GEOTECHNICAL ENGINEERING
PRELIMINARY REPORT OF
PERMEABILITY STUDY

FULLERTON COLLEGE
INSTRUCTIONAL BUILDING

LOCATED AT

321 E. CHAPMAN AVENUE
FULLERTON, CALIFORNIA

FOR

NORTH ORANGE COUNTY
COMMUNITY COLLEGE DISTRICT
1830-B WEST ROMNEYA DRIVE
ANAHEIM, CA 92801

PROJECT FC-5180-08

MAY 18, 2017

GEOTECHNICAL SOLUTIONS, INC.
GEOTECHNICAL AND ENVIRONMENTAL
ENGINEERING

Geotechnical Solutions, Inc.
Geotechnical, Structural & Environmental Engineering

May 18, 2017

Project No. FC-5180-08

North Orange County Community College District
c/o Campus Capital Projects
Fullerton College
321 east Chapman Avenue
Fullerton, CA 92832-2095

Attention: Mr. Oscar Saghieh
Project Manager, Campus Capital Projects

Re: **Permeability Study**
Fullerton College - Instructional Building
321 East Chapman Avenue
Fullerton, California

Gentlemen:

As requested and authorized, we performed geotechnical engineering field percolation tests at the designated area on the existing staff parking lot B where the new Instructional Building has been proposed to be constructed between Building 1400 and Building 1200 inside Fullerton College Campus, Fullerton, California.

The accompanying Engineering Report presents the results of our subsurface exploration, field percolation tests, performing laboratory tests, analyzing field and laboratory data and our conclusions and recommendations for geotechnical engineering aspects of the project design.

Our services were performed using the standard of care ordinarily exercised in this locality, at the time when the report was prepared.

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The investigation revealed that the top 7-feet of subgrade soil consists of permeable sandy layers followed by silty and clayey less permeable or non-permeable soil layers below 7-ft in depth.

The field testing and analysis was made in accordance with generally accepted geotechnical engineering principles and procedures and included such field and laboratory tests considered necessary under the circumstances. In the opinion of the undersigned, the accompanying report has been substantiated by mathematical and other data and presents fairly the design information requested by your organization.

This completes our scope of services for the initial design phase of the project. We appreciate this opportunity to be of service to you on this project.

Respectfully Submitted,

Geotechnical Solutions, Inc.

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Distribution: (4+pdf) Campus Capital Projects

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Introduction

Geotechnical Solutions, Inc. (GSI) has performed field percolation tests at the proposed designated area inside the Fullerton College Campus facility for the proposed development project namely construction of an Instructional Building inside Fullerton College Campus in the City of Fullerton, California.

The main purpose of this study is to provide infiltration rate of the subgrade material based on field percolation tests so that an appropriate system incorporating Storm Water permanent best management practice (BMP), e.g. CONSPAN retention system or dry well or any other approved system may be designed and existing drainage be improved.

Site Conditions

The site of the proposed development is inside the Fullerton College campus, at staff parking lot B, south of Building 1400 and north of Building 1200 in the City of Fullerton, California and west of existing baseball field as shown on Plate A and Plate B-1. The property is in a level, developed paved parking area.

Proposed Construction

The proposed development consists of constructing a new 3-story Instructional Building, 24,000 square feet on each floor and various drainage improvements which are not detailed at this time. We understand, the extent of drainage facilities will, in part depend on the amount of drainage and percolation available at the project site.

Field Investigation

During our field investigation for the proposed Instructional Building, we drilled five (5) hollow stem auger borings, B-1 through B-5 varying on depths from 36' to 51.5-feet below the ground surface including P-1 which is specially drilled for percolation test. Soil borings were performed using a truck-mounted hollow-stem auger drill rig. Supply truck

provided a water tank. Borings were drilled at the site, by means of an 8" hollow-stem drill rig at the approximate location shown on Plate B. Records of the materials encountered during drilling were made by our field representative and are presented on Plates E-1 to E-5 and P-1, Log of Test Holes.

The lines designating the interface between soil strata on the Log of Test Hole represent approximate boundaries. The transition between strata may be gradual. Relatively undisturbed samples were secured at frequent intervals from various depths for laboratory testing. The relative sampler penetration resistance exhibited by the soils types encountered is tabulated in the blows per foot column of the Log of Test Holes.

Soil samples were obtained by means of standard split-spoon sampling, modified California brass-ring-lined sampling, and bulk sampling from auger cuttings.

Field permeability testing was performed using a falling head permeability test, where water was added into the borehole and the rate of drop was measured.

Subsurface Conditions

1. The area drilled was parking lot called staff parking Lot B with paved areas with asphalt concrete and base in the surface zone.

2. The underlying materials to about 7-feet below surface were predominantly sandy alluvium materials.

3. From about 7-feet down to depth explored, the materials were generally mixtures layers of fine sand, silt, and clay.

Laboratory Testing

Laboratory testing was programmed following a review of the field investigation data to be evaluated. Tests included physical testing to determine soil characteristics and selective tests. Test results are presented in Appendix A.

A. Mechanical Analysis

Mechanical analyses by the hydrometer test method were performed to confirm field classifications. Test results are as follows:

Test Hole No.	Sample Depth (ft)	Sand Percent	Silt Percent	Clay Percent
B-1	1-3'	72	13	15
B-1	8'-10'	47	20	33
B-2	1-3'	74	15	11
B-2	7'-10'	50	18	32
B-5	1-3'	62	15	23
P-1	1-6'	76	16	8
P-1	7-10'	51	17	32

Field Percolation Test

Based on the soil profile realized at the time of drilling, we performed two field percolation tests, PC-1 (6') and PC-1 (15') at the depths of 6- feet and 15- feet at the two distinct soil layers, sand and silty clay layers respectively. Thus, at first, Boring P-1 was drilled to 7-feet only and appropriate percolation test, PC-1 is performed at this sandy layer. Because of the sandy soils, two consecutive measurements showed more than 6 inches seeping away in less than 25 minutes. Thus, further 6 readings every 10 minutes were obtained to complete percolation test in accordance with the Technical Guidance.

The percolation test procedure performed in accordance with the current acceptable method for one shallow (less than 10 feet) and one deep percolation test (more than 10

feet) by qualified personnel under the supervision of registered geotechnical engineer as per Technical Guidance Document, Orange County Public Works, Table VII.1 Recommended Infiltration Investigation Method: Percolation Test Procedure (Riverside County Department of Environmental Health).

Percolation Test PC-1 (at 6' depth):

- Borehole diameter was 8 inches.
- Test is performed at 6- feet in depth below the ground surface.
- Bottom elevation of test hole should correspond to bottom elevation of proposed dry well or any other system.
- The bottom of the test hole was covered with 2 inches of gravel prior to testing.
- Sides of the hole were not smeared after drilling and there was no caving.
- Hole was filled with clear water to 4-feet depth from the ground surface (appropriate depths at least 5 x radius of the hole (5 x 4" = 20 inches) from the bottom).
- Measurements showed that more than 6 inches of water seeped away in two - 25 minutes intervals. Thus, the tests were run for at least six 10-minutes interval with measurements.
- Measurements were taken with a precision of 0.25 inches or better.
- All the field percolation tests are tabulated and are presented on Table PC-1 in Appendix B.

After the percolation test is done at 6 feet depth, Boring B-6 is then further drilled to 15 feet depth encountering silty and clayey soils below 7 feet depth and filled up with water to be soaked for 24 hours.

