# ENGINEERING GEOLOGY INVESTIGATION

**DATE:**
October 12, 2020

**PROJECT NUMBER:**
SL11323-3

**CLIENT**:
Chris Lopez
3020 Ironwood Avenue
Morro Bay
California 93442

**PROJECT NAME:**
2420 Paradise Lane
Los Osos area
San Luis Obispo County,
California

**Dear Mr. Lopez**:

## 1.0 INTRODUCTION

This report presents the results of the geologic investigation for the proposed single-family residence, studio and barn to be located at 2420 Paradise Lane, APN: 067-171-049, in the Los Osos area of San Luis Obispo County, California. See Figure 1: Area Location Map for the general location of the project area, which was obtained from the computer program *TopoView* (TopoView, 2020).

### 1.1 Site Description

2420 Paradise Lane is located at 35.299237 degrees north latitude and -120.793294 degrees east longitude at a general elevation of 85 feet above mean sea level. The property is approximately 10.8 acres in size however the proposed development is limited to the southern portion of the property. The proposed single-family residence, studio and barn will hereafter be referred to as the "Site."

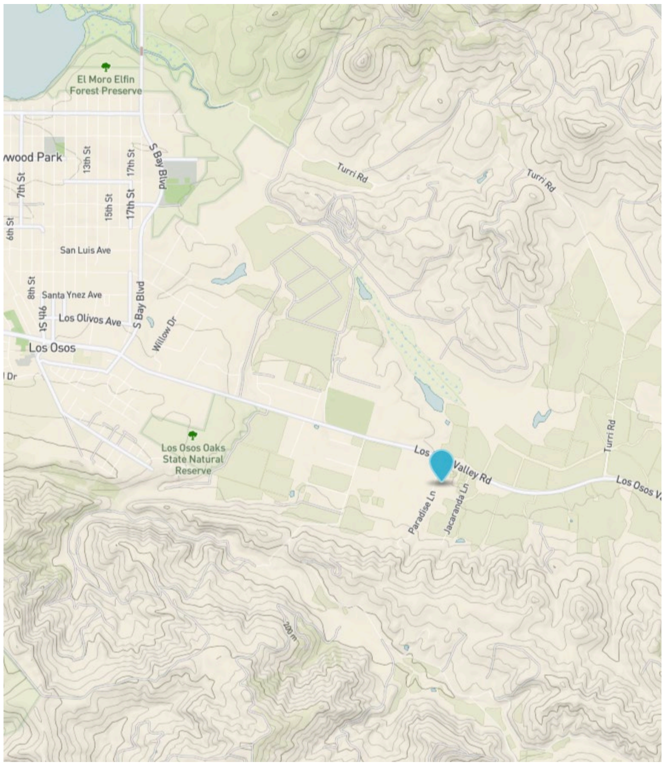

Figure 1: Area Location Map

The Site is approximately level with a slight gradient which slopes east and south. Surface drainage follows the topography to the east and south toward the drainage channel. Annual grasses currently vegetate the Site.

### 1.2 Project Description

The proposed single-family residence is proposed to be 6,512 square feet in size and one story in height. The proposed studio is proposed to be 600 square feet in size and two stories in height. It is anticipated that the proposed single-family residence will be founded on engineered fill.

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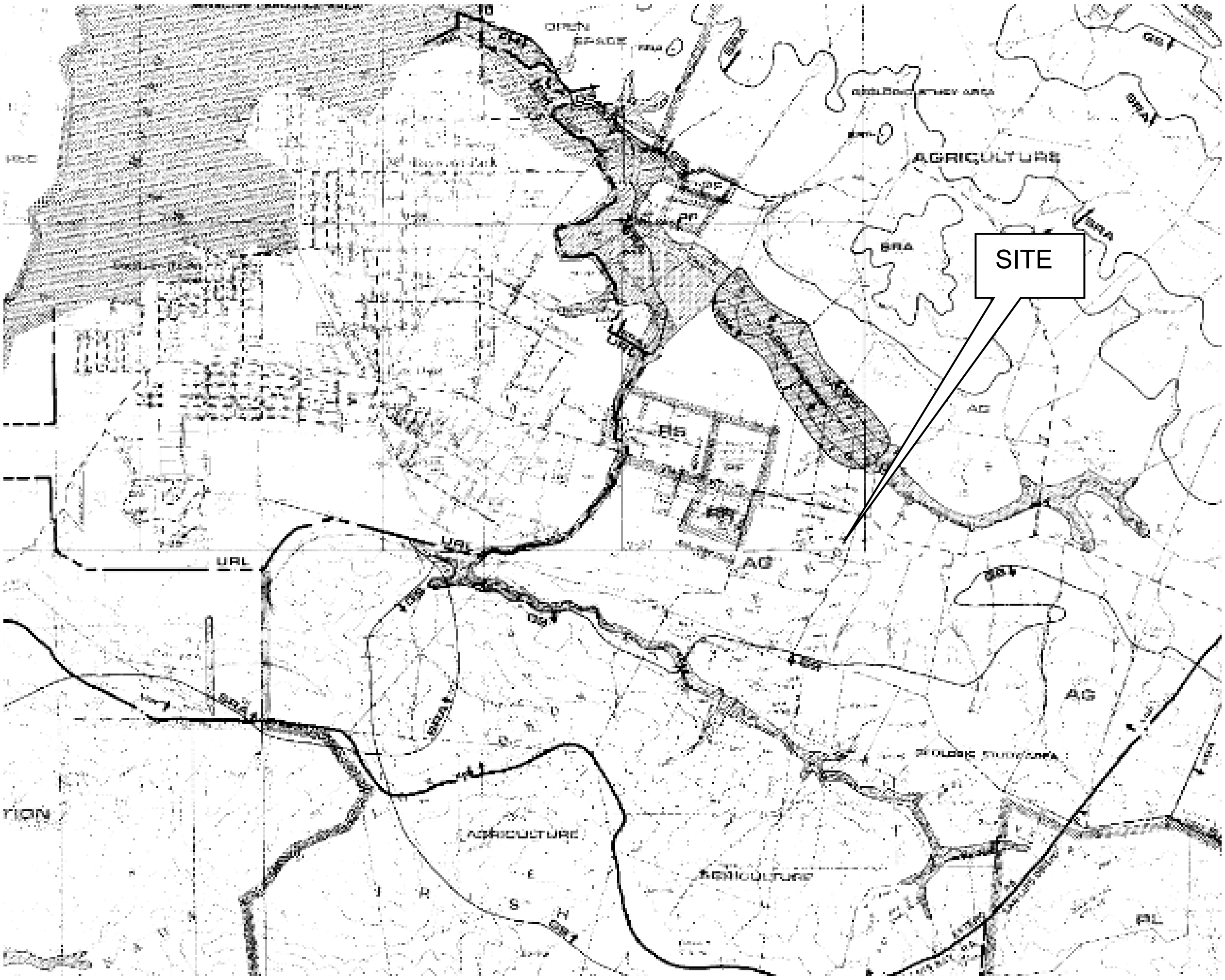


Figure 2: Geologic Study Area Map

## 2.0 PURPOSE AND SCOPE

The purpose of this investigation was to evaluate engineering geologic hazards at the Site and to develop conclusions and recommendations regarding site development. The scope of this investigation consisted of:

1. Review of historical aerial photographs, pertinent published and unpublished geotechnical studies and literature, and geologic maps for the subject project area.

2. A field study consisting of site reconnaissance and subsurface exploration including exploratory borings in order to formulate a description of the sub-surface conditions at the Site.

3. A review of regional faulting and seismicity hazards including a geophysical investigation to verify the presence of the Los Osos Fault Zone at the Site.

4. A review of landslide potential, surface and groundwater conditions, and liquefaction hazards.

5. Development of recommendations for site preparation.

6. Preparation of this report that summarizes our findings, conclusions, and recommendations regarding engineering geology aspects of the project.

## 3.0 GEOLOGIC RECOMMENDATIONS

The proposed development is geologically suitable provided that the recommendations provided herein are implemented. The following are recommended for implementation at the Site.

1. A **50-foot setback** for habitable structures (i.e. single-family residence) is recommended on both sides of the surface fault location identified as splays of the Los Osos Fault Zone at the Site (see Plate 1A). Non-habitable structures may be located within the setback zone, but it is our understanding that development is not proposed within the area at this time.

2. It is anticipated that foundations will be founded within engineered fill.

3. It is recommended that numerical slope stability analyses be conducted on cut and fill slopes constructed steeper than 2-to-1 (horizontal to vertical). Locally steeper slopes may be allowed depending on the results of a slope stability analysis.

4. Isolated seepage within formational units should be anticipated. Surface drainage facilities (graded swales, gutters, positive grades, etc.) are recommended at the base of cut slopes that allow surfacing water to be transferred away from the base of the slope. The project designer is recommended to offer specific design criteria for mitigation of water drainage behind walls and other areas of the site. This is especially imperative upslope of retaining walls for residences. Subsurface drainage systems should not be connected into conduit from surface drains and should not connect to downspout drainage pipes.

5. Surface drainage should be controlled to prevent concentrated water-flow discharge onto either natural or constructed slopes. Surface drainage gradients should be planned to prevent ponding and promote drainage of surface water away from building foundations, edges of pavements and sidewalks or natural or man-made slopes. For soil areas we recommend that a minimum of two (2) percent gradient be maintained.

6. Excavation, fill, and construction activities should be in accordance with appropriate codes and ordinances of the County of San Luis Obispo. In addition, unusual subsurface conditions encountered during grading such as springs or fill material should be brought to the attention of the Engineering Geologist and Soils Engineer.

7. Rock rip-rap is recommended for concentrated drainage outfall locations that do not discharge onto paved or exposed rock surfaces. It is recommended that geotextile fabric (Enkamat 7010 or similar) be placed underneath the rip-rap and installed per the manufacturer's recommendations.

8. Gutters are recommended to be installed along all sloped rooflines. Gutter downspouts should not allow concentrated drainage to discharge near the residence foundations but rather should convey the water in solid piping away from the residence and toward drainage facilities.

## 4.0 ENGINEERING GEOLOGY

### 4.1 Regional Geology

The Site is located in the vicinity of the San Luis Range of the Coast Range Geomorphic Province of California. The Coast Ranges lie between the Pacific Ocean and the Sacramento-San Joaquin Valley and trend northwesterly along the California Coast for approximately 600 miles between Santa Maria and the Oregon border.

Regionally, the Site is located on the Cambrian Slab composed of a large, thick block of Cretaceous age sediments that are surrounded by Franciscan Complex rocks. The Cambrian Slab extends from the Los Osos fault south of the property and northward to San Simeon Creek.

## 4.2 Local Geology

Locally, the site is located within Eolian Deposits as depicted on Plate 1A, Site Engineering Geology Map. Hall, 1973, Lettis and Hall, 1994, Dibblee, 2006 and Wiegers, 2009 mapped the Site as underlain by Holocene to Pleistocene age Sand Dune Deposits/Old Eolian Deposits (Qs/Qoe) units. Information derived from the subsurface exploration for the referenced Soils Engineering Report (GeoSolutions, 2019) was used to classify subsurface soil and formational units and to supplement geologic mapping. Five borings were previously drilled in the vicinity of the proposed single-family residence and barn to a maximum depth of 15 feet below ground surface.

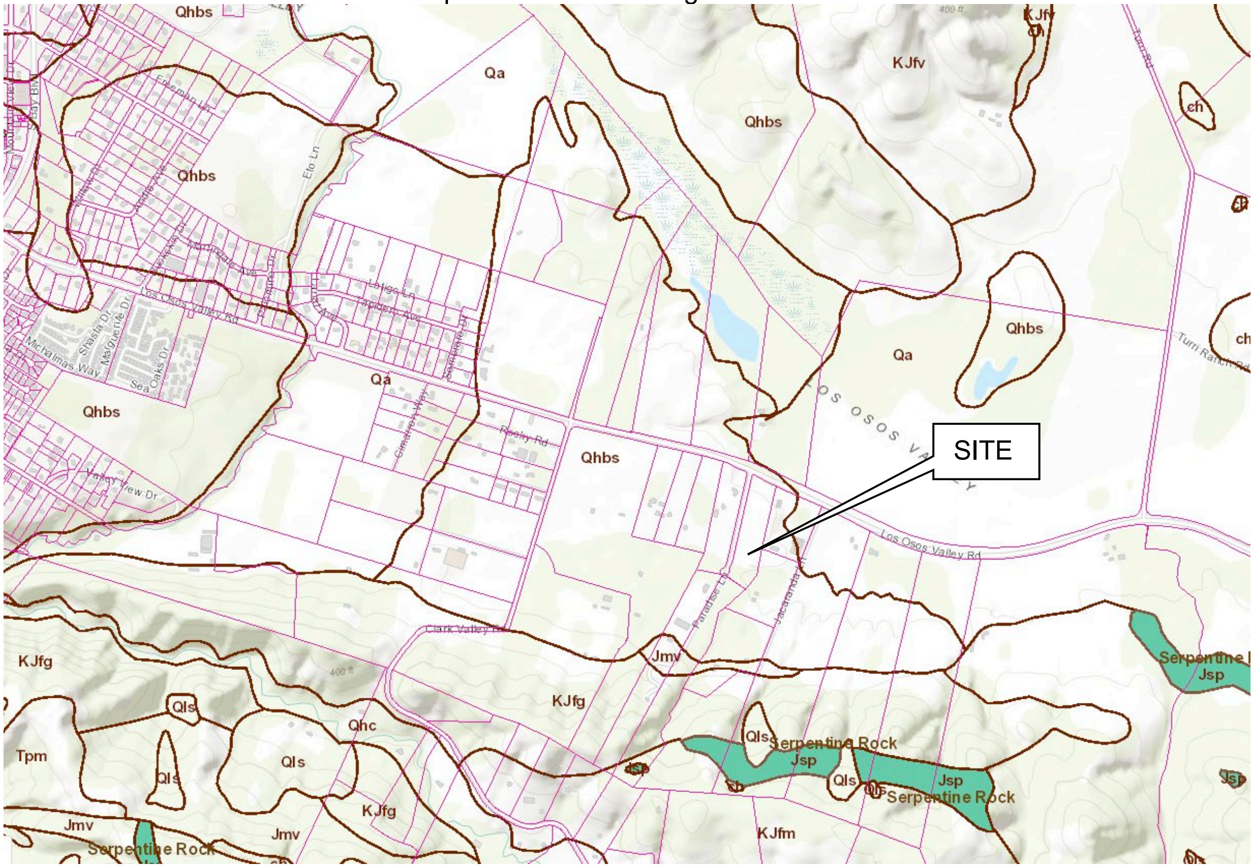


Figure 3: Geologic Map (County of San Luis Obispo Land Use View)

### 4.2.1 Older Alluvial Deposits

Wiegers, 2010 maps the Site as within Old Eolian Deposits (Qoe). Wiegers, 2010 describes the Old Eolian Deposits as “Old stabilized sand dune deposits consisting of moderately consolidated, well-sorted brown windblown sand. Deposits are capped by moderately well-developed pedogenic soil.” However, as depicted in the boring logs, subsurface soil consisted of dark brown sandy clay to yellowish brown sand with clay. Due to the density and clay contents, it is interpreted that the subsurface soils are Older Alluvial Deposits. Older Eolian Deposits consist primarily of well sorted, unconsolidated to moderately consolidated clean sand dune deposits as observed throughout the town of Los Osos. Based on seismic reflection and seismic refraction lines at the Site, the depth of Older Alluvial Deposits at the Site are approximately 50 feet below ground surface. Plate 1A depicts Older Alluvial Deposits (Qoa) throughout the property. Boring logs are presented in Appendix A.

