Pre-Bid Clarification Form (For CONTRACTOR's Use during Bid only)

PROJECT NAME:	Indian Springs High School- CTE Manufacturing		
PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/10/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	General	DRAWING NUMBER:	

REQUESTED CLARIFICATION:
Is there any abatement on this project? If so, Please provide us with the abatement report?
RESPONSE TO CLARIFICATION:
Currently no abatement for this project , district to provide abatement report to selected contractor Bryan Dunaj, RCA 2/17/21

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FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	General	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

We could not find any soils report in the bid documents. Please provide us with the Soils report for the project

RESPONSE TO CLARIFICATION:

Geotech Report attached

Bryan Dunaj, RCA 2/17/21

Geotechnical Investigation Report

Indian Springs High School CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

Prepared for:
San Bernardino City Unified School District
956 West 9th Street
San Bernardino, California 92411

June 14, 2019
Project No.: 190366.3

TWINING

2883 East Spring Street
Suite 300
Long Beach CA 90806

Tel 562.426.3355
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June 14, 2019
Project No. 190366.3

Mr. Tom Pace
Director, Facilities Planning and Operations
San Bernardino City Unified School District
956 West 9th Street
San Bernardino, CA 91762

Subject: **Geotechnical Investigation Report**
Indian Springs High School CTE Modernization
650 North Del Rosa Drive
San Bernardino, California

Dear Mr. Pace,

In accordance with your request and authorization, we are presenting the results of our geotechnical investigation for the proposed CTE Modernization project at Indian Springs High School in San Bernardino, California. The purpose of this investigation has been to evaluate the subsurface conditions at the site and to provide geotechnical engineering recommendations for the proposed improvements.

Based on our findings, the proposed project is geotechnically feasible, provided that the recommendations in this report are incorporated into the design and are implemented during construction of the project.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned.

Respectfully submitted,
TWINING, INC.

REGISTERED PROFESSIONAL ENGINEER
ADRIAN M. MORENO
C 87057
EXP. 6/30/19
CIVIL
STATE OF CALIFORNIA

Adrian Moreno, PE 87057
Senior Staff Engineer

REGISTERED PROFESSIONAL ENGINEER
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Liangcai He, GE 3033
Chief Geotechnical Engineer

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1. INTRODUCTION

This report presents the results of the geotechnical evaluation performed by Twining, Inc. (Twining) for the proposed CTE Modernization project to be constructed at Indian Springs High School in San Bernardino, California. A description of the site and the proposed development is provided in the following section. Our geotechnical evaluation was performed in conformance with Chapter 18A of Title 24, Part 2, Volume 2 of the 2016 California Building Code (CBC) and California Geological Survey (CGS) Note 48. The objectives of this study were to evaluate the subsurface conditions of the site, and to provide geotechnical recommendations for the design and construction of the proposed development, including recommendations for foundations and earthwork.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The project site is located within the Indian Springs High School campus at 650 North Del Rosa Drive in the City of San Bernardino, San Bernardino County, California. The school property is bounded by 9th Street on the north, by 6th Street on the south, by Del Rosa Drive on the east, and by residential development and vacant land on the west as shown in Figure 1, Site Location Map.

The proposed CTE modernization project is be located on the southwest side of campus at the existing M and N buildings. The project includes the modernization of buildings M and N, the modernization of the enclosed breezeway between buildings M and N, exterior courtyard improvements, and the addition of a new one-story structure. The new one-story addition will be approximately 1,850 square feet. The approximate footprint of the building addition is depicted on Figure 2, Site Plan and Boring Location Map.

The approximate site coordinates for the site are latitude 34.1109°N and longitude 117.2556°W. The site is relatively flat with a surface elevation of approximately 1,079 feet above mean sea level (msl). Drainage across the site is by sheet flow in the westerly direction.

3. SCOPE OF WORK

Our scope of services for this project consisted of the following:

- We reviewed readily available background data including previous geotechnical reports prepared by Twining (2014, 2015) for the performing arts center and the school aquatic center and stadium improvements, as well as in-house geotechnical data, geologic maps, topographic maps, and aerial photographs relevant to the subject site.

- We performed a geotechnical site reconnaissance to observe the general surface conditions at the site and to select exploratory locations. After the planned locations were delineated, Underground Service Alert (USA) was notified a minimum of 72 hours prior to excavation.

- We performed a subsurface evaluation, including the excavation, logging, and sampling of two exploratory hollow-stem auger borings. We obtained samples of earth materials from the borings and transported them to our in-house laboratory for examination and testing.

- We performed laboratory testing on selected samples in order to evaluate the geotechnical engineering properties of the on-site soils.

- We compiled and analyzed the data collected from our site reconnaissance, subsurface evaluation, and laboratory testing. Specifically, our analyses included the following:

- Evaluation of general subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials;
- Evaluation of geologic hazards and engineering seismology, including evaluation of fault rupture hazard, seismic shaking hazard, liquefaction and seismic settlement potential;
- Evaluation of seismic design parameters in accordance with 2016 California Building Code;
- Evaluation of current and historical groundwater conditions at the site and potential impact on design and construction;
- Evaluation of expansion potential of the on-site soils;
- Evaluation of project feasibility and suitability of on-site soils for foundation support;
- Development of general recommendations for earthwork, including requirements for placement of compacted fill;
- Evaluation of foundation design parameters including allowable bearing capacity for shallow foundations, estimated settlement, and lateral resistance;
- Recommendations for concrete slab-on-grade support;
- Recommendations for temporary excavations; and,
- Evaluation of the potential for the on-site materials to corrode buried concrete and metals.

- We prepared this report to present the work performed and data acquired and summarize our conclusions and geotechnical recommendations for the design and construction of the proposed improvements.

4. FIELD EXPLORATION AND LABORATORY TESTING

4.1. Field Exploration

Our subsurface exploration was conducted on May 18, 2019. The subsurface conditions were evaluated by advancing two 8-inch-diameter hollow stem auger borings within the footprint of the proposed building addition. The borings were advanced to approximate depths ranging from 31.5 to 51.5 feet below existing ground surface (bgs) using a CME-75 truck-mounted drill rig. Driven samples of the soil were obtained using Standard Penetration Test (SPT) and modified California split spoon samplers. The samplers were driven using a 140-pound, automatic-drop hammer falling approximately 30 inches. The blow counts were recorded, and the materials encountered in the borings were logged by our field personnel. Upon completion of drilling, the borings were backfilled by the drilling subcontractor using soil derived from the cuttings.

The approximate locations of the borings are shown on Figure 2, Site Plan and Boring Location Map. The logs of borings are presented in Appendix A, Field Exploration.

4.2. Geotechnical Laboratory Testing

Laboratory tests were performed on selected samples obtained from the boring in order to aid in the soil classification and to evaluate the engineering properties of the foundation soils. The following tests were performed in general accordance with ASTM standards:

- In-situ moisture and density;
- Maximum dry density-optimum moisture content;

- #200 Wash;
- Corrosivity;
- Consolidation; and
- Direct shear test.

The detailed laboratory test results are presented in Appendix B, Laboratory Testing.

5. REGIONAL GEOLOGIC SETTING AND SUBSURFACE CONDITIONS

An evaluation and discussion of the regional geologic setting and subsurface conditions at the site has been performed by AKW Geotechnical (2019) and is provided in Appendix D – Engineering Geology Investigation Report.

According to regional geologic mapping published by the Dibblee Geological Foundation (Dibblee, 2004a and 2004b), the project site is underlain by alluvial deposits consisting of unconsolidated and unindurated Quaternary alluvial deposits comprised of sand and clay. Geologic mapping compiled by the United States Geological Survey (Morton, 2004) further characterizes the sediments as consisting of poorly sorted fine to coarse sand and sandy-pebble to small-cobble gravel.

Our exploratory borings encountered artificial fill in the upper 3 feet of excavations, underlain by recent alluvial deposits to a depth of approximately 20 feet below the ground surface (map symbol Qa according to Dibblee), and underlain by older alluvial deposits at depths greater than 20 feet (map symbol Qoa according to DIbblee). A generalized description of the materials encountered is provided below. Detailed descriptions of the earth materials encountered in the exploratory borings are presented in Appendix A, Field Exploration. A cross section illustrating the geologic conditions at the site is presented in Figure 3, Cross Section A-A'. The regional geology based on the Dibblee Geological Foundation geologic maps is reproduced in Figure 4, Regional Geologic Map.

5.1. Site Geology

The following section provides generalized descriptions of the materials encountered.

5.1.1. Artificial Fill

Artificial fill was encountered in each of the exploratory borings at shallow depths up to 3 feet below the ground surface (bgs). The material generally consists of medium to reddish-brown silty sand with few fine gravel.

5.1.2. Recent Alluvial Deposits

Late Holocene alluvial deposits were encountered in both of the exploratory borings extending to the depths of approximately 20 feet bgs. The material generally consists of interlayered dark brown and orange-brown, loose to dense, moist, sand, and silty sand with gravel and cobble.

5.1.3. Older Alluvial Deposits

Older alluvium was encountered in both exploratory excavations at depths of approximately 20 feet bgs and extending to the total depth of exploration. The older alluvium generally consists of interlayered reddish-brown, grayish-brown, light brown, and gray, medium dense to very dense, moist, sand, silty sand and sandy silt with gravel.

5.2. Groundwater

Groundwater was not encountered within Twining's recent and previous exploratory excavations. Previous exploration at the site by John R. Byerly, Inc. (2003) encountered groundwater in one boring at a depth of approximately 33 feet. Based on our review of the State of California Department of Water Resources data for wells located in the site vicinity, the groundwater level was near the ground surface in the 1951. Recent measurements indicate that the groundwater level has been drawn down to depths exceeding 100 feet bgs. For our analyses, we have assumed the historical high groundwater elevation at the existing ground surface. Groundwater conditions may vary across the site due to stratigraphic and hydrologic conditions and may change over time as a consequence of seasonal and meteorological fluctuations, or of activities by humans at this and nearby sites.

6. SEISMIC HAZARDS AND GROUND MOTION

The seismology and the hazards associated with seismic shaking at the site are discussed in detail in AKW Geotechnical's Engineering Geology Report for the project (2019).

The subject site is not located within a State of California Earthquake Fault Zone (formerly known as an Alquist-Priolo Special Studies Zone (Hart and Bryant, 1997). However, the site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion in the project area is considered high during the design life of the proposed structure. According to the City of San Bernardino (2005) General Plan Safety Element, the site is located within an area designated as "high" with respect to liquefaction susceptibility. The map depicting the sites liquefaction potential is presented on Figure 5, Liquefaction Potential Map.

6.1. Liquefaction and Seismic Settlement Potential

Liquefaction is the phenomenon in which loosely deposited granular soils with silt and clay contents of less than approximately 35 percent, and non-plastic silts located below the water table undergo rapid loss of shear strength when subjected to strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to a rapid rise in pore water pressure and causes the soil to behave as a fluid for a short period of time.

Seismic settlement can occur when loose to medium dense granular materials densify during seismic shaking and liquefaction. Seismically-induced settlement may occur in dry, unsaturated, as well as saturated soils. Liquefaction is generally known to occur in loose, saturated, relatively clean, fine-grained cohesionless soils at depths shallower than approximately 50 feet. Factors to consider in the evaluation of soil liquefaction potential include groundwater conditions, soil type, grain size distribution, relative density, degree of saturation, and both the intensity and duration of ground motion. Other phenomena associated with soil liquefaction include sand boils, ground oscillation, and loss of foundation bearing capacity. Based on the presence of granular alluvial deposits and the historic high groundwater level, the project site is considered potentially liquefiable.

Liquefaction analyses were performed in accordance with the National Center for Earthquake Engineering Research (NCEER) procedure by Youd and others (2001) using the computer program LiqSVs (GeoLogismiki, 2012) and the data obtained from our exploratory borings. The analyses considered an earthquake modal moment magnitude of 7.91 obtained using the U.S. Geological Survey – Earthquake Hazards Program Unified Hazard Tool, the peak ground acceleration PGA_M of 0.757g obtained by the methods described in section 6.2 below, and a historic high groundwater level at the existing ground surface.

Our analyses were performed using SPT $N_{1,60}$ blow counts converted and standardized from SPT and modified California sampler blow counts taken during our exploratory borings for the project. Our analyses indicate that the liquefaction potential is at its peak at the soil layer located at approximately 40 feet bgs. We estimate that the liquefaction-induced ground settlement at the site will be approximately 2 inches during a seismic event as shown in Appendix C, Liquefaction Analysis. However, it is our opinion that, due to the depth of the anticipated liquefaction and the density of the soil layers above the liquefiable material, the liquefaction settlement will not be manifested at the surface.

6.2. CBC Seismic Design Parameters

Our recommendations for seismic design parameters have been developed in accordance with 2016 CBC and ASCE 7-10 (ASCE, 2010) standards. As discussed above, the project site is potentially liquefiable and would be classified as Site Class F per ASCE 7-10 Section 20.3.1. However, ASCE 7-10 provides an exception for structures with periods of vibration equal to or less than 0.5 seconds. Because the proposed one-story structure is anticipated to have a fundamental period of less than 0.5s, the site class may be determined using the definitions provided in Table 20.3.1. Based on the results of our field investigation the applicable Site Class is D consisting of a stiff soil profile with average SPT N between 15 and 50 blows per foot. Table 1 presents the seismic design parameters for the site in accordance with 2016 CBC and mapped spectral acceleration parameters.

Table 1
2016 California Building Code Design Parameters

Design Parameters	Value
Site Class	D
Mapped Spectral Acceleration Parameter at Period of 0.2-Second, S_s	1.915g
Mapped Spectral Acceleration Parameter at at Period 1-Second, S_1	0.920g
Site Coefficient, F_a	1.0
Site Coefficient, F_v	1.5
Adjusted MCE_R[1] Spectral Response Acceleration Parameter at Short Period, S_{MS}	1.915g
1-Second Period Adjusted MCE_R[1] Spectral Response Acceleration Parameter, S_{M1}	1.380g
Short Period Design Spectral Response Acceleration Parameter, S_{DS}	2/3 S_{MS} = 1.277g
1-Second Period Design Spectral Response Acceleration Parameter, S_{D1}	2/3 S_{M1} = 0.920g
Peak Ground Acceleration, PGA_M[2]	0.757g
Seismic Design Category[3]	E
Notes: [1] Risk-Targeted Maximum Considered Earthquake [2] Peak Ground Acceleration adjusted for site effects [3] For S_1 greater than or equal to 0.75g, the Seismic Design Category is E for risk category I, II, and III structures	

6.3. Site Specific Ground Motion Hazard Analysis

The site-specific ground motion hazard analysis was performed in accordance with Section 21.2 of ASCE Standard 7-10 (American Society of Civil Engineers, 2010) based on a 2% probability of exceedance in 50 years. Probabilistic and deterministic maximum considered earthquake (MCE) response accelerations were evaluated in order to develop the site-specific design response spectrum. The derivation of the site-specific design response spectra, including the probabilistic and deterministic seismic hazard analyses, are presented in Figure 6, Site-Specific Design Response Spectrum. The detailed analysis description and results are presented below.

6.3.1. Probabilistic Seismic Hazard Analysis

A site-specific probabilistic seismic hazard analysis was performed to evaluate the spectral response accelerations represented by a 5-percent-damped acceleration response spectrum having a 2 percent probability of exceedance within a 50-year period. The probabilistic seismic hazard analysis was performed using the commercially available computer program EZ-FRISK version 7.65 Build 004 (Risk Engineering, 2015). The probabilistic seismic hazard analyses were performed using the next generation attenuation (NGA) relationships by Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and Youngs (2008). The probabilistic maximum rotated horizontal component of 5-percent-damped ground motion having a 2 percent probability of exceedance within a 50-year period was obtained from our EZ- FRISK analyses.

6.3.2. Deterministic Seismic Hazard Analysis

A site-specific deterministic seismic hazard analysis was performed to evaluate the MCE response acceleration. The deterministic MCE response acceleration at specified periods was calculated as the 84th percentile of the maximum rotated component of ground motion computed at each period for characteristic earthquakes on known active faults within the region.

First, we performed an evaluation of potentially damaging earthquake sources by reviewing published geologic maps and sources that contribute to the probabilistic hazard analysis, according to the USGS 2008 Interactive Deaggregations website (http://geohazards.usgs.gov/deaggint/2008/). Based on our evaluation, we selected two “controlling” sources and seismic events: the San Andreas fault (San Bernardino South section) and the San Jacinto fault (San Bernardino Valley section).

Next, we used the NGA Models by Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and Youngs (2008) to estimate the ground motion distribution for each earthquake. The 5-percent-damped pseudo-absolute acceleration response spectrum was calculated for each earthquake using a Microsoft Excel spreadsheet issued by the Pacific Earthquake Engineering Research Center based on the NGA relationships (https://apps.peer.berkeley.edu/products/nga_gmpe_files/NGA_GMPE_files.zip). Seismic sources and distances to faults were evaluated using the USGS 2008 seismic hazard maps and site-specific data (https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/query_main.cfm). Site characteristics were evaluated based on field investigation programs performed for the site and the USGS site-specific data (https://earthquake.usgs.gov/data/vs30/us/). The resulting median 84th-percentile 5-percent-damped geometric-mean acceleration response spectra for the earthquakes from each fault were used to create a deterministic MCE response spectrum based on the maximum spectral acceleration at each period, and then converted to the maximum rotated components of ground motion using equations prepared by Watson-Lamprey and Boore (2007). The final deterministic spectral response accelerations were taken to be not lower than the deterministic lower limit as calculated using Figure 21.2-1 of ASCE 7-10, Chapter 21.

6.3.3. Site-Specific Design Response Spectrum

The site-specific MCE_R spectral response acceleration was calculated at each period to be the lesser of the spectral response accelerations from the probabilistic and deterministic MCE. Finally, the design spectral response acceleration at each period was calculated as two-thirds of the site-specific MCE spectral response acceleration, but taken as not less than 80 percent of the spectral response acceleration evaluated in accordance with Section 11.4.5 of ASCE 7-10. In order to calculate the 80 percent lower limit, mapped values from Seismic Design Maps of the Structural Engineers Association of California (SEAOC) and Office of Statewide Health Planning and Development of California (https://seismicmaps.org/) were used to calculate S_{DS}, S_{D1} and the design spectrum in accordance with Section 21.4 of ASCE 7-10. Applicable response spectra data are presented in Table 2 and on Figure 6, Site-Specific Design Response Spectrum.

Table 2
Site-Specific Design Response Spectrum Data

Period (sec)	Risk Coefficient C_R	Spectral Acceleration (g)							
		2%-in-50years Probabilistic Spectrum	Probabilistic MCE_R	84th percentile Deterministic Spectrum	Deterministic Lower Limit	Deterministic MCE_R	Site Specific MCE_R	80% Map-Based CBC General Design Response Spectrum	Site-Specific Design Response Spectrum
0.01	1.023	1.320	1.351	0.887	0.675	0.887	0.887	0.451	0.591
0.02	1.023	1.344	1.375	0.902	0.750	0.902	0.902	0.494	0.602
0.03	1.023	1.405	1.437	0.957	0.825	0.957	0.957	0.536	0.638
0.05	1.023	1.558	1.594	1.071	0.975	1.071	1.071	0.621	0.714
0.075	1.023	1.851	1.893	1.253	1.163	1.253	1.253	0.727	0.835
0.1	1.023	2.134	2.183	1.419	1.350	1.419	1.419	0.834	0.946
0.12	1.023	2.307	2.360	1.532	1.500	1.532	1.532	0.919	1.021
0.144	1.023	2.481	2.538	1.667	1.500	1.667	1.667	1.021	1.111
0.15	1.023	2.520	2.578	1.701	1.500	1.701	1.701	1.021	1.134
0.2	1.023	2.687	2.749	1.843	1.500	1.843	1.843	1.021	1.229
0.25	1.020	2.784	2.840	1.975	1.500	1.975	1.975	1.021	1.316
0.3	1.017	2.780	2.828	2.016	1.500	2.016	2.016	1.021	1.344
0.4	1.012	2.732	2.764	2.039	1.500	2.039	2.039	1.021	1.359
0.5	1.006	2.660	2.675	2.059	1.500	2.059	2.059	1.021	1.373
0.6	1.000	2.553	2.553	2.012	1.500	2.012	2.012	1.021	1.341
0.721	0.993	2.462	2.445	1.954	1.248	1.954	1.954	1.021	1.303
0.75	0.991	2.447	2.425	1.941	1.200	1.941	1.941	0.981	1.294
1	0.977	2.197	2.147	1.711	0.900	1.711	1.711	0.736	1.140
1.25	0.977	1.962	1.917	1.560	0.720	1.560	1.560	0.589	1.040
1.5	0.977	1.753	1.713	1.410	0.600	1.410	1.410	0.491	0.940
2	0.977	1.425	1.392	1.152	0.450	1.152	1.152	0.368	0.768
2.5	0.977	1.190	1.163	0.997	0.360	0.997	0.997	0.294	0.665
3	0.977	1.027	1.004	0.842	0.300	0.842	0.842	0.245	0.561
4	0.977	0.783	0.765	0.635	0.225	0.635	0.635	0.184	0.423

The site-specific design response parameters are provided in Table 3. These parameters were evaluated from Design Response Spectra values presented above in accordance with ASCE 7-10 Section 21.4 guidelines.

Table 3
Site-Specific Seismic Design Parameters

Site-Specific Seismic Design Parameters	Design Values (g)
Spectral Response Acceleration 0.2-second period, S_{MS}	1.853
Spectral Response Acceleration 1-second period, S_{M1}	1.71
Design Spectral Response Acceleration for short period, S_{DS}	1.236
Design Spectral Response Acceleration for 1-second period, S_{D1}	1.14

7. GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1. General Considerations

Based on the results of our literature review, field exploration, laboratory testing, and engineering analyses, it is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided that the recommendations in this report are incorporated into the design plans and are implemented during construction. Geotechnical engineering recommendations for this project are based on our understanding of the proposed development, our observations during our field exploration, the results of laboratory testing on soil samples taken from the site, and our engineering analyses.

The following is a list of geotechnical considerations for this project:

- Near surface soils at the site are generally suitable for use as engineered fill.
- Based on the subgrade soil types encountered during our investigation, laboratory testing, and the estimated potential settlement of the soils, the proposed project may be supported on shallow foundations.
- Undocumented fill was encountered in the upper approximately 3 feet in each of the exploratory borings performed at the site. Fill materials encountered within foundation excavations should be removed to the full depth of fill.
- We understand that the proposed building addition will be structurally separated from the existing buildings. We anticipate that settlement of the new structure will occur during construction process and that differential settlement between the structure addition and existing building joints will be less than 0.5 inches if the site preparation is performed per the recommendations provided in Section 7.4 below.
- Excavations shall not undermine the existing adjacent footings. We recommend that excavations for the proposed improvements do not encroach within a 1:1 plane from the top edge of the existing foundations, or where space is not available, that slot cuts be utilized. Excavations should be performed in accordance with the recommendations provided in Section 7.4.5 below.
- The nearest edge of the proposed new footings should be constructed at a distance equal to or greater than the width of the new footing plus the width of the existing footing.

Our geotechnical engineering analyses performed for this report were based on the earth materials encountered during the subsurface exploration for the site. If the design substantially changes, then our geotechnical engineering recommendations would be subject to revision based on our evaluation of the changes. The following sections present our conclusions and recommendations pertaining to the engineering design for this project.

7.2. Expansive Soil Evaluation

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from rainfall, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors, and may cause unacceptable settlement or heave of structures, concrete slabs supported on-grade, or pavements supported over these materials. Depending on the extent and location below finished subgrade, these soils could have a detrimental effect on the proposed construction.

Based on our observations, laboratory testing, and soil classification, the soils at the site consists of granular silty sands and sands. It is our opinion that site soils have a very low expansion potential. Mitigation measures for expansive soils are not required.

7.3. Corrosive Soil Evaluation

The potential for the near-surface on-site materials to corrode buried steel and concrete improvements was evaluated. Laboratory testing was performed on one selected near-surface soil to evaluate pH and electrical resistivity, as well as chloride and sulfate contents. The pH and electrical resistivity tests were performed in accordance with California Test 643, and the sulfate and chloride tests were performed in accordance with California Tests 417 and 422, respectively.

In accordance with the Caltrans Corrosion Guidelines (2018) criteria, corrosive soil is defined as soil which has a minimum resistivity less than 1,100 ohm-centimeters, a chloride concentration greater than 500 ppm, a sulfate concentration greater than 1,500 ppm, or a pH less than 5.5.

The results of the corrosivity testing indicated an electrical resistivity value of 4,800 ohm-cm. The soil pH value was 6.9. The tests indicated soluble chloride content of 32 parts per million (ppm) and soluble sulfate content of 226 ppm (i.e. 0.031 percent). Based on Caltrans (2018) criteria, the on-site soils would be classified as non-corrosive.

7.3.1. Reinforced Concrete

Laboratory tests indicate that the potential for sulfate attack on concrete in contact with the on-site soils is negligible in accordance with ACI 318, Table 4.3.1. As a minimum, we recommend that Type II cement and a water-cement ratio of no greater than 0.50 be used on the project.

Test results indicate that the potential for chloride attack of reinforcing steel in concrete structures and pipes in contact with soil is also negligible.

7.3.2. Metallic

Laboratory resistivity testing indicates that the on-site near-surface soils are considered moderately corrosive to buried ferrous metals. We recommend that a corrosion specialist may be consulted regarding suitable types of piping and appropriate protection for underground metal conduits, if needed.

7.4. Site Preparation and Earthwork

In general, earthwork should be performed in accordance with the recommendations presented in this report. Twining should be contacted for questions regarding the recommendations or guidelines presented herein.

7.4.1. Site Preparation

Site preparation should begin with the removal of utility lines, asphalt, concrete, vegetation, and other deleterious debris from areas to be graded. Tree stumps and roots should be removed to such a depth that organic material is generally not present. Clearing and grubbing should extend to the outside edges of the proposed excavation and fill areas. We recommend that unsuitable materials such as organic matter or oversized material be selectively removed and disposed offsite. The debris and unsuitable material generated during clearing and grubbing should be removed from areas to be graded and disposed at a legal dump site away from the project area.

7.4.2. Removals and Overexcavation

The site subgrade soils in general are considered as suitable for use as engineered fill. In order to prepare a relatively uniform bearing surface for the project foundations and to remove the undocumented fill encountered at the site, we recommend that the subgrade be overexcavated to a depth of at least 3 feet below the existing ground surface, or to the bottom of the undocumented fill, whichever is deeper. The excavation bottom should be scarified 12 inches and recompacted to 90 percent of the maximum dry density according to ASTM D 1557. The lateral extent of the overexcavation should be at least 3 feet beyond the edge of the proposed footings, where space is available. Deeper excavations may be required in areas where soft, saturated, or unsuitable materials, for example, if tree root balls or undocumented fill are encountered.

Building pad slabs-on-grade, pavements, and/or sidewalk areas should be over-excavated to a depth of at least 12 inches below the bottom of the pavement or sidewalk section, whichever is deeper. Deeper removals may be required in areas where soft, saturated, or unsuitable materials are encountered.

Foundation elements should be constructed on at least 1 foot of competent engineered fill. Where fill materials are encountered during foundation excavations, the fill should be removed to its full depth. The extent and depth of fill removals should be evaluated by Twining's representative in the field based on the materials exposed.

Should overexcavations expose soft or soils considered as unsuitable for use as fill by a Twining representative, additional removals may be recommended. The extent and depths of removal should be evaluated by Twining's representative in the field based on the materials exposed.

7.4.3. Materials for Fill

In general, the near surface soils encountered during our field exploration are suitable for use as engineered fill, provided that the material is free organics. The soil material used as fill should not contain contaminated materials, rocks, or lumps over 4 inches in largest dimension, and not more than 40 percent larger than ¾ inch. Utility trench backfill material should not contain rocks or lumps over 3 inches in largest dimension. Larger chunks, if generated during excavation, may be broken into acceptably sized pieces or may be disposed offsite.

Any imported fill material should consist of granular soil having a "very low" expansion potential (that is, expansion index of 20 or less). Import material should also have low corrosion potential (that is, chloride content less than 500 parts per million [ppm], soluble sulfate content of less than 0.1 percent, and pH of 5.5 or higher). Materials to be used as fill should be evaluated by a Twining representative prior to importing or filling.

7.4.4. Engineered Fill

Prior to placement of compacted fill, the contractor should request Twining to evaluate the exposed excavation bottoms. Unless otherwise recommended, the exposed ground surface should then be scarified to a depth of approximately 12 inches and moisture conditioned or dried, as needed, to achieve generally consistent moisture contents of approximately 2 percent above the optimum moisture content. The scarified materials should then be compacted to 90 percent relative compaction in accordance with the latest version of ASTM D 1557.

Compacted fill should be placed in horizontal lifts of approximately 8 to 10 inches in loose thickness. Prior to compaction, each lift should be moisture conditioned or dried as needed to achieve near optimum moisture condition, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other appropriate compacting rollers, to a relative compaction of 90 percent as evaluated by ASTM D1557. Successive lifts should be treated in a like manner until the desired finished grades are achieved.

Trench excavations to receive backfill shall be free of trash, debris or other unsatisfactory materials at the time of backfill placement. The utility should be bedded with clean sand to at least one foot over the crown. The bedding sand should have a sand equivalent (SE) of 30 or greater. The remainder of trench backfill may be onsite soils compacted to 90 percent of the laboratory maximum dry density as per ASTM Standard D1557.

7.4.5. Temporary Excavations

Temporary excavations are expected during site demolition, earthwork, and footing and utility trench preparation. We anticipate that unsurcharged excavations with vertical side slopes less than 4 feet high will generally be stable.

Where the space is available, temporary, unsurcharged excavation sides over 4 feet in height should be sloped no steeper than an inclination of 1H:1V (horizontal:vertical). Where sloped excavations are created, the tops of the slopes should be barricaded so that vehicles and storage loads do not encroach within 10 feet of the top of the excavated slopes. A greater setback may be necessary when considering heavy vehicles, such as concrete trucks and cranes. Twining should be advised of such heavy vehicle loadings so that specific setback requirements can be established. If the temporary construction slopes are to be maintained during the rainy season, berms are recommended to be graded along the tops of the slopes in order to prevent runoff water from entering the excavation and eroding the slope faces.

Excavations shall not undermine the existing adjacent foundations. Where space for sloped excavations is not available, slot-cut or temporary shoring (trench box) may be utilized. For temporary excavations that are less than 6 feet in height adjacent to existing buildings where the excavation extends deeper than the bottom of the existing footing, slot cuts may be utilized. The slots should be no wider than 8 feet and should be excavated in an A-B-C sequence so that there are at least 16 feet spacing between any two excavated slots. The excavated slots should not be left open overnight and should be backfilled on the same day it was excavated before the next set of slots are excavated.

Personnel from Twining should observe the excavations so that any necessary modifications based on variations in the encountered soil conditions can be made. All applicable safety requirements and regulations, including CalOSHA requirements, should be met.

7.4.6. Rippability

Based on our subsurface exploration of the site, the earth materials should be generally excavatable with heavy-duty earthwork equipment in good working condition.

7.5. Foundation Recommendations

Based upon the recommended removal and recompaction of existing fill materials, the proposed structure may be supported on continuous strip or isolated footings designed in accordance with the recommendations presented below.

7.5.1. Shallow Foundations Supported on Engineered Fill

A shallow foundation system (spread and continuous footings) may be used for support of the proposed project, provided that all the footings are placed on engineered fill prepared as described in the “Site Preparation” section of this report. The foundations should be designed by the structural engineer and should conform to the 2016 California Building Code. Our geotechnical design parameters are presented in Table 4. We have assumed that column loads will not exceed 125 kips for isolated pad footings and that wall loads will not exceed 8 kips per foot for continuous footings.

