REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY PROPOSED NEW DETACHED BARN FOR A WEDDING VENUE 179 HIGHWAY 173 LAKE ARROWHEAD AREA SAN BERNARDINO COUNTY CALIFORNIA

PROJECT NO.: 1279-A19
REPORT NO.: 1

OCOTBER 30, 2019

SUBMITTED TO:

LEE & TERRI MILLER
C/O ASPEN CONSTRUCTION
P.O. BOX 1507
LAKE ARROWHEAD, CA 92352

PREPARED BY:

HILLTOP GEOTECHNICAL, INC.
786 SOUTH GIFFORD AVENUE
SAN BERNARDINO, CA 92408

786 S. GIFFORD AVENUE • SAN BERNARDINO • CALIFORNIA 92408
hilltopg@hgeotech.com • FAX 909-890-9055 • **909-890-9079**

HILLTOP GEOTECHNICAL
INCORPORATED

October 30, 2019

Lee & Terri Miller
C/O Aspen Construction
P.O. Box 1507
Lake Arrowhead, CA 92352

Project No.: 1279-A19
Report No.: 1

Attention: Mr. & Mrs. Miller

Subject: **Report of Preliminary Geotechnical / Geologic Study, Proposed Detached Barn for a Wedding Venue, 179 Highway 173, Lake Arrowhead Area, San Bernardino County, California.**

References:

1. **Barn Pros Nationwide,** August 21, 2019, *Teton 36, Miller, Lee & Terri, 279 Highway 193, Lake Arrowhead, CA 92352.* Sheets 1 of 12 through sheets 12 of 12.

2. **Hilltop Geotechnical, Inc.,** June 21, 2019, *Geotechnical Investigation, for a Proposed Detention Basin Design, Double Ring Infiltrometer Testing, and Grading Recommendations, Lake Arrowhead Area, San Bernardino County, California,* Project No.: 1248-A19 Report No.: 1.

3. Technical References - See Appendix 'B.'

Mr. & Mrs. Miller:

According to your request, we have completed a preliminary geotechnical / geologic study for the design and construction of the proposed Wedding Venue Barn. We are presenting, herein, our findings and recommendations.

The recommendations presented in this report are considered preliminary since the final locations of the proposed structure, the proposed grading, the floor level elevation, etc. were not known at the time of this report. The findings of this study indicate that the project site is suitable for the proposed development provided the recommendations presented in the attached report are complied with and incorporated into the design and construction of the project.

Copies of this report should be forwarded to the other consultants for the project (i.e., Civil Engineer, Architect, Structural Engineer, etc.) as needed to implement the recommendations presented. The required number of the original, wet ink signed reports should be saved for submittal, and the other required documentation to the appropriate agency having jurisdiction over the project for review and permitting purposes.

If you have any questions after reviewing the findings and recommendations contained in the attached report, please do not hesitate to contact this office. This opportunity to be of professional service is sincerely appreciated.

Respectfully Submitted,
HILLTOP GEOTECHNICAL, INC.

PROFESSIONAL GEOLOGIST · MARK EDWARD HULETT No.1623 CERTIFIED ENGINEERING GEOLOGIST · STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER · MAIHAN NOORZAY No. GE3085 GEOTECHNICAL · STATE OF CALIFORNIA

Mark Hulett, CEG No. 1623
President

Maihan Noorzay, G.E. No. 3085
Geotechnical Engineer

PROFESSIONAL GEOLOGIST · ASHLEY DAWN HULETT No. GEO 9533 · STATE OF CALIFORNIA

Ashley Hulett, GEO No. 9533
Staff Geologist

AH/NS/MH/SH/ss

TABLE OF CONTENTS

Section Title **Page No.**

Distribution:	(4)	Addressee Via U.S. Postal Service
	(1)	Addressee pdf Copy Via E-Mail (Stacey.aspenconstruction@gmail.com) (millertime9664@icloud.com)

TABLE OF CONTENTS

TABLE OF CONTENTS

Section Title **Page No.**

TABLE OF CONTENTS

REPORT OF PRELIMINARY GEOTECHNICAL / GEOLOGIC STUDY PROPOSED NEW DETACHED BARN FOR A WEDDING VENUE 179 HIGHWAY 173 LAKE ARROWHEAD AREA SAN BERNARDINO COUNTY CALIFORNIA

PROJECT NO.: 1279-A19
REPORT NO.: 1

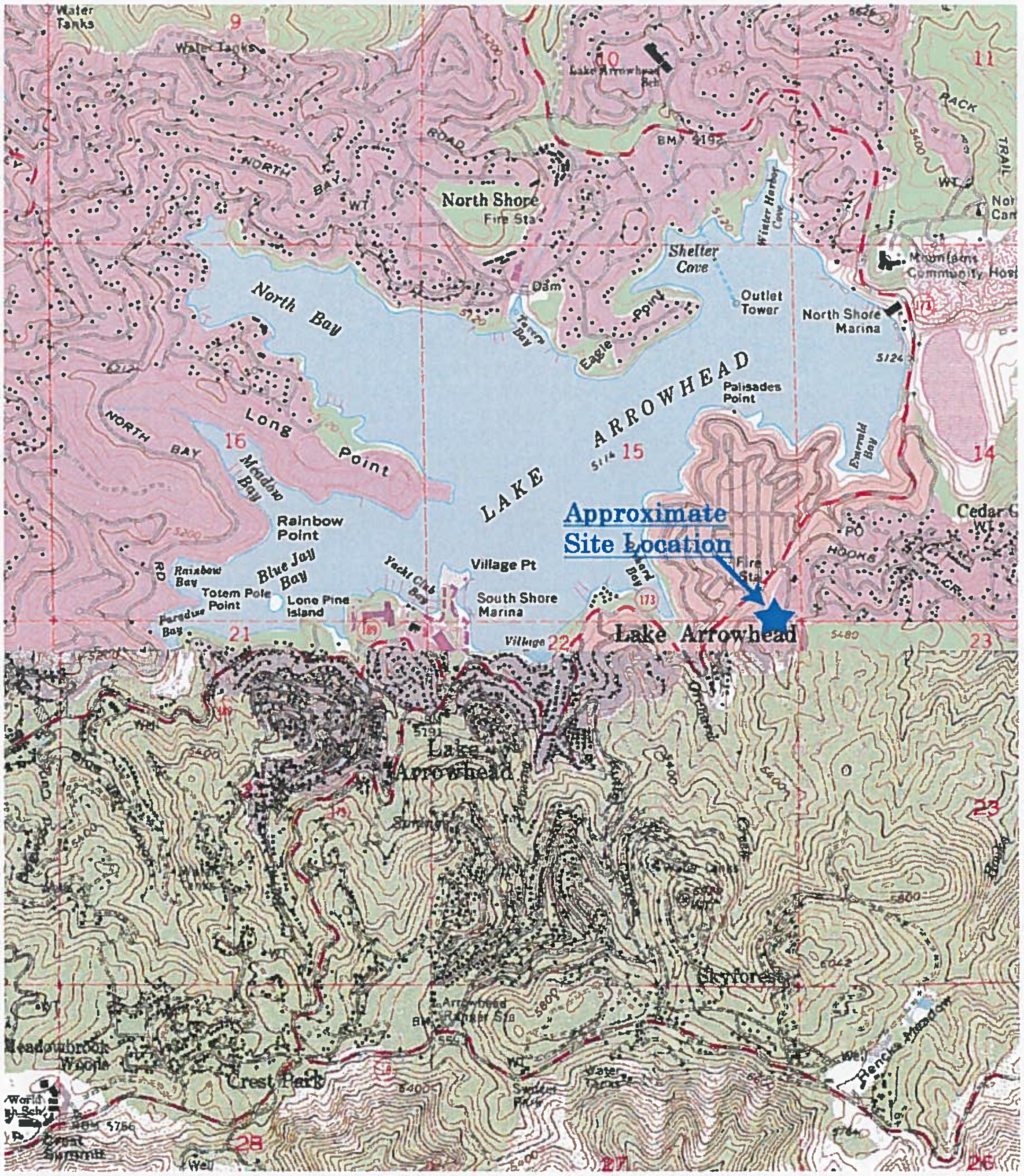
OCTOBER 30, 2019

INTRODUCTION

AUTHORIZATION

This report presents results of the preliminary geotechnical / geologic study conducted on the subject site for the proposed wedding venue barn to be located at 179 Highway 173 in the Lake Arrowhead Area San Bernardino County, California. The general location of the subject site is indicated on the 'Site Location Map,' Figure No. 1.

Authorization to perform this study was in the form of a signed proposal from **Hilltop Geotechnical, Inc. (HGI)** (Geotechnical / Geologic Consultant) to **Lee & Terri Miller in care of Aspen Construction** (Client), dated September 17, 2019, Proposal Number: P19174 and signed by Mrs. Terri Miller (Property Owner) on September 19th, 2019.



0 2000 4000
Approximate Scale in Feet

N

Reference: **United States Department of the Interior, Geologic Survey**, 1967, Photorevised 1988, *Harrison Mountain Quadrangle, California, San Bernardino Co.,* 7.5 Minute Topographic Series, Scale 1:24,000.
United States Department of the Interior, Geologic Survey, 1971, Photorevised 1988, *Lake Arrowhead Quadrangle, California, San Bernardino Co.,* 7.5 Minute Topographic Series, Scale 1:24,000.

HILLTOP GEOTECHNICAL INCORPORATED	SITE LOCATION MAP	
	By: AH	Date: 10/2019
	Project No.: 1279-A19.1	Figure No.: 1

PURPOSE AND SCOPE OF STUDY

The scope of work performed for this study was designed to determine and evaluate the surface and subsurface conditions in the vicinity of the proposed barn on the subject site with respect to geotechnical characteristics, including potential geologic hazards that may affect the development of the site, and to provide geotechnical recommendations and criteria for use in the design and construction of the proposed development. The scope of work included the following:

- Review of locally and easily available published and unpublished soil, geologic, and seismologic reports and data for the area (see References in Appendix 'B') available photographs via Google Earth, flood hazard maps, well data, etc. to ascertain earth material, geologic, and hydrologic conditions of the area.
- Meetings and telephone conversations with the client and/or representatives of the client.
- Site reconnaissance.
- Subsurface exploration by means of backhoe trenches to characterize the earth materials, geologic, and groundwater conditions that could influence the proposed development.
- Sampling of on-site earth materials from the exploratory excavations.
- Laboratory testing of selected earth material samples considered representative of the subsurface conditions to determine the engineering properties and characteristics.
- Define the general geology of the subject site and evaluate potential geologic hazards which would have an effect on the proposed site development.
- Determine seismic classification of the site to meet the requirements of the 2016 California Building Code (CBC), effective on January 1, 2017.

- Engineering analysis of field and laboratory data to provide a basis for geotechnical conclusions and recommendations regarding site grading and foundation, floor slab, pavement, etc. design parameters.

- Preparation of this report to present the geotechnical and geologic conclusions and recommendations for the proposed site development.

This report presents our conclusions and/or recommendations regarding:

- The geologic setting of the site.

- Potential geologic hazards (including landslides, seismicity, faulting, liquefaction potential, etc.)

- General subsurface earth conditions.

- Presence and effect of expansive, collapsible, and compressible earth materials.

- Groundwater conditions within the depth of our subsurface study.

- Excavation characteristics of the on-site earth materials.

- Evaluation of stability of proposed temporary cut slopes and permanent cut and/or fill slopes.

- Characteristics and compaction requirements of proposed fill and backfill materials.

- Recommendations and guide specifications for earthwork.

- Seismic design coefficients for structural design purposes.

- Types and depths of foundations.

- Allowable bearing pressure and lateral resistance for foundations.

- Preliminary corrosion potential evaluation for concrete and buried metal in direct contact with the on-site earth materials.

- Utility trench excavation and backfill recommendations.

- Preliminary pavement recommendations.

The scope of work performed for this report did not include any testing of earth materials or groundwater for environmental purposes, an environmental assessment of the property, or opinions relating to the possibility of surface or subsurface contamination by hazardous or toxic substances. In addition, evaluation of on-site private sewage disposal systems for the proposed development was not part of this study.

This study was prepared for the exclusive use of **Lee & Terri Miller** and their consultants for specific application to the development of the proposed wedding venue barn in accordance with generally accepted standards of the geotechnical and geologic professions and generally accepted geotechnical (soil and foundation) engineering principles and practices at the time this report was prepared. Other warranties, implied or expressed, are not made. Although reasonable effort has been made to obtain information regarding geotechnical / geologic and subsurface conditions of the site, limitations exist with respect to knowledge of unknown regional or localized off-site conditions which may have an impact at the site. The conclusions and recommendations presented in this report are valid as of the date of this report. However, changes in conditions of a property can occur with passage of time, whether they are due to natural processes or to works of man on this and/or adjacent properties.

