Appendix G Geotechnical Investigation

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John R. Byerly
INCORPORATED

GEOTECHNICAL INVESTIGATION

CHARTER SCHOOL DEVELOPMENT

ASSESSOR'S PARCEL NO. 0414-212-08

HESPERIA, CALIFORNIA

PATHWAYS TO COLLEGE

GEOTECHNICAL ENGINEERS • TESTING AND INSPECTION
2257 South Lilac Ave., Bloomington, CA 92316-2903
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John R. Byerly
INCORPORATED

GEOTECHNICAL INVESTIGATION

JANUARY 14, 2022

CHARTER SCHOOL DEVELOPMENT

ASSESSOR'S PARCEL NO. 0414-212-08

SOUTHEAST CORNER OF THIRD AVENUE AND MOJAVE STREET

HESPERIA, CALIFORNIA

CLIENT:

PATHWAYS TO COLLEGE

9144 THIRD AVENUE

HESPERIA, CALIFORNIA 92804

ATTENTION: CRAIG MERRILL, EXECUTIVE DIRECTOR
RICHARD HANSBERGER, ATTORNEY

RPT. NO.: 7253
FILE NO.: S-14446

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INTRODUCTION

During November and December of 2021 and January of 2022, an investigation of the soil conditions underlying the site of the proposed charter school facility was conducted by this firm. The purpose of our investigation was to evaluate the surface and subsurface conditions at the site with respect to safe and economical foundation types, vertical and lateral bearing values, liquefaction and seismic settlement potential, support of concrete slabs-on-grade, and site preparation. Included in the recommendations are the seismic design parameters as required by the California Building Code and ASCE Standard 7-16. Recommendations are also provided for the design of asphalt concrete pavement for a fire lane and parking and driveway areas, and for the expansion of Third Avenue and improvement of Mojave Street. Percolation testing for storm water disposal was performed within an area proposed for an infiltration basin. The report of the results of the percolation testing is presented under separate cover. Our geotechnical investigation, together with our conclusions and recommendations, is discussed in detail in the following report.

It is our understanding that this report will not be submitted to the Division of the State Architect (DSA) for review. This report will be processed through the City of Hesperia.

This report has been prepared for the exclusive use of Pathways to College and their design consultants for specific application to the project described herein. Should the project be modified, the conclusions and recommendations presented in this report should be reviewed by the geotechnical engineer. Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, express or implied.

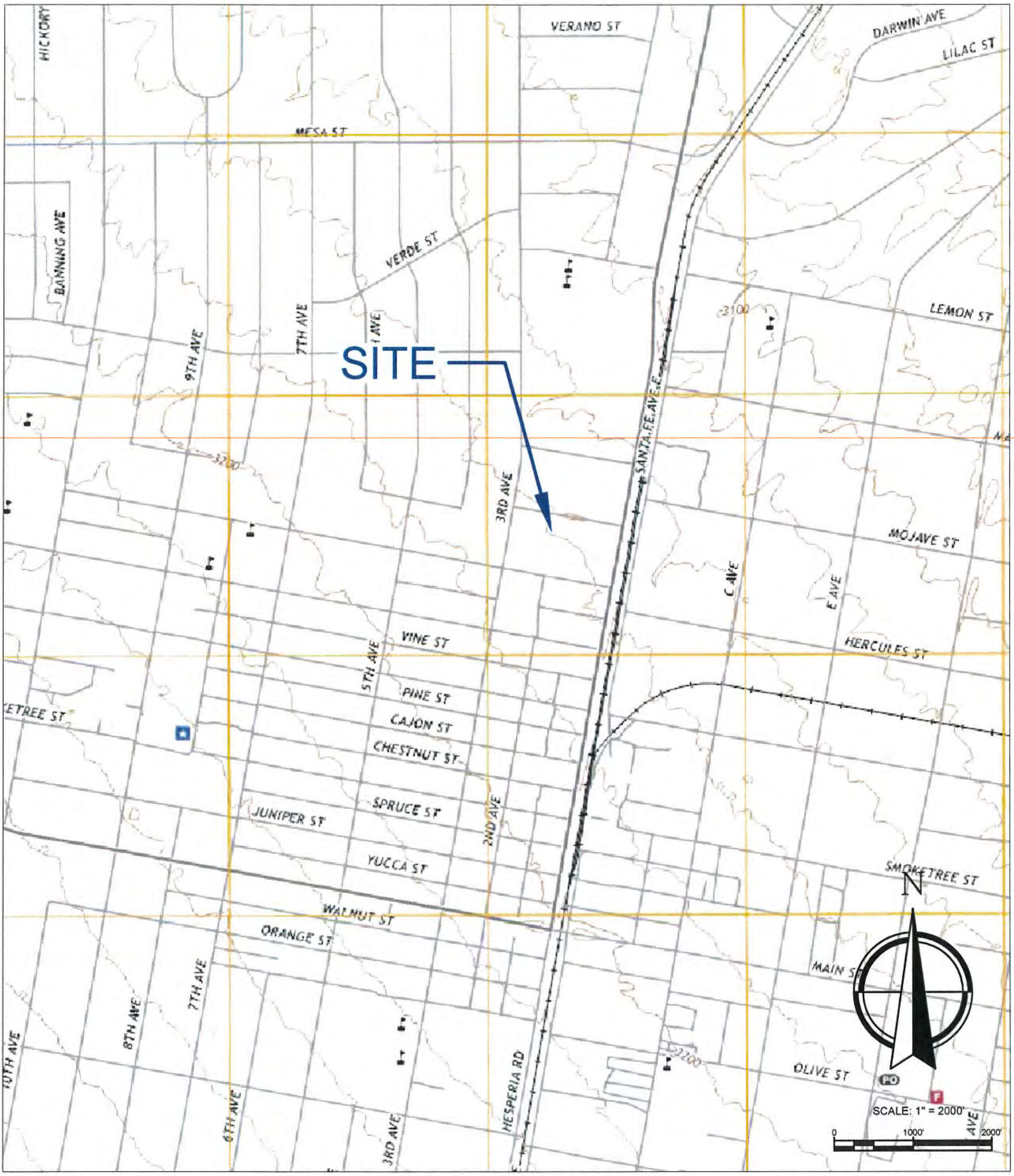
PROJECT DESCRIPTION

For the preparation of this report, we reviewed a plan (Site Plan, Pathways to College K-8, Charter School Development, 3rd Avenue, Hesperia, CA, 92345, Kirk Moeller Architects, Inc., File A1.1, Sheet Number A1.1, October 26, 2021) that was submitted to this office. We understand the proposed construction will consist of a new charter school facility that will primarily consist of a main permanent (site-built) building that will have a total footprint area of 21,400 square feet. This will be a concrete tilt-up structure that will incorporate a concrete slab-on-grade floor. The building will be supported by conventional shallow isolated and continuous footings that will impose moderate foundation loads on the underlying soils. Six classroom pods are planned east of the tilt-up building. Each pod will include six modular buildings. The modular buildings will have plan areas of 960 square feet. The referenced plan shows that six of these modular buildings will be constructed in the future. The modular buildings will have a crawl-space, and will be supported by isolated pad footings that will bear on asphalt concrete pavement that will be constructed below each building. The tilt-up building will be located in the western half of the property. Parking facilities paved with asphalt concrete are proposed between the tilt-up building and 3rd Avenue. A fire lane paved with asphalt concrete is planned immediately east of the new parking lot. A turf soccer field and turf playfield are planned in the eastern part of the property. An infiltration basin is proposed for the northeastern corner of the site. Third Avenue will be widened. Mojave Street will be paved, with a completed width of 26 feet. Walls retaining up to approximately 2 feet of soil are proposed between each pod. Based on the site topography, it is anticipated that maximum cuts and fills will be on the order of 5 feet. Slope construction is not expected. The site configuration and proposed development are illustrated on Enclosure 1.

SITE CONDITIONS

The 10.9-acre site is located on the southeast corner of Third Avenue and Mojave Street in the city of Hesperia. An Index Map showing the general vicinity of the site is presented on the following page. The coordinates of the site are latitude 34.4353° N and longitude 117.3027° W utilizing the North American Datum (NAD) from 1983. Mojave Street is an unpaved road that borders the northern site perimeter. The property is currently dirt-covered and vacant, and is covered with a light to moderate growth of typical desert brush. The remains of a burned tree up to 2 feet in diameter are present in the southwest corner of the site. Piles of end-dumped soil up to 2 feet in height are interspersed throughout the property. An excavation approximately 3 feet in depth and having plan dimensions of about 5 feet by 5 feet is present towards the east-central portion of the site. Minor trash and debris are scattered throughout the lot. The site is relatively flat, sloping downward to the east at a gradient of less than 3 percent. A small area topographically lower than the remainder of the site runs in an approximate northeast-southwest direction through the western portion of the property. This depressed area is up to about 2 feet lower than the adjacent ground. The properties surrounding the school site are either occupied by single-family residences or are vacant.

INDEX MAP



SOURCE DOCUMENTS: USGS HESPERIA QUADRANGLE, CALIFORNIA, 7.5 MINUTE SERIES, 2018

TOWNSHIP AND RANGE: SECTION 16, T4N, R4W

LATITUDE: 34.4353° N

LONGITUDE: 117.3027° W

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FIELD AND LABORATORY INVESTIGATION

The soils underlying the site were explored by means of 17 test borings drilled with a truck-mounted flight-auger to a maximum depth of 51.5 feet below the existing ground surface. The approximate locations of the test borings are indicated on Enclosure 1. The soils encountered were examined and visually classified by one of our field engineers. A summary of the soil classifications appears as Enclosure 2. The exploration logs show subsurface conditions at the dates and locations indicated, and may not be representative of other locations and times. The stratification lines presented on the logs represent the approximate boundaries between soil types, and the transitions may be gradual. A hollow-stem auger with an outside diameter of 7.9 inches was utilized. The inside diameter of the auger was 4.3 inches.

Bulk and relatively undisturbed samples were obtained at selected levels within the explorations and returned to our laboratory for testing and evaluation. The driving energy or blow counts required to advance the sampler at each sample interval were noted. Relatively undisturbed soil samples were recovered at various intervals in the borings with a California sampler. The California sampler was a 2.9-inch outside diameter, 2.5-inch inside diameter, split-barrel sampler lined with brass tubes. The sampler was 18 inches long. The sampler conformed to the requirements of ASTM D 3550. A 140-pound automatic trip hammer was lifted hydraulically and was dropped 30 inches for each blow. Standard penetration tests were performed as Boring 1 was advanced. The standard penetration test blow counts are shown on the logs for this boring. Standard penetration testing was performed with a 2.0-inch outside diameter, 1.5-inch inside diameter, split-barrel sampler. The sampler was 18 inches long and is machined to fit liners. The sampler was unlined and conformed to the requirements of ASTM D 1586. A 140-pound automatic trip hammer was lifted hydraulically and was dropped 30 inches for each blow. An efficiency value of 1.0 was assumed for the automatic trip hammer.

Included in our laboratory testing were moisture/density determinations on all undisturbed samples. Optimum moisture content/maximum dry density relationships were established for typical soil types so that the relative compaction of the subsoils could be determined. Consolidation testing was conducted on selected samples to evaluate the compressibility characteristics of the soil. The moisture/density data are presented on the boring logs presented in Enclosure 2. The maximum density and consolidation test results appear on Enclosures 3 and 4, respectively. Composite samples of potential subgrade soil were tested for gradation, sand equivalent and "R" value for pavement design purposes. The subgrade test results appear on Enclosure 5. Chemical testing, comprised of pH, soluble sulfate, chloride, redox potential, and resistivity testing was also performed. These test results are presented in the "Chemical Test Results" section of this report.

SOIL CONDITIONS

The natural soils encountered in our test borings consisted of medium dense to very dense sands and silty sands with varying amounts of gravel. Artificial fill was not noted at our boring locations, although piles of end-dumped soil were observed on the property. Neither free ground water nor bedrock was encountered in our test borings. The soils encountered in our test borings are granular and non-plastic materials, and are considered to have a very low expansion potential in accordance with ASTM D 4829.

LIQUEFACTION AND DYNAMIC SETTLEMENT

Liquefaction is a phenomenon that occurs when a soil undergoes a transformation from a solid state to a liquefied condition due to the effects of increased pore-water pressure. Loose saturated soils with particle sizes in the medium sand to silt range are particularly susceptible to liquefaction when subjected to seismic ground shaking. Affected soils lose all strength during liquefaction, and foundation failure can occur.

Free ground water was not encountered in our test borings. Based on a review of water well data from the State of California, the closest water well (State Well No. 04N04W21C001S) to the site is located approximately 0.7 mile to the south-southwest. The highest measured ground water in this well was at a depth of 342 feet below grade on January 1, 2017. A second well (State Well No. 04N04W15F001S) is situated approximately 0.9 mile to the east and measured a high ground water level of 298 feet below grade on November 8, 1995. For the purpose of this evaluation, we have assumed an historic high ground water table of 200 feet below the ground surface. This is the value used in our liquefaction analysis. Due to the great depth to ground water, the potential for liquefaction is low.

It is anticipated that major earthquake ground shaking will occur during the lifetime of the proposed development from the North Frontal fault zone, located approximately 7 miles to the southeast of the site. This fault would create the most significant earthshaking event. Based on an earthquake magnitude of 7.2, a peak horizontal ground acceleration of 0.50g is assigned to the site. To evaluate the potential for seismically induced settlement of the subsoils, the soils were analyzed for relative density. The most effective measurement of relative density of sands with respect to seismic settlement potential is standard penetration resistance. Standard penetration tests were performed as Boring 1 was advanced.

Using the information presented in Table 3 of Page 73 of the publication by Idriss and Boulanger (Soil Liquefaction During Earthquakes, Idriss and Boulanger, MNO-12, 2008) an analysis was conducted to determine the sampler correction factor Cs. The SPT sampler is machined to fit liners, therefore a correction factor of 1.0 may not be appropriate. Throughout the test boring, a calculation was performed to determine the average $(N_1)_{60}$ value from which Cs was subsequently determined. An average Cs value greater than 1.3 was calculated, therefore a value of 1.3 was used in the analysis.

The standard penetration data provided input for the LiquefyPro Version 4.3 program for seismically induced settlement potential. As indicated in Special Publication 117A (Revised), "Guidelines for Evaluating and Mitigating Seismic Hazards in California, March 2009," a safety factor of 1.3 was used in this analysis.

The results of this evaluation are shown on Enclosure 7 and reveal a total potential dynamic settlement of 0.35 inch. Since this is a relatively small value, it is our opinion that neither liquefaction nor seismically-induced settlement need to be a consideration in the design of the proposed structures.

CONCLUSIONS

The near-surface soils are in a medium dense to very dense condition. Since the relocatable buildings will exert relatively light loads on the underlying soils, it is acceptable to have the relocatable building footings bear directly on the undisturbed natural soil. Due to the weight of the tilt-up building, it is recommended that minor remedial earthwork be conducted below the tilt-up building footings in order to assure uniform foundation conditions. In addition, any undocumented fill encountered below the tilt-up building and relocatable buildings, retaining wall and screen wall footings, and below pavement and hardscape areas should be removed and replaced as engineered material. Loose natural soil encountered at the bearing level of the footings supporting the tilt-up building should also be removed. With appropriate site preparation, we conclude that the soil conditions underlying the areas of the new improvements are compatible with the proposed construction. Recommendations for foundation design are provided below for soils with a very low expansion potential.

RECOMMENDATIONS

FOUNDATION DESIGN

Where the site is prepared as recommended, the proposed buildings may be founded on conventional continuous and isolated footings. Footings supporting the tilt-up building and any retaining walls should be at least 18 inches deep and should be designed for a maximum safe soil bearing pressure of 2,500 pounds per square foot for dead plus live loads. Footings supporting the modular buildings may bear directly on asphalt concrete pavement and should be designed for a maximum safe soil bearing pressure of 1,500 pounds per square foot for dead plus live loads. These values may be increased by one-third for wind and seismic loading.

