R G S Engineering Geology

1225 Chestnut Street
Upland, California 91784
(951) 315-3517

September 2, 2018

Lisa and Bill Burtner
2040 10th Lane
Big Bear City, California 92315

SUBJECT: **ENGINEERING GEOLOGIC INVESTIGATION AND REPORT**
McDonald Daycare Center
Irwin Ranch Road (APN 0315-421-02)
Irwin Ranch, San Bernardino County, California

Mr. & Mrs. Burtner:

In accordance with your authorization, we have completed an engineering geologic report for the subject development. The purpose of our investigation was to evaluate the existing soil and geologic conditions of the site relative to the proposed development and provide geologic recommendations for design and construction.

Our findings, conclusions, and recommendations for design and construction of the proposed home site are presented herein. Should you have any questions, or require additional information, please do not hesitate to contact our office.

Sincerely,
RGS Engineering Geology

Christopher Krall, CEG 1816
Engineering Geologist

Distribution: (2) Addressee
(1) Electronic Copy

ACCOMPANYING MAPS, ILLUSTRATIONS, AND APPENDICES

Figure 1 - Site Location Map
Figure 2 - Geologic Site Map

APPENDIX A – References
APPENDIX B – Exploratory Trench Logs

INTRODUCTION

SCOPE OF WORK

For the purpose of this report we conducted the following scope of work:

- Review related geologic and soils information available in our files.
- Site reconnaissance and geologic mapping by our state certified Engineering Geologist.
- Observation and geologic logging of two exploratory excavations to a depth of approximately 10 feet below the ground surface to describe the subsurface site conditions.
- Bulk soil sampling and in-place density/moisture testing of native soil to determine the existing physical characteristics.
- Laboratory testing of representative soil samples to determine pertinent engineering parameters such as grain size distribution, expansion index, maximum dry density, optimum moisture content, and corrosion potential as warranted.
- Engineering geologic analysis and calculation of foundation design parameters to include allowable soil bearing value, lateral earth pressures, and seismic design parameters.
- Preparation of a report presenting our findings, conclusions, and geotechnical recommendations for site construction and foundation design.

Site Conditions

The property is located along the southeast side of Irwin Ranch Road, just east of State Highway 38, in the Irwin Ranch area of San Bernardino County, California. The geographical relationship of the site and vicinity are shown on our Site Location Map, Figure 1.

Access to the property is provided along Irwin Ranch Road which exists as a maintained

road. The property is currently undeveloped and exists in a natural condition. Topographically, the site is relatively flat with a uniform slope of less than 3% toward the northeast. Total relief across the property is less than 3 or 4 feet. Drainage is directed as sheet flow across the site to the northeast (Figure 1).

Vegetation on-site includes mature conifers and a sparse undergrowth of bushes and seasonal weeds and grasses. Properties to the north, east, and west are undeveloped. The property to the south currently supports a Christian Center.

No other improvements, including grading or earthwork, were noted during our field reconnaissance and geologic mapping.

Proposed Development

For this study, RGS was provided a preliminary site plan showing the proposed building, parking, and driveway, which was used as a base for our Site Geologic Map, Figure 2.

Based on our review of the plans and recent conversations, we understand the site development will include one building with associated parking and driveway. Considering the flat nature of the site, no earthwork is necessary or proposed. Although foundation plans are not available at this time, the building will likely be supported on continuous spread footings with concrete stem walls and isolated piers and a raised wood floor foundation system following the natural grade.

Regional Geologic Setting

The site is regionally situated within a natural geomorphic province in Southern California known as the Transverse Ranges. The Transverse Ranges consist of a set of easterly-trending mountains and geologic structures that are distinct from the general northwest-southeast grain of the other provinces of California. More specifically, the site is located within the San Bernardino Mountains, an easterly-trending structural block that is roughly 55 miles long and 20 miles wide. This mountain range was formed by intense folding and faulting in late geologic time. The geomorphology of the San Bernardino Mountains indicates that the range is very young, from a geologic standpoint, and was uplifted tectonically predominantly during Tertiary and Quaternary time.

