Preliminary Engineering Geologic Report

Proposed Grading and Development Project
3852 Thomas Road
Miranda, California
APN: 221-061-036

RECEIVED
OCT 31 2019
Humboldt County
Planning Division

Prepared for:
APP# 11780
Nicole Keenan

SHN

September 2019

018198

SHN 812 W. Wabash Avenue, Eureka, CA 95501-2138 707-441-8855
Civil Engineering, Environmental Services, Geosciences, Planning & Permitting, Surveying

Reference: 018198

September 17, 2019

Mrs. Nicole Keenan
3852 Thomas Road
Miranda, CA 95553

Subject: **Preliminary Engineering Geologic Report, Proposed Grading and Development Project, 3852 Thomas Road, Miranda, California; APN: 221-061-036**

Dear Nicole:

As requested, SHN is providing this preliminary engineering geologic report for the proposed improvements at your property in Miranda, California. It is our understanding that the project is in the early stages of design, and our investigation was based on conceptual improvements discussed during our site visit. The enclosed report presents our findings, conclusions, and recommendations to assist you and your design consultants with project planning and final design of the proposed project elements.

If you have any questions, please call me at 707-441-8855.

Sincerely,

SHN

Jason P. Buck, CEG 2641
Senior Engineering Geologist

JPB:lms

Enclosure: Report

Reference: 018198

Preliminary Engineering Geologic Report

Proposed Grading and Development Project
3852 Thomas Road
Miranda, California
APN: 221-061-036

Prepared for:
Nicole Keenan

CERTIFIED ENGINEERING GEOLOGIST
JASON PAUL
BUCK
No. 2641
STATE OF CALIFORNIA

Jason P. Buck, CEG 2641
Senior Engineering Geologist

Prepared by:

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812 W. Wabash Ave.
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September 2019

QA/QC:GSW

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List of Illustrations

Abbreviations and Acronyms

mm	millimeters
µm	micrometers
$(N_1)_{60}$	soil density/blow count
AAPG	American Association of Petroleum Geologists
APN	Assessor's parcel number
ASCE	American Society of Civil Engineers
ASTM	ASTM-International
BGS	below ground surface
CBC	California Building Code
HA	boring-number
M#	magnitude number
NR	no reference
OSHPD	California Office of Statewide Health Planning and Development
PWA	Pacific Watershed Associates
SEAOC	Structural Engineers Association of California
SPT	standard penetration test
UAV	unmanned aerial vehicle
USGS	U.S. Geological Survey

1.0 Introduction

1.1 General

This soils report presents the results of a field investigation conducted by SHN to support the design development of the proposed improvements on the property located at 3852 Thomas Road in Miranda, California (Figure 1). The project is located on Assessor's parcel number (APN) 221-061-036. The latitude and longitude of the site are 40.222375°N and -123.938771° W, respectively. This report was prepared for the sole use of the owner and their design consultants. The report is intended to satisfy the R-2 soils report requirements set forth by the Humboldt County Building Department.

The conclusions and recommendations presented in this report are provided to assist the project design consultants in the planning, design development, and construction of the proposed improvements. This report is based on our understanding of the proposed project, a review of published geologic literature and mapping in the vicinity of the project site, the data obtained from our field investigation, and from the exploratory hand boring excavated during our field investigation.

1.2 Project Description

We understand that the overall objective of the project is the relocation of existing greenhouses to an area outside of stream setbacks. The proposed location for the new greenhouse(s) is immediately north of an existing pond, on the crest of a small spur ridge, as shown on Figure 2. The development necessary to facilitate this configuration will include the grading of a pad, or series of stepped pads for the greenhouse structures (hoop houses are assumed) and the grading of an access road to the area. The general alignment of the access road, as discussed in the field is shown on Figure 2. The construction of some additional outbuildings/sheds was discussed in the field however final locations had not been developed. Our understanding of the proposed project is based on discussions in the field. We understand that the project elements and their configurations are preliminary and subject to change during the design phase. No project planning documents had been developed or provided to us at the time of this writing.

2.0 Scope of Work

The scope of SHN's services included reviewing available geologic and subsurface information; a field reconnaissance of the project site; the excavation of a shallow hand-augered boring; and providing general recommendations to aid in project planning, design, and construction.