Percolation test, PC-1 (15') was performed the following day as per the test procedures recommended in Technical Guidance Document as follows:

Percolation Test PC-1 (15' depth):

- Borehole diameter was 8 inches.
- Pre-soak the hole with water for 24 hours.
- Test is performed at 15- feet in depth below the ground surface.
- Bottom elevation of test hole should correspond to bottom elevation of proposed dry well or any other system.
- The bottom of the test hole was covered with 2 inches of gravel prior to testing.
- Sides of the hole were not smeared after drilling and there was no caving.
- Hole was filled with clear water to 10 feet depth from the ground surface and 5 feet from the bottom (appropriate depths at least 5 x radius of the hole (5 x 4" = 20 inches) from the bottom).
- At least 12 measurements were taken over at least for six (6) hours.
- Measure the drop in water level over a 30-minute period.
- Refill after every 30 minute reading, if required.
- Measurements were taken with a precision of 0.25 inches or better.
- All the field percolation tests are tabulated and are presented on Table PC-1 in Appendix B.
- The holes were backfilled with soil cuttings.

Percolation Rate Evaluation

To evaluate the percolation rates, testing was performed by filling the borehole with water and observing the rate of water drop from the fixed reference point on the ground surface. The depths of water drop for every 10 minutes intervals (for PC-1) and every 30 minutes intervals (for PC-1) were noted and tabulated and plotted as shown on Plate PC-1 in Appendix B.

Percolation rate, k can be correlated with the data in the form of the straight line equation as shown below:

$$t/R = b + kt$$

Where, t = average time in minutes

$R = \Delta t / d$

Δt = Time Interval, minutes

d = drop in inch = R1 – R2

R1 = Initial Readings, inch

R2 = Final Readings, inch

k = Percolation Rate inch/minute

R = 1/k at equilibrium rate

t/R is plotted against t as shown on the plots on Plates PC-1 (6') and PC-1 (15') and the regression analyses were performed to interpolate the data obtained in the field. The straight line interpolation gives the slope as a percolation rate, k.

Results and Conclusions

The results obtained from the analyses are as follows:

1. Near surface material up to 7-feet is medium to coarse grained sandy material which is permeable for percolation test PC-1 at 6-feet depth; whereas the percolation test at 15-feet depth encountered silty clay which is impermeable or very low permeability.

2. Where the subgrade materials consist of sand (for PC-1), over-all percolation rate is relatively fast and need to be designed by an acceptable system which drain water to the desired extent. Similarly, the subgrade soil beyond 7-feet depth will encounter very low percolation values and should be designed accordingly.

3. Field Percolation tests shows the following results:

Location	Coefficient of Permeability, k			
	Inch/minute	cm/sec	**Inch/hour Average**	**Inch/hr** based on **Last Reading**
PC-1 @ 6'	0.267	1.130xE-02	16.02	**16.5**
PC-2 @ 15'	0.0082	3.00xE-04	0.49	**0.50**

4. Based on the data presented in this report and the testing information accumulated, it is our judgment that the percolation rate is an average of **16.26 inch per hour** and it takes approximately **3.7 minutes to percolate 1 inch** for the upper 7 feet of soil layers.

5. For the bottom layers of soil beyond 7 feet depth, percolation rate is an average of **0.5 inch per hour** and it takes **2 hours to percolate 1 inch**.

6. This conclusion regarding percolation rate is based on the results of our field exploration and testing.

7. General range of permeability for some of the subgrade soils are as follows:

Type of Soil	Permeability (cm/sec)
Medium to coarse gravel	$> 10^{-1}$
Coarse sand to fine sand	between $1x10^{-1}$ to $1x10^{-3}$
Fine sand and silty sand	between $1x10^{-3}$ to $1x10^{-5}$
Silt, clayey silt or silty clay	between $1x10^{-4}$ to $1x10^{-6}$
Clays	$1x10^{-7}$ or less

Since the percolation rate average for PC-1 (upper 7 feet) is **1.13 x E-02 cm/Sec**, it falls into coarse sand to fine sand category as tabulated above and we conclude that percolation is fairly high at the project location at upper 7 feet of soil layer.

Similarly, the percolation rate average for PC-2 (beyond 7 feet) is **3.0 x E-04 cm/Sec**, it falls into fine Sand and silty sand category as tabulated above and we conclude that percolation is fairly low at the project location at depths of soil layers greater than 7 feet.

Infiltration Rate

As per Technical Guidance Document, Infiltration rate, I_t is calculated based on Percolation Rate Conversion using Porchet Method, aka Inverse Borehole Method as tabulated on Infiltration Rate for PC-1 and PC-2.

Also, Reduction Factor Formula (Rf) Method (County of Los Angeles) has been used and tabulated for both PC-1 and PC-2. The percolation rate must be reduced to account for the discharge of water from both the sides and bottom of the boring (i.e., non-vertical flow). The following formula has been used to determine the infiltration rate:

Reduction Factor (R_f) = $(2d_1 - \Delta d)/ (DIA) + 1$

Where, d_1 = Initial Water Depth (in)

Δd = Water Level Drop of Final Period of Stabilized Rate (in.)

DIA = Equivalent diameter of the boring (in)

Infiltration rate is then calculated as pre-adjusted Percolation rate divided by Reduction factor.

Percolation tests were performed with the depth of the test hole set at the infiltration surface level (bottom of basin).

After the minimum required number of testing intervals, the test was complete. The data collected at the final interval was used to calculate infiltration rates and are tabulated in the Table below:

The calculations and the results are tabulated and presented on Plates PC-1 and PC-2 in Appendix B.

TABLE

PERCOLATION – INFILTRATION (Porchet method)

PC-1

Location	**Percolation Rate inch/hour Based on last Readings**	**Infiltration Rate Inch/hour Based on Porchet Method aka Inverse Borehole Method**
PC-1	**15.94**	**1.54**
With Factor of Safety = 2.0		**0.77**
> 0.3 inch/hour		

Since the infiltration rate average is **0.77 inch per hour** (> than **0.3 inch per hour**), it satisfies the requirement of minimum 0.3 inch per hour criteria and it falls into coarse sand to fine sand category.

The following Table shows the calculation using R_f Method for PC-1:

TABLE

PERCOLATION – INFILTRATION

(Based on R_f Method)

PC-1(6')

Location	Percolation Rate in/hr	Initial Water Depth d_1 (in)	Water Level Drop (in)	Reduction Factor R_f	Infiltration Rate in/hr
PC-1	15.94	51.25	2.75	13.468	1.18
With Factor of Safety of 2.0					0.59
➢ 0.3 inch/hour					

TABLE

PERCOLATION – INFILTRATION (Porchet method)

PC-1 (15')

Location	Percolation Rate inch/hour Based on last Readings	Infiltration Rate Inch/hour Based on Porchet Method aka Inverse Borehole Method
PC-2	0.50	0.02
With Factor of Safety = 2.0		0.01
< 0.3 inch/hour		

Since the infiltration rate average is **0.01 inch per hour** (< than **0.3 inch per hour**), it does not satisfy the requirement of minimum 0.3 inch per hour criteria and it falls into fine sand and silty sand category.

The following Table shows the calculation using R_f Method for PC-2:

TABLE

PERCOLATION – INFILTRATION

(Based on R_f Method)

PC-1(15')

Location	Percolation Rate in/hr	Initial Water Depth d_1 (in)	Water Level Drop (in)	Reduction Factor R_f	Infiltration Rate in/hr
PC-2	0.5	123.95	0.25	31.956	0.156
With Factor of Safety of 2.0					0.078
< 0.3 inch/hour					

Note: It does not satisfy the requirement.

