taken of area 670+53 - sand filter crack repair. Ten 5-gallon buckets of sand were used. Four 5-loader buckets were used for the test pit. Vibratory plate was passed over cracks as well as in the test pit. Embankment fill continued at area 710+47.

RESULTS:

NOTIFICATION:

Notes/Comments: Weather was sunny, low 80s and slight breeze (0-5 mph).

AMEC Representative: Matt Manthey

04/18/2005

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	6		
Project Name	Buckeye Frs. No. 1	Date:	04/18/05	Time:	9:30am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Density Testing of Dam Crack Repair	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Water Truck

SCOPE:

Matt/AMEC and I went to all three sites, 710+47, 670+53 and 624+35. Matt explained the problems with the dam and the solution to repair it. I stayed at site 710+47 and observed the 950G Cat Loader backfill and wheel roll compact in the center section of the dam. I also observed the 140G Cat Grader and the water truck blending the native material to obtain the proper moisture context for the backfill.

RESULTS:

NOTIFICATION: Mike (MCFCD)

Notes/Comments: Weather was sunny and warm.

AMEC Representative: Frank Jurecki

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	7		
Project Name	Buckeye Frs. No. 1	Date:	04/19/05	Time:	9:30am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation/Testing of Dam Crack Repair	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	1	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
140G CAT Blade
Water Truck
(3) Operators

SCOPE:

The 950G Cat Loader was backfilling the upper center portion of the dam. The water truck and the 140G Cat Grader were blending the native material with water. Matt/AMEC arrived on site and took 1 insitu density test using nuclear gauge on embankment fill at area 710+47. Observed the compacting of embankment fill on upstream slope and crest.

RESULTS:

Test met minimum compaction requirements. Moisture was a little low.

NOTIFICATION:

Mike (MCFCD)

Notes/Comments:

Weather was sunny, low 80s and windy (10-15 mph).

AMEC Representative:

Matt Manthey

Project	**Buckeye Frs. No. 1**	Job Number	**4-117-001088**
Location	**I-10 and Sun Valley Parkway**	Date	**04/19/05**
		Report Number	7

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	710+47, Top of Dam -3'	04/19/05	-3'	0	114.7	6.2	117.8	6.2	**97**	**95**	F-3

* DEPTH OF REFERENCE POINT: 0

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	8		
Project Name	Buckeye Frs. No. 1	Date:	04/20/05	Time:	9:30am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Density Testing of Dam Crack Repair	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	1	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

950G Cat Loader
928G Cat Loader
140G CAT Blade
(2) Water Trucks
(5) Operators

SCOPE:

Work continued on area 710+47. Loader was finishing placement of embankment fill. Performed 1 insitu density test using nuclear gauge on fill at top of embankment structure. B. B. Panda/AMEC was at the site. The 950 Cat Loader was finishing the crest of the dam and was completed by early afternoon. Water truck and 140G Cat Grader were blending backfill. The 928 Cat Loader is placing sand on the face of site 670+53 to a depth of 12 inches. The 140G Grader moved to 670+53 and started to blend backfill material. The 140G Cat Grader then went to site 624+35 and cut down the toe to make it smoother.

RESULTS:

Test met project specifications.

NOTIFICATION:

Mike (MCFCD)

Notes/Comments:

AMEC Representative:

Matt Manthey/Frank Jurecki

amec

Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	04/20/05
		Report Number	8

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	710+47 Embank. Fill, Top Lift,Top of Dam Section	04/20/05	0	0	112.7	7.8	117.8	7.8	**96**	**95**	F-3

* DEPTH OF REFERENCE POINT: Existing Grade

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	9		
Project Name	Buckeye Frs. No. 1	Date:	04/27/05	Time:	10:00am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Compaction Testing	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	4	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS: 95% Compaction Requirement w/-3+1% of optimum moisture: 8.1-12.1

STRUCTURE: Berm Repair, Sec. 1 (673+10 - 673+80), Sec 2 (623+80 - 625+30)

PRODUCT: Native 123.0 @ 11.1

SCOPE: Performed 4 density tests using nuclear gauge, observed backfill of upstream slope with embankment material and took pictures.

RESULTS: Test met project specifications.

