GEOTECHNICAL INVESTIGATION REPORT
PROPOSED BUILDING AT TORRANCE TRANSIT SITE
20500 MADRONA AVENUE
TORRANCE, CALIFORNIA, 90503

Prepared for:

City of Torrance
3350 Civic Center Drive, Suite 201
Torrance, CA 90503

Prepared by:

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Project No. LA-1493
January 22, 2021

City of Torrance
3350 Civic Center Drive, Suite 201
Torrance, CA 90503

January 22, 2021
GD Project No. LA-1493

Attention: Ms. Nina Schroeder

Subject: Geotechnical Investigation Report
Proposed Building at Torrance Transit Site
20500 Madrona Avenue
Torrance, CA, 90503

Dear Ms. Schroeder,

Group Delta is pleased to submit this geotechnical investigation report for the proposed Building to be constructed at Torrance Transit Site located at 20500 Madrona Avenue, Torrance, California. Our scope of work was conducted in general accordance with our proposal dated December 11, 2020 which was authorized by you on December 15, 2020.

We appreciate the opportunity to provide geotechnical services for this significant project. Should you have any questions regarding this report, or if we can be of further service, please do not hesitate to contact us.

Sincerely,

GROUP DELTA CONSULTANTS, INC.

REGISTERED PROFESSIONAL ENGINEER PIROOZ KASHIGHANDI GE 3104 GEOTECHNICAL STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER ASHEESH PRADHAN No. C 89285 CIVIL STATE OF CALIFORNIA

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Distribution: Addressee (1 electronic copy)

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20500 MADRONA AVENUE
TORRANCE, CALIFORNIA

1.0 INTRODUCTION

This report presents our geotechnical findings and recommendations for the foundation design of the proposed building planned at Torrance Transit Site located at 20500 Madrona Avenue. The project site location is shown on the vicinity map in Figure 1, and the exploration locations are shown in Figure 2.

1.1 Project Description

We understand that the City of Torrance is installing a prefabricated metal storage building, approximately 40' X 80', 3200 Square Feet for the Transit Department. The non-conditioned prefabricated City Services Building will be located at the City Yard, at 20500 Madrona Ave., Torrance, California.

The City intends to use the building as a warehouse for vehicles for protection in order to maximize their useful life, and as a future partial maintenance garage (later outfitted with maintenance equipment). The building would need to have a high enough ceiling to be able to lift a bus in the future, approximately 24 feet in height.

This report includes the findings of our recent geotechnical investigation and provides geotechnical recommendations for foundation design and grading for the proposed building.

1.2 Scope of Work

This investigation was performed to evaluate the static physical characteristics of the soils of the proposed site and to provide updated recommendations for the design of foundations and grading for the development. We evaluated the existing soil and groundwater conditions at the site, including the corrosion potential of the soils, and developed recommendations per our scope of work outlined in our proposal as follows.

- Review available published geotechnical and geologic reports, maps, and subsurface data for the site and surrounding area.
- Perform a geotechnical field investigation to evaluate subsurface conditions that included two (2) borings to depths of up to approximately 30 feet below the existing grade.
- Evaluate geologic and seismic hazards including surface fault rupture, ground shaking, liquefaction, and other considered geologic hazards.
- Provide geotechnical recommendations for site grading, including demolition of existing improvements; the needs and limits for removal of unsuitable soils;

excavations; shoring; reuse of excavated materials for fill and backfill; and placement of compacted fill, structural backfill, and utility backfill.

- Evaluate geotechnical data and perform geotechnical analyses to develop foundation recommendations for the proposed new construction.
- Prepare this geotechnical investigation report.

2.0 GEOTECHNICAL INVESTIGATION

2.1 Field Investigation

The subsurface conditions at this site were explored by drilling two boring to a depth of about 31.5 feet below grade at the locations shown on Figure 2.

The explorations were performed under the supervision of a Group Delta engineer, who maintained logs of the soils encountered, visually classified the material, and assisted in obtaining soil samples. Bulk samples of drill cuttings were collected at depths of approximately 0 to 5 feet. Standard Penetration Test (SPT) and California Modified Split Spoon samples were taken in the borings at 5-foot intervals. The soil samples were returned to our laboratory for further visual examination and testing.

Drill cuttings were placed in 55-gallon steel drums, borings were backfilled with grout upon completion of the borings.

Details of our field exploration program, including the boring logs, are presented in Appendix A.

2.2 Laboratory Testing Program

A laboratory testing program was performed on selected soil samples collected during our field investigation. The purpose of the laboratory tests is to classify soil samples and evaluate their physical properties and engineering characteristics. Laboratory testing performed includes the following:

- Moisture Content and Dry Unit Weight
- Grain Size Distribution
- Direct shear tests
- Soil Corrosivity
- R-Value
- Compaction
- Soil Corrosivity

Laboratory test results are included in Appendix B of this report.

3.0 SITE CONDITIONS

3.1 Surface Conditions

The site is located within the paved areas of the Torrance Transit Site. The site is fairly flat with surface elevations ranging between El. 111 and 112 feet.

The existing asphalt pavement was found to consist of approximately 5 inches of asphalt over 0 to 3 inches of base over poorly-graded sands.

3.2 Subsurface Materials

Existing fill was encountered in our exploration locations within the hand-auger zone and extends to a depth of about 2.5 feet. Any existing fill is considered to be uncertified and should be removed and replaced with properly compacted engineered fill. However, the quality and depth of uncertified fill is expected to vary across the site and could locally be deeper.

Below the fill, the site is underlain by native sandy alluvium. In general, the soils consist of consists fine grained silty sand, and poorly graded sands. The sands are medium dense to very dense, with interpreted SPT blow counts typically ranging from about 15 to 50, with some higher blow counts as high as 77.

3.3 Groundwater

Groundwater was not encountered during our field exploration. The State of California Division of Mines and Geology 1998 report "Seismic Hazard Evaluation of the Torrance 7.5-Minute Quadrangle" includes an evaluation of the historical shallowest groundwater level within the Torrance Quadrangle, which includes the subject site. The groundwater depth contour map indicates the depth to "the historically highest shallow groundwater in perched, semi-perched, and other water table settings." The groundwater depth contour map indicates that the shallowest historic groundwater level at the subject site is at a depth of 10 below existing grade.

4.0 GEOLOGIC AND SEISMIC HAZARD EVALUATION

4.1 Surface Fault Rupture

The site is not located in an Alquist-Priolo (AP) Special Study Fault Zone. Based on a literature review, no known active faults are mapped as crossing or projecting towards the site. The closest fault to the site is the Compton Fault located about 3.5 kilometers to the southwest direction. Therefore, the possibility of ground surface fault rupture at the site is considered low at this time.

4.2 Liquefaction and Lateral Spreading Potential

Liquefaction involves sudden loss in strength of a saturated, cohesionless soil (predominantly sand) caused by the build-up of pore water pressure during cyclic loading, such as that produced by an earthquake. This increase in pore water pressure can temporarily transform the soil into a fluid mass, resulting in vertical settlement and can also cause lateral ground deformations. Typically, liquefaction occurs in areas where there are loose sands and the depth to groundwater is less than 50 feet from the surface. Seismic shaking can also cause soil compaction and ground settlement without liquefaction occurring, including settlement of dry sands above the water table.

The site is note located within a State of California Liquefaction Hazard Zone (CDMG 1998). The site is predominantly underlain with medium dense to very dense sands that are generally not susceptible to liquefaction. Therefore, the potential for liquefaction and seismic compaction to occur at the site is negligible at this site.

Since liquefaction potential is negligible at the site, the potential of lateral spreading is also remote.

4.3 Landslides and Slope Stability

The site and surrounding vicinity are relatively level. There are no mapped landslides or potential earthquake induced landslide slopes at the site. The potential for landslide hazards at the site is negligible. The proposed development may require some excavation up to 5 feet in depth. With proper engineered shoring and/or laying back of cut slopes, the potential hazard of slope instability at the site is low.

4.4 Seismic Site Parameters

Seismic design parameters are obtained from the United States Geological Service (USGS) generic code-based seismic design maps webtool provided by the through the Office of Statewide Health Planning and Development (OSHPD) and the Structural Engineers Association of California (SEAOC) (https://seismicmaps.org/).

The site predominantly consists of sands are medium dense to very dense, with interpreted SPT blow counts typically ranging from about 15 to 50, with some higher blow counts as high as 77. Based on this available geotechnical information and Section 1613 of the 2019, the site is classified as Site Class D. Table 1 presents the mapped seismic design parameters at the site, based on Site Class D soil classification. The peak ground acceleration adjusted for site class, PGA_M at the site is 0.861g.

Table 1: Mapped Seismic Design Acceleration Parameters

Design Parameters	General Seismic Design Parameter (ASCE 7-16 Section 11.4)
S_s (g)	1.791
S_1 (g)	0.641
Site Class	D
F_a	1.0
F_v	1.7
S_{MS} (g)	1.791
S_{M1} (g)	1.089
S_{DS} (g)	1.194
S_{D1} (g)	0.786
T_s	0.608 s
T_L	8 s

Per Section 11.4.8 of ASCE 7-16, a site-specific ground motion hazard analysis is required for "structures on Site Class D and E sites with S_1 greater than or equal to 0.2", unless certain exceptions are met. Based on the site subsurface conditions and the mapped seismic demand ($S_1 > 0.2$), the mapped design acceleration parameters (presented in Table 1) can only be used if Exception 2 of ASCE 7-16 Section 11.4.8 is met, as follows:

- If $T \leq 1.5\ T_S$: The value of the seismic response coefficient C_S is determined by Eq. (12.8-2), i.e., S_{DS} is used to obtain C_S, or
- If $T_L \geq T > 1.5\ T_S$: The value of seismic response coefficient C_S is taken as *1.5 times* the value computed in Eq. (12.8-3), i.e., *1.5**S_{D1} is used to obtain C_S, or
- If $T > T_L$: The value of seismic response coefficient C_S is taken as *1.5 times* the value computed in Eq. (12.8-4), i.e., *1.5**S_{D1} is used to obtain C_S.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

Based on the findings of our field explorations and engineering analyses, it is our opinion that the proposed project is feasible from a geotechnical standpoint. Site grading should include the removal and replacement of any existing uncertified fill.

