Appendix B: Geotechnical Investigations

THIS PAGE INTENTIONALLY LEFT BLANK

B.1 - Preliminary Geotechnical Investigation

THIS PAGE INTENTIONALLY LEFT BLANK

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

May 26, 2016
J.N.: 2495.00

Mr. Steve Sheldon
Sheldon Development, LLC
901 Dove Street, Suite 140
Newport Beach, California 92660

Subject: Preliminary Geotechnical Investigation, Proposed Residential Development, 440 Fair Drive, City of Costa Mesa, California.

Dear Mr. Sheldon,

Pursuant to your request, ***Albus-Keefe & Associates, Inc***. is pleased to present to you our preliminary geotechnical investigation report for the proposed residential development at the subject site. This report presents the results of our review of the referenced literature and aerial photographs for the site and surrounding areas, subsurface exploration, laboratory testing, and engineering/geologic analyses. Geotechnical conclusions and recommendations pertaining to the proposed site development are also provided herein.

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

Sincerely,

ALBUS-KEEFE & ASSOCIATES, INC.

Patrick M. Keefe
Principal Engineering Geologist

TABLE OF CONTENTS

REPORT

1.0 INTRODUCTION 1
1.1 PURPOSE AND SCOPE 1
1.2 SITE LOCATION AND DESCRIPTION 1
1.3 PROPOSED DEVELOPMENT 3
2.0 INVESTIGATION 3
2.1 RESEARCH 3
2.2 SUBSURFACE INVESTIGATION 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 ANALYSES 5
4.1 SEISMICITY 5
4.2 STATIC SETTLEMENT 5
5.0 CONCLUSIONS 5
5.1 FEASIBILITY OF PROPOSED DEVELOPMENT 5
5.2 SEISMIC HAZARDS 6
5.2.1 Ground Rupture 6
5.2.2 Ground Shaking 6
5.2.3 Landsliding 6
5.2.4 Liquefaction 6
5.3 MATERIAL CHARACTERISTICS 7
5.4 SETTLEMENT 7
5.5 SHRINKAGE AND SUBSIDENCE 7
6.0 RECOMMENDATIONS 7
6.1 EARTHWORK 7
6.1.1 General Earthwork and Grading Specifications 7
6.1.2 Pre-Grade Meeting and Geotechnical Observation 7
6.1.3 Site Clearing 8
6.1.4 Ground Preparation 8
6.1.5 Fill Placement 9
6.1.6 Import Materials 9
6.1.7 Temporary Excavations 9
6.2 SEISMIC DESIGN PARAMETERS 10
6.3 FOUNDATION DESIGN 10
6.3.1 General 10
6.3.2 Soil Expansion 10
6.3.3 Settlement 10
6.3.4 Allowable Bearing Value 10
6.3.5 Lateral Resistance 11
6.3.6 Post-Tension Slab-on-Grade 11
6.3.7 Foundation Observations 12
6.4 RETAINING AND SCREENING WALLS 12
6.4.1 General 12

TABLE OF CONTENTS (CONTINUED)

6.4.2 Allowable Bearing Value and Lateral Resistance 12
6.4.3 Active Earth Pressure 12
6.4.4 Drainage and Moisture-Proofing 13
6.4.5 Footing Reinforcement and Wall Jointing 13
6.4.6 Footing Observations 13
6.4.7 Retaining Wall Backfill 13
6.5 EXTERIOR FLATWORK 14
6.6 CONCRETE MIX DESIGN 14
6.7 PRELIMINARY PAVEMENT DESIGN 14
6.7.1 Preliminary Pavement Structural Sections 14
6.7.2 Subgrade Preparation 15
6.7.3 Aggregate Base 15
6.7.4 Asphaltic Concrete 15
6.7.5 Concrete Pavers 15
6.8 STORM WATER INFILTRATION 16
6.9 POST GRADING CONSIDERATIONS 16
6.9.1 Site Drainage and Irrigation 16
6.9.2 Utility Trenches 17
6.10 PLAN REVIEW AND CONSTRUCTION SERVICES 17
7.0 LIMITATIONS 18
REFERENCES 19

FIGURES AND PLATES

Figure 1 - Site Location Map
Plate 1 - Geotechnical Map

APPENDICES

APPENDIX A - EXPLORATION LOGS
Boring Logs - Plates A-1 through A-6

APPENDIX B - LABORATORY TESTING PROGRAM
Table B-1 - Summary of Laboratory Test Results
Plate B-1 - Grain-Size Distribution Plot
Plate B-2 – Direct Shear Plot
Plate B-3 and B-4 – Consolidation Test Results

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purposes of our investigation were to evaluate geotechnical conditions within the project area and to provide conclusions and recommendations relevant to the design and construction of the proposed residential development at the subject site. The scope of this investigation included the following:

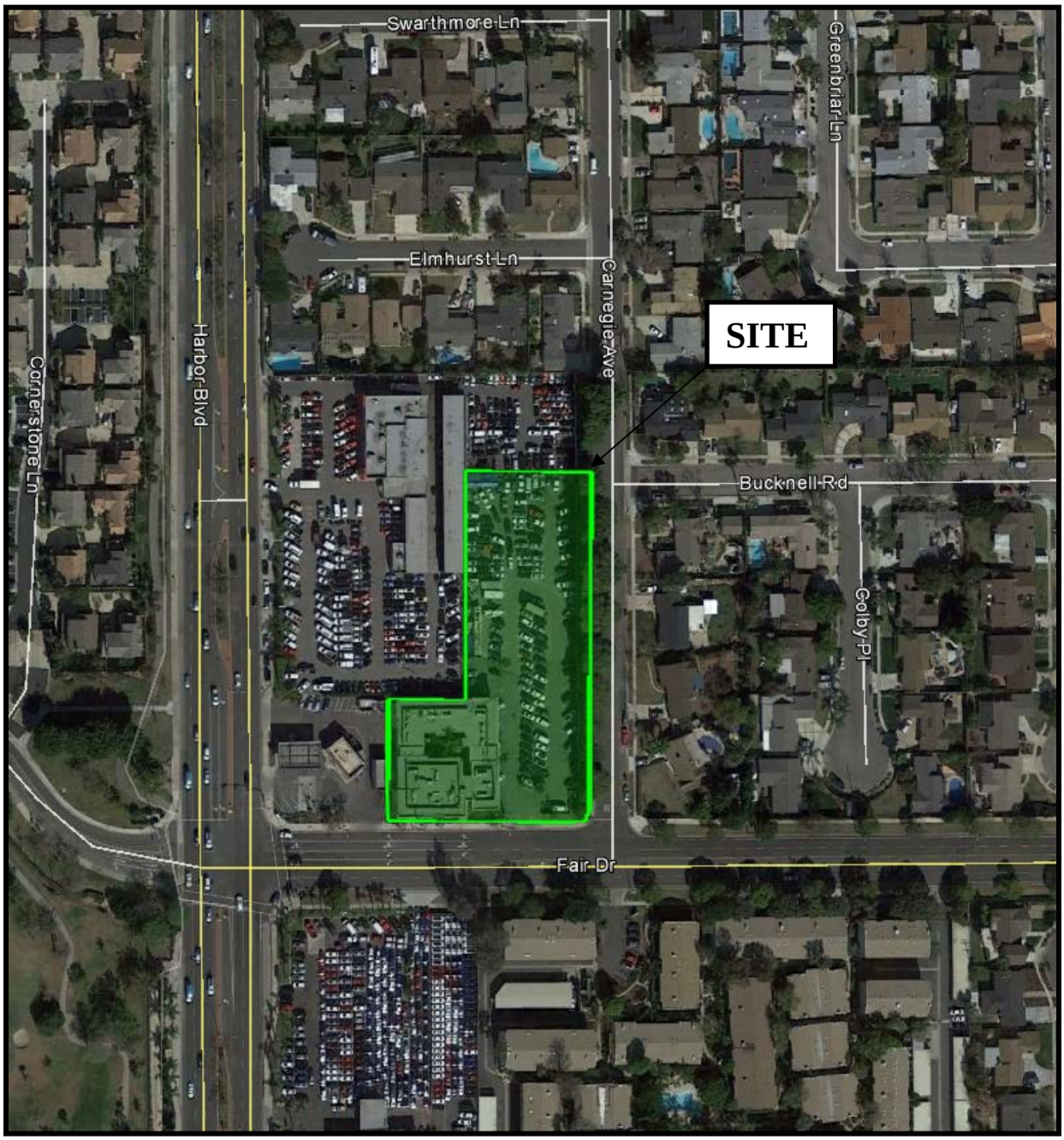
- Review of the referenced geologic and seismic data for the site and surrounding area
- Review of aerial photographs contained in our library for the site and surrounding area
- Review of the referenced Conceptual Site Plan
- Exploratory drilling and soil sampling
- Laboratory testing of selected soil 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 AND DESCRIPTION

The site is located at 440 Fair Drive within the city of Costa Mesa, California. The property is bordered by a Dodge and Fiat Auto Dealership to the north and northwest, a gas station to the southwest, Fair Drive to the south, and Carnegie Avenue to the east. The location of the site and its relationship to the surrounding areas is shown on Figure 1, Site Location Map.

The site is currently occupied by a two-story commercial building (mini-mall) with a large, asphalt paved parking lot. The northern portion of the parking lot area is currently sub-leased and used as car detailing area for a neighboring auto dealership. Associated improvements include some concrete flatwork, underground utilities and a masonry block screen wall along the east margin of the site. Chain-link fencing also bounds the property on the north and west property lines.

Vegetation on site consists of some mature trees along the east property line with some small landscape islands and planters around the building area. Based on Google Earth, topography on site is relatively level at approximately 70 feet above mean sea level. Drainage is generally directed as sheet flow to the south towards Fair Drive.



© 2016 Google

N

SITE LOCATION MAP

Sheldon Development, LLC
Proposed Residential Development
440 Fair Drive
Costa Mesa, California

NOT TO SCALE

FIGURE 1

1.3 PROPOSED DEVELOPMENT

Based on our review of the referenced conceptual site plan, the site will developed for construction of eight (8) two-story detached homes and twenty (20) three-story duplex units. Associated interior streets, parking stalls, decorative hardscape, and underground improvements are also anticipated.

We anticipate the proposed residences will be wood-framed, slab-on-grade structures yielding relatively light foundations loads. No grading or structural plans were available in preparing this report. However, we anticipate that minor rough grading of the site will be required to achieve future surface configurations.

2.0 INVESTIGATION

2.1 RESEARCH

We have reviewed the referenced geologic publications and maps for the site and nearby vicinity (see references). Data from these sources were utilized to develop some of our findings and conclusions presented in this report. We have also reviewed the referenced aerial photos for the site and surrounding areas. Our review indicates the subject property was originally developed sometime between 1953 and 1967. The site does not appear to be significantly altered since its original construction.

2.2 SUBSURFACE INVESTIGATION

Subsurface exploration for this investigation was conducted on May 6, 2016. Our exploration consisted of drilling three (3) exploratory borings to depths ranging from 21 to 51.5 feet below the existing ground surface utilizing a truck-mounted, hollow-stem-auger drill rig. Representatives of *Albus-Keefe & Associates, In*c. logged the exploratory excavations. Visual and tactile identifications were made of the materials encountered, and their descriptions are presented in the Exploration Logs in Appendix A. An additional boring was drilled adjacent Boring B-2 for percolation testing. 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 sampler was driven 12 or 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 log. 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.

2.3 LABORATORY TESTING

Selected samples of representative earth materials from the subsurface explorations were returned to our laboratory for testing. Tests consisted of in-situ moisture content and dry density, maximum dry density and optimum moisture content, expansion index, soluble sulfate content, consolidation/collapse, direct shear strength, grain-size/hydrometer analysis, Atterberg limits, and R-value. Descriptions of laboratory test criteria and a summary of the test results are presented in Appendix B and on the exploration logs in Appendix A.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Descriptions of the earth materials encountered during our investigation are summarized below and are presented in detail on the Exploration Logs presented in Appendix A.

Soil materials encountered at the site consist of terrace deposits covered by a minor thickness of artificial fill. The artificial fills encountered consist of brown to red-brown, moist, medium stiff sandy clay with trace gravel. The thickness of artificial fill materials measured about 12 to 18 inches. However, artificial fill materials of greater thickness are anticipated to exist beneath portions of the site, particularly in areas of structures and as backfill in underground utility trenches.

Terrace deposits were encountered below the artificial fills to the maximum depth explored, 51.5 feet below existing ground surfaces. The upper 2 to 3 feet of the terrace deposits consists of red-brown sandy clay that is generally damp to moist and very stiff. Below 3 feet, the terrace deposits consists of interlayered sands, silty sands, and sandy silts. These materials were light red-brown, yellow brown, gray, and light gray, dry to moist and medium dense to very dense/stiff to very stiff.

A more detailed description of the interpreted soil profile at the boring locations, based upon the borehole cuttings and soil samples, are presented in Appendix A. The stratigraphic descriptions in the logs represent the predominant materials encountered and relatively thin, often discontinuous layers of different material may occur within the major divisions.

3.2 GROUNDWATER

Groundwater was not encountered during this firm’s subsurface exploration to a maximum depth of 51.5 feet below the existing ground surface. A review of the CDMG Seismic Hazard Zone Report 03 indicates that historical high groundwater levels for the general site area is greater than 30 feet below the existing ground 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 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)
San Joaquin Hills	2.10	0.5	23	thrust	2	27
Newport Inglewood Connected alt 2	2.83	1.3	90	strike slip	0	208
Newport-Inglewood, alt 1	2.93	1	88	strike slip	0	65
Newport Inglewood Connected alt 1	2.93	1.3	89	strike slip	0	208
Newport-Inglewood (Offshore)	5.00	1.5	90	strike slip	0	66

4.0 ANALYSES

4.1 SEISMICITY

We have performed probabilistic seismic analyses utilizing the web-based U.S. Seismic Design Maps web application by the U.S. Geological Survey (USGS), we obtain a PGA of 0.645 in accordance with Figure 22-7 of ASCE 7-10. The F_{PGA} factor for this PGA and site class C is 1.0. Therefore, the PGA_M = 1.0 x 0.645 = 0.65g. The mean event associated with a probability of exceedance equal to 2% over 50 years to have a moment magnitude of 6.73 and the mean distance to the seismic source of 3.98 miles.

4.2 STATIC SETTLEMENT

Results of our subsurface exploration and laboratory testing indicate the fine-grained terrace deposits exhibit low compressibility and are over consolidated. The granular portions of the terrace deposit that underlay the fine-grained layer were found to be moderately compressible. Engineering analyses were performed to evaluate total settlement assuming footings are founded upon the granular terrace deposits as the fine-grained soils are anticipated to have a negligible contribution to settlement. Using an elastic theory of settlement, we estimate a continuous footing 1.25 feet wide, 1 foot deep, and applying a bearing pressure of 2,500 psf will undergo a total settlement of approximately 0.6 inches.

5.0 CONCLUSIONS

5.1 FEASIBILITY OF PROPOSED DEVELOPMENT

From a geotechnical point of view, the proposed site development is considered feasible provided the development is designed and constructed in accordance with the recommendations presented in this report.

5.2 SEISMIC HAZARDS

5.2.1 Ground Rupture

No active faults are known to project through the site nor does the site lie within the bounds of an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act. As such, 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 improvements, 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 4.1 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 Landsliding

Geologic hazards associated with landsliding are not anticipated at the site. Furthermore, the site is not located within an area identified by the California Geologic Survey (CGS) as having potential for seismic slope instability.

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

Groundwater was not encountered to the maximum depth explored (51 feet below the existing ground surface) and historical high groundwater in the general site area is 30 feet or greater. In addition, relative loose silty and or sandy soils are not anticipated below the historical high groundwater table. Therefore, the potential for liquefaction at the site is considered to be low. Furthermore, the site is not located within a mapped California Geologic Survey liquefaction hazard zone.

5.3 MATERIAL CHARACTERISTICS

The surficial earth materials are anticipated to be relatively easy to excavate with conventional heavy earthmoving equipment. Some earth materials are generally below the optimum moisture content and therefore will require the addition of water to achieve proper compaction.

The site contains materials with very differing characteristics with layers of clay soils and layers of granular soils. Excavations at the site are anticipated to encounter both materials resulting in a mixture of the two dissimilar materials. The contractor should anticipate the need to blend these differing materials in order to create a relatively uniform soil mix to make the materials suitable for placement as fill.

5.4 SETTLEMENT

The settlement potential of existing fill soils could vary significantly due to the unknown nature of these materials. As such, they are deemed unsuitable for support of proposed site development. Total and differential settlement due to the underlying Terrace Deposits is estimated to be less than 1 inch and ½ inch over 30 feet. Provided the existing fill soils are removed and recompacted as engineered materials in accordance with the recommendations herein, total and differential settlement is estimated to be less than 1 inch and ½ inch over 30 feet. These estimated magnitudes of settlement are considered tolerable for the proposed site development.

5.5 SHRINKAGE AND SUBSIDENCE

Volumetric changes in earth quantities will occur when excavated onsite soil materials are replaced as properly compacted fill. We estimate the upper 4 to 6 feet of surficial soils will shrink approximately 4 to 10 percent. Reprocessing of removal bottoms are anticipated to result in a general subsidence of approximately 0.05 foot. The estimates of shrinkage and subsidence are intended as an aid for project engineers in determining earthwork quantities. However, these estimates should be used with some caution since they are not absolute values. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that occurs during the grading process.

6.0 RECOMMENDATIONS

6.1 EARTHWORK

6.1.1 General Earthwork and Grading Specifications

All earthwork and grading should be performed in accordance with applicable requirements of Cal/OSHA, applicable specifications of the Grading Codes of the City of Costa Mesa, California in addition to the recommendations presented herein.

6.1.2 Pre-Grade Meeting and Geotechnical Observation

Prior to commencement of grading, we recommend a meeting be held between the developer, City Inspector, grading contractor, civil engineer, and geotechnical consultant to discuss the proposed grading and construction logistics. We also recommend a geotechnical consultant be retained to

provide soil engineering and engineering geologic services during site grading and foundation construction. This is to observe compliance with the design specifications and recommendations and to allow for design changes in the event that subsurface conditions differ from those anticipated. If conditions are encountered that appear to be different than those indicated in this report, the project geotechnical consultant should be notified immediately. Design and construction revisions may be required.

6.1.3 Site Clearing

Vegetation, concrete slabs and foundations, underground improvements to be abandoned and deleterious materials should be removed from the site. Onsite disposal systems consisting of septic tank and seepage pits are not anticipated but may be presented at the site. If onsite disposal system were encountered during site development, the septic tank should be completed removed from the site and seepage pits should be properly abandoned in accordance with the requirements established by the government agencies.

The project geotechnical consultant should be notified at the appropriate times to provide observation services during clearing operations to verify compliance with the above recommendations. Voids created by clearing and excavation should be left open for observation by the geotechnical consultant. Should any unusual soil conditions or subsurface structures be encountered during site clearing or grading that are not described or anticipated herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations as needed.

Temporary construction equipment (office trailers, power poles, etc.) should be positioned to allow adequate room for clearing and recommended ground preparation to be performed for proposed structures, pavements, and hardscapes.

6.1.4 Ground Preparation

All existing fill materials and the upper 1 foot of the Terrace Deposits are considered unsuitable for support of the structural improvements and should be removed within the limits of new site development to expose competent Terrace Deposits.

The removals should extend laterally a distance of at least 5 feet beyond the limits of the residential structures or a 1 to 1 projection down and away from the bottom of the footings, whichever is greater. Removals for pavement and free-standing retaining walls may be limited to the edge of the foundations or pavement where lateral restrictions to removals are present such as property lines. The actual depth of removals should be verified by the geotechnical consultant during site grading.

If these removals are restricted due to the presence of existing features such as property lines, additional considerations may be required in the design and construction of site improvements affected by these limitations.

Following removals, the exposed grade should first be scarified to a depth of 8 inches, brought to at least 110 percent of the optimum moisture content, and then compacted to at least 90 percent of the laboratory standard.