Infiltration BMP (General Descriptions)

There are several infiltration best management systems available. The project civil engineer may choose the system which is the most appropriate system based on the local and field conditions.

CON/SPAN

CON/SPAN is a modular precast system designed below grade storm-water detention or infiltration.

Combining the CON/SPAN arch unit with precast walls and cast-in-place foundations allows for an array of configuration to meet nearly any site need. Precast continuous foundation ensures structural integrity and eliminates differential settlements.

Detention systems are employed to reduce the quantity of storm-water runoff leaving a site by temporarily storing the runoff that exceeds a site's allowable discharge rate, and releasing it slowly over time.

Subsurface Infiltration Basin

An infiltration basin is a shallow impoundment that stores and infiltrates runoff over a level, un-compacted (preferably undisturbed area) with relatively permeable soils.

Subsurface infiltration beds provide temporary storage and infiltration of storm-water runoff by placing storage media of varying types beneath the proposed surface grade.

A subsurface infiltration bed generally consists of a vegetated, highly pervious soil media underlain by a uniformly graded aggregate (or alternative) bed for temporary storage and infiltration of storm-water runoff. Subsurface infiltration beds are ideally suited for flat open spaces, such as lawns, meadows, and playfields. Storm-water runoff from nearby impervious areas (including rooftops, parking lots, roads, walkways, etc.) can be conveyed to the surface storage media, where it is then distributed via a network of perforated piping.

Infiltration BMP should be located at a setback of at least **20 feet** from the building. Roof runoff generally has relatively low sediment levels, making it ideally suited for connection to an infiltration bed. However, cleanout (s) with a sediment sump are still recommended between the building and infiltration bed.

Catch basins, inlets, and area drains may be connected to subsurface infiltration beds. However, sediment debris removal should be provided. Storm structures should therefore include sediment trap areas below the inverts of discharge pipes to trap solids and debris.

Subsurface infiltration bed is typically comprised of a 12 to 36 inch section of aggregate, which ranges 1-2 inches in gradation. Aggregate should be uniformly graded, clean-washed, and contain at least 40% void space. The depth of the bed is a function of storm-

water storage requirements, frost depth considerations, and site grading. Project Civil Engineer should design the system.

The infiltration bed should be wrapped in non-woven geotextile filter fabric.

Water quality Inlet or Catch basin with sump is needed for all surface inlets. It should be designed to avoid standing water.

The slope of the infiltration beds should be level or less than 1% grade for even water distribution and infiltration.

Cleanouts or inlets should be installed at a few locations within the bed and at appropriate intervals to allow access to the perforated piping network and or storage media.

Adequate soil cover (generally 12-18 inches) should be maintained above the infiltration bed to allow for a healthy vegetative cover.

The surface (above the stone bed) should be compacted as minimally as possible to allow for surface percolation through the engineered soil layer and into the stone bed.

Surface grading should be relatively flat, although a relatively mild slope between 1% to 3% is recommended to facilitate drainage.

Drywell

Another possibility for this project is a drywell which is a common drainage system consisting of well may be at least 36 inch in diameter and 30 to 40 feet deep. A drywell is a subsurface storage facility designed to temporarily store and infiltrate runoff, rooftops or other impervious areas with low pollutant loading.

Drywells are similar to infiltration trenches in their design and function, but generally have a greater depth to footprint area ratio and can be installed at relatively large depths.

Drywells are vertically installed, underground infiltration facilities that receive runoff from impervious surfaces. Drywells reduce runoff flow rates, volumes and temperatures by infiltrating runoff into the surrounding soils.

Surface Drainage

It is recommended to provide positive surface drainage systems consisting of a combination of sloped concrete flatwork, sheet flow gradients, swales, surface area drains (where needed) around the building structure and within the wall areas to collect and direct all surface water to the proper outlet. Ground surfaces should have at a minimum gradient of 2 percent away from building foundations and similar structures. Surface waters should not be allowed to collect or pond against building foundations and within the level areas of the site.

Project Civil Engineer should select appropriate BMP infiltration system like Infiltration Basin, Dry-Well, Cudo System or other available systems.

Additional Services

This office will be available for further consultation and review of as built and proposed plans. Our additional services include, but are not necessarily limited to the following:

(a) Review of Infiltration System plans.

(b) Consultation with other consultants as required during this study.

(c) Observation and testing during construction, as needed.

Closure

Based on the data presented in this report and the testing information accumulated, it is the judgment of the undersigned that appropriate BMP infiltration system like Infiltration Basin, Dry-Well, Cudo System or other available systems may be chosen by the project

civil engineer. The conclusions presented in this report are based on the results of our field exploration and testing.

This report has been compiled for the exclusive use on the above referenced site, for the purpose stated above. It should not be transferred to or used by another party, or applied to any other project on this site, other than as described herein, without consent and/or thorough review by this office.

Geotechnical Solutions, Inc.

References

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

California Department of Water Resources groundwater well data http://wdl.water.ca.gov.

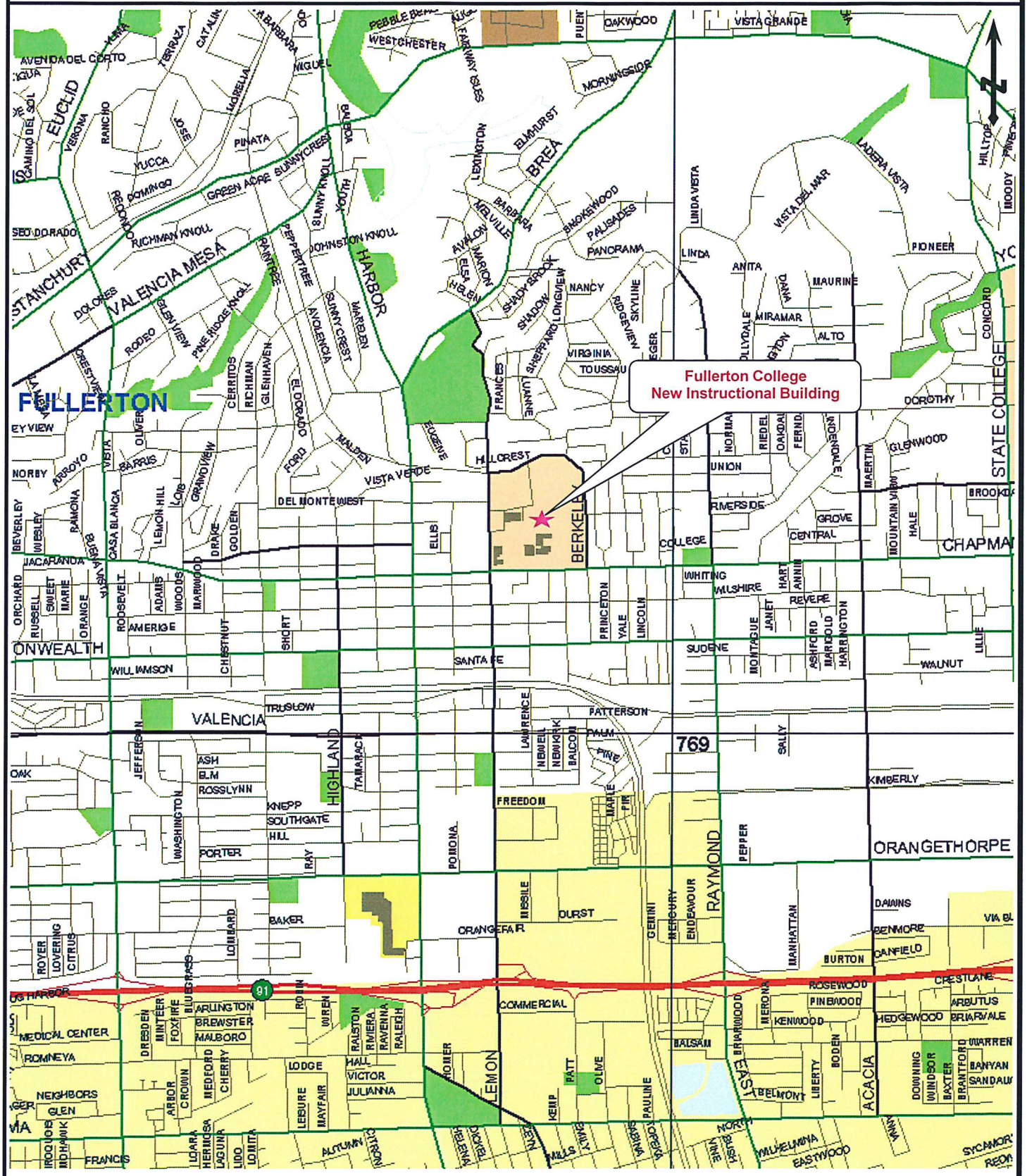
Santa Ana Regional Water Quality Control Board (SARWQCB) – North of El Toro Road, "Exhibit 7.III - Technical Guidance Document for the Preparation of Conceptual/ Preliminary and/or Project Water Quality Management Plans (WQMP's) - Updated December 2013.

