February 10, 2017
Project 7200-04

Kiddie Academy of Irvine
16655 Noyes
Irvine, California 92866

Attention: Mr. Joseph Haikal
President

Subject: Geotechnical Investigation Report
Proposed Child Development Center
1345 North Grand Avenue
Santa Ana, California

Dear Mr. Haikal:

1. INTRODUCTION

a) In accordance with your request, we are pleased to submit this *Geotechnical Investigation Report* for the proposed development at the subject site located in the city of Santa Ana, California.

b) Grading and structural plans are not available at this time. However, we understand that the planned development project will include the construction of a 6,500 to 7,000 ft^2 single story structure with associated parking and driveway areas.

c) We have assumed that the typical wall loads will not exceed 4 kip/ft and the column loads will not exceed 50 kips.

2. SCOPE

The scope of services we provided is as follows:

a) Preliminary planning and preparation;

b) Review of available geotechnical reports and maps pertaining to the site;

c) Field exploration consisting of drilling two borings to depths of 30 and 35 feet below the existing ground surface using a truck-mounted hollow-stem auger drill rig. An additional boring, 8 feet deep, was drilled for the purpose of conducting a percolation test;

d) Logging of the borings by our Engineering Geologist;

e) Obtaining in-situ and bulk samples for classification and laboratory testing;

f) Laboratory testing of selected samples considered representative of site conditions, in order to derive relevant engineering properties;

g) Office engineering and geologic analyses of the field and laboratory data;

h) Preparation of a final geotechnical report presenting our findings, conclusions and recommendations.

3. FIELD EXPLORATION

Details of the field investigation, including the *Logs of Boring* are presented in *Appendix B.*

4. LABORATORY TESTING

A description of the laboratory testing and the results are presented in *Appendix C.*

5. SITE DESCRIPTION

5.1 Location

a) The project site is located along the east side of Grand Avenue, just north of the northbound off-ramp from the I-5 Freeway, in the city of Santa Ana, California.

b) The approximate site location is shown on the *Location Map, Figure 1.*

5.2 Existing Surface Conditions

a) The 29,574-square foot site is currently vacant and void of any building structures. The southern 2/3^{rds} of the property area is a nearly square shaped pad covered by 1 to 2 inches of gravel rock and enclosed with chain link fencing. The northern 1/3rd of the site is currently an asphalt concrete paved street (Washington Place) with grass and shrub landscaping along both sides of the street.

b) The project site is relatively level. The local natural topography generally slopes to the southwest at an approximate gradient of 0.6 to 0.7 percent.

c) Surface drainage consists of sheet flow runoff of incident rainfall water derived primarily within the property boundaries and adjacent properties. The nearest primary drainage feature is Santiago Creek, located approximately 7,000 feet to the northwest of the subject property.

5.3 Geology

5.3.1 Regional Geologic Setting

The project site rests upon alluvial sediments in the floodplains of the Santa Ana River and Santiago Creek. This area forms part of the Peninsular Ranges Geomorphic Province of California. Geologic structures within this province are characterized by a northwest-trending topographic range that terminates directly against the Transverse Ranges to the north. The inland portions of the province include several high mountain ranges, underlain by igneous, metasedimentary and metavolcanic rock of the Paleozoic and Mesozoic age. The coastal portion is defined by clastic marine and non-marine terraces of the upper Cretaceous, Tertiary, and Quaternary age. Structurally, the province is regarded as an uplifted and westward tilted range, which has been faulted and broken up into several smaller sub-parallel blocks. The Peninsular Ranges province is both bounded and transected by several major fault zones. Principal faults include the San Andreas, San Jacinto, Newport-Inglewood and the Whittier-Elsinore Fault Zones.

5.3.2 Local Geologic Setting

The project site is situated on the nearly flat-lying area of the Tustin Plain, which contain deposits associated with the Santa Ana River and other nearby river systems. These deposits include late Pleistocene to Holocene floodplain and stream terrace, which consist of unconsolidated to poorly consolidated, non-marine mixtures of sand, silt, and gravel.