If conditions are observed or information becomes available during the design and construction process which are not reflected in this report, **HGI**, as Geotechnical / Geologic Consultant of record for the project, should be notified so that supplemental evaluations can be performed and conclusions and recommendations presented in this report can be verified or modified in writing, as necessary. Changes in applicable or appropriate standards of care in the geologic / geotechnical professions occur, whether they result from legislation or the broadening of knowledge and experience. Accordingly, the conclusions and recommendations presented in this report may be invalidated, wholly or in part, by changes outside the influence of the project Geotechnical / Geologic Consultant which occur in the future.

PREVIOUS SITE STUDIES

No previous geotechnical and/or geological studies for the subject site are known to have been performed or were made available for review at the time of this study, if any had been performed. However, a preliminary study performed by HGI was performed directly north of the site for the retention basin, Project No. 1248-A19.

PROJECT DESCRIPTION / PROPOSED DEVELOPMENT

As part of our study, we have discussed the project with Pat of Aspen Construction, the contractor for the project. We also have been provided with the Reference No. 1 'Teton 36 Plan' noted on the first page of the cover letter for this report.

Based on information presented to this firm, it is our understanding that the proposed project will consist of a single story 36 foot by 60 foot barn. The maximum dead loads plus frequently applied live loads for the structures are assumed to be light to moderate. The specific location of the proposed barn on the subject site and the pad elevation was not indicated on the referenced site plan. An overall site plan was not available for review at the time of this study. No cut and fill slopes were proposed for the development of the site. Retaining walls or subterranean construction are not anticipated for the development of the project.

The above project description and assumptions were used as the basis for the field exploration, laboratory testing program, the engineering analysis, and the conclusions and recommendations presented in this report. **HGI** should be notified if structures, foundation loads, grading, and/or details other than those represented herein are proposed for final development of the site so a review can be performed, a supplemental evaluation made, and revised recommendations submitted, if required.

FIELD EXPLORATION AND LAB TESTING

The field study performed for this report included a visual reconnaissance of existing surface conditions of the subject site and surrounding area. A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Surface and subsurface conditions were explored on September 26, 2019.

The subsurface exploration consisted of excavating two (2) exploratory backhoe trenches in the area of the proposed structure on the subject property. The approximate locations of the exploratory excavations are shown on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in Appendix 'A' of this report. The exploratory excavations were observed and logged by a representative of **HGI**. Earth materials encountered in the exploratory excavations were visually described in the field in general accordance with the current Unified Soils Classification System (USCS), ASTM D2488, visual-manual procedures, as illustrated on the attached, simplified 'Subsurface Exploration Legend,' Plate No. 2, presented in Appendix 'A' of this report. The results are presented on the 'Subsurface Exploration Log,' Plate Nos. 3 and 4, presented in Appendix 'A' of this report.

A more detailed explanation of the field study which was performed for this report is presented in Appendix 'A' of this report.

Representative bulk and chunk samples of on-site fill and natural earth materials were collected during the field exploration and returned to the laboratory for testing. Laboratory tests were conducted to evaluate the index and engineering properties of on-site earth materials and included in-situ dry density and moisture content tests, a soluble sulfate chemical test, an Atterberg Limit test, a maximum dry density / optimum moisture content relationship test, and a direct shear test. A more detailed explanation of laboratory tests performed for this study and test results are presented in Appendix 'A' of this report, Plate Nos. 5 through 7.

FINDINGS

SITE DESCRIPTION

The subject property comprises approximately 0.28 acres was generally rectangular in shape and approximately 100 feet by 120 feet in plan dimension as shown on the Assessor's parcel Map Book 0331 Page 09 San Bernardino County. The subject property is located at 179 Highway 173 in the Lake Arrowhead area of San Bernardino County, California. The subject property is located southwest side of State Highway 173 and northeast of the Mill Pond Retention Basin Development in the northeast one-quarter of the one-quarter of

Section 22, T2N, R3W of the San Bernardino Principle Meridian at Latitude: 34.2528° North, Longitude: 117.1739° West.

The Assessor's Parcel Number for the property is as follows:

(APN 0331-095-02)

The immediate areas of the proposed barn are bounded by the existing asphalt roadway to the southeast, a single story building to the north, Hook Creek to the northeast, and the Lake Arrowhead Nursery to the west. It is our understanding that the previous owners of the property were contractors and it was unknown what the use of the property was by the previous owners. At the time of this field study various tractors, backhoes, trucks and equipment was located in the vicinity of the barn.

The immediate area of the subject site was almost flat with a shallow, downward inclination toward the northwest at an average gradient of approximately 5 percent, calculated from Google Earth. Total on-site relief in the area of the proposed barn was approximately 3 feet. The minimum and maximum elevations within the immediate area of the proposed development on the subject site was approximately 5280 and 5278 Mean Sea Level (MSL), respectively. On-site drainage was accomplished by sheetflow toward the northwest.

At the time of the field study, two commercial buildings were present on the site near the Highway. Utilities consisting of electric, telephone, gas, sewer, water, as well as other unknown underground and overhead lines, were observed to be present on and adjacent to the site. Due to the ages of the structures and the locations on the site, it is anticipated that cisterns, leach lines, and septic tanks also may still be present in the vicinity of the building.

Several end dumped piles of construction debris, miscellaneous debris and refuse, soil, etc. were observed at various locations throughout the subject property generally outside of the building footprint.

At the time of the field study, vegetation along the creek and in the southern portion of the site was dense and wooded, the northern portion of the site contained very light vegetation likely developed from the gardening area to the north.

ENGINEERING GEOTECHNICAL ANALYSIS

Regional Geological Setting

The San Bernardino Mountains, the San Gabriel Mountains, and other ranges to the west and east of the subject site are portions of the Transverse Ranges Province, a nearly 300-mile-long belt of folded, faulted, and uplifted rocks of diverse lithologies. The east-west orientation of the Transverse Ranges markedly contrasts with the generally northwest-trending, structural grain of surrounding areas in Southern California. The presence and orientation of these ranges are generally attributed to north-south directed compressional forces and crustal shortening related to complications within the geometry of the San Andreas transform fault system. These complications are reflected in the kinematics of faults that bound virtually all sides of the San Bernardino Mountains block, faults that include right- and left-lateral strike-slip, and normal and reverse dip-slip displacements.

Basement rocks in the San Bernardino Mountains are similar to those observed in the Mojave Desert areas to the north and consist of Triassic through Cretaceous granitoid rocks of various compositions that have intruded prebatholithic orthogneiss (Proterozoic) and Late Proterozoic to Paleozoic metasedimentary rocks. The layered metasedimentary units consist of quartzites, marbles, pelitic schists, and gneisses, and are stratigraphic equivalents to marine sedimentary rocks that are widespread in the eastern Mojave and Great Basin regions. Deformed and undeformed suites of Mesozoic plutonic rocks predominate in the western San Bernardino Mountains. Least-common rock types around the margins of the range include banded and layered Mesozoic metasediments and several Tertiary sedimentary units, usually located within fault-bounded slivers and blocks.

The San Andreas fault zone is the dominant structural element in the central Transverse Ranges. Extending over 650 miles from the Gulf of California to the vicinity of Cape Mendocino in northwestern California, the San Andreas fault zone often comprises a strip up to several miles wide of subparallel, branching, and anastamosing fault strands. The fault zone accommodates mostly right-lateral, strike-slip displacements, with small vertical components locally significant in some areas. Current understanding of California tectonics indicates that the fault can be divided into several discrete segments along its length, based upon differing geologic and seismic characteristics. Each discrete segment appears to react to tectonic stress more or less independently from the others, and to have its own characteristic large earthquake with differing maximum magnitude potential and recurrence interval. The San Bernardino segment lies coincident to the southern edge of the San Bernardino Mountains.

The site contains artificial fill underlain by young alluvium and/or axial valley deposits. The alluvium was likely deposited from the adjacent drainage sometime in the recent geologic past. The wedding barn is proposed adjacent a drainage with dense foliage and trees. The result was marshy land that was soft, moist, and loose. Although not investigated, at depth, the site likely contains mixed granitic rocks of Heaps Peak. The general geology in the area of the subject site is shown on the 'Regional Geology Map,' Figure No. 2a, and the 'Regional Geology Map Legend,' Figure No. 2b.

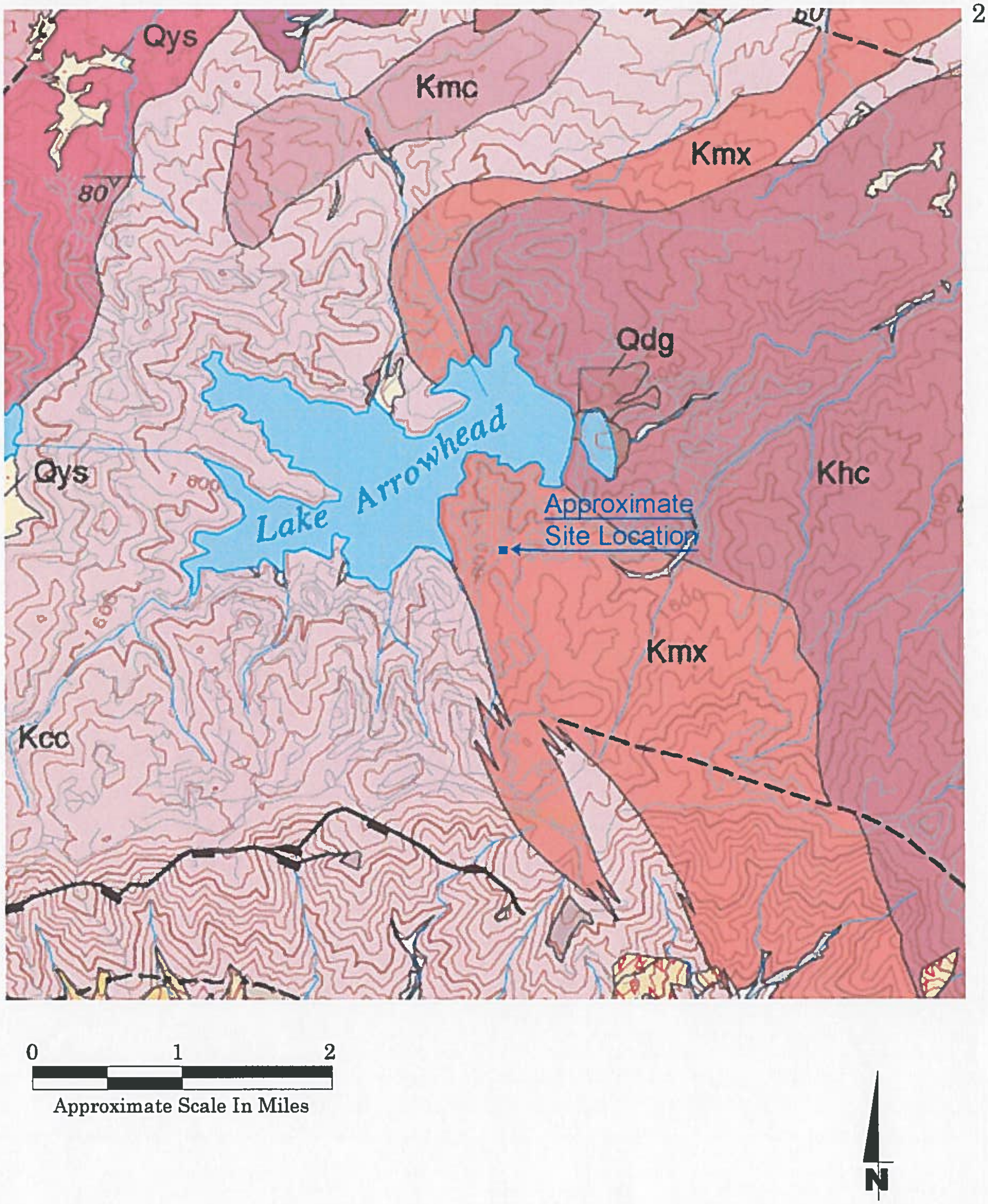
Local Subsurface Conditions

Earth Materials Description:

Presented as follows are brief descriptions of the earth materials encountered in the exploratory excavations. More detailed descriptions of encountered earth materials are presented on the 'Subsurface Exploration Log,' Plate Nos. 3 and 4, presented in Appendix 'A' of this report. The earth material strata, as shown on the logs, represent conditions at the actual exploratory excavation locations. Other variations may occur beyond and/or between the excavations. Lines of demarcation between earth materials on the logs represented the approximate boundary between the material types; however, the transition may be gradual.