## 4.3 Surface and Ground Water Conditions

Surface drainage follows the topography to the east and south toward the drainage channel. Surface drainage should be directed away from proposed structures and slopes. No springs or seeps were observed at the project at the time of the investigation. Groundwater was not observed within any borings to a depth of 15 feet below surface grade, however seasonal groundwater levels may vary.

## 4.4 Active Faulting and Coseismic Deformation

The Alquist-Priolo Earthquake Fault Zoning Act passed in 1972 requires that the State Geologist establish Earthquake Fault Zones around the surface traces of active faults and to issue appropriate maps. The subject site is not located within an Earthquake Fault Zone (Jennings, 2010).

**Table 1: Distance and Moment Magnitude of Closest Faults**

| Closest Active Faults to Site | Approximate Distance (miles) | Moment Magnitude (Mw) |
|---|---|---|
| Los Osos Fault Zone | 3.5 | 6.8 |
| Hosgri Fault Zone | 8.5 | 7.5 |
| San Andreas Fault Zone | 41.0 | 6.9 |

The closest known active portion of a Holocene age fault is an active portion of the Los Osos Fault Zone that is located approximately 3.5 miles east of the Site (Jennings, 2010). Plate 3 is a Regional Fault Map for the area. The San Andreas fault is the most likely active fault to produce ground shaking at the Site although it is not expected to generate the highest ground accelerations because of its distance from the Site.

### 4.4.1 Los Osos Fault Zone

Splays of the Los Osos Fault Zone is mapped through the subject property as depicted on Plate 2. Lettis and Hall, 1994 subdivided the Los Osos fault into four segments, from the northwest to the southwest they are the Estero Bay, Irish Hills, Lopez Reservoir, and Newsom Ridge segments. The Irish Hills segment is about 10 to 12 miles long and extends from the Pacific Ocean near Los Osos eastward to San Luis Creek and includes the study area. This segment of the fault forms the boundary between the Los Osos Valley and the Irish Hills and has documented Holocene offset (PG&E, 1988). PG&E suggests that the Irish Hills segment displays the most well-expressed geomorphic features displacing late Pleistocene and Holocene deposits.

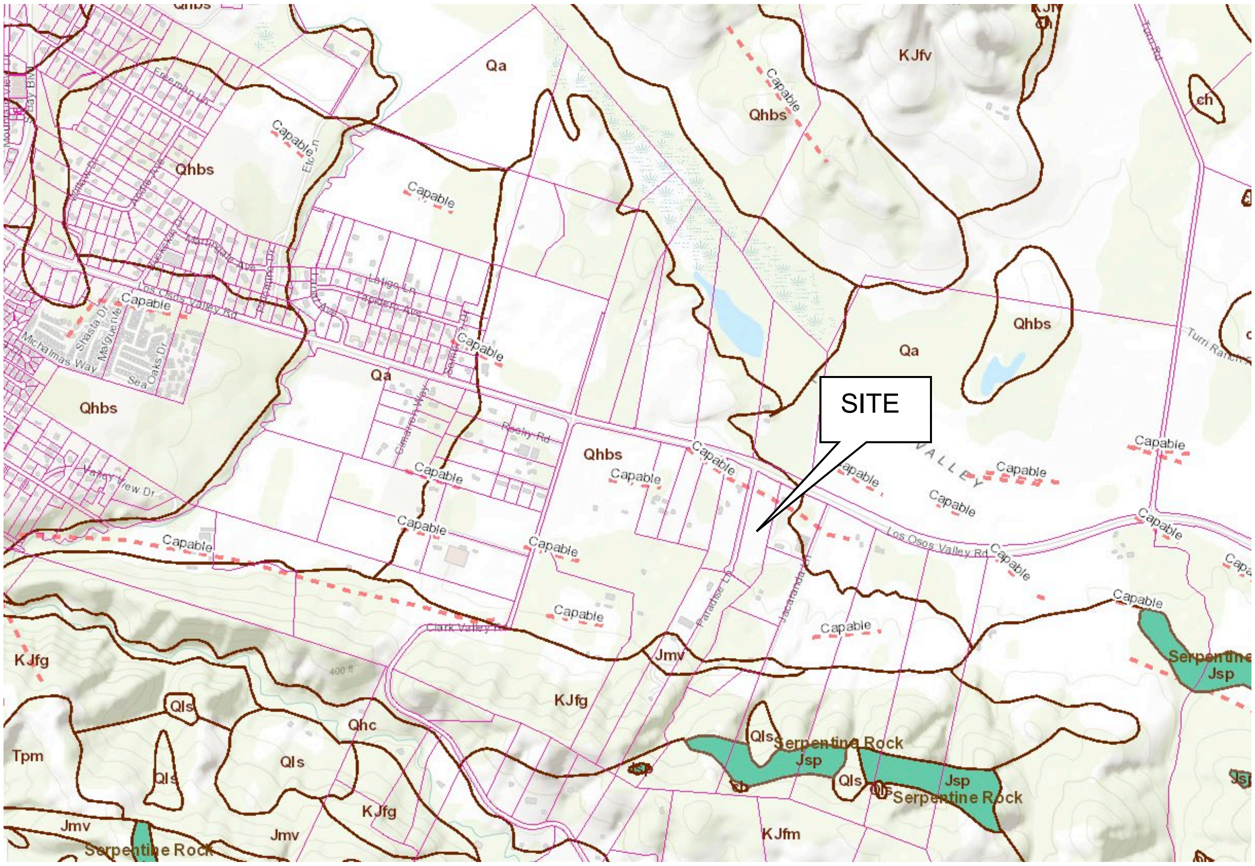


Figure 4: Fault Map (County of San Luis Obispo Land Use View)

The Los Osos fault zone has had a complex history of both strike-slip and dip-slip displacement (Lettis and Hall, 1990). The fault zone is a 50 km long, 2 km wide system of discontinuous, subparallel, and en echelon fault traces extending from Estero Bay on the north to an intersection with the West Huasna fault southeast of San Luis Obispo. Along the coast, the fault zone truncates a flight of marine terraces, indicating a vertical rate of separation across the fault zone of about 0.2 mm/yr. Preliminary results from new geomorphic mapping, interpretation of reprocessed seismic-reflection data, analysis of seismicity data, and structural analysis suggest that the fault zone dips steeply to the southeast (45 to 70 degrees or possibly steeper), and may be primarily an oblique-slip fault, with a significant component of dip slip to accommodate uplift of the range. (PG&E, January, 2011, Shoreline fault study).

A portion of the Irish Hills segment is considered active and has been included within Alquist-Priolo zoning by the State of California (1990). This active portion is located approximately 3.5 miles east of the Site. Lettis and Hall, 1994 and Wiegers, 2009 map splays of the Los Osos Fault through the Site.

### 4.4.2 Fault Investigation

A subsurface fault investigation was conducted at the site to determine if faulting was present in the vicinity of the Site as depicted on Lettis and Hall, 1994 and Wiegers, 2009. A seismic reflection and refraction survey was performed along the western property boundary (identified as Line 1 on Figure 5 to determine the presence of the fault at the Site due to the depth of Old Alluvial Deposits located at the Site. A detailed discussion of the geophysical investigation is presented in Appendix B.

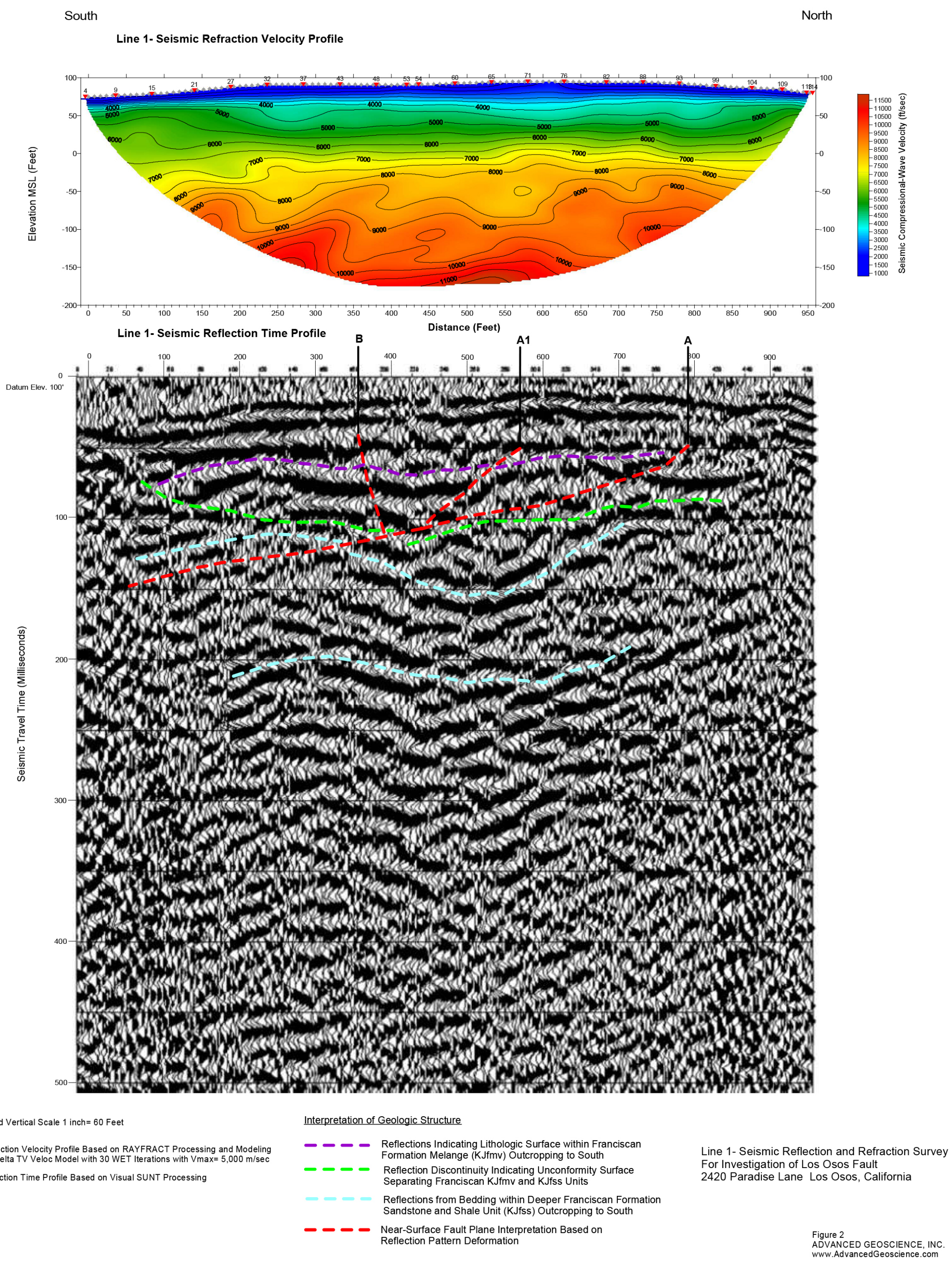
Site Map Showing Location of Line 1
Seismic Reflection and Refraction Surveys
2420 Paradise Lane Los Osos, California

Figure 1
ADVANCED GEOSCIENCE, INC.

Figure 5: Seismic Refraction and Reflection Line Location

### 4.4.3 Fault Discussion

As observed in the seismic reflection profile (see Figure 6), patterns of truncated sequences of Franciscan Complex units were observed greater than 50 feet below ground surface. The near surface interpretation of splays of the lower angle, southwest-dipping trust faults (identified as A and A1 {see Figure 6}) and steeper angle, northeast dipping secondary faulting (identified as B {see Figure 6}) of the Los Osos Fault Zone. The fault location was extended east in the approximate trend as depicted on Wiegers, 2009. As proposed structures are proposed over 50 feet away from identified fault splays, additional investigations were not performed to verify the trend, age of faulting or depth of faulting through the Site. To account for multiple splays and uncertainty of fault characteristics observed in the seismic reflection survey a **50-foot setback** for habitable structures (i.e. single-family residence) is recommended on both sides of the surface fault location (see Plate 1A). Non-habitable structures may be located within the setback zone, but it is our understanding that development is not proposed in the area at this time. If the future development is proposed with the setback area, additional investigation should be performed.



