SUN VALLEY AREA DRAINAGE MASTER PLAN

Preliminary Geologic/Geotechnical Investigation

Flood Control District of Maricopa County

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Dear Mr. Fuller:

Re: Preliminary Geologic/Geotechnical Investigation
Sun Valley Area Drainage Master Plan
Maricopa County, Arizona

Submitted herewith is the Preliminary Geologic/Geotechnical Investigation Report for the Sun Valley Area Drainage Master Plan, Maricopa County, Arizona.

Should you have any questions concerning the findings presented in this report, please contact one of the undersigned at your convenience.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

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ENCLOSED DATA CD INCLUDES:

- **Digital Copy of Report in PDF Format**
- **Photographs of Test Pits**

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SECTION 1: INTRODUCTION

A preliminary geologic/geotechnical investigation of the Sun Valley Area Drainage Master Plan (SVADMP) study area was conducted to characterize approximately 20 alluvial fan apex sites, existing stream channels/washes and areas up-gradient of the apex sites by AMEC Earth & Environmental, Inc. (AMEC). The purpose of this characterization was to provide general recommendations related to basins, channels, levees and other structures that may be included in the alternatives being evaluated by JE Fuller Hydrology and Geomorphology, Inc. (JE Fuller) for the Flood Control District of Maricopa County (District).

1.1 Project Description

The purpose of the SVADMP is to develop a conceptual drainage plan to serve as a roadmap that jurisdictional authorities and developers can use in planning flood control measures to mitigate flood hazards up to the 100-year event. The SVADMP incorporates development plans for the area and jurisdictional drainage policies to develop a preferred regional flood control solution.

The major objectives of the project include the following:

- Preparation of approximate alluvial fan floodplain delineations, and meeting Federal Emergency Management Agency (FEMA) and District standards, for those alluvial fans in the study area not previously delineated;
- Coordination between the ADMP regional flood control measures and the design of drainage features within the master planned community developments within the study area;
- Preparation of preliminary design of flood control facilities in areas not within master planned communities;
- Design of landscape aesthetics and visual character in accordance with the District's *Landscape Aesthetics and Multi-Use Consultant Handbook (April 2003)*; and
- Submittal of all contract deliverables in accordance with the District's *Consultant Guidelines (Third Edition – December 1, 2003 – Revision 1).*

Previously, the Phase I Buckeye/Sun Valley Area Drainage Master Study (ADMS), conducted by PBS&J, documented and analyzed existing conditions and identified drainage and flooding problems in the study area for the purpose of initial formulation of flood protection alternatives. The Phase II Sun Valley Area Drainage Master Plan builds on the Phase I findings by employing a 3-step process with the goal of developing a Recommended Alternative, consisting of both structural and non-structural measures, to address flood hazards in the study area.

The study area is located in western Maricopa County, Arizona and includes a total watershed area of 183 square miles. Figure 1 shows the location of the project study area. Most of the study area is located within the Town of Buckeye. The study area is bounded by the White Tank Mountains and Trilby Wash on the east, the Hassayampa River on the west, the Buckeye Flood Retarding Structures on the south and Gates Road to the north (see Sheet 1). The watercourses within the study area are all tributaries to the Hassayampa River or the Buckeye Flood Retarding Structures, except Fan 2 which is a tributary to Trilby Wash.

The purpose of the preliminary geologic/geotechnical investigation is to characterize approximately 20 alluvial fan apex sites, existing stream channels/washes and areas up-gradient of the apex sites for purposes of providing general recommendations related to basins, channels, levees and other structures that may be included in the alternatives being evaluated. The apex sites of primary concern to this investigation are located in the vicinity of the White Tank Mountains, and are generally at or near the mountain front. Due to their geographical locations, this study focused on six sub-areas within the overall study area: 1) CAP Sub-Area, 2) Wagner Wash Sub-Area, 3) Hassayampa Sub-Area, 4) White Tank Wash Sub-Area, 5) FRS 1 Sub-Area, and 6) FRS 2 & 3 Sub-Area. The sub-areas designations based on the outfall locations and the alluvial fans discharging to a particular outfall location, and are shown on Sheet 1.

This report summarizes the geologic and geotechnical conditions in the vicinity of the apex sites provided by JE Fuller and provides general engineering guidelines for use in the alternatives selection process.

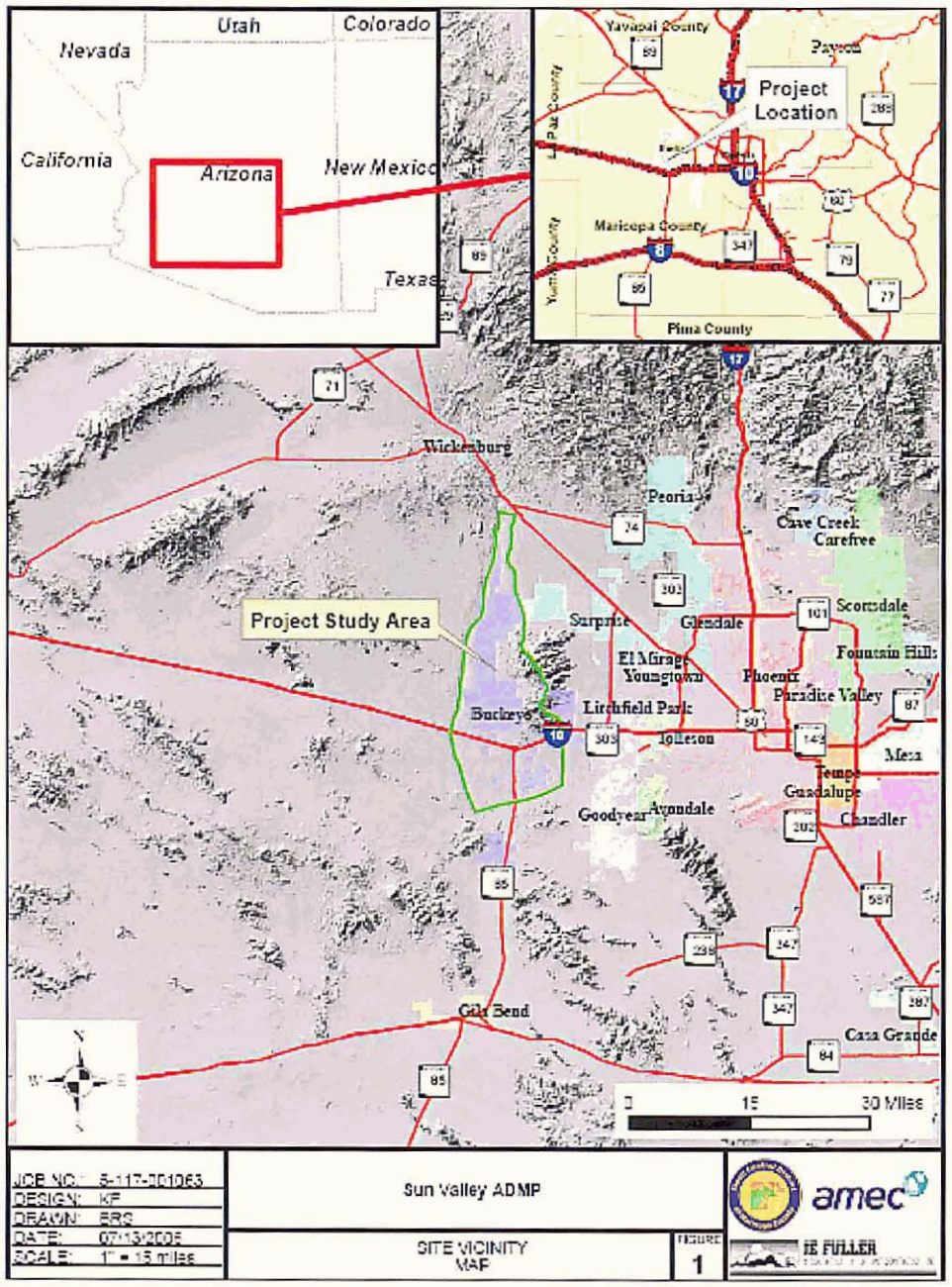

Figure 1.1

Site Vicinity Map

SECTION 2: INVESTIGATIVE APPROACH

The following discussion summarizes the investigative methods and data sets compiled for this preliminary investigation. The approach includes five basic components: 1) review of existing data and past analyses; 2) geologic reconnaissance; 3) exploratory test pits; 4) seismic refraction and ReMi shear wave profiling; and 5) laboratory testing.

2.1 Review of Existing Data and Past Analyses

The applicable data and past evaluations originate from three sources: published technical literature, regulatory agency databases, and internal District files. The published resources include regional geological and geohydrological studies. As of the publication of this report, the geohydrological study being conducted for the Town of Buckeye is not available for review. The literature review included GIS analyses of existing datasets pertaining to the study area, as well as a literature review of published Arizona Geological Survey (AZGS) geologic maps. Reports reviewed include *Surficial geology around the White Tank Mountains, Central Arizona* (Field and Pearthree, 1991), *Geologic mapping of flood hazards in Arizona: An example from the White Tanks Area, Maricopa County* (Field and Pearthree, 1992), *Map of Quaternary and Upper Tertiary Alluvium in the Phoenix South 30'X60' Quadrangle, Arizona* (Demsey, 1989) and *Geologic map of the White Tanks Mountains, Central Arizona* (Reynolds and others, 2002).

2.2 Geologic Reconnaissance

With the aid of aerial photography and published geological maps, apex sites were visited during the test pit and seismic portions of the investigation. An overview of the geology of the study area is shown in Sheet 1 and a more detailed presentation of the geology is shown on Sheets 2 through 8. Geologic reconnaissance was conducted by Kenneth Fergason, P.G. of AMEC with the aid of Karen Anglin and Michael Rucker, P.E., both of AMEC.

2.3 Exploratory Test Pits

Twenty-seven backhoe test pits (Test Pits TP-1 through TP-27, inclusive) were excavated at locations within the SVADMP at locations near or at apex sites or where basins are being considered. The test pits were excavated to depths ranging from 4.0 to 12.0 feet below ground surface (bgs) utilizing a Case 580 Super M backhoe with a 24-inch bucket, obtained and operated by JE Fuller personnel. Soil

samples recovered from these pits were visually inspected and continuously logged by Mr. Fergason, and classified in the field in accordance with the Unified Soil Classification System (USCS) (ASTM D2487). Upon completion of the field investigation, the test pits were backfilled by JE Fuller personnel with the previously excavated native spoil. The test pit locations are shown on Sheet 1, and logs of the test pits are presented in Appendix A.

2.4 Seismic Refraction and ReMi Shear Wave Profiling

Twenty 120-foot long seismic refraction surveys were completed by Mr. Rucker, Stephen Hargus and Craig Hannula, all with AMEC. Refraction microtremor (ReMi) shear wave (s-wave) surveys were also completed for each location. The purpose of these lines was to assist in characterizing the subsurface geotechnical profile. A Geometrics S-12 Smartseis signal enhancement seismograph and geophone array were used.

A sledgehammer energy source was used to collect compression wave (p-wave) data for seismic refraction analysis. A vehicle traveling alongside or just beyond the geophone array was used to generate energy for refraction microtremor analysis for a one-dimensional vertical shear wave (s-wave) profile at selected seismic lines. The results of the refraction seismic surveys are presented in Appendix B, along with brief descriptions of the seismic refraction equipment and procedures used. Seismic line locations are shown on the site plan presented as Sheet 1 and on Sheets 2 through 8.

2.5 Laboratory Testing

Sieve analysis, plasticity index, and moisture content tests were performed on eleven selected samples. The results of these tests are presented in Appendix C, along with a brief description of laboratory testing procedures.

SECTION 3: GEOLOGIC SETTING

The White Tank Mountains are located approximately 25 miles west of Phoenix and lie within the Sonoran region of the Basin and Range Physiographic Province. This region contains many broad, deeply founded, alluvium-filled basins, separated by structural highlands composed of competent bedrock. The White Tank Mountains are one of these uplifted highlands, composed of both metamorphic and granitoid bedrock (Reynolds and others, 2002). At the base of their slopes, the range is blanketed by relatively gentle sloping piedmonts and drainages. The piedmonts are comprised of alluvial surfaces and

deposits varying in age from present to greater than 1.0 million years old. No known quaternary faults are located within the study area.

Depth to bedrock within the basin is primarily dependent upon distance from the mountain front. Recent geophysical surveys (Sweeney and Hill, 2001), in the form of Bouguer gravity anomaly maps, indicate that depths to bedrock are greater than 1000 feet in the center of the basin.

Anderson and others (1992) predicted that the predevelopment groundwater levels in the vicinity of the southern portion of the study area were about 900 to 950 feet in elevation, about 100 feet below land surface. Schumann and Genualdi (1986) estimated that declines in the groundwater were from 0 to 100 feet in this area during the period from about 1950 to the early to mid-1980s. Anderson and others (1992) estimate that declines have been less than 50 feet. No significant subsidence has been observed within the study area.

3.1 Unconsolidated Geologic Units

Field and Pearthree (1991) detailed the surficial geology around the White Tank Mountains, covering the majority of the study area. Surficial geologic units identified in this study are summarized below; descriptions are modified from Field and Pearthree (1991) and Reynolds et al (2002) and are presented on Sheet 1 with detail views on Sheets 2 through 8.

Young Alluvium in Modern Stream Channels (Qyc) – Within the study area, this unit is limited to the active channels associated with the Hassayampa River and Wagner Wash. Deposits are dominated by clastic sediments of sand and gravel, with some cobbles and rare boulders. The age of unit Qyc is less than 3,000 years before present (ybp).

Young Alluvium (Qy) – Outside the active braided channels, this unit is locally comprised of a limited thickness of silty to clayey sand and sandy silt, overlain by a thin mantle of aolian silty sand. Little soil development is present and Stage I carbonate cementation development is common in the lower sands, with the upper loess largely uncemented. Moderate to strong rubification (reddening) is common in this unit. Within the ephemeral channels, the upper aolian deposits are absent, with larger amounts of gravel and cobbles present. Nearer the mountain front, the unit contains coarser sediments, including silt, sand and gravel mixtures. The age of unit Qy ranges from about 10,000 to >3,000 ybp. This unit is widespread throughout the project area and dominates the lower alluvial fan settings in the FRS No. 1, Wagner Wash, and CAP Sub-Areas.

Younger Middle Alluvium (Qm2) – This unit is locally comprised of moderately cemented (Stage I to II) clayey to silty sands, occasionally interbedded with silty to sandy gravels. These deposits usually display poor soil development and some rubification. The age of unit Qm2 ranges from 10,000 to 150,000 ybp. Qm2 deposits are not widespread and only occur locally within the project, particularly in the southern portions.

Older Middle Alluvium (Qm1) – This unit consists of poorly sorted, angular to sub-angular mixture of silt, sand and gravel deposits. The surfaces are moderately dissected on the upper piedmont with 3 to 20 feet of relief above the active channels. Interfluvial areas are generally flat and expansive with poorly preserved bar and swale topography. Desert pavement ranges from moderately to well developed and is found over 50 to 75 percent of the surface. Underlying soils are characterized by weakly developed argillic horizons with Stage II calcification. The age of unit Qm1 ranges from 300,000 to 1,000,000 ybp. Qm1 deposits are widespread throughout the study area, particularly in the White Tank Wash and Hassayampa Sub-Areas.

Undifferentiated Alluvium and Talus (Q) – This unit consists of undifferentiated alluvial deposits within the White Tank Mountains. Q deposits are not present in the six sub-areas of the current investigation.

Undifferentiated Middle Alluvium (Qm) – This unit consists of undifferentiated middle alluvium and is only present south of Interstate 10, south of the six sub-areas of the current investigation.

Undifferentiated Middle and Older Alluvium (Qmo) – This unit consists of undifferentiated middle and upper alluvial deposits. It is present to the north and west of Wagner Wash and is not found in the six sub-areas of the current investigation.

Older Alluvium (Qo) – Unit Qo is composed of early Pleistocene to late Pliocene alluvial fan deposits greater than 1,000,000 ybp. The unit generally consists of poorly sorted subangular gravels containing minor amounts of finer material ranging in thickness from a thin veneer over bedrock pediments to tens of feet thick. The surfaces of unit Qo are deeply dissected up to 50 feet with interfluvial areas and have well-rounded ridges with intervening swales or ravines. Soils are generally eroded away exposing remnants of Stage IV to VI petrocalcic horizons. Unit Qo is found near the White Tank Mountain front in the Hassayampa, White Tank Wash, and FRS No. 1 Sub-Areas.

Older Alluvium along Hassaymapa River (QTs) – These deposits are Early Pleistocene to late Pliocene river and terrace deposits along the Hassayampa River and are greater than 1,000,000 ybp. Deposits typically consist of rounded, sorted gravel deposits and typically are darkly varnished. Deposits display zones that are strongly indurated with carbonate cement (Stage IV and greater).

3.2 Bedrock Units

Bedrock within the study area is primarily found in the White Tank Mountains and inselbergs related to the White Tanks Mountains. Descriptions are modified from Field and Pearthree (1991) and Reynolds et al (2002).

Younger Sedimentary Rocks (Tsy) – This unit is found within the White Tank Mountains and north of the study area and consists of Tertiary sedimentary rocks, primarily sandstone and conglomerate. This unit is found in the upper portions of the White Tank Wash Sub-Area.

Intrusive and Hypabyssal Rocks (Ti) – This unit is comprised of fine- to medium-grained granite, middle Tertiary in age. Unit Ti occurs within the interior of the White Tank Mountains and is not present in any of the six sub-areas.

Rhyolite Flows, Tuffs, and Domes (Tr) – Consisting of Tertiary rhyolite flows, tuffs, and domes, unit Tr is found in the far north of the project area and not within any of the six sub-areas.

Sedimentary Rocks (Tsm) – Consisting of Tertiary-age conglomerate, sedimentary breccia, and other sedimentary rocks, unit Tsm is found in the far north of the project area and not within any of the six sub-areas.

Undifferentiated Volcanic Rocks (Tv) – Consisting of undifferentiated Tertiary volcanic rocks, unit Tv is found on the western flanks of the White Tank Mountains and inselbergs immediately west of the mountain front. This unit is present in the upper portions of the FRS No. 1 and White Tank Wash Sub-Areas and as inselbergs in the middle of the Wagner Wash Sub-Area.

Granite and Granodiorite (TKg) – Unit TKg consists of Late Cretaceous to early Tertiary granodiorite with granite, diorite and pegmatite rocks. This unit is found in the northern White Tank Mountains and is present in the upper portions of the Wagner Wash and CAP Sub-Areas.

Leucocratic Granite (TKgm) – Unit TKgm consists of Late Cretaceous to early Tertiary leucocratic granite that is found in the interior of the White Tank Mountains. This unit is not present within any of the six sub-areas.

Porphyry Intrusion (TKp) – Unit TKp is a Late Cretaceous to early Tertiary porphyry intrusion found in the northwest White Tank Mountains. It can be found in the upper and middle portions of the Wagner Wash Sub-Area.

Granitoid Rocks (Xg) – Unit Xg consists of Precambrian foliated granitoid rocks found within the interior of the White Tank Mountains. This unit is not present within any of the six sub-areas.

Undifferentiated Metamorphic Rocks (Xm) – Unit Xm consists of undifferentiated Precambrian metamorphic rocks, including gneiss, schist and intrusive rocks within the interior of the White Tanks Mountains. This unit is present in the upper portions of the FRS No. 2 and 3 and the FRS No. 1 Sub-Areas.

Metasedimentary Rocks (Xms) – Consisting of Precambrian metasedimentary rocks including schist phyllite, quartzite and others, unit Xms is found in the far northern portion of the project and is not present in any of the six sub-areas.

Tonalite, Diorite, and Granodiorite (Xt) – Unit Xt consists of Precambrian foliated tonalite and granodiorite found in the southern White Tank Mountains. This unit outcrops in the upper portions of the FRS No. 2 and 3 and the FRS No. 1 Sub-Areas.

SECTION 4: GEOTECHNICAL CONDITIONS

Soil conditions in the study area are typical of the alluvial basins of Arizona. As expected, soils tend to be coarser grained close to the mountain front and grade to finer grained soils in the basin. Wash deposits tend to be relatively clean with varying grain sizes.

The geotechnical profile throughout the project area can be generalized as a three-layer system as described below. Detailed descriptions are included in the test pit logs in Appendix A.

Unit GT-1 – Unit GT-1 contains surficial soils that are generally Holocene in age with little or no cementation. These soils tend to be a combination of fine-grain and clastic sediments and are typified by silty sands, clayey sands, sandy silts, and sandy clays. Calcium carbonate cementation is generally weak or not present (Stage I+ or less). Grain size is variable, but generally a greater amount of coarse sand and gravel is found closer to the mountain front. These soils range from non-plastic to medium in plasticity. Local areas of high plasticity likely exist, though no tested samples contained highly plastic soils. The depth of Unit GT-1 soils varies widely within the study. Generally the depth of these soils increases

basin-ward, but exceptions are common. Typically, observed depths of Unit GT-1 ranged from 2 to 8+ feet bgs.

Unit GT-2 – Unit GT-2 soils are generally cemented soils of Pleistocene age. Often these soils are coarser than Unit GT-1, and are typified by silty and clayey sand, silty and clayey gravel, and sand and gravel. Generally a 'cap' of greater cementation immediately underlies Unit GT-1 with lesser cementation below. These soils range from weakly cemented to strongly cemented (Stage I+ to III+), though zones with little to no cementation are present. Plasticity varies from nonplastic to low in plasticity and moisture contents are low. Depths of Unit GT-2 typically extend to the full depth of investigation.

Unit GT-3 – Unit GT-3 describes the soils and rock that underlie Units GT-1 and GT-2. This unit was rarely encountered in the investigation and is present at great depths in the basin. Near the mountain front, Unit GT-3 approaches the surface and generally consist of strongly cemented soils (Stage IV or greater) and bedrock. Cemented soils are generally silty sand gravel and cobbles and behave as a soft rock. In some areas along drainages nearer the mountain front, Unit GT-3 is exposed at the surface.

Not included in the generalized geotechnical profile described above are the young soils found within the washes that dissect the project. These soils typically contain little to almost no fine-grain sediments and are dominated by sand and gravel. Cobbles and boulders are very common nearer the mountain front, and less common basin-ward. Depths of these deposits vary from wash to wash and within washes and observed depths range from 1 to 8+ feet bgs.

The six sub-areas and the apices located within them are described in greater detail below. Descriptions include the geologic and geotechnical conditions as well as seismic velocities where available. The geotechnical units described above are general units for the project and are independent of the geologic units emphasized at the apex locations.

4.1 CAP Sub-Area

The CAP sub-area is located in the northern portion of White Tank Mountains. Bedrock outcrops within the CAP Sub-Area consists unit TKg. Fan apices 1 and 2 are located above the basin-ward pediment boundary mapped by Field and Pearthree (1991), indicating a likelihood of relatively shallow subsurface bedrock. Sheet 8 provides a detailed view of Apex 1 and Apex 2.

Test pits T3 and T27 and seismic lines RR115A, C920, RR110, and RR900 were located within the CAP Sub-Area and test pits T1 and T2 and seismic line RR120 were located near the boundary between the CAP and Wagner Wash Sub-Areas.

Seismic line RR120 was located at the intersection of a drainage intercepted by the drainage channel structure south of the Sun Valley Parkway. Site grading during drainage channel construction may have obliterated the original ground surface. A small channel incised about 2 feet into a cemented horizon was near the line center. Underlying soils below depths about 5 to 9 feet were interpreted to be moderately to strongly cemented (p-wave 2,600 to 3,200 feet per second (f/s) and s-wave 1,200 f/s). Test pit T2 was located in the vicinity of line RR120 and consisted of a surficial layer of silty to clayey sand to a depth of 1 foot with cemented (Stage I+ to III) soils underlying.

Seismic line RR115A was located in a fairly indistinct drainage area. Cohesionless material velocities (p-wave 1,200 to 1,300 f/s and s-wave 570 f/s) extended to depths of about 5 feet. The site was interpreted to be underlain by a strongly to very strongly cemented horizon (p-wave 3,900 to 5,200 f/s and s-wave 2,200 f/s) that was interpreted to be several feet thick. A less competent material horizon (s-wave 1,300 f/s) was interpreted to underlie that cemented horizon below a depth of about 10 feet.

Seismic line C920 was located north of Sun Valley Parkway in an area with minor drainage channels incised only a few feet. Seismic velocities (p-wave 2,300 to 2,900 f/s and s-wave 1,300 f/s) consistent with weak to moderate cementation are interpreted to begin at depths of about 5 to 10 feet.

4.1.1 Apex 1

Apex 1 is constrained by bedrock to the west and Unit Qm1 to the east, indicating that shallow bedrock conditions exist. Test pit T27 was located about 1,500 feet downstream of Apex 1 and seismic line RR110 was located about 600 feet upstream.

Seismic line RR110 was located across a drainage set against a mountain slope. At the west end of the line, geophones 1 through 3, were located on the slope of probable weathered to decomposed rock or colluvium (p-wave 2,700 to 4,400 f/s). Geophones 4 through 6 were in the streambed, and the remainder of the line was on overbank deposits with an elevation about 1 foot higher than the streambed. Streambed and overbank deposit velocities ranged from 900 to 1,500 f/s. Bedrock p-wave velocities (8,300 to 8,600 f/s) underlaid the overbank deposits beginning at depths of about 10 feet.

4.1.2 Apex 2

Apex 2 is located in an expanse of unit Qm1 about 3,200 feet east of Apex 1 and 1,500 feet west of a bedrock outcrop. Seismic line RR900 was located about 300 feet downstream of Apex 2 with a recent stream channel at geophones 1 through 4 and braided channels through the rest of the line. These materials (p-wave 3,000 to 5,300 f/s and s-wave 2,000 f/s) were interpreted to be moderately to strongly cemented beginning at depths of about 2 to 5 feet. Less competent materials (s-wave 870 f/s) were interpreted beginning at a depth of about 23 feet.

4.2 Wagner Wash Sub-Area

Apices 3, 13E, and13W are located within the Wagner Wash Sub-Area. These apices are located at or near the mountain front where unit TKp outcrops. Test Pits T4, T5, and T26 and seismic lines C155L, RR165, and RR130 are located within the Wagner Wash Sub-Area. Test pits T1 and T2 and seismic line RR120 were located near the boundary between the CAP and Wagner Wash Sub-Areas. Sheet 8 shows a detailed view of Apices 3, 13E, and 13W.

Seismic line C155L was located in a well established drainage with near vertical walls a few feet high on the east bank in the lower portions of the sub-area. Geophones 1 through 6 were located in the active drainage sand bottom, and geophones 7 through 12 were located on a gravelly overbank about 1 foot higher than the drainage channel. Both p-wave (1,600 to 1,800 f/s) and s-wave (810 f/s) results were consistent with the presence of cohesionless deposits to a depth of about 18 to 20 feet before a more competent horizon (p-wave 3,200 f/s, s-wave 1,500 f/s) was encountered. Another deeper lower velocity horizon (s-wave 930 f/s) was interpreted at depths of about 30 to 50 feet.

Seismic line RR165 was located in a large incised drainage channel with occasional bedrock exposures. Geophones 4 through 9 were located in the streambed channel, and bedrock was exposed in the streambed near geophones 8 and 9. Streambed material velocities (p-wave 1,200 to 1,500 f/s) were consistent with cohesionless materials while the bedrock (p-wave 7,100 to 11,000 f/s and s-wave 3,300 f/s) contact appeared to dip downward to the north. A strongly cemented horizon was interpreted at the extreme south end of the line. Test Pit T5 was located in the vicinity and encountered cemented silty sand and gravel at a depth of 1 foot and the backhoe refused at a depth of 7 feet.

4.2.1 Apex 3

Apex 3 is located in an area of foothills and inselbergs to the south of apices 13E and 13W in unit Qm1. Test Pit T26 was excavated about 1,300 feet downstream of the apex. Bedrock outcrops in hills within 200 feet and the test pit was excavated in young alluvial deposits (Qy) to a depth of 11 feet bgs.

4.2.2 Apices 13E & 13W

Apices 13E and 13W are separated by about 1,100 feet in a region of foothills and inselbergs. They are constrained by unit Qm1. Seismic line RR130 was in a drainage located near hills showing outcropping fanglomerates and bedrock at Apex 13W. The west half of the line was located in the drainage channel and the east half of the line was on slightly elevated (about 0.5 foot) overbank. A moderately cemented horizon (p-wave 2,200 to 3,100 f/s and s-wave 1,100 f/s) underlaid most of the surficial channel surface. At the east end, this horizon was missing and p-wave velocities were 1,200 f/s to a depth of about 10 feet. A several foot thick, very strongly cemented horizon (p-wave 5,500 to 5,700 f/s and s-wave 2,800 f/s) was interpreted to underlie the site at depths of about 10 to 15 feet. That horizon was interpreted to be underlain by a less competent horizon (s-wave 1,200 f/s). Test Pit T4 was excavated at the same location and found cemented soils (Stage II+ to III) at a depth of 2 feet and the backhoe refused at a depth of 4 feet.

4.3 Hassayampa Sub-Area

Apices 4 and 5 are located within the Hassayampa Sub-Area and are detailed on Sheet 7. These apices are located at or near the mountain front where unit Xg outcrops in areas of relatively shallow bedrock and cemented soils. Test Pits T6, T7, T8, and T25 and seismic lines C415 and C500 are located within the Hassayampa Sub-Area.

Line C415 was located on the Sun Valley Parkway shoulder at the upstream north edge of a culvert bridge. Shallow seismic velocities may have been influenced by roadway construction, or considerable strong to rock-like cementation is present, especially at depth. Test Pit T7 was located in the vicinity of line C415 and found cemented soils (Stage I+ to II+) below 7.5 feet bgs and the excavation terminated at 9 feet bgs.

Test Pits T6 and T8 were located somewhat downstream of Apices 4 and 5. T6 was excavated to a depth of 10 feet bgs and found cemented soils (Stage I+ to II+) below 2.5 feet bgs. T8 refused excavation at 4 feet bgs and found strongly cemented soils (Stage II+ to III+) below 1 foot bgs.

4.3.1 Apex 4

Apex 4 is constrained by units Qo and Qm1, about 1,600 feet to the west of a complex of foothills. Test pit T6 was excavated about 1,400 feet downstream of the apex. Cemented soils (Stage I+ to III) were encountered at a depth of 2.5 feet to the full depth of the excavation.

4.3.2 Apex 5

Apex 5 is constrained by unit Qm1 with unit Qo present about 500 feet to the south. Bedrock outcrops about 1,000 feet to north, indicating a possibility of relatively shallow rock. Seismic line C500 was located on a gravel overbank area about 700 feet downstream of the apex in a deeply incised, wide channel bottom. Seismic velocities (p-wave 3,100 to 4,300 f/s and s-wave 1,500 f/s) beginning at depths of 5 to 10 feet indicated probable strong cementation beginning at those depths. Test Pit T25 was excavated about 1,000 feet downstream of the apex in young alluvial deposits (Qy) to a depth of 8 feet. Weakly cemented (Stage I to I+) soils were encountered from 8 feet bgs to 11 feet bgs, the full depth of the excavation.

4.4 White Tank Wash Sub-Area

Apices 6, 38, and 39 are located within the White Tank Wash Sub-Area and are detailed on Sheets 5 and 6. Apices 6 and 38 are somewhat removed from the mountain front and Apex 39 is located near an inselberg composed of Tertiary volcanic rocks (unit Tv) and in the vicinity of older alluvium (unit Qo). Test pits T9, T10, T11, and T12 and seismic lines RRE4RA and RRF2 are located within the White Tank Wash Sub-Area. Test pit T15 and seismic line RRCJ1 are located downstream of Apex 38 near the boundary with the FRS 1 Sub-Area.

Line RRCJ1 was completed on overbank materials upstream of a highway culvert, with geophones 8 through 12 in channel sands. Cohesionless materials were interpreted (p-wave 1,100 to 2,000 f/s and s-wave 550 to 940 f/s) to depths of about 10 feet. Moderately to strongly cemented materials (p-wave 2,900 to 4,200 f/s and s-wave 1,600 f/s) were interpreted below about 10 feet and dropping or disappearing at the south end of the line near the active channel. Test pit T15 was located in the vicinity.

Line RRE4RA was completed across a minor incised channel between geophones 5 and 8 with a depth of about 4 feet. Test Pit T10 was located adjacent to the southeast end of this line. Shallow materials had interpreted p-wave velocities of 1,200 to 1,600 f/s and s-wave velocity of 840 f/s to depths of 10 to 15 feet. Strongly cemented materials (p-wave 3,300 to 3,500 f/s and s-wave 1,500 f/s) were interpreted to underlay that horizon to a depth of about 33 feet. Less competent material (s-wave velocity 700 f/s) was interpreted below a depth of about 33 feet.

4.4.1 Apex 6

Apex 6 is located below the basin-ward pediment boundary somewhat removed from the mountain front, indicating that the depth to bedrock is relatively deep. Test pit T9 was excavated about 1,400 feet upstream of the apex and encountered young alluvium (unit Qy) to a depth of 8 feet bgs.

4.4.2 Apex 38

Apex 38 is situated immediately below the basin-ward pediment boundary and is constrained by the Pleistocene alluvial fan deposits of unit Qm1. Apex 38 is somewhat removed from the mountain front with the nearest bedrock outcropping over a mile to the northwest. Unit Qo is present about 2,500 feet to the north. Test pit T12 was excavated about 1,400 feet upstream. Test pit T12 encountered cohesionless sand and gravel to a depth of 5 feet bgs and cemented material below that to the full depth of 10 feet.

4.4.3 Apex 39

Apex 39 is located on the basin-ward pediment boundary and surrounded by older alluvial terraces of units Qo and Qm1 with unit Qm1 constraining the apex. An inselberg of Tertiary volcanic rock is located about 2,500 feet to the east, indicating the possibility of relatively shallow bedrock.

Seismic line RRF2 was completed in a large incised drainage adjacent to the active channel about 1,700 feet downstream of Apex 39. Cohesionless material (p-wave 1,200 to 1,500 f/s) was interpreted to depths of about 4 to 5 feet. Weakly cemented materials (p-wave 1,800 to 2,200 f/s and s-wave 910 f/s) were interpreted under the cohesionless surface horizon. More competent strongly cemented materials overlying possible rock were interpreted to be dipping downward from the north end of the line.

Test pit T11 was also excavated about 1,300 feet upstream of the apex. T11 was excavated in young alluvium (unit Qy) to a depth of 9 feet bgs.

4.5 FRS 1 Sub-Area

Apices 7, 8, 9, 12, 36, and 37 are located within the FRS 1 Sub-Area and are detailed on Sheets 3, 4, and 5. Most of the apices are located at the mountain front or near foothills and inselbergs, indicating the likelihood of relatively shallow bedrock. Apex 37 is somewhat removed from the mountain front, but is within 1 mile of outcropping bedrock. Precambrian tonalite (unit Xt) is the primary bedrock unit at the mountain front. Test Pits T13, T14, T16, T17, T18, T19, and T20 and seismic lines RRM1, RRL3R, RRP1A, and RRL are located within the FRS 1 Sub-Area.

Seismic line RRL3R was completed upstream of the highway in the vicinity of a culvert. Cohesionless material (p-wave 1,000 to 1,300 f/s) was interpreted to depths of about 8 to 10 feet. Strongly cemented materials (p-wave 3,200 to 3,900 f/s and s-wave 1,600 f/s) were interpreted under the cohesionless surface horizon and dropping or disappearing at the south end of the line near the active channel. Test pit T16 was excavated in the vicinity.

Seismic line RRL was completed in an area of incipient headcutting erosion in the surface in an indistinct drainage area. Test pit T19 was excavated about 1,500 feet east of line RRL. Surface materials had low seismic velocities (p-wave 1,200 to 1,300 f/s and s-wave 600 f/s) to depths of about 5 to 7 feet. Materials below these depths were interpreted to be weakly cemented (p-wave 1,800 to 2,300 f/s and s-wave 900 f/s), with more competent, strongly cemented materials (p-wave 3,600 to 4,500 f/s and s-wave 1,900 f/s) occurring at or below depths of about 20 feet.

4.5.1 Apex 7

Apex 7 is located with about 100 feet of bedrock outcropping in a large foothill to the west and test pit T17 was excavated about 400 feet to down-stream. Unit Qm1 constrains the apex to the east. Young alluvium (unit Qy) was encountered to a depth of 9 feet bgs. Moderately to strongly cemented soils (Stage II+ to III) were encountered to a depth of 10 feet bgs where excavation was refused.

4.5.2 Apex 8

Apex 8 is constrained by unit Qm1 in close proximity to outcropping bedrock. Unit Xt outcrops about 600 feet to the west and shallow bedrock is likely. Test pit T18 was excavated about 300 feet downstream of the apex and seismic line RRP1A is within 100 feet.

Seismic line RRP1A was completed in a significant incised drainage near foothills with geophones 8 through 11 located in the main channel. Cohesionless material (p-wave 1,200 to 1,500 f/s and s-wave 750 f/s) was interpreted to depths of about 4 to 9 feet. A horizon of moderately cemented materials (p-wave 2,600 to 3,700 f/s and s-wave 1,700 f/s) was interpreted under the cohesionless horizon. Less competent materials (s-wave 1,100 f/s) were interpreted beneath the cemented horizon beginning at a depth of about 12 feet. Bedrock dipping to the northeast was interpreted to underlie the site at depths of about 20 to 30 feet. Test pit T18 encountered young alluvium (unit Qy) to a depth of about 7 feet bgs. Strongly cemented soils (stage III to III+) were encountered below 7 feet bgs and the excavation was refused at 7.5 feet bgs.

4.5.3 Apex 9

Apex 9 is located in very close proximity to a foothill of the White Tank Mountains immediately north of Buckeye FRS No. 1. No test pits or seismic lines were excavated in the vicinity.

4.5.4 Apex 12

Apex 12 is located in a cluster of foothills and inselbergs of the White Tank Mountains composed of Precambrian tonalite (unit Xt), indicating the likelihood of shallow bedrock. The closest outcrop of bedrock is about 500 feet to the north and the apex is located in unit Qm1. Test pit T20 was excavated about 350 feet downstream of the apex in middle alluvium (unit Qm1). Cemented soils (Stage I+ to II+) consisting of silty to clayey sand were encountered to a depth of 8.5 feet bgs.

4.5.5 Apex 36

Apex 36 is constrained by unit Qm1 with bedrock outcrops of unit Xt about 3,200 feet to the east and unit Tv about 2,600 feet to the south. Test pit T14 and seismic line RRM1 were located about 1,500 feet upstream from the apex.

Seismic Line RRM1 was completed in a significant incised drainage with geophones 1 through 4 located in the main channel. Cohesionless material (p-wave 1,400 to 1,800 f/s and s-wave 900 f/s) was interpreted to depths of about 10 to 15 feet. A horizon of moderately cemented materials (p-wave 3,200 to 3,600 f/s and s-wave 910 f/s) was interpreted under the cohesionless horizon. Less competent materials (s-wave 1,100 f/s) were interpreted beneath the cemented horizon beginning at a depth of about 23 feet. Test pit T14 was excavated in young alluvium (unit Qy) to a depth of 9 feet bgs.

4.5.6 Apex 37

Apex 37 is somewhat removed from the mountain front, with nearest bedrock outcrop approximately 4,500 feet to the northeast. The apex is constrained by unit Qm1 and unit Qo is present about 2,000 feet to the north. Test pit T13 was excavated about 2,500 feet to east in middle alluvium (unit Qm1). Moderately to strongly cemented soils (Stage III to IV) were encountered at a depth of 7 feet bgs and the excavation was refused at 8 feet bgs.

4.6 FRS 2 & 3 Sub-Area

Apices 10, 11, Sky, and Sky ET are located within the FRS 2 & 3 Sub-Area and are detailed on Sheets 2 and 3. The apices are located at the mountain front or near foothills and inselbergs, indicating the likelihood of relatively shallow bedrock. Precambrian tonalite (unit Xt) is the primary bedrock unit at the mountain front in the vicinity of the apices. Sheet 2 shows the geology at apices Sky and Sky ET.

Test Pits T21, T22, T23, and T24 and seismic lines RR810, 1W, and RRX1 are located within the FRS 2 & 3 Sub-Area. Line 1W was completed at an indistinct to minor drainage with little incision away from the apices. Cohesionless material (p-wave 1,000 to 1,300 f/s and s-wave 550 f/s) was interpreted to depths of about 3 to 6 feet. A horizon of weakly to moderately cemented materials (p-wave 1,800 to 3,700 f/s and s-wave 1,500 f/s) was interpreted under the cohesionless horizon. Strongly to very strongly cemented materials of bedrock dipping to the west was interpreted to underlie the site at depths of about 13 to 30 feet.

