October 1, 2018

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Duke Realty
200 Spectrum Center Drive, Suite 1600
Irvine, California 92618

Attention: Mr. Adam Schmid
Development Services Manager

Project No.: **18G185-2**

Subject: **Results of Infiltration Testing**
Proposed Warehouse
NEC Harvill Avenue and Rider Street
Riverside County, California

Reference: Geotechnical Investigation, Proposed Warehouse, NEC Harvill Avenue and Rider Street, Riverside County, California, prepared for Duke Realty, prepared by Southern California Geotechnical, Inc. (SCG), SCG Project No. 18G185-1, dated October 1, 2018.

Gentlemen:

In accordance with your request, we have conducted infiltration testing at the subject site. We are pleased to present this report summarizing the results of the infiltration testing and our design recommendations.

Scope of Services

The scope of services performed for this project was in general accordance with our Proposal No. 18P358, dated August 22, 2018. The scope of services included site reconnaissance, subsurface exploration, field testing, and engineering analysis to determine the infiltration rates of the onsite soils. The infiltration testing was performed in general accordance with ASTM Test Method D-3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer.

Site and Project Description

The subject site is located at the northeast corner of Harvill Avenue and Rider Street in an unincorporated portion of Riverside County near Perris, California. The site is bounded to the north by a vacant lot, to the west by Harvill Avenue, to the south by Rider Street, and to the east by a railroad easement. The general location of the site is illustrated on the Site Location Map, enclosed as Plate 1 of this report.

The subject site consists of two (2) parcels, totaling 14.4± acres in size. The southeastern area of the site was developed with an industrial building, approximately 4,500 ft^2 in size. The building is of metal construction and assumed to be supported on a conventional shallow foundation with a concrete slab-on-grade floor. Five (5) silo structures, 70± feet in diameter, are located in the southern area of the site. Two railroad spurs are located in the southeastern area of the site extending to the southeastern corner of the silos. There is a parallel curb and gutter, 6½± feet apart, that extends from the northwestern industrial area to Harvill Street The ground surface cover surface in the southeastern area of the site consists of asphaltic concrete pavements. The remaining areas of the site are vacant and undeveloped. The ground surface cover in these areas consist of exposed soil with moderate native grass and weed growth. There is a 10± foot-high soil berm at the northern section of the site that extends 275± feet.

Detailed topographic information was not available at the time of this report. However, based on topographic information obtained from Google Earth, the site topography ranges from 1503± feet mean sea level (msl) in the central-east area of the site to 1516± feet msl in the northern area of the site. The site topography slopes gently downward toward the southeast at a gradient of approximately 1± percent.

Proposed Development

A site plan for the proposed development, prepared by Duke Realty, was provided to our office by the client. This plan indicates that the site will be developed with a new warehouse. The building will be located in the west-central area of the site and will be 316,500± ft^2 in size. The building will be constructed with dock-high doors along the east side of the building. It is expected that the building will be surrounded by asphaltic concrete pavements for parking and drive lanes and Portland Cement Concrete (PCC) pavements in the loading docks. Several landscape planters and concrete flatwork are expected to be included throughout the site.

Although not indicated on the site plan, we understand that the proposed development may include on-site infiltration to dispose of storm water. Based on the current site layout and conversations with the client, the proposed infiltration system will consist of either a below-grade chamber system or infiltration/detention basin located in the southern area of the site. The bottom of the infiltration system will extend to a depth of 7± feet below the existing site grades.

Concurrent Study

Southern California Geotechnical, Inc. (SCG) recently conducted a geotechnical investigation at the subject site, which is referenced above. As a part of this study, six (6) borings were advanced to depths of 20 to 50± feet below existing site grades.

Asphaltic concrete pavements were encountered at the ground surface at Boring No. B-4. The pavement section at B-4 consists of 3± inches of asphaltic concrete underlain by 3± inches of aggregate base. Artificial fill soils were encountered beneath the pavements at Boring No. B-4, extending to depths of 5± feet below the existing site grades. The artificial fill soils generally consist of loose to medium dense silty fine to medium sands with trace clay content. The fill soils possess a disturbed appearance and artificial debris, including asphaltic concrete fragments, resulting in their classification as artificial fill. Native alluvium was encountered beneath the artificial fill soils at Boring No. B-4, and at the ground surface at all of the remaining borings. The near surface alluvial soils within the upper 20 to 30± feet generally consist of loose to medium dense silty sands and clayey sands. However, most of the borings also encountered hard fine sandy clay layers and/or dense to very dense clayey sand layers within the upper 10± feet. Some of the alluvial soils within the upper 5 to 6± feet are porous. Some of the soils encountered throughout the upper 20± feet are weakly cemented.

The native alluvial soils encountered between depths of 32± feet and the maximum depth explored of 50± feet generally consist of medium dense to dense silty fine to medium sands with trace to little clay content. Some of the recovered samples possessed trace fine gravel content.

Groundwater

Free water was not encountered during the drilling of any of the borings. Based on the lack of any water within the borings and the moisture contents of the recovered soil samples, the static groundwater table is considered to have existed at a depth in excess of 50± feet at the time of the subsurface exploration. As part of our research, we reviewed available groundwater data in order to determine the historic high groundwater level for the site. Recent water level data, obtained from GeoTracker, indicates that the nearest monitoring well is located 1.1± miles northeast of the subject site. Water level readings within this monitoring well indicates a high groundwater level of 79± feet (February 2015) below the ground surface.