Horizontal and Vertical Scale 1 inch= 60 Feet

Seismic Refraction Velocity Profile Based on RAYFRACT Processing and Modeling Using Initial Delta TV Veloc Model with 30 WET Iterations with Vmax= 5,000 m/sec

Seismic Reflection Time Profile Based on Visual SUNT Processing

Interpretation of Geologic Structure

| | |
|---|---|
| 🟪 | Reflections Indicating Lithologic Surface within Franciscan Formation Melange (KJfmv) Outcropping to South |
| 🟩 | Reflection Discontinuity Indicating Unconformity Surface Separating Franciscan KJfmv and KJfss Units |
| 🟦 | Reflections from Bedding within Deeper Franciscan Formation Sandstone and Shale Unit (KJfss) Outcropping to South |
| 🟥 | Near-Surface Fault Plane Interpretation Based on Reflection Pattern Deformation |

Line 1- Seismic Reflection and Refraction Survey
For Investigation of Los Osos Fault
2420 Paradise Lane Los Osos, California

Figure 2
ADVANCED GEOSCIENCE, INC.
www.AdvancedGeoscience.com

Figure 6: Line 1 Seismic Refraction and Reflection Profile

## 4.5 Landslides

The San Luis Obispo County Safety Element maps the property within a low potential landslide hazard zone. Hall, 1973, Lettis and Hall, 1994, Dibblee, 2006 and Wiegers, 2009 map landslides within the Franciscan Complex in the hills surrounding Los Osos Valley. During site mapping and review of recent and historical (1937, 1949) aerial photography, landslides were not observed at the Site. Plate 4 presents an aerial photograph. There is a low rockfall potential to affect the proposed residence based on the lack of boulders upslope of the proposed development.

**Figure 7: Historical Aerial Photograph (1937)**

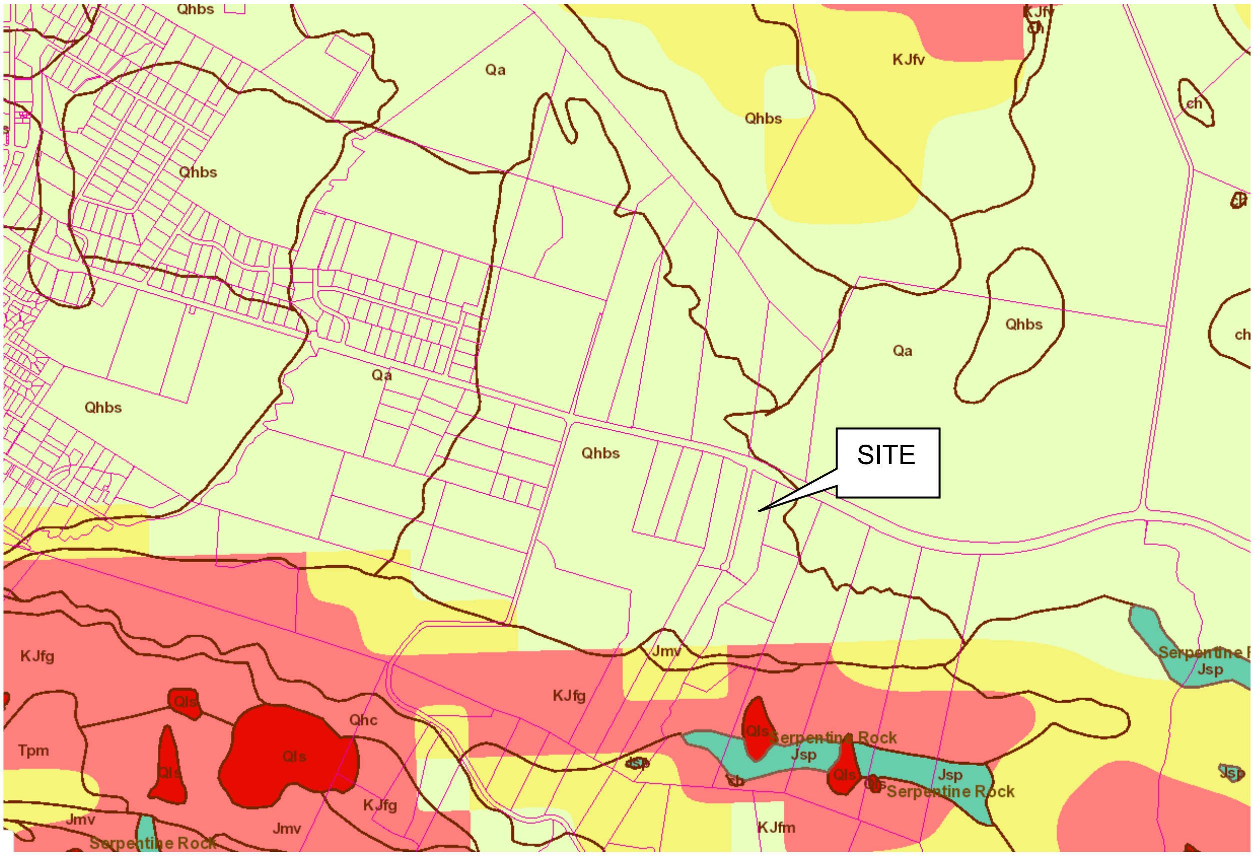


Figure 8: Landslide Potential Map (San Luis Obispo County Land Use View)

### 4.6 Flooding and Severe Erosion

The site is not located within or near the 100-year or 500-year flood zone based on Federal Emergency Management Agency flood zone maps (FEMA, 2012).

The surficial and formational deposits are subject to erosion where not covered with vegetation or hardscape. The potential for severe erosion is considered low provided that vegetation and erosion control measures are implemented immediately after the completion of grading.

### 4.7 On-site Septic Systems

Previous percolation testing was performed by this firm (GeoSolutions, 2009). It is our understanding, the location of the proposed septic system will be east of the proposed residence (100 feet from the riparian zone). The final septic system location should be designed in a manner that the effluent does not negatively impact or daylight out of adjacent slopes. A minimum of 10 feet to daylight should be maintained.

### 4.8 Hydrocollapse of Alluvial Fan Soils

The potential for hydrocollapse of subsurface materials is considered low due to the absence of alluvial fan material at the Site.

## 5.0 SISMOLOGY AND CALCULATION OF EARTHQUAKE GROUND MOTION

### 5.1 Seismic Hazard Analysis and Structural Building Design Parameters

Estimating the design ground motions at the Site depends on many factors including the distance from the Site to known active faults; the expected magnitude and rate of recurrence of seismic events produced on such faults; the source-to-site ground motion attenuation characteristics; and the Site soil profile characteristics. According to section 1613 of the 2019 CBC (CBSC, 2019), all structures and portions of structures should be designed to resist the effects of seismic loadings caused by earthquake ground motions in accordance with the ASCE 7: Minimum Design Loads for Buildings and Other Structures, hereafter referred to as ASCE 7-16 (ASCE, 2016). The Site soil profile classification (Site Class) can be determined by the average soil properties in the upper 100 feet of the Site profile and the criteria provided in Table 20.3-1 of ASCE 7-16.

Spectral response accelerations and peak ground accelerations, provided in this report were obtained using the computer-based Seismic Design Maps tool available from the Structural Engineers Association of California (SEAOC, 2019). This program utilizes the methods developed in ASCE 7-16 in conjunction with user-inputted Site location to calculate seismic design parameters and response spectra (both for period and displacement) for soil profile Site Classes A through E.

Site coordinates of 35.2991 degrees north latitude and -120.7931 degrees east longitude were used in the web-based probabilistic seismic hazard analysis (SEAOC, 2019). Based on the results from the in-situ tests performed during the field investigation, the Site was defined as Site Class D, “Stiff Soil” profile per ASCE7-10, Chapter 20. Relevant seismic design parameters obtained from the program area summarized in Table 2: Seismic Design Parameters.

**Table 2: Seismic Design Parameters**

| | |
|---|---|
| **Site Class** | **D “Stiff Soil”** |
| **Seismic Design Category** | **D** |
| **1-Second Period Design Spectral Response Acceleration, $S_{D1}$** | **(See Note 1)** |
| **Short-Period Design Spectral Response Acceleration, $S_{DS}$** | **0.847g** |
| **Site Specific MCE Peak Ground Acceleration, $PGA_M$** | **0.532g** |

**Note 1**: It is assumed that this design-period acceleration will not be required for the project.

## 6.0 LIQUEFACTION

Due to the densities within the sub-surface material and the presence of clays in the subsurface, the liquefaction potential at the Site is considered low.

## 7.0 TSUNAMIS AND SEICHES

Tsunamis and seiches are two types of water waves that are generated by earthquake events. Tsunamis are broad-wavelength ocean waves and seiches are standing waves within confined bodies of water, typically reservoirs. As the property is at an elevation over 85 feet and distance to the Pacific Ocean, the potential for a tsunami to affect the Site is low.

Flooding associated with a seismic event (seiche) is considered low due to the absence of a body of water upslope of the property.

## 8.0 HAZARDS FROM GEOLOGIC MATERIALS

### 8.1 Expansive Soils

The expansion potential within the Older Alluvial Deposits was high based on laboratory testing from the referenced Soils Engineering Report. The Soils Engineering Report provides additional recommendations for foundations within expansive soil.

### 8.2 Naturally Occurring Asbestos

There is a low potential for natural occurring asbestos to be present at the property due to the absence of Franciscan Complex units. Naturally occurring asbestos is associated with serpentinite rock units within the Franciscan Complex. Serpentinite was not observed within the borings.

### 8.3 Radon and Other Hazardous Gases

The potential for radon or other hazardous gases is low due to the absence of Monterey Formation formational units and other identified radon producing formations.

## 9.0 GRADING OPERATIONS, CUT AND FULL, SUBDRAINS

Based on the presence of Older Alluvial Deposits encountered at the site, it is anticipated that the foundations will be excavated into over excavated engineered fill. Conventional grading equipment may be used for excavations. The Soils Engineering Report provides additional foundation and construction recommendations. Based on the field investigation, subdrains are not anticipated at this time, however this may be reevaluated at the time of construction.

Construction inspections and testing during all grading and excavating operations should be performed by the project Soils Engineer/Engineering Geologist. Section 1705.6 of the 2019 CBC (CBSC, 2019) requires the following inspections by the Soils Engineer/Engineering Geologist as shown in Table 3: Required Verification and Inspections of Soils:

**Table 3: Required Verification and Inspections of Soils**

| Verification and Inspection Task | Continuous During Task Listed | Periodically During Task Listed |
|---|---|---|
| 1. Verify materials below footings are adequate to achieve the design bearing capacity. | - | X |
| 2. Verify excavations are extended to proper depth and have reached proper material. | - | X |
| 3. Perform classification and testing of controlled fill materials. | - | X |
| 4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of controlled fill. | X | - |
| 5. Prior to placement of controlled fill, observe sub-grade and verify that site has been prepared properly. | - | X |

## 10.0 ADDITIONAL SERVICES

The recommendations contained in this report are based on exploratory borings and on the continuity of the sub-surface conditions encountered. It is assumed that GeoSolutions, Inc. will be retained to perform the following services:

1. Consultation during plan development.

2. A preliminary plan review regarding the locations of proposed improvements and development once grading and drainage plans are available.

3. Final plan review of final grading and drainage documents prior to construction.

4. Additionally, construction observation by the Engineering Geologist and/or Soils Engineer may be necessary to verify sub-surface conditions during excavation activities.

5. Final grading report and as-built map in accordance with County Guidelines for Engineering Geology Reports, Item 29 (San Luis Obispo County Department of Planning and Building, 2016).

## 11.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed during our study. Should any variations or undesirable conditions be encountered during the development of the Site, GeoSolutions, Inc. should be notified immediately and GeoSolutions, Inc. will provide supplemental recommendations as dictated by the field conditions.

This report is issued with the understanding that it is the responsibility of the owner or his/her representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project, and incorporated into the project plans and specifications. The owner or his/her representative is responsible to ensure that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they are due to natural processes or to the works of man on this or adjacent properties. Therefore, this report should not be relied upon after a period of 3 years without our review nor should it be used or is it applicable for any properties other than those studied. However many events such as floods, earthquakes, grading of the adjacent properties and building and municipal code changes could render sections of this report invalid in less than 3 years.

Thank you for the opportunity to have been of service in preparing this report. If you have any questions or require additional assistance, please feel free to contact the undersigned at (805) 543-8539.