Table 4 - Geotechnical Design Parameters for Spread Footings on Engineered Fill

Minimum Footing Dimensions	• Continuous footings: At least 24 inches in width and at least 24 inches of embedment depth. • Square footings: At least 36 inches in width and 24 inches of embedment depth.
Allowable Bearing Pressure	• Footings should be supported on compacted fill. • For footings with the minimum dimensions shown above, an allowable bearing pressure of 2,000 pounds per square foot (psf) can be used. • Bearing capacity can be increased by 250 psf for each additional foot of width, and 250 psf for each additional foot of embedment up to a maximum allowable capacity of 3,000 psf. • The allowable bearing values may be increased by one-third for transient live loads from wind or earthquake.
Estimated Static Settlement	• Approximately 1 inch of total settlement with differential settlement estimated to be approximately 0.5 inch over 50 feet (for foundations designed in accordance with this report). • The static settlement of foundation system is expected to occur immediately upon application of loading.
Allowable Coefficient of Friction Below Footings	0.35
Unfactored Lateral Passive Resistance	400 pcf (equivalent fluid pressure)

The total allowable lateral resistance can be taken as the sum of the friction resistance and passive resistance, provided that the passive resistance does not exceed two-thirds of the total allowable resistance. The passive resistance values may be increased by one-third when considering wind or seismic loading.

7.6. Concrete Slabs

Slab-on-grade floors for buildings should be supported on at least 12 inches of engineered fill as described in the Site Preparation section of this report. For design of concrete floor slabs supported on engineered fill, a modulus of subgrade reaction (*k*) of 150 pounds per cubic inch (pci) may be used on compacted, engineered fill.

Floor slabs should be designed and reinforced in accordance with the structural engineer's recommendations. However, for slabs not supporting heavy loads, we recommend that the concrete should have a thickness of at least 4 inches, a 28-day compressive strength of at least 3,000 pounds per square inch (psi), a water-cement ratio of 0.45 or less, and a slump of 4 inches or less. Slabs should be reinforced with at least No. 3 reinforcing bars placed longitudinally at 18 inches on center. The reinforcement should be extended through the control joints to reduce the potential for differential movement. Control joints should be constructed in accordance with recommendations from the structural engineer or architect. For slabs supporting equipment, a minimum thickness of 5 inches is recommended. Additional thickness and reinforcement recommendations may be provided by the structural engineer.

7.7. Subgrade Preparation for Concrete Slabs

All underslab materials should be adequately compacted prior to the placement of concrete. Care should be taken during placement of the concrete to prevent displacement of the underslab materials. The granular material should be dry to moist, and should not be wetted or saturated prior to the placement of concrete. The concrete slab should be allowed to cure properly prior to placing vinyl or other moisture-sensitive floor covering.

Table 5 below provides recommendations for various levels of protection against vapor transmission through concrete floor slabs placed over a properly prepared subgrade.

Table 5 – Options for Subgrade Preparation below Concrete Floor Slabs

Primary Objective	Recommendation
Enhanced protection against vapor transmission	• Concrete floor slab-on-grade placed directly on a 15-mil-thick moisture vapor retarder that meets the requirements of ASTM E1745 Class C (Stego Wrap or similar) • The moisture vapor retarder membrane should be placed directly on the subgrade (ACI302.1R-67); if required for either leveling of the subgrade or for protection of the membrane from protruding gravel, then place about 2 inches of silty sand[1] under the membrane
Above-standard protection against vapor transmission	This option is available if the slab perimeter is bordered by continuous footings at least 24 inches deep, OR if the area adjacent and extending at least 10 feet from the slab is covered by hardscape without planters: • 2 inches of dry silty sand[1]; over • Waterproofing plastic membrane 10 mils in thickness; over • At least 4 inches of ¾-inch crushed rock[2] or clean gravel[3] to act as a capillary break
Standard protection against vapor transmission	• 2 inches of dry silty sand[1]; over • Waterproofing plastic membrane 10 mils in thickness • If required for either leveling of the subgrade or for protection of the membrane from protruding gravel, place at least 2 inches of silty sand[1] under the membrane.

Notes:

[1] The silty sand should have a gradation between approximately 15 and 40 percent passing the No. 200 sieve and a plasticity index of less than 4. The on-site sandy soils appear to meet these criteria.

[2] The ¾-inch crushed rock should conform to Section 200-1.2 of the latest edition of the "Greenbook" Standard Specifications for Public Works Construction (Public Works Standards, Inc., 2012).

[3] The gravel should contain less than 10 percent of material passing the No. 4 sieve and less than 3 percent passing the No. 200 sieve.

The recommendations presented above are intended to reduce the potential for cracking of slabs; however, even with the incorporation of the recommendations presented herein, slabs may still exhibit some cracking. The occurrence of concrete shrinkage cracks is independent of the supporting soil characteristics.

7.8. Drainage Control

The control of surface water is essential to the satisfactory performance of the building and site improvements. Surface water should be controlled so that conditions of uniform moisture are maintained beneath the improvements, even during periods of heavy rainfall. The following recommendations are considered minimal:

- Ponding and areas of low flow gradients should be avoided.
- If bare soil within 5 feet of the structure is not avoidable, then a gradient of 5 percent or more should be provided sloping away from the improvement. Corresponding paved surfaces should be provided with a gradient of at least 1 percent.
- The remainder of the unpaved areas should be provided with a drainage gradient of at least 2 percent.
- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and to convey water to appropriate discharge points.
- Concrete walks and flatwork should not obstruct the free flow of surface water.
- Brick flatwork should be sealed by mortar or be placed over an impermeable membrane.
- Area drains should be recessed below grade to allow free flow of water into the basin.
- Enclosed raised planters should be sealed at the bottom and provided with an ample flow gradient to a drainage device. Recessed planters and landscaped areas should be provided with area inlet and subsurface drain pipes.
- Planters should not be located adjacent to the structures wherever possible. If planters are to be located adjacent to the structures, the planters should be positively sealed, should incorporate a subdrain, and should be provided with free discharge capacity to a drainage device.
- Planting areas at grade should be provided with positive drainage. Wherever possible, the grade of exposed soil areas should be established above adjacent paved grades. Drainage devices and curbing should be provided to prevent runoff from adjacent pavement or walks into planted areas.
- Gutter and downspout systems should be provided to capture discharge from roof areas. The accumulated roof water should be conveyed to off-site disposal areas by a pipe or concrete swale system.
- Landscape watering should be performed judiciously to preclude either soaking or desiccation of soils. The watering should be such that it just sustains plant growth without excessive watering. Sprinkler systems should be checked periodically to detect leakage and they should be turned off during the rainy season.

8. DESIGN REVIEW AND CONSTRUCTION MONITORING

Geotechnical review of plans and specifications is of paramount importance in engineering practice. The poor performance of many structures has been attributed to inadequate geotechnical review of construction documents. Additionally, observation of excavations will be important to the performance of the proposed development. The following sections present our recommendations relative to the review of construction documents and the monitoring of construction activities.

8.1. Plans and Specifications

The design plans and specifications should be reviewed by Twining prior to bidding and construction, as the geotechnical recommendations may need to be reevaluated in the light of the actual design configuration and loads. This review is necessary to evaluate whether the recommendations contained in this report and future reports have been properly incorporated into the project plans and specifications. Based on the work already performed, this office is best qualified to provide such review.

8.2. Construction Monitoring

Site preparation, removal of unsuitable soils, assessment of imported fill materials, fill placement, foundation installation, and other site grading operations should be observed and tested. The substrata exposed during the construction may differ from that encountered in the test excavations. Continuous observation by a representative of Twining during construction allows for evaluation of the soil conditions as they are encountered, and allows the opportunity to recommend appropriate revisions where necessary.

The project engineer should be notified prior to exposure of subgrades. It is critically important that the engineer be provided with an opportunity to observe all exposed subgrades prior to burial or covering.

9. LIMITATIONS

The recommendations and opinions expressed in this report are based on information obtained from our field exploration for the site. In the event that any of our recommendations conflict with recommendations provided by other design professionals, we should be contacted to aid in resolving the discrepancy.

Due to the limited nature of our field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during excavation operations, for example, the presence of unsuitable soil, and that additional effort may be required to mitigate them.

Site conditions, including groundwater elevation, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Twining has no control.

Twining's recommendations for this site are, to a high degree, dependent upon appropriate quality control of foundation construction. Accordingly, the recommendations are made contingent upon the opportunity for Twining to observe foundation excavations for the proposed construction. If parties other than Twining are engaged to provide such services, such parties must be notified that they will be required to assume complete responsibility as the geotechnical engineer of record and the engineering geologist of record for the geotechnical phase of the project by concurring with the recommendations in this report and/or by providing alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Twining should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report has been prepared for the exclusive use by the client and its agents for specific application to the proposed design and construction of the project described herein. Any party other than the client who wishes to use this report for an adjacent or nearby project, shall notify Twining of such intended use. Land use, site conditions, or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of this report and the nature of the project, Twining may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or any other party will release Twining from any liability resulting from the use of this report by any unauthorized party.

Twining has endeavored to perform its evaluation using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this report.

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TWINING

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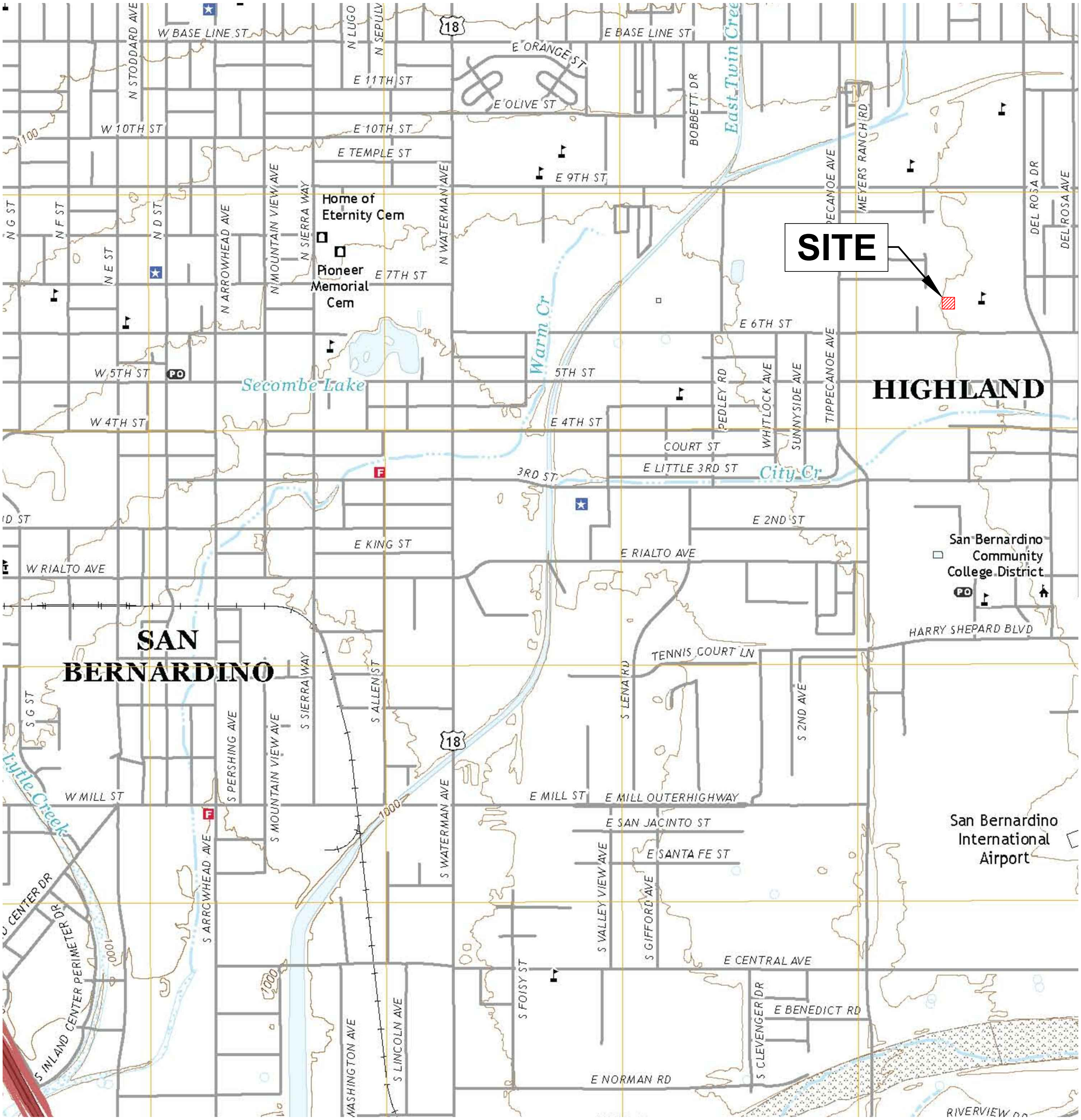
FIGURES



N

AREA ENLARGED IN FIGURE 2

0 2000' 4000'

REFERENCE: USGS (2018)

TWINING

SITE LOCATION MAP

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE 1
190366.3	June 2019	

LEGEND

B-1
TD=51.5'

APPROXIMATE LOCATION OF BORING
TOTAL DEPTH IN FEET

A A'

GEOLOGIC CROSS SECTION

af ARTIFICIAL FILL

Qa ALLUVIAL DEPOSITS

N

0 40' 80'

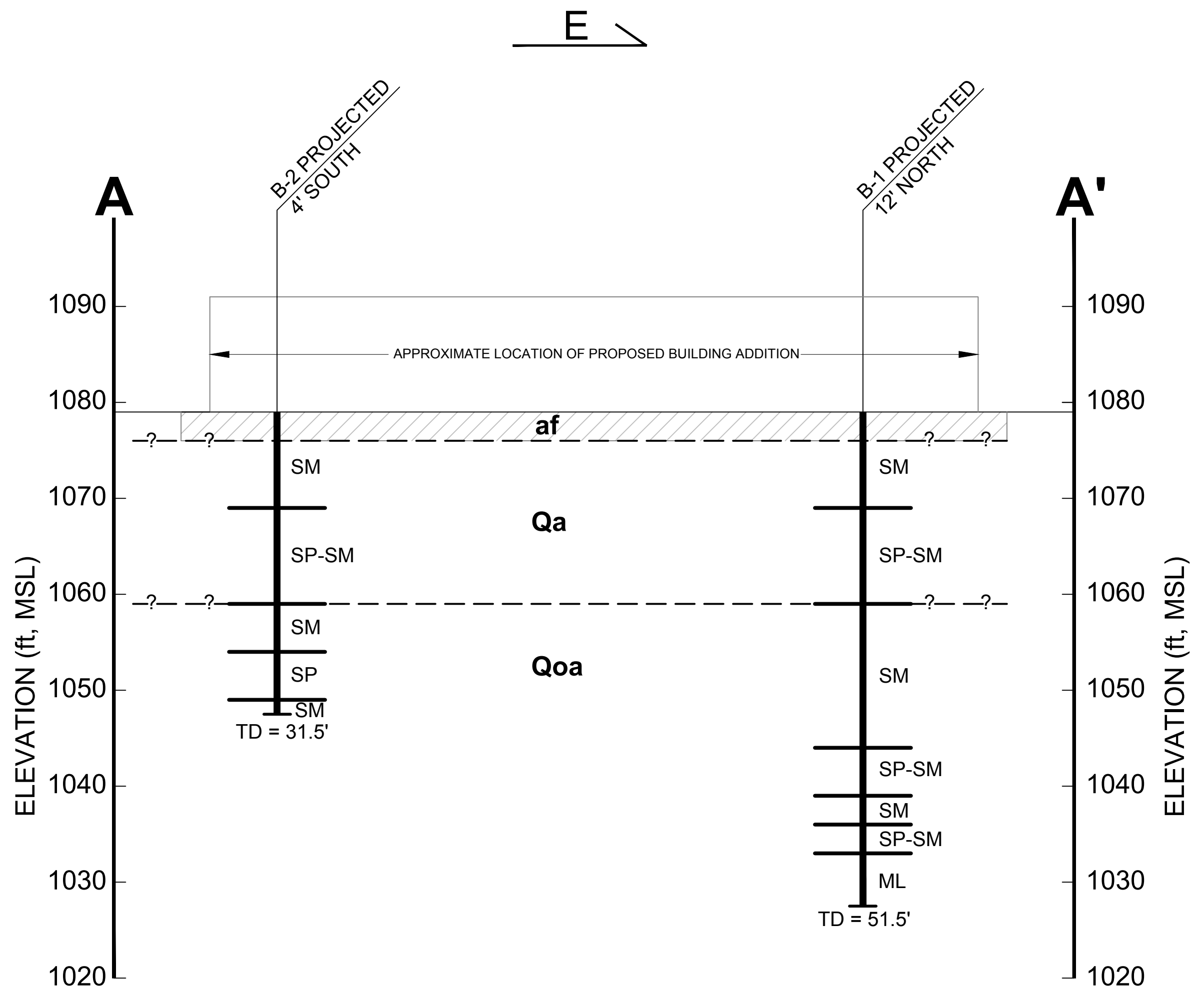
REFERENCE: GOOGLE (2019)

TWINING

SITE PLAN AND BORING LOCATION MAP

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE 2
190366.3	June 2019	



LEGEND

af	ARTIFICIAL FILL
Qa	RECENT ALLUVIAL DEPOSITS (LATE HOLOCENE)
Qoa	OLDER ALLUVIAL DEPOSITS (EARLY HOLOCENE TO LATE PLEISTOCENE)
———	EXISTING GRADE
▨▨▨	RECOMMENDED REMOVAL AND RECOMPACTION ZONE
—?— —?— — — — — —	APPROXIMATE LOCATION OF SOIL STRATA CONTACT (QUERIED WHERE UNCERTAIN)
B-1 TD=51.5'	APPROXIMATE LOCATION OF EXPLORATORY BORING TD = TERMINATION DEPTH IN FEET

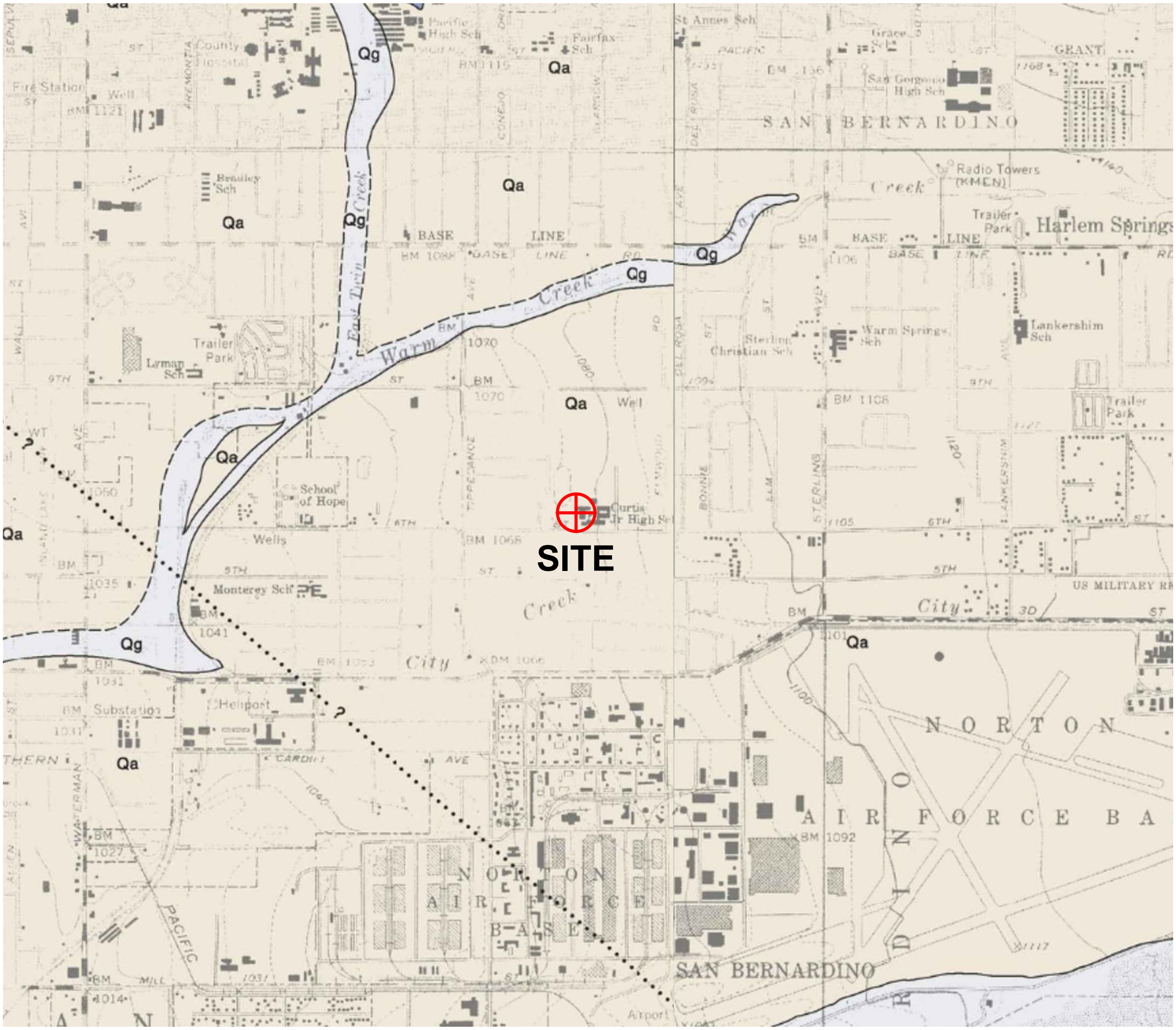
0 20' 40'

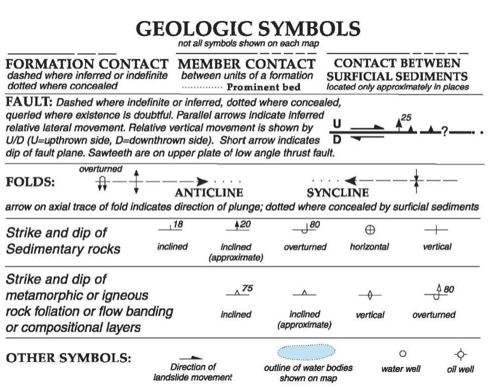
TWINING

CROSS SECTION A-A'

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE 3
190366.3	June 2019	





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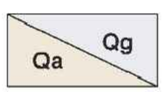


Qg ALLUVIAL GRAVEL AND SAND OF STREAM CHANNELS

Qa ALLUVIAL SAND AND CLAY OF VALLEY AREAS, COVERED WITH GRAY CLAY SOIL; INCLUDES ALLUVIAL PEBBLY SAND ADJACENT TO MOUNTAIN TERRANES

N

0 3,000' 6,000'

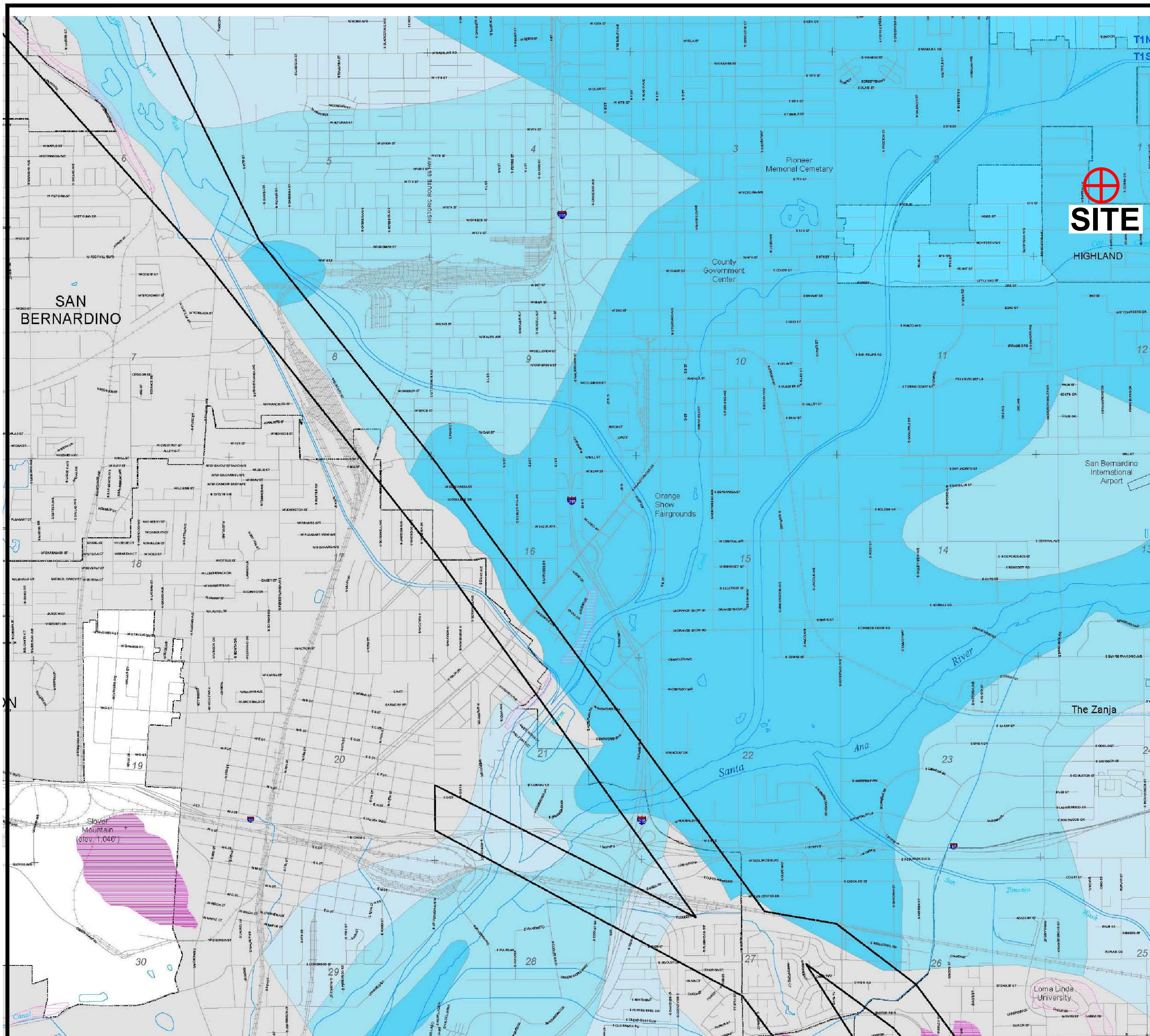
REFERENCE: DIBBLEE (2004a, 2004b)

TWINING

REGIONAL GEOLOGIC MAP

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE 4



LEGEND

Generalized Landslide Susceptibility
- Low to moderate
- Moderate to high
- Mapped, Existing Landslide
- Rockfall/Debris-Flow Hazard Area (Forest Falls Only)

Generalized Liquefaction Susceptibility
- Low
- Medium
- High

Earthquake Fault Zones
- Earthquake Fault Zone Boundary
- County Designated Fault Zones

Cities

N

0 4,000' 8,000'

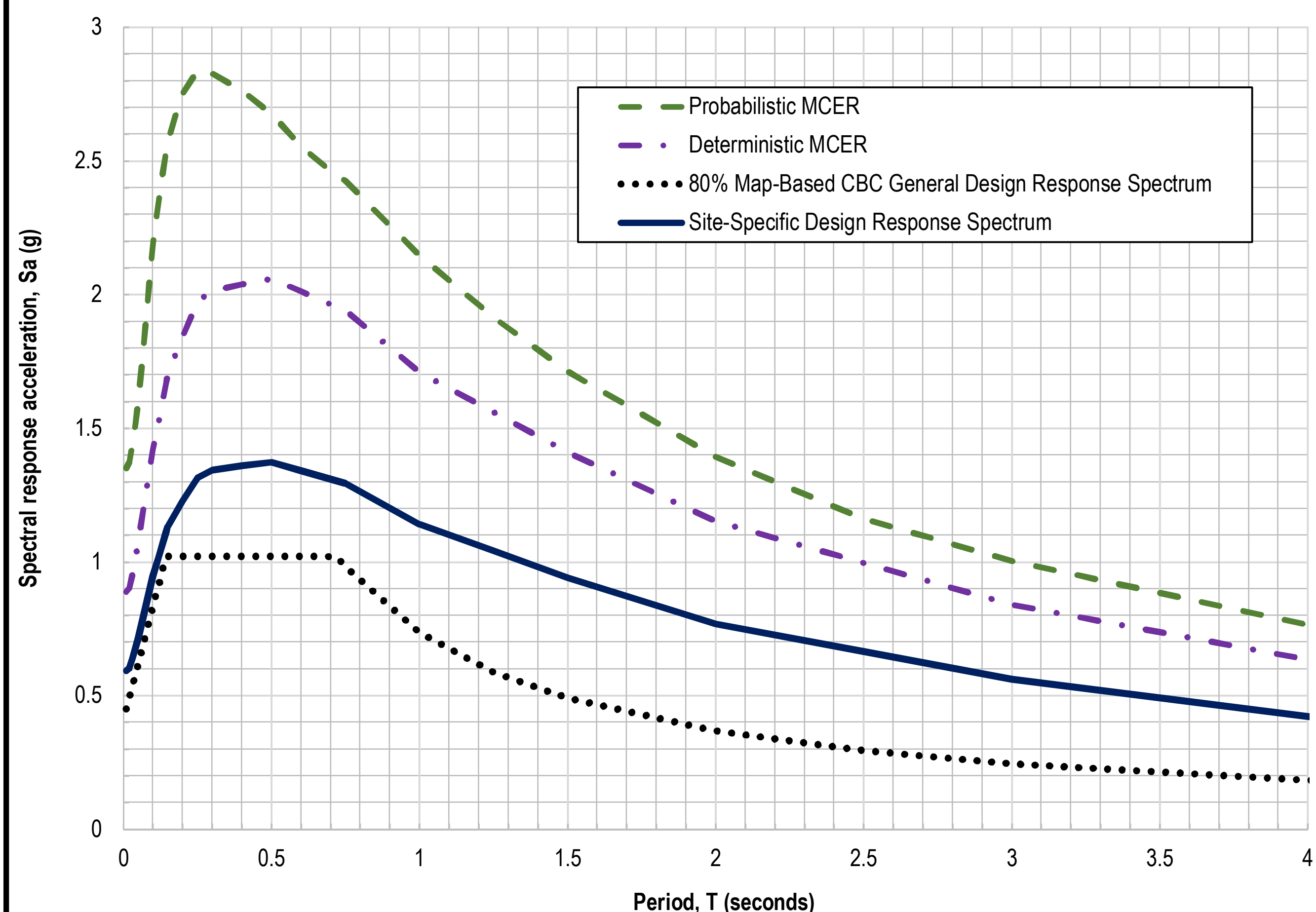
REFERENCE: COUNTY OF SAN BERNARDINO LAND USE PLAN (2007)

TWINING

LIQUEFACTION POTENTIAL MAP		
Indian Springs HS CTE Modernization 650 N. Del Rosa Drive San Bernardino, California		
PROJECT NO. 190366.3	REPORT DATE June 2019	FIGURE 5

PERIOD (seconds)	SITE-SPECIFIC DESIGN RESPONSE SPECTRUM Sa, (g)
0.010	0.591
0.020	0.602
0.030	0.638
0.050	0.714
0.075	0.835
0.100	0.946
0.120	1.021
0.144	1.111
0.150	1.134
0.200	1.229
0.250	1.316
0.300	1.344

PERIOD (seconds)	SITE-SPECIFIC DESIGN RESPONSE SPECTRUM Sa, (g)
0.400	1.359
0.500	1.373
0.600	1.341
0.721	1.303
0.750	1.294
1.000	1.140
1.250	1.040
1.500	0.940
2.000	0.768
2.500	0.665
3.000	0.561
4.000	0.423



TWINING

SITE-SPECIFIC DESIGN RESPONSE SPECTRUM

Indian Springs High School CTE Modernization
650 North Del Rosa Drive
San Bernardino, California

PROJECT NO.	DATE	FIGURE 6
190366.3	June 2019	

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APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

TWINING

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Appendix A
Field Exploration

General

The subsurface exploration program for the proposed project consisted of drilling and logging two 8-inch diameter exploratory borings at the site on May 18, 2019. The borings were advanced to a maximum depth of 51½ feet. The soil boring operations were performed using a truck-mounted CME-75 hollow-stem-auger drill rig. The soil borings were performed by 2R Drilling of Chino, California.

