PARIKH
Practicing in the Geosciences

MEMORANDUM

To:	**CSW | ST2** **CSW/Stube-Stroeh Engineering Group, Inc.**	January 10, 2020 Job No. 2019-147-GEO
Attn:	Mr. Robert Stevens, P.E.	
From:	Y. David Wang Ph.D., P.E.	
Subject:	Geotechnical Design Recommendations Mirada Road Pedestrian Bridge Replacement Project San Mateo County, California	

INTRODUCTION

The existing Mirada Road pedestrian bridge was installed by the County in 2004. The existing bridge is a single span structure supported on 24-inch diameter Cast-In-Drilled-Hole (CIDH) piles with a service load of 30 Tons per pile. Due to marine environment, the bridge has severe corrosion issue. The County performed study and the preferred approach is to replace the existing bridge with a clear span prefabricated aluminum truss bridge. Based on Parikh's previous involvement (the original bridge design in 2004 and evaluation performed in early 2018), it is our understanding that the existing 24-inch diameter CIDH piles could be reused for foundation support.

The structural designer is to design the current project to conform to current Caltrans seismic design criteria and AASHTO LRFD specifications. In addition to the pedestrian bridge, the coastal bluff of the general area is also of design considerations. The bridge replacement must address the threat of coastal erosion and the impact of Sea-Level Rise. A 2015 study completed by the US Army Corps of Engineers indicated that the bluff north of the Mirada Road revetment retreated at a rate of 1.64 feet per year from 1993 to 2012. The erosion occurring north and south of the existing bridge is threatening collapse of the original/old concrete arch structure at site.

The current project requires a comprehensive design that addresses a long-term solution which protects coastal access. For the bluff stabilization, we understand the current design concept of bluff stabilization is to use a shotcrete type tieback wall with rock riprap and engineering fabric at bottom to provide confinement of the material and to account for future Sea-Level Rise.

SUBSURFACE CONDITIONS

Parikh performed the original investigation for bridge and prepared a report in July 2001. In addition, WRECO performed borings and investigation on Mirada Road for retaining wall evaluation in May 2017. The project utilizes the existing soil boring data (Parikh 2001 and WRECO 2017) for the current design. The Log of Test Boring sheet is attached with the memo.

Based on the soil boring data, the subsoils consist of about 20 to 25 feet of interbedded very stiff sandy lean clay and medium dense clayey to poorly grade sand. Below that, the borings encountered generally medium dense to dense silty sand/clayey sand through Elev. -25 feet (~50 feet depth below existing Mirada Road).

Groundwater was encountered at about 25 feet and 31 feet depth below Mirada Road during Parikh's 2001 investigation. Groundwater levels may change with passage of time due to groundwater/tidal fluctuations from season to season, surface run-off, weather condition, and other factors which may not be present at the time of the investigation.

SEISMIC DESIGN CRITERIA

The recommended response spectrum was determined based on the Caltrans ARS Online tool (Ver. 2.3.09, 2012). The development of the design ARS curve is based on several input parameters, including site location (longitude/latitude), average shear wave velocity for the top 30 m (100 feet) (VS30m), and other site parameters, such as fault characteristics, and site-to-fault distances. The design methods incorporate both deterministic and probabilistic seismic hazards to produce the design response spectrum.

The average shear wave velocity (Vs) for the top 30m (100 feet) at the site was estimated by using established correlations and guidelines provided in Caltrans "Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendation," dated November 2012. The site condition may be classified as Site Class "D" per NEHRP. Based on the subsurface data, we recommend that a Vs value of 290 m/s be used for design.

The site location and the relevant parameters are summarized as follows, and the recommended ARS Design Curve is attached with the memo. The soil strength and calculation of the shear wave velocity (Vs_{30m}) are attached.

1. Site Location: 37.4934ºN/ 122.4598ºW
2. Recommended Vs_{30m} for design = 290 m/sec (Site Class D per NEHRP)
3. The recommended ARS curve is the envelope of the Deterministic and Probabilistic approaches per Caltrans ARS Online. For the site, the curve is governed by the Probabilistic approach.

4. To account for Near Fault effect, a factor of 1.2 is applied to Sa for structural periods over 1 second per Caltrans design guidelines.
5. Peak Ground Acceleration (PGA) = 0.712 g

LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under reversing cyclic shear stresses associated with earthquake shaking. Submerged cohesionless sands and silts of low relative density are most susceptible to liquefaction. Clays generally are not susceptible to liquefaction.

Based on the boring data, the underlying sands are generally dense to very dense. The liquefaction potential at the site is considered low.

LATERAL EARTH PRESSURES FOR TIEBACK WALL DESIGN

It is planned to use tiebacks with Rock Slope Protection (RSP) at the toe for bank stabilization at the site. The existing geology and boring data indicate that the site subsoils consist primarily of medium dense to dense, fine to coarse grained sands with some low plasticity fines. A tieback wall with shotcrete facing is anticipated.

The recommended soil properties for the tieback wall design are: ϕ = 34 deg and γ = 125 pcf. The existing grade near the north pedestrian bridge abutment is at approx. Elev. 31 feet, and the Mirada Road grade along the wall layout line appears to be between Elev. 26 and 30 feet.

Apparent Lateral Earth Pressure. The determination of lateral earth pressure for tieback wall design should follow AASHTO LRFD Spec with California Amendments (6th ed., 2012), Section 3.11.5.7. Refer to the section for the calculation of Pa, and the apparent earth pressure is in trapezoidal distribution as shown in Fig. 3.11.5.7.1-1 (see below). The anticipated wall height may be on the order of 20 to 25 feet. RSP is planned at the toe for wave protection. Additional surcharge such as traffic load should also be included for wall design. We anticipate that multiple levels of tiebacks will be used, and Figure 3.11.5.7.1-1 (b) is relevant for design. For level backfill case, Ka = tan (45-ϕ/2) ^2 = 0.28, γ = 125 pcf.

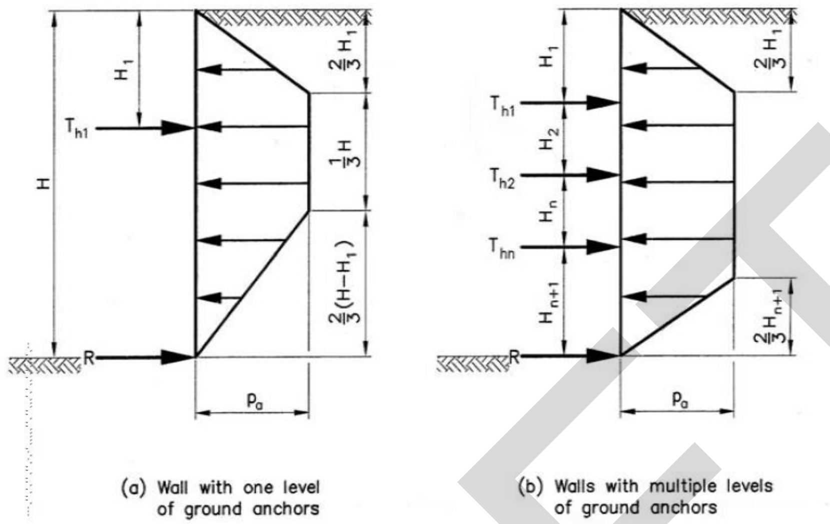


Figure 3.11.5.7.1-1—Apparent Earth Pressure Distributions for Anchored Walls Constructed from the Top Down in Cohesionless Soils

Seismic Lateral Earth Pressure. The determination of seismic lateral earth pressure for tieback wall design should follow AASHTO LRFD Spec with California Amendments, Section 11, Appendix A11. The PGA at the site is 0.712 g per Caltrans ARS online (V. 2.3.09). Per Section A11.3.2, a 50% reduction may be applied when defining Kh if 1 to 2 inches of ground deformation is permitted during the design seismic event. Therefore, a Kh value of 0.36 g is recommended for design.