Following proper site grading, the structures can be supported on shallow footings and slab-on-grade. Geotechnical recommendations for site grading and foundation design are provided in the following sections.

5.2 Demolition

Prior to the start of earthwork, demolition will be required to remove existing improvements that may include existing pavement, etc. Any void created from the demolition should be properly backfilled to the limits determined by the project geotechnical engineer. The civil engineer should identify the presence and location of all existing utilities on and adjacent to the site. Precautions will be required to remove, relocate or protect any existing utilities, as appropriate.

5.3 Removals

Approximately 2.5 feet of uncertified fill was encountered during our investigation. It should be anticipated that old fill can be present anywhere on the property and the thickness of the fill can vary and locally can extend significantly deeper. Any existing fill should be considered to be uncertified and should not be used for support of new structures or pavement.

Any uncertified fill and any other unsuitable soils should be removed and recompacted with properly compacted fill, to the limits directed by the project geotechnical engineer. The recompaction should extend for a horizontal distance of 5 feet outside the building pad.

5.4 Excavations

Based on our investigation, we anticipate the excavations will be made in generally sandy materials and should be readily accomplished using conventional heavy construction equipment. The sandy soils onsite are generally classified as CAL/OSHA Type C soils.

If the excavation is exposed during periods of rainfall, provisions for collection of the runoff should be made. All surface drainage should be controlled and prevented from running down into the excavation. Ponding water should not be allowed within the excavation.

All excavation slopes and shoring systems should meet minimum requirements of the Occupational Safety and Health (OSHA) Standards. Maintaining safe and stable slopes on excavations is the responsibility of the contractor and will depend on the nature of the soils and groundwater conditions encountered and his method of excavation. Excavations during construction should be carried out in such a manner that failure or ground movement will not occur. The short-term stability of excavation depends on many factors, including slope angle, engineering characteristics of the subsurface materials, height of the excavation, and length of time the excavation remains unsupported and exposed to equipment vibrations, rainfall, and desiccation. The contractor should perform any additional studies deemed necessary to supplement the information contained in this report for the purpose of planning and executing his excavation plan. Recommendations regarding sloped temporary excavations are provided in the sections below.

Temporary excavation slopes in the near surface sandy soils may be made vertical for cuts of less than two (2) feet with some sloughing to be expected. Cuts higher than two (2) feet may be constructed at an angle of 1.5H:1V (horizontal to vertical ratio), or flatter.

Surcharge loads from equipment or stockpiled material should be kept behind the top of the temporary excavations a horizontal distance of at least twice the depth of the excavation. Surface drainage should be controlled and prevented from running down the slope face. Ponding water should not be allowed within the excavation. Even with the implementation of the above recommendations, some sloughing of slopes and unstable soil zones may still occur within temporary excavations, and workmen should be adequately protected. Construction equipment and foot traffic should be kept off excavation slopes to minimize disturbance/sloughing.

5.5 Earthwork and Grading

All grading should conform to the City of Torrance requirements, and the general grading recommendations outlined below.

1. The grading contractor is responsible for notifying the project geotechnical engineer of a pre-grading meeting prior to the start of grading operations and anytime that the operations are resumed after an interruption.

2. Prior to the start of earthwork, all existing improvements will require demolition. Existing utilities should be removed, relocated or protected, as appropriate.

3. Any uncertified fill and other unsuitable soils encountered during excavation should be removed and backfilled with properly compacted fill, as directed by the project geotechnical engineer. The actual limits for removals should be determined by the project geotechnical engineer depending on the actual conditions encountered.

4. The bottom of the completed excavation should be observed and evaluated by the project geotechnical engineer, as it is proof rolled with heavy equipment. Any loose or unstable soils should be over-excavated to the limits determined by the project geotechnical engineer.

5. The exposed bottoms of excavations for removals and pads for near-surface improvements should be scarified to a depth of 6 inches, moisture conditioned to the optimum moisture content. In structural areas, compaction should be to at least 95 percent relative compaction, as determined by ASTM D1557. In non-structural areas and landscape areas, compaction should be to at least 90 percent relative compaction.

6. Any fill or backfill placed under structures or pavement and any backfill placed adjacent to buried walls is "structural fill." New fill should be predominantly sandy soil, free of expansive clay, rock greater than 3 inches in maximum size, debris, and other deleterious materials. All structural fill and backfill should be placed in maximum 8-inch lifts, moisture conditioned to optimum moisture, and compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. Any fill or backfill placed in non-structural areas should be compacted to at least 90 percent of its maximum dry density.

7. In general, the soils that are expected to be excavated at the site are suitable for reuse onsite as fill or backfill. All fill soils should be approved by the project geotechnical engineer.

8. If the construction is performed during the rainy season, the spoil pile should be covered and protected from becoming wet. During construction provisions should be made to prevent surface runoff from draining into the excavation.

9. All earthwork and grading should be performed under the observation of the project geotechnical engineer, including approval of the bottom of excavations, removal of existing fill, foundation excavations, and placement of fill and backfill.

10. Compaction testing of the fill soils shall be performed at the discretion of the project geotechnical engineer. Testing should be performed for approximately every 2 feet in fill thickness or 2,000 cubic yards of fill placed, whichever occurs first. If specified compaction is not achieved, additional compactive effort, moisture conditioning, and/or removal and recompaction of the fill soils will be required.

11. If, in the opinion of the project geotechnical engineer, contractor, or owner, and unsafe condition is created or encountered during grading, all work in the area shall be stopped until measures can be taken to mitigate the unsafe condition. An unsafe condition shall be considered any condition that creates a danger to workers, on-site structures, on-site construction, or any off-site properties or persons.

12. All materials used for asphalt, concrete, and base shall conform to the "Green Book" and shall be compacted to at least 95 percent relative compaction.

5.6 Foundation Recommendations

Following proper site grading, including removal of any uncertified fill, the structure can be supported on shallow footings with slab-on-grade.

5.6.1 Bearing Capacity

An allowable bearing value of 3,000 psf can be used for design. If individual footings are used, they should be at least 2 feet wide and should extend a minimum depth of 1.5 feet below the lowest adjacent grade. The allowable bearing pressure can be increased by one-third for temporary loads associated with wind and seismic loading.

All foundation excavations should be checked by the project geotechnical engineer before the placement of reinforcing steel. Any loose or soft soils should be excavated and replaced with structural fill to the limits determined by the geotechnical engineer.

5.6.2 Settlement

The proposed prefabricated building is anticipated to be relatively lightly loaded. The static settlement is estimated to be 1 inch, or less. The differential settlement is estimated to be less than 0.5 inch over a horizontal distance of 30 feet.

5.6.3 Lateral Capacity

Resistance to lateral loads can be provided by friction developed between the bottom of footings and the supporting soil, and by the passive soil pressure developed on the face of the footing. For design purposes, an allowable passive fluid pressure of 300 pcf and an allowable coefficient of friction of 0.35 may be used for lateral sliding resistance of new footings placed in new fill or firm native soil. Both the allowable passive and frictional resistances may be combined in design without reduction. These resistance values include a factor of safety of about 1.5.

5.6.4 Slab on Grade

The slab on grade shall be supported on native soils, or properly compacted subgrade. On-grade concrete floor slabs shall be placed on a 4-inch fill of coarse aggregate or on a 2-inch sand bed over a moisture barrier membrane. In accordance with ACI 302.2R-06, the material must comply with the requirements of ASTM E 1745, “Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs,” and have a permeance of less than 0.01 perms per ASTM E96. The installation of the moisture barrier should comply with ASTM E 1643-09.

5.7 Retaining Walls

5.7.1 Minor Retaining Walls

Minor retaining walls that are 36 inches or less in height and retaining level backfill, for hardscape around the building exterior (if used) may be supported near the finished grade on spread footings. Footings may be designed using an allowable bearing pressure of 1500 psf.

We recommended that higher retaining wall footings on level ground should have a minimum embedment of 18-inches below finished grade. Cantilever walls, which are free to move laterally at least 1/2 inch for each 10-foot height, may be designed for an equivalent fluid pressure of 36 pcf (with level backfill).

5.7.2 Retaining Wall Backfill

We recommend that retaining walls be backfilled with non-expansive granular soils with a PI less than 15 and percent passing No. 200 sieve of less than 15 percent. A 2-ft thick cap consisting of less pervious onsite materials should be used to minimize infiltration of surface water. The finished surface should be graded to drain away from proposed structures. Heavy compaction equipment operating adjacent to retaining walls can cause excessively high lateral soil pressures to be exerted on the wall. Therefore, soils within 5 feet of the wall should either be compacted with hand operated equipment or designed to withstand compaction pressure from heavy equipment.

5.8 Utility Trenches

Excavations for utility trenches should be readily accomplished with conventional excavating equipment. All shoring and excavation should comply with current OSHA regulations and observed by the designated competent person on site.

The bedding for any new sewer and water service pipelines should be a minimum of 4 inches thick and should consist of clean sand, No. 4 concrete aggregate or gravel, and should have a sand equivalent of not less than 30. The pipe zone material, which extends to a level 12 inches above the pipe should consist of sand and should have a sand equivalent of no less than 30, and a maximum rock size of 1 inch. All imported materials should be approved by the project geotechnical engineer before being brought onsite.

Trench zone backfill extends from a level 12 inches above the pipe to finished subgrade. In general, on-site excavated materials are suitable as backfill. Any boulders or cobbles larger than 3 inches in any dimensions, or any organics or other deleterious materials, should be removed before backfilling. We recommend that all backfill should be placed in lifts not exceeding six to eight inches in thickness and be compacted to at least 90 percent of relative compaction as determined by the ASTM D-1557. Mechanical compaction will be required to accomplish compaction above the bedding along the entire pipeline alignments. Jetting or flooding of backfill should not be permitted.