Subsurface Exploration

Scope of Exploration

The subsurface exploration for the infiltration testing consisted of two (2) backhoe-excavated trenches, extending to depths of 7± feet below existing site grades. The trenches were logged during excavation by a member of our staff. The approximate locations of the infiltration trenches (identified as I-1 and I-2) are indicated on the Infiltration Test Location Plan, enclosed as Plate 2 of this report.

Geotechnical Conditions

Asphaltic concrete pavements were encountered at the ground surface at Infiltration Trench No. I-1, measuring 3 to 4± inches in thickness. Artificial fill soils were encountered beneath the pavements at I-1, extending to a depth of 1½± feet below the existing site grades. The fill soils consist of dense silty fine sands with little medium to coarse sands. The fill soils possess a disturbed appearance resulting in their classification as artificial fill.

Native alluvium was encountered at the ground surface at Infiltration Trench No. I-2 and beneath the fill soils at I-1, extending to at least the maximum depth explored of 7± feet below existing site grades. The alluvial soils generally consist of loose to dense silty fine sands to fine sandy silts and silty fine to medium sands with varying coarse sand and clay content. Very dense, cemented silty sands were encountered at Infiltration Trench No. I-2, extending from 4½± feet to at least 7± feet below existing grade. The Trench Logs, which illustrate the conditions encountered at the infiltration test locations, are included with this report.

Infiltration Testing

The infiltration testing was performed in general accordance with ASTM Test Method D-3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer. Two stainless steel infiltration rings were used for the infiltration testing. The outer infiltration ring is 2 feet in diameter and 20 inches in height. The inner infiltration ring is 1 foot in diameter and 20 inches in height. At the test locations, the outer ring was driven 3± inches into the soil at the base of each trench. The inner ring was centered inside the outer ring and subsequently driven 3± inches into the soil at the base of the trench. The rings were driven into the soil using a ten-pound sledge hammer. The soil surrounding the wall of the infiltration rings was only slightly disturbed during the driving process.

Infiltration Testing Procedure

Infiltration testing was performed at both of the test locations. The infiltration testing consisted of filling the inner ring and the annular space (the space between the inner and outer rings) with water, approximately 3 to 4 inches above the soil. To prevent the flow of water from one ring to the other, the water level in both the inner ring and the annular space between the rings was maintained using constant-head float valves. The volume of water that was added to maintain a constant head in the inner ring and the annular space during each time interval was determined and recorded. A cap was placed over the rings to minimize the evaporation of water during the tests.

The schedule for readings was determined based on the observed soil type at the base of each backhoe-excavated trench. Based on the existing soils at each infiltration test location, the volumetric measurements were made at increments of 20 and 30 minutes. The water volume measurements are presented on the spreadsheets enclosed with this report. The infiltration rates for each of the timed intervals are also tabulated on these spreadsheets.

The infiltration rates for the infiltration tests are calculated in centimeters per hour and then converted to inches per hour. The rates are summarized below:

Infiltration Test No.	**Depth (feet)**	**Soil Description**	**Infiltration Rate (inches/hour)**
I-1	7	Silty fine to medium Sand, little Clay	0.7
I-2	7	Silty fine to medium Sand	0.1

Laboratory Testing

Moisture Content

The moisture contents for selected soil samples taken from the trenches were determined in accordance with ASTM D-2216 and are expressed as a percentage of the dry weight. These test results are presented on the Trench Logs.

Grain Size Analysis

The grain size distribution of selected soils collected from the base of each infiltration test trench has been determined using a range of wire mesh screens. These tests were performed in general accordance with ASTM D-422 and/or ASTM D-1140. The weight of the portion of the sample retained on each screen is recorded and the percentage finer or coarser of the total weight is calculated. The results of these tests are presented on Plates C-1 and C-2 of this report.

Design Recommendations

Two (2) infiltration tests were performed at the subject site. As noted above, the calculated infiltration rates at the infiltration test locations are **0.1** and **0.7** inches per hour. The cemented and very dense silty sands encountered at the bottom of Infiltration Trench No. I-2 resulted in very low and nearly non-existent infiltration rates at the I-2 location.

Based on the very low infiltration rates at the depth tested within I-2, the very dense, cemented soils in the southwestern region of the subject site are not considered suitable for infiltration. However, if the proposed infiltration system is located in the southeastern region of the subject site, we recommend a design infiltration rate of 0.7 inches per hour be used for the proposed infiltration system.

We recommend that a representative from the geotechnical engineer be on-site during the construction of the proposed infiltration system to identify the soil classification at the base of the system. It should be confirmed that the soils at the base of the proposed infiltration system correspond with those presented in this report to ensure that the performance of the system will be consistent with the rate reported herein.

The design of the proposed storm water infiltration system should be performed by the project civil engineer, in accordance with the City and/or County of Riverside guidelines. However, it is recommended that the system be constructed so as to facilitate removal of silt and clay, or other deleterious materials from any water that may enter the system. The presence of such materials would decrease the effective infiltration rate. **It is recommended that the project civil engineer apply an appropriate factor of safety. The infiltration rate recommended above is based on the assumption that only clean water will be introduced to the subsurface profile. Any fines, debris, or organic materials could significantly impact the infiltration rates.** It should be noted that the recommended infiltration rates are based on infiltration testing at two (2) discrete locations and the overall infiltration rate of the storm water infiltration system could vary considerably.