The earth materials encountered on the subject site during the field exploration were identified as man-made fill (af), and alluvium (Qal).

Man-made fill was encountered at both of the trench locations. The fill extended to a depth of approximately 8 to 10 feet at the location of the exploratory excavations. The fill generally consisted of non-plastic silty fine to coarse sand with traces of gravel and debris. The fill was gray brown, dark brown, and humid brown with traces of black. The base of the fill smelled of



Reference: **California Department of Conservation, Division of Mines and Geology**, 2006, Morton, D.M., Miller, F.K., (Digitally Prepared by Cossette, P.M. and Bovard, K.R.); *Preliminary Geologic Map of the San Bernardino 30' x 60' Quadrangle, California*, Version 1.0, Scale: 1:100,000.

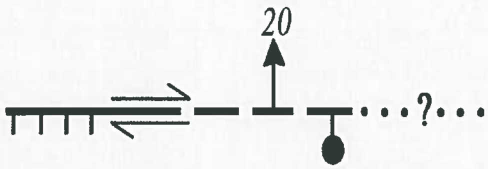
HILLTOP GEOTECHNICAL
INCORPORATED

REGIONAL GEOLOGY MAP	
By: AH	Date: 10/2019
Project No.: 1279-A19.1	Figure No.: 2a

Legend for Geologic Symbols and Units

Separates geologic-map units. Solid where meets map-accuracy standard; dashed where may not meet map-accuracy standard; dotted where concealed

Contact—Separates terraced alluvial units where younger alluvial unit is incised into older alluvial unit; hachures at base of slope, point toward topographically lower surface. Solid where meets map-accuracy standard; dashed where may not meet map-accuracy standard



Fault—Solid where meets map-accuracy standard; dashed where may not meet map accuracy standard. Dotted where concealed by mapped covering unit; queried where existence uncertain. Hachures indicate scarp, with hachures on downdropped block. Paired arrows indicate relative movement; single arrow indicates direction and amount of fault-plane dip. Bar and ball on down-thrown block.

Qls — Qls - Very young landslide deposits (late Holocene).

Tcf — Tcf - Conglomerate of Fredalba (Pliocene).

Kcc — Kcc - Monzogranite of Manzanita Springs (Triassic).

Kmx — Kmx - Mixed ganitic rock of Heaps Peak (Cretaceous).

Khc — Khc - Granodiorite of Hook Creek (Cretaceous).

Trm — Trm - Monzogranite of Manzanita Springs (Triassic).

Reference: **California Department of Conservation, Division of Mines and Geology**, 2006, Morton, D.M., Miller, F.K., (Digitally Prepared by Cossette, P.M. and Bovard, K.R.); *Preliminary Geologic Map of the San Bernardino 30' x 60' Quadrangle, California*, Version 1.0, Scale: 1:100,000.

HILLTOP GEOTECHNICAL INCORPORATED	**REGIONAL GEOLOGY MAP LEGEND**	
	By: AH	Date: 10/2019
	Project No.: 1279-A19.1	Figure No.: 2b

organics. The debris consisted of concrete particles, metals, PVC pipes and trash. The fill was dry at the surface to moist with depth, and loose in relative density. The in-place density tests indicated that the fill had an average relative compaction of approximately 70 to 81 percent. The fill is considered to be undocumented and unsuitable for support of structural fill and/or a building structure.

The alluvium was generally encountered in the lower portions of the subject site and generally consisted of silty fine to coarse sands with varying amounts of gravel (SM). The alluvium was light brown to brown in color and moist. Locally, the alluvium extended to depths in excess of 10 and 11 feet below the existing ground surfaces at the excavation locations on the subject site. The trenches were terminated in the alluvial deposit.

Groundwater

Groundwater was not encountered in the exploratory excavations to the maximum depth explored of approximately 11 feet below existing ground surface at the trench locations at the time the field study was performed for this report. However very moist vegetation was encountered at a depth of 8 feet in Trench No. 2 that is likely indicative of the groundwater elevation at some time in the past.

Groundwater was encountered at a depth of 11.5 feet below the existing ground surface at the time of the field work performed for Reference No. 2, southwest of the proposed barn.

Based on anticipated removal and replacement operations, we anticipate that groundwater may be a factor for project design and construction.

Surface Water

Surface water was observed in the creek bottom east of the proposed detention basin. During the winter month it is likely the creek increases flow velocities and erosional capabilities. The Civil engineer for the project should assess the scour depth of the creek and factor into the final design.

Site Variations

Based on results of our subsurface exploration and experience, variations in the continuity and nature of surface and subsurface conditions should be anticipated. Due to uncertainty involved in the nature and depositional characteristics of earth materials at the site, care should be exercised in extrapolating or interpolating subsurface conditions between and beyond the exploratory excavation locations.

Groundwater observations were made in the exploratory excavations at times and under conditions stated on the trench logs. These data have been reviewed and interpretations made in the text in other sections of this report. However, it should be noted that fluctuations in levels of groundwater, springs, and/or perched water may occur due to variations in precipitation, temperature, and other factors.

Faulting and Regional Seismicity

The site is situated in an area of active and potentially active faults, as is most of metropolitan southern California. Active faults present a variety of potential risks to structures, the most common of which are strong ground shaking, dynamic densification, liquefaction, mass wasting, and surface rupture at the fault plane. Generally speaking, the following four (4) factors are the principal determinants of seismic risk at a given location:

- Distance to seismogenically capable faults.
- The maximum or "characteristic" magnitude earthquake for a capable fault.
- Seismic recurrence interval, in turn related to tectonic slip rates.
- Nature of earth materials underlying the site.

Surface rupture represents the primary potential hazard to structures built in an active fault zone. A review of official maps delineating State of California earthquake fault zones found that the subject site lies in the southern portion of the Lake Arrowhead Quadrangle. No Alquist-Priolo fault study zones are located within this quadrangle. In addition, the site is not located within a zone of mandatory study for active faulting per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH15 C Lake Arrowhead, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general). Additionally, no known active faults trend toward the subject property.

The most recent, large earthquake that occurred in close proximity to the subject property was the June 28, 1992 Big Bear earthquake. The epicenter of this quake was located approximately 32.4 kilometers east southeast of the subject property at Latitude: 34.2030° North, Longitude: 116.8270° West. The Big Bear quake had a measured magnitude of 6.7, had no surface rupture, and is believed to have occurred on a blind thrust fault, the exact location and geometry of which currently are unknown. Several aftershocks also were centered very near the epicenter, including a magnitude 5.6 aftershock.

Ground shaking is judged to be the primary hazard most likely to affect the site, based upon proximity to nine (9) regionally significant active faults as listed in the following table. Other significant fault zones, including Pinto Mountain fault, the Sierra Madre fault, and several zones in the high desert area are located at distances exceeding 45 kilometers from the site. Greater distances, lower slip rates, and lesser maximum magnitudes indicate much lower risk to the site from the latter fault zones than the nine (9) closest faults including the regionally significant San Andreas fault. Characteristics of the major active fault zones selected for inclusion in analysis of strong ground shaking are listed in the following table:

Fault Zone[1]	Distance (km)[2] / Direction from Site	Fault Length (km)[1]	Slip Rate (mm/yr)[1]	Reference Earthquake M(Max)[1]	Fault Type[1]
[4]North Frontal (Western Segment) (r, 45 S)	0.0[4]/ North Northwest	51±5	1.0±0.5	7.2	B
Cleghorn (ll-ss)	4.3/ West	25±3	3.0±2.0	6.5	B
San Andreas (San Bernardino Segment) (rl-ss)	10.4 / Southwest	103±10	24.0±6.0	7.5	A
San Jacinto (San Bernardino Segment) (rl-ss)	23.0 / Southwest	36±4	12.0±6.0	6.7	A
Cucamonga (r,45 N)	24.9 / Southwest	28±3	5.0±2.0	6.9	B

Fault Zone[1]	Distance (km)[2] / Direction from Site	Fault Length (km)[1]	Slip Rate (mm/yr)[1]	Reference Earthquake M(Max)[1]	Fault Type[1]
San Jacinto (San Jacinto Valley Segment) (rl-ss)	26.8 / South Southwest	43±4	12.0±6.0	6.9	A
Helendale - S. Lockhardt (rl-ss)	29.6 / Northeast	97±10	0.6±0.4	7.3	B
San Andreas (Mojave Segment) (rl-ss)	33.3 / Northwest	103±10	30.0±7.0	7.4	A
North Frontal (Eastern Segment) (r,45 S)	33.6 / Northeast	27±3	0.5±0.3	6.7	B

1. **Tianqing, C.W., Bryant, W.A., Rowshandel, B., Branum, D., and Wills, C.J.**, June 2003, *The Revised 2002 California Probabilistic Seismic Hazards Maps (Appendix A - 2002 California Fault Parameters).*
   California Department of Conservation, Division of Mines and Geology, 1996, *Probabilistic Seismic Hazard Assessment for the State of California*, DMG Open-File Report 96-08.
2. **Blake, Thomas F.**, 2000, *Preliminary Fault-Data for EQFault, EQSearch and FriskSP* and **Blake, Thomas, F.,** *Computer Services and Software, Users Manuals, FriskSP v. 4.00, EQSearch v. 3.00, and EQFault v. 3.00.*
3. Fault Geometry: (ss) strike slip; (r) reverse; (n) normal; (rl) right lateral; (ll) left lateral; (O) oblique; (45 N) direction.
4. The North Frontal fault is shown by the computer program *EQFault* to be on-site. However, this is not correct and results from the computer search parameters combined with the geometry of the fault: it is a south-dipping, 45-degree, reverse fault. The closest surface expression of the North Frontal fault is approximately 10 kilometers to the north-northwest of the subject site.

Probabilistic seismic hazard maps and data files prepared by the **United States Geological Survey (USGS)** determine ground motions with a 10-percent probability of being exceeded in the next 50 years (475 years mean return time) as a fraction of the acceleration due to gravity for peak ground acceleration (PGA) and spectral accelerations (Sa) for short and moderately long periods, 0.2 seconds and 1.0 second, respectively. This data was available at the

USGS 'Unified Hazard Tool' web site (https://earthquake.usgs.gov/hazards/interactive/). The values are presented in the following table for reference:

GROUND MOTION*	SITE ACCELERATION Site Class D**
PGA	0.5273g
Sa @ 0.2 Sec.	1.2135g
Sa @ 1.0 Sec.	0.7865g
* 10-percent probability of being exceeded in the next 50 years (475 years mean return time). ** Shear Wave Velocity of 259 m/sec was assumed for the on-site materials.	

USGS assigns a 2-percent likelihood that a Peak Horizontal Ground Acceleration (PGA) of approximately 0.8566g will occur at this site within the next 50 years (2,475 years mean return time). This data was available at the **USGS** 'Unified Hazard Tool' web site (https://earthquake.usgs.gov/hazards/interactive/).

Actual shaking intensities at the site from any seismic source may be substantially higher or lower than estimated for a given earthquake magnitude, due to complex and unpredictable effects from variables such as:

- Near-source directivity effects.
- Direction, length, and mechanism of fault rupture (strike-slip, normal, reverse).
- Depth and consistency of unconsolidated sediments.

- Topography.
- Geologic structure underlying the site.
- Seismic wave reflection, refraction, and interference.

Secondary Seismic Hazards

Secondary hazards include induced landsliding or mass wasting, liquefaction, flooding (from ruptured tanks and reservoirs, surface oscillations in larger lakes, or seismic sea waves), and subsidence as a result of soil densification. Landsliding and liquefaction susceptibility maps have been prepared for much of coastal Los Angeles and Orange County, California by the **CGS**. However, this area of San Bernardino County, California is not presently scheduled for mapping by the State.

Landslide

The subject site is located within a designated area as having a low to moderate landslide susceptibility per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH15 C Lake Arrowhead Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

Field reconnaissance did not disclose the presence of older, existing landslides within or near the subject property. Due to the nature of the relatively flat area for the proposed barn, and the observed-up slope developments and observations the potential for landsliding and/or seismic induced landsliding is considered to be low.

Liquefaction

Liquefaction is a process in which strong ground shaking causes saturated soils to lose their strength and behave as a fluid (Matti and Carson, 1991). Ground failure associated with liquefaction can result in severe damage to structures. Soil types susceptible to liquefaction include sand, silty sand, sandy silt, and silt, as well as soils having a plasticity index (PI) less than 7 (Boulanger and Idriss, 2004) and loose soils with a PI less than 12 and a moisture content greater than 85 percent of the liquid limit (Bray and Sancio, 2006). The geologic conditions for increased susceptibility to liquefaction are: 1) shallow groundwater (generally less than 50 feet in depth); 2) the presence of unconsolidated sandy alluvium, typically Holocene in age; and 3) strong ground shaking. All three of these conditions must be present for liquefaction to occur.