6.1.5 Fill Placement

In general, materials excavated from the site may be used as fill provided they are free of deleterious materials and particles greater than 4 inches in maximum dimension. Fill materials should be placed in loose lifts no greater than approximately 8 inches in thickness. Each lift should be watered or air-dried as necessary to achieve at least 110 percent of the optimum moisture content, and then compacted in place to at least 90 percent of the laboratory standard. The laboratory standard for maximum dry density and optimum moisture content for each soil type should be determined in accordance with ASTM D 1557-07. Each lift should be treated in a similar manner. Subsequent lifts should not be placed until the project geotechnical consultant has tested the preceding lift. Lifts should be maintained relatively level and should not exceed a gradient of 20:1 (H:V).

Excavations into site materials may expose soils with very differing characteristics. If such differing materials are created through excavation, they should be blended to create a relatively uniform soil mix when reused as fill below the residential structures. The blending of each lift should be observed and approved by the geotechnical consultant prior to placement of additional lifts of fill.

6.1.6 Import Materials

If import materials are required to achieve the proposed finish grades, the proposed import soil should have an Expansion Index (EI) less than 75 and be non-corrosive to concrete and ferrous metals. The geotechnical consultant should be informed of import sources prior to hauling the materials to the site so that appropriate testing and evaluation of the proposed import material can be performed in advance.

6.1.7 Temporary Excavations

Temporary construction slopes in site materials that are not surcharged may be cut vertically up to a height of 4 feet. Temporary excavations greater than 4 feet but no greater than 10 feet in height that are not surcharged should be laid back at a maximum gradient of 1:1 (H:V) or properly shored. Slopes that expose friable soils should be laid back to a maximum gradient of 1.5:1 (H:V) or flatter if deemed appropriate by the geotechnical consultant. Temporary excavations greater than 10 feet in height or any excavations that will be surcharged should be reviewed by the geotechnical consultant for specific recommendations.

Excavations should not be left open for prolonged periods of time. The project geotechnical consultant should observe all temporary cuts to confirm anticipated conditions and to provide alternate recommendations if conditions dictate. All excavations should conform to the requirements of Cal/OSHA. Where insufficient room exists for recommended lay back cuts, shoring or slot cutting methods may be required. Additional recommendations for such conditions will be provided at that time.

The grading contractor should take appropriate measures when excavating adjacent existing improvements to avoid disturbing or compromising support of existing structures.

6.2 SEISMIC DESIGN PARAMETERS

For design of the project in accordance with Chapter 16 of the 2013 CBC, the following table presents the seismic design factors:

TABLE 6.1
2013 CBC Seismic Design Parameters

Parameter	Value
Site Class	C
Importance Factor	I, II, III
Mapped MCE_R Spectral Response Acceleration, short periods, S_S	1.625
Mapped MCE_R Spectral Response Acceleration, at 1-sec. period, S_1	0.598
Site Coefficient, Fa	1.000
Site Coefficient, Fv	1.300
Adjusted MCER Spectral Response Acceleration, short periods, S_{MS}	1.625
Adjusted MCER Spectral Response Acceleration, at 1-sec. period, S_{M1}	0.778
Design Spectral Response Acceleration, short periods, S_{DS}	1.083
Design Spectral Response Acceleration, at 1-sec. period, S_{D1}	0.519
MCE_R = Risk-Targeted Maximum Considered Earthquake	

6.3 FOUNDATION DESIGN

6.3.1 General

The following recommendations are presented for preliminary design and estimating purposes. These recommendations have been based on typical site materials encountered during our subsurface investigation. Final recommendations should be provided by the project geotechnical consultant following observation and testing of site materials during grading. Depending upon actual site conditions and foundation loads, the recommendations contained herein may require modification.

6.3.2 Soil Expansion

The recommendations presented herein are based on soils with a **Medium** expansion potential (EI<80 and PI<30). Following site grading, additional testing of site soils should be performed by the project geotechnical consultant to confirm the basis of these recommendations. If site soils with higher expansion potentials are encountered or imported to the site, the recommendations contained herein may require modification.

6.3.3 Settlement

Foundations should be designed for total and differential settlement up to 1 inch and ½-inch over 30 feet, respectively. These estimated magnitudes of settlement should be considered by the structural engineer in design of the proposed structures at the site.

6.3.4 Allowable Bearing Value

Provided site grading is performed in accordance with the recommendations provided by the project geotechnical consultant, a bearing value of 2,000 pounds per square foot (psf) may be used for

continuous footings or beams on post-tensioned slab systems having a minimum effective width of 12 inches and founded at a minimum of 12 inches below the lowest adjacent grade. This value may be increased by 300 psf and 700 psf for each additional foot in width and depth, respectively. Recommended allowable bearing values include both dead and live loads, and may be increased by one-third for wind and seismic forces.

6.3.5 Lateral Resistance

Provided site grading is performed in accordance with the recommendations provided by the project geotechnical consultant, a passive earth pressure of 300 pounds per square foot per foot of depth up to a maximum value of 900 pounds per square foot may be used to determine lateral bearing for beams. This value may be increased by one-third when designing for wind and seismic forces. A coefficient of friction of 0.30 times the dead load forces may also be used between concrete and the supporting soils to determine lateral sliding resistance. No increase in the coefficient of friction should be used when designing for wind and seismic forces.

The above values are based on footings placed directly against compacted fill or competent native soils. In the case where footing sides are formed, all backfill against the footings should be compacted to at least 90 percent of the laboratory standard (ASTM D 1557-07).

6.3.6 Post-Tension Slab-on-Grade

The thickness of the floor slabs should be determined by the project structural engineer. However, we recommend a minimum slab thickness of 4.5 inches.

Perimeter edge beams should be founded at a minimum depth of 15 inches below the lowest adjacent final ground surface. If a post-tension mat is used, the outer 12 inches should be thickened to provide a minimum embedment of 8 inches below lowest grade, or to the depth of the underlying sand, whichever is deeper. Interior beams may be founded at a minimum depth of 12 inches below the tops of the finish floor slabs.

Concrete floor slabs in areas to receive moisture sensitive coverings should be underlain with a minimum of 10-mil moisture vapor retarder conforming to ASTM E 1745, Class A. The membrane should be properly lapped, sealed, and underlain with at least 4 inches of sand having a sand equivalent (SE) no less than 30. One inch of this sand may be placed over the vapor barrier to aid in the curing of the concrete. This vapor retarder system is anticipated to be suitable for most flooring finishes that can accommodate some vapor emissions. However, this system may emit more than 4 pounds of water per 1000 sq. ft. and therefore, may not be suitable for all flooring finishes. Additional steps should be taken if such vapor emission levels are too high for anticipated flooring finishes.

Special consideration should be given to slabs in areas to receive ceramic tile or other rigid, crack-sensitive floor coverings. Design and construction should mitigate hairline cracking through the use of additional reinforcing and careful control of concrete slump.

Prior to placing concrete, subgrade soils below slab-on-grade/mat areas should be thoroughly moistened to provide moisture contents that are at least 110 percent of the optimum moisture content to a depth of 12 inches.

Based on the guidelines provided in the "Design of Post-Tensioned Slabs-on-Ground" 3rd Edition by Post-Tensioning Institute, the e_m and y_m values are summarized below:

TABLE 6.2
PTI Design Values

Parameter	Value
Edge Lift Moisture Variation Distance, e_m	4.1 feet
Edge Lift, y_m	1.89 inches
Center Lift Moisture Variation Distance, e_m	7.7 feet
Center Lift, y_m	1.29 inches

6.3.7 Foundation Observations

Foundation excavations should be observed by the project geotechnical consultant to verify that they have been excavated into competent bearing soils and to the minimum embedment recommended above. These observations should be performed prior to placement of forms or reinforcement. The excavations should be trimmed neat, level and square. Loose, sloughed or moisture-softened materials and debris should be removed prior to placing concrete.

6.4 RETAINING AND SCREENING WALLS

6.4.1 General

The following preliminary design and construction recommendations are provided for general retaining and screen walls supported by engineered compacted fill or competent native soils. Final wall designs specific to the site development should be provided for review once completed. The structural engineer and architect should provide appropriate recommendations for sealing at all joints and applying moisture-proofing material on the back of the walls.

6.4.2 Allowable Bearing Value and Lateral Resistance

Design of retaining and screen walls may utilize the bearing and lateral resistance values provided in Section 6.3.4 and 6.3.5.

6.4.3 Active Earth Pressure

Retaining walls up to 6 feet in height and having a level backfill should be designed for an active pressure based on a fluid pressure 60 pcf for onsite soils. Lower active pressures could be achieved by the use of select backfill soils. If required, specific recommendations can be provided for other materials.

Based on the 2013 CBC, walls that retain less than 6 feet need not be designed for seismic earth pressures. Retaining walls should be designed to support adjacent surcharge loads imposed by other nearby footings or traffic loads in addition to the active earth pressure.

6.4.4 Drainage and Moisture-Proofing

Retaining walls should be constructed with a perforated pipe and gravel subdrain to prevent entrapment of water in the backfill. The perforated pipe should consist of 4-inch-diameter, ABS SDR-35 or PVC Schedule 40 with the perforations laid down. The pipe should be embedded in ¾- to 1½-inch open-graded gravel wrapped in filter fabric. The gravel should be at least one foot wide and extend at least one foot up the wall above the footing and drainage outlet. Drainage gravel and piping should not be placed below outlets and weepholes. Filter fabric should consist of Mirafi 140N, or equal. Outlet pipes should be directed to positive drainage devices.

The use of weepholes may be considered in locations where aesthetic issues from potential nuisance water are not a concern. Weepholes should be 2 inches in diameter and provided at least every 6 feet on center. Where weepholes are used, perforated pipe may be omitted from the gravel subdrain.

Retaining walls supporting backfill should also be coated with a moisture-proofing compound or covered with such material to inhibit infiltration of moisture through the walls. Moisture-proofing material should cover any portion of the back of wall that will be in contact with soil and should lap over and cover the top of footing. A drainage panel should be provided between the water proofing and soil backfill. The panel should extend from the top of the subdrain gravel to within 12 inches of finish grade. The top of footing should be finished smooth with a trowel to inhibit the infiltration of water through the wall. The project structural engineer should provide specific recommendations for moisture-proofing, water stops, and joint details.

6.4.5 Footing Reinforcement and Wall Jointing

All continuous footings should be reinforced with a minimum of four No. 4 bars, two top and two bottom. Walls should be provided with cold joints spaced no more than 40 feet apart. The structural engineer may require different reinforcement or jointing and should dictate if greater than the recommendations provided herein. Where recommended removals are limited due to space restrictions, greater reinforcement and closer jointing may be recommended. Specific recommendations should be provided by the geotechnical consultant during grading based on as-built conditions exposed in the field.

6.4.6 Footing Observations

Footing excavations should be observed by the project geotechnical consultant to verify that they have been excavated into competent bearing soils and to the minimum embedment recommended herein. These observations should be performed prior to placement of forms or reinforcement. The excavations should be trimmed neat, level, and square. Loose, sloughed or moisture-softened materials and debris should be removed prior to placing concrete.

6.4.7 Retaining Wall Backfill

Onsite soils may generally be used for backfill of retaining walls. The project geotechnical consultant should approve all backfill used for retaining walls. Wall backfill should be moisture-conditioned to slightly over the optimum moisture content; placed in lifts no greater than 8 inches in thickness, and then mechanically compacted with appropriate equipment to at least 90 percent of the laboratory standard. Hand-operated compaction equipment should be used to compact the backfill

placed immediately adjacent the wall to avoid damage to the wall. Flooding or jetting of backfill material is not recommended.

6.5 EXTERIOR FLATWORK

Exterior flatwork should be a minimum 4 inches thick. Cold joints or saw cuts should be provided at least every 5 feet in each direction. Flatwork more than 5 feet in width across the minimum dimension should be reinforced with 6" by 6", W2.9 by W2.9 welded wire mesh or No 3 bars spaced 18 inches center to center in both directions. Cold joints should be keyed or provided with dowels spaced 18 inches on center. Such flatwork that meets the structure at points of entry should also be doweled into the footing or grade beam of the structure. Consideration should also be given to doweling flatwork into curbs where they meet.

Special jointing detail should be provided in areas of block-outs, notches, or other irregularities to avoid cracking at points of high stress. Subgrade soils below flatwork should be thoroughly moistened to a moisture content of at least 120 percent of the optimum moisture content to a depth of 12 inches. Moistening should be accomplished by lightly spraying the area over a period of a few days just prior to pouring concrete. The geotechnical consultant should observe and verify the density and moisture content of subgrade soils prior to pouring concrete to verify the recommended pre-moistening recommendations have been met.

Drainage from flatwork areas should be directed to local area drains or other appropriate collection devices designed to carry runoff water to the street or other approved drainage structures. Flatwork should provide a minimum slope of 1% away from residential structures.

6.6 CONCRETE MIX DESIGN

Laboratory testing of on-site soils indicates soluble sulfate content is less than 0.10%. We recommend following the procedures provided in ACI 318, Section 4.3, Table 4.3.1 for Exposure Class S0 unless more strict requirements are made by the structural engineer. Upon completion of rough grading, an evaluation of as-graded conditions and further laboratory testing should be completed for the site to confirm or modify the recommendations provided in this section.

6.7 PRELIMINARY PAVEMENT DESIGN

6.7.1 Preliminary Pavement Structural Sections

Based on an R-Value of 5 and estimated traffic volume, preliminary pavement sections are provided in the following table. The sections provided herein are for planning purposes only and should be re-evaluated subsequent to site grading. Final pavement sections should be based on actual R-value testing of in-place soils and analysis of anticipated traffic.

TABLE 6.3
PRELIMINARY PAVEMENT SECTIONS

Location	Traffic Index	AC (inches)	Concrete Pavers (mm)	AB (inches)
Entry and Secondary Drives	5.5	3.0	--	11
		4.0	--	8
		--	80	12
Parking Stalls	--	3.0	--	6.0

AC - Asphaltic Concrete AB - Aggregate Base

6.7.2 Subgrade Preparation

Prior to placement of pavement elements, subgrade soils should be moisture-conditioned to at least 110 percent of the optimum moisture content then compacted to at least 90 percent of the laboratory determined maximum dry density. Areas observed to pump or yield under vehicle traffic should be removed and replaced with firm and unyielding compacted soil or aggregate base materials.

6.7.3 Aggregate Base

Aggregate base materials should be Crushed Aggregate Base or Crushed Miscellaneous Base conforming to Section 200-2 of the Standard Specification for Public Works Construction (Greenbook) or Class 2 Aggregate Base conforming to the Caltrans' Standard Specifications. The materials should be moisture conditioned to slightly over the optimum moisture content then compacted to at least 95 percent of ASTM D 1557-07.

6.7.4 Asphaltic Concrete

Paving asphalt should be PG 64-10. Asphalt concrete materials should conform to Section 203-6 and construction should conform to Section 302 of the Greenbook.

6.7.5 Concrete Pavers

Concrete pavers should conform to the requirements of ASTM C 936. Construction of the pavers, including bedding sand, should follow manufacturer's specifications. Typical thickness of bedding sand is about 1 inch. The gradation of bedding sand should meet the requirement in Table 6.4.

Construction of edge restraints should also follow manufacturer's specifications. As a minimum, restraints should be provided along the perimeter of concrete pavers and where there is a change in the paving materials. Concrete bands should extend to the bottom of the base course underlying the concrete pavers.

TABLE 6.4
Gradation for Sand Bedding

Sieve Size	Percent Passing
⅜"	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 - 30
No. 100	0 - 10
No. 200	0 - 1

6.8 STORM WATER INFILTRATION

Results and recommendations for the proposed storm water infiltration system are provided in a separate report.

6.9 POST GRADING CONSIDERATIONS

6.9.1 Site Drainage and Irrigation

The ground immediately adjacent to foundations should be provided with positive drainage away from the structures in accordance with 2013 CBC, Section 1804.3. No rain or excess water should be allowed to pond against structures such as walls, foundations, flatwork, etc.

Excessive irrigation water can be detrimental to the performance of the proposed site development. Water applied in excess of the needs of vegetation will tend to percolate into the ground. Such percolation can lead to nuisance seepage and shallow perched groundwater. Seepage can form on slope faces, on the faces of retaining walls, in streets, or other low-lying areas. These conditions could lead to adverse effects such as the formation of stagnant water that breeds insects, distress or damage of trees, surface erosion, slope instability, discoloration and salt buildup on wall faces, and premature failure of pavement. Excessive watering can also lead to elevated vapor emissions within buildings that can damage flooring finishes or lead to mold growth inside the home.

Key factors that can help mitigate the potential for adverse effects of overwatering include the judicious use of water for irrigation, use of irrigation systems that are appropriate for the type of vegetation and geometric configuration of the planted area, the use of soil amendments to enhance moisture retention, use of low-water demand vegetation, regular use of appropriate fertilizers, and seasonal adjustments of irrigation systems to match the water requirements of vegetation. Specific recommendations should be provided by a landscape architect or other knowledgeable professional.

6.9.2 Utility Trenches

Trench excavations should be constructed in accordance with the recommendations contained in Section 6.1.7 of this report. Trench excavations must also conform to the requirements of Cal/OSHA.

Trench backfill materials and compaction criteria should conform to the requirements of the local municipalities. As a minimum, utility trench backfill should be compacted to at least 90 percent of the laboratory standard. Trench backfill should be brought to moisture content slightly over optimum, placed in lifts no greater than 12 inches in thickness, and then mechanically compacted with appropriate equipment to at least 90 percent of the laboratory standard. The project geotechnical consultant should perform density testing, along with probing, to test compaction. Site conditions are generally not suitable for jetting of trench backfill and jetting should not be completed without prior approval from the project geotechnical consultant.

Within shallow trenches (less than 18 inches deep) where pipes may be damaged by heavy compaction equipment, imported clean sand having a SE of 30 or greater may be utilized. The sand should be placed in the trench, thoroughly watered, and then compacted with a vibratory compactor. For utility trenches located below a 1:1 (H:V) plane projecting downward from the outside edge of the adjacent footing base or crossing footing trenches, concrete or slurry should be used as trench backfill.

6.10 PLAN REVIEW AND CONSTRUCTION SERVICES

We recommend *Albus-Keefe & Associates, Inc*. be engaged to review any future development plans, including civil plans (grading plans), foundation plans, and proposed structural loads, prior to construction. This is to verify that the assumptions of this report are valid and that the preliminary conclusions and recommendations contained in this report have been properly interpreted and are incorporated into the project plans and specifications. If we are not provided the opportunity to review these documents, we take no responsibility for misinterpretation of our preliminary conclusions and recommendations.

We recommend that a geotechnical consultant be retained to provide soil engineering services during construction of the project. These services are to observe compliance with the design, specifications or recommendations, and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

If the project plans change significantly from the assumed development described herein, the project geotechnical consultant should review our preliminary design recommendations and their applicability to the revised construction. If conditions are encountered during construction that appear to be different than those indicated in this report or subsequent design reports, the project geotechnical consultant should be notified immediately. Design and construction revisions may be required.

7.0 LIMITATIONS

This report is based on the proposed development and geotechnical data as described herein. The materials encountered on the project site and utilized in our laboratory testing for this investigation are believed representative of the total project area, and the conclusions and recommendations contained in this report are presented on that basis. However, soil and bedrock 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 during the grading and construction phases of the project are essential to confirming the basis of this report.

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 **Sheldon Development, LLC** and their project consultants in the planning and design 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.

This report is subject to review by the controlling governmental agency.

Respectfully submitted,

ALBUS-KEEFE & ASSOCIATES, INC.

David E. Albus
Principal Engineer
G.E. 2455

REFERENCES

Publications

California Geologic Survey, Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California, (2008).

California Department of Conservation, Division of Mines and Geology, Seismic Hazard Report 03, "Seismic Hazard Zone Report for the Anaheim and Newport Beach 7.5-Minute Quadrangles, Orange County, California", 1997.