5.4 Subsurface Conditions

The subsurface conditions, as encountered in our explorations, are described in the following sections and on our *Logs of Boring* presented as *Figures B-2* through *B-4*. The approximate locations of the borings are shown on our *Boring Location Plan, Plate 1.*

5.4.1 Fill

a) Artificial fill material was encountered in all of the borings excavated for this investigation. The depth of the fill was found to range from 2.5 to 3.5 feet.

b) The fill was found to consist of a variety of materials ranging from Silty to Clayey SAND and Silty CLAY.

c) In the absence of any documentation, the fill is considered to be uncertified and not suitable to support the proposed structures.

5.4.2 Alluvium

a) Holocene-aged alluvial deposits, consisting of Silty SAND, Gravelly SAND, and Sandy SILT were encountered in our borings to the maximum depths explored.

b) The Silty SAND sediments encountered in our excavations were generally observed to be fine grained, dark yellowish brown to orange brown, slightly moist to moist and loose to medium dense. The Gravelly SAND, encountered at a depth of 34 feet below ground surface in Boring B-2, was found to be fine to medium grained, yellow to orange brown, moist and medium dense.

c) The Sandy SILT deposits were typically observed to be dark yellowish to orange brown, moist and medium stiff.

5.4.3 Groundwater

a) No free groundwater or seepage was encountered in any of our excavations.

b) We have obtained ground water level data from the California Department of Water Resources (CDWR) Water Data Library website. The closest groundwater monitoring well is shown to be located approximately 2,500 feet southeast of the project site.

c) Several measurements were collected from the nearby well during the period from April 2008 to December 2010. The measurements indicate that the groundwater levels have generally fluctuated between 145 feet and 334 feet below ground surface during this time period. The last measurement was collected on December 16, 2010. The groundwater level at that time was reported to be 176 feet below ground surface.

d) Additional data was reviewed from two groundwater monitoring wells shown to be located approximately 4,200 feet south of the project site. Several measurements were collected from these wells during the period from 1990 to 2010. The measurements indicate that the groundwater levels have generally fluctuated between 77.5 feet and 144.5 feet below ground surface during this time period. The last measurement was collected on October 26, 2010. The groundwater level at that time was reported to be 115.3 feet below ground surface.

6. SEISMICITY

6.1 General

a) The property is located in the general proximity of several active and potentially active faults, which is typical for sites in the Southern California region. Earthquakes occurring on active faults within a 70-mile radius are capable of generating ground shaking of engineering significance to the proposed construction.

b) In Southern California, most of the seismic damage to manmade structures results from ground shaking and, to a lesser degree, from liquefaction and ground rupture caused by earthquakes along active fault zones. In general, the greater the magnitude of the earthquake, the greater is the potential damage.

6.2 Ground Surface Rupture

a) The project site is not located within a delineated Earthquake Fault Zone (previously referred to as the Alquist-Priolo Special Studies Zone).

b) The closest known active fault is the Newport-Inglewood Fault, located at a distance of approximately 10.3 miles southwest of the project site. Other known active faults include the Whittier Fault and Elsinore Fault, located at distances of about 10.9 miles and 11.6 miles, respectively, from the subject property.

c) Due to the distance of the closest active fault to the site, ground rupture is not considered a significant hazard at the site.

6.3 Ground Shaking

a) We utilized the *U.S. Seismic Design Maps* internet program provided by the U.S. Geological Survey to calculate the peak ground acceleration (PGA) at the project site location. Using the 2010 ASCE-7 (w/March 2013 errata) standard, the PGA at the subject property resulted to be 0.527g.

b) *Figure 2* shows the geographical relationships among the site locations, nearby faults and the epicenters of significant occurrences. From the seismic history of the region and proximity, the Newport-Inglewood, Whittier and Elsinore Faults have the greatest potential for causing earthquake damage related to ground shaking at this site.

6.4 Liquefaction

a) Liquefaction is the phenomenon where saturated soils develop high pore water pressures during seismic shaking and behave like a fluid.

b) The site is not located in a liquefaction zone as designated in State of California *Seismic hazard Zone.*

c) Free groundwater is expected to be deeper than 50 feet below ground surface. The potential for liquefaction is considered to be low.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 General

a) Our recommendations should be incorporated in the project plan designs and specifications, and are implemented during construction.

b) We are of the opinion that the proposed structures may be supported on shallow spread footings founded on the newly placed fill soils.

c) We are also of the opinion that with due and reasonable precautions, the required grading will not endanger adjacent property nor will grading be affected adversely by adjoining property.

d) The design recommendations in the report should be reviewed during the grading phase when soil conditions in the excavations become exposed.

e) The final grading plan and foundation plan/loads should be reviewed by the Geotechnical Engineer.