The subject site is not located within a designated area as having a liquefaction potential per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH15 C Lake Arrowhead, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

Groundwater is expected to be relatively shallow at the subject site (approximately 8 feet bgs) which may induce liquefaction-based settlement when subjected to strong groundshaking. Liquefaction potential and liquefaction-based settlement was not analyzed for this report. Additional exploration and analysis are warranted in order to evaluate liquefaction potential and liquefaction-based settlement.

Seismically Induced Subsidence

Loose sandy soils subjected to moderate to strong ground shaking can experience settlement. Experience from the Northridge Earthquake indicates that structural distress can result from such seismic settlement. Seismically induced subsidence was not analyzed for this report. Additional exploration and analysis are warranted in order to evaluate seismically induced subsidence.

Lateral Spreading

Lateral spread is the most pervasive type of liquefaction-induced ground failure. Lateral spreads can occur on gently sloping ground or where nearby drainage or stream channels can lead to static shear stress biases on essentially horizontal ground. During lateral spread, blocks of mostly intact, surficial earth material displace downslope or towards a free face along a shear zone that has formed within the liquefied sediment. The resulting ground deformation typically has extensional fissures or a graben at the head of the failure, shear deformations along the side margins, and compression or buckling of the earth material at the toe. The amount of lateral displacement typically ranges from a few centimeters to several meters and can cause considerable damage to engineered structures and lifelines.

Lateral spreading was not evaluated during preparation of this report. Additional exploration and analysis are warranted in order to evaluate lateral spreading.

Seiching

Seiching involves an enclosed body of water oscillating due to ground shaking, usually following an earthquake. Lakes and water towers are typical bodies of water affected by seiching. However, the site does not appear to be within the influence of large bodies of water and, as such, seiching should not be considered a geologic hazard for the development of the subject site.

Tsunamis

Because of the inland geographic location of the site, tsunamis are not considered a geologic hazard for the development of the subject site.

Lurching

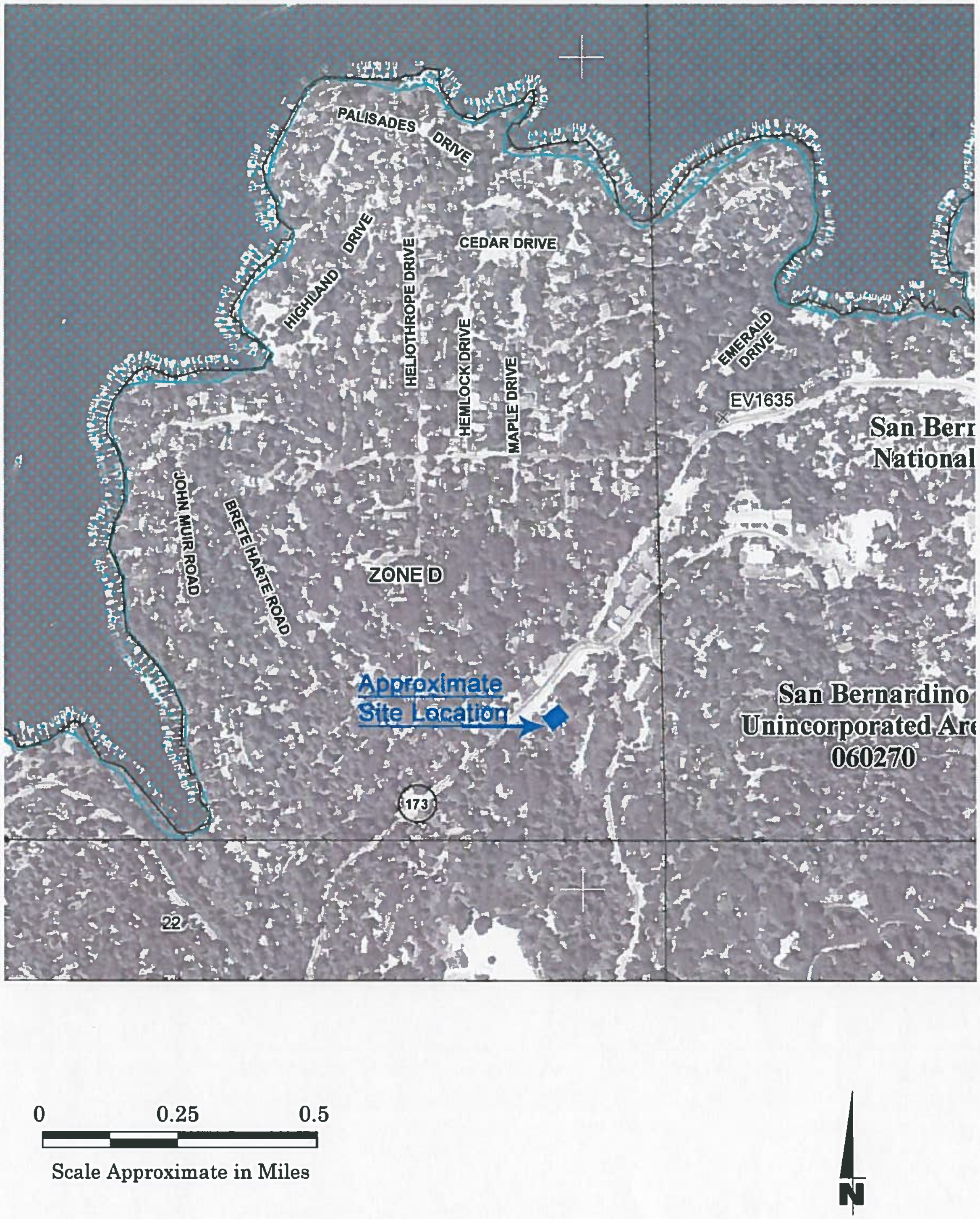
Lurching is a phenomenon in which ground cracking and/or secondary faulting occurs as a result of ground shaking. Generally, lurching primarily occurs in the immediate vicinity of faulting or within typical building setback zones or "No Human Occupancy" zones. No evidence of faulting was encountered on the site and although the potential for lurching cannot be entirely ruled out, the likelihood for lurching to impact the site is considered to be low.

OTHER GEOLOGIC HAZARDS

Flooding

The subject site is located within a designated area as having an "undetermined, but possible" flooding potential per **San Bernardino County Planning Department**, *San Bernardino County Land Use Plan, GENERAL PLAN, Hazard Overlays*, Sheet FH15 B Lake Arrowhead, Plot Date: 03/09/2010, Scale: 1:14,400 (http://www.co.san-bernardino.ca.us/landuseservices/general).

Flood Insurance Rate Maps (FIRM) were compiled by the **Federal Emergency Management Agency (FEMA)** for the Flood Insurance Program and are available for most areas within the United States at the **FEMA** web site (http://msc.fema.gov/). The attached 'FEMA Flood Hazard Map' and 'FEMA Flood Hazard Map Legend,' Figure Nos. 3a and 3b, respectively, are based on



Reference: **U.S. Federal Emergency Management Administration (FEMA)**, Revised August 28, 2008, *Flood Insurance Rate Map*, Map No. 06071C 7243 H. Site specific information obtained through FEMA website, Map Service Center (http://msc.fema.gov/).

HILLTOP GEOTECHNICAL INCORPORATED	FEMA FLOOD HAZARD MAP	
	By: AH	Date: 10/2019
	Project No.: 1279-A19.1	Figure No.: 3a

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

HILLTOP GEOTECHNICAL INCORPORATED

FEMA FLOOD HAZARD MAP LEGEND	
By: AH	Date: 10/2019
Project No.: 1279-A19.1	Figure No.: 3b

FIRMs provided by **FEMA** and are specific to the area around the subject site. The 'FEMA Flood Hazard Map,' Figure 3a, indicates that the site is located within 'Zone D' (an area in which flood hazards are undetermined but possible).

Expansion Potential

Materials tested during this investigation were considered granular and non-critically expansive. Specialized construction procedures to specifically resist expansive soil forces are not anticipated at this time. Requirements for reinforcing steel to satisfy structural criteria are not affected by this recommendation. Additional evaluation of soils for expansion potential should be conducted by the geotechnical engineer during the grading operation.

Hydroconsolidation

Based on the anticipated removal and replacement operation, it is our opinion that potential for hydrocollapse settlement to significantly affect the proposed structure should be considered low.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The conclusions and recommendations presented in this report should be considered preliminary and are, in part, based on information provided to this firm, the results of the field and laboratory data obtained from two (2) exploratory excavations located on the subject property, experience gained from work conducted by this firm on projects within the general vicinity of the subject site, the project description and assumptions presented in the 'Project Description / Proposed Development' section of this report, engineering analyses, and professional judgement.

Based on a review of the field and laboratory data and the engineering analysis, the proposed development is feasible from a geotechnical / geologic standpoint. The subject property can be developed without adverse impact onto or from adjoining properties providing the recommendations contained within this report are adhered to during project design and construction.

The field observations indicate that up to 10 feet of material present on the subject site is undocumented fill material, however, localized areas of deeper fills may be encountered during construction. These materials are considered loose and compressible and are not considered suitable for the support of structural fills, foundations, slabs-on-grade, hardscape, and/or pavement without removal and replacement as compacted fill. On this basis, it is recommended that the upper 10 feet of the site soils be removed and replaced as engineered fill in order to densify the material and minimize the potential for settlement to occur.

The actual conditions of the near-surface supporting material across the site may vary. The nature and extent of variations of the surface and subsurface conditions between the exploratory excavations may not become evident until construction. If variations of the material become evident during construction of the proposed development, **HGI** should be notified so that the project Geotechnical / Geologic Consultant can reevaluate the characteristics of the material and the conclusions and recommendations of this report, and, if needed, revise the conclusions and recommendations presented herein.

Preliminary recommendations for site grading, foundations, slab support, and pavement design are presented in the subsequent paragraphs.

RECOMMENDATIONS

2016 CALIFORNIA BUILDING CODE - SEISMIC PARAMETERS

Based on the geologic setting and anticipated earthwork for construction of the proposed project, the soils underlying the site are classified as Site Class "D, very dense soil", according to the 2016 California Building Code (CBC). The seismic parameters according to the 2016 CBC are summarized in the following table.

2016 CBC - Seismic Parameters	
Mapped Spectral Acceleration Parameters	S_s = 2.584 and S_1 = 0.919
Site Coefficients	F_a = 1.0 and F_v = 1.5
Adjusted Maximum Considered Earthquake Spectral Response Parameters	S_{MS} = 2.584 and S_{M1} = 1.378
Design Spectral Acceleration Parameters	S_{DS} = 1.722 and S_{D1} = 0.919
Peak Ground Acceleration	0.895g
Seismic Design Category	E

GENERAL SITE GRADING

It is imperative that no clearing and/or grading operations be performed without the presence of a representative of the geotechnical engineer. An on-site, pre-job meeting with the developer, the contractor and the geotechnical engineer should occur prior to all grading-related operations. Operations undertaken at the site without the geotechnical engineer present may result in exclusions of affected areas from the final compaction report for the project.

Grading of the subject site should be performed, at a minimum, in accordance with these recommendations and with applicable portions of the CBC. The following recommendations are presented for your assistance in establishing proper grading criteria.

INITIAL SITE PREPARATION

All areas to be graded should be stripped or cleaned of significant vegetation and other deleterious materials. These materials should be removed from the site for disposal. The cleaned soils may be reused as properly compacted fill. Rocks or similar irreducible material with a maximum dimension greater than 8 inches should not be used in compacted fills. If encountered, existing utility lines should be traced, removed and rerouted from areas to be graded.

MINIMUM MANDATORY REMOVAL OF EXISTING SOILS

All areas to be graded should have at least the upper 10 feet of existing soils or 2 feet beneath footings, whichever is greater, removed and the open excavation bottoms observed by our engineering geologist to verify and document in writing that all loose undocumented fill is removed prior to refilling with properly tested and documented compacted fill. The actual depth of removal should be determined at the time of grading by the project engineering geologist. The determination will be based on soil conditions exposed in the excavation.

Further subexcavation may be necessary depending on the conditions of the underlying soils. The actual depth of removal should be determined at the time of grading by the project geotechnical engineer/geologist. The determination will be based on soil conditions exposed within the excavations. At minimum, any undocumented fill, topsoil or other unsuitable materials should be removed and replaced as properly compacted fill.