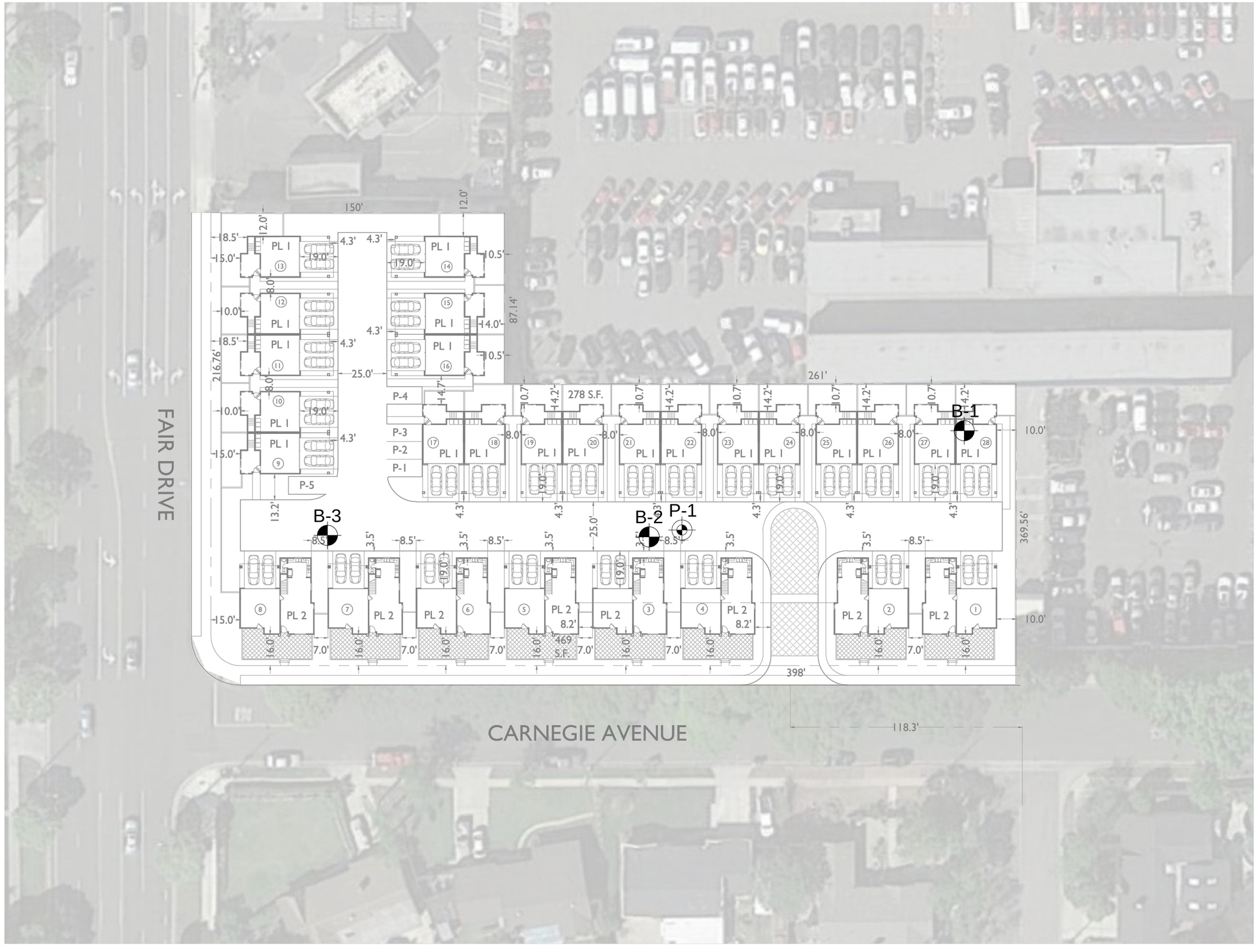
Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., and Stokoe, K.H., "Liquefaction 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.

Plans

Conceptual Site Plan, Fair Drive at Carnegie, Costa Mesa, CA, prepared by Summa Architecture, dated April 10, 2016.

Aerial Photographs

Photo Source	Date Flown	Flight No.	Photo No.
Continental Aerial Photo, Inc.	5-2-53	AXK-6K	69
Continental Aerial Photo, Inc.	3-01-67	1	50
Continental Aerial Photo, Inc.	1-9-87	F	260



ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GEOTECHNICAL MAP

Job No.: 2495.00	Date: 05/26/16	Plate: 1

EXPLANATION
(Locations Approximate)

B-3 - Exploratory Boring

P-1 - Percolation Well

SITE PLAN SUMMARY

OWNER: SHELDON DEVELOPMENT, LLC.
901 DOVE STREET, SUITE 230
NEWPORT BEACH, CA 92660
PHONE: (949)777-9400

SITE ADDRESS: FAIR DRIVE AT CARNEGIE

PROPOSED UNITS: 28 HOMES
20 - 3 STORY DUPLEX
8 - 2 STORY DETACHED

LOT AREA: 72,310 S.F. (1.66 ACRES)

DENSITY: 16.25 UNITS PER ACRE

SITE SUMMARY:

BLDG FOOTPRINTS:	21,060 S.F. (31.5%)
PRIV. STREETS/DRIVES:	24,150 S.F. (29.2%)
OPEN SPACE:	22,808 S.F. (31.5% AT GRADE)
BALCONIES	1,080 S.F. (2ND FLOOR)
ROOF DECKS	8,000 S.F.
TOTAL OPEN SPACE	31, 888 S.F. (44.0%)

PLAN SUMMARY:

		LIVABLE AREA
3 STORY - 4 BDRM		
PLAN 1	1ST FLR	157 S.F.
	2ND FLR	897 S.F.
	3RD FLR	809 S.F.
	TOTAL LIVABLE	1,863 S.F.
	GARAGE	471 S.F.
	BALCONY	54 S.F.
	ROOF DECK	400 S.F.
3 STORY - 3 BDRM		
PLAN 2	1ST FLR	609 S.F.
	2ND FLR	1,174 S.F.
	3RD FLR	237 S.F.
	TOTAL LIVABLE	2,020 S.F.
	GARAGE	453 S.F.

PARKING SUMMARY:

REQUIRED PARKING = 20 UNITS X 4 STALLS/UNIT = 80 STALLS
8 UNITS X 4 STALLS/UNIT = 32 STALLS
112 STALLS

PLAN 1	2 CAR ATTACHED GARAGE X 20 UNITS =	40 STALLS
PLAN 2	2 CAR ATTACHED GARAGE X 8 UNITS =	16 STALLS
GUEST	PRIVATE DRIVE STALLS =	56 STALLS
GUEST	ADD'L OPEN UNASSIGNED STALLS =	5 STALLS
		117 STALLS

BUILDING HEIGHT: 3 STORIES, 44'-0" MAXIMUM HEIGHT

CARNEGIE AVENUE - COSTA MESA - 28 HOMES

SITE PLAN

Sheldon Development, LLC.
901 Dove Street, Suite 230
Newport Beach, CA 92660
Phone: (949)777-9400

0 10 20 40

APRIL 10, 2016

NORTH

SUMMA ARCHITECTURE
5256 S. Mission Road, Ste. 404 Bonsall, CA 92003
www.summarch.com 760.724.1198

APPENDIX A

EXPLORATION LOGS

EXPLORATION LOG

Project:		Location:
Address:		Elevation:
Job Number:	Client:	Date:
Drill Method:	Driving Weight:	Logged By:

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		EXPLANATION							
		Solid lines separate geologic units and/or material types.							
5		Dashed lines indicate unknown depth of geologic unit change or material type change.							
		Solid black rectangle in Core column represents California Split Spoon sampler (2.5in ID, 3in OD).			■				
		Double triangle in core column represents SPT sampler.			⧗				
10		**Solid black rectangle** in Bulk column respresents large bag sample.				■			
		Other Laboratory Tests:							
		Max = Maximum Dry Density/Optimum Moisture Content							
		EI = Expansion Index							
		SO4 = Soluble Sulfate Content							
15		DSR = Direct Shear, Remolded							
		DS = Direct Shear, Undisturbed							
		SA = Sieve Analysis (1" through #200 sieve)							
		Hydro = Particle Size Analysis (SA with Hydrometer)							
		200 = Percent Passing #200 Sieve							
		Consol = Consolidation							
		SE = Sand Equivalent							
20		Rval = R-Value							
		ATT = Atterberg Limits							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-1
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 5.5 inches AC / No base							EI SO4 ATT RVal
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		21			15.3	88	
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, moist, very stiff, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pinhole pores		15			6.6	106.6	Max DS
				10					
		Clayey Sand/Silty Sand (SC/SM): Light red-brown to yellow-brown, damp, medium dense, fine to medium grained sand, trace coarse grained sand and gravel, trace pores		21					
10		Sand (SP): Light red-brown, damp, medium dense, fine to medium grained sand, some coarse grained sand and gravel, sample disturbed @ 8 ', no recovery		31					
		Silt with some Sand (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining							
15		Sandy Silt (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining		23			10	115.5	
		Silty Sand (SM): Light gray, dry to damp, dense, fine grained sand, some orange oxidation staining							
20				57			2.9	91	
		Total Depth: 21 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 4.5 inches AC / No base							
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		40	■		6.6	119.3	Consol
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, damp to moist, hard, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pores		19	■		6.7	104.4	Consol
				10	■		2.4	98.1	
10		Clayey Sand/Silty Sand (SC/SM): Light red-brown to yellow-brown, damp, medium dense, fine grained sand, some pinhole pores @ 6 ', becomes loose, dry to damp, increased fine grained sand, some medium grained sand, trace clay		43	■		1.9	Dist.	
		Sand (SP): Light red-brown to tan, dry, dense, fine to coarse grained sand, some gravel							
15		Sandy Silt (ML): Gray, moist, hard, fine grained sand, some orange oxidation staining, some pinhole pores		74	■		3.9	96.5	
20		Silty Sand/Sand with Silt (SM/SP-SM): Light gray, dry to damp, very dense, fine grained sand, some orange oxidation staining @ 20 ', becomes damp, dense, decreased silt		44	■		4.3	95.1	SA Hydro

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		@ 25 ', becomes very dense, increased silt, trace gravel		43					
30		@ 30 ', same		74					
35		@ 35 ', occasional 1-inch sand layers		64					
40		@ 40 ', becomes damp to moist, fine to medium grained sand, decreased silt		54					
		Silty Sand/Sandy Silt (SM/ML): Gray, moist, dense/hard, fine grained sand, some orange oxidation staining							
45		@ 45 ', becomes gray to olive-gray		36					

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
				39					
		Total Depth: 51.5 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch Perc. well set 10 feet offset							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-3
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 4.5 inches AC / No base							
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		35	■		12.4	118.3	
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, moist, very stiff, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pores and rootlets		38	■		7.3	112.7	
		Clayey Sand (SC): Light red-brown, damp to moist, medium dense, fine grained sand, some medium to coarse grained sand		20	■		6.3	Dist.	
10		Sand (SP): Yellow-brown, moist, medium dense, fine to coarse grained sand, some gravel, trace clay		26	■		10.7	111.3	
		Silty Sand (SM): Light red-brown, moist, medium dense, fine grained sand, some medium grained sand, some clay							
		Silt with Sand (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining							
15		Silty Sand (SM): Light gray, moist, medium dense, fine grained sand, some orange oxidation staining		32	■		19.6	89.5	
20		Sand (SP): Light red-brown to gray, dry to damp, very dense, fine to medium grained sand, trace coarse grained sand and gravel		70	■		2.9	99.6	
		Total Depth: 21 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch							

APPENDIX B

LABORATORY TESTING PROGRAM

LABORATORY TESTING PROGRAM

Soil Classification

Soils encountered within the exploratory borings and trenches were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D 2488-06). The samples were re-examined in the laboratory and classifications reviewed and then revised where appropriate. The assigned group symbols are presented on the logs provided in Appendix A.

In-Situ Moisture Content and Dry Density

Moisture content and dry density of in-place soil materials were determined in representative strata. Test data are presented on the Exploration Logs provided in Appendix A.

Maximum Dry Density and Optimum Moisture Content

Maximum dry density and optimum moisture content of onsite soils were determined for a selected sample in general accordance with Method B and C of ASTM D 1557-07. Pertinent test values are given on Table B-1.

Direct Shear

A direct shear test was performed for a sample remolded to 90 percent of the estimated maximum dry density. This test was performed in general accordance with ASTM D3080-98. Three specimens were prepared for the test. The test specimens were artificially saturated, and then sheared under varied normal loads at a constant rate. Results are graphically presented on Plate B-2.

Expansion Potential

An Expansion Index test was performed on a selected sample in accordance with Uniform Building Code Standard 18-2. The expansion potential classification was determined from U.B.C. Table 18-I-B on the basis of the expansion index value. The test result and expansion potential are presented on Table B-1.

Soluble Sulfate Content

A chemical analysis was performed on a selected soil sample to determine soluble sulfate content. The test was performed in accordance with California Test Method (CTM) 417. The test result is included in Table B-1.

Grain Size Analysis

Grain size analysis was performed on a selected sample to verify visual classifications performed in the field. The test was performed in accordance with ASTM D 422-63. Test results are graphically presented on Plate B-1.

Consolidation

Consolidation tests were performed for selected soil samples in general conformance with ASTM D 2435-04. Axial loads were applied in several increments to a laterally restrained 1-inch-high sample. Loads were applied in geometric progression by doubling the previous load, and the resulting deformations were recorded at selected time intervals. The test samples were inundated at a selected load to evaluate the effects of a sudden increase in moisture content (hydro-consolidation potential). Results of the tests are graphically presented on Plates B-3 and B-4.

Atterberg Limits

Atterberg Limits (Liquid Limit, Plastic Limit, and Plasticity Index) were performed in accordance with Test Method ASTM D-4318-93. Pertinent test values are presented within Table B-1.

TABLE B-1
Summary of Laboratory Test Results

Boring No.	Sample Depth (ft.)	Soil Description	Test Results	
B-1	0-5	Sandy Clay (CL)	Expansion Index: Expansion Potential: Soluble Sulfate Content: Sulfate Exposure: R-Value: Liquid Limit: Plastic Index:	75 Medium 0.006 Negligible 5 44.6 28.7
B-1	5-10	Silty Sand (SM)	Maximum Dry Density: Optimum Moisture Content:	118.5 13.0

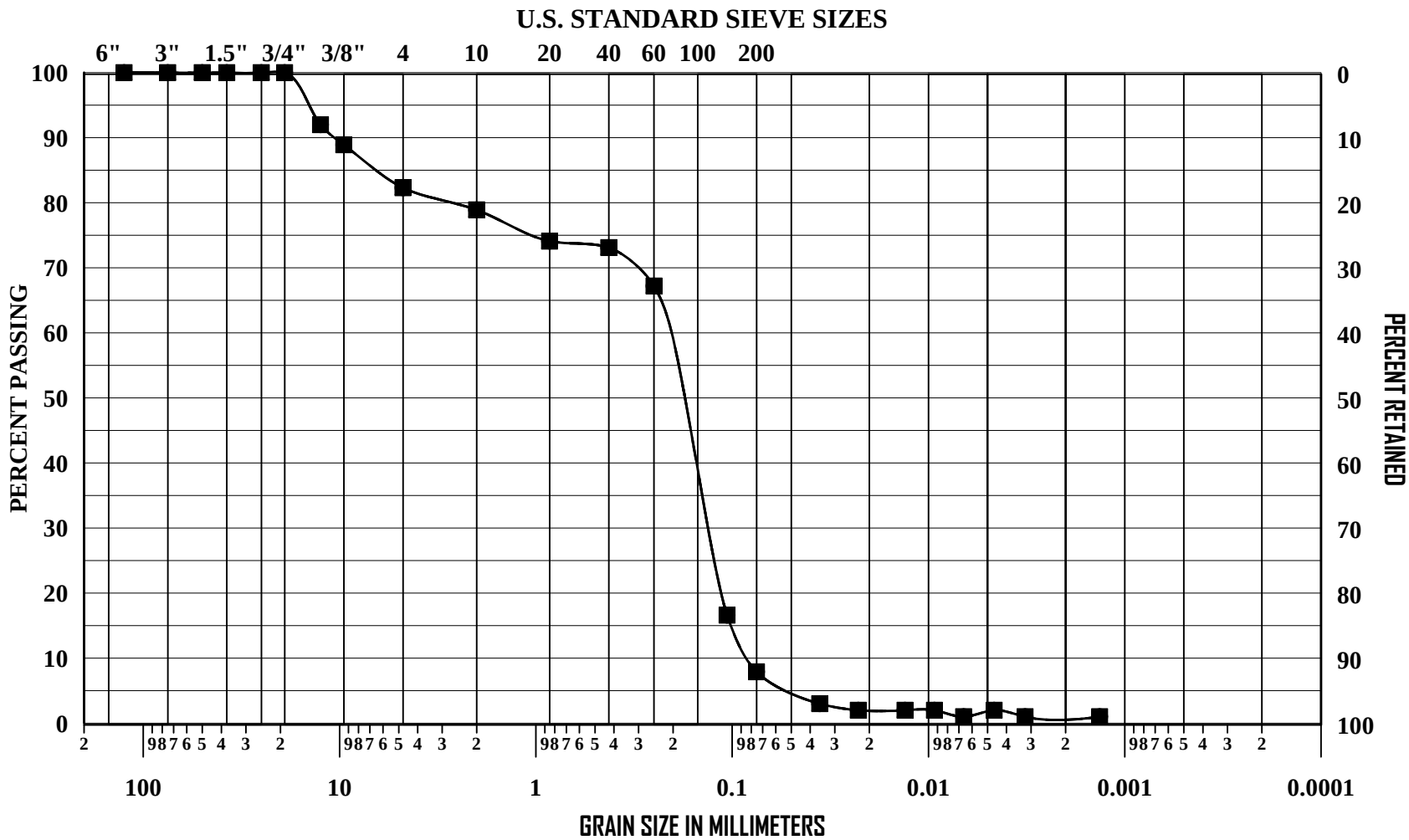
Note: Additional laboratory test results are provided on the boring logs provided in Appendix A.