Specifically, the following information, recommendations, and design criteria are presented in this report:

- Description of site terrain and local geology
- Description of soil and groundwater conditions, interpreted based on our field exploration and review of existing information
- Log of the hand-augered boring (Appendix 1)
- Assessment of potential earthquake-related geologic/geotechnical hazards (for example, strong earthquake ground shaking, surface fault rupture, liquefaction, slope instability)
- Seismic design parameters in accordance with the applicable portions of the 2016 California Building Code (CBC) and American Society of Civil Engineers (ASCE) 7-10 Standard, including site soil classification, seismic design category, and spectral response accelerations

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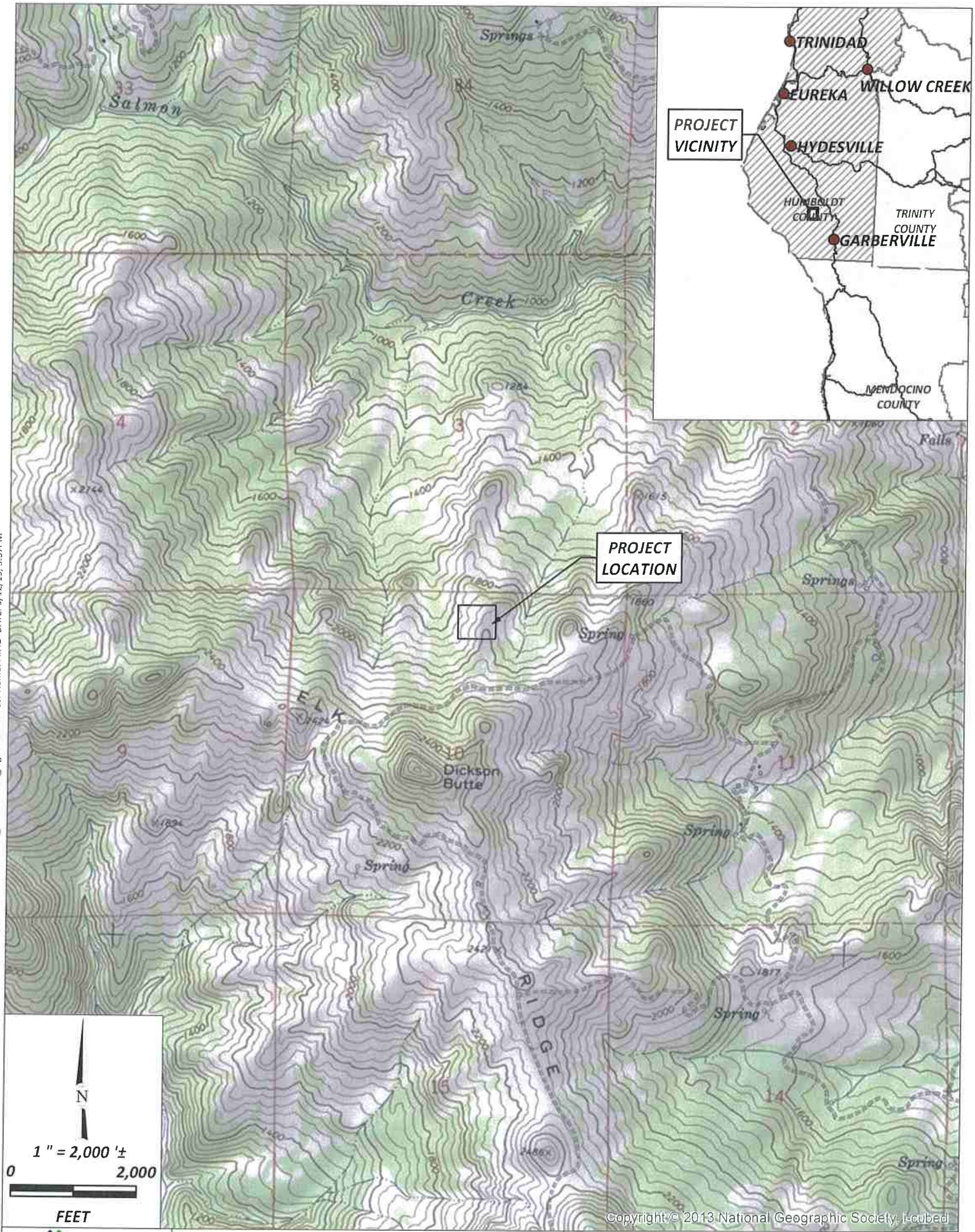

