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REPORT ON GEOTECHNICAL INVESTIGATION

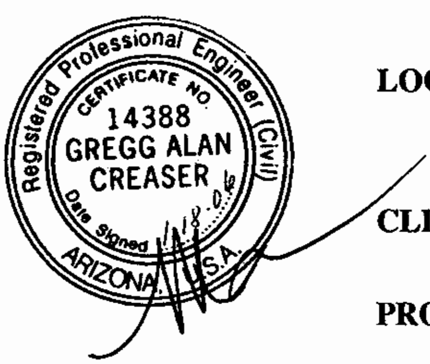
DESIGNATION: Las Sendas Office Condo

LOCATION: 7565 E. Eagle Crest Drive
Mesa, Arizona

CLIENT: groupRENAISSANCE

PROJECT NO: 052093SA

DATE: January 18, 2006



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February 23, 2007

Mr. Jerry Vest
groupRENAISSANCE
2078 West Cambridge Avenue
Phoenix, Arizona 85009

RE: Project No. 052093SA
Las Sendas Office Condo
7567 E. Eagle Crest Drive
Mesa, AZ
Addendum 1 – Review of Grading Plan

Dear Mr. Vest:

A site plan showing the proposed building layout and grading plan was unavailable at the time of our original investigation therefore we conducted our seismic investigation in the center portion of the property. Now that a site plan and grading plan has been provided a review of the original report and field investigation is warranted. This addendum addresses the issues related to the large cut and fills that are proposed on the site as well as stormwater retention, drainage and footing bearing medium.

Review of the grading plan provided to us indicates that the majority of the site appears to be cuts. The only area that appears to have some fill is the parking area on the north side of the buildings. This area also has a proposed steep fill slope which will need to be designed to meet the proposed slopes.

Based on the grading plans provided, it appears that the areas around the building will mostly be cut although there is a possibility that the structure still may be supported on bedrock, or partially supported on bedrock and/or soil (native and/or fill). Differential settlement is a major concern when foundations for one structure are placed on different bearing media. Structural damage could occur due to differential movement along interfaces with the different bearing media. **In order to avoid this, the structure should be supported entirely on one bearing medium,** especially in the area of interfaces with rocklike materials and soil. Due to the shallow depth and the cuts likely, it is highly recommended to place all foundation elements entirely on weathered to competent bedrock. This may require slightly deeper than normal footings along portions of the structure.

Permanent cut and fill slopes should be constructed as indicated in section 3.2 of the original report. The steeper 1(h):1(v) slopes as shown on the plan north of the parking lot are not acceptable in fills. In order to construct and maintain such steep slopes mechanically stabilized earth (MSE) system will be required unless consideration can be given to retaining walls. This will require additional design and evaluation by an engineer that specializes in these systems. Our current staff does not have this expertise.

3331 East Wood Street ▪ Phoenix, AZ 85040 ▪ Phone 602-997-6391 ▪ Fax 602-943-5508 ▪ www.speedie.net

The report addressed some concerns about drainage away from the structures and the location of the retention basins that may encroach on the bearing zones. Review of the grading plan and the information provided to us indicate that there is a possibility of surface retention adjacent to the southern proposed building. The concern with the retention basins near the foundations of the building is the wetting of the bearing soils and causing settlement. In general the structure should be founded on shallow spread footings bearing directly on the weathered to competent bedrock, at a minimum depth of **18 inches below lowest adjacent finished exterior grade within 5 feet of the footing element**. The remaining drainage appears to be directed away from the site toward the low area/wash area along the north and east boundaries. This is considered acceptable.

We recommend that a representative of the Soils Engineer observe and test the earthwork and foundation portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report. If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Based on the proposed design the recommendations and limitations in the original report remain the same. This addendum should be attached to the original report and made a part thereof.

Respectfully submitted,
SPEEDIE & ASSOCIATES

Registered Professional Engineer (Civil)
CERTIFICATE NO. 37292
KEITH RYAN GRAVEL
Date Signed 2-23-07
ARIZONA, U.S.A.

Keith R. Gravel, P.E.

CC: John Shinske – Desert Development Engineering, LLC

SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers

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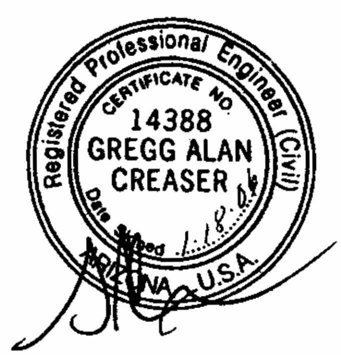

1.0 INTRODUCTION

This report presents the results of a limited subsoil investigation carried out at the site of the proposed office condo to be constructed on a hill side lot at 7565 East Eagle Crest Drive in Mesa, Arizona.

Preliminary information calls for the construction of a one to two story office condo on a 1.5 acre site. The structure is assumed to be slab on grade with masonry and/or wood frame construction. Structural loads are expected to be light to moderate and no special considerations regarding settlement tolerances are known at this time. Adjacent areas will be landscaped or paved to support passenger car traffic. Landscaped areas will be utilized for storm water retention and disposal.

The site was not accessible to conventional drilling equipment to conduct a standard subsurface investigation. In addition shallow refusal on bedrock was anticipated. Accordingly, geophysical survey was performed. Our sub-consultant, Geological Consultants, conducted the geophysical survey with two lines recorded in the building area. The results of their work are appended.

2.0 GENERAL SITE AND SOIL CONDITIONS

2.1 Site Conditions

The site is bounded on the north by East Eagle Crest Drive, on the south by an access road to Las Sendas Golf Course, on the west by the access road followed by vacant land, and on the east by residential. The site consists of a knoll (high point) in the center of the site which slopes sharply to the north and gradually to the south. The site surface consists of typical native desert vegetation and there were no signs of mass fill on the site, nor the observation of previous structures.

2.2 General Subsurface Conditions

As indicate above, it was not possible to access the site with standard drilling equipment. Surface soils consist of nil to less than 3 feet of silty sand with gravels derived from weathered granite bedrock. Shallow granite bedrock is predominate across the site with some low height granite boulder outcrops.

3.0 ANALYSIS AND RECOMMENDATIONS

3.1 Analysis

Analysis of the field and laboratory data indicates that subsoils at the site are generally favorable for the support of the proposed structure on shallow foundations and for slab-on-grade construction.

No Site/Grading Plan was provided for this investigation. Until a grading plan has been reviewed by this office, this report should be considered preliminary until addendum is issued presenting any changes necessary due to plan details. Issues of concern would include location of storm water retention facilities, drainage and cuts/fills.

Ground water is not expected to be a factor in the design or construction of shallow foundations and underground utilities. **However, it is possible to encounter perched water flows in the soils overlying the bedrock surfaces.** The design should consider intercepting the flows (including subsurface flows down to the bedrock surface) from the uphill side of the lot and directing it around the house. This would prevent flows under the house that could result in increased slab moisture and ensuing problems with wet slabs.

Depending on grading scheme, it is possible that the structure may be supported on bedrock, or partially supported on bedrock and/or soil (native and/or fill). Differential settlement is a major concern when foundations for one structure are placed on different bearing media. Structural damage could occur due to differential movement along interfaces with the different bearing media. **In order to avoid this, a structure should be supported entirely on one bearing medium**, especially in the area of interfaces with rocklike materials and soil. Due to the shallow depth, it is highly recommended to place all foundation elements entirely on weathered to competent bedrock. This may require slightly deeper than normal footings along portions of the structure.