Drilling and Sampling

The Boring Logs are presented as Figures A-2 through A-3. An explanation of these logs is presented as Figure A-1. The Boring Logs describe the earth materials encountered, samples obtained, and show the field and laboratory tests performed. The log also shows the boring number, drilling date, and the name of the logger and drilling subcontractor. The borings were logged by an engineer using the Unified Soil Classification System. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual. Drive and bulk samples of representative earth materials were obtained from the borings.

Disturbed samples were obtained using a Standard Penetration Sampler (SPT). This sampler consists of a 2-inch O.D., 1.4-inch I.D. split barrel shaft that is advanced into the soil at the bottom of the drilled hole a total of 18 inches. The number of blows required to drive the sampler the final 12 inches is presented on the boring logs. Soil samples obtained by the SPT were retained in plastic bags.

A California modified sampler was used to obtain drive samples of the soil encountered. This sampler consists of a 3-inch outside diameter (O.D.), 2.4-inch inside diameter (I.D.) split barrel shaft that was driven a total of 12-inches into the soil at the bottom of the boring by a safety hammer weighing 140 pounds at a drop height of approximately 30 inches. The soil was retained in brass rings for laboratory testing. Additional soil from each drive remaining in the cutting shoe was usually discarded after visually classifying the soil. The number of blows required to drive the sampler the final 12 inches is presented on the boring logs.

Upon completion of the borings, the boreholes were backfilled with soil cuttings derived from the excavations. The surface was patched with rapid-set concrete and to match the existing surface.

UNIFIED SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

COARSE-GRAINED SOILS			FINE-GRAINED SOILS	
Relative Density	**SPT (blows/ft)**	**Relative Density (%)**	**Consistency**	**SPT (blows/ft)**
Very Loose	<4	0 - 15	Very Soft	<2
Loose	4 - 10	15 - 35	Soft	2 - 4
Medium Dense	10 - 30	35 - 65	Medium Stiff	4 - 8
Dense	30 - 50	65 - 85	Stiff	8 - 15
Very Dense	>50	85 - 100	Very Stiff	15 - 30
			Hard	>30

NOTE: SPT blow counts based on 140 lb. hammer falling 30 inches

Sample Symbol	Sample Type	Description
	SPT	1.4 in I.D., 2.0 in. O.D. driven sampler
	California Modified	2.4 in. I.D., 3.0 in. O.D. driven sampler
	Bulk	Retrieved from soil cuttings
	Thin-Walled Tube	Pitcher or Shelby Tube

LABORATORY TESTING ABBREVIATIONS

ATT	Atterberg Limits
C	Consolidation
CORR	Corrosivity Series
DS	Direct Shear
EI	Expansion Index
GS	Grain Size Distribution
K	Permeability
MAX	Moisture/Density (Modified Proctor)
O	Organic Content
RV	Resistance Value
SE	Sand Equivalent
SG	Specific Gravity
TX	Triaxial Compression
UC	Unconfined Compression

TWINING

EXPLANATION FOR LOG OF BORINGS

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE A-1

DATE DRILLED	5/18/19	LOGGED BY	AM	**BORING NO.**	**B-1**
DRIVE WEIGHT	140 lbs.	DROP	30 inches	DEPTH TO GROUNDWATER (ft.)	NE
DRILLING METHOD	8" HSA	DRILLER	2R Drilling	SURFACE ELEVATION (ft.)	1079 ±(MSL)

ELEVATION (feet)	DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS / FOOT	MOISTURE (%)	DRY DENSITY (pcf)	ADDITIONAL TESTS	GRAPHIC LOG	U.S.C.S. CLASSIFICATION	DESCRIPTION
										Concrete Slab = 4 inches
	0–3	X					MAX, RDS		SM	FILL: Silty SAND, dark brown, moist, few fine gravel, fine- to medium-grained sand
									SM	RECENT ALLUVIAL DEPOSITS (LATE HOLOCENE): Silty SAND, orange-brown, damp, medium dense, fine-grained sand
1074	5		X	22	12.3	112.3	#200			-- dark brown -- orange-brown
										-- difficult drilling, gravel up to 3 inches in diameter encountered
1069	10		X	19			#200		SP-SM	Poorly graded SAND with SILT, light brown, moist, medium dense, fine-grained sand
										-- difficult drilling, gravel layer encountered
1064	15		X	67	3.0	98.8	#200			-- fine- to medium-grained sand
										-- difficult drilling between 17 and 19 feet, coarse gravel layer encountered
1059	20		X	33					SM	OLDER ALLUVIAL DEPOSITS (EARLY HOLOCENE TO LATE PLEISTOCENE): Silty SAND, reddish-brown, moist, dense, fine- to coarse-grained sand, few fine gravel,
1054	25		X	50/3"						-- medium to grayish-brown with fine gravel -- grades to reddish-brown, medium to coarse-grained
1049	30		X	26						-- medium brown, fine-grained sand
1044	35									

BORING LOG 190366.3 - ISHS CTE.GPJ TWINING LABS.GDT 6/12/19

TWINING

LOG OF BORING

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE A - 2

DATE DRILLED	5/18/19	LOGGED BY	AM	BORING NO.	B-1
DRIVE WEIGHT	140 lbs.	DROP	30 inches	DEPTH TO GROUNDWATER (ft.)	NE
DRILLING METHOD	8" HSA	DRILLER	2R Drilling	SURFACE ELEVATION (ft.)	1079 ±(MSL)

ELEVATION (feet)	DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS / FOOT	MOISTURE (%)	DRY DENSITY (pcf)	ADDITIONAL TESTS	GRAPHIC LOG	U.S.C.S. CLASSIFICATION	DESCRIPTION
			X	50/5"					SP-SM	Poorly graded SAND with silt, light brown, moist, very dense, fine-grained sand -- 2-inch diameter rock in sampler
1039	40			21					SM	Interbedded reddish-brown silty SAND and gray SILT, moist, fine-grained sand
									SP-SM	Poorly graded SAND with silt, light brown, moist, dense, fine- to coarse-grained sand -- olive-brown lense of lean clay at tip of sampler
1034	45			34					ML	Sandy SILT, gray with mica flecks, moist, hard
1029	50			20						
										Total Depth = 51.5 feet Backfilled on 5/18/2019 Groundwater not encountered. Borehole backfilled with soil cuttings. Surface patched with rapid-set concrete.
1024	55									
1019	60									
1014	65									
1009	70									

TWINING

LOG OF BORING

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE A - 2

DATE DRILLED	5/18/19	LOGGED BY	AM	**BORING NO.**	**B-2**
DRIVE WEIGHT	140 lbs.	DROP	30 inches	DEPTH TO GROUNDWATER (ft.)	NE
DRILLING METHOD	8" HSA	DRILLER	2R Drilling	SURFACE ELEVATION (ft.)	1079 ±(MSL)

ELEVATION (feet)	DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS / FOOT	MOISTURE (%)	DRY DENSITY (pcf)	ADDITIONAL TESTS	U.S.C.S. CLASSIFICATION	DESCRIPTION
	0	Bulk				#200, CORR	SM	Concrete Slab = 4 inches FILL: Silty SAND, medium to reddish-brown, moist, fine- to medium-grained sand
							SM	RECENT ALLUVIAL DEPOSITS (LATE HOLOCENE): Silty SAND, dark brown, moist, fine- to medium-grained sand
1074	5	Driven	8					-- loose
1069	10	Driven	30	7.6	94.9	DS	SP-SM	Poorly graded SAND with SILT, reddish-brown, moist, medium dense, fine- to coarse-grained sand
1064	15	Driven	19					-- medium to grayish-brown, fine- to medium-grained sand
1059	20	Driven	48	14.0	109.6	#200, CONSOL	SM	OLDER ALLUVIAL DEPOSITS (EARLY HOLOCENE TO LATE PLEISTOCENE): Silty SAND, reddish-brown, moist, dense, fine- to coarse-grained sand -- lense of gray sandy silt at tip of sampler
1054	25	Driven	50/5"			#200	SP	Poorly graded SAND, reddish-brown, moist, very dense, fine- to coarse-grained sand, few fine gravel
1049	30	Driven	71				SM	Silty SAND, grayish brown, moist, dense, fine- to medium-grained sand
1044	35							Total Depth = 31.5 feet Backfilled on 5/18/2019 Groundwater not encountered. Borehole backfilled with soil cuttings. Surface patched with rapid-set concrete.

TWINING

LOG OF BORING

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE A - 3

TWINING

2883 East Spring Street
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APPENDIX B
LABORATORY TESTING

Appendix B
Laboratory Testing

Laboratory Moisture Content and Density Tests

The moisture content and dry densities of driven samples obtained from the exploratory borings were evaluated in general accordance with the latest version of ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A and also summarized in Table B-1.

Table B-1
Laboratory Moisture Content and Dry Density

Boring No.	Depth (feet)	Moisture Content (%)	Dry Unit Weight (pcf)
B-1	5	12.3	112.3
B-1	15	3.0	98.8
B-2	10	7.6	94.9
B-2	20	14.0	109.6

Wash Sieve

The amount of fines passing the No. 200 sieve was evaluated by the wash sieve on selected soil samples. The test procedure was in general accordance with ASTM D 1140. The test results are presented in Table B-2.

Table B-2
No. 200 Wash Sieve Results

Boring No.	Depth (feet)	Percent Passing #200
B-1	5	28.1
B-1	10	6.8
B-1	15	9.4
B-2	0-5	37.2
B-2	20	16.7
B-2	25	4.1

Maximum Dry Density-Optimum Moisture Content

One selected bulk sample was tested to evaluate the maximum dry density and its optimum moisture content. The test was performed in general accordance with ASTM test method D 1557. The result is presented on Figure B-1.

Remolded Direct Shear Test

A remolded direct shear test was performed on a selected bulk sample in general accordance with the latest version of ASTM D 3080 to evaluate the shear strength characteristics of the selected materials. Prior to testing the bulk sample was remolded to 90% of the maximum dry density, as determined by ASTM D 1557. The sample was inundated during shearing to represent adverse field conditions. Test results are presented on Figures B-2.

Direct Shear Test

Direct shear tests were performed on selected samples in general accordance with the latest version of ASTM D 3080 to evaluate the shear strength characteristics of the selected materials. The samples were inundated during shearing to represent adverse field conditions. Test results are presented on Figures B-3 and B-4.

Consolidation Test

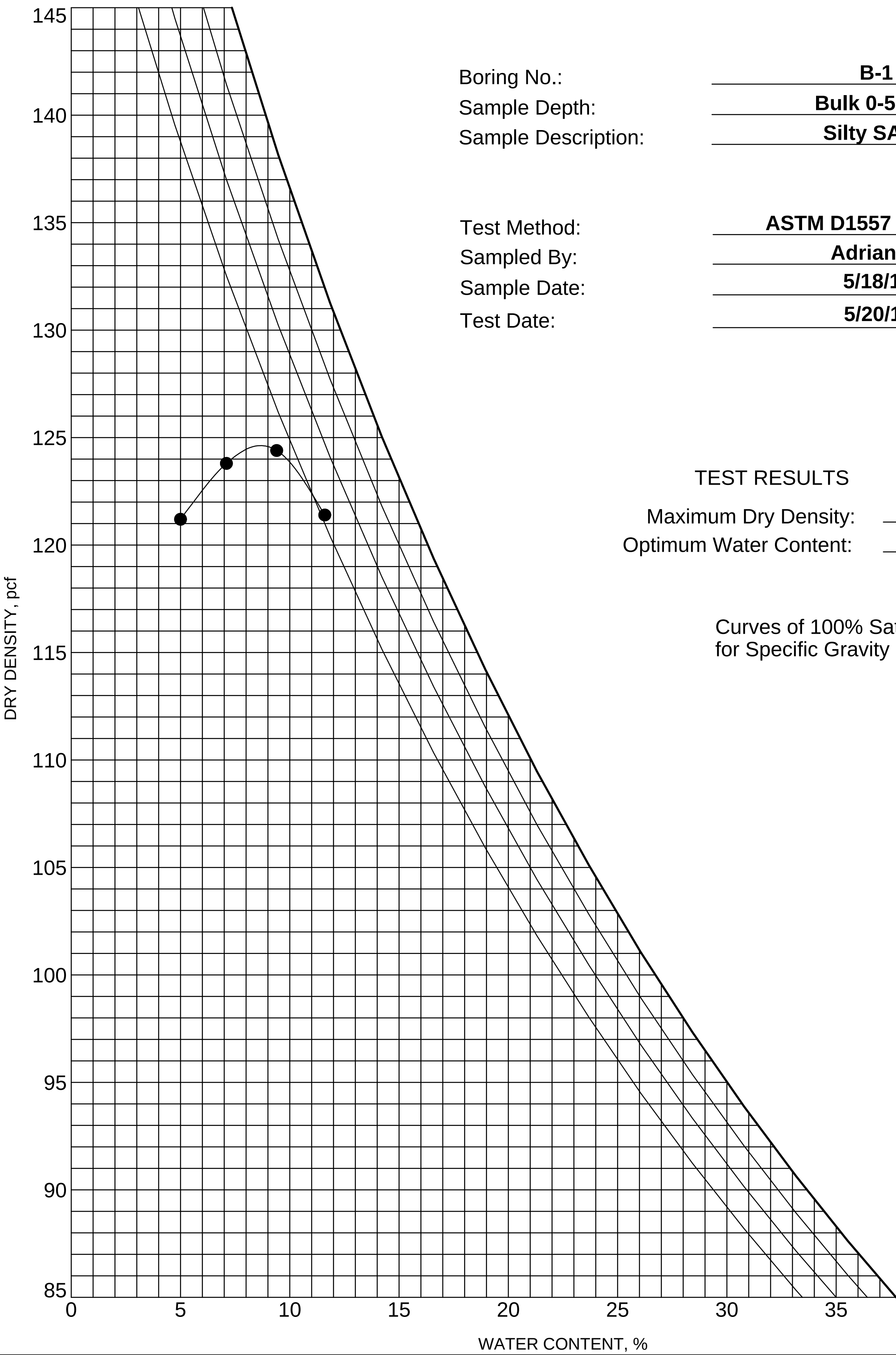
Consolidation tests were performed on selected samples in general accordance with the latest version of ASTM D 2435. The samples were inundated during testing to represent adverse field conditions. The percent consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of testing are presented on Figures B-5.

Corrosivity

Soil pH and resistivity tests were performed by Anaheim Test Lab, Inc. on a representative soil sample. The resistivity of the soil assumes saturated soil conditions. The chloride and sulfate contents of the selected samples were evaluated in general accordance with the latest versions of Caltrans test methods CT417, CT422, and CT 643. The test results are presented on Table B-3.

Table B-3
Corrosivity Test Results

Boring No.	Depth (feet)	pH	Water Soluble Sulfate (ppm)	Water Soluble Chloride (ppm)	Minimum Resistivity (ohm-cm)
B-2	0 – 5	6.9	226	32	4,800



Boring No.:	**B-1**
Sample Depth:	**Bulk 0-5 feet**
Sample Description:	**Silty SAND**

Test Method:	**ASTM D1557 Method A**
Sampled By:	**Adrian M.**
Sample Date:	**5/18/19**
Test Date:	**5/20/19**

TEST RESULTS

Maximum Dry Density: **124.5 pcf**

Optimum Water Content: **8.5 %**

Curves of 100% Saturation
for Specific Gravity Equal to:

2.80

2.70

2.60

2.50

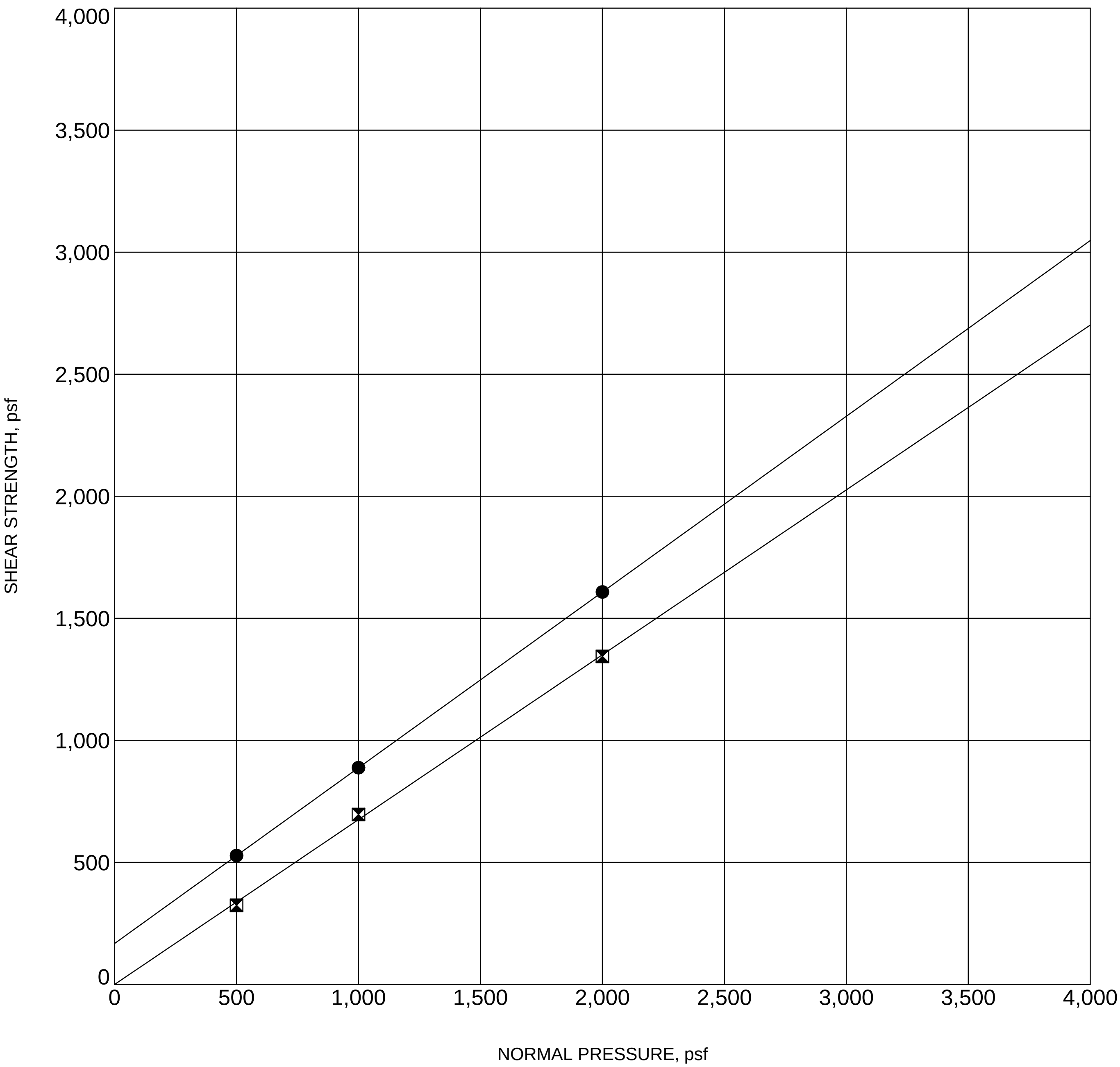
TWINING

MOISTURE-DENSITY RELATIONSHIP

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE B-1
190366.3	June 2019	

COMPACTION (MODIFIED BY PAUL) 190366.3 - ISHS CTE.GPJ TWINING LABS.GDT 6/5/19



Boring No.: B-1
Sample Depth (ft): 0 - 5'
Sample Description: Silty SAND
Strain Rate (in./min): 0.005
Dry Density (pcf): 112.1

Shear Strength Parameters

	Peak	Ultimate
Cohesion, C (psf):	150	0
Friction Angle, Ø (deg):	36	36

Initial Moisture (%): 8.7
Final Moisture (%): 11.6

Note: Sample remolded to 90% of maximum density per ASTM D 1557.

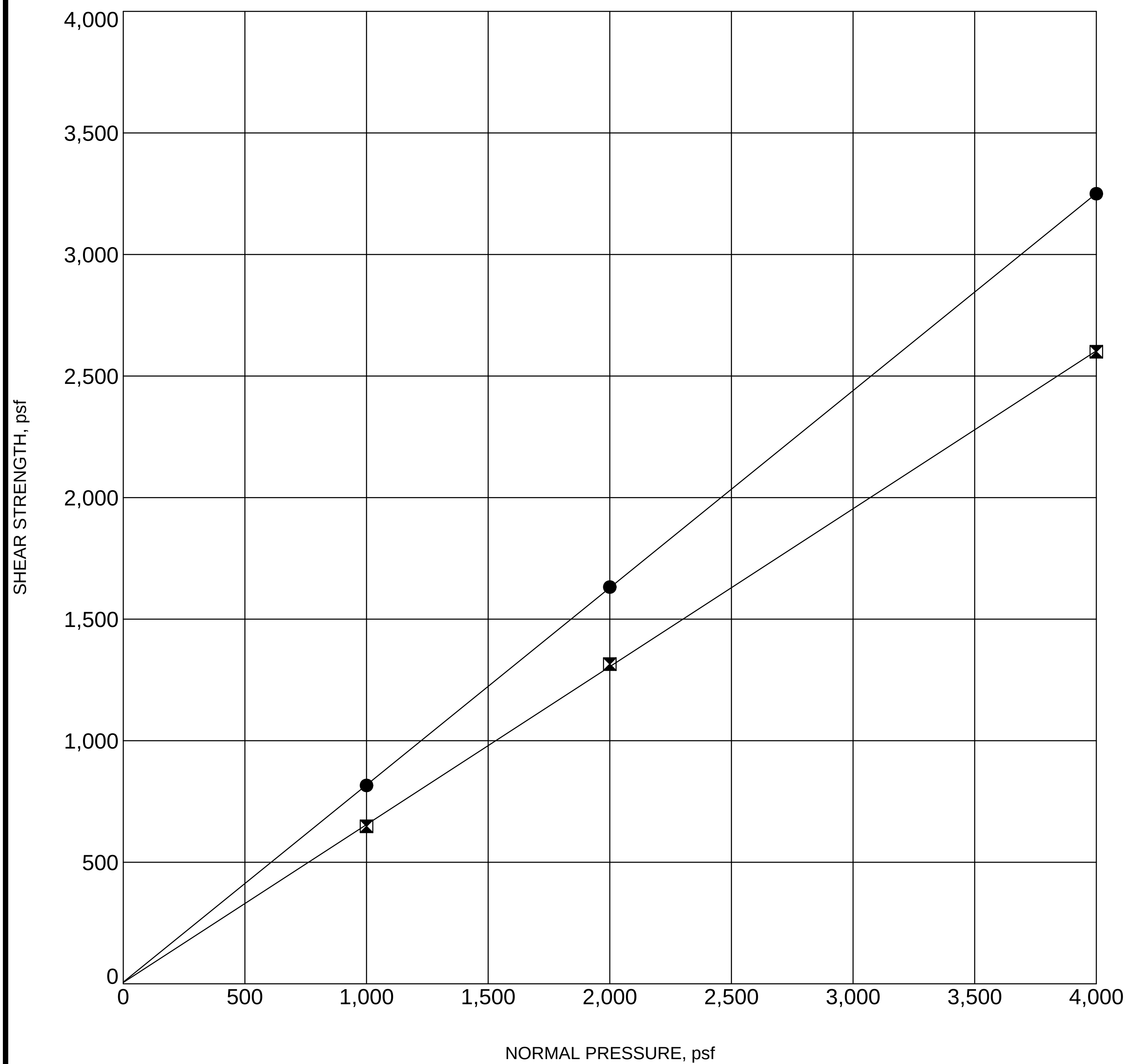
DIRECT SHEAR 190366.3 - ISHS CTE.GPJ TWINING LABS.GDT 6/5/19

TWINING

REMOLDED DIRECT SHEAR TEST

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE B-2



Shear Strength Parameters

	Peak	Ultimate
Cohesion, C (psf):	0	0
Friction Angle, Ø (deg):	39	33

Boring No.: B-2
Sample Depth (ft): 10
Sample Description: Poorly graded SAND with SILT
Strain Rate (in./min): 0.005
Dry Density (pcf): 94.9

Initial Moisture (%): 7.6
Final Moisture (%): 17.4

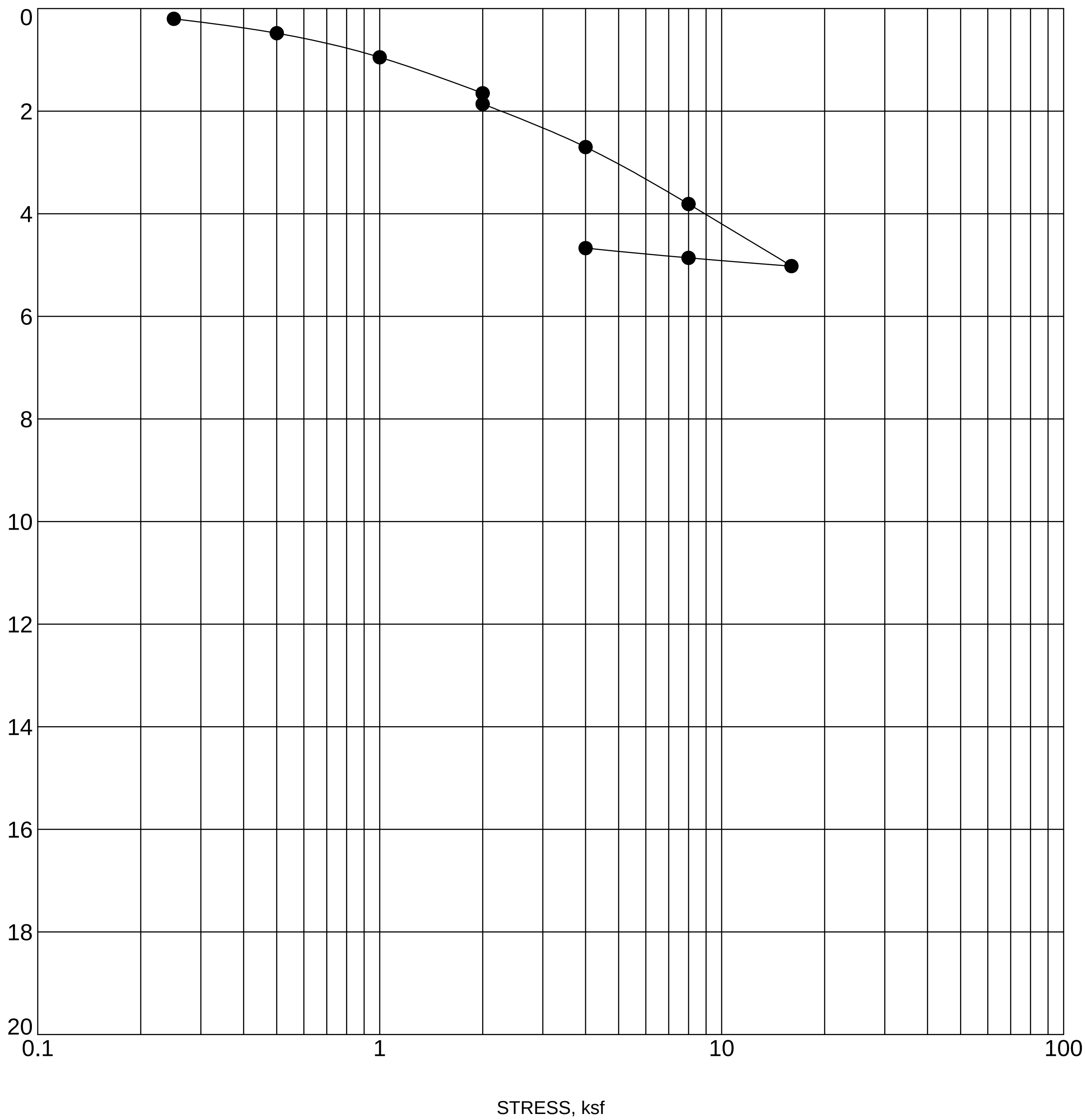
TWINING

DIRECT SHEAR TEST

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE B-3
190366.3	June 2019	

DIRECT SHEAR 190366.3 - ISHS CTE.GPJ TWINING LABS.GDT 6/5/19



	Sample Location	Soil Description	Dry Density (pcf)	Moisture Content (%)
●	**B-2 at 20 ft**	**Silty SAND**	**109.6**	**14.0**

TWINING

CONSOLIDATION TEST

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	
190366.3	June 2019	FIGURE B-4

TWINING

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APPENDIX C
LIQUEFACTION ANALYSIS

Twining, Inc.
2883 E. Spring Street, #300
Long Beach, California

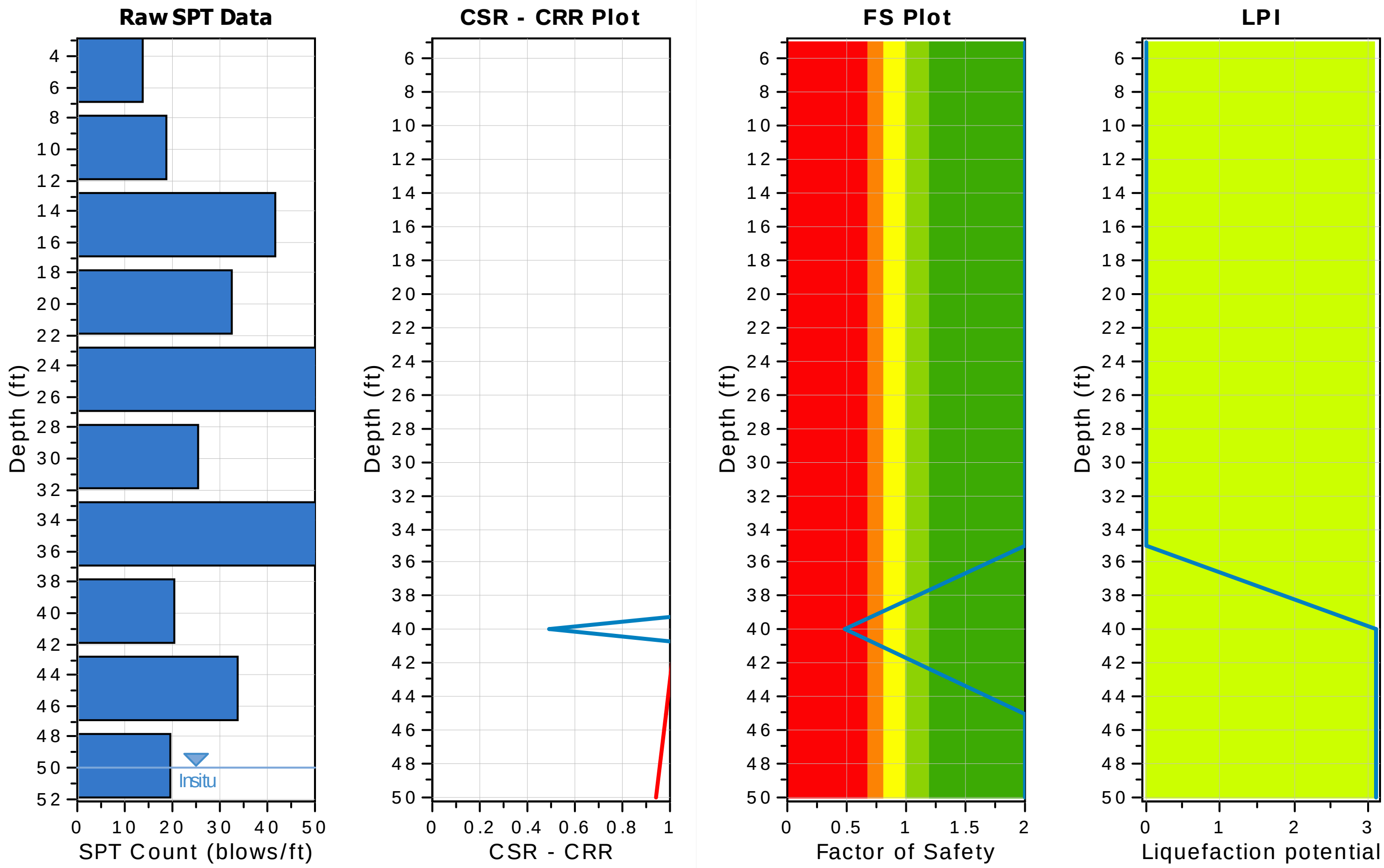
SPT BASED LIQUEFACTION ANALYSIS REPORT

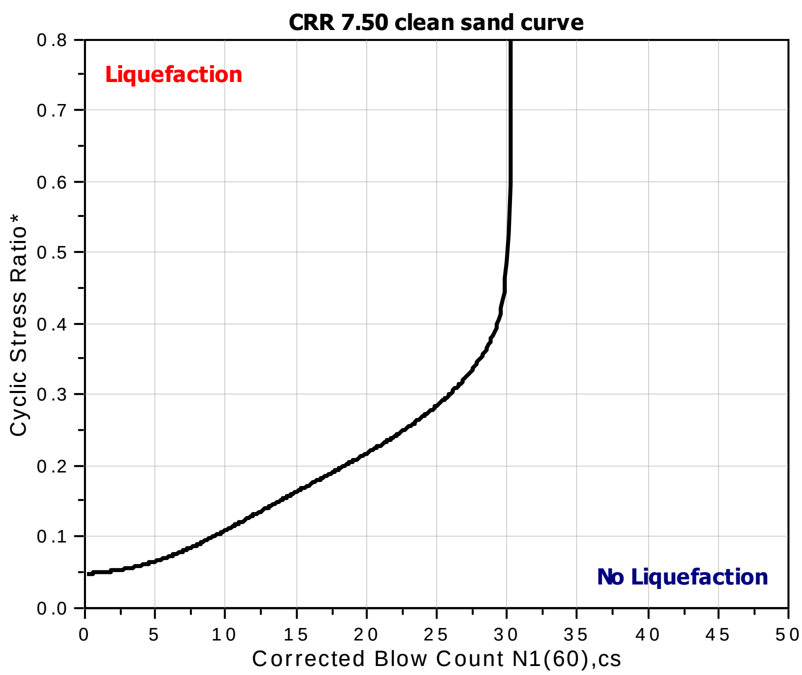
Project title : Indian Springs HS CTE **SPT Name: SPT #1**