Per Figure A11.3.2-3, the recommended Kae (total seismic lateral pressure) is 0.5. We considered ~25 feet height of the wall and a nominal cohesion of ~100 psf for the soils. The Kae may be used in Section 3.11.5.7 to determine the total seismic lateral pressure. The distribution of the total seismic lateral pressure takes the same distribution shape as the static trapezoidal shape per NCHRP Report 611.

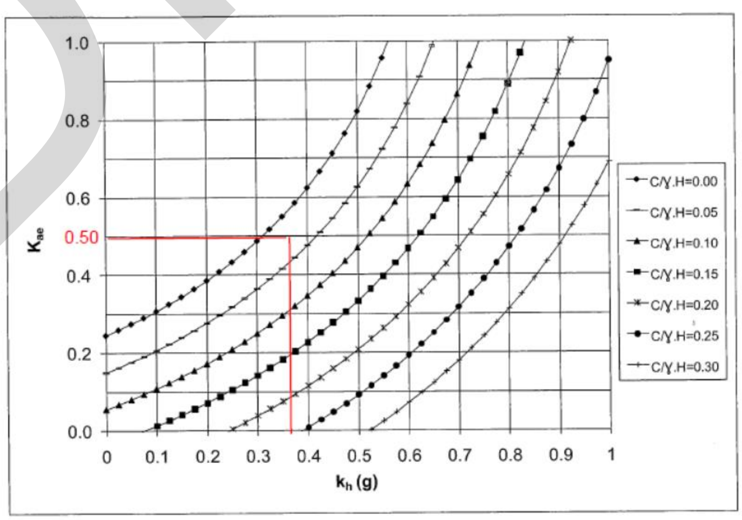


Figure A11.3.2-3—Seismic Active Earth Pressure Coefficient for ϕ = 35 degrees (*c* = soil cohesion, γ = soil unit weight, and *H* = retaining wall height)

Presumptive Ultimate Unit Bond Stress. Based on the boring data, it is anticipated that the anchor bond zone would be in the native sandy soil material. It should be noted that changes in the subsurface conditions during construction may be expected. Caltrans standard performance specifications for anchor systems should be utilized for attaining the required design capacity. The contractor should develop their design and construction criteria.

The bond stress for design of anchor bond length depends on factors such as installation technique, grouting procedures, diameter of the holes, etc. Per Section 11.9.4.2 of the AASHTO LRFD, for preliminary cost estimate, the estimated presumptive ultimate unit bond stress is on the order of 4.5 ksf. It is assumed that pressure-grouted anchors will be used. Note that anchor is a design-build system, and the contractor should determine the bond length, drilling and grouting method, etc.

The anchors should be constructed and tested as per Caltrans standard performance specifications for anchor systems. All anchors should be either performance tested, or proof tested. We recommend that at least 5% of the total number of anchors be performance tested. The remaining anchors should be proof tested. If the design capacity is not achieved during the initial test program, post-grouting technique, large diameter holes, etc. may be considered for the anchor installation. Per Section 11.5.6 of the California Amendments, the Resistance Factor is 1.0 for pullout resistance of anchors where proof tests are conducted.

Because of the variability in the soil conditions and the limitations in the exploration program, it is recommended that several cost control measures be implemented in the specifications for the anchor system. The contractor should be advised to verify the field conditions and verify the capacity through his own efforts. It would be advisable for the contractor to have capability to perform post-grouting for the anchor installation. He should also verify the drilling conditions into the existing material (such as by horizontal drilling). This is to see if the operation may require special drilling tools and equipment.

Unbonded Length, Inclination Angle & Drainage. The minimum distance between the beginning of the grout/bond zone and the active zone should be 5 feet or H/5, whichever is greater (See the excerpted Figure 11.9.1-1 below from AASHTO LRFD specs). For the site, the active zone is at an angle of 62 degrees (= $45+\phi/2$) from horizontal. A minimum unbonded length of 15 feet is recommended. In addition, for the first level of tiebacks, the overburden depth should be minimum 10 feet. Typically, an inclination of 10 to 15 degrees is planned for anchor installation. Drainage, such as using geocomposite drain, should be provided for the wall.

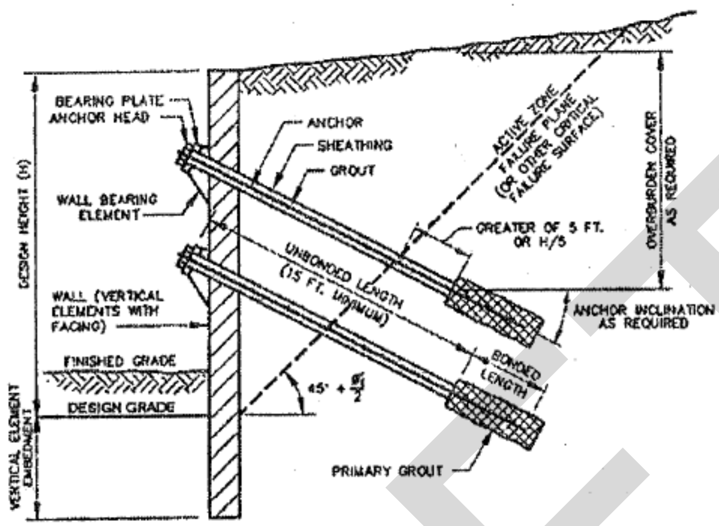


Figure 11.9.1-1 Anchored Wall Nomenclature and Anchor Embedment Guidelines.

ADDITIONAL CONSTRUCTION CONSIDERATIONS FOR TIEBACK WALL

Depending on the wall layout line and existing terrain, the very upper part maybe "in the air" and may require fill to build up. Some special detail may be needed for such case.

The designer needs to determine the "wall bottom elevation" and construction sequence. Based on the preliminary information, it is expected that RSP with fabric is planned at the toe for wave protection. From geotechnical standpoint, we should avoid the situation of doing the wall first, over-excavating later for the RSP and end up losing material behind/underneath the wall.

The construction sequence should be strategized so that the tieback wall will not be undermined by construction.

