RIVERSIDE COUNTY TRANSPORTATION COMMISSION

Riverside-Downtown
STATION IMPROVEMENTS

Appendix J. Geotechnical Exploration Report

GEOTECHNICAL EXPLORATION RIVERSIDE-DOWNTOWN STATION TRACK & PLATFORM PROJECT (MP 9.9 TO MP 10.2) RIVERSIDE COUNTY TRANSPORTATION COMMISSION (RCTC) CITY OF RIVERSIDE, CALIFORNIA

Prepared for

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601 W. 5th Street, Suite 1000
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Project No. 12624.001

August 14, 2020

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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HNTB Corporation
601 W. 5th Street, Suite 1000
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Attention: Mr. Graham Christie

Subject: Geotechnical Exploration
Riverside-Downtown Station Track & Platform Project
(MP 9.9 to MP 10.2)
Riverside County Transportation Commission (RCTC)
City of Riverside, California

In accordance with your request, we are pleased to provide this geotechnical exploration report for the subject project summarizing our geotechnical findings, conclusions and recommendations regarding the design and construction of the proposed improvements. Based on the results of our findings and conclusions, it is our opinion that the site is suitable for the intended use provided the recommendations included in herein are implemented during design and construction phases of development.

If you have any questions regarding this report, please do not hesitate to contact the undersigned. We appreciate this opportunity to be of service on this project.

Respectfully submitted,

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1.0 INTRODUCTION

1.1 Purpose and Scope

This geotechnical exploration is for the Riverside-Downtown Station upgrade project located in downtown Riverside between Mission Inn Boulevard and Fourteenth Street along the north side of Howard Avenue (see Figure 1). Our scope of services for this exploration included the following:

- Review of available site-specific geologic information and a provided Preliminary Site Plan.
- Review of a previous geotechnical report prepared by Diaz Yourman and Associates (DYA, 2010) that was prepared for the Downtown Station. Approximate locations of previous exploratory borings are depicted on the *Boring Location Map (Figure 2)*.
- A site reconnaissance and excavation of four (4) exploratory borings. Approximate locations of these geotechnical borings are depicted on the *Boring Location Map (Figure 2)*. The logs of exploratory borings are presented in Appendix A.
- Geotechnical laboratory testing of selected soil samples collected during this exploration. Test results are presented in Appendix B.
- Geotechnical engineering analyses performed or as directed by a California registered Geotechnical Engineer (GE) and reviewed by a California Certified Engineering Geologist (CEG).
- Preparation of this report which presents our geotechnical conclusions and recommendations regarding the proposed structures.

This report is not intended to be used as an environmental assessment (Phase I or other), or foundation plan review.

1.2 Site and Project Description

The overall Riverside downtown station is located between Mission Inn Boulevard and Fourteenth Street along the north side of Howard Avenue (see Figure 1). The County Assessor Parcel Numbers (APNs) for this site are 211-231-024, -025 & -026. The site of the new platform/track is located south of the existing tracks and currently occupied by paved driveways, parking areas, and an industrial building (Prism Aerospace Inc.). Topographically, the site is relatively flat, draining gently in a northwestern direction.

Based on our communications, we understand that site improvements consist of upgrading Riverside-Downtown Station with an additional platform (26-foot wide by

710-foot long), an extended pedestrian overpass, new platform tracks, along with other associated improvements including a retaining wall along Howard Avenue. Grading plans were not provided as of the date of this report; however, we anticipate cut and fill grading of less than 5 feet to create finish site grades. If site development plans significantly differ from those described herein, the report should be subject to further review and evaluation.

1.3 Previous Geotechnical Report

As noted above, Leighton reviewed a geotechnical report for the Riverside Downtown Station prepared by DYA (DYA, 2010). This previous report presented similar findings to those included herein. Relevant exploration logs from this previous report are included in Appendix A.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

Our field exploration consisted of the excavation of four (4) hollow stem borings located generally in areas of planned improvements to provide basis for foundation and pavement design. During exploration, disturbed/bulk samples were collected for further laboratory testing and evaluation. Approximate locations of these and previous filed explorations are depicted on the *Boring Location Map* (see Figure 2). Sampling was conducted by a technical staff from our firm. After logging and sampling, the excavations were loosely backfilled with spoils generated during excavation. The exploration logs from this exploration are provided in Appendix A.

2.2 Laboratory Testing

Laboratory tests were performed on representative bulk samples to provide a basis for development of earthwork control and foundation design. The laboratory testing program included maximum density and moisture content relationship, expansion index, R-value, collapse potential, and soluble sulfate content. The results of our laboratory testing from this and previous explorations are presented in Appendix B.

3.0 GEOTECHNICAL AND GEOLOGIC FINDINGS

3.1 Regional Geology

The site is located within a prominent natural geomorphic province in southwestern California known as the Peninsular Ranges. This province is characterized by steep, elongated ranges and valleys that trend northwestward. More specifically, the proposed site is located within the northern portion of the relatively stable Perris Block.

The Perris Block, approximately 20 miles by 50 miles in extent, is bounded by the San Jacinto Fault Zone to the northeast, the Chino Fault to the West and Elsinore Fault Zone to the southwest. The Perris Block has had a complex tectonic history, apparently undergoing relative vertical land-movements of several thousand feet in response to movement on the Elsinore and San Jacinto Fault Zones. Thin sedimentary and volcanic materials locally mantle crystalline bedrock, consisting of the Val Verde Tonalite (Kvt) and lesser amounts of Cretaceous granitic dikes (Kg).

3.2 Site Specific Geology

Our field exploration, observations, and review of the pertinent literature indicate that the site is underlain by artificial fill and alluvial deposits within the depth explored. A more detailed description of each unit is provided on the logs of borings in Appendix A.

- **Undocumented Artificial Fill:** Undocumented artificial fill is generally associated with previous grading and existing structures/roadways improvements. The undocumented fill layers may extend up to 10 feet below ground surface (BGS) in some areas, especially near the Prism Aerospace building. Localized pockets of artificial fill that were not identified during our exploration may also be encountered elsewhere on this site below surface. Where encountered, the artificial fill is medium dense to dense and consist of silty to clayey sand.
- **Young Alluvial Fan Deposit:** Young alluvial soils were encountered in the western portion of the site, mainly between 10th Street and 13th Street. This alluvium may extend up to 15 feet BGS (LB-3), and generally consist of loose to medium dense silty to clayey sand (SM/SC). These materials are expected to generally possess a low expansion potential (EI<51) and collapse potential of up to 6.5 percent as encountered in Boring LB-4 along Howard Avenue.
- **Old Alluvial Fan Deposit:** Older alluvial soils were encountered in all borings below the artificial fill and/or younger alluvium. As encountered, these soils generally consist of loose to dense silty to clayey sand (SM/SC) and localized poorly-graded sand (SP). This older alluvium is expected to generally possess a low expansion potential (EI<51) and slight collapse potential (<1.5%).

3.3 Groundwater and Surface Water

No standing or surface water was observed on the site at the time of our field exploration. In addition, groundwater was not encountered during previous exploration to the total depth explored of 50 feet. Historic groundwater data information from a facility/case approximately 500 feet northeast of the Site (Riverside MGP Site) indicates that the depth to groundwater at this nearby facility was approximately 107 feet in 2008, and the flow direction was northwest to west-southwest (EnviroStor, 2019). The Riverside Canal is located immediately adjoining the western most portion of the site.

3.4 Regional Faulting and Fault Activity

The subject site, like the rest of Southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates. The principal source of seismic activity is movement along the northwest-trending regional fault systems such as the San Andreas, San Jacinto, and Elsinore Fault Zones. Based on published geologic hazard maps, this site is not located within a currently designated Alquist-Priolo (AP) Earthquake Fault Zone; nor located within a County Fault Zone.

3.5 Seismic Coefficients per 2019 CBC

In accordance with ASCE 7-16 procedures and prevailing subsurface soils conditions, our site-specific ground motion analysis is based on a Site Class D. A summary of seismic coefficients are listed in Table 2 below and further described in Appendix C.

Table 1. 2019 CBC Site-Specific Seismic Coefficients

Site Seismic Coefficients / Coordinates		Value
Latitude		33.9764
Longitude		-117.3688
Mapped Spectra (OSHPD)	Spectral Response – Class D (short), S_S	1.50
	Spectral Response – Class D (1 sec), S_1	0.60
	Site Modified Peak Ground Acceleration, PGA_M	0.59
Site-Specific Response Spectra	Max. Considered Earthquake Spectral Response Acceleration (short), S_{MS}	1.71
	Max. Considered Earthquake Spectral Response Acceleration – (1 sec), S_{M1}	1.48
	5% Damped Design Spectral Response Acceleration (short), SDS	1.14
	5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	0.98
	Site-Specific Peak Ground Acceleration, PGA	0.73

Based on the above, strong ground shaking can be expected at the site during moderate to severe earthquakes in this general region. This is common to virtually all of Southern California. Intensity of ground shaking at a given location depends primarily upon earthquake magnitude, site distance from the source, and site response (soil type) characteristics.

3.6 Secondary Seismic Hazards

Ground shaking can induce "secondary" seismic hazards such as liquefaction, dynamic densification, lateral spreading, flooding, seiche/tsunami, collapsible soils, and ground rupture, as discussed in the following subsections:

3.6.1 Dynamic Settlement (Liquefaction and/or Dry Settlement)

Riverside County Geologic Hazards maps indicate that the site is located in a zone of low to moderate liquefaction potential. However, liquefaction-induced or dynamic dry settlement is not expected to be a significant hazard at this site due to the absence of shallow groundwater, near surface saturated sand layers, and underlying dense older alluvium. Our analysis of dynamic settlement due to ground shaking based on PGA of 0.73g with a moment magnitude (Mw) of 8.1 is estimated to be 3.5 inches (see Appendix C). This settlement is expected to be generally global and over a large area. As such, the seismic differential settlement is not expected to exceed 1-inch in a 30-foot horizontal distance within this site.

3.6.2 Lateral Spreading

Due to a relatively flat terrain and dense underlying older alluvium, lateral spreading is not considered a geologic hazard on this site.

3.6.3 Flooding

This report does not address conventional flood hazard risk associated with this site. However, per the official FEMA Flood Hazard Areas Map (FIRM Panel 06065C0726G), this site is located in Zone AE – "Floodway Area".

3.6.4 Seiche and Tsunami

Due to the site location and lack of nearby open bodies of water, the possibility of the affects due to seiches or tsunami is considered very low.

3.6.5 Collapsible Soils

Laboratory testing indicates that the onsite soils (older alluvium) are expected to possess a slight collapse potential (<1.5%), however the surficial soil and younger alluvium are expected to possess a collapse potential of up to 6.6 percent. Remedial grading recommendations are provided in Section 4.2.1 to mitigate for this geologic hazard.

3.6.6 Expansive Soils

Limited laboratory testing indicated that onsite soils generally possess a low expansion potential (EI<51). The mitigation for this geologic hazard is presented in Section 4.2.4 of this report.

3.6.7 Ground Rupture

Since this site is not located within a mapped Fault Zone, the possibility of ground surface-fault-rupture is very low at this site.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based on the results of this exploration, it is our opinion that the site is suitable for the proposed development from a geotechnical viewpoint. Grading of the site should be in accordance with our recommendations included in this report and future recommendations and evaluations made during construction by the geotechnical consultant.

4.2 Earthwork

Earthwork construction should be performed in accordance with our recommendations included in this report and applicable local, state, and federal codes and safety regulations. These also include applicable standards and regulations of SCRRA and AREMA. The contract between the owner and earthwork contractor should be worded such that it is the responsibility of the contractor to place fill properly in accordance with the recommendations of this report and applicable Grading Ordinances, notwithstanding the testing and observation of the geotechnical consultant during construction. The recommendations contained in Appendix D, are general grading specifications provided for typical grading projects and some of the recommendations may not be strictly applicable to this project. The specific recommendations contained in the text of this report supersede the general recommendations in Appendix D.

4.2.1 Site Preparation

Prior to grading, the proposed structural improvement areas (i.e. all-structural fill areas, pavement, buildings, etc.) should be cleared of surface and subsurface pipelines and obstructions. Heavy vegetation, roots and debris should be disposed of offsite. Any onsite wells or septic waste system should be removed or abandoned in accordance with the Riverside Country Department of Environmental Health. Voids created by removal of buried/unsuitable materials should be backfilled with properly compacted soil in general accordance with the recommendations of this report.

4.2.2 Remedial Grading

Remedial grading/ over-excavation (OX) is required for all structural areas or beneath all settlement-sensitive structures. Remedial grading or OX requirements should be performed as follows:

- ***Track/Platform:*** To reduce the potential for excessive differential settlement, the depth of removal should extend a minimum of 3 feet BGS or finish subgrade, whichever is deeper.
- ***Bridge/Elevator Foundation:*** If bridge foundations are to be supported on shallow foundations, the depth of removal should extend a minimum of 5 feet BGS or 2 feet below bottom of footings, whichever is deeper.
- ***Retaining Wall along Howard Avenue (LB-4):*** To reduce the potential for excessive differential settlement, the depth of removal should extend a minimum of 7 feet BGS or 5 feet below finish subgrade, whichever is deeper.
- ***Pavement/Street Areas:*** The depth of removal should extend a minimum of 3 feet BGS or 2 feet below finish subgrade, whichever is deeper.

The removal limit should be horizontally established by a 1:1 (H:V) projection from the edge of structural fill or outside edge of footings downward and outward to competent material identified by the geotechnical consultant. This may require remedial grading that extends beyond the limits of design grading or shoring systems to protect existing structures or utilities. Removal will also include benching into competent material as the fills rise. Steeper temporary cut slopes in these areas may be considered.

After completion of the recommended removal of unsuitable soils and prior to fill placement, the exposed surface should be scarified to a minimum depth of 8-inches, moisture conditioned as necessary to optimum moisture content and compacted using heavy compaction equipment to an unyielding condition. All structural fill should be compacted throughout to 90 percent of the ASTM D 1557 laboratory maximum density.

4.2.3 Structural Fills

The onsite soils are generally suitable for re-use as compacted fill, provided they are free of debris and organic matter. Fills placed within 10 feet of finish grades or slope faces should contain no rocks over 12 inches in maximum dimension. In addition, encountered expansive clayey soils layers (EI>51), if any, should be placed at a depth greater than 5 feet below finished grades.