Location : 650 N. Del Rosa Drive, San Bernardino, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	50.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	0.00 ft
Sampling method:	Sampler wo liners	Earthquake magnitude M_w:	7.91
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.76 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.33		

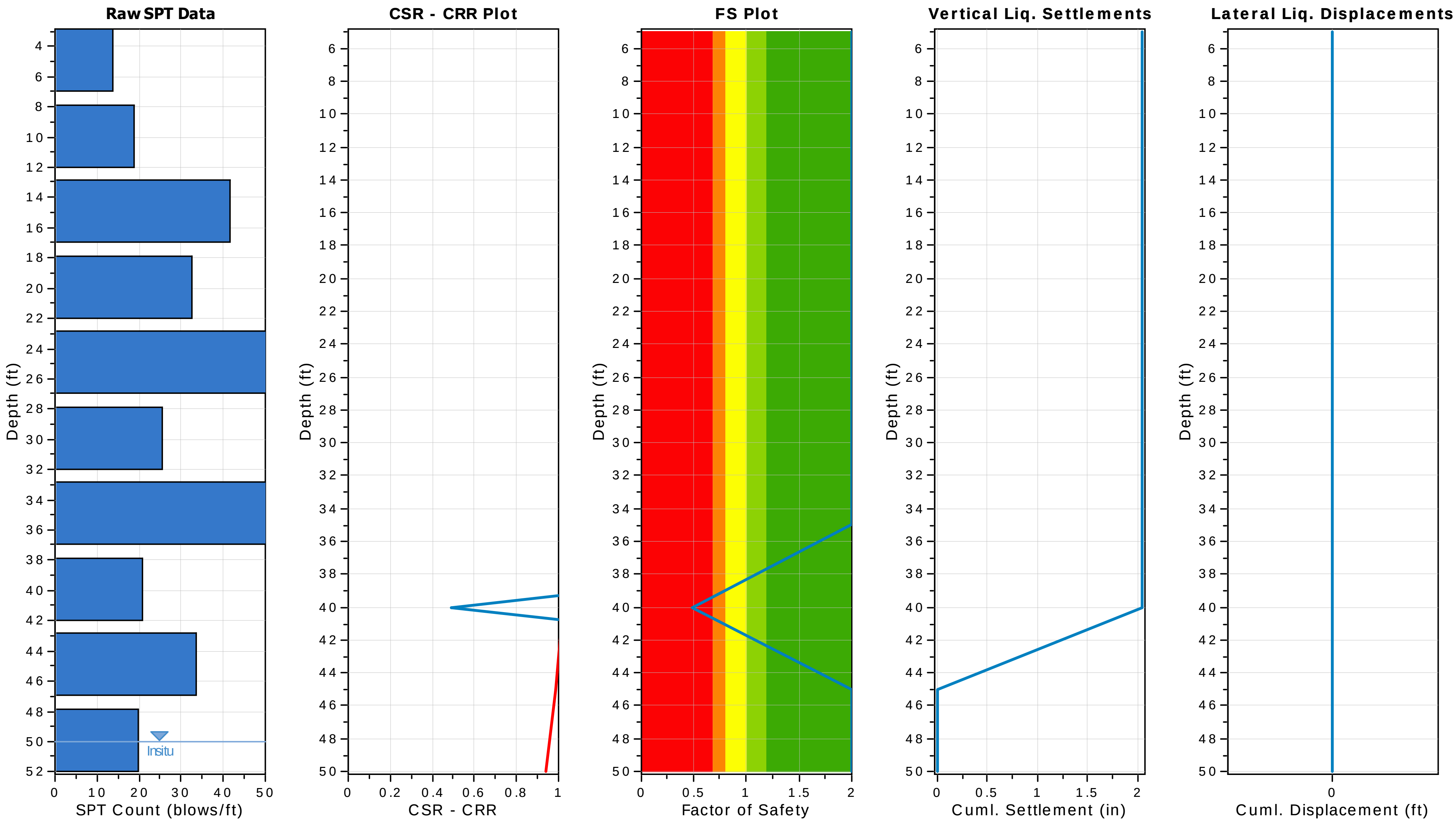




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
5.00	14	35.00	125.00	5.00	Yes
10.00	19	7.00	105.00	5.00	Yes
15.00	42	10.00	105.00	5.00	Yes
20.00	33	15.00	125.00	5.00	Yes
25.00	63	15.00	125.00	5.00	Yes
30.00	26	15.00	125.00	5.00	Yes
35.00	63	10.00	125.00	5.00	Yes
40.00	21	50.00	125.00	5.00	Yes
45.00	34	10.00	125.00	5.00	Yes
50.00	20	65.00	125.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
5.00	14	125.00	0.31	0.00	0.31	1.47	1.33	1.00	0.75	1.20	25	35.00	5.00	1.20	35	4.000
10.00	19	105.00	0.57	0.00	0.57	1.26	1.33	1.00	0.85	1.20	33	7.00	0.12	1.01	33	4.000
15.00	42	105.00	0.84	0.00	0.84	1.10	1.33	1.00	0.85	1.20	63	10.00	0.87	1.02	65	4.000
20.00	33	125.00	1.15	0.00	1.15	0.96	1.33	1.00	0.95	1.20	48	15.00	2.50	1.05	53	4.000
25.00	63	125.00	1.46	0.00	1.46	0.85	1.33	1.00	0.95	1.20	81	15.00	2.50	1.05	87	4.000
30.00	26	125.00	1.78	0.00	1.78	0.76	1.33	1.00	1.00	1.20	32	15.00	2.50	1.05	36	4.000
35.00	63	125.00	2.09	0.00	2.09	0.69	1.33	1.00	1.00	1.20	70	10.00	0.87	1.02	72	4.000
40.00	21	125.00	2.40	0.00	2.40	0.63	1.33	1.00	1.00	1.20	21	50.00	5.00	1.20	30	0.488
45.00	34	125.00	2.71	0.00	2.71	0.58	1.33	1.00	1.00	1.20	32	10.00	0.87	1.02	34	4.000
50.00	20	125.00	3.03	0.00	3.03	0.54	1.33	1.00	1.00	1.20	17	65.00	5.00	1.20	25	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
5.00	125.00	0.31	0.16	0.16	0.99	1.00	0.977	0.87	1.120	1.00	1.120	2.000	●
10.00	105.00	0.57	0.31	0.26	0.98	1.00	1.058	0.87	1.212	1.00	1.212	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
15.00	105.00	0.84	0.47	0.37	0.97	1.00	1.084	0.87	1.243	1.00	1.243	2.000	●
20.00	125.00	1.15	0.62	0.53	0.96	1.00	1.033	0.87	1.185	1.00	1.185	2.000	●
25.00	125.00	1.46	0.78	0.68	0.94	1.00	0.997	0.87	1.143	1.00	1.143	2.000	●
30.00	125.00	1.78	0.94	0.84	0.92	1.00	0.962	0.87	1.103	1.00	1.103	2.000	●
35.00	125.00	2.09	1.09	1.00	0.89	1.00	0.923	0.87	1.058	1.00	1.058	2.000	●
40.00	125.00	2.40	1.25	1.15	0.85	1.00	0.876	0.87	1.004	0.98	1.021	0.478	●
45.00	125.00	2.71	1.40	1.31	0.80	1.00	0.823	0.87	0.943	0.96	0.984	2.000	●
50.00	125.00	3.03	1.56	1.47	0.75	1.00	0.768	0.87	0.880	0.94	0.939	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
5.00	2.000	0.00	9.24	5.00	0.00
10.00	2.000	0.00	8.48	5.00	0.00
15.00	2.000	0.00	7.71	5.00	0.00
20.00	2.000	0.00	6.95	5.00	0.00
25.00	2.000	0.00	6.19	5.00	0.00
30.00	2.000	0.00	5.43	5.00	0.00
35.00	2.000	0.00	4.67	5.00	0.00
40.00	0.478	0.52	3.90	5.00	3.11
45.00	2.000	0.00	3.14	5.00	0.00
50.00	2.000	0.00	2.38	5.00	0.00

Overall potential I_L : 3.11

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
5.00	0.01	2.10	0.00	5.00	0.000
10.00	0.05	3.30	0.00	5.00	0.000
15.00	0.05	3.30	0.00	5.00	0.000
20.00	0.01	2.10	0.00	5.00	0.000
25.00	0.01	2.10	0.00	5.00	0.000

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
30.00	0.01	2.10	0.00	5.00	0.000
35.00	0.05	3.30	0.00	5.00	0.000
40.00	0.01	2.10	3.41	5.00	2.046
45.00	0.05	3.30	0.00	5.00	0.000
50.00	0.01	2.10	0.00	5.00	0.000

Cumulative settlements: 2.046

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
5.00	25	70.00	0.00	5.00	0.000	0.00
10.00	33	80.42	0.00	5.00	0.000	0.00
15.00	63	100.00	0.00	5.00	0.000	0.00
20.00	48	100.00	0.00	5.00	0.000	0.00
25.00	81	100.00	0.00	5.00	0.000	0.00
30.00	32	79.20	0.00	5.00	0.000	0.00
35.00	70	100.00	0.00	5.00	0.000	0.00
40.00	21	64.16	22.70	5.00	0.000	0.00
45.00	32	79.20	0.00	5.00	0.000	0.00
50.00	17	57.72	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

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APPENDIX D
ENGINEERING GEOLOGY INVESTIGATION REPORT

AKW GEOTECHNICAL

GEOLOGICAL CONSULTANTS

Project No. M1126-01
June 14, 2019

Mr. Paul Soltis
Twining Consulting, Inc.
Irvine, California 92614

Subject: ENGINEERING GEOLOGY INVESTIGATION
PROPOSED CTE MODERNIZATION
INDIAN SPRINGS HIGH SCHOOL
650 NORTH DEL ROSA DRIVE
SAN BERNARDINO, CALIFORNIA

Dear Mr. Soltis:

In accordance with your authorization, we have performed an engineering geology investigation for the proposed CTE Modernization on the campus of Indian Springs High School, in the city of San Bernardino, California. The accompanying report presents results of our investigation and includes conclusions and recommendations pertaining to the geologic aspects of the improvements on the site as presently proposed. Twining Consulting, Inc. will be presenting the primary geotechnical report for the subject site. It is our understanding that this engineering geology investigation will be included as an appendix in your report.

Should you have questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Respectfully submitted,
AKW GEOTECHNICAL

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ENGINEERING GEOLOGY INVESTIGATION

1. PURPOSE AND SCOPE

This report presents the findings of our engineering geology investigation for the proposed CTE Building Modernization. The purpose of the study was to address potential site geologic hazard conditions for the proposed structure in accordance with 2016 California Building Code (CBSC, 2016) and California Geological Survey (CGS) Note 48 (CGS, 2013a).

To prepare this investigation we conducted a review of readily available published and unpublished reports, maps and documents pertinent to the proposed site improvements. We performed a geologic field reconnaissance of the site and the surrounding area concurrently with the site investigation by Twining Consulting, Inc. (Twining, 2019).

2. SITE AND PROJECT CONDITIONS

2.1. EXISTING SITE CONDITIONS

Indian Springs High School is located at 650 North Del Rosa Drive in the city of San Bernardino, California (see *Site Location Map*, Enclosure 1). Based on our review of existing USGS topographic maps, the current high school campus was officially opened in Fall of 2012. The new high school campus occupies the former Curtis Junior High School campus. Based on our review of digital and vintage aerial photography (Google Earth, SBCFCD), Curtis JHS was opened in July 1964. In 2009, the existing Junior High School was closed and grading operations for construction of the Indian Springs High School campus began. Three structures from the original Curtis Junior High School campus were incorporated into the new development and are immediately adjacent along the north and east portions of the proposed site additions. During the field portion of this investigation, a recent crack was observed in one of the three pre-existing structures, immediately east of Boring B-1 in the west-facing building wall. This observed crack was previously repaired and shows an approximate repair diameter of less than one-inch wide. No additional information is available for the pre-existing CJHS structures. The current topography of the approximately 60-acre campus lies between 1,071 feet and 1,090 feet above Mean Sea Level (MSL) and slopes gently towards the west. The proposed CTE Building Modernization (site) lies at an approximate elevation of 1,079 feet above MSL. The existing structures are surrounded by landscape and hardscape improvements. The site topography has been modified to direct drainage to area drains in the landscape and hardscape areas of the campus. The coordinates of the site are Latitude 34.110952° N and Longitude 117.255620° W, utilizing the North American Datum (NAD) from 1983. The site is located in Township T1S, Range R4W, of the San Bernardino Baseline and Meridian in the San Bernardino South 7.5 Minute USGS

Quadrangle. Indian Springs High School is administered by the San Bernardino City Unified School District.

2.2. PROPOSED DEVELOPMENT

Based on information provided by Ruhnau Clarke Architects, the proposed development consists of a 1.850 square-foot addition to the existing structure (Enclosure 3, Site Geologic Map). Detailed building plans were not available for our review. However, it is our understanding that significant cuts, cut slopes, fills, fill slopes, and/or retaining walls are not proposed with the development of the site based on the existing site topography.

2.3. AERIAL PHOTOGRAPH AND TOPOGRAPHIC MAP REVIEW

Vintage stereoscopic aerial photographs of the site and vicinity from the years between 1930 and 2014, USGS topographic maps from the years between 1896 and 2018, and three-dimensional computer-aided photography flown between the years of 1994 and 2018 and presented by Google Earth (Google, 2019) were reviewed for this report. The earliest images of the vicinity indicate agricultural use up to 1964. According to historical records and our vintage aerial photograph survey, the Curtis Junior High School campus was established in mid-1964 on the north side of Sixth Street approximately 0.3 miles (0.5 kilometers) east of Tippecanoe Avenue. The existing CTE structure was constructed sometime after 1964. Multiple northwest-trending lineaments were observed in the region both north and south of the overall school campus on several of the pre-1963 San Bernardino County Flood Control District (SBCFCD) aerial photographs (*USDA-AXM-1930, 1938, 1943, 1953, 1959, 1962*). Most of these lineaments are oriented parallel to the San Andreas and San Jacinto fault systems and possibly suggest a tectonic origin (John R. Byerly, 2007, 2008; AKW Geotechnical 2008). One particular lineament transects the northeastern-most corner of the school campus and continues along a trend of N45°W to N55°W just west of Perris Hill. This lineament was addressed by previous consultants (Gary S. Rasmussen and Associates, 2003; John R. Byerly, 2003; Twining, 2015). Because of the similarity of these trends and faulting in the San Bernardino Valley, we agree with previous consultants that any improvements proposed in the northeast quadrant of the campus be properly evaluated by the Project Engineering Geologist. No lineaments indicative of faulting were observed within the proposed construction during our aerial photograph and topographic map review. However, and as a precaution, all removal bottoms created during grading should be observed and evaluated by the Project Engineering Geologist for final determination of fault rupture hazard assessment.

3. GEOLOGY

3.1. GEOLOGIC SETTING

The site is located in the northern portion of the Peninsular Ranges Geomorphic province, within the subsiding San Bernardino Valley structural block. The Peninsular Ranges Geomorphic province extends southeastward from the foot of the Santa Monica and San Gabriel Mountains to beyond the Mexican border and is subdivided into several major structural units; such as the Los Angeles Basin, the California Continental Borderland, the Palos Verdes, Santa Ana, Perris, San Jacinto Mountain, San Bernardino, San Gabriel and San Jacinto Valley blocks. The Peninsular Ranges province is generally characterized by northwest-oriented valleys and mountain ranges bounded by major right lateral strike-slip fault zones. The San Andreas Fault zone constitutes the eastern provincial boundary; the Patton Escarpment constitutes the western provincial boundary, while the San Jacinto, Elsinore and Newport-Inglewood Fault zones are located within the center of the province. Rocks of the Peninsular Ranges are typically Cretaceous igneous and marine sedimentary and Paleozoic to Mesozoic metasedimentary rocks. Tertiary marine and non-marine sedimentary and volcanic rock along with Quaternary sediment lies unconformably on either the Cretaceous sedimentary or the older basement rock. The San Bernardino Valley structural block is bounded by the San Andreas fault on the northeast, the San Jacinto fault on the southwest, the Crafton Hills and Redlands faults on the east and by the Loma Linda Hills on the south. The earth materials encountered on the subject site are described in more detail in a subsequent section of this report. The geologic units encountered onsite are Artificial Fill associated with school construction and Quaternary Holocene and Pleistocene Alluvium (see *Regional Geologic Map*, Enclosure 2). These units are discussed below.

3.2. GEOLOGIC UNITS

Artificial Fill

Recent geotechnical borings excavated at the site (Twining, 2019) encountered 3 feet of artificial fill. The fill consists of moist, medium to dark to reddish brown fine to medium grained silty sand with gravel. No documentation for the artificial fill was encountered during our reference review. The fill was probably placed during initial site grading in 1964, with portions of the fill possibly reworked during the 2009 – 2012 High School construction phase. The Artificial Fill should be evaluated by the project Geotechnical Engineer for competency with respect to any proposed settlement sensitive structures.

Recent Alluvial Deposits (Late Holocene)

Recent Alluvial Deposits the site consists of moist, loose to medium dense, dark brown to orange brown sand with varying amounts of silt and coarse layered gravel. The alluvium should be evaluated by the project Geotechnical Engineer for competency with respect to any proposed settlement sensitive structures.

Older Alluvial Deposits (Early Holocene to Late Pleistocene)

At a depth of approximately 20 feet (6.1 meters) drill cuttings indicated a separate alluvium unit with significantly more dense, reddish brown fine to coarse sand with varying amounts of silt. Individual sand grains were coated with secondary clay minerals, indicating a significantly greater age for the sediments. The Older Alluvial Deposits are considered to be Early Holocene to Late Pleistocene in age and underlie the site to the maximum depth of recent exploratory borings placed on the site [approximately 51.5 feet (15.7 meters) bgs] (Twining, 2019). The Older Alluvial Deposit at the site is estimated to extend to a depth of approximately 1,300 feet (400 meters) bgs, and is underlain by denser, metamorphic bedrock (Anderson, et. al., 2004). Based upon our conversation with the Project Geotechnical Engineer, seismic design parameters have been developed in accordance with 2016 CBC and ASCE 7-10 (ASCE, 2010) standards. As discussed in the main geotechnical engineering report (Twining, 2019), the project site is classified as Site Class D per ASCE 7-10 Section 20.3.1.

Bedrock

Recent geotechnical borings excavated at the site (Twining, 2019) did not encounter bedrock. Based on recent groundwater and geophysical surveys (Mendez, et. al., 2018; Anderson, et. al., 2004), formational bedrock is anticipated to consist of Pelona Schist metamorphic rock at a depth of 1,600 feet (488 meters) bgs in the vicinity of the site. Surficial exposures of the Pelona Schist can be seen at two hillside locations northwest of the site, Perris Hill and the Shandin Hills, located approximately 1.4 and 3.9 miles (2.3 and 6.3 kilometers) respectively northwest of the site.

4. SEISMIC HAZARDS

4.1. FAULTING

The site is not located within or adjacent to an Alquist-Priolo Earthquake Fault Zone (EFZ). The boundary of the closest Alquist-Priolo EFZ is located approximately 3.1 miles (5.0 kilometers) northeast of the site associated with the San Andreas fault (Bryant and Hart, 2007). Enclosure 5 shows the locations of the recognized nearby faults with respect to the site. The City of San Bernardino (2005) lists the Loma Linda fault as an active fault, with a corresponding Alquist-Priolo EFZ located southwest of the school site. However the California Geological Survey (CGS) removed the Alquist-Priolo EFZ in March, 1976. The Loma Linda fault (as shown on the City of San Bernardino General plan) lies approximately 2.7 miles (4.3 kilometers) southwest of the site. The

County of San Bernardino (2007) does not identify any additional hazardous faults in the immediate site vicinity.

A fault table of the active or potentially active faults within 62 miles (100 kilometers) of the site was generated by EQFAULT (Blake, 2000a) and was reviewed for this investigation. However, due to the limitations of the data base utilized by Blake, all of the fault distances were determined by individual measurements from more precise geologic maps, including the State's Alquist-Priolo EFZ maps, California Geological Survey (2013b), Morton and Miller (2006), Ziony and Jones (1989), Jennings (1975, 1977, 1992, 1994), Jennings and Bryant (2010), Jennings et al. (2010), USGS (2018). A regional fault map, included as Enclosure 5, displays the approximate locations of the larger or better known of these faults closest to the site (CGS, 2005; USGS 2019). A regional fault table, included as Enclosure 6, lists the approximate distances, locations and other pertinent details for the most significant faults to the site.

Furthermore, the closest mapped faults and observed lineaments discussed below are considered to represent the closest and most significant potential hazard to the site with respect to potential ground surface rupture and/or generate strong ground motion in the event of a moderately sized or larger earthquake.

Lineaments

Multiple northwest-trending lineaments were observed in the region both north and south of the overall school campus on several of the pre-1963 San Bernardino County Flood Control District (SBCFCD) aerial photographs (USDA-AXM-1930, 1938, 1943, 1953, 1959, 1962). Most of these lineaments are oriented parallel to the San Andreas and San Jacinto fault systems and possibly suggest a tectonic origin. Various fault trench investigations in the region indicate some of the lineaments are the result of faulting and others are simply erosional or depositional features (John R. Byerly, 2007, 2008; AKW 2008). One particular lineament transects the northeastern-most corner of the school campus and continues along a trend of N45°W to N55°W just west of Perris Hill. This lineament was addressed by previous consultants (Gary S. Rasmussen and Associates, 2003; John R. Byerly, 2003; Twining, 2015). The intersection of the unnamed normal fault discussed below and the lineament observed across the northeast corner of the site suggests that the existence of one most likely precludes the other. Because of the similarity of these trends and faulting in the San Bernardino Valley, we agree with previous consultants that any improvements proposed in the northeast quadrant of the campus be properly evaluated by the Project Engineering Geologist. This lineament is shown on Enclosure 5 *Regional Fault Map*.

Unnamed Normal Fault

An unnamed normal fault appears in the literature (Anderson, et. al., 2004) and is postulated to exist near the site based on geophysical evidence. The subsurface fault is located between Perris Hill and the site and is the result of pull-apart basin formation process followed by clockwise rotation of the San Bernardino Valley block. Based on the geophysical data, the fault may lie along the northern boundary of the school site approximately 0.3 miles (0.5 kilometers) to the north and trend roughly east-west. This potential fault is the closest mapped fault to the site (see *Regional Geologic Map*, Enclosure 5). The intersection of the lineament discussed above and the unnamed normal fault is suggests that the existence of one most likely precludes the other. Based on our review of the geophysical evidence, the estimated depth to site-bedrock of of 1,600 feet (488 meters) bgs, and the proximity of surficial 130 foot-tall (40 meters) Pelona Schist bedrock exposed above the valley floor roughly 1.4 miles (2.3 kilometers) north of the school campus site at Perris Hill, we feel the possibility of a normal fault is highly plausible. This unnamed fault is not listed in the Documentation for the 2008 and 2014 Updates of the National Seismic Hazard Maps (USGS; 2008, 2014).

Unnamed Strike Slip Fault

Several unnamed strike-slip faults appear in the literature (Anderson, et. al., 2004) and are postulated south of the site based on geophysical evidence. These subsurface faults are the result of pull-apart basin formation process followed by clockwise rotation of the San Bernardino Valley block. Based on the geophysical data, groundwater well logs, and micro-seismicity plots, faults are most likely active and lie approximately 1.5 to 4.7 miles (2.4 to 7.6 kilometers) to the south and southeast of the site. These unnamed strike-slip faults are not listed in the Documentation for the 2008 and 2014 Updates of the National Seismic Hazard Maps (USGS; 2008, 2014).

Loma Linda Fault

The Loma Linda fault is located approximately 2.7 miles (4.3 kilometers) south-southwest of the site. The Loma Linda fault was originally classified as active within State's Alquist-Priolo EFZ maps, but later removed (Hart, 1976) due to lack of evidence indicating Holocene rupture. The San Bernardino County General Plan is in agreement with the State's Alquist Priolo designation, but the City of San Bernardino General Plan still shows the fault as active. The Loma Linda fault is not listed in the Documentation for the 2008 and 2014 Updates of the National Seismic Hazard Maps (USGS; 2008, 2014).

San Andreas Fault

The surface trace of the northwest-striking southern strand of the San Andreas fault is located 3.2 miles (5.2 kilometers) northeast of the site and is classified as active within State's Alquist-Priolo EFZ maps. The San Andreas fault forms the recognized tectonic boundary between the Pacific Plate on the southwest and the North American Plate on the northeast. Geodetic and GPS surveys attribute an average of approximately 25 millimeters (1-inch) of accrued slip along the fault each year. Based on fault length it is estimated that the San Andreas fault is capable of a M_W = 7.9 earthquake and several meters of right-lateral strike slip surface rupture. Higher magnitudes of up to 8.2 are possible with additional strands rupturing (such as the Mojave, San Bernardino Mountain, and or Coachella sections), but are listed as more unlikely. Numerous geologic maps delineate the location of various fault strands. The San Andreas fault is listed as a potential hazard in both the San Bernardino City and County General Plans and is listed in the Documentation for the 2008 and 2014 Updates of the National Seismic Hazard Map (USGS; 2008, 2014).

San Jacinto fault

The northwest-striking San Bernardino Valley strand of the San Jacinto fault is located approximately 3.6 mi (5.8 km) southwest of the site. Recent subsurface investigations suggest that the San Jacinto and San Andreas faults have ruptured together multiple times over the past 2,000 years (Onderdonk et.al., 2018). This suggests that the San Jacinto also acts as the North American Pacific Plate boundary. Based on fault length it is estimated that the San Jacinto fault is capable of a M_W=7.7 earthquake and several meters of right-lateral strike slip surface rupture. The San Jacinto fault is listed as a potential hazard in both the San Bernardino City and County General Plans and is listed in the Documentation for the 2008 and 2014 Updates of the National Seismic Hazard Map (USGS; 2008, 2014).

4.2. EARTHQUAKE HISTORY

The recorded history of earthquakes prior to the seismograph is sparse and inconsistent. The oldest seismographs (or recordable earthquake devices) originated in Italy in the mid 1800s. The modern seismograph was developed in Japan in 1880 (Richter, 1958). Electromagnetic seismometers (calibrated seismographs) were developed between 1928 and 1930. Townley and Allen (1939) documented earthquakes along the Pacific Coast of the U.S. between 1769 and 1928. The systematic recording of large earthquakes in California began in 1932-1933 by the U.S. Coast and Geodetic Survey (Richter, 1958). As part of our investigation, we reviewed earthquake data recorded between A.D. 1800 and 2016 by searching the USGS database (USGS, 2016). Earthquakes in our review are derived from Townley and Allen (1939), Richter (1958), Proctor (1973), Real *et al*. (1978), Toppozada et al. (1981, 2000), Goter (1988, 1992), Goter *et al*. (1994), Bechtold et al. (1973a, b), DuBois et al., (1982), Blake 1989-2000, rev. 2006), U.S.G.S. (2013, 2006), CGS (2009), Southern California Earthquake Data Center (2010), Hutton (2010). The nearest significant (above M_W 4.5) earthquake epicenters to the site is most likely the M_W 7.5 1812 Wrightwood Earthquake. The previously mentioned M_W 5.1 La Habra earthquake was located approximately 14.7 miles (23.6 kilometers) north of the site and is the closest recent significant earthquake. A table of the most significant earthquakes is presented as Enclosure 7. The epicentral locations of these and other nearby earthquakes are presented as Enclosure 8.

5. GROUND MOTION

The 2016 California Building Code, Section 11.4 ground motion values were generated using the U.S Geological Survey (2013) "US Seismic Design Maps" website and tool. The site coordinates input to the USGS program are Latitude 34.110952° N and Longitude 117.255620° W, NAD 1983. The mapped MCE ground motion parameter, S_S, is 1.916g from Figure 22-1 of ASCE 7-10 (American Society of Civil Engineers, 2010). The mapped MCE ground motion parameter, S_1, is 0.920g from Figure 22-2 of ASCE 7-10. S_1, therefore, is greater than 0.75g.

The Site Coefficient, F_a, is 1.0 from Table 11.4-1 of the ASCE 7-10, based on S_S greater than 1.25g and Site Class D. The interpolated Site Coefficient, F_v, is 1.5 from Table 11.4-2 of the ASCE 7-10, based on S_1 greater than 0.50g and Site Class D. The Section 11.4.3 Adjusted MCE_R spectral response acceleration parameter, S_{MS}, is 1.916g. The Section 11.4.3 Adjusted MCE_R spectral response acceleration parameter, S_{M1}, is 1.380g. The Section 11.4.4 Design spectral response acceleration parameter, S_{DS}, is 1.277g. The Section 11.4.4 Design spectral response acceleration parameter, S_{D1}, is 0.920g. The Long-period Transition Period, T_L, is 8 seconds from Figure 22-12 of ASCE 7-10.

The proposed structure on the site is expected to belong to Occupancy Category III. Based on the S_1 parameter being greater than 0.75g and the Occupancy Category being III, **the proposed development would be assigned to Seismic Design Category E per the 2016 CBC**. As a result, a site-specific ground motion analysis in accordance with Section 11.4.7 is necessary.

In lieu of a site-specific ground motion study, the Peak Ground Acceleration, PGA, for the site is 0.757g from Figure 22-7 of ASCE 7-10. From Table 11.8-1 of ASCE 7-10, the Site Coefficient, F_{PGA}, is 1.0, based on a PGA equal to 0.757g and Site Class D. The mapped MCE Geometric Mean Peak Ground Acceleration, PGA_M, is equal to the Peak Ground Acceleration utilizing Equation 11.8-1 from ASCE 7-10. The Geotechnical Engineer of Record should determine whether or not liquefaction settlement potential could affect proposed settlement sensitive structures.