7.2 Grading

7.2.1 Processing of On-Site Soils

a) We recommend that the existing fill soils are not considered suitable to support the proposed structures and should be removed entirely from the structural area including the building, exterior hardscape and pavement.

b) Additionally, the site soils should be overexcavated such that there is at least 3 feet of compacted fill below the bottom of the footings, 3 feet below the interior slab-on-grade and one foot below the exterior hardscape and pavement. The overexcavation should extend laterally for a distance of 3 feet beyond the edges of the new footings.

c) Wherever structural fills are to be placed, the upper 6 to 8 inches of the subgrade should, after stripping or overexcavation, first be scarified and reworked.

d) Any loosening of reworked or native material, consequent to the passage of construction traffic, weathering, etc., should be made good prior to further construction.

e) The depths of overexcavation should be reviewed by the Geotechnical Engineer during construction. Any surface or subsurface obstructions, or any variation of site materials or conditions encountered during grading should be brought immediately to the attention of the Geotechnical Engineer for proper exposure, removal or processing, as directed. No underground obstructions or facilities should remain in any structural areas.

f) Depressions and/or cavities created as a result of the removal of obstructions should be backfilled properly with suitable materials, and compacted.

7.2.2 Material Selection

a) After the site has been stripped of any debris, vegetation and organic soils, excavated on-site soils are considered satisfactory for reuse in the construction of on-site fills, with the following provisions:

i) The soils will have to be moisture-conditioned to bring to near-optimum moisture content;

ii) The organic content does not exceed one percent by volume;

iii) Large size rocks greater than 8 inches in diameter should not be incorporated in compacted fill;

iv) Rocks greater than 4 inches in diameter should not be incorporated in compacted fill to within 1 foot of the underside of the footings and slabs.

b) Any import soils should comply with the following specifications. Also, the import soils should be approved by the geotechnical engineer prior to bringing them to the site.

i) The organic content does not exceed one percent by volume;

ii) Large size rocks greater than 8 inches in diameter should not be incorporated in compacted fill;

iii) Rocks greater than 4 inches in diameter should not be incorporated in compacted fill to within 1 foot of the underside of the footings and slabs;

iv) The expansion index should be less than 50.

7.2.3 Compaction Requirements

a) Reworking/compaction shall include moisture-conditioning/drying as needed to bring the soils to slightly above the optimum moisture content. All reworked soils and structural fills should be densified to achieve at least 90 percent relative compaction with reference to laboratory compaction standard. The optimum moisture content and maximum dry density should be determined in the laboratory in accordance with ASTM Test Designation D1557.

b) Fill should be compacted in lifts not exceeding 8 inches (loose).

7.2.4 Excavating Conditions

a) Excavation of on-site materials may be accomplished with standard earthmoving or trenching equipment. No hard rock was encountered which will require blasting.

b) No groundwater or seepage was encountered in our excavation. Dewatering is not anticipated.

7.2.5 Expansion Potential

a) Based on the laboratory test results, the expansion potential of the subgrade soils is considered *low*.

b) The soil expansion potential for any doubtful soil should be determined during the final stages of rough grading.

7.2.6 Soil Corrosion Potential

a) Soil Corrosion potential for metal and concrete was estimated by performing water soluble sulfate, chloride, pH, and electrical resistivity tests during this investigation.

b) In general, the chemical test showed a water soluble sulfate of 0.1317 percent for near surface soils, indicating a *moderate* degree of sulfate exposure on concrete in accordance with the building code.

c) Electrical resistivity is a measure of soil resistance to the flow of corrosion currents. Corrosion currents are generally high in low resistivity soils. The electrical resistivity of a soil decreases primarily with an increase in its chemical and moisture contents. A commonly accepted correlation between electrical resistivity and corrosivity for buried ferrous metals is presented below:

Electrical Resistivity, Ohm-cm	**Corrosion Potential**
Less than 1,000	Severe
1,000-2,000	Corrosive
2,000-10,000	Moderate
Greater than 10,000	Mild

d) Results of electrical resistivity test indicate 152 ohm-cm for the near-surface soils. Based on this data, it is our opinion that, in general, on-site near-surface soils have a *severe* corrosion potential. This potential should be considered in design of underground metal pipes.