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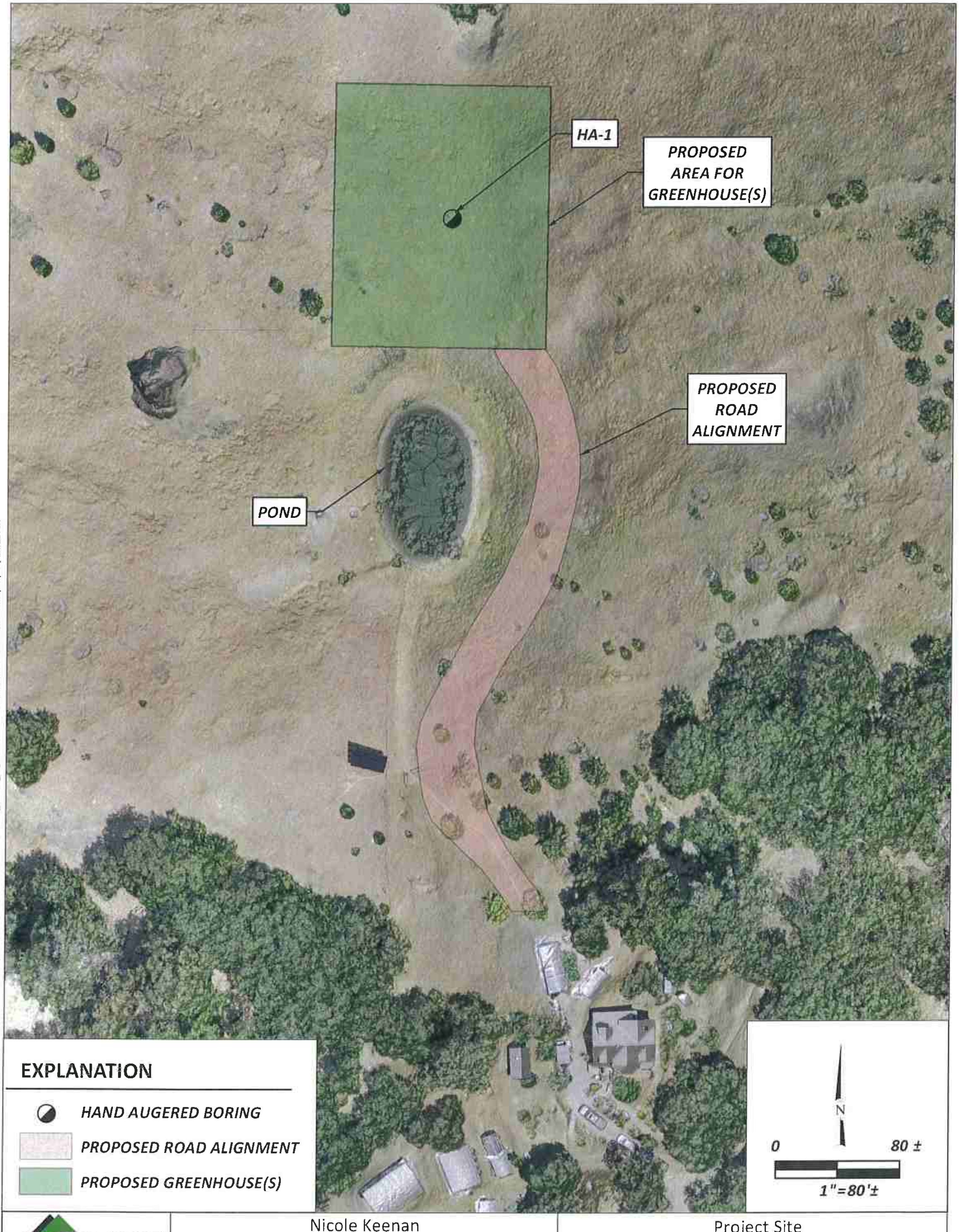
Nicole Keenan
Keenan Homesite
Miranda, California

Project Location

SHN 018198

September 2019	KeenanFocused_SiteLocationl_Figure1	Figure 1



Nicole Keenan
Keenan Homesite
Miranda, California

Project Site
Aerial Image
SHN 018198

September 2019

KeenanFocused_Aerial_Figure2

Figure 2

Path: \\derpbox\e\PROJECTS\2018\018198 Keenan Home Site\GIS\PROJ_MXD\KeenanFocused_Aerial_Figure2.mxd User Name: hhummel DATE: 9/17/19, 12:23PM

- General recommendations for new site improvements, including site and subgrade preparation, fill material, and placement and compaction requirements

3.0 Field Investigation

On July 12, 2019, a project geologist from SHN met with the owner at the project site and discussed the conceptual design of the proposed improvements. SHN conducted a reconnaissance inspection of the project site, evaluated the existing conditions of the surrounding slopes, and logged and sampled a shallow hand-augered boring at the project site. The boring was excavated to a depth of 5 feet below existing ground surface (BGS) in a location considered to be representative of the onsite soils. The boring was located within the proposed footprint of the graded pad that would support future greenhouses (Figure 2).