Using Method 1 of Section 21.2.1.1 of ASCE 7-10, C_{RS} is 1.023 from Figure 22-17 of ASCE 7-10; C_{R1} is 0.977 from Figure 22-18 of ASCE 7-10.

6. GROUNDWATER

Groundwater was not encountered in the exploratory borings placed on the site during the recent geotechnical investigation (Twining, 2019). Based on our review of historical groundwater information (Mendedhall, 1905), this area of San Bernardino shows artesian water conditions. Therefore, historic high groundwater in the vicinity of the site is 0 feet (at the surface). Based on the referenced literature we recommend a depth of 0 feet (0 meters) bgs be used for any applicable liquefaction evaluation.

7. LIQUEFACTION AND LATERAL SPREADING

The California Geological Survey has not conducted Seismic Hazards Mapping for San Bernardino County. The United States Geological Survey has characterized liquefaction susceptibility in the San Bernardino Valley (Matti & Carson, 1991) and indicates the site lies within a zone of Moderate to Moderately High susceptibility for ground failure potential for liquefaction. San Bernardino County General Plan (2007) and City of San Bernardino General Plan (2005) also include the site in an established High Liquefaction Susceptibility hazard zone. Ground water was not encountered in the exploratory borings placed on the site during the current geotechnical investigations (Twining, 2019). The site alluvium encountered in the borings is considered to be Holocene to possibly Late Pleistocene in age. The potential for liquefaction at the site is to be considered “high” and should be quantitatively evaluated by the Geotechnical Engineer as per CGS Special Publication 117A (2009) and appropriate recommendations for the proposed structures should be established. No grading plans were available for our review. It is our understanding that no significant slopes will be constructed. Therefore Lateral Spreading is not anticipated to be a concern.

8. LANDSLIDE AND SLOPE STABILITY

The California Geological Survey (CGS) has not conducted Seismic Hazards Mapping for the San Bernardino South 7.5 Minute Quadrangle. Previous State of California hazard assessment for Southwestern San Bernardino County (Fife et. al., 1976) addresses landslides and slope stability. No areas have been designated as “zones of required investigation for earthquake induced landslides” as defined by the State’s Seismic Hazard Mapping Act. It is our understanding that significant cuts, cut slopes, fills, fill slopes, and/or retaining walls are not proposed with the development of the site based on the existing site topography. Therefore, slope stability hazards are not expected to affect the proposed structure on the site. City Creek Channel is located approximately 0.25 miles (0.4 km) south of the site, and Warm Creek Channel is located approximately 0.5 miles (0.9 km) northwest of the site. Therefore, lateral spreading is not considered to be a hazard.

9. SUBSIDENCE AND INFLATION

Subsidence is a regional lowering of the ground surface. Inflation is a regional rising of the ground surface. Subsidence and inflation can result from either tectonic or non-tectonic stress changes. Tectonically-induced subsidence or tectonically-induced inflation is the result of extension or compression (respectively) of the crust. Non-tectonic subsidence or non-tectonic inflation of the ground surface is commonly associated with the removal or addition (respectively) of fluids from either an aquifer (ground water) or a reservoir (oil, gas, steam, *et cetera*).

The City of San Bernardino General Plan (2005) includes the site in an established Subsidence Hazard Zone. The City General plan also notes that the San Bernardino Municipal Water District instituted a groundwater recharge program in 1972 and that "*problems with ground subsidence have not been identified since the groundwater recharge program began*".

10. FLOODING

10.1 Site Flooding

The Federal Emergency Management Agency [FEMA] (2009) Flood Insurance Rate Map indicates the site lies outside the area designated as Zone X described as an area with a 0.2% annual flood chance. The City of San Bernardino General Plan does not show the site within an established flood zone.

10.2. Seismically Induced Flooding

No water reservoirs are located near to and higher than the site at the time of this investigation (Google, 2019). The City of San Bernardino (2005) indicates the campus lies within the Seven Oaks Dam Inundation Area. Seven Oaks Dam is an embankment dam located in Upper Santa Ana Canyon, near Mentone, Ca. Its primary purpose is flood control for the Santa Ana River floodplain in southwestern San Bernardino, western Riverside County and Orange County (USACE, 2003). Since the primary purpose of Seven Oaks Dam is flood control and not water storage, the probability of a catastrophic seismic failure event during flooding is highly unlikely. The potential for seismically induced flood hazard from the Seven Oaks Dam failure is presented as Enclosure 9.

10.3. Seiches

A seiche is an oscillating body and surface wave that is often generated in open bodies of water, such as lakes and reservoirs, by large earthquakes. No large open bodies of water are located on or in the vicinity of the site at the time of this investigation. Seiches are not considered to be a potential hazard to the proposed structure.

10.4. Tsunamis

A tsunami is a seismically generated ocean wave. The site is located approximately 50 miles (80 km) from the Pacific Ocean. Therefore, tsunamis are not a hazard to the site.

11. OTHER GEOLOGIC HAZARDS OR ADVERSE SITE CONDITIONS

The California Geological Survey has identified several additional geologic hazards that may impact California Public Schools, Hospitals and Essential Services Buildings (CGS Note 48, 2013). These exceptional geologic hazards do not occur statewide; however, they may be pertinent to any given site. Where these conditions exist, relevant information should be communicated to the design team so that appropriate mitigation measures can be considered prior to development. These hazards include expansive soils, soluble sulfates and corrosive soils, hazardous materials (such as methane gas, hydrogen-sulfide gas or tar seeps), volcanic eruption, Radon-222 gas, naturally occurring asbestos, and hydro-collapse of alluvial fan soils.

11.1 Expansive Soils

Based on our field observations, and the recent subsurface investigation and associated laboratory testing (Twining, 2019), highly expansive surficial soils were not observed at the subject site.

11.2 Volcanic Activity

Volcanic activity in California has usually been associated with former subduction zone tectonism or extensional tectonism that permits mantle-derived basalt to extrude onto the surface. Volcanic activity can also be associated with hot spot plumes emanating from the mantle, like Hawaii. Jennings (1994) did not show recent volcanic eruptions in the vicinity of the site. Since a significant source of recent volcanism is not located in the vicinity of the site, volcanic activity is not anticipated on or near the site during the lifetime of the proposed development.

11.3 Radon

Historically, Radon-222 gas has not typically been recognized as an environmental hazard consideration in this portion of San Bernardino. The site is not located near organic-rich marine shales, commonly characterized to potentially contain Radon-222 gas. The California Geological

Survey indicates the site has a “Low” potential for Radon Gas (CGS, 2015), with less than 5 percent of home indoor-radon measurements in this study area are likely to exceed the U.S. EPA recommended action level of 4 picocuries per liter.

11.4 Asbestos

Due to the lack of proximal sources of serpentine or ultramafic rock bodies (CGS, 2000), naturally occurring asbestos is not considered a hazard at the site.

The grading plan for the proposed development should be reviewed and approved by the project engineering geologist before initiating grading on the site.

12. CONCLUSIONS AND RECOMMENDATIONS

The proposed development consists of a 1.850 square-foot addition to the existing structure. Indian Springs High School is located at 650 North Del Rosa Drive in the city of San Bernardino, California. The coordinates of the site are Latitude 34.110952° N and Longitude 117.255620° W, utilizing the North American Datum (NAD) from 1983. The site is located in Township T1S, Range R4W, Section 14 of the San Bernardino Baseline and Meridian in the San Bernardino South 7.5 Minute USGS Quadrangle.

The geologic units encountered in borings onsite are Artificial Fill and Holocene Alluvium. The fill consists of moist, medium to reddish brown fine to medium grained sand with gravel. No documentation for the artificial fill was encountered during our reference review. The Holocene Alluvium on the site consists of moist, loose to medium dense, dark brown to orange brown sand with varying amounts of silt and gravel. At a depth of approximately 20 feet (6.1 meters) drill cuttings indicated a separate alluvium unit with significantly more dense, reddish brown fine to coarse sand with varying amounts of silt. Individual sand grains were coated with secondary clay minerals, indicating a significantly greater age for the sediments. The Holocene and Older (possibly Pleistocene?) Alluvium underlies the site to the maximum depth of recent exploratory borings placed on the site [approximately 51.5 feet (15.7 meters). Recent geotechnical borings excavated at the site (Twining, 2019) did not encounter bedrock. Based on recent groundwater and geophysical surveys, formational bedrock is anticipated to consist of Pelona Schist metamorphic rock at a depth of 1,600 feet (488 meters) bgs in the vicinity of the site. As discussed in the main geotechnical engineering report (Twining, 2019), is classified as Site Class D per ASCE 7-10 Section 20.3.1. Accordingly, a site-specific ground motion hazard analysis is required for the proposed building.

The site is not located within or near an Alquist-Priolo Earthquake Fault Zone (EFZ). The boundary of the closest Alquist-Priolo EFZ is located approximately 3.1 miles (5.0 kilometers) northeast of the site associated with the San Andreas fault. The San Andreas fault is estimated to be capable of generating a M_W = 7.9 earthquake. No evidence for active faulting was observed traversing the site on the digital aerial photography reviewed for this investigation.

The nearest significant (above M_W 5.0) earthquake epicenter to the site are the M_W 7.5 1812 Wrightwood Earthquake at a distance of approximately 28.7 miles (46.2 kilometers) northwest of the site. Based upon our conversation with the Project Geotechnical Engineer, seismic design parameters have been developed in accordance with 2016 CBC and ASCE 7-10 standards. As discussed in the main geotechnical engineering report (Twining, 2019), the project site classified as Site Class D per ASCE 7-10 Section 20.3.1. The interpolated Site Coefficient, F_v, is 1.5 from Table 11.4-2 of the ASCE 7-10, based on S_1 greater than 0.50g and Site Class D. The Section 11.4.3 Adjusted MCE_R

spectral response acceleration parameter, S_{MS}, is 1.916g. The Section 11.4.3 Adjusted MCE_R spectral response acceleration parameter, S_{M1}, is 1.380g. The Section 11.4.4 Design spectral response acceleration parameter, S_{DS}, is 1.277g. The Section 11.4.4 Design spectral response acceleration parameter, S_{D1}, is 0.920g. The Long-period Transition Period, T_L, is 8 seconds from Figure 22-12 of ASCE 7-10. Accordingly, a site-specific ground motion hazard analysis is required for the proposed building.

Groundwater was not encountered in the exploratory borings placed on the site during the recent geotechnical investigation (Twining, 2019). Based on our review of historical groundwater information (USGS, 1905), this area of San Bernardino shows artesian water conditions. Therefore, historic high groundwater in the vicinity of the site is 0 feet (at the surface). Based on the referenced literature we recommend a depth of 0 feet (0 meters) bgs be used for any applicable liquefaction evaluation.

The United States Geological Survey has characterized liquefaction susceptibility in the San Bernardino Valley and indicates the site lies within a zone of Moderate to Moderately High susceptibility for ground failure potential for liquefaction. San Bernardino County General Plan and City of San Bernardino General Plan also include the site in an established High Liquefaction Susceptibility hazard zone. The potential for liquefaction at the site is to be considered "high" and should be quantitatively evaluated by the Geotechnical Engineer as per CGS Special Publication 117A and appropriate recommendations for the proposed structures should be established. No grading plans were available for our review. It is our understanding that no significant slopes will be constructed. Therefore Lateral Spreading is not anticipated to be a concern.

Previous State of California hazard assessment for Southwestern San Bernardino County addresses landslides and slope stability. No areas have been designated as "zones of required investigation for earthquake induced landslides" as defined by the State's Seismic Hazard Mapping Act. It is our understanding that significant cuts, cut slopes, fills, fill slopes, and/or retaining walls are not proposed with the development of the site based on the existing site topography. Therefore, slope stability hazards are not expected to affect the proposed structure on the site. City Creek Channel is located approximately 0.25 miles (0.4 km) south of the site, and Warm Creek Channel is located approximately 0.5 miles (0.9 km) northwest of the site. Therefore, lateral spreading is not considered to be a hazard.

The City of San Bernardino General Plan includes the site in an established Subsidence Hazard Zone. The City General plan also notes that the San Bernardino Municipal Water District instituted a groundwater recharge program in 1972 and that "*problems with ground subsidence have not been identified since the groundwater recharge program began*".

The Federal Emergency Management Agency [FEMA] Flood Insurance Rate Map indicates the site lies within an area designated as Zone X described as an area with a 0.2% annual flood chance. The City of San Bernardino General Plan does not show the site within an established flood zone.

The City of San Bernardino General Plan indicates the campus lies within the Seven Oaks Dam Inundation Area.

Seiches are not considered to be a potential hazard to the proposed structure.

The site is located approximately 50 miles (80 km) from the Pacific Ocean. Therefore, tsunamis are not a hazard to the site.

A discussion regarding the geotechnical parameters and site expansive soil potential will be provided in the geotechnical portion of Twining's report. Since a significant source of recent volcanism is not located in the vicinity of the site, volcanic activity is not anticipated on or near the site during the lifetime of the proposed development. The California Geological Survey indicates the site has a "Low" potential for Radon Gas.

The grading plan for the proposed development should be reviewed and approved by the project engineering geologist before initiating grading on the site.

APPENDIX A
TECHNICAL REFERENCES

Presented below is a list of appropriate and current geology and seismology references pertinent to the project site-specific conditions. Regional or "standard of practice" references that generally pertain to this type of report are referenced in our report, but omitted in the Technical References section for brevity. Please contact our office for a full reference list.

1. AKW Geotechnical (2008). Supplemental Fault Trenching Report, Proposed Highland Community Day School, North Side of Baseline Street, West of Victoria Avenue, Highland, California; Project No. M1025-FE, 10p, 5 enc.
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4. California Building Standards Commission (2016). "2016 California Building Code." California Building Standards Commission, after the International Code Council, Inc.
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12. Fife, D., Rodgers, D., Chase, R., Sprotte, E., & Morton, D., (1976). Geologic Hazards in Southwestern San Bernardino County, California, CGS* Special Report 113, 41p. 11 plates.

13. Gary S. Rasmussen & Associates, Inc., 2003, Engineering Geology Investigation, Proposed High School No. 8, Northwest of Del Rosa Drive and 6th Street, San Bernardino, California: dated November 5, 29 pp. plus enclosures [incorporated into John R. Byerly, Inc. (2003), q.v.].

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16. John R. Byerly, (2008). Proposed Highland Community Day School, North Side of Baseline Street, West of Victoria Avenue, Highland, California; Response to Engineering Geology and Seismology review: Project No. S-12209, 7p, 5 enc.

17. John R. Byerly, (2007). Geotechnical Report, Proposed Highland Community Day School, North Side of Baseline Street, West of Victoria Avenue, Highland, California; Project No. S-12209, 41p, 23 enc.

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24. Ruhnau Clarke Architects, Indian Springs HS CTE Modernization, CTE Building Floor Plan A1-1.2, plans dated 11/27/2018.

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26. Twining (2019). Geotechnical Engineering and Engineering Evaluation Report, Indian Springs High School CTE Building Modernization, 650 North Del Rosa Drive, San Bernardino, California, (report in progress).

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30. United States Geological Survey (2012a). "US Seismic Design Maps Tool", U.S. Department of the Interior, Geological Survey, Webpage: http://geohazards.usgs.gov/designmaps/us/application.php. (including revisions based on pending ASCE 7-10 April 2013 Erratum).

31. United States Geological Survey 2019a, Quaternary fault and fold database for the United States, accessed 5/19/2019, from USGS web site: https://earthquake.usgs.gov/static/lfs/nshm/qfaults/.

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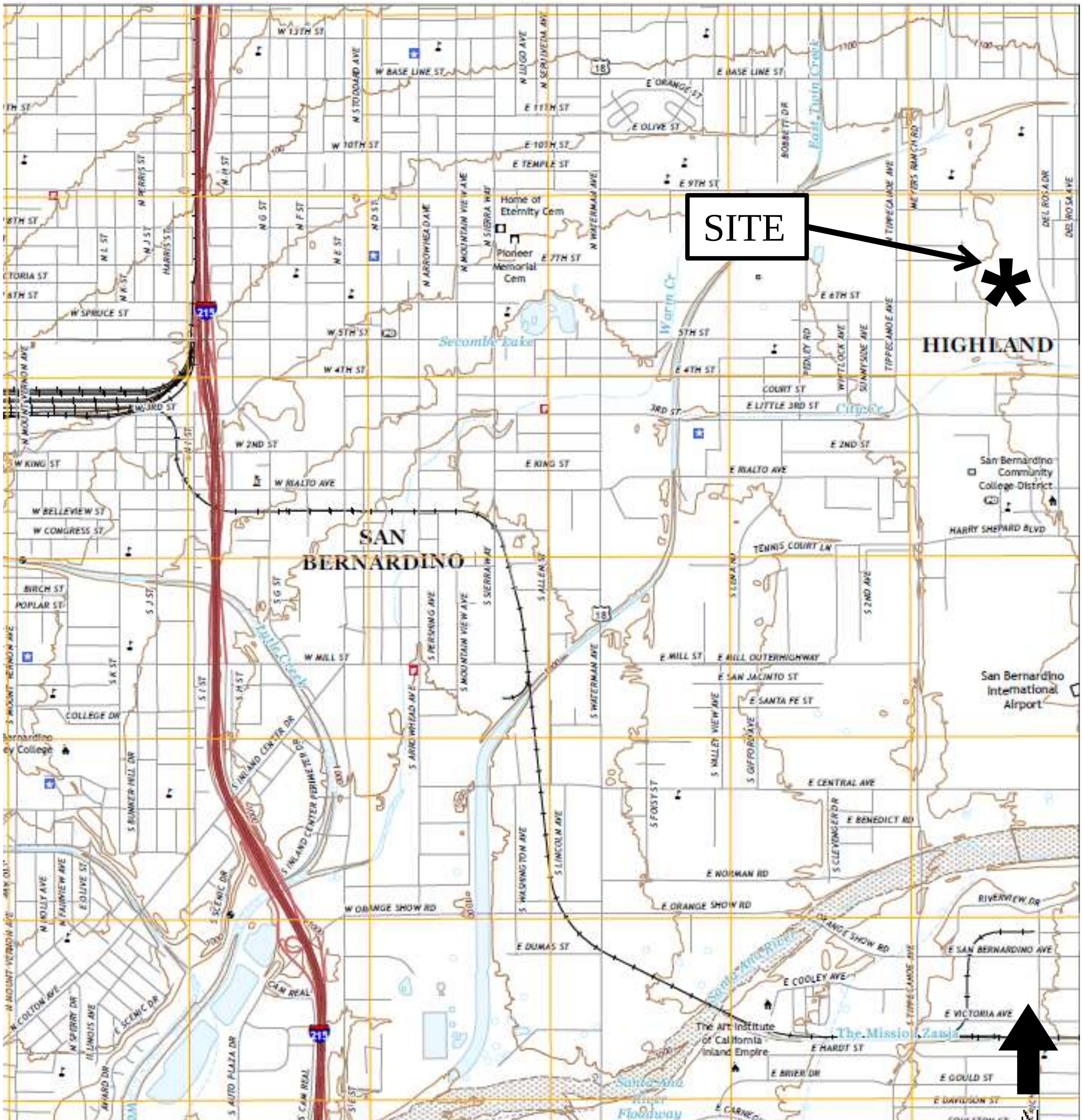
* California Geological Survey was named "California Division of Mines and Geology" prior to August, 2006.



SOURCE: 2018 USGS 7.5 MINUTE SERIES
TOPOGRAPHIC MAP
SAN BERNARDINO SOUTH QUADRANGLE
SAN BERNARDINO COUNTY, CALIFORNIA

NO SCALE

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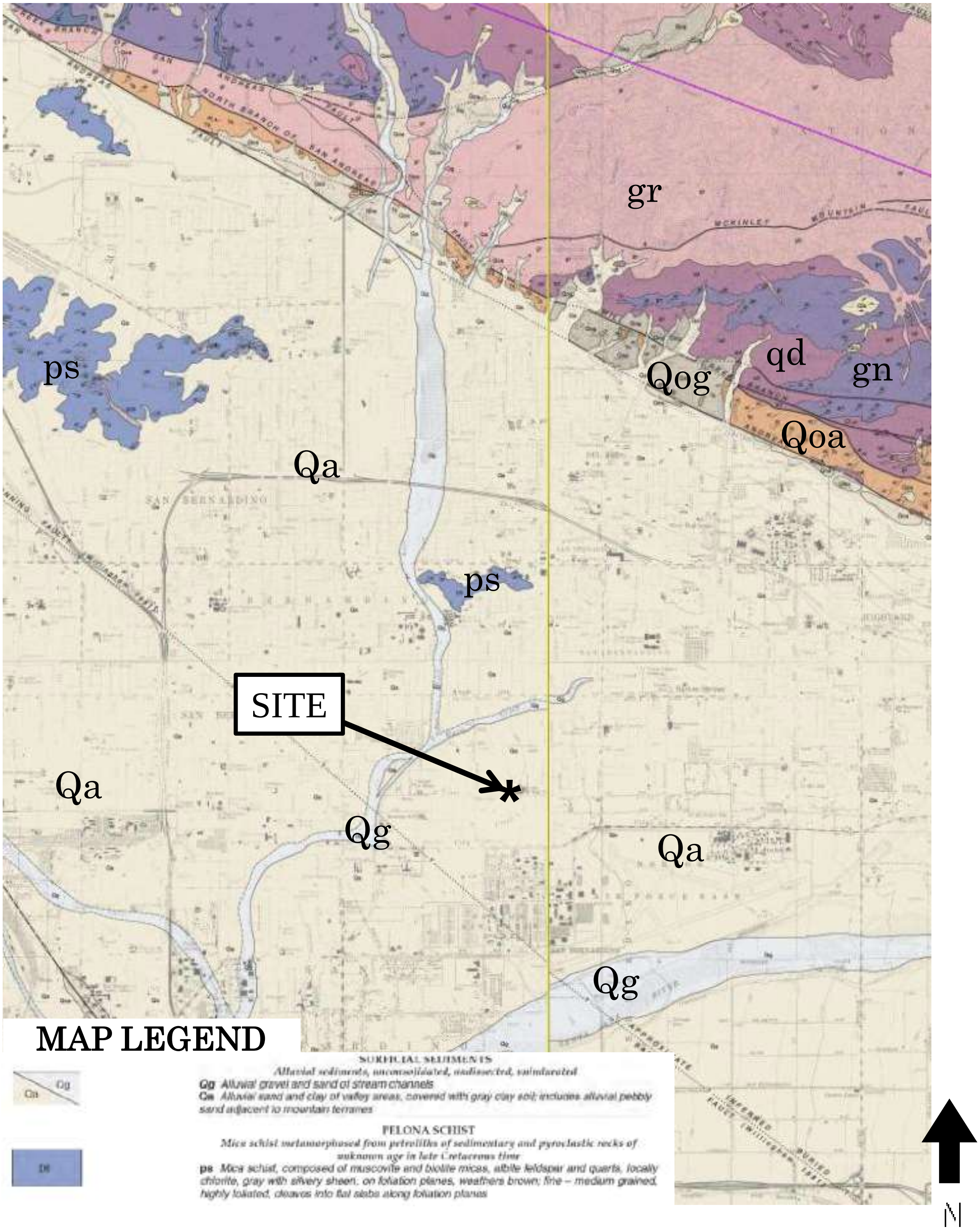
SITE LOCATION MAP

ENGINEERING GEOLOGY INVESTIGATION
PROPOSED CTE MODERNIZATION
INDIAN SPRINGS HIGH SCHOOL
650 NORTH DEL ROSA DRIVE
SAN BERNARDINO, CALIFORNIA

EWR	DATE 6-14-2019	PROJECT NO. M1126-01	ENCLOSURE 1



SOURCE: Dibblee, 2004, Geologic Maps of the San Bernardino North / North ½ of the San Bernardino South and the Harrison Quadrangles, Maps DF-126 & 127

AKW GEOTECHNICAL P.O. BOX 891173, TEMECULA, CA 92589 PHONE (951) 265-9849		REGIONAL GEOLOGIC MAP ENGINEERING GEOLOGY INVESTIGATION PROPOSED CTE MODERNIZATION INDIAN SPRINGS HIGH SCHOOL 650 NORTH DEL ROSA DRIVE SAN BERNARDINO, CALIFORNIA	
EWR	DATE 6-14-2019	PROJECT NO. M1126-01	ENCLOSURE 2

LEGEND

B-1
TD=51.5'

APPROXIMATE LOCATION OF BORING
TOTAL DEPTH IN FEET

A A'

GEOLOGIC CROSS SECTION

af — ARTIFICIAL FILL

Qa — ALLUVIAL DEPOSITS

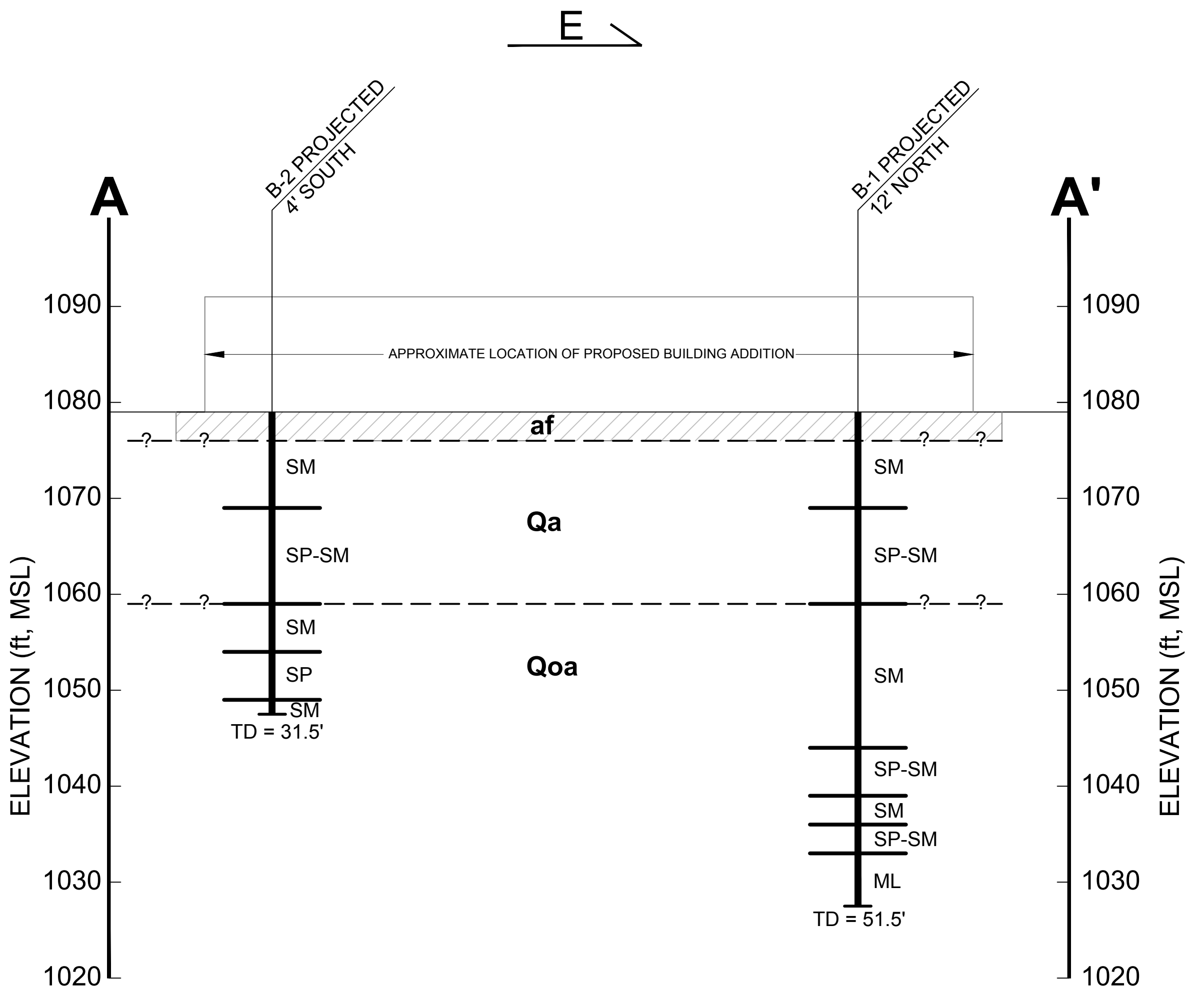
N

0 40' 80'

REFERENCE: GOOGLE (2019)

TWINING

SITE PLAN AND BORING LOCATION MAP		
Indian Springs HS CTE Modernization 650 N. Del Rosa Drive San Bernardino, California		
PROJECT NO. 190366.3	REPORT DATE June 2019	FIGURE 2



LEGEND

af	ARTIFICIAL FILL
Qa	RECENT ALLUVIAL DEPOSITS (LATE HOLOCENE)
Qoa	OLDER ALLUVIAL DEPOSITS (EARLY HOLOCENE TO LATE PLEISTOCENE)
——	EXISTING GRADE
▨	RECOMMENDED REMOVAL AND RECOMPACTION ZONE
—?— —?— — — —	APPROXIMATE LOCATION OF SOIL STRATA CONTACT (QUERIED WHERE UNCERTAIN)
B-1 TD=51.5'	APPROXIMATE LOCATION OF EXPLORATORY BORING TD = TERMINATION DEPTH IN FEET

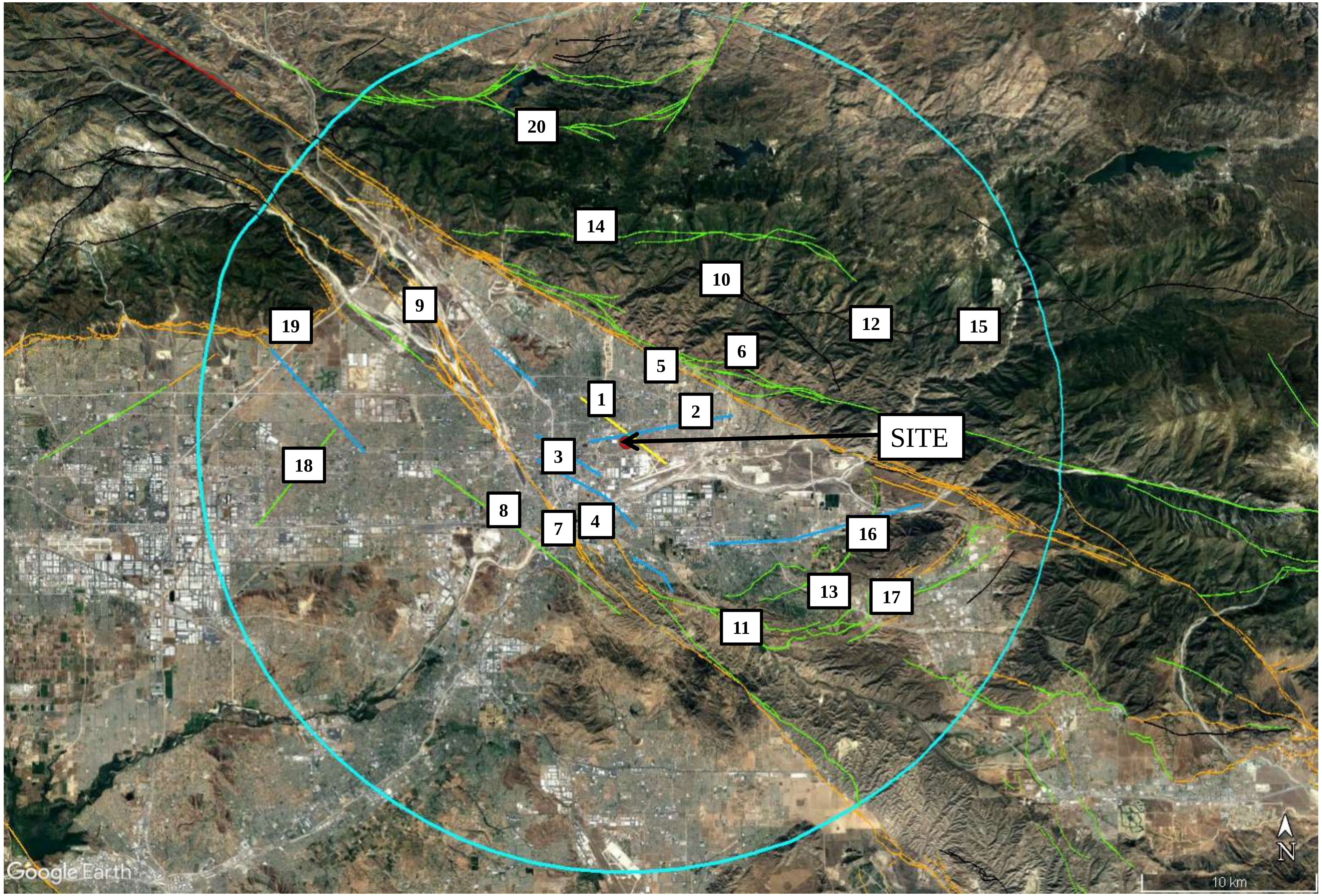
0 20' 40'