Areas to receive structural fill and/or other surface improvements should be scarified to a minimum depth of 8 inches, conditioned to at least optimum moisture content, and recompacted. Fill soils should be placed at a minimum of 90 percent relative compaction (based on ASTM D1557) at or above optimum moisture content. Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of the geotechnical consultant. The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in thickness.

Fills placed on slopes steeper than 5:1 (horizontal:vertical) should be benched into dense soils (see Appendix D for benching detail). Benching should be of sufficient depth to remove all loose material. A minimum bench height of 2 feet into approved material should be maintained at all times.

4.2.4 Import Soils

Import soils and/or borrow sites, if needed, should be evaluated by us prior to import. Import soils should be uncontaminated, granular in nature, free of organic material (loss on ignition less-than 2 percent), have very low expansion potential (E<21) and have a low corrosion impact to the proposed improvements.

4.2.5 Utility Trenches

Utility trenches should be backfilled with compacted fill in accordance with the *Standard Specifications for Public Works Construction,* ("Greenbook"), 2018 Edition. Fill material above the pipe zone should be placed in lifts not exceeding 8 inches in uncompacted thickness and should be compacted to at least 90 percent relative compaction (ASTM D 1557) by mechanical means only. Site soils may generally be suitable as trench backfill provided these soils are screened of rocks over 3 inches in diameter and organic matter. If imported sand is used as backfill, the upper 3 feet in building and pavement areas should be compacted to 95 percent. The upper 6 inches of backfill in all pavement areas should be compacted to at least 95 percent relative compaction.

Where granular backfill is used in utility trenches adjacent to moisture sensitive subgrades and foundation soils, we recommend that a cut-off "plug" of impermeable material be placed in these trenches at the perimeter of buildings, and at pavement edges adjacent to irrigated landscaped areas. A "plug" can consist of a 5-foot long section of clayey soils with more than 35-percent passing the No. 200 sieve, or a Controlled Low Strength Material (CLSM) consisting of one sack of Portland-cement plus one sack of bentonite per cubic-yard of sand. CLSM should generally conform to requirements of the "Greenbook". This is intended to reduce the likelihood of water permeating trenches from landscaped areas, then seeping along permeable trench backfill into the building and pavement subgrades, resulting in wetting of moisture sensitive subgrade earth materials under buildings and pavements.

Excavation of utility trenches should be performed in accordance with the project plans, specifications and the *California Construction Safety Orders* (latest Edition). The contractor should be responsible for providing a "competent person" as defined in Article 6 of the *California Construction Safety Orders*. Contractors should be advised that sandy soils (such as fills generated from the onsite alluvium) could make excavations particularly unsafe if all safety precautions are not properly implemented. In addition, excavations at or near the toe of slopes and/or parallel to slopes may be highly unstable due to the increased driving force and load on the trench wall. Spoil piles from the excavation(s) and construction equipment should be kept away from the sides of the trenches. Leighton Consulting, Inc. does not consult in the area of safety engineering.

4.2.6 Shrinkage

The volume change of excavated onsite soils upon recompaction is expected to vary with materials, density, insitu moisture content, and location and compaction effort. The in-place and compacted densities of soil materials vary and accurate overall determination of shrinkage and bulking cannot be made. Therefore, we recommend site grading include, if possible, a balance area or ability to adjust grades slightly to accommodate some variation. Based on our geotechnical laboratory results, we expect recompaction shrinkage (when recompacted to an average 92 percent of ASTM D1557) to be in the 5 to 15% range.

4.2.7 Drainage

All drainage should be directed away from structures and pavements by means of approved permanent/temporary drainage devices. Adequate storm drainage of any proposed pad should be provided to avoid wetting of foundation soils. Irrigation adjacent to buildings should be avoided when possible. As an option, sealed-bottom planter boxes and/or drought resistant vegetation should be used within 5-feet of buildings.

4.3 Foundation Design

4.3.1 Design Parameters – Spread/Continuous Shallow Footings

Footings should be embedded at least 12-inches below lowest adjacent grade for the proposed structure. Footing embedment should be measured from lowest adjacent finished grade, considered as the top of interior slabs-on-grade or the finished exterior grade, excluding landscape topsoil, whichever is lower. Footings located adjacent to utility trenches or vaults should be embedded below an imaginary 1:1 (horizontal:vertical) plane projected upward and outward from the bottom edge of the trench or vault, up towards the footing.

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- **Bearing Capacity**: For footings on newly placed, properly compacted fill soil, an allowable vertical bearing capacity of 2,000 pounds-per-square-foot (psf) should be used. These footings should have a minimum base width of 18 inches for continuous wall footings and a minimum bearing area of 3 square feet (1.75-ft by 1.75-ft) for pad foundations. The bearing pressure value may be increased by 250 psf for each additional foot of embedment or each additional foot of width to a maximum vertical bearing value of 3,000 psf. Additionally, these bearing values may be increased by one-third when considering short-term seismic or wind loads. A modulus of subgrade reaction, K of 150 pci may be used for onsite soil compacted to minimum 90% relative compaction.
- **Lateral loads**: Lateral loads may be resisted by friction between the footings and the supporting subgrade. A maximum allowable frictional resistance of 0.35 may be used for design. In addition, lateral resistance may be provided by passive pressures acting against foundations poured neat against properly compacted granular fill. We recommend that an allowable passive pressure based on an equivalent fluid pressure of 350 pounds-per-cubic-foot (pcf) be used in design. These friction and passive values have already been reduced by a factor-of-safety of 1.5.

4.3.2 Settlement Estimates

For settlement estimates, we assumed that column loads will be no larger than 90 kips, with bearing wall loads not exceeding 5 kips per foot of wall. If greater column or wall loads are required, we should re-evaluate our foundation recommendation, and re-calculate settlement estimates.

Buildings located on compacted fill soils as required per Section 4.2.1 above should be designed in anticipation of 1 inch of total static settlement and 0.5-inch of static differential settlement within a 30-foot horizontal run. Differential settlement due to seismic loading is expected to be less than 1-inch in a 30-foot horizontal run.

4.4 Vapor Retarder

It has been a standard of care to install a moisture-vapor retarder underneath all slabs where moisture condensation is undesirable. Moisture vapor retarders may retard but not totally eliminate moisture vapor movement from the underlying soils up through the slabs. Moisture vapor transmission may be additionally reduced by use of concrete additives. Leighton Consulting, Inc. does not practice in the field of moisture vapor transmission evaluation/mitigation. Therefore, we recommend that a qualified person/firm be engaged/consulted with to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person/firm should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate.

However, based on our experience, the standard of practice in Southern California has evolved over the last 15 to 20 years into a construction of a vapor retarder system that generally consisted of a membrane (such as 15-mil thick), underlain by a capillary break consisting of 4 inches of clean ½-inch-minimum gravel or 2-inch sand layer (SE>30). The structural engineer/architect or concrete contractor often require a sand layer be placed over the membrane (typically 2-inch thick layer) to help in curing and reduction of curling of concrete. If such sand layer is placed on top of the membrane, the contractor should not allow the sand to become wet prior to concrete placement (e.g., sand should not be placed if rain is expected).

In conclusion, the construction of the vapor barrier/retarder system is dependent on several variables which cannot be all geotechnically evaluated and/or tested. As such, the design of this system should be a design team/owner decision taking into consideration finish flooring materials and manufacture's installation requirements of proposed membrane. Moreover, we recommend that the design team also follow ACI Committee 302 publication for "Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials" (ACI 302.2R-06) which includes a flow chart that assists in determining if a vapor barrier/retarder is required and where it is to be placed.

4.5 Retaining Walls

Retaining wall earth pressures are a function of the amount of wall yielding horizontally under load. If the wall can yield enough to mobilize full shear strength of backfill soils, then the wall can be designed for "active" pressure. If the wall cannot yield under the applied load, the shear strength of the soil cannot be mobilized and the earth pressure will be higher. Such walls should be designed for "at rest" conditions. If a structure moves toward the soils, the resulting resistance developed by the soil is the "passive" resistance. Retaining walls backfilled with non-expansive soils can be designed using the following equivalent fluid pressures:

Table 2. Retaining Wall Design Earth Pressures (Static, Drained)

Loading Conditions	Equivalent Fluid Density (pcf)	
	Level Backfill	2:1 Backfill
Active	36	50
At-Rest	55	85
Passive*	350	150 (2:1, sloping down)

* This assumes level condition in front of the wall will remain for the duration of the project, not to exceed 3,500 psf at depth.

Unrestrained (yielding) cantilever walls should be designed for the active equivalent-fluid weight value provided above for very low to low expansive soils that are free draining. In the design of walls restrained from movement at the top (non-yielding) such as basement or elevator pit/utility vaults, the at-rest equivalent fluid weight value should be used. Total depth of retained earth for design of cantilever walls should be measured as the vertical distance below the ground surface measured at the wall face for stem design, or measured at the heel of the footing for overturning and sliding calculations. Should a sloping backfill other than a 2:1 (horizontal:vertical) be constructed above the wall (or a backfill is loaded by an adjacent surcharge load), the equivalent fluid weight values provided above should be re-evaluated on an individual case basis by us. Non-standard wall designs should also be reviewed by us prior to construction to check that the proper soil parameters have been incorporated into the wall design.

The above equivalent fluid pressures do not include the effect of earthquake loading. As such, we recommend a uniform pressure distribution of 14H (psf) be considered to estimate seismic lateral pressures acting against retaining walls higher than 6 feet.

All retaining walls should be provided with appropriate drainage. The outlet pipe should be sloped to drain to a suitable outlet. Wall backfill should be non-expansive (EI $\leq$ 21) sands compacted by mechanical methods to a minimum of 90 percent relative compaction (ASTM D 1557). Clayey site soils should not be used as wall backfill. Walls should not be backfilled until wall concrete attains the 28-day compressive strength and/or as determined by the Structural Engineer that the wall is structurally capable of supporting backfill. Lightweight compaction equipment should be used, unless otherwise approved by the Structural Engineer.

4.6 Sulfate Attack

Based on past experience in this area, the onsite soils are expected to possess negligible sulfate content. Type II concrete or equivalent may be used. Further testing should be performed at the completion of site grading to confirm such conditions.

4.7 Preliminary Pavement Design

Our preliminary pavement design is based on an R-value of 23 and the Caltrans Highway Design Manual. For planning and estimating purposes, the pavement sections are calculated based on Traffic Indexes (TI) as indicated in Table below:

Table 3. Asphalt Pavement Sections

General Traffic Condition	Traffic Index (TI)	Asphalt Concrete (inches)	Aggregate Base* (inches)
Automobile Parking Lanes	4.5	3.0	5.5
	5.0	3.5	5.5
Truck Access & Driveways	6.0	4.0	8.0
	6.5	4.0	10.0

Appropriate Traffic Index (TI) should be selected or verified by the project civil engineer and actual R-value of the subgrade soils will need to be verified after completion of site grading to finalize the pavement design. Pavement design and construction should also conform to applicable local, county and industry standards. The Caltrans pavement section design calculations were based on a pavement life of approximately 20 years with periodic flexible pavement maintenance.

Where applicable, we recommend that a minimum of 7 inches of PCC pavement be used in high impact load areas or if to be subjected to truck traffic. The PCC pavement should be placed on a minimum 4-inch aggregate base. The PCC pavement may be placed directly on a compacted subgrade with an R-Value of 40 or higher. The PCC pavement should have a minimum of 28-day compressive strength of 3250 psi. Other requirements of Caltrans Standard Specifications regarding mixing and placing of concrete should be followed.

The upper 6 inches of the subgrade soils should be moisture-conditioned to near optimum moisture content, compacted to at least 95 percent relative compaction (ASTM D1557) and kept in this condition until the pavement section is constructed. Minimum relative compaction requirements for aggregate base should be 95 percent of the maximum laboratory density as determined by ASTM D1557. If applicable,

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aggregate base should conform to the "Standard Specifications for Public Works Construction" (green book) current edition or Caltrans Class 2 aggregate base.

If pavement areas are adjacent to heavily watered landscape areas, some deterioration of the subgrade load bearing capacity and pavement failure may result. Moisture control measures such as deepened curbs or other moisture barrier materials may be used to prevent the subgrade soils from becoming saturated. The use of concrete cutoff or edge barriers should be considered when pavement is planned adjacent to either open (unfinished) or irrigated landscaped areas.

5.0 GEOTECHNICAL CONSTRUCTION SERVICES

Geotechnical review is of paramount importance in engineering practice. Poor performances of many foundation and earthwork projects have been attributed to inadequate construction review. We recommend that Leighton Consulting, Inc. be provided the opportunity to review the grading plan and foundation plan(s) prior to bid.

Reasonably-continuous construction observation and review during site grading and foundation installation allows for evaluation of the actual soil conditions and the ability to provide appropriate revisions where required during construction. Geotechnical conclusions and preliminary recommendations should be reviewed and verified by Leighton Consulting, Inc. during construction, and revised accordingly if geotechnical conditions encountered vary from our findings and interpretations. Geotechnical observation and testing should be provided:

- After completion of site demolition and clearing,
- During over-excavation of compressible soil,
- During compaction of all fill materials,
- After excavation of all footings and prior to placement of concrete,
- During utility trench backfilling and compaction, and
- When any unusual conditions are encountered.

Additional geotechnical exploration and analysis may be required based on final development plans, for reasons such as significant changes in proposed structure locations/footprints. We should review grading (civil) and foundation (structural) plans, and comment further on geotechnical aspects of this project.

6.0 LIMITATIONS

This report was based in part on data obtained from a limited number of observations, site visits, soil excavations, samples and tests. Such information is, by necessity, incomplete. The nature of many sites is such that differing soil or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, our findings, conclusions and recommendations presented in this report are based on the assumption that we (Leighton Consulting, Inc.) will provide geotechnical observation and testing during construction as the Geotechnical Engineer of Record for this project. Please refer to Appendix E, GBA's *Important Information About This Geotechnical-Engineering Report*, prepared by the Geoprofessional Business Association (GBA) presenting additional information and limitations regarding geotechnical engineering studies and reports.

This report was prepared for the sole use of Client and their design team, for application to design of the proposed maintenance building, in accordance with generally accepted geotechnical engineering practices at this time in California. Any unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify Leighton Consulting, Inc. from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of Leighton Consulting, Inc.