Continuous footings should be reinforced with at least four No. 4 bars, two placed near the top and two near the bottom of the footings. This recommendation for foundation reinforcement is based on geotechnical considerations. Structural design may require additional foundation reinforcement.

For footings thus designed and constructed, we would anticipate a maximum settlement of less than 1 inch and a maximum differential settlement slope of 1:850.

SEISMIC DESIGN PARAMETERS

The seismic design coefficients as required by the 2019 California Building Code and ASCE Standard 7-16 are provided in the following table:

Factor or Coefficient	***Value***
Latitude	34.4353° N
Longitude	117.3027° W
Mapped S_S	1.357g
Mapped S_1	0.523g
F_a	1.2
F_v	1.777
Final S_{MS}	1.628g
Final S_{M1}	0.929g
Final S_{DS}	1.085g
Final S_{D1}	0.619g
PGA	0.50g
T_L	12 seconds
Site Class	D

LATERAL LOADING

Retaining wall backfill within 6 feet of the walls should consist of granular soil exhibiting a very low (expansion potential between 0 and 21) expansion potential. For a level backfill surface and cantilever retaining wall conditions, we recommend an active earth pressure of 35 pounds per square foot per foot of depth, exclusive of surcharge loads. For braced walls with level backfill surface conditions, we recommend an at-rest earth pressure of 60 pounds per square foot per foot of depth, exclusive of surcharge loads. For shallow footings, resistance to lateral loads will be provided by passive earth pressure and basal friction. For footings bearing against compacted fill or medium dense natural soil, passive earth pressure may be considered to develop at a rate of 300 pounds per square foot per foot of depth. Basal friction may be computed at 0.35 times the normal dead load. The resistance from basal friction and passive earth pressure may be combined directly without reduction. A backdrain system or weep holes should be provided to prevent buildup of hydrostatic pressure behind retaining walls. The allowable lateral resistance may be increased by one-third for wind and seismic loading.

SLABS-ON-GRADE

Concrete slab-on-grade design recommendations are presented below. The slab-on-grade recommendations assume underlying utility trench backfills and pad subgrade soils have been densified to a relative compaction of at least 90 percent (ASTM D1557).

1. It is our opinion that the compacted fill soils or medium dense natural soil should provide adequate support for concrete slabs-on-grade without the use of a gravel base. The final pad surface should be rolled to provide a smooth dense surface upon which to place the concrete.

2. Slab-on-grade floors should be at least 4 inches thick – structural considerations may require a thicker slab. The concrete slabs-on-grade may be designed using a modulus of subgrade reaction of 250 pounds per cubic inch.

3. It is recommended that concrete slabs-on-grade be reinforced with No. 3 bars at 16 inches each way in the middle third of the slab, or equivalent. All slab reinforcement should be supported by chairs or precast concrete blocks to ensure positioning of reinforcement of the slab. Lifting of unsupported reinforcement during concrete placement should not be allowed.

4. Slabs to receive moisture-sensitive floor coverings should be underlain with a moisture vapor retardant membrane, such as 10-mil Stego Wrap or equivalent. The moisture vapor retardant membrane should conform to ASTM E 1745-11 (Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs). The moisture vapor retardant membrane should be lapped into the footing excavations to provide full coverage of the subgrade soils. Punctures and/or holes cut for plumbing should be taped to minimize moisture emissions through the membrane. The project inspector and/or a representative of the geotechnical engineer should inspect the placement of the moisture vapor retardant membrane prior to covering. Installation of the moisture vapor retardant membrane should be performed in accordance with ASTM E 1643-11 (Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs).

5. A 2-inch layer of clean sand (SE>30, no more than 7 percent passing the No. 200 sieve) should be placed over the moisture vapor retardant membrane to promote uniform setting of the concrete. Concrete should be placed on the sand blanket when the sand is damp. Excess moisture should not be allowed to accumulate within the sand blanket prior to concrete placement. At the time of concrete placement, the moisture content of the sand blanket above the moisture vapor retardant membrane should not exceed 2 percent <u>below</u> the optimum moisture content.

6. In lieu of placing the sand blanket described above and to further minimize future moisture vapor emissions through the slabs-on-grade, the slab concrete may be placed directly on the moisture vapor retardant membrane. Placing concrete directly on the moisture vapor retardant membrane will increase shrinkage and curling forces and make finishing more difficult. To accommodate these concerns, the structural engineer should provide appropriate mix design criteria for concrete placed directly on the moisture vapor retardant membrane.

7. We recommend a maximum water-cement ratio of 0.50 for all building slab concrete. Architectural or structural considerations may require the utilization of a lower water-cement ratio. Where slab concrete is placed directly on the moisture vapor retardant membrane without the presence of an intervening layer of absorptive sand, a lower maximum water-cement ratio may be needed.

8. Preparation of the concrete floor slabs should conform to ASTM F 710-11 (Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring) and the manufacturer's recommendations. Moisture vapor emission tests should be performed to verify acceptable moisture emission rates prior to flooring installation.

SITE PREPARATION

We assume that the site will be prepared in accordance with the California Building Code or the current City of Hesperia Grading Ordinance. The recommendations presented below are to establish additional grading criteria. These recommendations should be considered preliminary and are subject to modification or expansion based on a geotechnical review of the project foundation and grading plans.

- All areas to be graded should be stripped of organic matter, man-made obstructions, and other deleterious materials. Underground utilities should be removed and relocated or abandoned. All cavities created during site clearing should be cleaned of loose and disturbed soil, shaped to provide access for construction equipment, and backfilled with fill placed and compacted as described below.

- Undocumented fill encountered during earthwork operations should be removed from building, retaining wall, screen wall, pavement, and hardscape areas. Deleterious material should be separated from the removed fill and hauled from the site. The excavated fill should be stockpiled pending replacement or be placed in previously prepared areas.

- Overexcavation

    - <u>Building areas and retaining wall footings</u> – Below footings supporting the tilt-up building and retaining walls, and subsequent to removal of any undocumented fill, loose natural soils encountered below the bottom of the footings should be overexcavated until competent natural soil is encountered. Competent natural soil is defined as relatively non-porous soil exhibiting a relative compaction of at least 85 percent (ASTM D1557). If there is a transition condition between competent material and artificial fill, the competent material should be overexcavated so there is at least 2 feet of overexcavated and recompacted soil below the bottom of the footings. The soils exposed in the bottom of the excavations should be evaluated by a representative of the geotechnical engineer.

    - <u>Asphalt concrete slab below relocatable buildings</u> – Subsequent to removal of any undocumented fill and in areas where no fill is present, the natural soils below the bottom of the asphalt concrete that will be situated below the relocatable buildings should be scarified to a depth of 12 inches below existing grade or 12 inches below proposed finished grade, whichever is greater. Finished grade is defined as the top of the subgrade. The scarified soil should be moisture conditioned to at least the optimum moisture content and densified to a relative compaction of at least 90 percent (ASTM D1557).

  - Screen wall footings – Subsequent to removal of any undocumented fill, the natural soils below the bottom of screen wall footings should be overexcavated to a depth of 2 feet below proposed finished grade or 2 feet below the bottom of the footings, whichever is greater.

  - Limits of overexcavation – The overexcavation should extend beyond the building areas and retaining wall and screen wall footings a horizontal distance at least equal to the depth of overexcavation below the bottom of the foundation elements or 5 feet, whichever is greater.

  - Asphalt concrete roadway, parking, fire lane and driveway areas – Undocumented fill should be removed below parking, driveway and fire lane areas. Artificial fill should be removed below Mojave Street and the portion of Third Avenue that will be widened. The natural soils below these areas should be scarified to a depth of 12 inches below existing grade or 12 inches below proposed finished grade, whichever is greater. Finished grade is defined as the top of the subgrade. The scarified soil should be moisture conditioned to at least the optimum moisture content and densified to a relative compaction of at least 90 percent (ASTM D1557).

  - Hardscape areas – Undocumented fill should be removed below proposed hardscape areas. The natural soils below these areas should be scarified to a depth of at least 12 inches, moisture conditioned to at least the optimum moisture content, and densified to a relative compaction of at least 90 percent (ASTM D1557).

- Approved subexcavated surfaces and all other surfaces to receive fill should be scarified to a minimum depth of 8 inches, moisture conditioned to at least the optimum moisture content, and densified to a relative compaction of at least 90 percent (ASTM D1557).

- The on-site soils should provide adequate quality fill material below building and hardscape areas provided they are free from significant organic matter and other deleterious materials and are at acceptable moisture contents. Import fill should be inorganic, granular, non-expansive soil free from rocks or lumps greater than 8 inches in maximum dimension and should exhibit a very low expansion potential (expansion index less than 21), negligible sulfate content (less than 1,000 ppm soluble sulfate by weight), and low corrosion potential. Prior to bringing import fill to the site, the contractor should obtain certification to verify that the proposed import meets the State of California Department of Toxic Substance Control (DTSC) environmental standards. Proposed import should be sampled at the source and tested by this firm for expansion index, soluble sulfate content, and corrosion potential.

- Engineered fill within 6 feet of retaining walls should exhibit a very low expansion potential (expansion index less than 21).

- All fill should be placed in 8-inch or less lifts; each lift should be moisture conditioned to at least the optimum moisture content, and densified to a minimum relative compaction of 90 percent (ASTM D1557).

- The surface of the site should be graded to provide positive drainage away from the structures. Drainage should be directed to established swales and then to appropriate drainage structures to minimize the possibility of erosion. Water should not be allowed to pond adjacent to footings.

SHRINKAGE AND SUBSIDENCE

Volume change in going from cut to fill conditions is anticipated where near-surface grading will occur. Assuming the fill will be compacted to an average relative compaction of 93 percent, an average cut-fill shrinkage of 10 to 15 percent is estimated. Further volume loss will occur through subsidence during preparation of the natural ground surface. Although the contractor's methods and equipment utilized in preparing the natural ground will have a significant effect on the amount of natural ground subsidence that will occur, our experience indicates as much as 0.10 to 0.15 foot of subsidence in areas prepared to receive fill should be anticipated. These values are exclusive of losses due to stripping or removal of subsurface obstructions.

ASPHALT CONCRETE AND PORTLAND CEMENT CONCRETE HARDSCAPE

A representative sample of near-surface soil at the site has been tested for relevant subgrade properties. A Traffic Index of 5.0 was assumed for the new parking lots and drive areas for conventional vehicular traffic, and a Traffic Index of 6.0 was assumed for areas accommodating heavier truck or bus traffic and fire lanes. A Traffic Index of 5.5 was recommended by the project civil engineer for the widening of Third Avenue and the improvement of Mojave Street. An attempt was made to contact the City of Hesperia to obtain a Traffic Index for Third Avenue and Mojave Street. It may be prudent to verify with the City of Hesperia that a Traffic Index of 5.5 will apply to these streets. In conjunction with the test data shown on Enclosure 5, we believe the sections presented on the following table should provide durable pavement.

Asphalt Concrete Pavement

			Thickness (Inches)	
Location	**TI**	**"R" Value**	**Asphalt Concrete**	**Aggregate Base**
Conventional Passenger Vehicles	5.0	48	2.5	4.0
Fire Lane, Bus and Truck Traffic Areas	6.0	48	3.0	5.0
Expansion of Third Avenue	5.5	48	3.0	4.0
Improvement of Mojave Street	5.5	48	3.0	4.0

For hardscape areas to receive only pedestrian traffic, we recommend portland cement concrete pavement be at least 3.5 inches in thickness and be placed directly on the compacted subgrade soil. Prior to the placement of hardscape concrete, we recommend that the final subgrade surface be scarified to a depth of at least 12 inches, moisture conditioned to at least the optimum moisture content, and densified to a minimum relative compaction of 90 percent (ASTM D1557).

The above designs are preliminary and for estimating purposes only. We recommend that during the process of rough grading, observation and additional testing of the actual subgrade soils should be performed. Final pavement design sections can then be determined. The foregoing pavement sections assume that utility trench backfill below all proposed pavement areas will be compacted to at least 90 percent relative compaction. Prior to the placement of aggregate base, we recommend that the final subgrade surface be scarified to a depth of at least 12 inches, moisture conditioned to at least the optimum moisture content, and compacted to a minimum relative compaction of 90 percent (ASTM D1557). Aggregate base should be densified to at least 95 percent relative compaction. Suggested specifications for aggregate base material are presented on Enclosure 6. The preparation of the subgrade and compaction of the aggregate base should be monitored by a representative of the geotechnical engineer.

CHEMICAL TEST RESULTS

The chemical test results from a sample taken from Boring 1 between the ground surface and a depth of 5 feet are shown on the following table:

Analysis	Result	Units
Saturated Resistivity	11200	ohm-cm
Chloride	ND (Not Detected)	ppm
Sulfate	60	ppm
pH	9.0	pH units
Redox Potential	158	mV

The soil tested exhibited negligible soluble sulfate content; therefore, sulfate-resistant concrete will not be required for this project. Since the soils have a relatively high pH value, they may be detrimentally corrosive to ferrous-metal pipes. Recommendations for protection of buried ferrous metal pipe should be provided by a corrosion engineer.

FOUNDATION AND GRADING PLAN REVIEW

The project foundation and grading plans should be reviewed by the geotechnical engineer. Additional recommendations may be required at that time.

CONSTRUCTION OBSERVATIONS

All grading operations, including the preparation of the natural ground surface, should be observed and compaction tests performed by this firm. No fill should be placed on any prepared surface until that surface has been evaluated by the representative of the geotechnical engineer.

The footing excavations for the building and retaining walls should be evaluated by a representative of the geotechnical engineer prior to placement of forms or reinforcing steel.

The conclusions and recommendations presented in this report are based upon the field and laboratory investigation described herein and represent our best engineering judgment. Should conditions be encountered in the field that appear different from those described in this report, we should be contacted immediately in order that appropriate recommendations might be prepared.