7.2.7 Utility Trenching

a) The walls of temporary construction trenches in fill should stand nearly vertical, with only minor sloughing, provided the total depth does not exceed 3 feet. Shoring of excavation walls or flattening of slopes may be required, if greater depths are necessary.

b) Trenches should be located so as not to impair the bearing capacity or to cause settlement under foundations. As a guide, trenches should be clear of a 45-degree plane, extending outward and downward from the edge of foundations. Shoring should comply with Cal-OSHA regulations.

c) Existing soils may be utilized for trenching backfill, provided they are free of organic materials.

d) All work associated with trench shoring must conform to the state and federal safety codes.

7.2.8 Surface Drainage Provisions

Positive surface gradients should be provided adjacent to the buildings to direct surface water run-off away from structural foundations and to suitable discharge facilities.

7.2.9 Grading Control

All grading and earthwork should be performed under the observation of a Geotechnical Engineer in order to achieve proper subgrade preparation, selection of satisfactory materials, placement and compaction of all structural fill. Sufficient notification prior to stripping and earthwork construction is essential to make certain that the work will be adequately observed and tested.

7.3 Slab-on-Grade

a) Concrete floor slabs may be founded on the imported, suitably compacted fill surface.

b) The slab-on-grade should be underlain by 4 inches of SAND. A plastic vapor barrier should be placed at the mid-height of the SAND.

c) It is recommended that #4 bars on 16-inch center, both ways, be provided as minimum reinforcement in slabs-on-grade. Joints should be provided and slabs should be at least 4 inches thick.

d) The FFL should be at least 6 inches above highest adjacent grade.

e) The subgrade should be kept moist prior to the concrete pour.

7.4 Spread Foundations

The proposed structures can be founded on shallow spread footings. The criteria presented below should be adopted:

7.4.1 Dimensions/Embedment Depths

	Minimum Width (ft)	**Minimum Embedment Below Lowest Finished Surface (ft)**	
One Story Wall Footings	1.25	Perimeter	1.5
		Interior	1.0
Square Column Footings to 50 kip	-	2.0	

7.4.2 Allowable Bearing Capacity

Embedment Depth (ft)	**Allowable Bearing Capacity (lb/ft^2)**
1.0	1,800

(Notes:

- The allowable bearing capacity may be increased by 600lb/ft^2 for each additional foot increase in depth and by 200 lb/ft^2 for each additional foot increase in width, to a maximum value of 3,600 lb/ft^2;
- These values may be increased by one-third in the case of short-duration loads, such as induced by wind or seismic forces;
- At least 4x#4 bars should be provided in wall footings, two on top and two at the bottom;
- Tie the pad footings using grade beams in at least two directions;
- In the event that footings are founded in structural fills consisting of imported materials, the allowable bearing capacities will depend on the type of these materials, and should be re-evaluated;
- Bearing capacities should be re-evaluated when loads have been obtained and footings sized during the preliminary design;

- Planter areas should not be sited adjacent to walls;
- Footing excavations should be observed by the Geotechnical Engineer;
- Footing excavations should be kept moist prior to the concrete pour;
- It should be insured that the embedment depths do not become reduced or adversely affected by erosion, softening, planting, digging, etc.)

7.4.3 Settlement Estimates

Total and differential settlements under spread footings are expected to be within tolerable limits and are not expected to exceed 1 inch and ¾ inches over a horizontal distance of 40 feet, respectively.

7.5 Lateral Pressures

a) The following lateral pressures are recommended for the design of retaining structures.