Infiltration versus Permeability

Infiltration rates are based on unsaturated flow. As water is introduced into soils by infiltration, the soils become saturated and the wetting front advances from the unsaturated zone to the saturated zone. Once the soils become saturated, infiltration rates become zero, and water can only move through soils by hydraulic conductivity at a rate determined by pressure head and soil permeability. The infiltration rates presented herein were determined in accordance with the ASTM Test Method D-3385-03 standard and are considered valid for the time and place of the actual test. Changes in soil moisture content will affect these infiltration rates. Infiltration rates should be expected to decrease until the soils become saturated. Soil permeability values will then govern groundwater movement. Permeability values may be on the order of 10 to 20 times less than infiltration rates. The system designer should incorporate adequate factors of safety and allow for overflow design into appropriate traditional storm drain systems, which would transport storm water off-site.

Location of Infiltration Systems

The use of on-site storm water infiltration systems carries a risk of creating adverse geotechnical conditions. Increasing the moisture content of the soil can cause the soil to lose internal shear strength and increase its compressibility, resulting in a change in the designed engineering properties. Overlying structures and pavements in the infiltration areas could potentially be damaged due to saturation of subgrade soils. **The proposed infiltration system for this site should be located at least 25 feet away from any structures, including retaining walls.** Even with this provision of locating the infiltration system at least 25 feet from the building, it is possible that infiltrating water into the subsurface soils could have an adverse effect on the proposed or existing structures. It should also be noted that utility trenches which happen to collect storm water can also serve as conduits to transmit storm water toward the structure, depending on the slope of the utility trench. Therefore, consideration should also be given to the proposed locations of underground utilities which may pass near the proposed infiltration system.

General Comments

This report has been prepared as an instrument of service for use by the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. This report may be provided to the contractor(s) and other design consultants to disclose information relative to the project. However, this report is not intended to be utilized as a specification in and of itself, without appropriate interpretation by the project architect, structural engineer, and/or civil engineer. The design of the infiltration system is the responsibility of the civil engineer. The role of the geotechnical engineer is limited to determination of infiltration rate only. By using the design infiltration rates contained herein, the civil engineer agrees to indemnify, defend, and hold harmless the geotechnical engineer for all aspects of the design and performance of the infiltration system. The reproduction and distribution of this report must be authorized by the client and Southern California Geotechnical, Inc. Furthermore, any reliance on this report by an unauthorized third party is at such party's sole risk, and we accept no responsibility for damage or loss which may occur.

The analysis of this site was based on a subsurface profile interpolated from limited discrete soil samples. While the materials encountered in the project area are considered to be representative of the total area, some variations should be expected between trench locations and testing depths. If the conditions encountered during construction vary significantly from those detailed herein, we should be contacted immediately to determine if the conditions alter the recommendations contained herein.

This report has been based on assumed or provided characteristics of the proposed development. It is recommended that the owner, client, architect, structural engineer, and civil engineer carefully review these assumptions to ensure that they are consistent with the characteristics of the proposed development. If discrepancies exist, they should be brought to our attention to verify that they do not affect the conclusions and recommendations contained herein. We also recommend that the project plans and specifications be submitted to our office for review to verify that our recommendations have been correctly interpreted. The analysis, conclusions, and recommendations contained within this report have been promulgated in accordance with generally accepted professional geotechnical engineering practice. No other warranty is implied or expressed.

Closure

We sincerely appreciate the opportunity to be of service on this project. We look forward to providing additional consulting services during the course of the project. If we may be of further assistance in any manner, please contact our office.

Respectfully Submitted,

SOUTHERN CALIFORNIA GEOTECHNICAL, INC.