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION

COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

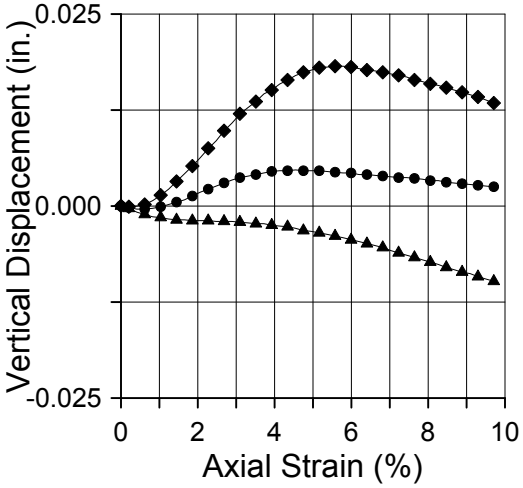


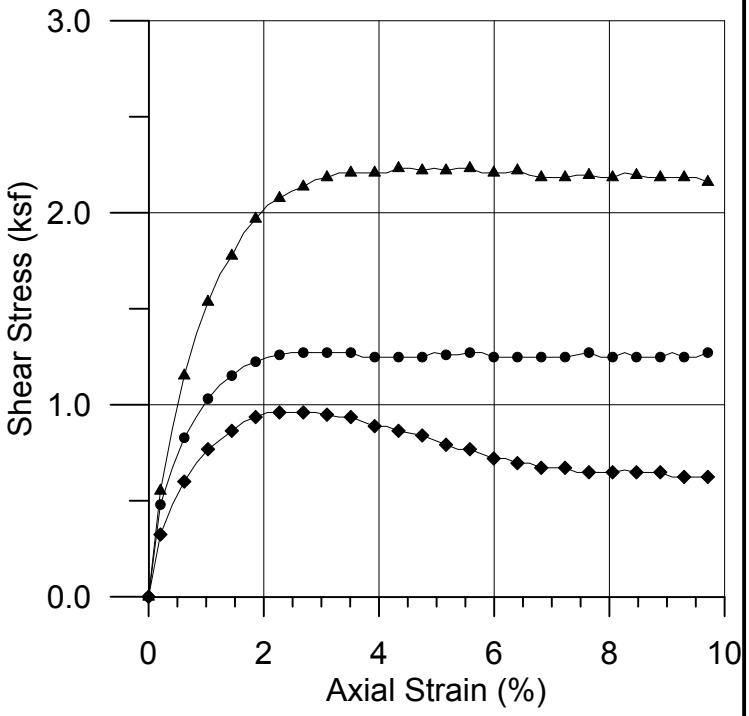
LOCATION	SAMPLE	SYMBOL	LL	PI	CLASSIFICATION
B-2	20 feet	●——●			Sand with Silt (SP-SM)

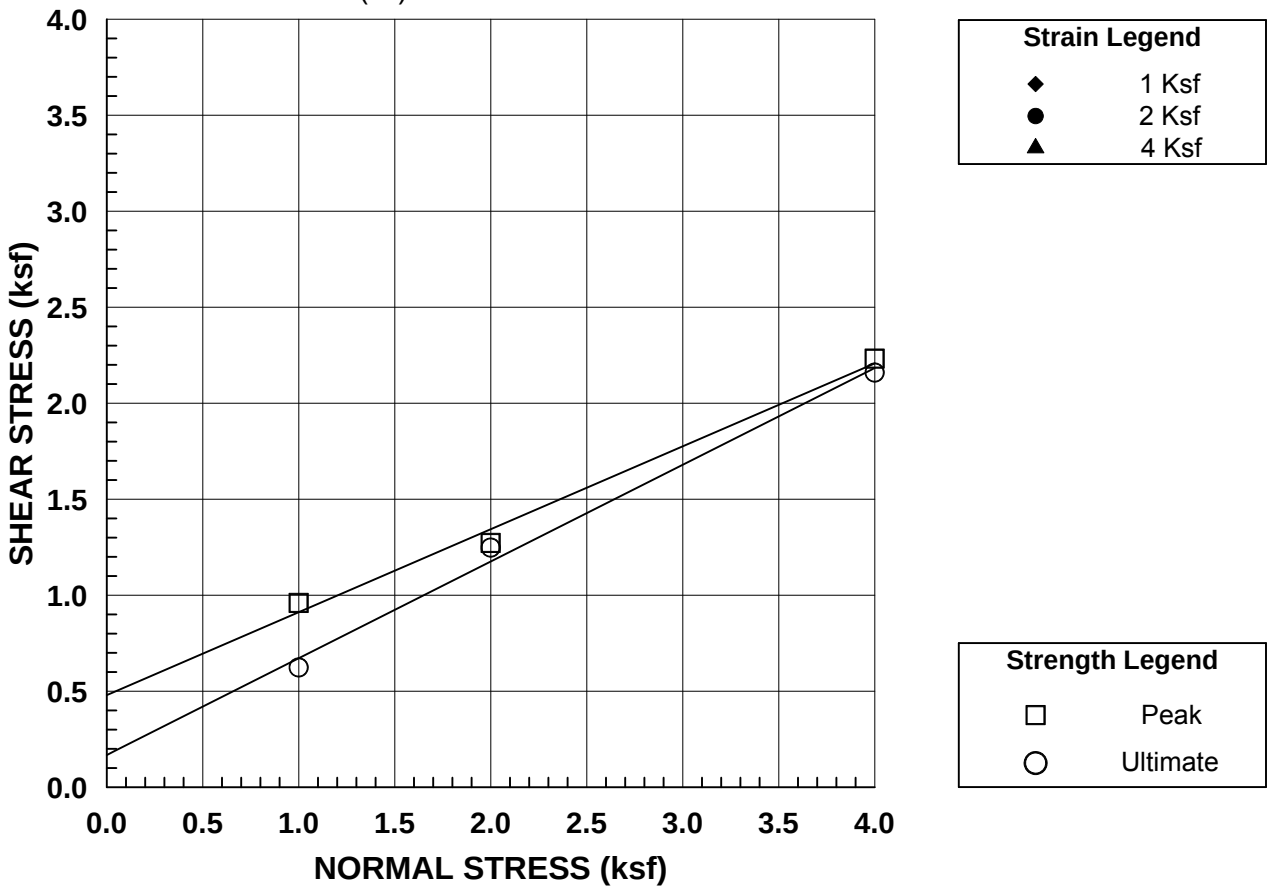
Job No: 2495.00

Plate No: B-1

Specimen No.	1	2	3
Normal Stress (ksf)	1	2	4
Peak Stress (ksf)	0.96	1.272	2.232
Peak Displacement (in)	0.0182	0.0047	0.0108
Ultimate Stress (ksf)	0.624	1.248	2.16
Ultimate Displacement (in)	0.25	0.25	0.25
Initial Dry Density	106.7	106.7	106.7
Initial Moisture Content (%)	12.98	12.98	12.98
Strain Rate (in/min)	0.010		







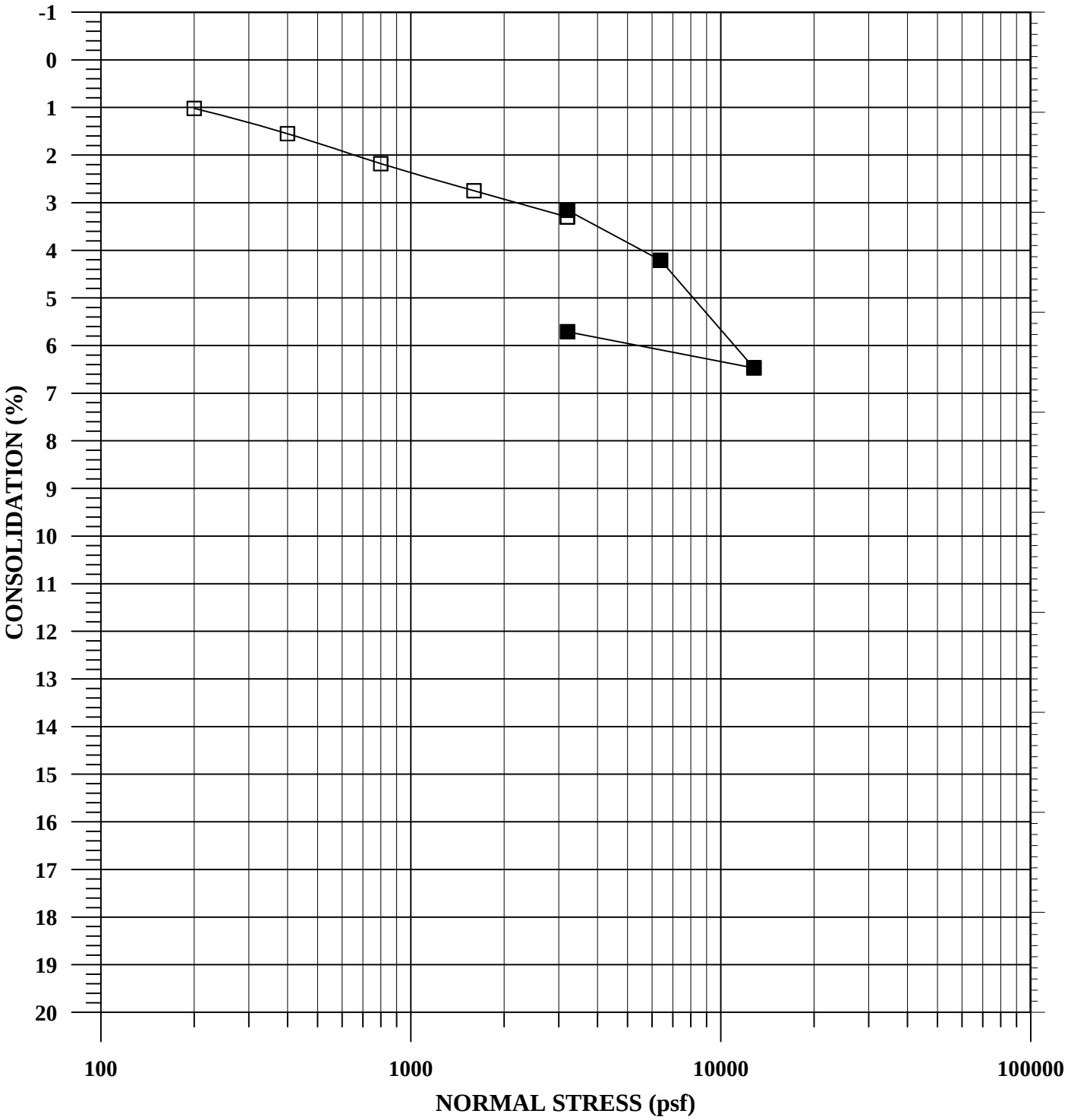
SAMPLE LOCATION	SAMPLE TYPE	SAMPLE DESCRIPTION
B-1 @ 5-10 feet	Remolded to 90% of 118.5pcf @ 13.0%	Silty Sand (SM)

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

DIRECT SHEAR

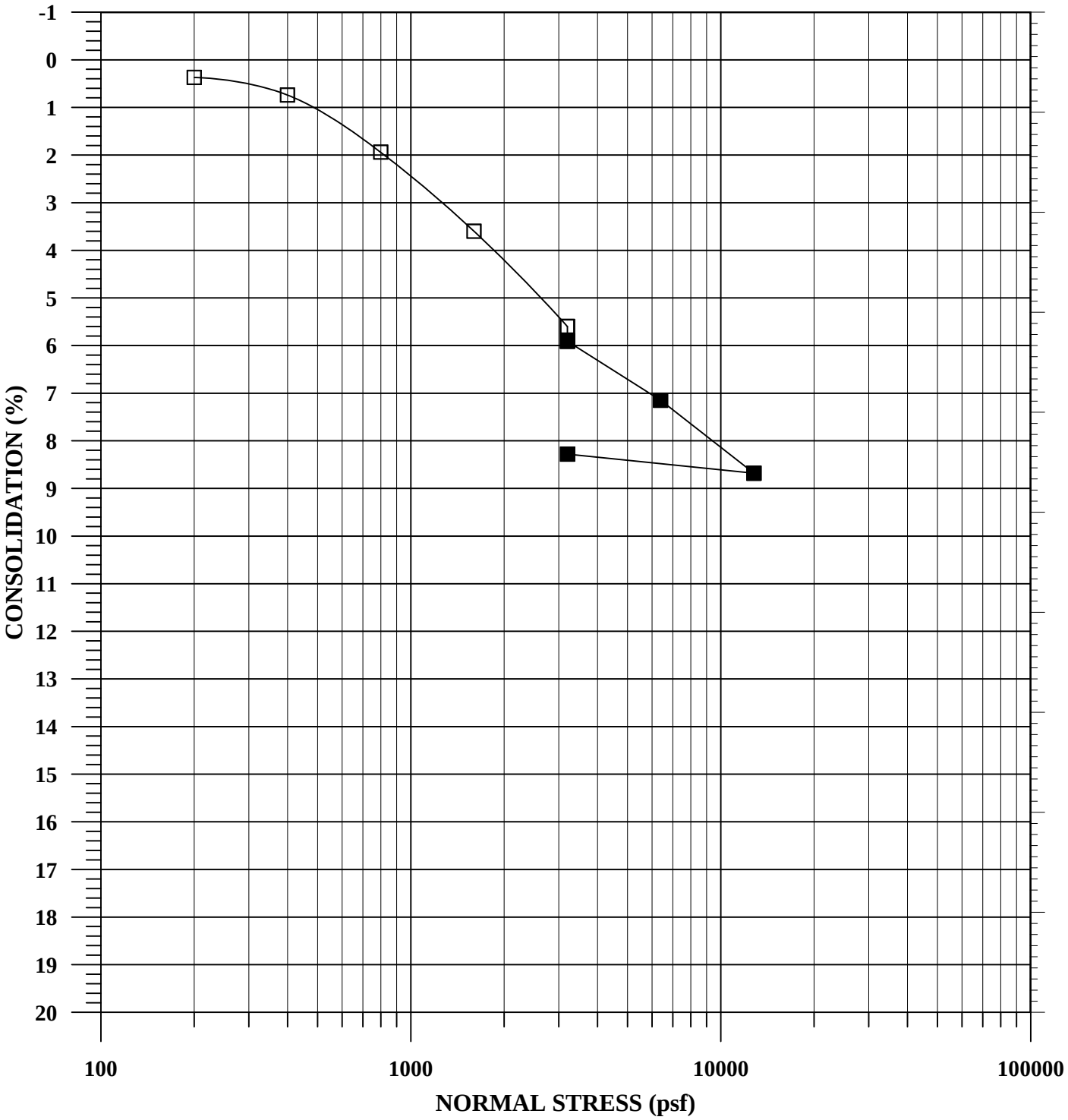
Job No: 2495.00

Plate No: B-2



Sample Location:	B-2	Initial Dry Density (pcf):	113.4	**Legend**
Sample Depth:	2 ft	Initial Moisure Content (%):	11.1	□ □ □ Field Moisture ■—■—■ Saturated
Classification:	CL	Final Moisture Content (%):	15.1	

ALBUS-KEEFE & ASSOCIATES, INC. GEOTECHNICAL CONSULTANTS	**CONSOLIDATION TEST RESULTS**	Job No: 2495.00 Plate No: B-3



Sample Location:	B-2	Initial Dry Density (pcf):	100.6	**Legend**
Sample Depth:	4 ft	Initial Moisure Content (%):	7.7	□ □ □ Field Moisture ■—■—■ Saturated
Classification:	SC/SM	Final Moisture Content (%):	18	

ALBUS-KEEFE & ASSOCIATES, INC. GEOTECHNICAL CONSULTANTS	CONSOLIDATION TEST RESULTS	Job No: 2495.00 Plate No: B-4

THIS PAGE INTENTIONALLY LEFT BLANK

B.2 - Geotechnical Investigation for Proposed Water Quality Improvements

THIS PAGE INTENTIONALLY LEFT BLANK

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

June 10, 2016
J.N.: 2495.00

Mr. Steve Sheldon
Sheldon Development, LLC
901 Dove Street, Suite 140
Newport Beach, California 92660

Subject: Geotechnical Investigation for Proposed Water Quality Improvements, Proposed Residential Development, 440 Fair Drive, City of Costa Mesa, California

Dear Mr. Sheldon,

Pursuant to your request, ***Albus-Keefe & Associates, Inc***. has completed a geotechnical investigation of the site for evaluation of the percolation characteristics of the site soils. The scope of this investigation consisted of the following:

- Exploratory drilling, soil sampling and test well installation
- Field percolation testing
- Laboratory testing of selected soil samples
- Engineering analysis of the data
- Preparation of this report

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

Site Location and Description

The site is located at 440 Fair Drive within the city of Costa Mesa, California. The property is bordered by a Dodge and Fiat Auto Dealership to the north and northwest, a gas station to the southwest, Fair Drive to the south, and Carnegie Avenue to the east. The location of the site and its relationship to the surrounding areas is shown on Figure 1, Site Location Map.

The site is currently occupied by a two-story commercial building (mini-mall) with a large, asphalt paved parking lot. The northern portion of the parking lot area is currently sub-leased and used as car detailing area for a neighboring auto dealership. Associated improvements include some concrete flatwork, underground utilities and a masonry block screen wall along the east margin of the site. Chain-link fencing also bounds the property on the north and west property lines.

Vegetation on site consists of some mature trees along the east property line with some small landscape islands and planters around the building area. Based on Google Earth, topography on site is relatively level at approximately 70 feet above mean sea level. Drainage is generally directed as sheet flow to the south towards Fair Drive.

© 2016 Google

N

SITE LOCATION MAP

Sheldon Development, LLC
Proposed Residential Development
440 Fair Drive
Costa Mesa, California

NOT TO SCALE

FIGURE 1

Proposed Development

Based on our review of the referenced conceptual site plan, the site will developed for construction of eight (8) two-story detached homes and twenty (20) three-story duplex units. Associated interior streets, parking stalls, decorative hardscape, and underground improvements are also anticipated.

We anticipate the proposed residences will be wood-framed, slab-on-grade structures yielding relatively light foundations loads. No grading or structural plans were available in preparing this report. However, we anticipate that minor rough grading of the site will be required to achieve future surface configurations.

Storm water quality management is anticipated to utilize infiltration BMPs within the site. The specific location and type are not known at this time. The site generally drains to the north and as such, we anticipate the primary infiltration BMP will be located near the northern end of the site.

SUMMARY OF FIELD AND LABORATORY WORK

Subsurface Investigation

Subsurface exploration for this investigation was conducted on May 6, 2016. Our exploration consisted of drilling three (3) exploratory borings to depths ranging from 21 to 51.5 feet below the existing ground surface utilizing a truck-mounted, hollow-stem-auger drill rig. Representatives of *Albus-Keefe & Associates, In*c. logged the exploratory excavations. Visual and tactile identifications were made of the materials encountered, and their descriptions are presented in the Exploration Logs in Appendix A. An additional boring was drilled adjacent Boring B-2 for percolation testing. 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 sampler was driven 12 or 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 log. 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.

Upon completion of drilling, one additional boring was drilled approximately 10 feet away from Boring B-2 in order to install 3-inch-diameter casing for subsequent percolation testing. Well screens were installed from near the bottom of the borings to ground surface. The annular space of the well screen sections were filled with #3 Monterey sand for depths covering the extent of our testing. The remaining annular space was then backfilled with native soils. Subsequent to completion of well installation, the casings were then filled with water until the minimum volume of water was achieved for presoaking the test wells as required by test method USBR 7300-89.

Percolation Testing

Percolation testing was performed on May 6, 2016, in general conformance with the constant-head test procedures outlined in the referenced Well Permeameter Method (USBR 7300-89). A water hose attached to a water truck was connected to an inline flow meter to measure the water flow. The flow meter is capable of measuring flow rates up to 10 gallons per minute and as low as 0.1 gallons per minute. A valve was connected in line with the flow meter to control the flow rate. A filling hose was used to connect the flow meter and the test wells. Water was introduced by the filling hose near the bottom of the test wells. A water level meter with 1/100-foot divisions was used to measure the depths to water surface from the top of well casings.

Flow to the wells was terminated upon either completion of testing of all the pre-determined water levels or the flow rate reached the maximum capacity of the flow meter. Measurements obtained during the percolation testing are provided on Plate C-1.

Laboratory Testing

Selected soil samples of representative earth materials were tested to assist in the formulation of conclusions and recommendations presented in this report. Tests consisted of grain-size analysis. Laboratory testing relevant to percolation characteristics are presented in Appendix B.

ANALYSIS OF DATA

Subsurface Conditions

Soil materials encountered at the site consist of terrace deposits covered by a minor thickness of artificial fill. The artificial fills encountered consist of brown to red-brown, moist, medium stiff sandy clay with trace gravel. The thickness of artificial fill materials measured about 12 to 18 inches. However, artificial fill materials of greater thickness are anticipated to exist beneath portions of the site, particularly in areas of structures and as backfill in underground utility trenches.

Terrace deposits were encountered below the artificial fills to the maximum depth explored, 51.5 feet below existing ground surfaces. The upper 2 to 3 feet of the terrace deposits consists of red-brown sandy clay that is generally damp to moist and very stiff. Below 3 feet, the terrace deposits consists of interlayered sands, silty sands, and sandy silts to a depth of about 15 feet. Below a depth of 15 feet, the materials generally consisted of silty sands. These materials were light red-brown, yellow brown, gray, and light gray, dry to moist and medium dense to very dense/stiff to very stiff.

A more detailed description of the interpreted soil profile at the boring locations, based upon the borehole cuttings and soil samples, are presented in Appendix A. The stratigraphic descriptions in the logs represent the predominant materials encountered and relatively thin, often discontinuous layers of different material may occur within the major divisions.

Ground Water

Groundwater was not encountered during this firm's subsurface exploration to a maximum depth of 51.5 feet below the existing ground surface. A review of the CDMG Seismic Hazard Zone Report 03 indicates that historical high groundwater levels for the general site area is greater than 30 feet below the existing ground surface.

We performed research on available groundwater well data in the general area. We identified 4 wells in proximity to the site that provided long-term monitoring data. The data was obtained from the California Department of Water Resources. The data spans a period of time from 1982 to 2011 (29 years). The depth to groundwater has generally dropped over this time frame and has always remained below a depth of 50 feet (not counting some questionable data points obtained in one well. Plots of the well data and a map indicating the locations of the wells are provided in Appendix D. Based on this data, we conclude that groundwater is unlikely to rise above a depth of 50 feet during the lifespan of the project.