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Project: 12624.001	Eng/Geol: SIS/RFR
Scale:1 " = 2,000 '	Date: June 2020

Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton
Author: (kmanc)

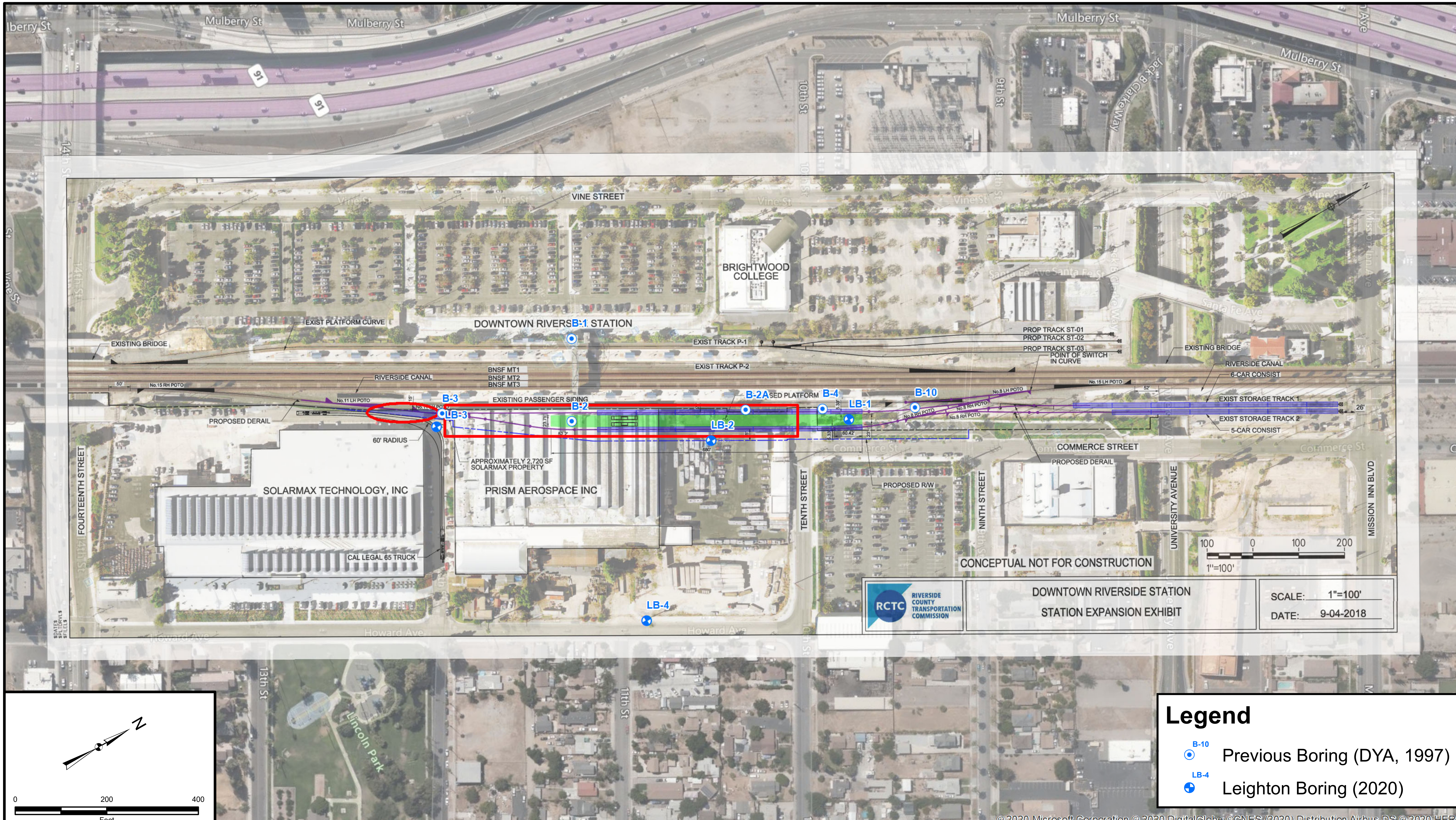
SITE LOCATION MAP

Riverside Downtown Station Expansion
Track & Platform Project (MP 9.9 to MP 10.2)
Riverside, California

Figure 1

Leighton

Map Saved as V:\drafting\12624\001\GIS\12624.001_Figure1_SLM.mxd on 3/12/2020 2:35:45 PM



Project: 12624.001	Eng/Geol: SIS/RFR
Scale: 1 " = 200 '	Date: June 2020

Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton
Author: (kmanc)

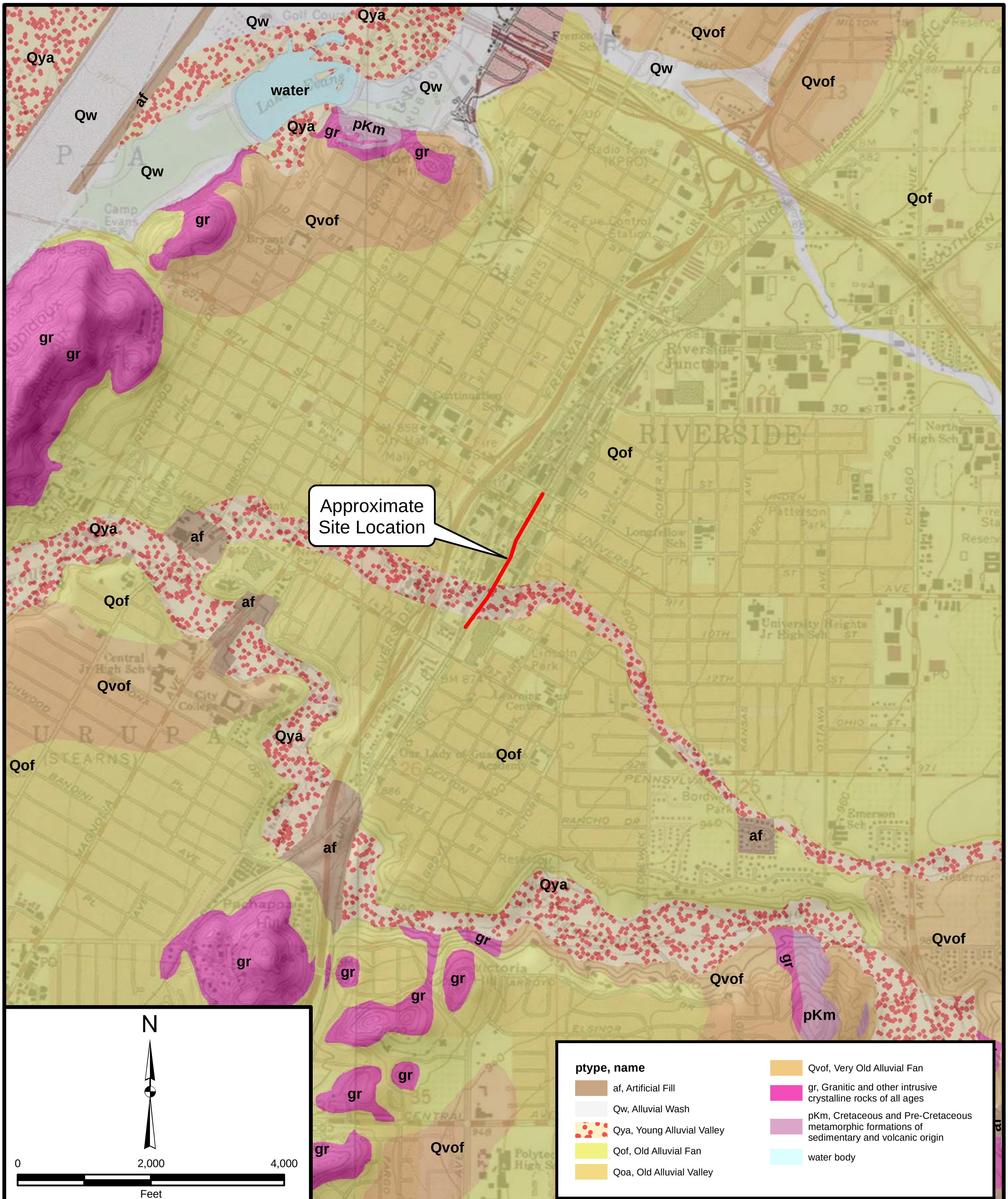
BORING LOCATION MAP

Riverside Downtown Station Expansion
Track & Platform Project (MP 9.9 to MP 10.2)
Riverside, California

Figure 2

Leighton

Map Saved as V:\drafting\12624\001\GIS\22624.001_Figure1_BLM.mxd on 3/12/2020 2:49:00 PM



Project: 12624.001	Eng/Geol: SIS/RFR
Scale:1 " = 2,000 '	Date: June 2020

Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton
Author: (kmanchikanti)

REGIONAL GEOLOGY MAP

Riverside Downtown Station Expansion
Track & Platform Project (MP 9.9 to MP 10.2)
Riverside, California

Figure 3

Leighton

Map Saved as V:\Drafting\12624\001\GIS\12624.001_Fig3_RGM.mxd on 3/16/2020 9:07:48 AM

APPENDIX A

LOGS OF EXPLORATORY BORINGS

Encountered earth materials were logged and sampled in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D 2488). Representative soil samples were transported to our in-house Temecula laboratory for geotechnical testing. After logging and sampling, our borings were backfilled with spoils generated during drilling.

The attached subsurface exploration logs and related information depict subsurface conditions only at the locations indicated and at the particular date designated on these logs. Subsurface conditions at other locations may differ from conditions occurring at these logged locations. Passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on these logs represent an approximate boundary between sampling intervals and soil types; and transitions may be gradual.

GEOTECHNICAL BORING LOG LB-1

Project No.	12624.001	**Date Drilled**	2-28-20
Project	RCTC Downtown Station Expansion	**Logged By**	BSS
Drilling Co.	2R Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	NA'
Location	See Boring Location Map	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				SM	**Young Alluvium (Qya):** SILTY SAND with GRAVEL, dense, dark brown, moist, fine sand	
				R-1	21 12 12	119	12	SC	CLAYEY SAND, medium dense, light brown, moist, fine sand, trace gravel	
	5			R-2	10 21 31	123	12	SC-SM	**Old Alluvium (Qof):** SILTY, CLAYEY SAND, dense, light brown, moist, fine sand	
	10			R-3	22 26 30				dense, light reddish brown, moist, fine to medium sand	
	15			R-4	9 13 18	106	5	SP	Poorly graded SAND, medium dense, reddish brown, moist, fine sand, few gravel, trace silt	
	20			R-5	21 38 50-5"			SM	SILTY SAND, very dense, light reddish brown, moist, fine sand, some calcium carbonate	
									Drilled to 20' Sampled to 21.5' Groundwater not encountered Backfilled with soil cuttings (2/28/20)	
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-2

Project No.	12624.001	**Date Drilled**	2-28-20
Project	RCTC Downtown Station Expansion	**Logged By**	BSS
Drilling Co.	2R Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	NA'
Location	See Boring Location Map	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0								3 inches Asphalt over 4.5 inches Base	
				B-1				SM	**Artificial Fill/Young Alluvium (Qya):** SILTY SAND, medium dense, light brown, slightly moist, fine sand, (SA: 32% fines, 3% gravel)	SA
	5			R-1	18 33 50-5"	107	8		dense, light brown, moist, fine sand	
				R-2	14 21 30				dense, light brown, moist, fine sand, more silt	
	10			R-3	14 18 20	100	8		medium dense, light brown, moist, fine sand	
									Old Alluvium (Qof):	
	15			R-4	2 4 7	105	5	SC-SM	SILTY, CLAYEY SAND, loose, reddish brown, moist, fine to medium sand, (CO = -1.11%)	CO
	20			R-5	3 6 7	123	3	SP	Poorly graded SAND, loose, light reddish brown, moist, fine sand, some coarse sand and fine gravel	
								SC	CLAYEY SAND, loose, dark reddish brown, moist, fine sand	
	25			R-6	10 20 29	119	13		dense, dark reddish brown, moist, fine sand, few medium sand	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-2

Project No.	12624.001	**Date Drilled**	2-28-20
Project	RCTC Downtown Station Expansion	**Logged By**	BSS
Drilling Co.	2R Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	NA'
Location	See Boring Location Map	**Sampled By**	BSS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	30			R-7	10 15 17	124	10	SC-SM	SILTY, CLAYEY SAND, medium dense, dark reddish brown, moist, fine to medium sand, few fine gravel	
	35			R-8	19 30 40			SP	Poorly graded SAND, dense, light reddish brown, moist, fine sand, few coarse sand	
									Drilled to 35' Sampled to 36.5' Groundwater not encountered Backfilled with bentonite chips at 32', some mixed with cuttings at 15', and asphalt patch on top (2/28/20)	
	40									
	45									
	50									
	55									
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-3

Project No.	12624.001	**Date Drilled**	2-28-20
Project	RCTC Downtown Station Expansion	**Logged By**	BSS
Drilling Co.	2R Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	NA'
Location	See Boring Location Map	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								3 inches Asphalt over 9 inches Concrete	
				B-1				SC-SM	**Young Alluvium (Qya):** SILTY, CLAYEY SAND, medium dense, dark reddish brown, moist, fine sand, few gravel (MD: 132.6 @ 8.8%, RV = 23, EI = 0)	MD, RV, EI, CR
	5			R-1	5 5 7	110	13	SC	CLAYEY SAND, loose, dark brown, moist, fine sand, trace coarse sand, to Sandy CLAY	
	10			R-2	2 3 6	108	15		loose, dark reddish brown, moist, fine sand	
	15			R-3	19 37 48	118	11	SP-SM	**Old Alluvium (Qof):** Poorly graded SAND with SILT, dense, dark reddish brown, moist, fine sand, more sandy at the bottom	
	20			R-4	25 42 50-5"			SM	SILTY SAND, very dense, dark reddish brown, moist, fine to medium sand, few fine gravel	
									Drilled to 20' Sampled to 21.5' Groundwater not encountered Backfilled with soil cuttings and asphalt patch on top (2/28/20)	
	25									
	30									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-4