In backfill areas, where mechanical compaction of soil backfill is impractical due to space constraints, 2-sack slurry (CLSM) may be substituted for compacted backfill.

5.9 Soil Corrosivity

A representative near surface bulk sample was tested to evaluate corrosion characteristics. results indicate the sample had a pH of 7.79, water-soluble sulfate content of less than 0.01% and soluble chloride content of less than 100 ppm. The results indicate that the sulfate exposure is considered negligible.

Results of laboratory electrical resistivity tests indicate a minimum resistivity value of 19,660 ohm-cm for the near-surface soils. To evaluate the corrosion potential of near-surface soils, we used the following correlation between electrical resistivity and corrosion potential:

Table 2. Corrosion Potential Criteria

Electrical Resistivity (Ohm-cm)	**Corrosion Potential**
Less than 1,000	Severe
1,000 – 2,000	Corrosive
2,000 – 10,000	Moderate
Greater than 10,000	Mild

Based on this data, the onsite near-surface soils tested are considered mildly corrosive for buried metal. All underground metal pipes should consider this corrosion potential. A corrosion expert should be consulted for further evaluation and to develop optimum protection.

5.10 Pavement Design

Near surface soils consist of sandy materials. A representative near surface bulk sample was tested to evaluate the R-value of the near surface soils, which resulted in an R-value of 68. The following pavement sections are recommended based on R-value of 50, and Traffic Index (TI) values of 4, 5, and 6:

Table 3. Pavement Section Thickness

Traffic Index (TI)	Section Thickness (inches) Asphalt (AC) over Aggregate Base (AB)
4	3 / 4
5	3½ / 4
6	4 / 4

Traffic Index values of 4 to 5 are recommended for car parking and non-truck areas. Traffic index of 6 may be used for truck areas. The upper 12 inches of subgrade supporting pavements should be compacted to at least 95 percent relative compaction (ASTM D1557).

For concrete entrance driveways, we recommend a pavement section of 6 inches of PCC over 6 inches of aggregate base (CAB or CMB). The aggregate base layer should be compacted to at least 95 percent of its maximum dry density.

5.11 Site Drainage

Surface drainage during construction should be controlled and directed to appropriate drainage facilities. All surface drainage should be prevented from running down along the face of the excavation. Ponding water should not be allowed within the excavation.

6.0 LIMITATIONS

This investigation was performed in accordance with generally accepted Geotechnical Engineering principles and practice. The professional engineering work and judgments presented in this report meet the standard of care of our profession at this time. No other warranty, expressed or implied, is made. This report has been prepared for the City of Torrance and their design consultants. It may not contain sufficient information for other parties or other purposes, and should not be used for other projects or other purposes without review and approval by Group Delta.

The recommendations for this project, to a high degree, are dependent upon proper quality control of site grading, fill and backfill placement, and pile foundation installation. The recommendations are made contingent on the opportunity for Group Delta to observe the earthwork operations. This firm should be notified of any pertinent changes in the project, or if conditions are encountered in the field, which differ from those described herein. If parties other than Group Delta are engaged to provide such services, they must be notified that they will be required to assume complete responsibility for the geotechnical phase of the project and must either concur with the recommendations in this report or provide alternate recommendations.

7.0 REFERENCES

American Society of Civil Engineers (ASCE). (2017). *ASCE Standard, ASCE/SEI 7-16, Minimum Design Loads for Buildings and Other Structures*. ASCE, Reston, Virginia.

California Building Code (CBC). (2019). *California Code of Regulations Title 24*, Part 2, Volumes 1 and 2. Sacramento, CA.

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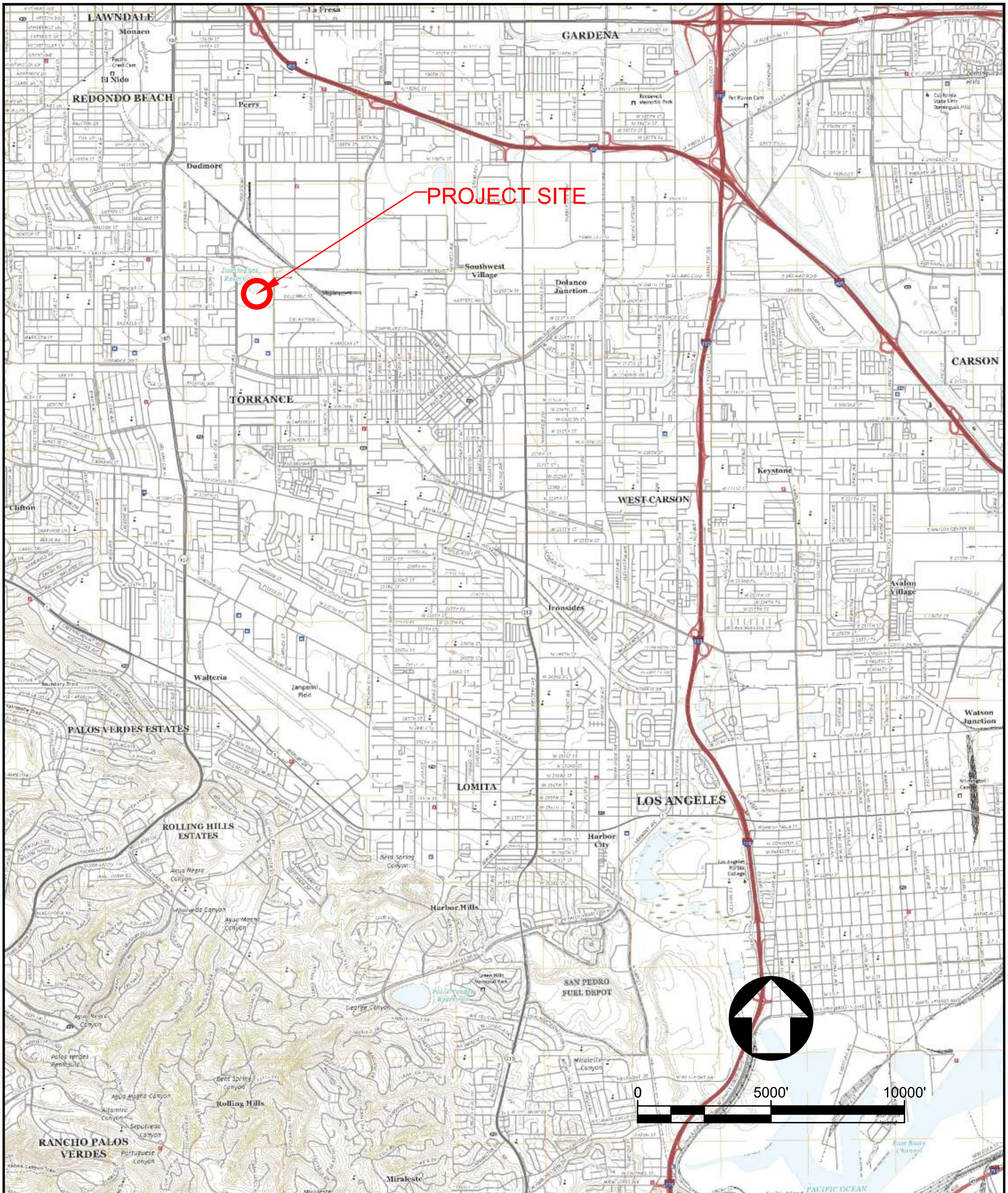
United States Geological Survey. (2010). *Quaternary Faults in Google Earth*, http://earthquake.usgs.gov/hazards/qfaults/google.php

FIGURES



REFERENCE: TORRANCE AND SAN PEDRO QUADRANGLES USGS 7.5 MINUTE SERIES

DATE: 1/20/2021	DRAWN BY: AP	GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA. 90501	SITE VICINITY MAP	PROJECT NUMBER: LA-1493
REVIEWED BY: -	APPROVED BY: -			20500 MADRONA AVENUE TORRANCE, CALIFORNIA	SCALE: AS SHOWN
PREPARED BY: -					FIGURE NUMBER: 1

DATE: 1/20/2021	DRAWN BY: AP	GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA. 90501	EXPLORATION LOCATION MAP	PROJECT NUMBER: LA-1493
REVIEWED BY: -	APPROVED BY: -			20500 MADRONA AVENUE TORRANCE, CALIFORNIA	SCALE: AS SHOWN
PREPARED BY: -					FIGURE NUMBER: 2

APPENDIX A – FIELD INVESTIGATION

APPENDIX A
FIELD INVESTIGATION

A.1 Introduction

A geotechnical subsurface investigation was conducted for the proposed development in Torrance, California on December 5 of 2020. The investigation consisted of drilling two (2) hollow stem auger (HSA) borings. The exploration locations and numbers are shown in Figure 2 of the main report. The summary table of the field investigation is provided in Table A-1.

A.2 Soil Borings

Two HSA borings were drilled to the proposed depth of about 31.5 feet below the existing grade. The borings were performed under the continuous technical supervision of a Group Delta Consultant's field engineer, who maintained a detailed log of the soil encountered, classified the materials, according to the Unified Soil Classification System (USCS), and assisted in obtaining soil samples.

Drive samples and bulk samples of the encountered materials were obtained from the borings and recorded on the boring log. Drive samples were obtained with a Modified California Sampler lined with 1-inch high metal sample rings and a Standard Penetration Test (SPT) sampler. The Modified California Sampler has an outside diameter of 3-inches and the inside diameter of 2.5-inches with a 2.42-inches inside diameter cutting shoe. The samples were retained in brass rings and placed in sealed plastic canisters to prevent moisture loss. Standard penetration tests (SPT) were conducted using a standard 2-inch outside diameter, 1.375-inch inside diameter, the split-spoon sampler per ASTM D1586. SPT samples were placed in sealable plastic bags to protect the natural moisture. The SPT and Modified California samplers were driven into the soil at the bottom of the borehole using a 140-pound hammer free-falling 30 inches. The penetration resistance (or "blow count") in blows per six inches of driving was recorded on the logs. Bulk samples were obtained in the upper 5 feet by a shovel and placed into polyethylene bags.