Sincerely,
**GeoSolutions, Inc.**

Jeffrey Pfost, CEG 2493
Principal Engineering Geologist

PROFESSIONAL GEOLOGIST
JEFFREY PFOST
NO. 2493
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

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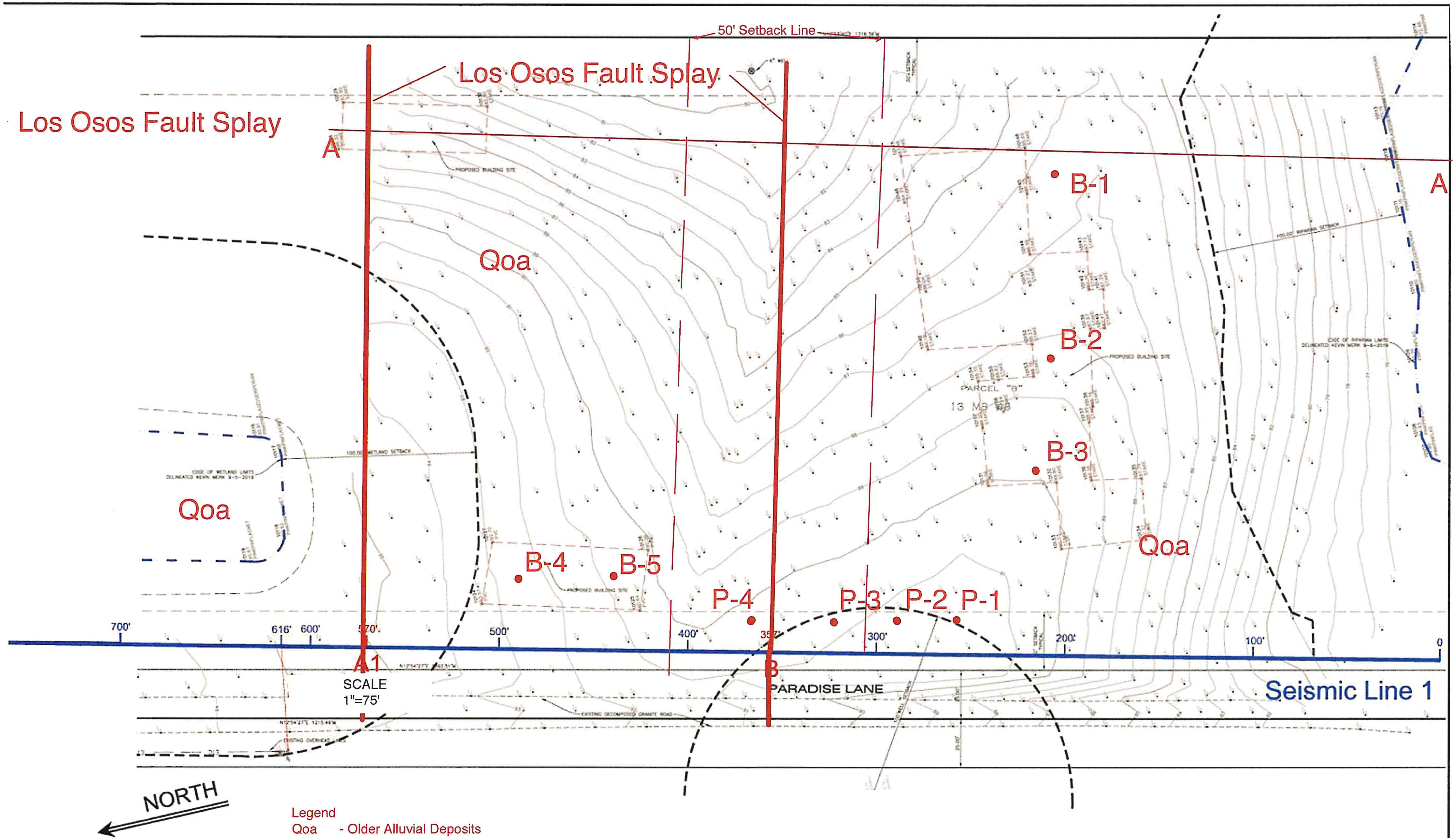
# PLATES

Plate 1A, 1B - Site Engineering Geologic Map and Cross Section
Plate 2– Regional Geologic Map, Wiegers, 2009 and explanation
Plate 3 – Regional Fault Map, Jennings, 2010
Plate 4 – Aerial Photograph



Scale 1 inch= 50 Feet

Legend
Qoa - Older Alluvial Deposits
KJfmv - Franciscan Complex (Cretaceous or Jurassic Age)
——— - Fault (Dashed Where Approximate, Depict to Fault Splays Unknown)
● B-1 - Boring Location
● P-1 - Percolation Testing Location

PLATE
1A

PROJECT
SL11323-3

SITE ENGINEERING GEOLOGY MAP
2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

GeoSolutions, Inc.
220 High Street
San Luis Obispo, CA 93401
P: 805-543-8539

Legend

| | |
|---|---|
| Qoa | - Older Alluvial Deposits |
| KJfmv | - Franciscan Complex (Cretaceous or Jurassic Age) |
| — — | - Contact (Dash Where Approximate) |
| _ _ ?_ | - Fault (Dashed Where Approximate, Depict to Fault Splays Unknown) |

Scale
1" = 50'

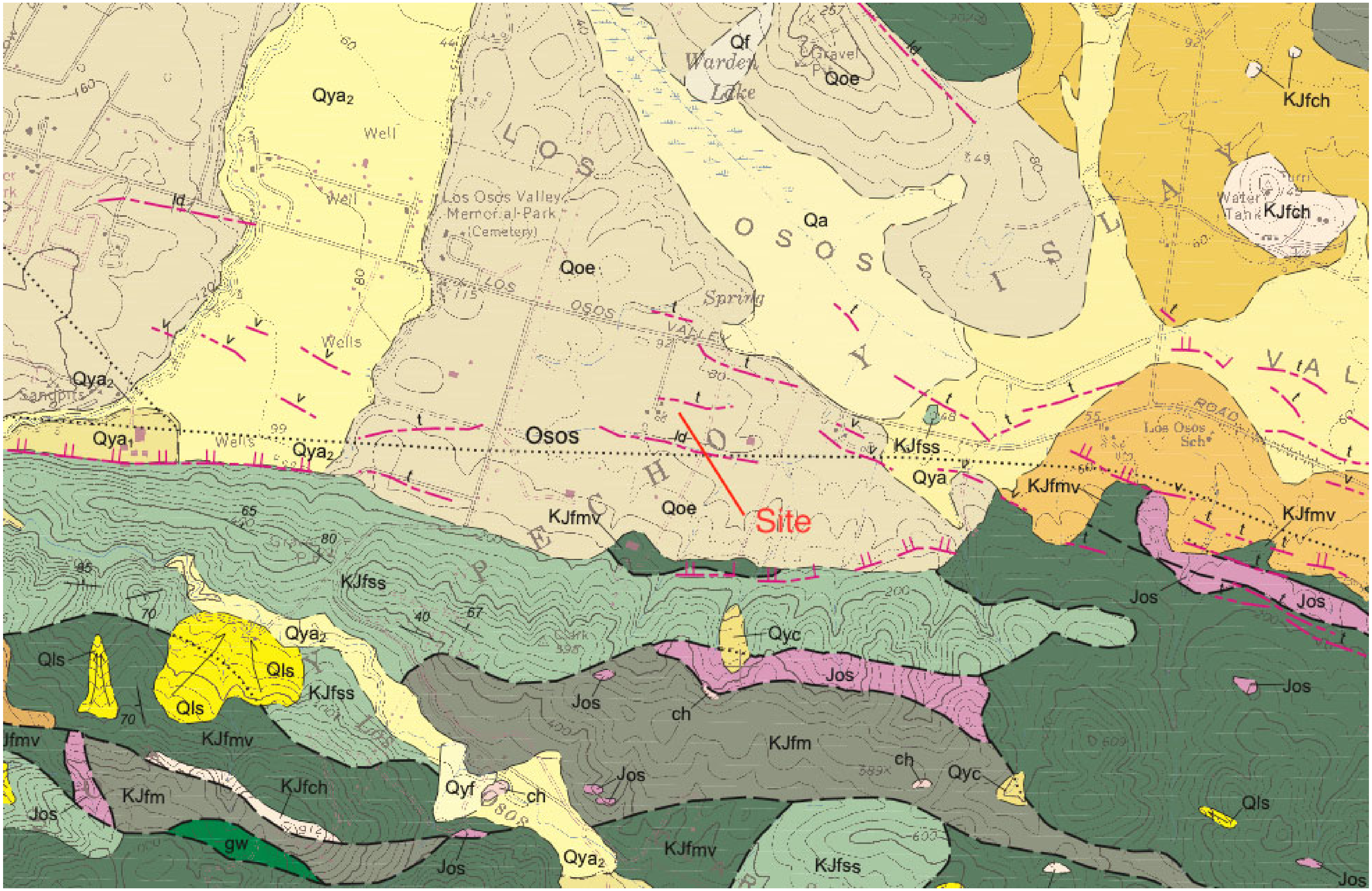
PLATE
1B

PROJECT
SL11323-3

# SITE CROSS SECTION

2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

GeoSolutions, Inc.
220 High Street
San Luis Obispo, CA 93401
(805) 543-8539



**GeoSolutions, Inc.**
220 High Street
San Luis Obispo, California 93401
(805) 543-8539

## REGIONAL GEOLOGY MAP (Wiegers, 2009)

2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
2A

**PROJECT NO:**
SL11323-3

## DESCRIPTION OF MAP UNITS

### QUATERNARY DEPOSITS

**Very Young Surficial Deposits**

af — **Artificial fill (late Holocene)** – Deposits resulting from human construction, including engineered and non-engineered fill. Not mapped in some areas.

Qa — **Alluvial flood-plain deposits (late Holocene)** - Active and recently active flood-plain deposits. Consists of unconsolidated sandy, silty and clay-bearing alluvium.

Qf — **Alluvial fan deposits (late Holocene)** – Small active alluvial fans at the mouths of steep mountain streams. Consists of cobbles, gravel, sand, and silt.

Qmb — **Marine beach deposits (late Holocene)** – Unconsolidated beach deposits consisting mostly of fine and medium-grained sand.

Qpe$_{1-2}$ — **Paralic estuarine deposits (late Holocene)** – Unconsolidated estuarine deposits composed of fine-grained sand and clay. Divided into:

- Qpe$_1$ — **Salt marsh deposits** – Unconsolidated sand and clay underlying salt marshes at mouth of Chorro Creek and Los Osos Creek.
- Qpe$_2$ — **Tidal flat deposits** – Unconsolidated sand and clay underlying tidal flats of Morro Bay

Qe — **Eolian Deposits (Holocene)** – Unconsolidated, well-sorted white to brown windblown sand. Forms active sand dunes along west side of Morro Bay.

Qls — **Landslide deposits, undivided (Holocene and Pleistocene)** – Highly fragmented to largely coherent landslide deposits. Many of the landslides occur in Franciscan mélange. A large block slide in Pismo Formation siltstone is present along the axis of the Pismo syncline near the mouth of Islay Creek.

**Young Surficial Deposits**

Qya — **Young alluvial flood-plain deposits, undivided (Holocene to late Pleistocene)** – Unconsolidated sand, silt, and clay-bearing alluvium deposited on flood-plains and along valley floors. Locally divided by relative age (2 = youngest, 1 = oldest):

- Qya$_2$ — **Young alluvial flood-plain deposits, Unit 2**
- Qya$_1$ — **Young alluvial flood-plain deposits, Unit 1**

Qyf — **Young alluvial fan deposits (Holocene to late Pleistocene)** – Fine-grained alluvial fan and flood-plain sediments deposited on gently-sloping margins of Los Osos Valley. Consists primarily of clay with interbedded lenses of sand and minor gravel.

Qyc — **Young colluvial deposits (Holocene to late Pelstocene)** – Poorly sorted sandy and silty slope wash deposits.

**Old Surficial Deposits**

Qoa — **Old alluvial flood-plain deposits (late to middle Pleistocene)** – Fluvial sediments preserved above active flood plains and channels. These deposits are moderately consolidated, slightly dissected and capped by moderate to well-developed pedogenic soils. Consists of gravel, sand, silt, and clay-bearing alluvium.

Qoe — **Old eolian deposits (late to middle Pleistocene)** – Old stabilized sand dune deposits consisting of moderately consolidated, well-sorted brown windblown sand. Deposits are capped by moderately well-developed pedogenic soil. Dissected by Los Osos Creek.

Qop$_{1-6}$ — **Old paralic deposits (late to middle Pleistocene)** – Marine terrace deposits consisting of beach and near shore deposits covered by alluvial and colluvial deposits. These deposits rest on emergent wave-cut abrasion platforms preserved by regional uplift. Marine deposits consist of well-sorted sand and gravel locally containing fossils and shell fragments. Some deposits contain iron-rich nodular zones. Overlying non-marine cover consist of poorly-sorted gravel, sand, silt, and clay deposited by slope wash and alluvial processes. Divided by relative age (6 = youngest, 1 = oldest). Estimated ages of deposits are as follows (Hanson and others, 1994):

- Qop$_6$ — **Old paralic deposits, Unit 6 - 80 ka**
- Qop$_5$ — **Old paralic deposits, Unit 5 - 120 ka**
- Qop$_4$ — **Old paralic deposits, Unit 4 - 210 ka**
- Qop$_3$ — **Old paralic deposits, Unit 3 - 330 ka**
- Qop$_2$ — **Old paralic deposits, Unit 2 - 430 ka**
- Qop$_1$ — **Old paralic deposits, Unit 1 - 480 ka**

**Very Old Surficial Deposits**

Qvop$_{1-5}$ — **Very old paralic deposits (middle to early Pleistocene)** – Marine terrace deposits consisting of beach and near shore deposits covered by alluvial and colluvial deposits. These deposits rest on emergent wave-cut platforms preserved by regional uplift. Divided by relative age (5 = youngest, 1 = oldest). All terraces older than 560 ka (Hanson and others, 1994):

- Qvop$_5$ — **Very old paralic deposits, Unit 5**
- Qvop$_4$ — **Very old paralic deposits, Unit 4**
- Qvop$_3$ — **Very old paralic deposits, Unit 3**
- Qvop$_2$ — **Very old paralic deposits, Unit 2**
- Qvop$_1$ — **Very old paralic deposits, Unit 1**

### TERTIARY AND OLDER ROCKS

**Pismo Formation (Pliocene to Miocene)**

5'

Tmpm — **Miguelito Member** – Buff to light-brown siltstone, shale, porcelaneous shale, opaline shale, diatomaceous shale, minor friable sandstone. Well-bedded, relatively soft.

Tmpe — **Edna Member, sandstone** – Gray to brown friable sandstone, 80% to 90% quartz, 5% to 15% feldspar.

Tmpes — **Edna Member, siltstone** – Buff to gray sandy siltstone, locally bituminous **(bit)**.

**Monterey Formation (Miocene)**

Tmc — **Tmc** – Resistant, hard siliceous shale and interbedded chert. Commonly white to brown, brittle with conchoidal fractures, laminated.

Tmts — **Tmts** – Tuffaceous siltstone, locally dolomitic siltstone, with some opaline chert.

Tmb — **Tmb** – Tan to white tuffaceous siltstone and fine sandstone, dolomitic claystone, siliceous siltstone with some opaline chert.

Tot — **Obispo Formation (Miocene)** – Fine- to coarse-grained tuff, white to light-gray, contains subangular clasts of pumice, perlite, white to dark-gray glass shards and feldspar in a vitric, ashy matrix. Contains dark-black, silicified resistant tuff and lenses of perlitic glass and breccia.

Tor — **Rincon Shale (Oligocene)** – Dark-brown to orange-brown siltstone and silty claystone, poorly to well-bedded, weathers to light-brown. Contains calcareous concentrations.