Respectfully submitted,

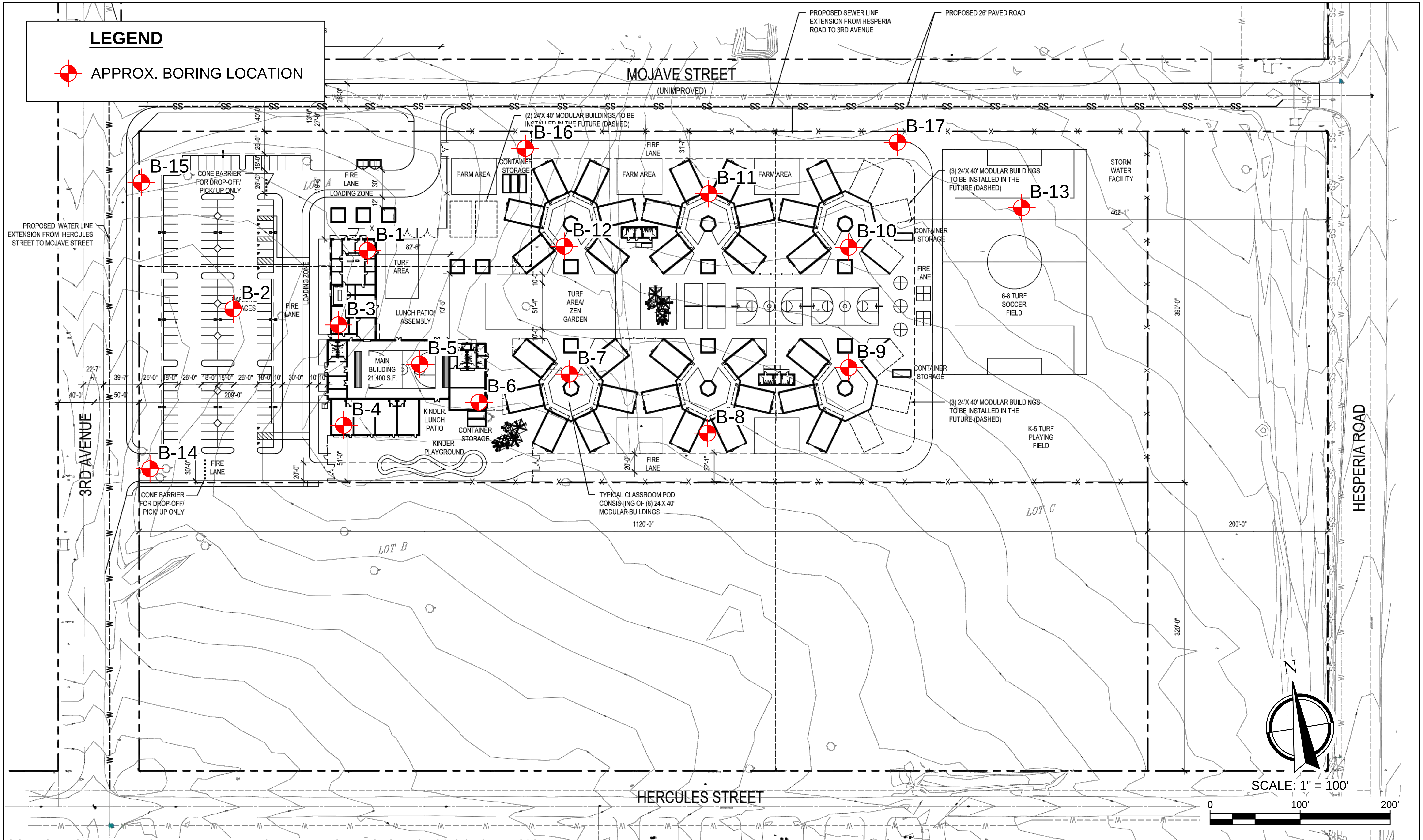
JOHN R. BYERLY, INC.

John R. Byerly, Geotechnical Engineer
President

LICENSED PROFESSIONAL ENGINEER
JOHN R. BYERLY
GE 000179
EXP. 06/30/23
GEOTECHNICAL
STATE OF CALIFORNIA

JRB:GSF:jet

Enclosures:
(1) Plot Plan
(2) Test Boring Logs
(3) Maximum Density Determinations
(4) Consolidation Test Results
(5) Subgrade Test Results
(6) Specifications for Aggregate Base
(7) Liquefaction Analysis



SOURCE DOCUMENT: SITE PLAN, KIRK MOELLER ARCHITECTS, INC., 26 OCTOBER 2021

John R. Byerly INCORPORATED	SOILS INVESTIGATION	G-21 APN 0414-212-08 SOUTHEAST CORNER OF THIRD AVENUE AND MOJAVE STREET HESPERIA, CALIFORNIA	Enclosure 1 Rpt. No.: 7253 File No.: S-14446

B-1

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		26	118	0.9	89	
		31	118	1.0	89	
		50/9"	117	2.3	88	
	39					
10						
		50/6"	121	2.3	---	
	50					
		50/11"	118	2.2	91	
	43					
20						
		50/8"	---	1.7	---	
	41					
		50/8"	112	1.3	---	
	51					
30						
		50/7"	115	3.1	---	
	42					
	43					
40						
	38					
	55					
50						
	61					
60						
70						

SM	Light brown silty fine to medium sand, dry and medium dense
SM	Light brown silty fine to coarse sand with gravel, dry and dense
SP	Light brown fine to coarse sand with gravel, damp and dense to very dense
SP	Light brown gravelly fine to coarse sand, dry and dense
SP	Light brown fine to coarse sand with gravel, damp and dense to very dense
SM	Light brown silty fine to medium sand with gravel, damp and dense - becoming very dense at 45.0 feet

Total Depth at 51.5 Feet
No Free Ground Water Encountered

LOG OF BORING

B-2

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0		45	121	1.2	91	GWT not encountered	SM	Red-brown silty fine to coarse sand with a trace of gravel, dry and dense
		57	121	2.0	92		SM	Red-brown silty fine to coarse sand with gravel, dry and dense to very dense
5		50/6"	123	2.9	94			
								Total Depth at 6.0 Feet No Free Ground Water Encountered
10								
15								
20								
25								
30								
35								

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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Rpt. No.: 7253
File No.: S-14446

B-3

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0						GWT not encountered	SM	Light brown silty fine to medium sand, damp and dense
		50/6"	118	3.9	89			
							SM	Light brown silty fine to coarse sand with gravel, damp and dense to very dense
		50/6"	120	3.8	91			
5								
		50	121	2.9	92			
		50	116	2.9	88			
							SP	Brown gravelly fine to coarse sand, dry and dense
10								
		43	116	2.7	90			
15								
		36	111	1.7	86			- becoming medium dense a 15.0 feet
							SP	Light brown fine to coarse sand with gravel, dry and dense
20								
		47	---	1.8	---			
								Total Depth at 21.5 Feet No Free Ground Water Encountered
25								
30								
35								

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

Enclosure 2, Page 3
Rpt. No.: 7253
File No.: S-14446

B-4

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		50/11"	117	2.0	88	
		50/6"	121	5.1	91	
5		50/8"	---	3.9	---	
		50/11"	120	2.1	91	
10		47	120	1.4	---	
15		44	116	1.6	90	
20		47	117	2.1	---	
25		50/11"	118	2.2	---	
30		50	122	5.8	---	
35						

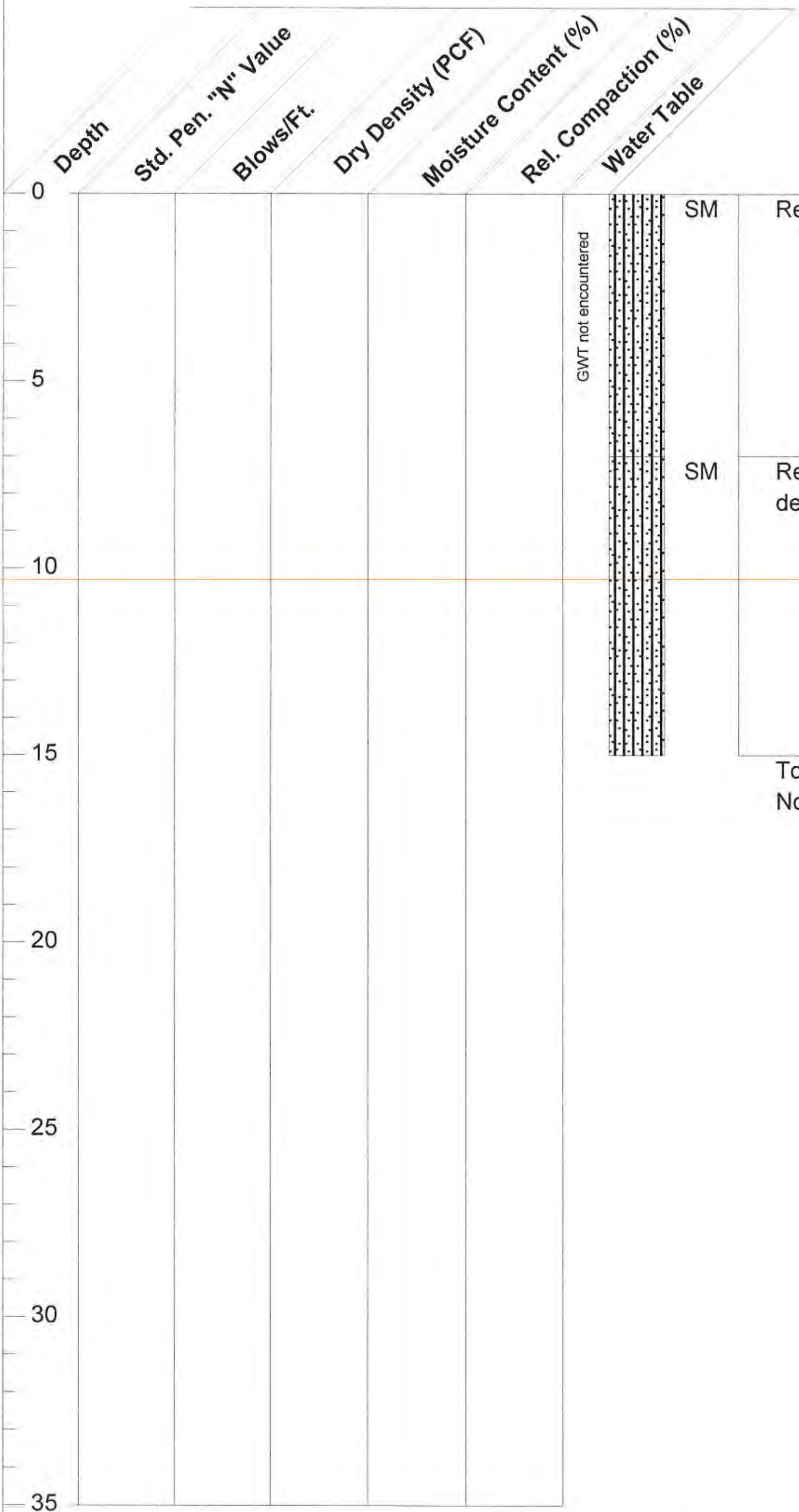
SM	Light brown silty fine to medium sand, dry and medium dense - becoming dense to very dense at 3.5 feet
SM	Light brown silty fine to coarse sand with gravel, dry and dense
SP	Light brown fine to coarse sand with gravel and a trace of silt, dry and dense
SP	Light brown gravelly fine to coarse sand, dry and dense
SP	Light brown fine to medium sand, dry and dense
SP SM	Light brown fine to medium sand with gravel and silt, dry and dense - becoming damp at 30.0 feet

Total Depth at 31.5 Feet
No Free Ground Water Encountered

LOG OF BORING

B-5

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger



SM	Red-brown silty fine to coarse sand, dry and dense
SM	Red-brown silty fine to coarse sand with gravel, damp and dense

Total Depth at 15.0 Feet
No Free Ground Water Encountered

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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B-6

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		40	119	1.3	89	
		45	123	1.1	92	
5		50/6"	---	3.6	---	
		50	119	1.9	91	
10		50/10"	122	4.0	---	
15		50/8"	---	1.6	---	
20		50/9"	122	2.3	---	
25		50/8"	---	1.2	---	
30		50/7"	121	2.5	94	
35						

SM	Light brown silty fine to medium sand, dry and medium dense - becoming dense at 3.5 feet - becoming damp and very dense at 5.5 feet
SM	Light brown silty fine to coarse sand with gravel, dry and dense
SM	Light brown fine to medium sand with gravel and silt, damp and dense
SP	Red-brown fine to coarse sand with gravel, dry and very dense
SP	Light brown gravelly fine to coarse sand, dry and very dense

Total Depth at 31.5 Feet
No Free Ground Water Encountered

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

Enclosure 2, Page 6
Rpt. No.: 7253
File No.: S-14446

B-7

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0						GWT not encountered	SM	Red-brown silty fine to coarse sand with a trace of gravel, dry and medium dense
								- becoming dense at 4.0 feet
5							SM	Red-brown silty fine to coarse sand with gravel, damp and dense
10								
15								Total Depth at 15.0 Feet No Free Ground Water Encountered
20								
25								
30								
35								

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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File No.: S-14446

B-8

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		25	116	2.0	87	
		33	117	2.7	88	
5		42	120	6.8	91	
		47	121	6.0	92	
10		46	118	5.2	90	
15		50/9"	116	2.4	90	
20		50/11"	117	5.8	91	
25						
30						
35						

SM	Light brown silty fine to medium sand, dry and medium dense
SM	Brown silty fine to coarse sand with gravel, damp and dense
SP	Light brown gravelly fine to coarse sand, dry and dense - becoming damp at 20.0 feet

Total Depth at 21.4 Feet
No Free Ground Water Encountered

LOG OF BORING

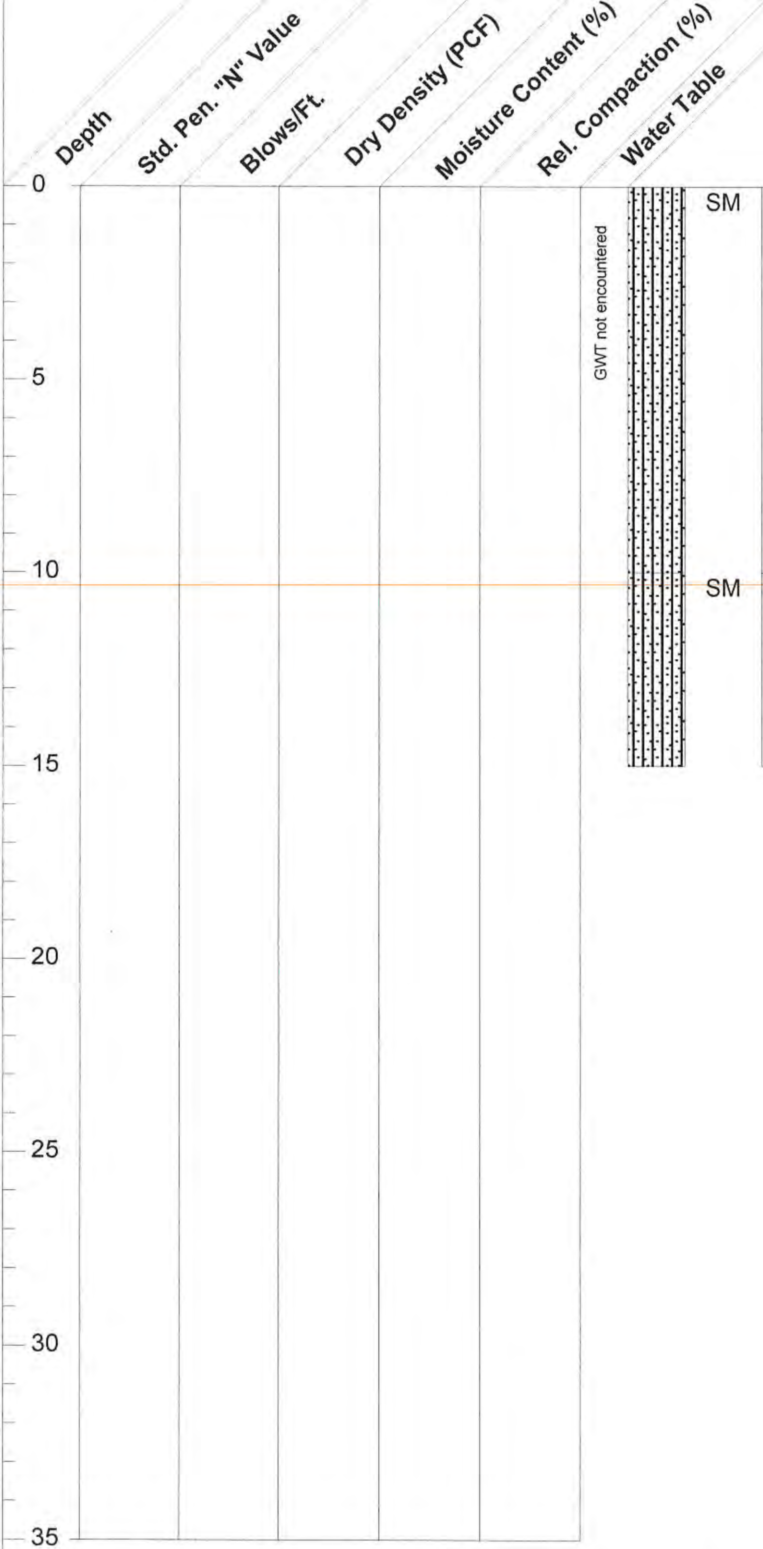
John R. Byerly, Inc.