Lateral Force	Soil Profile	Pressure ($lb/ft^2/ft$ depth)	
		Unrestrained Wall	**Rigidly Supported Wall**
Active Pressure	Level	38	-
At-Rest Pressure	Level	-	60
Passive Resistance (ignore upper 1.5 ft.)	Level	300	-

b) Friction coefficient: 0.37 (includes a Factor of Safety of 1.5). While combining friction with passive resistance, reduce passive by 1/3.

c) These values apply to the existing soil, and to compacted backfill generated from in-situ material. Imported material should be evaluated separately. It is recommended that where feasible, imported granular backfill be utilized, for a width equal to approximately one-quarter the wall height, and not less than 1.5 feet.

d) Backfill should be placed under engineering control.

e) Subdrains comprised of 4-inch perforated (holes facing downward) SDR-35 or equivalent Schedule-40 PVC pipe covered in a minimum of one cubic foot per linear foot of filter rock and wrapped in Mirafi 140N filter fabric should be provided behind retaining walls. The installation of all subdrains must be observed by the Geotechnical Engineer prior to backfill.

7.6 Seismic Coefficients and Liquefaction Potential

a) For seismic analysis of the proposed project in accordance with the seismic provisions of 2016 California Building Code, we recommend the following:

ITEM	VALUE	REFERENCE
Site Longitude (Decimal-degrees)	-117.8514	Google Earth
Site Latitude (Decimal-degrees)	33.7564	Google Earth
Site Class	D	2016 CBC Section 1613.3.2 & Chapter 20 of ASCE 7
Seismic Design Category	D	2016 CBC Section 1613.3.5 & Tables 1613.3.5(1)(2)
Mapped Spectral Response Acceleration-Short Period (0.2 Sec) - S_S	1.465	2016 CBC Section 1613.3.1(1)
Mapped Spectral Response Acceleration-1 Second Period – S_1	0.536	2016 CBC Section 1613.3.1(2)
Short Period Site Coefficient-F_a	1.0	2016 CBC Section 1613.3.3(1)
Long Period Site Coefficient F_v	1.5	2016 CBC Section 1613.3.3(2)
Adjusted Spectral Response Acceleration @ 0.2 Sec. Period (Sms)	1.465	2016 CBC Section 1613.3.3 Equation 16-37
Adjusted Spectral Response Acceleration @ 1Sec.Period (S_{m1})	0.804	2016 CBC Section 1613.3.3 Equation 16-38
Design Spectral Response Acceleration @ 0.2 Sec. Period (S_{Ds})	0.976	2016 CBC Section 1613.3.4 Equation 16-39
Design Spectral Response Acceleration @ 1-Sec. Period (S_{D1})	0.536	2016 CBC Section 1613.3.4 Equation 16-40

b) The site is not located in a State of California delineated *Seismic Hazard Zone* for liquefaction. Ground water was not encountered in our borings. The liquefaction potential is considered to be low.

7.6 Pavement Section

7.6.1 Asphalt Concrete

a) Based on Traffic Index (T.I.) and the anticipated “R”-Value of 37, the following tentative structure pavement sections are recommended:

Location	T.I.	Asphaltic Concrete (inches)	Aggregate Base (inches)
Parking	5.0	3.0	4.0
Driveway	5.5	3.0	6.0
Truck Traffic	6.0	4.0	5.0

b) The subgrade soils should be tested for R-Value at the conclusion of rough grading and the pavement section should be finalized then.

7.6.2 Subgrade Preparation

All pavement areas shall be inspected, tested for compaction requirements, reworked where required and approved immediately prior to the placement of aggregate base. Subgrade soils should be prepared as per the recommendations provided in *Section 7.2.1*.

7.6.3 Base Preparation

Unless otherwise specified, the base shall consist of Class II ¾-inch aggregate base or approved Crushed Miscellaneous Base (CMB). The base shall be compacted to a minimum of 95 percent relative compaction in accordance with the procedures described in ASTM Test Method D1557.

7.6.4 Concrete Pavement

In areas where concrete pavements are proposed, we recommend that the thickness of the concrete pavement should be at least 6 inches. It is preferred that the concrete pavement is reinforced with minimum reinforcement to of #3 bars on 24-inch center both ways. The concrete should be underlain by 4-inch thick base placed in accordance with *Section 7.6.3* above.