Percolation Data

Analyses were performed to evaluate permeability using the flow rate obtained at the end of the constant-head stage of field percolation testing. These analyses were performed in accordance with the procedures provided in the referenced USBR 7300-89. The procedure essentially uses a closed-form solution to the percolation out of a small-diameter well.

Using the USBR method, we calculated a composite permeability value for the head condition maintained in the well. The results are summarized in Table 1 below and the supporting analyses are included in Appendix C, Plate C-2.

TABLE 1
Summary of Back-Calculated Permeability Coefficient

Location	Total Depth of Well (ft)	Depth to Water in Well (ft)	Height of Water in Well (ft)	Static Flow Rate (gal./min.)	Estimated Permeability, k_s (in/hr.)
P-1 (B-2)	24.6	20	4.6	4.5	7.59

Design of Dry Well

Infiltration in a dry well was modeled using the software Seep/W, version 2007, by Geo-Slope International. The program allows for modeling of both partially-saturated and saturated porous medium using a finite element approach to solve Darcy's Law. The program can evaluate both steady-state and transient flow in planer and axisymmetric cases. Boundaries of the model can be identified with various conditions including fix total head, fix pressure head, fix flow rate, and head

as a function of flow. Soil conductivity properties can be modeled with either Fredlund et al (1994), Green and Corey (1971), or Van Genuchten (1980). The Van Genuchten parameters were selected for use in our models and were based on test results of particle-size analyses and estimated in-place densities. The saturated conductivities for the infiltration zones are set to the values obtained from back-calculation of the percolation tests.

A model was setup with two zones of material to represent the general soil profile. The conductivity of zone 1 (Material No. 1) was set to highly restrict water flow from this zone. Based on our testing, this zone would actually provide significant lateral infiltration but interbeds of fine-grained soils would tend to restrict the downward movement of water. Therefore, the infiltration of this upper zone was ignored. The conductivity of zone 2 (Material No. 2) was based on the back-analyzed percolation test and represents the infiltration zone. A summary of the well profile is provided in Table 2.

TABLE 2
Summary of Characteristic Curve Parameters

Material No.	Depth (ft.)	USCS	Ks (in/hr)	Van Genuchten Parameters				
				a (1/cm)	n	m	Sat. Water Content	Residual Water Content
1	0-15	Impermeable	0.001	0.004	1.11	0.061	0.55	0.01
2	>15	SM	7.0	0.037	1.42	0.29	0.25	0.025

Steady state analysis was performed to estimate the maximum inflow that the wells could accommodate. The water head was set at a depth of 5 feet below ground level. Using a well that is 4 feet in diameter and 40 feet in depth, we obtain a static total flow of 0.35 ft^3/sec. An effective percolation surface area (wetted surface) of 327 ft^2 was determined for the zone from 15 to 40 feet. The static flow divided by the effective surface area (Q/A) would then yield an average infiltration rate of 46 in/hr. A Plot depicting the resulting pressure head contours and flow vectors for the model are provided on Plate C-3 in Appendix C.

To evaluate the time required to empty the wells once no more water is introduced, the models were reanalyzed with a variable head condition that was dependent upon the volume of water leaving the wells. As water infiltrates into the surrounding soil, the volume of water remaining in the well is reduced as well as the resulting water head. A graph of the well head versus exit volume for a depth of 40 feet is provided in Figure 2. The function assumes a void ratio of 0.4 within the zones occupied by gravel. If some other well configuration is used, then the analyses may require updating. The model is based on a 40 foot-deep well with a 6 foot outer diameter and 4 foot inner chamber diameter in the upper 15 feet and a 4 foot diameter in below 15 feet. Gravel is assumed to occupy the annular space between the outer and inner diameters. A more detailed model of the dry well designs can be found on Plate 2.

Analysis was performed as a transient case over a total time of 2 hours. The condition in the model was evaluated in several increments of time over the total duration. The water was completely evacuated in 1.2 hours. Plots depicting the resulting pressure head contours and flow vectors are provided in Appendix C on Plates C-4 through C-8. A plot of time versus water height in the well is shown on Figure 3.

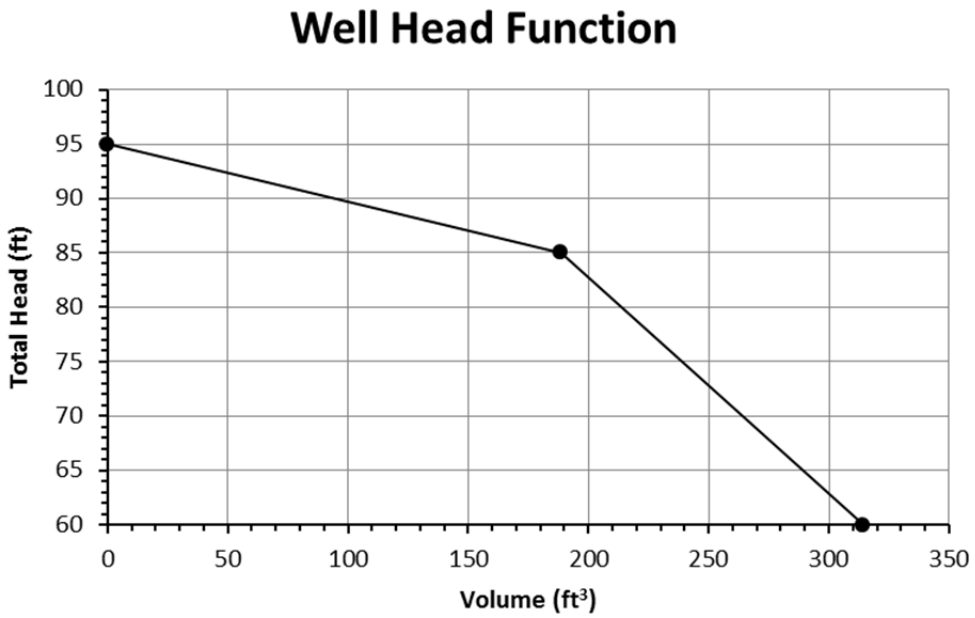


FIGURE 2

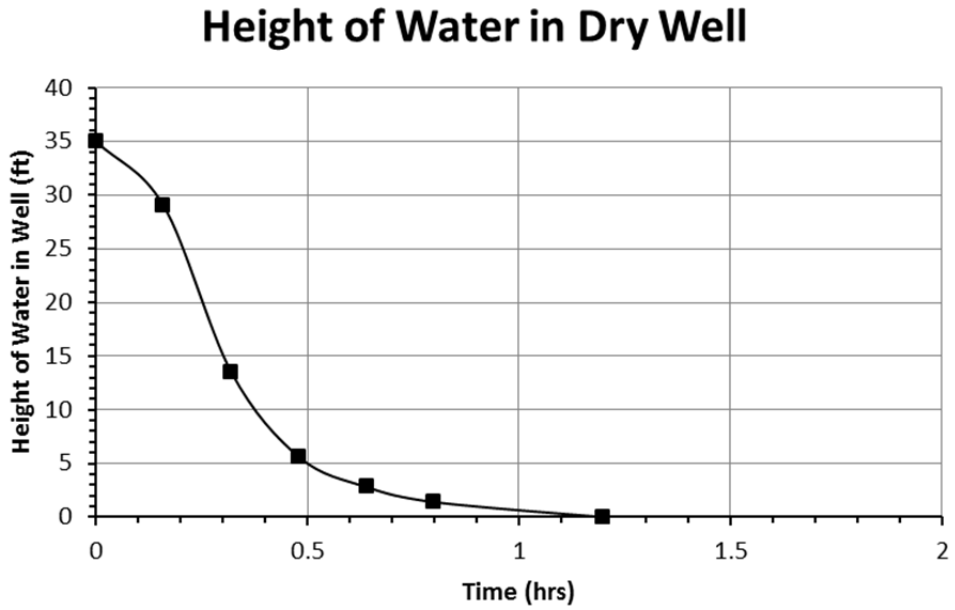


FIGURE 3

CONCLUSIONS AND RECOMMENDATIONS

General

Results of our work indicate a storm water disposal system consisting of either a dry well or chamber system is feasible at the site. The following provides conclusions and recommendations pertaining to each option.

Dry Well

Based on results of percolation testing and analyses, the percolation rate for a 4-foot-diameter dry well with a total depth of at least 40 feet may utilize an unfactored peak flow rate of 0.35 ft^3/sec. At this flow rate, an average measured peak infiltration rate of 46 in/hr may is achieved by the dry well system when applied to the wetted surface area from 15 to 40 feet. Based on this average infiltration rate, the minimum require rate are required by the Santa Ana Regional Water Quality Control Board is achieved.

An appropriate factor of safety should be applied to these values as required by the appropriate governmental authority. The project geotechnical consultant should observe the drilling to confirm the intent of this report.

The Regional Water Quality Boards generally requires the dry wells to empty within 72 hours. From our analyses, a 4-foot-diameter dry well with depth of 40 feet will empty in 1.2 hours. Therefore this maximum value is met.

The entire site is suitable for infiltration by a dry well. Should you require multiple dry wells across the site, the wells should be spaced at least 50 feet center to center to avoid cross influence. The wells should be placed at least 10 feet from any residential structure or property line.

The actual flow capacity of the dry well could be more or less than the estimated value. As such, provisions should be made to accommodate excess flow quantities in the event the dry well does not infiltrate the anticipated amount. The design also assumes that sediments will be removed from the inflowing water. Sediments that are allowed to enter the dry well will tend to degrade the flow capacity by plugging up the infiltration surfaces.

In general, the dry well may consist of a concrete inner chamber surrounded by ½-inch open graded gravel. The concrete chamber should have perforations sized to prevent piping of the gravel into the chamber. A minimum of 6 inches of gravel should be provided around the inner chamber. The gravel should terminate no closer than 5 feet from the ground surface. The remaining space around and above the chamber should be backfilled with 2-sack slurry. A general diagram of a dry well is provided on Plate 2.

The dry well shaft may be adequately stable under temporary construction conditions for uncased drilling. However, most of the site soils are very granular and will be prone to sloughing and caving

shortly after drilling are even as drilling advances. The contractor should be prepared to provide casing to maintain stability of the shaft in the event of caving. Workers should not enter the shaft unless the excavation is laid back or shored in accordance with OSHA requirements. The placement and compaction of backfill materials, including the gravel, should be observed by the project geotechnical consultant.

Chamber System

Conditions at the site are suitable for infiltration by a shallow chamber system provided the system infiltrates at a depth of 15 feet or more. If the chambers do not extend to a depth of 15 feet, the area below the chambers can be excavated and refilled with a Class II permeable filter mix per Caltrans or ¾ crushed rock wrapped in filter fabric such as Mirafi 140N or equivalent approved by the geotechnical consultant.

Chambers may be designed based on a "measured" infiltration rate of 7 inches per hour. A factor of safety should be applied to this value to obtain the "design" infiltration rate in accordance with the agency requirements.

Chambers should be placed to provide a minimum setback from residential structures and property lines a distance of at least 10 feet. The sidewalls of the excavations for chambers should be covered with an impermeable membrane if they will be placed within 20 feet of a residential structure to limit lateral flow of water. This requirement includes portions of the excavation that are removed and replaced with permeable filter mix. The membrane should be lapped and sealed at all joints.

LIMITATIONS

This report is based on the geotechnical data as described herein. The materials encountered in our boring excavations and utilized in our laboratory testing for this investigation are believed representative of the project area, and the conclusions and recommendations contained in this report are presented on that basis. However, soil and bedrock 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, observations by a geotechnical consultant during the construction phase of the storm water infiltration systems are essential to confirming the basis of this report.

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 **Sheldon Development, LLC** to assist the project consultants in the design 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.

This report is subject to review by the controlling governmental agency.

We appreciate this opportunity to be of service to you. If you should 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

Enclosures: Plate 1- Geotechnical Map
Plate 2 – Diagram of Dry Well
Appendix A - Exploratory Logs
Appendix B - Laboratory Testing
Appendix C - Percolation Testing and Analyses

REFERENCES

Publications and Reports

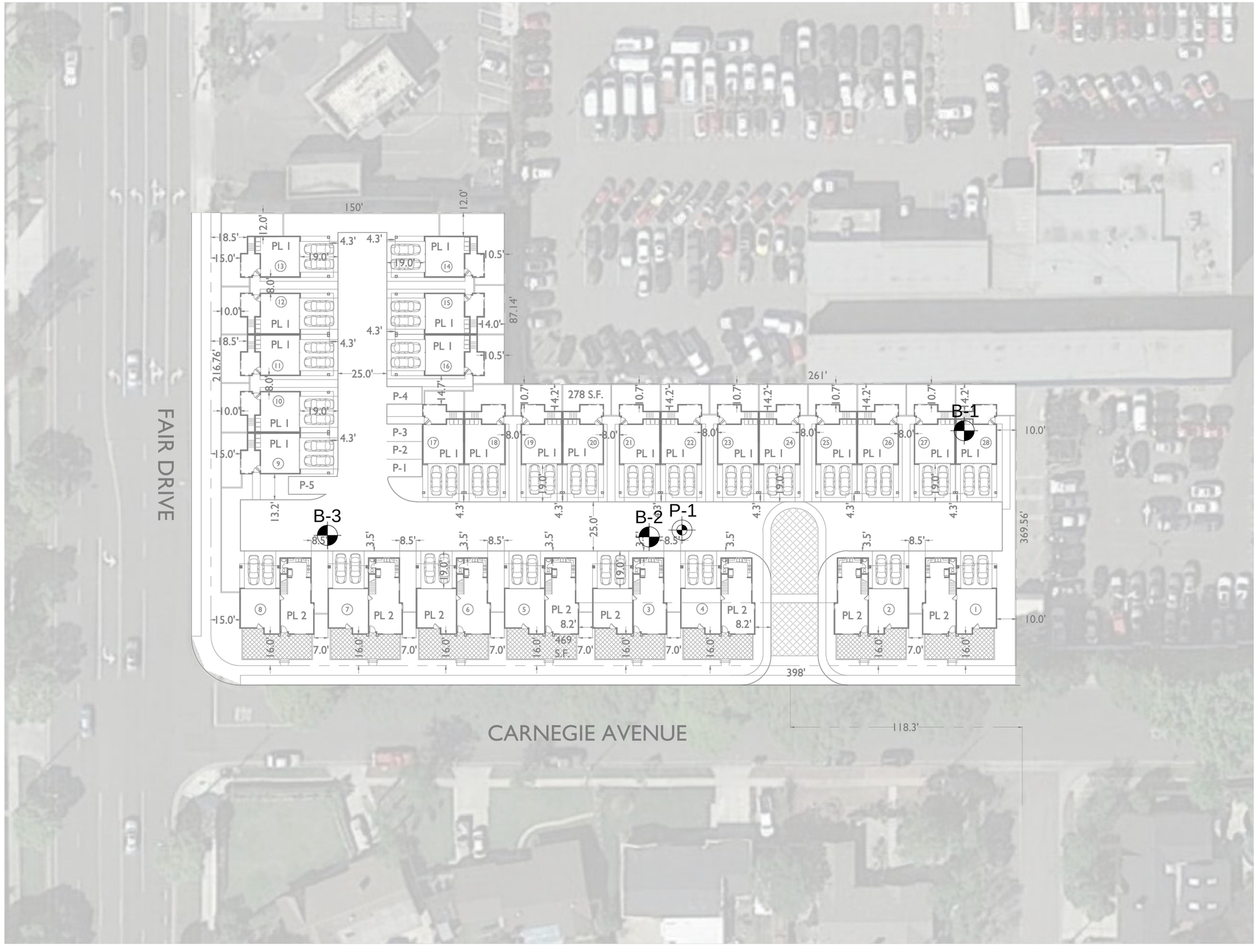
CDMG, "Seismic Hazard Zone Report for the El Monte 7.5-Minute Quadrangle, Los Angeles County, California", Seismic Hazard Zone Report 024, (1998).

Procedure for Performing Field Permeability Testing by the Well Permeameter Method, by United States Department of The Interior, Bureau of Reclamation (USBR 7300-89).

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GEOTECHNICAL MAP

Job No.: 2495.00	Date: 06/10/16	Plate: 1



EXPLANATION
(Locations Approximate)

B-3 - Exploratory Boring

P-1 - Percolation Well

SITE PLAN SUMMARY

OWNER: SHELDON DEVELOPMENT, LLC.
901 DOVE STREET, SUITE 230
NEWPORT BEACH, CA 92660
PHONE: (949)777-9400

SITE ADDRESS: FAIR DRIVE AT CARNEGIE

PROPOSED UNITS: 28 HOMES
20 - 3 STORY DUPLEX
8 - 2 STORY DETACHED

LOT AREA: 72,310 S.F. (1.66 ACRES)

DENSITY: 16.25 UNITS PER ACRE

SITE SUMMARY:

BLDG FOOTPRINTS:	21,060 S.F. (31.5%)
PRIV. STREETS/DRIVES:	24,150 S.F. (29.2%)
OPEN SPACE:	22,808 S.F. (31.5% AT GRADE)
BALCONIES	1,080 S.F. (2ND FLOOR)
ROOF DECKS	8,000 S.F.
TOTAL OPEN SPACE	31, 888 S.F. (44.0%)

PLAN SUMMARY:

		LIVABLE AREA
3 STORY - 4 BDRM		
PLAN 1	1ST FLR	157 S.F.
	2ND FLR	897 S.F.
	3RD FLR	809 S.F.
	TOTAL LIVABLE	1,863 S.F.
	GARAGE	471 S.F.
	BALCONY	54 S.F.
	ROOF DECK	400 S.F.
3 STORY - 3 BDRM		
PLAN 2	1ST FLR	609 S.F.
	2ND FLR	1,174 S.F.
	3RD FLR	237 S.F.
	TOTAL LIVABLE	2,020 S.F.
	GARAGE	453 S.F.

PARKING SUMMARY:

REQUIRED PARKING = 20 UNITS X 4 STALLS/UNIT = 80 STALLS
8 UNITS X 4 STALLS/UNIT = 32 STALLS
112 STALLS

PLAN 1	2 CAR ATTACHED GARAGE X 20 UNITS =	40 STALLS
PLAN 2	2 CAR ATTACHED GARAGE X 8 UNITS =	16 STALLS
GUEST	PRIVATE DRIVE STALLS =	56 STALLS
GUEST	ADD'L OPEN UNASSIGNED STALLS =	5 STALLS
		117 STALLS

BUILDING HEIGHT: 3 STORIES, 44'-0" MAXIMUM HEIGHT

CARNEGIE AVENUE - COSTA MESA - 28 HOMES

SITE PLAN

Sheldon Development, LLC.
901 Dove Street, Suite 230
Newport Beach, CA 92660
Phone: (949)777-9400

0 10 20 40

APRIL 10, 2016

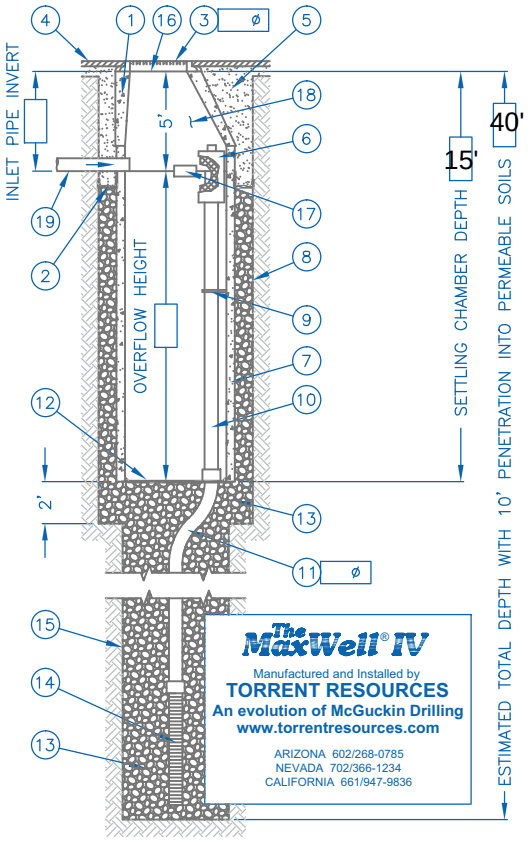
NORTH

SUMMA ARCHITECTURE
5256 S. Mission Road, Ste. 404 Bonsall, CA 92003
www.summarch.com 760.724.1198

MAXWELL® IV DRAINAGE SYSTEM DETAIL AND SPECIFICATIONS

ITEM NUMBERS

1. **Manhole Cone** - Modified Flat Bottom.
2. **Moisture Membrane** - 6 Mil. Plastic. Applies only when native material is used for backfill. Place membrane securely against eccentric cone and hole sidewall.
3. **Bolted Ring & Grate** - Diameter as shown. Clean cast iron with wording **"Storm Water Only"** in raised letters. **Bolted in 2 locations** and secured to cone with mortar. Rim elevation ±0.02' of plans.
4. **Graded Basin or Paving** (by Others).
5. **Compacted Base Material** - 1-Sack Slurry except in landscaped installtions with no pipe connections.
6. **PureFlo® Debris Shield** - Rolled 16 ga. steel X 24" length with vented anti-siphon and Internal .265" Max. SWO flattened expanded steel screen X 12" length. **Fusion bonded epoxy coated.**
7. **Pre-cast Liner** - 4000 PSI concrete 48" ID. X 54" OD. **Center in hole** and align sections **to maximize bearing surface.**
8. **Min. 6' Ø Drilled Shaft.**
9. **Support Bracket** - Formed 12 Ga. steel. **Fusion bonded epoxy coated.**
10. **Overflow Pipe** - Sch. 40 PVC mated to drainage pipe at base seal.
11. **Drainage Pipe** - ADS highway grade with TRI-A coupler. **Suspend pipe** during backfill operations to prevent buckling or breakage. Diameter as noted.
12. **Base Seal** - Geotextile or concrete slurry.
13. **Rock** - Washed, sized between 3/8" and 1-1/2" to **best complement soil conditions.**
14. **FloFast® Drainage Screen** - Sch. 40 PVC 0.120" slotted well screen with 32 slots per row/ft.Diameter varies 120" overall length with TRI-B coupler.
15. **Min. 4' Ø Shaft** - Drilled to **maintain permeability** of drainage soils.
16. **Fabric Seal** - U.V. resistant geotextile - **to be removed by customer** at project completion.
17. **Absorbent** – Hydrophobic Petrochemical Sponge. Min. to 128 oz. capacity.
18. **Freeboard Depth** Varies with inlet pipe elevation. Increase settling chamber depth as needed to maintain all inlet pipe elevations above overflow pipe inlet.
19. **Optional Inlet Pipe** (Maximum 4", by Others). Extend moisture membrane and compacted base material or 1 sack slurry backfill below pipe invert.