Appendix A

Plates:

- Vicinity Map
- Site Plan & Percolation Tests Location Map
- Topographic Map
- Google Map
- Boring Logs B-1 to B-5 & P-1

VICINITY MAP



Fullerton College- New Instructional Building 321 E. Chapman Avenue, Fullerton, California	Project No.	FC-5180-06
	Plate:	A

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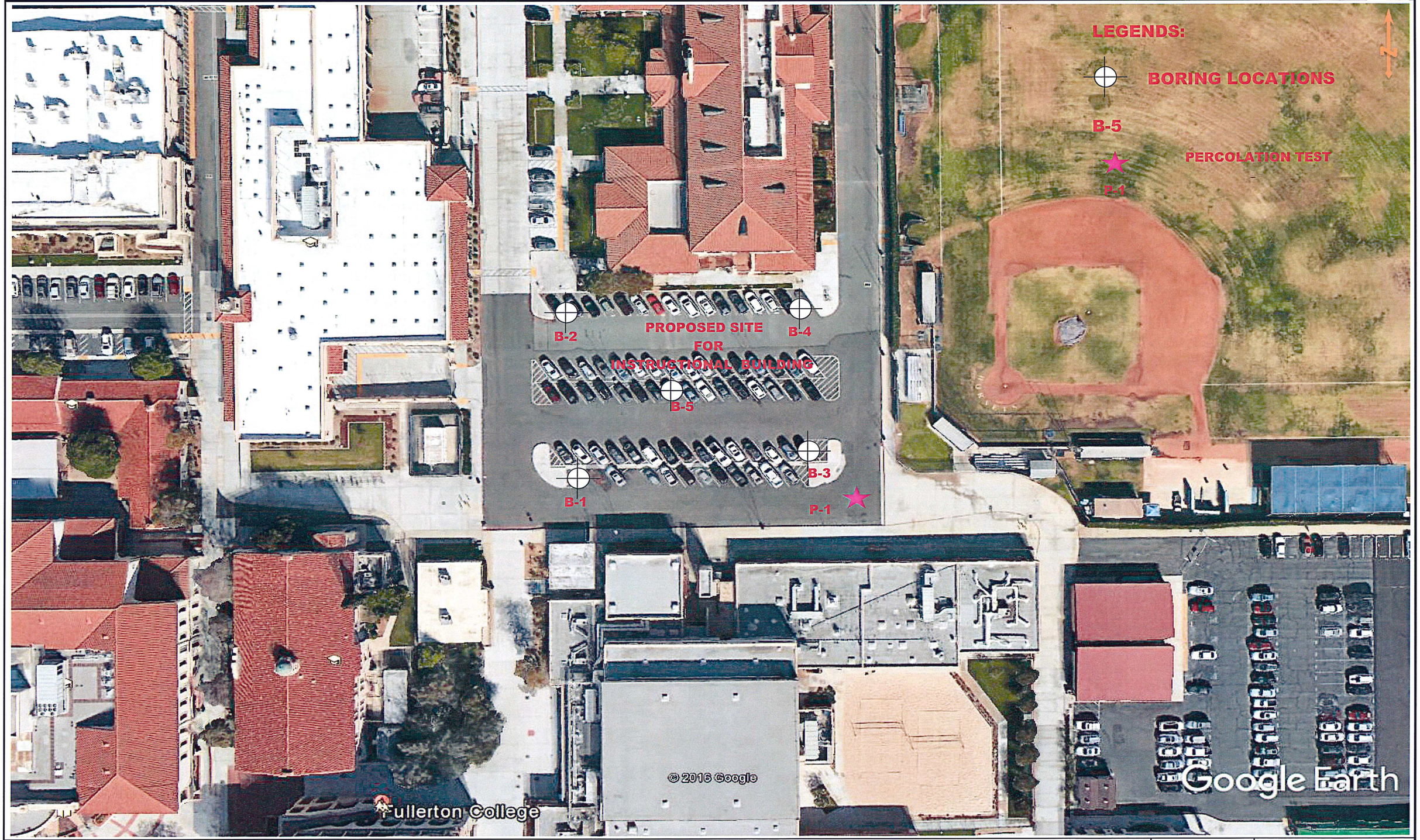
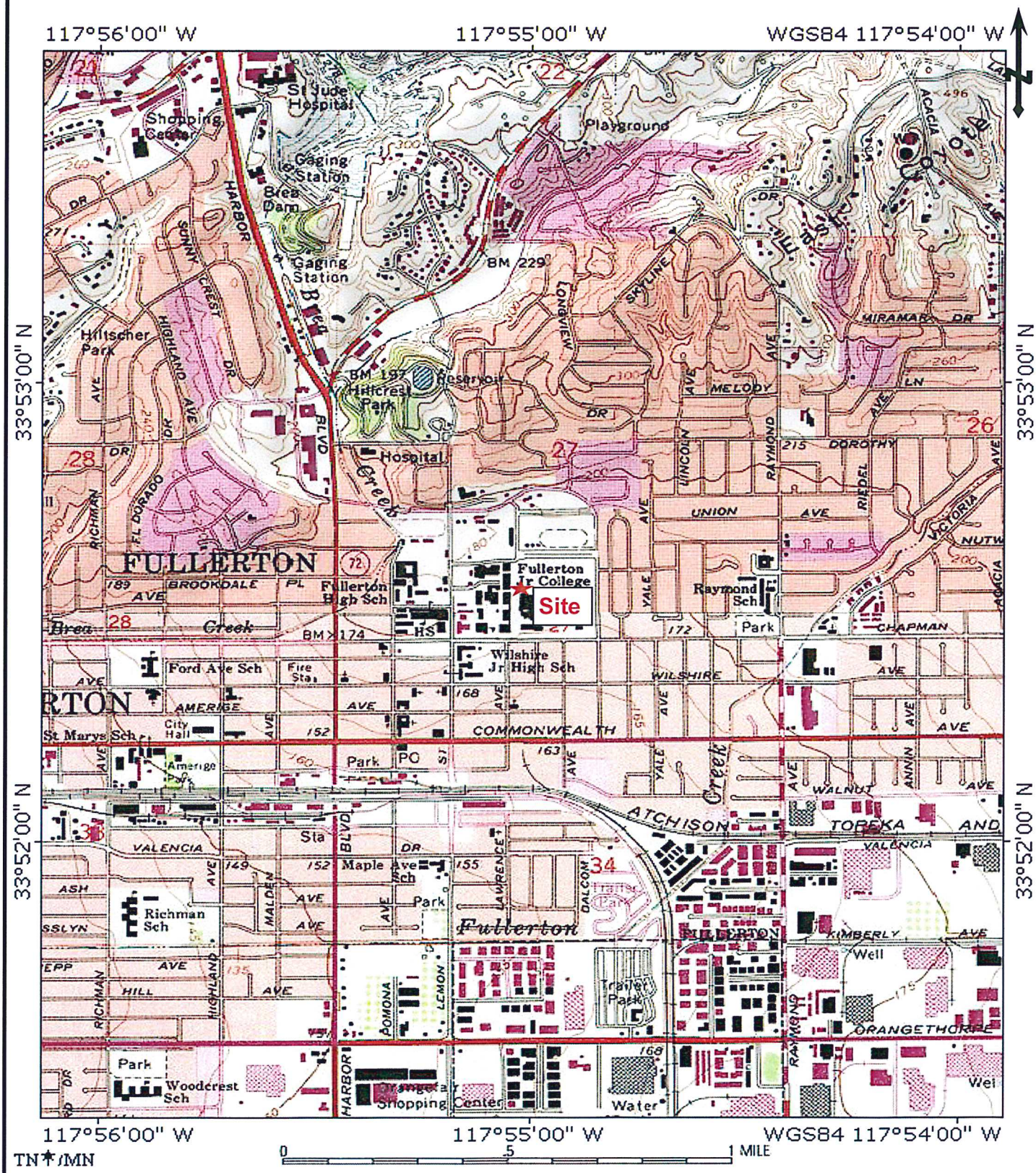
SITE PLAN & PERCOLATION TEST LOCATION MAP