4.6.1 Apices 10 and 11

Apices 10 and 11 are located in close proximity to each other, being separated by about 1,600 feet. They are constrained by unit Qm1 and located in close proximity to inselbergs of unit Xt, indicating the possibility of relatively shallow bedrock.

Apex 10 is located about 500 feet west of outcropping bedrock. Seismic line RR810 was located at Apex 10 and had a small streambed located at geophones 1 through 3. Subsurface materials were interpreted to be largely uncemented (p-wave 1,000 to 1,700 f/s and s-wave 530 to 880 f/s) to depths of about 10 to 15 feet that were underlain by a horizon of moderately to strongly cemented materials (p-wave 3,000 to 3,100 f/s and s-wave 1,800 f/s). Less competent materials (s-wave 940 f/s) were interpreted under the cemented horizon.

Test pit T21 was located immediately upstream of Apex 11. Bedrock outcrops about 400 feet to the east and 800 feet to the west. Test pit T21 encountered young alluvium (unit Qy) to a depth of about 3 feet bgs. Strongly cemented (Stage III to III+) soils were encountered to a depth of 5 feet bgs where the backhoe refused.

4.6.2 Apex Sky

At apex Sky unit Qy is constrained by unit Qm1 and the bedrock unit Xt outcrops within 1,000 feet, indicating the likelihood of shallow bedrock conditions. Test pit T22 was located about 1,800 feet down downstream of Apex Sky. Young alluvium (Qy) was encountered to full depth of the excavation of 9 feet bgs. Strongly cemented soils of unit Xt (Stage III to IV) outcrop within 100 feet of the excavation to the west.

4.6.3 Apex Sky ET

Apex Sky ET is constrained by unit Qm1 on the west and bedrock unit Xt to the north and east. Seismic line RRX1 was located 200 feet north of the apex in a streambed located at the toe of a hill slope. Cohesionless material (p-wave 1,100 to 1,800 f/s and s-wave 700 to 890 f/s) was interpreted to depths of about 8 to 14 feet. A horizon of primarily strongly cemented materials or weathered, fractured rock (likely unit Xt) with p-wave velocities of 3,900 to 5,600 f/s and s-wave velocities 2,900 f/s was interpreted under the cohesionless horizon. Test pit T24 was excavated about 600 feet to the northwest. Young alluvium (Qy) was encountered to a depth of 2.5 feet bgs, below which cemented soils (Stage II to III+) was encountered. The backhoe was refused at 7 feet bgs.

SECTION 5: DISCUSSION

5.1 Temporary and Permanent Cut Slopes

Temporary excavation slopes may be required for construction of below grade structural solutions. In general temporary excavation side slopes may be maintained no steeper than 1:1 (horizontal to vertical), however, site specific soil conditions may warrant shallower temporary excavation slopes. These recommended slopes are based on the weakly cemented cohesive materials encountered in the test pits and OSHA (1990) requirements. All construction loads, such as excavation spoils piles, construction equipment and construction materials should maintain a minimum clear distance from the edge of all excavations as designed by a geotechnical engineer when accounting for site specific soils conditions. Cut slopes should be observed by the geotechnical engineer during excavation. Should excavations be made in close proximity of adjacent existing structures shoring may be required to limit the width of the excavation. Temporary shoring utilizing trench shields likely will be the most cost-effective means of excavation stabilization. Steeper temporary excavations, including those to employ trench shoring, should be made only if based on stability analyses by a registered geotechnical engineer. The analysis should take into account the slope angles, excavation geometries, and any surcharge loadings resulting from construction and support activities.

AMEC recommends that slopes associated with permanent basin excavations or structural solutions that include permanent embankment fill slopes be generally no steeper than 2.5:1 (horizontal to vertical), unless otherwise required by State or Federal regulatory agencies. Steeper permanent slopes for both cut and embankment solutions may be made only if designed by a registered geotechnical engineer. The analysis should take into account the slope angles, excavation geometries, and any surcharge loadings resulting from short and long-term loading conditions.

5.2 Excavations

In general the shallow test pits indicate that conventional earthwork equipment may be used for excavation of most soils within the project area, nevertheless some isolated areas may require more aggressive excavation techniques. Generally shallow soils may be ripped for mass excavation with a larger bulldozer or trenched by conventional tractor-mounted backhoes. Deeper excavations and trenches may require non-conventional excavation equipment and or techniques. Rock may be encountered at shallow depths higher in the watershed towards the base of the White Tank Mountains or in isolated

locations within the project area. Heavier excavation equipment or blasting could be required in those areas. Table 1 relates seismic velocity and the Kirsten Excavatibility Index and horsepower.

5.3 Moisture Sensitive Soils

AMEC's experience with soils in the desert southwest indicates that there may be areas within the project that contain variable thickness of moisture sensitive soil that may collapse upon wetting. Often these soils are Holocene in age and due to their evulsive nature of an active alluvial fan surface create an environment where the presence and depth of moisture-sensitive soils is highly variable. In this environment it is difficult to predict the presence and depth of these soils due to this variability and the potential presence of buried channels.

The existence of these soils often creates unacceptable foundation soil conditions in areas where basins, channels, storm drains and other flood control structures are to be constructed. If these soils are not properly identified during design and mitigated during construction, structural distress and impacts to the operation of flood control solutions may occur. Adverse impacts may include differential settlement and embankment cracking.

Table 1
Approximate Erodability & Excavatability of Materials Limestone & Cemented Soils (Caliche)

Seismic Velocity (P-Wave), ft/sec (Rucker and Fergason, 2006)	Trackhoe / Dozer Type & Power (Cat, 1984, 1993)	Erodability / Excavatibility Index (Kirsten, 1982, 1988; NRCS, 2001)	Erosion Threshold Stream Power, kW/m^2 (Annandale, 1995)
<1,500	hand spade	<0.01	very erodable
1,500 - 3,000	hand pick & spade Cat 416C 78 hp	0.01 – 0.099	very erodable - 0.2
3,000 - ~3,500	Cat 325BL 168 hp Cat D6D 136 hp	0.1 – 0.99	0.2 – 1.0
~3,500 - 4,000	Cat 330BL 222 hp Cat D7G 200 hp	1.0 – 9.99	1.0 – 5.0
~4,000 - 5,900	Cat 345BL 321 hp Cat D8L 335 hp	10 - 99	5.0 – 30
5,900 - 7,200	Cat 375 428 hp Cat D9L 460 hp	100 - 999	30 - 200

Notes: Bulldozer and backhoe power ranges are presented by Kirsten (1982, 1988) as a measure of equivalent performance for excavation. All velocities are approximate and represent a typical range. Seismic velocity ranges for backhoes and trackhoes in cemented soils with typical p-wave velocity less than 6,000 f/s are from Rucker and Fergason (2006). See the Caterpillar Performance Handbook (Caterpillar, 1984, 1993 or current edition) for details on use of seismic information for rippability. Different model configurations include variations in weight and horsepower.

5.4 Embankment Cracking

Flood control solutions like dams or levees that are constructed or above grade embankment fills, may be susceptible to embankment cracking. The likely cause of these cracks is differential settlement of the foundation soils resulting from partial wetting of moisture sensitive foundation soils and/or

desiccation. This mechanism has been identified as the likely cause of cracking at several District flood control dams.

AMEC recommends that in addition to the removal of moisture sensitive soils from the foundations of all flood control solutions, that an engineered granular filter be included in all dam and levee alternatives. The use of a sand and gravel filter is most likely the most cost-effective solution needed to prevent internal erosion or piping of soil in embankments or foundations of hydraulic structures. A registered geotechnical engineer should perform a filter analysis to select a suitable backfill material that would function as a filter for all embankment fills. The filter should have a minimum width of 6 feet and extend into the native foundation soils. The depth of penetration should be determined by the geotechnical engineer based on site specific foundation conditions.

5.5 Structural Fill

Structural fill will be required for construction of above grade flood control solutions. In general all structural fill should be free of vegetation, debris and other deleterious material, and should contain no particles larger than 6 inches in diameter. Borrow materials that are more granular and less plastic are generally less susceptible to cracking and should be considered. All structural fill should be compacted to within the range of 5 percent below to 1 percent below the optimum moisture content and to a density of at least 95 percent of maximum dry density as determined by ASTM D698. The plasticity index when determined in accordance with ASTM D4318 should not exceed 12. It appears that most of the project area soils encountered in the test-pits will meet these criteria.

5.6 Information for Evaluation of Potential Scour Depth

To predict scour it is necessary to compare the in-situ materials resistance to scour to the hydraulic energy of the water. The discussions that follow only address the resistance to scour of the in-situ material.

Estimated ranges of hydraulic stream power needed to initiate head cutting erosion are summarized in Table 1. Annandale (1995) reviews the determination of stream power as a function of hydraulic flow conditions. For purposes of comparison and correlation, ranges of hydraulic stream power are compared to excavation equipment needed to perform effective excavation as estimated (quantified) by seismic p-wave velocities. Annandale (1995) presents relationships between stream power and initiation of head cutting erosion through an erodability index based on the Kirsten excavatability index (Kirsten 1982, 1986) for geo-materials.

5.7 Bank and Channel Protection

Based on AMEC's experience with similar soil conditions, test pit data and visual observations from the project area, bank protection may be required for open flood conveyance channels and structural solutions where flow velocities exceed 3 feet per second. Most near surface materials found in the study area do not appear to be sufficiently erosion resistant, based on classification and visual observations. Of the locations where test pit samples were obtained the majority of project area soils within the upper 5 feet consist of a fine to well-graded silty sands, sands and gravels that are weakly to moderately lime cemented, non-cohesive and prone to erosion. Conversely erosion resistant rock may be encountered in isolated locations.

Bank and channel protection may be provided by a number of common soft and hard structural applications such as; vegetation, rock riprap (grouted and ungrouted), gabions (baskets or mattresses), check dams, soil cement, and concrete. Toe protection will be required to prevent undermining of the bank protection measure. Erodible channels should have protection to the maximum estimated depth of scour.

5.8 Subsidence and Earth Fissuring

No significant subsidence and earth fissuring has been documented within the study area. However, if groundwater is pumped from aquifers underlying the project area, significant land subsidence could occur, including the development of earth fissures. The potential effect of future land subsidence and earth fissuring should be considered for engineered facilities and technologies such as synthetic aperture radar interferometry (InSAR) should be utilized to monitor for land subsidence.

5.9 Concrete Structures

An assessment of the potential for chemical attack of concrete structures was not part of the AMEC geotechnical investigation scope of work. As part of the final design, representative samples of native site soils should be tested relative to potential for corrosion of steel reinforcement and chemical attack of concrete structures. Electrical resistivity, pH and total soluble sulfates tests should be performed using applicable standard test methods to identify appropriate cement types and steel corrosion protection requirements.

5.10 Levees

Based upon AMEC's experience with similar projects and the investigations performed for the Sun Valley ADMP, suitable soils within the project area would appear to exist for the construction of levee flood control structures. Specialized design requirements will be required for construction of a levee alternative. As detailed above, consideration must be given to slope stability, moisture sensitive foundation soils, embankment cracking, subsidence and earth fissuring, and bank protection components. Levees shall provide a minimum of 3 feet of residual freeboard and bank and channel erosion protection. Foundation seepage may be a concern due to the identified zones of more permeable foundation materials. Cut-offs or special foundation treatments may be required to reduce under seepage and soil piping failure modes. Additionally, levees will require long-term maintenance which will be dictated by an Operation and Maintenance plan. AMEC recommends that state-of-the-practice dam safety criteria be utilized in levee design and construction.

5.11 Additional Geotechnical Investigations

The investigation performed for the Sun Valley ADMP is preliminary and broad in nature and has been utilized by AMEC to provide general geotechnical recommendations for use during the alternatives analysis phases. A comprehensive, site specific, geotechnical field investigation, laboratory and engineering analysis will be required for all future structural flood control solutions. Investigations should include combinations of borings, test pits and laboratory testing catered to the requirements necessary to properly design the preferred alternative.

5.12 Possible Alternatives

Possible alternatives for flood control solutions may be grouped into five primary categories; channels, basins, levees, dams and storm drains. Final alternative configuration may include combinations of these primary alternatives. All alternatives should be developed in accordance with Federal, State, and Local regulations. For example, dam structures that exceed 6 feet in height and have a storage capacity greater than 50 acre-feet will fall under the Arizona Department of Water Resources (ADWR) statutory authority. Levees that are intended to provide 100-year flood protection will fall under the Department of Homeland Security Federal Emergency Management Agency (FEMA) authority.

5.13 Cost Estimating

Based on AMEC's experience with similar construction projects the following unit rates (Table 2) are recommended for alternative cost estimating purposes.

Table 2
Cost Estimates

DESCRIPTION	UNIT	UNIT PRICE
Construction		
Clear and grub	AC	$500.00
Excavation	CY	$3.25
Mass grading	CY	$2.25
Structural fill	CY	$4.00
Soil cement	CY	$45.00
Geotextile	SY	$2.50
Structural concrete	CY	$350.00
Haul of excess material	CY	$5.00
Riprap	CY	$75.00
Gabions (mattress)	SY	$70.00
Gabions (basket)	CY	$195.00
General Requirements (percentage of sub-total)		
Contingency	LS	25.00%
Engineering (planning, design, geotechnical)	LS	10.00%
Supplemental general conditions	LS	3.00%
Construction management	LS	8.00%
Regulatory permitting fees	LS	0.50%

SECTION 6: REFERENCES

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Appendix A

Test Pit Logs

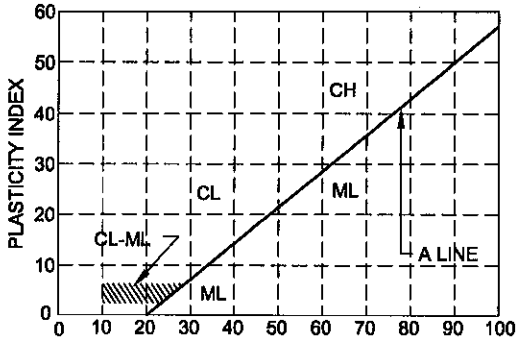
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

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

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.65634° N
112.66666° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0			D		SM/SC	slightly moist moderately firm	**SILTY TO CLAYEY SAND,** trace of predominantly fine grained gravel, predominantly medium to fine grained sand, uncemented (Stage I), low plasticity, light brown note: occasional lense of SP-SC/SP-SM
1							
2							
3							
4			D	3	SC/CL	slightly moist firm	**CLAYEY SAND TO SANDY CLAY,** some silt, predominantly medium to fine grained sand, weakly lime cemented (Stage I+), low plasticity, light reddish-brown
5							
6							
7							
8					SC	slightly moist firm to very firm	**CLAYEY SAND,** some silt, trace to some gravel, rare cobbles, predominantly medium to fine grained sand, weakly lime cemented (Stage I+), low plasticity, light brown note: occasional lense of clayey SGC
9							Stopped Backhoe at 9'
10							

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. T-1

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.65701° N
112.65204° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0			D		SC/SM	slightly moist soft	**SILTY TO CLAYEY SAND,** trace to some gravel, well graded sand, uncemented (Stage I), low plasticity, light brown
1					SM/ SP-SM	slightly moist very firm to hard	**SILTY SAND TO SAND WITH SILT,** trace to some clay, some to considerable gravel, rare cobbles, well graded sand, weakly to moderately lime cemented (Stage II+-III), low plasticity, light grayish-brown note: difficult digging
2							
3							
4			D	3	SM/SC	slightly moist very firm to hard	**SILTY SAND TO CLAYEY SAND,** some gravel, well graded sand, weakly lime cemented (Stage I+-II), low to medium plasticity, light brown note: occasional lense of SP-SM note: gravel decreases with depth
5							
6			D				note: medium to fine grained sand below 6'
7							
8							
9							
10							Stopped Backhoe at 10'

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. T-2

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.65982° N
112.62578° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist soft	**SILTY SAND,** trace of clay, trace to some gravel, predominantly medium to fine grained sand, uncemented, low plasticity, light brown
1							
					SC/SM		**SILTY TO CLAYEY SAND,** some to considerable predominantly fine grained gravel, weakly to moderately lime cemented (Stage II+-III), low plasticity, light brown to light grayish-brown
2			D	3		slightly moist very firm to hard	note: occasional zone of GC/GM
3							
4							
					SC		**CLAYEY SAND,** trace of gravel, trace of silt, predominantly fine to medium grained sand, weakly lime cemented (Stage I+-II), low plasticity, brown
5			D			slightly moist very firm to hard	
6							
7							
8							
9							
10							Stopped Backhoe at 10'

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. T-3

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.63364° N
112.63574° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0			D		SP-SC/ GP-GC	slightly moist dense	**SAND & GRAVEL WITH CLAY,** occasional to some cobbles, well graded sand, subangular to angular, uncemented (Stage I), nonplastic to low plasticity, light reddish-brown
1							
2					SM	slightly moist hard	**SILTY SAND,** some to considerable gravel, rare cobbles, well graded sand, subangular to angular, moderately lime cemented (Stage II-III), nonplastic to low plasticity, light grayish-brown
3			D				
4							Backhoe refused at 4'
5							
6							
7							
8							
9							
10							

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. T-4

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.62382° N
112.64599° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					GP-GC	slightly moist dense	**SAND & GRAVEL WITH CLAY,** occasional cobble, subangular to angular, rare boulder, well graded sand & gravel, uncemented, nonplastic to low plasticity, reddish-brown
1					SM	slightly moist hard	**SILTY SAND,** some to considerable gravel, occasional cobble, well graded sand & gravel, weakly to moderately lime cemented (Stage II+-III), nonplastic, light grayish-brown
2			D				
3					SC/GC	slightly moist very firm to hard	**CLAYEY SAND & GRAVEL,** occasional cobble, well graded sand & gravel, subangular to angular, weakly lime cemented (Stage II), low plasticity, light brown
4			D				
5							
6							note: II+ below 6'6" note: difficult digging
7							Stopped Backhoe at 7'
8							
9							
10							

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. T-5

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/7/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.58146° N
112.66914° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist soft	**SILTY SAND,** trace of gravel, predominantly medium to fine grained sand, uncemented (Stage I), nonplastic to low plasticity, brown
1							
2			D				
3					SM/SC	slightly moist very firm to hard	**SILTY SAND & GRAVEL,** rare small boulder, some cobbles, well graded sand & gravel, subangular to subrounded, weakly to moderately lime cemented (Stage II+), nonplastic to low plasticity, light brown to light grayish-brown note: occasional lense SGC
4							
5			D				
6							
7							note: Stage I+ below 7'
8					GP-GC	slightly moist very dense	**SAND, GRAVEL & COBBLES WITH CLAY,** well graded sand & gravel, subangular to subrounded, weakly lime cemented (Stage I+-II), nonplastic, brown
9							
10							Stopped Backhoe at 10'

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. T-6

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.57886° N
112.68610° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM/ GP-GM	slightly moist medium dense	**SAND & GRAVEL WITH SILT,** occasional to some cobbles, rare boulder, well graded sand & gravel, subangular, uncemented (Stage I-I+), nonplastic, light brown note: occasional lense of SM/GM, Stage I+
1			D				
2							
3							
4							
5			D				
6							
7			D		SM/GM	slightly moist hard	**SILTY SAND & GRAVEL,** occasional cobble, well graded, subangular, weakly to moderately lime cemented (Stage I+-II+), nonplastic to low plasticity, light grayish-brown
8							
9							Stopped Backhoe at 9'
10							

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. T-7

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.57309° N
112.66961° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0			D		SM/GM	slightly moist soft	**SILTY SAND & GRAVEL,** occasional cobble, predominantly medium to fine grained sand, well graded gravel, subangular to angular, uncemented (Stage I), nonplastic to low plasticity, light brown
1					SM	slightly moist hard	**SILTY SAND,** some to considerable gravel, predominantly medium to fine grained sand, subangular to angular, moderately to strongly cemented (Stage II+-III), nonplastic to low plasticity, light grayish-brown note: some Stage III+ at 2'
2							
3							
4							Backhoe refused at 4'
5							
6							
7							
8							
9							
10							

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. T-8

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.55631° N
112.66931° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					GM/ GP-GM	slightly moist dense	**SILTY SAND, GRAVEL & COBBLES,** occasional small boulder, well graded, subangular to subrounded, uncemented (Stage I), nonplastic to low plasticity, light brown
1							
2			D	1			
3							
4							
5							
6							
7							
8							Stopped Backhoe at 8'
9							
10							

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. T-9

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.53461° N
112.71931° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist very firm	**SILTY SAND,** trace to some predominantly fine grained gravel, predominantly fine to medium grained sand, subangular to subrounded, uncemented (Stage I), nonplastic, light brown note: 2' to 3' thick lense of SP-SM/GP-GM, well graded, occasional cobble, subrounded, uncemented, nonplastic
1			D				
2							
3							
4					SM	slightly moist to moist soft to moderately firm	**SILTY SAND,** trace of gravel, predominantly fine grained sand, uncemented (Stage I), nonplastic, light brown
5							
6					GP-GM	slightly moist medium dense	**SAND & GRAVEL WITH SILT,** occasional cobble, well graded, subangular to subrounded, uncemented (Stage I), nonplastic, light brown
7							
8			D		SM	slightly moist firm	**SILTY SAND,** trace of clay, rare gravel, predominantly fine grained sand, uncemented (Stage I-I+), nonplastic to low plasticity, light reddish-brown
9							
10							

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. T-10

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.53461° N
112.71931° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
10					SM	slightly moist firm	**SILTY SAND,** continued
11							
12							Stopped Backhoe at 12'
13							
14							
15							
16							
17							
18							
19							
20							

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. T-10

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.54383° N
112.61622° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM/ GP-GM	slightly moist medium dense	**SAND, GRAVEL & COBBLES WITH SILT,** occasional boulder, well graded, subangular, uncemented (Stage I), nonplastic, brown
1							
2			D	1			
3							
4							
5							
6			D				
7							
8							
9							Stopped Backhoe at 9'
10							

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. T-11

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.52939° N
112.64837° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist moderately firm	**SILTY SAND,** some gravel, occasional cobble, predominantly medium to fine grained sand, subangular to subrounded, uncemented (Stage I), nonplastic to low plasticity, light reddish-brown note: occasional lense of GM/GP-GM
1							
2			D	2			
3							
4							
5					SC	slightly moist firm to very firm	**CLAYEY SAND,** some gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly cemented (Stage I+), low plasticity, reddish-brown note: occasional lense of GC/GP-GC
6					SM	slightly moist very firm to hard	**SILTY SAND,** some gravel, predominantly medium to fine grained sand, subangular to subrounded, weakly to moderately lime cemented (Stage II-II+), nonplastic to low plasticity, light brown note: occasional gravel (GM) lense
7			D				
8							
9							
10							Stopped Backhoe at 10'

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. T-12

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.52226° N
112.61720° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist firm	**SILTY SAND,** considerable gravel, occasional, well graded sand, subangular, uncemented (Stage I), nonplastic, light brown note: occasional lense GP-GM
1							
2							
3			D				
4							
5							
6			D				
7					SM	slightly moist hard	**SILTY SAND,** some to considerable gravel, occasional cobble, well graded sand, subangular, moderately to strongly lime cemented (Stage III-III+), occasional zone IV, nonplastic to low plasticity, light brown to gray
8							Backhoe refused at 8'
9							
10							

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. T-13

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.51528° N
112.61839° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM/ SP	slightly moist loose	**SAND TO SAND WITH SILT,** some to considerable gravel, rare cobble, well graded sand, subangular, uncemented (Stage I), nonplastic, brown note: occasional lense GP-GM, occasional cobble, rare boulder
1							
2			D	1			
3							
4							
5					GP-GM/ SP-SM	slightly moist medium dense	**SAND, GRAVEL & COBBLES WITH SILT,** occasional boulder, well graded, subangular to subrounded, uncemented (Stage I), nonplastic, brown
6			D				
7							
8							
9							Stopped Backhoe at 9'
10							

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. T-14

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.51765° N
112.67748° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM/ SP-SM	slightly moist firm	**SILTY SAND,** trace of clay, some to considerable gravel, occasional cobble, well graded, subangular to subrounded, uncemented (Stagel-I+), nonplastic to low plasticity, brown note: occasional lense GP-GM
1			D				
2							
3							
4					SM	slightly moist firm to very firm	**SILTY SAND,** some predominantly fine grained gravel, well graded sand, subangular to subrounded, uncemented (Stage I-I+), nonplastic to low plasticity, light brown note: Stage II-II+ below 6' note: occasional lense of GP-GM/GM
5			D				
6							
7							
8							
9							Stopped Backhoe at 9'
10							

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. T-15

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/8/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.49344° N
112.67698° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM/ML	slightly moist soft to moderately firm	**SILTY SAND TO SANDY SILT,** trace of gravel, predominantly medium to fine grained sand, uncemented (Stage I), nonplastic to low plasticity, brown note: occasional lense SM note: trace of clay below 5', Stage I+
1							
2			D	2			
3							
4							
5							
6			D			slightly moist very firm to hard	**SILTY SAND,** some to considerable gravel, trace of clay, predominantly medium to fine grained sand, weakly lime cemented (Stage II), low plasticity, light brown
7							
8							
9							Stopped Backhoe at 9'
10							

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. T-16

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/17/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.49202° N
112.62455° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM/ GP-GM	slightly moist loose to medium dense	**SAND & GRAVEL WITH SILT,** occasional cobbles, well graded sand & gravel, subangular, uncemented, nonplastic, brown note: occasional lense of SM note: occasional zone with cobbles & small diameter boulders
1							
2			D				
3							
4							
5							
6							
7			D				
8							
9					SM	slightly moist hard	**SILTY SAND,** some gravel, predominantly medium to fine grained sand, moderately lime cemented (Stage II+-III), low plasticity to nonplastic, light brown Backhoe refused at 10'
10							

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. T-17

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/9/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.47477° N
112.61606° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM	slightly moist loose to medium dense	**SAND & GRAVEL WITH SILT,** occasional cobble, well graded sand & gravel, subangular, uncemented (Stage I), nonplastic, light brown note: occasional lense of GP-GM
1			D				
2							
3					GP-GM	slightly moist medium dense	**SAND, GRAVEL & COBBLES WITH SILT,** well graded sand & gravel, subangular, uncemented (Stage I), nonplastic, brown
4							
5					SP-SC	slightly moist dense	**SAND & GRAVEL WITH CLAY,** occasional cobble, well graded sand & gravel, subangular, uncemented (Stage I), nonplastic, light reddish-brown note: occasional lense of GP-GC
6			D				
7					GM	slightly moist hard	**SILTY GRAVEL,** some sand, well graded, occasional cobble, subangular, strongly lime cemented (Stage III-III+), nonplastic, light brown
8							Backhoe refused at 7'6"
9							
10							

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. T-18

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/9/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.46448° N
112.69364° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist moderately firm	**SILTY SAND,** trace of predominantly fine grained gravel, predominantly medium to fine grained sand, uncemented (Stage I), nonplastic to low plasticity, light brown
1			D	1			
2					SM/ SP-SM	slightly moist medium dense	**SAND WITH SILT,** some gravel, rare cobble, well graded sand, uncemented (Stage I), nonplastic, light brown note: occasional lense of GP-GM
3							
4							
5			D		SM	slightly moist very firm	**SILTY SAND,** trace of gravel, trace of clay, predominantly medium to fine grained sand, weakly lime cemented (Stage II), nonplastic to low plasticity, light brown
6							
7							
8							
9							
10							

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. T-19

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/9/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.46448° N
112.69364° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
10						slightly moist very firm	**SILTY SAND,** continued
11							Stopped Backhoe at 11'
12							
13							
14							
15							
16							
17							
18							
19							
20							

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. T-19

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 3/9/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.45381° N
112.61501° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM	slightly moist loose	**SILTY SAND,** some gravel, well graded sand, uncemented (Stage I), nonplastic, light brown
1			D		SM	slightly moist very firm to hard	**SILTY SAND,** trace to some gravel, predominantly fine to medium grained sand, weakly lime cemented (Stage II-II+), low plasticity, light brown note: occasional gravelly lense with occasional cobble
2							
3							
4							
5			D				
6					SC	slightly moist hard	**CLAYEY SAND,** some gravel, well graded sand, weakly lime cemented (Stage I+), low plasticity, reddish-brown
7							
8							
9							Stopped Backhoe at 8'6"
10							

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. T-20

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/16/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.44468° N
112.57753° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM/GM	slightly moist moderately firm to firm	**SILTY SAND & GRAVEL,** some cobbles, well graded sand & gravel, subangular, uncemented to weakly lime cemented (Stage I-I+), nonplastic to low plasticity, light brown
1			D				
2							
3							
4			D		GM	slightly moist hard	**SILTY SAND, GRAVEL & COBBLES,** well graded sand & gravel, subangular, moderately to strongly lime cemented (Stage III-III+), nonplastic to low plasticity, light grayish-brown
5							Backhoe refused at 5'
6							
7							
8							
9							
10							

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. T-21

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/16/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.46910° N
112.55562° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					GP-GM	slightly moist loose	**SAND, GRAVEL & COBBLES WITH SILT,** some boulders up to 2' in diameter, well graded sand & gravel, subangular, uncemented, nonplastic, brown note: Stage III+-IV soils outcrop within 100' of test pit
1							
2			D				
3					SP-SC/ GP-GC	slightly moist dense	**SAND & GRAVEL WITH CLAY TO CLAYEY SAND & GRAVEL,** some cobbles, rare boulder, well graded sand, predominantly fine grained gravel, subangular, uncemented, nonplastic to low plasticity, light reddish-brown
4							
5							
6			D				
7							
8							
9							Stopped Backhoe at 9'
10							

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. T-22

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/16/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.46487° N
112.53985° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SM/GM	slightly moist firm to hard	**SILTY SAND & GRAVEL,** trace of clay, occasional cobble, well graded sand & gravel, subangular, weakly lime cemented (Stage I-II), low plasticity to nonplastic, reddish-brown
1			D	4			
2					SM	slightly moist hard	**SILTY SAND,** considerable gravel, occasional cobble, well graded sand, moderately to strongly lime cemented (Stage III), nonplastic, low plasticity, light grayish-brown
3			D				
4							
5							Backhoe refused at 4'6"
6							
7							
8							
9							
10							

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. T-23

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/16/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.46696° N
112.53278° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM/ GP-GM	slightly moist loose to dense	**SAND, GRAVEL & COBBLES WITH SILT,** well graded, subangular to angular, uncemented to weakly lime cemented, nonplastic, brown
1							
2			D				note: Stage II-II+ below 2'6"
3							note: occasional zone of SP-SC
4							
5			D				
6					SM	slightly moist hard	**SILTY SAND,** considerable gravel, predominantly fine grained, occasional cobble, well graded sand, subangular to angular, moderately to strongly lime cemented (Stage III-III+), nonplastic, light gray
7							Backhoe refused at 7'
8							
9							
10							

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. T-24

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/17/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.57977° N
112.64584° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					GP/SP	slightly moist medium dense	**SAND, GRAVEL & COBBLES,** trace of silt, some boulders, well graded sand & gravel, subangular to subrounded, uncemented, nonplastic, brown note: Stage IV cementation outcropping on south side of wash note: occasional zone with greater silt content (GP-GM/SP-SM)
1							
2			D	1			
3							
4							
5							
6			D				note: Stage IV cemented soils outcropping with 200' of test pit
7							
8							Stopped Backhoe at 8'
9							
10							

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. T-25

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/17/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.62804° N
112.63545° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM	slightly moist loose to medium dense	**SAND WITH SILT,** some gravel, occasional cobbles, well graded sand, subangular, uncemented, nonplastic, brown note: occasional zone of GP-GM
1							
2			D				
3							
4							
5							
6			D				
7							
8					SP-SC/ SC	slightly moist dense	**SAND WITH CLAY,** some to considerable gravel, occasional cobble, well graded, subangular, weakly lime cemented (Stage I-I+), nonplastic, light reddish-brown
9							
10							

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. T-26

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/17/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.62804° N
112.63545° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
10					SP-SC/ SC		**SAND WITH CLAY,** continued
11							Stopped Backhoe at 11'
12							
13							
14							
15							
16							
17							
18							
19							
20							

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. T-26

PROJECT Sun Valley ADMP

JOB NO. 5-117-001063 **DATE** 5/17/06

BACKHOE TYPE CASE 580 Super M
LOCATION 33.64005° N
112.61606° W
SURFACE ELEV.
DATUM J.E. Fuller

GROUNDWATER

	DEPTH	HOUR	DATE
▽		none	
▼			

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	SOIL DESCRIPTION
0					SP-SM	slightly moist medium dense	**SAND WITH SILT,** some to considerable gravel, occasional cobble, well graded sand, subangular, uncemented, nonplastic, light brown
1			D				
2							
3							
4							
5							
6							
7			D				
8							
9							
10							Stopped Backhoe at 10'

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. T-27

Appendix B

Seismic Results

Explanation of Seismic Results

Seismic results presented in this appendix include both seismic refraction and refraction microtremor surface methods. The seismic refraction results presented here utilize the first arrival of the compression wave (p-wave) from a sledgehammer energy source to interpret subsurface profiles in two dimensions (distance and depth). A major limitation of seismic refraction in this geologic setting is that the method can only be used to interpret ground with subsurface horizons that increase in p-wave velocity with depth. If a lower p-wave velocity horizon underlies a higher velocity horizon, known as a velocity reversal, the seismic refraction method cannot detect that lower velocity horizon. Such velocity reversals can be common in profiles that include horizons of cemented soils overlying horizons of uncemented or less cemented soils. The refraction microtremor results presented here utilize surface waves from ambient or complex noise typically generated by a person jogging alongside or jumping near the end of the seismic line that correspond to shear waves (s-wave). A velocity reversal can be interpreted in the s-wave profile data to complement that weakness in the p-wave seismic refraction interpretation. However, the s-wave interpretation is in only one dimension (depth); the p-wave interpretation presents horizontal variation in the interpreted subsurface profile. Descriptions of basic field procedures and interpretations are presented in the equipment and procedures sections that that precede the seismic results.

There are two pages of interpretation results presented for each seismic line. The first page is the Refraction Seismic Interpretation. It includes two graphs. The upper graph is the result of the seismic interpretation process. Red lines are interpreted interfaces P-wave of different velocity subsurface material horizons. These lines are based on depth interpretations presented as blue triangles. Seismic p-wave velocities are presented as black numbers. Unless otherwise noted, these numbers are in feet per second (f/s). A dotted blue line with variable depth is the interpreted depth of investigation of the p-wave results. This depth of investigation is interpreted using the SEISOPT2D software package. Results of the refraction microtremor (Remi) interpretation for the seismic line are presented in green in the upper graph. The bold dashed green line presents the one-dimensional interpretation of interface depths, and the green numbers and notes present s-wave velocities, also in f/s unless otherwise noted, and deeper interpreted data that do not fit on the graph depth scale.

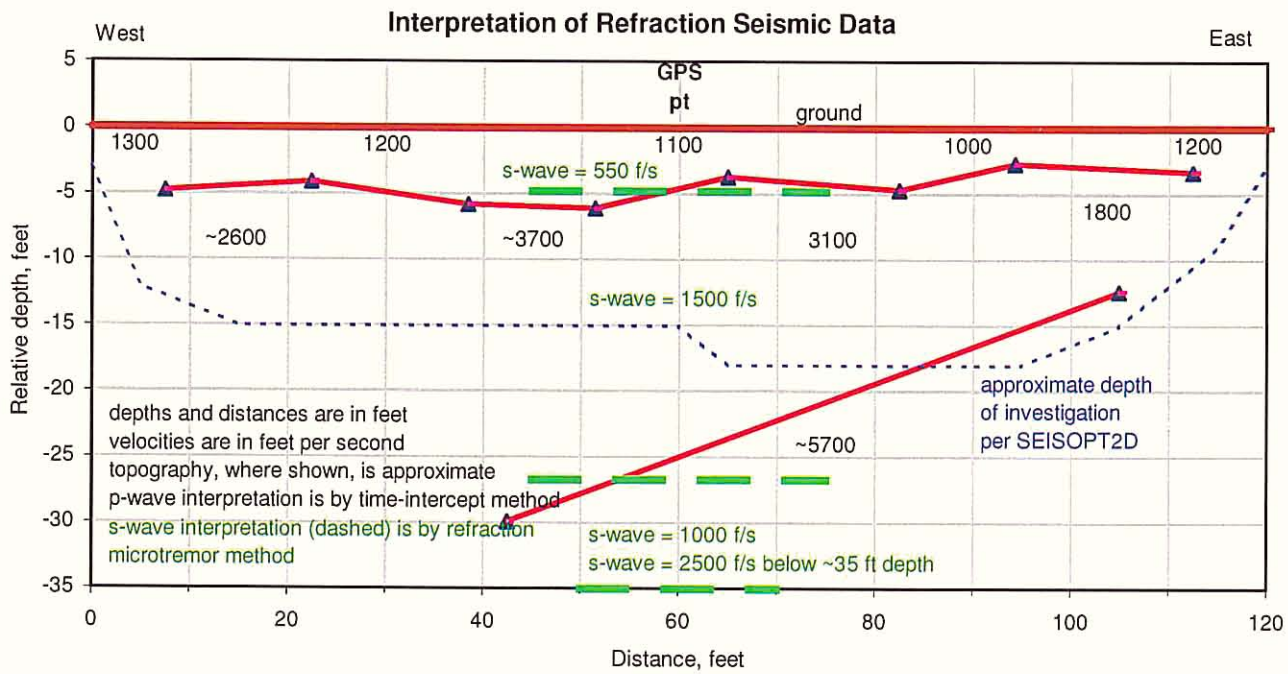
The lower graph is the p-wave first arrival time-distance plots upon which the seismic refraction interpretations are based. Seismic velocities and depth interpretations are labeled in black. This information is presented to document the data upon which the p-wave interpretation is based, and provide that data for review of the geophysical results.

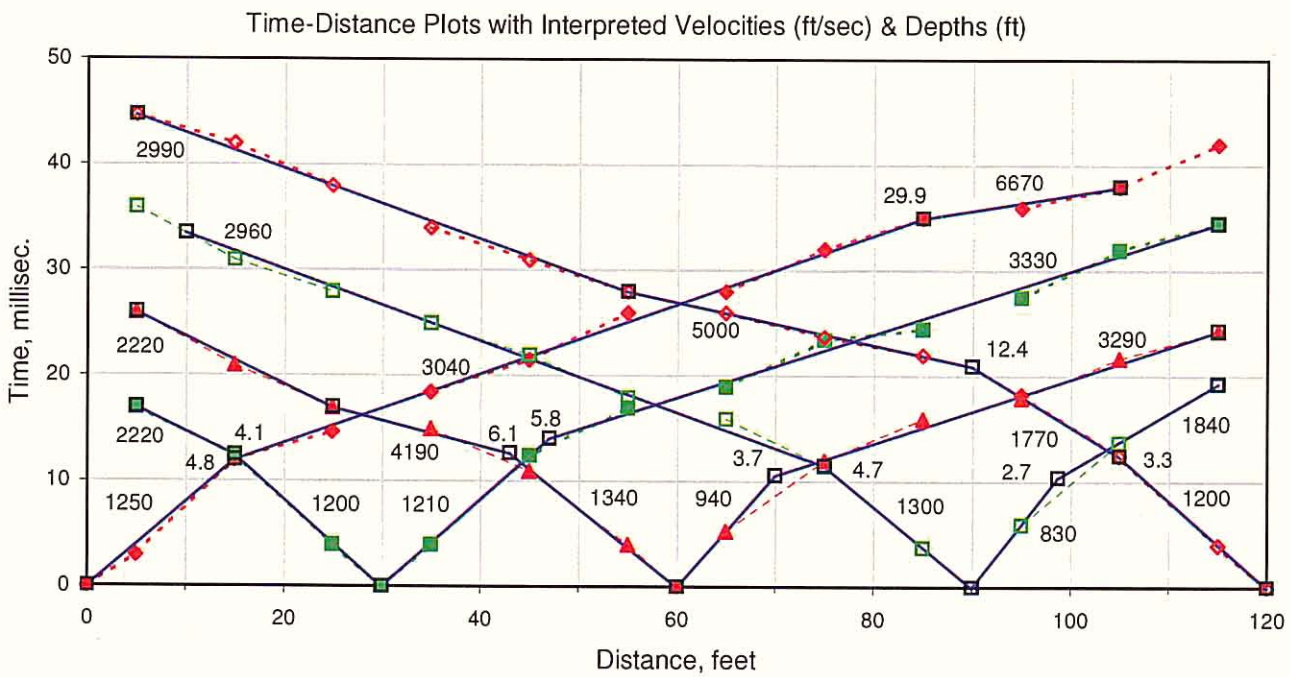
The second page of interpretation results is the Refraction Microtremor S-wave interpretation presentation that is summarized in the previously described upper graph. Interpretation of an s-wave profile is based on a frequency / s-wave velocity dispersion curve. Dispersion point data consists of frequency / velocity point picks shown in the color presentation within the figure. The dispersion points, and the interpreted dispersion curve that results from fitting an s-wave profile to the dispersion point data, are plotted in the figure as s-wave velocity versus frequency. The one-dimensional depth and velocity information tabulated in the figure is the information presented in green on the first page upper graph. An estimated depth of investigation, based on the lowest frequency reliable dispersion point from the interpretation, is also presented in the figure.