The presence of shallow bedrock will make site preparation, foundation excavation, and utility installations difficult. Weathered rock material may interfere with 'neat' foundation excavations and result in soil disturbance. This may result in concrete overages for foundation pours and/or the need to recompact soils in the areas disturbed. **Excavation difficulties may be encountered in areas where bedrock is highly competent.** Rock removal techniques may be required. This may include blasting and/or pneumatic rock hammering.

3.2 Permanent Cut/Fill Slope Limitations

Generally, permanent cut or fill slopes should be no steeper than 2 horizontal to 1 vertical (2:1). Where particular conditions make it appropriate to vary from these slopes, these must be addressed on a case by case basis, either in this report or at special request directed to a representative of this office. Steeper cut slopes in stable rock may be possible (depending of geology), not very likely in soils. Determination of acceptable steeper slope ratios is predicated on a stability analysis of the specific geometry, determinations of soil and groundwater characteristics, structure set backs, surcharge loads and slope stabilization.

The geological reconnaissance indicates that typical shallow cut slopes (< 10 ft) in this type of material can range from 1½:1 to ½:1 (horizontal: vertical) depending on the slope structure of the rock formation. Without further analysis, we recommend shallow cut slopes in the granite bedrock of about 1:1 until the exposed face can be examined. Steeper cuts will likely be possible but will require inspection by qualified personnel at the time of construction in order to observe the cut face. Deeper cuts will require further analysis. Permanent fill slopes should be placed no steeper than 2h:1v. Fill slopes of 1.5h:1v may be employed if they can be compacted out to the face of the slope and/or plated with large rock to reduce the potential for sloughing and erosion. However, there may be some surficial instability such as raveling of the slope face that may require periodic maintenance. If steeper slopes are required, consideration will have to be given to retaining walls or a mechanically stabilized earth (MSE) system.

In accordance with Building Code requirements, all occupied structures should be set back from the crest (top edge) of the slope such that the outer edge of the nearest foundation is no closer than a distance equal to at least one third (⅓) of the total height of the slope. See specific building code requirements for additional detail and/or placement of structures at the bottom (toe) of slopes.

Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical (5:1), the bank shall be stepped or benched to remove all loose soils and to provide a level surface for placement of fill. Ground slopes which are flatter than 5 to 1 may require benching when considered necessary by a representative of this office. The benches should be cut wide enough to remove loose surface soils and allow proper compaction of fills. A minimum bench width of 8 feet is typically recommended for the first lift (toe) of any fill placed on a slope. This width may be reduced at the direction of the field engineer depending on the presence of loose soils, slope steepness, exposed rock and lift thickness.

Placement and obtaining compaction of fill adjacent to fill slopes may be very difficult. Depending on soil type and final slope configuration, it may be necessary to over-build the slope and cut back to the final configuration to obtain the required degree of compaction.

3.3 Site Preparation

The entire area to be occupied by the proposed construction should be stripped of all vegetation, debris, rubble and obviously loose surface soils.

All cut areas and areas above footing bottom elevation that are to receive floor slab only fill should be scarified 8 inches, moisture conditioned to at least optimum, and uniformly compacted to 95 percent of maximum dry density as determined by ASTM D-698. **Scarification of rock is not necessary**.

3.4 Foundation Design

It is recommended that the structure be founded on shallow spread footings bearing directly on weathered to competent bedrock, at a minimum depth of **18 inches below lowest adjacent finished exterior grade within 5 feet of the footing element**. (Note: If hard competent rock is encountered in the footing excavation, the depth of the footing may be reduced to a nominal 12 inches.) If site preparation is carried out as set forth herein, a recommended safe allowable bearing capacity of **5,000 psf** can be utilized for design. (Note: Contact this office if higher bearing values are required.) This bearing capacity refers to the total of all loads, dead and live, and is a net pressure. It may be increased one-third for wind, seismic or other loads of short duration. All footing excavations should be level and cleaned of all loose or disturbed materials. **Positive drainage away from the proposed building must be maintained at all times**.

As an alternate option to extending the foundations down to bedrock, the footings may be over-excavated to the planned footing width and backfilled with a lean 2-sack (500 psi) concrete grout back up to the proposed bottom of footing elevation.

Although borings were not advanced to 100 feet, based on the nature of the subsoils encountered in the borings and geology in the area, Site Class Definition, Class B (Table 1615.1.1, 2000 & 2003 IBC) may be used for design of the structures due to the shallow bedrock.

Continuous masonry wall footings and isolated rectangular footings should be designed with minimum widths of 16 and 24 inches respectively, regardless of the resultant bearing pressure. Lightly loaded interior partitions (less than 800 plf) may be supported on reinforced thickened slab sections (minimum 12 inches of bearing width).

Footings should be situated such that a 45-degree plane below an upper foundation does not intersect the walls of an adjacent structure such as retaining walls. This will prevent the imposition of foundation surcharge loads on the walls. Foundations placed on the backfill zone of the retaining walls may be subject to settlement should consolidation of the backfill occur. Accordingly, they are not recommended. It is preferable to support at-grade portions of the building on a grade beam and/or stepped down foundation to span/penetrate the backfill zone.

Estimated settlements under design loads for spread footings bearing on bedrock are negligible. Additional localized settlements of the fill material could approach 10 percent of the fill height if native supporting soils were to experience a significant increase in moisture content. Therefore, no footings should be founded on retaining wall backfill. Positive drainage away from structures and controlled routing of roof runoff **must** be provided to prevent ponding adjacent to perimeter walls (that could create a perched water table problem). Planters requiring heavy watering should be considered with caution. Care should be taken in design and construction to insure that domestic and interior storm drain water is contained to prevent seepage or has a place to drain.

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements, and long walls should be provided with control joints to accommodate these movements. **Reinforcement and frequent control joints are recommended to allow slight movement and prevent minor floor slab cracking especially in floor areas to be covered with hard tile.**

3.5 Lateral Pressures

The following lateral pressure values may be utilized for the proposed construction:

Active Pressures	
Unrestrained Walls	35 pcf
At-Rest Pressures	
Restrained Walls	60 pcf
Passive Pressures(**)	
Continuous Footings	350 pcf
Spread Footings or Drilled Piers	400 pcf
Coefficient of Friction (w/ passive pressure)	0.35
Coefficient of Friction (w/out passive pressure)	0.45
Coefficient of Friction (concrete on clean rock)	0.70

(Note **: Reduce or do not rely on passive pressure values where slope drops steeply (>3:1) below retaining wall foundations.)

All backfill must be compacted to not less than 95 percent (ASTM D-698) to mobilize these passive values at low strain. Reliance on passive pressure should either not be used or reduced in areas where there is a greater than 10 percent natural slope below the footing. Expansive soils should not be used as retaining wall backfill, except as a surface seal to limit infiltration of storm/irrigation water. The expansive pressures could greatly increase active pressures. The exposed rock cut must be cleaned of all loose debris by high-pressure air or water to take advantage of the higher coefficient of friction.