A key for soil classification and a boring record legend are presented in Figures A-1a to A-2c. The boring logs are presented in Figures A-3a to A-4b.

A.3 List of Attached Tables and Figures

The following table and figures are attached and complete this appendix:

Table A-1	Summary of Group Delta's Field Exploration
Figures A-1a to A-1b	Key for Soil Classification
Figure A-2a to A-2c	Boring Record Legend
Figures A-3a to A-4b	Boring Log

TABLES

Table A-1

Summary of Group Delta's Field Explorations

Exploration No.	Date Performed	Total Depth (ft)	Groundwater Depth During/After (ft)	Exploration Type
B-1	12/5/2020	31.5	NE	HSA
B-2	12/5/2020	31.5	NE	HSA

FIGURES

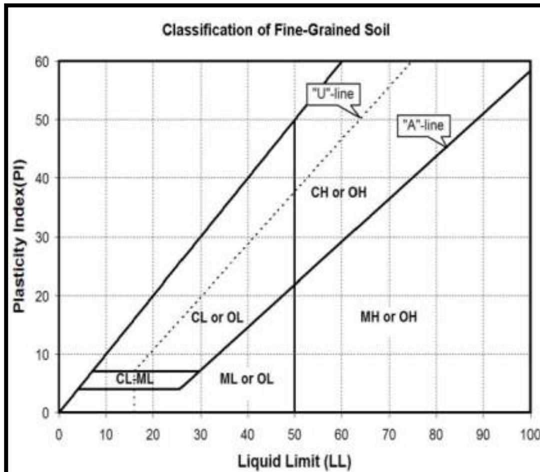
CLASSIFICATION OF INORGANIC FINE GRAINED SOILS (Soils with >50% finer than No. 200 Sieve)

GROUP SYMBOL				GROUP NAME
CL	<30% plus No. 200	<15% plus No. 200		Lean clay
CL	<30% plus No. 200	15-25% plus No. 200	%sand ≥ %gravel	Lean clay with sand
CL	<30% plus No. 200	15-25% plus No. 200	%sand < %gravel	Lean clay with gravel
CL	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy lean clay
CL	≥30% plus No. 200	% sand ≥ % gravel	≥15% gravel	Sandy lean clay with gravel
CL	≥30% plus No. 200	% sand < % gravel	<15% sand	Gravelly lean clay
CL	≥30% plus No. 200	% sand < % gravel	≥15% sand	Gravelly lean clay with sand
ML	<30% plus No. 200	<15% plus No. 200		Silt
ML	<30% plus No. 200	15-25% plus No. 200	%sand ≥ %gravel	Silt with sand
ML	<30% plus No. 200	15-25% plus No. 200	%sand < %gravel	Silt with gravel
ML	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy silt
ML	≥30% plus No. 200	% sand ≥ % gravel	≥15% gravel	Sandy silt with gravel
ML	≥30% plus No. 200	% sand < % gravel	<15% sand	Gravelly silt
ML	≥30% plus No. 200	% sand < % gravel	≥15% sand	Gravelly silt with sand
CH	<30% plus No. 200	<15% plus No. 200		Fat clay
CH	<30% plus No. 200	15-25% plus No. 200	%sand ≥ %gravel	Fat clay with sand
CH	<30% plus No. 200	15-25% plus No. 200	%sand < %gravel	Fat clay with gravel
CH	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy fat clay
CH	≥30% plus No. 200	% sand ≥ % gravel	≥15% gravel	Sandy fat clay with gravel
CH	≥30% plus No. 200	% sand < % gravel	<15% sand	Gravelly fat clay
CH	≥30% plus No. 200	% sand < % gravel	≥15% sand	Gravelly fat clay with sand
MH	<30% plus No. 200	<15% plus No. 200		Elastic silt
MH	<30% plus No. 200	15-25% plus No. 200	%sand ≥ %gravel	Elastic silt with sand
MH	<30% plus No. 200	15-25% plus No. 200	%sand < %gravel	Elastic silt with gravel
MH	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy elastic silt
MH	≥30% plus No. 200	% sand ≥ % gravel	≥15% gravel	Sandy elastic silt with gravel
MH	≥30% plus No. 200	% sand < % gravel	<15% sand	Gravelly elastic silt
MH	≥30% plus No. 200	% sand < % gravel	≥15% sand	Gravelly elastic silt with sand

Reference:
ASTM D 2487 and 2488

Laboratory Classification of Clay and Silt

REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).



CL: LL<50; above A-Line.

CH: LL>50; above A-Line.

ML: LL<50; below A-Line, or PI<4, or Non-Plastic

MH: LL>50; below A-Line.

CL-ML: above A-Line and PI=4 to 7

CL/CH, ML/MH: at or near LL=50

ML/CL, MH/CH: at or near the A-Line

Field Identification of Clays and Silts

Group Symbol	Dry Strength	Dilatancy	Toughness	Plasticity
ML	None to low	Slow to rapid	Low or thread cannot be formed	Low to nonplastic
CL	Medium to high	None to slow	Medium	Medium
MH	Low to medium	None to slow	Low to medium	Low to medium
CH	High to very high	None	High	High

GROUP DELTA

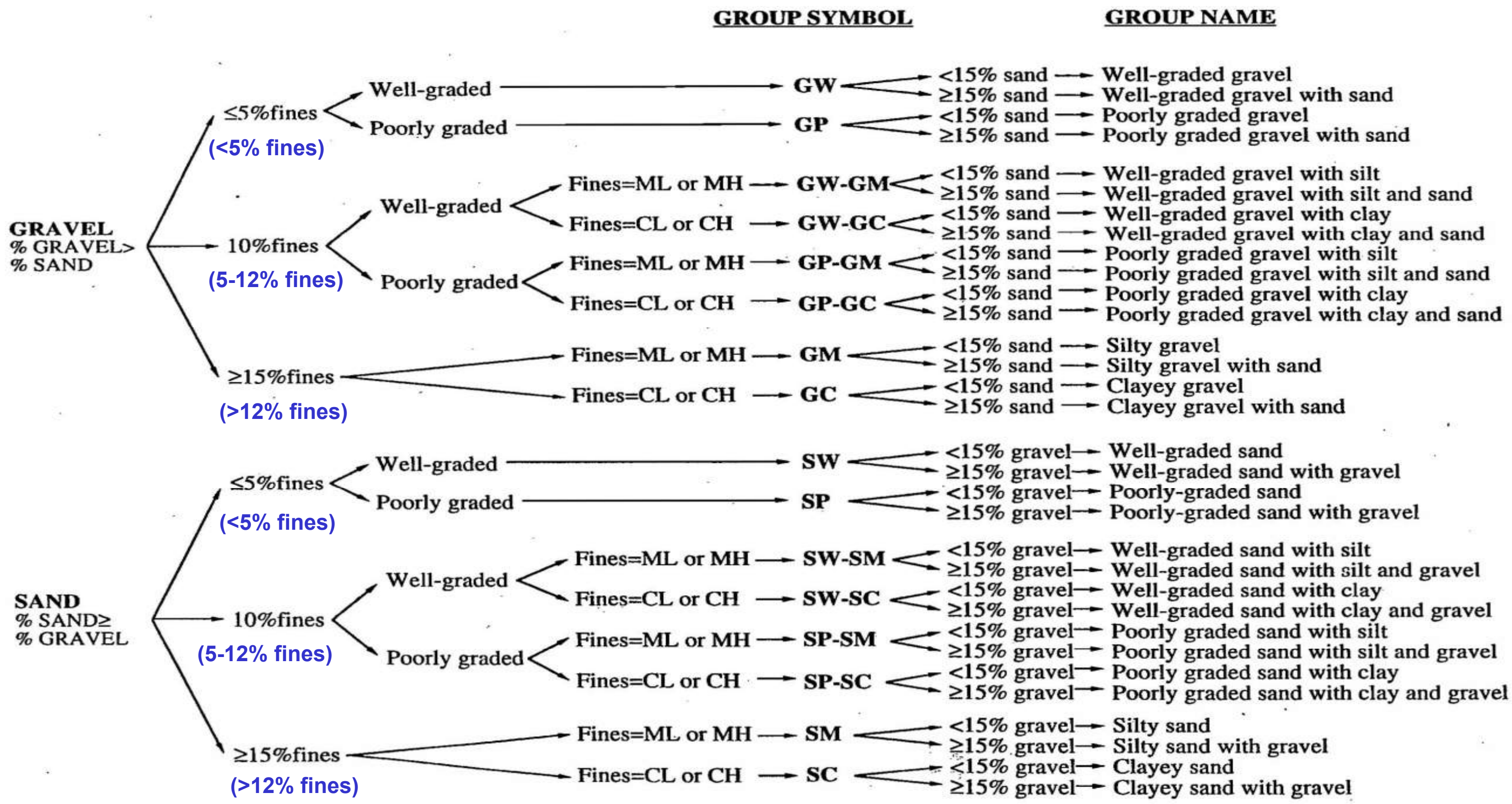
GDC Project No. LA-1493

City of Torrance - Torrance Transit

KEY FOR SOIL CLASSIFICATION #1

Figure A-1a

CLASSIFICATION OF COARSE-GRAINED SOILS (Soils with <50% “fines” passing No. 200 Sieve)



Reference:

ASTM D 2487 and 2488

Note: Values estimated to nearest 5% to be used for visual identification, values in parentheses to be used for classification when based on laboratory grain size data.