Use of the seismic results is based on the information presented in the first page upper graph 'Interpretation of Refraction Seismic Data.' Depths and thicknesses of subsurface horizons are presented as the bold red (p-wave) or green dash (s-wave) lines, and material strengths or resistance to excavation or erosion, are characterized as seismic velocities. Table 1 in the report text (page 22) summarizes material resistance to excavation and erosion as a function of the size equipment needed to excavate the material or the stream power needed to initiate erosion and the material seismic p-wave velocity in f/s.

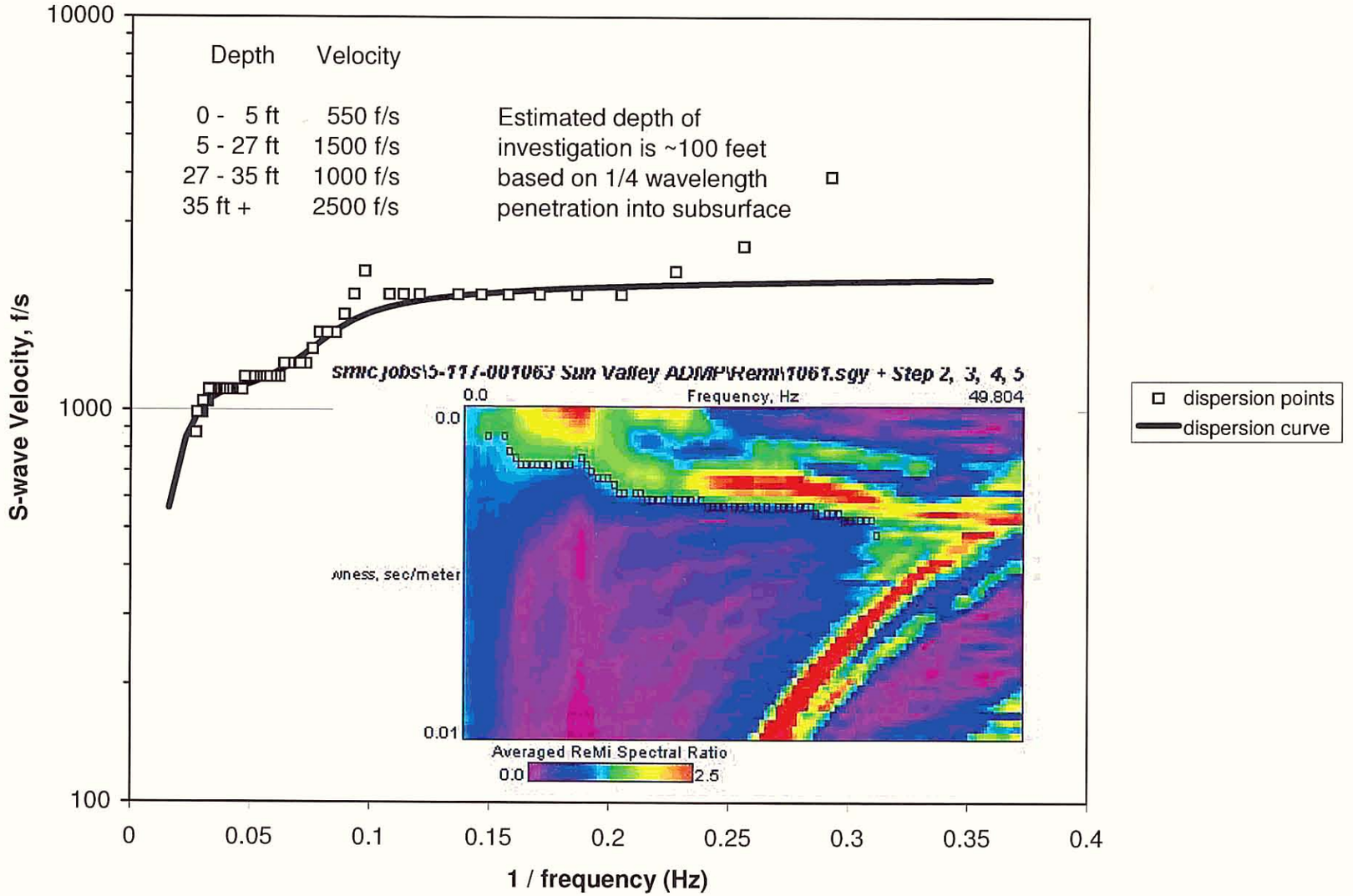
An example of application of seismic results for excavating a basin at Seismic Line 1W (the first line in this appendix) is as follows. For an excavation of about 4 feet or less across the seismic line, the maximum interpreted p-wave velocity is about 1,800 f/s, located at the east end of the line. Referring to Table 1, a rubber-tired backhoe with less than about 100 hp, such as a Cat 416C, can effectively excavate such material up to a p-wave velocity of about 3,000 f/s. Should the excavation have to extend to a depth greater than about 4 to 6 feet, then material with p-wave velocities of about 3,100 to 3,700 f/s would be encountered in the center portion of the line. At a depth greater than about 6 feet, heavier excavating equipment, such as a Cat 330BL trackhoe or Cat D7G bulldozer, would be needed to effectively excavate the 3,700 f/s material. If the excavation needed to extend to a depth of about 15 feet or greater towards the east end of Line 1W, then very heavy equipment, such a Cat 375 trackhoe or Cat D9L bulldozer may become necessary for effective excavation.

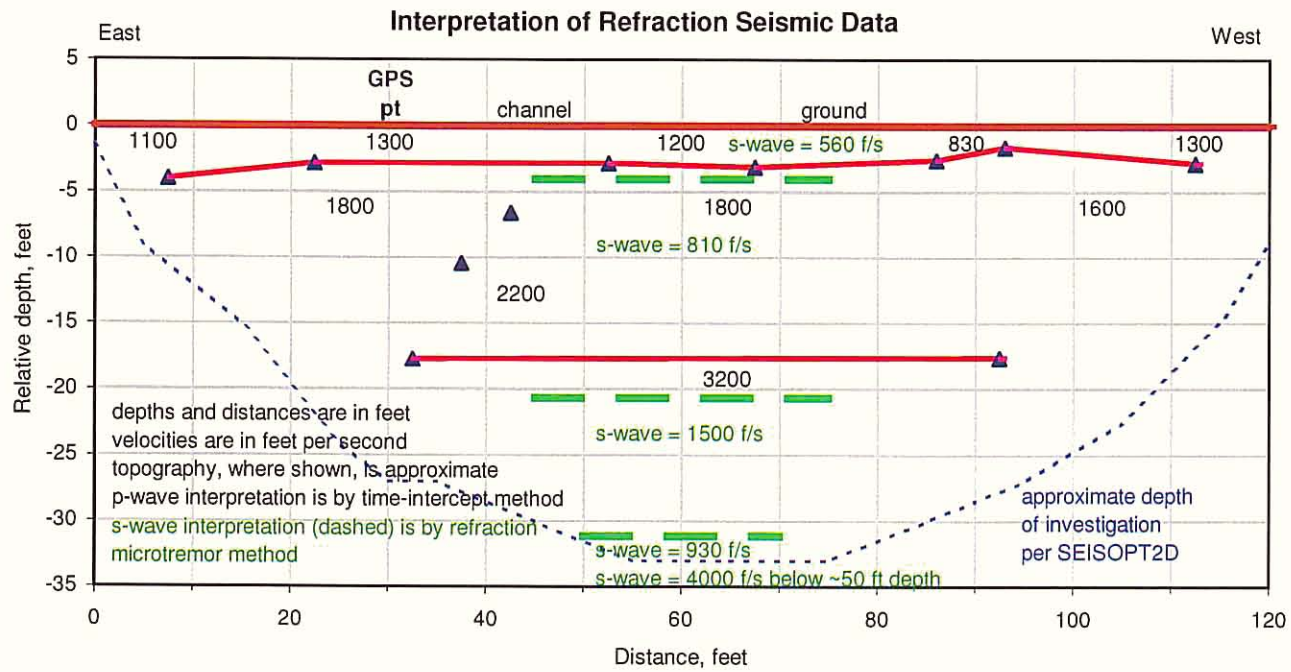
An example of application of seismic results to predicting scour erosion at Seismic Line C155L, (the second line in this appendix) is as follows. The upper few feet of the subsurface profile has p-wave velocities of 1,300 f/s and less. Such material is very erodable. Beneath the upper few feet and extending to depths of about 17 to 18 feet, material p-wave velocities increase to about 1,600 f/s to 1,800 f/s to about 2,200 f/s. Such materials may still be erodable if scour were to reach those depths. Below a depth of about 18 feet, the material p-wave velocity increases to about 3,200 f/s. To initiate erosion in this deeper underlying material, stream power applied to the material would need to be in the range of 0.2 to 1.0 kilowatts per square meter.

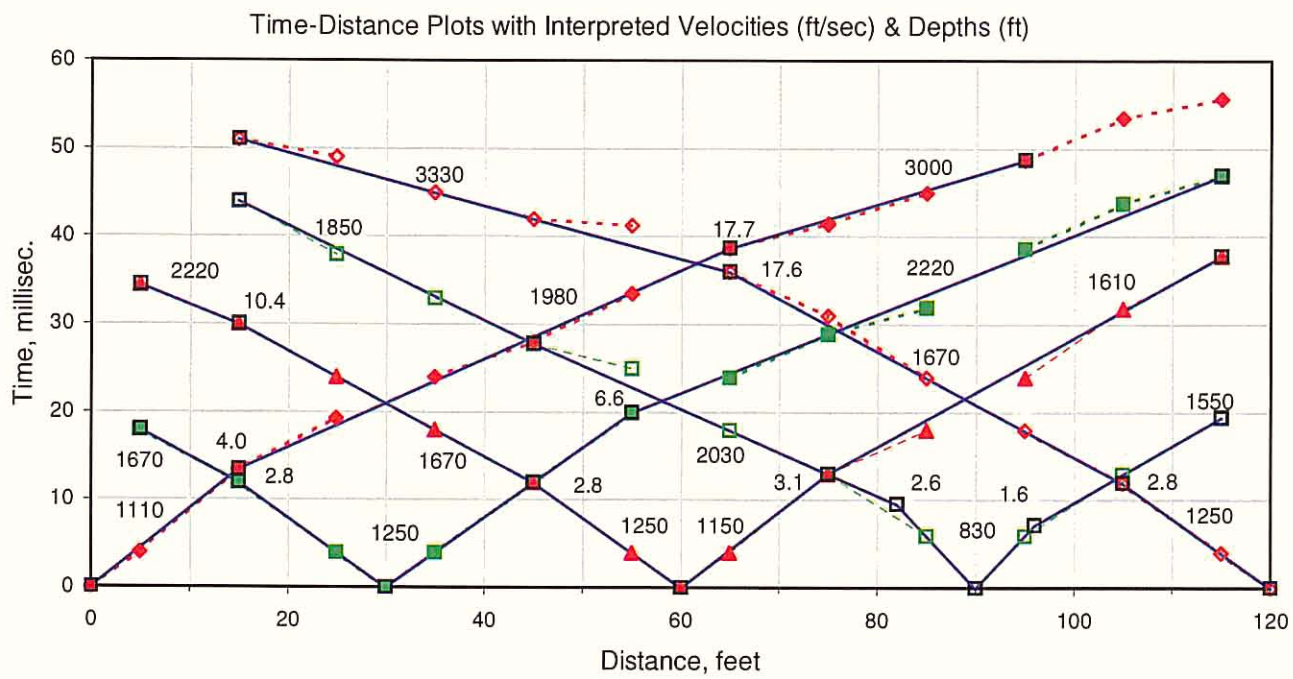

Interpretation of Refraction Seismic Data
West
East
GPS pt
ground
1300
1200
1100
1000
1200
s-wave = 550 f/s
~2600
~3700
3100
1800
s-wave = 1500 f/s
approximate depth of investigation per SEISOPT2D
~5700
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 1000 f/s
s-wave = 2500 f/s below ~35 ft depth
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
2990
2960
2220
2220
1250
4.8
4.1
1200
4190
1210
3040
6.1
5.8
1340
5000
940
3.7
4.7
1300
29.9
6670
12.4
3330
1770
2.7
830
3290
3.3
1840
1200

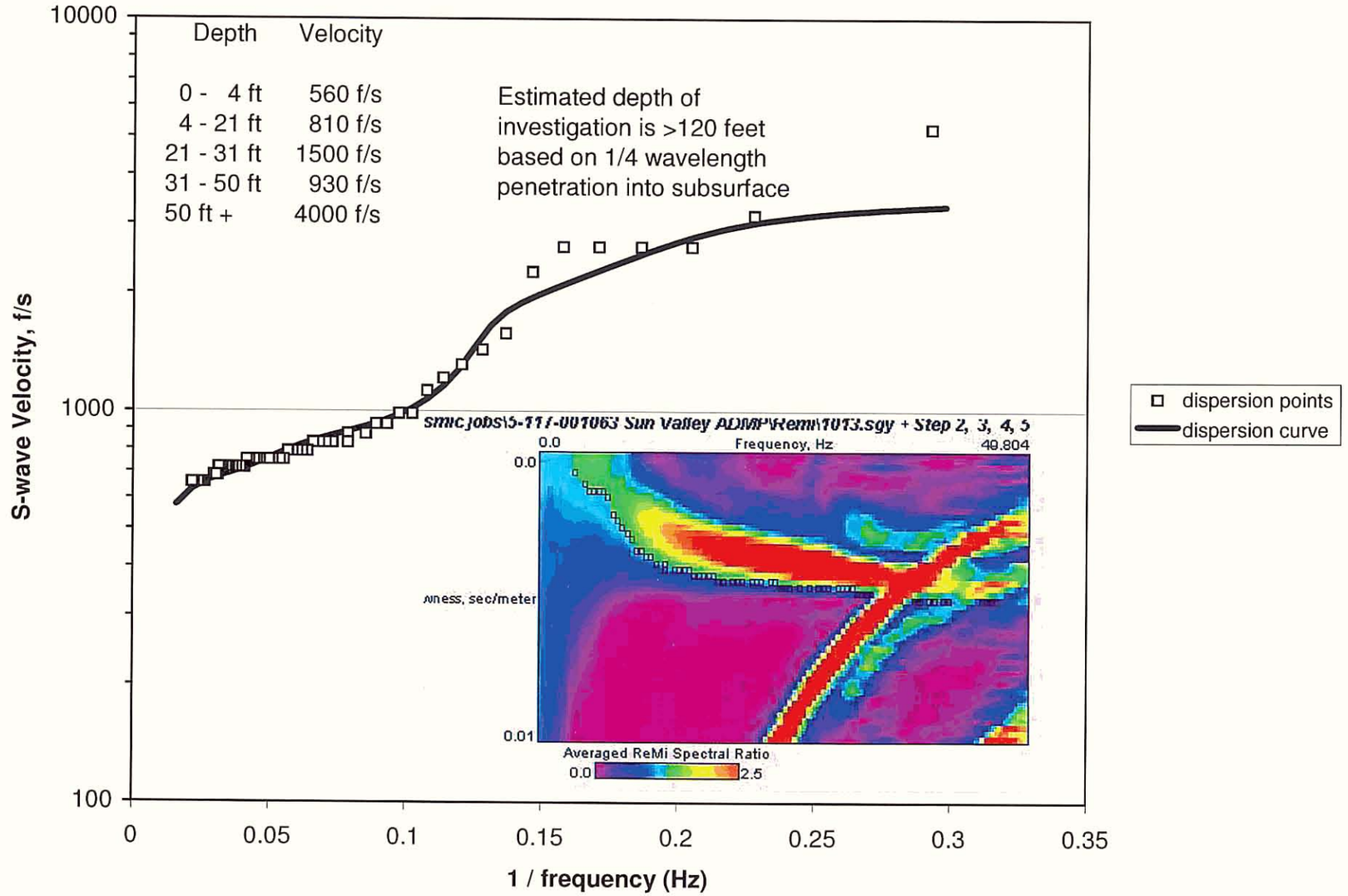
Refraction Microtremor S-wave Interpretation **Line 1W** AMEC Job No. 5-117-001063

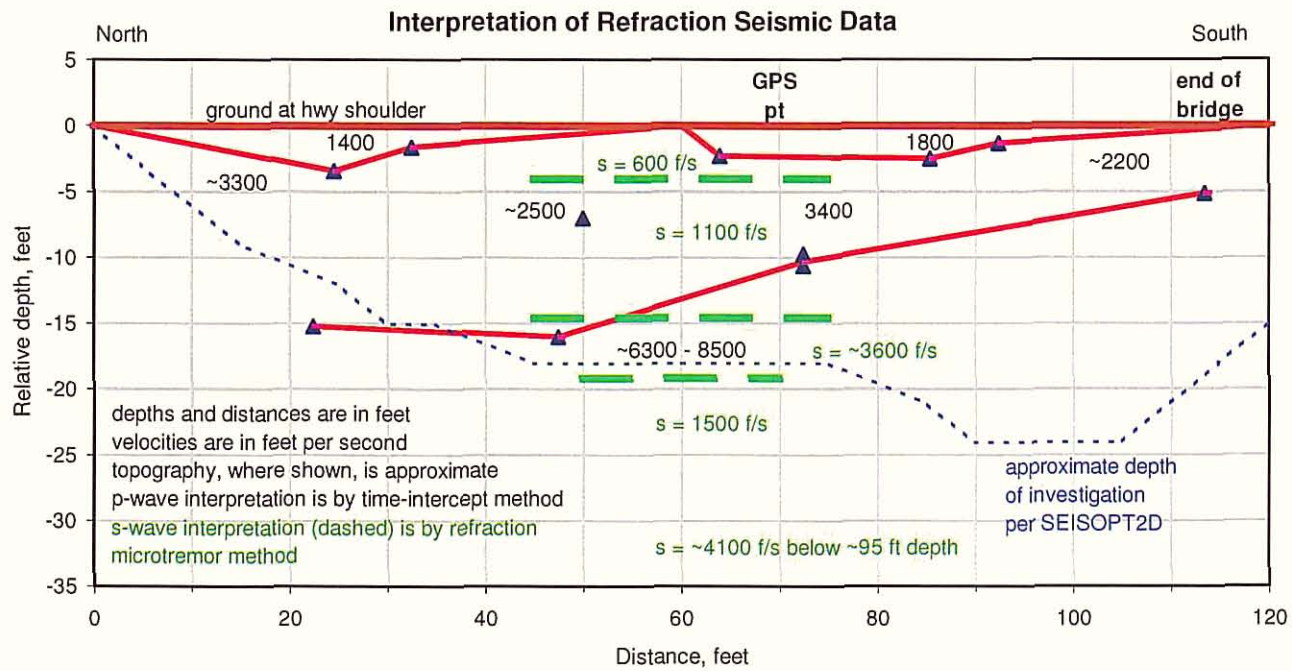


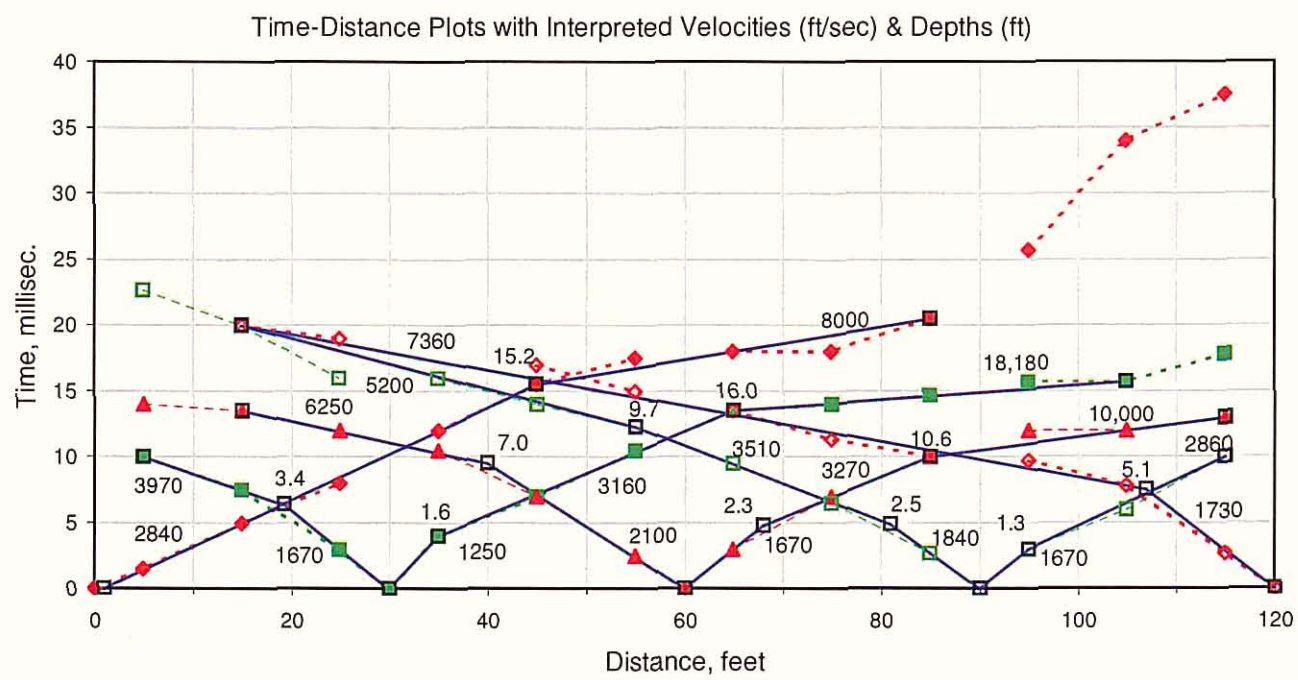

Interpretation of Refraction Seismic Data
East
West
GPS pt
channel
ground
1100
1300
1200
s-wave = 560 f/s
830
1300
1800
1800
1600
s-wave = 810 f/s
2200
3200
s-wave = 1500 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 930 f/s
s-wave = 4000 f/s below ~50 ft depth
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

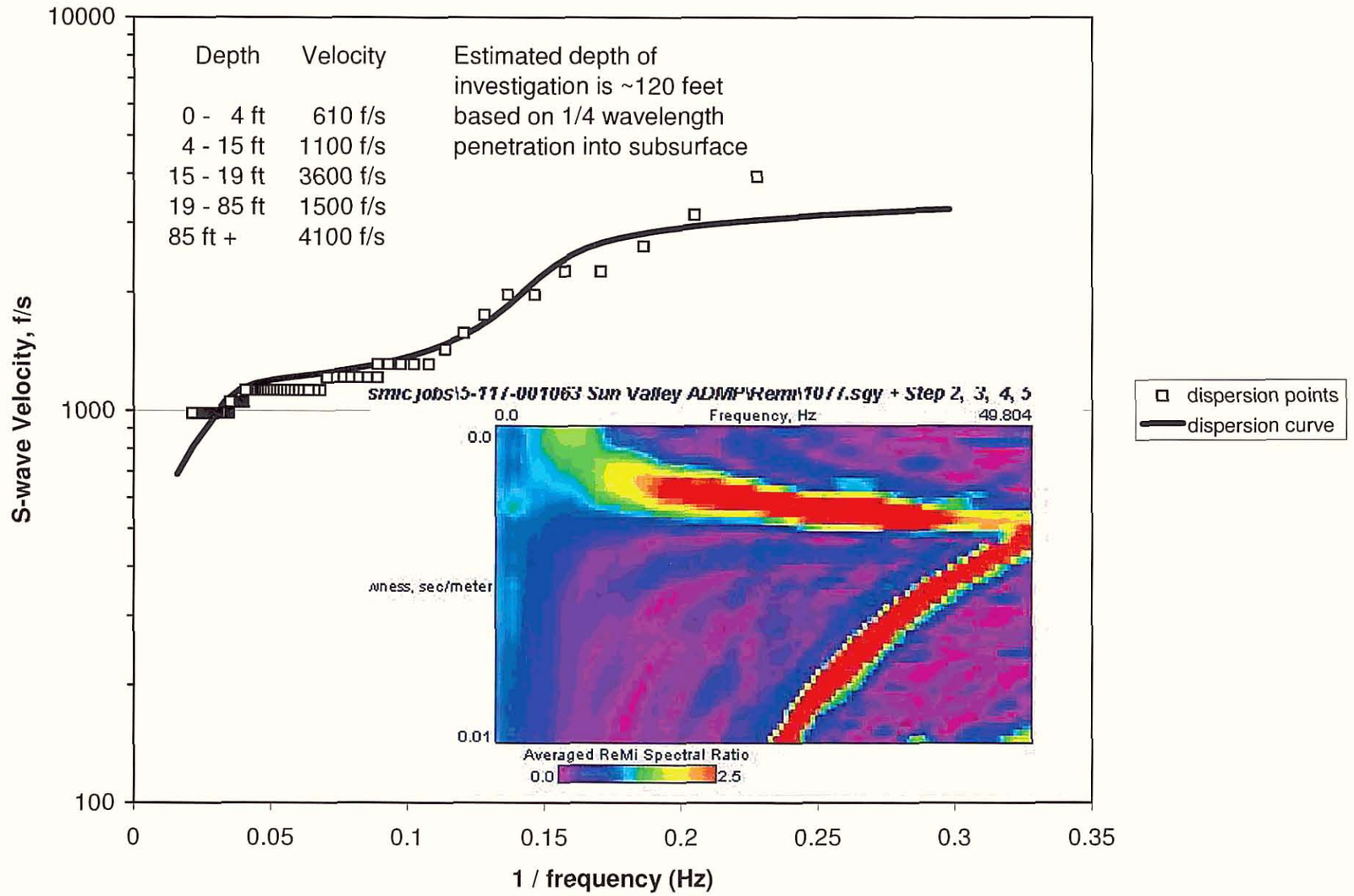

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
3330
3000
1850
17.7
17.6
2220
2220
10.4
1980
1610
1670
6.6
1550
4.0
1670
1670
2.8
2030
2.8
3.1
2.6
1.6
2.8
1110
1250
1250
1150
830
1250

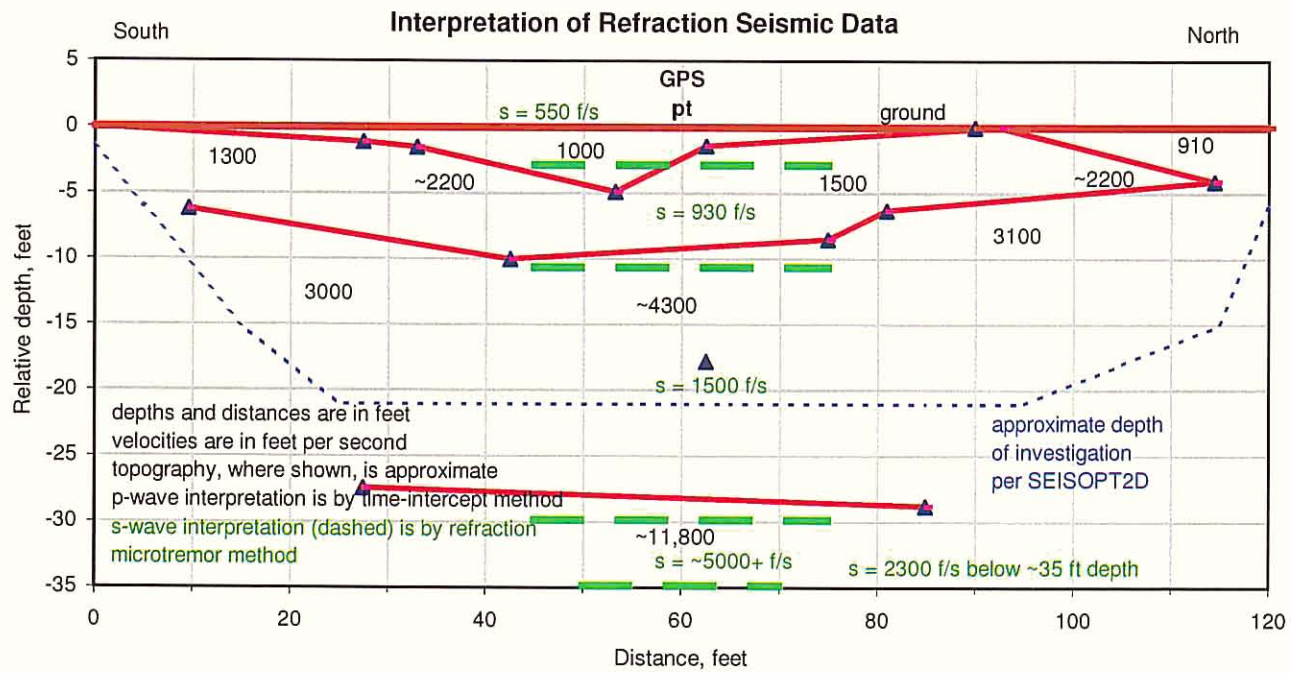
Refraction Microtremor S-wave Interpretation **Line C155L** AMEC Job No. 5-117-001063

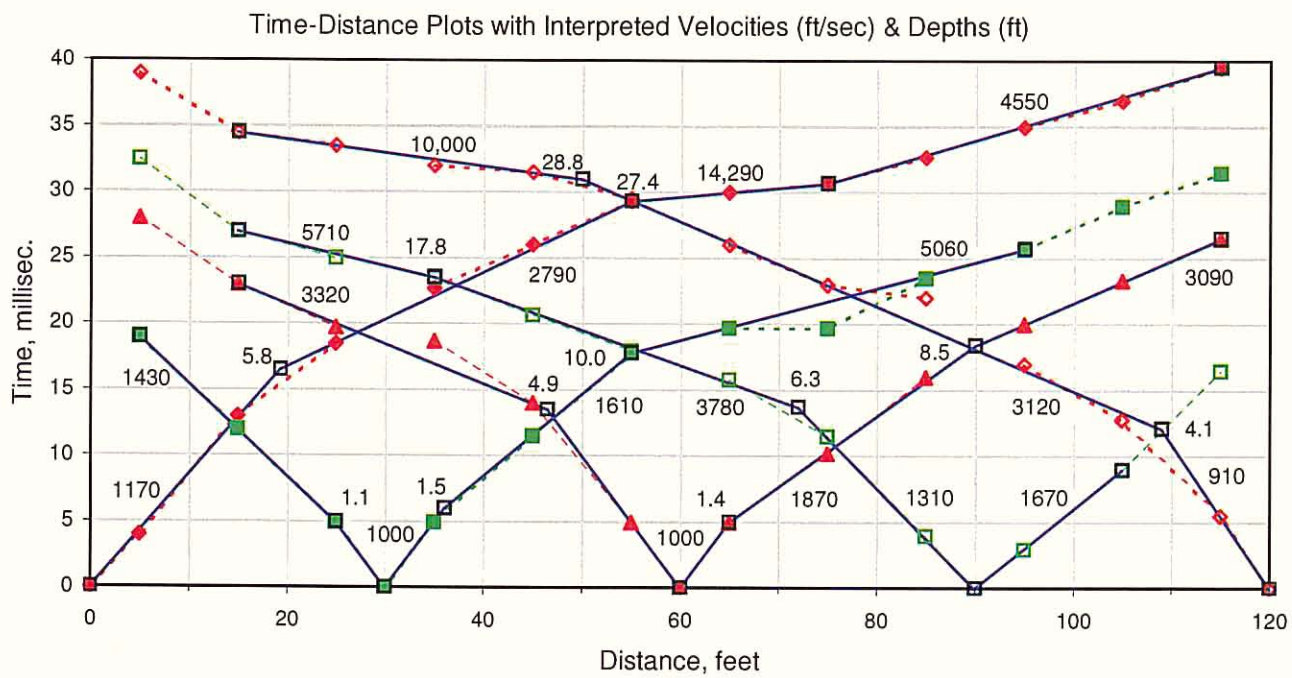



Interpretation of Refraction Seismic Data
North
South
GPS pt
end of bridge
ground at hwy shoulder
1400
~3300
~2500
3400
1800
~2200
s = 600 f/s
s = 1100 f/s
~6300 - 8500
s = ~3600 f/s
s = 1500 f/s
s = ~4100 f/s below ~95 ft depth
depths and distances are in feet
velocities are in feet per second
topography, 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

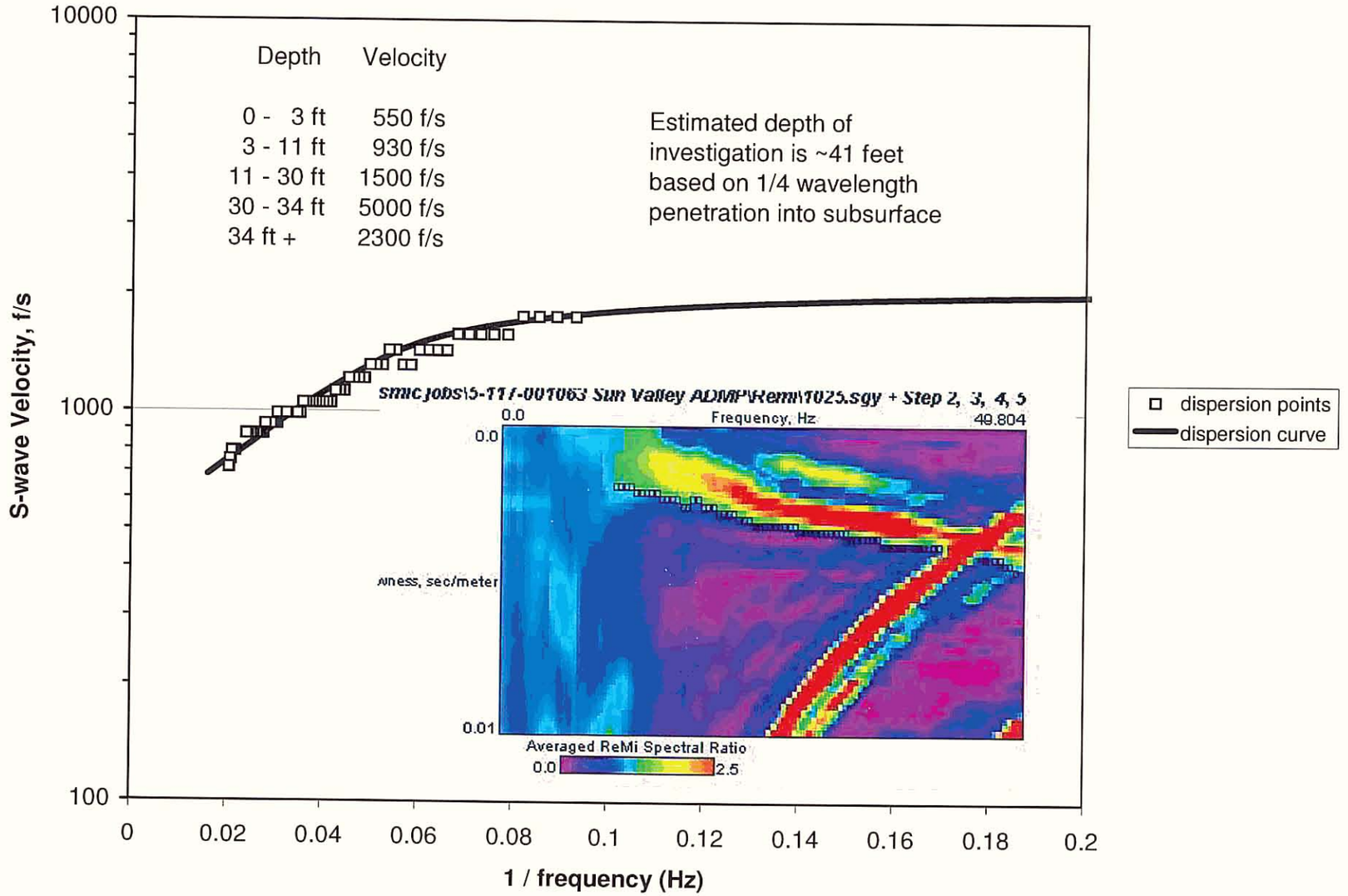

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
7360
15.2
8000
5200
6250
9.7
16.0
18,180
10,000
7.0
3510
10.6
2860
3970
3.4
3160
3270
5.1
1.6
2.3
2.5
1730
2840
1670
1250
2100
1670
1840
1.3
1670

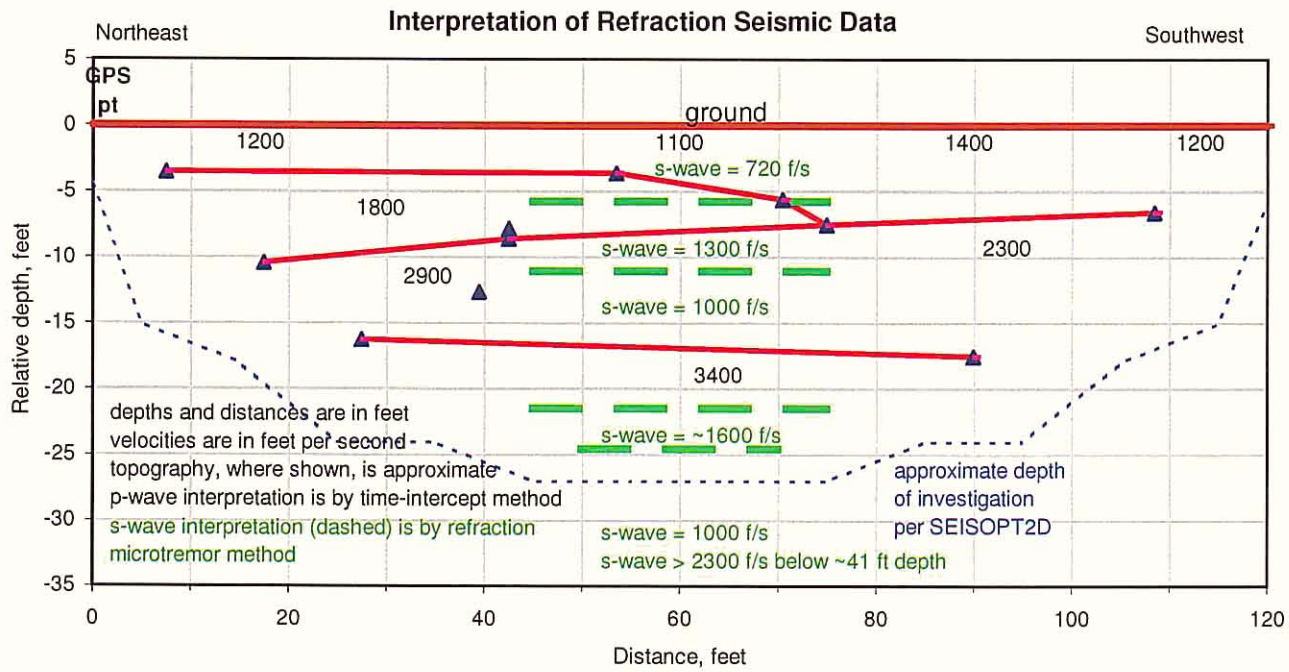

Depth Velocity
0 - 4 ft 610 f/s
4 - 15 ft 1100 f/s
15 - 19 ft 3600 f/s
19 - 85 ft 1500 f/s
85 ft + 4100 f/s
Estimated depth of investigation is ~120 feet based on 1/4 wavelength penetration into subsurface
smic jobs\5-117-001063 Sun Valley ADMP\Remi\1077.sgy + Step 2, 3, 4, 5
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
2.5
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
1 / frequency (Hz)