The structural block which creates the San Bernardino Mountains is bordered on the north by a zone of south-dipping thrust faults (North Frontal Fault System), and along the south by the San Andreas Fault.

Local Geologic Setting

Locally, the site is situated along the southern margin of the Irwin Lake valley. In this area alluvial fan sediment has been deposited emanating from canyons along the north flank of Sugarloaf Mountain which rises directly south of the site (Figure 2).

SITE INVESTIGATION

Our site investigation included review of available geologic reports, maps, and illustrations in our files. This was followed by field work which included site reconnaissance and geologic mapping. To evaluate the subsurface conditions at the site, a total of two exploratory trenches were excavated in the proposed building pad area using a John Deere backhoe equipped with a 18-inch wide bucket. The approximate locations of the exploratory trenches are shown on our Geologic Site Map, **Figure 2.**

General descriptions of the earth materials encountered in our exploratory trenches are provided below. Detailed descriptions in the form of exploratory trench logs are provided in **Appendix B** of this report.

SUMMARY OF FINDINGS

Earth Materials

Our exploratory excavations confirm that the site area is underlain by well dissected, older alluvial fan deposits that appear to be of late Pleistocene age based on the local geomorphology and soil horizon development. More recent active alluvial sediment is confined to local drainage courses traversing southwest to northeast and incising the older geomorphic surface on which the site is located.

The sediment underlying the site consists of gravelly sand (Unified Soil Classification – GW to SW) that is dark reddish brown (Munsell soil color notation 5YR 4/3), fine to coarse grained, dense, well graded, non-cohesive and friable. Numerous rocks to cobble size were encountered and the trenches were excavated with some difficulty. The gravel and cobbles are sub-angular confirming the relatively short distance traveled. Overall the material is classified as well graded gravelly sand with cobble that is dense, non-cohesive and friable.

Just south of the site, the margin of the alluvial fan is juxtaposed against the crystalline rock that comprises the regional basement complex and forms Sugarloaf Mountain to the south. This bedrock extends northward and underlies the site, likely at shallow depth.

Expansive Soil Conditions

Based on our visual inspection and field classification, the on-site alluvial sediment is classified as gravelly silty sand (Unified Soil Classification System – GW to SW) and considered to represent non-expansive soil in accordance with the California Building Code Section 1803.5.3. No special foundation design considerations are considered necessary relative to expansive soil conditions for the subject development.

Groundwater

During our field investigation no indication of shallow groundwater or springs, such as phreatophytes, was observed. No springs or shallow groundwater are mapped in the area (Figure 1) or known to exist.

Perched water likely flows along the basal contact of the alluvial sediment and the underlying bedrock during periods of heavy rainfall and snow melt. This condition is not expected to impact the proposed development or construction activities.

Erosion Control

The alluvial sediment is susceptible to erosion during periods of heavy or prolonged rainfall. Snow melt may also contribute to erosion locally. The degree of erosion is dependent on numerous factors including the volume of water, velocity of water, and soil conditions. While the on-site soil can be impacted by erosion, the volume and velocity of water are unknown. The potential for erosion to impact the western property boundary should be evaluated by the project civil engineer and appropriate mitigation measures incorporated into the building plans if applicable.

FAULTING AND SEISMICITY

Faulting

The site is not located within an Earthquake Fault Zone (Bryant and Hart, 2007) designated for known active faults, nor are any faults known to traverse the site. The closest known major fault zone showing surface expression is the North Frontal Fault zone located approximately 7.0 miles to the north northeast and the San Andreas Fault system is located approximately 13.0 miles to the southwest (Bortugno and Spittler, 1986). The North Frontal Fault zone in this area is characterized as a reverse thrust fault dipping to the south with a total length of approximately 65 kilometers. This zone has an established slip rate of 1.0 mm/yr with probable magnitudes events of 6.0 to 7.1 Mw and an unknown recurrence interval (SCEDC Website, 2017 - http://www.data.scec.org/significant/northfrontal.html).

