ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

October 23, 2014
J.N.: 2231.00

Ms. Doris Nguyen
The Olson Company
3010 Old Ranch Parkway, Suite 100
Seal Beach, California 90740

Subject: Geotechnical Due Diligence Investigation, Proposed Residential Development, Northeast of La Mirada Boulevard and Chalco Street, La Mirada, California

Dear Ms. Nguyen,

Albus-Keefe & Associates, Inc. is pleased to present to you our geotechnical due-diligence report for the proposed residential development at the subject site. This report presents the results of our literature review, subsurface exploration, laboratory testing, and engineering analyses. Conclusions relevant to the feasibility of the proposed site development are also presented in this report based on the findings of our work.

We appreciate this opportunity to be of service to you. If you have any questions regarding the contents of this report, please do not hesitate to call.

Sincerely,

ALBUS-KEEFE & ASSOCIATES, INC.

David E. Albus
Principal Engineer
G.E. 2455

TABLE OF CONTENTS

REPORT

1.0 INTRODUCTION 1
1.1 PURPOSE AND SCOPE 1
1.2 SITE LOCATION 1
1.3 PROPOSED DEVELOPMENT 3
2.0 INVESTIGATION 3
2.1 AERIAL PHOTOGRAPH REVIEW 3
2.2 SUBSURFACE EXPLORATION 3
2.3 LABORATORY TESTING 4
3.0 SUBSURFACE CONDITIONS 4
3.1 SOIL CONDITIONS 4
3.2 GROUNDWATER 4
3.3 FAULTING 4
4.0 SEISMICITY 5
5.0 CONCLUSIONS 5
5.1 FEASIBILITY OF PROPOSED DEVELOPMENT 5
5.2 GEOLOGIC HAZARDS 6
5.2.1 Ground Rupture 6
5.2.2 Ground Shaking 6
5.2.3 Liquefaction 6
5.3 STATIC SETTLEMENT 7
5.4 EXCAVATION AND MATERIAL CHARACTERISTICS 7
5.5 SOIL EXPANSION 8
5.6 FOUNDATIONS 8
5.7 CONCRETE MIX DESIGN 8
5.8 PAVEMENT SECTIONS 8
5.9 PERCOLATION CHARACTERISTICS 9
6.0 LIMITATIONS 9
REFERENCES 11

FIGURES AND PLATES

Figure 1 - Site Location Map
Plate 1 - Geotechnical Map

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of our work was to evaluate the feasibility of proposed site development in order to assist you in your land acquisition evaluation and due-diligence review. The scope of our work for this investigation was focused primarily on the geotechnical issues that we expect could have significant fiscal impacts on future site development. *While this report is comprehensive for the intended purpose, it is not intended for final design purposes. As such, additional geotechnical studies may be warranted based on our review of future rough grading plans and foundation plans.*