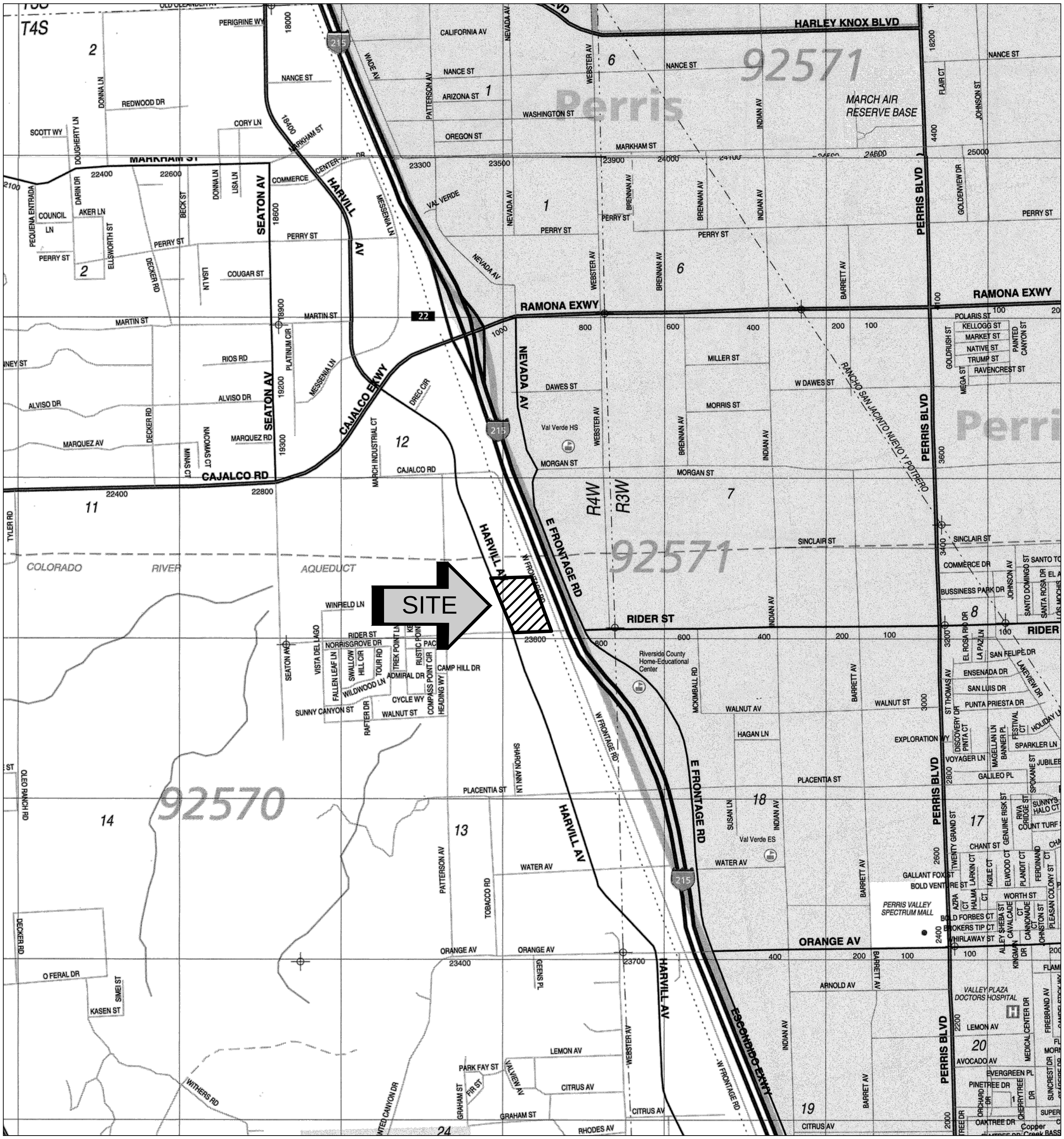
Scott McCann
Staff Scientist

Robert G. Trazo, GE 2655
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
ROBERT TRAZO
No. 2655
GEOTECHNICAL
STATE OF CALIFORNIA

Distribution: (1) Addressee

Enclosures: Plate 1 - Site Location Map
Plate 2 - Infiltration Test Location Plan
Trench Logs (2 pages)
Infiltration Test Results Spreadsheets (2 pages)
Grain Size Distribution Graphs (2 pages)



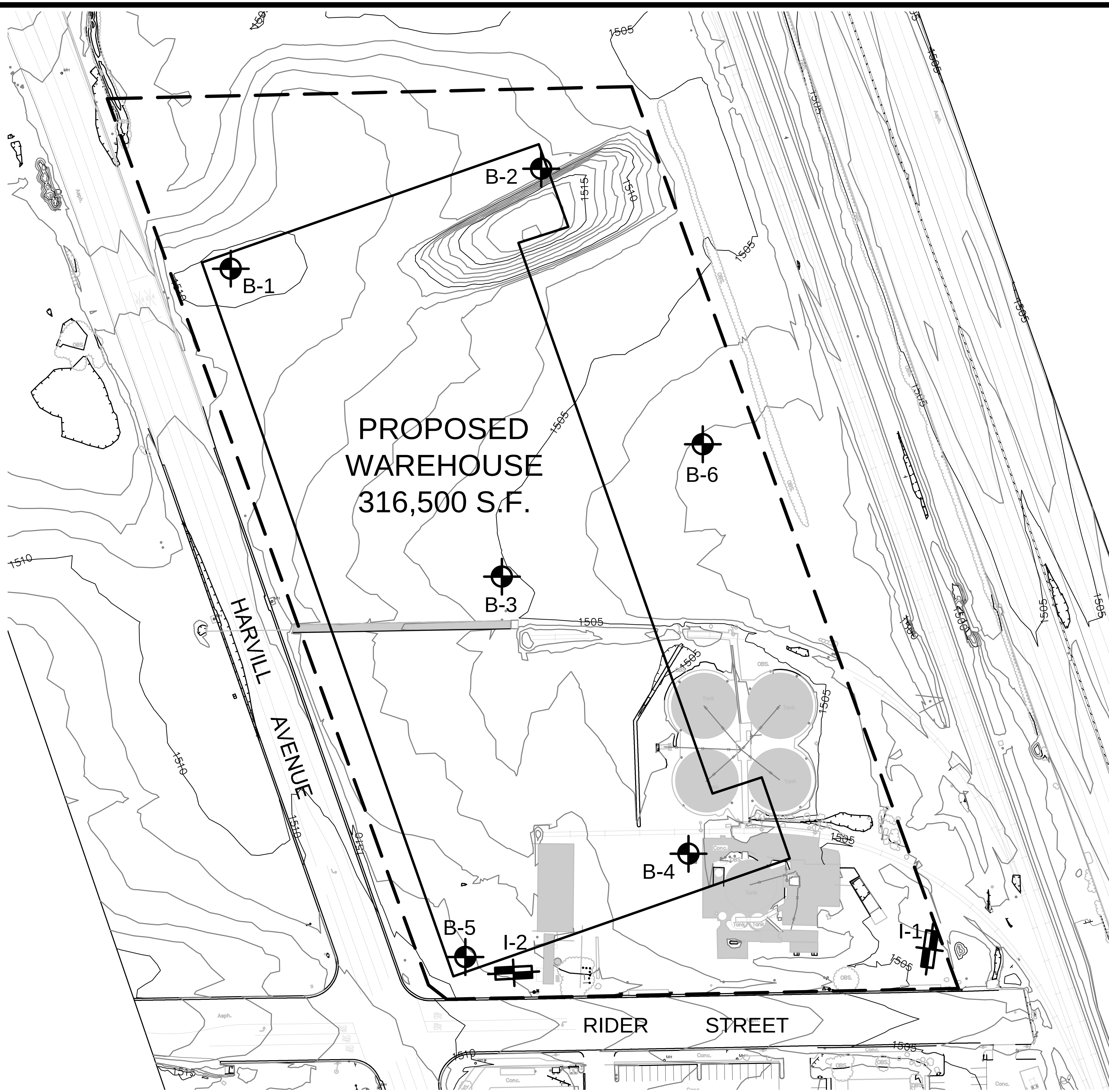
SOURCE: RIVERSIDE COUNTY
THOMAS GUIDE, 2013