Granular Soil Gradation Parameters

Coefficient of Uniformity: $C_u = D_{60}/D_{10}$

Coefficient of Curvature: $Cc = D_{30}^2 / (D_{60} \times D_{10})$

D_{10} = 10% of soil is finer than this diameter

D_{30} = 30% of soil is finer than this diameter

D_{60} = 60% of soil is finer than this diameter

Group Symbol	Gradation or Plasticity Requirement
SW	$C_u > 6$ and $1 \le C_c \le 3$
GW	$C_u > 4$ and $1 \le C_c \le 3$
GP or SP	Clean gravel or sand not meeting requirement for SW or GW
SM or GM	Non-plastic fines or below A-Line or PI<4
SC or GC	Plastic fines or above A-Line and PI>7

GROUP DELTA

GDC Project No. LA-1493

City of Torrance - Torrance Transit

KEY FOR SOIL CLASSIFICATION #2

Figure A-1b

SOIL IDENTIFICATION AND DESCRIPTION SEQUENCE

Sequence		Refer to Section: Field	Refer to Section: Lab	Required	Optional
1	Group Name	2.5.2	3.2.2	●	
2	Group Symbol	2.5.2	3.2.2	●	
	Description Components				
3	Consistency of Cohesive Soil	2.5.3	3.2.3	●	
4	Apparent Density of Cohesionless Soil	2.5.4		●	
5	Color	2.5.5		●	
6	Moisture	2.5.6		●	
7	Percent or Proportion of Soil	2.5.7	3.2.4	●	◍
	Particle Size	2.5.8	2.5.8	●	◍
	Particle Angularity	2.5.9			○
	Particle Shape	2.5.10			○
8	Plasticity (for fine-grained soil)	2.5.11	3.2.5		○
9	Dry Strength (for fine-grained soil)	2.5.12			○
10	Dilatency (for fine-grained soil)	2.5.13			○
11	Toughness (for fine-grained soil)	2.5.14			○
12	Structure	2.5.15			○
13	Cementation	2.5.16		●	
14	Percent of Cobbles and Boulders	2.5.17		●	
	Description of Cobbles and Boulders	2.5.18		●	
15	Consistency Field Test Result	2.5.3		●	
16	Additional Comments	2.5.19			○

Describe the soil using descriptive terms in the order shown

Minimum Required Sequence:

USCS Group Name (Group Symbol); Consistency or Density; Color; Moisture; Percent or Proportion of Soil; Particle Size; Plasticity (optional).

◍ = optional for non-Caltrans projects

Where applicable:

Cementation; % cobbles & boulders;
Description of cobbles & boulders;
Consistency field test result

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010)

HOLE IDENTIFICATION

Holes are identified using the following convention:

H-YY-NNN

Where:
H: Hole Type Code
YY: 2-digit year
NNN: 3-digit number (001-999)

Hole Type Code	Description
A	Auger boring (hollow or solid stem, bucket)
R	Rotary drilled boring (conventional)
RC	Rotary core (self-cased wire-line, continuously-sampled)
RW	Rotary core (self-cased wire-line, not continuously sampled)
P	Rotary percussion boring (Air)
HD	Hand driven (1-inch soil tube)
HA	Hand auger
D	Driven (dynamic cone penetrometer)
CPT	Cone Penetration Test
O	Other (note on LOTB)

Description Sequence Examples:

SANDY lean CLAY (CL); very stiff; yellowish brown; moist; mostly fines; some SAND, from fine to medium; few gravels; medium plasticity; PP=2.75.

Well-graded SAND with SILT and GRAVEL and COBBLES (SW-SM); dense; brown; moist; mostly SAND, from fine to coarse; some fine GRAVEL; few fines; weak cementation; 10% GRANITE COBBLES; 3 to 6 inches; hard; subrounded.

Clayey SAND (SC); medium dense, light brown; wet; mostly fine sand,; little fines; low plasticity.

GROUP DELTA	GROUP DELTA CONSULTANTS, INC. GEOTECHNICAL ENGINEERS AND GEOLOGISTS	FIGURE NUMBER A-2a
	PROJECT NAME: City of Torrance - Torrance Transit	PROJECT NUMBER LA-1493
	BORING RECORD LEGEND #1	

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names	Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (after drilling, date)

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010)

DEFINITIONS FOR CHANGE IN MATERIAL

Term	Definition	Symbol
Material Change	Change in material is observed in the sample or core, and the location of change can be accurately measured.	———
Estimated Material Change	Change in material cannot be accurately located because either the change is gradational or because of limitations in the drilling/sampling methods used.	- - - - - - - - -
Soil/Rock Boundary	Material changes from soil characteristics to rock characteristics.	∼

GROUP DELTA	GROUP DELTA CONSULTANTS, INC. GEOTECHNICAL ENGINEERS AND GEOLOGISTS	FIGURE NUMBER A-2b
	PROJECT NAME: City of Torrance - Torrance Transit	PROJECT NUMBER LA-1493
	BORING RECORD LEGEND #2	

CONSISTENCY OF COHESIVE SOILS

Descriptor	Shear Strength (tsf)	Pocket Penetrometer, PP Measurement (tsf)	Torvane, TV. Measurement (tsf)	Vane Shear, VS. Measurement (tsf)
Very Soft	< 0.12	< 0.25	< 0.12	< 0.12
Soft	0.12 - 0.25	0.25 - 0.50	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.50	0.50 - 1.0	0.25 - 0.50	0.25 - 0.50
Stiff	0.50 - 1.0	1.0 - 2.0	0.50 - 1.0	0.50 - 1.0
Very Stiff	1.0 - 2.0	2.0 - 4.0	1.0 - 2.0	1.0 - 2.0
Hard	> 2.0	> 4.0	> 2.0	> 2.0

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60} - Value (blows / foot)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

MOISTURE

Descriptor	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Descriptor	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Descriptor		Size (in)
Boulder		> 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		< 1/300

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CONSISTENCY OF COHESIVE SOILS VS. N_{60}

Description	SPT N_{60} (blows / foot)
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	> 30

Ref: Peck, Hansen, and Thornburn, 1974, "Foundation Engineering", Second Edition

Note: Only to be used (with caution) when pocket penetrometer or other data on undrained shear strength are unavailable. Not allowed by Caltrans Soil and Rock Logging and Classificaton Manual, 2010

CEMENTATION

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010), with the exception of consistency of cohesive soils vs. N_{60}.

GROUP DELTA

GROUP DELTA CONSULTANTS, INC. GEOTECHNICAL ENGINEERS AND GEOLOGISTS	FIGURE NUMBER A-2c
PROJECT NAME: City of Torrance - Torrance Transit	PROJECT NUMBER LA-1493

BORING RECORD LEGEND #3

BORING RECORD

PROJECT NAME	City of Torrance - Torrance Transit
PROJECT NUMBER	LA1493
HOLE ID	B-1
PROJECT FEATURE	Prefabricated Metal Storage Building
OWNER	City of Torrance
START DATE	1/5/2021
FINISH DATE	1/5/2021
SHEET NO.	1 of 2
SEGMENT NO.	NA
BOREHOLE LOCATION (Latitude; Longitude) DATUM:	As shown in Site Plan
BOREHOLE LOCATION (Offset, Station, Line)	As shown in Site Plan
DRILLING COMPANY	ABC Liovin Drilling, Inc.
DRILL RIG	CME 85
DRILLING METHOD	Hollow Stem Auger
LOGGED BY	A. Pradhan
CHECKED BY	
HAMMER TYPE (WEIGHT/DROP)	Automatic (140 lbs, 30 inch)
HAMMER EFFICIENCY (ERi)	84 %
BORING DIA. (in)	8
TOTAL DEPTH (ft)	31.5
GROUND ELEV (ft)	114.5
DEPTH/*ELEV.* GW (ft)	∇ NE / *NE* DURING DRILLING; ▼ NE / *NE* AFTER DRILLING
DRIVE SAMPLER TYPE(S) & SIZE (ID)	Bulk;SPT (1.4"); MC (2.4")
NOTES	N_{60}* = 1.40N_{SPT} = 0.94N_{MC}
BOREHOLE BACKFILL & COMPLETION	Cement Grout

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0															ASPHALT (5") ON BASE (3").
		Bulk	BULK-1						8			R CP			**ALLUVIUM** Poorly-graded SAND with SILT (SP-SM); reddish brown to light reddish brown; moist; mostly fine SAND.
5	110	MC	R-2	7 15 18	33	31			15	113		DS			SILTY SAND (SM); dense; reddish brown; moist; mostly fine SAND; trace CLAY.
10	105	SPT	S-3	6 10 10	20	28									Poorly-graded SAND with SILT (SP-SM); medium dense; light reddish brown; moist; mostl fine SAND; trace CLAY.
15	100	MC	R-4	7 18 37	55	52			6	96					Poorly-graded SAND (SP); very dense; light reddish brown; moist; mostly fine.
20	95	SPT	S-5	7 12 19	31	43									Dense.
	90														

GROUP DELTA

GROUP DELTA CONSULTANTS, INC.