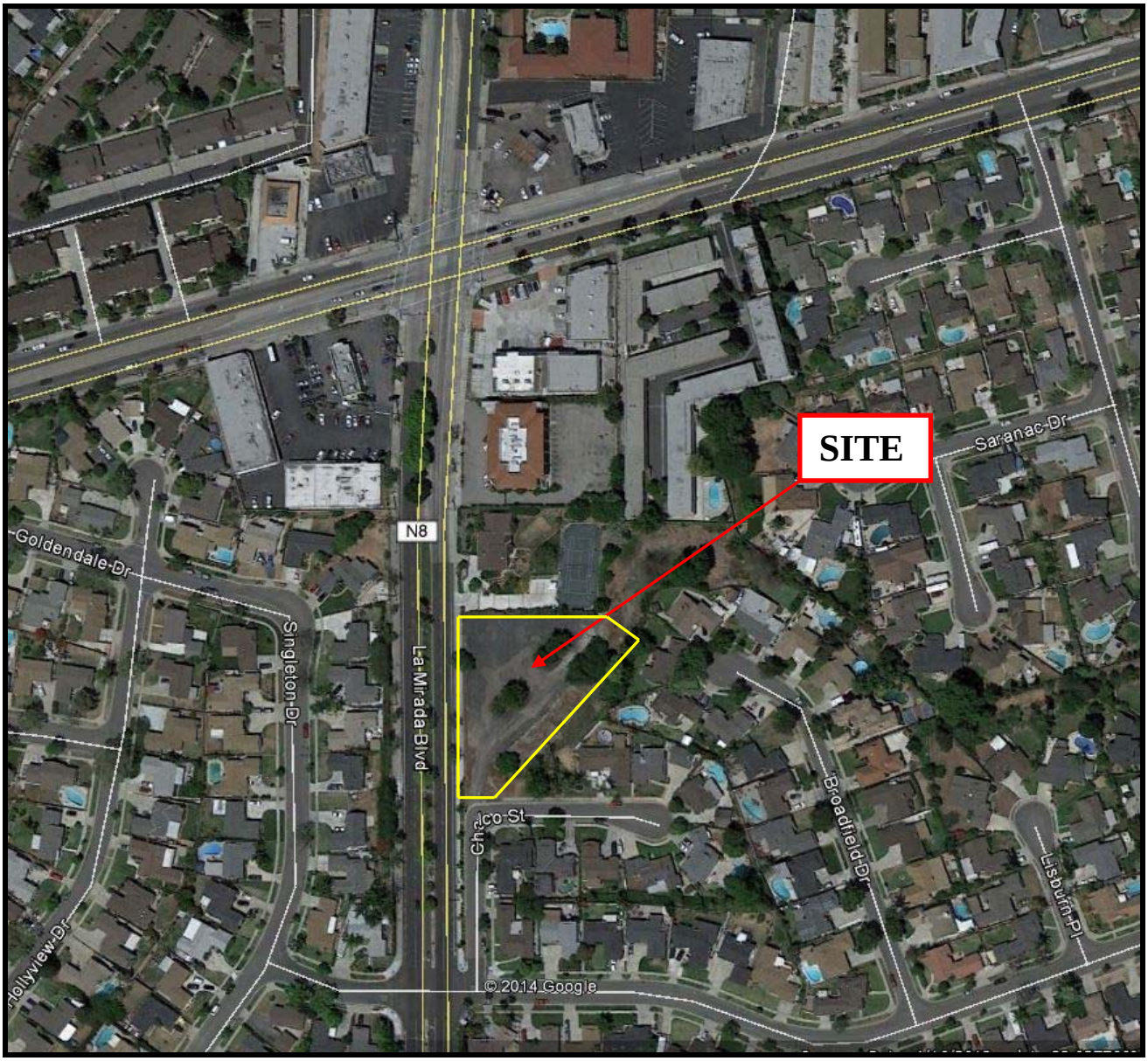
The scope of our geotechnical due-diligence work included the following:

- Review of published geologic and seismic data for the site and surrounding area
- Exploratory drilling and soil sampling
- Laboratory testing of selected soil samples
- Engineering analyses of data obtained from our review, exploration and laboratory testing
- Evaluation of site seismicity, liquefaction potential and settlement potential
- Preparation of this report

1.2 SITE LOCATION

The site is located northeast of La Mirada Boulevard and Chalco Street, in the city of La Mirada, California. The property is triangular in shape and bordered by residential properties to the north, Chalco Street to the south, an unlined drainage channel along the easterly margins and La Mirada Boulevard along the west.

The site comprises approximately 0.9 acres of land. Much of the site is relatively level to gently sloping and paved with asphaltic concrete for automobile parking. The easterly perimeter of the site, however, descends at gradients varying from approximately 1.5:1 to 2:1 (h:v) to an unlined drainage channel. Other site improvements consist of masonry walls along the northerly and westerly property lines, tree wells at two locations within the parking lot and underground storm drain improvements beneath portions of the descending slope and drainage channel. Vegetation at the site consists of weeds, low shrubs and scattered trees within the descending slope. Drainage is directed as sheet flow to the south and southeast.



© 2014 Google

N

SITE LOCATION MAP

The Olson Company
Proposed Residential Development
11606 La Mirada Boulevard
La Mirada, California

NOT TO SCALE

FIGURE 1

1.3 PROPOSED DEVELOPMENT

No site grading or structural plans were available in preparing of this report. However, we anticipate that moderate rough grading of the site will be required to conduct remedial grading measures and to achieve future surface configurations. We understand the proposed residential dwellings will be 2- or 3-story, wood-framed structures with concrete slabs on grade yielding relatively light foundation loads.