BRIDGE FOUNDATION DESIGN

It is our understanding that the existing CIDH piles will remain and will be re-used for foundation support. The superstructure will be replaced, and the required demand does not exceed the existing pile capacity. Due to update of design standards and seismic design criteria, the structural engineer needs to re-evaluate the lateral design. For analyses using LPILE program, the geotechnical parameters are provided below:

Geotechnical Parameters for LPILE Analysis

North Abutment (Boring B-2, Parikh 2001)

Approx. Depth (ft.)	Generalized Soil Profile	LPILE Soil Type	Soil Strength	Effect. Unit Wt. (pcf)
0 to 4	Clayey Sand, medium dense	Sand (Reese)	ϕ= 34º	125
4 to 9	Lean Clay, stiff	Stiff Clay w/o free water	C = 1600 psf	125
9 to 25	Clayey Sand & Silty Sand, medium dense to dense	Sand (Reese)	ϕ= 38º	125
25 to 30	Clayey Sand, dense	Sand (Reese)	ϕ= 38º	63

South Abutment (Boring B-1, Parikh 2001)

Approx. Depth (ft.)	Generalized Soil Profile	LPILE Soil Type	Soil Strength	Effect. Unit Wt. (pcf)
0 to 4	Clayey Sand, medium dense	Sand (Reese)	ϕ= 34º	125
4 to 14	Lean Clay, stiff	Stiff Clay w/o free water	C = 2000 psf	125
14 to 25	Clayey Sand & Silty Sand, medium dense to dense	Sand (Reese)	ϕ= 38º	125
25 to 30	Clayey Sand, dense	Sand (Reese)	ϕ= 38º	63

Use default values for ε_{50} and k in LPILE program
Depth "0" is at existing grade of Mirada Road

At each abutment, the two piles are at about 15 feet apart. There is no group reduction, and p-multiplier = 1.0.

Design Consideration at North Abutment near the Wall/Slope. It is our understanding that the outermost pile on the north abutment is in close proximity to the planned wall/slope. At the location, the design will have a tieback wall to go around the existing slope. The evaluation needs collaboration between the bridge designer, the wall designer, and the geotechnical engineer for wall/tieback design near this pile.

When the pile is under lateral load "going away" from the bluff (seismic condition), additional load will be imposed on the "protective" tieback wall. The determination of tieback demand needs to consider the additional pile reaction. When the actual wall layout is finalized (by Moffatt Nichol), Parikh will need to check the distance between the pile and the wall and obtain LPILE analyses (by Cornerstone) to verify the pile reaction along the pile length. The pile reaction becomes loading/demand on the tieback wall. It is likely that two vertical rows of the tiebacks will see additional loads.

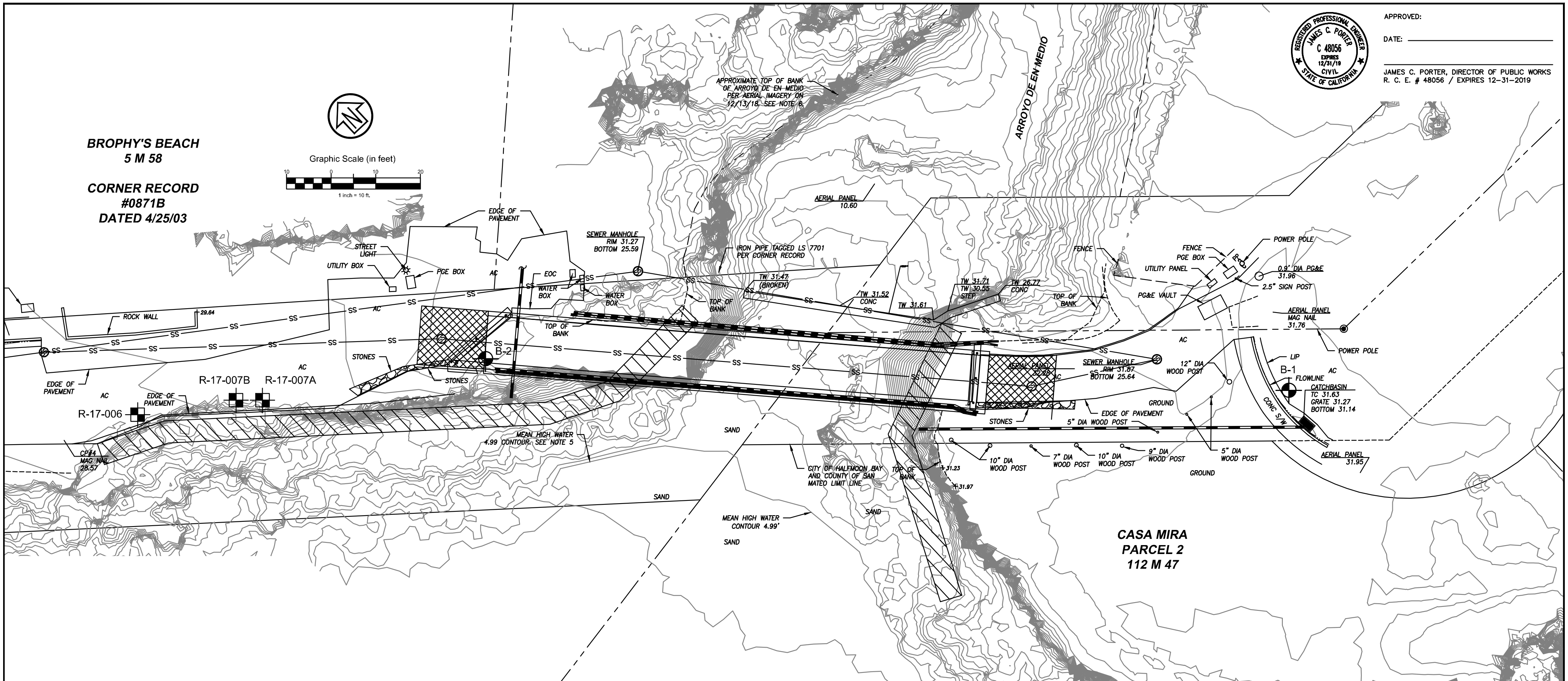
For verification of the abutment design, the following parameters are recommended: Active Earth Pressure = 36 pcf, and At-Rest Earth Pressure = 55 pcf; drainage should be provided. For ultimate passive under seismic condition, please design the abutments per the bilinear model as shown in Section 6.3.1 of Caltrans latest Seismic Design Criteria (SDC version 2.0, April 2019).

Please be advised that we are performing a professional service and that our conclusions are professional opinions only. All work done and all recommendations made are in accordance with generally accepted geotechnical engineering principles and practices. No warranty expressed or implied, of merchantability or fitness, is made or intended in connection with our work.

ATTACHMENTS:

- Log of Test Borings
- ARS Design Curves
- Soil Strength & Vs_{30m} Calculation

Log of Test Borings



APPROVED:

DATE:

JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS
R. C. E. # 48056 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER JAMES C. PORTER C 48056 EXPIRES 12/31/19 CIVIL STATE OF CALIFORNIA

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APPROVED DATE:
NAME NAME, CITY ENGINEER
HALF MOON BAY
R.C.E. # 00000 / EXPIRES 00-00-0000

APPROVED DATE:
PARIKH Practicing in the Geosciences
GARY PARIKH, P.E.
PARIKH CONSULTANTS, INC.
R.C.E. # G.E. 666 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/19 GEOTECHNICAL STATE OF CALIFORNIA

COUNTY OF SAN MATEO PUBLIC WORKS

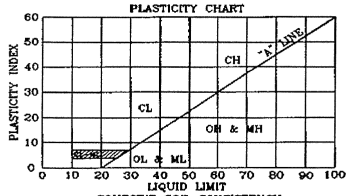
		DESIGNED BY: RCS	LOG OF TEST BORINGS 1 OF 5 MIRADA ROAD		SCALE: AS SHOWN
		CHECKED BY: RCS			DATE: 10/30/2019
		DRAWN BY: MJV			FILE NO.: 4122700
		JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS SAN MATEO COUNTY		555 COUNTY CENTER, 5th FLOOR REDWOOD CITY, CALIFORNIA 94063	
REVISION	DATE	FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4			□O□B-1 SHEET 1 OF 5