370 Amapola Ave., Suite 212

Torrance, CA 90501

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE

A-3 a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
City of Torrance - Torrance Transit	LA1493	**B-1**

PROJECT FEATURE	OWNER	START DATE	FINISH DATE	SHEET NO.
Prefabricated Metal Storage Building	City of Torrance	1/5/2021	1/5/2021	2 of 2

SEGMENT NO.	BOREHOLE LOCATION (Latitude; Longitude) DATUM:	BOREHOLE LOCATION (Offset, Station, Line)
NA	As shown in Site Plan	As shown in Site Plan

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin Drilling, Inc.	CME 85	Hollow Stem Auger	A. Pradhan	

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Automatic (140 lbs, 30 inch)	84 %	8	31.5	114.5	∇ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk;SPT (1.4"); MC (2.4")	$N_{60}^{*} = 1.40N_{SPT} = 0.94N_{MC}$	Cement Grout	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^{*}_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
			R-6	6 20 39	59	55									Very dense.
	85														
30			S-7	7 15 33	48	67									Very dense.
															The boring was terminated at planned depth of 31.5 feet below existing grade. Groundwater was not encountered. The borehole was backfilled with cement grout.
	80														
35															
	75														
40															
	70														
45															
	65														

BORING LOG_AP_2019 LA1493.GPJ GDC2013.GDT 1/21/21

BORING RECORD

PROJECT NAME City of Torrance - Torrance Transit		**PROJECT NUMBER** LA1493	**HOLE ID** **B-2**
PROJECT FEATURE Prefabricated Metal Storage Building	**OWNER** City of Torrance	**START DATE** 1/5/2021	**FINISH DATE** 1/5/2021
SHEET NO. 1 of 2			
SEGMENT NO. NA	**BOREHOLE LOCATION (Latitude; Longitude)** DATUM: As shown in Site Plan	**BOREHOLE LOCATION (Offset, Station, Line)** As shown in Site Plan	
DRILLING COMPANY ABC Liovin Drilling, Inc.	**DRILL RIG** CME 85	**DRILLING METHOD** Hollow Stem Auger	**LOGGED BY** A. Pradhan
CHECKED BY			
HAMMER TYPE (WEIGHT/DROP) Automatic (140 lbs, 30 inch)	**HAMMER EFFICIENCY (ERi)** 84 %	**BORING DIA. (in)** 8	**TOTAL DEPTH (ft)** 31.5
GROUND ELEV (ft) 116	**DEPTH/*ELEV.* GW (ft)** ▽ NE / *NE* DURING DRILLING ▼ NE / *NE* AFTER DRILLING		
DRIVE SAMPLER TYPE(S) & SIZE (ID) Bulk;SPT (1.4"); MC (2.4")	**NOTES** $N_{60}^{*} = 1.40N_{SPT} = 0.94N_{MC}$	**BOREHOLE BACKFILL & COMPLETION** Cement Grout	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N_{60}^{*}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0															ASPHALT (5"); NO BASE.
	115	Bulk	BULK-1						7			CR			**FILL** Poorly-graded SAND with SILT (SP-SM); reddish brown; moist; mostly fine SAND; trace fine GRAVEL; angular; debri; asphalt pieces.
															ALLUVIUM Poorly-graded SAND (SP); reddish brown; moist; mostly fine.
5	110	MC	R-2	8 6 10	16	15			14	96		DS			SILTY SAND (SM); dense; reddish brown; moist; mostly fine SAND; trace CLAY.
10	105	SPT	S-3	5 10 14	24	34									
15	100	MC	R-4	8 15 25	40	38			8	97					Poorly-graded SAND (SP); dense; light reddish brown; moist; mostly fine.
20	95	SPT	S-5	9 16 25	41	57									Very dense.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE

A-4 a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
City of Torrance - Torrance Transit	LA1493	**B-2**

PROJECT FEATURE	OWNER	START DATE	FINISH DATE	SHEET NO.
Prefabricated Metal Storage Building	City of Torrance	1/5/2021	1/5/2021	2 of 2

SEGMENT NO.	BOREHOLE LOCATION (Latitude; Longitude) DATUM:	BOREHOLE LOCATION (Offset, Station, Line)
NA	As shown in Site Plan	As shown in Site Plan

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin Drilling, Inc.	CME 85	Hollow Stem Auger	A. Pradhan	

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Automatic (140 lbs, 30 inch)	84 %	8	31.5	116	⊻ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk;SPT (1.4"); MC (2.4")	$N_{60}^* = 1.40N_{SPT} = 0.94N_{MC}$	Cement Grout	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
	90		R-6	8 27 55	82	77			6	97					Very dense.
30	85		S-7	10 15 17	32	45									Dense.
															The boring was terminated at planned depth of 31.5 feet below existing grade. Groundwater was not encountered. The borehole was backfilled with cement grout.
35	80														
40	75														
45	70														

APPENDIX B – LABORATORY TESTING

APPENDIX B
LABORATORY TESTING

B.1 Introduction

The laboratory testing was performed using an appropriate American Society for Testing and Materials (ASTM) and Caltrans Test Methods (CTM).

Modified California drive samples, Standard Penetration Test (SPT) drive samples, and bulk samples collected during the field investigation were carefully sealed in the field to prevent moisture loss. The samples of earth materials were then transported to Group Delta's laboratory for further examination and testing. Tests were performed on selected samples as an aid in classifying the earth materials and to evaluate their physical properties and engineering characteristics. Laboratory testing for this investigation included:

- Soil Classification: USCS (ASTM D2487) and Visual Manual (ASTM D2488);
- Moisture content (ASTM D2216) and Dry Unit Weight (ASTM D2937);
- Grain Size Distribution (ASTM D6913)
- Direct Shear (ASTM D3080);
- Resistance R-Value Test (CTM 301);
- Proctor Compaction Test (ASTM D2937/2487/2488)
- Soil Corrosivity:
    - pH (CTM 643);
    - Water-Soluble Sulfate (ASTM D516, CTM 417);
    - Water-Soluble Chloride(Ion-Specific Probe, CTM 422);
    - Minimum Electrical Resistivity (CTM 643);

A brief description of the laboratory testing program and test results are presented below.

B.2 Soil Classification

The subsurface materials were classified visually in the field using the Unified Soil Classification System (USCS), per ASTM Test Methods D2487 and D2488 and following Caltrans Soil and Logging Classification and Presentation Manual (2010). Soil classifications were modified as necessary based on further inspection and testing in the laboratory. The soil classifications are presented on the key for soil classification and the boring logs in Appendix A.

B.3 Moisture Content and Dry Unit Weight

The natural moisture content and dry unit weights of selected samples were determined in general accordance with ASTM D2216 and ASTM D2937. Results of these tests are presented on the boring log in Appendix A.

B.4 Grain Size Distribution

Determination of grain size distribution of soils was performed to separate particles into size ranges and to determine quantitatively the mass of particles in each range following ASTM D6913. This test method uses a square opening sieve criterion in determining the gradation of soil between the 3-in. (75-mm) and No. 200 (75-µm) sieves. Results of grain size distribution are shown as a percentage per soil type in the boring logs in Appendix A.

B.5 Direct Shear

Two direct shear tests were performed on selected samples per ASTM D3080. After the initial weight and volume measurements were made, the samples was placed in a calibrated shear machine and a selected normal load was applied. The samples were then saturated and allowed to consolidate, and then were sheared under a constant strain rate to failure. Shear stress and sample deformations were monitored throughout the test. The test results are presented in Figures B-1a and B-1b.

B.6 Resistance R-Value Test

R-Value test was performed by stabilometer method on a selected bulk sample of the subgrade soil. The test was conducted in general accordance with CTM 301. The result of the test is shown in Figure B-2.

B.7 Proctor Compaction Test

The relation between maximum dry density and optimum water content for compaction of shallow subsurface soils was determined in accordance with ASTM D2937. Result of the test is presented in Figure B-3.

B.8 Soil Corrosivity

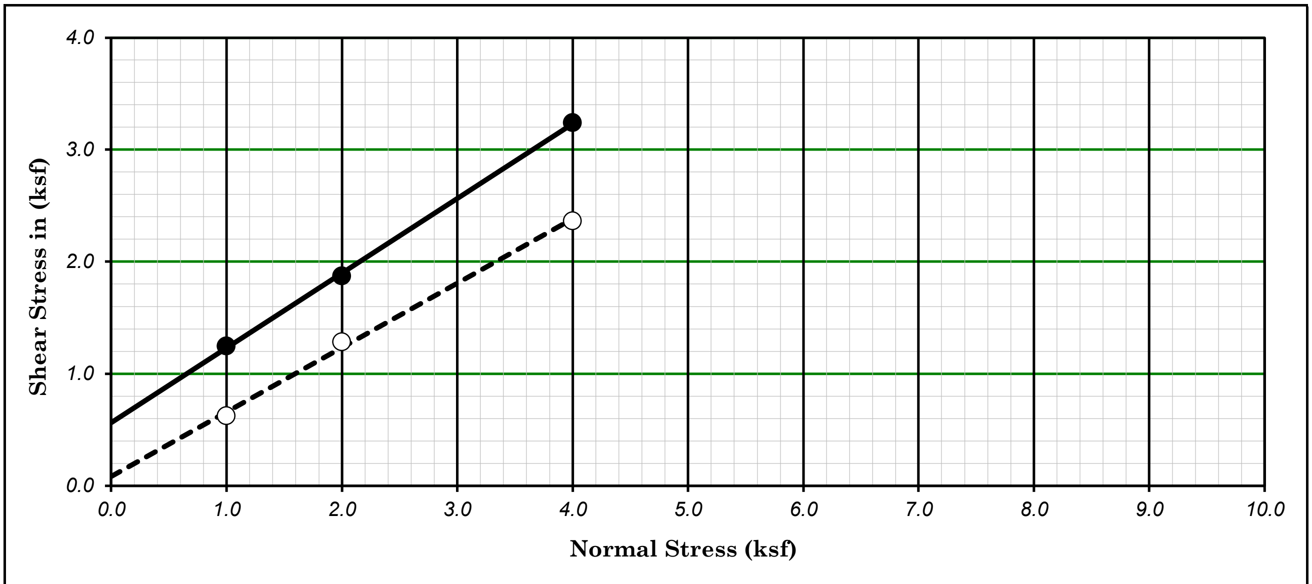
A representative near-surface bulks sample was tested to evaluate corrosion characteristics of the site soil. Corrosivity testing included minimum electrical resistivity and soil pH (Caltrans method 643), water-soluble chlorides (Caltrans Test Method 422), and water-soluble sulfates (ASTM D 516). The result of this test is discussed in Section 5.9 of the main report