2.0 INVESTIGATION

2.1 AERIAL PHOTOGRAPH REVIEW

Historical aerial photographs dating from 1954 through 1995 of the subject site and vicinity were reviewed as part of this study. The 1954 photographs show the site and much of the surrounding properties as undeveloped. Overall topography within the subject property appears to fall towards a natural drainage course along the easterly boundary of the site. Sometime between 1954 and 1960, heavy residential and commercial improvements had been made to the surrounding properties. The 1960 photographs indicate that stockpiles of soil and possibly construction debris were transported to the subject site. Access roads and embankment slopes descending from La Mirada Boulevard (to the west) suggest the site was at a lower elevation than the current topographic expression of the site. By 1975, the site appears to have been raised to a more level configuration and paved for parking lot improvements. The perimeter slope along the westerly boundary of the property appears to have been extended into the natural drainage course. From 1975 through current, the site appears relatively unchanged.

2.2 SUBSURFACE EXPLORATION

Subsurface exploration for the subject site was conducted on December 3, 2013 and May 23, 2014. Our exploration consisted of drilling six (6) exploratory borings. These borings were drilled to depths ranging from approximately 15.5 to of 51.5 feet below the existing ground surface utilizing a truck-mounted, hollow-stem-auger drill rig. Representatives of *Albus-Keefe & Associates, Inc*. logged the exploratory excavations. Visual and tactile identifications were made of the materials encountered, and their descriptions were recorded on field boring logs. The approximate locations of the exploratory excavations completed by this firm are shown on the enclosed Geotechnical Map, Plate 1.

Bulk, relatively undisturbed and Standard Penetration Test (SPT) samples were obtained at selected depths within the exploratory borings for subsequent laboratory testing. Relatively undisturbed samples were obtained using a 3-inch O.D., 2.5-inch I.D., California split-spoon soil sampler lined with brass rings. SPT samples were obtained from the borings using a standard, unlined SPT soil sampler. During each sampling interval, the California split-spoon soil sampler was driven 12 inches and the SPT sampler was driven 18 inches with successive drops of a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler was recorded for each six inches of advancement. The total blow count for the lower 12 inches of advancement per soil sample is recorded on the exploration logs. Samples were placed in sealed containers or plastic bags and transported to our laboratory for analyses. The borings were backfilled with auger cuttings upon completion of sampling and capped with asphaltic concrete cold patch.

2.3 LABORATORY TESTING

Selected samples of representative earth materials from the borings excavated at the site were tested in the laboratory. Tests consisted of in-situ moisture content and dry density, maximum dry density/optimum moisture content, expansion index, soluble sulfate content, consolidation/collapse, direct shear strength, grain-size/hydrometer analysis, Atterberg limits soluble sulfate and corrosion series.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Soil materials encountered at the boring locations within the subject site consist of undocumented artificial fill materials overlying Quaternary alluvial deposits. The artificial fill materials are comprised primarily of clayey sand, clayey silt and silty clay with local concentrations of concrete and asphalt rubble mixed at various depths. These materials were typically firm to stiff and moist to wet. The artificial fill materials encountered vary from approximately 6 feet to as much as approximately 14 feet in thickness beneath the site. The fill materials appear to generally thicken towards the drainage channel.

The Quaternary alluvial deposits encountered consisted of interlayered sequences of fine- and coarse-grained soils. The fine-grained soils generally consist of grayish brown to orange-brown, moist, medium stiff to very stiff clay, silt, silty clay and sandy silt. The coarse-grained soils generally consist of light brown to yellow-brown, damp to very moist, fine- to coarse-grained clayey sand and silty sand.

3.2 GROUNDWATER

Groundwater was encountered in exploratory borings at depths as shallow as 14 feet below the existing ground surface. A review of the CDMG Seismic Hazard Zone Report 037 indicates that historical high groundwater levels have been estimated at depths greater than 40 feet below the ground surface in the vicinity of the subject site. The elevated groundwater conditions identified through our recent field exploration are likely due to local groundwater mounding as a result of concentrated urban runoff within the natural drainage course along the lower reaches of the property. The groundwater appears to be a perched condition with the confining aquitard likely occurring at a depth of several feet to 10’s of feet below the phreatic water surface.