Seismicity

The primary geologic hazard that exists at the site is that of ground shaking. The strength of earthquake-induced ground shaking is commonly measured as maximum or peak ground acceleration. Acceleration is defined as the time rate of change of velocity of a referenced point during an earthquake, commonly expressed in percentage of gravity (g). Its value at a particular site is a function of many factors, including, but not limited to, earthquake magnitude, distance to causative earthquake, various seismic-source parameters, site location relative to direction of energy propagation, and geologic conditions at the site.

Considering the location of the site relative to the North Frontal and San Andreas Fault

zones, the site is likely to experience strong ground shaking during the design life of the proposed development. Specifically, the site could experience peak ground accelerations (PGA) on the order of 0.405g based on a 10 percent probability of exceedance and a 50 year exposure period (http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html).

SECONDARY SEISMIC HAZARDS

Liquefaction

Soil liquefaction is the loss of soil strength due to increased pore water pressures caused by a significant ground shaking (seismic) event. Liquefaction typically consists of the re-arrangement of the soil particles into a denser condition resulting, in this case, in localized areas of settlement, sand boils, and flow failures. Areas underlain by loose to medium dense cohesionless soils, where groundwater is within 30 to 40 feet of the surface, are particularly susceptible when subject to ground accelerations such as those due to earthquake motion. The liquefaction potential is generally considered greatest in saturated loose, poorly graded fine sands with a mean grain size (D_{50}) in the range of 0.075 to 0.2mm.

Our investigation indicates that the property is underlain by moderately dense to dense, well graded sand and gravel underlain by crystalline bedrock. The physical properties and density of these materials coupled with the underlying bedrock anticipated at shallow depth, suggest a low potential for liquefaction hazard to impact the site.

Ground Rupture

Ground rupture usually occurs along pre-existing surface fault traces. As previously discussed, no active faults are known to traverse, or trend toward the site. Therefore, the potential for ground rupture from tectonic sources during a seismic event is considered low.

Earthquake Induced Settlement

Considering the moderately dense to dense nature of the underlying alluvial sediment, the potential for settlement during a significant earthquake is considered low. Provided the residential structure is designed and constructed in accordance with the recommendations of this report, and the requirements of the California Building Code, the potential for settlement induced by seismic activity to impact the building is considered low.

Rockfall

There are no large rock outcrops located along hillsides on, or adjacent to the site, that could become dislodged during a seismic event and impact the proposed development. This specifically includes the ascending hillside immediately adjacent to and west of the site.

Considering the absence of large rock outcrops on or near the property, the potential for

seismically induced rockfall hazard to impact the proposed development is considered very low to nil.

Landslide Hazard

No indications of hillside instability along the ascending slope west of the site were noted during our field geologic mapping. The hillside directly west of the site consists of stable crystalline bedrock and is not considered a landslide hazard threat. Considering the local topography and geology, the potential for landslide hazard to impact the site is considered low.

CONCLUSIONS

- Development of the proposed residence is considered feasible from a geologic standpoint provided the specific conclusions and recommendations of this report are considered and adhered to during future site planning, design, and construction.

- The subject site is underlain by relatively shallow older alluvial sediment and crystalline bedrock. These earth materials are considered suitable for support of the single-story building provided the foundation is designed and constructed in accordance with minimum standards of the current California Building Code.

- On-site soils are classified as non-expansive and no special considerations for foundation design are considered necessary relative to expansive soil. On-site soils are susceptible to erosional forces.

- Shallow groundwater is not expected to impact the proposed development or construction activities. Near surface seepage, however, should be anticipated during periods of rainfall or snowmelt and should be considered during site design.

- No active faults are known to traverse through or toward the site. Known active faults or seismic sources in the area include the North Frontal and San Andreas Fault zones, located approximately 7 miles to the north and 13 miles to the southwest, respectively.

- The potential for secondary seismic hazards including, ground rupture, landslide hazard, liquefaction, rockfall, and earthquake induced settlement are considered low.

RECOMMENDATIONS

General

General engineering geologic recommendations for site development are provided in the following sections of this report based on our limited field exploration. Please understand that these recommendations are subject to review and change based on actual field

conditions observed during construction and review of the final project foundation and/or grading plans.