B.9 List of Attached Figures

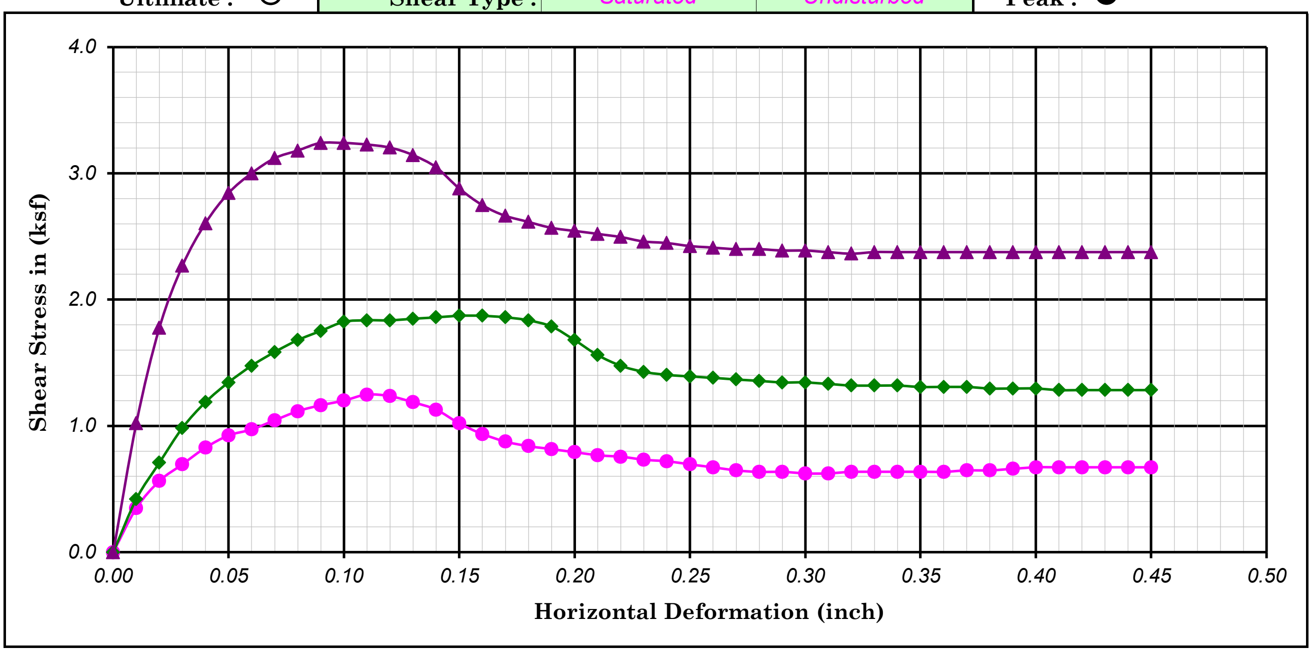
The following figures are attached and complete this appendix:

Figures B-1a and B-1b	Direct Shear Test Result
Figure B-2	R-Value Test
Figure B-3	Proctor Compaction Test

FIGURES



Ultimate : ○ | Shear Type : Saturated | Undisturbed | Peak : ●



Boring No. : B-1	Strength Intercept (C) :	0.56	(ksf)	Peak	0.08	(ksf)	Ultimate
Sample No. : R-2		27.00	(kPa)		4.02	(kPa)	
Depth (ft/m) : 6.0 / 1.83	Friction Angle (ϕ) :	33.70	Degree		29.87	Degree	

Description : Dark yellowish Brown Silty Sand — Shear Rate (inch/minute) : 0.004

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.82	114.06	17.95	0.48	1.00	47.88	1.25	59.75	0.62	29.88
◆	18.27	114.27	17.99	0.48	2.00	95.76	1.87	89.63	1.28	61.48
▲	18.59	114.59	18.04	0.47	4.00	191.52	3.24	155.13	2.36	113.19

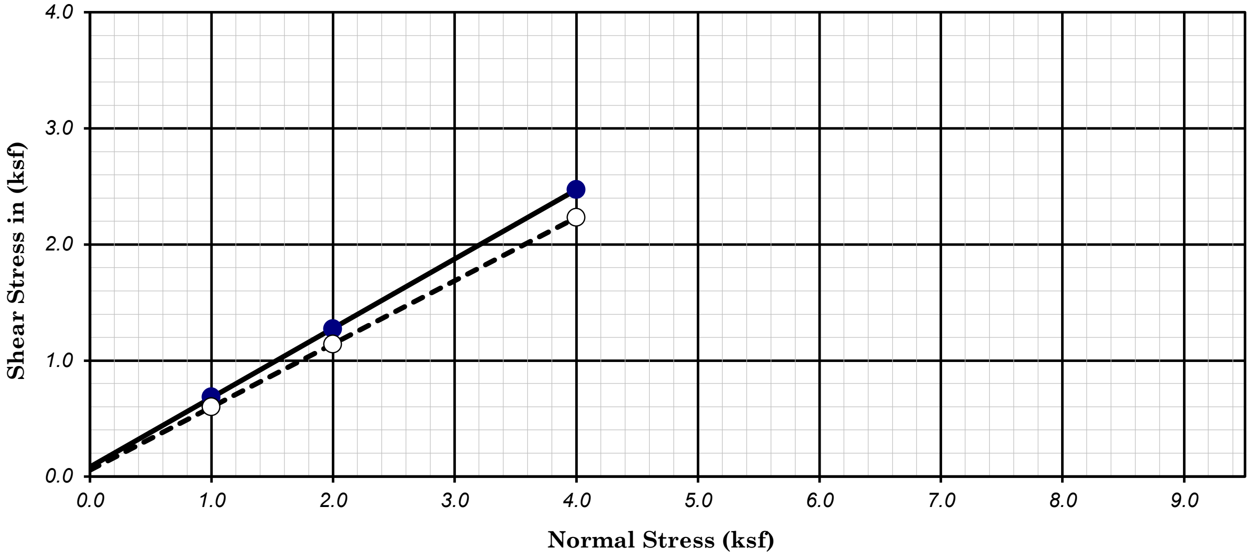
GROUP DELTA

City of Torrance - Torrance Transit

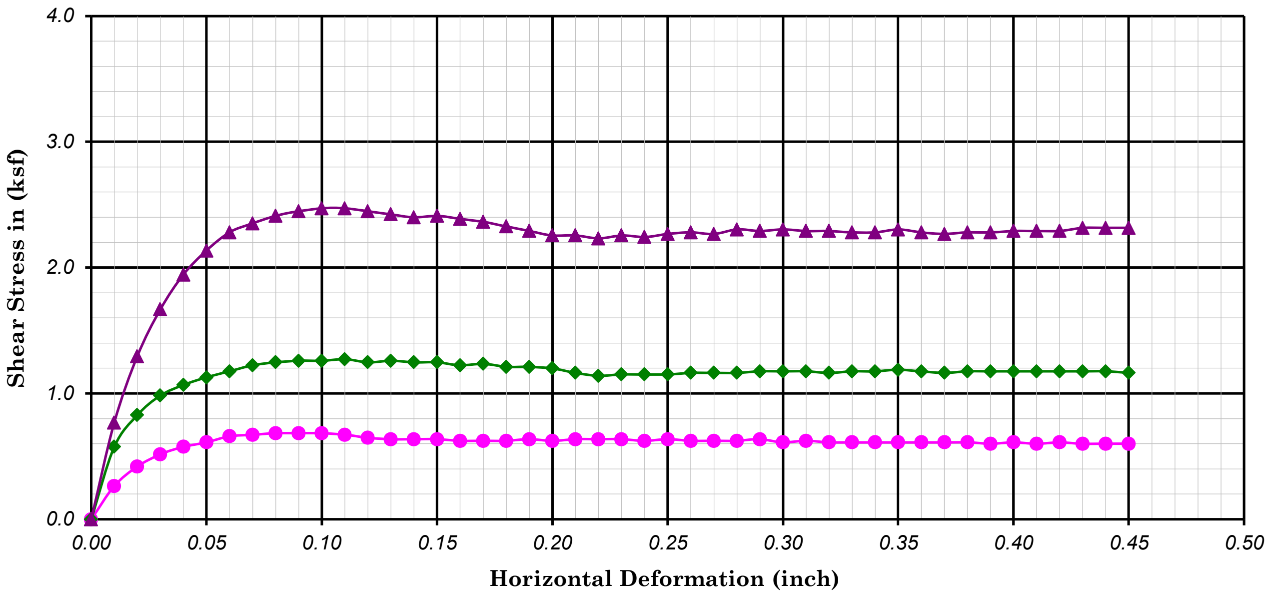
Project No. : LA1493 **Date :** 01/11/21

DIRECT SHEAR TEST
(ASTM D -3080)

Figure B-1a



Ultimate : ○ | Shear Type : Saturated | Undisturbed | Peak : ●



Boring No. : B-2		Strength Intercept (C) :		0.08	(ksf)	Peak	0.05	(ksf)	Ultimate		
Sample No. : R-2				4.02	(kPa)		2.59	(kPa)			
Depth (ft/m) : 6.0 | 1.83		Friction Angle (ϕ) :		30.82	Degree		28.56	Degree			
Description : Yellowish Brown Poorly-graded Sand to Silty Sand							Shear Rate (inch/minute) : 0.005				

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.21	96.54	15.20	0.75	1.00	47.88	0.68	32.75	0.60	28.73
◆	25.60	90.54	14.25	0.86	2.00	95.76	1.27	60.90	1.14	54.58
▲	26.64	93.33	14.69	0.81	4.00	191.52	2.47	118.36	2.23	106.87