3.3 FAULTING

Geologic literature and field exploration do not indicate the presence of active faulting within the site. The site does not lie within an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act. Table 3.1 presents a summary of all the known active faults within 10 miles of the site.

TABLE 3.1
Summary of Faults

Name	Distance (miles)	Slip Rate (mm/yr.)	Preferred Dip (degrees)	Slip Sense	Rupture Top (km)	Fault Length (km)
Puente Hills (Santa Fe Springs)	0.58	0.7	29	thrust	2.8	11
Puente Hills (Coyote Hills)	2.67	0.7	26	thrust	2.8	17
Elsinore;W	3.35	2.5	75	strike slip	0	46
Elsinore;W+GI	3.35		81	strike slip	0	83
Elsinore;W+GI+T	3.35		84	strike slip	0	124
Elsinore;W+GI+T+J	3.35		84	strike slip	0	200
Elsinore;W+GI+T+J+CM	3.35		84	strike slip	0	242
Puente Hills (LA)	7.27	0.7	27	thrust	2.1	22

4.0 SEISMICITY

We have performed probabilistic seismic analyses utilizing computer program OpenSHA developed by Field, E.H., T.H. Jordan, and C.A. Cornell (2003). OpenSHA is an open-source, Java-based platform for conducting seismic hazard analysis. As an object-oriented framework, OpenSHA can accommodate arbitrarily complex (e.g., physics based) earthquake rupture forecasts (ERFs), ground-motion models, and engineering-response models.

The computer program OpenSHA predicts the peak ground acceleration (PGA) having a 10 percent chance of being exceeded in 50 years is approximately 0.44g when averages of three attenuation relationships are used (Sadigh et al 1997, Abrahamson & Silva 1997, and Campbell & Bozorgnia 2003). The program also predicts the PGA having a 2 percent chance of being exceeded in 50 years is approximately 0.77g when averages of three attenuation relationships are used (Sadigh et al 1997, Abrahamson & Silva 1997, and Campbell & Bozorgnia 2003).

5.0 CONCLUSIONS

5.1 FEASIBILITY OF PROPOSED DEVELOPMENT

From a geotechnical point of view, the proposed site development is considered feasible. Furthermore, it is also our opinion that the proposed development will not adversely impact the stability of adjoining properties. The adequacy and sufficiency of the preliminary findings and conclusions provided herein should be assessed based upon the final grading and structural plans. A supplemental geotechnical investigation report will be required for design, permitting and construction.

5.2 GEOLOGIC HAZARDS

5.2.1 Ground Rupture

No known active faults are known to project through the site nor does the site lie within the boundaries of an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act. The closest known active fault is the Puente Hills fault (Santa Fe Springs) located about 0.58 miles from the site. Therefore, the potential for ground rupture due to a fault displacement beneath the site is considered very low.

5.2.2 Ground Shaking

The site is situated in a seismically active area that has historically been affected by generally moderate to occasionally high levels of ground motion. The site lies in relative close proximity to several active faults; therefore, during the life of the proposed structures, the property will probably experience similar moderate to occasionally high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region. Potential ground accelerations have been estimated for the site and are presented in Section 4.0 of this report. Design and construction in accordance with the current California Building Code (CBC) requirements is anticipated to address the issues related to potential ground shaking.

5.2.3 Liquefaction

Engineering research of soil liquefaction potential (Youd, et al., 2001) indicates that generally three basic factors must exist concurrently in order for liquefaction to occur. These factors include:

- A source of ground shaking, such as an earthquake, capable of generating soil mass distortions.
- A relatively loose silty and/or sandy soil.
- A relative shallow groundwater table (within approximately 50 feet below ground surface) or completely saturated soil conditions that will allow positive pore pressure generation.

The liquefaction susceptibility of the onsite soils was evaluated by analyzing the potential concurrent occurrence of the above-mentioned three basic factors. The liquefaction evaluation for the site was completed under the guidance of Special Publication 117A: Guidelines for Evaluating and Mitigating Seismic Hazards in California (CDMG, 2008).