SITE LOCATION MAP

PROPOSED WAREHOUSE

RIVERSIDE COUNTY, CALIFORNIA

SCALE: 1" = 2400'	SOUTHERN CALIFORNIA GEOTECHNICAL
DRAWN: CT CHKD: RGT	
SCG PROJECT 18G185-2	
PLATE 1	



GEOTECHNICAL LEGEND

- APPROXIMATE INFILTRATION TEST LOCATION
- APPROXIMATE BORING LOCATION FROM CONCURRENT STUDY (SCG PROJECT NO. 18G185-1)
- EXISTING STRUCTURES TO BE DEMOLISHED

NOTE: TOPOGRAPHIC INFORMATION PROVIDED BY ALBERT A. WEBB ASSOCIATES.
CONCEPTUAL SITE PLAN PROVIDED BY DUKE REALTY.

INFILTRATION TEST LOCATION PLAN

PROPOSED WAREHOUSE

RIVERSIDE COUNTY, CALIFORNIA

SCALE: 1" = 120'

DRAWN: JLL
CHKD: RGT

SCG PROJECT
18G185-2

PLATE 2

SoCalGeo

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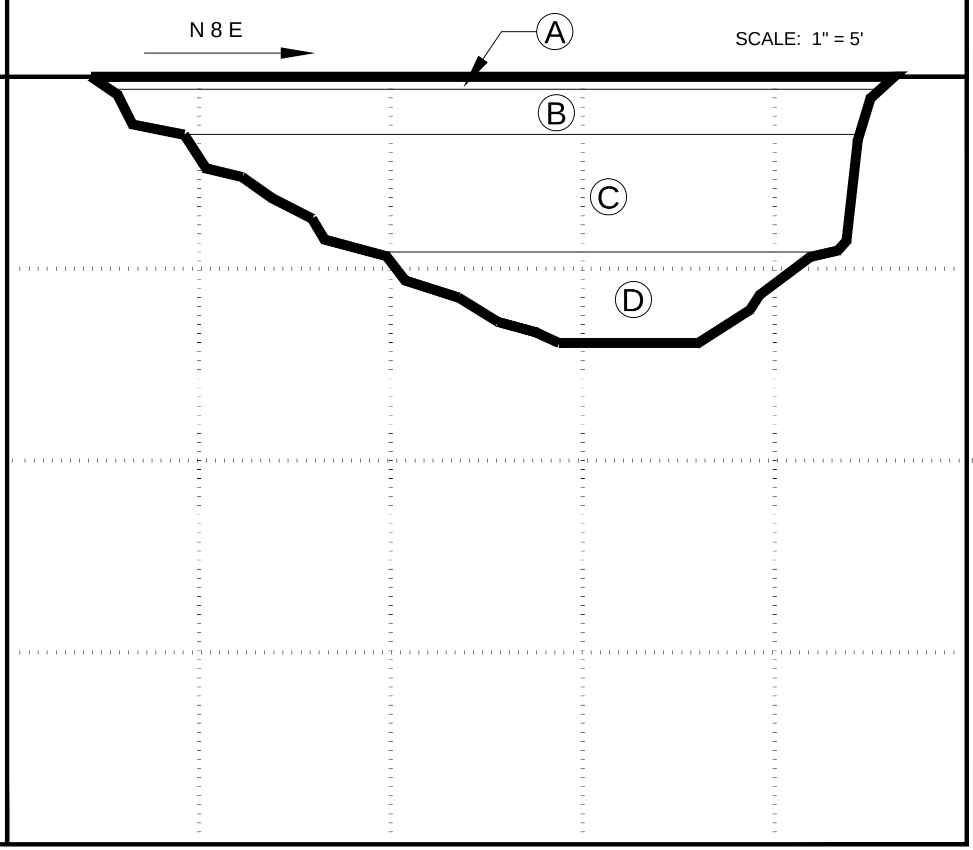
TRENCH NO. I-1

JOB NO.: 18G185-2	EQUIPMENT USED: Backhoe	WATER DEPTH: Dry
PROJECT: Proposed Warehouse	LOGGED BY: Scott McCann	SEEPAGE DEPTH: Dry
LOCATION: Riverside County, CA	ORIENTATION: N 8 E	READINGS TAKEN: At Completion
DATE: 9-6-2018	TOP OF TRENCH ELEVATION: 1504.5 feet msl	

DEPTH	SAMPLE	DRY DENSITY (PCF)	MOISTURE (%)	EARTH MATERIALS DESCRIPTION
	b		5	A: ASPHALTIC CONCRETE (AC): 3 to 4 inches thick B: FILL: Brown Silty fine Sand, little medium to coarse Sand, dense - damp
	b		8	C: ALLUVIUM: Brown fine Sandy Silt, trace medium Sand, medium dense - damp to moist
5				D: ALLUVIUM: Brown Silty fine to medium Sand, little Clay, dense - damp to moist
	b		9	
				Trench Terminated @ 7 feet Bottom of Trench Elevation: 1497.5 feet msl
10				
15				