NOTIFICATION: Mike (MCFCD)

Notes/Comments:

AMEC Representative: Zach Manthey

amec

Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	04/27/05
		Report Number	9

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6
1	Native	123.0	11.1

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	Berm Repair @ Sta. 673+50 (mid-way up berm)	04/27/05	-6"	0	123.9	9.4	123.0	9.4	**100+**	**95**	1
2	Berm Repair @ Sta. 673+20 (mid-way up berm)	"	-6"	0	123.6	11.1	123.0	11.1	**100+**	**95**	1
3	Berm Repair @ Sta. 625+05 (bottom of berm)	"	-2'	0	124.5	9.1	123.0	9.1	**100+**	**95**	1
4	Berm Repair @ Sta. 624+45 (bottom of berm)	"	-2'	0	122.6	9.1	123.0	9.1	**100**	**95**	1

* DEPTH OF REFERENCE POINT: Finished Grade

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	10		
Project Name	Buckeye Frs. No. 1	Date:	04/28/05	Time:	9:00am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Observation	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests		Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS:

STRUCTURE:

EQUIPMENT:

928G Cat Loader
950G Cat Loader
140G CAT Grader
Water Truck

SCOPE:

FCD crew had two loaders filling material near the crest of Sta. 670+53. I talked to operator, Roy Arnold, and he said that Sta. 670+53 would be finished today. I went to Sta. 624+35. FCD had 140G Cat Grader mixing material. FCD crew already filled the toe of Sta. 624+35. I checked depth of sand (about 1 foot). At 10:30, Dan Michaels of FCD sent the two loader operators to another job. The water truck broke down so the grader operator had to stop mixing material. Mike Winkler said the job was stopped at 12 noon. A crew may be on-site on Saturday, April 30, 2005.

RESULTS:

NOTIFICATION: Mike (MCFCD)

Notes/Comments: Weather overcast and breezy.

AMEC Representative: Frank E. Jurecki

amec

DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	11		
Project Name	Buckeye Frs. No. 1	Date:	05/02/05	Time:	9:15am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Compaction Testing	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	3	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS: 95% Compaction Requirement w/-3+1% of optimum moisture: 8.1-12.1

STRUCTURE: Berm Repair, Sec. 1 (673+10 - 673+80)

EQUIPMENT:
950G Cat Loader
140G CAT Blade
Water Truck
(3) Operators

PRODUCT: Native 123.0 @ 11.1

SCOPE: Performed 3 density tests, observed and Frank took pictures. FCD had three operators working to finish the dam's crest. Zach/AMEC arrived and took 3 density tests on 670+53. I went to look at site 624+35 and additional work had been done on the toe of the dam over the weekend. The 140G Cat Grader moved to site 624+35 and smoothed the toe section then started to mix the backfill material. The 950 G Cat Loader moved to site 624+35 and began to work on toe of the dam.

RESULTS: Test met project specifications.

NOTIFICATION: Mike (MCFCD)

Notes/Comments:

AMEC Representative: Zach Manthey/Frank Jurecki

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Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	05/02/05
		Report Number	11

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6
1	Native	123.0	11.1

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	Berm Repair @ Sta. 673+60 (lower half of berm)	05/02/05	0	0	127.0	8.5	123.0	8.5	**100+**	**95**	1
2	Berm Repair @ Sta. 673+30 (lower half of berm)	"	0	0	116.9	8.7	123.0	8.7	**95**	**95**	1
3	Berm Repair @ Sta. 673+45 (midway of berm)	"	0	0	119.4	9.6	123.0	9.6	**97**	**95**	1

* DEPTH OF REFERENCE POINT: Finished Grade

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	**4-117-001088**	Report No:	12		
Project Name	**Buckeye Frs. No. 1**	Date:	**05/09/05**	Time:	**1:00pm**
Project Location	**I-10 and Sun Valley Parkway**				
Services Requested	**Compaction Testing**	By:	**MCFCD**		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	5	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS: 95% Compaction Requirement w/-3+1% of optimum moisture: 8.1-12.1

STRUCTURE: Berm Repair, Sec. 1 (673+10 - 673+80); Sec. 2 (623+80 - 625+30)

PRODUCT: Native 123.0 @ 11.1

SCOPE: Performed 5 density tests using nuclear gauge and took pictures of area worked.

RESULTS: Test met project specifications.