GROUP DELTA

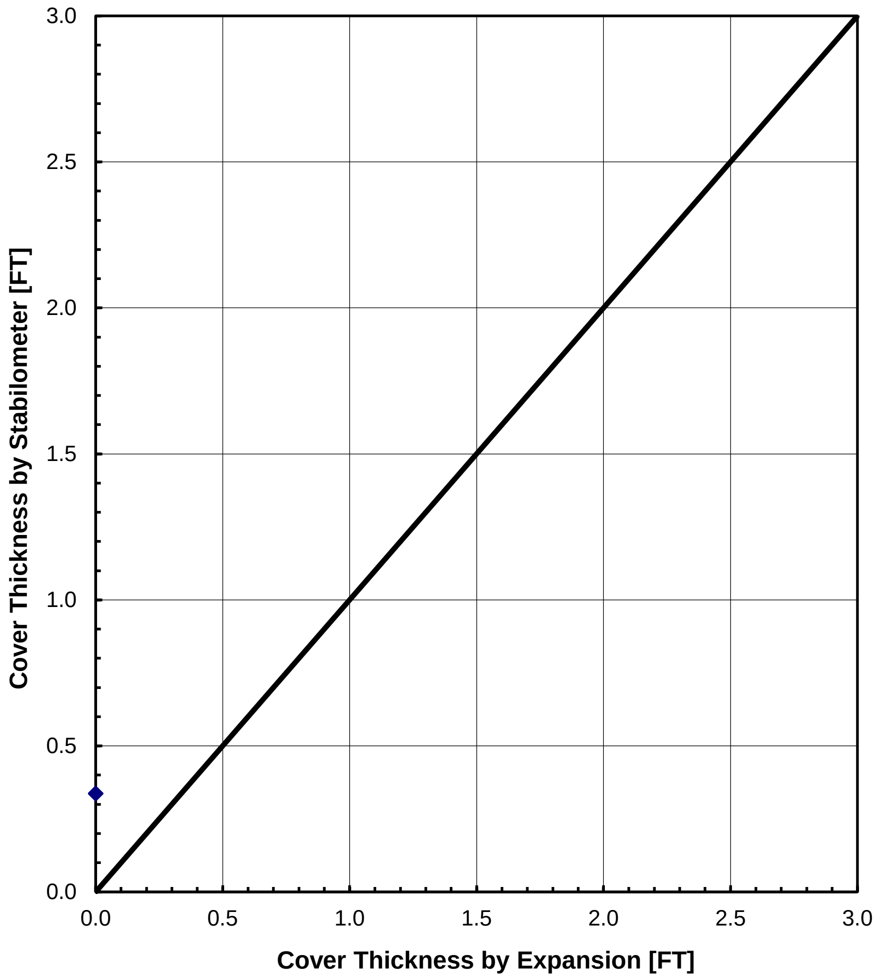
City of Torrance - Torrance Transit

Project No. : LA1493 **Date :** 01/12/21

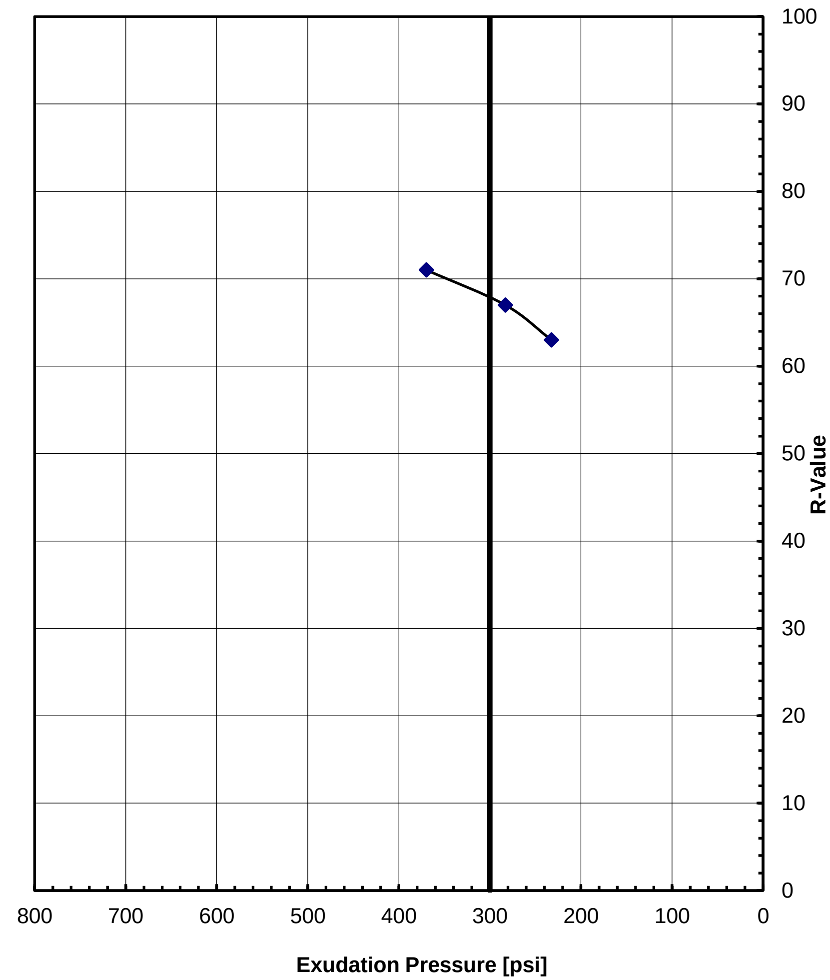
DIRECT SHEAR TEST
(ASTM D -3080)

Figure B-1b

Sample: B-1, Bulk-1 @ 0 - 5'



R-Value at Equilibrium: 68



GROUP DELTA
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ANAHEIM, CALIFORNIA 92806

COVER AND EXUDATION CHARTS

Project No. LA1493

FIGURE B-2

GROUP DELTA CONSULTANTS, INC
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ANAHEIM, CA 92806

STANDARD TEST METHOD FOR MOISTURE - DENSITY RELATIONSHIP (ASTM D1557)

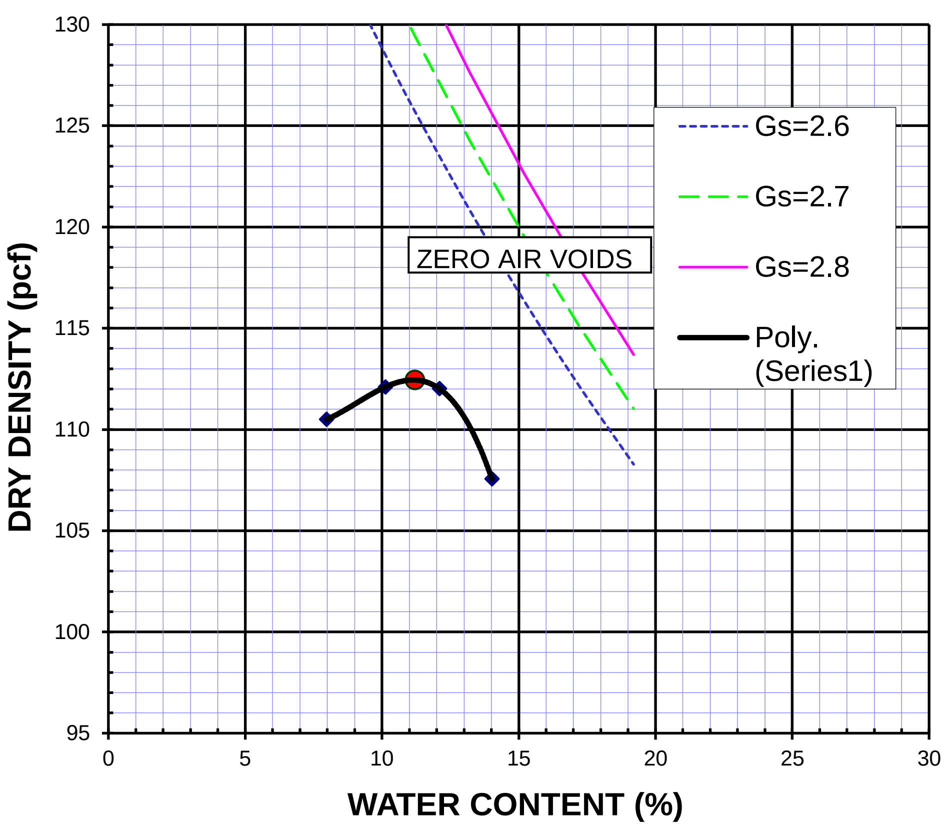
REV. 1, DATED 09/19/19

PROJECT: City of Torrance - Torrance Transit
SAMPLE ID: SO5944
PROJECT NO.: LA1493
DATE: January 8, 2021
TESTED BY: Eric Y.
CHECKED BY: Asheesh P.
SAMPLE DESCRIPTION: Dark Yellowish Brown Silty Sand with traces of Gravel and crushed Asphalt
LOCATION: B-1 Bulk-1 @ 0 - 5'

Method: Mechanical ☑ Manual☐ **Hammer:** 10lb.☑ 5.5 lb.☐

A) WATER ADDED	52	104	156	0			milliliters
B) MOLD TARE WEIGHT	1939.5	1939.5	1939.5	1939.5			grams
C) WEIGHT OF WET SOIL AND MOLD	3808.5	3840.6	3796.3	3745.7			grams
D) WET SOIL WEIGHT (C - B)	1869.0	1901.1	1856.8	1806.2			grams
E) WET DENSITY (D / V)	123.4	125.6	122.6	119.3			pcf
F) DRY DENSITY (E / [(L/100) + 1])	112.1	112.0	107.6	110.5			pcf

G) TARE WEIGHT	239.0	233.7	230.2	230.5			grams
H) WEIGHT OF WET SOIL AND TARE	1207.1	1224.8	1239.6	1109.6			grams
I) WEIGHT OF DRY SOIL AND TARE	1118.1	1117.8	1115.5	1044.7			grams
J) WEIGHT OF WATER (H - I)	89.0	107.0	124.1	64.9			grams
K) DRY WEIGHT OF SOIL (I - G)	879.1	884.1	885.3	814.2			grams
L) MOISTURE CONTENT (J / K)* 100)	10.1	12.1	14.0	8.0			percent



4 inch: V= 15.14 pcf/gm
6 inch: V= 33.98 pcf/gm

A	METHOD USED (A,B or C)

4 inch	MOLD USED
15.14	MOLD VOLUME CORRECTION (V)
# 4	SIEVE NUMBER
2.1%	PERCENT RETAINED

WITH ROCK CORRECTION

	MAXIMUM DENSITY [PCF]
	OPTIMUM MOISTURE [%]

WITHOUT ROCK CORRECTION

112.5	**MAXIMUM DENSITY [PCF]**
11.2	**OPTIMUM MOISTURE [%]**

Figure B-3