In-place density tests may be taken in the removal bottom areas where appropriate to provide data to help support and document the engineer/geologist's decision.

PREPARATION OF FILL AREAS

Prior to placing fill, and after the mandatory subexcavation operation, the surfaces of all areas to receive fill should be scarified and moisture treated to a depth of 6 inches or more. The soils should be moisture conditioned to near optimum moisture content and compacted to a minimum relative compaction of 90 percent in accordance with ASTM D1557.

PREPARATION OF SHALLOW FOOTING AREAS

All footings should rest upon at least 24 inches of properly compacted fill material. The required overexcavation should extend at least 5 feet laterally beyond the footing lines, where reasonably possible. In instances where the 5-foot lateral overexcavation may not be accomplished, this firm should be contacted to evaluate the effect. The bottom of this excavation should then be scarified and moisture treated to a depth of at least 6 inches, brought to near optimum moisture content and compacted to a minimum of 90 percent relative compaction in accordance with ASTM D1557 prior to refilling the excavation to the required grade as properly compacted fill.

Foundations for the proposed structures on slopes that are steeper than 10H:1V (Horizontal to Vertical) (10 percent slope) should be designed in accordance with the provisions of Section 1809.3, 'Stepped Footings,' in the 2016 CBC. The top and bottom surface of the footings should be level or should be stepped so that both the top and bottom of such foundations are in accordance with the provisions in Section 1809.3 in the 2016 CBC. The stepped foundation should be suitably reinforced and designed by a qualified Civil or Structural Engineer.

All footing excavations should be observed by a representative of the project geotechnical engineer to verify that they have been excavated into compacted fill materials prior to placement of forms, reinforcement, or concrete. The excavations should be trimmed neat, level, and square. All loose, sloughed or moisture-softened soils should be removed from the excavations prior to placing of concrete. Excavated soils derived from the footing and/or utility trenches should not be placed in building slab-on-grade areas or exterior concrete flatwork areas unless the soils are brought to near optimum moisture content and compacted to at least 90 percent of the maximum dry density.

Thickness of compacted fill underneath foundations should not be allowed to vary by more than 50 percent for a single structure. In areas where, by virtue of grading, the fill thickness will exceed this maximum allowable differential, the subexcavation depths should be increased as necessary to reduce the differential fill thickness. This deepening of the subexcavation may involve additional removals of native soils. A determination of specific structural areas that require additional subexcavation should be performed at the time of grading.

In no case should footings for a single structure span from cut to fill conditions.

COMPACTED FILLS

The on-site soils should provide adequate quality fill material provided they are free from organic matter and other deleterious materials. Rocks or similar irreducible material with a maximum dimension greater than 8 inches should not be used in compacted fills.

If utilized, import fill should be inorganic, non-expansive granular soils free from rocks or lumps greater than 6 inches in maximum dimension. The contractor shall notify the geotechnical engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" potential for sulfate attack based upon current American Concrete Institute (ACI) criteria and is "mildly corrosive" to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job.

Fill should be spread in near-horizontal layers, approximately 8 inches thick. Thicker lifts may be approved by the geotechnical engineer if testing indicates that the grading procedures are adequate to achieve the required compaction. Each lift should be spread evenly, thoroughly mixed during spreading to attain uniformity of the material and moisture in each layer, brought to near optimum moisture content and compacted to a minimum relative compaction of 90 percent in accordance with ASTM D1557.

Based upon the relative compaction anticipated for compacted fill soils, we estimate compaction shrinkage of approximately 10 to 20 percent. Therefore, 1.10 cubic yards to 1.20 cubic yards of in-place soil material would be necessary to yield one cubic yard of properly compacted fill material. These values are exclusive of losses due to stripping, tree removal, or the removal of other subsurface obstructions, if encountered, and may vary due to differing conditions within the project boundaries and the limitations of this investigation.

Values presented for shrinkage are estimates only. Final grades should be adjusted, and/or contingency plans to import or export material should be made to accommodate possible variations in actual quantities during site grading.

SHALLOW FOUNDATION DESIGN

The proposed barn structure may be safely founded on spread foundations, either individual spread footings and/or continuous wall footings, bearing a minimum of 24 inches of engineered fill. In no case should footings for a single structure span from cut to fill conditions. Fill thickness differential should not exceed 50 percent across the span of a single structure.

Footings should be a minimum of 18 inches wide and should be embedded a minimum depth of 18 inches below the lowest adjacent grade. Exterior footings should have a minimum of two No. 4 bars at the top and two No. 4 bars at the bottom. Interior footings should have a minimum of one No. 4 bar at the top and one No. 4 bar at the bottom. Additional reinforcement may be required by the structural engineer.

For a minimum width and depth, footings may be designed for a maximum safe soil bearing pressure of 1,800 pounds per square foot (psf) for dead plus live loads. This allowable bearing pressure may be increased by 300 psf for each additional foot of width and by 800 psf for each additional foot of depth to a maximum safe soil bearing pressure of 3,000 psf for dead plus live loads. These bearing values may be increased by one-third for wind or seismic loading.

For footings thus designed and constructed on properly compacted engineered, we would anticipate a maximum static settlement of less than 1 inch. Differential static settlement between similarly loaded adjacent footings is expected to be approximately half the total settlement. Static settlement is expected to occur during construction or shortly after.

LATERAL LOADING

Resistance to lateral loads will be provided by passive earth pressure and base friction. For footings bearing against compacted fill, passive earth pressure may be considered to be developed at a rate of 360 psf per foot of depth. Base friction may be computed at 0.40 times the normal load. Other than conservative soil modeling, the lateral passive earth pressure and base friction values recommended do not include factors of safety. If the design is to be based on allowable lateral resistance values, we recommend that minimum factors of safety of 1.5 and 2.0 be applied to the friction coefficient and passive lateral earth pressure, respectively. The resulting allowable lateral resistance values follow:

Allowable Lateral Resistance Values			
	Ultimate	**Allowable**	**Factor of Safety**
Passive Lateral Earth Pressure (psf/ft)	360	180	2.0
Base Friction Coefficient	0.40	0.27	1.5

Allowable base friction and passive earth pressure may be combined without reduction.

SLABS-ON-GRADE

To provide adequate support, concrete slabs-on-grade should bear on a minimum of 18 inches of compacted soil. The compacted soil should be moisture conditioned to near optimum moisture content and compacted to 90 percent relative compaction. Concrete slabs-on-grade should be a minimum of 4 inches in thickness. The final pad surfaces should be rolled to provide smooth, dense surfaces. On-grade slabs should have a minimum of No. 3 bars spaced 16 inches on center each way.

HGI does not practice in the field of moisture vapor transmission evaluation / mitigation. Therefore, it is recommended that a qualified person or firm be engaged or consulted with to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person or firm should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate in accordance with ACI, PCA, ASTM, PTI, the California Building Code, and/or the International Residential Code.

In heated / air-conditioned areas in a structure where moisture sensitive floor coverings are anticipated over the floor slab, the use of a vapor barrier / moisture retarder beneath the slab should be considered. Typically, a vapor retarder is not utilized under the floor slabs in garages, utility buildings, and other unheated accessory structures, driveways, walks, patios, and/or other flatwork not likely to be enclosed and heated at a later date. The use or non-use of a vapor barrier / moisture retarder, the thickness of the vapor barrier / moisture retarder, the use of a granular layer over the vapor barrier / moisture retarder, the thickness of the granular materials, the type of granular material, etc. should be determined by the Structural Engineer who is designing the floor slab in conjunction with the Architect who is specifying the use and the type of floor coverings to be placed over the floor slab, and/or a person or firm that practices in the field of moisture vapor transmission evaluation / mitigation. The vapor barrier / moisture retarder recommendations provided by the supplier of the flooring materials should also be incorporated into the project plans.

TEMPORARY EXCAVATIONS

The near surface soils encountered within our exploratory borings are generally classified as a Type "C" soil in accordance with the CAL/OSHA excavation standards. Unless specifically evaluated by our engineering geologist, all the trench excavations should be performed following the recommendation of CAL/OSHA (State of California, 2013) for Type "C" soil. Based upon a soil classification of Type "C", the temporary excavations should not be inclined steeper than 1-1/2 horizontal to 1 vertical for maximum trench depth of less than 15 feet. For trench excavations deeper than 15 feet or for soil conditions that differ from those described for Type "C" in the CAL/OSHA excavation standards, this firm should be contacted.

POTENTIAL EROSION AND DRAINAGE

The potential for erosion should be mitigated by proper drainage design. The site should be graded so that surface water flows away from structures at a minimum gradient of 5 percent for a minimum distance of 10 feet from structures. Impervious surfaces within 10 feet of structures should be sloped a minimum of 2 percent away from the structure. Water should not be allowed to flow over graded areas or natural areas so as to cause erosion. Graded areas should be planted or otherwise protected from erosion by wind or water.

Water should not be permitted to collect or pond in yard areas. Structures should be provided with roof drains, gutters, and downspouts connected to subsurface pipes. Roof water should not be allowed to discharge onto the ground surface without collecting into surface drains and pipes. Water should not be allowed to collect against foundations or retaining walls.

TRENCH BEDDING AND BACKFILL

Trench Bedding - Pipe bedding material should meet and be placed according to the current edition of the Standard Specifications for Public Works Construction "Greenbook" or other project specifications. Pipe bedding should be uniform, free-draining, granular material with a sand equivalent of at least 30. Proposed pipe bedding material should be evaluated to confirm sand equivalent values by this firm prior to use as pipe bedding material.

Backfill - The on-site soils should provide quality backfill material provided they are free from organic matter and other deleterious materials. Rock or similar irreducible material with a maximum dimension greater than 8 inches should not be buried or placed in backfills.

Fill to be compacted by heavy equipment should be spread in near-horizontal layers, approximately 8 inches in thickness. For fill to be compacted by hand-operated equipment, thinner lifts, 4 to 6 inches in thickness, should be utilized. Each lift should be spread evenly, moisture conditioned to near optimum moisture content and compacted to a minimum relative compaction of 90 percent in accordance with ASTM D1557. To avoid pumping, backfill material should be mixed and moisture treated outside of the excavation prior to lift placement in the trench.

A controlled low-strength material could be considered to fill any cavities, such as voids created by caving or undermining of soils beneath existing improvements

SOIL CORROSION

A selected sample of material was tested for preliminary corrosivity analysis. Laboratory testing consisted of pH, resistivity, chlorides and sulfates. The results of the laboratory tests appear in Appendix A.

The result from the resistivity test indicates a "moderately corrosive" condition to ferrous metals. Specific corrosion control measures, such as coating of the pipe with non-corrosive material or alternative non-metallic pipe material, are considered necessary.

Results of the soluble sulfate testing indicate a Class S0 anticipated exposure to sulfate attack. Based on the criteria from Table 19.3.2.1 of the American Concrete Institute Manual of Concrete Practice (2014), special measures, such as specific cement types or water-cement ratios, will not be needed for this Class S0 exposure to sulfate attack.

The soluble chloride content of the soils tested was not at levels high enough to be of concern with respect to corrosion of reinforcing steel. The results should be considered in combination with the soluble chloride content of the hardened concrete in determining the effect of chloride on the corrosion of reinforcing steel.

HGI does not practice corrosion engineering. If further information concerning the corrosion characteristics, or interpretation of the results submitted herein, is required, then a competent corrosion engineer could be consulted.

Salt Crystallization Exposure

Damage of concrete, concrete masonry units, slump stone block, etc. surface can occur when evaporation of moisture takes place at the surface of the materials. As evaporation takes place, salts (i.e., carbonates, chloride, sulfur, sodium, potassium, etc.) are deposited in or form on the surfaces. As the salts crystalize, they can exert extreme pressures in the pore spaces of the materials they are deposited in and/or on. The formation of the crystals within the pore spaces of the material can result in what is generally called 'salt crystallization damage.' This results in the scaling and/or etching of the surface of the material on which they are deposited. The damaging effects of this phenomenon can be greatly reduced and/or even eliminated by the following or other such methods: 1) either using a higher strength concrete or a denser, low porosity product; 2) seal the surface of the material with a water proofing substance which will prevent the evaporation of the moisture from within the cementitious product.

If 'salt crystallization damage' is considered to be an issue, an engineer or chemist specializing in this area should be consulted regarding the potential damage due evaporation and the deposition of salts. The engineer or chemist should recommend appropriate types of materials or protective measures where needed.