NOTIFICATION: Mike (MCFCD)

Notes/Comments:

AMEC Representative: Zach Manthey

amec

Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	05/09/05
		Report Number	12

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6
1	Native	123.0	11.1

SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	Berm Repair @ Sta. 673+30 (bottom of berm)	05/09/05	0	0	127.1	7.9	123.0	7.9	**100+**	**95**	1
2	Berm Repair @ Sta. 673+45 (middle of berm)	"	0	0	116.3	10.8	123.0	10.8	**95**	**95**	1
3	Berm Repair @ Sta. 673+60 (top of berm)	"	0	0	117.9	9.4	123.0	9.4	**96**	**95**	1
4	Berm Repair @ Sta. 625+00 (bottom of berm)	"	-6"	0	121.8	8.3	123.0	8.3	**99**	**95**	1
5	Berm Repair @ Sta. 624+00 (bottom of berm)	"	-6"	0	122.3	8.6	123.0	8.6	**99**	**95**	1

* DEPTH OF REFERENCE POINT: Finished Grade

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DAILY PROGRESS REPORT

SERVICES SCHEDULED

Project Number	4-117-001088	Report No:	13		
Project Name	Buckeye Frs. No. 1	Date:	05/18/05	Time:	11:30am
Project Location	I-10 and Sun Valley Parkway				
Services Requested	Compaction Testing	By:	MCFCD		

SERVICES PERFORMED

SOIL/ABC		CONCRETE		ASPHALT		MASONRY	
Sandcone tests		Concr, volume		AC placement (tons)		# of grout prisms	
Nuclear tests	1	Sets of cyl.		Nuclear tests		# of mortar specimens	
Spec. Insp		# of cylinders		# of samples		# of masonry prisms	
Testing Only		# of cores		# of cores		Special Inspection	
Footing Insp		Spec. Insp.		Observation & testing		Testing only	
Caisson Insp.		Testing only		Testing only		Sample pickup	
Sample pickup		Monitor slump		Other			
		Sample pickup					

SPECIFICATIONS: 95% Compaction Requirement w/-3+1% of optimum moisture: 8.1-12.1

STRUCTURE: Berm Repair, Sec. 1 (673+10 - 673+80)

PRODUCT: Native 123.0 @ 11.1

SCOPE: Performed 1 insitu density test by nuclear gauge at the site of backfilled test pit on downstream side. Took picture of the constructed downsteam toe.

RESULTS: Test met project specifications.

NOTIFICATION: Mike (MCFCD)

Notes/Comments:

AMEC Representative: Larry Matthews

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Project	Buckeye Frs. No. 1	Job Number	4-117-001088
Location	I-10 and Sun Valley Parkway	Date	05/18/05
		Report Number	13

DENSITY OF SOIL IN PLACE BY THE SAND CONE METHOD (ASTM D1556, AAHSTO T217 & T224)
DENSITY OF SOIL IN PLACE BY THE NUCLEAR METHOD (ASTM D2922 & D3017)

CURVES:

	DESCRIPTION:	DENS. (PCF)	MOIST (%)
F-3	Native	117.8	11.6
1	Native	123.0	11.1

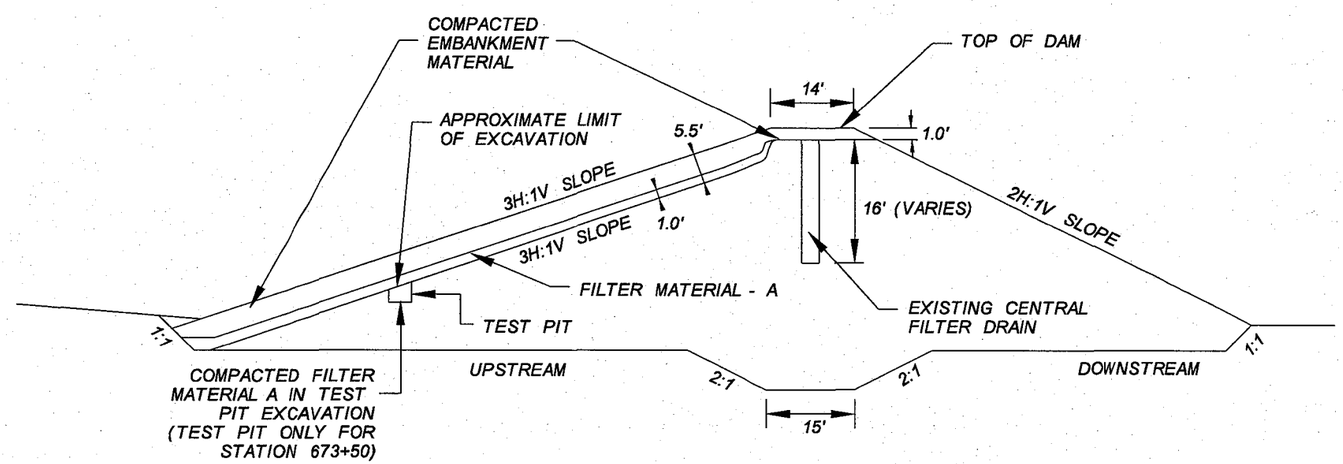
SAND CONE TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve