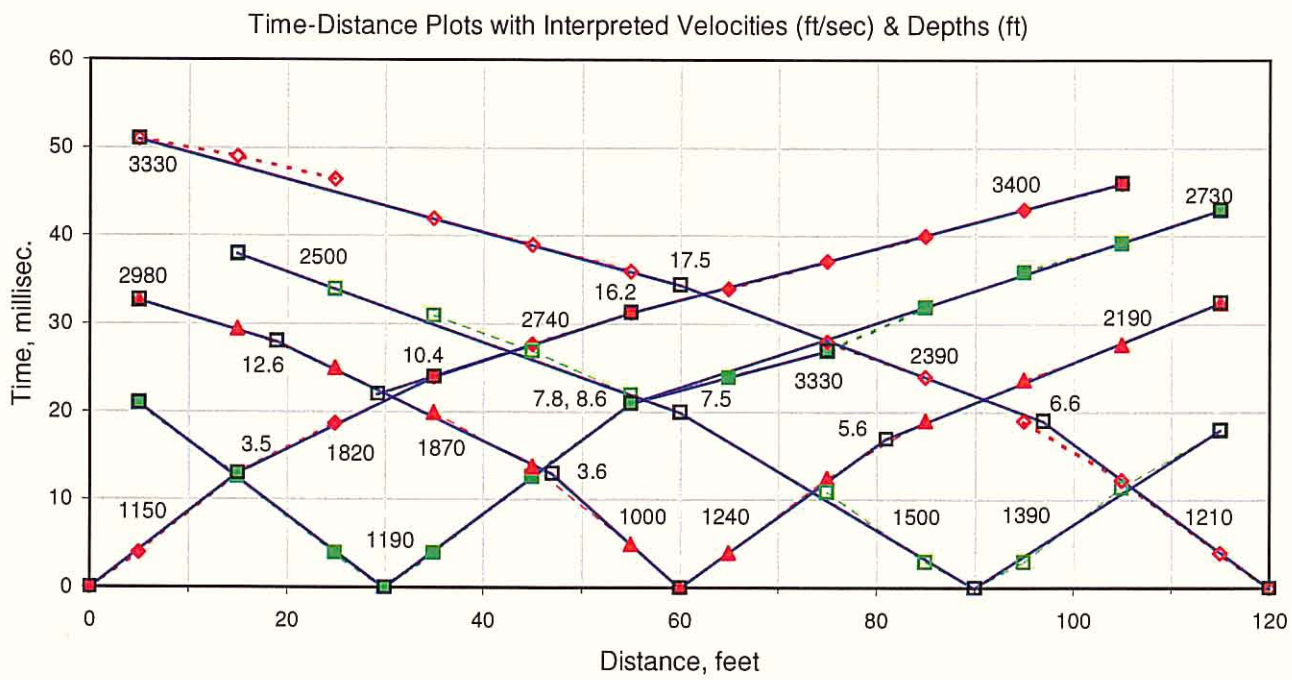

Interpretation of Refraction Seismic Data
South
North
GPS pt
s = 550 f/s
ground
1300
1000
910
~2200
1500
~2200
s = 930 f/s
3100
3000
~4300
s = 1500 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
~11,800
s = ~5000+ f/s
s = 2300 f/s below ~35 ft depth
Relative depth, feet
Distance, feet


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

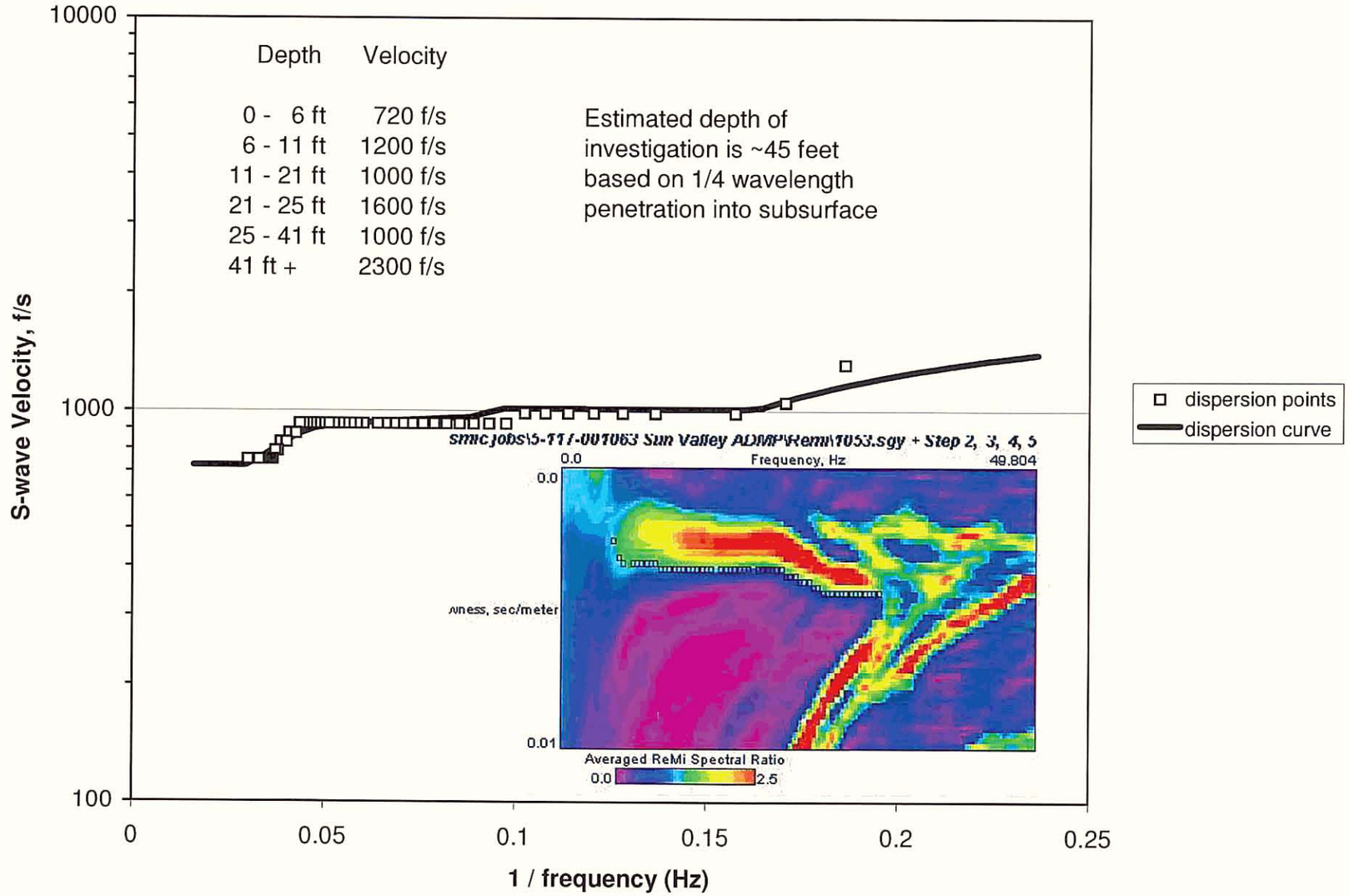
Refraction Microtremor S-wave Interpretation **Line C500** AMEC Job No. 5-117-001063




Interpretation of Refraction Seismic Data
Northeast
Southwest
GPS pt
ground
1200
1100
1400
1200
s-wave = 720 f/s
1800
s-wave = 1300 f/s
2300
2900
s-wave = 1000 f/s
3400
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
approximate depth of investigation per SEISOPT2D
s-wave = 1000 f/s
s-wave > 2300 f/s below ~41 ft depth
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3330
3400
2730
2500
17.5
2980
16.2
2740
2190
12.6
10.4
2390
3330
7.8, 8.6
7.5
6.6
5.6
3.5
1820
1870
3.6
1150
1190
1000
1240
1500
1390
1210
Time, millisec.
Distance, feet

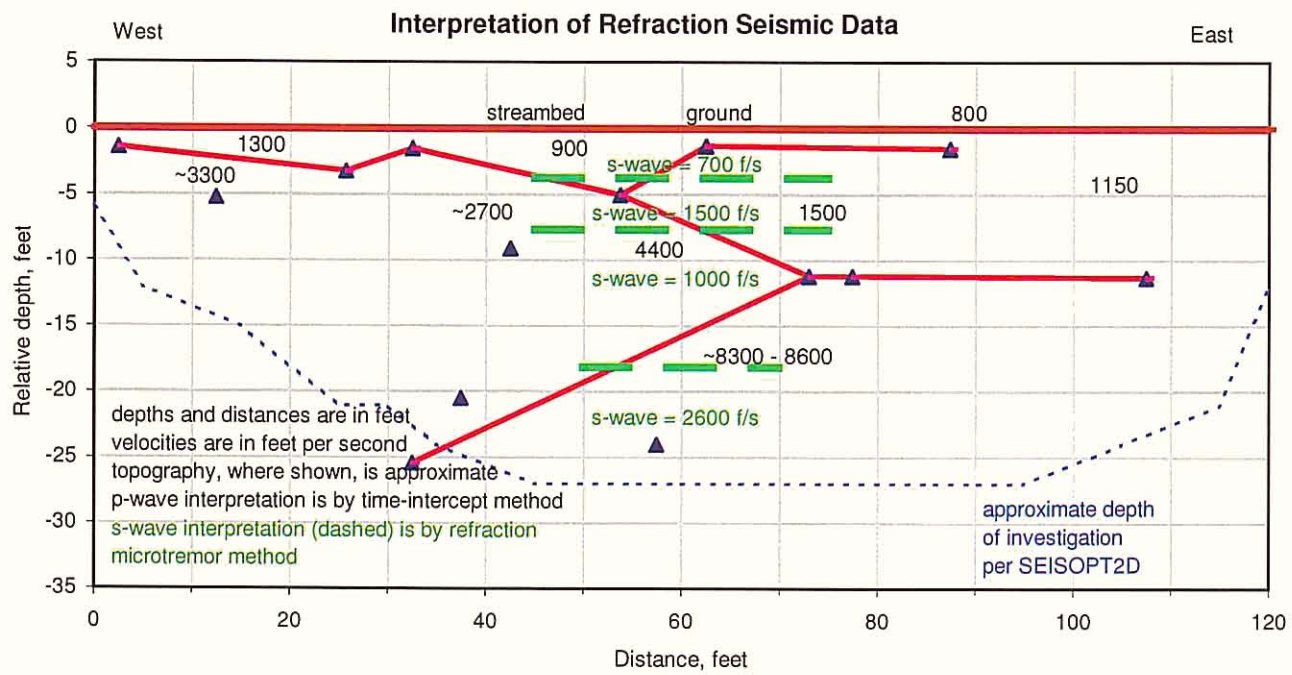
Refraction Microtremor S-wave Interpretation **Line C920** AMEC Job No. 5-117-001063

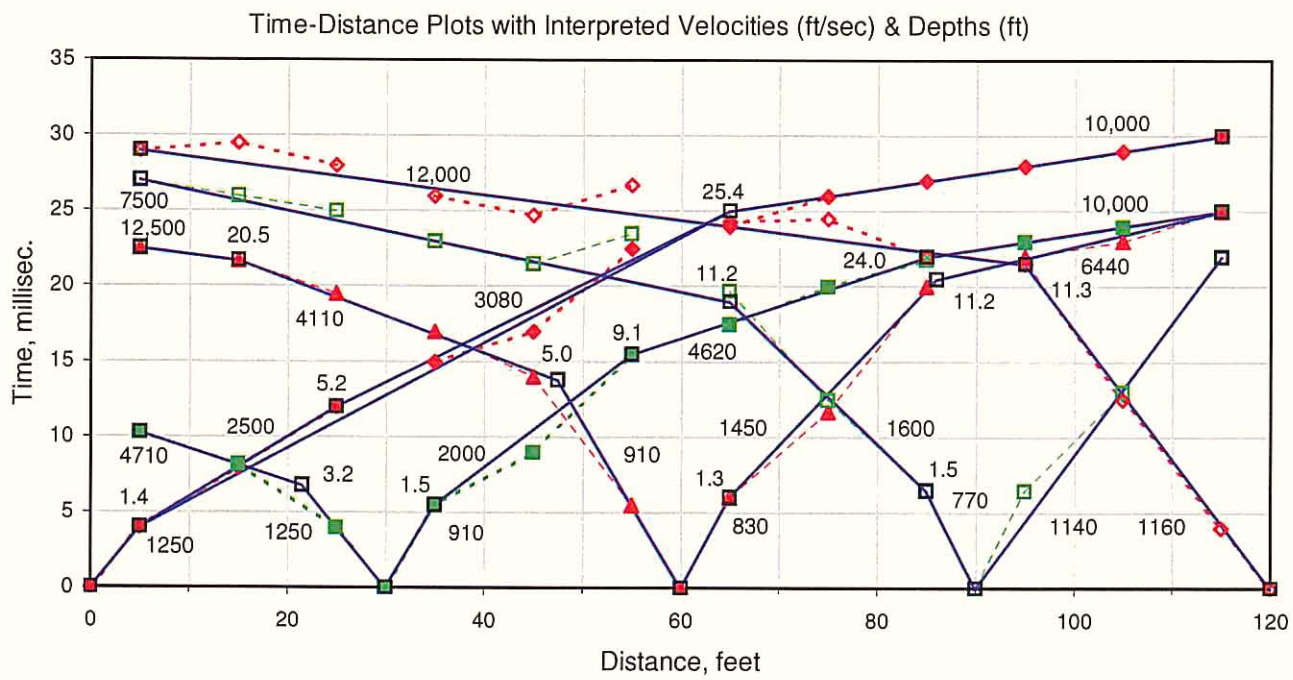


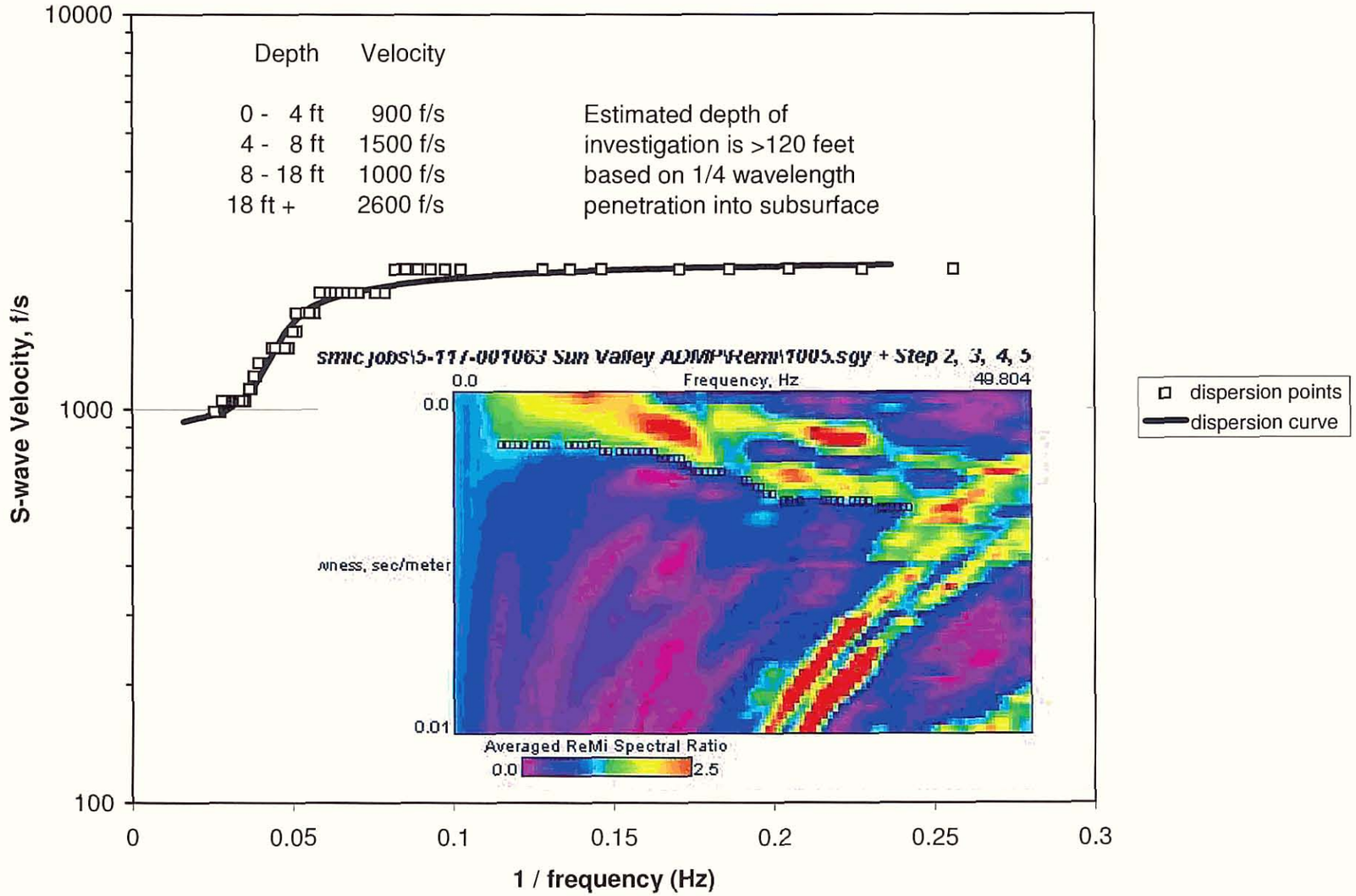
Refraction Seismic Interpretation

Line RR110

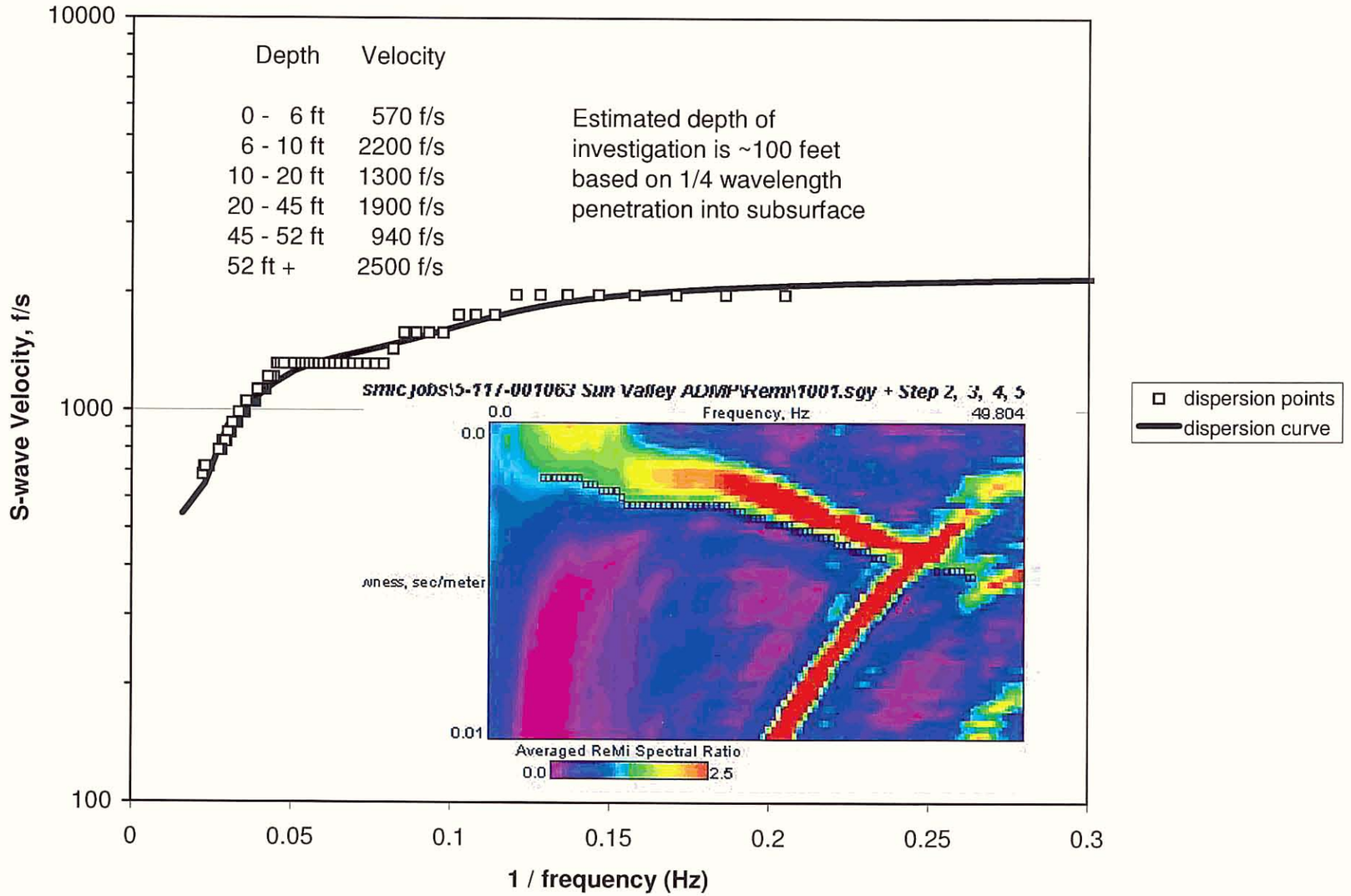
AMEC Job No. 5-117-001063

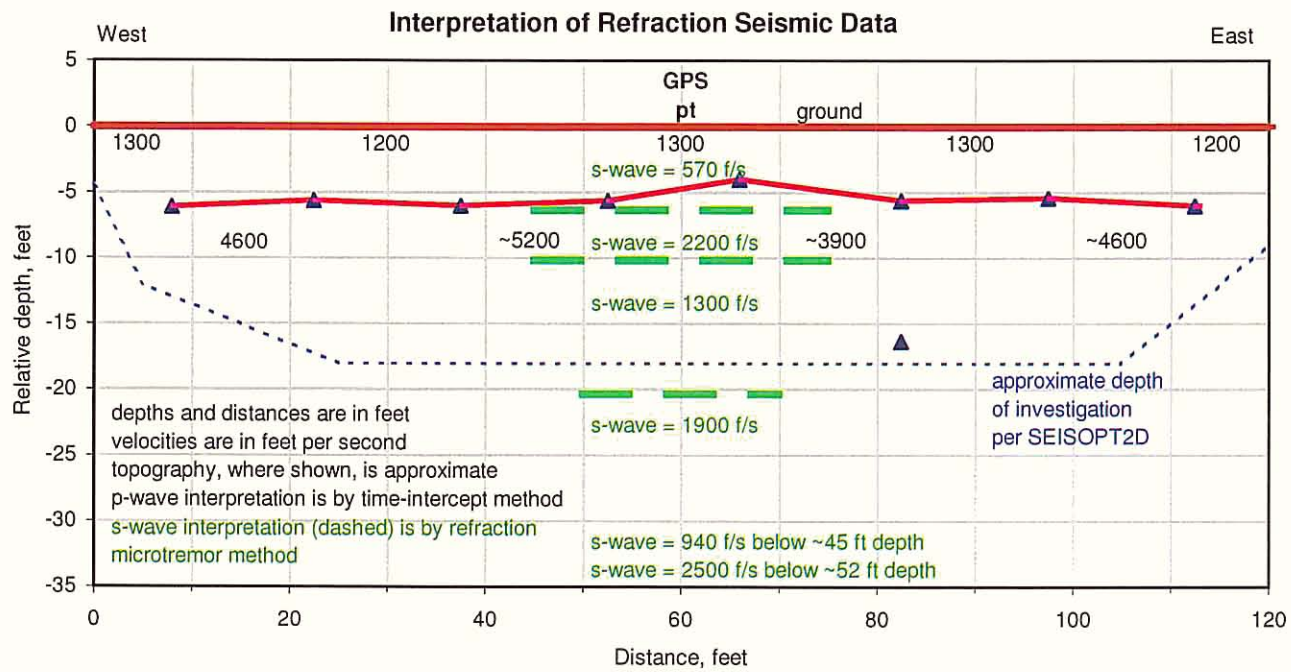


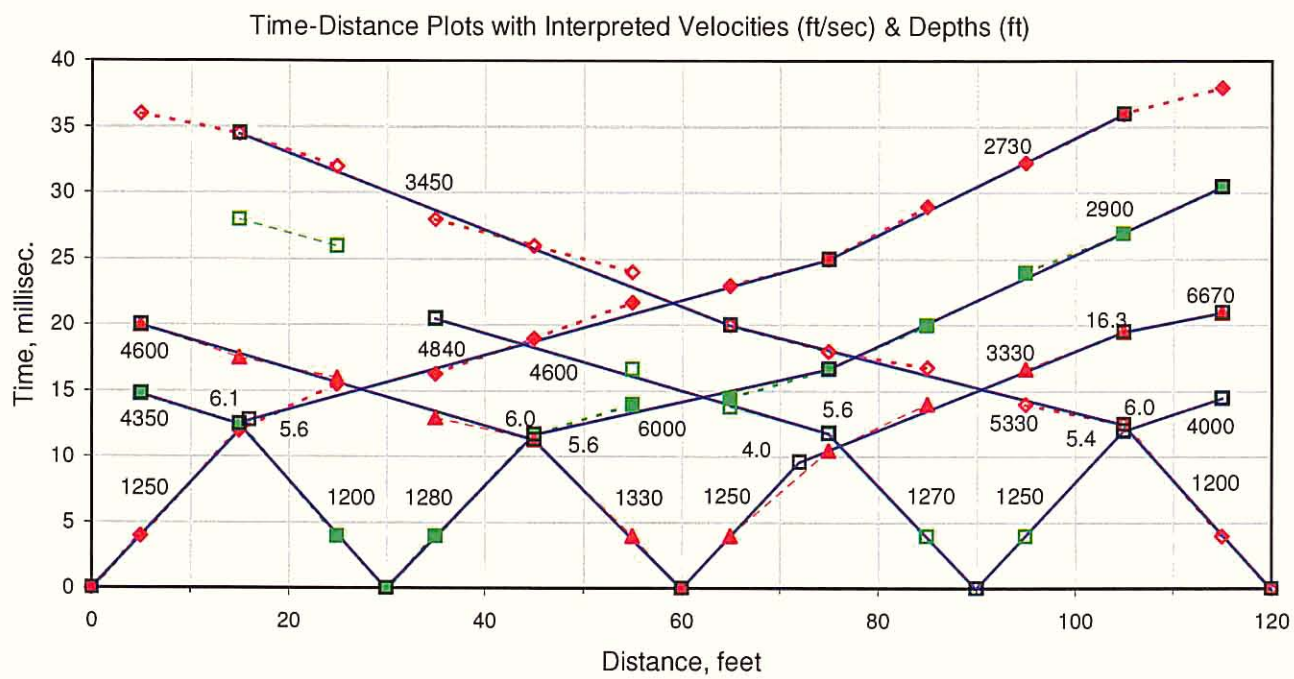


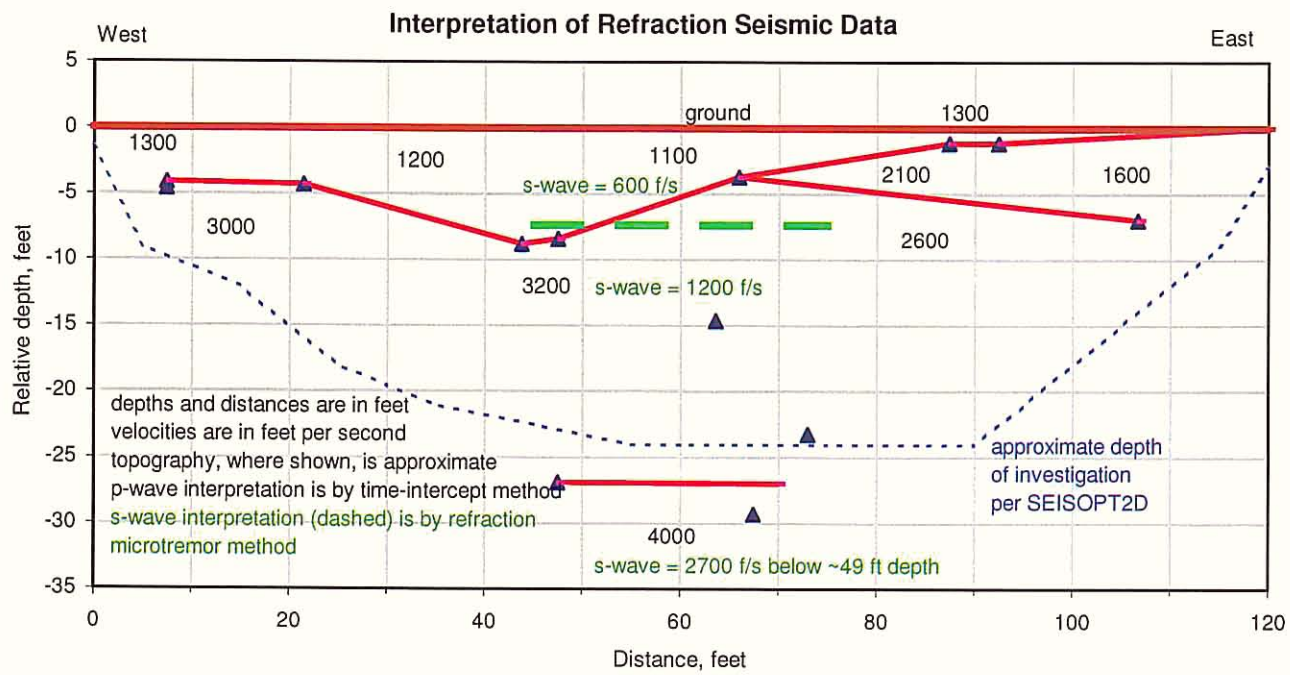

Depth Velocity
0 - 4 ft 900 f/s
4 - 8 ft 1500 f/s
8 - 18 ft 1000 f/s
18 ft + 2600 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
smic jobs\5-117-001063 Sun Valley ADMP\Remi\1005.sgy + Step 2, 3, 4, 5
0.0
Frequency, Hz
49.804
0.0
wness, sec/meter
0.01
Averaged ReMi Spectral Ratio
0.0
2.5
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
1 / frequency (Hz)

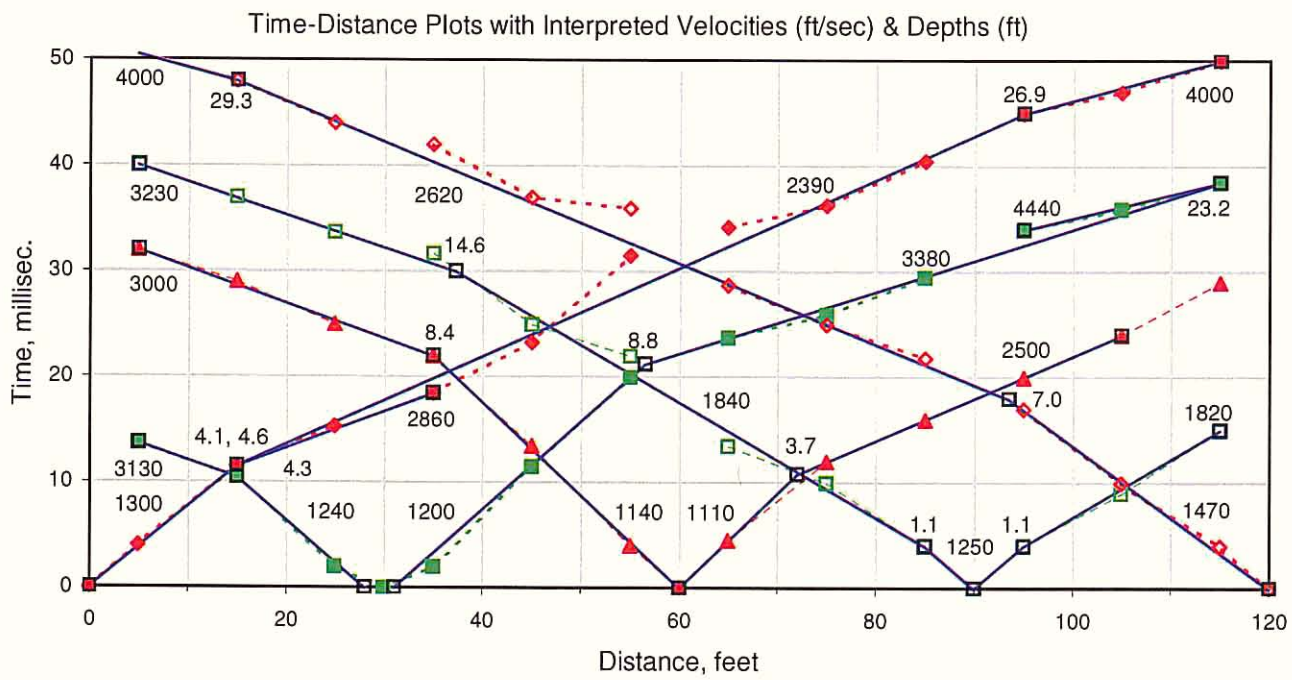
Refraction Microtremor S-wave Interpretation **Line RR115A** AMEC Job No. 5-117-001063



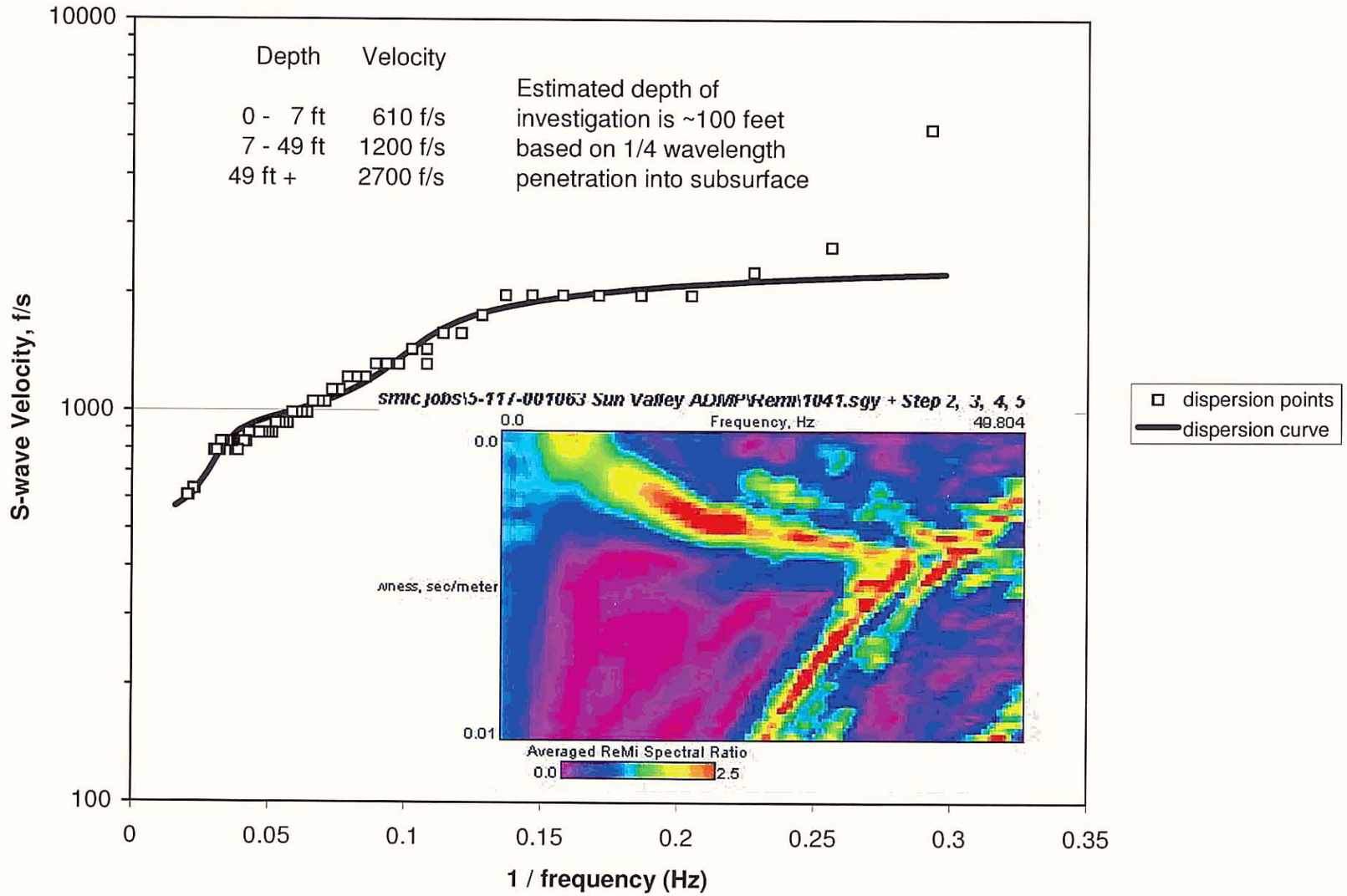

Interpretation of Refraction Seismic Data
West
East
GPS pt
ground
1300
1200
1300
1300
1200
s-wave = 570 f/s
4600
~5200
s-wave = 2200 f/s
~3900
~4600
s-wave = 1300 f/s
s-wave = 1900 f/s
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 940 f/s below ~45 ft depth
s-wave = 2500 f/s below ~52 ft depth
Relative depth, feet
Distance, feet

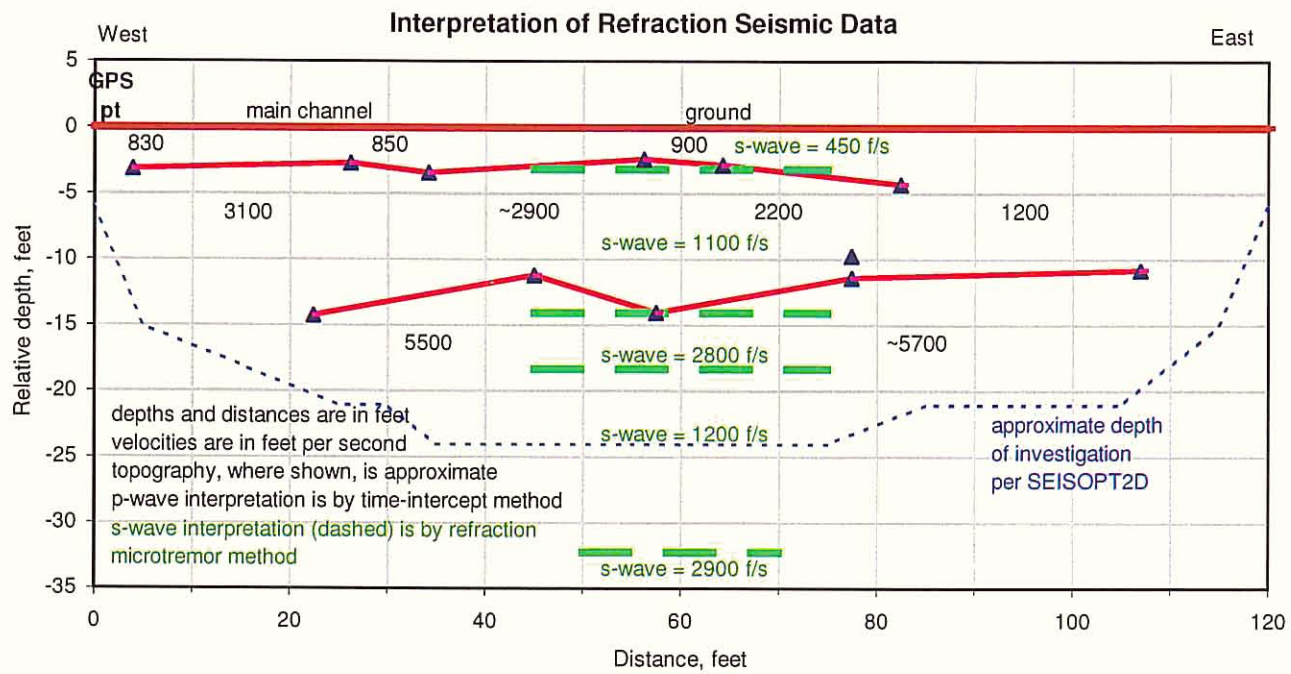

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
3450
2730
2900
6670
16.3
4600
4840
4600
3330
4350
6.1
5.6
6.0
5.6
6000
4.0
5.6
5330
5.4
6.0
4000
1250
1200
1280
1330
1250
1270
1250
1200