PRELIMINARY FLEXIBLE PAVEMENT DESIGN

The following recommended structural sections were calculated based on traffic indices (TIs) provided in the Caltrans Highway Design Manual, Minimum TI's for Safety Roadside Rest Areas, Table 613.5B (Caltrans, 2012). Based upon an estimated R-value of 20, the structural sections tabulated below should provide satisfactory asphalt concrete pavement.

Recommended Structural Sections			
Usage	**TI**	**R-Value**	**Recommended Structural Section**
Auto Parking Areas	5.0	20	0.25' HMA/0.60' Class 2 AB
Auto Roads	5.5	20	0.25' HMA/0.80' Class 2 AB
Truck Parking Areas	6.0	20	0.30' HMA/0.90' Class 2 AB
Truck Ramps and Roads	8.0	20	0.40' HMA/1.25' Class 2 AB

HMA = hot mix asphalt AB = aggregate base

The above structural sections are predicated upon proper compaction of the utility trench backfills and the subgrade soils, with the upper 6 inches of subgrade soils and all aggregate base material brought to a minimum relative compaction of 95 percent in accordance with ASTM D1557 prior to paving. The aggregate base should meet Caltrans requirements for Class 2 base.

It should be noted that the above pavement designs were based upon an estimated R-value of 20 and should be verified by sampling and testing during construction when the actual subgrade soils are exposed.

HGI does not practice traffic engineering. The TIs used to develop the recommended pavement sections are typical for projects of this type. We recommend that the project civil engineer or traffic engineer review the TIs to verify that they are appropriate for this project.

GRADING PLAN REVIEW

The project Civil Engineer should review this report, incorporate critical information on to the grading plan and/or reference this geotechnical / geologic study, by Company Name, Project No., Report No., and report date, on the grading plan. Final grading plans should be reviewed by HGI when they become available to address the suitability of our grading recommendations with respect to the proposed development.

FOUNDATION PLAN REVIEW

It is recommended that **HGI** review the foundation plans for the proposed structures as they become available. The purpose of this review is to determine if these plans have been prepared in accordance with the recommendations contained in this report. This review will also provide **HGI** an opportunity to submit additional recommendations as conditions warrant.

CONSTRUCTION OBSERVATION

All grading operations, including site clearing and stripping, should be observed by a representative of the geotechnical engineer. The geotechnical engineer's field representative will be present to provide observation and field testing and will not supervise or direct any of the actual work of the contractor, his employees or agents. Neither the presence of the geotechnical engineer's field representative nor the observations and testing by the geotechnical engineer shall excuse the contractor in any way for defects discovered in his work. It is understood that the geotechnical engineer will not be responsible for job or site safety on this project, which will be the sole responsibility of the contractor.

LIMITATIONS

REVIEW, OBSERVATION, AND TESTING

The recommendations presented in this report are contingent upon review of final plans and specifications for the project by **HGI**. The project Geotechnical / Geologic Consultant should review and verify in writing the compliance of the final grading plan and the final foundation plans with the recommendations presented in this report.

It is recommended that **HGI** be retained to provide continuous Geotechnical / Geologic Consulting services during the earthwork operations (i.e., rough grading, utility trench backfill, subgrade preparation for slabs-on-grade and pavement areas, finish grading, etc.) and foundation installation process. This is to observe compliance with the design concepts, specifications and recommendations and to allow for design changes in the event that subsurface conditions differ from those anticipated prior to start of construction. If **HGI** is replaced as Geotechnical / Geologic Consultant of record for the project, the work on the project should be stopped until the replacement Geotechnical / Geologic Consultant has reviewed the previous reports and work performed for the project, agreed in writing to accept the recommendations and prior work performed by **HGI** for the subject project, or has submitted their revised recommendations.

UNIFORMITY OF CONDITIONS

The recommendations and opinions expressed in this report reflect our understanding of the project requirements based on an evaluation of subsurface earth material conditions encountered at the subsurface exploration locations and the assumption that earth material conditions do not deviate appreciably from those encountered. It should be recognized that the performance of the foundations may be influenced by undisclosed or unforeseen variations in earth material conditions that may occur in intermediate and unexplored areas. Any unusual conditions not covered in this report that may be encountered during site development should be brought to the attention of the **HGI** so that we may make modifications, if necessary.

CHANGE IN SCOPE

HGI should be advised of any changes in the project scope of proposed site grading so that it may be determined if recommendations contained herein are valid. This should be verified in writing or modified by a written addendum.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they be due to natural processes or the work of man on this or adjacent properties. In addition, changes in the State-of-the-Art and/or government codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a period of two (2) years without a review by **HGI** verifying the validity of the conclusions and recommendations.

PROFESSIONAL STANDARD

In the performance of our professional services, we comply with the standard of care and skill ordinarily exercised under similar circumstances by members of the geologic / geotechnical professions currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the locations where our surveys and exploratory excavations were made, and that our data, interpretations, and recommendations are based solely on information obtained by us. We will be responsible for those data, interpretations, and recommendations, but should not be responsible for interpretations by others of the information presented and/or developed. Our services consist of professional consultation and observation only, and other warranties, expressed or implied, are not made or intended in connection with work performed by **HGI** or by the proposal for consulting or other services or by the furnishing of oral or written reports or findings.

CLIENT'S RESPONSIBILITY

It is the responsibility of the client and/or the client's representatives to ensure that information and recommendations contained herein are brought to the attention of the Engineers and Architect for the project and incorporated into project plans and specifications. It is further their responsibility to take measures so that the contractor and his subcontractors carry out such recommendations during construction.

APPENDIX A

FIELD EXPLORATION

The field study performed for this report included a visual reconnaissance of existing surface conditions of the subject site and surrounding area. Site observations were conducted on September 26, 2019 by a representative of **HGI**.

A study of the property's subsurface condition was performed to evaluate underlying earth strata and the presence of groundwater. Two (2) exploratory backhoe excavations were performed in the area of the proposed structure on the subject site on September 26, 2019. Locations of the exploratory excavations were determined in the field by the contractor's approximate grade stakes and the layout of the proposed barn. Approximate locations of the exploratory excavations are denoted on the 'Exploratory Excavation Location Plan,' Plate No. 1, presented in this Appendix. Approximate elevations at the locations of the exploratory excavations were determined from the Google Earth Website (http://www/google.com/earth). Locations and elevations of the exploratory excavations should be considered accurate only to the degree implied by the method used in determining them.

The exploratory trenches were excavated by using a rubber tired, tractor mounted backhoe. The depths explored in the trenches was approximately 10 to 11 feet below the existing ground surface at the excavation locations. Bulk and relatively undisturbed chunk samples were obtained from cuttings developed during the backhoe excavation process and represent the earth materials within the depth indicated. In-place dry density and moisture content tests were also performed at various depths in the backhoe exploratory excavations. The tests were performed in general accordance with current Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) - ASTM D6938 test method. The dry density and moisture content test results are presented on the 'Subsurface Exploration Log,' Plate Nos. 3 and 4, presented in this Appendix.

Groundwater observations were made during, and at the completion of the excavation process and are noted on the 'Subsurface Exploration Log' presented in this Appendix, if encountered.

The exploratory excavations were logged by a representative of **HGI** for the fill material, natural earth material, and subsurface conditions encountered. Earth materials encountered in the exploratory excavations were visually described in the field in general accordance with the current Unified Soils Classification System (USCS), ASTM D2488, visual-manual procedures, as illustrated on the attached, simplified 'Subsurface Exploration Legend,' Plate No. 2, presented in this Appendix. The visual textural description, color of the earth material at natural moisture content, apparent moisture condition of the earth materials, and apparent relative density or consistency of the earth materials, etc., were recorded on the field logs. The 'Relative Density' of granular soils (SP, SW, SM, SC, GP, GW, GM, GC) is given as very loose, loose, medium dense, dense, or very dense and is based on the number of blows to drive the sampler 1.0 foot or fraction thereof. The 'Consistency' of silts or clays (ML, CL, MH, CH) is given as very soft, soft, medium stiff, stiff, very stiff, or hard and is also based on the number of blows to drive the sampler 1.0 foot or fraction thereof. The field log for each excavation contains factual information and interpretation of earth material conditions between samples. The 'Subsurface Exploration Log' presented in this Appendix represent our interpretation of the field log contents and results of laboratory observations and tests performed on samples obtained in the field from the exploratory excavations.

LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected bulk samples obtained from exploratory excavations during the field study. Tests were performed in general accordance with generally accepted American Society for Testing and Materials (ASTM), State of California - Department of Transportation (CALTRANS), Environmental Protection Agency (EPA) or other suitable test methods or procedures. The remaining samples obtained during the field study will be discarded 30 days after the date of this report. This office should be notified immediately if retention of samples will be needed beyond 30 days. A brief description of the tests performed is presented below:

CLASSIFICATION

The field classification of earth material materials encountered in the exploratory excavations was verified in the laboratory in general accordance with the current Unified Soils Classification System, ASTM D2488, 'Standard Practice for Determination and Identification of Soils (Visual-Manual Procedures).' The final classification is shown on the 'Subsurface Exploration Log,' Plate Nos. 3 and 4, presented in this Appendix.

IN-SITU MOISTURE CONTENT AND DRY DENSITY

The in-situ moisture content and dry density were determined in general accordance with current ASTM D2216 (Moisture Content) and D1188 (Bulk Specific Gravity and Density of Paraffin Coated Specimens) procedures, respectively, for selected undisturbed samples obtained. This information was an aid to classification and permitted recognition of variations in material consistency with depth. The dry density is determined in pounds per cubic foot and the moisture content is determined as a percentage of the oven dry weight of the earth material. Test results are shown on the 'Subsurface Exploration Log,' Plate Nos. 3 and 4, presented in this Appendix.

CHEMICAL AND MINIMUM ELECTRICAL RESISTIVITY

The concentration of soluble chloride, pH, as well as other chemical constituents and the minimum electrical resistivity were determined for a selected sample of near-surface earth material. The pH test was performed in general accordance with current EPA 9045 C procedures. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 5, presented in this Appendix.

ATTERBERG LIMITS

The Atterberg Limits (Liquid Limit and Plastic Limit) of a selected sample of earth material was determined in general accordance with current ASTM D4318 procedures, 'Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.' The Liquid Limit of a earth material is defined as the moisture content at which a sample of earth material placed in a standard liquid limit cup and cut by a groove 11-mm wide at the top, 2-mm wide at the bottom, and 8-mm deep will flow together at the base of the groove for a distance of 13-mm (0.5 inch) when subjected to 25 shocks from the cup being dropped 10-mm in a standard Liquid Limit apparatus at a rate of two (2) blows per second. The Plastic Limit of an earth material is defined as the moisture content at which a sample of earth material cannot be deformed by rolling into 1/8 inch diameter threads without crumbling. The Plasticity Index for the earth material is equivalent to the Liquid Limit minus the Plastic Limit. The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 5, presented in this Appendix.

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST

A maximum dry density / optimum moisture content relationship determination was performed on a sample of near-surface earth material in general accordance with current ASTM D1557 procedures using a 4-inch diameter mold. Samples were prepared at various moisture contents and compacted in five (5) layers using a 10-pound weight dropping 18 inches and with 25 blows per layer. A plot of the compacted dry density versus the moisture content of the specimens was constructed and the maximum dry density and optimum moisture content determined from the plot. The test results are summarized in the 'Maximum Dry Density / Optimum Moisture Content Relationship Test Results,' Plate No. 6, presented in this Appendix.