Fullerton College- New Instructional Building 321 E. Chapman Avenue, Fullerton, California	Project No.	FC-5180-06
	Plate:	B

Geotechnical Solutions, Inc.

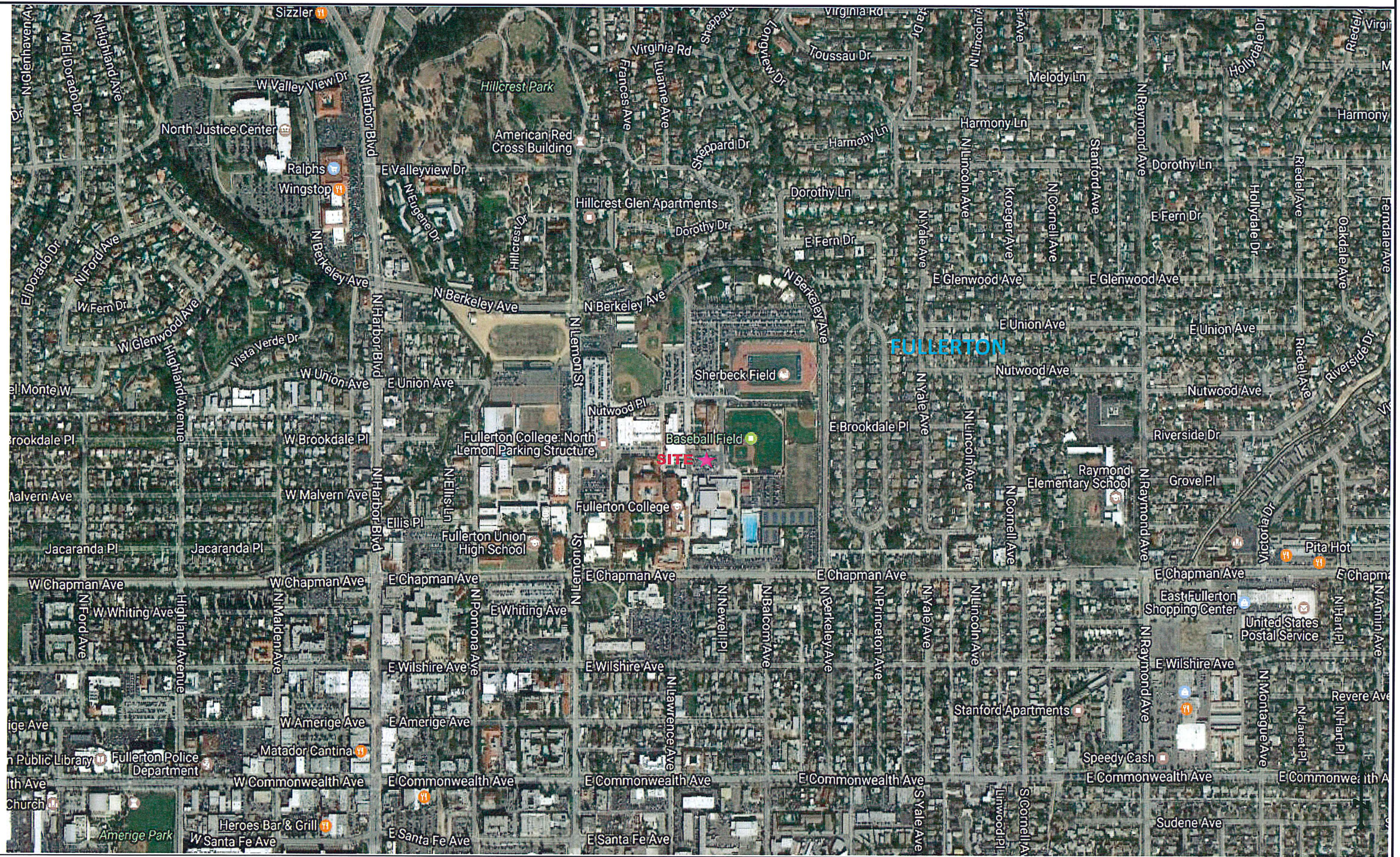
SITE TOPO MAP



Fullerton College- New Instructional Building 321 E. Chapman Avenue, Fullerton, California	Project No.	FC-5180-06
	Plate:	C

Geotechnical Solutions, Inc.

GOOGLE MAP



Fullerton College- New Instructional Building

321 E. Chapman Avenue, Fullerton, California

Project No.	FC-5180-06
Plate:	D

Geotechnical Solutions, Inc.