Project No.	12624.001	**Date Drilled**	2-28-20
Project	RCTC Downtown Station Expansion	**Logged By**	BSS
Drilling Co.	2R Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	NA'
Location	See Boring Location Map	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								5 inches Asphalt over 3 inches Base	
								SC-SM	<u>Young Alluvium (Qya):</u> SILTY, CLAYEY SAND, medium dense, reddish brown, moist, fine sand	
				R-1	3 5 6	114	5	SM	SILTY SAND, loose, light brown, moist, fine sand	
	5			R-2	4 5 7	99	7		loose, light brown, slightly moist, fine sand, few gravel (CO = -6.57%)	CO
	10			R-3	6 16 23			SP-SM	<u>Old Alluvium (Qof):</u> Poorly graded SAND with SILT, medium dense, dark reddish brown, moist, fine to medium sand	
	15			R-4	13 15 19	113	8	SC-SM	SILTY, CLAYEY SAND, medium dense, reddish brown, moist, fine sand	
									Drilled to 15' Sampled to 16.5' Groundwater not encountered Backfilled with soil cuttings and asphalt patch on top (2/28/20)	
	20									
	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

BORING LOCATION (feet): See Plate 2	ELEVATION AND DATUM (feet):
DRILLING EQUIPMENT: CME-75	DRILLING METHOD: Hollow Stem Auger
BORING DIAMETER (inches): 8	BORING DEPTH (feet): 82
DATE STARTED: 1/14/97	DATE COMPLETED: 1/14/97
SPT HAMMER DROP: 30 inches WT: 140 lbs	DRIVE HAMMER DROP: 30 inches WT: 140 lbs
LOGGED BY: JGS CHECKED BY: VRN	DRIVE SAMPLER DIAMETER (inches) ID: 2.5 OD: 3.0

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
							SILTY SAND (SM); light brown, moist, medium dense, fine-grained sand, few brick fragments, grass at surface, [FILL]						
	5			4 4 5	5		SILT with SAND (ML); brown, moist, firm, low plasticity, fine-grained sand, few brick fragments, asphalt and tar residues, trace fine-grained gravel, [FILL]	108	15				
	10			7 10 12	22		SILT (ML); brown, moist, hard, low plasticity, trace caliche						
	15			4 6 14	10		SILTY SAND (SM); brown, moist, loose to medium dense, fine- to coarse- grained sand						
	20			5 9 10	19		POORLY GRADED SAND with SILT (SP-SM); light brown, dry to moist, medium dense, fine- to coarse-grained sand					5	CA
	25			3 5 8	7		CLAYEY SAND (SC); dark brown, moist, loose, fine- to coarse-grained sand, low to medium plasticity clay	110	16				
							SILTY SAND (SM); brown, moist, medium dense, fine-						

185-01
SM

AMY
2/97

LOG OF BORING B- 1

Metrolink Downtown Station
Riverside, California

A2a

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				5 7 7	14		to medium-grained sand, trace coarse-grained sand						
							SANDY LEAN CLAY (CL); dark brown, moist, firm, low to medium plasticity, trace fine- to coarse-grained sand						
	35			4 7 11	9					36	17	70	
							SILTY SAND (SM); dark brown, moist, dense, fine- to coarse-grained sand						
	40			11 16 25	41		CLAYEY SAND (SC); dark brown, moist, dense, fine- to coarse-grained sand, low plasticity, trace fine gravel, interval of decomposed granite						
	45			14 19 50	35								
	50			9 13 12	34		SILTY SAND (SM); brown, moist, dense, fine- to coarse-grained sand						
	55			11 23 28	26		decreased coarse-grained sand content						
							SILTY SAND to POORLY GRADED SAND (SM\SP); light brown, moist, dense, fine- to medium- grained sand						
	60			13 20 25	45								
	65			18 31 34	18		increased coarse-grained sand content						

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				15 18 25	43		trace fine gravel						
							CLAYEY SAND (SC); dark brown, moist, dense, fine- to coarse-grained sand, low plasticity						
	75			37 39 50/5"			very dense						
	80			20 11 16	27		SILTY SAND (SM); dark brown, moist, medium dense, low plasticity, fine- grained sand						
							Bottom of boring at 82 feet. No groundwater encountered. Boring backfilled with soil cuttings.						
	85												
	90												
	95												
	100												
	105												

185-01
SM

AMY
2/97

LOG OF BORING B- 1

Metrolink Downtown Station
Riverside, California

A2c

BORING LOCATION (feet): See Plate 2	ELEVATION AND DATUM (feet):
DRILLING EQUIPMENT: Limited Access Rig	DRILLING METHOD: Hollow Stem Auger
BORING DIAMETER (inches): 6	BORING DEPTH (feet): 51
DATE STARTED: 1/21/97	DATE COMPLETED: 1/21/97
SPT HAMMER DROP: 30 inches WT: 140 lbs	DRIVE HAMMER DROP: 30 inches WT: 140 lbs
LOGGED BY: JGS CHECKED BY: VRN	DRIVE SAMPLER DIAMETER (inches) ID: 2.5 OD: 3.0

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
							Concrete, 6 inches						
							SILT (ML); light brown, dry to moist, very hard, low plasticity, trace debris (1/2 inch diamèter steel pipe, rusted and filled with soot), [FILL]						
	5			28 38 50	88								
				20 28 40	34		SILT with SAND (ML); brown, moist, very hard, low plasticity, fine- to medium-grained sand			26	2	76	DS
	10												
				9 14 21	18		hard, increased sand content						
	15												
				7 12 14	26		SILTY SAND (SM); brown, moist, medium dense, fine- to coarse-grained sand, micaceous					17	SA
	20												
				24 26 45	36		SILT with SAND (ML); dark brown, moist, very hard, low plasticity, fine- grained sand, micaceous						
	25												
				20 23 30	53		CLAYEY SAND (SC); dark brown, moist, very dense, low plasticity, fine- to medium-grained sand						

185-01
JGS

AMY
2/97

LOG OF BORING B- 2

Metrolink Downtown Station
Riverside, California

A3a

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				20 26 30	28		SILTY SAND (SM); dark brown, moist, medium dense, fine- to coarse-grained sand						
	35												
				12 14 14	28		increased white fine- to coarse-grained sand (decomposed granite) content						
	40												
				10 37 50	44		CLAYEY SAND (SC); dark brown, dense, fine- to coarse-grained sand, trace fine gravel, low plasticity clay						
	45												
							rig chatter						
				10 26 50	76		very dense, increased clay content in sampler tip						
	50												
							Bottom of boring at 51 feet. Drilling terminated due to drilling refusal. No groundwater encountered. Boring backfilled with soil cuttings. Surface patched with ready mix concrete.						
	55												
	60												
	65												

185-01
JGS

AMY
2/97

LOG OF BORING B- 2

Metrolink Downtown Station
Riverside, California

A3b

BORING LOCATION (feet): See Plate 2	ELEVATION AND DATUM (feet):
DRILLING EQUIPMENT: Limited Access Rig	DRILLING METHOD: Hollow Stem Auger
BORING DIAMETER (inches): 6	BORING DEPTH (feet): 3
DATE STARTED: 1/21/97	DATE COMPLETED: 1/21/97
SPT HAMMER DROP: 30 inches WT: 140 lbs	DRIVE HAMMER DROP: 30 inches WT: 140 lbs
LOGGED BY: JGS CHECKED BY: VRN	DRIVE SAMPLER DIAMETER (inches) ID: 2.5 OD: 3.0

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				6 8 14	11		Concrete, 4 inches						
							SANDY SILT (ML); dark brown, moist, firm, low plasticity, fine- grained sand	111	13	23	3	63	
							Boring terminated due to presence of a brick like object at 3 feet. No groundwater encountered. Boring backfilled with soil cuttings.						
	5												
	10												
	15												
	20												
	25												

185-01 AMY
SM 2/97

LOG OF BORING B- 3

Metrolink Downtown Station
Riverside, California

BORING LOCATION (feet): See Plate 2	ELEVATION AND DATUM (feet):
DRILLING EQUIPMENT: CME-75	DRILLING METHOD: Hollow Stem Auger
BORING DIAMETER (inches): 8	BORING DEPTH (feet): 17
DATE STARTED: 1/15/97	DATE COMPLETED: 1/15/97
SPT HAMMER DROP: 30 inches WT: 140 lbs	DRIVE HAMMER DROP: 30 inches WT: 140 lbs
LOGGED BY: JGS CHECKED BY: VRN	DRIVE SAMPLER DIAMETER (inches) ID: 2.5 OD: 3.0

Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				6 3 3	6		ASPHALT - 4 inches SILT with SAND (ML); olive brown, moist, firm, low plasticity silt, fine- grained sand						
				4 3 3	3		dark brown, soft, medium plasticity, fine- to medium-grained sand						DS
	5			4 8 11	10		SILTY SAND (SM); light olive brown, moist, loose to medium dense, fine- to medium-grained sand, trace fine gravel					43	
	10			3 7 9	16		SILT with SAND (ML); brown, moist, hard, low plasticity, fine- grained sand						
							SILTY SAND (SM); light olive brown, moist, loose, fine- to coarse-grained sand						
	15			3 5 6	6								
							Bottom of boring at 17 feet. No groundwater encountered. Boring backfilled with soil cuttings.						
	20												
	25												

185-01
JGS

AMY
2/97

LOG OF BORING B- 4

Page 1 of 1

Metrolink Downtown Station

Riverside, California

A5

BORING LOCATION (feet): See Plate 2	ELEVATION AND DATUM (feet):
DRILLING EQUIPMENT: CME-75	DRILLING METHOD: Hollow Stem Auger
BORING DIAMETER (inches): 8	BORING DEPTH (feet): 17
DATE STARTED: 1/15/97	DATE COMPLETED: 1/15/97
SPT HAMMER DROP: 30 inches WT: 140 lbs	DRIVE HAMMER DROP: 30 inches WT: 140 lbs
LOGGED BY: JGS CHECKED BY: VRN	DRIVE SAMPLER DIAMETER (inches) ID: 2.5 OD: 3.0

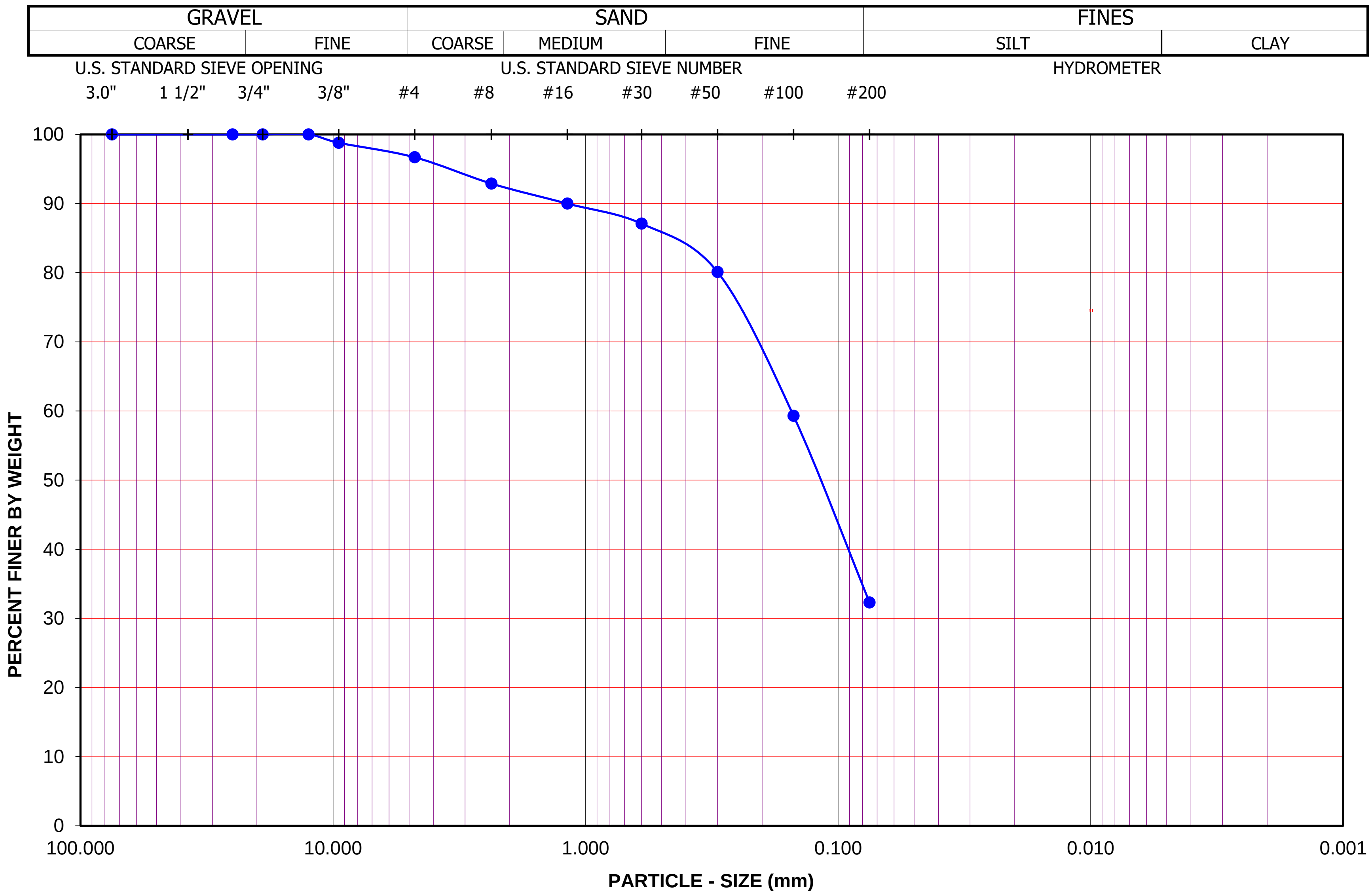
Elevation (feet)	Depth (feet)	Sampler	Symbol	Blows per 6 Inches	SPT N Blows per Foot	Field Unc. Comp. Str. (tsf)	DESCRIPTION	Dry Density (pcf)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve	Other Tests [PID]
				2 3 3	3		SILT with SAND (ML); dark brown, soft, low plasticity, fine- to medium-grained sand	105	13				
				1 1 1	2		decreased sand content						
	5			2 4 6	5		firm						
	10			11 19 16	35		CLAYEY SAND (SC); light brown, moist, dense, fine- to coarse-grained sand						
	15			3 7 7	7		loose, increased coarse-grained sand content						
							Bottom of boring at 17 feet. No groundwater encountered. Boring backfilled with soil cuttings.						
	20												
	25												

185-01 JGS	AMY 2/97	**LOG OF BORING B-10** Page 1 of 1 Metrolink Downtown Station Riverside, California

A9

APPENDIX B

RESULTS OF GEOTECHNICAL LABORATORY TESTING



Project Name: RCTC Downtown Station

Project No.: 12624.001

Boring No.: LB-2 Sample No.: B-1

Depth (feet): 0 - 5.0 Soil Type : SM

Soil Identification: Silty Sand (SM), Dark Yellowish Brown.