3.6 Fill and Backfill

Native soils are considered suitable for use in general grading fills, stem wall backfill and as engineered fill provided particles in excess of 3 inches are crushed or removed. In special cases, it may be allowable to use up to 6-inch rock provided that the contractor can demonstrate proper compaction and sufficient fines in the matrix to limit voids.

Successful backfill of retaining walls can be difficult to achieve in tight access conditions. Placement and compaction must be carefully controlled in order to minimize the potential for post construction settlement should the backfill zone be subjected to water infiltration. Even the most well controlled granular fills could experience additional settlement on the order of 1 or more inches if subjected to significant moisture increases. Non-granular fills could be subject to greater water induced settlement, on the order of several percent of the wall height. **Accordingly, it is recommended to use structural slabs over the backfill zone in the most critical areas or reinforce and pin the landing/entry slabs to the building stem wall to span over the backfill zone. This will reduce the potential for the exterior slab dropping and creating a tripping hazard.** Critical areas can be considered to include not only concrete walkways and slabs, but also concrete and asphaltic concrete paving. Paving over wall backfill zones should be detailed to minimize the effects of backfill settlement. Utility lines, especially gravity sewer lines, should be avoided in this zone expect for building service connections.

If imported common fill for use in site grading is required, it should be examined by a Soils Engineer to ensure that it is of low swell potential and free of organic or otherwise deleterious material. In general, the fill should have 100 percent passing the 3-inch sieve and no more than 60 percent passing the 200 sieve. For the fine fraction (passing the 40 sieve), the liquid limit and plasticity index should not exceed 30 percent and 10 percent, respectively. It should exhibit less than 1.5 percent swell potential when compacted to 95 percent of maximum dry density (ASTM D-698) at a moisture content of 2 percent below optimum, confined under a 100 psf surcharge, and inundated.

Fill should be placed on subgrade which has been properly prepared and approved by a Soils Engineer. Fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±2 percent. Fill should be placed in horizontal lifts of 8-inch thickness (or as dictated by compaction equipment) and compacted to the percent of maximum dry density per ASTM D-698 set forth as follows:

A.	Building Areas		
	1.	Below footing level	Slurry
	2.	Below slabs-on-grade (non-expansive soils)	95
B.	Pavement Subgrade or Fill		95
C.	Utility Trench Backfill		
	1.	More than 2.0' below finish subgrade	95
	2.	Within 2.0' of finish subgrade (non-granular)	95
	3.	Within 2.0' of finish subgrade (granular)	100
D.	Aggregate Base Course		
	1.	Below floor slabs	95
	2.	Below asphalt paving	100
E.	Landscape Areas		
	1.	Miscellaneous fill	90
	2.	Utility trench - more than 1.0' below finish grade	85
	3.	Utility trench - within 1.0' of finish grade	90

3.7 Utilities Installation

Trench excavations for utilities may encounter rock or rock like materials that conventional trenching equipment may have a difficult time excavating. **Rock excavation will be required depending on location and depth**. Waist-high trench walls in the overburden soils should stand near-vertical for the relatively short periods of time required to install shallow utilities although some sloughing may occur in looser and/or sandier soils requiring laying back of side slopes and/or temporary shoring. Adequate precautions must be taken to protect workmen in accordance with all current governmental regulations.

Backfill of trenches may be carried out with native excavated material provided particles in excess of 3 inches are first removed. Material with particle sizes larger than 1.5 inches should not be used around the pipe. This material should be moisture-conditioned, placed in 8-inch lifts and mechanically compacted. Water settling is not recommended. Compaction requirements are summarized in the "Fill And Backfill" section of this report.

Bedding should be selected per the requirements of the pipe materials used and the trench loading conditions.

3.8 Slabs-on-Grade

To facilitate fine grading operations and aid in concrete curing, a 4-inch thick layer of granular material conforming to the gradation for Aggregate Base (A.B.) as per M.A.G. Specification Section 702 should be utilized beneath the slab. Dried subgrade soils **must** be re-moistened prior to placing the A.B. layer if allowed to dry out.

3.9 Pavement

If earthwork in paved areas is carried out to finish subgrade elevation as set forth herein, the subgrade will provide adequate support for pavements.

For pavement areas to be used primarily for automobile traffic and parking, our experience in the area indicates that a minimum of 2.0 inches of asphalt over 4.0 inches of aggregate base course will provide satisfactory service. Heavy duty areas subject to occasional, low volume, light truck traffic should be increased to 3.0 inches of asphalt over 4.0 inches of. This assumes that all subgrades are prepared in accordance with the recommendations contained in the "Site Preparation" and "Fill and Backfill" sections of this report, and paving operations carried out in a proper manner. If pavement subgrade preparation is not carried out immediately prior to paving, the entire area should be proof-rolled at that time with a heavy pneumatic-tired roller to identify locally unstable areas for repair.

Pavement base course material should be aggregate base per M.A.G. Section 702 Specifications. Asphalt concrete materials and mix design should conform to M.A.G. 710 using the Marshall mix design criteria for low volume traffic. It is recommended that a 12.5mm or 19.0mm mix designation be used for the pavements. While a 19.0mm mix may have a somewhat rougher texture, it offers more stability and resistance to scuffing, particularly in turning areas. Pavement installation should be carried out under applicable portions of M.A.G. Section 321 and municipality standards. The asphalt supplier should be informed of the pavement use and required to provide a mix that will provide stability and be aesthetically acceptable. Some of the newer M.A.G. mixes are very coarse and could cause placing and finish problems. A mix design should be submitted for review to determine if it will be acceptable for the intended use.

Portland Cement Concrete Pavement must have a minimum 28-day flexural strength 550 psi (compressive strength of approximately 3,700 psi). While it may be cast directly on the prepared subgrade with proper compaction (reduced) and the elevated moisture content as recommended in the report, it is recommended to provide a nominal 4-inch AB subbase to aid in fine grading and reduce curling. Attention must be paid to using low slump concrete and proper curing, especially on the thinner sections. No reinforcing is necessary. Joint design and spacing should be in accordance with ACI recommendations. Construction joints should contain dowels or be tongue and grooved to provide load transfer. Tie bars are recommended on the joints adjacent to unsupported edges. Maximum joint spacing in feet should not exceed 2 to 3 times the thickness in inches. Joint sealing with a quality silicone sealer is recommended to prevent water from entering the subgrade allowing pumping and loss of support.

Proper subgrade preparation and joint sealing will reduce (but not eliminate) the potential for slab movements (thus cracking) on the expansive native soils. Frequent jointing will reduce uncontrolled cracking and increase the efficiency of aggregate interlock joint transfer.

4.0 GENERAL

The scope of this investigation and report does not include regional considerations such as seismic activity and ground fissures resulting from subsidence due to groundwater withdrawal, nor any considerations of hazardous releases or toxic contamination of any type.

Our analysis of data and the recommendations presented herein are based on the assumption that soil conditions do not vary significantly from those found at specific sample locations. Our work has been performed in accordance with generally accepted engineering principles and practice; this warranty is in lieu of all other warranties expressed or implied.

We recommend that a representative of the Soils Engineer observe and test the earthwork and foundation portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report. If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Respectfully submitted,
SPEEDIE & ASSOCIATES, INC.

Keith R. Gravel, P.E.

A. Creaser, P.E.

SPEEDIE AND ASSOCIATES
Geotechnical • Environmental • Materials Engineers

APPENDIX

SEISMIC REFRACTION SURVEY
(Geological Consultants Inc.)