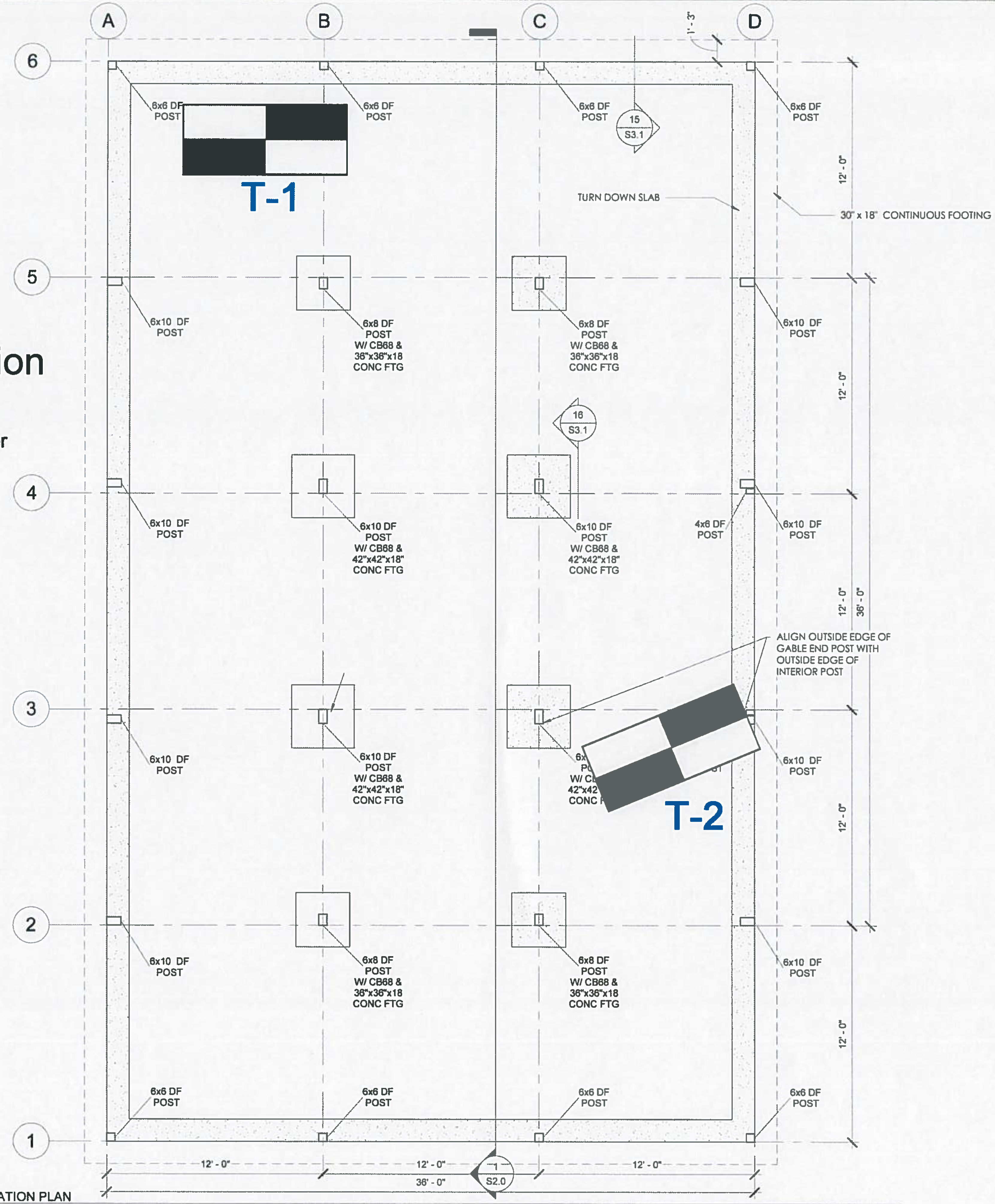
DIRECT SHEAR TEST

A direct shear test was performed on a selected remolded sample of near-surface earth material obtained from the trenches in general accordance with current ASTM D3080 procedures. The shear machine is of the constant strain type. The shear machine is designed to receive a 1-inch high, 2.416-inch diameter ring sample. Three (3) specimens from the selected bulk sample of earth material were remolded at approximately 90 percent relative compaction and at optimum moisture content based on the maximum dry density and optimum moisture content of the earth material as determined by current ASTM D1557 procedures. Specimens from the remolded samples were sheared at various pressures normal to the face of the specimens. The specimens were tested in a submerged condition. The peak and ultimate shear stresses were plotted verses the normal confining stresses to determine the shear strength (cohesion and angle of internal friction). The test results are summarized in the 'Summary of Laboratory Test Results,' Plate No. 7, presented in this Appendix.

Legend

T-2 *Approximate Trench Location

*Note: Contractor Staked Building perimeter on site. Trench Locations are Approximate



1 FOUNDATION PLAN 1/4" = 1'-0"

BARN PROS NATIONWIDE

STRUCTURAL ONLY

Teton 36
Miller, Lee & Terri
179 Highway 173
Lake Arrowhead, CA 92352

SUBMITTALS

REVISIONS

No.	Description	Date

FOUNDATION PLAN

Drawn by: BC

Approved by: OPERATIONS

S1.0

Exploratory Excavation Location Plan

By: AH

Date: 10/2019

Project No.: 1279-19.1

Plate No.: 1

HILLTOP GEOTECHNICAL INCORPORATED

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM
Visual-Manual Procedure (ASTM D2488-09a)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
Coarse-Grained Soils* More than 50 % Retained on No. 200 Sieve	Gravels 50 % or more of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels	GW	Well Graded Gravels and Gravel-Sand Mixtures, Little or no Fines
			GP	Poorly Graded Gravels and Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines	GM	Silty Gravels, Gravel-Sand-Silt Mixtures**
			GC	Clayey Gravel, Gravel-Sand-Clay Mixtures**
	Sands More than 50 % of Coarse Fraction Passes No. 4 Sieve	Clean Sands	SW	Well Graded Sands and Gravely Sands, Little or no Fines
			SP	Poorly Graded Sands and Gravelly Sands, Little or no Fines
		Sands with Fines	SM	Silty Sands, Sand-Silt Mixtures**
			SC	Clayey Sands, Sand-Clay Mixtures**
Fine Grained Soils* 50 % or more Passes No. 200 Sieve	Silts and Clays Liquid Limits 50 % or less		ML	Inorganic Silts, Sandy Silts, Rock Flour
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Silts and Organic silty Clays of Low Plasticity
	Silts and Clays Liquid Limits Greater than 50 %		MH	Inorganic Silts, Micaceous or Diatomaceous silts, Plastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity
Highly Organic Soils			PT	Peat, Muck, or Other Highly Organic Soils

CONSISTENCY / RELATIVE DENSITY

CRITERIA

Reference: 'Foundation Engineering', Peck, Hansen, Thornburn, 2nd Edition.

Standard Penetration Test
Granular Soils

Penetration Resistance, N, (Blows / Foot)	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
> 50	Very Dense

Standard Penetration Test
Cohesive Soils

Penetration Resistance, N, (Blows / Foot)	Consistency	Unconfined Compressive Strength, (Tons / Sq. Ft.)
< 2	Very Soft	< 0.25
2 - 4	Soft	0.25 - 0.5
5 - 8	Firm (Medium Stiff)	0.5 - 1.0
9 - 15	Stiff	1.0 - 2.0
16 - 30	Very Stiff	2.0 - 4.0
> 31	Hard	> 4.0

* Based on material passing the 3-inch sieve.

** More than 12% passing the No. 200 sieve; 5% to 12% passing No. 200 sieve requires use of duel symbols (i.e., SP-SM., GP-GM, SP-SC, GP-GC, etc.); Border line classifications are designated as CH/Cl, GM/SM, SP/SW, etc.

U.S. Standard Sieve Size 12" 3" 3/4" #4 #10 #40 #200

Unified Soil Classification Designation	Boulders	Cobbles	Gravel		Sand			Silt and Clay
			Coarse	Fine	Coarse	Medium	Fine	

Moisture Condition

Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible moisture.
Wet	Visible free water, usually below the water table.

Material Quantity

Trace	< 5 %
Few	5 - 10%
Little	15 - 25%
Some	30 - 45 %

Other Symbols

C - Core Sample
S - SPT Sample
B - Bulk Sample
CK - Chunk Sample
R - Ring Sample
N - Nuclear Gauge Test
∇ - Water Table

HILLTOP GEOTECHNICAL INCORPORATED

(Revised 11-23-2015)

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-1

HILLTOP GEOTECHNICAL INCORPORATED

Project Name: Miller, Lee Highway 173, Proposed Wedding Venue Barn
Project No.: 1279-A19.1 Date: 9/26/2019 Logged By: AH
Equipment Used: Rubber Tire Mounted Backhoe Elevation: ± 5280

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
0			SM			af		ARTIFICIAL FILL: Upper 6" Miscellaneous Base Silty fine to coarse sand, trace gravel, trace boulders, trace clay; PVC Pipe, Organics; Gray brown; Moist.
3.5								Metal pipes, concrete.
4.5	CK			105.8	9.4			
9								Concrete with rebar.
10						Qaf		ALLUVIUM: Silty fine to coarse sand; Yellowish brown; Moist.
11								Bottom of trench at 11.0 feet. No groundwater encountered. Trench backfilled with excavated material.

Depth scale: 1–25 ft.

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

HILLTOP GEOTECHNICAL INCORPORATED

SUBSURFACE EXPLORATION LOG
TRENCH NO. T-2

Project Name: Miller, Lee Highway 173, Proposed Wedding Venue Barn
Project No.: 1279-A19.1 Date: 9/26/2019 Logged By: AH
Equipment Used: Rubber Tire Mounted Backhoe Elevation: ± 5279

Depth (ft.)	Sample Type	Penetration Resistance	Soil Classification	Dry Density (lb/ft3)	Moisture Content (%)	Lithology	Groundwater	Description
0			SM			af		ARTIFICIAL FILL:
1								Silty fine to coarse sand, trace gravel, trace clay; Dark brown; Moist.
2								Trace concrete debris.
	CK/N			110.9	15.1			
				103.8	8.9			
3	B							
4								Metal pipes, concrete.
5	N			83.5	25.4			Small organics.
6								
7								
8	CK			94.0	21.3	Qaf		ALLUVIUM:
9								Silt, a little fine ro coarse sand, trace roots up to 3" diameter; Gray brown; Moist.
10								Bottom of trench at 10.0 feet. No groundwater encountered. Trench backfilled with excavated material.
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

B - Bulk Sample N - Nuclear Gauge Test CK - Chunk Sample

SUMMARY OF LABORATORY TEST RESULTS
PROPOSED WEDDING VENUE BARN
179 HIGHWAY 173, LAKE ARROWHEAD, CA

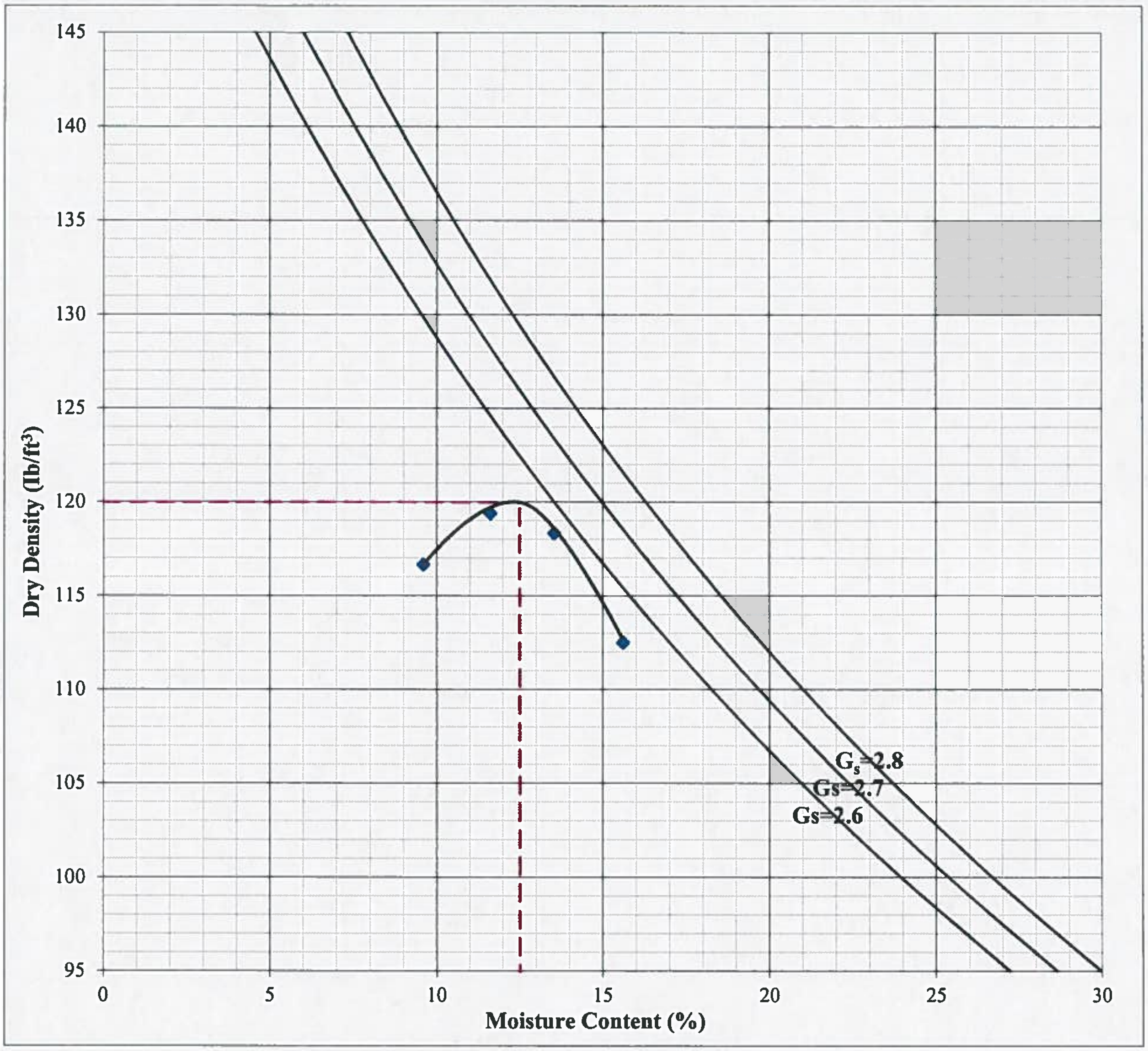
CHEMICAL / MINIMUM ELECTRICAL RESISTIVITY TEST RESULTS

SAMPLE	RESISTIVITY Minimum (ohm-cm)	pH*	SULFIDE	CHLORIDE (ppm)**	SOLUBLE SULFATE (%)**
T-2, 3'	7,021	6.82	Neg.***	7.4	0.0015

* Test performed by **A & R Laboratories** in accordance with EPA 9045 C procedures.
** Test performed by **A & R Laboratories** in accordance with EPA 300.0 test procedures.
*** Neg. - Negative.