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	ILLUSTRATIVE GROUP NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines	GW	Well graded gravel, Well graded gravel with sand
			GP	Poorly graded gravel, Poorly graded gravel with sand
		GRAVELS WITH FINES More than 12% fines	GM	Silty gravel, Silty gravel with sand
			GC	Clayey gravel, Clayey gravel with sand
	SANDS 50% or more of coarse fraction passing No. 4 sieve	CLEAN SANDS Less than 5% fines	SW	Well graded sand, Well graded sand with gravel
			SP	Poorly graded sand, Poorly graded sand with gravel
		SANDS WITH FINES More than 12% fines	SM	Silty sand, Silty sand with gravel
			SC	Clayey sand, Clayey sand with gravel
FINE-GRAINED SOILS 50% or more passing No. 200 sieve	SILTS AND CLAYS Liquid Limit less than 50%		ML	Silt, Sandy silt with gravel
			CL	Lean clay, Sandy lean clay with gravel
			OL	Organic clay, Sandy organic clay with gravel
	SILTS AND CLAYS Liquid Limit more than 50%		MH	Elastic silt, Sandy elastic silt with gravel
			CH	Fat clay, Sandy fat clay with gravel
			OH	Organic clay, Sandy organic clay with gravel
HIGHLY ORGANIC			PT	Peat, Highly organic silts

NOTE: 1. Coarse-grained soils receive dual symbols if: (a) their fines are CL-ML (e.g. SC-SM or GC-GM) or (b) they contain 5-12% fines (e.g. SW-SM, GP-GC, etc.). Fine-grained soils receive dual symbols if their limits plot in the hatched zone of the Plasticity Chart (CL-ML).
2. The table lists 30 out of a possible 110 Group Names, all of which are assigned to unique proportions of the constituent soils. Flow charts in ASTM D 2487-93 aid assignment of the Group Names.

PLASTICITY CHART



GRAIN SIZE CLASSIFICATION

CLASSIFICATION	US STANDARD SIEVE SIZE
BOULDERS	Above 12"
COBBLES	12" to 3"
GRAVEL Coarse	3" to 3/4"
GRAVEL Fine	3/4" to No. 4
SAND Coarse	No. 4 to No. 10
SAND Medium	No. 10 to No. 40
SAND Fine	No. 40 to No.200
SILT & CLAY	Below No. 200

COHESIVE SOIL CONSISTENCY

CLASSIFICATION	UNCONFINED COMP. STRENGTH (psf)
Very Soft	< 500
Soft	500 - 1000
Medium(Firm)	1000 - 2000
Stiff	2000 - 4000
Very Stiff	4000 - 8000
Hard	> 8000

COHESIONLESS SOIL RELATIVE DENSITY

CLASSIFICATION	SPT BLOW COUNTS (Blows/ft)
Very Loose	< 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	> 50

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

JOB NO.: 201131.10 | PLATE NO.: A-1A

Boring Location, Elevation & Date Drilled:

Drilling Method:

BORING NUMBER
LEGEND
Sheet 1 of 1

Sampling Method:

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	Description	
					0	Compressive strength as measured by Pocket Penetrometer, in tsf.	pp=1.0tsf
1			22			2 inch I.D. California Sampler (C).	
2	110	12	23	1.2	5	2-1/2 inch I.D. Modified California Sampler (MC).	
3	98	28	100 psi	0.8		3.5-inch I.D. Pitcher Tube Sampler (Cored).	
					10		
4	-	10	35	-		1-3/8 inch I.D. Standard Splitspoon Sampler (SPT).	
5	95	20		0.7	15	1.9 inch I.D. Hand Sampler driven with a slide hammer.	
						Groundwater level first encountered during drilling	
					20	Groundwater level at completion of boring	
6	-	12				Bulk sample stored in plastic bag.	
						Liquid Limit (LL), in percent Plasticity Index (PI), in percent	LL=30 PI=10
7	-	-		12.0	25	NX Core.	
						Percent gravel and coarser in sample,(+#4) Percent fines (silt/clay) in sample, (-#200)	+#4=20% -#200=50%
					30	Triaxial Test	TX

LEGEND FOR LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

Date: 7/2001 | Job No.: 201131.10

This log is part of the report prepared by Parikh Consultants, Inc. for the named project and should be read together with that report for complete interpretation. 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 actual conditions encountered.

Plate: A-1B

LEGEND LEGEN 2-20-01

APPROVED:
DATE:
JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS
R. C. E. # 48056 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER JAMES C. PORTER C 48056 EXPIRES 12/31/19 CIVIL STATE OF CALIFORNIA

DRA

APPROVED DATE:	
NAME NAME, CITY ENGINEER	
HALF MOON BAY	
R.C.E. # 00000 / EXPIRES 00-00-0000	

APPROVED DATE:
PARIKH Practicing in the Geosciences
GARY PARIKH, P.E.
PARIKH CONSULTANTS, INC.
R.C.E. # G.E. 666 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/19 GEOTECHNICAL STATE OF CALIFORNIA

COUNTY OF SAN MATEO PUBLIC WORKS

REVISION	DATE	DESIGNED BY: RCS CHECKED BY: RCS DRAWN BY: MJV	LOG OF TEST BORINGS 2 OF 5 MIRADA ROAD	SCALE: AS SHOWN DATE: 10/30/2019 FILE NO.: 4122700
		JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS SAN MATEO COUNTY	555 COUNTY CENTER, 5th FLOOR REDWOOD CITY, CALIFORNIA 94063	B-2 SHEET 2 OF 5

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4

APPROVED:

DATE: ____________

JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS
R. C. E. # 48056 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER — JAMES C. PORTER — C 48056 — EXPIRES 12/31/19 — CIVIL — STATE OF CALIFORNIA

LOG OF BORING — B-1, Sheet 1 of 2

Boring Location, Elevation & Date Drilled: SEE ATTACHED SITE PLAN; Elev. approx. 31.0 ft.; drilled on 4-17-01

Drilling Method: 8-inch dia. Hollow stem auger, MOBILE B-53

Sampling Method: 2 1/2" I.D. Mod. Cal. (MC)/2" I.D. Cal. (C)/1 3/8" I.D. Std. Pen., 140 lbs hammer, 30 inch drop.

BORING NUMBER B-1 — Sheet 1 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description
					0		2 inches of ASPHALT CONCRETE over 15 inches of AGGREGATE BASE
MC-1	108	16	27			SC	CLAYEY SAND (SC), medium dense, dark gray, moist, trace lean clay, fine to medium grained, trace coarse grained
MC-2	106	21	45		5	CL	SANDY LEAN CLAY (CL), very stiff, mottled gray/brown, moist, trace friable white shale
MC-3	106	21	37	2.1	10		--very stiff, trace coarse grained sand
MC-4	113	16	48		15	SC	CLAYEY SAND (SC), medium dense, mottled gray/brown, moist, fine to medium grained, trace coarse grained, trace friable white shale
MC-5	102	12	45		20	SP SM	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, yellowish brown, moist, fine to medium grained, trace coarse grained
MC-6	117	16	75		▼25	SC	CLAYEY SAND (SC), dense, olive gray, wet, fine grained, trace coarse grained, trace clay
					30	SM	

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Geotechnical & Materials Engineering

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

Date: JULY 2001 — Job No.: 201131.10

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Plate: A-2A

LB 21131 7-13-01

LOG OF BORING — B-1, Sheet 2 of 2

Boring Location, Elevation & Date Drilled: SEE ATTACHED SITE PLAN; Elev. approx. 31.0 ft.; drilled on 4-17-01

Drilling Method: 8-inch dia. Hollow stem auger, MOBILE B-53

Sampling Method: 2 1/2" I.D. Mod. Cal. (MC)/2" I.D. Cal. (C)/1 3/8" I.D. Std. Pen., 140 lbs hammer, 30 inch drop.