The soils encountered in the boring were logged and field classified in general accordance with the Manual-Visual Classification Method (ASTM-International [ASTM] D 2488). During excavation, the project geologist evaluated the in situ soil consistency based on equipment performance and level of effort required to advance the boring. A final log of the soils encountered in the boring is presented in Appendix 1.

An unmanned aerial vehicle (UAV) was used to map the existing conditions of the project site and vicinity. The digital surface model derived from the processed UAV data is shown on Figure 3 and highlights the geomorphic features of the project site.

4.0 Site Conditions

The following sections describe the geologic setting of the site, the site surface conditions, and subsurface soil and groundwater conditions encountered at the time of our field exploration.

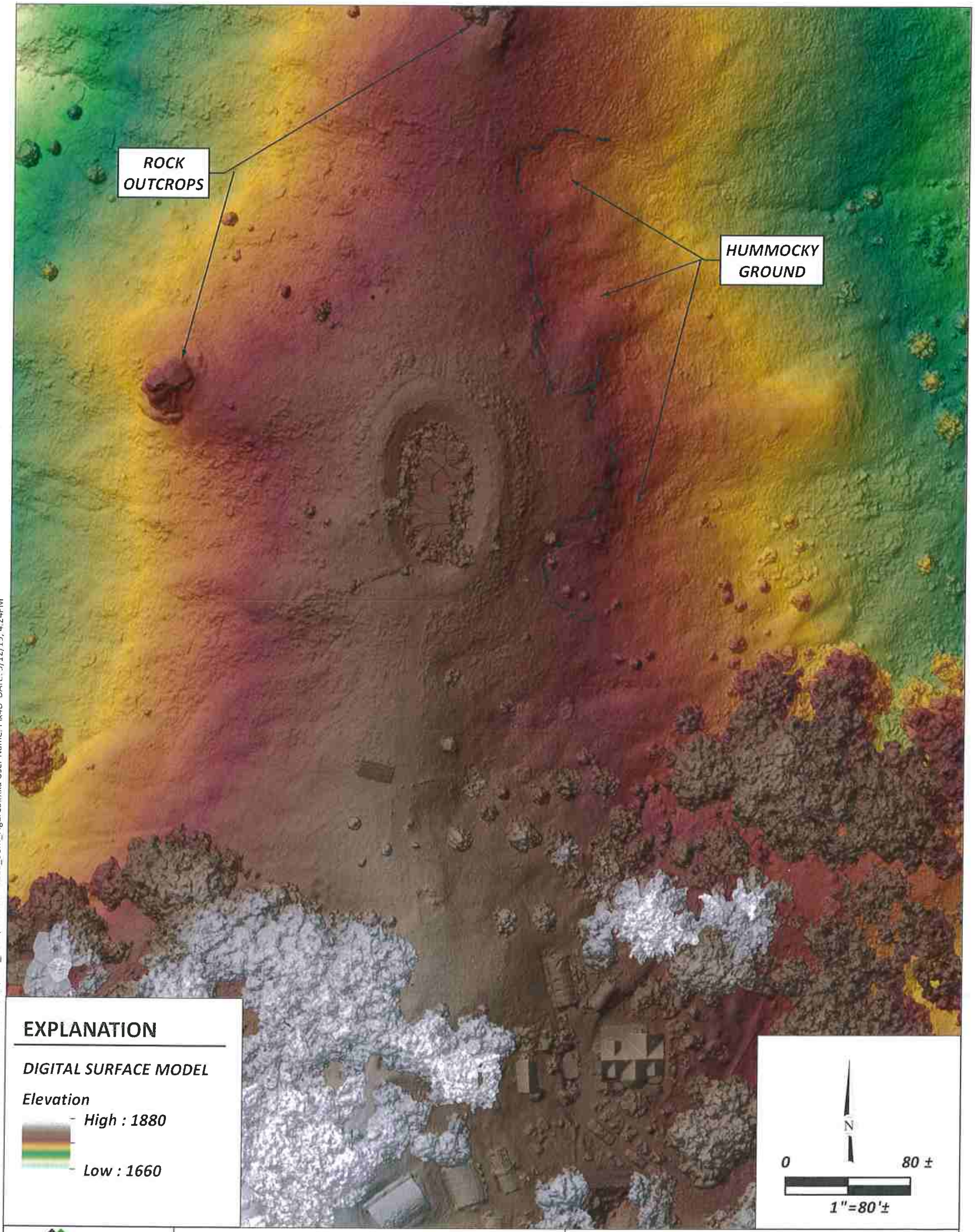
4.1 Geologic Setting

The project site is located in a geologically complex area. The underlying basement rock is mapped as undifferentiated late Jurassic- to late Cretaceous-age mélange of the Franciscan Complex (McLaughlin and others, 2000; Clarke, 1992). The Franciscan basement rock in this area consists of block and matrix lithology with coherent blocks of bedrock "floating" within a matrix of sheared and weathered rock. The landscape, which is reflective of this geologic condition, is dominated by isolated exposed bedrock outcrops surrounded by hummocky grassland. Bedrock outcrops often define the ridges or other high points in the landscape as they are resistant to erosion, whereas the surrounding grasslands often host landslide morphology of various scales. The project site itself has rocky outcrops immediately to the north and west.

The project site is situated within a complex zone affected by the Coastal Belt Thrust, a major boundary between regional geologic units. Northwest-southeast oriented Quaternary faults associated with the Garberville-Briceland fault zone have been mapped by McLaughlin (2000). No active fault is mapped within the vicinity of the project site.

4.2 Site Description

The project site is situated high on a spur ridge on the north side of Dickson Butte, approximately 6 miles west of Miranda, California. The landscape in the project area generally consists of north facing, gentle to steep hillslopes. The slopes are primarily vegetated with grasses and brush, with pockets of forested canopy



Nicole Keenan
Keenan Homesite
Miranda, California

Project Site
Digital Surface Model
SHN 018198

September 2019

KeenanFocused_DSM_Figure3

Figure 3

Path: E:\PROJECTS\2018\018198 Keenan Home Site\GIS\PROJ_MXD\KeenanFocused_DSM_Figure3.mxd User Name: Pix4D DATE: 9/12/19, 4:24PM in isolated areas and within stream drainages. Rock outcrops are found scattered across the landscape, and tend to form resistant landforms. Rock outcrops were observed immediately north and southwest of the proposed greenhouse area.