GRAPHIC REPRESENTATION



KEY TO SAMPLE TYPES:
B - BULK SAMPLE (DISTURBED)
R - RING SAMPLE 2-1/2" DIAMETER
(RELATIVELY UNDISTURBED)

TRENCH LOG

PLATE B-1

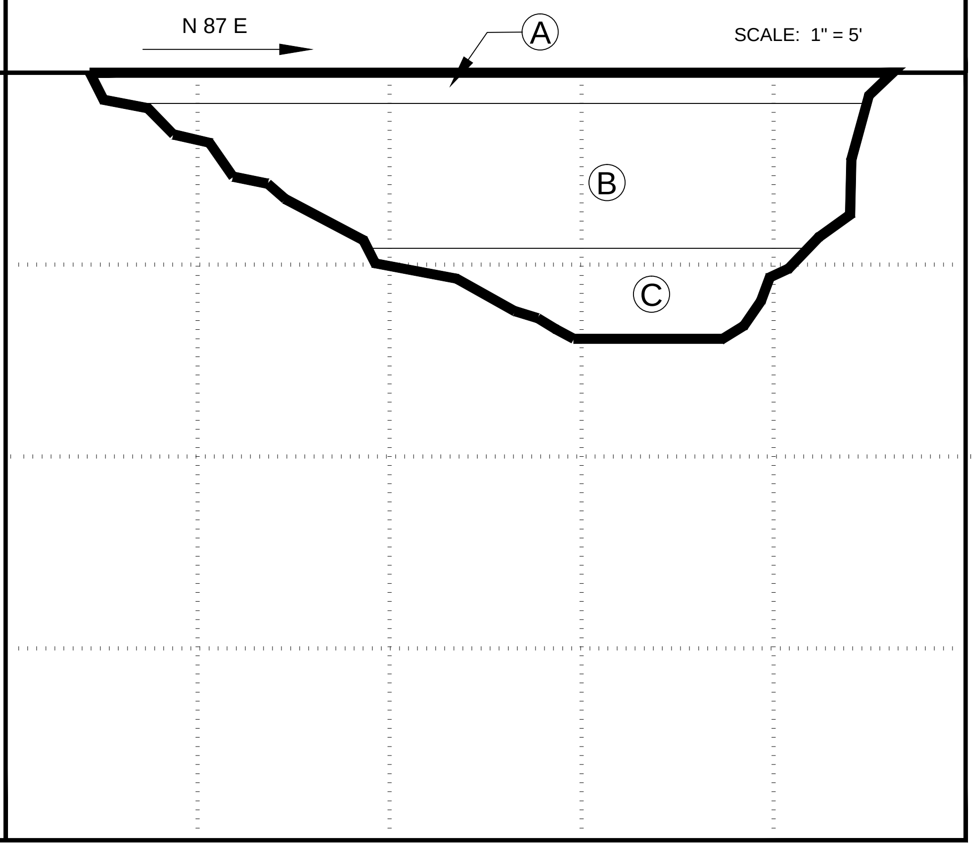
SOUTHERN CALIFORNIA GEOTECHNICAL

TRENCH NO. I-2

JOB NO.: 18G185-2	EQUIPMENT USED: Backhoe	WATER DEPTH: Dry
PROJECT: Proposed Warehouse	LOGGED BY: Scott McCann	SEEPAGE DEPTH: Dry
LOCATION: Riverside County, CA	ORIENTATION: N 87 E	READINGS TAKEN: At Completion
DATE: 9-6-2018	TOP OF TRENCH ELEVATION: 1509 feet msl	

DEPTH	SAMPLE	DRY DENSITY (PCF)	MOISTURE (%)	EARTH MATERIALS DESCRIPTION
				A: ALLUVIUM: Light Brown fine to medium Sandy Silt, little coarse Sand, abundant fine root fibers, loose - dry
	b		4	B: ALLUVIUM: Brown Silty fine Sand to fine Sandy Silt, little medium to coarse Sand, trace calcareous veining, slightly cemented, dense - damp
5				C: ALLUVIUM: Brown Silty fine to medium Sand, cemented, very dense - damp
	b		6	
				Trench Terminated @ 7 feet Bottom of Trench Elevation: 1502 feet msl
10				
15				

GRAPHIC REPRESENTATION



KEY TO SAMPLE TYPES:
B - BULK SAMPLE (DISTURBED)
R - RING SAMPLE 2-1/2" DIAMETER
(RELATIVELY UNDISTURBED)

TRENCH LOG

PLATE B-2

INFILTRATION CALCULATIONS

Project Name	Proposed Warehouse
Project Location	Riverside County, CA
Project Number	18G185-2
Engineer	Scott McCann

Infiltration Test No	I-1

Constants			
	Diameter (ft)	Area (ft^2)	Area (cm^2)
Inner	1	0.79	730
Anlr. Spac	2	2.36	2189