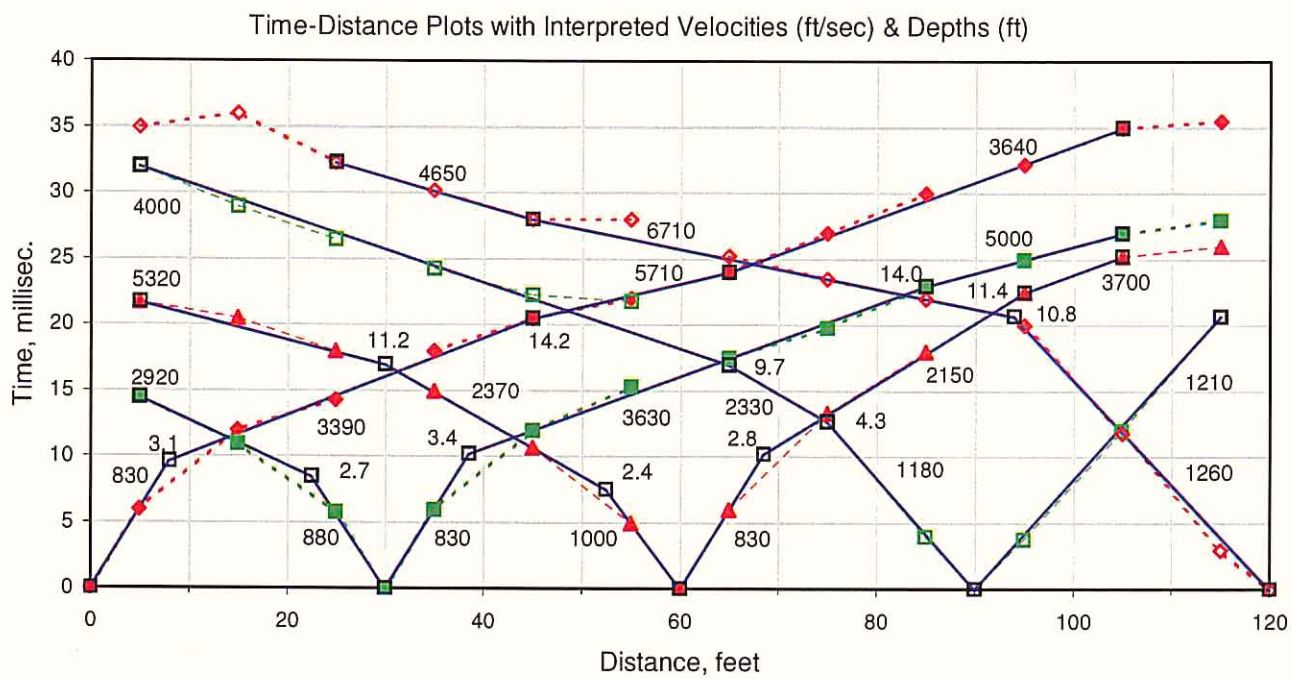

Interpretation of Refraction Seismic Data
West
East
ground
1300
1200
1100
1300
2100
1600
3000
2600
3200
s-wave = 600 f/s
s-wave = 1200 f/s
4000
s-wave = 2700 f/s below ~49 ft depth
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation 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)
4000
29.3
26.9
4000
3230
2620
2390
4440
23.2
14.6
3380
3000
8.4
8.8
2500
1840
7.0
1820
4.1, 4.6
2860
3.7
3130
4.3
1300
1240
1200
1140
1110
1.1
1250
1.1
1470
Time, millisec.
Distance, feet

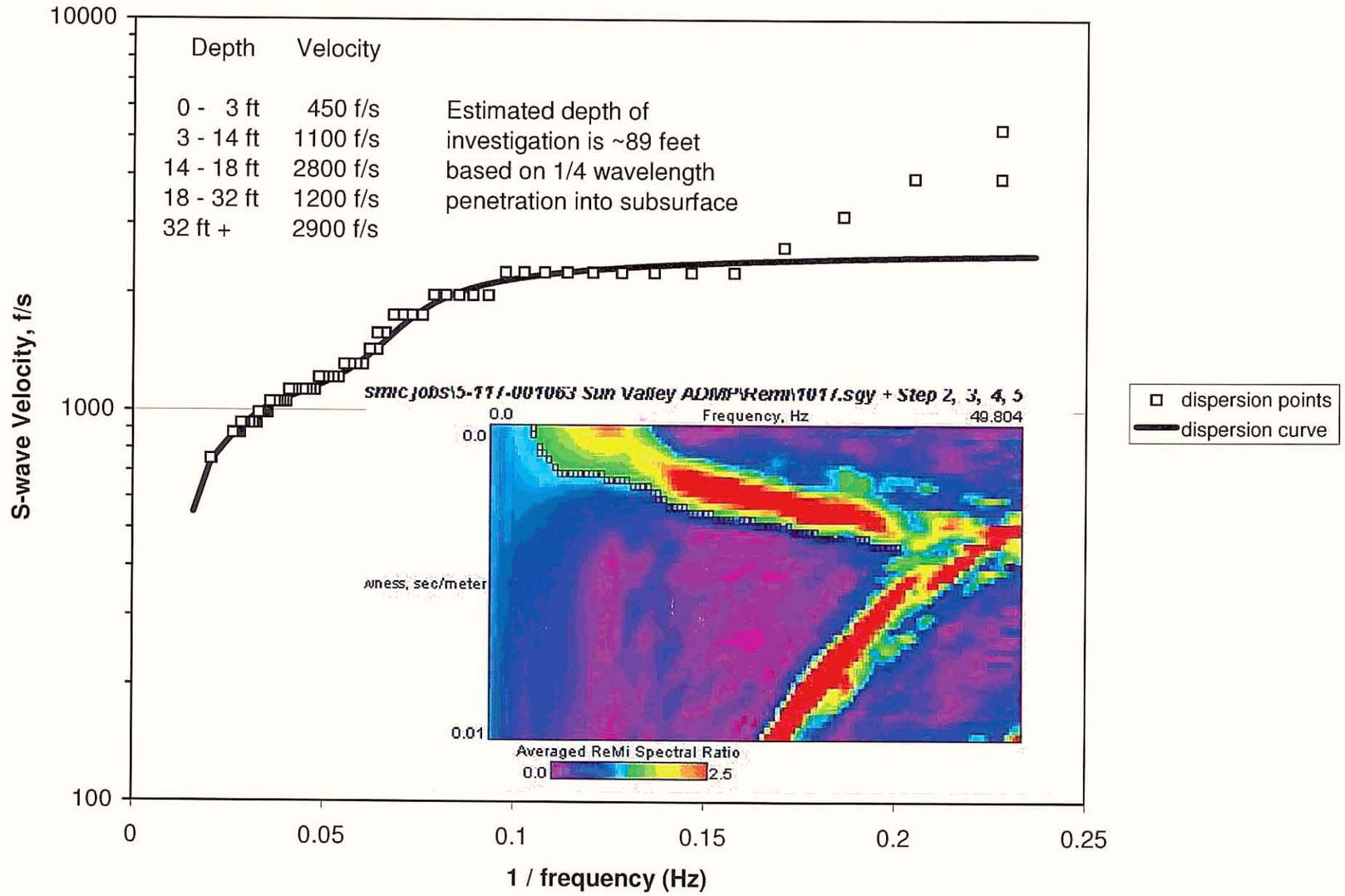
Refraction Microtremor S-wave Interpretation **Line RR120** AMEC Job No. 5-117-001063




Interpretation of Refraction Seismic Data
West
East
GPS pt
main channel
ground
830
850
900
s-wave = 450 f/s
3100
~2900
2200
1200
s-wave = 1100 f/s
5500
~5700
s-wave = 2800 f/s
s-wave = 1200 f/s
s-wave = 2900 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
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
4650
6710
3640
4000
5320
5710
5000
3700
14.0
11.4
10.8
11.2
14.2
9.7
2920
2370
3390
3630
2330
2150
1210
3.1
3.4
2.8
4.3
830
2.7
2.4
1180
1260
880
830
1000
830

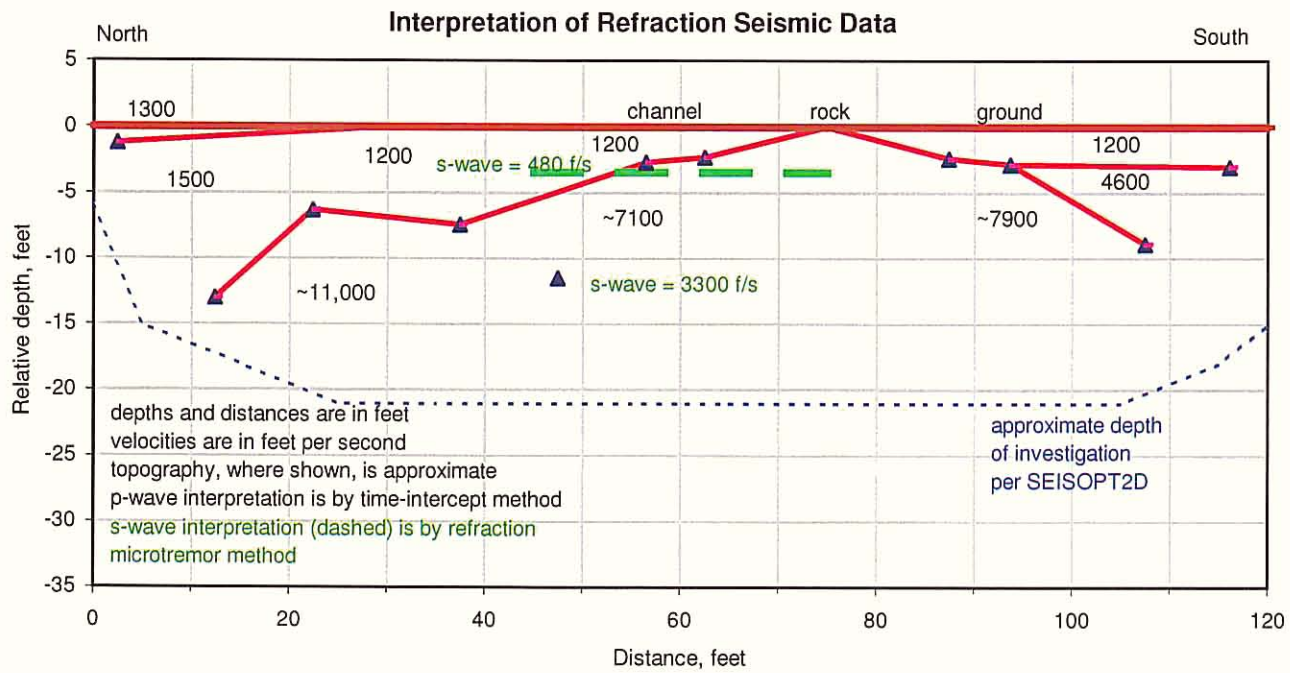
Refraction Microtremor S-wave Interpretation **Line RR130** AMEC Job No. 5-117-001063

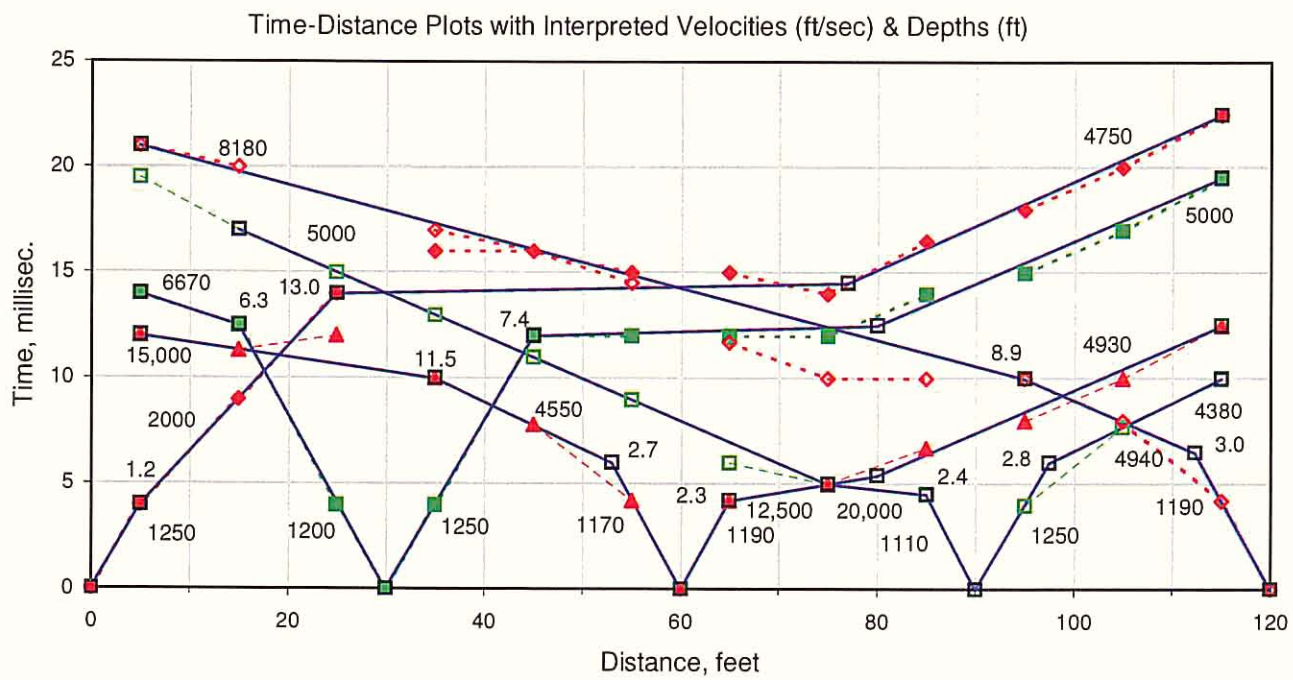


Refraction Seismic Interpretation

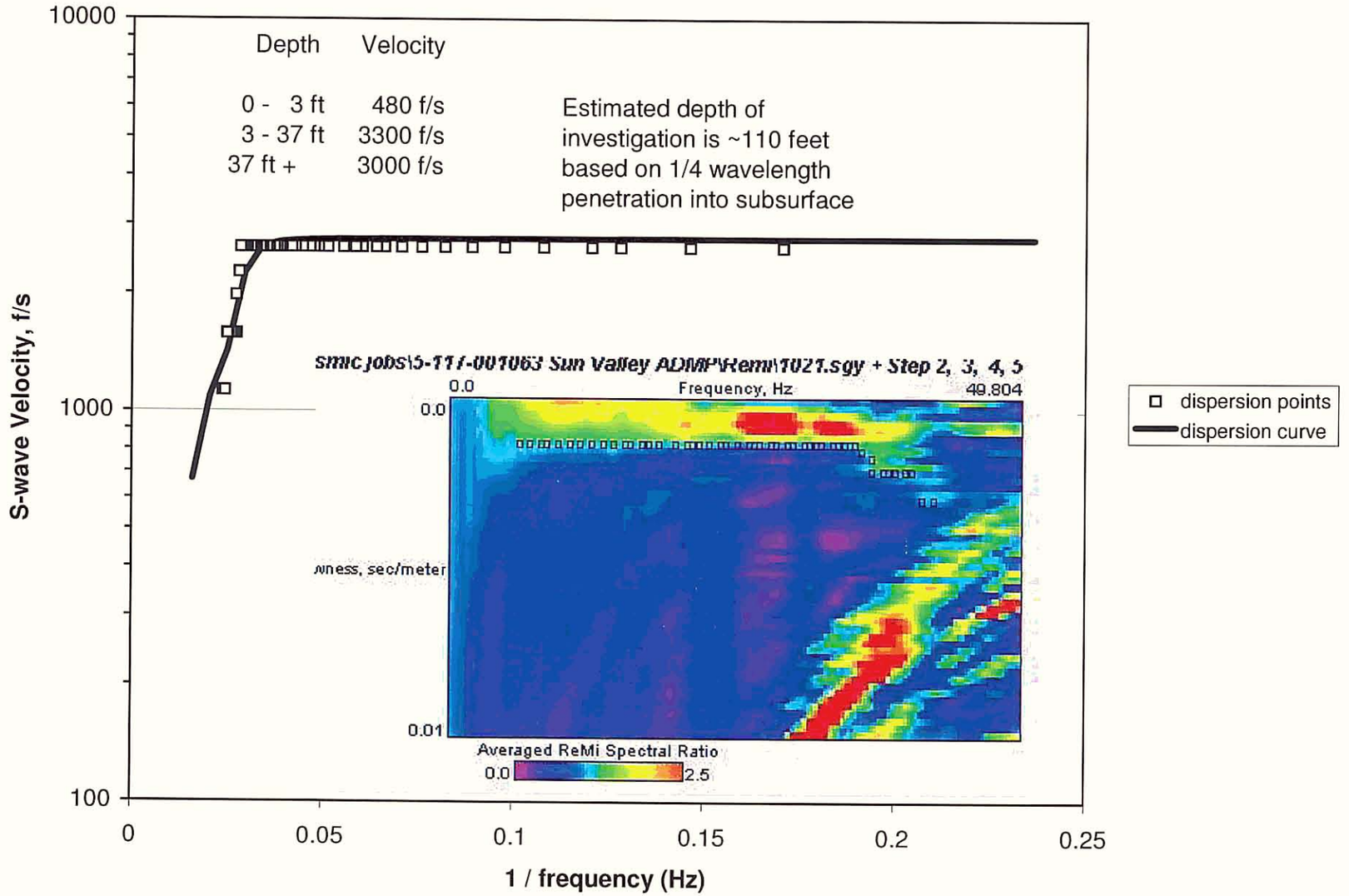
Line RR165

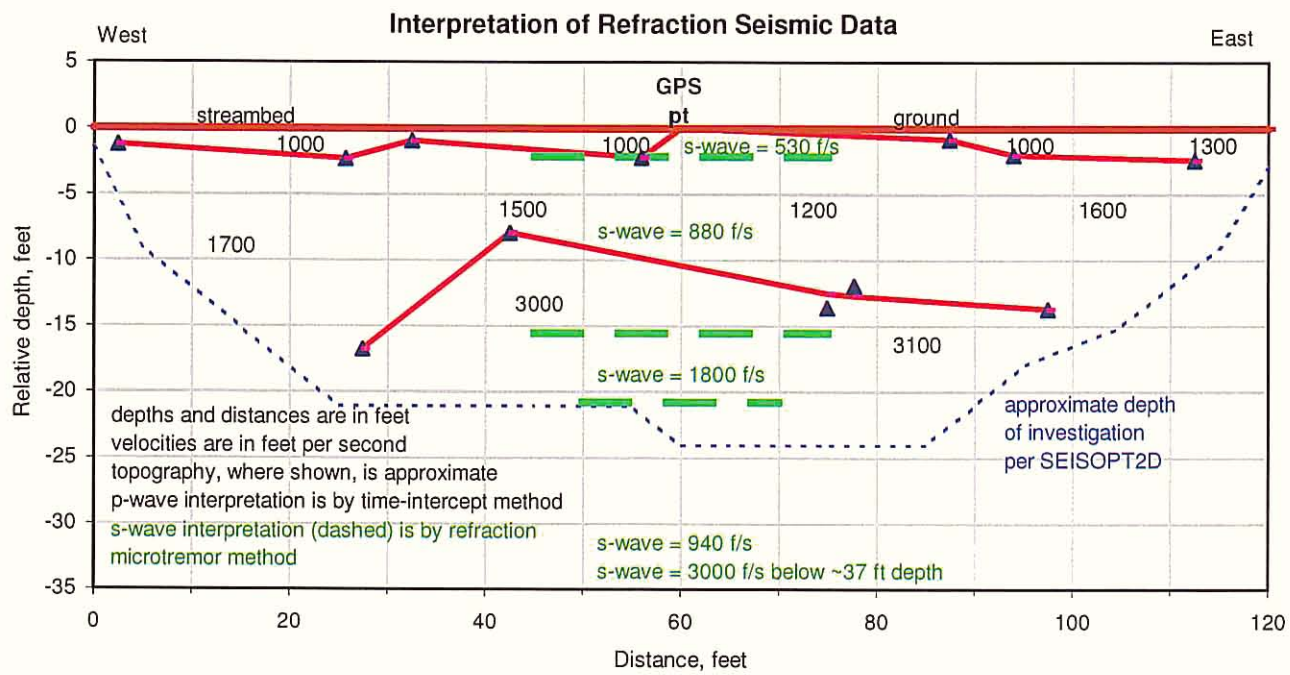
AMEC Job No. 5-117-001063

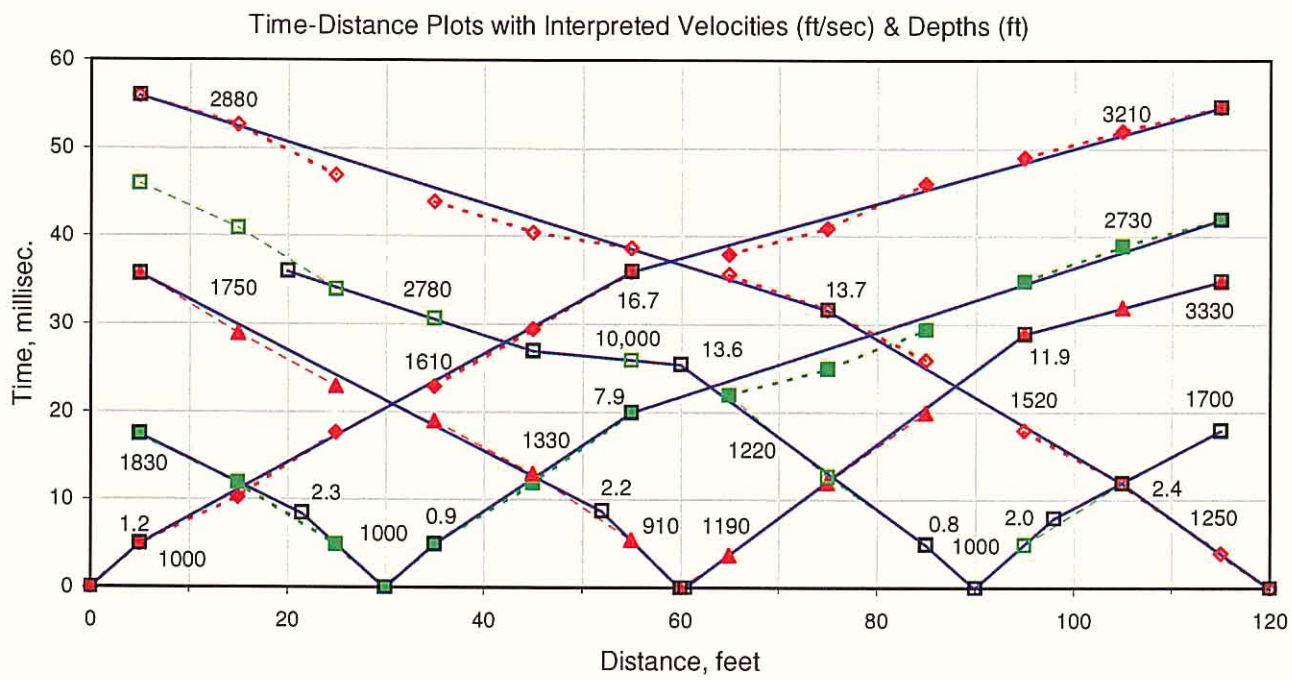


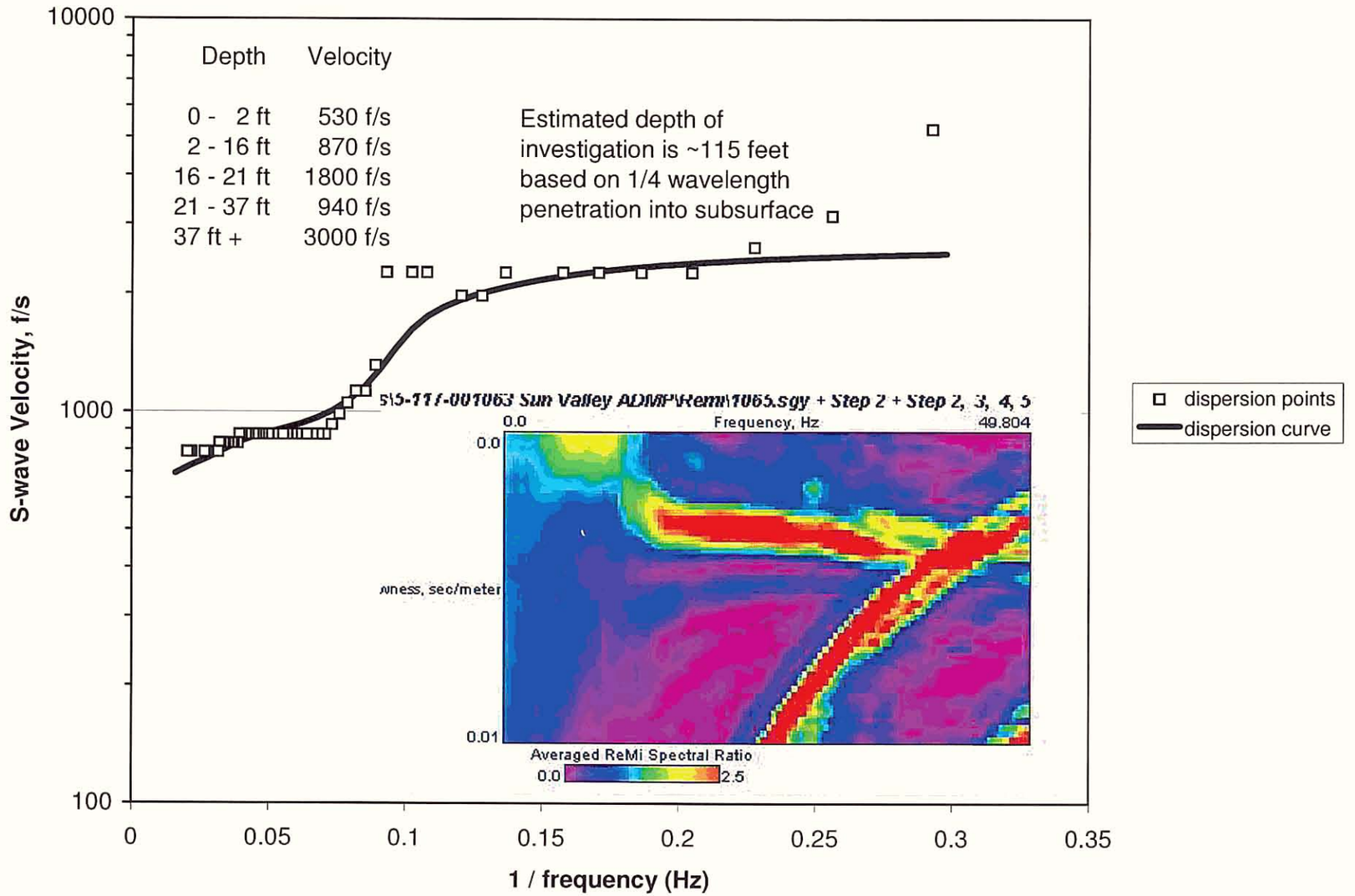


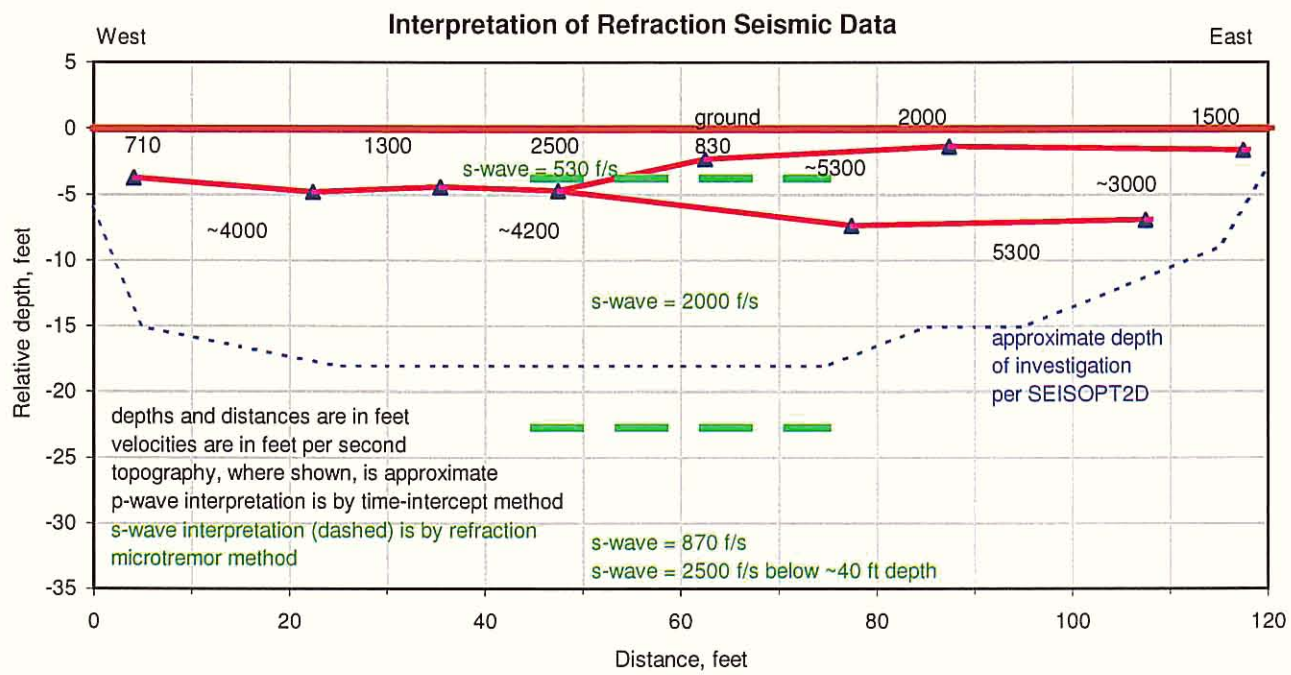
Refraction Microtremor S-wave Interpretation **Line RR165** AMEC Job No. 5-117-001063

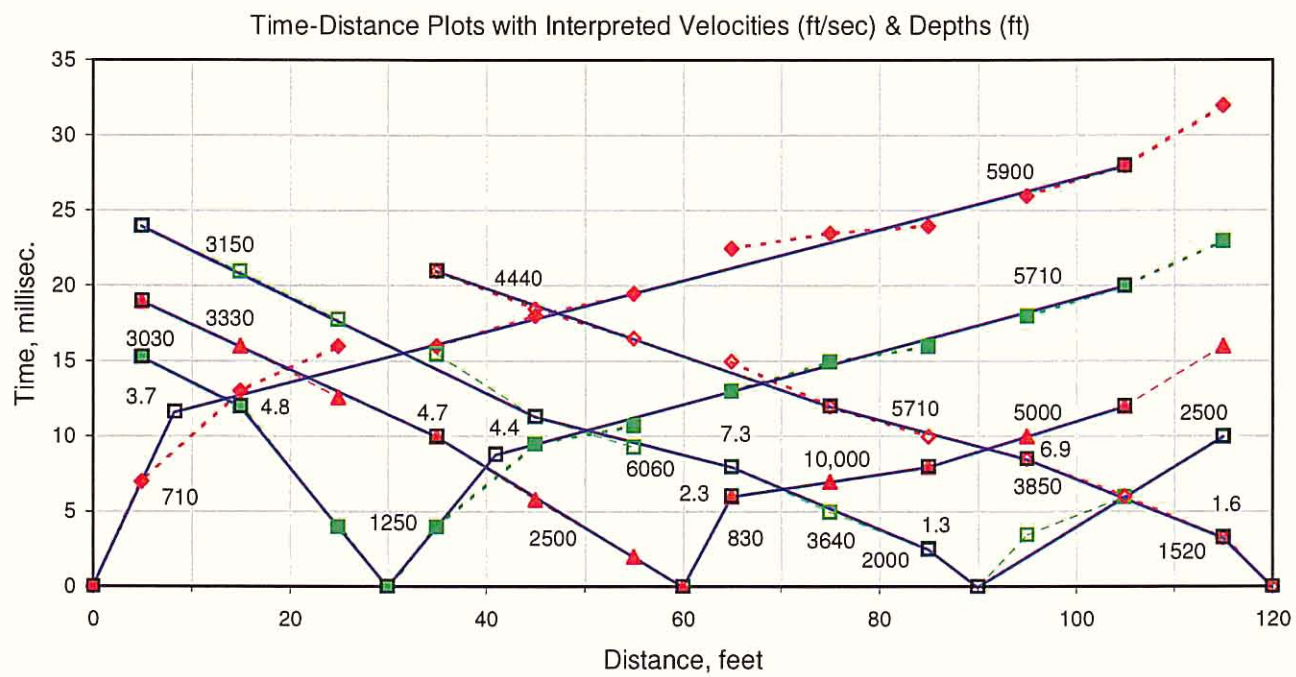



Interpretation of Refraction Seismic Data
West
East
GPS pt
streambed
ground
1000
1000
1000
1300
s-wave = 530 f/s
1500
1200
1600
1700
s-wave = 880 f/s
3000
3100
s-wave = 1800 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
approximate depth
of investigation
per SEISOPT2D
s-wave = 940 f/s
s-wave = 3000 f/s below ~37 ft depth
Relative depth, feet
Distance, feet

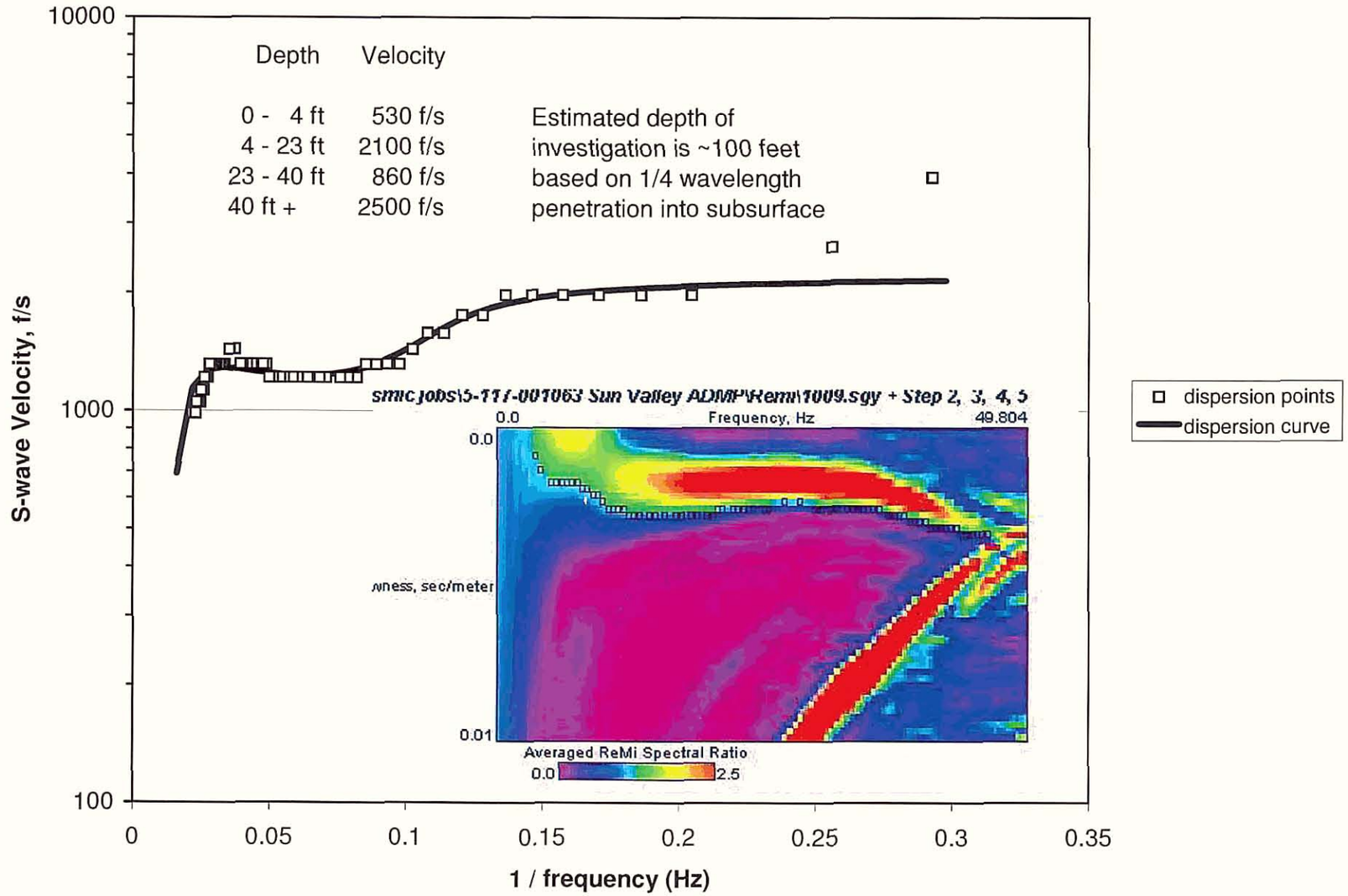

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2880
3210
2730
1750
2780
16.7
13.7
3330
10,000
13.6
1610
11.9
7.9
1520
1700
1330
1220
1830
2.3
2.2
2.4
1.2
0.9
910
1190
0.8
2.0
1250
1000
1000
1000
Time, millisec.
Distance, feet

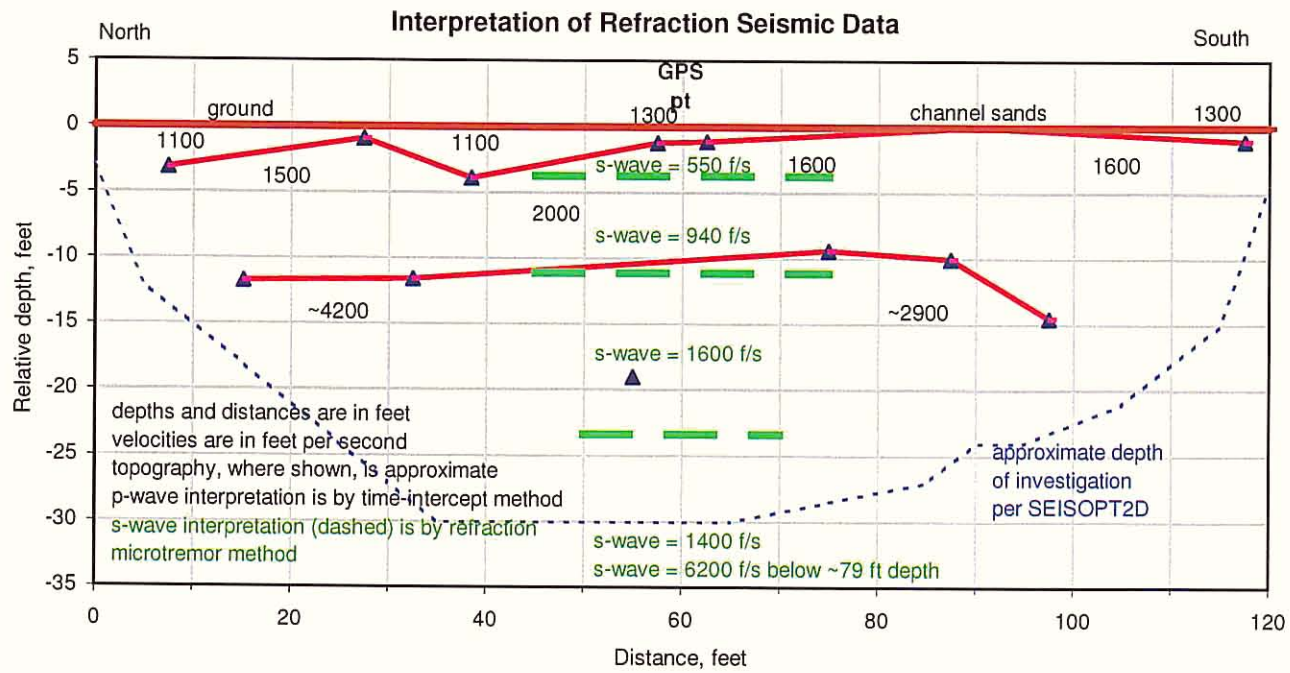

10000
1000
100
S-wave Velocity, f/s
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
1 / frequency (Hz)
Depth Velocity
0 - 2 ft 530 f/s
2 - 16 ft 870 f/s
16 - 21 ft 1800 f/s
21 - 37 ft 940 f/s
37 ft + 3000 f/s
Estimated depth of investigation is ~115 feet based on 1/4 wavelength penetration into subsurface
5\5-117-001063 Sun Valley ADMP\Remi\1065.sgy + Step 2 + Step 2, 3, 4, 5
Frequency, Hz
0.0
49.804
0.0
0.01
Averaged ReMi Spectral Ratio
0.0
2.5
dispersion points
dispersion curve