Charter School Development
Hesperia, California

Enclosure 2, Page 8
Rpt. No.: 7253
File No.: S-14446

B-9

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger



SM Red-brown silty fine to coarse sand with a trace of gravel, dry and dense

SM Red-brown silty fine to coarse sand with gravel, dry and dense

Total Depth at 15.0 Feet
No Free Ground Water Encountered

LOG OF BORING

B-10

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		25	115	2.3	87	
		27	116	3.1	88	
5		56	121	5.6	92	
		77	123	4.9	94	
10		50/6"	---	4.1	---	
15		50/6"	---	6.5	---	
20		50/3"	121	4.9	---	
25						
30						
35						

SM	Red-brown silty fine to coarse sand with a trace of gravel, dry and medium dense
SM	Red-brown silty fine to coarse sand with gravel, damp and medium dense - becoming very dense at 5.0 feet
SM	Red-brown silty fine to coarse sand with gravel and a trace of clay, damp and very dense
SM	Red-brown silty fine to coarse sand, damp and very dense

Total Depth at 21.3 Feet
No Free Ground Water Encountered

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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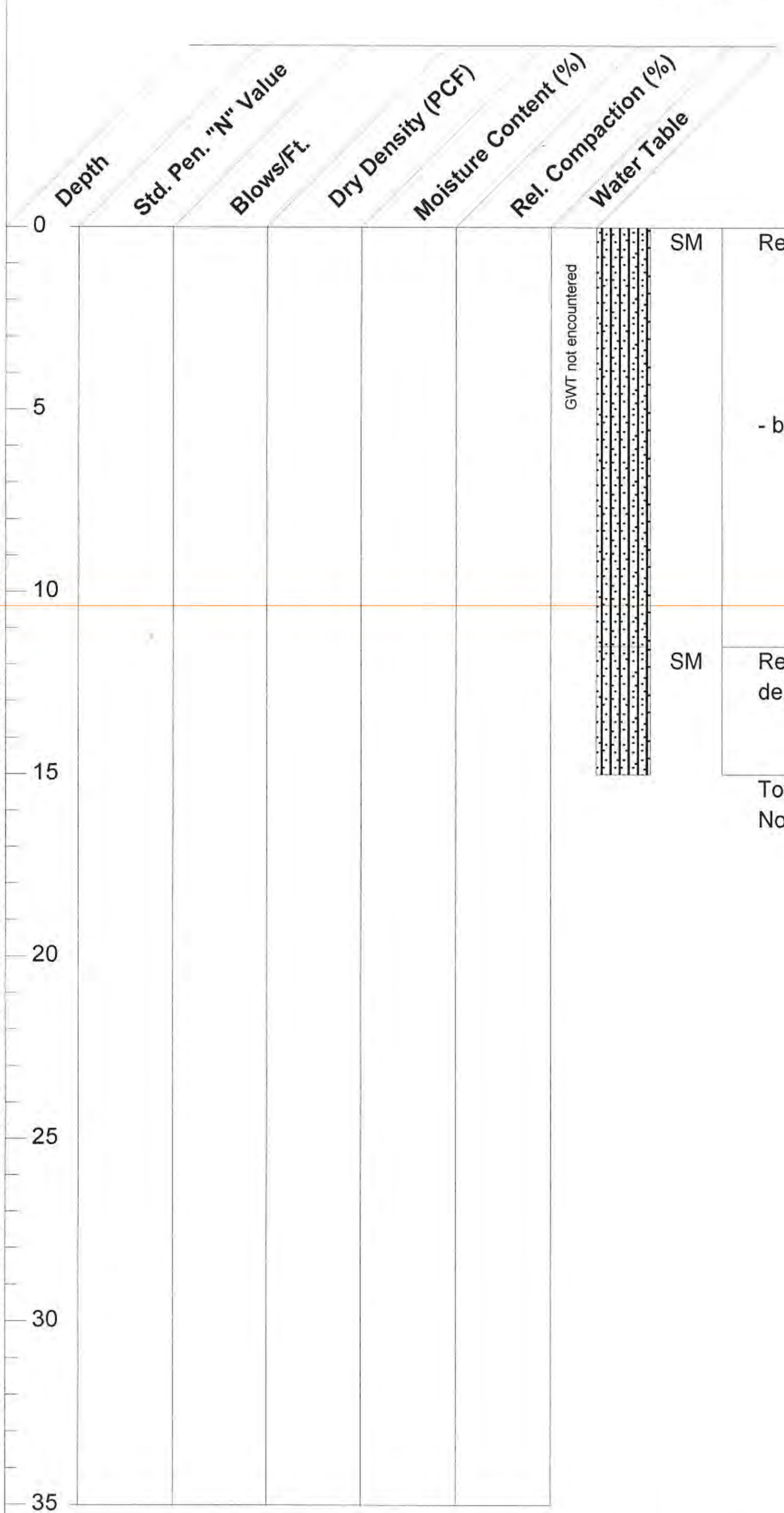
Rpt. No.: 7253
File No.: S-14446

B-11

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger



SM Red-brown silty fine to coarse sand, dry and medium dense

- beocming dense at 5.0 feet

SM Red-brown silty fine to coarse sand with gravel, dry and dense

Total Depth at 15.0 Feet
No Free Ground Water Encountered

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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File No.: S-14446

B-12

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0		50/6"	125	3.0	95	GWT not encountered	SM	Red-brown silty fine to coarse sand with gravel, damp and very dense
		50/6"	125	5.1	95			
5		78	124	4.8	94			
		75	119	2.8	---		SM	Red-brown fine to coarse sand with silt, dry and dense
10		61	117	5.3	---			
15		53	119	2.9	93		SP	Brown gravelly medium to coarse sand, damp and very dense
20		79	118	4.3	92			
25								
30								
35								

Total Depth at 21.5 Feet
No Free Ground Water Encountered

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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File No.: S-14446

B-13

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0						GWT not encountered	SM	Red-brown silty fine to coarse sand, dry and dense
5								
10							SM	Red-brown silty fine to coarse sand with gravel, dry and dense
15								Total Depth at 15.0 Feet No Free Ground Water Encountered
20								
25								
30								
35								

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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Rpt. No.: 7253
File No.: S-14446

B-14

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0						GWT not encountered	SM	Red-brown silty fine to coarse sand with a trace of gravel, damp and dense
		93	120	3.1	90			
		100	120	4.5	90			
5		78	120	4.9	---		SP	Red-brown fine to coarse sand with gravel, damp and very dense
								Total Depth at 6.5 Feet No Free Ground Water Encountered
10								
15								
20								
25								
30								
35								

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECT\File No. S-14446 (Rpt. No. 7253).log Date: 1/14/2022

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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File No.: S-14446

B-15

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		50/6"	122	4.7	92	
		50/6"	---	4.2	---	
5		70	124	3.9	93	
10						
15						
20						
25						
30						
35						

SM Red-brown silty fine to coarse sand with gravel, damp and very dense

Total Depth at 6.5 Feet
No Free Ground Water Encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\PROJECT\File No. S-14446 (Rpt. No. 7253).log Date: 1/14/2022

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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B-16

Boring Date: 11/20/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table
0						GWT not encountered
		38	115	3.0	86	
		50/6"	---	3.4	---	
5		49	124	6.4	93	
10						
15						
20						
25						
30						
35						

SM Red-brown silty fine to medium sand, damp and medium dense

SM Red-brown silty fine to coarse sand with gravel, damp and very dense

Total Depth at 6.5 Feet
No Free Ground Water Encountered

LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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Rpt. No.: 7253
File No.: S-14446

B-17

Boring Date: 12/04/21
Surface Elevation:
Drilling Method: Truck-Mounted Flight-Auger

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table		
0						GWT not encountered	SM	Red-brown silty fine to medium sand, dry and very dense
		50/6"	124	2.9	93			
		50/6"	---	6.0	---		SM	Brown silty fine to coarse sand with gravel, damp and very dense
5		50/5"	124	5.6	93			
								Total Depth at 6.4 Feet No Free Ground Water Encountered
10								
15								
20								
25								
30								
35								

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LOG OF BORING

John R. Byerly, Inc.

Charter School Development
Hesperia, California

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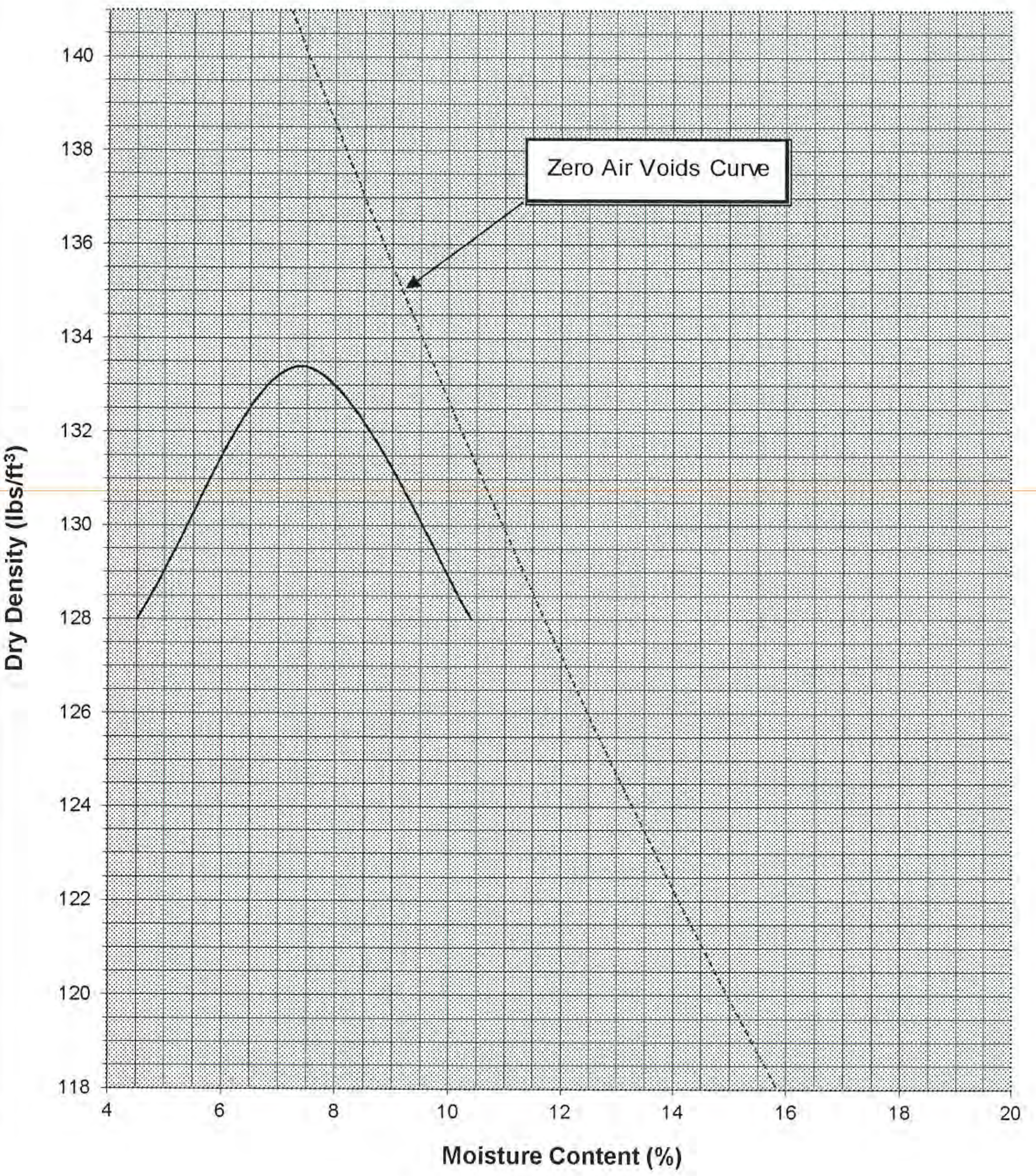
Rpt. No.: 7253
File No.: S-14446

Moisture/Density Relationship
ASTM D1557 (Method A)



Boring No.	B-1
Depth (ft.)	1.5
Optimum Moisture (%)	7.4
Maximum Dry Density (pcf)	133.4
Soil Classification	Light brown silty fine to medium sand (SM)

Charter School Development
Hesperia, California

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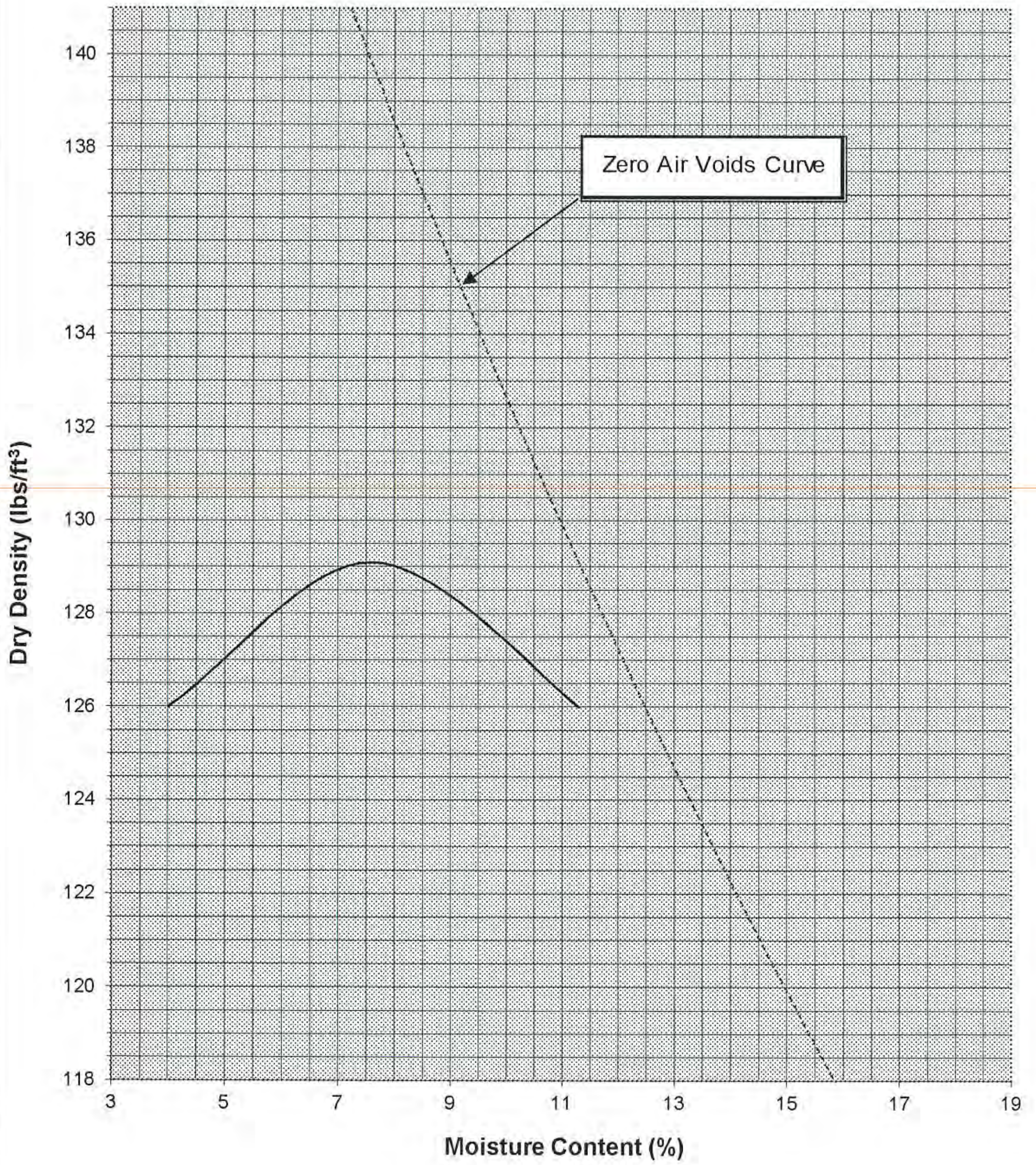
File No.: S-14446