Tov — **Vaqueros Sandstone (Oligocene)** – Gray-brown, medium to coarse sandstone, poorly to well-indurated, with silty, calcareous matrix. Clasts are well-rounded to subrounded with a typical composition of 40% to 60% quartz, 5% to 15% feldspar, 30% to 50% rock fragments. Contains fossiliferous zones with broken mollusk shells and large oysters.

Toi / Toif — **Morro Rock – Islay Hill volcanic intrusive complex (Oligocene)** – **Toi** - Porphyritic dacite. Approximately 50% of rock consists of phenocrysts with a typical composition of 65% andesine; 15% biotite and clay; 10% hornblende; 5% quartz; and 5% magnetite, apatite and zeolites. Groundmass consists of altered plagioclase, biotite, glass, quartz and hornblende (Hall, 1973). These rocks are exposed in a series of volcanic plugs and lava domes that form distinctive peaks between Morro Bay and San Luis Obispo. Flow banding is common. Radiometric ages range from 27 to 23 Ma (Stanley and others, 2000). **Toif** – Fine-grained dacite flow facies. Phenocrysts are absent or rare. Flow banding common.

**Franciscan Complex (Cretaceous to Jurassic)**

KJfm — **Mélange** – Chaotic mixture of fragmented rock masses embedded in a penetratively sheared matrix of argillite and crushed metasandstone. Individual rock masses contained in the matrix range from less than a meter to kilometers in scale. Blocks large enough to be shown on the map include high grade blueschist **(bs)**, greenstone **(mv)**, graywacke **(gw)** and chert **(ch)**. Penetrative deformation of matrix postdates metamorphism of enclosed rock masses.

KJfss — **Sandstone and shale** – Fine- to medium-grained, massive- to thin-bedded graywacke sandstone interbedded with shale and siltstone. Composed of 60% to 70% quartz, 20% to 30% feldspar, 5% biotite and 10% shale fragments embedded in a muddy matrix. Rocks are generally moderately to intensely sheared, often obscuring original stratification. This unit lacks exotic blocks characteristic of mélange.

KJfch — **Chert** – Red and green radiolarian chert associated with greenstone. Commonly veined and recrystallized, locally bleached to yellow or white. Deposited in deep oceanic setting on greenstone prior to influx of sandstone and shale. Locally interbedded with thin layers of argillite.

KJfmv — **Metavolcanic rocks** – Primarily greenstone, metamorphosed from basalt. Includes massive to pillowed basalt flows, breccia, tuff, and diabase. Commonly deeply weathered.

**Coast Range Ophiolite (Jurassic)**

Jos — **Serpentinized ultramafic rocks** – Peridotite, dunite, and harzburgite, pervasively sheared and metamorphosed to sepentinite. Occur as lenticular fault-bounded bodies in Franciscan mélange. Considered to be dismembered bodies of the Coast Range Ophiolite tectonically interleaved with mélange during subduction. Locally, hydrothermally altered to silica-carbonate rock.

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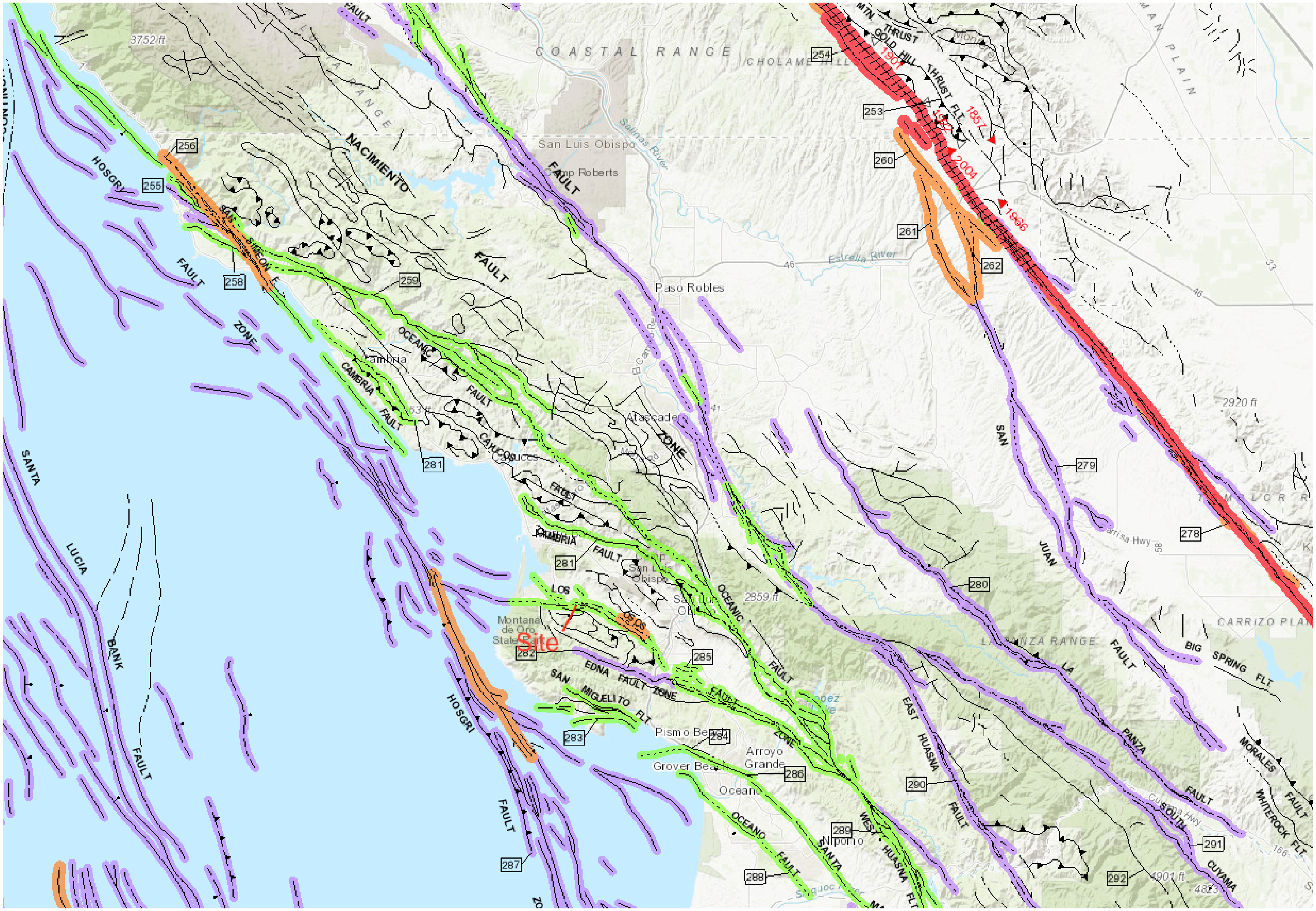
# REGIONAL GEOLOGY MAP LEGEND (Wiegers, 2009)

2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
2B

**PROJECT NO:**
SL11323-3



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# REGIONAL FAULT MAP (Jennings, 2010)

2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
3

**PROJECT NO:**
SL11323-3

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## AERIAL PHOTOGRAPH (Google, 2020)

2420 PARADISE LANE, LOS OSOS AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
4

**PROJECT NO:**
SL11323-3

# APPENDIX A

## Boring Logs

GEO SOLUTIONS

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1021 Tama Lane, Ste 105, Santa Maria, CA 93455
Phone: 805-614-6333
201 S. Milpas St, Ste 103, Santa Barbara, CA 93103
Phone: 805-966-2200

# BORING LOG

**BORING NO.** B-1
**JOB NO.** SL11323-1

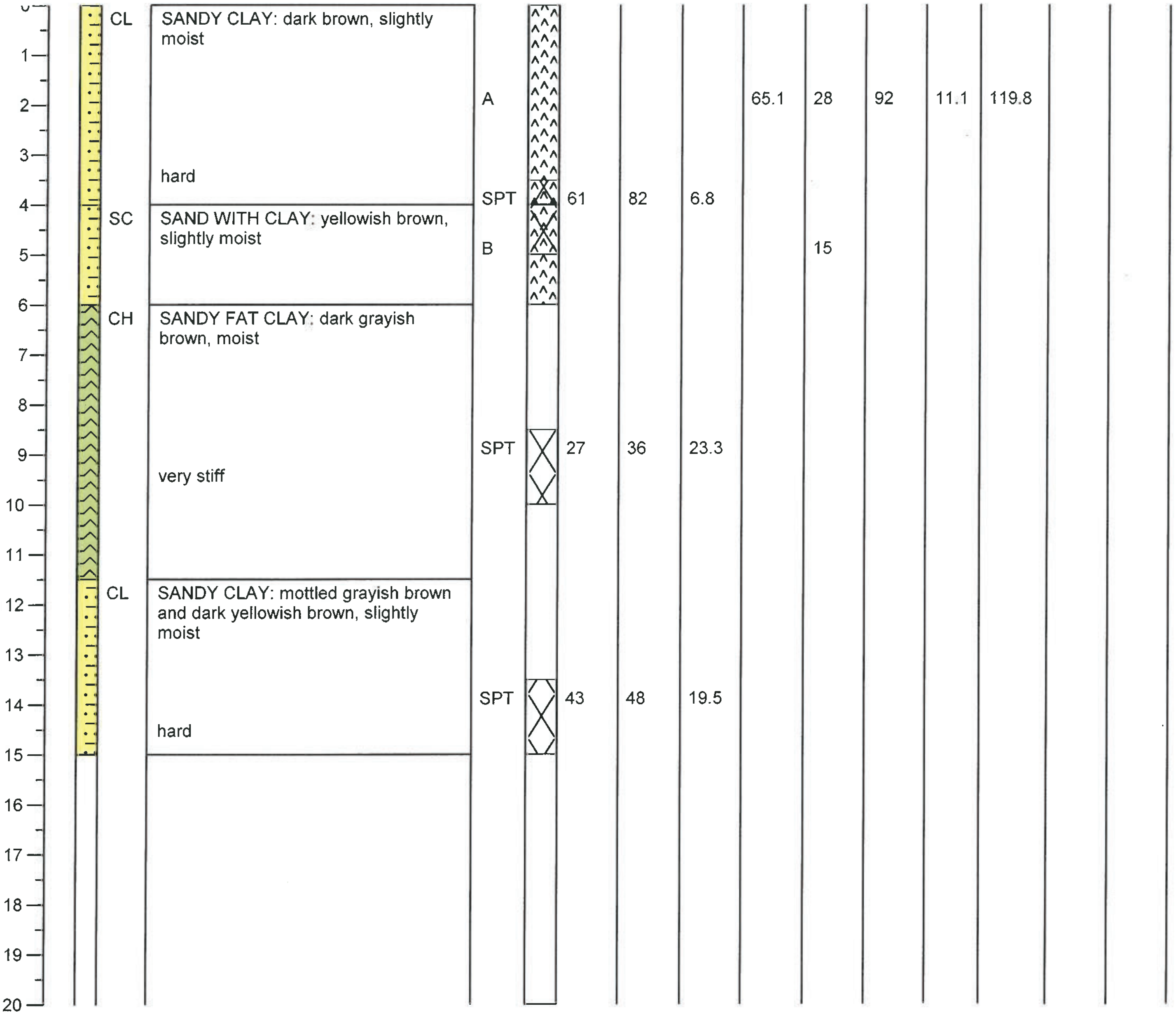
## PROJECT INFORMATION

PROJECT: **2420 Paradise Lane**
DRILLING LOCATION: **See Figure 2, Site Plan**
DATE DRILLED: **8/20/19**
LOGGED BY: **GTV**

## DRILLING INFORMATION

DRILL RIG: **B-24**
HOLE DIAMETER: **6 Inches**
SAMPLING METHOD: **SPT**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **15 Feet** Page 1 of 1



| DEPTH | LITHOLOGY | USCS | SOIL DESCRIPTION | SAMPLE ID | SAMPLERS TYPE | BLOWS/ 12 IN | N 1/60 | MOISTURE CONTENT (%) | FINES CONTENT (%) | PLASTICITY INDEX (PI) | EXPANSION INDEX (EI) | OPTIMUM WATER CONTENT (%) | MAXIMUM DRY DENSITY (pcf) | COHESION, C (psf) | FRICTION ANGLE, (degrees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | CL | SANDY CLAY: dark brown, slightly moist | | | | | | | | | | | | |
| 2 | | | | A | | | | | 65.1 | 28 | 92 | 11.1 | 119.8 | | |
| | | | hard | | | | | | | | | | | | |
| 4 | | | | SPT | | 61 | 82 | 6.8 | | | | | | | |
| | | SC | SAND WITH CLAY: yellowish brown, slightly moist | | | | | | | | | | | | |
| 5 | | | | B | | | | | | 15 | | | | | |
| 6 | | CH | SANDY FAT CLAY: dark grayish brown, moist | | | | | | | | | | | | |
| 9 | | | | SPT | | 27 | 36 | 23.3 | | | | | | | |
| | | | very stiff | | | | | | | | | | | | |
| | | CL | SANDY CLAY: mottled grayish brown and dark yellowish brown, slightly moist | | | | | | | | | | | | |
| 14 | | | | SPT | | 43 | 48 | 19.5 | | | | | | | |
| | | | hard | | | | | | | | | | | | |

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Phone: 805-966-2200

# BORING LOG

**BORING NO.** **B-2**

**JOB NO.** **SL11323-1**

## PROJECT INFORMATION

PROJECT: **2420 Paradise Lane**
DRILLING LOCATION: **See Figure 2, Site Plan**
DATE DRILLED: **8/20/19**
LOGGED BY: **GTV**