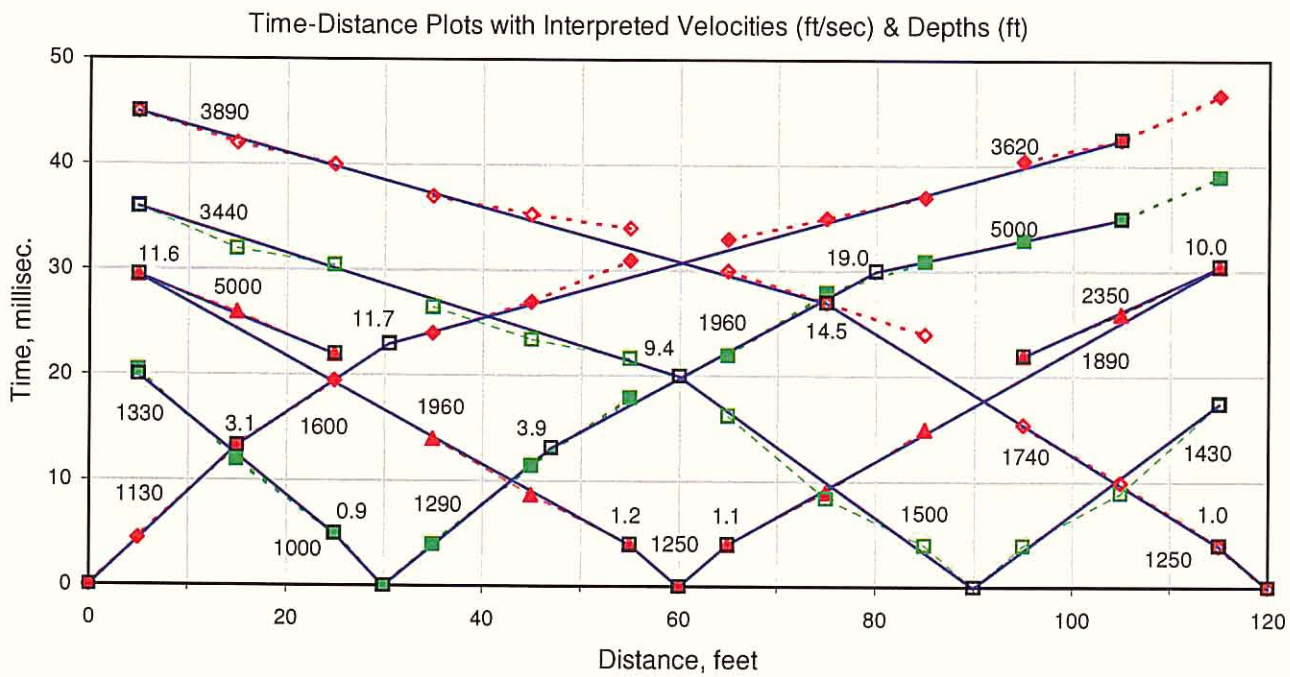

Interpretation of Refraction Seismic Data
West
East
ground
710
1300
2500
830
2000
1500
s-wave = 530 f/s
~5300
~3000
~4000
~4200
5300
s-wave = 2000 f/s
approximate depth
of investigation
per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction
microtremor method
s-wave = 870 f/s
s-wave = 2500 f/s below ~40 ft depth
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
5900
3150
4440
5710
3330
3030
3.7
4.8
4.7
4.4
7.3
5710
5000
2500
6.9
10,000
6060
3850
710
1250
2.3
1.6
2500
830
3640
1.3
2000
1520

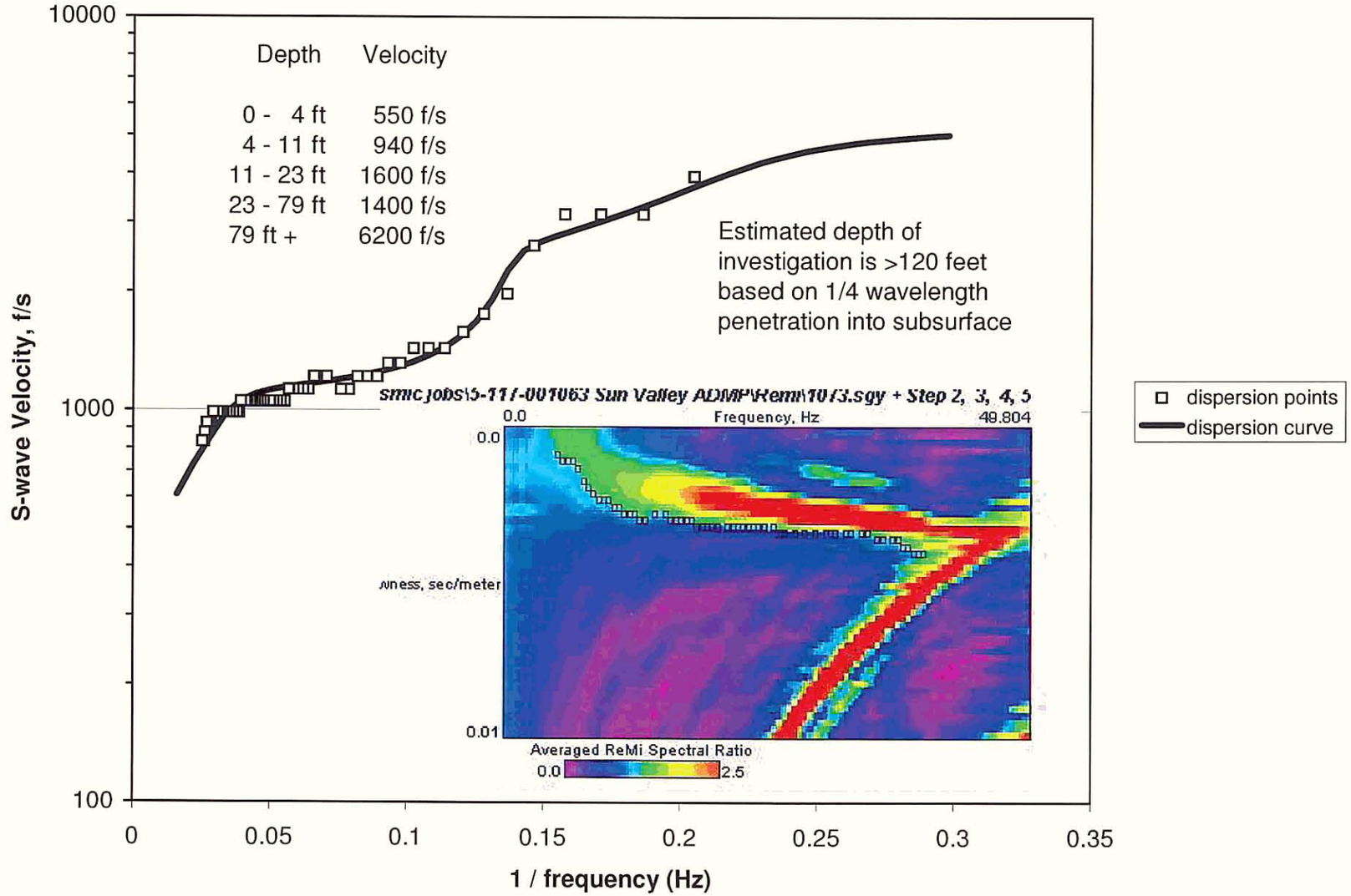
Refraction Microtremor S-wave Interpretation **Line RR900** AMEC Job No. 5-117-001063

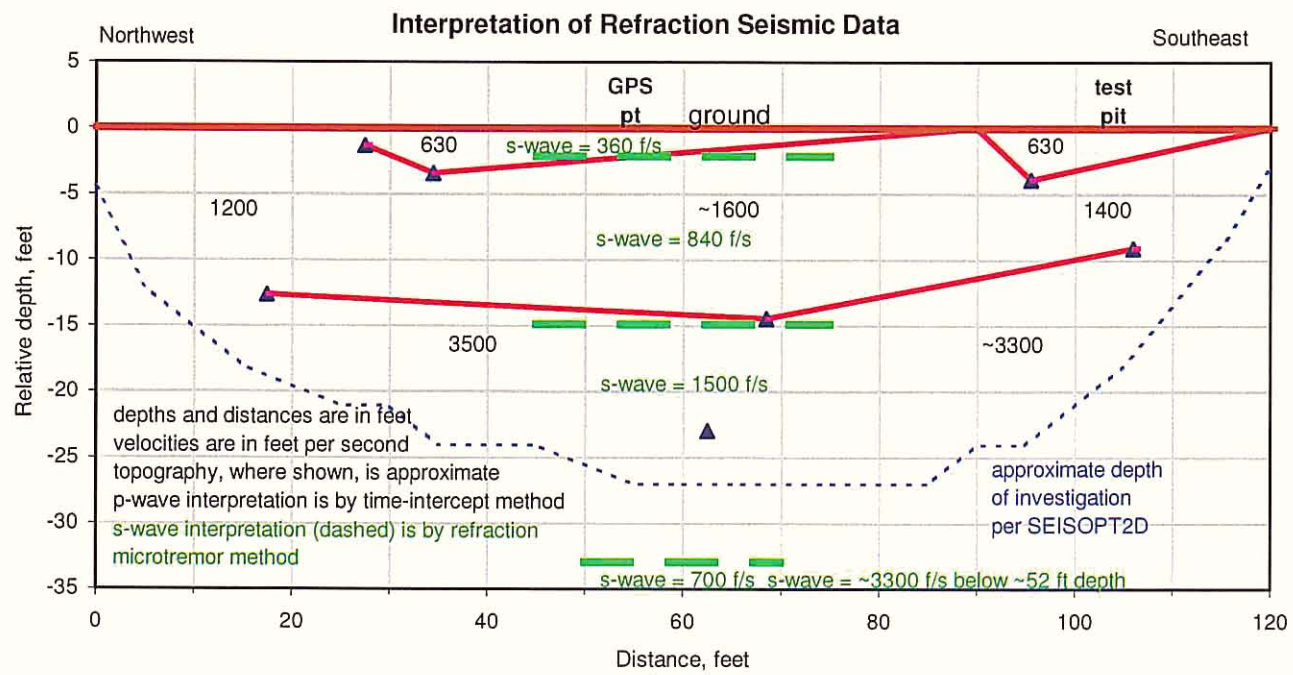


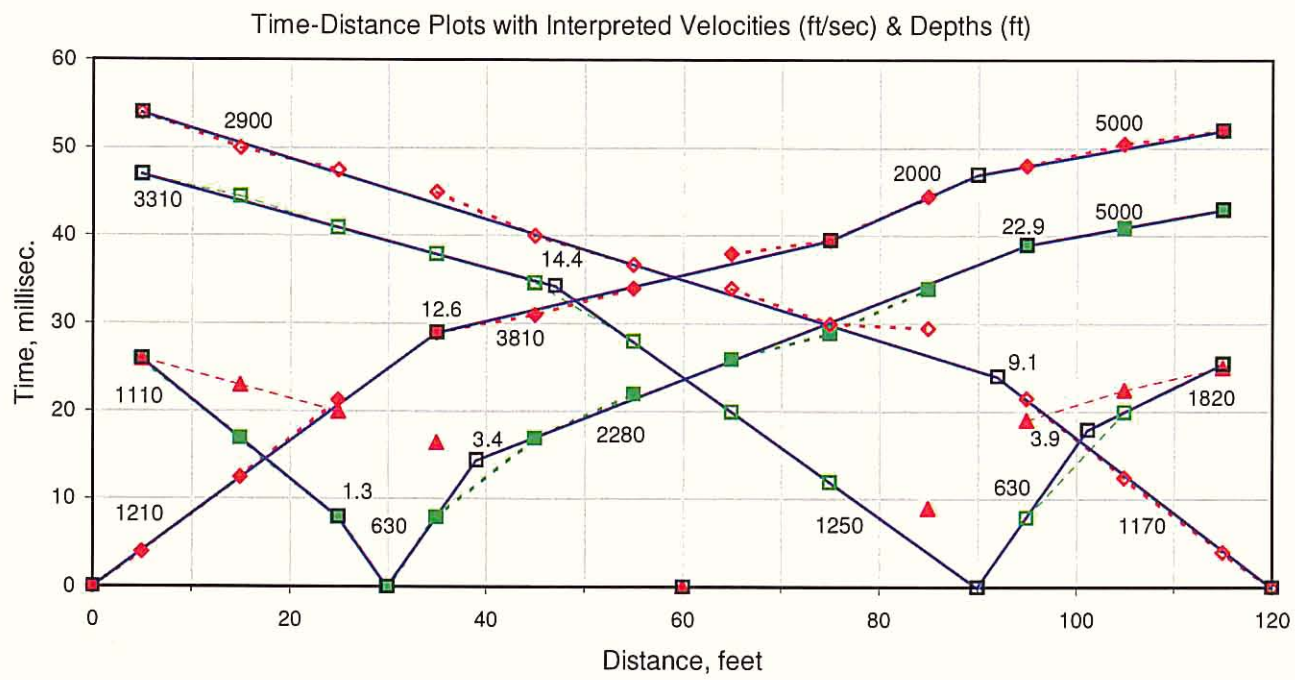

Interpretation of Refraction Seismic Data
North
South
GPS pt
ground
channel sands
1100
1500
1100
1300
1600
1600
1300
2000
s-wave = 550 f/s
s-wave = 940 f/s
~4200
~2900
s-wave = 1600 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 1400 f/s
s-wave = 6200 f/s below ~79 ft depth
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3890
3440
11.6
5000
1330
3.1
1600
1130
0.9
1000
11.7
1960
1290
9.4
3.9
1960
1.2
1250
1.1
19.0
14.5
3620
5000
1500
1740
2350
1890
10.0
1430
1.0
1250
Time, millisec.
Distance, feet

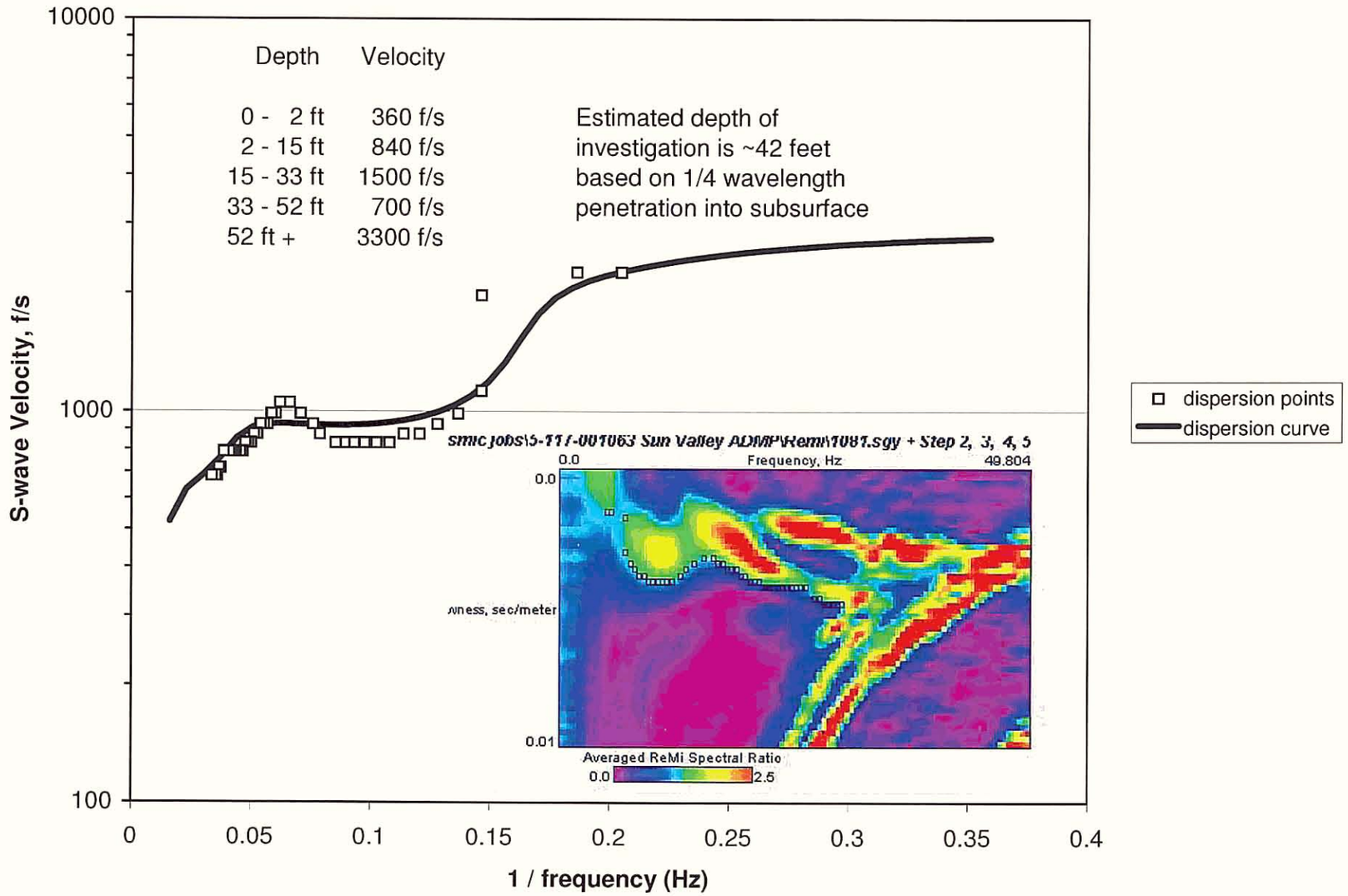
Refraction Microtremor S-wave Interpretation **Line RRCJ1** AMEC Job No. 5-117-001063

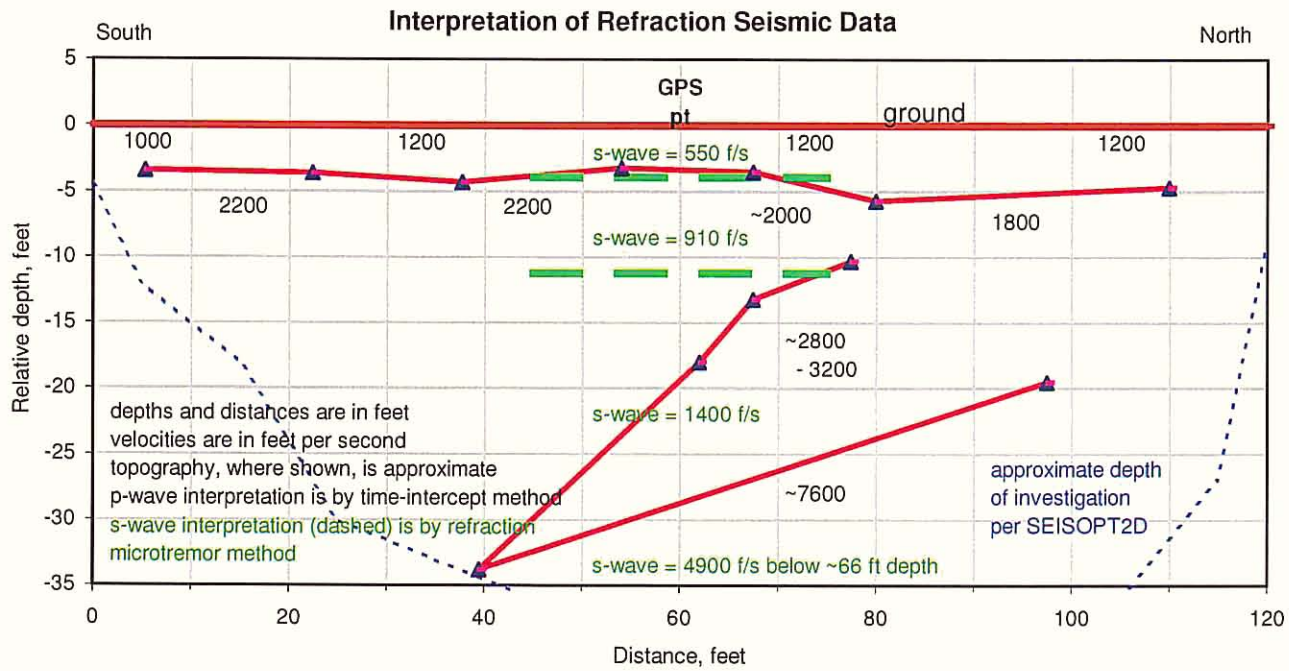


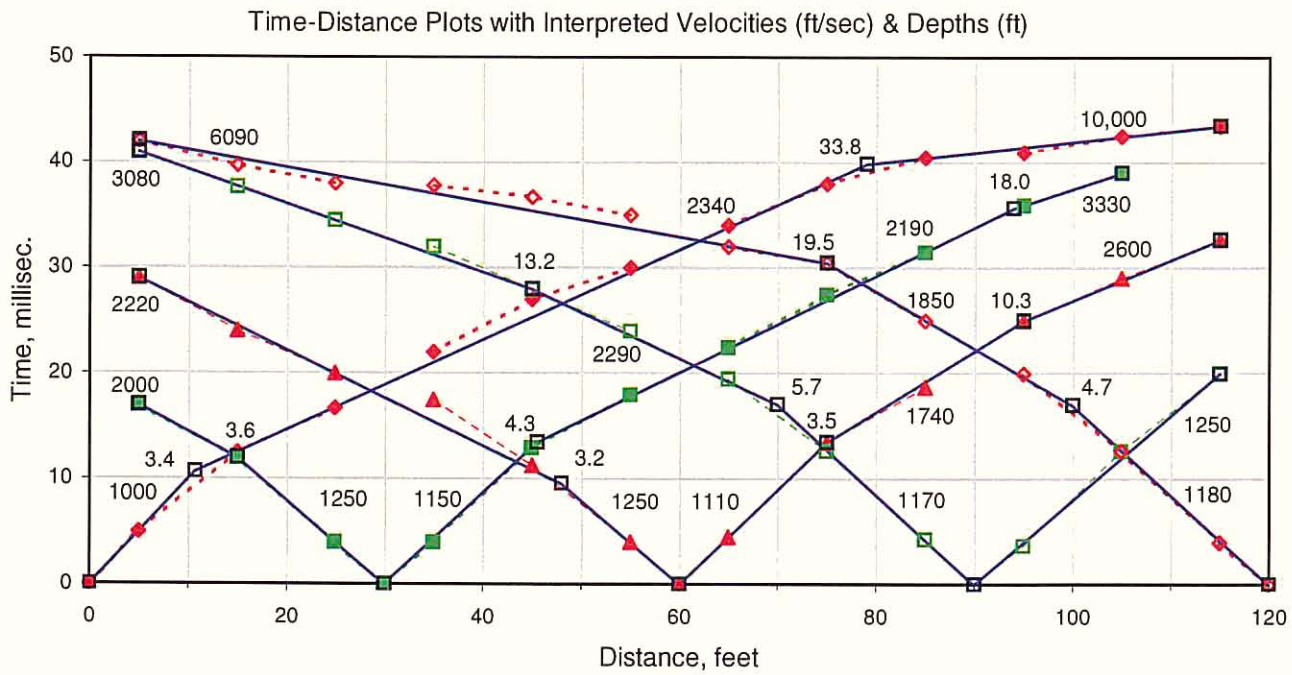

Interpretation of Refraction Seismic Data
Northwest
Southeast
GPS pt
ground
test pit
630
s-wave = 360 f/s
630
1200
~1600
1400
s-wave = 840 f/s
3500
~3300
s-wave = 1500 f/s
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
s-wave = 700 f/s
s-wave = ~3300 f/s below ~52 ft depth
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2900
3310
14.4
12.6
3810
2000
5000
22.9
5000
9.1
1820
1110
3.4
2280
3.9
1.3
630
630
1210
1250
1170
Time, millisec.
Distance, feet

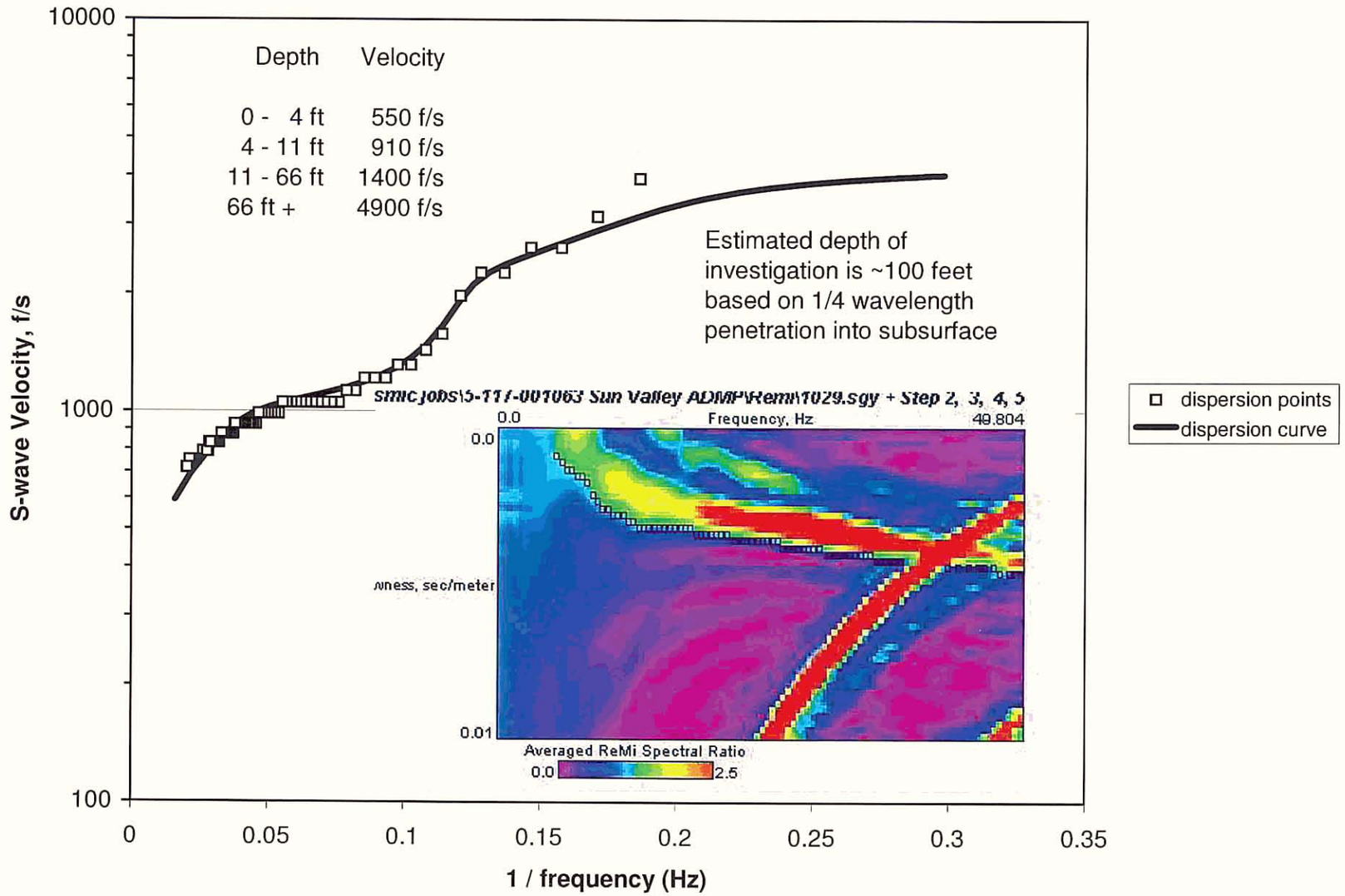
Refraction Microtremor S-wave Interpretation **Line RRE4RA** AMEC Job No. 5-117-001063

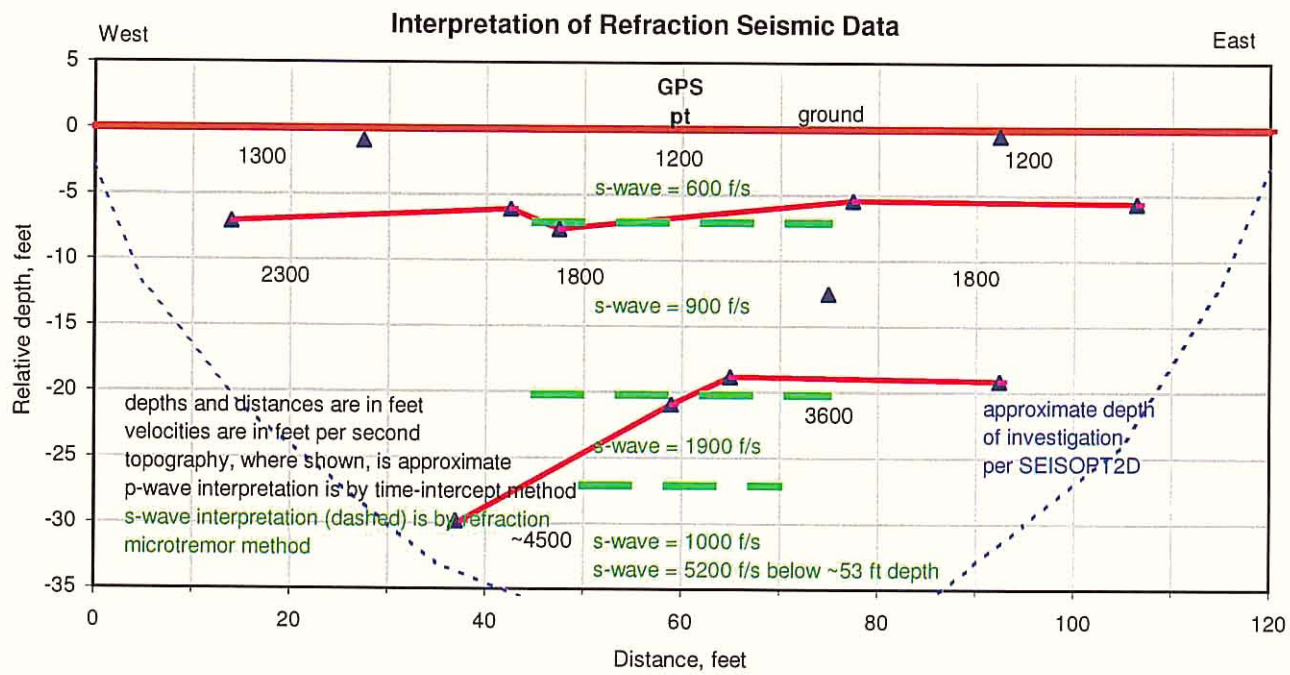


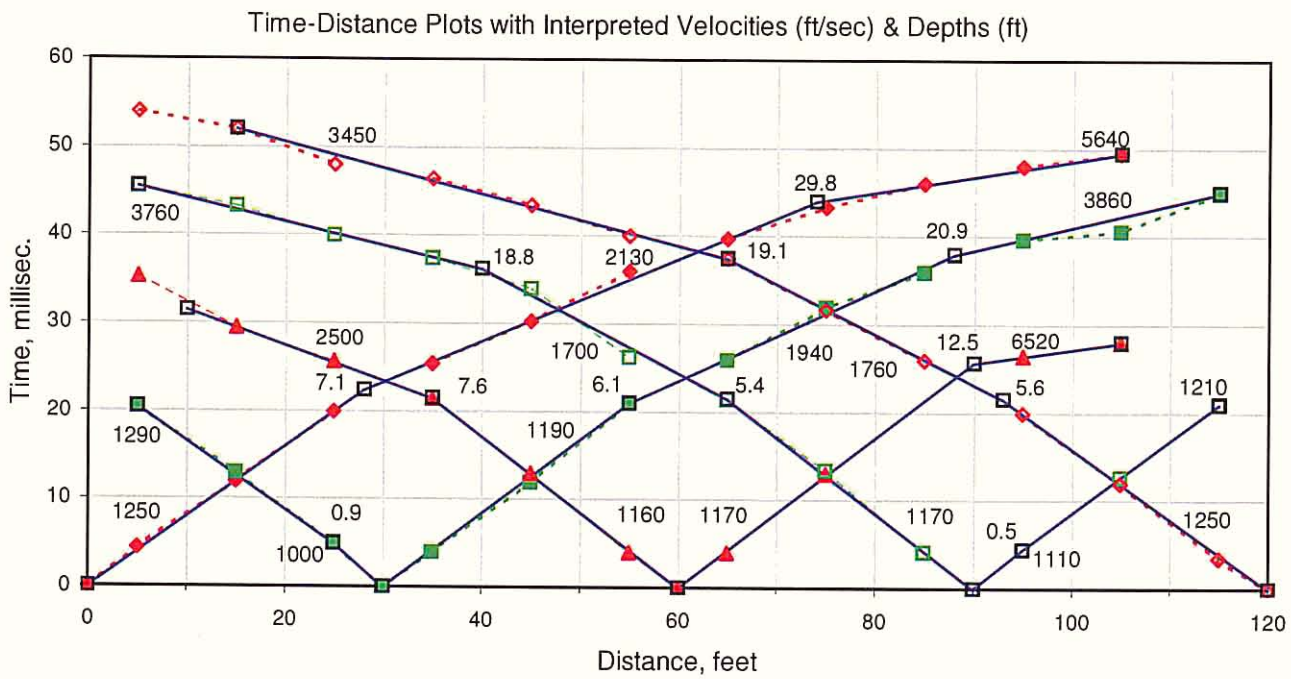

Interpretation of Refraction Seismic Data
South
North
GPS pt
ground
1000
1200
1200
1200
2200
2200
~2000
1800
s-wave = 550 f/s
s-wave = 910 f/s
~2800
- 3200
s-wave = 1400 f/s
~7600
s-wave = 4900 f/s below ~66 ft depth
depths and distances are in feet
velocities are in feet per second
topography, where 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)
6090
3080
2220
2000
1000
3.4
3.6
1250
1150
13.2
4.3
3.2
2290
1250
1110
2340
33.8
19.5
5.7
3.5
2190
1850
1740
1170
18.0
10.3
3330
2600
4.7
1250
1180
10,000
Time, millisec.
Distance, feet

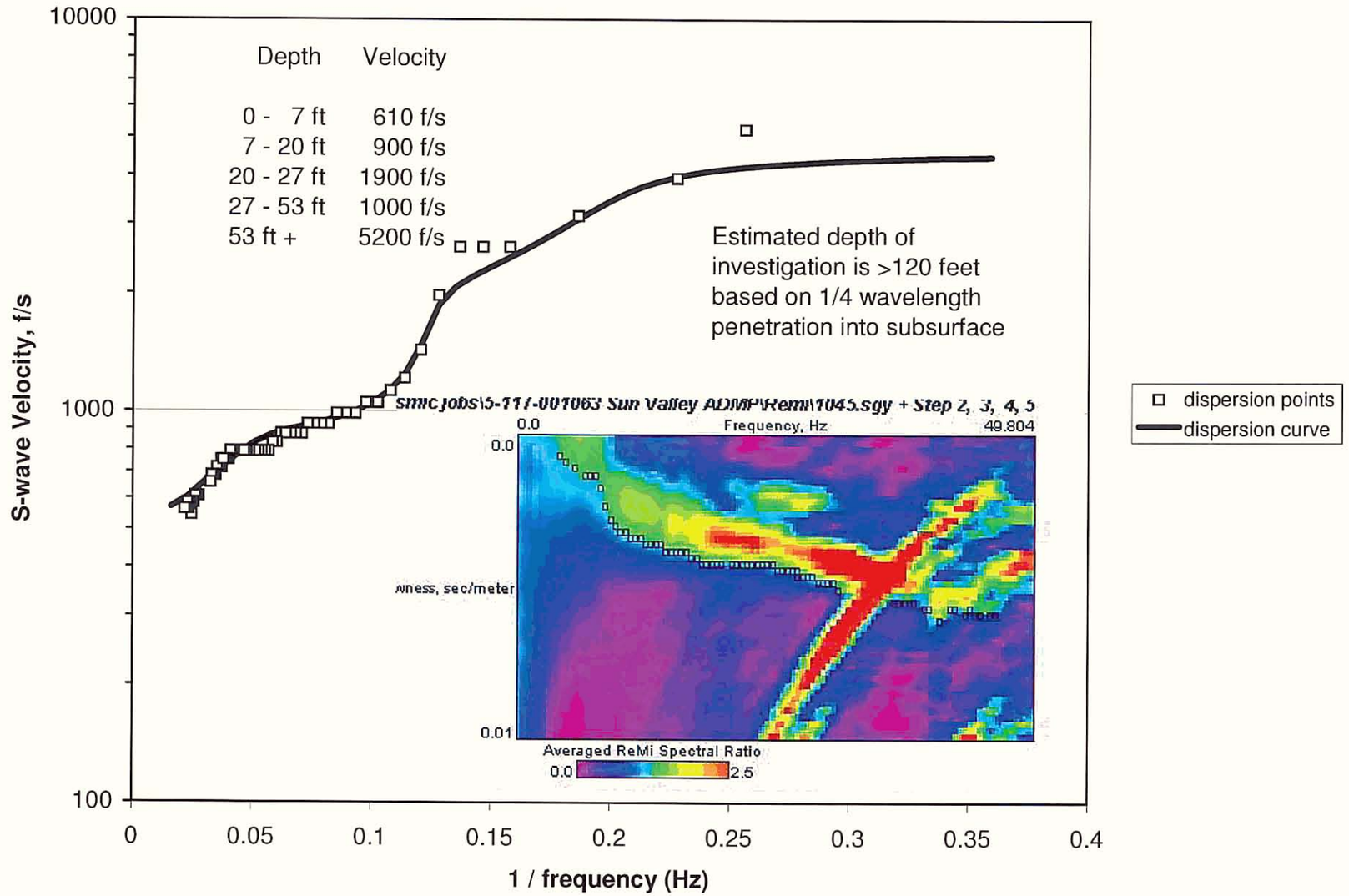
Refraction Microtremor S-wave Interpretation **Line RRF2** AMEC Job No. 5-117-001063




Interpretation of Refraction Seismic Data
West
East
GPS pt
ground
1300
1200
1200
s-wave = 600 f/s
2300
1800
1800
s-wave = 900 f/s
3600
s-wave = 1900 f/s
~4500
s-wave = 1000 f/s
s-wave = 5200 f/s below ~53 ft depth
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)
3450
5640
3760
3860
29.8
18.8
2130
19.1
20.9
2500
1700
1940
1760
12.5
6520
7.1
7.6
6.1
5.4
5.6
1210
1290
1190
1250
0.9
1160
1170
1170
0.5
1250
1000
1110
Time, millisec.
Distance, feet

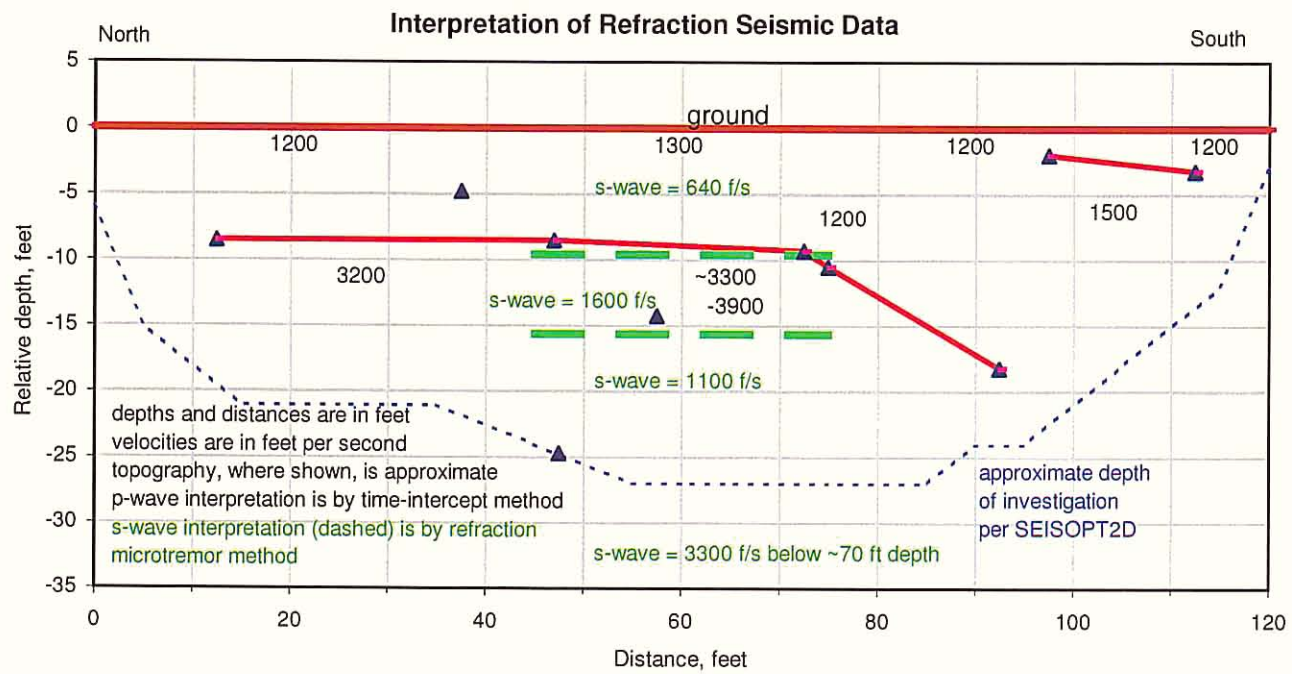
Refraction Microtremor S-wave Interpretation **Line RRL** AMEC Job No. 5-117-001063