The site is predominately underlain by finer-grained soils that are not susceptible to liquefaction. Some limited thin layers and lenses of granular soils are present in the alluvial materials although most of these materials were found to be dense and are not susceptible to liquefaction. A few limited layers of loose granular soils are present that may be susceptible to liquefaction. Due to the depth and very limited thickness of these materials, the adverse effects from liquefaction are anticipated to be of low concern. Relatively minor magnitudes of seismic settlement could occur due to a liquefaction event. This condition can be readily mitigated through the use of post-tension slab foundation systems to support residential structures. Other non-habitable structures would not require special foundations for mitigation of liquefaction.

5.3 STATIC SETTLEMENT

Laboratory test results, field blow count data and visual assessments of the undocumented fill materials suggest these materials possess variable engineering properties. While portions of these materials exhibit low compressibility and significant over-consolidation, other portions were highly compressible and normally or under-consolidated. These materials are anticipated to result in large differential settlements and as such, are considered unsuitable for the support of engineered fills and proposed residential improvements.

Provided the undocumented artificial fill materials are removed and re-compacted below the influence of future foundations, total and differential static settlements are not anticipated to exceed 1 inch and ½-inch over 30 feet, respectively. These estimated magnitudes of static settlements are considered within tolerable limits for the proposed structures. Due to limitations of property line constraints, complete removal of artificial fill materials within the influence of the entire site is not feasible. We have estimated the limits to which removal of artificial fills can readily be accomplished using open cuts for excavation and removal. Based on these limits, we have estimated the anticipated structural setbacks required for residential structures on the site as depicted on the attached Geotechnical Map, Plate 1. Provided structures are located within the setback limits indicated on Plate 1, the estimated tolerable settlements discussed above will apply. Residential structures that extend beyond these limits would require the use of deepened footings to achieve the equivalent setback. Generally, for each foot horizontally the building extends beyond the setback, the footing will require a deepening of 1 foot.

Structures and improvements located outside these limits may be subjected to higher magnitudes of settlement. We anticipate such structures would consist of underground utilities, pavement, and retaining/screen walls. Estimated settlements in areas outside of the setback limits are anticipated to be within the tolerable limits of these structures. Retaining and screen walls will likely require the use of additional reinforcement in footings and closely-spaced cold joints to provide crack control due to the elevated degree of settlement.

5.4 EXCAVATION AND MATERIAL CHARACTERISTICS

Undocumented artificial fill materials were encountered beneath the site at depths varying from approximately 6 feet to as much as 14 feet. The thickness of these materials appears to increase towards the existing drainage channel to the east/southeast. To mitigate potential adverse effects from excessive differential settlement, the undocumented fill could be removed and replaced as compacted engineered fill. Temporary backcuts inclined at a gradient of 1:1 (h:v) or flatter could be used to remove unsuitable fill soils. Structural setbacks associated with this approach are indicated on Plate 1 as discussed in Section 5.3. Setbacks could be lessened through the use of shoring and/or slot cut methods.

A large diameter reinforced-concrete storm drain pipe exists within a portion of the descending slope and natural drainage course along the southeast boundary of the site. The grading contractor should exercise particular care when conducting temporary excavations in close proximity to the storm drain. Specific excavation details will be require once more detailed development plans are available to assess methods to protect the storm drain pipe during future rough grading operations.

Onsite earth materials are anticipated to be relatively easy to excavate with conventional heavy earthmoving equipment. However, the presence of the relatively shallow groundwater may result in pumping ground conditions and may require ground stabilization methods such as placement of gravel blankets or the use of excavators to remove unsuitable soils as removals approach the groundwater table. Wet materials excavated from the site would require significant processing to dry them back to a moisture content suitable for reuse as fill

The site is currently occupied by a paved parking lot. Asphaltic concrete and concrete debris generated by demolition can be reduced to no more than 4 inches in maximum dimension and uniformly incorporated with fill soils during earthwork operations.

Removal and recompaction of the site materials will result in some moderate shrinkage and subsidence. Design of site grading will require consideration of this loss when evaluating earthwork balance issues.

5.5 SOIL EXPANSION

Based on our laboratory test results and the USCS visual manual classification, the near-surface soils within the site are generally anticipated to possess a **Medium** expansion potential. Additional testing for soil expansion will be required subsequent to rough grading and prior to construction of foundations and other concrete work to confirm these conditions.