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 3 : 65 : 32

Mar-20

Sieve; LB-2, B-1 (02-28-20)

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	RCTC Downtown Station	Tested By:	F. Mina	Date:	03/03/20
Project No.:	12624.001	Input By:	M. Vinet	Date:	03/05/20
Boring No.:	LB-3	Depth (ft.):	1.0 - 5.0		
Sample No.:	B-1				
Soil Identification:	Silty, Clayey Sand (SC-SM), Dark Reddish Brown.				

Preparation Method: [X] Moist [ ] Dry — [X] Mechanical Ram [ ] Manual Ram

Mold Volume (ft³) 0.03340 — *Ram Weight = 10 lb.; Drop = 18 in.*

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	5588	5693	5750	5670		
Weight of Mold (g)	3572	3572	3572	3572		
Net Weight of Soil (g)	2016	2121	2178	2098		
Wet Weight of Soil + Cont. (g)	1563.2	1705.6	1663.2	1497.2		
Dry Weight of Soil + Cont. (g)	1499.5	1618.0	1547.5	1383.3		
Weight of Container (g)	277.8	420.8	332.9	415.0		
Moisture Content (%)	5.2	7.3	9.5	11.8		
Wet Density (pcf)	133.1	140.0	143.8	138.5		
Dry Density (pcf)	126.5	130.5	131.3	123.9		

Maximum Dry Density (pcf) 132.6 **Optimum Moisture Content (%)** 8.8

PROCEDURE USED

[X] **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

[ ] **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

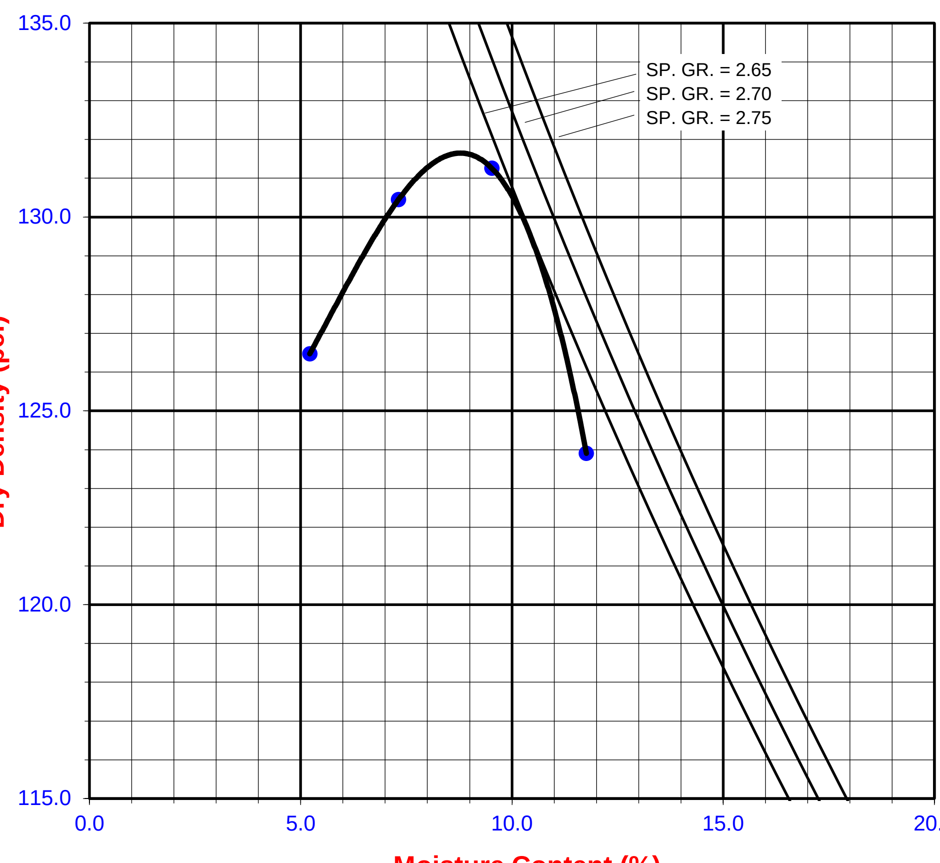
[ ] **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



Leighton

R-VALUE TEST RESULTS

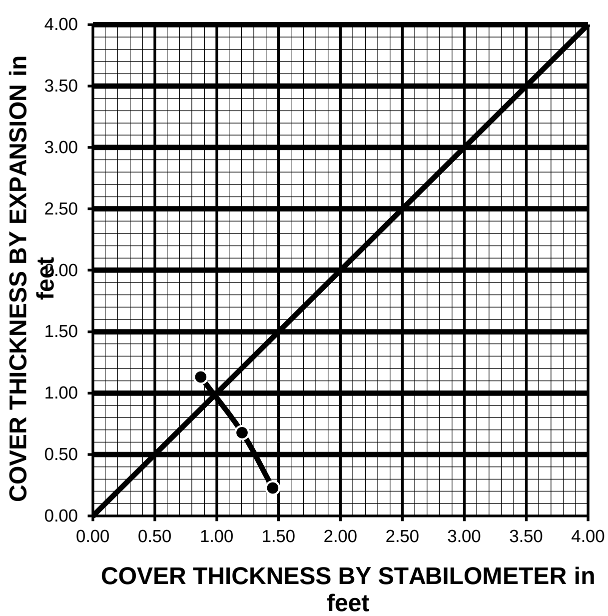
ASTM D 2844

Project Name:	RCTC Downtown Station	Date:	3/3/20
Project Number:	12624.001	Technician:	F. Mina
Boring Number:	LB-3	Depth (ft.):	1.0 - 5.0
Sample Number:	B-1	Sample Location:	N/A
Sample Description:	Silty, Clayey Sand (SC-SM), Dark Reddish Brown.		

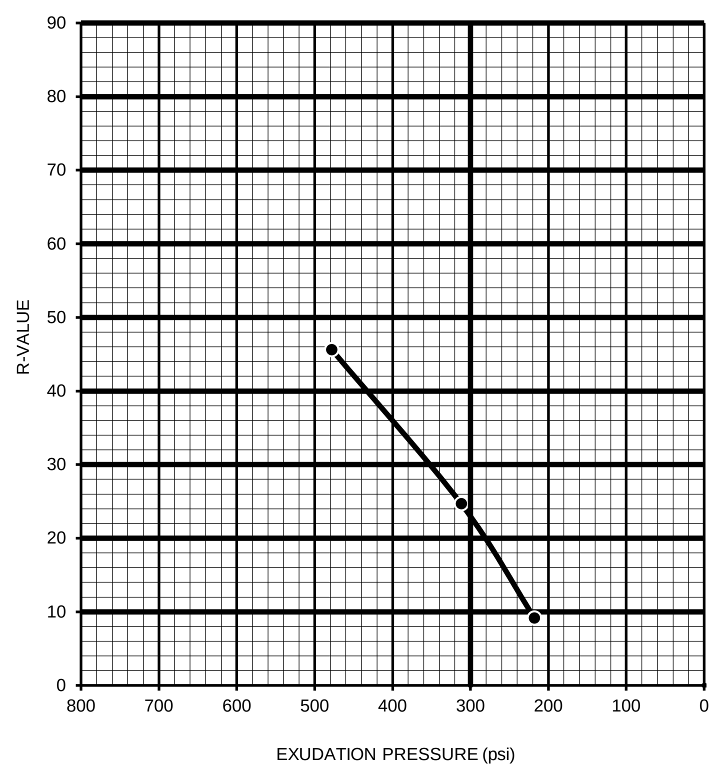
TEST SPECIMEN	A	B	C
MOISTURE AT COMPACTION %	11.1	12.2	13.3
HEIGHT OF SAMPLE, Inches	2.49	2.55	2.50
DRY DENSITY, pcf	112.4	113.4	112.5
COMPACTOR AIR PRESSURE, psi	125	100	75
EXUDATION PRESSURE, psi	478	312	218
EXPANSION, Inches x 10exp-4	30	18	6
STABILITY Ph 2,000 lbs (160 psi)	64	100	134
TURNS DISPLACEMENT	4.47	4.58	4.80
R-VALUE UNCORRECTED	46	25	9
R-VALUE CORRECTED	46	25	9

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.87	1.21	1.45
EXPANSION PRESSURE THICKNESS, ft.	1.13	0.68	0.23

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	38
R-VALUE BY EXUDATION:	23
EQUILIBRIUM R-VALUE:	23

Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	RCTC Downtown Station	Tested By:	F. Mina	Date:	3/3/20
Project No. :	12624.001	Checked By:	M. Vinet	Date:	3/5/20
Boring No.:	LB-3	Depth:	1.0 - 5.0		
Sample No. :	B-1	Location:	N/A		
Sample Description:	Silty, Clayey Sand (SC-SM), Dark Reddish Brown.				

Dry Wt. of Soil + Cont. (gm.)	2051.2
Wt. of Container No. (gm.)	0.0
Dry Wt. of Soil (gm.)	2051.2
Weight Soil Retained on #4 Sieve	36.6
Percent Passing # 4	98.2

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0003
Wt. Comp. Soil + Mold (gm.)	595.1	620.2
Wt. of Mold (gm.)	180.7	180.7
Specific Gravity (Assumed)	2.70	2.70
Container No.	7	7
Wet Wt. of Soil + Cont. (gm.)	350.1	620.2
Dry Wt. of Soil + Cont. (gm.)	326.6	381.9
Wt. of Container (gm.)	50.1	180.7
Moisture Content (%)	8.5	15.1
Wet Density (pcf)	125.0	132.5
Dry Density (pcf)	115.2	115.2
Void Ratio	0.463	0.464
Total Porosity	0.317	0.317
Pore Volume (cc)	65.5	65.6
Degree of Saturation (%) [S meas]	**49.5**	**87.8**

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h.

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
3/3/20	9:30	1.0	0	0.5000
3/3/20	9:40	1.0	10	0.5000
	Add Distilled Water to the Specimen			
3/4/20	6:00	1.0	1220	0.5003
3/4/20	7:00	1.0	1280	0.5003

Expansion Index (EI meas) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	0.3
Expansion Index (Report) = Nearest Whole Number or Zero (0) if Initial Height is > than Final Heigh	**0**

Rev. 03-08

One-Dimensional Swell or Settlement Potential of Cohesive Soils

(ASTM D 4546) -- Method 'B'

Leighton

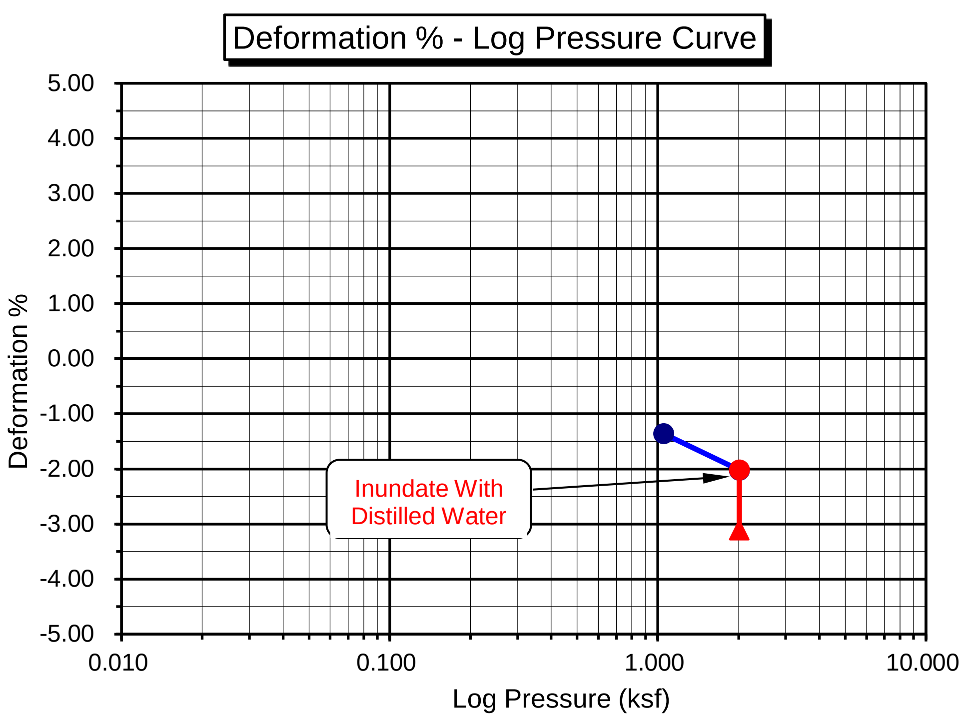
Project Name: RCTC Downtown Station — Tested By: M. Vinet — Date: 3/2/20
Project No.: 12624.001 — Checked By: M. Vinet — Date: 3/5/20
Boring No.: **LB-2** — Sample Type: IN SITU
Sample No.: **R-4** — Depth (ft.) 15.0
Sample Description: Silty Sand (SM), Reddish Brown.
Source and Type of Water Used for Inundation: Arrowhead (Distilled)
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	106.4
Initial Moisture (%):	6.3
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0000
Inside Diameter of Ring (in):	2.416

Final Dry Density (pcf):	109.8
Final Moisture (%) :	16.7
Initial Void ratio:	0.5847
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	28.9

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0136	0.9864	0.00	-1.36	0.5631	-1.36
2.013	0.0202	0.9798	0.00	-2.02	0.5527	-2.02
H2O	0.0311	0.9689	0.00	-3.11	0.5354	-3.11

Percent Swell / Settlement After Inundation = -1.11



One-Dimensional Swell or Settlement Potential of Cohesive Soils
(ASTM D 4546) -- Method 'B'