The property is developed with a primary access road, an existing residence, and numerous miscellaneous outbuildings, including a series of greenhouses. Most of the structures and greenhouses are built on graded cut-and-fill pads. A series of Class II/III stream channels incised 5 to 10 feet traverses the property, flowing to the north/northeast. No water was flowing in the channels at the time of our field review. Three ponds have been developed on the property, one of which is situated at the top of the spur ridge near the proposed improvements.

4.3 Subsurface Soil and Groundwater Conditions

During our site reconnaissance, we reviewed exposed native soils in cut slopes and stream bank exposures. We also installed a hand-augered boring (HA-1; Figure 2) within the vicinity of the proposed new greenhouse pad. The results of our subsurface investigation and review of exposures indicate that the site is underlain by a mixture of weathered bedrock and a matrix material consisting of silty clay with variable amounts of gravel. Based on our field observations, we characterize the shallow subsurface materials that would support structures to be medium dense to medium stiff. The site soils are anticipated to vary laterally and with depth, with some areas primarily soil like, and others consisting of fractured rock. In some places, deep cracks in near surface soils were observed. These cracks are interpreted to be shrinkage cracks that may be indicative of expansive soils.

Native re-worked fill materials are present on the property at locations where grading has occurred. Grading for the residential structure, outbuildings, and greenhouses generally has included the cutting into the slope and placement of fill on the down slope side of the pads. The ponds have berms constructed of fill materials, and the road surface has a fill prism on the outboard edge in many places.

Groundwater conditions at the proposed graded pad are anticipated to be dependent upon the season. During the dry season, groundwater is anticipated to be limited to non-existent within the upper 20(+) feet, whereas some perched water may develop during the wet season, though given the project is situated on a spur ridge, even winter groundwater is anticipated to be minimal. Water seepage into the subsurface from the pond may be creating localized areas of moist and/or saturated soil conditions that persist into the dry season. No groundwater was encountered within the boring (HA-1), installed to a depth of 5 feet BGS. No seep, spring, or other emergent groundwater was noted on the property during our field review. Groundwater levels fluctuate seasonally, and the levels observed during our investigation are anticipated to represent seasonal low levels. We do not anticipate groundwater to be encountered during the construction of the proposed improvements, particularly if the work is conducted during the dry season.

4.4 Geologic Hazards

Potential geologic/geotechnical hazards common to the local area include seismic ground shaking, surface fault rupture, seismically induced ground deformation (liquefaction and seismic compaction), and slope instability. Our assessment of these potential hazards is presented below.