## DRILLING INFORMATION

DRILL RIG: **B-24**
HOLE DIAMETER: **6 Inches**
SAMPLING METHOD: **SPT**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **15 Feet** Page 1 of 1

| DEPTH | LITHOLOGY | USCS | SOIL DESCRIPTION | SAMPLE ID | SAMPLERS TYPE | BLOWS/ 12 IN | N 1/60 | MOISTURE CONTENT (%) | FINES CONTENT (%) | PLASTICITY INDEX (PI) | EXPANSION INDEX (EI) | OPTIMUM WATER CONTENT (%) | MAXIMUM DRY DENSITY (pcf) | COHESION, C (psf) | FRICTION ANGLE, (degrees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 |  | CL | SANDY CLAY: dark brown, slightly moist |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  | SC | CLAYEY SAND: yellowish brown, dry |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  | very dense | SPT | ☒ | 53 | 71 | 15.4 |  |  |  |  |  |  |  |
| 5 |  | CL | SANDY CLAY: dark grayish brown, slightly moist |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  | SC | CLAYEY SAND: dark yellowish brown, slightly moist |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  | CH | SANDY FAT CLAY: dark grayish brown, dry, hard | SPT | ☒ | 49 | 66 |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 |  |  | moist |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 |  |  |  | SPT | ☒ | 51 | 57 |  |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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Phone: 805-966-2200

# BORING LOG

**BORING NO.** B-3
**JOB NO.** SL11323-1

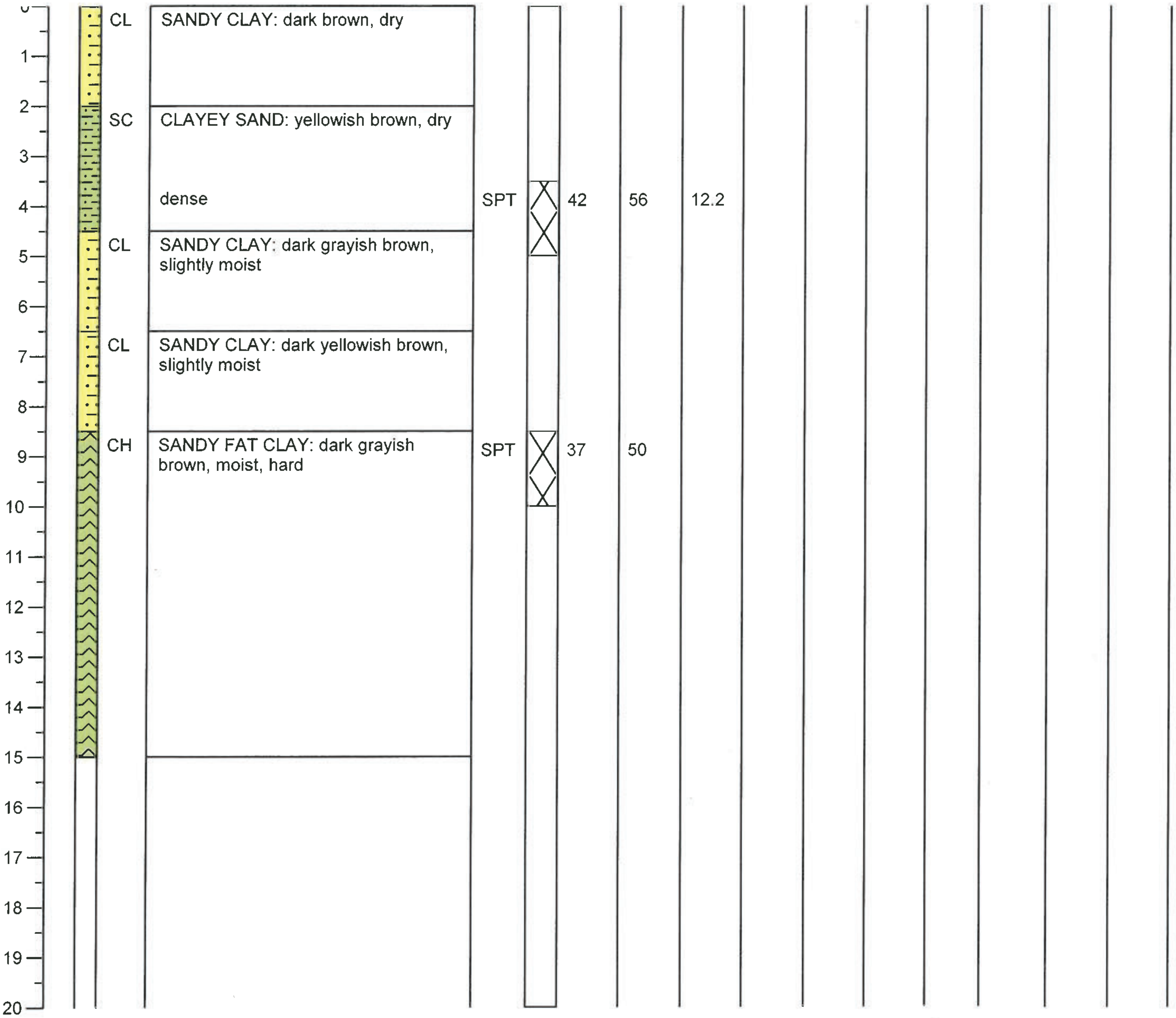
## PROJECT INFORMATION

PROJECT: **2420 Paradise Lane**
DRILLING LOCATION: **See Figure 2, Site Plan**
DATE DRILLED: **8/20/19**
LOGGED BY: **GTV**

## DRILLING INFORMATION

DRILL RIG: **B-24**
HOLE DIAMETER: **6 Inches**
SAMPLING METHOD: **SPT**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **15 Feet** Page 1 of 1



| DEPTH | USCS | SOIL DESCRIPTION | SAMPLE ID | SAMPLERS TYPE | BLOWS/ 12 IN | N 1/60 | MOISTURE CONTENT (%) | FINES CONTENT (%) | PLASTICITY INDEX (PI) | EXPANSION INDEX (EI) | OPTIMUM WATER CONTENT (%) | MAXIMUM DRY DENSITY (pcf) | COHESION, C (psf) | FRICTION ANGLE, (degrees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | CL | SANDY CLAY: dark brown, dry | | | | | | | | | | | | |
| 2 | SC | CLAYEY SAND: yellowish brown, dry | | | | | | | | | | | | |
| 4 | | dense | SPT | | 42 | 56 | 12.2 | | | | | | | |
| 4.5 | CL | SANDY CLAY: dark grayish brown, slightly moist | | | | | | | | | | | | |
| 6.5 | CL | SANDY CLAY: dark yellowish brown, slightly moist | | | | | | | | | | | | |
| 8.5 | CH | SANDY FAT CLAY: dark grayish brown, moist, hard | SPT | | 37 | 50 | | | | | | | | |

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Phone: 805-966-2200

# BORING LOG

**BORING NO.** **B-4**
**JOB NO.** **SL11323-1**

## PROJECT INFORMATION

PROJECT: **2420 Paradise Lane**
DRILLING LOCATION: **See Figure 2, Site Plan**
DATE DRILLED: **8/20/19**
LOGGED BY: **GTV**

## DRILLING INFORMATION

DRILL RIG: **B-24**
HOLE DIAMETER: **6 Inches**
SAMPLING METHOD: **SPT**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **15 Feet** Page 1 of 1

| DEPTH | LITHOLOGY | USCS | SOIL DESCRIPTION | SAMPLE ID | SAMPLERS TYPE | BLOWS/ 12 IN | N 1/60 | MOISTURE CONTENT (%) | FINES CONTENT (%) | PLASTICITY INDEX (PI) | EXPANSION INDEX (EI) | OPTIMUM WATER CONTENT (%) | MAXIMUM DRY DENSITY (pcf) | COHESION, C (psf) | FRICTION ANGLE, (degrees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 🟨 | CL | SANDY CLAY: dark brown, slightly moist | | | | | | | | | | | | |
| 1 | 🟨 | | | | | | | | | | | | | | |
| 2 | 🟨 | | | | | | | | | | | | | | |
| 3 | 🟨 | | | | | | | | | | | | | | |
| 4 | 🟩 | SC | CLAYEY SAND: dark grayish brown, slightly moist | SPT | ☒ | 36 | | 14.4 | | | | | | | |
| 5 | 🟩 | | | | | | | | | | | | | | |
| 6 | 🟩 | | dark yellowish brown | | | | | | | | | | | | |
| 7 | 🟩 | | | | | | | | | | | | | | |
| 8 | 🟩 | CH | SANDY FAT CLAY: dark grayish brown, slightly moist | | | | | | | | | | | | |
| 9 | 🟩 | | | SPT | ☒ | 30 | | 24.2 | | | | | | | |
| 10 | 🟩 | | | | | | | | | | | | | | |
| 11 | 🟩 | | | | | | | | | | | | | | |
| 12 | 🟩 | | | | | | | | | | | | | | |
| 13 | 🟩 | | | | | | | | | | | | | | |
| 14 | 🟩 | | | SPT | ☒ | 26 | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | |

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# BORING LOG

**BORING NO.** **B-5**
**JOB NO.** **SL11323-1**

## PROJECT INFORMATION

PROJECT: **2420 Paradise Lane**
DRILLING LOCATION: **See Figure 2, Site Plan**
DATE DRILLED: **8/20/19**
LOGGED BY: **GTV**

## DRILLING INFORMATION

DRILL RIG: **B-24**
HOLE DIAMETER: **6 Inches**
SAMPLING METHOD: **SPT**
APPROX. ELEVATION: **Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **10 Feet** Page 1 of 1

| DEPTH | LITHOLOGY | USCS | SOIL DESCRIPTION | SAMPLE ID | SAMPLERS TYPE | BLOWS/ 12 IN | N 1/60 | MOISTURE CONTENT (%) | FINES CONTENT (%) | PLASTICITY INDEX (PI) | EXPANSION INDEX (EI) | OPTIMUM WATER CONTENT (%) | MAXIMUM DRY DENSITY (pcf) | COHESION, C (psf) | FRICTION ANGLE, (degrees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | CL | SANDY CLAY: dark brown, slightly moist | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | SC | | SPT | ☒ | 44 | | 17.7 | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | SANDY CLAY: dark yellowish brown, dry | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | CH | SANDY FAT CLAY: dark grayish brown, slightly moist | | | | | | | | | | | | |
| 9 | | | | SPT | ☒ | 31 | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | |

# APPENDIX B

Summary Report (Advanced Geoscience, 2020)

ADVANCED GEOSCIENCE, INC.
Geology and Geophysics
Subsurface Exploration Non-Destructive Evaluation

24701 Crenshaw Blvd.
Torrance, California
90505 USA
Telephone (310) 378-7480
Fax (310) 872-5323
www.AdvancedGeoscience.com

September 16, 2020
via. Email (Pages 1-5 + Attachments)

GeoSolutions, Inc.
220 High Street
San Luis Obispo, California 93401

Attention: Mr. Jeffery Pfost, C.E.G
Principal

**Subject: Summary Report**
**Seismic Reflection and Refraction Surveys for Investigation of Subsurface Faulting at 2420 Paradise Lane**
**Los Osos, California**

## INTRODUCTION

This report summarizes the seismic reflection and refraction surveys completed by Advanced Geoscience, Inc. at the referenced site to help investigate subsurface faulting associated with the Los Osos fault. Evidence of faulting associated with this fault zone is shown to cross this site on the Geologic Map of the Morro Bay South 1.5' Quadrangle (Wiegers, 2009).

Seismic reflection and refraction data were recorded along a north-south survey line positioned across the site, designated as Line 1 (shown on site map in Figure 1). Line 1 was positioned on a straight-line traverse set up east of Paradise Lane. The seismic data recorded on Line 1 underwent computer processing to prepare: 1) seismic refraction velocity profile showing subsurface compressional-wave velocity layering in the upper 200 feet, and 2) seismic reflection time and depth profiles showing approximate reflection images of deeper subsurface layering within the Franciscan Formation bedrock. These profiles were evaluated for consistent patterns of sharp separations (apparent offsets) and changes in dip in reflections from geologic interfaces which would reveal the orientation of subsurface fault planes.

The following section provides a summary our field data recording and computer processing procedures. A concluding section discusses our geologic interpretation of the seismic profiles and our current evaluation of subsurface faulting beneath Line 1.

# SURVEY PROCEDURES

## Field Data Recording

The setup and seismic data recording along Line 1 was conducted during a one-day field program completed on August 29, 2020. Line 1 was set up with 952 feet of geophone coverage from the south edge of the property and continuing along the dirt surface east of Paradise Lane to a point on the north part of the property (as shown in Figure 1).

The seismic data were recorded using a Seistronix EX-6, 102-channel seismic data acquisition system. This system was connected to two overlapping spreads of 102 geophones, spaced 8-feet apart along Line 1. The geophones consisted of single 40-Hertz vertical geophones commonly used for both high-resolution reflection and refraction surveys. The geophones were firmly coupled to the ground surface by pressing the metal spikes attached to their base plates into the dirt surface.

The seismic waves were generated at “shot points” positioned along Line 1 and recorded into all 102 geophone channels. The shot points started 28 feet south of the first geophone position and continued along the line between the geophones at 8-foot intervals to a point 956 feet from the first geophone position. After shot points advanced past the center of the first 102 geophone channels, the geophone spread was shifted forward by 18 geophone channels to extend the last geophone position to 952 feet.

The seismic waves were generated using a 60-pound, man-portable weight drop impacting a steel plate placed on the ground surface. Multiple impacts were recorded and summed together at each shot point to increase the signal-to-noise ratio.

Each seismic field record (from a single shot point location) was recorded with a 0.8-second time length and 0.25 millisecond sampling rate with 24-bit analog-to-digital resolution.

After the seismic data recording was completed the geophone positions set up on Line 1 were marked on the ground surface at 80-foot intervals with stakes. The geophone locations were mapped on to a topographic map of the south part of the site using compass azimuths and the measured distance to Line 1 from the electrical power line pole along Paradise Lane.

## Computer Processing and Display

A ground surface elevation profile of the geophone positions was first prepared. This profile was prepared using the elevations interpolated from the topographic map of the south part of the property and relative elevations determined for the north part of Line 1 from Google Earth.