Subgrade Preparation

The underlying earth material is considered suitable for support of the proposed building provided the provisions of the California Building Code are implemented for foundation design. All footing elements should be supported directly on the native alluvial sediment. Depth of footings must meet minimum depth requirements for the frost conditions expected and should extend through the root zone noted to 12 inches below the ground surface. The bottom of footing excavations should be free of roots or tree stumps. All footing excavations must be inspected and approved by our certified Engineering Geologist to assure anticipated subsurface conditions are present.

Seismic Design Considerations

Seismic design parameters should conform to the 2016 California Building Code, Section 1613. Considering the physical characteristics of the shallow sediment and underlying bedrock, an estimated site class of 'C' should be considered for structural design of the project in accordance with Chapter 20 of ASCE 7, Table 20.3-1 - Site Classification. The site specific seismic design parameters are provided in Appendix B of this report.

Surface Drainage

Surface drainage should be directed away from foundations of buildings or appurtenant structures. All drainage should be directed toward streets or natural drainage patterns in a controlled manner. Where landscaping and planters are proposed adjacent to foundations, subsurface drains should be provided to prevent standing water or saturation of foundations by landscape irrigation water.

The on-site earth materials are susceptible to erosional forces. Measure to control erosion and protect the western portion of the property should be evaluated by the project civil engineer. Considering the mountain location of the development and the seasonal snow melt, French drains around the perimeter of the footings should be considered to assure that melting snow does not wick up the concrete footing elements. Drains could daylight to the south or west of the site.

Footing Inspection

The project Engineering Geologist should be retained to inspect all footing excavations to assure that anticipated condition exists. Specific recommendations based on conditions observed within the footing excavations can be made at that time, if warranted. The footing inspection and approval should be documented by field memo for submittal to the oversight agency.