5.6 FOUNDATIONS

Considering the potential adverse effects of expansive soils and potential for liquefaction, post-tension ribbed or post-tension mat foundations are expected to be require for support of the proposed residential structures at the site.

Considering the **Medium** expansion potential, other site improvements such as retaining walls, screen walls, and flatwork will likely require some considerations to mitigate adverse effects of expansive soils. Generally such mitigation would entail additional reinforcing bars and shorter spacing of wall joints.

5.7 CONCRETE MIX DESIGN

Laboratory testing of existing near-surface soils for soluble sulfate content indicates soluble sulfate concentration less than 0.10%. The procedures provided in ACI 318, Section 4.3, Table 4.3.1 for **negligible** sulfate exposure are anticipated to be suitable for concrete construction at the site. Additional testing for soluble sulfate content will be required subsequent to rough grading and prior to construction of foundations and other concrete work to confirm these conditions.

5.8 PAVEMENT SECTIONS

Existing near-surface soils are anticipated to have a very low R-value. Based on the assumed R-value of 5 and a traffic index of 5.0, a preliminary pavement structural section of 4 inches asphaltic concrete over 7 inches of aggregate base may be used for planning and estimating purpose. R-value

testing will be required subsequent to rough grading and prior to construction of interior driveways to confirm these conditions.

5.9 PERCOLATION CHARACTERISTICS

The site materials consist predominantly of fine-grained soils with very low permeability characteristics. In addition, perched groundwater was encountered beneath the site at depths as shallow as 14 feet below the ground surface. As such, the onsite materials are not suited for storm water infiltration. Treatment of storm water for water quality purposes should utilize other methods such as capture and reuse or biofiltration.

6.0 LIMITATIONS

This report is based on the proposed development and geotechnical data as described herein. The materials described herein and in other literature are believed representative of the total project area, and the conclusions contained in this report are presented on that basis. However, soil materials can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. As such, observation and testing by a geotechnical consultant prior to and during the grading and construction phases of the project are essential to confirming the basis of this report.

This report summarizes several geotechnical topics that should be beneficial for project planning and budgetary evaluations. *The information presented herein is intended only for a preliminary feasibility evaluation and is not intended to satisfy the requirements of a site specific and detailed geotechnical investigation required for further planning and permitting.*

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein.

This report has been prepared for the exclusive use of **The Olson Company** to assist the project consultants in determining the feasibility of the proposed development. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

Respectfully submitted,

ALBUS-KEEFE & ASSOCIATES, INC

Patrick M. Keefe
Principal Engineering Geologist
CEG 2022

David E. Albus
Principal Engineer
GE 2455

REFERENCES

Publications

Abrahamson, N. A., and W. J. Silva (1997), "Empirical Response Spectral Attenuation Relations for Shallow Crustal Earthquakes", Seismological Research Letters, 68(1), 94-127.

California Department of Conservation, Division of Mines and Geology, Special Publication 117A "Guidelines for Evaluating and Mitigating Seismic Hazards in California", 2008.

Campbell, K. W. and Y. Bozorgnia (2003), "Updated Near-source Ground Motion (Attenuation) Relations for the Horizontal and Vertical Components of Peak Ground Acceleration and Acceleration Response Spectra", Bulletin of the Seismological Society of America, 93(1), 314 -331.