NUCLEAR TESTS:

Test #	Location	Date	Elevation*	Rock (%)	Dry Density (pcf)	Moisture (%)	Maximum Density	Corrected Moisture (%)	Compaction (%)	Required Compaction	Curve
1	Berm Repair @ Sta. 637+50	05/18/05	FG	0	120.1	9.8	123.0	9.8	**98**	**95**	1

* DEPTH OF REFERENCE POINT: Finished Grade



CROSS-SECTION

JOB NO.	4-117-001088
DESIGN:	BB
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

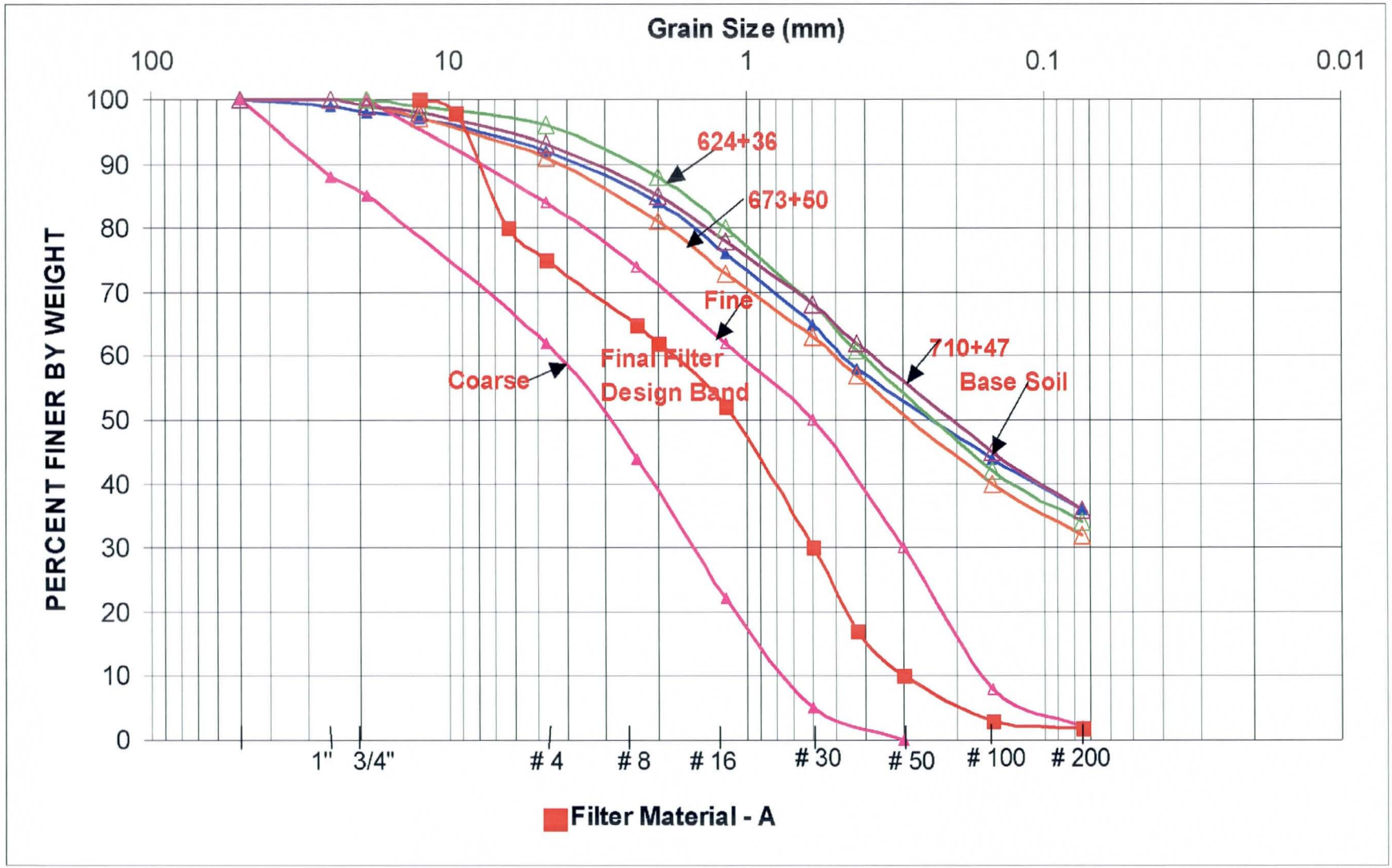
CONSTRUCTED INTERIM DAM SAFETY MEASURES
TYPICAL CROSS-SECTION

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO. 1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-1

amec

G:\Engineering Department \2004 Projects\4-117-001088 Buckeye Supplemental \Cadd\Figure E-2.dwg



JOB NO.	4-117-001088
DESIGN:	BB
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

FILTER MATERIAL

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-2

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VIEW OF EXISTING UPSTREAM SLOPE BEFORE EXCAVATION

VIEW OF EXCAVATION OF UPSTREAM SLOPE