ATTERBERG LIMITS TEST RESULTS (ASTM D4318 Test Method)

SAMPLE	EARTH MATERIAL DESCRIPTION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX
T-2, 3'	Silty fine to coarse sand trace gravel (SM)	32.6	0	Not Plastic

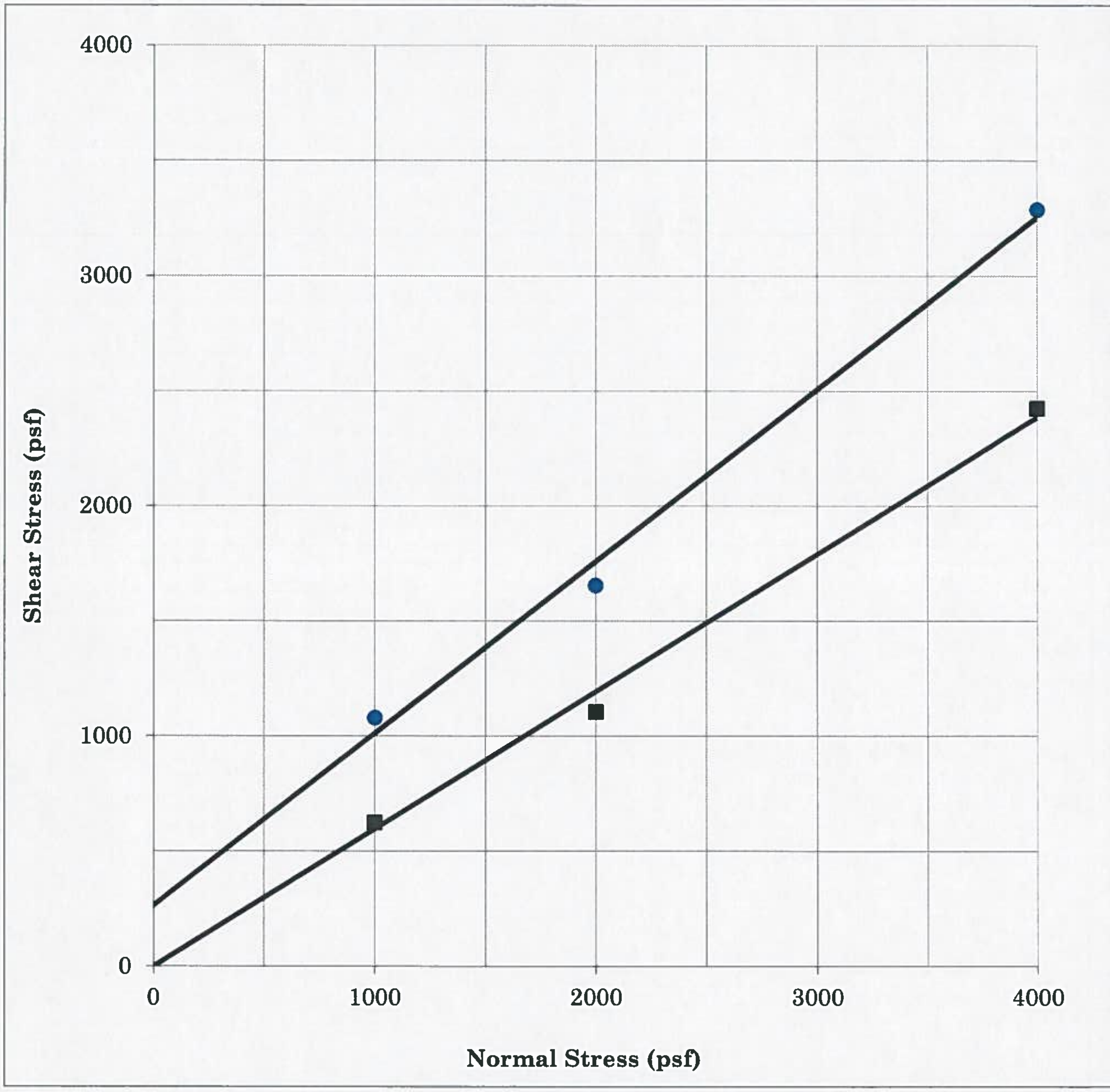


Maximum Dry Density (lb/ft^3)	120.0
Optimum Moisture Content (%)	12.5
Procedure	B

HILLTOP GEOTECHNICAL INCORPORATED

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE CONTENT RELATIONSHIP TEST RESULTS (ASTM D1557 Test Method)

SAMPLE: T-2, 4 feet			
SOIL DESCRIPTION:	Silty fine to coarse sand, trace gravel (SM)		
BY: SH		DATE:	10/2019
JOB NO.: 1279-A19.1		PLATE NO.:	6



Shear Speed: 0.004 in. / min.

Samples tested in a submerged condition.

Average Remolded Dry Density (pcf)	108.3
Average Remolded Moisture Content (%)	12.1

Peak •	Cohesion	264 psf
	Internal Friction Angle	37 degrees
Ultimate ■	Cohesion	0 psf
	Internal Friction Angle	31 degrees
Residual	Cohesion	
	Internal Friction Angle	

HILLTOP GEOTECHNICAL INCORPORATED

DIRECT SHEAR TEST RESULTS (ASTM D3080 Test Method)

SAMPLE: T-2, 3 feet

SOIL DESCRIPTION: Silty fine to coarse sand, trace gravel (SM)

BY:	SH	DATE:	10/2019
PROJECT NO.:	1279-A19.1	PLATE NO.:	7

APPENDIX B

TECHNICAL REFERENCES

American Concrete Institute, 2014, Building Code Requirements for Structural Concrete (ACI 318-14), Commentary on Building Code Requirements for Structural Concrete (ACI 318R-14), American Concrete Institute.

American Concrete Institute, 2001, Guide for Design and Construction of Concrete Parking Lots (ACI 330R-01), American Concrete Institute Committee 330.

American Society of Civil Engineers, 2010, *Minimum Design Loads for Buildings and Other Structures*: ASCE Standard No. 7-10.

Blake, Thomas F., 2000, *Preliminary Fault-Data for EQFAULT, EQSEARCH and FRISKSP.*

Blake, Thomas, F., *Computer Services and Software, Users Manuals, FRISKSP v. 4.00, EQSEARCH v. 3.00, and EQFAULT v. 3.00.*

California Building Standards Commission, Effective January 1, 2017, *2016 California Building Code*: California Code of Regulations, Title 24, Part 2, Volume 1 of 2 and Volume 2 of 2 (Based on 2012 International Building Code).

California Department of Conservation, Division of Mines and Geology, *Geomorphic Provinces and Some Principal Faults of California*: CDMG Note 36.

California Department of Conservation, Division of Mines and Geology, 1986, *Guidelines for Evaluating the Hazard of Surface Fault Rupture*: CDMG Note 41.

California Department of Conservation, Division of Mines and Geology, *Guidelines to Geologic/Seismic Reports*: CDMG Note 42.

California Department of Conservation, Division of Mines and Geology, *Guidelines for Preparing Engineering Geologic Reports*: CDMG Note 44.

TECHNICAL REFERENCES

California Department of Conservation, Division of Mines and Geology, 1982, *Earthquake Planning Scenario for a Magnitude 8.3 Earthquake on the San Andreas Fault in Southern California*: Special Publication 60.

California Department of Conservation, Division of Mines and Geology, 1976, *Geologic Hazards in Southwestern San Bernardino County, California*: Special Report 113.

California Department of Conservation, Division of Mines and Geology, 2003, Morton, D.M., Miller, F.K., (Digitally Prepared by Cossette, P.M., Bovard, K.R.); *Preliminary Geologic Map of the San Bernardino 30′ x 60′ Quadrangle, California*; Version 1.0, Scale 1:100,000.

California Department of Conservation, Division of Mines and Geology, 2006, Morton, D.M., Miller, F.K., (Digitally Prepared by Cossette, P.M., Bovard, K.R.); *Geologic Map of the San Bernardino 30′ x 60′ Quadrangle, California*; Version 1.0, Scale 1:100,000.

California Department of Conservation, Division of Mines and Geology, Effective July 1, 1974, *State of California Special Studies Zones, Harrison Mountain Quadrangle, Official Map*: Scale: 1:24,000.

California's Office of Statewide Health Planning and Development, Internet Website (https://seismicmaps.org/), Cited February 6, 2019.

Coduto, Donald P., 1998, Geotechnical Engineering Principles and Practices: Prentice-Hall, Inc., New Jersey.

Coduto, Donald P., 2001, Foundation Design, Principles and Practices 2nd Edition, Prentice-Hall.

Harden, D.R., 1997, *California Geology*: Prentice Hall.

Inland Geological Society, 1986, *Geology Around the Margins of the Eastern San Bernardino Mountains*: Volume I.

TECHNICAL REFERENCES

International Conference of Building Officials, 2016, California Building Code, 2016 Edition: Whittier, California.

Ishihara, K., 1985, *Stability of Natural Deposits During Earthquakes*: Proceedings: 11th International Conference on Soil Mechanics and Foundation Engineering, San Francisco, Vol. 1. pp. 321-376.

Ishihara, K., 1993, *Liquefaction and Flow Failures During Earthquakes*: Geotechnique, Vol.43, No. 3, pp. 351-415.

Meisling, K.E. and Weldon, R.J., 1989, *Late Cenozoic Tectonics of the Northwestern San Bernardino Mountains, Southern Ca.*: Geologic Society of America, Bulletin 101, pp. 106-128.

Public Works Standards, Inc., 2012 Edition with 2014 Cumulative Supplement, *The "Greenbook", Standard Specifications for Public Works Construction.*

San Bernardino County Planning Department, *San Bernardino Land Use Plan, GENERAL PLAN, Hazard Overlays*, Sheet FH15 B Lake Arrowhead, Plot Date: 03/09/2010, Scale: 1:14,400.

San Bernardino County Planning Department, *San Bernardino Land Use Plan, GENERAL PLAN, Geologic Hazard Overlays*, Sheet FH15 C Lake Arrowhead, Plot Date: 03/09/2010, Scale: 1:14,400.

Southern California Earthquake Center, June 2002, *Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California.*

State of California, Department of Transportation, 2010 with Revisions Dated February 21, 2014, *Standard Specifications.*

U.S. Department of the Interior, U.S. Geological Survey, Design Maps Web Site (https://earthquake.usgs.gov/designmaps/us/application.php).

TECHNICAL REFERENCES

U.S. Department of the Interior, U.S. Geological Survey, Geologic Hazards Science Center's 2008 NSHMP PSHA Interactive Deaggregation Web Site (https://geohazards.usgs.gov/deaggint/2008/).

U.S. Department of the Interior, U.S. Geological Survey, 1967, Photorevised 1988, *Harrison Mountain Quadrangle, California – San Bernardino Co.:* 7.5-Minute Series (Topographic), Scale: 1:24,000.

U.S. Department of the Interior, U.S. Geological Survey, 1971, Photorevised 1988, *Lake Arrowhead Quadrangle, California – San Bernardino Co.:* 7.5-Minute Series (Topographic), Scale: 1:24,000.

U.S. Federal Emergency Management Administration (FEMA), Revised August 28, 2008, *Flood Insurance Rate Map*: Map No. 06071C7243 H. Site specific information obtained through FEMA Website, Map Service Center, (http://msc.fema.gov/)