AZ Lic. ROC070465 A, ROC047067 B-4, ADWR 363
CA Lic. 528080, C-42, HAZ.
NV Lic. 0035350 A - NM Lic. 90504 GF04

U.S. Patent No. 4,923,330 - ™ Trademark 1974, 1990, 2004

The referenced drawing and specifications are available on CAD either through our office or web site. This detail is copyrighted (2004) but may be used as is in construction plans without further release. For information on product application, individual project specifications or site evaluation, contact our Design Staff for no-charge assistance in any phase of your planning.

CALCULATING MAXWELL IV REQUIREMENTS

The type of property, soil permeability, rainfall intensity and local drainage ordinances determine the number and design of MaxWell Systems. For general applications draining retained stormwater, use one standard **MaxWell IV** per the instructions below for up to 3 acres of landscaped contributory area, and up to 1 acre of paved surface. For larger paved surfaces, subdivision drainage, nuisance water drainage, connecting pipes larger than 4" Ø from catch basins or underground storage, or other demanding applications, refer to our **MaxWell® Plus** System. For industrial drainage, including gasoline service stations, our **Envibro® System** may be recommended. For additional considerations, please refer to **"Design Suggestions For Retention And Drainage Systems"** or consult our Design Staff.

COMPLETING THE MAXWELL IV DRAWING

To apply the **MaxWell IV** drawing to your specific project, simply fill in the blue boxes per instructions below. For assistance, please consult our Design Staff.

ESTIMATED TOTAL DEPTH

The Estimated Total Depth is the approximate depth required to achieve 10 continuous feet of penetration into permeable soils. Torrent utilizes specialized **"crowd"** equipped drill rigs to penetrate difficult, cemented soils and to reach permeable materials at depths up to **180 feet.** Our extensive database of drilling logs and soils information is available for use as a reference. Please contact our Design Staff for site-specific information on your project.

SETTLING CHAMBER DEPTH

On MaxWell IV Systems of over 30 feet overall depth and up to 0.25cfs design rate, the **standard** Settling Chamber Depth is **18 feet .** For systems exposed to greater contributory area than noted above, extreme service conditions, or that require higher design rates, chamber depths up to 25 feet are recommended.

OVERFLOW HEIGHT

The Overflow Height and Settling Chamber Depth determine the effectiveness of the settling process. The higher the overflow pipe, the deeper the chamber, the greater the settling capacity. For normal drainage applications, an overflow height of **13 feet** is used with the standard settling chamber depth of **18 feet**. Sites with higher design rates than noted above, heavy debris loading or unusual service conditions require greater settling capacities

"Ø DRAINAGE PIPE

This dimension also applies to the **PureFlo®** Debris Shield, the **FloFast®** Drainage Screen, and fittings. The size selected is based upon system design rates, soil conditions, and the need for adequate venting. Choices are 6", 8", or 12" diameter. Refer to "Design Suggestions for Retention and Drainage Systems" for recommendations on which size best matches your application.

"Ø BOLTED RING & GRATE

Standard models are quality cast iron and available to fit 24" Ø or 30" Ø manhole openings. All units are bolted in two locations with wording "Storm Water Only" in raised letters. For other surface treatments, please refer to "Design Suggestions for Retention and Drainage Systems."

"Ø INLET PIPE INVERT

Pipes up to 4" in diameter from catch basins, underground storage, etc. may be connected into the settling chamber. Inverts deeper than 5 feet will require additional settling chamber depth to maintain effective overflow height.

TORRENT RESOURCES INCORPORATED
1509 East Elwood Street, Phoenix Arizona 85040~1391
phone 602~268~0785 fax 602~268~0820
Nevada 702~366~1234
AZ Lic. ROC070465 A, ROC047067 B-4; ADWR 363
CA Lic. 528080 A, C-42, HAZ ~ NV Lic. 0035350 A ~ NM Lic. 90504 GF04

TORRENT RESOURCES (CA) INCORPORATED
phone 661~947~9836
CA Lic. 886759 A, C-42
www.TorrentResources.com
An evolution of McGuckin Drilling

The watermark for drainage solutions.®

PLATE 2

TORRENT® RESOURCES

APPENDIX A

EXPLORATORY LOGS

EXPLORATION LOG

Project:		Location:
Address:		Elevation:
Job Number:	Client:	Date:
Drill Method:	Driving Weight:	Logged By:

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		EXPLANATION							
		Solid lines separate geologic units and/or material types.							
5		Dashed lines indicate unknown depth of geologic unit change or material type change.							
		Solid black rectangle in Core column represents California Split Spoon sampler (2.5in ID, 3in OD).			■				
		Double triangle in core column represents SPT sampler.			⧗				
10		**Solid black rectangle** in Bulk column respresents large bag sample.				■			
		Other Laboratory Tests:							
		Max = Maximum Dry Density/Optimum Moisture Content							
		EI = Expansion Index							
		SO4 = Soluble Sulfate Content							
15		DSR = Direct Shear, Remolded							
		DS = Direct Shear, Undisturbed							
		SA = Sieve Analysis (1" through #200 sieve)							
		Hydro = Particle Size Analysis (SA with Hydrometer)							
		200 = Percent Passing #200 Sieve							
		Consol = Consolidation							
		SE = Sand Equivalent							
20		Rval = R-Value							
		ATT = Atterberg Limits							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-1
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 5.5 inches AC / No base							EI SO4 ATT RVal
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		21			15.3	88	
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, moist, very stiff, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pinhole pores		15			6.6	106.6	Max DS
				10					
		Clayey Sand/Silty Sand (SC/SM): Light red-brown to yellow-brown, damp, medium dense, fine to medium grained sand, trace coarse grained sand and gravel, trace pores		21					
10		Sand (SP): Light red-brown, damp, medium dense, fine to medium grained sand, some coarse grained sand and gravel, sample disturbed @ 8 ', no recovery		31					
		Silt with some Sand (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining							
15		Sandy Silt (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining		23			10	115.5	
		Silty Sand (SM): Light gray, dry to damp, dense, fine grained sand, some orange oxidation staining							
20				57			2.9	91	
		Total Depth: 21 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 4.5 inches AC / No base							
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		40	■		6.6	119.3	Consol
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, damp to moist, hard, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pores		19	■		6.7	104.4	Consol
				10	■		2.4	98.1	
10		Clayey Sand/Silty Sand (SC/SM): Light red-brown to yellow-brown, damp, medium dense, fine grained sand, some pinhole pores @ 6 ', becomes loose, dry to damp, increased fine grained sand, some medium grained sand, trace clay		43	■		1.9	Dist.	
		Sand (SP): Light red-brown to tan, dry, dense, fine to coarse grained sand, some gravel							
15		Sandy Silt (ML): Gray, moist, hard, fine grained sand, some orange oxidation staining, some pinhole pores		74	■		3.9	96.5	
20		Silty Sand/Sand with Silt (SM/SP-SM): Light gray, dry to damp, very dense, fine grained sand, some orange oxidation staining @ 20 ', becomes damp, dense, decreased silt		44	■		4.3	95.1	SA Hydro

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		@ 25 ', becomes very dense, increased silt, trace gravel		43					
30		@ 30 ', same		74					
35		@ 35 ', occasional 1-inch sand layers		64					
40		@ 40 ', becomes damp to moist, fine to medium grained sand, decreased silt		54					
		Silty Sand/Sandy Silt (SM/ML): Gray, moist, dense/hard, fine grained sand, some orange oxidation staining							
45		@ 45 ', becomes gray to olive-gray		36					

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-2
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
				39					
		Total Depth: 51.5 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch Perc. well set 10 feet offset							

EXPLORATION LOG

Project: 440 Fair Drive, Costa Mesa		Location: B-3
Address: 440 Fair Dr, Costa Mesa, CA 92626		Elevation: 70
Job Number: 2495.00	Client: Sheldon Development, LLC	Date: 5/6/2016
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: BJP

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Concrete (AC): 4.5 inches AC / No base							
		ARTIFICIAL FILL (Af) Sandy Clay (CL): Brown to red-brown, moist, medium stiff, fine grained sand, trace coarse grained sand and gravel		35	■		12.4	118.3	
5		**TERRACE DEPOSITS (Qt)** Sandy Clay (CL): Red-brown, moist, very stiff, fine grained sand, trace medium to coarse grained sand and gravel, some blocky ped development, some pores and rootlets		38	■		7.3	112.7	
		Clayey Sand (SC): Light red-brown, damp to moist, medium dense, fine grained sand, some medium to coarse grained sand		20	■		6.3	Dist.	
10		Sand (SP): Yellow-brown, moist, medium dense, fine to coarse grained sand, some gravel, trace clay		26	■		10.7	111.3	
		Silty Sand (SM): Light red-brown, moist, medium dense, fine grained sand, some medium grained sand, some clay							
		Silt with Sand (ML): Gray, moist, very stiff, fine grained sand, some orange oxidation staining							
15		Silty Sand (SM): Light gray, moist, medium dense, fine grained sand, some orange oxidation staining		32	■		19.6	89.5	
20		Sand (SP): Light red-brown to gray, dry to damp, very dense, fine to medium grained sand, trace coarse grained sand and gravel		70	■		2.9	99.6	
		Total Depth: 21 feet No groundwater Backfilled with soil cuttings and capped with AC cold patch							

APPENDIX B

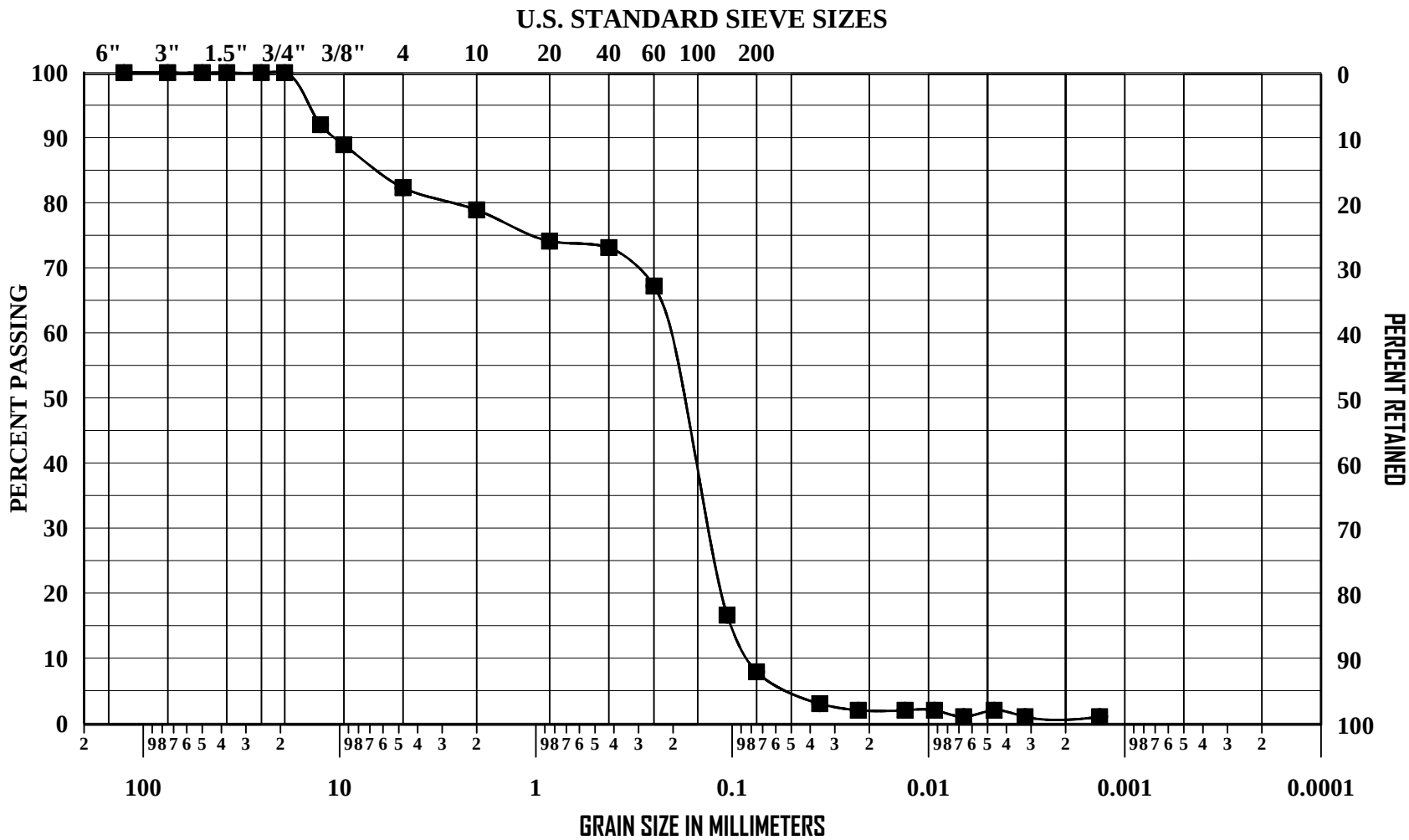
LABORATORY TESTING

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION

COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



LOCATION	SAMPLE	SYMBOL	LL	PI	CLASSIFICATION
B-2	20 feet	●——●			Sand with Silt (SP-SM)

Job No: 2495.00

Plate No: B-1

APPENDIX C

PERCOLATION TESTING AND ANALYSES

Field Percolation Testing

Client: Sheldon Development
Job. No.: 2495.00
Date Tested: 5/6/2016
Test by: BJP
Location: P-1 (B-2)

Top of Casing to Bottom of Well (ft): 24.6
Elev. of Ground Surface (ft): ~70
Diam. of Test Hole (in): 8
Diam. of Casing (in): 2
Ht. to Top of Casing (ft): 0
Water Tempurature (C°):

Constant Head

Elapsed Time (minutes)	Time	Depth to H2O (ft)	Flow Rate (gal./min.)
0.0	12:40	20	5.6
15.0	12:55	20	5.2
25.0	13:05	20	5
35.0	13:15	20	4.8
50.0	13:30	20	4.5
70.0	13:50	20	4.5
90.0	14:10	20	4.5

Falling Head

Elapsed Time (minutes)	Time	Depth to H2O (ft)

INFILTRATION WELL DESIGN

Constant Head
USBR 7300-89 Method
J.N.: 2495.00
Client: Sheldon Development
Well No. P-1 (B-2)

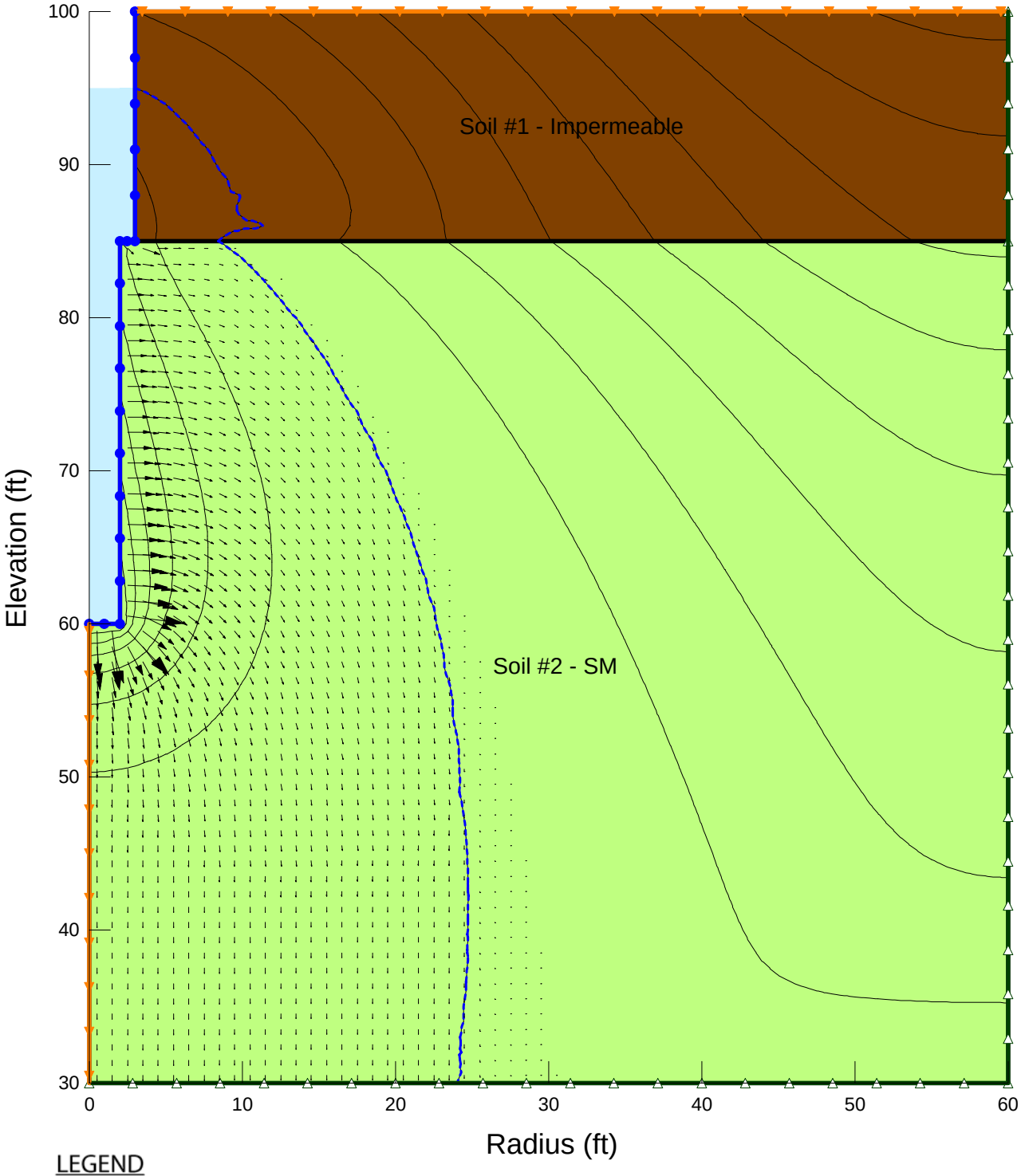
Low Water Table	Condition 1	
High Water Table & Water Below Bottom of Well	Condition 2	
High water Table with Water Above the Well Bottom	Condition 3	
		Units:
Enter Condition (1, 2 or 3):	1	
Ground Surface to Bottom of Well (**h_1**):	24.6	feet
Depth to Water (**h_2**):	20	feet
Height of Water in the Well (h_1-h_2=**h**):	4.6	feet
Radius of Well (**r**):	4.0	Inches
Minimum Volume Required:	1209.6	Gal.
Discharge Rate of Water Into Well for Steady-State Condition (**q**):	4.5	Gal/min.
Temperature (**T**):	21	Celsius
(Viscosity of Water @ Temp. T) / (Viscosity of water @ 20° C) (**V**):	0.9647	ft^3/min.
Unsaturated Distance Between the Water Surface in the Well and the Water table (**T_u**):		Ignore T_u
Factor of Safety:	1	
Coefficient of Permeability @ 20° C (**k_{20}**):	1.05E-02	ft/min.
Design k_{20}:	7.59	in./hr.
Design k_{20}:	15.18	ft./day

The presence or absence of a water table or impervious soil layer within a distance of less than three times that of the water depth in the well (measured from the water surface) will enable the water table to be classified as **Condition I**, **Condition II**, **Condtion III**.