BORING NUMBER B-1 — Sheet 2 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description
SPT-7	-	22	58		30		SILTY SAND (SM), very dense, gray/brown, wet, fine to medium grained, trace coarse grained
SPT-8	-	17	65		35	SC	CLAYEY SAND (SC), very dense, grayish brown, wet, fine grained, trace lean clay
MC-9	113	19	37		40		--medium dense, gray/brown, wet, fine grained, trace medium to coarse grained
SPT-10	-	19	64		45	SM	SILTY SAND (SM), very dense, grayish brown, wet, fine grained, trace medium grained
							Bottom of boring at 46.5 feet
					50		
					55		
					60		

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

Date: JULY 2001 — Job No.: 201131.10

This log is part of the report prepared by Parikh Consultants, Inc. for the named project and should be read together with that report for complete interpretation. 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 actual conditions encountered.

Plate: A-2B

LB 21131 7-13-01

DRA

APPROVED DATE:	
NAME NAME, CITY ENGINEER	
HALF MOON BAY	
R.C.E. # 00000 / EXPIRES 00-00-0000	

APPROVED DATE:
PARIKH — Practicing in the Geosciences
GARY PARIKH, P.E.
PARIKH CONSULTANTS, INC.
R.C.E. # G.E. 666 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER — GARY PARIKH — No. G.E. 666 — Exp. 12/31/19 — GEOTECHNICAL — STATE OF CALIFORNIA

COUNTY OF SAN MATEO PUBLIC WORKS

REVISION	DATE	DESIGNED BY: RCS	LOG OF TEST BORINGS	SCALE: AS SHOWN
		CHECKED BY: RCS	3 OF 5	DATE: 10/30/2019
		DRAWN BY: MJV	MIRADA ROAD	FILE NO.: 4122700
		JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS SAN MATEO COUNTY	555 COUNTY CENTER, 5th FLOOR REDWOOD CITY, CALIFORNIA 94063	B-3
		FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES	0 1 2 3 4	SHEET 3 OF 5

APPROVED:

DATE:

JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS
R. C. E. # 48056 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER JAMES C. PORTER C 48056 EXPIRES 12/31/19 CIVIL STATE OF CALIFORNIA

LOG OF BORING

Boring Location, Elevation & Date Drilled: SEE ATTACHED SITE PLAN; Elev. approx. 31.0 ft.; drilled on 4-17-01

Drilling Method: 8-inch dia. Hollow stem auger MOBILE B-53

Sampling Method: 2 1/2" I.D. Mod. Cal. (MC)/2" I.D. Cal. (C)/1 3/8" I.D. Std. Pen., 140 lbs hammer, 30 inch drop.

BORING NUMBER B-2 — Sheet 1 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description
					0	SC	1 inches of ASPHALT CONCRETE over 8 inches of AGGREGATE BASE
MC-1	105	12	40				CLAYEY SAND (SC), medium dense, dark gray/black, moist, trace lean clay, fine grained, trace medium to coarse grained
MC-2	111	18	38	1.65	5	CL	SANDY LEAN CLAY (CL), very stiff, gray/brown, moist, trace friable white shale
MC-3	110	18	37		10	SC	CLAYEY SAND (SC), medium dense, gray/brown, moist, fine to coarse grained, trace fine gravel, trace friable white shale
MC-4	118	15	64	1.95	15		--dense, gray/brown, moist, fine to coarse grained
MC-5	114	17	56		20	SM	SILTY SAND (SM), dense, yellowish brown, moist, fine grained, trace medium to coarse grained
MC-6	111	17	75/10"		25	SC	CLAYEY SAND (SC), dense, olive gray, moist, fine grained, trace medium to coarse grained
					30	SM	

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

Date: JULY 2001 Job No.: 201131.10

This log is part of the report prepared by Parikh Consultants, Inc. for the named project and should be read together with that report for complete interpretation. 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 actual conditions encountered.

Plate: A-3A

LB 21131 7-13-01

LOG OF BORING

Boring Location, Elevation & Date Drilled: SEE ATTACHED SITE PLAN; Elev. approx. 31.0 ft.; drilled on 4-17-01

Drilling Method: 8-inch dia. Hollow stem auger MOBILE B-53

Sampling Method: 2 1/2" I.D. Mod. Cal. (MC)/2" I.D. Cal. (C)/1 3/8" I.D. Std. Pen., 140 lbs hammer, 30 inch drop.

BORING NUMBER B-2 — Sheet 2 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
MC-7	118	15	79		30		SILTY SAND (SM), dense, gray, moist to wet, fine to medium grained, trace coarse grained	
SPT-8	-	16	31		35	SC	CLAYEY SAND (SC), dense, grayish brown, wet, fine grained, trace medium grained, trace lean clay	
SPT-9	-	22	47		40	SW SM	WELL-GRADED SAND WITH SILT (SW-SM), dense, yellowish brown, wet	+#4=0.2% -#200=11.4%
SPT-10	-	19	55		45	SM	SILTY SAND (SM), very dense, gray, wet, fine to medium grained, trace coarse grained	
							Bottom of boring at 46.5 feet	
					50			
					55			
					60			

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

MIRADA ROAD PEDESTRIAN BRIDGE
SAN MATEO COUNTY, CALIFORNIA

Date: JULY 2001 Job No.: 201131.10

This log is part of the report prepared by Parikh Consultants, Inc. for the named project and should be read together with that report for complete interpretation. 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 actual conditions encountered.

Plate: A-3B

LB 21131 7-13-01

DRA

APPROVED DATE:	
NAME NAME, CITY ENGINEER	
HALF MOON BAY	
R.C.E. # 00000 / EXPIRES 00-00-0000	

APPROVED DATE:
PARIKH Practicing in the Geosciences
GARY PARIKH, P.E.
PARIKH CONSULTANTS, INC.
R.C.E. # G.E. 666 / EXPIRES 12-31-2019