*Note: The infiltration rate was calculated based on current time interval

				Flow Readings				Infiltration Rates			
Test Interval		Time (hr)	Interval **Elapsed** (min)	Inner Ring (ml)	Ring Flow (cm^3)	Annular Ring (ml)	Space Flow (cm^3)	Inner Ring* (cm/hr)	Annular Space* (cm/hr)	Inner Ring* (in/hr)	Annular Space* (in/hr)
1	Initial	11:15 AM	20	1200	600	550	2150	2.47	2.95	0.97	1.16
	Final	11:35 AM	**20**	1800		2700					
2	Initial	11:35 AM	20	1900	550	2700	1800	2.26	2.47	0.89	0.97
	Final	11:55 AM	**40**	2450		4500					
3	Initial	11:55 AM	20	450	500	500	1650	2.06	2.26	0.81	0.89
	Final	12:15 PM	**60**	950		2150					
4	Initial	12:15 PM	20	950	450	3200	1600	1.85	2.19	0.73	0.86
	Final	12:35 PM	**80**	1400		4800					
5	Initial	12:35 PM	20	200	425	1250	1500	1.75	2.06	0.69	0.81
	Final	12:55 PM	**100**	625		2750					
6	Initial	12:55 PM	20	650	400	2800	1450	1.64	1.99	0.65	0.78
	Final	1:15 PM	**120**	1050		4250					
7	Initial	1:15 PM	20	1050	400	2050	1450	1.64	1.99	0.65	0.78
	Final	1:35 PM	**140**	1450		3500					
8	Initial	1:35 PM	20	250	400	900	1400	1.64	1.92	0.65	0.76
	Final	1:55 PM	**160**	650		2300					

INFILTRATION CALCULATIONS

Project Name	Proposed Warehouse
Project Location	Riverside County, CA
Project Number	18G185-2
Engineer	Scott McCann

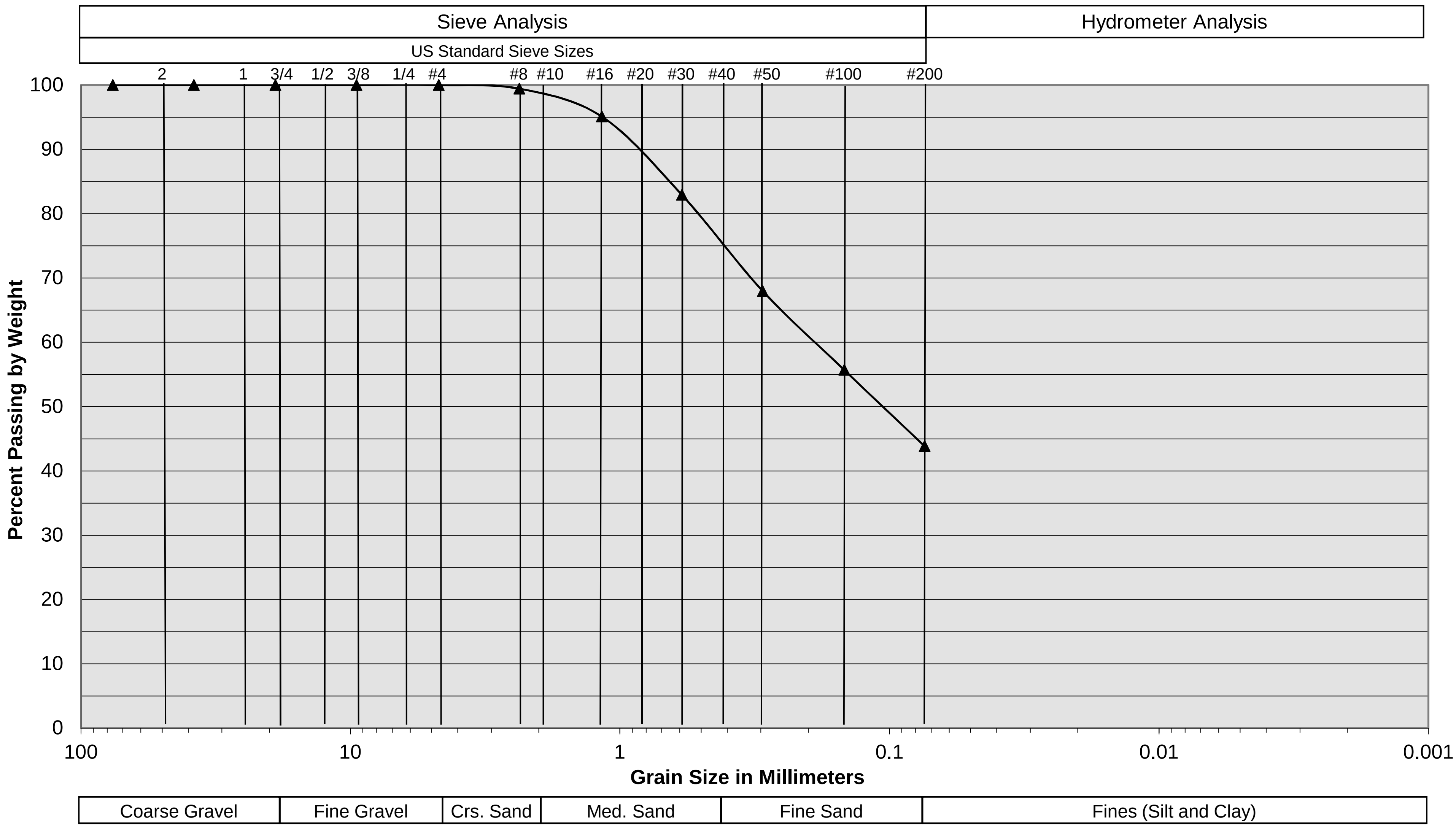
Infiltration Test No: I-2

Constants			
	Diameter (ft)	Area (ft^2)	Area (cm^2)
Inner	1	0.79	730
Anlr. Spac	2	2.36	2189