8. LIMITATIONS

a) Soils and bedrock over an area show variations in geological structure, type, strength and other properties from what can be observed, sampled and tested from specimens extracted from necessarily limited exploratory borings. Therefore, there are natural limitations inherent in making geologic and soil engineering studies and analyses. Our findings, interpretations, analyses and recommendations are based on observation, laboratory data and our professional experience; and the projections we make are professional judgments conforming to the usual standards of the profession. No other warranty is herein expressed or implied.

b) In the event that during construction, if the conditions are exposed which are significantly different from those described in this report, they should be brought to the attention of the Geotechnical Engineer.

c) The recommendations provided in this report are intended to minimize the potential of distress to the structures caused by the subgrade soils. However, it should be noted that certain amount of distress to the existing and proposed improvements of the slab is unavoidable and should be anticipated during the lifetime of the existing and the proposed structures.

The opportunity to be of service is sincerely appreciated. If you have any questions or if we can be of further assistance, please call.

Very truly yours,

GLOBAL GEO-ENGINEERING, INC.

Mohan B. Upasani	Kevin B. Young
Principal Geotechnical Engineer	Principal Engineering Geologist
RGE 2301	CEG 2253
(Exp. March 31, 2017)	(Exp. October 31, 2017)

MBU/KBY: fdg

Enclosures:

Location Map	- Figure 1
Seismicity Map	- Figure 2
Terms and Conditions	
References	- Appendix A
Field Exploration	- Appendix B
Unified Soils Classification System	Figure B-1
Logs of Borings	Figure B-2 through B-4
Laboratory Testing	- Appendix C
Boring Location Plan	- Plate 1

TERMS AND CONDITIONS OF AUTHORIZATION

Consultant shall serve Client by providing professional counsel and technical advice regarding subsurface conditions consistent with the scope of services agreed-to between the parties. Consultant will use his professional judgment and will perform his services using that degree of care and skill ordinarily exercised under similar circumstances, by reputable foundation engineers and/or engineering geologists practicing in this or similar localities.

- In assisting Client, the Consultant may include or rely on information and drawings prepared by others for the purpose of clarification, reference or bidding; however, by including the same, the Consultant assumes no responsibility for the information shown thereon and Client agrees that Consultant is not responsible for any defects in its services that result from reliance on the information and drawings prepared by others. Consultant shall not be liable for any incorrect advice; judgment or decision based on any inaccurate information furnished by the Client or any third party, and Client will indemnify Consultant against claims, demands, or liability arising out of, or contribute to, by such information.

- Unless otherwise negotiated in writing, Client agrees to limit any and all liability, claim for damages, cost of defense, or expenses to be levied against Consultant on account of design defect, error, omission, or professional negligence to a sum **not to exceed ten thousand dollars or charged fees whichever is less**. Further, Client agrees to notify any construction contractor or subcontractor who may perform work in connection with any design, report, or study prepared by Consultant of such limitation of liability for design defects, errors, omissions, or professional negligence, and require as a condition precedent to their performing the work a like limitation of liability on their part as against the Consultant. In the event the Client fails to obtain a like limitation of liability provision as to design defects, errors, omissions or professional negligence, any liability of the Client and Consultant to such contractor or subcontractor arising out of a negligence shall be allocated between Client and Consultant in such a manner that the aggregate liability of Consultant for such design defects to all parties, including the Client shall **not exceed ten thousand dollars or charged fees whichever is less**. No warranty, expressed or implied of merchantability or fitness, is made or intended in connection with the work to be performed by Consultant or by the proposal for consulting or other services or by the furnishing of oral or written reports or findings made by Consultant.

- The Client agrees, to the fullest extent permitted by law, to indemnify, defend and hold harmless the Consultant, its officers, directors, employees, agents and subconsultants from and against all claims, damages, liabilities or costs, including reasonable attorney's fees and defense costs, of any nature whatsoever arising from or in connection with the Project to the extent that said claims, damages, liabilities or costs arise out of the work, services, or conduct of Client or Client's contractors, subconsultants, or other third party not under Consultant's control. Client further agrees that the duty to defend set forth herein arises immediately and is not contingent on a finding of fault against Client or Client's contractors, subconsultants, or other third parties. Client shall not be obligated under this provision to indemnify Consultant for Consultant's sole negligence or willful misconduct.

- Client shall grant free access to the site for all necessary equipment and personnel and Client shall notify any and all possessors of the project site that Client has granted Consultant free access to the project site at no charge to Consultant unless expressly agreed to otherwise in writing.