Leighton

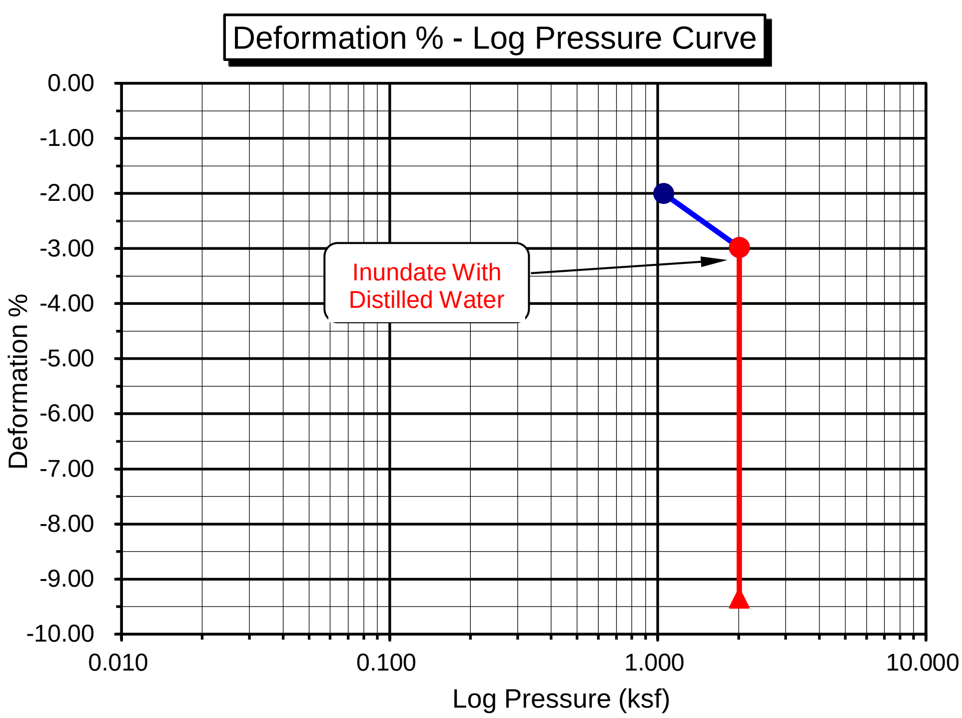
Project Name: RCTC Downtown Station
Tested By: M. Vinet Date: 3/2/20
Project No.: 12624.001
Checked By: M. Vinet Date: 3/5/20
Boring No.: LB-4
Sample Type: IN SITU
Sample No.: R-2
Depth (ft.) 5.0
Sample Description: Silty Sand (SM), Reddish Brown.
Source and Type of Water Used for Inundation: Arrowhead (Distilled)
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	98.7
Initial Moisture (%):	6.4
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0000
Inside Diameter of Ring (in):	2.416

Final Dry Density (pcf):	108.8
Final Moisture (%) :	18.9
Initial Void ratio:	0.7086
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	24.3

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0200	0.9800	0.00	-2.00	0.6744	-2.00
2.013	0.0298	0.9702	0.00	-2.98	0.6577	-2.98
H2O	0.0935	0.9065	0.00	-9.35	0.5488	-9.35

Percent Swell / Settlement After Inundation = -6.57



Rev. 01-10

SOIL RESISTIVITY TEST

DOT CA TEST 643

Leighton

Project Name:	RCTC Downtown Station	Tested By :	M. Vinet	Date:	03/04/20
Project No. :	12624.001	Data Input By:	M. Vinet	Date:	03/05/20
Boring No.:	LB-3	Depth (ft.) :	1.0 - 5.0		
Sample No. :	B-1				

Soil Identification:* Silty, Clayey Sand (SC-SM)

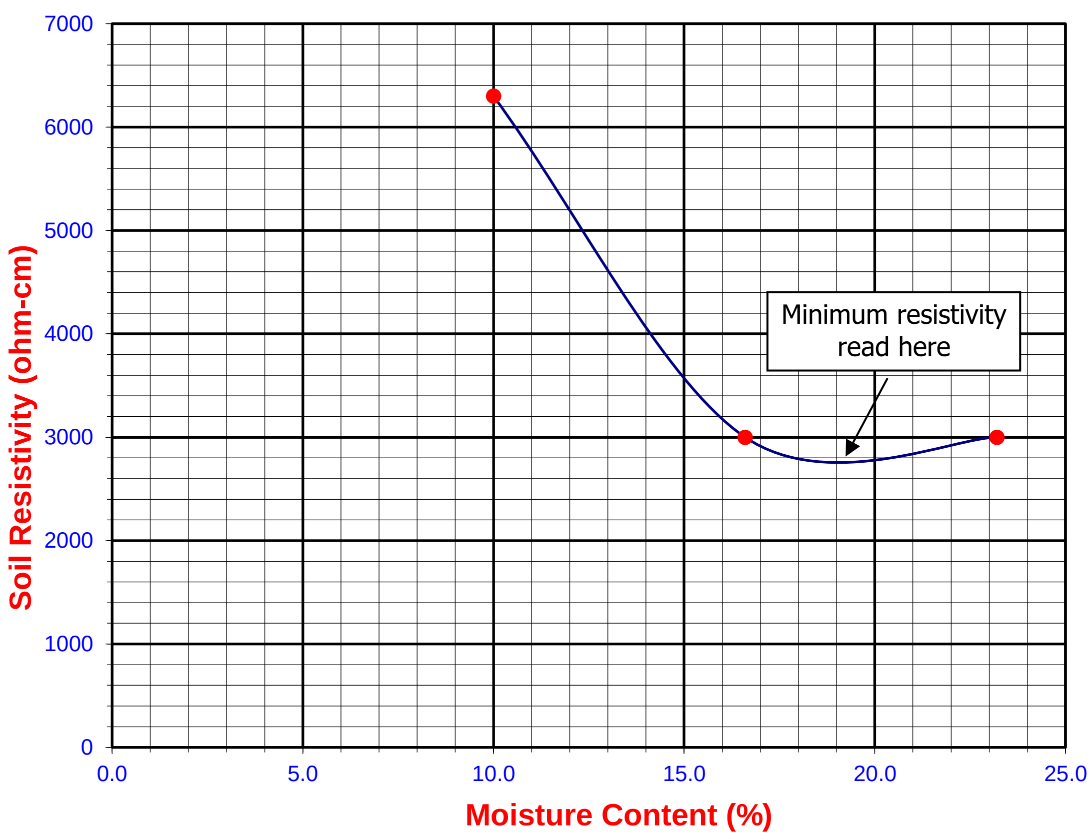
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	10.00	6300	6300
2	83	16.60	3000	3000
3	116	23.20	3000	3000
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	100.00
Dry Wt. of Soil + Cont. (g)	100.00
Wt. of Container (g)	0.00
Container No.	A
Initial Soil Wt. (g) (Wt)	500.00
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH: pH	Soil pH: Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2780	**19.0**	**193**	**140**	**7.29**	**21.0**



APPENDIX C

SITE-SPECIFIC ANALYSIS AND SETTLEMENT CALCUALTIONS

SUMMARY TABLE

Site-Specific Seismic Analysis (per ASCE 7-16)

	Site Seismic Coefficients / Coordinates	Value
	Latitude	33.9764
	Longitude	-117.3688
Mapped Spectra (OSHPD)	Spectral Response – Class D (short), S_S	1.50
	Spectral Response – Class D (1 sec), S_1	0.60
	Site Modified Peak Ground Acceleration, PGA_M	0.59
Site-Specific Response Spectra	Max. Considered Earthquake Spectral Response Acceleration (short), S_{MS}	1.50
	Max. Considered Earthquake Spectral Response Acceleration – (1 sec), S_{M1}	1.26
	5% Damped Design Spectral Response Acceleration (short), S_{DS}	1.00
	5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	0.84
	Site-Specific Peak Ground Acceleration, PGA	0.59

Probabilistic Response Spectrum					
Period (S)	**UHGM (g)**	**RTGM (g)**	**Max Dir SF**	**Max Dir RTGM (g)**	**Probabilistic Response (g)**
0.01	0.818	0.811	1.1	0.892	0.892
0.10	1.427	1.427	1.1	1.570	1.570
0.20	1.836	1.866	1.1	2.053	2.053
0.30	2.057	2.026	1.124	2.277	2.277
0.50	1.962	1.877	1.175	2.205	2.205
0.75	1.599	1.498	1.2375	1.854	1.854
1.00	1.336	1.234	1.3	1.604	1.604
2.00	0.767	0.691	1.35	0.933	0.933
3.00	0.534	0.476	1.4	0.666	0.666
4.00	0.402	0.354	1.45	0.513	0.513
5.00	0.314	0.276	1.5	0.414	0.414

Peak Sa	**Fa**	**1.2Fa**	**Peak Sa < 1.2Fa**	**Deterministic Needed?**
2.277	1.0	1.2	NO	YES

UHGM - Obtained from Unified Hazard Maps
RTGM - Risk Target Ground Motion
DO NOT EDIT

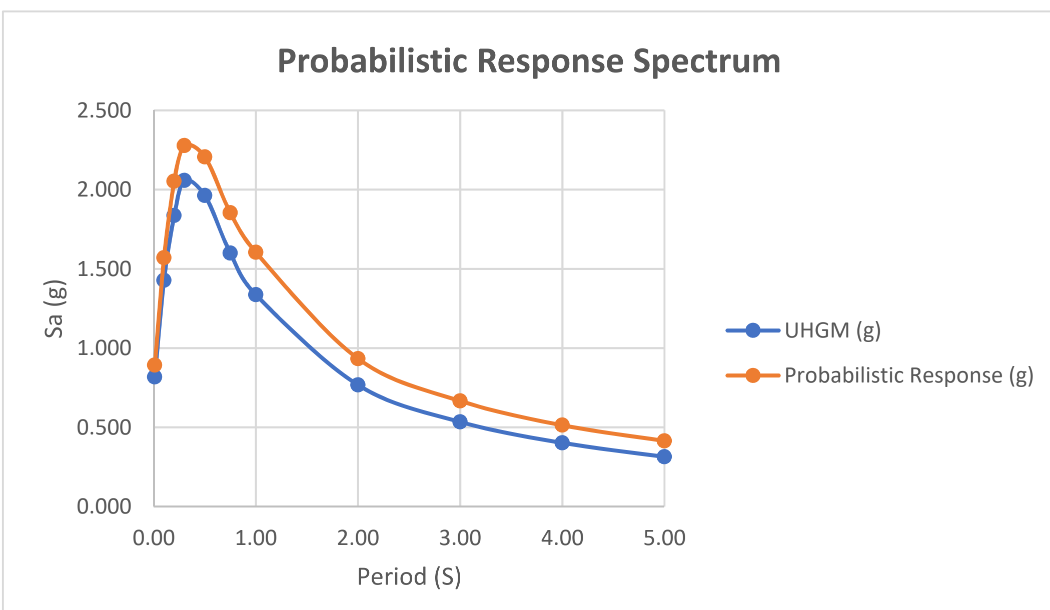


Exhibit S-2

Deterministic Response Spectrum				
Period (S)	**84th Percentile for 5% Damping**	**Max Dir SF**	**Max Dir Deterministic Sa**	**Scaled Max Dir Deterministic Sa**
0.01	0.589	1.1	0.648	0.648
0.1	0.881	1.1	0.969	0.969
0.2	1.190	1.1	1.309	1.309
0.3	1.385	1.124	1.557	1.557
0.5	1.422	1.175	1.671	1.671
0.75	1.144	1.2375	1.416	1.416
1	0.916	1.3	1.191	1.191
2	0.465	1.35	0.628	0.628
3	0.297	1.4	0.416	0.416
4	0.209	1.45	0.304	0.304
5	0.158	1.5	0.237	0.237

Obatined from NGA West 2 GMPE Worksheet - UCERF3 fault

DO NOT EDIT

Peak Sa	**Fa**	**1.5Fa**	**Peak Sa < 1.5Fa**	**Scaling Factor**
1.671	1.0	1.5	NO	1.000

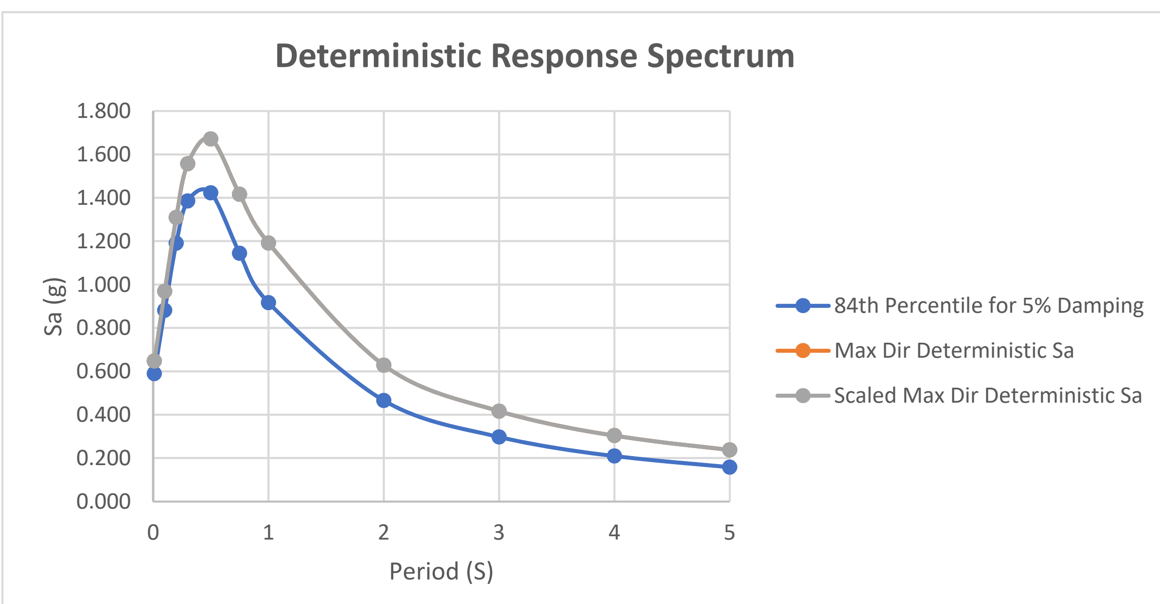


Exhibit S-3

SPECTRA COMPARISION				
Period (s)	**Probabilistic Response (g)**	**Scaled Max Dir Deterministic Sa (g)**	**MCE_{R*} Response Spectra S_{aM} (g)**	**2/3 MCER Response Spectra Sa (g)**
0.01	0.892	0.648	0.648	0.432
0.1	1.570	0.969	0.969	0.646
0.2	2.053	1.309	1.309	0.873
0.3	2.277	1.557	1.557	1.038
0.5	2.205	1.671	1.671	1.114
0.75	1.854	1.416	1.416	0.944
1	1.604	1.191	1.191	0.794
2	0.933	0.628	0.628	0.419
3	0.666	0.416	0.416	0.277
4	0.513	0.304	0.304	0.202
5	0.414	0.237	0.237	0.158