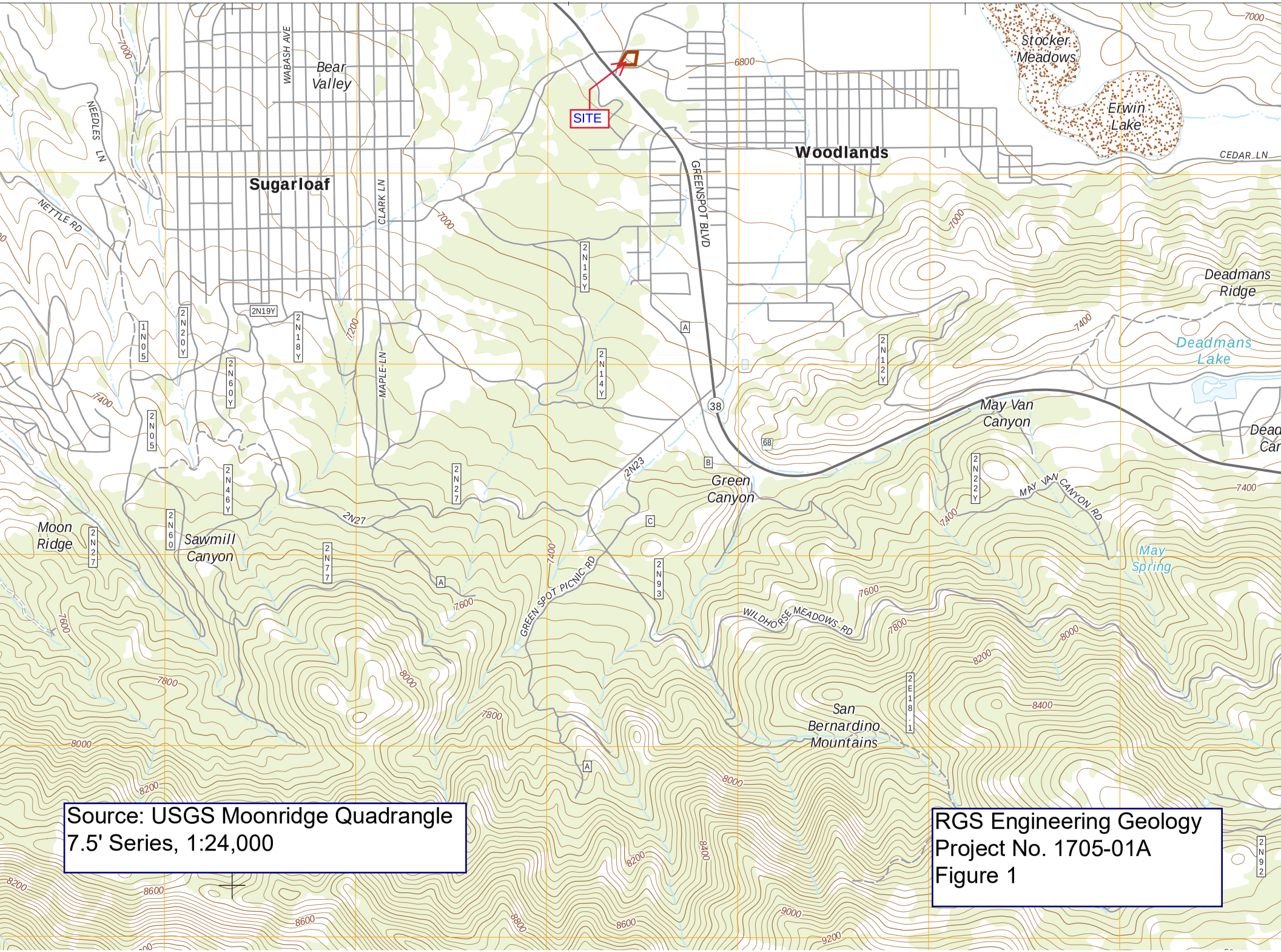
CLOSURE

Our investigation was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers and geologists practicing in this and other localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The samples taken and used for testing, and the observations made are believed to be representative of the entire project; however, soil and geologic conditions can vary significantly between test locations. As in most projects, conditions revealed during construction may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by the project geotechnical engineer and/or geologist and designs adjusted as required or alternate designs recommended.

This report is issued with the understanding that it is the responsibility of the owner, or his representatives, to ensure the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary steps taken to see that the contractor and subcontractors carry out such recommendations in the field. This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for other than our own personnel on the site; therefore, the safety of others is the responsibility of the contractor. The contractor should notify the owner if he considers any of the recommended actions herein to be unsafe.