- If Client is not the property owner for the subject Project, Client agrees that it will notify the property owner of the terms of this agreement and obtain said property owner's approval to the terms and conditions herein. Should Client fail to obtain the property owner's agreement as required herein, Client agrees to be solely responsible to Consultant for all damages, liabilities, costs, including litigation fees and costs, arising from such failure that exceed that limitation of Consultant's liability herein.

- Client shall locate for Consultant and shall assume responsibility for the accuracy of his representations as to the locations of all underground utilities and installations. Consultant will not be responsible for damage to any such utilities or installation not so located.

- Client and Consultant agree to waive claims against each other for consequential damages arising out of or relating to this agreement. Neither party to this agreement shall assign the contract without the express, written consent of the other party.

- Consultant agrees to cover all open test holes and place a cover to carry a 200-pound load on each hole prior to leaving project site unattended. Consultant agrees that all test holes will be backfilled upon completion of the job. However, Client may request test holes to remain open after completion of Consultants work. In the event Client agrees to pay for all costs associated with covering and backfilling said test holes at a later date, and Client shall indemnify, defend and hold harmless Consultant for all claims, demands and liabilities arising from his request, except for the sole negligence of the Consultant, to the extent permitted by law.

- Consultant shall not be responsible for the general safety on the job or for the work of Client, other contractors and third parties.

- Consultant shall be excused for any delay in completion of the contract caused by acts of God, acts of the Client or Client's agent and/or contractors, inclement weather, labor trouble, acts of public utilities, public bodies, or inspectors, extra work, failure of Client to make payments promptly, or other contingencies unforeseen by Consultant and beyond reasonable control of the Consultant.

- In the event that either party desires to terminate this contract prior to completion of the project, written notification of such intention to terminate must be tendered to the other party. In the event Client notifies Consultant of such intention to terminate Consultant's services prior to completion of the contract, Consultant reserves the right to complete such analysis and records as are necessary to place files in order, to dispose of samples, put equipment in order, and (where considered necessary to protect his professional reputation) to complete a report on the work performed to date. In the event that Consultant incurs cost in Client's termination of this Agreement, a termination charge to cover such cost shall be paid by Client.

- If the Client is a corporation, the individual or individuals who sign or initial this Contract, on behalf of the Client, guarantee that Client will perform its duties under this Contract. The individual or individuals so signing or initialing this Contract warrant that they are duly authorized agents of the Client.

- Any notice required or permitted under this Contract may be given by ordinary mail at the address contained in this Contract, but such address may be changed by written notice given by one party to the other from time to time. Notice shall be deemed received in the ordinary course of the mail. This agreement shall be deemed to have been entered into the County of Orange, State of California.

LIMITATIONS

Our findings, interpretations, analyses, and recommendations are professional opinions, prepared and presented in accordance with generally accepted professional practices and are based on observation, laboratory data and our professional experience. Consultant does not assume responsibility for the proper execution of the work by others by undertaking the services being provided to Client under this agreement and shall in no way be responsible for the deficiencies or defects in the work performed by others not under Consultant's direct control. No other warranty herein is expressed or implied.

APPENDIX A

References

1. Boore, D.M., Joyner, W.B., and Fumal, T.E., 1997, *Equations for the Estimating Horizontal Response Spectra and Peak Acceleration from Western North American Earthquakes: A Summary of Recent Work*: Seismological Research Letters, Vol. 68, No. 1, pp. 128-153.

2. California Code of Regulations, 2013, *California Code of Regulations, Title 24, Part 2, Volume 2 of 2,* California Building Standards Commission;

3. California Geological Survey (formerly California Division of Mines and Geology), 2000, *Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones, Southern Region*;

4. California Geological Survey (formerly California Division of Mines and Geology), April 15, 1998, *Seismic Hazard Zones, Official Map, Orange Quadrangle*;

5. California Geological Survey (formerly California Division of Mines and Geology), 1997 (Revised/Updated 2001, 2005, and 2006), *Seismic Hazard Zone Report for the Orange 7.5-minute Quadrangle, Orange County, California,* Seismic Hazard Zone Report 011;