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. B-1
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. E-1
Project Number :	**FC-5180-06**		Page 1 of 1

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	36.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				Brown clayey Sand, medium dense, slightly moist			28	HD: 72%-13%-15%
	2										DS: P=Peak / Ult=Ultimate
			R1	5-9-9		18	@2': Brown SILTY SAND (SM), slightly moist, medium dense, fine to coarse grained,	6	93		$\phi = 32^0$, c = 250 psf (P) $\phi = 30^0$, c = 200 psf (Ult)
165	5										
			R2	2-3-3		6	@5': Light Brown SAND (SP), very moist, very fine to fine, loose	21	90		$\phi = 29^0$, c = 350 psf (P) $\phi = 28^0$, c = 300 psf (Ult)
							@7': Sandy Clay (CL), medium stiff, moist, brown			53	HD: 47%-20%-33%
160	10										
			R3	2-4-5		9	@10': Brown Sandy Clay (CL), medium stiff, very moist, fine grained, medium plasticity	20	95		
155	15										
			S-4	3-3-4		7	@15': Brown Sandy Clay/clayey sand (CL/SC), medium stiff, fine grained, low plasticity, slightly moist	9	-		
150	20										
			S-5	7-14-21		35	@20': Silty Sand w / little Clay (SM), dense, medium grained, moist, brown	11	-		
145	25										
			S-6	7-7-9		16	@25': Brown Sandy Clay/Clayey Sand (CL/SC), moist, very very stiff, fine grained, medium plasticity	15	-		
140	30										
			S-7	5-7-11		18	@30': Brown SILTY SAND, moist, medium dense, fine grained	16	-		
135	35										
			S-8	6-8-12		20	@35': Brown Silty Sand (SM), moist, medium dense, fine to medium grained	14	-		
130	40						Total Depth = 36.5 feet No Groundwater encountered during drilling Backfilled w/Cuttings				
	45										

GEOTECHNICAL SOLUTIONS, INC.

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. B-2
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. E-2
Project Number :	**FC-5180-06**		Page 1 of 1

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	36.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				Brown Clayey SAND (SC), medium dense, slightly moist			30	HD: 70%-14%-16%
	2		R1	5-8-9		17	@2': Brown SILTY SAND (SM), moist, medium dense, fine to coarse grained,	16	106		
165	5		R2	2-3-3		6	@5': Light Brown Clayey Silt (ML), very moist, very fine to fine, soft to medium stiff, fine grained, low plasticity	26	91		
							@7': Clayey Sand (SC), medium stiff, moist, brown			50	HD: 71%-15%-14%
160	10		R3	4-8-9		17	@10': Brown Silty Clay/Clayey Silt (CL/ML), moist, stiff, moist, medium plasticity	20	99		
155	15		S-4	3-5-8		13	@15': Brown Silty Sand (SM), slightly clayey, moist, medium dense, fine to medium grained	14	-		
150	20		S-5	6-13-19		32	@20': Same as above	10	-		
145	25		S-6	5-6-8		14	@25': Brown SANDY CLAY, moist, very stiff, medium plasticity, fine grained	17	-		
140	30		S-7	5-9-11		20	@30': Brown SILTY SAND, moist, medium dense, fine grained	11	-		
135	35		S-8	6-9-9		18	@35': Brown SANDY SILT, moist, stiff, fine grained	18	-		
130	40						Total Depth = 36.5 feet No Groundwater encountered during drilling Backfilled w/Cuttings				
	45										

GEOTECHNICAL SOLUTIONS, INC.

Project :	Fullerton College- New Instructional Building	LOG OF TEST HOLE	Borehole No. B-3
Project Location :	321 E. Chapman Avenue, Fullerton, California		Plate No. E-3
Project Number :	FC-5180-06		Page 1 of 1

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	36.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				Brown Clayey SAND (SC), medium dense, slightly moist				
	2		R1	11-9-11		20	@2': Brown SAND (SP), silty, very moist, medium dense, fine to coarse grained,	16	103		
165	5		R2	2-4-5		9	@5': Brown Sandy Silt (ML), clayey, very moist, very fine grained, low Plasticity	24	95		
160	10		R3	5-8-10		18	@10': Brown Silt (ML), clayey/sandy, very moist, stiff, medium plasticity	30	92		
155	15		S-4	6-9-14		23	@15': Brown Silty Sand (SM), slightly clayey, moist	12	-		
150	20		S-5	7-10-16		26	@20': Same as above	14	-		
145	25		S-6	4-8-13		21	@25': Brown SANDY CLAY, moist, very stiff, medium plasticity, fine grained	16	-		
140	30		S-7	3-4-4		8	@30': Same as above, medium stiff to stiff	18	-		
135	35		S-8	6-10-10		20	@35':Same as above, very stiff	15	-		
130	40						Total Depth = 36.5 feet No Groundwater encountered during drilling Backfilled w/Cuttings				
	45										

GEOTECHNICAL SOLUTIONS, INC.

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. B-4
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. E-4
Project Number :	**FC-5180-06**		Page 1 of 1

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	36.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				Brown Clayey SAND (SC), medium dense, slightly moist				
	2		R1	5-9-9		18	@2': Brown SILTY SAND (SM), slightly moist, medium dense, fine to coarse grained,	5	99		DS: P=Peak / Ult=Ultimate $\phi = 31^0$, c = 300 psf (P) $\phi = 30^0$, c = 250 psf (Ult)
165	5		R2	3-3-3		6	@5': Light Brown Sany Silt (ML), very moist, very fine to fine, soft to medium @7': Sandy SILT (ML) w/Clay, medium stiff, moist, brown	21	93		
160	10		R3	3-5-7		12	@10': Brown Silt (ML), clayey/sandy, moist, medium stiff, medium plasticity	24	95		DS: P=Peak / Ult=Ultimate $\phi = 29^0$, c = 400 psf (P) $\phi = 28^0$, c =300 psf (Ult)
155	15		S-4	3-4-6		10	@15': Brown Sandy Silt (ML), slightly clayey, moist, stiff	14	-		
150	20		S-5	9-10-18		28	@20': Brown Silty Sand (SM), moist, medium dense, fine to medium grained.	14	-		
145	25		S-6	7-8-10		18	Brown SANDY CLAY, moist, very stiff, medium plasticity, fine grained	14	-		
140	30		S-7	5-10-11		21	@30': Same as above	18	-		
135	35		S-8	6-9-11		20	@35': Brown SANDY SILT, moist, stiff, fine grained	13	-		
130	40						Total Depth = 36.5 feet No Groundwater encountered during drilling Backfilled w/Cuttings				
	45										

GEOTECHNICAL SOLUTIONS, INC.

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. B-5
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. E-5
Project Number :	**FC-5180-06**		Page 1 of 2

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	51.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				@0-2': Brown Cayey Sand, medium dense, slightly moist			38	HD: 62%-15%-23%
	2		R1	7-9-7		16	@2': Brown SAND (SP), slightly silty, moist, medium dense, fine to coarse grained,	15	96		
165	5		R2	7-3-4		7	@5': Silty Sand (SM)/ Sandy Silt (ML), clayey, brown, loose/ soft, fine grained, very moist	22	99		
160	10		R3	4-7-9		16	@10': Brown Silty/Sandy CLAY, very moist, stiff, med plasticity	24	91		
155	15		S-4	6-7-10		17	@15': Brown SANDY CLAY, very moist, very stiff, low to med plasticity, silty	23	-		
150	20		S-5	7-10-15		25	@20': Brown Sandy Clay at top followed by SILTY SAND, moist, medium dense	18	-		
145	25		S-6	4-7-10		17	@25': Brown Silty SAND (SM), moist, medium dense, moist, fine to medium grained	16	-		
140	30		S-7	5-11-12		23	@30': Olive brown Sandy Clay (CL), moist, very stiff, fine grained, med plasticity	18	-		
135	35		S-8	6-9-11		20	@35': Brown Silty SAND (SM), moist, medium dense, moist,	17	-		
130	40		S-9	7-10-17		27	@40': Same as above	12	-		
	45						**Continued on Next page .....**	-	-		

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. B-5
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. E-5
Project Number :	**FC-5180-06**		Page 2 of 2

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	51.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	45										
			S-10	6-9-11		20	@45': Grayish brown SANDY SILT, very moist, very stiff, low plasticity	14	-		
165	50										
			S-11	10-14		24	@50': Same as above, clayey	23	-		
160							End of Boring at 51.5' No groundwater encountered Backfilled w/soil cuttings				

GEOTECHNICAL SOLUTIONS, INC.