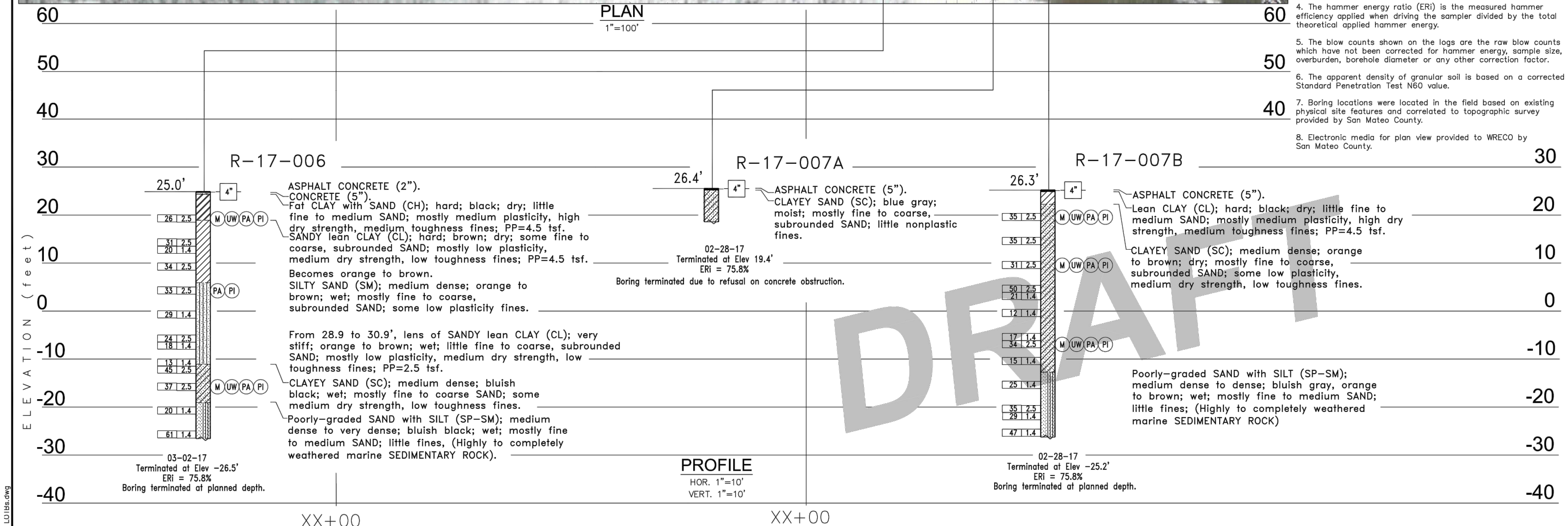
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/19 GEOTECHNICAL STATE OF CALIFORNIA

COUNTY OF SAN MATEO PUBLIC WORKS

DESIGNED BY: RCS	LOG OF TEST BORINGS 4 OF 5 MIRADA ROAD	SCALE: AS SHOWN	
CHECKED BY: RCS		DATE: 10/30/2019	
DRAWN BY: MJV		FILE NO.: 4122700	
REVISION / DATE	JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS SAN MATEO COUNTY	555 COUNTY CENTER, 5th FLOOR REDWOOD CITY, CALIFORNIA 94063	
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4		B-4 SHEET 4 OF 5	

ELEVATION REFERENCE:
Boring elevations estimated from topographic data provided by San Mateo County.

PLAN
1"=100'



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	XX			

REGISTERED GEOTECHNICAL ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of scanned copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER ROBERT LAWRENCE No. 2785 Exp. 06-30-18 GEOTECHNICAL STATE OF CALIFORNIA

WRECO
8331 SIERRA COLLEGE BLVD SE 208
ROSEVILLE, CALIFORNIA 95661 WRECO JOB NO: P15102 TO-03

County Of San Mateo Department of Public Works
555 County Center, 5th Floor
Redwood City, CA 94063-1665

Notes:

1. Field classification of soils was performed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010 Edition).

2. The 1.4 and 2.5 inch ID split barrel drive samplers were driven using a 140 pound auto-trip hammer free falling 30 inches in general conformance for performing the Standard Penetration Test (ASTM D1586) and the Modified California Split Barrel Tests (ASTM D3550). The 1.4 inch ID split barrel sampler was driven without any liner or sand catcher installed while the 2.5 inch ID split barrel sampler was fitted with three, six inch stainless steel liners installed.

3. The number of blows to drive a split barrel drive sampler the last 12 inches of an 18 inch drive was recorded as the blow count (N).

4. The hammer energy ratio (ERi) is the measured hammer efficiency applied when driving the sampler divided by the total theoretical applied hammer energy.

5. The blow counts shown on the logs are the raw blow counts which have not been corrected for hammer energy, sample size, overburden, borehole diameter or any other correction factor.

6. The apparent density of granular soil is based on a corrected Standard Penetration Test N60 value.

7. Boring locations were located in the field based on existing physical site features and correlated to topographic survey provided by San Mateo County.

8. Electronic media for plan view provided to WRECO by San Mateo County.

ENGINEERING SERVICES		GEOTECHNICAL SERVICES		PREPARED FOR SAN MATEO COUNTY	XX PROJECT ENGINEER	BRIDGE NO. XXX-XXXX	MIRADA ROAD REVETMENT PROJECT
FUNCTIONAL SUPERVISOR XX	DRAWN BY: D. Lukashov / CHECKED BY: A. Kahn	FIELD INVESTIGATION BY: K. Patrick	DATE: 02-28-17 & 03-02-17		CU XXXXXX / EA XXXXXX	POST MILE XX.XX	LOG OF TEST BORINGS 3 of 3

OGS CIVIL LOG OF TEST BORINGS SHEET — ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 — DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES (PRELIMINARY STAGE ONLY) — SHEET XX OF XX

3/29/2017 MIRADA LOTBs.dwg

APPROVED: JAMES C. PORTER C 48056 EXPIRES 12/31/19 CIVIL STATE OF CALIFORNIA

DATE:

JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS
R. C. E. # 48056 / EXPIRES 12-31-2019

APPROVED DATE:	
NAME NAME, CITY ENGINEER	
HALF MOON BAY	
R.C.E. # 00000 / EXPIRES 00-00-0000	

APPROVED DATE:
PARIKH Practicing in the Geosciences
GARY PARIKH, P.E.
PARIKH CONSULTANTS, INC.
R.C.E. # G.E. 666 / EXPIRES 12-31-2019

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH G.E. 666 Exp. 12/31/19 GEOTECHNICAL STATE OF CALIFORNIA