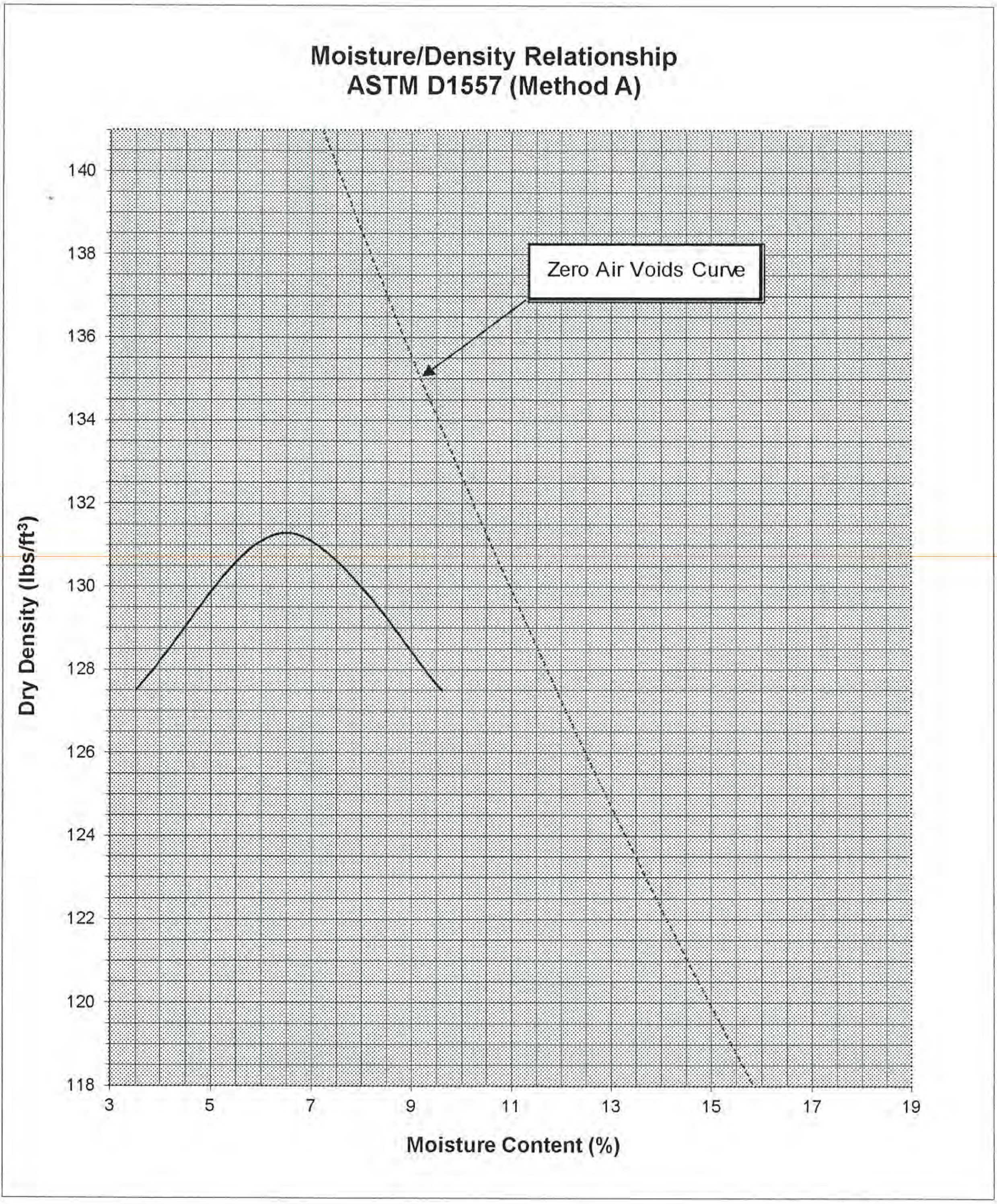
Moisture/Density Relationship
ASTM D1557 (Method A)



Boring No.	B-3
Depth (ft.)	10.5
Optimum Moisture (%)	7.6
Maximum Dry Density (pcf)	129.1
Soil Classification	Brown gravelly fine to coarse sand (SP)

Charter School Development
Hesperia, California

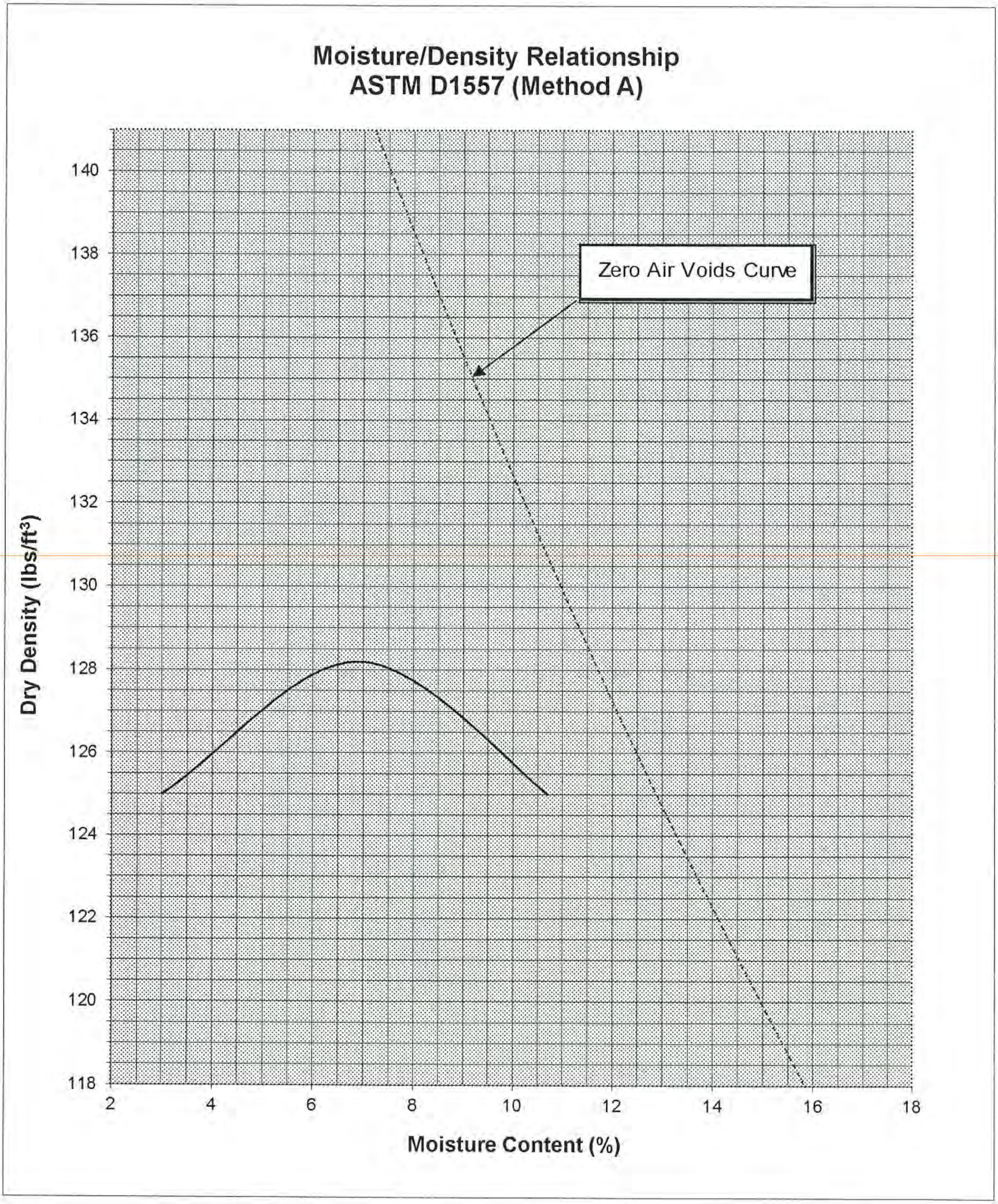
Enclosure 3, Page 2
Rpt. No.: 7253
File No.: S-14446



Boring No.	B-5
Depth (ft.)	8.0
Optimum Moisture (%)	6.5
Maximum Dry Density (pcf)	131.3
Soil Classification	Brown gravelly fine to coarse sand (SP)

Charter School Development
Hesperia, California

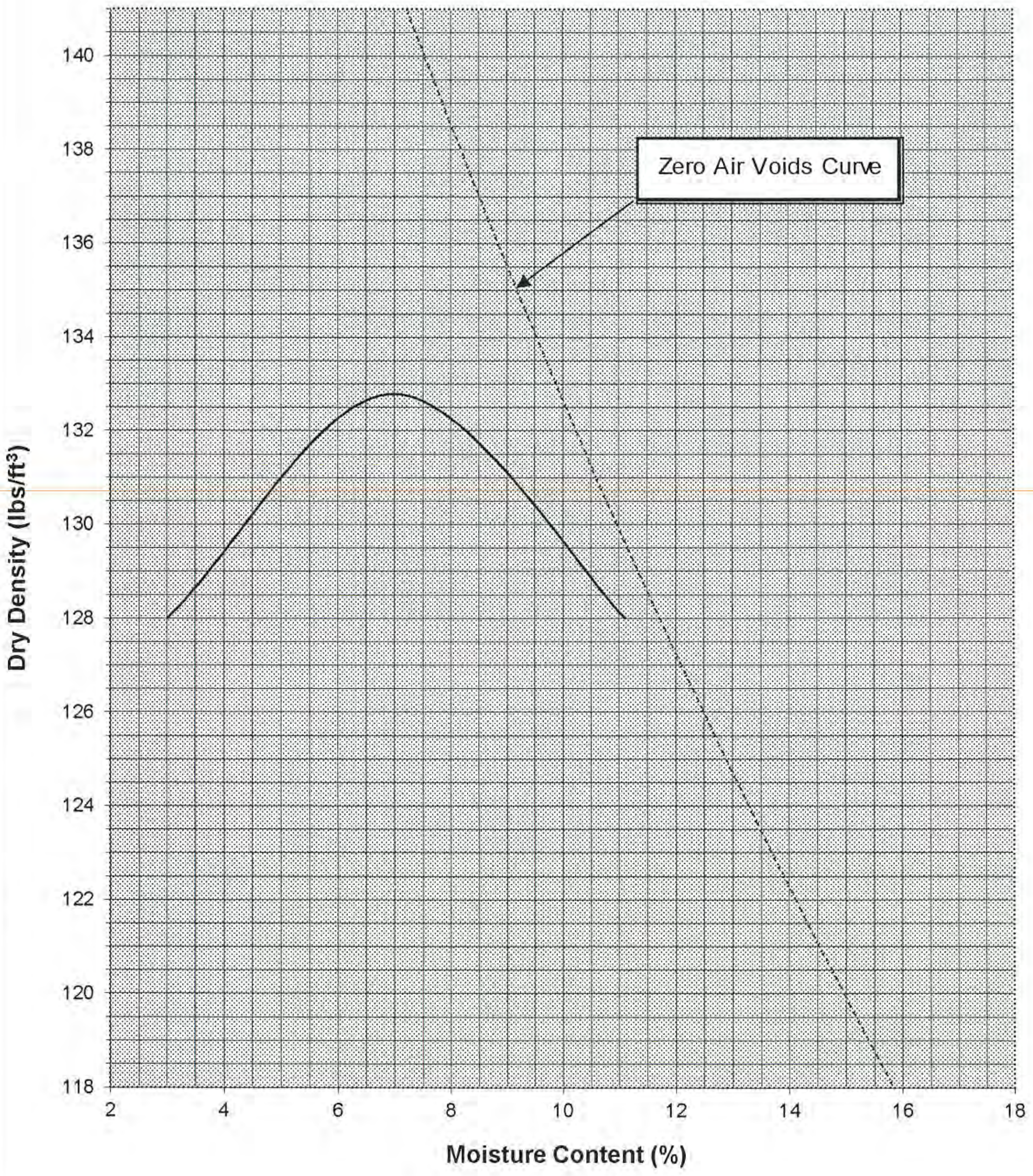
Enclosure 3, Page 3
Rpt. No.: 7253
File No.: S-14446



Boring No.	B-12
Depth (ft.)	15.5
Optimum Moisture (%)	6.9
Maximum Dry Density (pcf)	128.2
Soil Classification	Brown gravelly medium to coarse sand (SP)

Charter School Development Hesperia, California	Enclosure 3, Page 4 Rpt. No.: 7253 File No.: S-14446

Moisture/Density Relationship
ASTM D1557 (Method A)



Boring No.	B-14
Depth (ft.)	1.5
Optimum Moisture (%)	7.0
Maximum Dry Density (pcf)	132.8
Soil Classification	Red-brown silty fine to coarse sand with a trace of gravel (SM)

Charter School Development
Hesperia, California

Enclosure 3, Page 5
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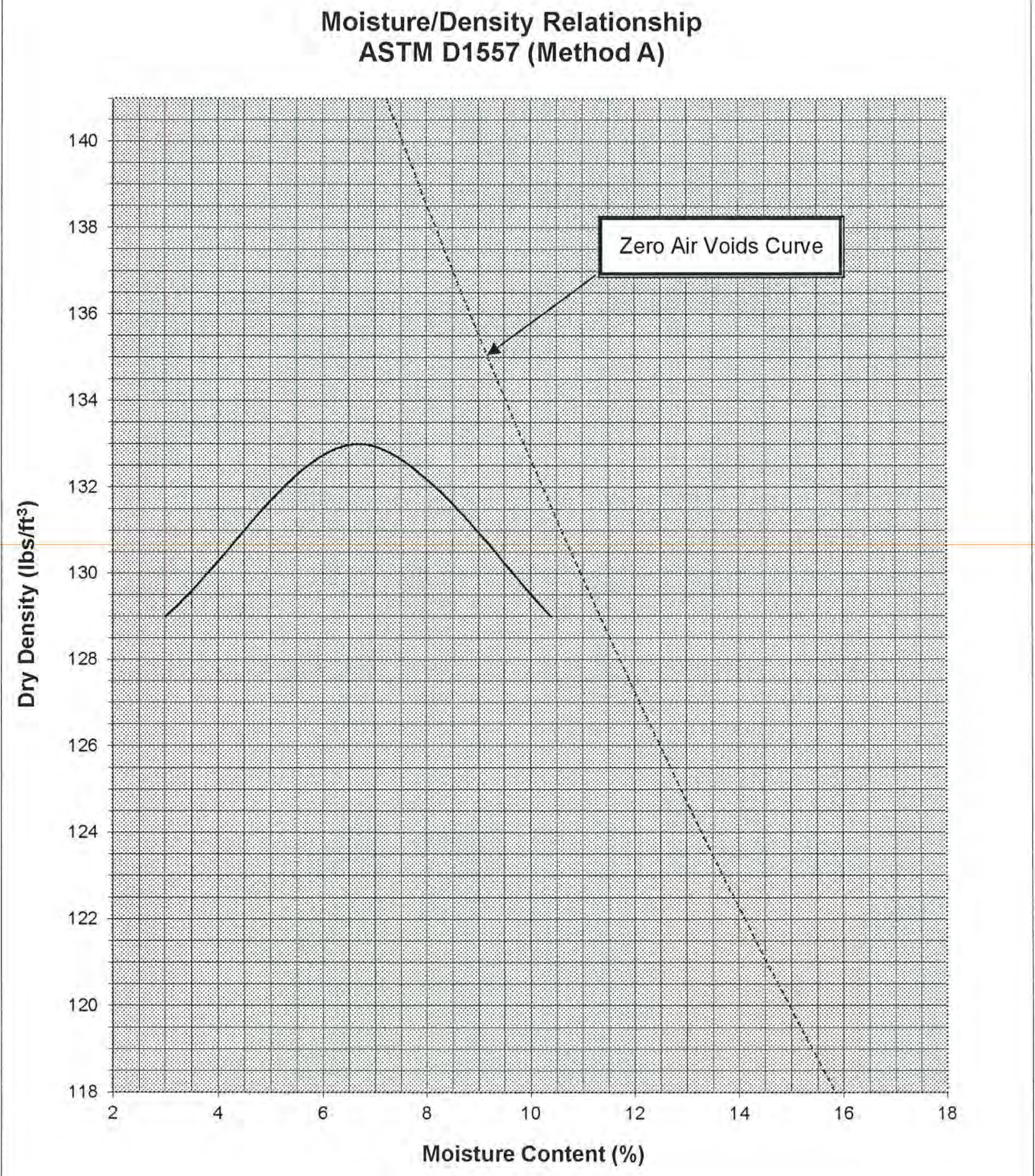
File No.: S-14446