Low Water Table-When the distance from the water surface in the test well to the ground water table, or to an impervious soil layer which is considered for test puposes to be equivalent to a water table, is greater than three times the depth of water in the well, classify as **Condition I**.

High Water Table-When the distance from the water surface in the test well to the ground water table or to an impervious layer is less than three times the depth of water in the well, a high water table condition exists. Use **Condition II** when the water table or impervious layer is below the well bottom. Use **Condition III** when the water table or impervious layer is above the well bottom.

STEADY STATE
FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

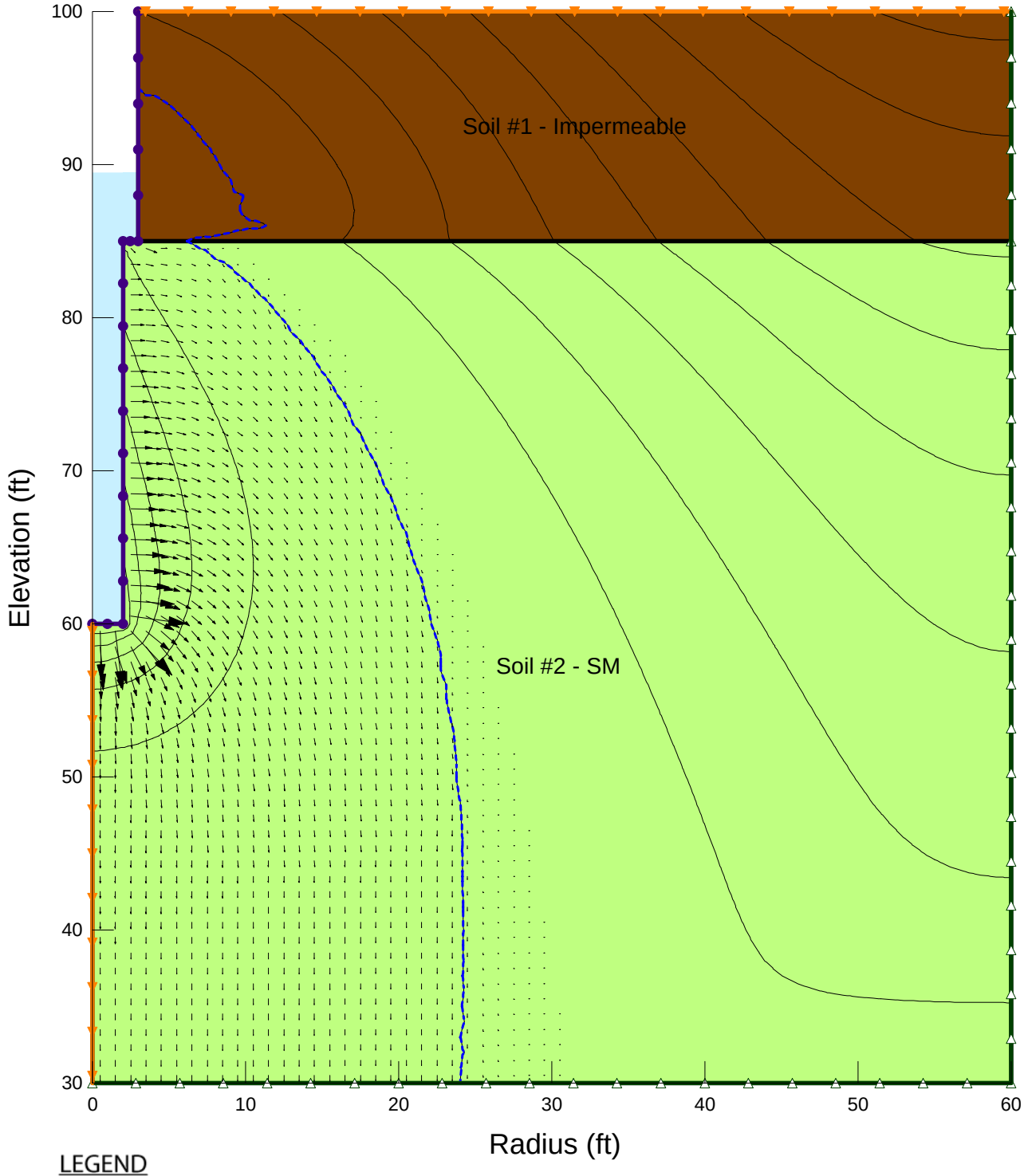
Potential Seepage Face

Fixed Total Head = 95′

Contours are Pressure Head in Feet.

Arrows indicate direction of flow and relative magnitude of velocity.

TRANSIENT STATE TIME=0.16 HOURS
FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

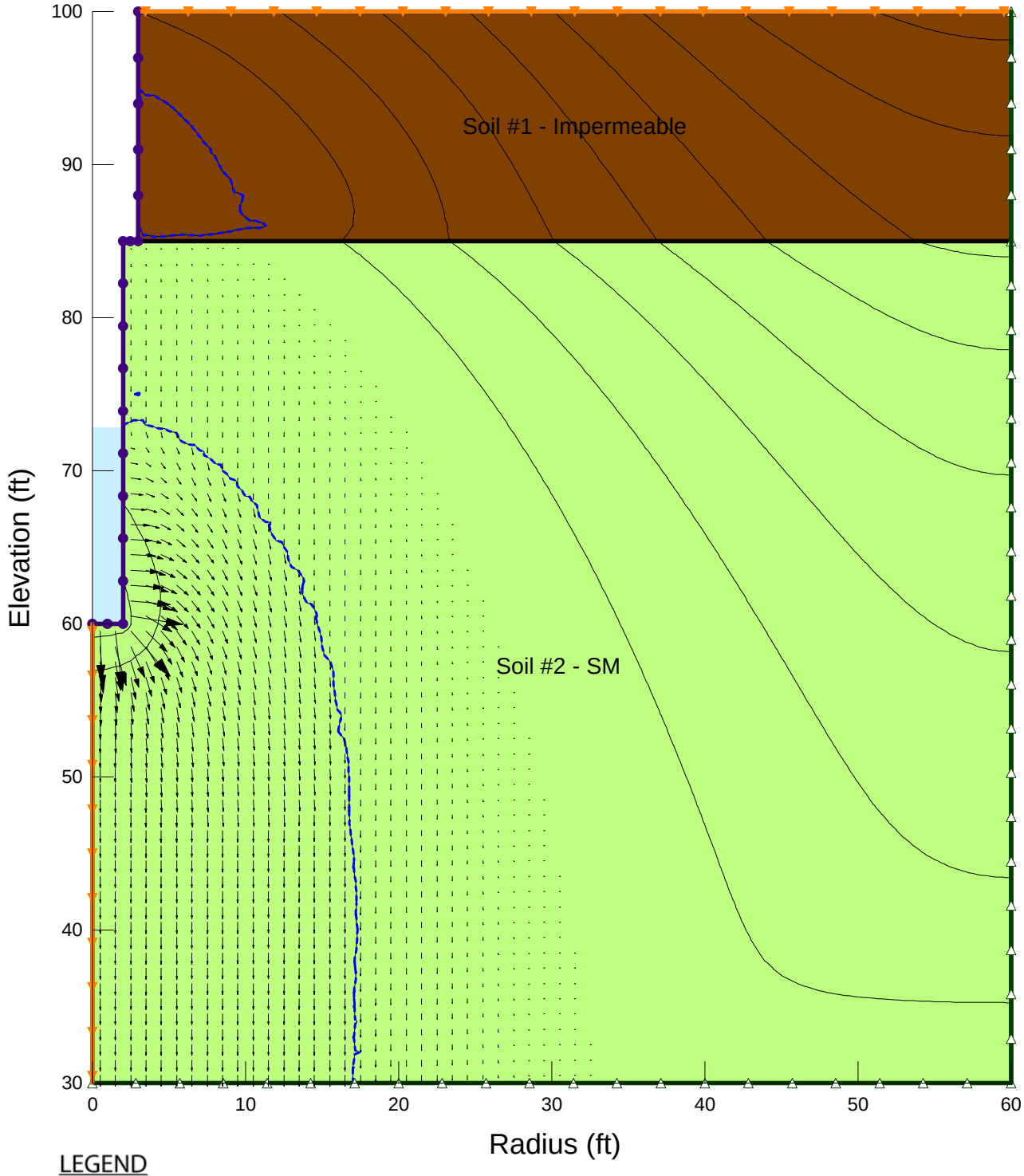
Potential Seepage Face

Fixed Total Head = 95′

Contours are Pressure Head in Feet.

Arrows indicate direction of flow and relative magnitude of velocity.

TRANSIENT STATE TIME =0.32 HOURS
FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

Potential Seepage Face

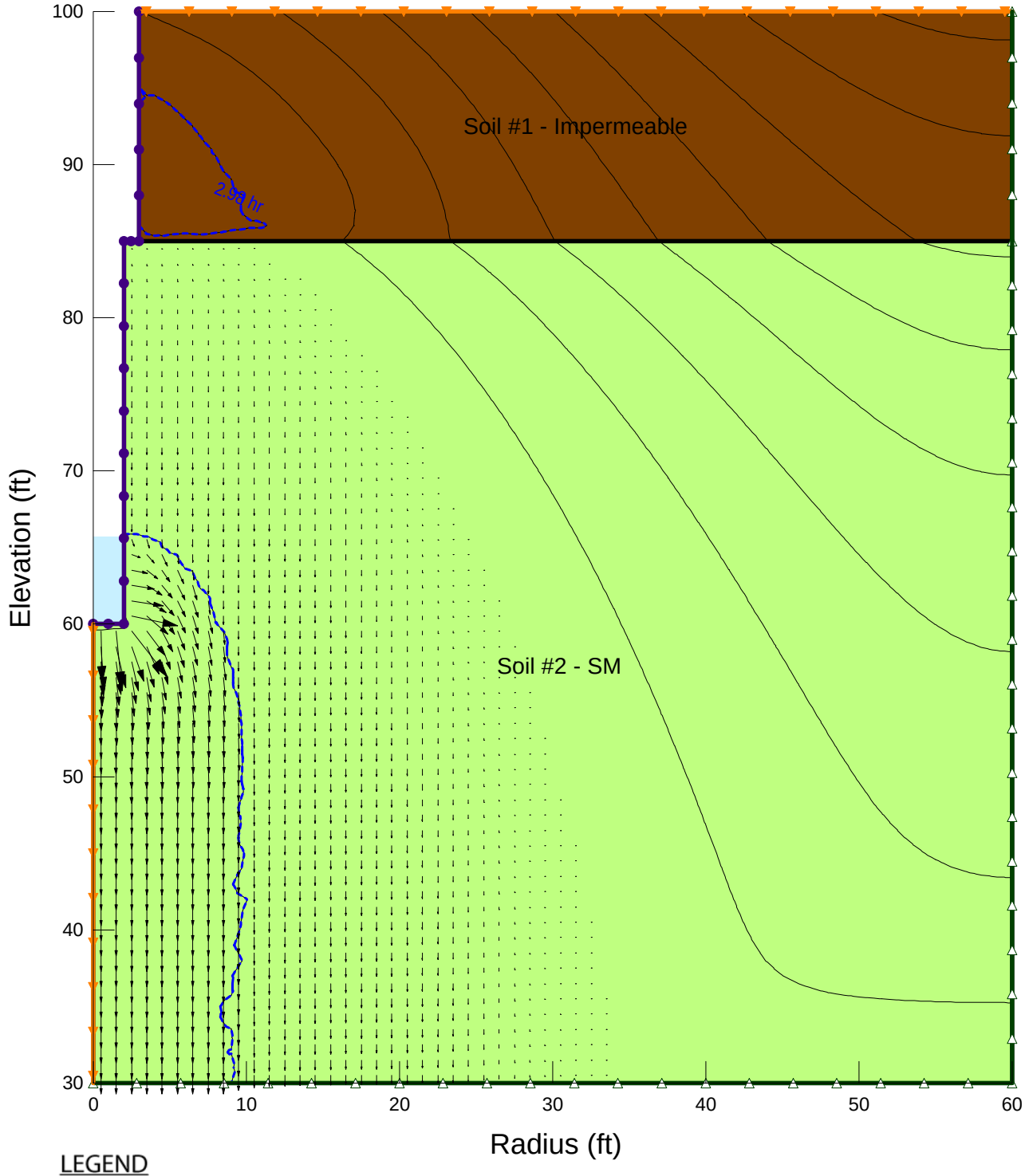
Fixed Total Head = 95′

Contours are Pressure Head in Feet.TR

Arrows indicate direction of flow and relative magnitude of velocity.

TRANSIENT STATE TIME=0.48 HOURS

FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

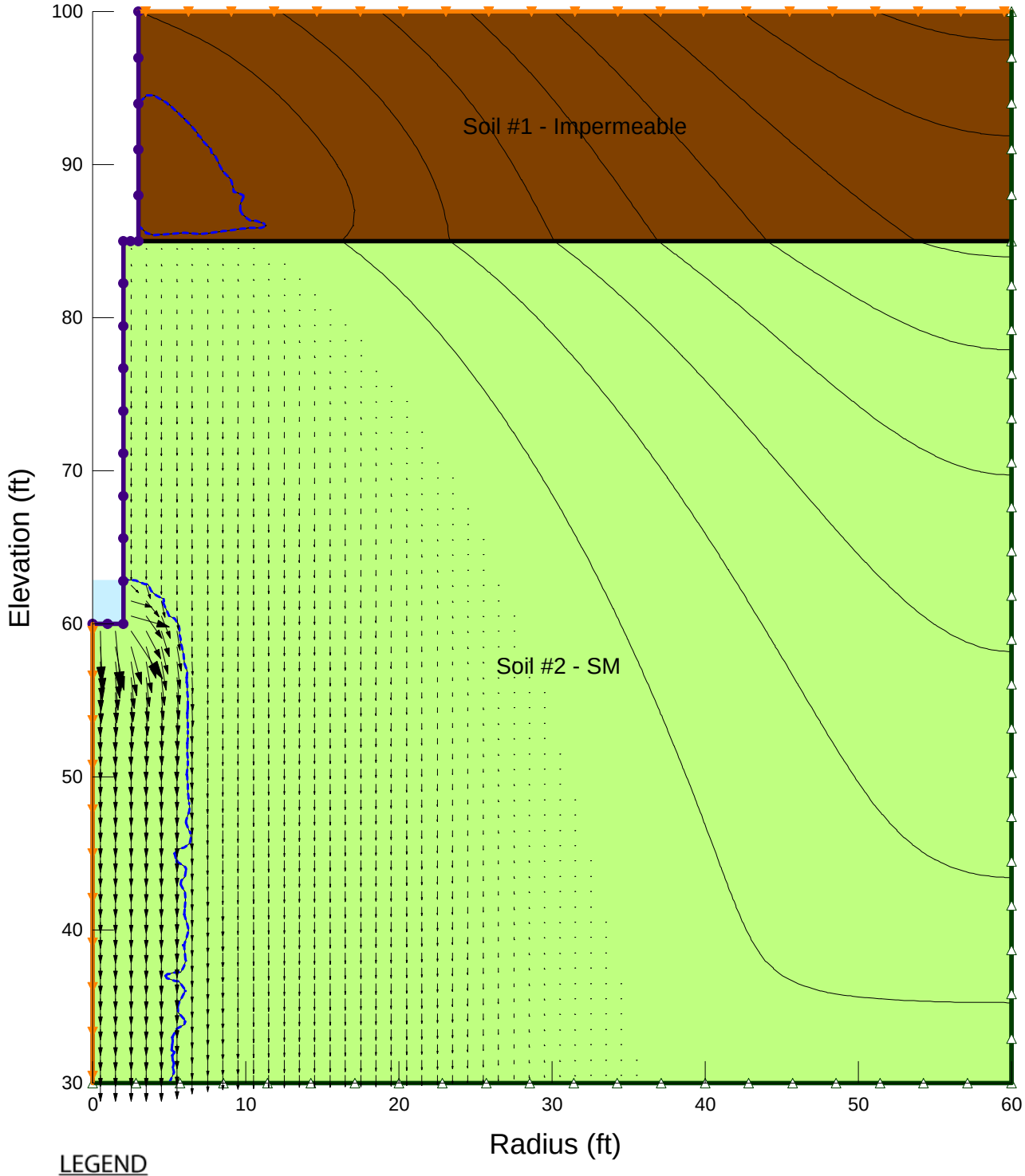
Potential Seepage Face

Fixed Total Head = 95′

Contours are Pressure Head in Feet.

Arrows indicate direction of flow and relative magnitude of velocity.

TRANSIENT STATE TIME=0.64 HOURS
FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

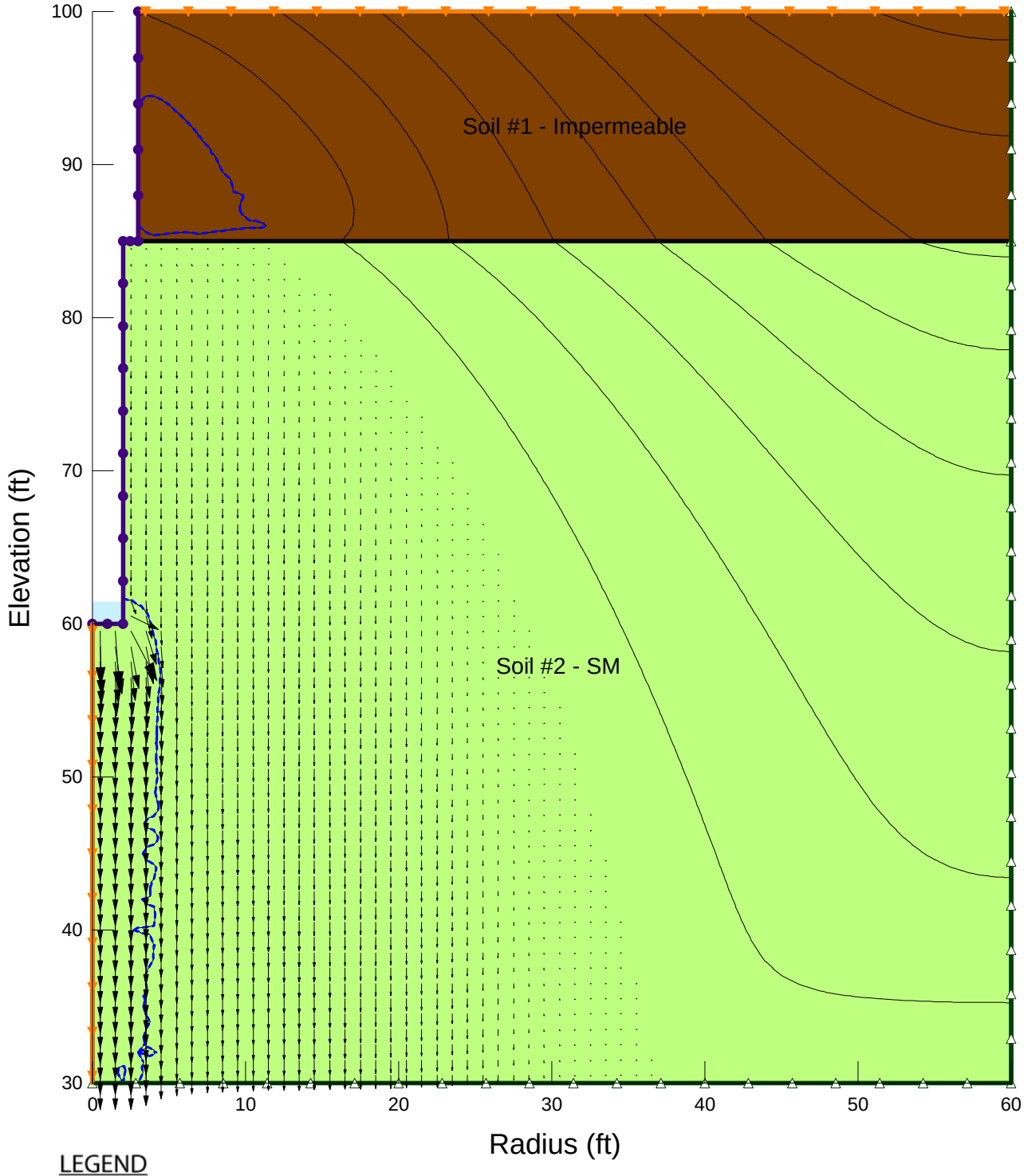
Potential Seepage Face

Fixed Total Head = 95′

Contours are Pressure Head in Feet.