VIEW OF EXCAVATED AREA OF UPSTREAM SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 710+47

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-3

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VIEW OF CLEANING OF EXCAVATED AREA

VIEW OF THE CRACK OPENING AFTER CLEANING

VIEW OF CRACK OPENING FILLED BY FILTER MATERIAL

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 710+47

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-4

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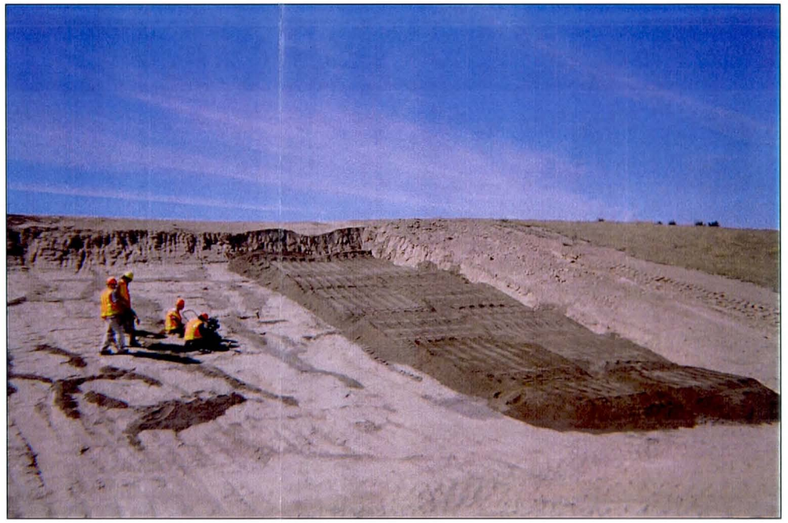
VIEW OF THE INFILLING OF CRACK WITH THE HELP OF VIBRATORY PLATE

VIEW OF INFILLING OF MAJOR CRACK OPENING EXPOSED ON THE EXCAVATED SLOPE AREA



VIEW OF PLACEMENT OF 1-FOOT THICK FILTER MATERIAL ON EXCAVATED SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
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SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-5

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VIEW OF FIELD DENSITY TEST ON COMPACTED EMBANKMENT MATERIAL PLACED ABOVE THE FILTER MATERIAL