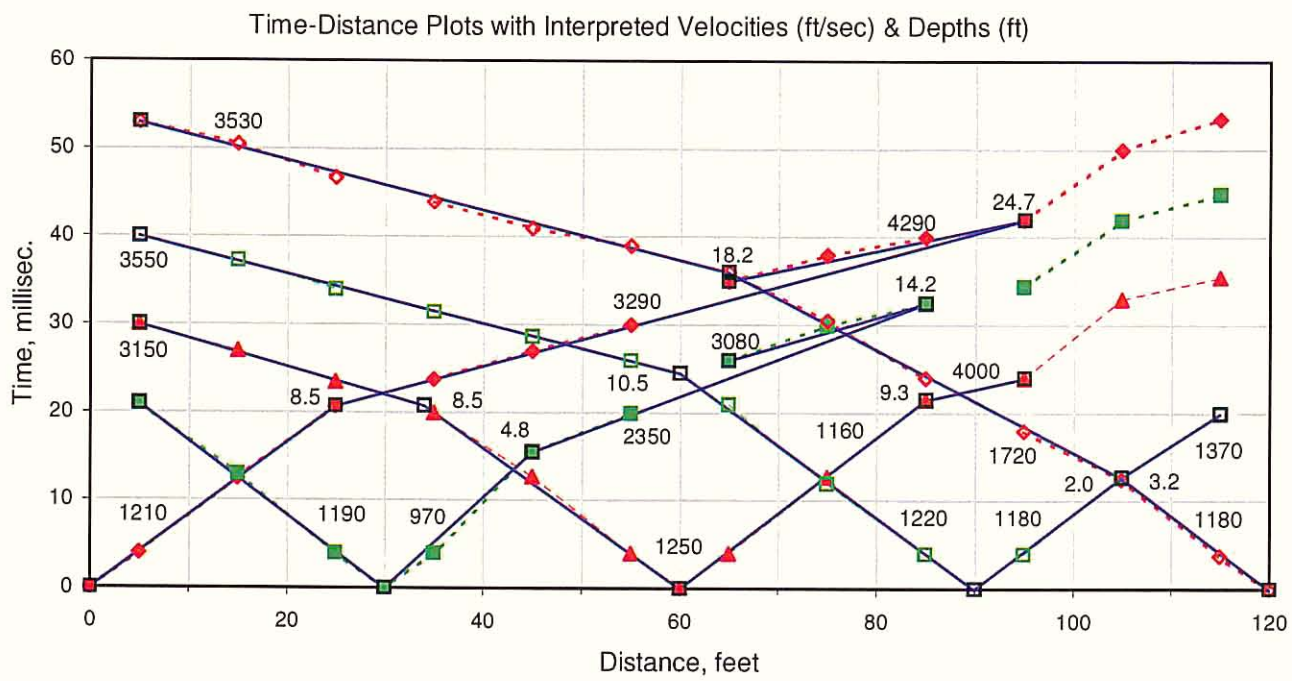


Refraction Seismic Interpretation

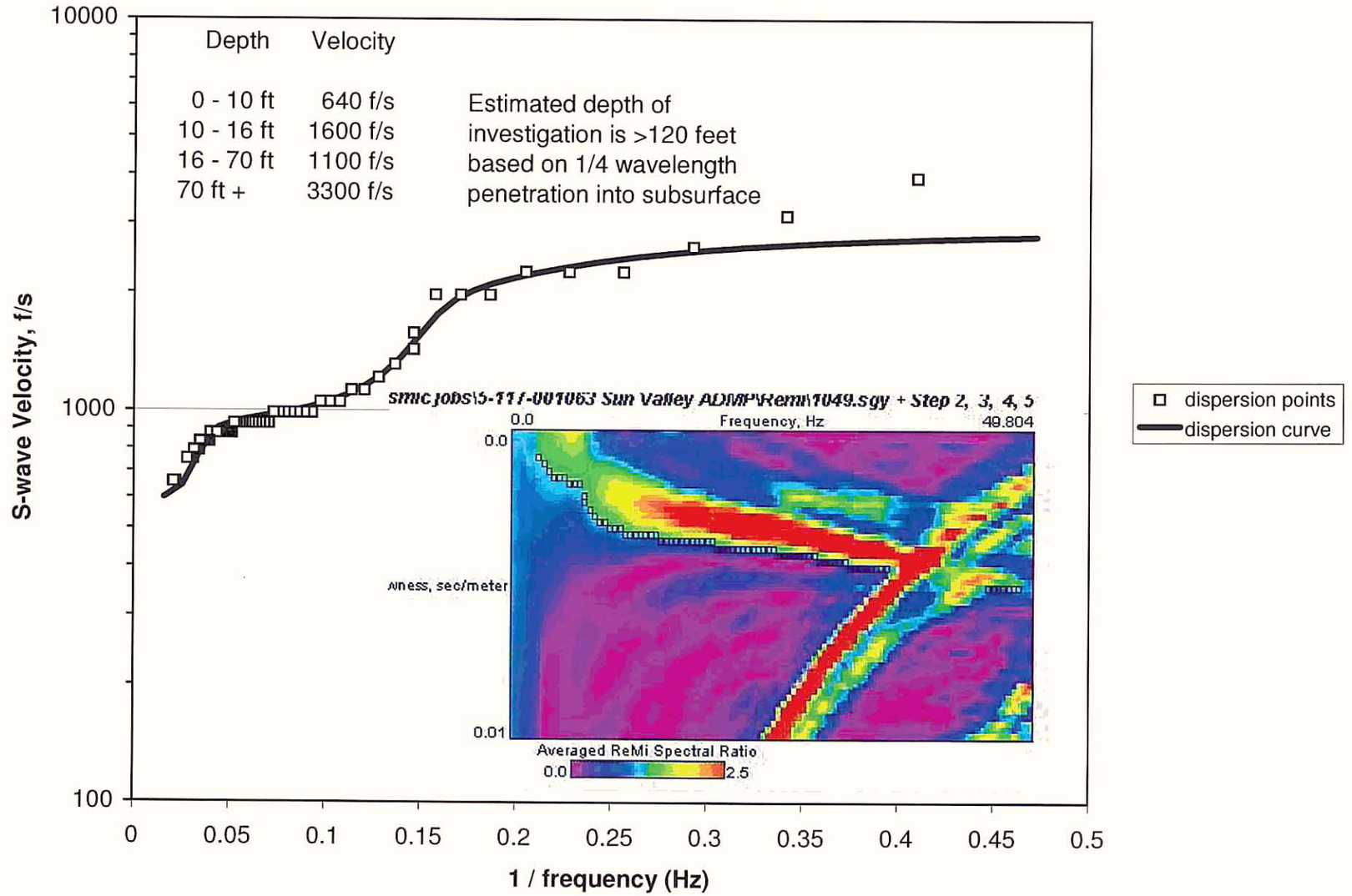
Line RRL3R

AMEC Job No. 5-117-001063





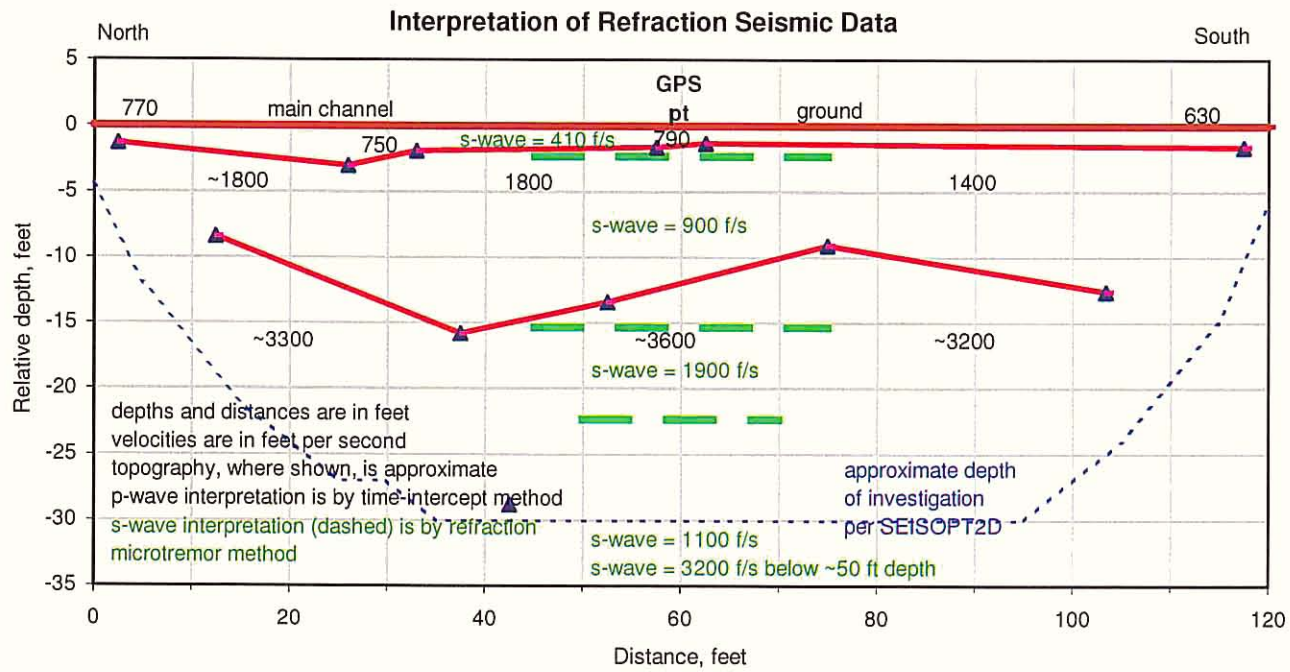
Refraction Microtremor S-wave Interpretation **Line RRL3R** AMEC Job No. 5-117-001063

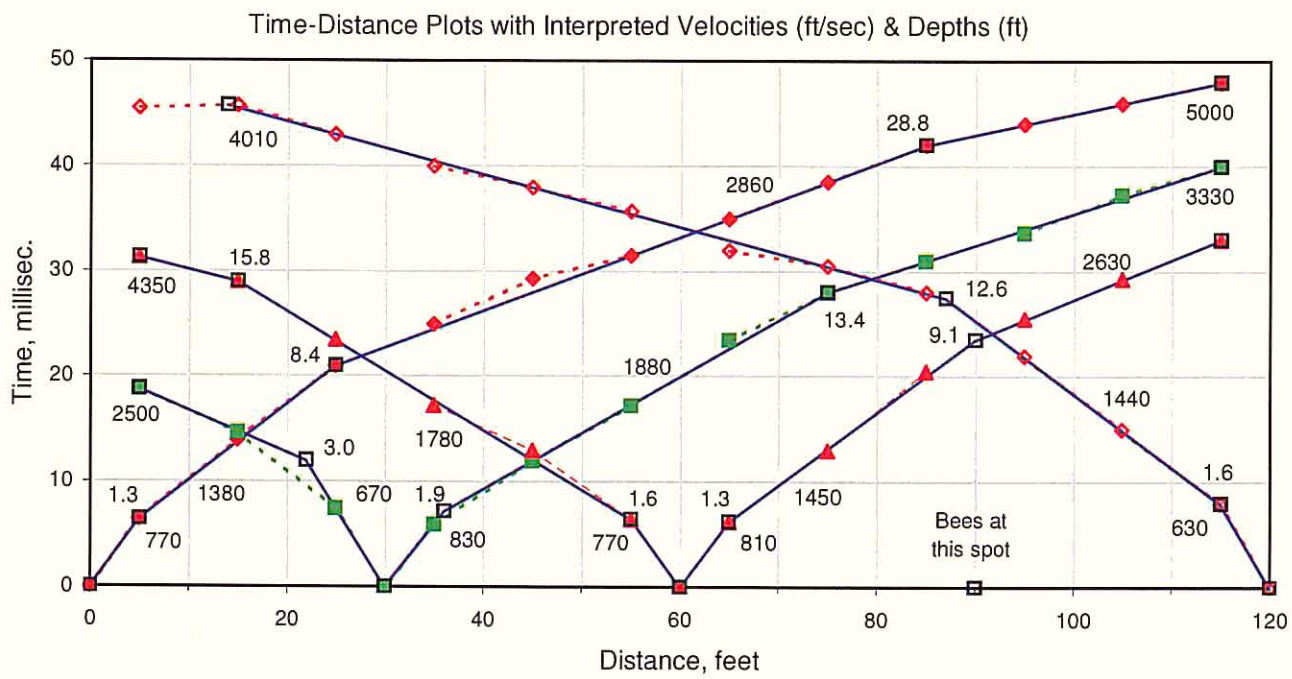


Refraction Seismic Interpretation

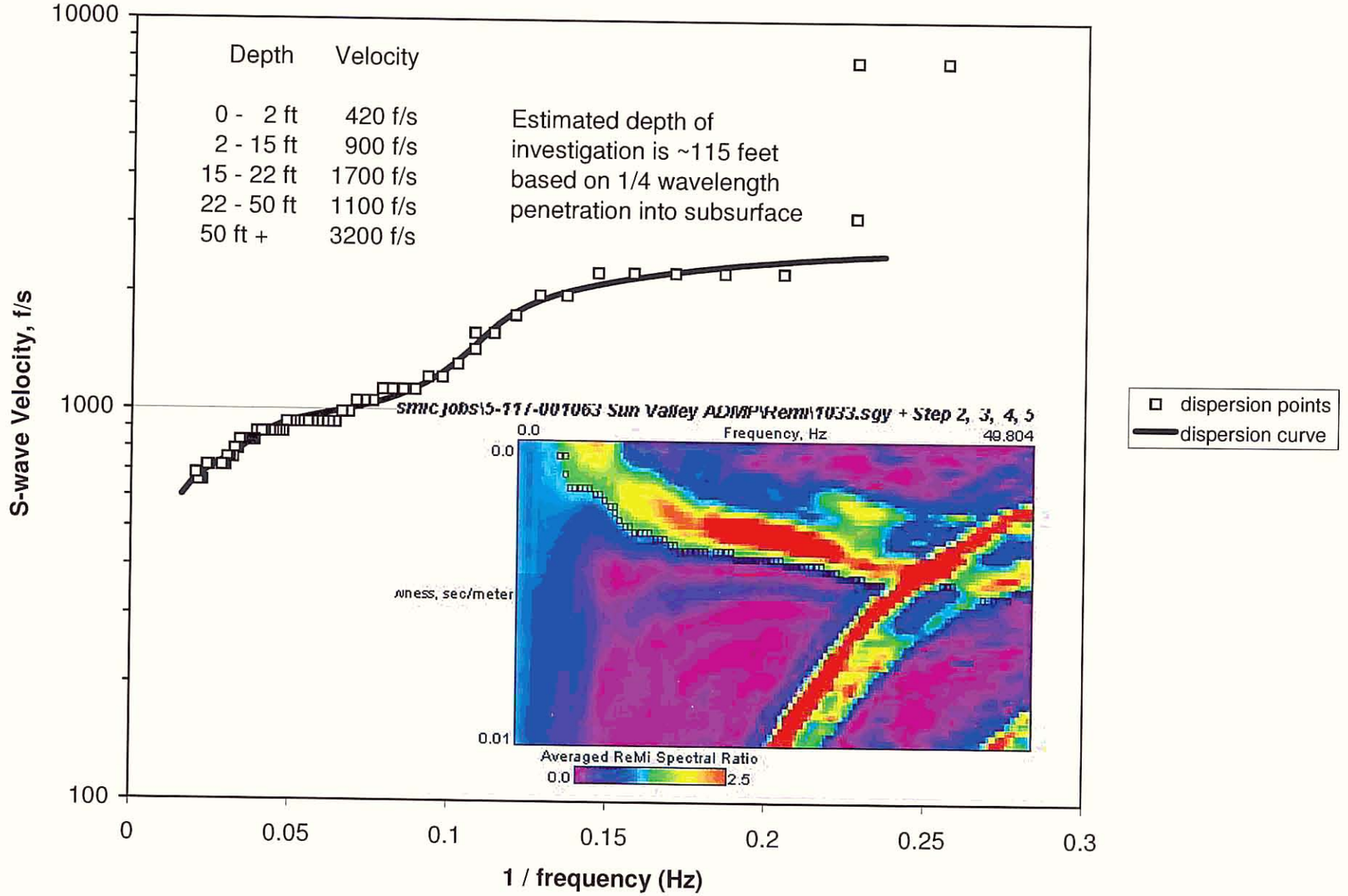
Line RRM1

AMEC Job No. 5-117-001063





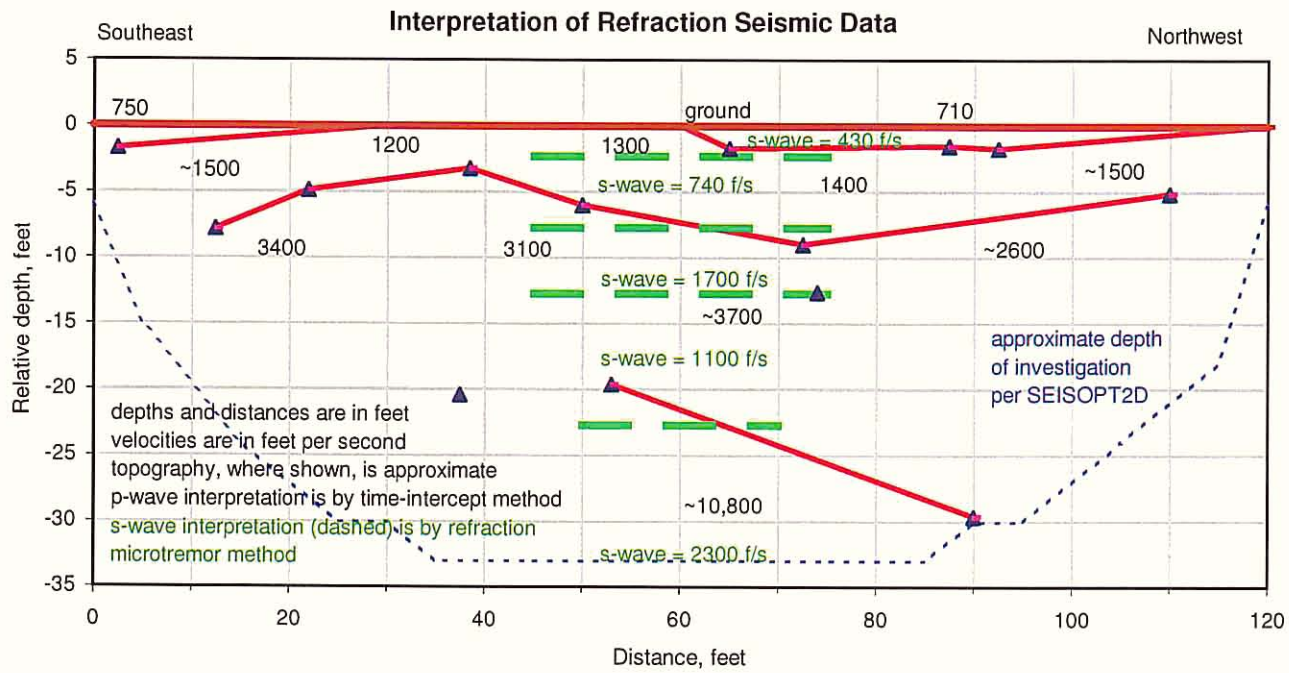
Refraction Microtremor S-wave Interpretation **Line RRM1** AMEC Job No. 5-117-001063

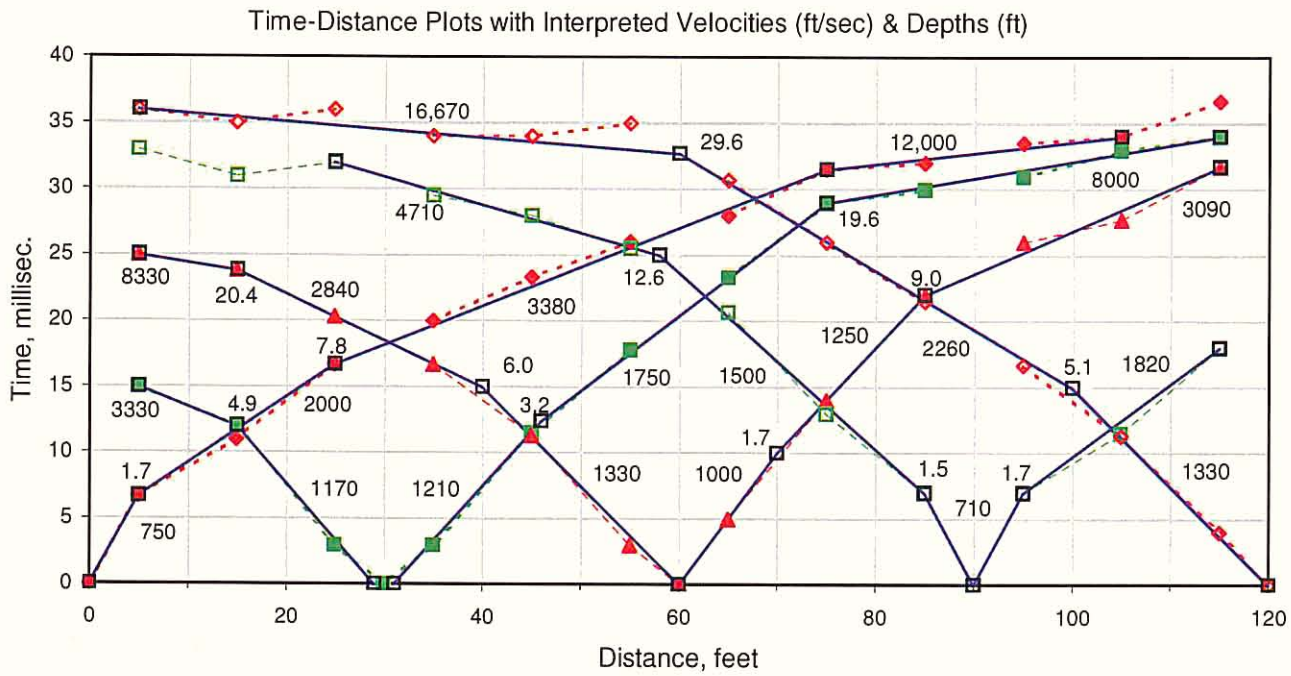


Refraction Seismic Interpretation

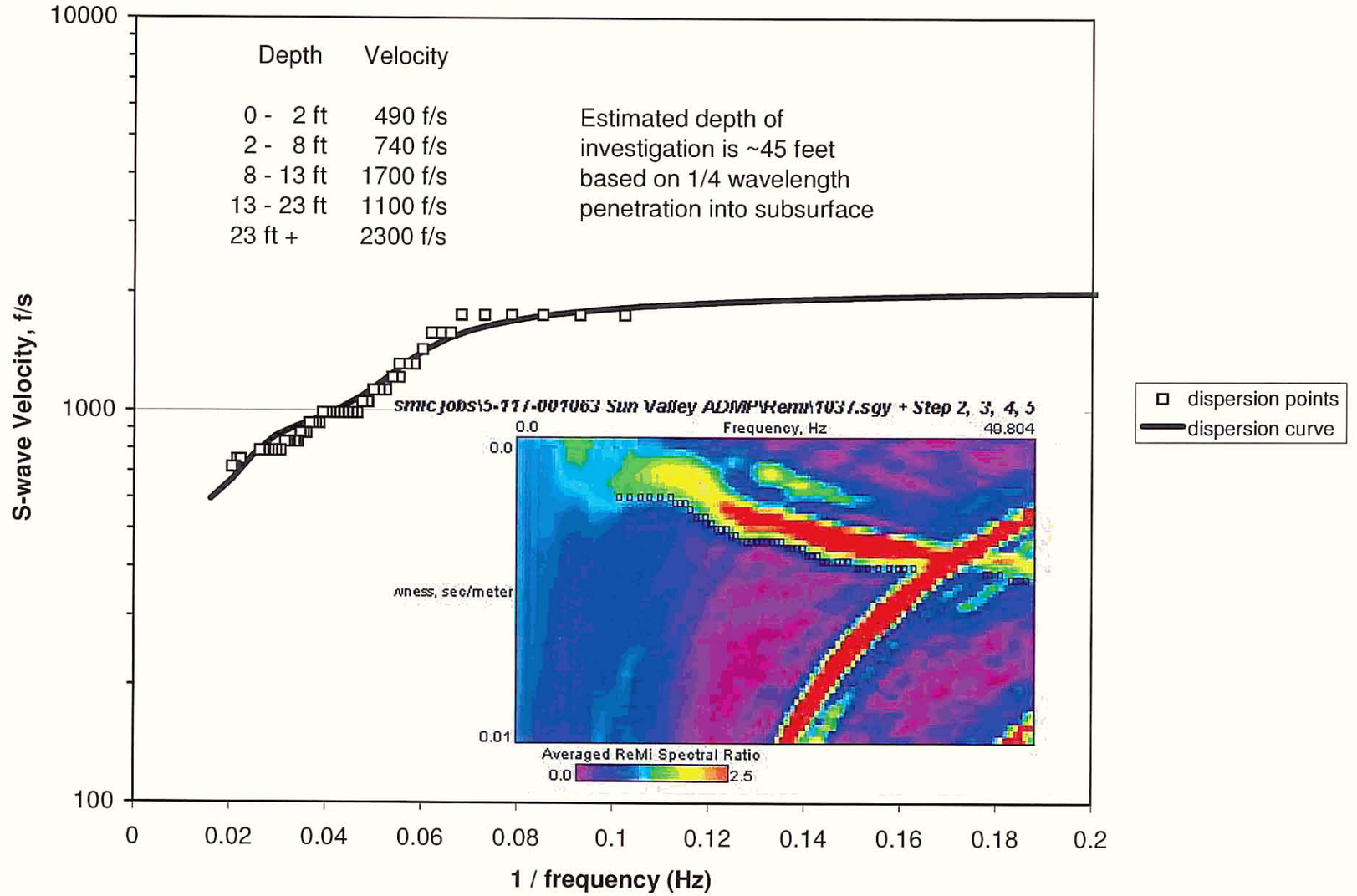
Line RRP1A

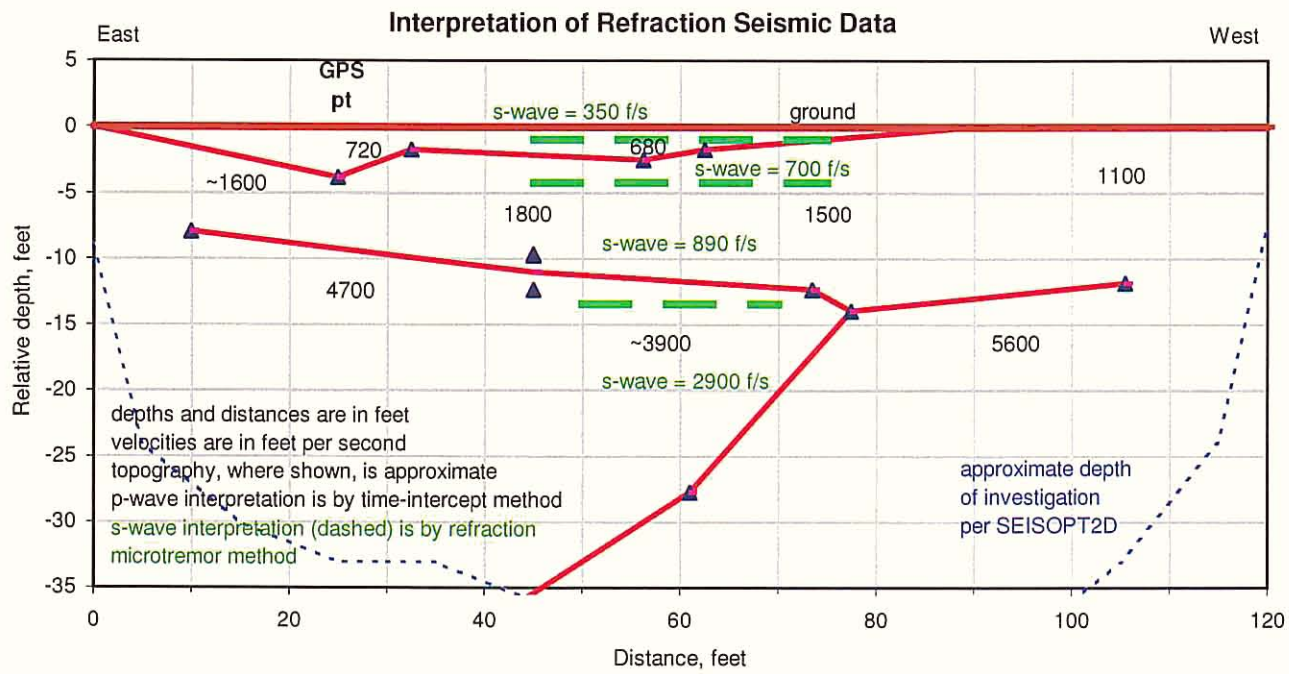
AMEC Job No. 5-117-001063

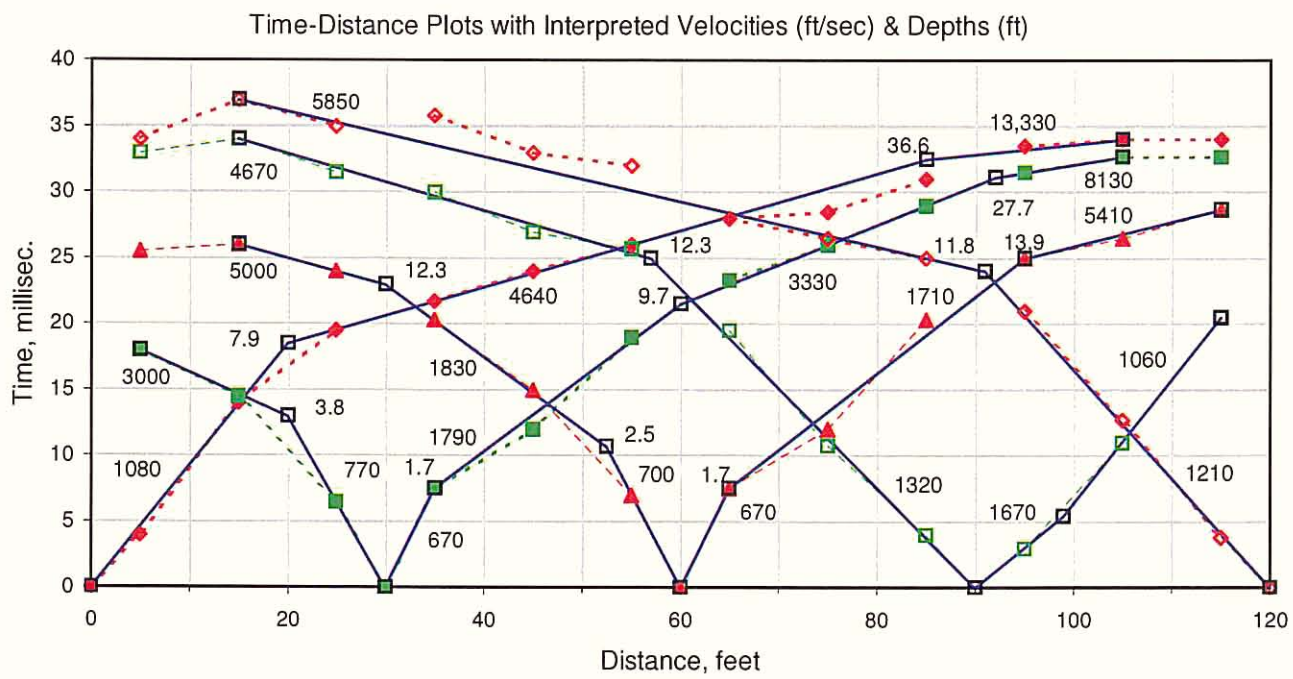


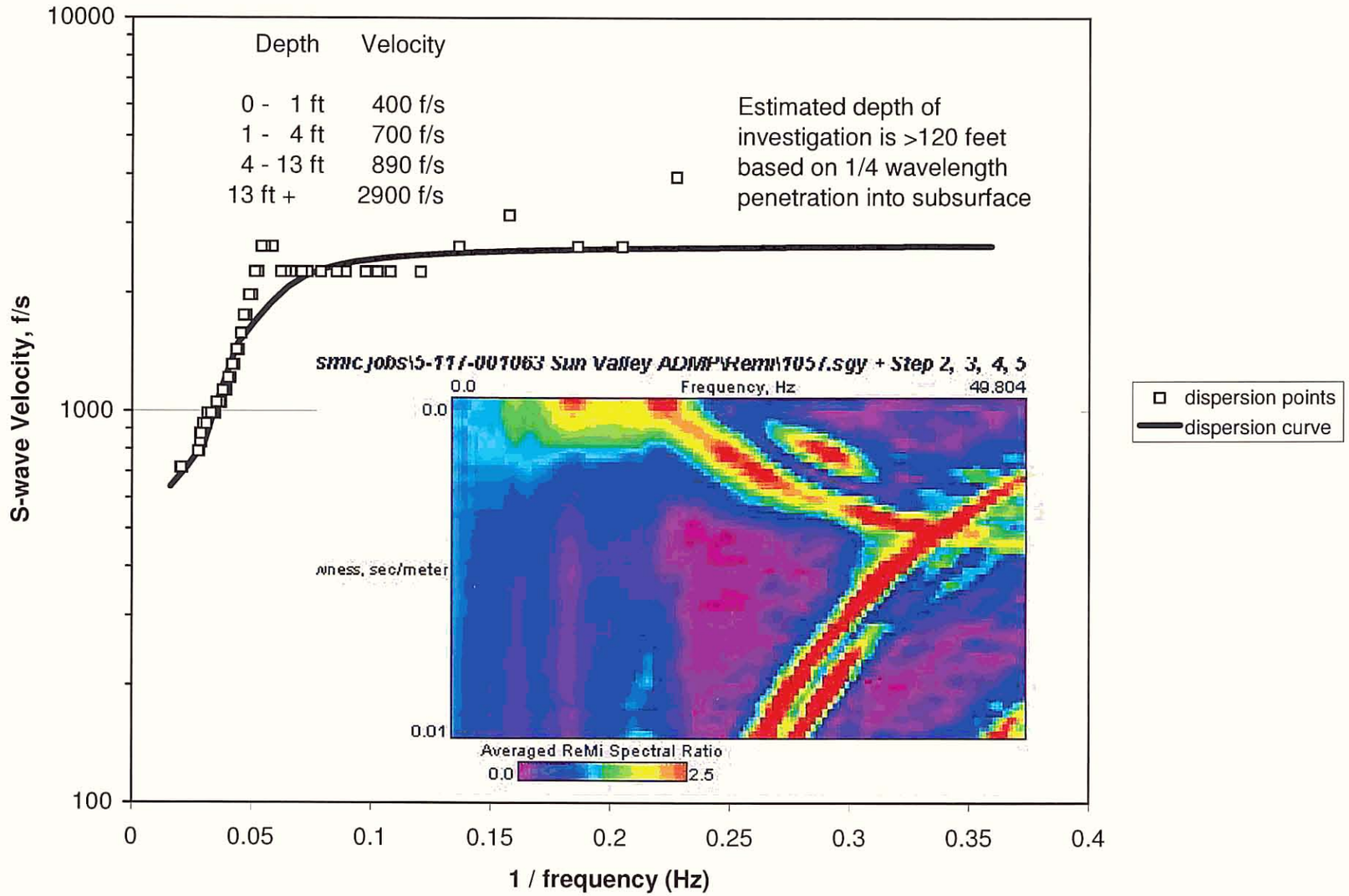


Refraction Microtremor S-wave Interpretation **Line RRP1A** AMEC Job No. 5-117-001063




Interpretation of Refraction Seismic Data
East
West
GPS pt
ground
s-wave = 350 f/s
s-wave = 700 f/s
s-wave = 890 f/s
s-wave = 2900 f/s
720
680
~1600
1800
1500
1100
4700
~3900
5600
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)
5850
4670
5000
4640
3330
13,330
8130
5410
3000
1830
1710
1060
1080
770
1790
700
670
1320
1670
1210
7.9
3.8
1.7
2.5
1.7
12.3
9.7
36.6
27.7
11.8
13.9
Time, millisec.
Distance, feet


Depth Velocity
0 - 1 ft 400 f/s
1 - 4 ft 700 f/s
4 - 13 ft 890 f/s
13 ft + 2900 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
smic jobs\5-117-001063 Sun Valley ADMP\ReMi\105 f.sgy + Step 2, 3, 4, 5
Frequency, Hz
0.0
49.804
0.01
Averaged ReMi Spectral Ratio
0.0
2.5
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)

Appendix C

Laboratory Results

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.

amec

PROJECT:	Sun Valley ADMP	JOB NO:	5-117-001063
LOCATION:	Maricopa County, Arizona	WORK ORDER NO:	1
SAMPLE SOURCE:	SEE BELOW	DATE ASSIGNED:	5/19/06