Boring No.	B-15
Depth (ft.)	1.5
Optimum Moisture (%)	6.7
Maximum Dry Density (pcf)	133.0
Soil Classification	Red-brown silty fine to coarse sand with gravel (SM)

Charter School Development
Hesperia, California

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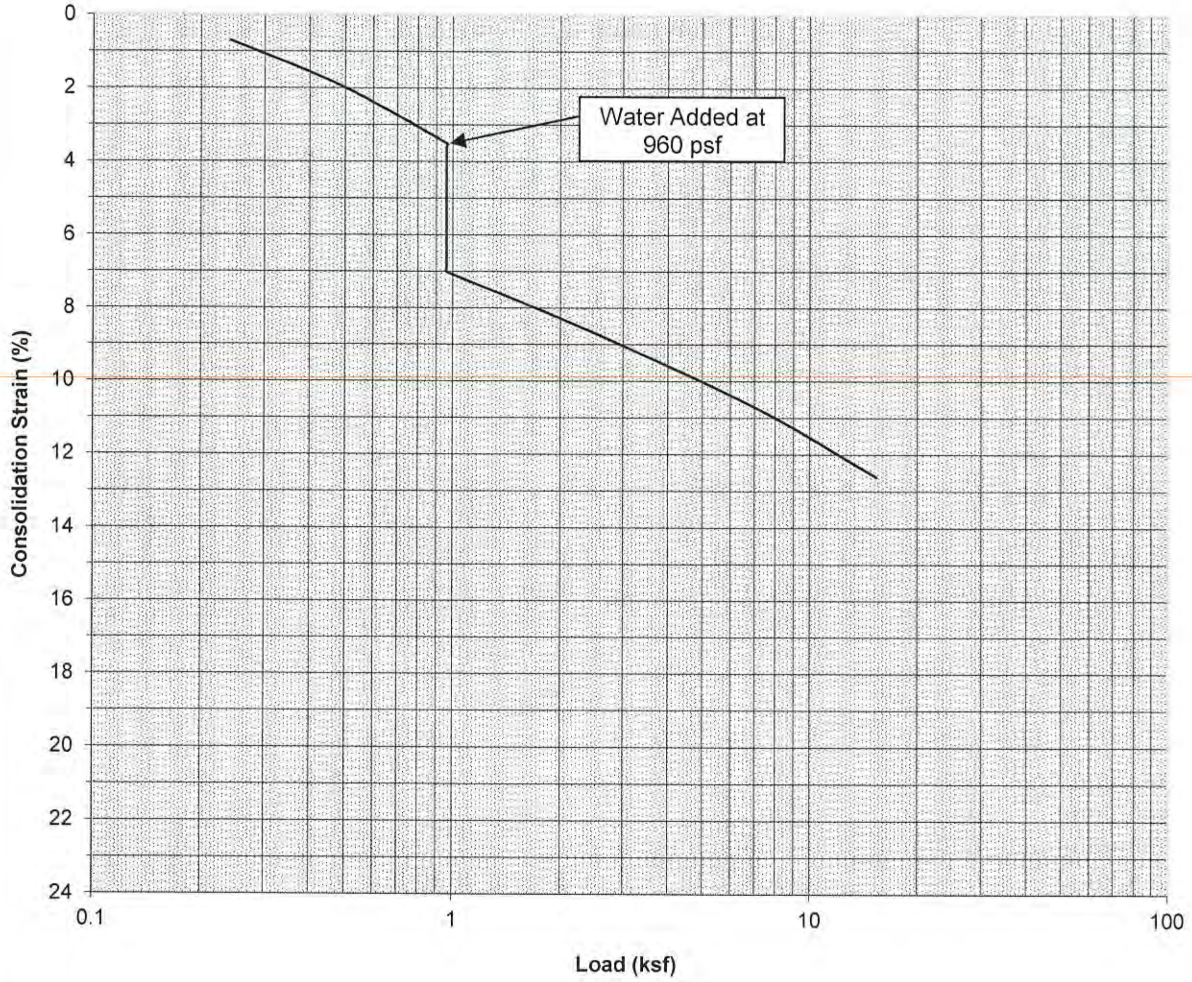
Consolidation Test Results



Classification: SM

Boring Number:	B-1
Depth (ft)	3.5
Specimen Diameter (in)	2.4
Specimen Thickness (in)	1.0

Initial Moisture Content (%)	1.0
Final Moisture Content (%)	14.9
Initial Dry Density (pcf)	118

Enclosure 4
Rpt. No.: 7253
File No.: S-14446

RESULTS OF SUBGRADE SOIL TESTS

California Department of Transportation Test Methods 202, 217, & 301
ASTM Designations C136 and D2419

PROJECT: Charter School Development

Sample No.	Location	Percent Passing Sieve Size: 3”	2½”	2”	1½”	1”	3/4”	1/2”	3/8”	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	Sand Equiv.
1	B-17 at 0-5’					100	100	100	100	98	96	88	74	54	36	24	18

STABILOMETER “R” VALUE

Sample No.		1	
Moisture Content (%)	7.3	8.1	9.0
Dry Density (lbs./cu. ft.)	126.8	124.9	122.8
Exudation Pressure (psi)	567	406	236
Expansion Pressure (psf)	64.950	47.630	34.640
“R” Value	55	51	46
“R” Value at 300 PSI Exudation		48	

Enclosure 5
Rpt. No.: 7253
File No.: S-14446

SUGGESTED SPECIFICATIONS FOR CLASS II BASE

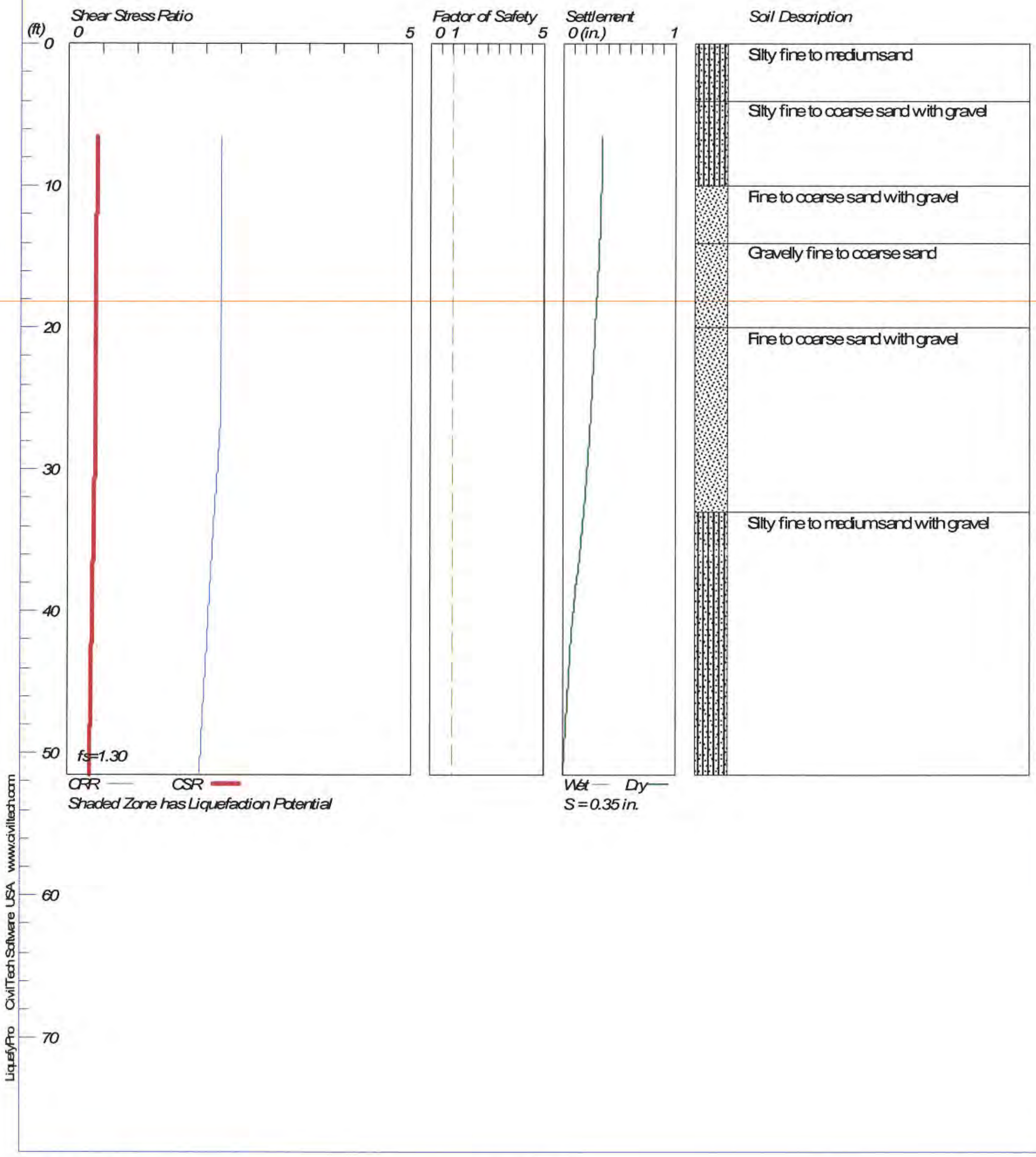
Sieve Size	**Percent Finer Than**
1 Inch	100
3/4 Inch	90 - 100
No. 4	35 - 60
No. 30	10 - 30
No. 200	2 - 9
Sand Equivalent (Minimum)	25
"R" Value (minimum) at 300 psi Exudation	78

LIQUEFACTION ANALYSIS

PATHWAYS TO COLLEGE

Hole No.=B-1 Water Depth=200 ft

Magnitude=7.2
Acceleration=0.50g



CivilTech Corporation **S-14446**

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*************************************************************************************
*******************
                                LIQUEFACTION ANALYSIS CALCULATION SHEET

                                              Version 4.3
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*************************************************************************************
*******************
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        Input File Name: T:\Liquefy4\S-14446.liq
        Title:  PATHWAYS TO COLLEGE
        Subtitle:  S-14446

        Surface Elev.=
        Hole No.=B-1
        Depth of Hole= 51.5 ft
        Water Table during Earthquake= 200.0 ft
        Water Table during In-Situ Testing= 200.0 ft
        Max. Acceleration= 0.5 g
        Earthquake Magnitude= 7.2
        User defined factor of safty (applied to CSR)       User fs=1.3
        fs=user,  Plot one CSR (fs=user)

        Hammer Energy Ratio, Ce=1
        Borehole Diameter, Cb=1
        Sampeling Method, Cs=1.3
        SPT Fines Correction Method: Stark/Olson et al.*
        Settlement Analysis Method: Ishihara / Yoshimine*
        Fines Correction for Liquefaction: Stark/Olson et al.*
        Fine Correction for Settlement: Post-Liq. Correction *
        Average Input Data: Smooth*
        * Recommended Options

Input Data:
        Depth    SPT      Gamma    Fines
        ft                pcf      %
        ____________________________________
        6.5      39.0     120.0    15.0
        11.5     50.0     124.0    2.0
        16.5     43.0     121.0    2.0
        21.5     41.0     119.0    2.0
        26.5     51.0     113.0    2.0
        31.5     42.0     119.0    2.0
        35.0     43.0     130.0    15.0
        40.0     38.0     130.0    15.0
        45.0     55.0     130.0    15.0
        50.0     61.0     130.0    15.0
        ____________________________________

Output Results:
        Settlement of saturated sands=0.00 in.
        Settlement of dry sands=0.35 in.
        Total settlement of saturated and dry sands=0.35 in.
        Differential Settlement=0.174 to 0.230 in.

        Depth    CRRm     CSRfs    F.S.     S_sat.   S_dry    S_all
        ft                w/fs              in.      in.      in.
```

```
______________________________________________________________________
6.50    2.22    0.42    5.00    0.00    0.35    0.35
7.50    2.22    0.42    5.00    0.00    0.35    0.35
8.50    2.22    0.41    5.00    0.00    0.34    0.34
9.50    2.22    0.41    5.00    0.00    0.34    0.34
10.50   2.22    0.41    5.00    0.00    0.34    0.34
11.50   2.22    0.41    5.00    0.00    0.33    0.33
12.50   2.22    0.41    5.00    0.00    0.33    0.33
13.50   2.22    0.41    5.00    0.00    0.33    0.33
14.50   2.22    0.41    5.00    0.00    0.32    0.32
15.50   2.22    0.41    5.00    0.00    0.32    0.32
16.50   2.22    0.41    5.00    0.00    0.31    0.31
17.50   2.22    0.41    5.00    0.00    0.30    0.30
18.50   2.22    0.40    5.00    0.00    0.29    0.29
19.50   2.22    0.40    5.00    0.00    0.29    0.29
20.50   2.22    0.40    5.00    0.00    0.28    0.28
21.50   2.22    0.40    5.00    0.00    0.28    0.28
22.50   2.22    0.40    5.00    0.00    0.27    0.27
23.50   2.22    0.40    5.00    0.00    0.26    0.26
24.50   2.22    0.40    5.00    0.00    0.26    0.26
25.50   2.22    0.40    5.00    0.00    0.25    0.25
26.50   2.22    0.40    5.00    0.00    0.24    0.24
27.50   2.21    0.40    5.00    0.00    0.23    0.23
28.50   2.20    0.39    5.00    0.00    0.23    0.23
29.50   2.18    0.39    5.00    0.00    0.22    0.22
30.50   2.17    0.39    5.00    0.00    0.21    0.21
31.50   2.16    0.39    5.00    0.00    0.20    0.20
32.50   2.14    0.38    5.00    0.00    0.19    0.19
33.50   2.13    0.38    5.00    0.00    0.18    0.18
34.50   2.12    0.38    5.00    0.00    0.17    0.17
35.50   2.11    0.37    5.00    0.00    0.16    0.16
36.50   2.09    0.37    5.00    0.00    0.14    0.14
37.50   2.08    0.37    5.00    0.00    0.13    0.13
38.50   2.07    0.36    5.00    0.00    0.11    0.11
39.50   2.05    0.36    5.00    0.00    0.10    0.10
40.50   2.04    0.36    5.00    0.00    0.09    0.09
41.50   2.03    0.35    5.00    0.00    0.08    0.08
42.50   2.02    0.35    5.00    0.00    0.07    0.07
43.50   2.01    0.35    5.00    0.00    0.06    0.06
44.50   2.00    0.34    5.00    0.00    0.05    0.05
45.50   1.98    0.34    5.00    0.00    0.04    0.04
46.50   1.97    0.34    5.00    0.00    0.04    0.04
47.50   1.96    0.33    5.00    0.00    0.03    0.03
48.50   1.95    0.33    5.00    0.00    0.02    0.02
49.50   1.94    0.33    5.00    0.00    0.01    0.01
50.50   1.93    0.32    5.00    0.00    0.01    0.01
51.50   1.92    0.32    5.00    0.00    0.00    0.00
______________________________________________________________________
* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5,  CRR is limited to 2,    CSR is limited to 2)

Units           Depth = ft, Stress or Pressure = tsf (atm), Unit Weight =
pcf, Settlement = in.