Project :	**Fullerton College- New Instructional Building**	**LOG OF TEST HOLE**	Borehole No. P-1
Project Location :	**321 E. Chapman Avenue, Fullerton, California**		Plate No. P-1
Project Number :	**FC-5180-06**		Page 1 of 1

Date(s) Drilled :	May 6, 2017	Logged By :	BA	Checked By :	Abraham Baha
Drilling Method :	Hollow-Stem Auger	Drill Bit Size / Type :	8-inch-OD rock bit	Total Depth of Borehole, feet :	36.5
Drill Rig Type :	CME-75	Drilling Contractor :	Redman Drilling	Approx. Surface Elevation, feet :	170 feet MSL
Groundwater Level and Date Measured:	No Groundwater encountered	Sampling Method :	SPT, California (ring), bulk	Hammer Data :	Downhole wire 140 lbs / 30-inch drop
Borehole Backfill :	Drill cuttings	Comments :	Refer to site plan for location		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Penetration Resistance, Blows / 6"	No Recovery (NR)	Blows / 12"	MATERIAL DESCRIPTION	Moisture Content, %	Dry Unit Weight, pcf	Percent Passing No. 200 Sieve (%)	OTHER TESTS AND REMARKS
170	0						4" AC over 4" AB				
			Bag #1				Brown clayey Sand, medium dense, slightly moist				
	2						@2': Brown SILTY SAND (SM), slightly moist, medium dense, fine to coarse grained,				
165	5						@6': PC-1 percolation Test is done				
							@7': Sandy Clay (CL), medium stiff, moist, brown				
160	10						@10': Brown Sandy Clay (CL), medium stiff, very moist, fine grained, medium plasticity				
155	15						Brown Sandy Clay				
							@15': PC-2 Percolation test is done				
150	20										
145	25										
140	30										
135	35										
130	40										
	45										

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Appendix B – Percolation Test Results

- Pre-Test at Location PC-1
- Percolation Test Result at Location PC-1
- Infiltration Rate Calculations (IR-1)

- Percolation Test Result at Location PC-2
- Infiltration Rate Calculations (IR-2)

INITIAL TEST

PERCOLATION TEST DATA SHEET							
Project:	Fullerton College		Project No.:	FC-5180-06		Date:	5/7/2017
Test Hole Number:		P-1	Tested By:	AB & BA			
Depth of Test Hole, DT		6'	USCS Soil Classification:	Sand (SP)			
Test Hole Dimensions (inches)					Length	Width	
Diameter (if Round) =		8"	Sides (if Rectangular) =				
Sandy Soil Criteria Test *							
Trial No.	Start Time	Stop Time	Time Interval (Min)	Initial Depth to Water (in)	Final Depth to Water (in)	Change in Water Level (in)	Greater than or Equal to 6"? y/n
1	10:00 AM	10:25 AM	25	17	25	8	> 6"
2	10:25 AM	10:50 AM	25	25	32	7	> 6"

* If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30 minute Intervals) with a precision of at least 0.25".

PERCOLATION TEST

Borehole No. PC-1 — Depth 72 inch

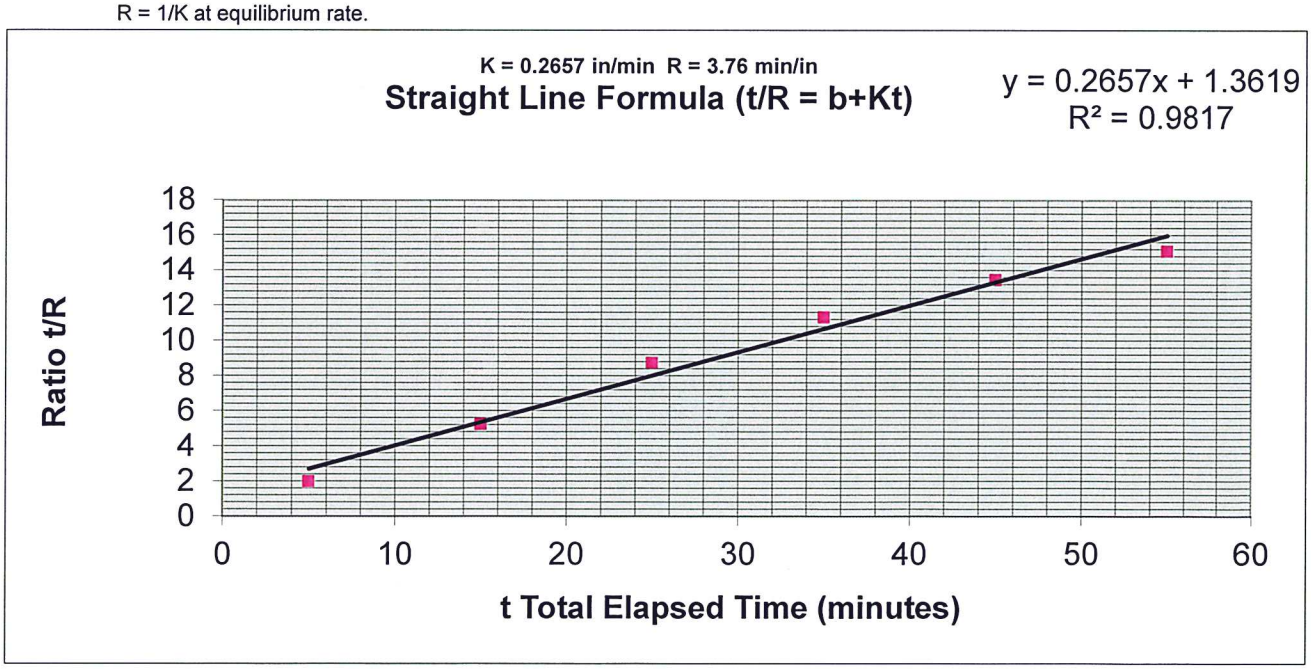
Date	Time of Reading	Δt (min.)	Total Elapsed Time (t)	Average t (minutes)	Reading R_1 (inches)	Reading R_2 (inches)	Drop d (inches)	R=Δt/d (min./in.)	t/R (in.)	k * 1000 (cm/s)
5/6/2017	10:55 AM	0	0							
	11:05 AM	10	10	5	34.00	38.00	4.00	2.50	2.00	16.9
	11:15 AM	10	20	15	38.00	41.50	3.50	2.86	5.25	14.8
	11:25 AM	10	30	25	41.50	45.00	3.50	2.86	8.75	14.8
	11:35 AM	10	40	35	45.00	48.25	3.25	3.08	11.38	13.8
	11:45 AM	10	50	45	48.25	51.25	3.00	3.33	13.50	12.7
	11:55 AM	10	60	55	51.25	54.00	2.75	3.64	15.13	11.6

Plot: t/R as ordinate vs. 't' as abscissa; tanOC = K.

R_1 = Vertical distance from reference point to water level after refilling at beginning of increment period.

R_2 = Vertical distance from reference point to water level at the end of increment period.

R = 1/K at equilibrium rate.



Fullerton College - New Instructional Building
321 East Chapman Avenue, Fullerton, California

Project:	FC-5180-06
Plate:	PC-1

GEOTECHNICAL SOLUTIONS, INC.