MCER* is the lesser of the prbabilitic and deterministic spectra

DO NOT EDIT

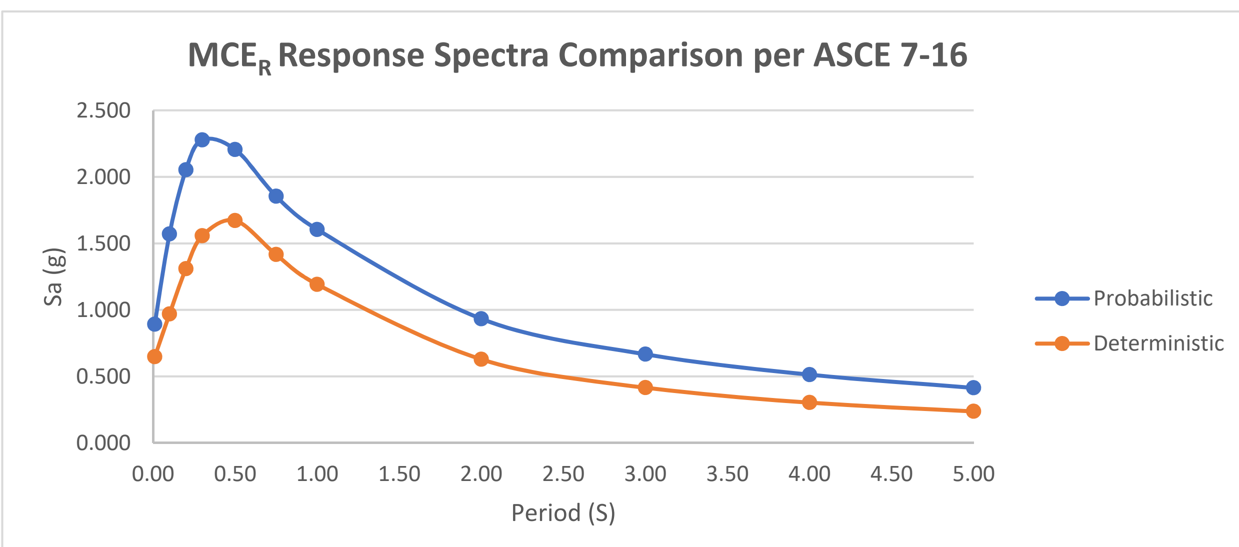


Exhibit S-4

S_s	1.500
S_1	0.600
Fa	1
Fv	2.5
S_{MS}	1.500
S_{M1}	1.500
S_{DS}	1.000
S_{D1}	1.000

since S_1 >0.2

T_0	0.2
T_S	1

PGA	0.536
PGA_M	0.589

Period (S)	Code-Based Sa (g)	80% Code-Based Sa (g)	2/3 MCER Response Spectra Sa (g)	Design Response Spectra Sa (g)
0.01	0.430	0.344	0.432	0.432
0.10	0.700	0.560	0.646	0.646
0.20	1.000	0.800	0.873	0.873
0.30	1.000	0.800	1.038	1.038
0.50	1.000	0.800	1.114	1.114
0.75	1.000	0.800	0.944	0.944
1.00	1.000	0.800	0.794	0.800
2.00	0.500	0.400	0.419	0.419
3.00	0.333	0.267	0.277	0.277
4.00	0.250	0.200	0.202	0.202
5.00	0.200	0.160	0.158	0.160

FROM SEISMIC MAPS (ATC OR OSHPD)

DO NOT EDIT

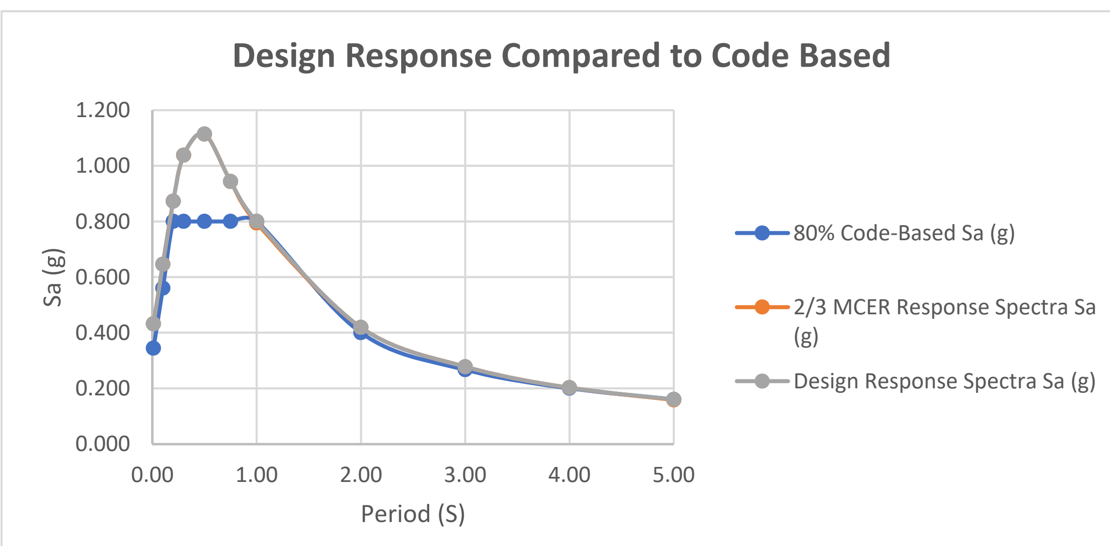


Exhibit S-5

Period (s)	MCER* Response Spectra SaM (g)	Design Response Spectra Sa (g)
0.01	0.648	0.432
0.10	0.969	0.646
0.20	1.309	0.873
0.30	1.557	1.038
0.50	1.671	1.114
0.75	1.416	0.944
1.00	1.191	0.800
2.00	0.628	0.419
3.00	0.416	0.277
4.00	0.304	0.202
5.00	0.237	0.160

Max Sa between T=0.2s and 5s is **1.114**

S_{DS} = 0.9*Max Sa = **1.003**
S_{MS} = 1.5*S_{DS} = **1.504**

Short Period Spectrum

V_{S30} = 259 ms < 365 m/s **Site Class D**

Max T*S_a between T=1s and 5s is **0.838**

Therefore, S_{D1} = **0.838**
S_{M1} = 1.5*S_{D1} = **1.256**

Long Period Spectrum

Probabilistic PGA	**0.818**
Deterministic PGA	**0.589**
80% Code-Based PGA_M	**0.471**
Site-Specific PGA	**0.589**

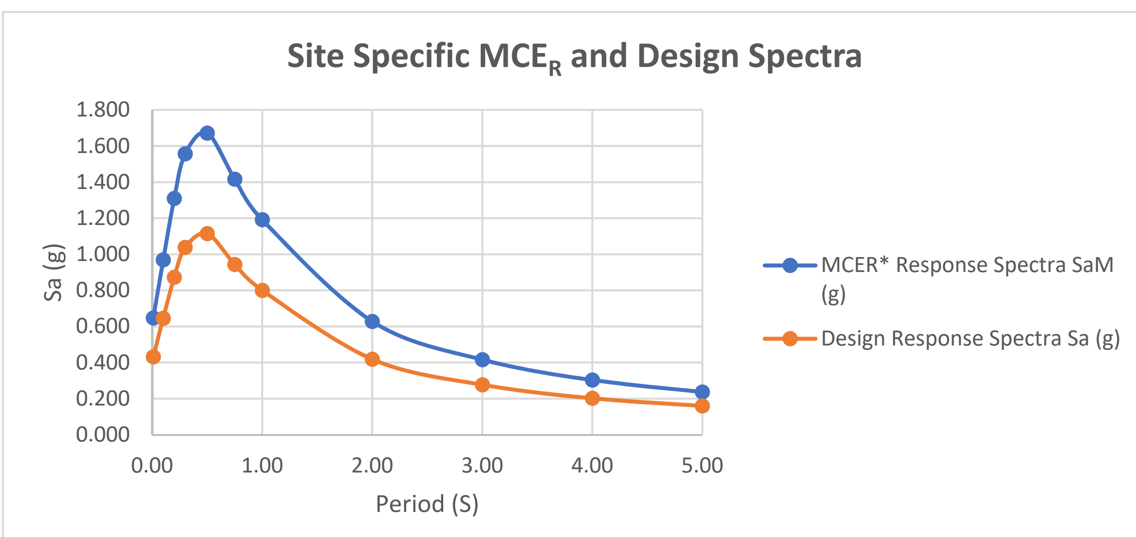


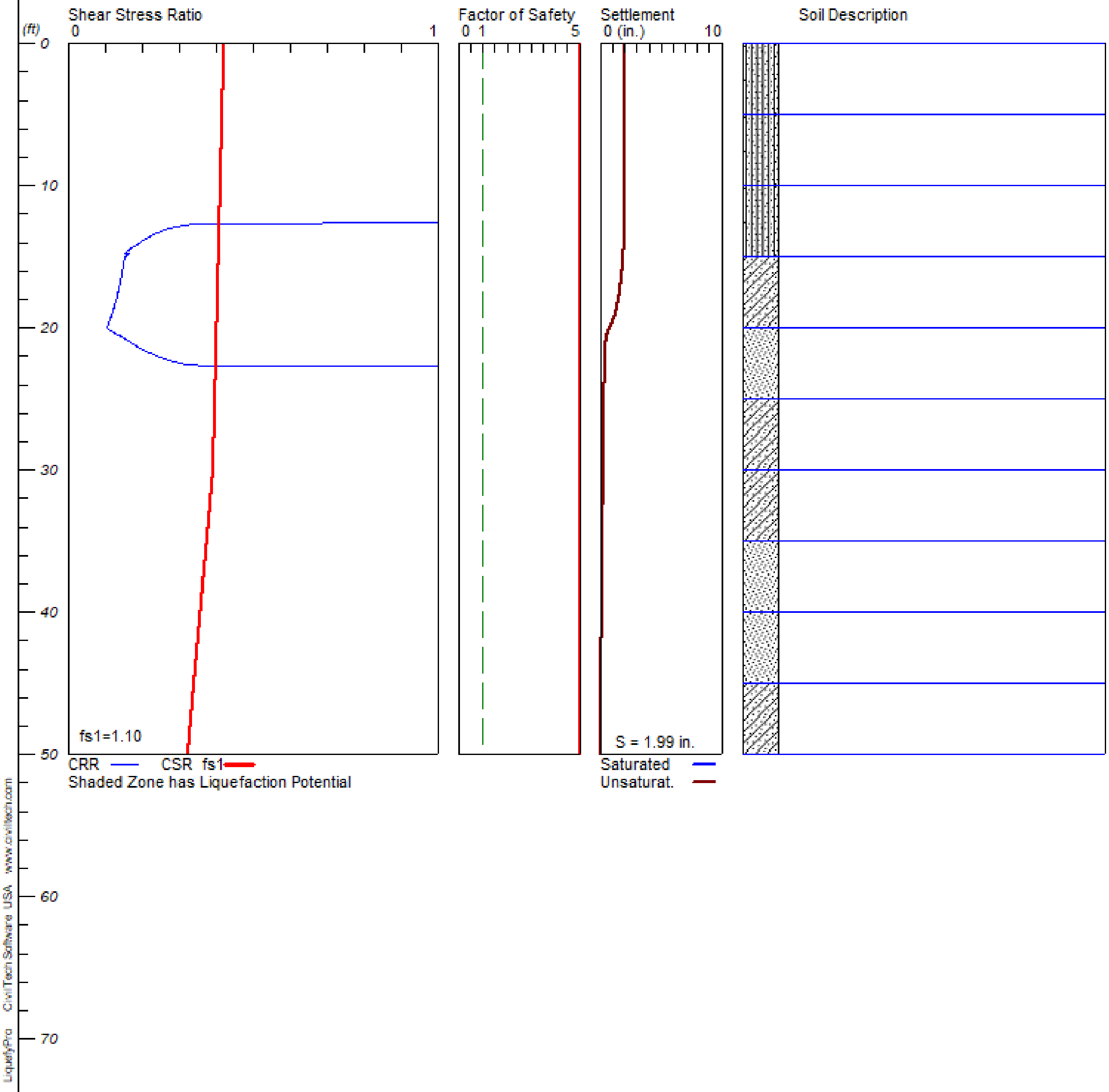
Exhibit S-6

LIQUEFACTION/SETTLEMENT ANALYSIS

RCTC Downtown Station

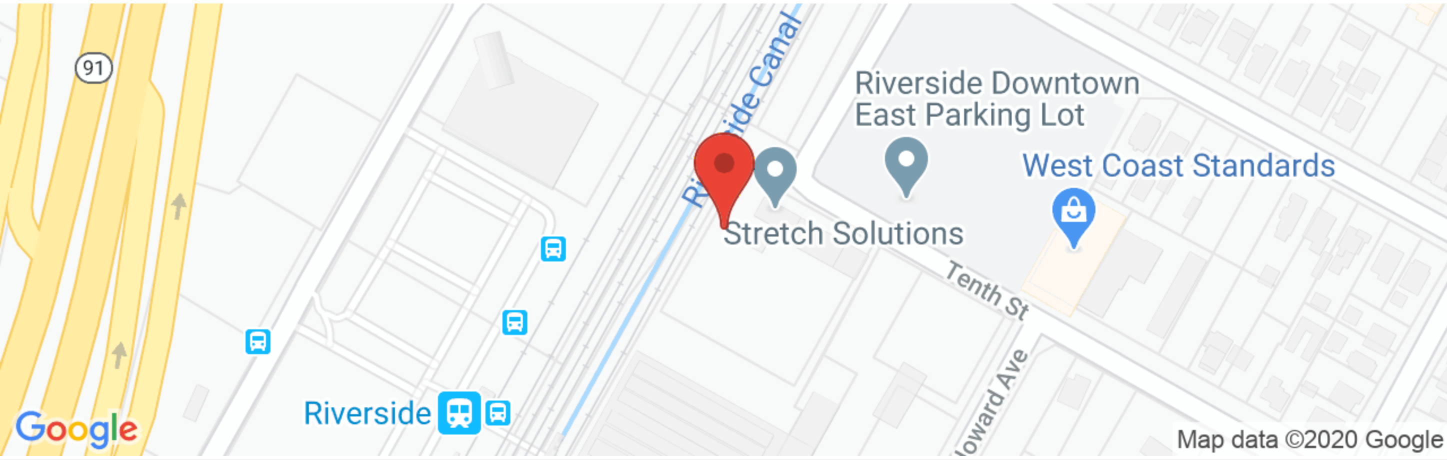
Hole No.=LB-2   Water Depth=100 ft

Magnitude=8.1
Acceleration=0.59g



RCTC Downtown Station

Latitude, Longitude: 33.9764, -117.3688



Date	3/17/2020, 9:15:34 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.5	MCE_R ground motion. (for 0.2 second period)
S_1	0.6	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.5	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.536	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.589	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.722	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.834	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.638	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.699	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.536	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.939	Mapped value of the risk coefficient at short periods
C_{R1}	0.913	Mapped value of the risk coefficient at a period of 1 s