The seismic field records from Line 1 first underwent computer processing using the RAYFRACT refraction tomography software (www.Rayfract.com) to generate a velocity-depth profile for Line 1. Selected field records from Line 1 were used to pick first arrival times ("first breaks") for refracted seismic waves traveling in the surface layer and along deeper higher-velocity layers. The travel time data from these first breaks were used together with geophone and shot point x-coordinates and elevations to conduct refraction tomography imaging of seismic velocity layering. An initial velocity-depth model was first estimated using the Delta TV velocity modeling procedure. This initial model was then refined to produce a closer fit to the first breaks using the Wavepath Eikonal Traveltime (WET) tomographic inversion method with 20 iterations. This best-fit, velocity-depth model was then gridded and color contoured with SURFER (written by Golden Software, Inc.) to show estimated lateral and vertical velocity variations. Figures 2 and 3 show the resulting refraction velocity-depth profile generated for Line 1.

The seismic field records for Line 1 underwent reflection data processing using the computer program Visual_SUNT (www.wgeosoft.ch). The complete set of field records were input into Visual_SUNT together with the geophone and shot point x-coordinates and elevations to perform a specialized sequence of digital filtering, trace sorting, and normal moveout (NMO) velocity corrections to prepare the common-midpoint (CMP) summed (stacked) reflection time profile shown in Figure 2.

Elevation differences along Line 1 were accounted for in this reflection processing by applying time shifts to the seismic traces, after NMO corrections and CMP stacking. The time shifts introduced by this step effectively positioned time=0 on the reflection profile to a horizontal datum elevation of 100 feet.

The seismic reflection time profile underwent additional Visual_SUNT processing to prepare an approximate seismic reflection depth profile. The refraction velocity profile was used to prepare a smoothed set of velocity-versus-time functions to convert the reflection travel time profile to a depth profile. Figure 3 shows the resulting seismic reflection depth profile generated from this procedure.

The seismic refraction and reflection depth profiles in Figures 3 are displayed with no vertical exaggeration at the same horizontal and vertical scale 1-inch= 60 feet.

## DISCUSSION OF RESULTS

### Geologic Interpretation and Evaluation of Subsurface Faulting

The seismic refraction velocity profile for Line 1 in Figures 2 and 3 first revealed 4,000 to 4,500 ft/sec velocity layering in the upper 50 feet below the ground surface (BGS) that indicates the transition from older alluvium to upper weathered bedrock. Below this depth the velocities increase rapidly with depth into the bedrock which is shown on the geologic map of this area as consisting of Franciscan Formation units (Wiegers, 2009).

The seismic reflection time profile for Line 1 in Figure 2 shows a consistent reflection pattern (just below the 50 msec time line) that indicates a continuous geologic interface within the Franciscan bedrock. This reflection interface is highlighted by the dashed-purple line and is interpreted as a lithologic surface within the Franciscan melange (KJfmv). This KJfmv unit is shown on the geologic map outcropping to the south of the site. The deeper pattern of reflections (below the 100 msec time line), highlighted by the dashed-light blue lines, are interpreted as bedding plane surfaces within the Franciscan sandstone and shale unit (KJfss). This unit is also shown on the geologic map as outcropping stratigraphically beneath the KJfmv unit to the south of the site. Based on this mapped stratigraphy and the apparent truncation between these reflection sequences observed in Figure 2 the dashed-green line was interpreted and drawn to show the unconformity separating these two units.

The seismic reflection depth profile in Figure 3 shows similar patterns of reflections approximately converted to depth at 1:1 horizontal to vertical scale. The stratigraphic interpretation shown on the reflection profile in Figure 2 is also visible and drawn on this depth profile.

To investigate subsurface faulting associated with the Los Osos fault zone these reflection profiles were evaluated for consistent patterns of sharp separations (apparent offsets) and changes in dip in reflections from geologic interfaces which would reveal the orientation of subsurface fault planes. To help guide this interpretation of fault plane orientation, consideration was also given to a previous fault trench investigation on the Los Osos fault zone conducted at the Ingley site seven miles southeast of Line 1 (Lettis and Hall, 1994). At this location trenches T-1 and T-2 revealed lower-angle, southwest-dipping trust faulting with steeper-angle, northeast-dipping secondary faulting to the south.

The reflection profiles in Figures 2 and 3 show our current interpretation of the orientation of near-surface fault planes beneath Line 1. These fault planes labeled A, A1, and B appear to be located near the ground surface at the points shown. Faults A and A1 show south-dipping trust faulting similar to the faulting observed in trench T-2. Fault B shows secondary faulting steeply-dipping to the north and located to the south, similar to that observed in trench T-1. Faults A and A1 appear to be the major causes of fault deformation beneath the site.

The topographic map of the south part of the property in Figure 4 shows the locations where fault planes A, A1, and B are located near the ground surface. Further subsurface geologic investigation is needed to confirm the existence, recency, and location of these fault patterns.

Advanced Geoscience appreciates this opportunity to be of continued service to GeoSolutions. If you have any questions concerning this report please contact the undersigned.

Thank you.

Sincerely,

**Advanced Geoscience, Inc.**

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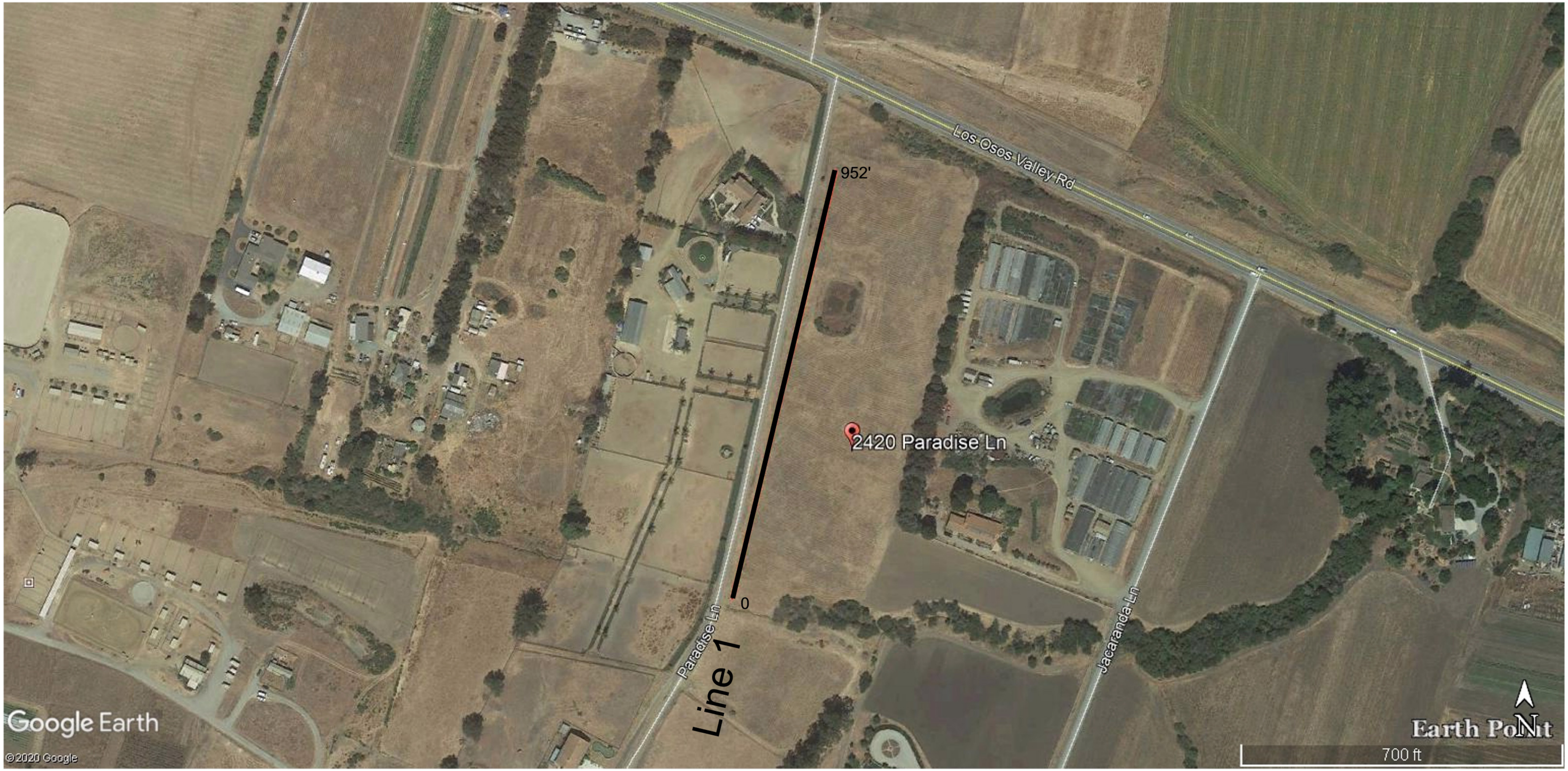
|---|---|
| Attachments: | Figure 1- Site Map Showing Location of Line 1<br>Figure 2- Line 1 Seismic Refraction and Reflection Time Profiles<br>Figure 3- Line 2 Seismic Refraction and Reflection Depth Profiles<br>Figure 4- Topographic Map of South Part of Property |

References: Wiegers, 2009, Geologic Map of the Morro Bay South 7.5’ Quadrangle, San Luis Obispo, California, by Mark O. Wiegers, Revised 2009, California Geological Survey, CA Department of Conservation.

Lettis and Hall, 1994, Los Osos Fault Zone, San Luis Obispo County, California Geological Society of America Special Paper 292.

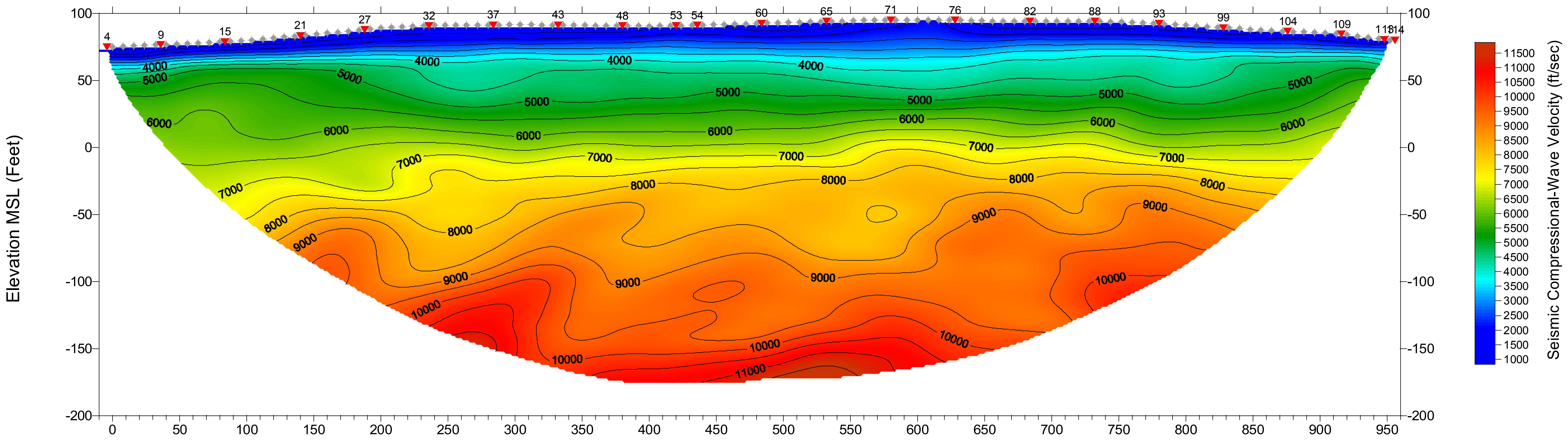


Site Map Showing Location of Line 1
Seismic Reflection and Refraction Surveys
2420 Paradise Lane Los Osos, California

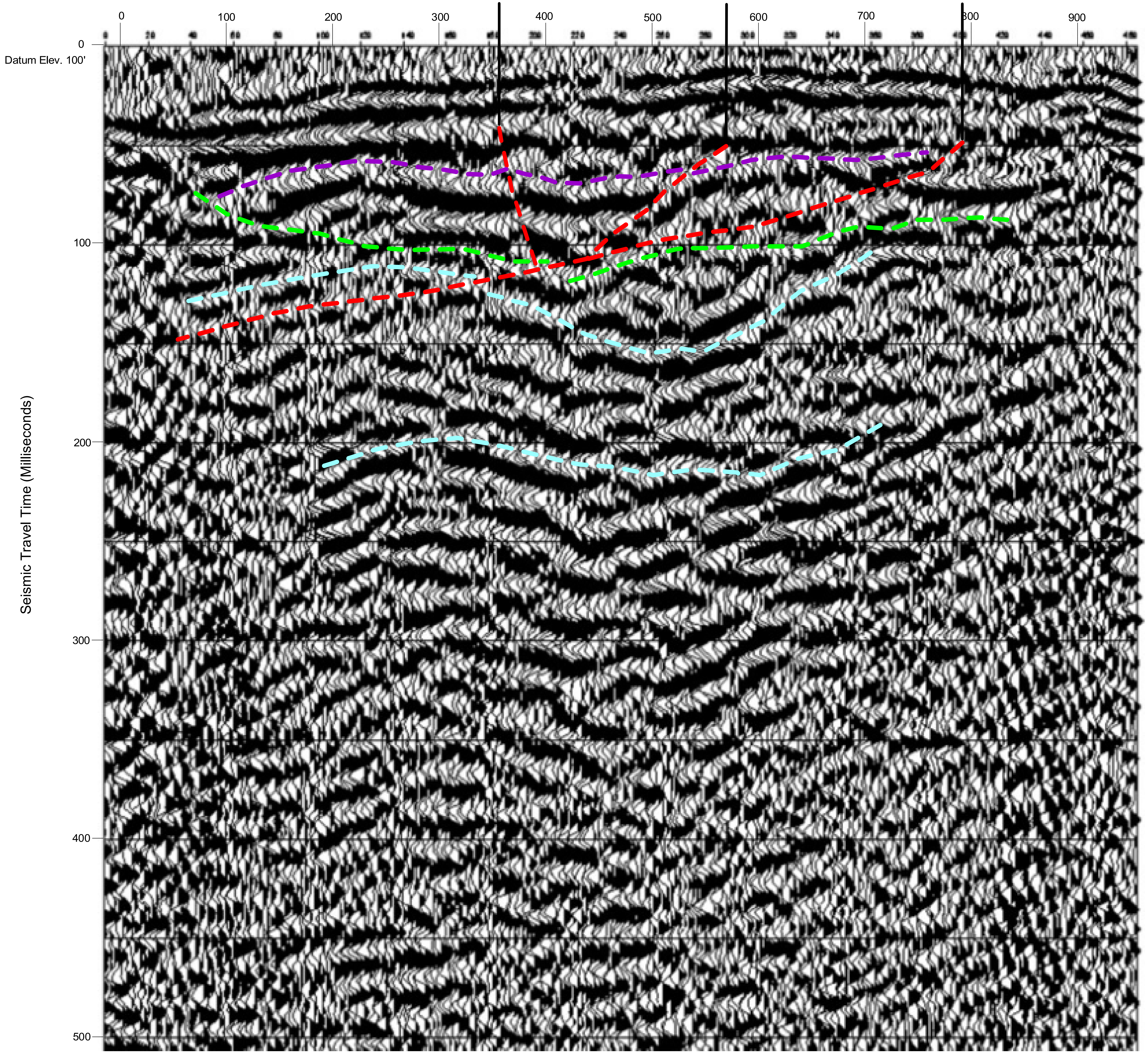
Figure 1
ADVANCED GEOSCIENCE, INC.