Arrows indicate direction of flow and relative magnitude of velocity.

TRANSIENT STATE TIME=0.80 HOURS
FLOW ANALYSIS OF 40 ft DEEP, 4 ft DIAMETER DRY WELL



LEGEND

Zero Flux

Potential Seepage Face

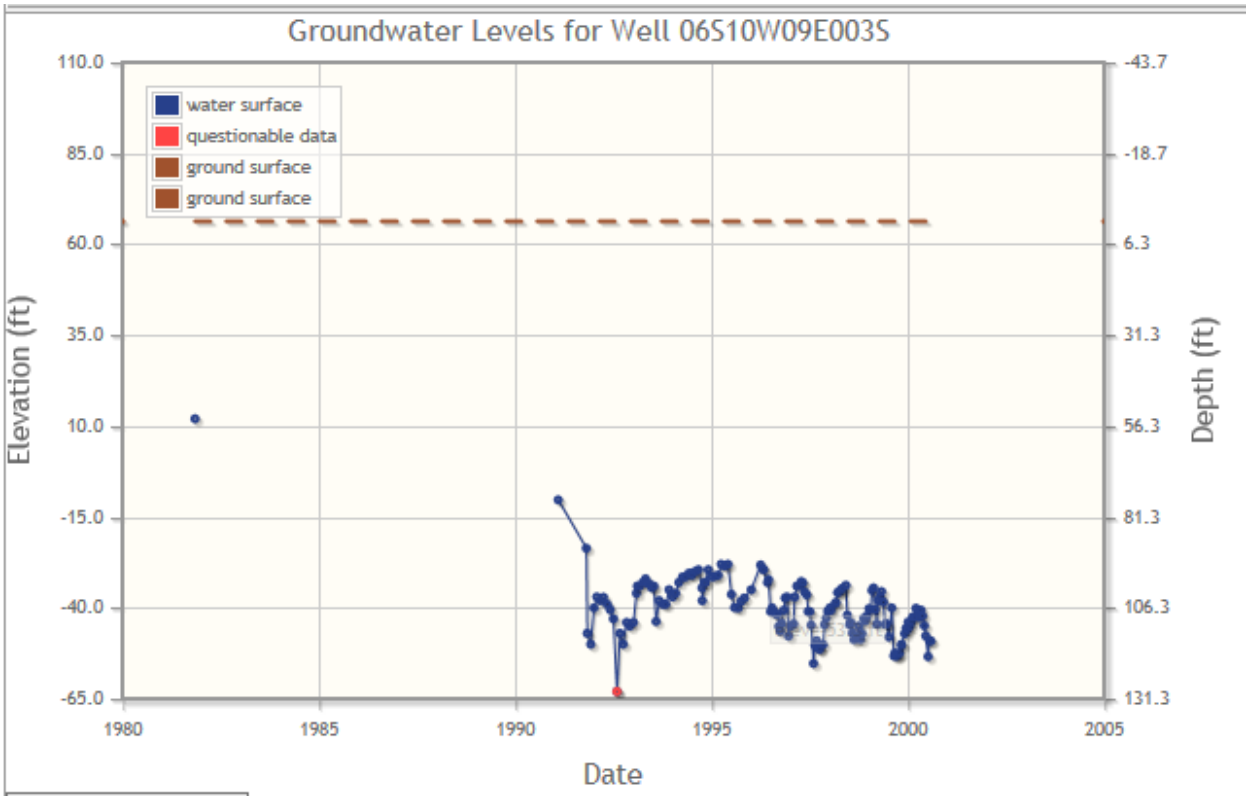
Fixed Total Head = 95′

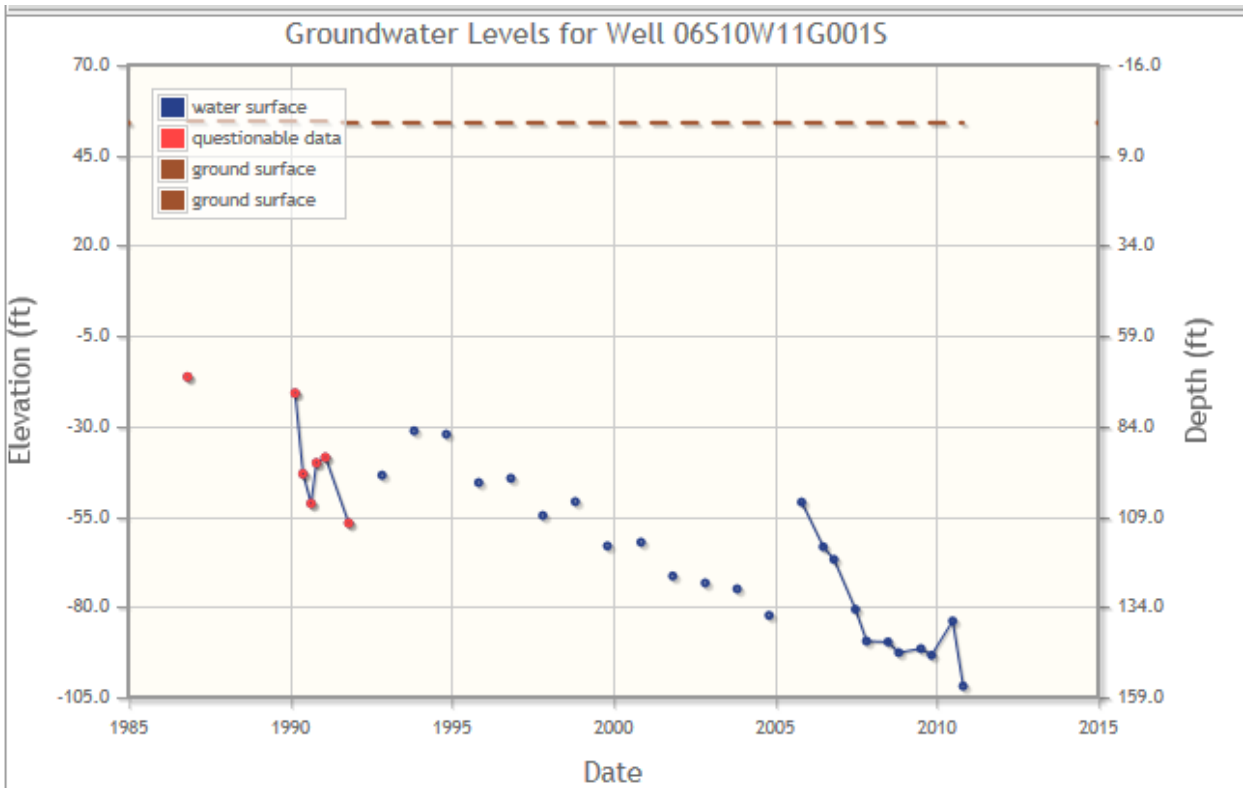
Contours are Pressure Head in Feet.TRANSIENT

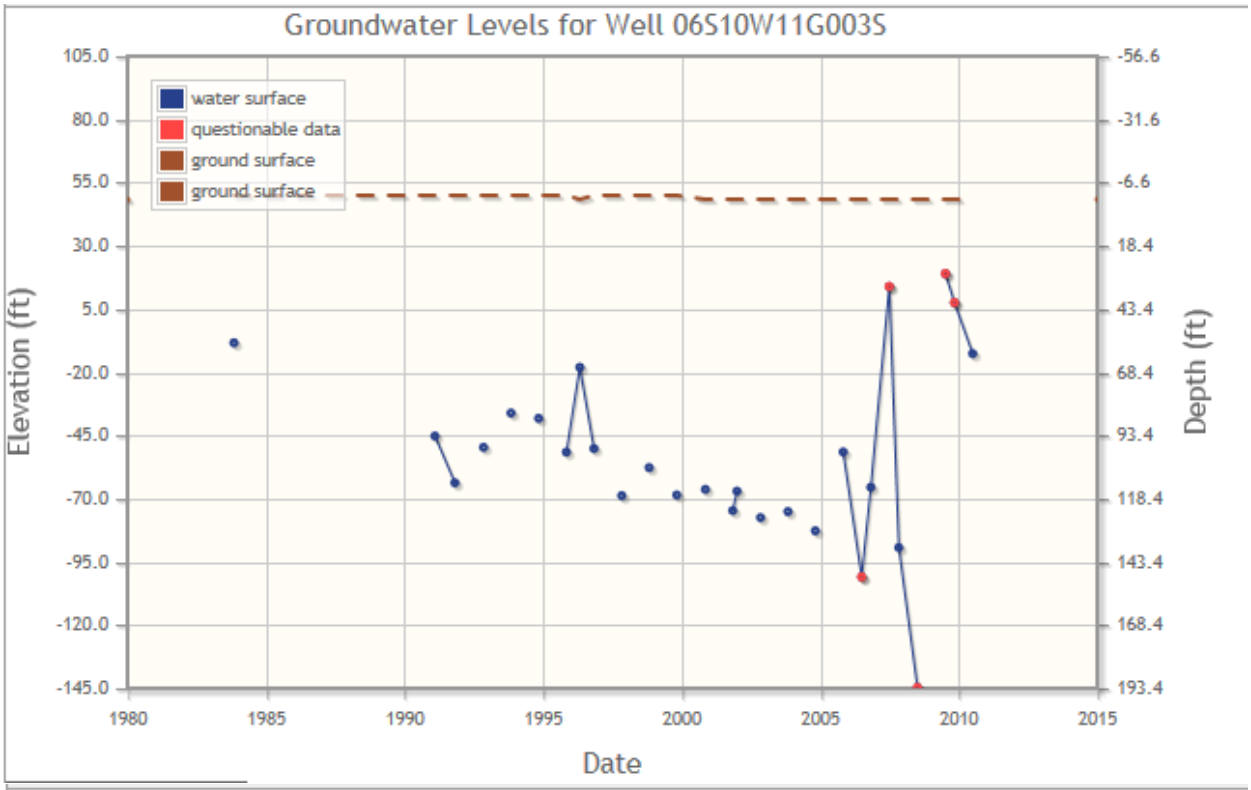
Arrows indicate direction of flow and relative magnitude of velocity.

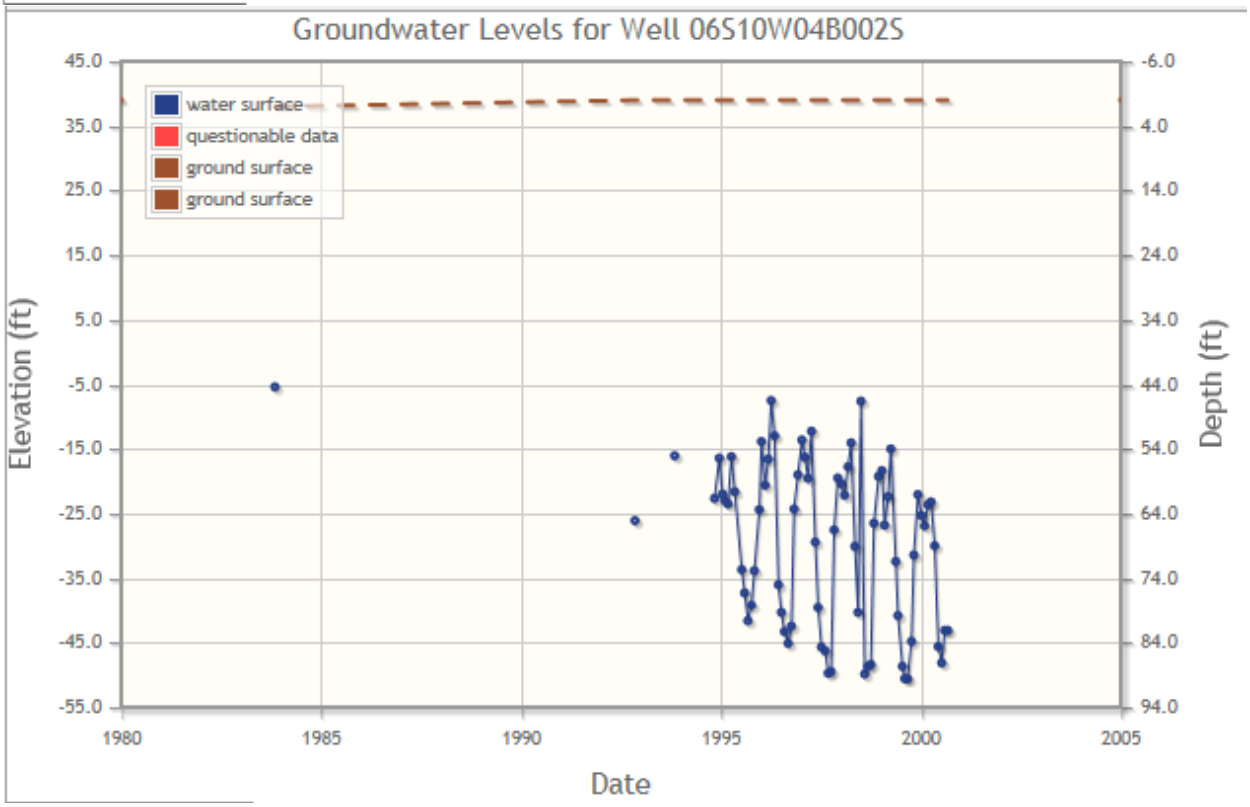
APPENDIX D

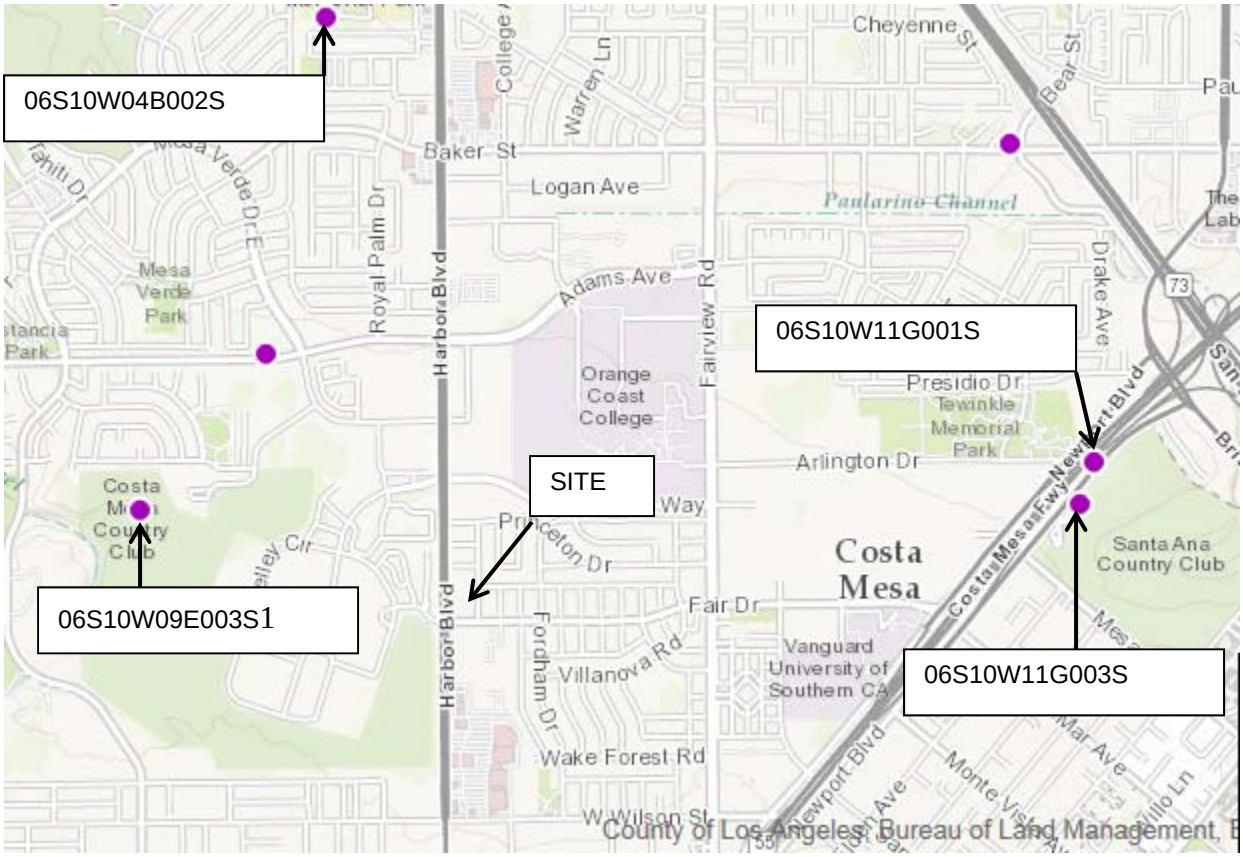
GROUNDWATER DATA


Groundwater Levels for Well 06S10W09E003S
water surface
questionable data
ground surface
ground surface
Elevation (ft)
Depth (ft)
Date
110.0
85.0
60.0
35.0
10.0
-15.0
-40.0
-65.0
-43.7
-18.7
6.3
31.3
56.3
81.3
106.3
131.3
1980
1985
1990
1995
2000
2005


Groundwater Levels for Well 06S10W11G001S
water surface
questionable data
ground surface
ground surface
Elevation (ft)
Depth (ft)
Date
70.0
45.0
20.0
-5.0
-30.0
-55.0
-80.0
-105.0
-16.0
9.0
34.0
59.0
84.0
109.0
134.0
159.0
1985
1990
1995
2000
2005
2010
2015


Groundwater Levels for Well 06S10W11G003S
water surface
questionable data
ground surface
ground surface
Elevation (ft)
Depth (ft)
Date
105.0
80.0
55.0
30.0
5.0
-20.0
-45.0
-70.0
-95.0
-120.0
-145.0
-56.6
-31.6
-6.6
18.4
43.4
68.4
93.4
118.4
143.4
168.4
193.4
1980
1985
1990
1995
2000
2005
2010
2015


Groundwater Levels for Well 06S10W04B002S
water surface
questionable data
ground surface
ground surface
Elevation (ft)
Depth (ft)
Date
45.0
35.0
25.0
15.0
5.0
-5.0
-15.0
-25.0
-35.0
-45.0
-55.0
-6.0
4.0
14.0
24.0
34.0
44.0
54.0
64.0
74.0
84.0
94.0
1980
1985
1990
1995
2000
2005



Well Location Map

THIS PAGE INTENTIONALLY LEFT BLANK