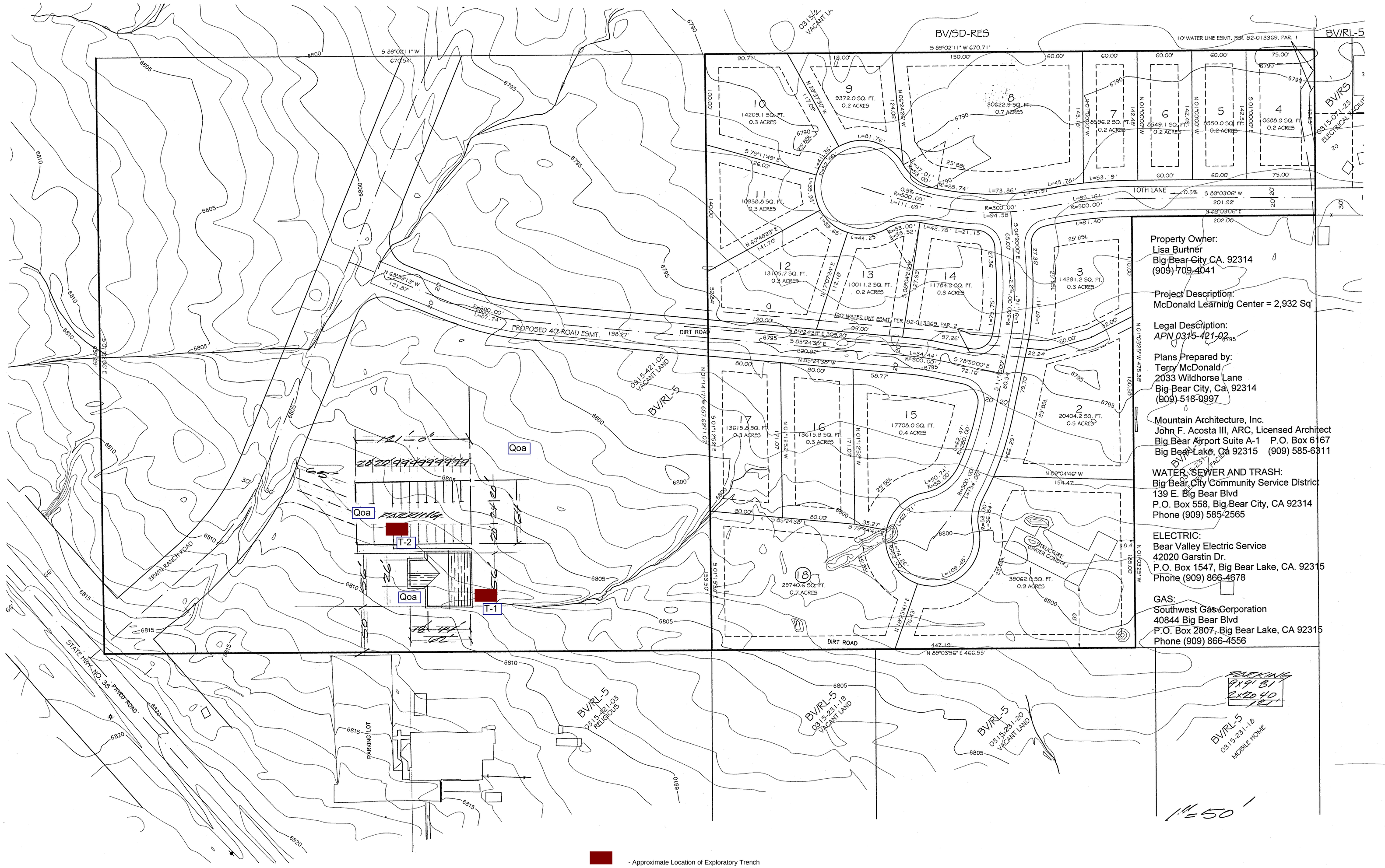
The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and revision as changed conditions are identified.



Source: USGS Moonridge Quadrangle
7.5' Series, 1:24,000

RGS Engineering Geology
Project No. 1705-01A
Figure 1

SITE GEOLOGIC MAP



Property Owner:
Lisa Burtner
Big Bear City CA. 92314
(909) 709-4041

Project Description:
McDonald Learning Center = 2,932 Sq'

Legal Description:
APN 0315-421-02

Plans Prepared by:
Terry McDonald
2033 Wildhorse Lane
Big Bear City, Ca. 92314
(909) 518-0997

Mountain Architecture, Inc.
John F. Acosta III, ARC, Licensed Architect
Big Bear Airport Suite A-1 P.O. Box 6167
Big Bear Lake, Ca 92315 (909) 585-6311

WATER, SEWER AND TRASH:
Big Bear City Community Service District
139 E. Big Bear Blvd
P.O. Box 558, Big Bear City, CA 92314
Phone (909) 585-2565

ELECTRIC:
Bear Valley Electric Service
42020 Garstin Dr.
P.O. Box 1547, Big Bear Lake, CA. 92315
Phone (909) 866-4678

GAS:
Southwest Gas Corporation
40844 Big Bear Blvd
P.O. Box 2807, Big Bear Lake, CA 92315
Phone (909) 866-4556

RGS Engineering Geology
Project No. 1705-01A
Figure 2

APPENDIX A

REFERENCES

REFERENCES

Bortugno, E.J., and Spittler, T.E., 1986, Geologic Map of the San Bernardino Quadrangle, Scale 1:250,000, Map No. 3A, Regional Geologic Map Series of the California Division of Mines and Geology, Second Printing, 1998.

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California Division of Mines and Geology, 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California, CDMG Special Publication 117

California Geological Survey, 1988, Earthquake Fault Zones (Special Studies Zones), Fawnskin 7.5' Quadrangle, Effective March 1, 1988, Scale 1:24,000.