Percolation Rate Conversion
Infiltration Rate, I_t
Porchet Method, aka Inverse Borehole Method

Fullerton College - Instructional Building
Project No: FC-5180-06

Data collected at the Final Interval analysed:

Percolation Test PC-1

As per Test Result, Percolation Rate = 0.2657 inch/Min = 15.94 inch/hour

Time Interval, Δ t	=	10	Minutes	Initial Depth to Water, D_0	=	51.25	Inches
Total Depth of Test Hole, D_t	=	72	Inches	Final Depth to Water, D_f	=	54	Inches
Test Hole Radius, r	=	4	Inches				

Initial Height of Water at the selected time interval, H_0	=	20.75	Inches	$(D_t - D_0)$
Final Height of Water at the Selected time interval, H_f	=	18	Inches	$(D_t - D_f)$
Change in Height over the time interval, Δ H	=	2.75	Inches	$(H_0 - H_f)$
Average Head Height over the time interval, H_{avg}	=	19.375	Inches	$(H_0 + H_f)/2$

Tested Infiltration Rate, I_t = $\Delta H (60 r) / ((\Delta t)(r + 2 H_{avg}))$ in/hr

Therefore, I_t = **1.54 inch/hour**

PERCOLATION TEST

Borehole No. PC-2 | Depth 180 inch

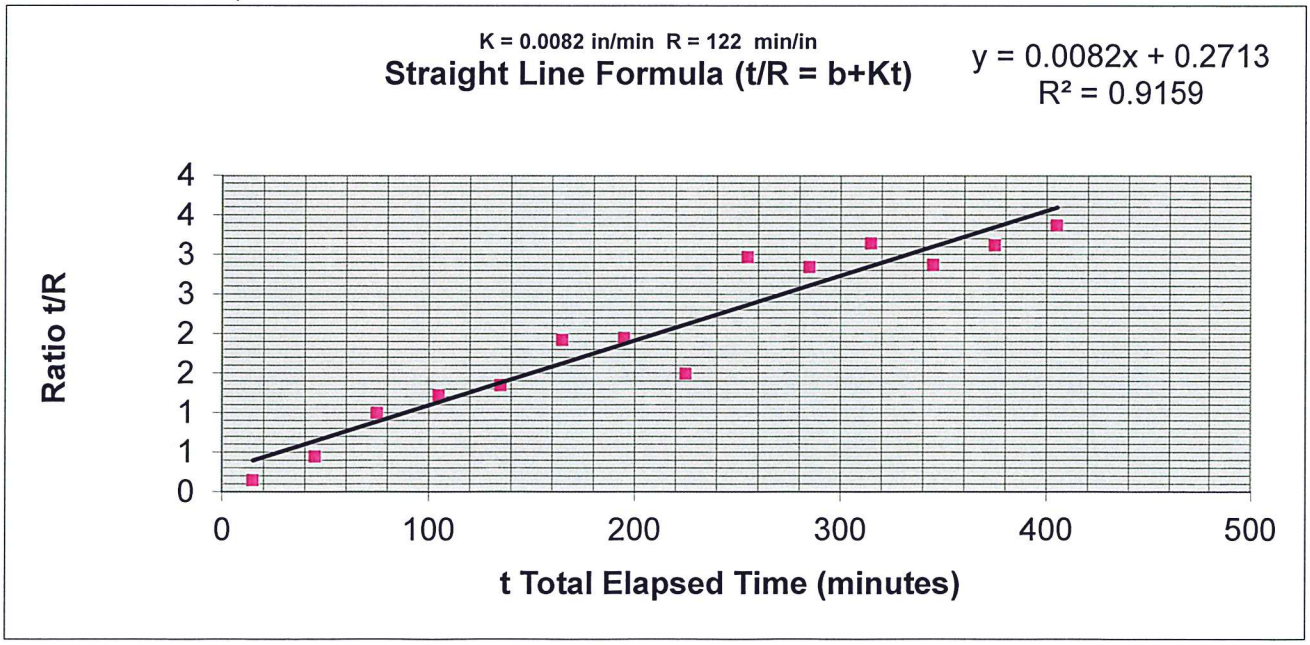
Date	Time of Reading	Δt (min.)	Total Elapsed Time (t)	Average t (minutes)	Reading R_1 (inches)	Reading R_2 (inches)	Drop d (inches)	R=Δt/d (min./in.)	t/R (in.)	k * 1000 (cm/s)
5/7/2017	8:10 AM	0	0							
	8:40 AM	30	30	15	120.00	120.30	0.30	100.00	0.15	0.4
	9:10 AM	30	60	45	120.30	120.60	0.30	100.00	0.45	0.4
	9:40 AM	30	90	75	120.60	121.00	0.40	75.00	1.00	0.6
	10:10 AM	30	120	105	121.00	121.35	0.35	85.71	1.22	0.5
	10:40 AM	30	150	135	121.35	121.65	0.30	100.00	1.35	0.4
	11:10 PM	30	180	165	121.65	122.00	0.35	85.71	1.92	0.5
	11:40 PM	30	210	195	122.00	122.30	0.30	100.00	1.95	0.4
	12:10 PM	30	240	225	122.30	122.50	0.20	150.00	1.50	0.3
	12:40 PM	30	270	255	122.50	122.85	0.35	85.71	2.97	0.5
	1:10 PM	30	300	285	122.85	123.15	0.30	100.00	2.85	0.4
	1:40 PM	30	330	315	123.15	123.45	0.30	100.00	3.15	0.4
	2:10 PM	30	360	345	123.45	123.70	0.25	120.00	2.88	0.4
	2:40 PM	30	390	375	123.70	123.95	0.25	120.00	3.13	0.4
	3:10 PM	30	420	405	123.95	124.20	0.25	120.00	3.38	0.4

Plot: t/R as ordinate vs. 't' as abscissa; tanOC = K.

R_1 = Vertical distance from reference point to water level after refilling at beginning of increment period.

R_2 = Vertical distance from reference point to water level at the end of increment period.

R = 1/K at equilibrium rate.



Fullerton College - New Instructional Building 321 East Chapman Avenue, Fullerton, California	Project:	FC-5180-06
	Plate:	PC-2

GEOTECHNICAL SOLUTIONS, INC.

Percolation Rate Conversion
Infiltration Rate, I_t
Porchet Method, aka Inverse Borehole Method

Fullerton College - Instructional Building
Project No: FC-5180-06

Data collected at the Final Interval analysed:

Percolation Test PC-2

As per Test Result, Percolation Rate = 0.0082 inch/Min = 0.5 inch/hour

Time Interval, Δt	=	30	Minutes	Initial Depth to Water, D_0	=	123.95	Inches
Total Depth of Test Hole, D_t	=	180	Inches	Final Depth to Water, D_f	=	124.2	Inches
Test Hole Radius, r	=	4	Inches				

Initial Height of Water at the selected time interval, H_0	=	56.05	Inches	$(D_t - D_0)$
Final Height of Water at the Selected time interval, H_f	=	55.8	Inches	$(D_t - D_f)$
Change in Height over the time interval, ΔH	=	0.25	Inches	$(H_0 - H_f)$
Average Head Height over the time interval, H_{avg}	=	55.925	Inches	$(H_0 + H_f)/2$

Tested Infiltration Rate, I_t = $\Delta H\ (60\ r) / ((\Delta t)(r + 2\ H_{avg}))$ in/hr

Therefore, I_t = **0.02 inch/hour**