______________________________________________________________________
        CRRm            Cyclic resistance ratio from soils
        CSRfs           Cyclic stress ratio induced by a given earthquake (with user
request factor of safety)
        F.S.            Factor of Safety against liquefaction, F.S.=CRRm/CSRfs
        S_sat           Settlement from saturated sands
        S_dry           Settlement from dry sands
        S_all           Total settlement from saturated and dry sands
        NoLiq           No-Liquefy Soils
```

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************************************************************************************
*******************
                                    LIQUEFACTION ANALYSIS CALCULATION SHEET

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                                         (425) 453-6488  Fax (425) 453-5848

************************************************************************************
*******************
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        Input File Name: T:\Liquefy4\S-14446.liq
        Title:  PATHWAYS TO COLLEGE
        Subtitle:  S-14446

 Input Data:

        Surface Elev.=
        Hole No.=B-1
        Depth of Hole=51.5 ft
        Water Table during Earthquake= 200.0 ft
        Water Table during In-Situ Testing= 200.0 ft
        Max. Acceleration=0.5 g
        Earthquake Magnitude=7.2
        User defined factor of safty (applied to CSR)        User fs=1.3
        fs=user,  Plot one CSR (fs=user)

        Hammer Energy Ratio, Ce=1
        Borehole Diameter, Cb=1
        Sampeling Method, Cs=1.3
        SPT Fines Correction Method: Stark/Olson et al.*
        Settlement Analysis Method: Ishihara / Yoshimine*
        Fines Correction for Liquefaction: Stark/Olson et al.*
        Fine Correction for Settlement: Post-Liq. Correction *
        Average Input Data: Smooth*
        * Recommended Options

        Depth   SPT     Gamma   Fines
        ft              pcf     %
        ____________________________________
        6.5     39.0    120.0   15.0
        11.5    50.0    124.0   2.0
        16.5    43.0    121.0   2.0
        21.5    41.0    119.0   2.0
        26.5    51.0    113.0   2.0
        31.5    42.0    119.0   2.0
        35.0    43.0    130.0   15.0
        40.0    38.0    130.0   15.0
        45.0    55.0    130.0   15.0
        50.0    61.0    130.0   15.0
        ____________________________________


 Output Results:          (Interval = 1.00 ft)

        CSR Calculation:
        Depth   gamma   sigma   gamma'  sigma'   rd      CSR     fs      CSRfs
        ft      pcf     tsf     pcf     tsf                      (user)  w/fs
        ________________________________________________________________________
```

```
      6.50     120.0    0.390    120.0    0.390    0.98     0.32     1.3      0.42
      7.50     120.8    0.450    120.8    0.450    0.98     0.32     1.3      0.42
      8.50     121.6    0.511    121.6    0.511    0.98     0.32     1.3      0.41
      9.50     122.4    0.572    122.4    0.572    0.98     0.32     1.3      0.41
      10.50    123.2    0.633    123.2    0.633    0.98     0.32     1.3      0.41
      11.50    124.0    0.695    124.0    0.695    0.97     0.32     1.3      0.41
      12.50    123.4    0.757    123.4    0.757    0.97     0.32     1.3      0.41
      13.50    122.8    0.818    122.8    0.818    0.97     0.31     1.3      0.41
      14.50    122.2    0.880    122.2    0.880    0.97     0.31     1.3      0.41
      15.50    121.6    0.941    121.6    0.941    0.96     0.31     1.3      0.41
      16.50    121.0    1.001    121.0    1.001    0.96     0.31     1.3      0.41
      17.50    120.6    1.062    120.6    1.062    0.96     0.31     1.3      0.41
      18.50    120.2    1.122    120.2    1.122    0.96     0.31     1.3      0.40
      19.50    119.8    1.182    119.8    1.182    0.95     0.31     1.3      0.40
      20.50    119.4    1.242    119.4    1.242    0.95     0.31     1.3      0.40
      21.50    119.0    1.301    119.0    1.301    0.95     0.31     1.3      0.40
      22.50    117.8    1.360    117.8    1.360    0.95     0.31     1.3      0.40
      23.50    116.6    1.419    116.6    1.419    0.95     0.31     1.3      0.40
      24.50    115.4    1.477    115.4    1.477    0.94     0.31     1.3      0.40
      25.50    114.2    1.535    114.2    1.535    0.94     0.31     1.3      0.40
      26.50    113.0    1.591    113.0    1.591    0.94     0.30     1.3      0.40
      27.50    114.2    1.648    114.2    1.648    0.94     0.30     1.3      0.40
      28.50    115.4    1.706    115.4    1.706    0.93     0.30     1.3      0.39
      29.50    116.6    1.763    116.6    1.763    0.93     0.30     1.3      0.39
      30.50    117.8    1.822    117.8    1.822    0.93     0.30     1.3      0.39
      31.50    119.0    1.881    119.0    1.881    0.92     0.30     1.3      0.39
      32.50    122.1    1.942    122.1    1.942    0.91     0.30     1.3      0.38
      33.50    125.3    2.003    125.3    2.003    0.90     0.29     1.3      0.38
      34.50    128.4    2.067    128.4    2.067    0.89     0.29     1.3      0.38
      35.50    130.0    2.131    130.0    2.131    0.89     0.29     1.3      0.37
      36.50    130.0    2.196    130.0    2.196    0.88     0.29     1.3      0.37
      37.50    130.0    2.261    130.0    2.261    0.87     0.28     1.3      0.37
      38.50    130.0    2.326    130.0    2.326    0.86     0.28     1.3      0.36
      39.50    130.0    2.391    130.0    2.391    0.85     0.28     1.3      0.36
      40.50    130.0    2.456    130.0    2.456    0.84     0.27     1.3      0.36
      41.50    130.0    2.521    130.0    2.521    0.84     0.27     1.3      0.35
      42.50    130.0    2.586    130.0    2.586    0.83     0.27     1.3      0.35
      43.50    130.0    2.651    130.0    2.651    0.82     0.27     1.3      0.35
      44.50    130.0    2.716    130.0    2.716    0.81     0.26     1.3      0.34
      45.50    130.0    2.781    130.0    2.781    0.80     0.26     1.3      0.34
      46.50    130.0    2.846    130.0    2.846    0.80     0.26     1.3      0.34
      47.50    130.0    2.911    130.0    2.911    0.79     0.26     1.3      0.33
      48.50    130.0    2.976    130.0    2.976    0.78     0.25     1.3      0.33
      49.50    130.0    3.041    130.0    3.041    0.77     0.25     1.3      0.33
      50.50    130.0    3.106    130.0    3.106    0.76     0.25     1.3      0.32
      51.50    130.0    3.171    130.0    3.171    0.75     0.25     1.3      0.32
      ____________________________________________________________________________
      CSR is based on water table at 200.0 during earthquake

      CRR Calculation from SPT or BPT data:
      Depth    SPT      Cebs     Cr       sigma'   Cn       (N1)60   Fines    d(N1)60
(N1)60f CRR7.5
      ft                                                             %

______________________________________________________________________________________
_
      6.50     39.00    1.30     0.75     0.390    1.60     60.89    15.0     2.40
63.29 2.00
      7.50     41.20    1.30     0.75     0.450    1.49     59.87    12.4     1.78
61.65 2.00
      8.50     43.40    1.30     0.85     0.511    1.40     67.10    9.8      1.15
68.25 2.00
      9.50     45.60    1.30     0.85     0.572    1.32     66.64    7.2      0.53
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67.17     2.00
          10.50   47.80   1.30    0.85    0.633   1.26    66.38   4.6     0.00
66.38     2.00
          11.50   50.00   1.30    0.85    0.695   1.20    66.28   2.0     0.00
66.28     2.00
          12.50   48.60   1.30    0.85    0.757   1.15    61.73   2.0     0.00
61.73     2.00
          13.50   47.20   1.30    0.85    0.818   1.11    57.65   2.0     0.00
57.65     2.00
          14.50   45.80   1.30    0.85    0.880   1.07    53.96   2.0     0.00
53.96     2.00
          15.50   44.40   1.30    0.95    0.941   1.03    56.54   2.0     0.00
56.54     2.00
          16.50   43.00   1.30    0.95    1.001   1.00    53.07   2.0     0.00
53.07     2.00
          17.50   42.60   1.30    0.95    1.062   0.97    51.06   2.0     0.00
51.06     2.00
          18.50   42.20   1.30    0.95    1.122   0.94    49.21   2.0     0.00
49.21     2.00
          19.50   41.80   1.30    0.95    1.182   0.92    47.49   2.0     0.00
47.49     2.00
          20.50   41.40   1.30    0.95    1.242   0.90    45.88   2.0     0.00
45.88     2.00
          21.50   41.00   1.30    0.95    1.301   0.88    44.39   2.0     0.00
44.39     2.00
          22.50   43.00   1.30    0.95    1.360   0.86    45.53   2.0     0.00
45.53     2.00
          23.50   45.00   1.30    0.95    1.419   0.84    46.65   2.0     0.00
46.65     2.00
          24.50   47.00   1.30    0.95    1.477   0.82    47.76   2.0     0.00
47.76     2.00
          25.50   49.00   1.30    0.95    1.535   0.81    48.85   2.0     0.00
48.85     2.00
          26.50   51.00   1.30    0.95    1.591   0.79    49.93   2.0     0.00
49.93     2.00
          27.50   49.20   1.30    0.95    1.648   0.78    47.33   2.0     0.00
47.33     2.00
          28.50   47.40   1.30    1.00    1.706   0.77    47.18   2.0     0.00
47.18     2.00
          29.50   45.60   1.30    1.00    1.763   0.75    44.64   2.0     0.00
44.64     2.00
          30.50   43.80   1.30    1.00    1.822   0.74    42.18   2.0     0.00
42.18     2.00
          31.50   42.00   1.30    1.00    1.881   0.73    39.81   2.0     0.00
39.81     2.00
          32.50   42.29   1.30    1.00    1.942   0.72    39.45   5.7     0.17
39.62     2.00
          33.50   42.57   1.30    1.00    2.003   0.71    39.10   9.4     1.06
40.16     2.00
          34.50   42.86   1.30    1.00    2.067   0.70    38.75   13.1    1.95
40.71     2.00
          35.50   42.50   1.30    1.00    2.131   0.68    37.84   15.0    2.40
40.24     2.00
          36.50   41.50   1.30    1.00    2.196   0.67    36.40   15.0    2.40
38.80     2.00
          37.50   40.50   1.30    1.00    2.261   0.66    35.01   15.0    2.40
37.41     2.00
          38.50   39.50   1.30    1.00    2.326   0.66    33.67   15.0    2.40
36.07     2.00
          39.50   38.50   1.30    1.00    2.391   0.65    32.36   15.0    2.40
34.76     2.00
          40.50   39.70   1.30    1.00    2.456   0.64    32.93   15.0    2.40
35.33     2.00
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         41.50    43.10    1.30     1.00     2.521    0.63     35.28    15.0     2.40
37.68    2.00
         42.50    46.50    1.30     1.00     2.586    0.62     37.59    15.0     2.40
39.99    2.00
         43.50    49.90    1.30     1.00     2.651    0.61     39.84    15.0     2.40
42.24    2.00
         44.50    53.30    1.30     1.00     2.716    0.61     42.04    15.0     2.40
44.44    2.00
         45.50    55.60    1.30     1.00     2.781    0.60     43.34    15.0     2.40
45.74    2.00
         46.50    56.80    1.30     1.00     2.846    0.59     43.77    15.0     2.40
46.17    2.00
         47.50    58.00    1.30     1.00     2.911    0.59     44.19    15.0     2.40
46.59    2.00
         48.50    59.20    1.30     1.00     2.976    0.58     44.61    15.0     2.40
47.01    2.00
         49.50    60.40    1.30     1.00     3.041    0.57     45.02    15.0     2.40
47.42    2.00
         50.50    61.00    1.30     1.00     3.106    0.57     44.99    15.0     2.40
47.39    2.00
         51.50    61.00    1.30     1.00     3.171    0.56     44.53    15.0     2.40
46.93    2.00

_
         CRR is based on water table at 200.0 during In-Situ Testing

         Factor of Safety,  - Earthquake Magnitude= 7.2:
         Depth    sigC'    CRR7.5   Ksigma   CRRv     MSF      CRRm     CSRfs    F.S.
         ft       tsf      tsf                                          w/fs     CRRm/CSRfs
         ______________________________________________________________________________
         6.50     0.25     2.00     1.00     2.00     1.11     2.22     0.42     5.00
         7.50     0.29     2.00     1.00     2.00     1.11     2.22     0.42     5.00
         8.50     0.33     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         9.50     0.37     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         10.50    0.41     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         11.50    0.45     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         12.50    0.49     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         13.50    0.53     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         14.50    0.57     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         15.50    0.61     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         16.50    0.65     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         17.50    0.69     2.00     1.00     2.00     1.11     2.22     0.41     5.00
         18.50    0.73     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         19.50    0.77     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         20.50    0.81     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         21.50    0.85     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         22.50    0.88     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         23.50    0.92     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         24.50    0.96     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         25.50    1.00     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         26.50    1.03     2.00     1.00     2.00     1.11     2.22     0.40     5.00
         27.50    1.07     2.00     0.99     1.99     1.11     2.21     0.40     5.00
         28.50    1.11     2.00     0.99     1.98     1.11     2.20     0.39     5.00
         29.50    1.15     2.00     0.98     1.97     1.11     2.18     0.39     5.00
         30.50    1.18     2.00     0.98     1.96     1.11     2.17     0.39     5.00
         31.50    1.22     2.00     0.97     1.94     1.11     2.16     0.39     5.00
         32.50    1.26     2.00     0.97     1.93     1.11     2.14     0.38     5.00
         33.50    1.30     2.00     0.96     1.92     1.11     2.13     0.38     5.00
         34.50    1.34     2.00     0.95     1.91     1.11     2.12     0.38     5.00
         35.50    1.39     2.00     0.95     1.90     1.11     2.11     0.37     5.00
         36.50    1.43     2.00     0.94     1.89     1.11     2.09     0.37     5.00
         37.50    1.47     2.00     0.94     1.87     1.11     2.08     0.37     5.00
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38.50    1.51     2.00     0.93     1.86     1.11     2.07     0.36     5.00
39.50    1.55     2.00     0.93     1.85     1.11     2.05     0.36     5.00
40.50    1.60     2.00     0.92     1.84     1.11     2.04     0.36     5.00
41.50    1.64     2.00     0.91     1.83     1.11     2.03     0.35     5.00
42.50    1.68     2.00     0.91     1.82     1.11     2.02     0.35     5.00
43.50    1.72     2.00     0.90     1.81     1.11     2.01     0.35     5.00