TWINING

CROSS SECTION A-A'

Indian Springs HS CTE Modernization
650 N. Del Rosa Drive
San Bernardino, California

PROJECT NO.	REPORT DATE	FIGURE 3
190366.3	June 2019	



MAP LEGEND

Circle Radius = 25 km

Numbers correspond to Faults listed in Enclosure 6: Regional Fault Table

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EWR | DATE 6-14-2019

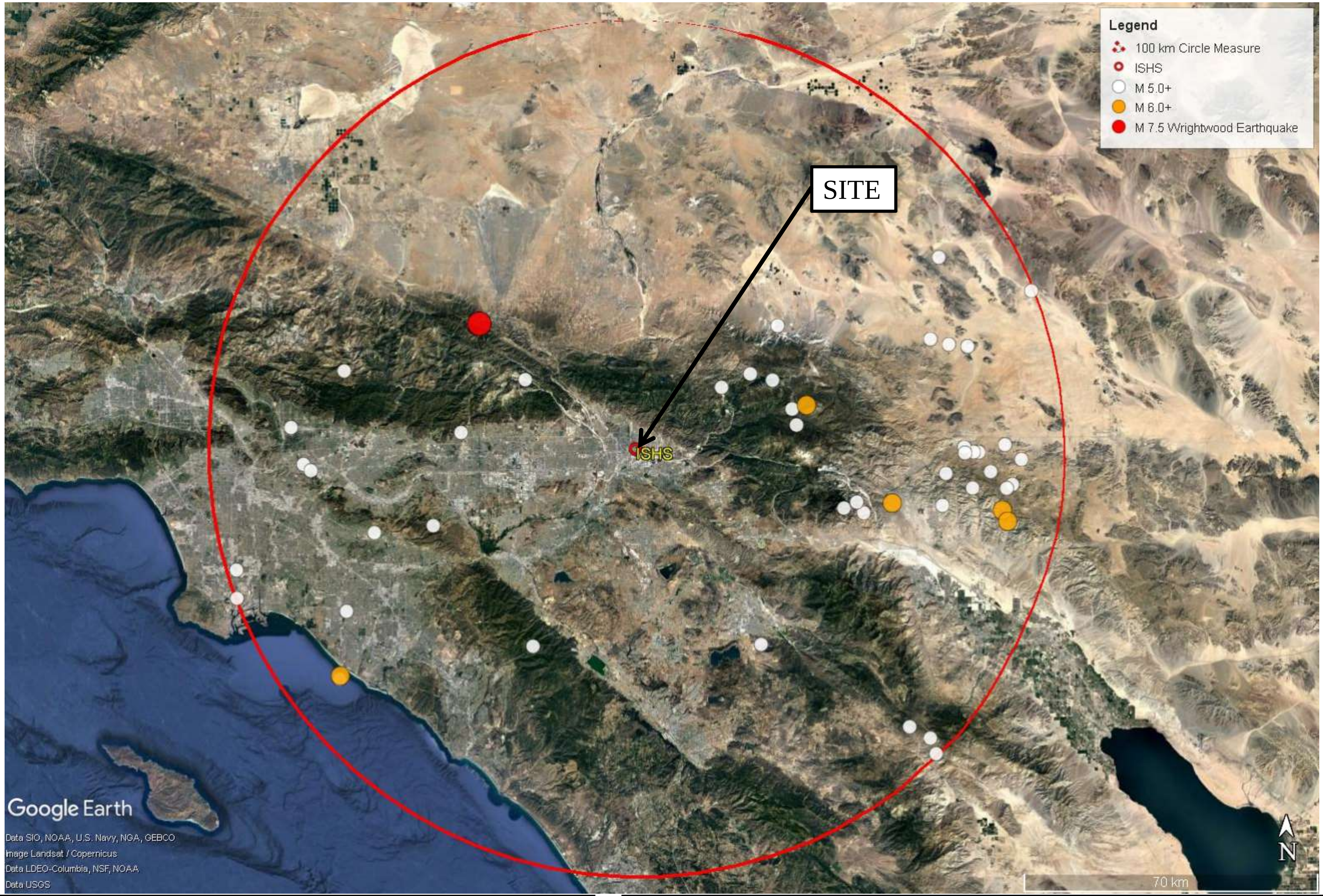
REGIONAL FAULT MAP

ENGINEERING GEOLOGY INVESTIGATION
PROPOSED CTE MODERNIZATION
INDIAN SPRINGS HIGH SCHOOL
650 NORTH DEL ROSA DRIVE
SAN BERNARDINO, CALIFORNIA

PROJECT NO. M1126-01 | ENCLOSURE 5

Regional Fault Table

	Fault	Maximum Potential Magnitude	Closest Distance to Site (km)	Closest Distance to Site (mi)	Direction	Fault Type
1	lineament		0.5	0.3	NE	SS?
2	unnamed normal fault		0.5	0.3	N	N
3	unnamed strike slip fault		2.4	1.5	SW	SS
4	Loma Linda	7.7	4.3	2.7	SSW	SS
5	San Andreas	7.9	5.2	3.2	NE	SS
6	Mill Creek fault	7.9	5.8	3.6	NE	SS
7	San Jacinto (San Bernardino Valley Section)	7.7	5.8	3.6	SW	SS
8	Rialto-Colton fault	7.7	7.9	4.9	SW	R
9	Glen Helen fault	7.7	8.5	5.3	WNW	SS?
10	Devils Canyon fault		8.9	5.6	NE	SS
11	San Timoteo Canyon		9.2	5.7	SSE	SS
12	Arrowhead fault		10.8	6.7	NNE	R
13	Redlands fault		11.1	6.9	SE	SS
14	Waterman Canyon fault	6.5	11.5	7.1	N	R
15	Santa Ana fault		12.3	7.6	NE	R
16	Reservoir Canyon		14.4	8.9	ESE	SS
17	Crafton Hills	6.4	16.6	10.3	SE	N?
18	Fontana Seismic Trend	6.2	17.5	10.9	W	SS?
19	Sierra Madre	6.6	19.3	12.0	WNW	R
20	Cleghorn	6.7	18.1	11.2	N	SS



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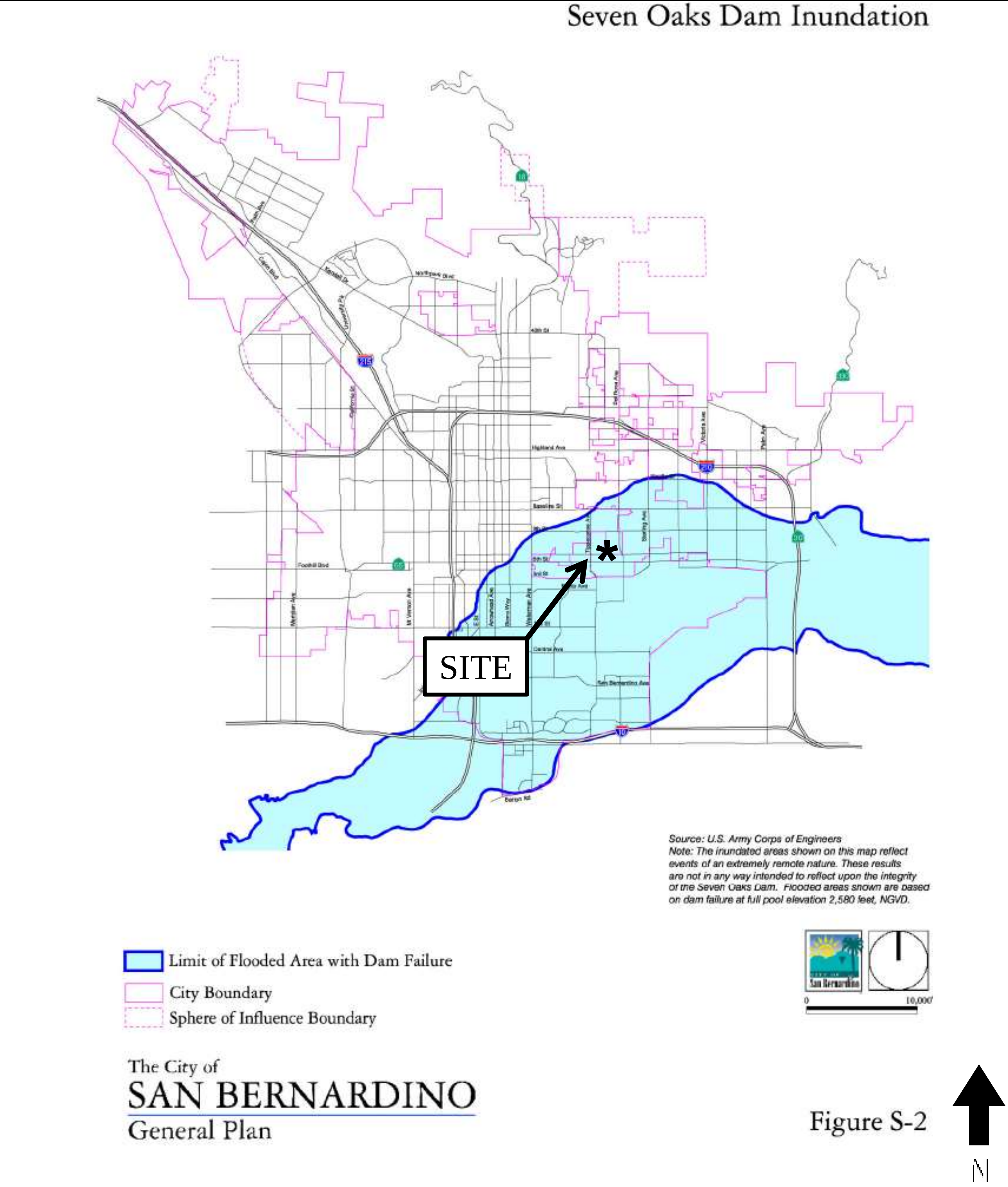
HISTORIC EARTHQUAKE EPICENTER MAP

ENGINEERING GEOLOGY INVESTIGATION
PROPOSED CTE MODERNIZATION
INDIAN SPRINGS HIGH SCHOOL
650 NORTH DEL ROSA DRIVE
SAN BERNARDINO, CALIFORNIA

EWR	DATE 6-14-2019	PROJECT NO. M1126-01	ENCLOSURE 7

HISTORIC EARTHQUAKE TABLE

Latitude	Longtitude	Date	Depth (km)	Quake Magnitude
34.371	-117.650	12/8/1812	??	7.5
33.631	-118.000	3/11/1933	6.0	6.4
34.203	-116.827	6/28/1992	3.6	6.3
33.960	-116.317	4/23/1992	11.6	6.1
33.983	-116.331	12/4/1948	6.0	6.0
33.999	-116.608	7/8/1986	9.5	6.0
34.061	-118.079	10/1/1987	8.9	5.9
34.270	-117.993	6/28/1991	8.0	5.8
34.120	-116.323	6/28/1992	5.7	5.7
34.105	-116.403	6/29/1992	9.6	5.7
34.240	-117.040	10/16/1999	6.0	5.6
34.162	-116.852	6/28/1992	9.6	5.5
34.144	-117.697	2/28/1990	3.3	5.5
34.115	-116.426	6/28/1992	7.5	5.5
33.949	-117.766	7/29/2008	15.5	5.4
34.341	-116.511	6/28/1992	4.4	5.4
34.442	-116.253	10/16/1999	0.8	5.4
33.475	-116.500	2/25/1980	19.4	5.3
34.330	-116.464	7/1/1992	5.1	5.3
34.089	-116.282	5/18/1940	6.0	5.3
33.994	-116.481	7/24/1947	6.0	5.3
33.624	-118.001	3/11/1933	6.0	5.3
33.704	-116.938	9/23/1963	10.7	5.3
34.512	-116.488	6/1/1975	0.1	5.3
34.268	-116.968	8/29/1943	6.0	5.3
34.255	-116.912	6/28/1992	6.6	5.3
34.064	-116.361	9/15/1992	7.2	5.3
34.369	-116.898	12/4/1992	1.3	5.3
34.074	-118.098	10/4/1987	7.7	5.3
34.002	-116.699	6/12/1944	6.0	5.2
34.030	-116.406	7/25/1947	6.0	5.2
34.326	-116.416	3/15/1979	9.3	5.2
34.195	-116.863	8/17/1992	9.4	5.2
33.699	-117.511	5/31/1938	10.2	5.2
34.255	-117.534	9/12/1970	10.8	5.2
33.533	-116.567	6/12/2005	13.1	5.2
34.037	-116.307	5/18/1940	6.0	5.2
33.791	-118.264	11/14/1941	6.0	5.1
33.933	-117.916	3/29/2014	5.1	5.1
34.105	-116.390	6/29/1992	11.2	5.1
33.989	-116.731	6/12/1944	6.0	5.1
33.979	-116.681	12/16/1988	6.9	5.0
34.151	-118.130	12/3/1988	13.7	5.0
33.508	-116.514	10/31/2001	13.7	5.0
33.767	-117.985	3/11/1933	6.0	5.0
34.029	-116.321	8/21/1993	8.2	5.0
34.061	-116.473	6/28/1992	5.4	5.0
34.103	-116.425	6/28/1992	5.6	5.0
33.850	-118.266	3/11/1933	16.0	5.0



SOURCE: City of San Bernardino General Plan, 2005
Scale as shown

AKW GEOTECHNICAL P.O. BOX 891173, TEMECULA, CA 92589 PHONE (951) 265-9849	SEISMICALLY INDUCED FLOODING HAZARD MAP ENGINEERING GEOLOGY INVESTIGATION PROPOSED CTE MODERNIZATION INDIAN SPRINGS HIGH SCHOOL 650 NORTH DEL ROSA DRIVE SAN BERNARDINO, CALIFORNIA

EWR	DATE 6-14-2019	PROJECT NO. M1126-01	ENCLOSURE 9

Pre-Bid Clarification Form (For CONTRACTOR's Use during Bid only)

PROJECT NAME:	Indian Springs High School- CTE Manufacturing		
PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/10/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	General	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Would it be possible to arrange another job walk with the sub contractors on February 18th or February 19th?

RESPONSE TO CLARIFICATION:

District held one job walk, no additional site walks

Bryan Dunaj, RCA 2/17/21

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DATE:	02/10/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	General	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

1. Is Bldg 'L' going to be occupied during the construction?
2. Is it possible for the contractor to access the site from 6th Street ?
3. Is it possible for the contractor to use portion of Parking lot for Employee parking and lay down of trailer offices?
4. Is it possible to use the area adjacent to Bldg 'M' and 'N' on each side for material laydown?

RESPONSE TO CLARIFICATION:

1. Building L potentially will be occupied. District to verify at pre-con meeting with selected contractor.
2 to 4 - Refer to spec section 01 52 00, 01 52 13 and 01 55 00

Bryan Dunaj, RCA 2/17/21

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DATE:	02/10/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	General	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Please provide us with the list and specs of the equipment to be removed, Salvaged and relocated from Building M to Building N.
Also, If there are any additional equipment that needs to go into the CTE labs in Bldg N, Please specify the specifications of new equipment.

RESPONSE TO CLARIFICATION:

Refer to addendum E for all equipment to be removed, salvaged and relocated to its new location. Go to the following link to download pictures and cut sheets of existing equipment. new Equipment listed on the attached file.

Link: https://files.ruhnauclarke.com/public/73dc10

Bryan Dunaj, RCA 2/17/21

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	06 4100	DRAWING NUMBER:	A1-1.1

REQUESTED CLARIFICATION:

Sheet A1-1.1 Note#02.550 shows "existing casework and furniture remains." Is it intent to Remove, Salvage and put back the casework in the same location since in many locations the concrete slab is scheduled to be demoed.

RESPONSE TO CLARIFICATION:

Refer to addendum 1 - dated 1/19/21, Keynote 02.550 has been revised to read as follows: "EXISTING CASEWORK AND FURNITURE TO BE REMOVED, SALVAGED, STORED AND RE-INSTALLED IN CURRENT PLACE."

Bryan Dunaj, RCA 2/17/21

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	23 0000	DRAWING NUMBER:	M1-1.1

REQUESTED CLARIFICATION:

Sheet S1-3.2 shows all the plywood roof substrate is removed and replaced. M1-1.1 Note#2 shows ductwork to be remain in place at storage room. Is ductwork attached to plywood to be demolished to new plywood substrate? Please advise.

RESPONSE TO CLARIFICATION:

Existing duct work to be removed, salvaged stored and re-installed in current place. Contractor to coordinate with mechanical plans to modify any existing duct with new RCP layout.

Bryan Dunaj, RCA 2/17/21

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	26 0000	DRAWING NUMBER:	E1-1.1

Sheet E1-1.1, Please confirm that the electric power brought to bldg. M & N is existing.

REQUESTED CLARIFICATION:

RESPONSE TO CLARIFICATION:

Confirmed. See single line diagram (E0.10) and site plan (E1.1)
Brian Smith, 2021-01-12
Senior Vice President
Salas O'Brien

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	26 0000	DRAWING NUMBER:	E1-1.3

REQUESTED CLARIFICATION:

Sheet E1-1.3, Please confirm that there are existing conduits and no new conduits are required to bring signaling to Bldg. M & N.

RESPONSE TO CLARIFICATION:

Confirmed. See site plans (E1-1.1 and E1-1.3)
Brian Smith, 2021-01-12
Senior Vice President
Salas O'Brien

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	C 3.1

REQUESTED CLARIFICATION:

On sheet C 3.1, Note#2 shows "Vault is adjusted to grade".
1. What kind of Vault is it?
2. Is there adequate space for the piping in the vault to be adjusted without adding new piping?

RESPONSE TO CLARIFICATION:

The smaller square symbol shown is identified by the survey as a water utility box. The larger square symbol is identified as unknown utility. There was no utility survey conducted and adjustment requirements will have to be determined in the field.

Rick Gothe
EPIC Engineers
2/12/21

Pre-Bid Clarification Form (For CONTRACTOR's Use during Bid only)

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DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	C 3.1

REQUESTED CLARIFICATION:

Please confirm that the deepened footing shown on C3.1 at addition for Bldg. M is per detail 1/SD 1.1. If not, Please clarify

RESPONSE TO CLARIFICATION:

The structural engineer will need to verify the details required for the construction of the deepened footing.

Rick Gothe
EPIC Engineers
2/12/2021

Refer to structural drawings for footing details

Bryan Dunaj, RCA 2/17/21

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	C 1.1 and AS 2.2

REQUESTED CLARIFICATION:

On Sheet C 1.1 Legend "Area of Removal" indicates removal at existing parking lot for ADA compliance. On Plan Sheet AS 2.2, Detail 9 Enlarged parking lot layout, Note 02.449 shows concrete paving to remain. Please confirm that no new concrete paving is required per Detail 9/AS 2.2.

RESPONSE TO CLARIFICATION:

No new pavement is required in parking lot. The lines are the existing striping pattern not area of removal hatch.

Rick Gothe
EPIC Engineers
2/12/2021

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	AS 2.1

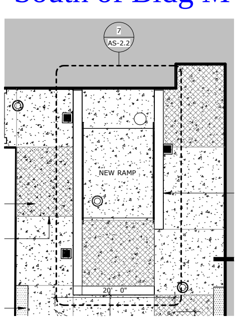
REQUESTED CLARIFICATION:

Per Detail 2 on Sheet AS 2.1, Please confirm that new ramp to the south of Bldg M is detail 7/AS2.2 and New ramp to the west of the Bldg M is detail 6/AS 2.2.

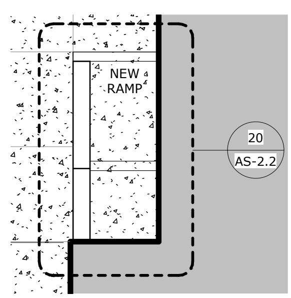
RESPONSE TO CLARIFICATION:

New ramps for building M are details 7 & 20/AS-2.2. See snapshots below:

South of Bldg M



West of Bldg M



Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	AS 2.2

REQUESTED CLARIFICATION:
Please confirm that all detectable warning tiles shown on Detail 9/AS 2.2 are existing and remain in place.
RESPONSE TO CLARIFICATION:
Confirmed, all detectable warning tiles are existing to remain in place Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	A1-1.1`

REQUESTED CLARIFICATION:

On Sheet A1-1.1 Note 02.493 and 02.494 shows Gas kiln and Elect. Kiln to be relocated. Please provide Model number and specifications for Gas Kiln and Elec. Kiln.

Please provide details on M1-1.3 to vent gas kiln hood.

RESPONSE TO CLARIFICATION:

The gas kiln has a hood that is to be moved with it and there is an opening in the new roof above the new location to accommodate it.
David L. Nack, PE
2-12-2021

Refer to addendum E for additional information on the model numbers.

Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	A1-3.1

REQUESTED CLARIFICATION:
Please confirm that the existing HVAC equipment and Exhaust fans are to be removed per legend on sheet A1-3.1
RESPONSE TO CLARIFICATION:
That is not correct. They are to be removed by Mechanical Plans and associated addendums. David L. Nack, PE 2-12-2021

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:		DRAWING NUMBER:	S1-3.2

REQUESTED CLARIFICATION:

Per Sheet S1-3.2, Please confirm that all the roof sheathing is to be removed and replaced

RESPONSE TO CLARIFICATION:

Confirmed, all existing roof plywood sheathing is to be removed and replaced as indicated on the approved plans.
-James Donahue, KNA Structural Engineers, 02/15/2021

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	Page#99 Article 3.3.7	DRAWING NUMBER:	

REQUESTED CLARIFICATION:
Are the material delivery timings to the job site limited? If so, Please specify the timings for delivery
RESPONSE TO CLARIFICATION:
Refer to spec section 01 10 00 and 01 32 16 for procedures. Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	Article 3.3.11 Page#100	DRAWING NUMBER:	

REQUESTED CLARIFICATION:
Please specify the periods of testing for contractor use so that noise can be controlled.
RESPONSE TO CLARIFICATION:
Refer to summary spec section 01 10 00 - 5 - 1.08 - E Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	Artical 3.6 Page#101	DRAWING NUMBER:	

REQUESTED CLARIFICATION:
Please confirm that no off site permit fee is required.
RESPONSE TO CLARIFICATION:
Refer to spec section 01 10 00 - 3 - 1.06 Permits , Licenses and Fees Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	Article 13.12 Page 202	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Since there is less than 1 acre being disturbed, Please confirm that SWPPP is not required

RESPONSE TO CLARIFICATION:

If under disturbed area is under an acre, no SWPPP required, but erosion protection measures should still be implemented during construction..

Rick Gothe
EPIC Engineers
2/18/2021

Pre-Bid Clarification Form (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	01 3114	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Spec Section 01 3114 Facility service coordination Paragraph 3.01 J 1.a., Please confirm that a full time on site project manager is required along with full time project superintendent.

RESPONSE TO CLARIFICATION:

Confirmed

Bryan Dunaj, RCA 2/17/21

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	01 3114	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Spec Section 01 3114 Facility service coordination Paragraph 3.02 A.1., Please confirm that the BIM coordination and drawings are required for this project.

RESPONSE TO CLARIFICATION:

confirmed

Bryan Dunaj, RCA 2/17/21

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DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	01 9113	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Spec Section 019113 general commissioning 1.02 A.1.a., What are the building envelope criteria that are subjected to air tightness commissioning.

RESPONSE TO CLARIFICATION:

Selected contractor to employee commissioning authority per spec section 01 91 13. Commissioning agent authority to provide criteria.

Bryan Dunaj, RCA 2/18/21.

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	02 4100	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Since the demolition will be completed before August, will it be acceptable for noise control per spec section 02 4100 3.01 E. 6 a. sound level to be 70 dB measured on the face of Bldg R

RESPONSE TO CLARIFICATION:

Keep noise control per spec section requirements

Bryan Dunaj, RCA 2/17/21

Pre-Bid Clarification Form (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	03 01 00 3.04	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

1. Spec section 03 0100 3.04, Please identify size/diameter of crack that will require epoxy adhesive injection.

2. Will the district establish a quantity of crack repair for all bidders to include in their bid for competitive bidding.

RESPONSE TO CLARIFICATION:

Quantity of crack repair will not be fully evident until demolition precedes. District will not be establishing quantity of crack repair for all bidders. Contractor to provide best judgment in establishing crack repair allowance in bid

Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

PROJECT NAME:	Indian Springs High School- CTE Manufacturing		
PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	03 01 00 3.05	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

1. Spec section 03 0100 3.05 Surface repair, what percentage of concrete remaining after detailed concrete demo (A1-1.1) should contractor include for concrete surface repair.

RESPONSE TO CLARIFICATION:

Contractor to use best practices. final percentage of concrete repair will not be fully evident until demolition takes place.

Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/11/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	04 0100	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

1. Spec section 04 0100 1.01 A, what percentage of existing masonry mortar joints will need to be repointed.

2. Is there any damaged masonry required to be repaired. If so, please specify the locations and specs.

RESPONSE TO CLARIFICATION:

1. Contractor to provide best judgment in establishing repointing of masonry repair allowance in bid.

2. Areas of masonry repair identified on forthcoming addendum. Refer to spec section 04 01 00 for repair of damaged masonry.

Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/12/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	01 9113	DRAWING NUMBER:	

REQUESTED CLARIFICATION:

Spec Section 01 9113 1.02. 9. Indoor air quality procedures : See section 01 5719 for temporary environmental controls. But there is no Spec section 01 5719 in the bid documents. Please advise.

RESPONSE TO CLARIFICATION:

Refer to spec 01 57 00 Temporary Controls .

Bryan Dunaj, RCA 2/17/21

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TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/12/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	07 5400	DRAWING NUMBER:	A1-3.2

REQUESTED CLARIFICATION:

Spec section 075400-7 2.03 A. Insulation shows additional tapered polyisocyanurate layers for crickets, where as 2.06. 4. shows Tapered board : Slope as indicated. Is tapered polyisocyanurate board for the entire roof deck or just for the return crickets? Please clarify

RESPONSE TO CLARIFICATION:

Tapered board as needed to achieve proper roof drainage to new or existing crickets on new roof finish

Bryan Dunaj, RCA 2/17/21

<u>Pre-Bid Clarification Form</u> (For CONTRACTOR's Use during Bid only)

PROJECT NAME:	Indian Springs High School- CTE Manufacturing		
PROJECT NUMBER:	F21-01		
TO:	Mr. Bryan K. Dunaj	EMAIL:	bids@ruhnauclarke.com

DATE:	02/12/2021		
FROM:	P.H. Hagopian Contractor, Inc.	EMAIL:	Builders@phhagopian.com
DOCUMENT/DIVISION NUMBER:	A1-1.1	DRAWING NUMBER:	A1-3.2

REQUESTED CLARIFICATION:

Plan Sheet A1-1.1 Keynote 02-203 shows existing cantilever metal rack. Please provide us with the location of existing cantilever metal rack.

2. Where is it relocated to?

3. Please provide us with the specifications of Cantilever metal rack.

RESPONSE TO CLARIFICATION:

1. Refer to forthcoming addendum for existing rack location on sheet A1-1.1.
2. Refer to addendum E for placement of relocated racks (space M102).
3. Do not have specs for existing rack but photos of rack & image of sign on rack seen below.

Bryan Dunaj, RCA 2/17/21

RFI # 32

SECTION 00 40 25

REQUEST FOR INFORMATION

RFI NUMBER: 001 **DATE:** 2/12/2021

PROJECT NAME: INDIAN SPRINGS HS CTE - MODERNIZATION PROJECT NO.: 1-78-25

TO: RUHNAU CLARKE ARCHITECTS

. 3775 Tenth Street, Riverside, California 92501

Attention: Bryan Dunaj

Contractor: Angeles Contractor, Inc.

Address: 783 Phillips Drive, City of Industry, CA 91748

Request By: Luis Ramirez Date: 2/12/2021

BRIEF SUMMARY OF RFI: Missing Drawing Sheets

Sheets A1-5.1, A1-7.4, A1-9.2, AD-1.1, E2-1.1 are not included in the bid set. Please provide.

Drawing No. A1-5.1, A1-7.4, A1-9.2, AD-1.1, E2-1.1 Detail No. ___________

Specification Section _______________ Title ____

. Page _______________ Paragraph ______________

DETAILS OF THIS RFI:

Refer to Addendum 01 issued on 1/29/21 by Crisp Imaging. Addedum can be purchased at https://order.planwell.com/Pwell_Project_Main.asp?show=yes&SessionFlag=Y&pub=1027-1-6145

Bryan Dunaj, RCA 2/17/21

Attachments: ____

RESPONSE WILL BE INCLUDED IN AN ADDENDUM

END OF RFI

SECTION 00 43 25

SUBSTITUTION REQUEST FORM - DURING PROCUREMENT

SUBSTITUTION REQUEST NO. ________________

DATE: 2/9/21

PROJECT NAME: **INDIAN SPRINGS HS CTE - MODERNIZATION**

PROJECT NUMBER: **1-78-25**

TO: **RUHNAU CLARKE ARCHITECTS**

. 3775 Tenth Street, Riverside, California 92501

From: Alfrex

We hereby submit for your consideration the following product comparisons of the specified product and the proposed substitution. The undersigned fully understands that failure to answer any item below may be cause for rejection of request for substitution.

Request for substitution shall only be made during bidding (not later than 7 days prior to bid opening for inclusion by Addendum) except under conditions beyond control of Contractor.

SPECIFIED PRODUCT: Metal Composite Material

Project Manual Section Title Metal Composite Number 074213.23 Page ____ Paragraph 2.01B

Drawing No. ________________ Detail No. ____________

Proposed Substitution: Alfrex FR Metal Composite Material

Manufacturer: Alfrex Tel: 803-464-3418

A. Is the point-by-point comparative data attached? — REQUIRED BY A/E

B. Reason request for substitution is being submitted: Alfrex is an as equal product to the specification.

DIFFERENCES BETWEEN PROPOSED SUBSTITUTION AND SPECIFIED PRODUCT

A. Does proposed substitution affect in any way the Structural Safety, Access Compliance, or Fire & Life Safety portions of the project? No x Yes__

Explain ________________

B. Does proposed substitution affect dimensions, gages, weights, etc. on Drawing? No x Yes__

Explain ________________

C. Does proposed substitution require changes in Drawings or design and installation changes?
No x Yes___ ______________________________
(If yes, cost of these changes is the responsibility of the Contractor.)

D. Does proposed substitution affect product cost, delivery time, or construction schedule?
No x Yes___ Explain ______________________________

E. Does proposed substitution comply with specified ICC Number, UL Rating, ASTM Numbers?
No___ Yes x Explain ______________________________

F. Does proposed substitution affect other trades and systems such as wiring, piping, ductwork, structure, etc.? No x Yes ____ (Explain which and how) ______________________________

G. Does proposed substitution product guarantee differ from that of the specified product?
No x Yes___ Explain ______________________________

Attach a listing of 3 similar projects (one in service for at least 3 years) using the proposed substitution.