GEOLOGICAL CONSULTANTS INC

KENNETH M. EUGE, R.G.
JASON C. WILLIAMS, R.G.

Report Prepared for:

Speedie & Associates Inc.
3331 E Wood Street
Phoenix, AZ 85040
Speedie & Associates Project No. 052093SA

Report Prepared by:

Geological Consultants Inc.
2333 West Northern Avenue, Suite 1A
Phoenix, Arizona 85021
Project No. 2005-220

January 17, 2006

REGISTERED GEOLOGIST CERTIFICATE NO. 41794 JASON C. WILLIAMS Date Signed 1-17-06 ARIZONA, U.S.A.

REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE Date Signed 01/17/06

Jason C. Williams, R.G.

Reviewed by:
Kenneth M. Euge, R.G.

SEISMIC REFRACTION SURVEY

LAS SENDAS OFFICE CONDO

MESA, ARIZONA

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APPENDIX A - SEISMIC REFRACTION SURVEY

SEISMIC REFRACTION SURVEY

LAS SENDAS OFFICE CONDO

MESA, ARIZONA

1.0 INTRODUCTION

This report presents results of a seismic refraction geophysical field investigation and analysis performed to assess site subsurface conditions for a proposed office condo complex located in the foothills of the Usery Mountains within the Las Sendas Residential community (Figure 1). The site is located south of East Eagle Crest Drive, and east of the entrance road to the to the Golf Course Clubhouse. The street address of the property is 7565 East Eagle Crest Drive in Mesa, Arizona. At the time of the survey, the lot was native desert. Seismic refraction surveys were used to characterized subsurface characteristics in areas inaccessible by a drill rig.

The project site is underlain primarily by shallow granite bedrock. Depth to bedrock in the vicinity of the seismic survey lines ranges from nil to less than three feet. A few low height granite boulder outcops are located within the development area limits. Surface soils are uncemented silty sand with gravels derived from weathered granite bedrock. No fill soils were observed in the vicinity of the seismic survey lines.

Seismic survey data are used to develop reasonable interpretations of subsurface conditions of the site. The objectives of the seismic refraction geophysical surveys are to provide for, by indirect means, a higher level of confidence to:

- Indirectly characterize earth fill, natural soil, bedrock, or bedrock-like materials that may be present within representative portions of the proposed lot development area.

- Evaluate the thicknesses of existing soil overburden that may be present, and depth to bedrock or rocklike materials.

The requirements for this study were defined in discussions with Mr. Kenny Euge II of Speedie & Associates, Inc. Seismic survey field work was completed on October 27, 2005

The Scope of Work performed to accomplish the objectives of this study included:

- Mobilization and demobilization of personnel and equipment to and from the job site.
- Completion of (2) two shallow seismic refraction surveys and preliminary field analysis of survey results. The location of the seismic refraction surveys are depicted on Figure 2.
- A rough position survey to locate the seismic lines relative to cultural features depicted on the site plan.
- A brief examination of the geologic materials exposed at the project site.
- Computer analysis of field data and interpretation of results was performed to complete the assessment of the materials present and their relative quality.
- Preparation of this report documenting the refraction seismic survey, its findings, interpretations, conclusions, and recommendations.

The seismic survey was designed to envelop the anticipated excavation depths. The effective penetration of the seismic survey is estimated to be 20 feet below ground surface. Velocity, thickness, and depth computations of different horizons, or zones, are provided to generally characterized site materials within the depth of interest expected at the proposed office/condo site. No direct subsurface explorations, such as test pits, were made by Geological Consultants Inc. as part of this seismic refraction survey.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the cursory site reconnaissance, seismic surveys, and the data interpretations, the following conclusions and recommendations are provided:

2.1 The project site is underlain primarily by shallow granite bedrock. Depth to bedrock in the vicinity of the seismic survey lines ranges from nil to less than three feet. A few low height granite boulder outcops are located within the development area limits. Surface soils are uncemented silty sand with gravels derived from weathered granite bedrock. No fill soils were observed in the vicinity of the seismic survey lines.

2.2 Granite core stones, granite boulders, or localized areas of shallow, very hard, dense granite may be encountered in site excavations within both the low velocity and high velocity zones (Figures 3 and 4). If encountered, excavateabililty constraints should be expected to range from moderate to severe (Table 2).

2.4 Interpreted stratigraphy at the site, developed from interpretation of the seismic survey data are depicted on Figures 3 and 4. Based on our interpretations of the seismic data, the conclusions presented regarding the depth to various velocity zones are believed to be reasonable at the location of the seismic survey line. The conditions characterized by indirect seismic methods along the seismic survey lines probably represent subsurface conditions that could be found in adjacent areas of the site where depicted on the site plan provided by Speedie & Associates. Summarys of the calculated depth/velocity ranges are summarized in Table 1.

Table 1
Seismic Survey Line Calculated Depth/Velocity Ranges

Survey Line Number	Depth* Range (feet)	Average Seismic Velocity (ft/sec)	Interpreted Geologic Description	Qualitative Rippability
S-1	0-2	1,089	Residual Soil / Decomposed Granite	Slight
	2-4	3,886	Strongly to Moderately Weathered Granite Bedrock	Marginal
	>4	4,075	Moderately Weathered Granite Bedrock	Marginal
S-2	0-2	1,375	Residual Soil / Decomposed Granite	Slight
	2-14	5,673	Moderately Weathered Granite Bedrock	Marginal/Severe
	>14	8,751	Slightly Weathered Granite Bedrock	Severe

*Depth range only applicable at center of seismic survey line.

Table 2
Seismic Survey Line Calculated Depth/Velocity Ranges

Unit	Average Velocity (feet per second)	Excavatability Constraints
Residual Soil / Decomposed Granite	< 3,000	**Slight-** Should be excavateable using conventional earthmoving equipment. Boulder-sized fragments could be generated and granite core stones could be encountered.
Strongly to Moderately Weathered Bedrock	3,000 to 6,000	**Marginal-** Potentially difficult to excavate with conventional equipment. Ram hoe and ripping could be required to fragment and excavate efficiently. Could require blasting for efficient excavation. Very hard granite core stones and boulders could be encountered within this velocity zone.
Slightly Weathered Bedrock	> 6,000	**Severe-** Blasting could be required for effective fragmentation. May be locally rippable along joint surfaces. Heavy backhoe or ram-hoe could be effective but slow. Boulder size rock fragments could be generated.

2.4 The estimated qualitative excavatability summarized in Table 2 is based on the interpretations of the seismic survey data, understanding of the site geological conditions, and professional experience. There is no guarantee that the seismic refraction survey results or the qualitative excavatability can be duplicated by others. We recommend this information be used with caution and only as guidelines.

Because the seismic velocities used to determine qualitative excavateablility may vary from 10 to 20 percent, and due to the variability of the subsurface material, qualitative excavatability listed in Table 2 may overlap at the transition from one constraint category to the next.

The excavation constraints described in this report are, in our opinion, reasonable for the locations where the seismic refraction surveys were conducted. However, the ultimate excavatability is dependent on many factors (variably cemented soils, presence of core stones, bedrock and soil physical properties, excavation methods, size and age of excavation equipment, level of effort applied by the contractor, etc.) and it may not be possible to correlate these factors with the results of the seismic refraction surveys conducted for this investigation. The excavation contractor must exercise caution, and assume associated risks, when attempting to extrapolate these data to other areas where seismic surveys have not been conducted.