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

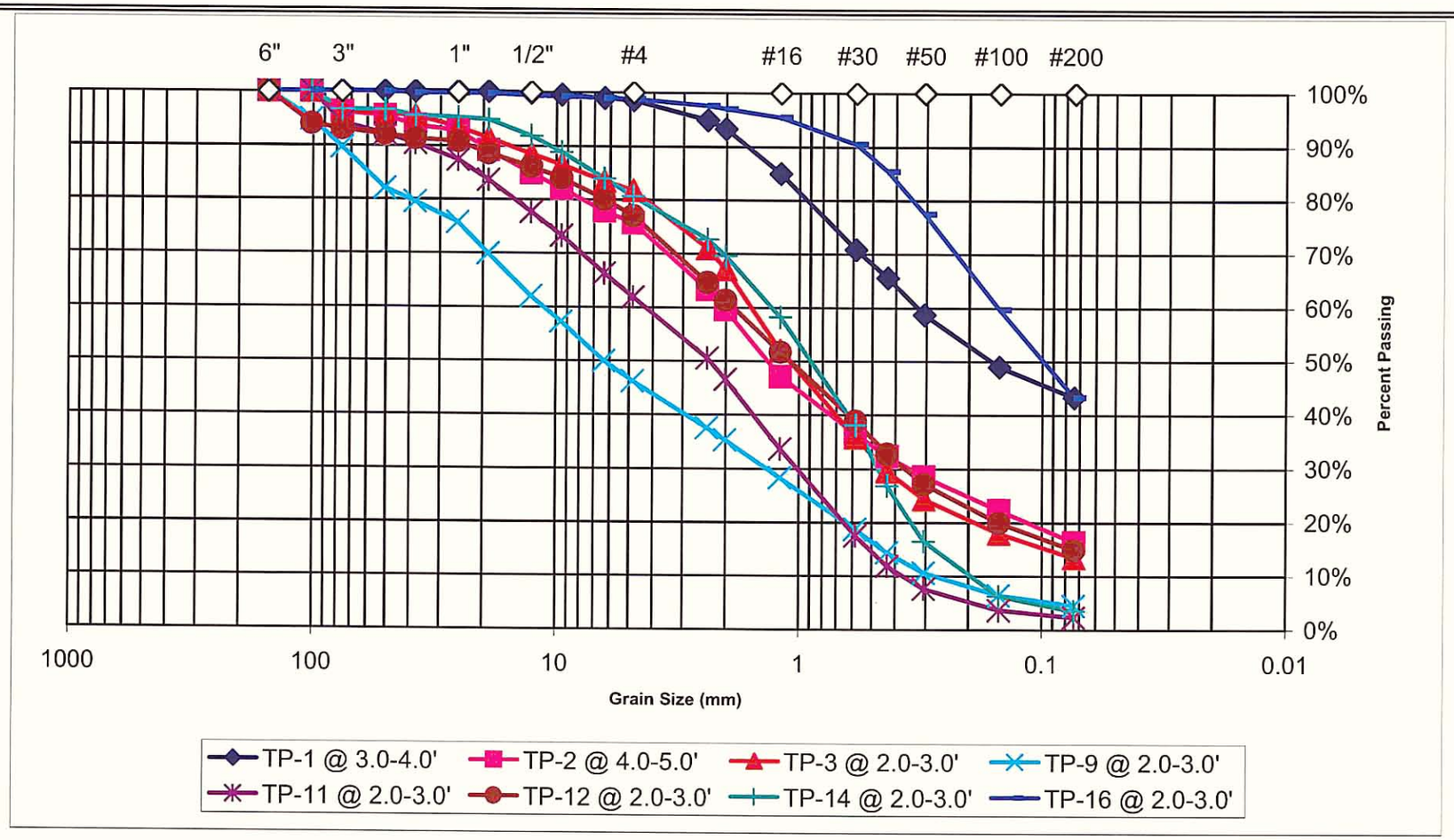
TP-1 @ 3.0-4.0'	SC-SM	24	6	43	49	59	66	71	85	93	95	98	99	99	100	100	100	100	100	100	100	100	2
TP-2 @ 4.0-5.0'	SC	37	13	16	22	28	32	36	47	60	63	76	78	82	85	89	93	94	95	96	100	100	4
TP-3 @ 2.0-3.0'	SM	29	5	13	18	24	29	36	52	67	71	82	83	86	88	91	93	96	96	96	100	100	6
TP-9 @ 2.0-3.0'	GP	19	1	4.5	6	11	14	19	28	35	38	46	50	57	62	70	76	79	82	90	95	100	20
TP-11 @ 2.0-3.0'	SP	NV	NP	2.3	4	8	12	17	34	47	51	62	66	73	78	84	87	90	92	94	100	100	23
TP-12 @ 2.0-3.0'	SM	19	2	15	20	27	33	39	52	61	65	77	80	84	86	89	91	91	92	93	94	100	25
TP-14 @ 2.0-3.0'	SP	NV	NP	3.5	6	16	27	38	58	70	73	81	84	89	92	95	95	96	97	97	100	100	29
TP-16 @ 2.0-3.0'	SM	NV	NP	43	60	77	85	90	95	97	98	99	99	99	99	100	100	100	100	100	100	100	33

AASHTO R18

REVIEWED BY

PROJECT:	Sun Valley ADMP	**JOB NO:**	5-117-001063
LOCATION:	Maricopa County, Arizona	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	5/19/06

MECHANICAL SIEVE ANALYSIS



amec

PROJECT:	Sun Valley ADMP	JOB NO:	5-117-001063
LOCATION:	Maricopa County, Arizona	WORK ORDER NO:	1
SAMPLE SOURCE:	SEE BELOW	DATE ASSIGNED:	5/19/06

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

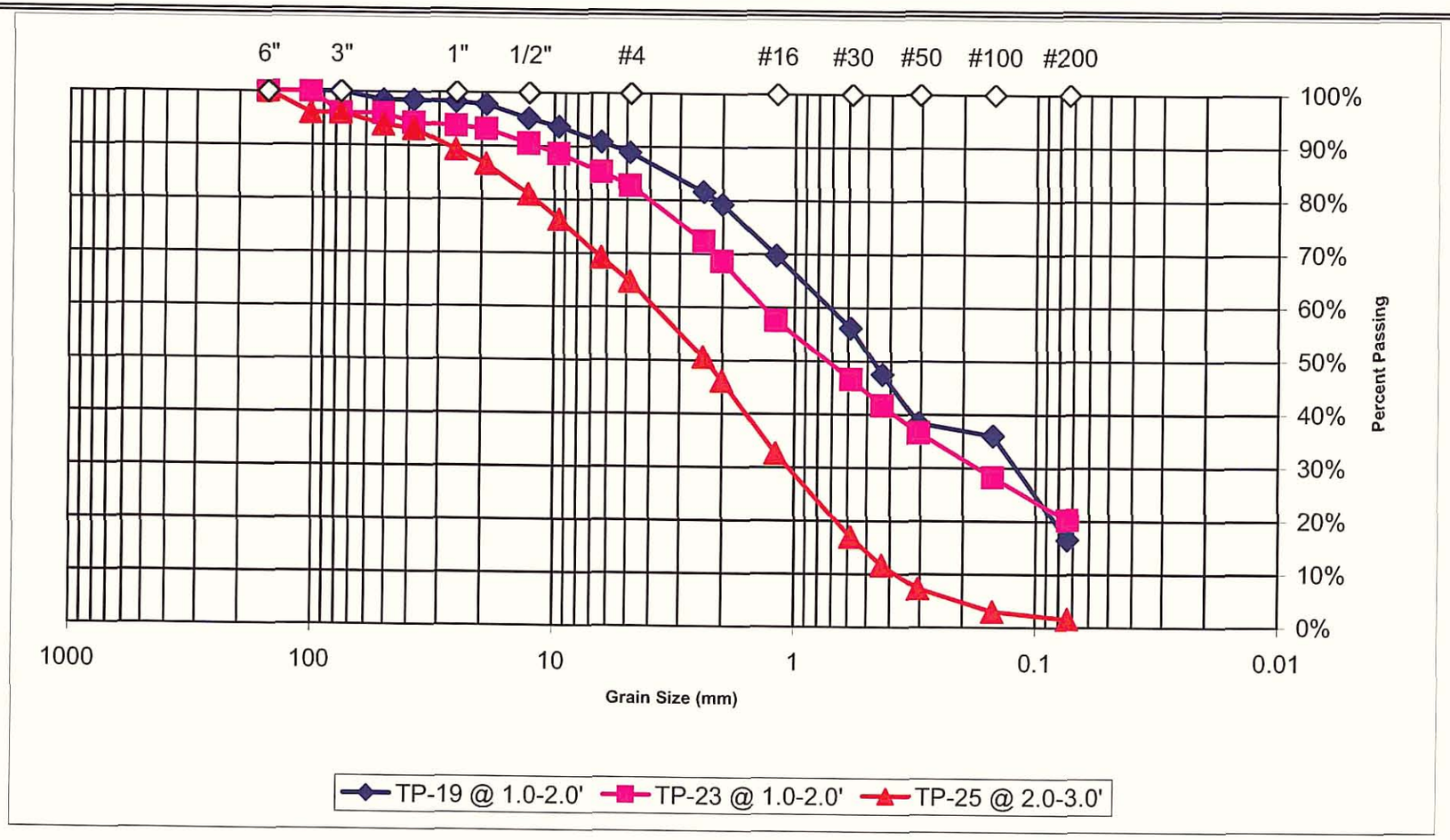
TP-19 @ 1.0-2.0'	SM	NV	NP	16	36	38	47	56	70	79	82	89	91	94	95	98	98	98	98	100	100	100	37
TP-23 @ 1.0-2.0'	SM	NV	NP	20	28	37	42	46	57	68	72	83	85	89	90	93	94	94	96	96	100	100	47
TP-25 @ 2.0-3.0'	SP	NV	NP	1.6	3	7	12	17	33	46	51	65	69	76	81	87	89	93	94	96	96	100	51

AASHTO R18

REVIEWED BY CG

PROJECT:	Sun Valley ADMP	**JOB NO:**	5-117-001063
LOCATION:	Maricopa County, Arizona	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	5/19/06

MECHANICAL SIEVE ANALYSIS



amec

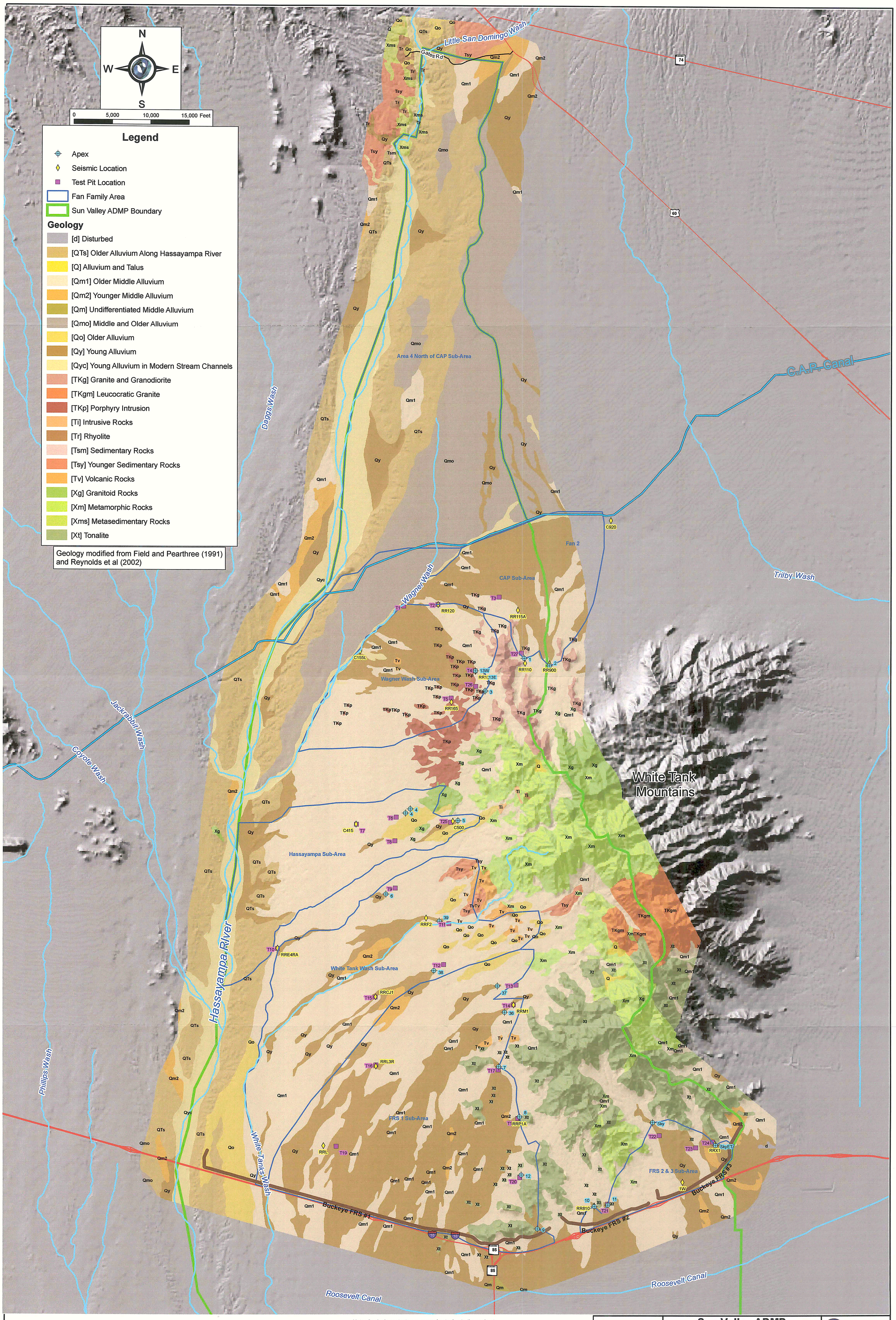
PROJECT:	Sun Valley ADMP	**JOB NO:**	5-117-001063
LOCATION:	Maricopa County, Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	See Below
SAMPLE SOURCE:	See Below	**DATE ASSIGNED:**	5/19/06

MOISTURE CONTENT OF SOIL (ASTM D2216)

LAB #	BORING & DEPTH	WET WT. (gram)	DRY WT. (gram)	MOISTURE CONTENT
2	TP- 1 @ 3.0-4.0'	541.0	525.1	3.0%
4	TP-2 @ 4.0-5.0'	516.0	501.3	2.9%
6	TP-3 @ 2.0-3.0'	507.0	493.1	2.8%
20	TP-9 @ 2.0-3.0'	533.0	526.0	1.3%
23	TP-11 @ 2.0-3.0'	508.5	503.7	1.0%
25	TP-12 @ 2.0-3.0'	507.5	499.0	1.7%
29	TP-14 @ 2.0-3.0'	592.5	586.9	1.0%
33	TP-16 @ 2.0-3.0'	518.0	507.4	2.1%
37	TP-19 @ 1.0-2.0'	595.0	588.9	1.0%
47	TP-23 @ 1.0-2.0'	558.6	538.3	3.8%
51	TP-25 @ 2.0-3.0'	595.0	590.3	0.8%

AASHTO R18

REVIEWED BY



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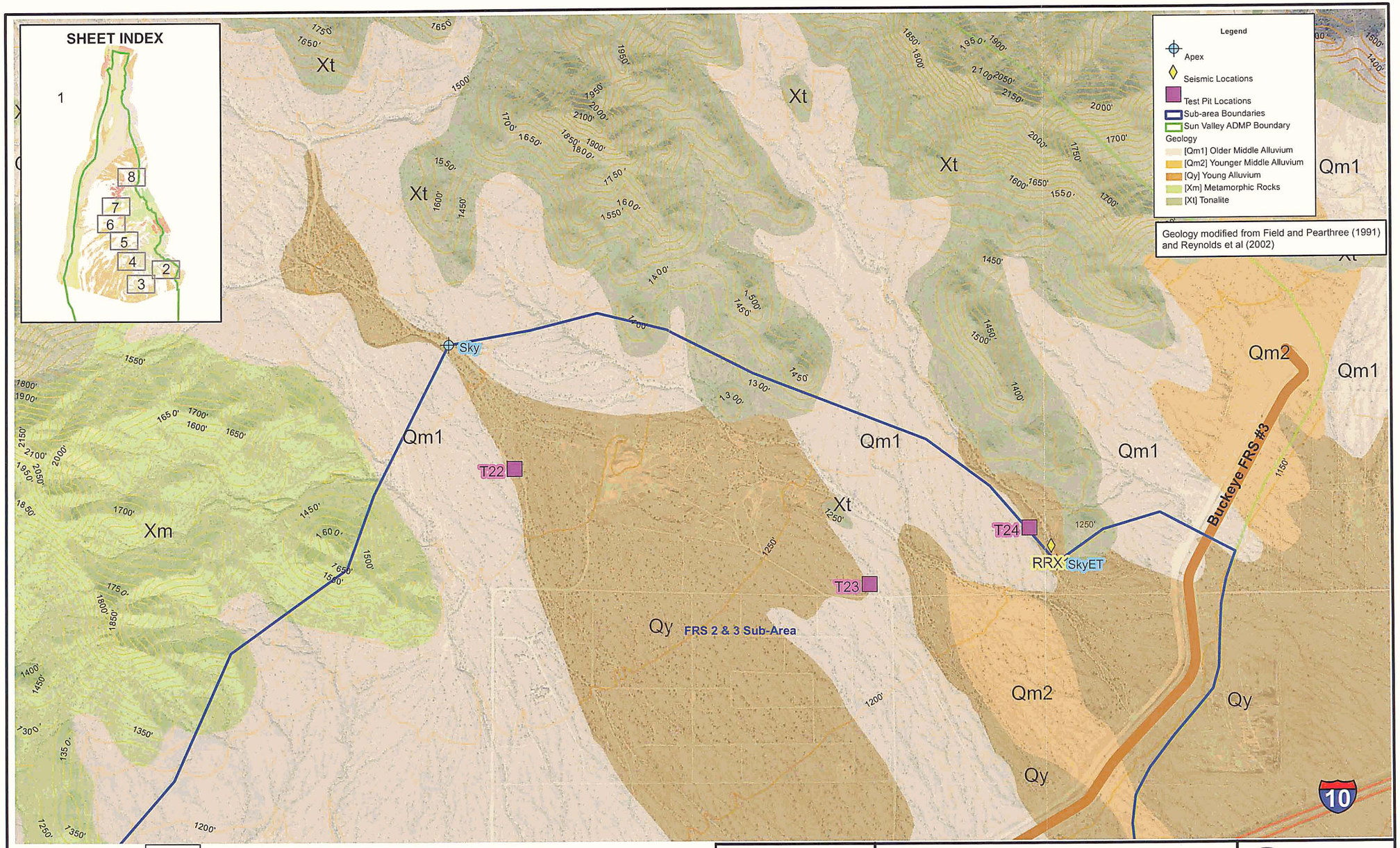
Note: Geologic contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/13/2006
SCALE:	1" = 5000'

Sun Valley ADMP
Site Plan & Geologic Map

Sheet 1 of 8

amec
JE FULLER HYDROLOGY & GEOCHEMISTRY, INC.



Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

0 500 1,000 1,500 2,000 Feet

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 2: APICES Sky, SkyET

amec

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Map Document: (\\Phx1-fs1\gis_share\Projects\5-117-001063\MXD\Sheet2.mxd)
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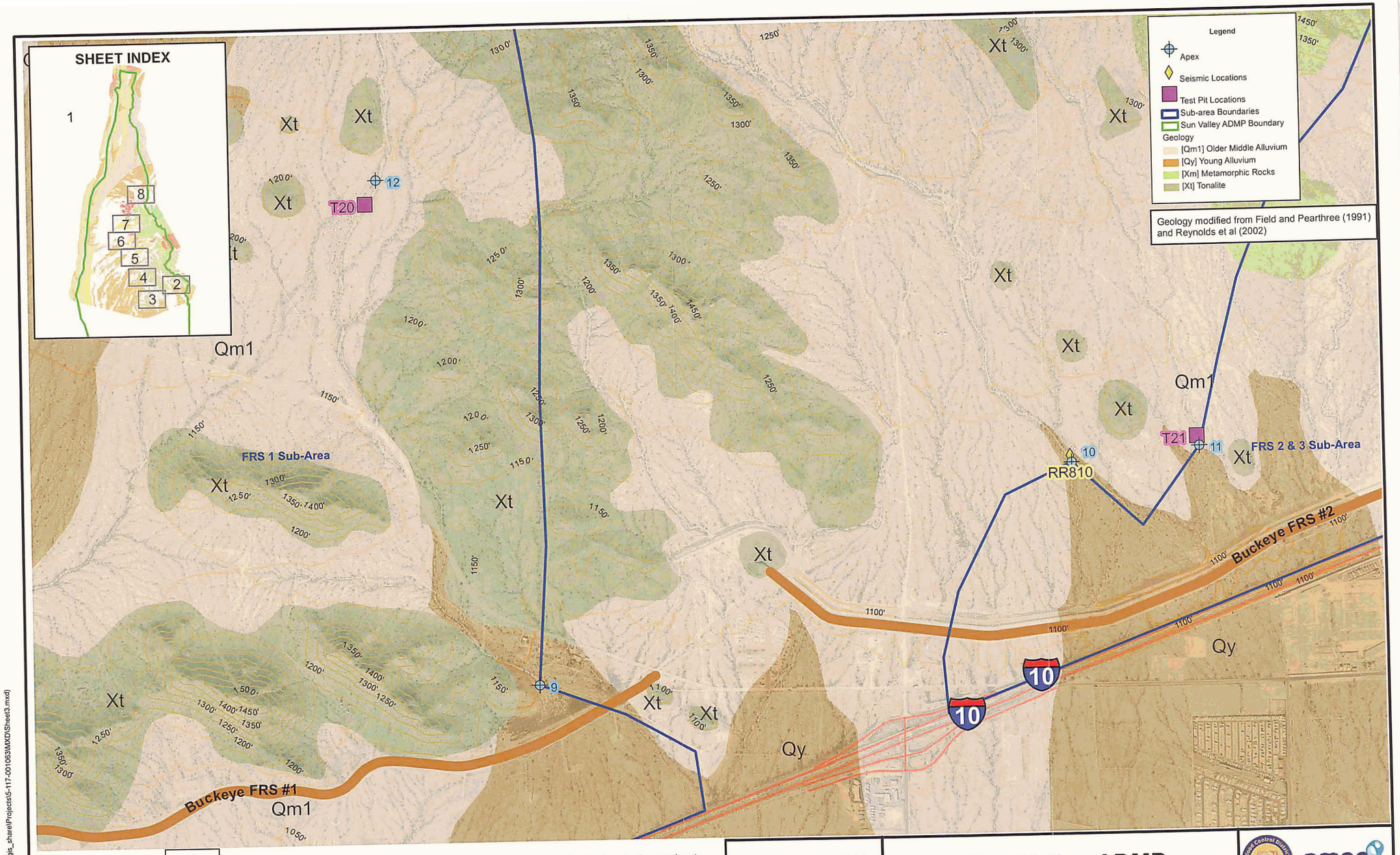

N
W E
S

0 500 1,000 1,500 2,000 Feet

Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 3: APICES 9,10,11,12

amec

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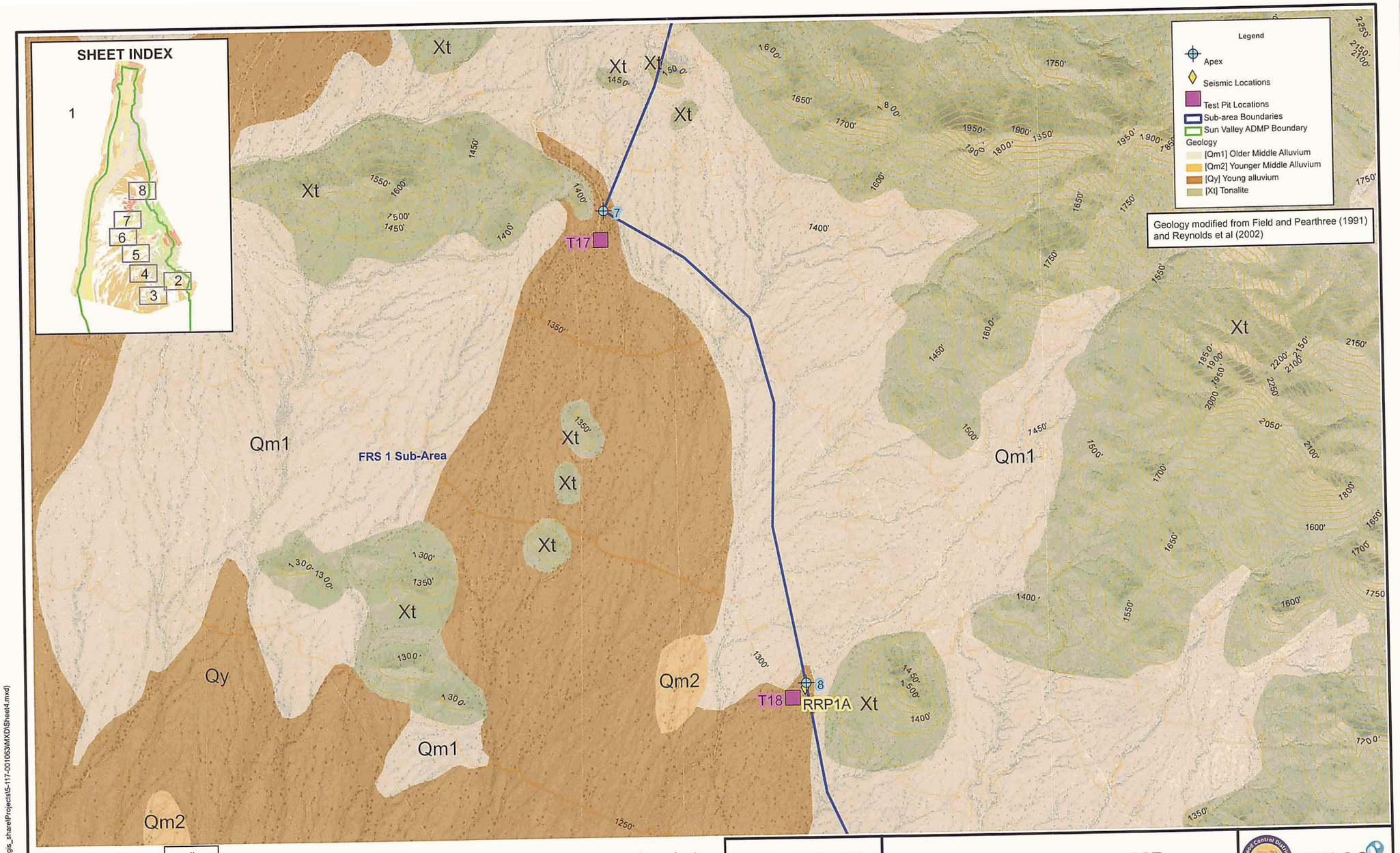

Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

0 500 1,000 1,500 2,000 Feet

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 4: APICES 7,8

amec

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

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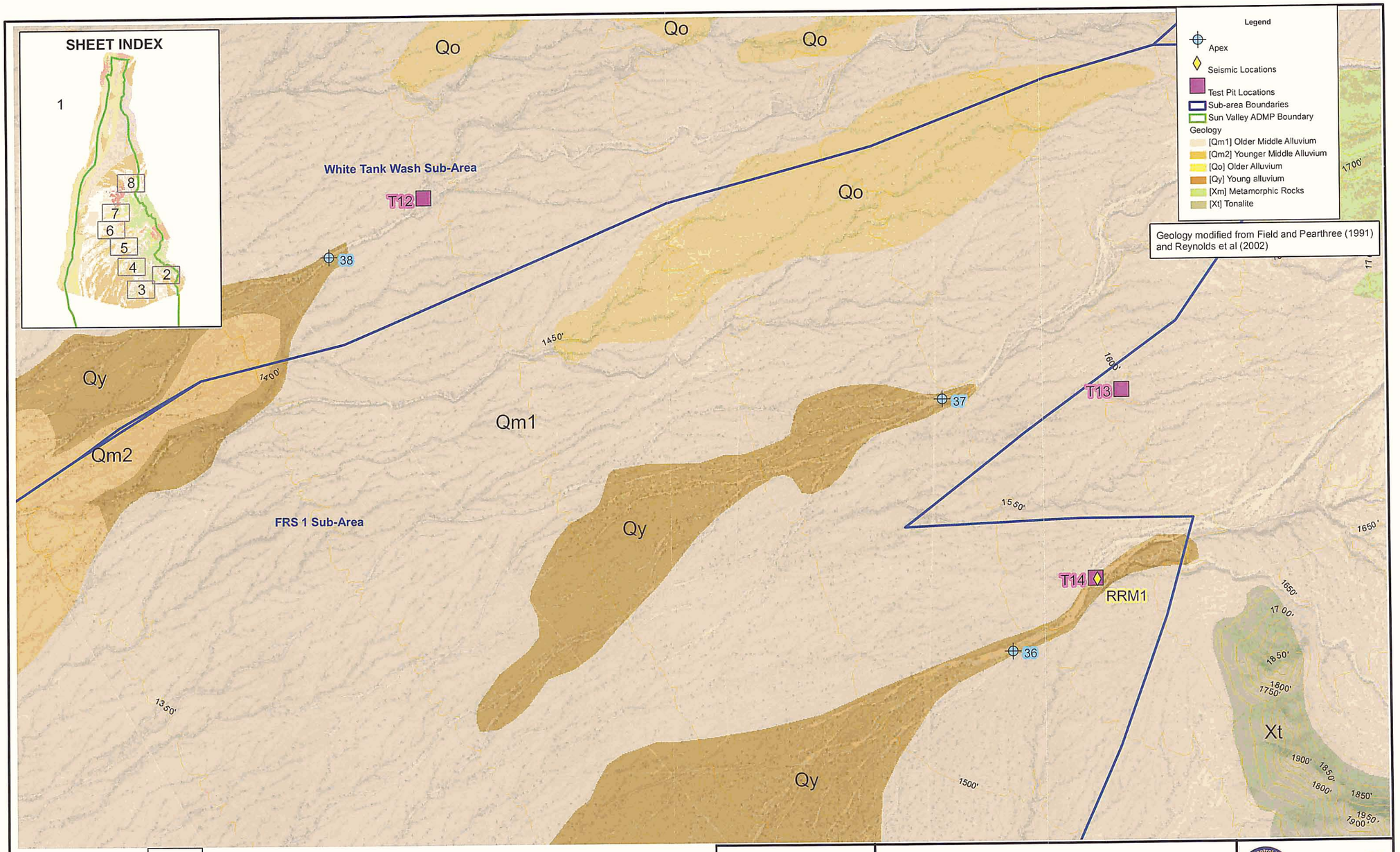

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Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 5: APICES 36,37,38

Flood Control District of Maricopa County

amec

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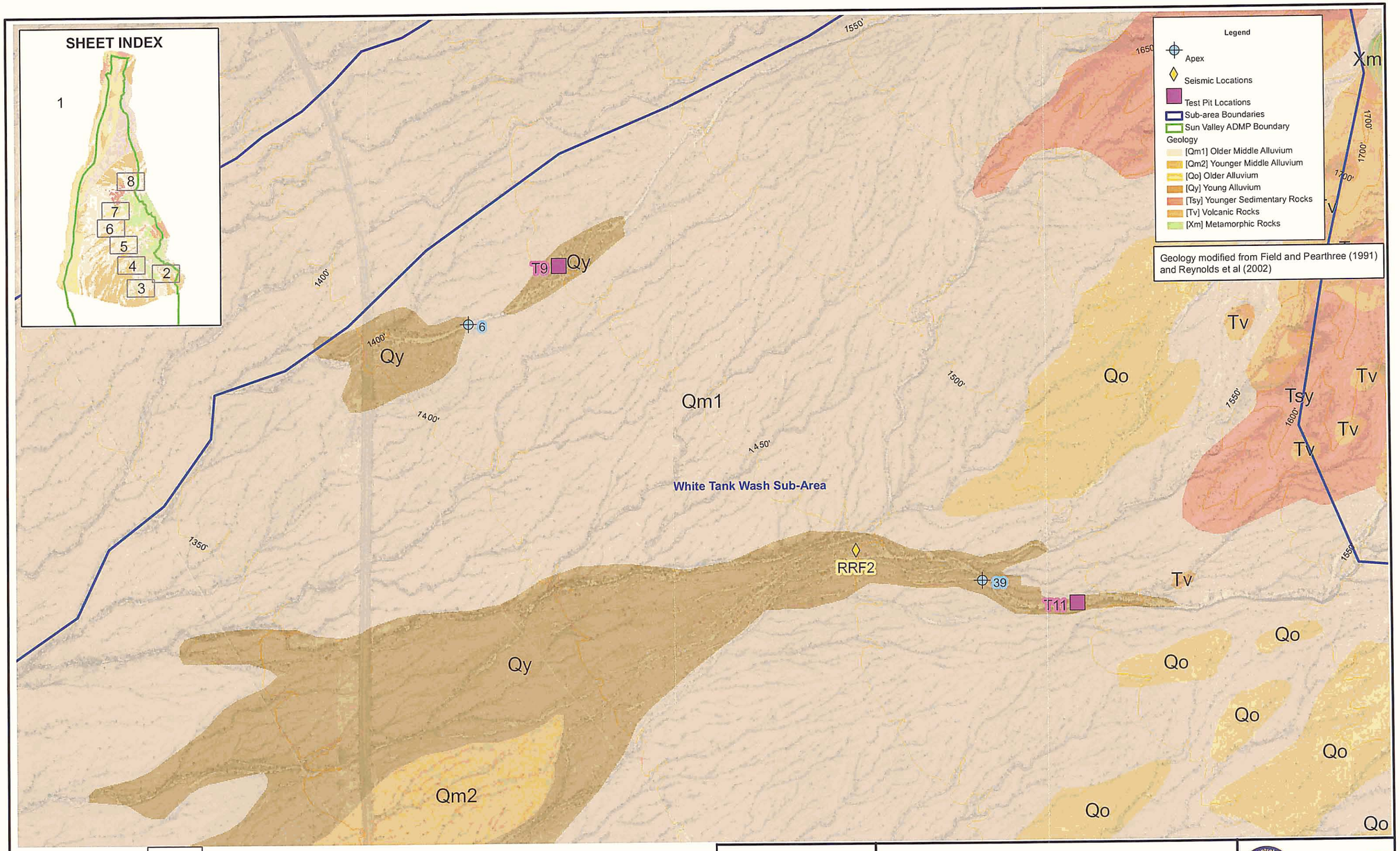

Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 6: APICES 6,39

Flood Control District of Maricopa County

amec

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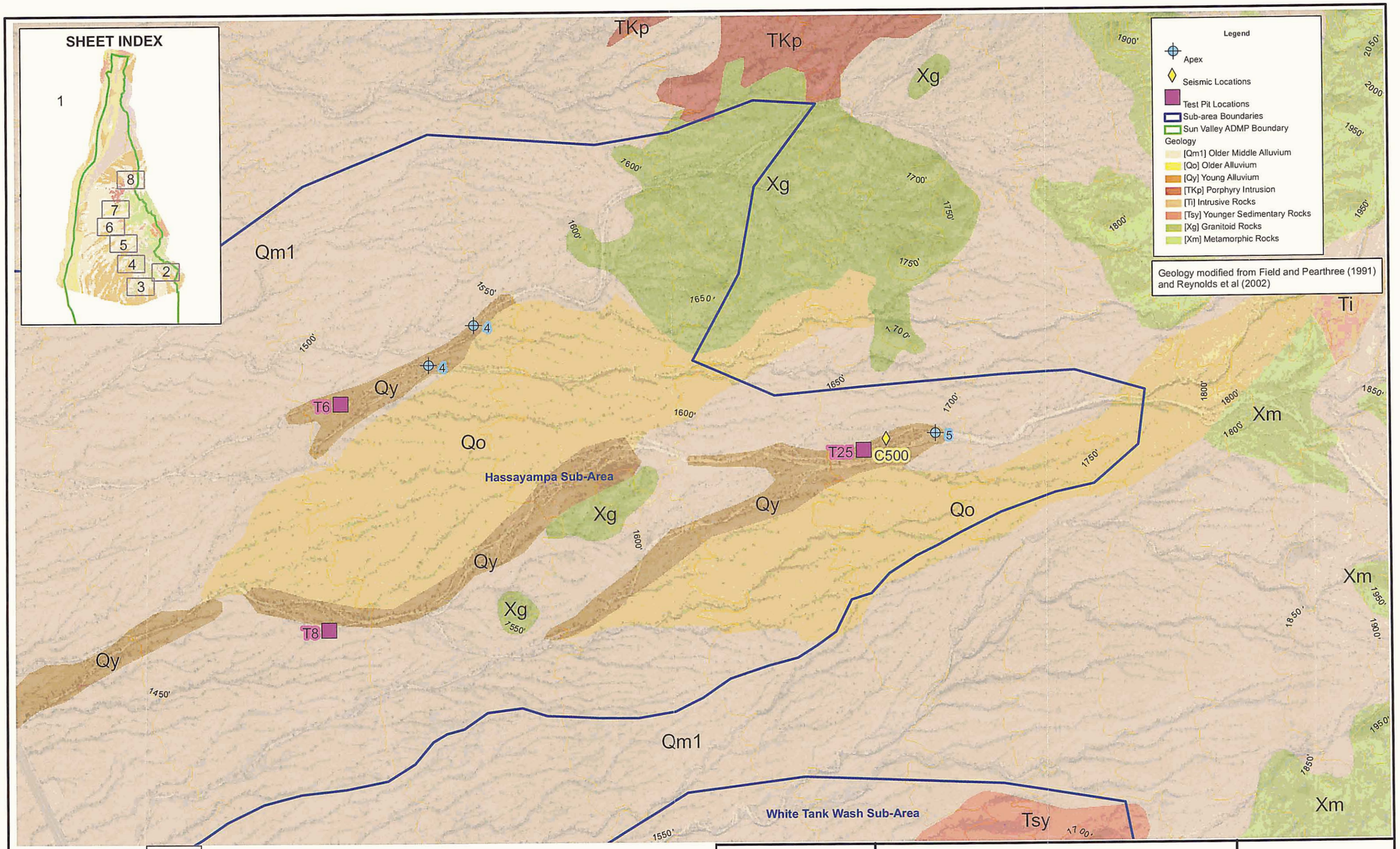

N
W E
S

0 500 1,000 1,500 2,000 Feet

Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 7: APICES 4,5

amec

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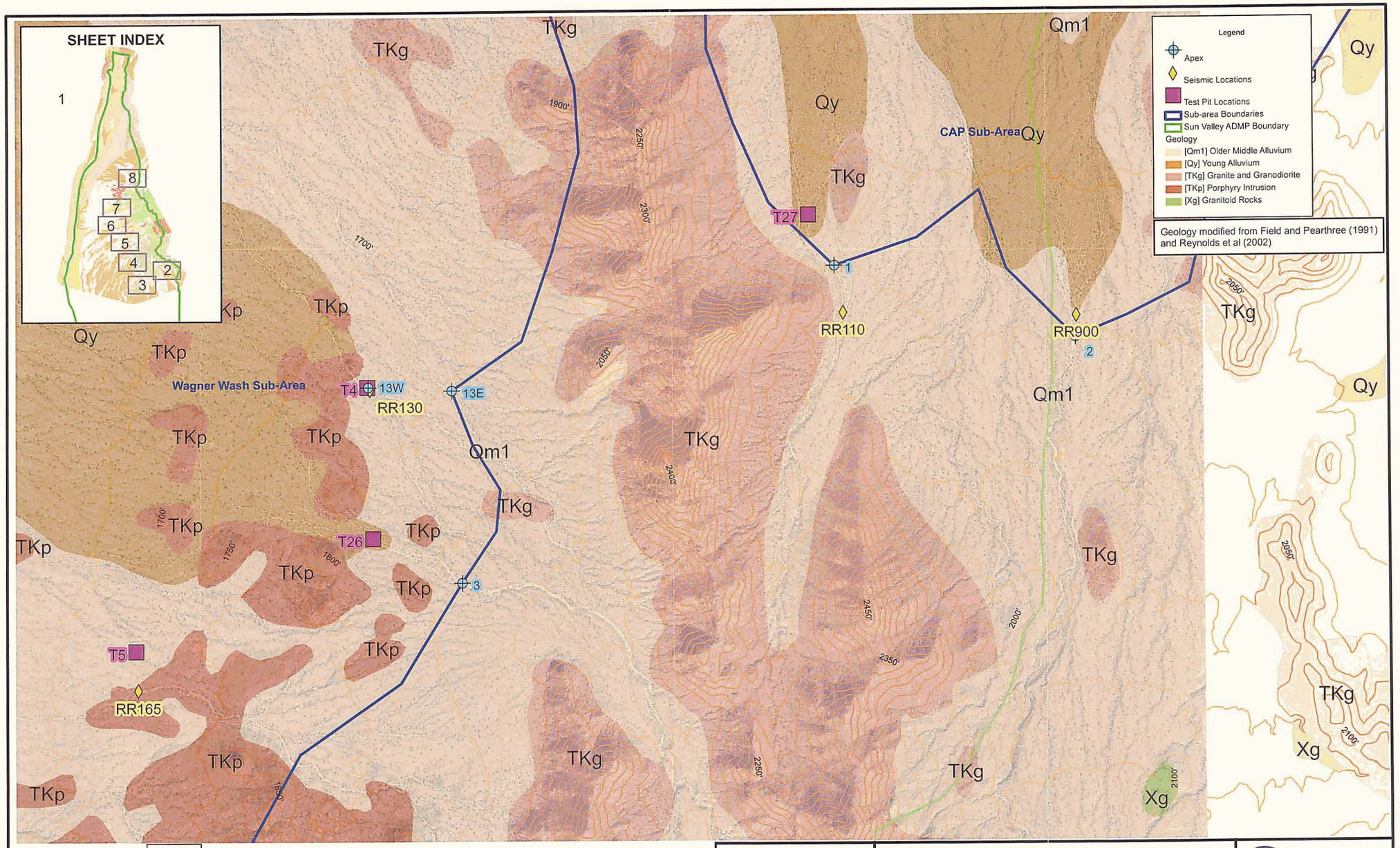

Note: Geologic Contacts are approximate due to the scale at which mapping was originally completed. Contact locations were adjusted in the vicinity of apices and other locations to more accurately represent geologic conditions, but not adjusted at all locations.

JOB NO.:	5-117-001063
DESIGN:	KCF
DRAWN:	EMP
DATE:	07/10/2006
SCALE:	1" = 500'

Sun Valley ADMP

Sheet 8: APICES 1,2,3,13E,13W

Flood Control District of Maricopa County

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