****
LIQUEFACTION ANALYSIS SUMMARY

****

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Input File Name: P:\Leighton - Infocus\12000 - 12999\12624 RCTC On-Call Rails\001 Riverside Downtown Station HNTB TO-003\Analyses\LB-2.liq
Title: RCTC Downtown Station
Subtitle: 12624.001

Surface Elev.=
Hole No.=LB-2
Depth of Hole= 50.00 ft
Water Table during Earthquake= 100.00 ft
Water Table during In-Situ Testing= 100.00 ft
Max. Acceleration= 0.59 g
Earthquake Magnitude= 8.10

Input Data:
Surface Elev.=
Hole No.=LB-2
Depth of Hole=50.00 ft
Water Table during Earthquake= 100.00 ft
Water Table during In-Situ Testing= 100.00 ft
Max. Acceleration=0.59 g
Earthquake Magnitude=8.10
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. SPT or BPT Calculation.
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Idriss/Seed
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio,   Ce = 1.25
7. Borehole Diameter,   Cb= 1.15
8. Sampling Method,   Cs= 1
9. User request factor of safety (apply to CSR) ,   User= 1.1
   Plot one CSR curve (fs1=User)
10. Use Curve Smoothing: Yes*
* Recommended Options

In-Situ Test Data:

Depth ft	SPT	gamma pcf	Fines %
0.00	50.00	116.00	32.00
5.00	50.00	116.00	32.00
7.00	31.00	108.00	32.00
10.00	23.00	108.00	32.00
15.00	7.00	110.00	30.00
20.00	8.00	127.00	10.00
25.00	30.00	134.00	30.00
30.00	20.00	136.00	30.00
35.00	43.00	135.00	10.00
40.00	28.00	130.00	25.00
45.00	44.00	135.00	25.00
50.00	76.00	135.00	25.00

Output Results:

Settlement of Saturated Sands=0.00 in.
Settlement of Unsaturated Sands=1.99 in.
Total Settlement of Saturated and Unsaturated Sands=1.99 in.
Differential Settlement=0.997 to 1.316 in.

Depth ft	CRRm	CSRfs	F.S.	S_sat. in.	S_dry in.	S_all in.
0.00	1.64	0.42	5.00	0.00	1.99	1.99
1.00	1.64	0.42	5.00	0.00	1.99	1.99
2.00	1.64	0.42	5.00	0.00	1.99	1.99
3.00	1.64	0.42	5.00	0.00	1.99	1.99
4.00	1.64	0.42	5.00	0.00	1.99	1.99
5.00	1.64	0.42	5.00	0.00	1.99	1.99
6.00	1.64	0.42	5.00	0.00	1.98	1.98
7.00	1.64	0.41	5.00	0.00	1.98	1.98
8.00	1.64	0.41	5.00	0.00	1.98	1.98
9.00	1.64	0.41	5.00	0.00	1.98	1.98
10.00	1.64	0.41	5.00	0.00	1.97	1.97
11.00	1.64	0.41	5.00	0.00	1.97	1.97
12.00	1.64	0.41	5.00	0.00	1.96	1.96
13.00	0.28	0.41	5.00	0.00	1.95	1.95
14.00	0.19	0.41	5.00	0.00	1.92	1.92
15.00	0.15	0.41	5.00	0.00	1.86	1.86
16.00	0.15	0.41	5.00	0.00	1.77	1.77
17.00	0.14	0.41	5.00	0.00	1.64	1.64
18.00	0.13	0.40	5.00	0.00	1.46	1.46
19.00	0.12	0.40	5.00	0.00	1.19	1.19
20.00	0.10	0.40	5.00	0.00	0.73	0.73
21.00	0.17	0.40	5.00	0.00	0.40	0.40
22.00	0.24	0.40	5.00	0.00	0.34	0.34

23.00	1.64	0.40	5.00	0.00	0.32	0.32
24.00	1.64	0.40	5.00	0.00	0.30	0.30
25.00	1.64	0.40	5.00	0.00	0.30	0.30
26.00	1.64	0.40	5.00	0.00	0.29	0.29
27.00	1.64	0.40	5.00	0.00	0.28	0.28
28.00	1.65	0.39	5.00	0.00	0.27	0.27
29.00	1.64	0.39	5.00	0.00	0.25	0.25
30.00	1.63	0.39	5.00	0.00	0.23	0.23
31.00	1.61	0.39	5.00	0.00	0.20	0.20
32.00	1.60	0.39	5.00	0.00	0.19	0.19
33.00	1.59	0.38	5.00	0.00	0.18	0.18
34.00	1.58	0.38	5.00	0.00	0.16	0.16
35.00	1.57	0.38	5.00	0.00	0.15	0.15
36.00	1.56	0.37	5.00	0.00	0.14	0.14
37.00	1.56	0.37	5.00	0.00	0.13	0.13
38.00	1.55	0.36	5.00	0.00	0.12	0.12
39.00	1.54	0.36	5.00	0.00	0.10	0.10
40.00	1.53	0.36	5.00	0.00	0.08	0.08
41.00	1.52	0.35	5.00	0.00	0.07	0.07
42.00	1.51	0.35	5.00	0.00	0.06	0.06
43.00	1.50	0.35	5.00	0.00	0.05	0.05
44.00	1.49	0.34	5.00	0.00	0.04	0.04
45.00	1.49	0.34	5.00	0.00	0.03	0.03
46.00	1.48	0.34	5.00	0.00	0.03	0.03
47.00	1.47	0.33	5.00	0.00	0.02	0.02
48.00	1.46	0.33	5.00	0.00	0.01	0.01
49.00	1.45	0.33	5.00	0.00	0.01	0.01
50.00	1.44	0.32	5.00	0.00	0.00	0.00

* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft; Settlement = in.

_
1 atm (atmosphere) = 1 tsf (ton/ft2)

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

APPENDIX D

EARTHWORK AND GRADING SPECIFICATIONS

APPENDIX D

LEIGHTON CONSULTING, INC.
EARTHWORK AND GRADING GUIDE SPECIFICATIONS

TABLE OF CONTENTS

D-1.0 GENERAL

D-1.1 <u>Intent</u>

These Earthwork and Grading Guide Specifications are for grading and earthwork shown on the current, approved grading plan(s) and/or indicated in the Leighton Consulting, Inc. geotechnical report(s). These Guide Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the project-specific recommendations in the geotechnical report shall supersede these Guide Specifications. Leighton Consulting, Inc. shall provide geotechnical observation and testing during earthwork and grading. Based on these observations and tests, Leighton Consulting, Inc. may provide new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

D-1.2 <u>Role of Leighton Consulting, Inc.</u>

Prior to commencement of earthwork and grading, Leighton Consulting, Inc. shall meet with the earthwork contractor to review the earthwork contractor's work plan, to schedule sufficient personnel to perform the appropriate level of observation, mapping and compaction testing. During earthwork and grading, Leighton Consulting, Inc. shall observe, map, and document subsurface exposures to verify geotechnical design assumptions. If observed conditions are found to be significantly different than the interpreted assumptions during the design phase, Leighton Consulting, Inc. shall inform the owner, recommend appropriate changes in design to accommodate these observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include (1) natural ground after clearing to receiving fill but before fill is placed, (2) bottoms of all "remedial removal" areas, (3) all key bottoms, and (4) benches made on sloping ground to receive fill.

Leighton Consulting, Inc. shall observe moisture-conditioning and processing of the subgrade and fill materials, and perform relative compaction testing of fill to determine the attained relative compaction. Leighton Consulting, Inc. shall provide *Daily Field Reports* to the owner and the Contractor on a routine and frequent basis.

D-1.3 <u>The Earthwork Contractor</u>

The earthwork contractor (Contractor) shall be qualified, experienced and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Guide

Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing grading and backfilling in accordance with the current, approved plans and specifications.

The Contractor shall inform the owner and Leighton Consulting, Inc. of changes in work schedules at least one working day in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that Leighton Consulting, Inc. is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish earthwork and grading in accordance with the applicable grading codes and agency ordinances, these Guide Specifications, and recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of Leighton Consulting, Inc., unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, adverse weather, etc., are resulting in a quality of work less than required in these specifications, Leighton Consulting, Inc. shall reject the work and may recommend to the owner that earthwork and grading be stopped until unsatisfactory condition(s) are rectified.

D-2.0 PREPARATION OF AREAS TO BE FILLED

D-2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies and Leighton Consulting, Inc.. Care should be taken not to encroach upon or otherwise damage native and/or historic trees designated by the Owner or appropriate agencies to remain. Pavements, flatwork or other construction should not extend under the “drip line” of designated trees to remain.

Leighton Consulting, Inc. shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 3 percent of organic materials (by dry weight: ASTM D 2974). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area. As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

D-2.2 Processing

Existing ground that has been declared satisfactory for support of fill, by Leighton Consulting, Inc., shall be scarified to a minimum depth of 6 inches (15 cm). Existing ground that is not satisfactory shall be over-excavated as specified in the following Section D-2.3. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

D-2.3 Overexcavation

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by Leighton Consulting, Inc. during grading. All undocumented fill soils under proposed structure footprints should be excavated

D-2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), (>20 percent grade) the ground shall be stepped or benched. The lowest bench or key shall be a minimum of 15 feet (4.5 m) wide and at least 2 feet (0.6 m) deep, into competent material as evaluated by Leighton Consulting, Inc.. Other benches shall be excavated a minimum height of 4 feet (1.2 m) into competent material or as otherwise recommended by Leighton Consulting, Inc.. Fill placed on ground sloping flatter than 5:1 (horizontal to vertical units), (<20 percent grade) shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

D-2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by Leighton Consulting, Inc. as suitable to receive fill. The Contractor shall obtain a written acceptance (*Daily Field Report*) from Leighton Consulting, Inc. prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys and benches.

D-3.0 FILL MATERIAL

D-3.1 Fill Quality

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by Leighton Consulting, Inc. prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to Leighton Consulting, Inc. or mixed with other soils to achieve satisfactory fill material.

D-3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 6 inches (15 cm), shall not be buried or placed in fill unless location, materials and placement methods are specifically accepted by Leighton Consulting, Inc.. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 feet (3 m) measured vertically from finish grade, or within 2 feet (0.61 m) of future utilities or underground construction.

D-3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section D-3.1, and be free of hazardous materials ("contaminants") and rock larger than 3-inches (8 cm) in largest dimension. All import soils shall have an Expansion Index (EI) of 20 or less and a sulfate content no greater than (≤) 500 parts-per-million (ppm). A representative sample of a potential import source shall be given to Leighton Consulting, Inc. at least four full working days before importing begins, so that suitability of this import material can be determined and appropriate tests performed.

D-4.0 FILL PLACEMENT AND COMPACTION

D-4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill, as described in Section D-2.0, above, in near-horizontal layers not exceeding 8 inches (20 cm) in loose thickness. Leighton Consulting, Inc. may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers, and only if the building officials with the appropriate jurisdiction approve. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

D-4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM) Test Method D 1557.

D-4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, each layer shall be uniformly compacted to not-less-than (≥) 90 percent of the maximum dry density as determined by ASTM Test Method D 1557. In some cases, structural fill may be specified (see project-specific geotechnical report) to be uniformly compacted to at-least (≥) 95 percent of the ASTM D 1557 modified Proctor laboratory maximum dry density. For fills thicker than (>) 15 feet (4.5 m), the portion of fill deeper than 15 feet below proposed finish grade shall be compacted to 95 percent of the ASTM D 1557 laboratory maximum density. Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

D-4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by back rolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet (1 to 1.2 m) in fill elevation, or by other methods producing satisfactory results acceptable to Leighton Consulting, Inc.. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of the ASTM D 1557 laboratory maximum density.

D-4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by Leighton Consulting, Inc.. Location and frequency of tests shall be at our field representative(s) discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

D-4.6 Compaction Test Locations

Leighton Consulting, Inc. shall document the approximate elevation and horizontal coordinates of each density test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that Leighton

Consulting, Inc. can determine the test locations with sufficient accuracy. Adequate grade stakes shall be provided.

D-5.0 EXCAVATION

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by Leighton Consulting, Inc. during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by Leighton Consulting, Inc. based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, then observed and reviewed by Leighton Consulting, Inc. prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by Leighton Consulting, Inc..

D-6.0 TRENCH BACKFILLS

D-6.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations. Work should be performed in accordance with Article 6 of the *California Construction Safety Orders*, 2009 Edition or more current (see also: http://www.dir.ca.gov/title8/sb4a6.html).

D-6.2 Bedding and Backfill

All utility trench bedding and backfill shall be performed in accordance with applicable provisions of the 2015 Edition of the *Standard Specifications for Public Works Construction* (Green Book). Bedding material shall have a Sand Equivalent greater than 30 (SE>30). Bedding shall be placed to 1-foot (0.3 m) over the top of the conduit, and densified by jetting in areas of granular soils, if allowed by the permitting agency. Otherwise, the pipe-bedding zone should be backfilled with Controlled Low Strength Material (CLSM) consisting of at least one sack of Portland cement per cubic-yard of sand, and conforming to Section 201-6 of the 2015 Edition of the *Standard Specifications for Public Works Construction* (Green Book). Backfill over the bedding zone shall be placed and densified mechanically to a minimum of 90 percent of relative compaction (ASTM D 1557) from 1 foot (0.3 m) above the top of the conduit to the surface. Backfill above the pipe zone shall **not** be jetted. Jetting of the bedding around the conduits shall be observed by Leighton Consulting, Inc. and backfill above the pipe zone (bedding) shall be observed and tested by Leighton Consulting, Inc..

D-6.3 Lift Thickness

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to Leighton Consulting, Inc. that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method, and only if the building officials with the appropriate jurisdiction approve.

APPENDIX E

GBA - IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will <u>not</u> likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

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