The results of the seismic refraction surveys are depicted in Figures 3 and 4. Figures 3 and 4 depict the average seismic velocities of the materials encountered along the seismic lines, a thickness profile of the different velocity zones, the calculated velocity zone boundaries and our interpretation of the geologic materials represented by the calculated seismic velocities.

2.5 If heavy vibration-producing equipment, such as a ram-hoe, or blasting is used to assist with the excavations made at this site, the contractor should be required to keep ground vibrations from any construction source within applicable safe limits for surrounding structures including buildings and utilities.

Blasting could be used for bedrock fragmentation. If blasting is proposed, it should be conducted by a contractor experienced with controlled blasting in residential areas in granite bedrock terrain. Also the blasting should be conducted in accordance with the Uniform Fire Code, Article 77 or other rules and codes mandated by the City of Mesa and State and Federal agencies that have jurisdiction relative to blasting operations. We recommend preconstruction and pre-blast surveys be made of all structures within 300 feet of the proposed construction. We recommend adequate "safety zones" be established and maintained around the proposed excavation sites during construction. Likewise, construction equipment operations and blasting should be monitored during construction to assure the ground vibrations are within safe limits. However, we recommend the construction/blasting vibrations be limited to less than one inch per second for residential areas and for sensitive structures or components such as buried gas and water lines unless more restrictive allowable vibration limits are specified by other regulatory authorities. The purpose of the preconstruction surveys and construction vibration monitoring is to limit liability for property owners, the contractor, and other involved parties.

3.0 GEOPHYSICAL SITE INVESTIGATION

A seismic refraction survey was conducted to indirectly investigate subsurface conditions and to develop reasonable interpretations of subsurface conditions at the Las Sendas Office Condo site.

3.1 Site Specific Seismic Surveys

Following the completion of a site reconnaissance to identify the survey location, a seismic refraction survey was made at the sites' depicted in Figure 2. The seismic survey was conducted to evaluate the soil/colluvium overburden thickness, to identify fills that may be present in likely excavation areas, and to generally characterize subsurface conditions.

The seismic survey line locations were located by personnel from Speedie & Associates and Geological Consultants. The survey locations are depicted on Figure 2. A rough position survey was conducted by Geological Consultants Inc. to locate the seismic survey line endpoints relative to existing cultural and topographic features depicted on the site plan (Figure 2).

Three shot points are used along the seismic survey line to evaluate possible non-horizontal subsurface boundary conditions (buried sloping surfaces, cementation zones, bedrock boundaries, etc.) that could be expected in this type of geological terrain, and to improve the accuracy of the seismic wave velocity determinations. The seismic traverse was run over a length sufficient to achieve adequate depth penetration (of at least 20 feet) and to identify the subsurface zones that could influence excavations at the project site.

As with any type of geophysical investigation method, there are limitations to its usefulness and application. Refer to Appendix A for additional information regarding seismic refraction surveys and their limitations.

3.2 Equipment

Travel-time data for the seismic traverses were obtained using Geometrics Inc. Model S12 SmartSeis™ 12-Channel Exploration Seismograph. Seismic wave arrivals are detected with digital grade vertical geophones with a dual hum-bucking coil and a frequency response above 14 Hz natural frequency. The seismic shock wave is produced by repeated impacts of a 16-pound sledge hammer onto a soft steel striking plate. Hammer impacts were made at each end of the seismic line traverse and at a shot point located at the center of the survey line spread. The distance from the impact station to the geophones and the travel time recorded for each station is stored in the seismographs on-board computer. If the field seismic data plots indicated the possible presence of anomalous subsurface conditions or spurious noise coincident with the hammer impacts, repeated impacts are used to verify the initial data reading or to correct the data. Topography, outcrops, and other natural or man-made features found along the seismic survey lines that might influence the data interpretations are annotated with the field data plots.

3.3 Results

Interpretations of the seismic survey data obtained at the project site suggest the presence of a distinctive subsurface stratigraphic profile along each of the seismic survey lines. Seismic velocities, calculated zone thicknesses, and depth to velocity zone boundaries for each interpreted bedrock or soil types are depicted in Figures 3 and 4. The elevation data depicted on the Y-axis of the Depth Cross-Sections is based on information derived from the site plan. The data depicted on the figures can be used to scale depths to different velocity layers below ground surface. The estimated accuracy of the velocity layer boundaries is approximately 20 percent.