4.4.1 Seismic Ground Shaking

The entire North Coast region is a seismically active area where strong seismic shaking presents a significant hazard. The closest fault considered active by the State of California is the northern segment of the San

Andreas fault, located along the coast approximately 10 miles to the west. The Cascadia Subduction zone is a major plate boundary fault located about 40 miles northwest of the project site, offshore. Cascadia earthquakes occur roughly every 300 to 500 years, and may have magnitudes ranging from magnitude M8.5 to M9.0. A rupture event originating on any one of these nearby faults would generate very strong shaking at the site.

4.4.2 Surface Rupture

The project site is not known to be near an active fault, and the risk to the project posed by the hazard of surface rupture is considered negligible. The nearest active fault recognized by the State of California is the San Andreas fault, located approximately 10 miles to the west of the project.

4.4.3 Liquefaction

Liquefaction is the sudden loss of soil shear strength due to a rapid increase of soil pore water pressure caused by cyclic loading from a seismic event.

Generally, in order for liquefaction to occur, the following soil conditions are needed:

- Non-plastic granular soils (sand, silty sand, sandy silt, and some gravels)
- A shallow depth to groundwater (less than 50 feet BGS)
- Low relative density soil (standard penetration test [SPT] blow count $[N_1]_{60}$ less than 30, usually associated with materials of young geologic age)

Geologic materials most susceptible to liquefaction are geologically recent (that is, late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. These "most susceptible" conditions do not exist in the materials underlying the project site. We conclude that the hazard associated with liquefaction is negligible.

4.4.4 Slope Instability

The proposed developments are situated on gently to moderately sloping ground, with isolated areas of steep ground (>50%). The ridge itself is generally smooth with pockets of hummocky ground on the side slopes, examples of which are shown on Figure 3. The hummocky ground is interpreted to be associated with a few different conditions. In places, the variability of the ground surface appears to be an expression of the long-term landscape evolution of the slope caused by differential erosion. In other places the hummocky areas appear to be associated with slow downhill creep of shallow soils or a very slow moving earthflow. We did not observe any significant slope failures or other traditional landslide features. Soils undergoing down slope creep and/or associated with earthflows are considered the primary stability hazard to the proposed developments. Strategies for minimizing risk associated with these areas are discussed in Section 5 below. Provided our recommendations are adhered to, we conclude that the potential for slope instability to affect the development is low.

5.0 Conclusions and Recommendations

Based on the results of our field investigation, it is our opinion that the project is feasible from a geotechnical standpoint, provided that our recommendations are implemented during design and construction. The geotechnical considerations for development of the proposed improvements include the potential for strong seismic shaking, and the presence of laterally variable subgrade materials including silty clay with gravel, potentially expansive soils, weathered bedrock of different strength and competency, and localized areas of native re-worked fill materials.

The most significant slope stability hazard to the proposed developments is the potential for soil creep. The risk is dependent upon the type of improvements being developed and the tolerance to differential movement. Unpaved road surfaces or graded pads that support hoop houses or other structures that are simply placed on the surface are considered low risk. Periodic re-grading may be necessary, depending upon the rate of soil creep and the sensitivity to the topographic change. The hummocky areas should be avoided when sighting any developments that are sensitive to settlement, such as structures with foundations, or critical drainage features (such as, culverts).

Final configuration and design of the improvements will be important in the long-term stability of the project elements. We should be consulted if the type, character, or locations of any of the proposed improvements change from that described in this report. Proper grading practices (including subgrade preparation, fill placement, and proper drainage development) are critically important to the longevity of the improvements. A good resource for guidance on rural road construction is the *Handbook for Forest, Ranch & Rural Roads* put together by Pacific Watershed Associates and available online (PWA, 2015). Poor long-term stability of graded pads and road surfaces and settlement of improvements represent the greatest risks to the project. Our recommendations to mitigate these risks are provided below.