VIEW OF COMPACTION OF EMBANKMENT MATERIAL TO RECONSTRUCT UPSTREAM SLOPE

VIEW OF THE RECONSTRUCT UPSTREAM SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF STATION 710+47

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-6

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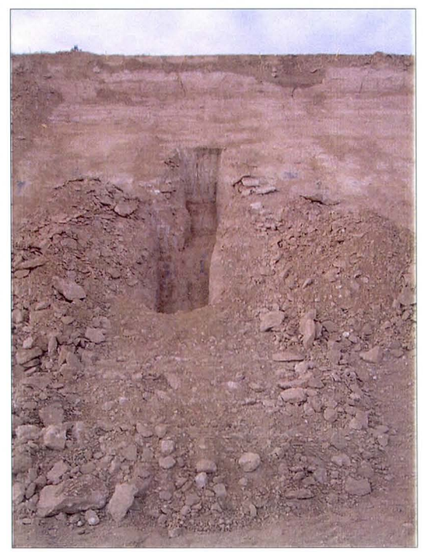
VIEW OF EXISTING UPSTREAM SLOPE BEFORE EXCAVATION

VIEW OF (EXCAVATED AREA OF) UPSTREAM SLOPE

VIEW OF EXCAVATION OF TEST PIT ON UPSTREAM SLOPE



VIEW OF TEST PIT UPSTREAM SLOPE

VIEW OF EXPOSED CRACK ON WALL
OF TEST PIT ON UPSTREAM SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 673+50

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-7

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VIEW OF CLEANING OF EXCAVATED AREA

VIEW OF THE CRACK OPENING FILLED BY FILTER MATERIAL

VIEW OF BACKFILLING OF TEST PIT ON UPSTREAM SLOPE BY COMPACTED FILTER MATERIAL

JOB NO. 4-117-001088	SELECT PHOTOGRAPHS OF STATION 673+50		amec
DESIGN: REW			
DRAWN: GWH	SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS BUCKEYE FRS NO.1 CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5	FIGURE	
DATE: 5/2005		E-8	
SCALE: N.T.S.			

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VIEW OF PLACEMENT OF 1-FOOT THICK FILTER MATERIAL ON EXCAVATED SLOPE

VIEW OF COMPACTION OF EMBANKMENT MATERIAL TO RECONSTRUCT UPSTREAM SLOPE

VIEW OF THE RECONSTRUCT UPSTREAM SLOPE

JOB NO. 4-117-001088	SELECT PHOTOGRAPHS OF STATION 673+50		amec
DESIGN: REW			
DRAWN: GWH	SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS BUCKEYE FRS NO.1 CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5	FIGURE E-9	
DATE: 5/2005			
SCALE: N.T.S.			

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VIEW OF THE RECONSTRUCT UPSTREAM CREST & SLOPE

VIEW OF TEST PIT EXCAVATED ON DOWNSTREAM TOE

VIEW OF BACKFILLING OF TEST PIT ON DOWNSTREAM TOE BY COMPACTED FILTER MATERIAL

VIEW OF COMPACTION OF EMBANKMENT SOIL ON TOP OF TEST PIT ON DOWNSTREAM SLOPE TO BACKFILL THE TEST PIT

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 673+50

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-10

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VIEW OF EXISTING UPSTREAM SLOPE BEFORE EXCAVATION

VIEW OF EXCAVATED AREA OF UPSTREAM SLOPE

VIEW OF PLACEMENT OF 1-FOOT THICK FILTER MATERIAL ON EXCAVATED SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 624+35

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-11

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VIEW OF PREPARATION OF EMBANKMENT MATERIAL

VIEW OF PLACEMENT OF EMBANKMENT MATERIAL ON TOP OF FILTER MATERIAL ON UPSTREAM SLOPE

VIEW OF PLACEMENT OF COMPACTED EMBANKMENT MATERIAL ON UPSTREAM SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF
STATION 624+35

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE
E-12

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VIEW OF FILED DENSITY TEST ON COMPACTED EMBANKMENT MATERIAL PLACED ABOVE THE FILTER MATERIAL

VIEW OF RECONSTRUCTED UPSTREAM SLOPE

VIEW OF RECONSTRUCTED UPSTREAM CREST & SLOPE

JOB NO.	4-117-001088
DESIGN:	REW
DRAWN:	GWH
DATE:	5/2005
SCALE:	N.T.S.

SELECT PHOTOGRAPHS OF STATION 624+35

SUPPLEMENTAL INVESTIGATION OF TRANSVERSE CRACKS
BUCKEYE FRS NO.1
CONTRACT FCD 2003C014, WORK ASSIGNMENT NO. 5

FIGURE E-13

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