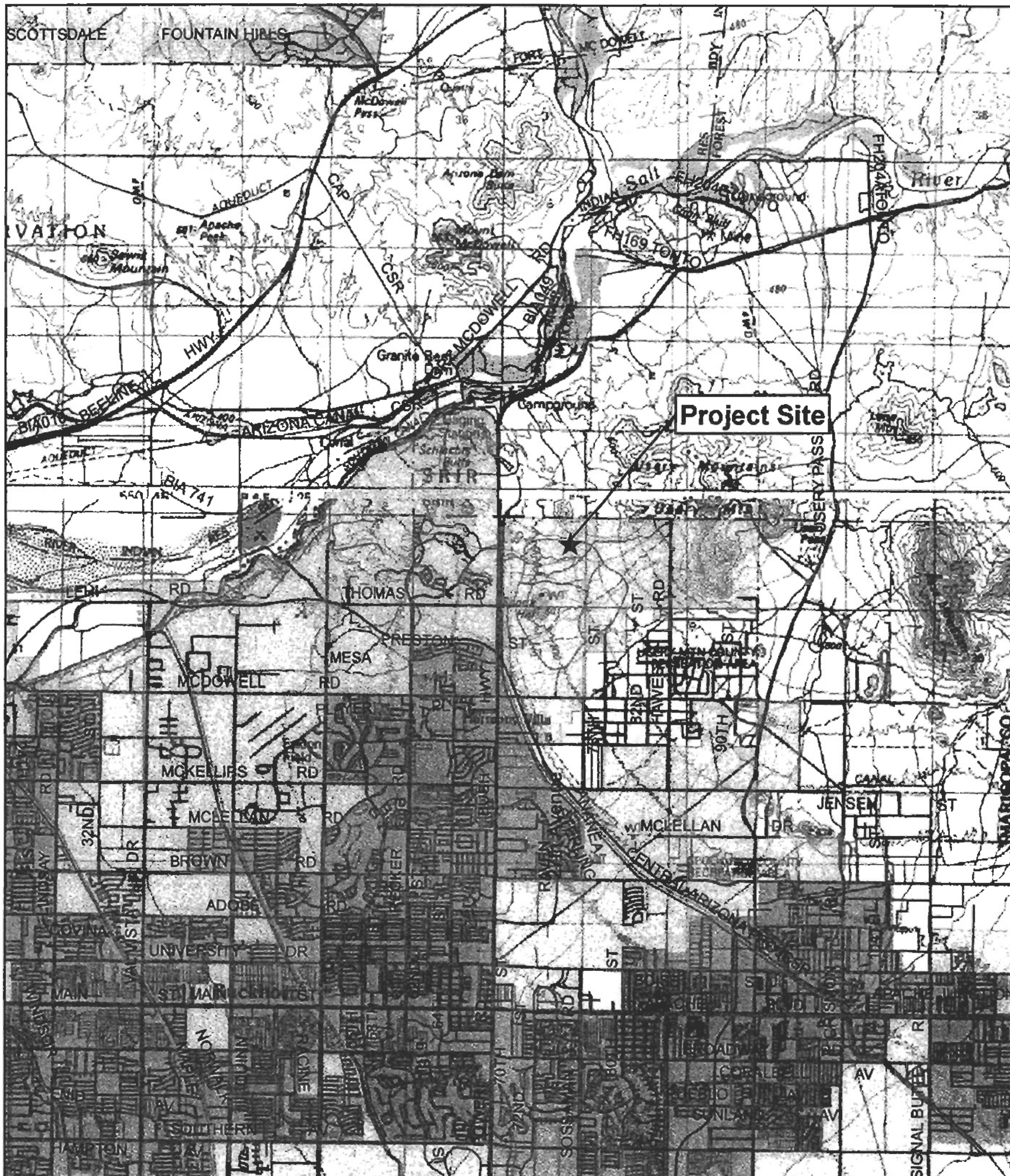
4.0 GENERAL LIMITATIONS

The geologic observations, findings, conclusions, and recommendations presented in this report are based on (1) cursory observations of surface conditions and geologic materials if exposed and (2) analysis of the seismic refraction data gathered at the site. The services provided by Geological Consultants Inc. were performed in accordance with generally accepted geological principals and standard practices used by members of the geological profession in this locale at the time of this study.

It must be recognized that subsurface geologic conditions may vary from place to place and from those found at locations where measurements or surveys are made by the investigator. Generalized geological and excavatability recommendations presented in this report are based on the results of this investigation and it may not be possible for others to accurately correlate the geological and excavatability results to test explorations or investigations conducted by others. No warranty or representation, either expressed or implied, is or should be construed regarding geological conditions at locations other than those evaluated as part of this study.

The professional opinions, conclusions and recommendations presented in this report relate only to the project and locations specified in this report. If any changes are made in the project, the conclusions and/or recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this study are modified and approved in writing by Geological Consultants Inc.

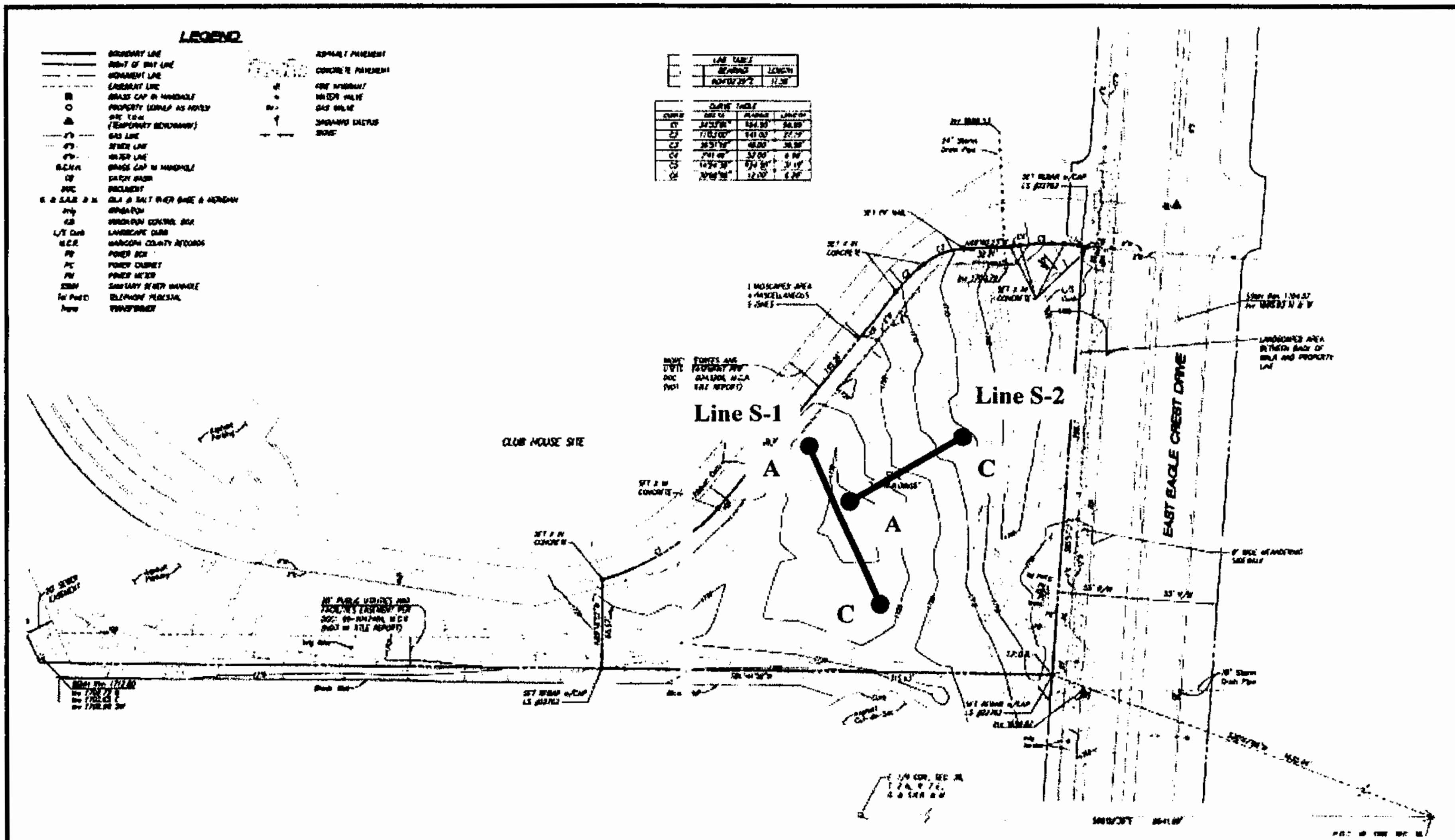
FIGURES



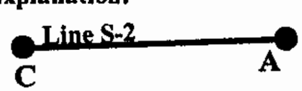
1:100,000

Seismic Refraction Survey
Las Sendas Office Condo
Location Map
Figure 1

GEOLOGICAL CONSULTANTS INC.
2333 West Northern Ave. Suite 1A
Phoenix, AZ 85021
phone 602-864-1888
fax 602-864-1899