5.1 Building Pad and Access Road for Relocated Greenhouse(s)

The proposed location for the greenhouse(s) and the alignment of the proposed access road is generally situated along the top of a small spur ridge. The ridgetop appears to be a stable location and minimal cut and fill will be necessary to develop a relatively flat surface for the greenhouse(s). Ideally, the footprint of the building pad avoids the hummocky areas noted on Figure 3. The road alignment discussed in the field would need to be routed around the existing pond, which puts it onto the upper part of the east-facing slope. The road surface is anticipated to intersect the head of some of the hummocky areas, depending upon the width of the final road surface. We should be consulted to review the proposed orientation of the pad(s) and the access road prior to final design so that we can provide specific recommendations as necessary. We have the following recommendations to aid in planning the arrangement of the road and pads:

- Pads should be located where they coincide with naturally occurring benches (conform to the existing topography as much as feasible) such as, the top of the ridge and/or midslope benches.
- The road surface should be routed to take advantage of low-gradient areas of the slope and avoid steep breaks in slope.
- Use full cut techniques when feasible, particularly where steep slopes (>50%) are present,
- If fill placement on slopes steeper than 50% is required, then the installation of a keyway and benching the subgrade is recommended prior to fill placement.
- Fill slopes should be constructed no steeper than a 2:1 (horizontal to vertical) slope and cutslopes constructed no steeper than 1.5:1.
- Granular fill materials (sand and gravels) should be used to build up road grades and fill prisms.
- Native clayey soils can be difficult to moisture condition and should be mixed with rocky soils if planned for use as fill.
- Outslope the surfaces to drain through sheet flow whenever possible.

- Direct and discharge any concentrated flow away from fill slopes and into areas that are stable.
- Armor any flow paths and discharge locations with rock or other suitable material to minimize the potential for erosion.
- The final road surface should be stabilized with clean rock. The pads should be stabilized with rock, vegetation, or other means to minimize erosion.

5.2 Seismic Design Criteria

Based on the subsurface conditions encountered at our exploration location, and our interpretation of soil conditions within 100 feet of the ground surface, we classify the site as a Site Class D consisting of a "stiff soil profile" in accordance with Chapter 20 of ASCE 7-10. On this basis, the mapped and design spectral response accelerations were determined using the Structural Engineers Association of California (SEAOC) and California's Office of Statewide Health Planning and Development (OSHPD) Seismic Design Maps (Accessed August 30, 2019) website in conjunction with the site class and the site coordinates (40.222375° N, -123.938771° W). Calculated values for ASCE 7-10 are presented in Table 1.

Table 1. ASCE 7-10 Standard Seismic Design Parameters
Keenan Project
Miranda, California

Parameter	Calculated Value
S_S	2.23
S_1	0.916
F_a	1.0
F_v	1.5
S_{MS}	2.23
S_{M1}	1.374
S_{DS}	1.487
S_{D1}	0.916
Risk Category	II
Seismic Design Category	E

5.3 General Site Preparation and Grading

- As appropriate, notify Underground Service Alert prior to commencing site work, and use this location service and other methods to avoid injury or risk to life and to avoid damaging underground and/or overhead utilities.
- Earthwork should be completed during dry season conditions. If grading commences in the winter or spring, or after a period of excessive rainfall, the surficial soils will become saturated and may cause difficulties in access with grading and trenching equipment and difficulties in loading, spreading, and compaction of fill material.
- Site preparation for the construction of the access road, pads for the greenhouse(s), and other shallow surficial improvements should include the stripping of the vegetation and any upper weak, compressible topsoil and/or soft/loose fill within the footprint of the development prior to placement of fill.

- Where soft, loose, or otherwise unsuitable subgrade materials are encountered, over-excavation and backfill may be necessary to rebuild a suitable subgrade. The use of geotextile fabric or other stabilization techniques may be appropriate based on the nature and extent of the unsuitable materials, and the specific development.

5.4 Engineered Fill Placement and Compaction

Fill placed in areas to support structures, pavement or other flatwork should meet the requirements for select engineered fill. Engineered fill should have less than 2 percent by dry weight of vegetation and deleterious material and should meet the gradation requirements presented in Table 2.

Table 2. Fill Gradation Criteria
Miranda, California

Sieve Designation	Percent Passing by Dry Weight
3-inch (50 mm)[1]	100
1½-inch (37.5 mm)	90 minimum
¾-inch (19 mm)	70 minimum
No. 4 (4.75 mm)	60 minimum
No. 200 (75 µm)[2]	5 minimum; 30 maximum
1. mm: millimeters 2. µm: micrometers	

- Fine-grained soil with a liquid limit greater than 40 and a plasticity index greater than 15 should not be used as engineered fill. If clayey soils do not meet the plasticity requirements, mixing of the clayey soils with sandier soils may be required.
- Clayey soils found onsite are not anticipated to be suitable for use as engineered fill. Rocky soils as seen in cutslopes closer to the primary residence may be more suitable.
- Engineered fill should be placed in loose lifts not exceeding 8 inches in thickness and compacted to a minimum of 90 percent relative compaction.
- A qualified field technician should be present to observe fill placement and perform field density tests in accordance with ASTM D 6938 at random locations throughout each lift to verify the specified compaction is being achieved.