44.50    1.77     2.00     0.90     1.80     1.11     2.00     0.34     5.00
45.50    1.81     2.00     0.89     1.79     1.11     1.98     0.34     5.00
46.50    1.85     2.00     0.89     1.78     1.11     1.97     0.34     5.00
47.50    1.89     2.00     0.88     1.77     1.11     1.96     0.33     5.00
48.50    1.93     2.00     0.88     1.76     1.11     1.95     0.33     5.00
49.50    1.98     2.00     0.87     1.75     1.11     1.94     0.33     5.00
50.50    2.02     2.00     0.87     1.74     1.11     1.93     0.32     5.00
51.50    2.06     2.00     0.86     1.73     1.11     1.92     0.32     5.00
______________________________________________________________________________
* F.S.<1: Liquefaction Potential Zone.  (If above water table: F.S.=5)
(F.S. is limited to 5,  CRR is limited to 2,    CSR is limited to 2)


CPT convert to SPT for Settlement Analysis:
Fines Correction for Settlement Analysis:
Depth    Ic       qc/N60   qc1      (N1)60   Fines    d(N1)60  (N1)60s
ft                         tsf               %
_______________________________________________________________________
6.50     -        -        -        60.89    15.0     1.37     62.26
7.50     -        -        -        59.87    12.4     1.15     61.02
8.50     -        -        -        67.10    9.8      0.92     68.02
9.50     -        -        -        66.64    7.2      0.68     67.32
10.50    -        -        -        66.38    4.6      0.44     66.82
11.50    -        -        -        66.28    2.0      0.19     66.47
12.50    -        -        -        61.73    2.0      0.19     61.92
13.50    -        -        -        57.65    2.0      0.19     57.85
14.50    -        -        -        53.96    2.0      0.19     54.15
15.50    -        -        -        56.54    2.0      0.19     56.73
16.50    -        -        -        53.07    2.0      0.19     53.27
17.50    -        -        -        51.06    2.0      0.19     51.25
18.50    -        -        -        49.21    2.0      0.19     49.40
19.50    -        -        -        47.49    2.0      0.19     47.68
20.50    -        -        -        45.88    2.0      0.19     46.08
21.50    -        -        -        44.39    2.0      0.19     44.58
22.50    -        -        -        45.53    2.0      0.19     45.72
23.50    -        -        -        46.65    2.0      0.19     46.85
24.50    -        -        -        47.76    2.0      0.19     47.95
25.50    -        -        -        48.85    2.0      0.19     49.04
26.50    -        -        -        49.93    2.0      0.19     50.12
27.50    -        -        -        47.33    2.0      0.19     47.52
28.50    -        -        -        47.18    2.0      0.19     47.38
29.50    -        -        -        44.64    2.0      0.19     44.83
30.50    -        -        -        42.18    2.0      0.19     42.38
31.50    -        -        -        39.81    2.0      0.19     40.00
32.50    -        -        -        39.45    5.7      0.54     40.00
33.50    -        -        -        39.10    9.4      0.88     39.98
34.50    -        -        -        38.75    13.1     1.21     39.97
35.50    -        -        -        37.84    15.0     1.37     39.21
36.50    -        -        -        36.40    15.0     1.37     37.77
37.50    -        -        -        35.01    15.0     1.37     36.38
38.50    -        -        -        33.67    15.0     1.37     35.04
39.50    -        -        -        32.36    15.0     1.37     33.74
40.50    -        -        -        32.93    15.0     1.37     34.30
41.50    -        -        -        35.28    15.0     1.37     36.66
42.50    -        -        -        37.59    15.0     1.37     38.96
43.50    -        -        -        39.84    15.0     1.37     41.21
44.50    -        -        -        42.04    15.0     1.37     43.41
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        45.50   -        -        -        43.34   15.0     1.37     44.71
        46.50   -        -        -        43.77   15.0     1.37     45.14
        47.50   -        -        -        44.19   15.0     1.37     45.56
        48.50   -        -        -        44.61   15.0     1.37     45.98
        49.50   -        -        -        45.02   15.0     1.37     46.39
        50.50   -        -        -        44.99   15.0     1.37     46.36
        51.50   -        -        -        44.53   15.0     1.37     45.90
        _______________________________________________________________


        Settlement of Saturated Sands:
        Settlement Analysis Method: Ishihara / Yoshimine*
        Depth   CSRfs    F.S.     Fines    (N1)60s Dr       ec       dsz      dsv      S
        ft      w/fs              %                %        %        in.      in.      in.

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________________________________________________________________________________
        Settlement of Saturated Sands=0.000 in.
        dsz is per each segment: dz=0.05 ft
        dsv is per each print interval: dv=1 ft
        S is cumulated settlement at this depth

        Settlement of Dry Sands:
        Depth   sigma'   sigC'    (N1)60s  CSRfs   Gmax     g*Ge/Gm  g_eff    ec7.5    Cec
ec      dsz     dsv      S
        ft      tsf      tsf               w/fs    tsf                        %
%       in.     in.      in.

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        51.45   3.17     2.06     45.92    0.32    2295.3   4.4E-4   0.0961   0.0304   0.98
0.0299  3.6E-4  0.000    0.000
        50.50   3.11     2.02     46.36    0.32    2280.0   4.4E-4   0.0955   0.0302   0.98
0.0297  3.6E-4  0.007    0.007
        49.50   3.04     1.98     46.39    0.33    2256.6   4.4E-4   0.0955   0.0302   0.98
0.0297  3.6E-4  0.007    0.014
        48.50   2.98     1.93     45.98    0.33    2225.6   4.4E-4   0.0960   0.0304   0.98
0.0298  3.6E-4  0.007    0.021
        47.50   2.91     1.89     45.56    0.33    2194.5   4.4E-4   0.0965   0.0305   0.98
0.0300  3.6E-4  0.007    0.029
        46.50   2.85     1.85     45.14    0.34    2163.1   4.4E-4   0.0970   0.0307   0.98
0.0301  3.6E-4  0.007    0.036
        45.50   2.78     1.81     44.71    0.34    2131.5   4.4E-4   0.0973   0.0308   0.98
0.0303  3.6E-4  0.007    0.043
        44.50   2.72     1.77     43.41    0.34    2085.9   4.5E-4   0.0991   0.0313   0.98
0.0308  3.7E-4  0.007    0.050
        43.50   2.65     1.72     41.21    0.35    2025.4   4.5E-4   0.1025   0.0324   0.98
0.0319  3.8E-4  0.008    0.058
        42.50   2.59     1.68     38.96    0.35    1963.3   4.6E-4   0.1062   0.0361   0.98
0.0355  4.3E-4  0.008    0.066
        41.50   2.52     1.64     36.66    0.35    1899.6   4.7E-4   0.1105   0.0436   0.98
0.0429  5.1E-4  0.009    0.075
        40.50   2.46     1.60     34.30    0.36    1833.9   4.8E-4   0.1154   0.0523   0.98
0.0514  6.2E-4  0.011    0.087
        39.50   2.39     1.55     33.74    0.36    1799.5   4.8E-4   0.1158   0.0542   0.98
0.0533  6.4E-4  0.013    0.100
        38.50   2.33     1.51     35.04    0.36    1797.4   4.7E-4   0.1114   0.0484   0.98
0.0476  5.7E-4  0.012    0.112
        37.50   2.26     1.47     36.38    0.37    1794.5   4.6E-4   0.1703   0.0684   0.98
0.0672  8.1E-4  0.015    0.127
        36.50   2.20     1.43     37.77    0.37    1790.8   4.5E-4   0.1612   0.0593   0.98
0.0583  7.0E-4  0.015    0.142
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          35.50    2.13     1.39     39.21    0.37     1786.2   4.5E-4   0.1526   0.0509   0.98
0.0501    6.0E-4   0.013    0.155
          34.50    2.07     1.34     39.97    0.38     1770.0   4.4E-4   0.1471   0.0465   0.98
0.0457    5.5E-4   0.011    0.166
          33.50    2.00     1.30     39.98    0.38     1742.9   4.4E-4   0.1443   0.0455   0.98
0.0448    5.4E-4   0.011    0.177
          32.50    1.94     1.26     40.00    0.38     1716.0   4.3E-4   0.1415   0.0446   0.98
0.0439    5.3E-4   0.011    0.188
          31.50    1.88     1.22     40.00    0.39     1689.2   4.3E-4   0.1387   0.0439   0.98
0.0431    5.2E-4   0.010    0.198
          30.50    1.82     1.18     42.38    0.39     1694.7   4.2E-4   0.1288   0.0407   0.98
0.0400    4.8E-4   0.010    0.208
          29.50    1.76     1.15     44.83    0.39     1698.8   4.1E-4   0.1189   0.0376   0.98
0.0370    4.4E-4   0.009    0.217
          28.50    1.71     1.11     47.38    0.39     1701.6   4.0E-4   0.1091   0.0345   0.98
0.0339    4.1E-4   0.008    0.226
          27.50    1.65     1.07     47.52    0.40     1674.5   3.9E-4   0.1048   0.0331   0.98
0.0326    3.9E-4   0.008    0.234
          26.50    1.59     1.03     50.12    0.40     1674.8   3.8E-4   0.0965   0.0305   0.98
0.0300    3.6E-4   0.007    0.241
          25.50    1.53     1.00     49.04    0.40     1632.8   3.7E-4   0.0946   0.0299   0.98
0.0294    3.5E-4   0.007    0.249
          24.50    1.48     0.96     47.95    0.40     1590.0   3.7E-4   0.0925   0.0292   0.98
0.0287    3.4E-4   0.007    0.255
          23.50    1.42     0.92     46.85    0.40     1546.4   3.7E-4   0.0903   0.0286   0.98
0.0281    3.4E-4   0.007    0.262
          22.50    1.36     0.88     45.72    0.40     1501.9   3.6E-4   0.0881   0.0278   0.98
0.0274    3.3E-4   0.007    0.269
          21.50    1.30     0.85     44.58    0.40     1456.5   3.6E-4   0.0857   0.0271   0.98
0.0266    3.2E-4   0.006    0.275
          20.50    1.24     0.81     46.08    0.40     1438.5   3.5E-4   0.0796   0.0252   0.98
0.0247    3.0E-4   0.006    0.282
          19.50    1.18     0.77     47.68    0.40     1419.5   3.4E-4   0.0737   0.0233   0.98
0.0229    2.8E-4   0.006    0.287
          18.50    1.12     0.73     49.40    0.40     1399.4   3.2E-4   0.1144   0.0362   0.98
0.0356    4.3E-4   0.007    0.295
          17.50    1.06     0.69     51.25    0.41     1378.2   3.1E-4   0.1002   0.0317   0.98
0.0312    3.7E-4   0.008    0.303
          16.50    1.00     0.65     53.27    0.41     1355.6   3.0E-4   0.0878   0.0278   0.98
0.0273    3.3E-4   0.007    0.310
          15.50    0.94     0.61     56.73    0.41     1341.8   2.9E-4   0.0752   0.0238   0.98
0.0234    2.8E-4   0.006    0.316
          14.50    0.88     0.57     54.15    0.41     1277.7   2.8E-4   0.0718   0.0227   0.98
0.0223    2.7E-4   0.005    0.321
          13.50    0.82     0.53     57.85    0.41     1259.8   2.7E-4   0.0615   0.0194   0.98
0.0191    2.3E-4   0.005    0.326
          12.50    0.76     0.49     61.92    0.41     1239.2   2.5E-4   0.0528   0.0167   0.98
0.0164    2.0E-4   0.004    0.330
          11.50    0.69     0.45     66.47    0.41     1215.9   2.4E-4   0.0455   0.0144   0.98
0.0141    1.7E-4   0.004    0.334
          10.50    0.63     0.41     66.82    0.41     1162.6   2.2E-4   0.0413   0.0130   0.98
0.0128    1.5E-4   0.003    0.337
          9.50     0.57     0.37     67.32    0.41     1107.5   2.1E-4   0.0373   0.0118   0.98
0.0116    1.4E-4   0.003    0.340
          8.50     0.51     0.33     68.02    0.41     1050.4   2.0E-4   0.0392   0.0124   0.98
0.0122    1.5E-4   0.003    0.343
          7.50     0.45     0.29     61.02    0.42     951.1    2.0E-4   0.0387   0.0122   0.98
0.0120    1.4E-4   0.003    0.346
          6.50     0.39     0.25     62.26    0.42     891.2    1.8E-4   0.0346   0.0109   0.98
0.0107    1.3E-4   0.003    0.348
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        Settlement of Dry Sands=0.348 in.
        dsz is per each segment: dz=0.05 ft
        dsv is per each print interval: dv=1 ft
        S is cumulated settlement at this depth

        Total Settlement of Saturated and Dry Sands=0.348 in.
        Differential Settlement=0.174 to 0.230 in.

        Units           Depth = ft, Stress or Pressure = tsf (atm), Unit Weight =
pcf, Settlement = in.

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        SPT             Field data from Standard Penetration Test (SPT)
        BPT             Field data from Becker Penetration Test (BPT)
        qc              Field data from Cone Penetration Test (CPT)
        fc              Friction from CPT testing
        Gamma           Total unit weight of soil
        Gamma'          Effective unit weight of soil
        Fines           Fines content [%]
        D50             Mean grain size
        Dr              Relative Density
        sigma           Total vertical stress [tsf]
        sigma'          Effective vertical stress [tsf]
        sigC'           Effective confining pressure [tsf]
        rd              Stress reduction coefficient
        CSR             Cyclic stress ratio induced by earthquake
        fs              User request factor of safety, apply to CSR
        w/fs            With user request factor of safety inside
        CSRfs           CSR with User request factor of safety
        CRR7.5          Cyclic resistance ratio (M=7.5)
        Ksigma          Overburden stress correction factor for CRR7.5
        CRRv            CRR after overburden stress correction, CRRv=CRR7.5 * Ksigma
        MSF             Magnitude scaling factor for CRR (M=7.5)
        CRRm            After magnitude scaling correction CRRm=CRRv * MSF
        F.S.            Factor of Safety against liquefaction F.S.=CRRm/CSRfs
        Cebs            Energy Ratio, Borehole Dia., and Sample Method Corrections
        Cr              Rod Length Corrections
        Cn              Overburden Pressure Correction
        (N1)60          SPT after corrections, (N1)60=SPT * Cr * Cn * Cebs
        d(N1)60         Fines correction of SPT
        (N1)60f         (N1)60 after fines corrections, (N1)60f=(N1)60 + d(N1)60
        Cq              Overburden stress correction factor
        qc1             CPT after Overburden stress correction
        dqc1            Fines correction of CPT
        qc1f            CPT after Fines and Overburden correction, qc1f=qc1 + dqc1
        qc1n            CPT after normalization in Robertson's method
        Kc              Fine correction factor in Robertson's Method
        qc1f            CPT after Fines correction in Robertson's Method
        Ic              Soil type index in Suzuki's and Robertson's Methods
        (N1)60s         (N1)60 after seattlement fines corrections
        ec              Volumetric strain for saturated sands
        ds              Settlement in each Segment dz
        dz              Segment for calculation, dz=0.050 ft
        Gmax            Shear Modulus at low strain
        g_eff           gamma_eff, Effective shear Strain
        g*Ge/Gm         gamma_eff * G_eff/G_max,        Strain-modulus ratio
        ec7.5           Volumetric Strain for magnitude=7.5
        Cec             Magnitude correction factor for any magnitude
        ec              Volumetric strain for dry sands, ec=Cec * ec7.5
        NoLiq           No-Liquefy Soils

        References:
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NCEER Workshop on Evaluation of Liquefaction Resistance of Soils. Youd, T.L., and Idriss, I.M., eds., Technical Report NCEER 97-0022.

SP117. Southern California Earthquake Center. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California. University of Southern California. March 1999.