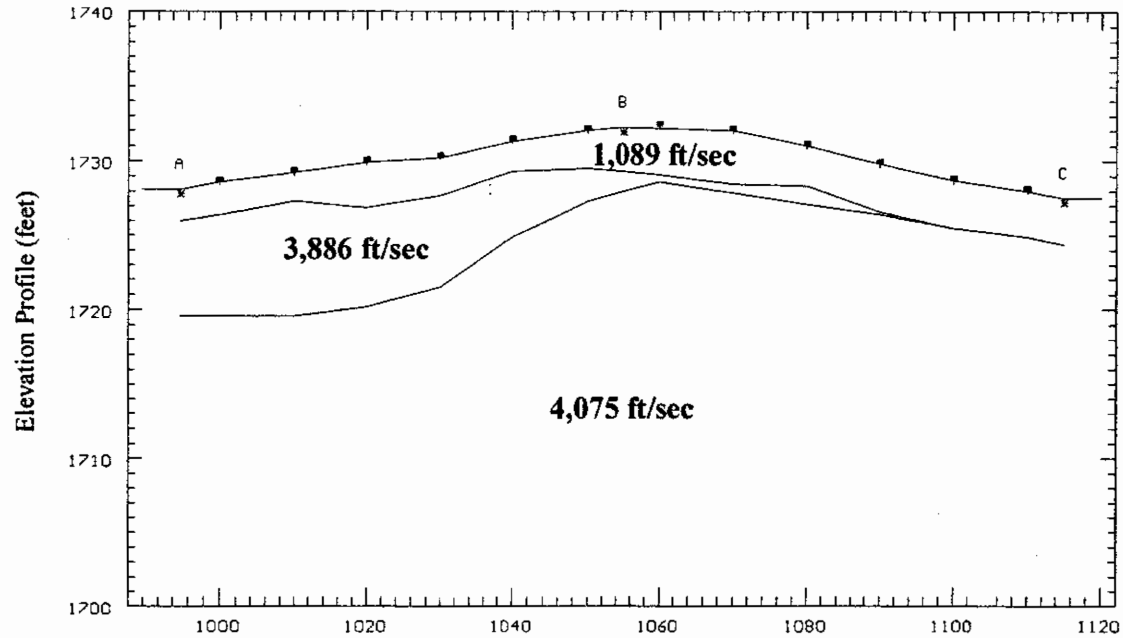
Explanation:



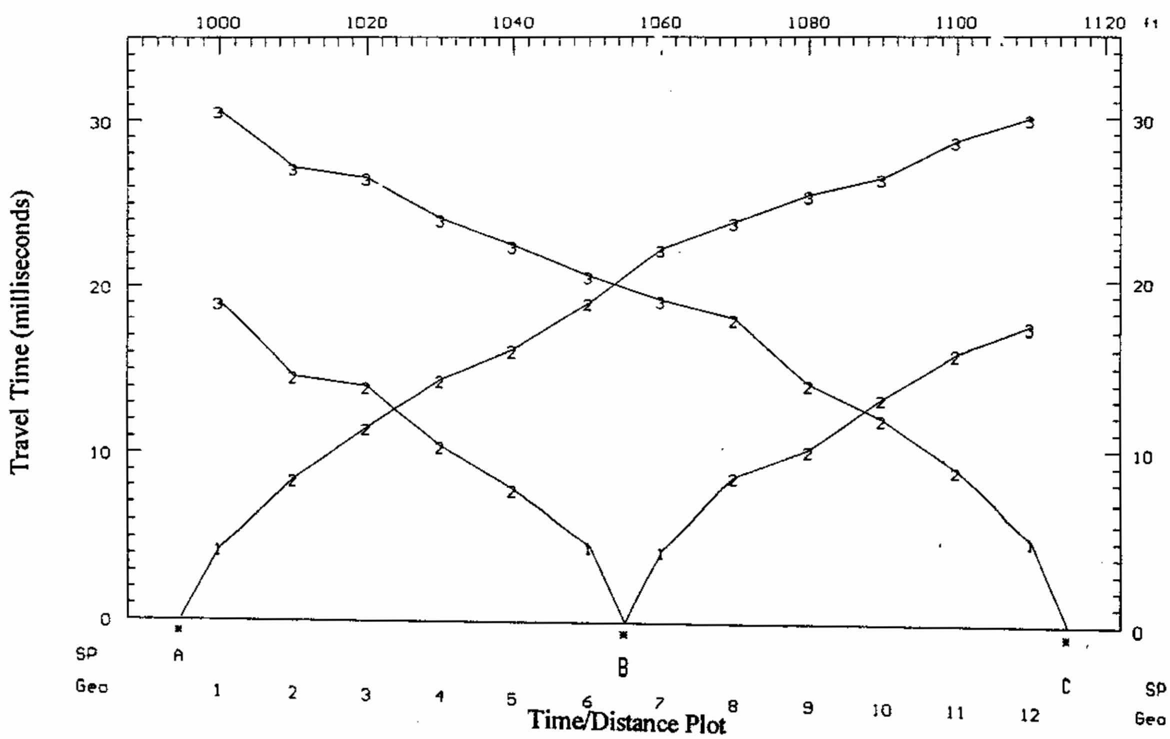
Seismic survey line location: A-shot point start; C-shot point end.
Refer to Figures 3 and 4 for interpreted seismic line profiles.

Seismic Refraction Survey
Las Sendas Office Condo
Seismic Survey Line Location Map
Figure 2

Geological Consultants Inc.
2333 West Northern Ave. Ste 1A
Phoenix, Arizona 85021
Phone 602-864-1888
Fax 602-864-1899



Interpreted Velocity Profile



Time/Distance Plot

Refer to Figure 2 for survey line location.

Seismic Refraction Survey
Las Sendas Office Condo
Seismic Survey Line S-1
Figure 3

Geological Consultants Inc.