*Note: The infiltration rate was calculated based on current time interval

				Flow Readings				Infiltration Rates			
Test Interval		Time (hr)	Interval **Elapsed** (min)	Inner Ring (ml)	Ring Flow (cm^3)	Annular Ring (ml)	Space Flow (cm^3)	Inner Ring* (cm/hr)	Annular Space* (cm/hr)	Inner Ring* (in/hr)	Annular Space* (in/hr)
1	Initial	8:00 AM	30	250	400	600	1250	1.10	1.14	0.43	0.45
	Final	8:30 AM	**30**	650		1850					
2	Initial	8:30 AM	30	650	150	1850	600	0.41	0.55	0.16	0.22
	Final	9:00 AM	**60**	800		2450					
3	Initial	9:00 AM	30	50	75	300	350	0.21	0.32	0.08	0.13
	Final	9:30 AM	**90**	125		650					
4	Initial	9:30 AM	30	125	50	650	300	0.14	0.27	0.05	0.11
	Final	10:00 AM	**120**	175		950					
5	Initial	10:00 AM	30	200	50	1000	300	0.14	0.27	0.05	0.11
	Final	10:30 AM	**150**	250		1300					
6	Initial	10:30 AM	30	250	50	1300	300	0.14	0.27	0.05	0.11
	Final	11:00 AM	**180**	300		1600					

Grain Size Distribution



Sample Description	I-1 @ 7 feet
Soil Classification	Brown Silty fine to medium Sand, little Clay

Proposed Warehouse
Riverside County, CA
Project No. 18G185-2
PLATE C-1

SOUTHERN CALIFORNIA GEOTECHNICAL
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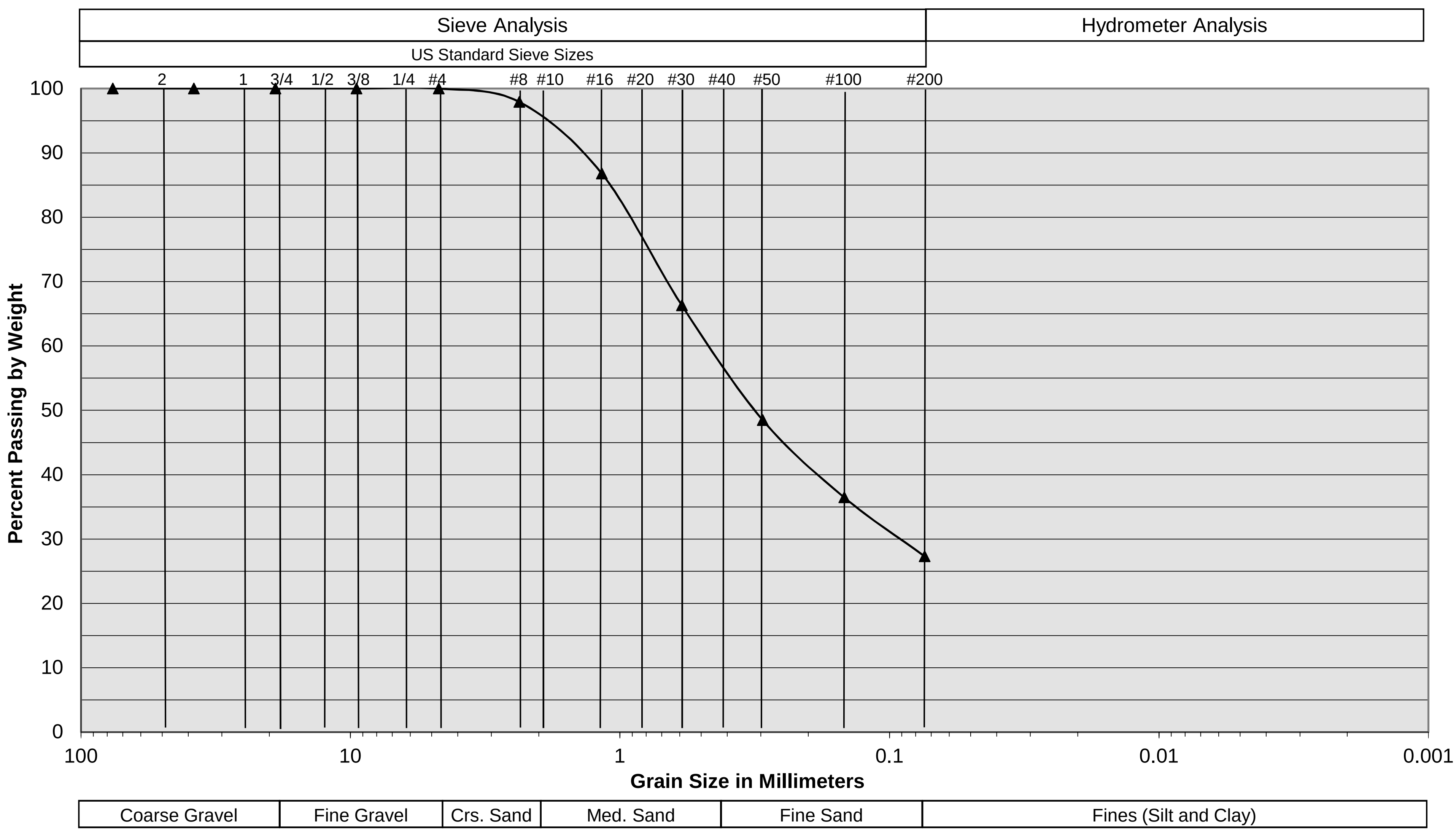
Grain Size Distribution



Sample Description	I-2 @ 7 feet
Soil Classification	Brown Silty fine to medium Sand

Proposed Warehouse
Riverside County, CA
Project No. 18G185-2
PLATE C-2

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