6. United States Geological Survey, Earthquake Hazards Program, U.S. Seismic Design Maps Application, ASCE 7-10 Standard;

7. U. S. Geological Survey, 1950, 7.5-Minute Topographic Map, Orange, California Quadrangle;

8. U. S. Geological Survey, 1964 photorevised 1972, 7.5-Minute Topographic Map, Orange, California Quadrangle;

9. U. S. Geological Survey, 1964 photorevised 1981, 7.5-Minute Topographic Map, Orange, California Quadrangle.

APPENDIX B

Field Exploration

a) The site was explored on January 10, 2017, utilizing a truck-mounted, Mobile B-53 hollow stem auger drill rig to excavate three borings to a maximum depth of 35 feet below the existing ground surface.

b) The soils encountered in the borings were logged and sampled by our Engineering Geologist. The soils were classified in accordance with the Unified Soil Classification System described in *Figure B-1*. The Logs of Boring are presented in *Figures B-2* through *B-4.* The approximate locations of the borings are shown on the *Boring Location Plan, Plate 1.* The log, as presented, is based on the field log, modified as required from the results of the laboratory tests. Driven ring and bulk samples were obtained from the excavation for laboratory inspection and testing. The depths at which the samples were obtained are indicated on the logs.

c) The number of blows of the hammer during sampling was recorded, together with the depth of penetration, the driving weight and the height of fall. The blows required per foot of penetration for given samples are indicated on the logs. These blow counts provide a measure of the density and consistency of the soil.

d) No seepage or free groundwater was encountered in any of our boring excavations.

APPENDIX C

Laboratory Testing Program

The laboratory-testing program was directed towards providing quantitative data relating to the relevant engineering properties of the soils. Samples considered representative of site conditions were tested as described below. Laboratory test results are also shown below.

a) Moisture-Density

Moisture-density information usually provides a gross indication of soil consistency. Local variations at the time of the investigation can be delineated, and a correlation obtained between soils found on this site and nearby sites. The dry unit weights and field moisture contents were determined for selected samples. The results are shown on the *Log of Boring.*

b) Compaction

A representative soil sample was tested in the laboratory to determine the maximum dry density and optimum moisture content, using the ASTM D1557 compaction test method. This test procedure requires 25 blows of a 10-pound hammer falling a height of 18 inches on each of five layers, in a 1/30 cubic foot cylinder. The results of the test are shown below:

Boring No.	**Sample Depth (ft)**	**Soil Description**	**Optimum Moisture Content (%)**	**Maximum Dry Density (lb/ft^3)**
B-1	0-2	Clayey SAND (without rock correction)	9.5	126.2
B-1	0-2	Clayey SAND (with rock correction)	8.6	129.3

c) Direct Shear

Direct shear tests were conducted on remolded samples, using a direct shear machine at a constant rate of strain in accordance with ASTM Test Method D3080. Variable normal or confining loads are applied vertically and the soil shear strengths are obtained at these loads. The angle of internal friction and the cohesion are then evaluated. The samples were tested at saturated moisture contents. The test results are shown in terms of the Coulomb shear strength parameters, as shown below:

Boring No.	Sample Depth (ft)	Soil Description	Coulomb Cohesion (lb/ft^2)	Angle of Internal Friction (°)	Peak/ Residual
B-1	0-2	Clayey SAND	200 150	29 29	Peak Residual

d) Corrosivity Series Tests

Corrosivity Tests were performed on a representative sample. Soluble sulphate was obtained in accordance with California State Standard Test No. 417A and minimum resistivity was obtained per California State Standard Test No. 643C. The results are given below:

Boring No.	Sample Depth (ft)	Soil Description	pH	Sulphate Content (%)	Soluble Chlorides (%)	Minimum Resistivity (ohm-cm)
B-1	0-2	Clayey SAND	7.6	0.1317	0.1206	152

e) <u>Expansion Potential</u>

Surface soils were collected in the field and tested in the laboratory in accordance with the ASTM Test Method D4829. The degree of expansion potential is determined from soil volume changes occurring during saturation of the specimen. The results of the tests are presented below:

Boring No.	**Sample Depth (ft.)**	**Soil Description**	**Expansion Index**	**Expansion Potential**
B-1	0-2	Clayey SAND	15	Very Low