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Phone 602-864-1888
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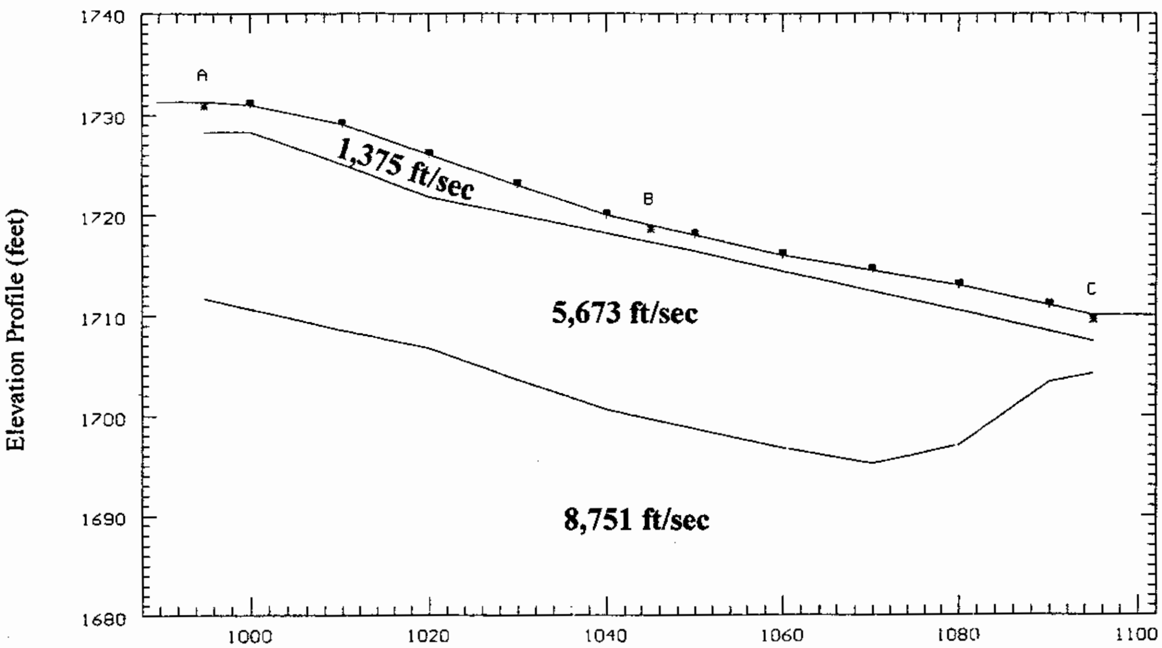
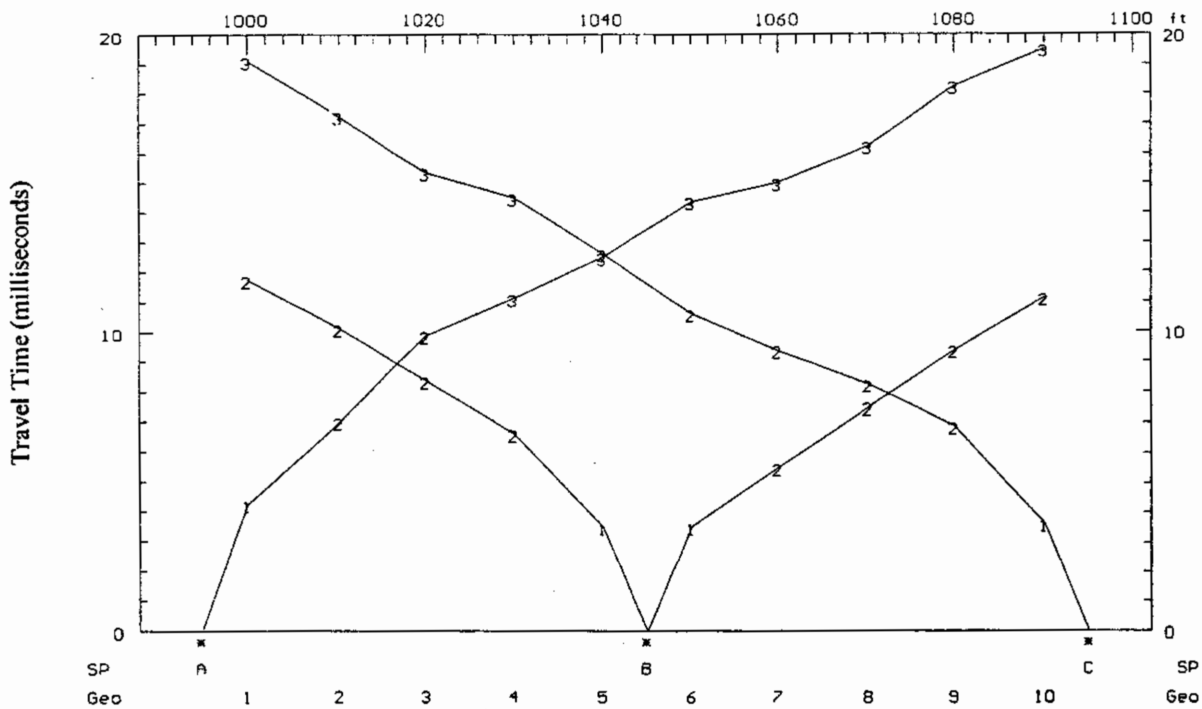


Interpreted Velocity Profile



Time/Distance Plot

Refer to Figure 2 for survey line location.

Seismic Refraction Survey
Las Sendas Office Condo
Seismic Survey Line S-2
Figure 4

GEOLOGICAL CONSULTANTS INC.

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APPENDIX A

SEISMIC REFRACTION SURVEY

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SEISMIC REFRACTION SURVEY

A.1 GENERAL

In general, seismic wave velocities are related to the hardness, consolidation, and density of the materials through which seismic (shock) waves travel. Seismic velocities of subsurface soils and bedrock can be correlated to some of the physical properties of the material with reasonable levels of confidence. As with rock rippability (ease of excavation) for example, the Caterpillar tractor Company has correlated ranges of seismic velocities in different rock and soil materials to qualitative estimates of rippability for their D-9 tractor with a mounted hydraulic No.9 ripper.

The use of seismic velocities measured in various soils and rock types are considered reasonably conservative for evaluating soil and rock characteristics by "indirect" shallow geophysical seismic methods. Some general correlations are as follows:

- Soil, loose surface material, alluvium and strongly weathered and broken bedrock has velocities ranging from 500 feet per second (fps) to 1,200 fps;
- Moderately hard, slightly to moderately cemented, dense alluvial and colluvial sediments and moderately weathered and broken bedrock range from 1,200 fps to 3,000 fps;
- Very dense, hard, well-cemented soils and moderately competent bedrock range from 3,000 fps to 6,000 fps;
- Sound, relatively homogeneous or tightly jointed bedrock and uniformly, strongly cemented soils (silica hardpan, caliche, calcrete, etc.) have seismic velocities greater than 6,000 fps.

Soils and rock with velocities of less than 3,000 fps can usually be excavated with conventional earth moving equipment. Where materials with velocities in excess of 6,000 fps are found, blasting would normally be required for efficient fragmentation. However, if the rock is thinly bedded, jointed, or fractured, it may be possible to break the rock with heavy ripping using a single shank ripper or large ram-hoe. The resulting fragments will be of a size consistent with the fracture spacing and the progress of the excavation would be very slow. The intermediate material (velocities between 3,000 fps and 6,000 fps) would likely require heavy equipment and possibly the localized use of jack-hammers, ram-hoes, or selective blasting to provide cost-effective excavation.

A.2 DATA COLLECTION

Refraction data were collected along seismic survey lines consisting of 12 geophones spaced 10 feet apart. This geometry provided coverage of about 110 feet along each survey line. Refer to Figure 2 for the seismic survey line locations. Seismic waves were generated at shot points located at line ends and the center to measure shallow materials (near surface) seismic velocities. Data recorded from offsets (10 feet) past the line ends measured the deeper velocities. Data were recorded from both line ends so the effect of layer inclination, or dip on velocity boundaries, could be calculated. This geometry provided at least 40 feet, or more, of penetration at most line locations.

A.3 REFRACTION SEISMIC SURVEY LIMITATIONS

The seismic survey data presented in this report are derived from and interpreted from an indirect geophysical investigative technique (seismic refraction surveys) employed at the specific locations indicated and from observations made of the surface geologic conditions exposed at the site. The interpretations made at the specific seismic survey sites are believed to be reasonable based on the information available at the time of this study. The interpretations may not represent, nor are they intended to represent, subsurface conditions at other locations.

Geologic contacts between rock and soil units are approximate, may be either gradual or abrupt, and the calculated depths could vary from 10 to 20 percent or more. Geological and geotechnical information provided others and our experience on similar projects in similar geological terrain were considered in the interpretations of subsurface conditions.

A.4 REFRACTION DATA PROCESSING

Seismic Refraction Interpretation Programs (SIP) computer programs by RIMROCK GEOPHYSICS, were used to analyze seismic data obtained in the field. The programs calculate average velocities of any number of layers assuming the multilayered intervals do not include velocity inversions or "hidden" zones (i. e., high velocity zone over a low velocity zone). Thicknesses of each layer, except for the lowermost layer, are calculated along with the dip (inclination) angle of the layer boundary.

The depth below ground surface to each layer boundary is also provided.

Input data, velocity of each layer and seismic wave arrival times, obtained during the field work are checked by the computer program to assure that they satisfy reciprocity at least within 20 percent. These data are used to develop a meaningful geological model used to interpret subsurface stratigraphic conditions.