Substantiating Data: Attach product data/brochures and Vendor qualifications for both specified and substitute product. Provide samples for both specified and substitute products, if applicable.

Certification: Undersigned has examined Construction Documents, is familiar with specified product, understands indicated application of product, and understands design intent of the Architect caused by the requested substitution.

Submitted by: Camille Knezevich ____ 2/9/21 ____
(Type Name) Signature Date

Signature must be made by person having legal authority to bind his firm to the above terms.

Architect's Comments:

_____ Accepted, _____ accepted as noted, X not accepted, _____ received too late.

Reviewed by:

______________________________ ______________
Architect Date

______________________________ ______________
Construction Manager Date

______________________________ ______________
District Date

Alfrex is not a composite metal panel manufacturer but only a facing material for such system as Altech panel systems

END OF SECTION

ALFREX is NOT A composite metal panel manufacturer but only a facing material for such systems as ALtech panel systems.

Fire Resistant & Non-Combustible Cladding

ALFREX FR MCM

SUBMITTAL PACKAGE

ARCHITECTURAL

TABLE OF CONTENTS

Alfrex FR MCM Sell Sheet

4mm Aluminum Composite Material

alfrex

Fire Resistant & Non-Combustible Cladding

ALFREX 4mm FR MCM

- Fire Resistant Core Only - No PE
- In-house produced FR core
- Minimal price difference between solid, mica and metallics
- Thickness: Standard 4mm
  [Available in 3mm and 6mm]
- Width: Standard 62in
  50in in select colors
  40.2in and 49.2in also available
- Max length 300in
- 10 Year Bond Integrity Warranty
- 10, 20, & 30 Year Finish Warranties
- 30 colors in Finished Goods

MATCHING FLAT SHEET

- Sheet Size: 0.040in x 48in x 120in
- 28 standard matching colors in stock
- Perfect for trim and accessories
- Same paint finishes as Alfrex FR

LEAD TIMES

	Alfrex FR (Currently)	Alfrex FR (Winter '20 - '21)	Matching Flat Sheet
Finished Goods	3 days	3 days	3 days
Standards	6 weeks	2 weeks	3 days
Customs	10 weeks	8 weeks	-

FINISHED GOODS

- Stocking Locations: Atlanta and Toronto
- MCM FR: 30 standard colors - 4mm X 62in X 196in lengths
- Matching Flat Sheet: 28 colors - 0.040in X 48in X 120in
- 3mm Plate: 62in X 165in in 4 standard colors

STANDARD COLORS

Alfrex FR MCM

- 2-Coat Solid:
- 2-Coat Mica:
- 3-Coat Metallic:
- Wood Series:
- Metal Series:
- Specialty Series:

CUSTOM COLORS

- Minimum 1,000 sf production quantity
- Custom colors extremely competitive
- Require color sample, paint code, PMS or Pantone number
- Wood and Metal Series 22,000 sf minimum

PRODUCT CERTIFICATIONS

Alfrex FR ACM - Building Codes

» ICC AC-25	Certificate WHI18-26206601 (Spec ID 36858)
» ICC-ESR Evaluation Report	ESR-4566
» ICC-ESR Supplements [California]	CBC (California Building Code)
	DSA (Division of the State Architect)
	OSHPD (Office of Statewide Health Planning Development)
	LABC (Los Angeles Building Code)
» Los Angeles Research Report	Per IB119 exempt with ICC ESR
» Florida Product Approval	Product Approval with HVHZ

Alfrex FR MCM - Fire Performance

- ASTM E84
- ASTM E119
- NFPA 285
- CAN/ULC S102
- CAN/ULC S134

LEED Certification Recycled Content MR Credit 4 - 26.07%

- LEED v3 : 2 Points
- LEED v4 : 1 Point

MANUFACTURING PLANT

- 100,000sf facility in metro Atlanta
- Winter '20 - '21 start-up
- Production line design:
  - No danger of pressure mottling
  - Numerous color changeovers, minimal scrap, no line stoppage
  - Cost control - 7,500sf as efficient as 50,000sf

ALFREX FR PRODUCT GUIDE

ABOUT US

ABOUT ALFREX, LLC.

Alfrex, LLC specializes in fire-resistant and non-combustible architectural metal wall cladding with a portfolio including Alfrex FR Metal Composite Material, matching flat sheet, coil coated aluminum Alfrex Plate, and primer coated Alfrex Plate for post painting small lot, custom colors.

Its parent company, Unience, Co Ltd., began operation in 2000 as a manufacturer of specialty fire-resistant coatings, bonding materials, and pelletized mineral filled compound for the manufacture of Fire-Resistant FR Aluminum and Metal Composite Panels (MCM). In 2008, after supplying numerous major MCM brands with FR compound, Unience launched Alfrex FR ACM in South Korea with a multi-line MCM production facility dedicated to the exclusive production of FR ACM utilizing in-house, fire-resistant core technology. Sales growth across 5 continents prompted the 2016 move of Unience's Global Headquarters to the USA and the establishment of Alfrex, LLC, with North American commercial offices in Atlanta and Toronto.

In mid-2020, Alfrex will commence production at its new FR-only MCM production facility in Buford, Georgia. The operation will provide the market with a more competitive domestically produced FR ACM product with shorter lead times, and a differentiated extended product line including 3mm thick, non-combustible, coil coated aluminum plate.

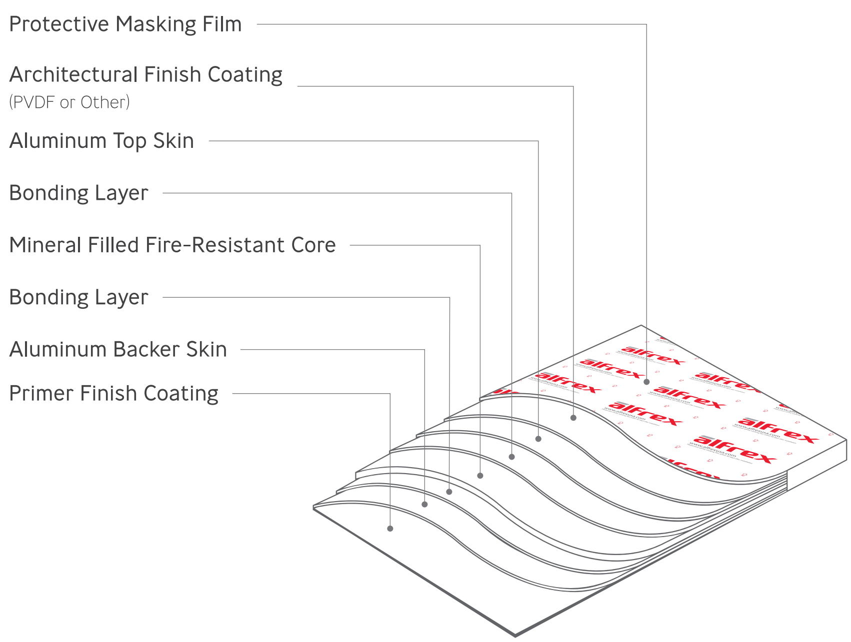
PRODUCT INTRODUCTION

INTRODUCING ALFREX FR

Alfrex FR is a continuous process manufactured aluminum composite material (ACM) consisting of an extruded fire-resistant core permanently bonded to pre-finished aluminum skins on each side. It is extremely lightweight and exceptionally flat, yet easy to fabricate into any shape.
Alfrex FR is coil coated utilizing 70% PVDF Kynar resin and other high-quality paint finishes – providing color uniformity, an extensive range of colors, unique coating patterns and textures, and the confidence of industry standard performance warranties. Its properties make Alfrex FR an ideal choice for most any architectural design intent imaginable.

PRODUCT COMPOSITION

COMPOSITION OF ALFREX FR



PRODUCT FEATURES

FEATURES OF ALFREX FR

Coil Coated for Performance

Alfrex FR premium quality paint finishes are applied by coil coating lines specialized in the continuous roll coating of fluoropolymer and specialty paint coating systems. The process ensures superior color uniformity and the overall long-term performance expected of exterior architectural coatings.

Wide Standard Color Range

Alfrex FR is offered in a broad range of standard colors geared towards exterior architectural building applications. Finishes utilizing 70% PVDF Kynar resin span popular color ranges in 2-coat solid, 2-coat mica, and 3-coat metallic configurations. Other specialty finishes include Prismatic Color-Shifting, Textured Wood Grain, Stone, Brushed Aluminum, and Faux Natural Metals.

Custom Colors

Alfrex provides custom matching to transform your imagination into reality using the color or finish of your choice. Simply send us a color sample, coating manufacturer paint code, Pantone number, or PMS number, and we'll quickly turn around an accurate match that meets your project requirements.

Fire-Resistance is a Core Competency

The fire-resistant core of Alfrex FR is an in-house manufactured, mineral-filled extruded material permanently bonded to aluminum skins. This provides an economical advantage for customers without sacrificing quality. Alfrex FR has passed American and Canadian testing standards including ASTM E84, ASTM E119, NFPA 285, CAN/ULC S102, and CAN/ULC S134.

Lightweight and Highly Durable

Alfrex FR is lightweight, at only 1.51 lbs / sqft, yet durable with non-corrosive aluminum skins and weather resistant architectural coatings.

Ease of Fabrication and Formability

Alfrex FR can be fabricated using proven methods such as: cutting, routing, shearing, bending, folding, and roll forming.

PRODUCT CERTIFICATIONS

BUILDING CODES

ICC AC-25	Certificate WHI18-26206601 (Spec ID 36858)	
ICC-ESR Evaluation Report	ESR-4566	
ICC-ESR Supplements [California]	CBC	California Building Code
	DSA	Division of the State Architect
	OSHPD	Office of Statewide Health Planning Development
	LABC	Los Angeles Building Code
Los Angeles Research Report	Per IB119 exempt with ICC ESR	
Florida Product Approval	Product Approval with HVHZ	

FIRE PERFORMANCE

ASTM E84	Class A
ASTM E119	Fire Rating - 2 hours
NFPA 285	Passed
CAN/ULC S102	Class A
CAN/ULC S134	Passed

ADDITIONAL PRODUCTS AND PUBLICATIONS

ALFREX MATCHING FLAT SHEET

Alfrex stocks tension leveled 0.040" (1mm) aluminum flat sheet in coordinated standard colors.

ALFREX PLATE : CUSTOMIZABLE AND NON-COMBUSTIBLE

Coil Coated 3mm Plate is a standard with Alfrex Plate. Projects requiring a non-combustible solution can count on Alfrex Plate coil coated in coordinated colors with Alfrex FR as well as custom colors.

Small Lot Custom Colors for MCM are very expensive and difficult to source. Alfrex offers a solution by stocking Alfrex 3mm thick aluminum plate in 62" wide x 165" long sheets with a primed back side. This enables the post-painting of sheets in both air dry or baked on spray finishes, and a more economical solution than purchasing the minimum quantities for a custom ACM color.

For more information on Alfrex Plate, please consult the Alfrex Plate Product Brochure or visit www.alfrexusa.com.

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ALFREX FR MCM TECHNICAL DATA SHEET

COMPOSITION

Aluminum Skin Alloy	3003-H14	
Core Material	Fire rated mineral filled core	
PROPERTY	**4mm FR**	**UNITS**
Panel Thickness	0.157	in
	4.0	mm
Skin Thickness (*nominal*)	0.020	in
	0.50	mm
Panel Weight	1.51	lb / ft^2
	7.37	kg / m^2
Specific Gravity (Product)	1.76	
Specific Gravity (Core Layer)	1.43	

STANDARD SIZES

PROPERTY	4mm FR		UNITS
Standard Widths	50	62	in
	1,270	1,575	mm
Other Available Widths	40.2	49.2	in
	1,020	1,270	mm
Maximum Length	300		in
	7,620		mm

PRODUCTION TOLERANCES

PROPERTY	4mm FR	UNITS
Width	+/- 0.080	in
	2.0	mm
Length	+/- 0.157	in
	4.0	mm
Thickness	+/- 0.008	in
	0.20	mm
Squareness	+/- 0.157	in
	4.0	mm

FIRE PERFORMANCE

TEST	RESULT
ASTM E84	Class A
NFPA 285	Passed
CAN/ULC-S102	Class A
CAN/ULC-S134	Passed
ASTM E119	2 Hours Passed
CAN/ULC S102 & S134	Passed

WARRANTIES

See warranty tables and sample warranties for conditions and exclusions

Bond Integrity	10 Years	Product
Hairline Aluminum	10 Years	Finish
2-Coat Solid 2-Coat Mica	30 Years	Finish
2-Coat Vivid Solid	20 Years	Finish
3-Coat Metallic	30 Years	Finish
Wood and Metal Series	20 Years	Finish

TECHNICAL PROPERTIES

PROPERTY		4mm FR	UNITS
Minimum Bond Strength	ASTM D1781	22.5	in•lb/in
		100	Nm/m
Transverse Shear Stress	ASTM C393	3.34	Psi
		23 X 10^{-3}	Mpa
Coefficient of Expansion	ASTM E831	182 X 10^{-6}	in/in/°F (@ 32-212°F)
Flexular Modulus	ASTM C393	5.22 X 10^{6}	Psi
		36 X 10^{3}	Mpa
Modulus of Elasticity	ASTM E8	2.46 X 10^{6}	Psi
		17 X 10^{3}	Mpa
Moment of Inertia		1.9 X 10^{-4}	in^4/in
		7.9 X 10^{-3}	cm^4/m
Section Modulus		1.81 X 10^{-3}	in^3/in
		29.7 X 10^{-3}	cm^3/m
Tensile Strength *(Aluminum Skin)*	ASTM E8	6.96 X 10^{3}	Psi
		48	Mpa
Yield Strength *(Aluminum Skin)*	ASTM E8	6.23 X 10^{3}	Psi
		43	Mpa
Elongation	ASTM E8	5	%
Deflection Temperature	ASTM D648	› 428	°F
		› 220	°C
Core Density		0.054	lb/in^3
		1.5	g/cm^3
Self Ignition Temperature	ASTM 1929	775	°F
		413	°C
Oxygen Index	D2863	32	%
Thermal Conductivity	C518	0.422	W/(m•K)

COATING PROPERTIES

70% Kynar 500 / Hylar 5000 PVDF Resin Coatings
AAMA 2605 Compliant

PROPERTY	STANDARD	COIL COATED ALUMINUM
Color Uniformity	ASTM D2244	Max. 2 Delta E
Color Retention - Fade	ASTM D2244	≤ 5 Delta E units
Chalk Rating	ASTM D4214	≤ 8 units
Specular Gloss	ASTM D523	± 5 units
Dry Film Hardness	ASTM D3363	F - 2H
Dry Adhesion	ASTM D3359	No coating removal
Abrasion Resistance	ASTM D968	Abrasion Coefficient Value ≥ 40
Reverse Impact	ASTM D2794	No coating removal
Muriatic Acid Resistance *(10% HCl, 15 mins)*	ASTM D1308	No blistering or visual change
Nitric Acid Resistance *(HNO_3, 30 mins)*	ASTM D1308	≤ 5 Delta E
Alkali Mortar Resistance *(10%, 25% NaOH, 60 mins)*	ASTM D1308	No removal. No loss of adhesion or visual change
Flexibility	ASTM D4145	2T - no pick off
Humidity Resistance	ASTM D714 ASTM D2247	4000 hour exposure Less than "few" blisters Size No. 8
Cyclic Corrosion	ASTM B117 AAMA 2605-13	2000 hour exposure. Min rating of 7 scribe or cut edge Min. blister rating of 8

MCM COMPETITOR COMPARISON MATRICES

alfrexusa.com | 470.589.7449 | contact@alfrexusa.com | 943 Gainsville Hwy. Building 100-4000, Buford, GA 30518

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COMPETITOR TECHNICAL DATA COMPARISON

Section	Company MCM Brand	**Alfrex, LLC** **Alfrex FR**	Arconic Reynobond FR	Mitsubishi Chemical Alpolic fr	3A Composites Alucobond Plus	Alucoil N. America Larson by Alucoil
GENERAL COMPARISON	**Product** 4mm Aluminum Composite Material (ACM / MCM)	✓	✓	✓	✓	✓
	MCM Manufacturing Experience 10+ Years	✓	✓	✓	✓	✓
	MCM Manufacturing Process Continuous Process Manufactured with No Glues or Adhesives	✓	✓	✓	✓	✓
	Fire Resistant Mineral Filled Core	✓	✓	✓	✓	✓
	FR Core Manufactured In-House	✓		✓	✓	
	USA Manufacturing Plant Location	Buford, GA	Eastman, GA	Chesapeake, VA	Benton, KY	Manning, SC
	Product Bond Integrity Warranty	✓	✓	✓	✓	✓
	Members of MCM Manufacturers Council	✓	✓	✓	✓	✓
	AIA Show Exhibitors	✓	✓	✓	✓	✓
PRODUCT CERTIFICATIONS	**3rd Party Certifying Agencies** Intertek / International Code Council, Inc. (ICC)	✓	✓	✓	✓	✓
	ICC-ESR Certification Report	ESR-4566	ESR-3435	ESR-2653	ESR-1185	
	ICC-AC 25 Certification for ACM / MCM	✓	✓	✓	✓	✓
	Fire Performance Certification USA NFPA 285, ASTM E84, ASTM E119	✓	✓	✓	✓	✓
	Fire Performance Certification Canada CAN / ULC S102, S134	✓		✓	✓	✓
	ICC Supplement CBC California Building Code	✓				
	ICC Supplement DSA Division of the State Architect - California	✓				
	ICC Supplement OSHPD Office of Statewide Health Planning Development - California	✓				
	ICC Supplement LABC Los Angeles Building Code - California	✓	✓			
	Los Angeles Research Report Per IB119 exempt with ICC ESR	✓	✓	✓	✓	
	Florida State Product Approval	✓	✓	✓	✓	
	High Velocity Hurricane Zone	✓	✓	✓	✓	
FIRE PERFORMANCE	**ASTM E84** Class A	✓	✓	✓	✓	✓
	NFPA 285 Passed	✓	✓	✓	✓	✓
	CAN / ULC S102 Class A	✓		✓	✓	✓
	CAN / ULC S134 Passed	✓		✓	✓	✓

* All data was compiled from published sources and is displayed for comparative reference purposes only.

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COMPETITOR TECHNICAL DATA COMPARISON

Company MCM Brand	**Alfrex, LLC** **Alfrex FR**	Arconic Reynobond FR	Mitsubishi Chemical Alpolic fr	3A Composites Alucobond Plus	Alucoil N. America Larson by Alucoil
ARCHITECTURAL PRODUCT OFFERING AND SERVICES					
Standard Widths (62″ / 50″)	✓	✓	✓	✓	✓
Other Widths (49.2″ / 40″)	✓	✓	✓	✓	✓
Custom Lengths : Panels are Cut to Length during Manufacturing	✓	✓	✓	✓	✓
Standard Colors : 30+ Solid, Mica, 3-coat Metallic, Wood Grain, Brushed Metal, Natural Metals, Corten Rust	✓	✓	✓	✓	✓
Custom Colors	✓	✓	✓	✓	✓
Finished Goods ACM Panels	✓	✓	✓	✓	✓
Company Finished Goods Locations	USA & Canada	USA only	USA only	USA only	USA only
Matching Flat Sheet	✓	✓	✓	✓	✓
Matching Flat Sheet Thickness	0.040″	0.040″	0.032″	0.040″	0.040″
TECHNICAL DATA COMPARISON					
Product 4mm Aluminum Composite Material (ACM / MCM)	✓	✓	✓	✓	✓
Aluminum Alloy 3000 Series	✓	✓	✓	✓	✓
Product Thickness 4mm / 0.157″	✓	✓	✓	✓	✓
Aluminum Skin Thickness (nominal) *0.020″ Top Skin / 0.020″ Bottom Skin*	✓	✓	✓	✓	✓
Panel Weight *Pounds per Square Foot*	1.51	1.53	1.56	1.56	1.57
Minimum Bond Strength [ASTM 1781] *in•lb / in*	22.5	22.5	22.5	22.5	22.5
Tensile Strength [ASTM E8] (Aluminum skin) *Psi*	6.96 X 10^3		7.13 X 10^3		
Yield Strength [ASTM E8] (Aluminum skin) *Psi*	6.96 X 10^3	6.37 X 10^3	6.34 X 10^3		
Elongation [ASTM E8] %	5		5		
ARCHITECTURAL PAINT SYSTEMS					
Primary System	70% Kynar PvDF	70% Kynar PvDF	Lumiflon	70% Kynar PvDF	70% Kynar PvDF
Secondary System	Lumiflon	Lumiflon	70% Kynar PvDF	Lumiflon	Lumiflon
Primary Paint Suppliers	PPG	PPG Beckers	Sherwin-Williams PPG	PPG Akzo Noble	PPG Akzo Noble
AAMA 2605 Compliant	✓	✓	✓	✓	✓
30 Year Finish Performance Warranty	✓	✓	✓	✓	✓

* All data was compiled from published sources and is displayed for comparative reference purposes only.

ALFREX PRODUCT FINISHES COLOR CHART

STANDARD MCM FR FINISHES

2 COAT **SOLIDS** 30 Year Finish Warranty

JY-5195
Classic White

JY-5165
Bone White

JY-5110
Ascot White

JY-6120
Dove Gray

JY-6130
Fashion Gray

JY-6140
Dark Gray

JY-6150
Charcoal

JY-6220
Black

JY-6160
Castle Gray

JY-6175
Sea Wolf

JY-6180
Bronze

VIVID **SOLIDS** 20 Year Finish Warranty

JY-7110
Signal Blue

JY-7120
Vibrant Red

2 COAT **MICA** 30 Year Finish Warranty

JY-2510
Anodic Clear Mica

JY-2520
Exotic Silver Mica

JY-2530
Gray Silver Mica

JY-2540
Pewter Mica

JY-2550
Champagne Mica

JY-2560
Medium Bronze Mica

JY-2570
Copper Penny Mica

MICA & METALLIC FINISHES

are directional finishes - requiring special precautions during planning, purchasing, fabrication, and installation in order to minimize the chance of visual color differences due to color batch variation or metallic flop. It is highly recommended that all material for a single project be ordered at the same time. With these finishes, directional arrows on product protective film should always be installed in the same direction.

3 COAT **METALLICS** 30 Year Finish Warranty

JY-3510
Bright Silver Metallic

JY-3520
Champagne Metallic

JY-3530
Graphite Metallic

WOOD SERIES 20 Year Finish Warranty

JY-W120
Teak

JY-W140
Golden Oak

JY-W150
Dark Walnut

METAL SERIES 20 Year Finish Warranty

JY-M110
Faux Zinc Graphite

JY-M120
Faux Zinc

JY-M130
Faux Zinc Lite

JY-M140
Tile Corten

SPECIALTY SERIES*

* Please contact us for Specialty Series warranty details. 470.589.7449

JY-H100
Hairline Clear

JY-A160
Mirror

STANDARD 3MM PLATE FINISHES 20 Year Finish Warranty

2 COAT SOLIDS

JY-5195
Classic White

JY-6190
Monument

JY-6220
Black

2 COAT MICA

JY-1220
Pure Silver

SPECIFICATION : 07 42 13 COMPOSITE METAL WALL PANELS

SECTION 07 42 13

COMPOSITE METAL WALL PANELS

PART 1: GENERAL

1.01 SCOPE

A. Section Includes

1. MCM - Fire resistant composite metal panels.
2. Panel system requirements of composite fire resistive panels including exterior and interior installation assemblies, components, and accessories.

B. Related Sections: Section(s) related to this section include:

1. Division 05 Metal Framing Sections
2. Division 07 Air and Vapor Barrier
3. Division 07 Flashing and Trim Sections
4. Division 07 Joint Treatment Section
5. Division 08 Aluminum Windows Section
6. Division 08 Glass and Glazing Section
7. Division 08 Curtain Wall Sections

1.02 QUALITY ASSURANCE

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed have either been identified by the International Building Code (IBC), local building code, or specific requirement for this building construction type.

B. Aluminum Association (AA)

1. Aluminum Design Manual
2. AA-M12C22A41: Anodized - Clear Coating
3. AA-M12C22A44: Anodized - Color Coating

C. American Society for Testing and Materials (ASTM) International

1. ASTM D1781 Standard Test Method for Climbing Drum Peel for Adhesives
2. ASTM D1929 Standard Test Method for Determining Ignition Temperature of Plastics
3. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
4. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
5. ASTM E330 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference
6. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Curtain Wall, and Doors By Uniform Static Air Pressure Difference

D. American Architectural Manufacturers Association (AAMA)

1. AAMA 2605 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. AAMA 509 Voluntary Test and Classification Method of Drained and Back Ventilated Rain Screen Wall Cladding Systems

E. National Fire Protection Association (NFPA):

1. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Provide installed MCM system designed to withstand specified loadings while maintaining allowable deflection, thermal movement performance as defined by the Manufacturer.

B. Deflection and Thermal Movement: Provide installed MCM systems that have been designed to resist to the wind loading, acting inward and outward.

1. Perimeter Framing Deflection: Deflection of panel perimeter framing member shall not exceed L/175 normal to plane of the wall where L is the unsupported span of the perimeter framing member.

2. Panel Deflection: Deflection of the panel face shall not exceed L/60 at design load where L is the unsupported span of the panel.

3. Anchor Deflection: At connection points of framing members to anchors, anchor deflection in any direction shall not exceed 0.0625 inch (1.6 mm).

4. Thermal Movements: Allow for free and noiseless horizontal and vertical thermal movement due to expansion and contraction of component parts over a temperature range of -20°F (- 29°C) to +180°F (82.2°C) at the material surface.

   a. Buckling, opening of joints, undue stress on fasteners, failure of sealants, or any other detrimental effects of thermal movement will not be permitted.

   b. Fabrication, assembly and erection procedures shall take into account the ambient temperature range at the time of the respective operation.

C. Water and Air Leakage: Provide systems that have been tested and certified to conform to the following criteria:

1. Air Leakage, ASTM E283: Not more than 0.06 cfm per ft_2 of wall area (0.003 (L/s m_2) when tested at 1.57 psf (0.075 kPa).

2. Water Penetration: No water infiltration under static pressure when tested in accordance with ASTM E331 at a differential of 10% of inward acting design load, 6.24 psf (0.299 kPa) minimum, after 15 minutes.

   a. Water penetration is defined as the appearance of uncontrolled water in the wall.

   b. Wall design shall feature provisions to drain to the exterior face of the wall any leakage of water at joints and any condensation that may occur within the construction.

D. Structural: Provide systems that have been tested in accordance with ASTM E330 at a design pressure of [specify design pressure in psf (kPa)] and have been certified to be without permanent deformation or failures of structural members.

E. Fire Performance: Provide composite fire rated panels that have been evaluated and are in compliance with regulatory code agency requirements specified herein.

1.04 SUBMITTALS

A. Submit in accordance with Conditions of the Contract and Division 01 Submittal Procedures Section.

B. Submit product data, including manufacturer’s brochures and Spec-Data Sheets SPEC-DATA sheets.

C. Shop Drawings: Submit shop drawings showing project layout and elevations; fastening and anchoring methods; detail and location of joints, sealants, and gaskets, including joints necessary to accommodate thermal movement; trim; flashing; and accessories.

D. Samples: Submit selection and verification samples for finishes, colors and textures.

1. Selected Samples: Manufacturer’s color charts or chips illustrating full range of colors, finishes and patterns available for composite metal panels with factory applied finishes.

2. Verification Samples:

   a. Panel System Assembly: Two samples of each assembly 12 inch × 12 inch (304 × 304 mm) 4

b. Two samples of each color in coil coated, or drawdown samples on aluminum substrate, not less than 3 inches × 4 inches (76 mm × 102 mm).

E. Quality Assurance Submittals: Submit the following:

1. Product Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties, or a third-party listing documenting compliance to a comparable code section.

2. Product Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements.

3. Manufacturer's Product Literature

4. Manufacturer’s Field Reports: Manufacturer’s field reports.

F. Closeout Submittals: Submit the following:

1. Warranty: Warranty documents specified.

1.05 QUALITY ASSURANCE

A. MCM Manufacturer Qualifications

1. MCM Manufacturer Qualifications: Company with a minimum of 10 years of continuous experience manufacturing MCM of the type specified.

c. Able to provide specified warranty on finish.

d. Able to provide a list of other projects of similar size, including approximate date of installation and name of Architect for each.

e. Able to produce the composite material without outsourcing of the fire-resistant core manufacture and compounding, or panel bonding process.

B. MCM Fabricator Qualifications

1. MCM system fabricator will have at least (3) years of continuous documented experience fabricating the panel material type specified.

2. MCM system fabricator will have been in business under its present name for at least five (5) years prior to the start of this project.

3. MCM system fabricator will be capable of providing field service representation during construction.

4. MCM system fabricator will not have filed for protection from creditors under state or federal insolvency or debtor relief statues or codes

C. MCM System Installer Qualifications

1. MCM system fabricator will have been in business under its present name for at least five (5) years prior to the start of this project and have experience with similar sized MCM system projects.

2. MCM system fabricator will be capable of providing field service representation during construction.

3. The MCM System Installer must be an approved installer by the MCM Fabricator for the installation of their MCM System and have undergone proper training for the specified system thereof.

D. Mock-Up

1. At location on building and to extent directed by Architect, install areas of specified wall panels, support framing, flashing, trim and accessories to show:

a. Substrate preparation

f. Support framing, furring, and flashing

g. Clearances and gaps between members

h. Fastening methods

i. Trim details

j. Joint protection

k. Workmanship

2. Prepare mock-up for Architect's approval before start of wall panel work. Prepare additional mock-ups, if required by Architect, until approved.
3. Maintain approved mock-up during construction to establish required standard of workmanship and basis of comparison for installation of wall panel work. Approved mock-up may remain as part of finished work.

E. Installation Documents On-Site

1. Maintain copies of installation instructions, approved submittals and other execution related documents on-site; make available as needed to confirm proper installation.

F. [___]

1.06 DELIVERY, STORAGE & HANDLING

A. Adhere to manufacturer's ordering instructions and lead time requirements to avoid delays.

B. Deliver materials to fabricator in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Protect finish of panels by applying heavy-duty removable plastic film during production.

D. After fabrication, package composite wall panels for protection against transportation damage.

E. Store material in accordance with manufacturer's guidelines.

1. Exercise care unloading, storing and installing panels to prevent bending, warping, twisting and surface damage to the factory applied finish.
2. Store materials protected from exposure to harmful weather conditions, out of direct sunlight when unpackaged, and at temperatures not to exceed 120 degrees F.
3. Protect panels from moisture and condensation with tarpaulins or other suitable weather tight covering installed to provide ventilation.
4. Slope panels to ensure positive drainage of any accumulated water.
5. Avoid contact with any other materials that might cause staining, denting or other surface damage to the factory applied finish.

1.07 WARRANTY

A. Manufacturer's Warranties: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

B. Warranty Periods:

1. Panel Integrity: 10 years commencing on Date of Substantial Completion.
2. Painted Finish: 20 years commencing on Date of Substantial Completion.
3. MCM Natural Metals: No finish warranty
4. Anodized Finish: 5 years commencing on Date of Substantial Completion.

PART 2: PRODUCTS

2.01 FIRE RESISTANT METAL COMPOSITE MATERIAL (MCM)

A. Fire Resistant Metal Composite Material (MCM) Manufacturer

1. Alfrex, LLC, 943 Gainesville HWY, Building 100, Suite 4000, Buford, GA 30518; Phone (470) 589-7449; Website: http://alfrexusa.com/; Email: alfrex@alfrexusa.com

2.02 BASIS OF DESIGN

A. Alfrex FR – Metal Composite Material

B. Description: Two sheets of aluminum sandwiching a solid core of extruded thermoplastic fire-resistant material formed in a continuous process with no glues or liquid adhesives between dissimilar materials. The core material shall be free of voids and/or air spaces and not contain foamed insulation material. Products that are laminated sheet by sheet in a batch process using glues or adhesives between materials shall not be acceptable.