South North

**Line 1- Seismic Refraction Velocity Profile**



**Line 1- Seismic Reflection Time Profile**



Horizontal and Vertical Scale 1 inch= 60 Feet

Seismic Refraction Velocity Profile Based on RAYFRACT Processing and Modeling
Using Initial Delta TV Veloc Model with 30 WET Iterations with Vmax= 5,000 m/sec

Seismic Reflection Time Profile Based on Visual SUNT Processing

Interpretation of Geologic Structure

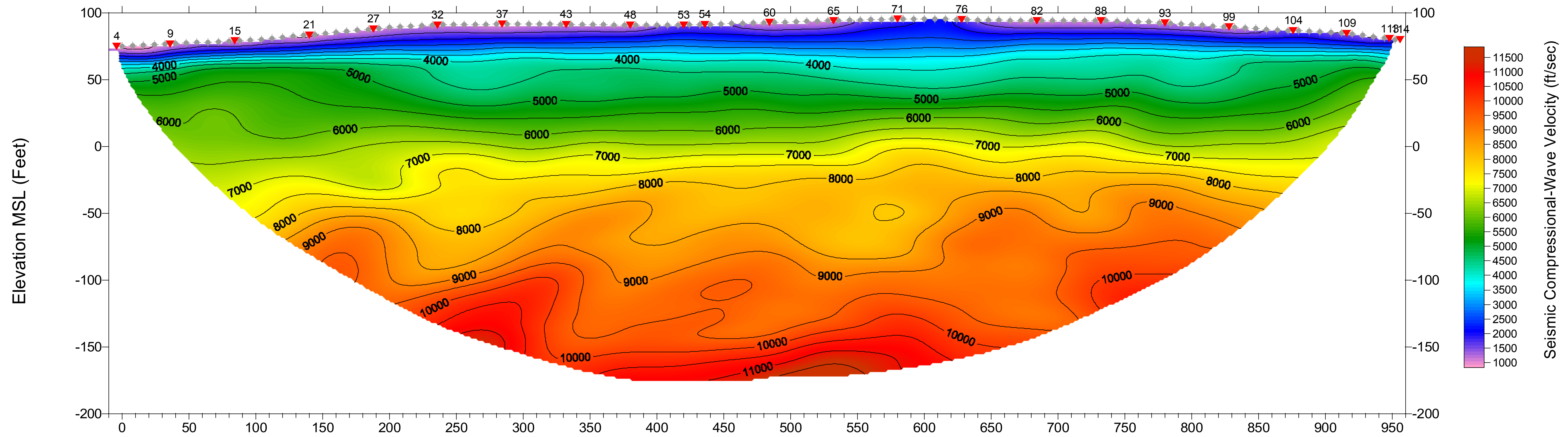
- 🟪 Reflections Indicating Lithologic Surface within Franciscan Formation Melange (KJfmv) Outcropping to South
- 🟩 Reflection Discontinuity Indicating Unconformity Surface Separating Franciscan KJfmv and KJfss Units
- 🟦 Reflections from Bedding within Deeper Franciscan Formation Sandstone and Shale Unit (KJfss) Outcropping to South
- 🟥 Near-Surface Fault Plane Interpretation Based on Reflection Pattern Deformation

Line 1- Seismic Reflection and Refraction Survey
For Investigation of Los Osos Fault
2420 Paradise Lane Los Osos, California

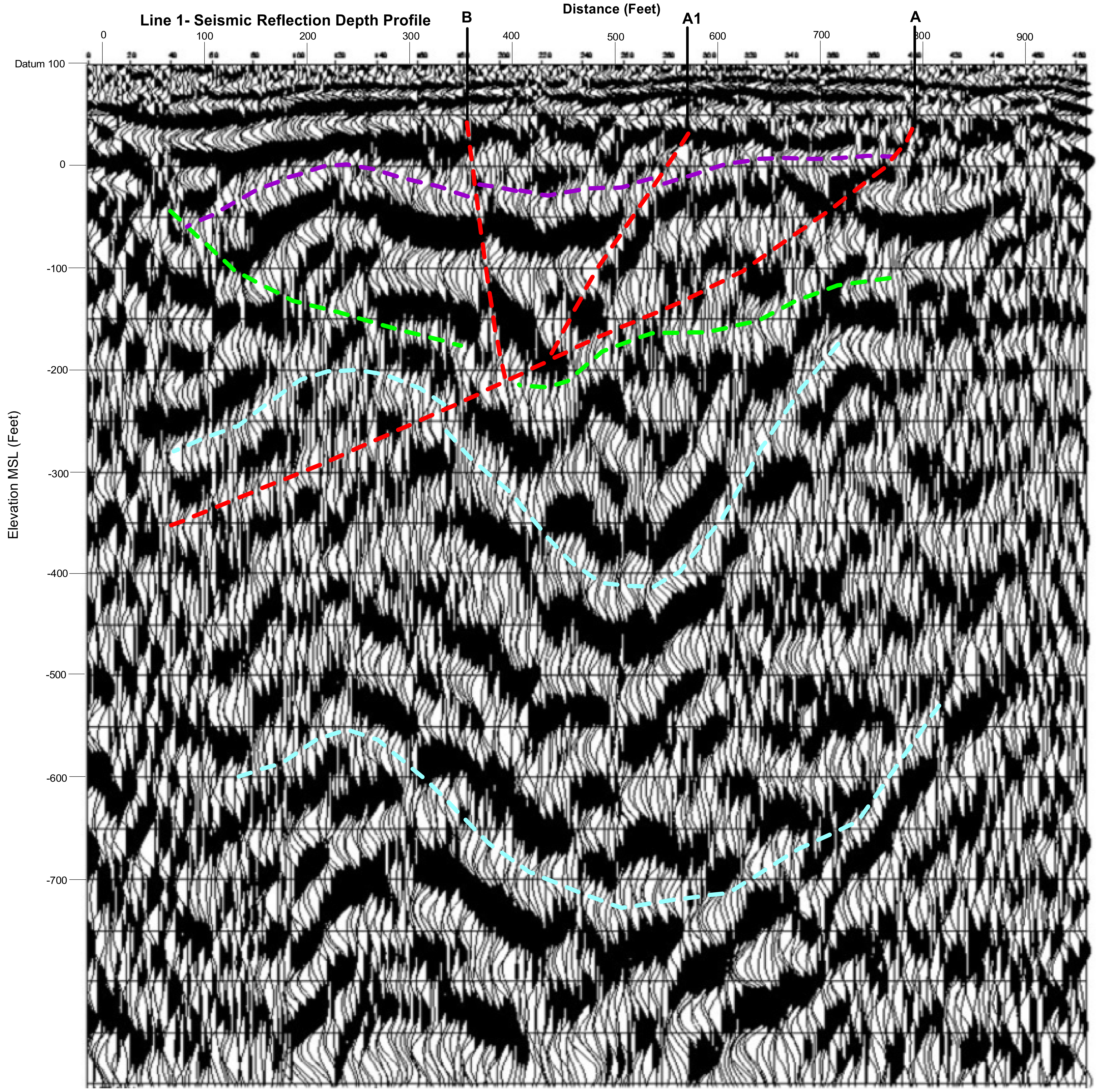
Figure 2
ADVANCED GEOSCIENCE, INC.
www.AdvancedGeoscience.com

South North

## Line 1- Seismic Refraction Velocity Profile



## Line 1- Seismic Reflection Depth Profile



Horizontal and Vertical Scale 1 inch= 60 Feet

Seismic Refraction Velocity Profile Based on RAYFRACT Processing and Modeling
Using Initial Delta TV Veloc Model with 30 WET Iterations with Vmax= 5,000 m/sec

Seismic Reflection Time Profile Based on Visual SUNT Processing
Conversion of Time Profile to Depth Based on Refraction and NMO Correction Velocities

Interpretation of Geologic Structure

╌╌╌ Reflections Indicating Lithologic Surface within Franciscan Formation Melange (KJfmv) Outcropping to South

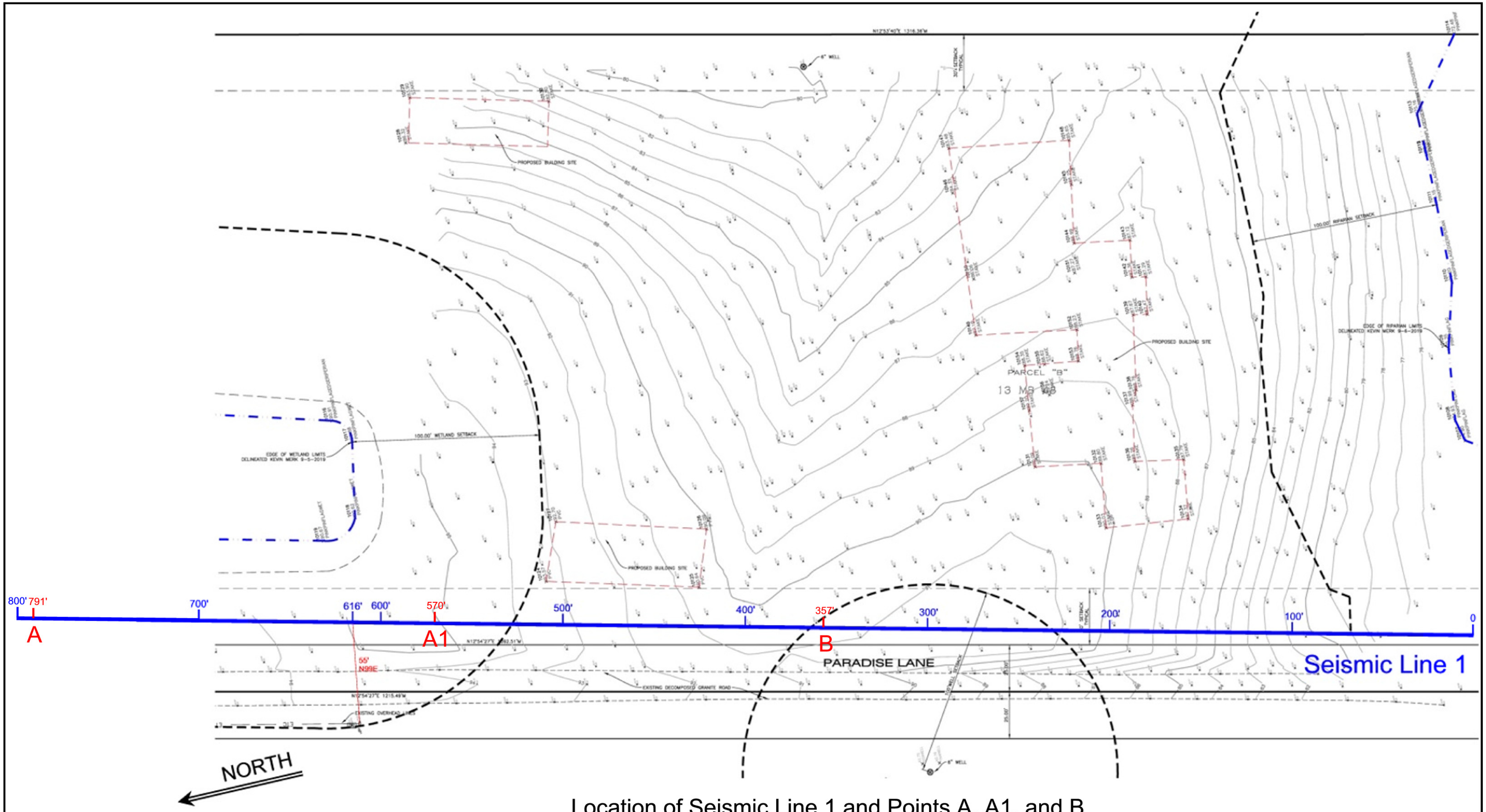
╌╌╌ Reflection Discontinuity Indicating Unconformity Surface Separating Franciscan KJfmv and KJfss Units

╌╌╌ Reflections from Bedding within Deeper Franciscan Formation Sandstone and Shale Unit (KJfss) Outcropping to South

╌╌╌ Near-Surface Fault Plane Interpretation Based on Reflection Pattern Deformation

Line 1- Seismic Reflection and Refraction Survey
For Investigation of Los Osos Fault
2420 Paradise Lane Los Osos, California

Figure 3
ADVANCED GEOSCIENCE, INC.
www.AdvancedGeoscience.com



Scale 1 inch= 50 Feet

Location of Seismic Line 1 and Points A, A1, and B
Topographic Map of South Part of Property
At 2420 Paradise Lane Los Osos, California

Figure 4
ADVANCED GEOSCIENCE, INC.