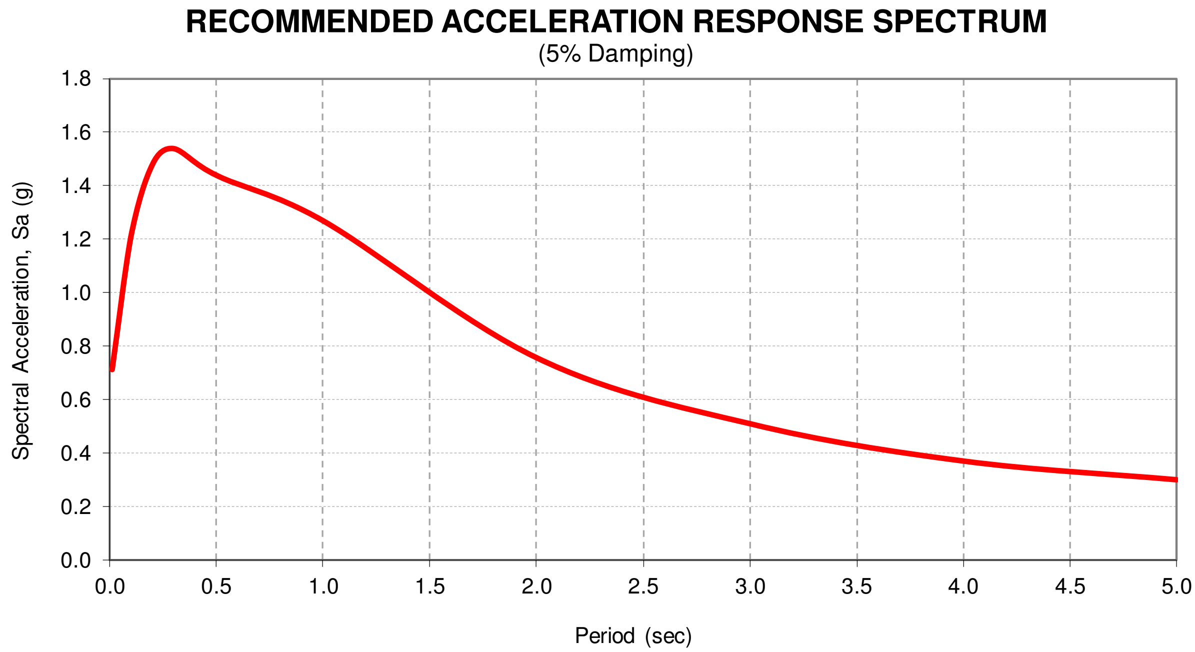
COUNTY OF SAN MATEO PUBLIC WORKS

		DESIGNED BY: RCS	LOG OF TEST BORINGS 5 OF 5 MIRADA ROAD	SCALE: AS SHOWN
		CHECKED BY: RCS		DATE: 10/30/2019
		DRAWN BY: MJV		FILE NO.: 4122700
REVISION	DATE	JAMES C. PORTER, DIRECTOR OF PUBLIC WORKS SAN MATEO COUNTY	555 COUNTY CENTER, 5th FLOOR REDWOOD CITY, CALIFORNIA 94063	B-5 SHEET 5 OF 5

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3 4

DRA

ARS Design Curves



Site Information

Latitude:	37.4934
Longitude	-122.4598
V_{S30} (m/s) =	290
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from Caltrans ARS. Dist (km) =	5.65

Governing Curve:

Caltrans Online Probabilistic ARS

Recommended Response Spectrum

Period (sec)	Caltrans Online Probabilistic Spectral Acceleration (g)	Adjusted for Near Fault Effect	Adjusted For Basin Effect	Final Adjusted Spectral Acceleration (g)
0.0	0.712	1	1	0.712
0.1	1.208	1	1	1.208
0.2	1.481	1	1	1.481
0.3	1.538	1	1	1.538
0.5	1.438	1	1	1.438
1.0	1.058	1.2	1	1.270
2.0	0.63	1.2	1	0.756
3.0	0.425	1.2	1	0.510
4.0	0.309	1.2	1	0.371
5.0	0.25	1.2	1	0.300

Source:

1. Caltrans ARS Online tool (V.2.3.09, http://dap3.dot.ca.gov/ARS_Online/)

2. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

PARIKH
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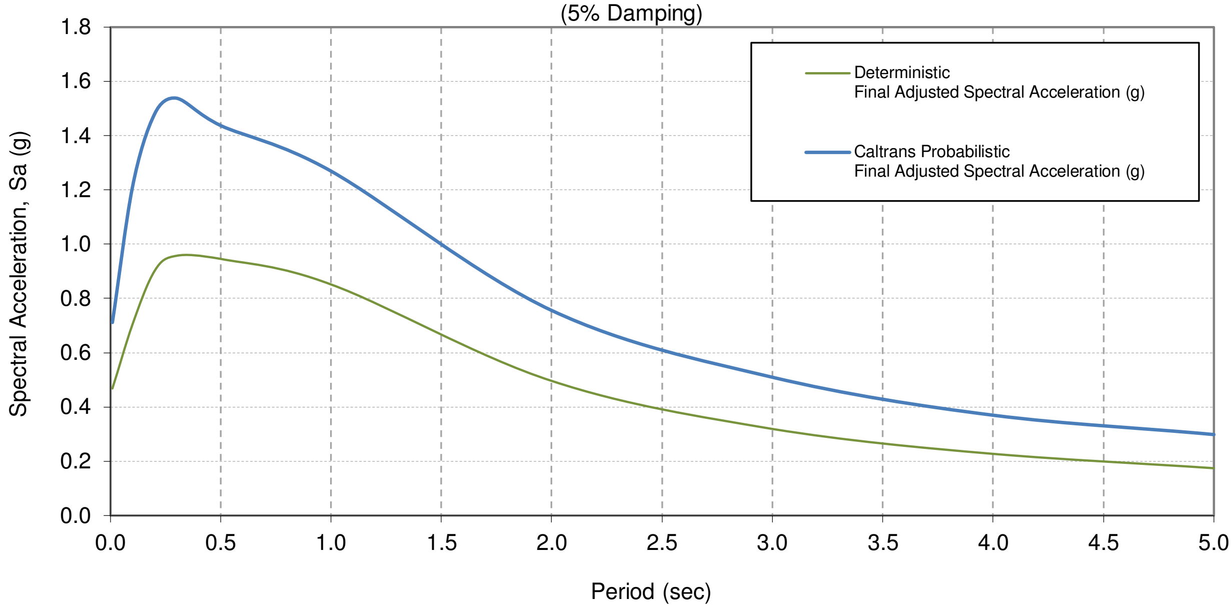
MIRADA ROAD PEDESTRIAN BRIDGE **HALF MOON BAY, CALIFORNIA**	
Project No.: 2019-147-GEO	**Plate No.: IV-A**

ACCELERATION RESPONSE SPECTRUM COMPARISON

(Deterministic & Probablistic Curves)
(5% Damping)



Site Information

Latitude:	37.4934
Longitude	-122.4598
V_{S30} (m/s) =	290
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	5.65

Period (sec)	Deterministic Final Adjusted Spectral Acceleration (g)	Caltrans Probabilistic Final Adjusted Spectral Acceleration (g)
0.0	0.470	0.712
0.1	0.703	1.208
0.2	0.902	1.481
0.3	0.958	1.538
0.5	0.946	1.438
1.0	0.853	1.270
2.0	0.496	0.756
3.0	0.320	0.510
4.0	0.228	0.371
5.0	0.176	0.300

Source:

1. Caltrans ARS Online tool (V.2.3.09, http://dap3.dot.ca.gov/ARS_Online/)

2. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

PARIKH
Practicing in the Geosciences

MIRADA ROAD PEDESTRIAN BRIDGE
HALF MOON BAY, CALIFORNIA

Project No.: 2019-147-GEO | **Plate No.: IV-B**

Soil Strength & V_{s30m} Calculation

SOIL STRENGTH PARAMETERS & V_{s30}

Calc By: J. Zhang
Date: 12/16/19

PROJECT NAME: ***Mirada Road Bridge***
PROJECT NO.: ***2019-147-GEO***
STRUCTURE:
BORING NO.: ***B-1 (As-built, 2001)***

SOIL GROUPS
1. SANDS & GRAVELS
2. CLAYS AND PLASTIC SILTS
3. NON TO LOW PLASTIC SILTS
4. YOUNG SEDIMENTARY ROCKS
5. LIQUEFIABLE SANDS (RESIDUAL STRENGTH)
6. LIQUEFIABLE SILTS (RESIDUAL STRENGTH)

BOREHOLE DIA (in)= 8 — *HAMMER ENERGY =* 60%
GW DEPTH (ft)= 25 — *DRILLING RODS (Y/N)=* Y

Nd 32 — V_{sd} (m/s) *236*
N_{30} 40 — V_{s30} (m/s) *292*
Correlation 1) Caltrans