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RGS Engineering Geology, 2003, Engineering Geologic Study, 8 Acre Parcel, APN 304-231-14, Fawnskin Area, San Bernardino County, California, Project No. 802-01, July 10, 2003.

RGS Engineering Geology, 2004, Preliminary Geotechnical Investigation and Slope Stability Analysis, 30 Acre Subdivision, APN 304-231-035, Easterly of Canyon Road, Fawnskin Area of San Bernardino County, California, Project No. 0895-01, June 4, 2004.

RGS Engineering Geology, 2006, Preliminary Geotechnical Investigation, Proposed Garage and Elevator Addition (APN 304-174-12), 1090 Bruin Trail, Fawnskin, California, Project No. 1257-01, March 31, 2006.

Sadler, P.M., 1982, Geology of the NE San Bernardino Mountains, San Bernardino County, California, CDMG, Open File Report 82-18, 1977-1981, Published 1982.

APPENDIX B

EXPLORATORY TRENCH LOGS

EXPLORATORY TRENCH LOG

PROJECT NAME McDonald ELEVATION NA TRENCH NO. _T-1_____

PROJECT No. _____ EQUIPMENT _JD 410_____

DEPTH (FEET)	TYPE OF TEST*	SAMPLE DEPTH	DRY DENSITY (PCF)	MOISTURE CONTENT %	(USCS) SOIL CLASSIFICATION	EARTH MATERIAL	GEOTECHNICAL DESCRIPTION **LOGGED BY CK DATE 5-14-18** **SAMPLED BY CK**
	NG		115.2	5.5	GW	Qoa	**OLDER ALLUVIUM (Qoa)** *Gravelly Silty Sand* (GW) Dark Reddish Brown (5YR 4/3), fine to coarse grained
	BULK						Damp to Moist, well graded, cobbles to 20%
	NG		110.8	7.5			Gravel & cobbles are sub-angular, dense, roots in
5							Upper 12 inches to 2" diameter, matrix is moderately
							Indurated.
10							
							Total Depth 10 ft.
							No Groundwater or Seepage
							Difficult Excavation
							Trench Backfilled
15							

GRAPHIC LOG Trend: Scale: 1" = 5'

*TEST SYMBOLS

B - BULK SAMPLE
R - RING SAMPLE
SC - SANDCONE
MD - MAXIMUM DENSITY
GS - GRAIN SIZE
SE - SAND EQUIVALENT
NG - NUCLEAR GAUGE
(90) - RELATIVE COMPACTION

RGS Engineering Geology

EXPLORATORY TRENCH LOG

PROJECT NAME McDonald ELEVATION ___NA_____ TRENCH NO. _T-2_____

PROJECT No. _____ EQUIPMENT _JD 410_____

DEPTH (FEET)	TYPE OF TEST*	SAMPLE DEPTH	DRY DENSITY (PCF)	MOISTURE CONTENT %	(USCS) SOIL CLASSIFICATION	EARTH MATERIAL	GEOTECHNICAL DESCRIPTION
							LOGGED BY ___CK_____ DATE 5-14-18 _____ **SAMPLED BY ___CK_____**
	NG		109.4	6.7	GW	Qoa	**OLDER ALLUVIUM (Qoa)** *Gravelly Silty Sand* (GW) Dark Reddish Brown (5YR 4/3), fine to coarse grained Damp to Moist, well graded, cobbles to 10% Gravel & cobbles are sub-angular, dense, roots in Upper 12 inches to 2" diameter, matrix is moderately Indurated.
	BULK						
	NG		112.7	8.2			
5							
10							Total Depth 10 ft. No Groundwater or Seepage Difficult Excavation Trench Backfilled
15							

GRAPHIC LOG Trend: Scale: 1" = 5'

*TEST SYMBOLS

B - BULK SAMPLE
R - RING SAMPLE
SC - SANDCONE
MD - MAXIMUM DENSITY
GS - GRAIN SIZE
SE - SAND EQUIVALENT
NG - NUCLEAR GAUGE
(90) - RELATIVE COMPACTION

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