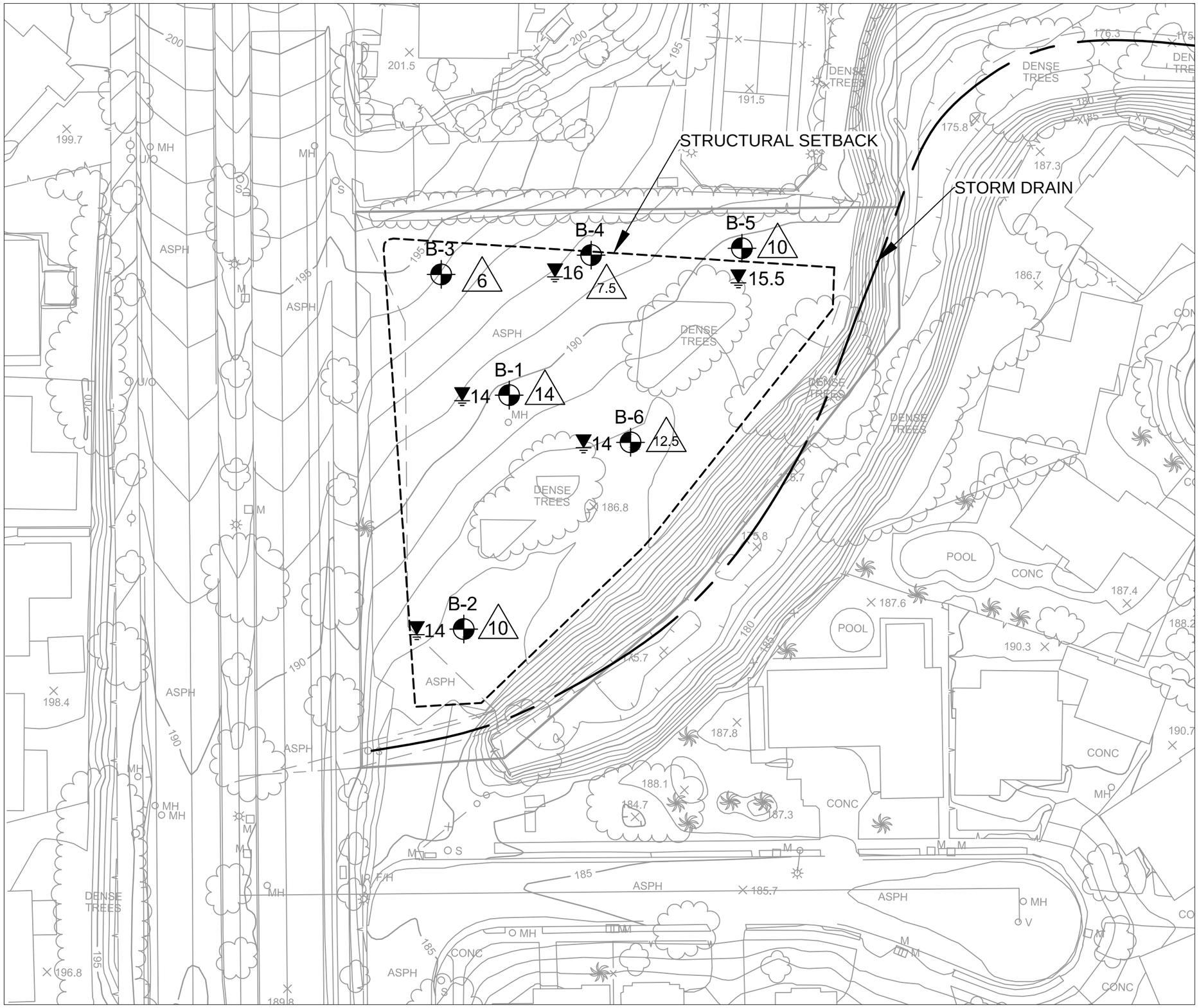
Field, E.H., T.H. Jordan, and C.A. Cornell, OpenSHA, A Developing Community-Modeling Environment for Seismic Hazard Analysis, Seismological Research Letters,74, no. 4, p. 406-419, (2003).

Southern California Earthquake Center (SCEC), University of Southern California, "Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California," March, 1999.

California Department of Conservation, Division of Mines and Geology, Seismic Hazard Report 037, "Seismic Hazard Zone Report for the Whittier 7.5-Minute Quadrangle, Los Angeles and Orange Counties, California", 1998.

Sadigh, K., Chang, C.Y., Egan, J.A., Makdisi, F., and Youngs, R.R. "Attenuation Relationships for Shallow Crustal Earthquakes Based on California Strong Motion Data," Seismological Research Letters, Vol. 68, No.1, January/February 1997.

Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., and Stokoe, K.H., "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils", Journal of Geotechnical and Geoenvironmental Engineering, October, 2001.



EXPLANATION

(LOCATIONS APPROXIMATE)

B-6 - Exploratory Boring

12.5 - Estimated Depth of Fill (in feet)

16 - Depth to Groundwater (in feet)

- Approximate Structural Setback Line

- Storm Drain

0 20 40 80

SCALE : 1" = 40'

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GEOTECHNICAL MAP

Job No.: 2231.00	Date: 10/23/14	Plate: 1