C. MCM Thickness: 4mm (0.157 inch)

D. MCM Face Sheets:

1. Front Face: 0.5mm (0.020”) nominal

2. Fire Resistant Mineral Core: 3.0 mm (0.117 inch) nominal

3. Back Face: 0.5mm (0.020”) nominal

E. Aluminum Alloy: 3003-H14

F. Weight: 1.51 lb/ft2 (7.37 kg/m2)

G. Finishes

1. Coil coated KYNAR® 500 or HYLAR® 5000 based Polyvinylidene Fluoride (PVDF) or Fluoro Ethylene - Alkyl Vinyl Ether (FEVE) resin in conformance with the following general requirements of AAMA 2605.

a. Color: (Select one of the following)

1) Standard color as selected by the owner / architect / engineer from manufacturer's standard, color selection.

a) 2-Coat Solid
b) 2-Coat Mica
c) 3-Coat Metallic
d) [___]

2) Custom color to be matched by the panel supplier.

a) 2-Coat Solid
a) 2-Coat Mica
b) 3-Coat Metallic
c) [___]

3) Clear coat over hairline aluminum substrate.

b. Dry Film Thickness:

1) 2-Coat: 1.0mil (±0.2mil).

2) 3-Coat: 1.0mil (±0.2mil) + 0.50 mil (± 0.05 mil).

c. Hardness: ASTM D-3383; HB minimum using Eagle Turquoise Pencil.

d. Impact Resistance

1) Test method: ASTM D_2794; Gardner Variable Impact Tester with 5/8" mandrel.

2) Coating shall withstand reverse impact of 1.5”/pounds per mil substrate thickness.

3) Coating shall adhere tightly to metal when subjected to #600 Scotch Tape pick-off test. Slight

minute cracking permissible. No removal of film to substrate.

e. Adhesion:

1) Test Method: ASTM D-3359: Coating shall not pick off when subjected to an 11" x 11" x 1/16" grid and taped with #600 Scotch Tape.

f. Humidity Resistance:

1) Test Method: ASTM D-2247.

2) No formation of blisters when subject to condensing water fog at 100% relative humidity and 100°F for 4000 hours.

g. Salt Spray Resistance:

1) Test Method: ASTM B-117; Expose coating system to 4000 hours, using 5% NaCl solution,

2) Corrosion creepage from scribe line: 1/16" max.

3) Minimum blister rating of 8 within the test specimen field.

h. Weather Exposure:

1) Outdoor:

a) Ten-year exposure at 45° angle facing south Florida exposure.
b) Maximum color change of 5 Delta E units as calculated in accordance with ASTM D-2244.
c) Minimum chalk rating of 8 in accordance with ASTM D-4214.
d) No checking, crazing, adhesion loss.

i. Chemical Resistance:

1) ASTM D-1308 utilizing 10% Muriatic Acid for an exposure time of 15 minutes. No loss of film adhesion or visual change when viewed by the unaided eye.

2) ASTM D-1308 utilizing 20% Sulfuric Acid for an exposure time of 18 hours. No loss of film adhesion or visual change when viewed by the unaided eye.

3) AAMA 2605 utilizing 70% reagent grade Nitric Acid vapor for an exposure time of 30 minutes. Maximum color change of 5 Delta E units as calculated in accordance with ASTM D-2244.

2.03 ALTERNATES

A. Base Bid/Contract Manufacturer: [Specify base bid/contract manufacturer].

1. Product: [Specify product base bid/contract brand/trade name with product attributes and characteristics].

A. Alternate No. [Specify #]: [Specify alternate manufacturer].

1. Product: [Specify product alternate brand/trade name with product attributes and characteristics].

B. Alternate No. [Specify #]: [Specify alternate manufacturer].

1. Product: [Specify product alternate brand/trade name with product attributes and characteristics].

2.04 MCM PRODUCT PERFORMANCE

1. Bond Integrity: Tested for resistance to delamination as follows:

a. Peel Strength (ASTM D1781): 22.5 in-lb/in (100 N-m/m) minimum.

b. No degradation in bond performance after 8 hours of submersion in boiling water at 212 degrees Fahrenheit, (100 degrees Celsius).

c. No degradation in bond performance after and 21 days of immersion in water at 70 degrees Fahrenheit, (21 degrees Celsius).

d. Thermally bonded to the fire-resistant core material in a continuous process under tension.

2. Fire Performance:
    a. Flamespread, ASTM E84: <25.
    b. Smoke Developed, ASTM E84: <450.
    c. Surface Flammability, Modified ASTM E108: Pass.
    d. Ignition Temperature:
        1) Flash, ASTM D1929: 716 degrees F (380 degrees C).
        2) Ignition: 752 degrees F (400 degrees C).
    e. Flammability, Exterior, Non-load-bearing wall assemblies and panels, NFPA 285: Pass.
3. Production Tolerances:
    a. Width: +/- 0.080 inch (2.0 mm)
    b. Length: + 0.197 inch (5 mm)
    c. Thickness (4 mm Panel): +/- 0.008 inch (0.2 mm)
    d. Thickness (6 mm Panel): +/- 0.012 inch (0.3 mm)
    e. Bow: Maximum 0.2% length or width.
    f. Squareness: Maximum 0.157 inch (4 mm)

2.05 FABRICATION

A. General: Shop fabricate to sizes and joint configurations indicated on drawings.
    1. Fabricate panels too dimensions indicated on drawings based on an assumed design temperature of 70°F (21°C). Allow for ambient temperature range at time of fabrication.
    2. Formed MCM panel lines, breaks and angles to be sharp and true, with surfaces that are free from warp or buckle.
    3. Fabricate panels with sharply cut edges and no displacement of face sheet or protrusion of core.
B. Fabrication Tolerances: Shop-fabricate panels to sizes and joint configurations indicated on drawings.
    4. Width: +/- 0.079 inch [+/- 2 mm] @ 70°F (21°C)
    5. Length: +/- 0.079 inch [+/- 2 mm] @ 70°F (21°C)
    6. Squareness: +/- 0.079 inch [+/- 2 mm] @ 70°F (21°C)

PART 3: EXECUTION

3.01 MCM FABRICATOR/INSTALLER INSTRUCTIONS

A. Compliance: Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instructions and product carton instructions.

3.02 EXAMINATION AND PREPARATION

A. Verify that conditions of substrates previously installed under other sections or divisions are acceptable for MCM system installation. Documentation should be provided indicating any conditions detrimental to the performance or installation of the MCM System.
    1. Notify [Architect] of unacceptable conditions once discovered.
    2. Proceed with preparation and installation only after unacceptable conditions have been corrected.
B. Field Measurements
    1. If required per project conditions, field measurements of the site condition are to be taken prior to beginning fabrication work and notification of any material modifications and resulting schedule adjustment shall be formally documented.

2. Field measurements are to be made once all substrate and adjacent materials are installed, verifying the locations of wall framing members and wall opening dimensions before commencement of installation. Indicate measurements on the "As Built Shop Drawings".

C. Project Schedule: Provisions in the project schedule must accommodate the time interval between field measurements and fabrication/installation.

D. Miscellaneous Framing: Install miscellaneous MCM system support members and anchorage according to MCM System written instructions and drawings supplied by the MCM System Fabricator.

3.04 INSTALLATION

A. General:

1. Install panels plumb, level and true in compliance with fabricator's recommendations.
2. Anchor panels securely in place in accordance with fabricator's approved shop drawings.
3. Comply with fabricator's instructions for installation of concealed fasteners and with provisions of Section 07 90 00 for installation of joint sealers.
4. Installation Tolerances: Maximum deviation from horizontal and vertical alignment of installed panels: 0.25 inch in 20 feet (6.4 mm in 6.1 m), noncumulative.
5. Separate contact of dissimilar metals with bituminous paint, approved plastic shims, or other approved methods as defined within the Aluminum Design Manual (ASD). Use gasketed or approved coated fasteners where needed to eliminate the possibility of corrosive or electrolytic action between metals.

B. Related Products

1. General: Refer to other related sections in Related Sections paragraph specified herein for related materials, including cold-form metal framing, flashing and trim, joint sealants, aluminum windows, glass and glazing and curtain walls.

3.05 FIELD QUALITY REQUIREMENTS

A. Field Quality Control: Comply with panel system fabricator's recommendations and guidelines for field forming of panels.

B. Field Quality Control: When required by contract, mock up shall be constructed and tested at the expense of the Architect/Owner/General Contractor.

C. Testing Agency: If required, the Owner shall engage a qualified testing agency top perform tests and inspections.

D. Fabricator's Field Services: Upon Owner's request, provide fabricator's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with fabricator's instructions.

3.06 ADJUSTING AND CLEANING

A. ADJUSTING

1. Remove and replace panels damaged beyond repair as a direct result of the panel installation. After installation, panel repair and replacement are the responsibility of the General Contractor.
2. Removal of panels damaged by other trades is the responsibility of the General Contractor.
3. Repair components of the MCM system that present with minor damage provided said repairs are not visibly apparent at a distance of 10 feet (3m) from the surface at a 90° angle per AAMA 2605.
4. Remove and replace components of the MCM system damaged beyond repair.
5. Remove protective film immediately after installation of MCM and immediately prior to completion of the MCM system work. Protective film intentionally left in place after panel installation on any elevation at the direction of the General Contractor, is the responsibility of the General Contractor.
6. Any additional protection, after installation, is the responsibility of the General Contractor.
7. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.

8. Promptly remove from the jobsite any damaged MCM panels, protective film, and other debris attributable to MCM system and installation, and legally dispose of said materials.

B. CLEANING

1. After MCM system installation remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

3.06 PROTECTION

A. Protect installed products from damage during subsequent construction work until final inspection and acceptance by Owner

B. [___]

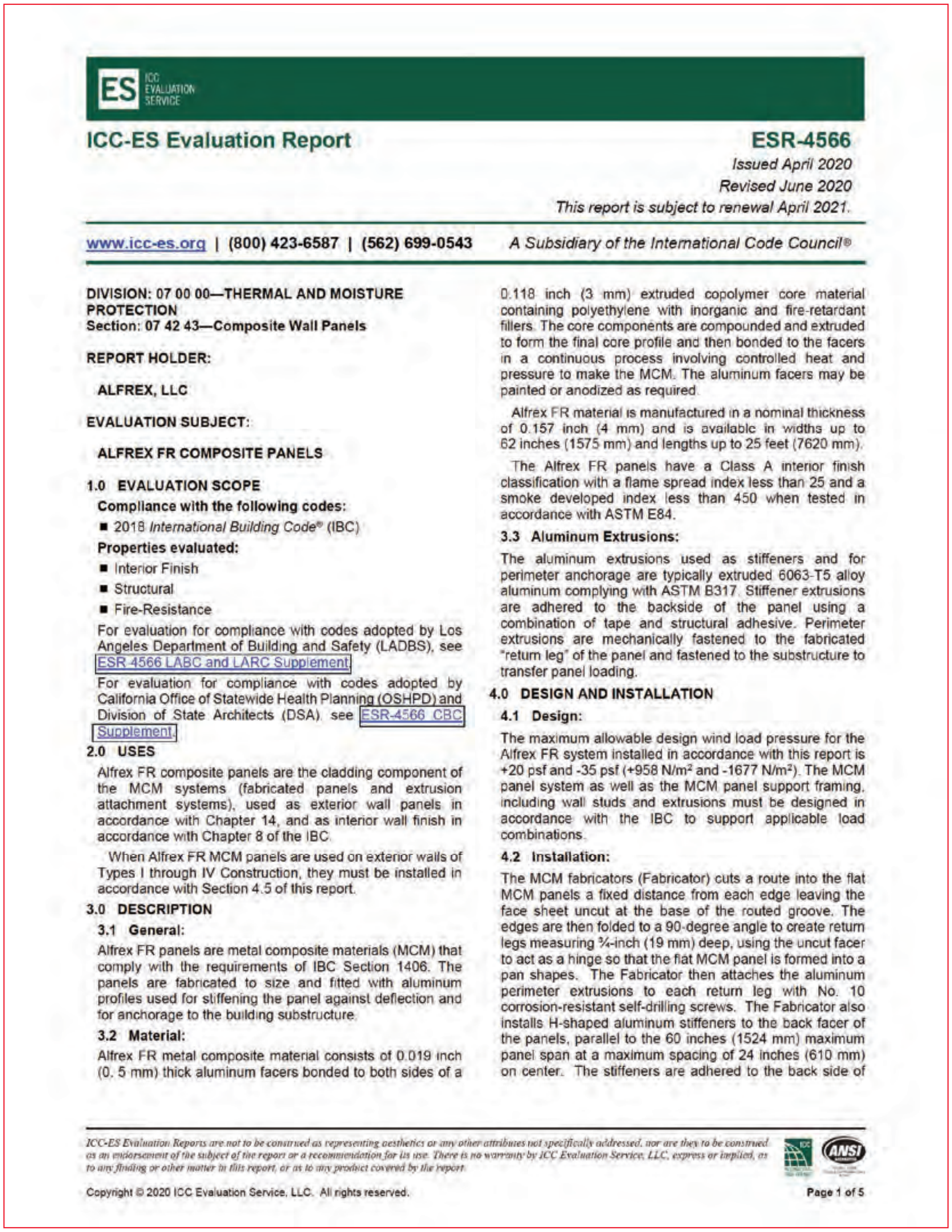
END OF SECTION

ICC-ES EVALUATION REPORT

ICC-ES REPORT: ESR-4566

An ICC-ES Report is one of the most powerful documents for verification of a product's compliance with code requirements and acceptance criteria. ICC-ESR 4566 for Alfrex FR MCM may be accessed via the link below for confirmation of compliance with 2018 IBC, Acceptance Criteria ICC AC25, various supplemental codes for the state of California, and exemption from the LARR city of Los Angeles Research Report.

VIEW REPORT



ES ICC EVALUATION SERVICE

ICC-ES Evaluation Report

ESR-4566

Issued April 2020
Revised June 2020
This report is subject to renewal April 2021.

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DIVISION: 07 00 00—THERMAL AND MOISTURE PROTECTION
Section: 07 42 43—Composite Wall Panels

REPORT HOLDER:

ALFREX, LLC

EVALUATION SUBJECT:

ALFREX FR COMPOSITE PANELS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018 *International Building Code®* (IBC)

Properties evaluated:

- Interior Finish
- Structural
- Fire-Resistance

For evaluation for compliance with codes adopted by Los Angeles Department of Building and Safety (LADBS), see ESR-4566 LABC and LARC Supplement.

For evaluation for compliance with codes adopted by California Office of Statewide Health Planning (OSHPD) and Division of State Architects (DSA) see ESR-4566 CBC Supplement.

2.0 USES

Alfrex FR composite panels are the cladding component of the MCM systems (fabricated panels and extrusion attachment systems), used as exterior wall panels in accordance with Chapter 14, and as interior wall finish in accordance with Chapter 8 of the IBC.

When Alfrex FR MCM panels are used on exterior walls of Types I through IV Construction, they must be installed in accordance with Section 4.5 of this report.

3.0 DESCRIPTION

3.1 General:

Alfrex FR panels are metal composite materials (MCM) that comply with the requirements of IBC Section 1406. The panels are fabricated to size and fitted with aluminum profiles used for stiffening the panel against deflection and for anchorage to the building substructure.

3.2 Material:

Alfrex FR metal composite material consists of 0.019 inch (0. 5 mm) thick aluminum facers bonded to both sides of a 0.118 inch (3 mm) extruded copolymer core material containing polyethylene with inorganic and fire-retardant fillers. The core components are compounded and extruded to form the final core profile and then bonded to the facers in a continuous process involving controlled heat and pressure to make the MCM. The aluminum facers may be painted or anodized as required.

Alfrex FR material is manufactured in a nominal thickness of 0.157 inch (4 mm) and is available in widths up to 62 inches (1575 mm) and lengths up to 25 feet (7620 mm).

The Alfrex FR panels have a Class A interior finish classification with a flame spread index less than 25 and a smoke developed index less than 450 when tested in accordance with ASTM E84.

3.3 Aluminum Extrusions:

The aluminum extrusions used as stiffeners and for perimeter anchorage are typically extruded 6063-T5 alloy aluminum complying with ASTM B317. Stiffener extrusions are adhered to the backside of the panel using a combination of tape and structural adhesive. Perimeter extrusions are mechanically fastened to the fabricated "return leg" of the panel and fastened to the substructure to transfer panel loading.

4.0 DESIGN AND INSTALLATION

4.1 Design:

The maximum allowable design wind load pressure for the Alfrex FR system installed in accordance with this report is +20 psf and -35 psf (+958 N/m² and -1677 N/m²). The MCM panel system as well as the MCM panel support framing, including wall studs and extrusions must be designed in accordance with the IBC to support applicable load combinations.

4.2 Installation:

The MCM fabricators (Fabricator) cuts a route into the flat MCM panels a fixed distance from each edge leaving the face sheet uncut at the base of the routed groove. The edges are then folded to a 90-degree angle to create return legs measuring ¾-inch (19 mm) deep, using the uncut facer to act as a hinge so that the flat MCM panel is formed into a pan shapes. The Fabricator then attaches the aluminum perimeter extrusions to each return leg with No. 10 corrosion-resistant self-drilling screws. The Fabricator also installs H-shaped aluminum stiffeners to the back facer of the panels, parallel to the 60 inches (1524 mm) maximum panel span at a maximum spacing of 24 inches (610 mm) on center. The stiffeners are adhered to the back side of

ICC-ES Evaluation Reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by ICC Evaluation Service, LLC, express or implied, as to any finding or other matter in this report, or as to any product covered by the report.

CERTIFICATIONS AND COMPLIANCE REPORTS

alfrexusa.com | 470.589.7449 | contact@alfrexusa.com | 943 Gainsville Hwy. Building 100-4000, Buford, GA 30518

CERTIFICATIONS AND COMPLIANCE REPORTS

Alfrex FR MCM is thoroughly tested by independent third party laboratories and passes all necessary requirements for use in the USA and Canada.

Please click on the links below to access.

Warnock Hersey: Intertek Fire Performance Listing USA & Canada

VIEW DOCUMENT

NFPA 285 Fire Performance Summary Letter

VIEW DOCUMENT

LEED Certification Summary Alfrex FR

VIEW DOCUMENT

Material Safety Data Sheet Alfrex FR MCM

VIEW DOCUMENT

ACCU-TRAC® PANEL SYSTEM DETAILS

ACCU-TRAC® is shown courtesy of Altech Panel Systems
Alfrex only manufactures MCM sheets

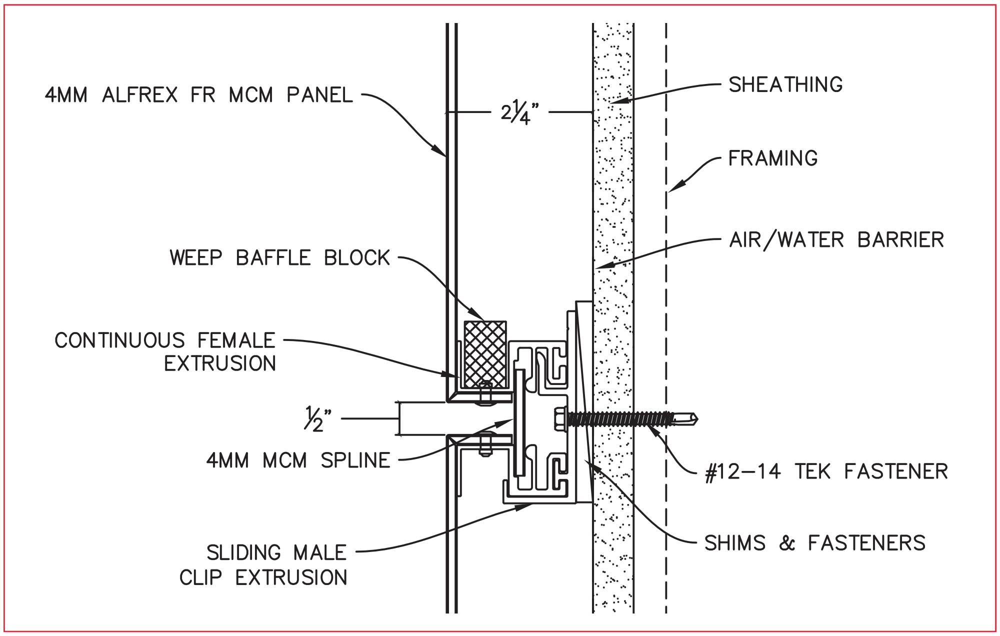
alfrexusa.com | 470.589.7449 | contact@alfrexusa.com | 943 Gainsville Hwy. Building 100-4000, Buford, GA 30518

ACCU-TRAC®
ATTACHMENT SYSTEMS TYPICAL DETAILS

Courtesy of Altech Panel Systems

ACCU-TRAC® DS

Pressure Equalized Rainscreen System

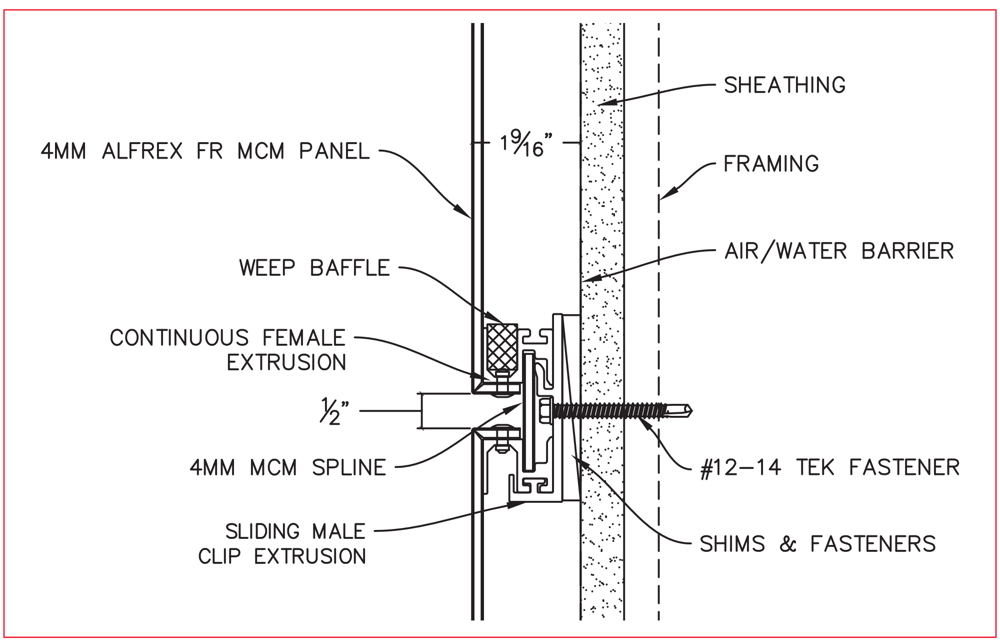


FULL DETAILS

TEST DATA

ACCU-TRAC® Low Profile DS

Back Ventilated Rainscreen System



FULL DETAILS

DOCUMENTATION

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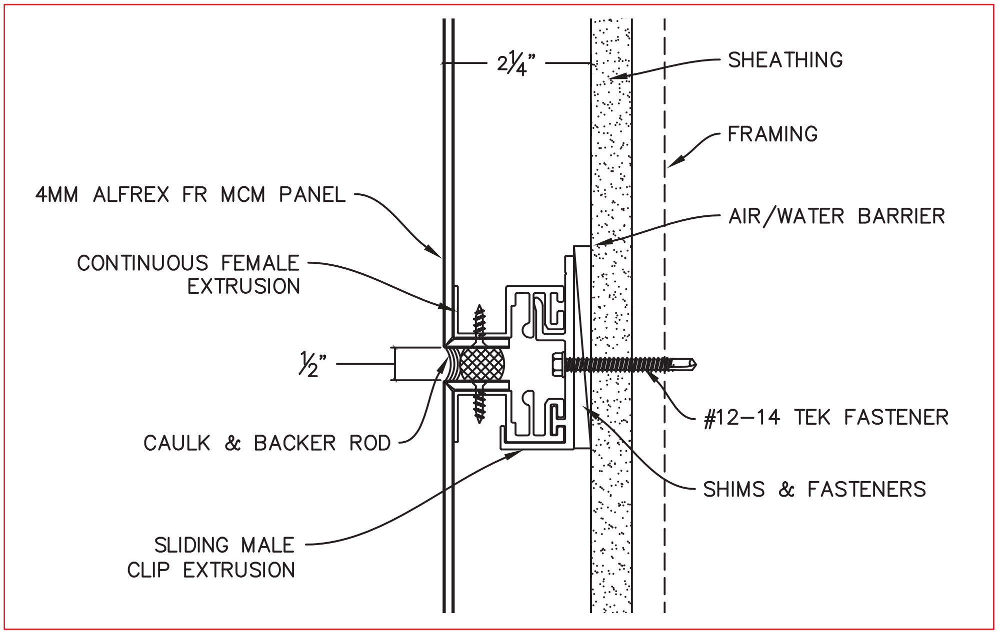
ACCU-TRAC®
ATTACHMENT SYSTEMS TYPICAL DETAILS

Courtesy of Altech Panel Systems

ACCU-TRAC® ES

Route & Return Exposed Sealant System

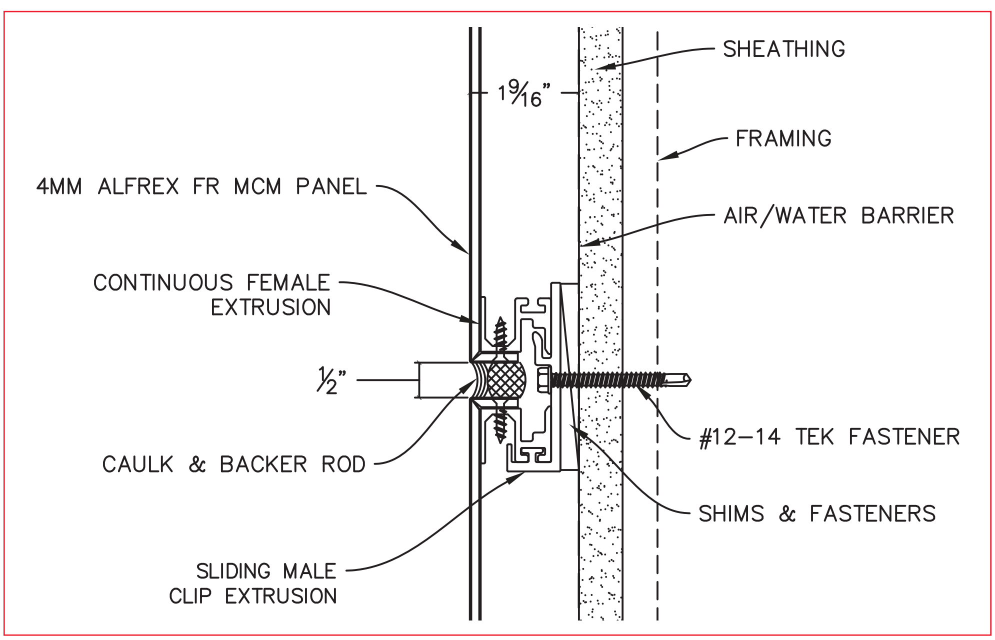


FULL DETAILS

TEST DATA

ACCU-TRAC® Low Profile ES

Low Profile Route & Return Exposed Sealant System



FULL DETAILS

DOCUMENTATION

The details below are provided for conceptual purposes only and are the property of Altech Panel Systems. Panel systems and assembly design, fabrication, and installation are provided by qualified fabricators and installers. Alfrex, LLC does not make any warranties, express or implied including merchantability and fitness for purpose.

NORTH AMERICAN ALFREX FR PROJECT REFERENCES

alfrexusa.com | 470.589.7449 | contact@alfrexusa.com | 943 Gainsville Hwy. Building 100-4000, Buford, GA 30518

alfrex

NORTH AMERICAN ALFREX FR PROJECT REFERENCES

LOCATION	PROJECT NAME	SIZE (sqft)	ARCHITECTURAL FIRM	ARCH CONTACT	GENERAL CONTRACTOR	GC CONTACT
Nova Scotia, Canada	Fenwick Tower / The Vuze	231,974	Stantec Architecture	866.782.6832	Templeton Construction	902.422.6901
Alberta, Canada	HAT at West Village	140,485	NORR Architects	403.264.4000	Cidex Group	403.245.6996
Ontario, Canada	Kipling Go Bus Station	87,904	Strasman Architects	416.588.1800	EllisDon Design-Build Inc.	905.896.8900
Manitoba, Canada	The Arc	62,870	Ark	647.777.3500	Concord Pacific	604.681.8882
Alberta, Canada	Casadona Place	59,077	Gibbs Gage	403.233.2000	EllisDon Design-Build Inc.	905.896.8900
Ontario, Canada	CAMH - 1st	48,731	KPMB Architects	416.977.5104	PLC Constructors Canda Inc.	905.276.7600
Ontario, Canada	SNC Lavalin Office	44,833	De Silva Architect	905.491.6823	Arguson Projects Inc.	905.848.0707
Alberta, Canada	The Windsor	37,303	NORR Architects	403.264.4000	Westpointe Building Services, Inc.	587.774.9579
New York, USA	Victoria Theater	37,131	Aufgang Architects	845.368.0004	Flintlock Construction	914.630.7503
Alberta, Canada	HAT at East Village	34,395	NORR Architects	403.264.4000	Cidex Group	403.245.6996
Utah, USA	Fairbourne Station Office Tower	33,616	EDA Architects	801.531.7600	ICO Development	213.270.8000
Alberta, Canada	West Village - 1	29,536	NORR Architects	403.264.4000	Cidex Group	403.245.6996
Ontario, Canada	360 Oakville	18,116	B+H Architects	416.596.2299	Cooper Construction	905.829.0444
New Jersey, USA	Rutgers University Health Athletic Performance Center	17,018	Perkins Eastman	212.353.7200	Epic Management	732.752.6100
Ontario, Canada	Gateway Meadowvale	16,041	Quadrangle Architects	416.598.1240	Carttera Private Equities	416.593.4747
Utah, USA	Mountain Tech South	15,696	FFKR Architects	801.521.6186	R&O Construction	801.627.1403
Alberta, Canada	West Village - 2	12,658	NORR Architects	403.264.4000	Cidex Group	403.245.6996
Idaho, USA	Fruitland Subaru	10,127	BRS Architects	208.336.8370	ESI Construction	208.362.3040
New York, USA	Hutchinson Metro Center Tower II and Atrium	N/A	Newman Design	212.673.3110	Mc Gowan	201.865.4666
Alberta, Canada	Canadian Blood Services	5,908	Norr Architecture	403.264.4000	Bird Construction	403.319.0470
B. Columbia, Canada	Tempo Amenity Building	2,115	Robert Ciccozzi Architecture	604.687.4741	Cressey Development	604.683.1256

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COUNTRY	PROJECT NAME	ARCHITECTURAL FIRM	SQ. FEET
Korea	The Hillstate	kmd architects & Samoo Architects	753,480
Korea	Doosan We've The Zenith	De Stefano + Partners	317,538
Korea	Sangam Kaiser Palace	HAEAHN Architecture	269,100
Korea	Kolon-Parkpolis	Morphosis Architects	258,336
Korea	Seongnam City hall	kmd architects & Samoo Architects	129,168
Korea	OCI Central R&D center	HAEAHN Architecture + H Architecture	129,168
Korea	Dangin Power Plant of TAIHAN	Obra Architects	118,404
Korea	Lions Valley	Mass Studies	107,640
Korea	National Police Agency	H Architecture	96,876
Korea	KEPCO Reaearch Institute	KEPCO Reaearch Institute	75,348
Korea	Korea Land & Housing Corp	DRDS, Moo Young & Tomoon	16,146
Thailand	Honda Big Wing	VaSLab Architecture	53,820
Vietnam	Landmark 81 Tower	Atkins	484,380