5.5 Foundations

No specific building or residential structure meant for human occupancy has been proposed at this time, so we don't have specific foundation recommendations. Lightly loaded structures (such as, the proposed greenhouses/hoop houses) are anticipated to be placed directly on the ground surface. If any developments that would be supported by foundations are considered in the future, we should be consulted to review of the proposed building site and develop site-specific recommendations as necessary. The following discussion and recommendations are for general consideration in future planning.

In general, the native, onsite soils encountered in our boring, and observed in cutslopes appear suitable for support of lightly loaded, wood framed structures. Standard of practice dictates that all foundation elements bear on native soils below any topsoil, loose native soils or undocumented fill. The native topsoil appears to be thin in most areas, particularly along the ridge crest. Fills were noted in areas where historical site grading had occurred, particularly around the pond and where cut/fill benches have been cut into sloping ground.

At one location during our site visit, we noted what appeared to be shrinkage cracks that may be indicative of expansive soils. Expansive soils swell during the wet season and shrink during the dry season and can be a significant problem for shallow foundations. A foundation design that mitigates the risks associated with expansive soils is complex and generally expensive, and so it is best to avoid developing in areas that have expansive soils. Laboratory testing of representative soils is required to verify the presence/absence of expansive soils.

6.0 Additional Services

We suggest communications be maintained during the design phase between the design team and SHN to optimize compatibility between the design and soil conditions. We also recommend that SHN be retained during the construction phase to verify the implementation of our recommendations related to earthwork.

6.1 Plan and Specification Review

We have assumed, in preparing our recommendations, that SHN will be retained to review those portions of the plans and specifications that pertain to earthwork and foundations, if prepared by others. The purpose of this review is to confirm that our earthwork and foundation recommendations have been properly interpreted and implemented during design. If we are not provided this opportunity for review of the plans and specifications, our recommendations could be misinterpreted.

6.2 Construction-Phase Monitoring

In order to assess construction conformance with the intent of our recommendations, it is important that a representative of SHN be involved during construction to review subgrade preparation and observe and test placement of fill.

This construction-phase monitoring is important, because it provides SHN the opportunity to verify anticipated site conditions and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary from those described in this report. It also allows SHN to recommend appropriate changes in design or construction procedures if construction methods adversely affect the competence of onsite soils to support the structural improvements.

7.0 Closure and Limitations

The analyses, conclusions, and recommendations contained in this report are based on site conditions that we observed at the time of our investigation and our experience with similar projects located in similar geotechnical environments.

If there is a substantial lapse of time between the submission of our report and the client's submission of a building permit application, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we should review our report to determine the applicability of the conclusions and recommendations. This report is applicable only to the project and site studied.

The conclusions and recommendations presented in this report are professional opinions derived in accordance with current standards of professional practice. Our recommendations are tendered on the assumption that design of the improvements will conform to their intent. No warranty is expressed or implied.

The field work was conducted to investigate the site characteristics specifically addressed by this report. Assumptions about other site characteristics, such as hazardous materials contamination or environmentally sensitive or culturally significant areas, should not be made from this report.

8.0 References

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Subsurface Exploration Log

1

PROJECT: Keenan Property

LOCATION: 3852 Thomas Rd. Miranda, CA

GROUND SURFACE ELEVATION: 1970 Feet

EXCAVATION METHOD: Hand Auger

LOGGED BY: JPB

JOB NUMBER: 018198

DATE DRILLED: 7-12-19

TOTAL DEPTH OF BORING: 5.0 feet BGS

SAMPLER TYPE: N/A

BORING NUMBER
HA-1

DEPTH (FT)	BULK SAMPLE	TUBE SAMPLE		USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits		REMARKS
											Liquid Limit	Plastic Index	
0.0				OL		ORGANIC RICH TOPSOIL: SILT, dark brown, soft, dry.							
				ML/CL		SILT WITH SAND/ CLAY WITH SAND, dark brownish gray, stiff, dry to moist.							
-3.0				CL		LEAN CLAY WITH GRAVEL, dark gray to dark brown, stiff to very stiff, moist, approximately 20% angular gravel.							
-4.0				ML/CL		SILT WITH SAND/ CLAY WITH SAND, dark brownish gray, stiff, dry to moist.							
-5.0						Bottom of boring at 5 feet BGS. No free groundwater observed.							

0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0

LOG OF BORING