Sample No	Layer Thickness from	Layer Thickness to	Sample Depth (ft)	Soil Type	Field Blow Count	Sampler Type	Unit Weight (pcf)	σ_v (psf)	σ_v' (psf)	SPT-$N_{eq.}$	N_{60} CE Corr.	N_{60} CR,CB,CS Corr.	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	Correlated Strength Parameters ϕ (°)	Correlated Strength Parameters c (psf)	Correlated Strength Parameters S_r (psf)	Lab Test Results c (psf)	Vs (m/s)
1	0.0	4.0	2.5	1	27	MC	125	312.5	313	18	17.6	15.1	1.70	25.7		25.7	40				142
2	4.0	9.0	6	2	45	MC	125	750	750	29	29.3	26.9	1.63	43.9				3656			213
3	9.0	14	11	2	37	MC	125	1375	1375	24	24.1	23.5	1.21	28.4				3006		2100	208
4	14.0	20	16	1	48	MC	125	2000	2000	31	31.2	34.1	1.00	34.1		34.1	39				233
5	20.0	23	21	1	45	MC	125	2625	2625	29	29.3	32.0	0.87	27.9		27.9	38				247
6	23.0	29	26	1	75	MC	125	3250	3188	49	48.8	56.1	0.79	44.4		44.4	39				272
7	29.0	33	31	1	58	SPT	125	3875	3501	58	58.0	86.7	0.76	65.5		65.5	41				282
8	33.0	38	36	1	65	SPT	125	4500	3814	65	65.0	97.2	0.72	70.4		70.4	42				291
9	38.0	43	41	1	37	MC	125	5125	4127	24	24.1	27.7	0.70	19.3		19.3	35				270
10	43.0	46.5	46	1	64	SPT	125	5750	4440	64	64.0	95.7	0.67	64.2		64.2	40				302

Note:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner), C_N (Overburden) are per Youd 2001
2. For fine-grained materials, the correlation between blow-counts and shear is based on NAVFAC DM 7.1.
3. The phi angle was estimated based on Meyerhof (1956).
4. Residual Strength (Sr) is based on Caltrans "Guidelines on Foundation Loading and Deformation Due to Liquefaction Induced Lateral Spreading", Caltrans 2011
5. The Vs were correlated based on N_{60} for Soil Types 1,3, 4; based on N_{60} or c_{lab} for Soil Type 2 and based on Sr for Soil Types 5 & 6 per Caltrans Guidelines (2012).
6. Spreadsheet Revision Date: 10/29/13

SOIL STRENGTH PARAMETERS & V_{s30}

Calc By: J. Zhang
Date: 12/16/19

PROJECT NAME: ***Mirada Road Bridge***
PROJECT NO.: ***2019-147-GEO***
STRUCTURE:
BORING NO.: ***B-2 (As-built, 2001)***

SOIL GROUPS
1. SANDS & GRAVELS
2. CLAYS AND PLASTIC SILTS
3. NON TO LOW PLASTIC SILTS
4. YOUNG SEDIMENTARY ROCKS
5. LIQUEFIABLE SANDS (RESIDUAL STRENGTH)
6. LIQUEFIABLE SILTS (RESIDUAL STRENGTH)

BOREHOLE DIA (in)= 8 — *HAMMER ENERGY =* 60%
GW DEPTH (ft)= 31 — *DRILLING RODS (Y/N)=* Y

Nd 35 — V_{sd} (m/s) *236*
N_{30} 43 — V_{s30} (m/s) *292*
Correlation 1) Caltrans

Sample No	Layer Thickness from	Layer Thickness to	Sample Depth (ft)	Soil Type	Field Blow Count	Sampler Type	Unit Weight (pcf)	σ_v (psf)	σ_v' (psf)	SPT-$N_{eq.}$	N_{60} CE Corr.	N_{60} CR,CB,CS Corr.	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	Correlated Strength Parameters ϕ (°)	Correlated Strength Parameters c (psf)	Correlated Strength Parameters S_r (psf)	Lab Test Results c (psf)	Vs (m/s)
1	0.0	4.0	2.5	1	40	MC	125	312.5	313	26	26.0	22.4	1.70	38.1		38.1	42				148
2	4.0	8.5	6	2	38	MC	125	750	750	25	24.7	22.7	1.63	37.1				3088		1650	185
3	8.5	13.5	11	1	37	MC	125	1375	1375	24	24.1	23.5	1.21	28.4		28.4	39				208
4	13.5	19	16	1	64	MC	125	2000	2000	42	41.6	45.4	1.00	45.4		45.4	41				240
5	19.0	23	21	1	56	MC	125	2625	2625	36	36.4	39.8	0.87	34.7		34.7	39				252
6	23.0	28.5	26	1	75	MC	125	3250	3250	49	48.8	56.1	0.78	44.0		44.0	39				273
7	28.5	33	31	1	79	MC	125	3875	3875	51	51.4	59.1	0.72	42.4		42.4	39				286
8	33.0	39	36	1	31	SPT	125	4500	4188	31	31.0	46.3	0.69	32.0		32.0	37				277
9	39.0	44	41	1	47	SPT	125	5125	4501	47	47.0	70.3	0.67	46.8	11%	49.5	39				294
10	44.0	46.5	46	1	55	SPT	125	5750	4814	55	55.0	82.2	0.64	53.0		53.0	39				303

Note:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner), C_N (Overburden) are per Youd 2001
2. For fine-grained materials, the correlation between blow-counts and shear is based on NAVFAC DM 7.1.
3. The phi angle was estimated based on Meyerhof (1956).
4. Residual Strength (Sr) is based on Caltrans "Guidelines on Foundation Loading and Deformation Due to Liquefaction Induced Lateral Spreading", Caltrans 2011
5. The Vs were correlated based on N_{60} for Soil Types 1,3, 4; based on N_{60} or c_{lab} for Soil Type 2 and based on Sr for Soil Types 5 & 6 per Caltrans Guidelines (2012).
6. Spreadsheet Revision Date: 10/29/13

SOIL STRENGTH PARAMETERS & V_{s30}

PROJECT NAME:	***Mirada Road Bridge***
PROJECT NO.:	***2019-147-GEO***
STRUCTURE:	
BORING NO.:	***R-17-006 (WRECO 2017)***
BOREHOLE DIA (in)=	4
GW DEPTH (ft)=	20
HAMMER ENERGY =	76%
DRILLING RODS (Y/N)=	Y

SOIL GROUPS
1. SANDS & GRAVELS
2. CLAYS AND PLASTIC SILTS
3. NON TO LOW PLASTIC SILTS
4. YOUNG SEDIMENTARY ROCKS
5. LIQUEFIABLE SANDS (RESIDUAL STRENGTH)
6. LIQUEFIABLE SILTS (RESIDUAL STRENGTH)

Calc By:	J. Zhang		
Date:	12/16/19		
Nd	27	V_{sd} (m/s)	*245*
N_{30}	33	V_{s30} (m/s)	*298*
		Correlation	1) Caltrans

Sample No	Layer Thickness from	to	Sample Depth (ft)	Soil Type	Field Blow Count	Sampler Type	Unit Weight (pcf)	σ_v (psf)	σ_v' (psf)	SPT-$N_{eq.}$	N_{60} CE Corr.	N_{60} CR,CB,CS Corr.	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	Correlated Strength Parameters ϕ (°)	c (psf)	S_r (psf)	Lab Test Results c (psf)	Vs (m/s)
1	0.0	6.5	5	2	26	MC	125	625	625	17	21.4	16.0	1.70	27.2				2669			192
2	6.5	11.5	11	2	31	MC	125	1375	1375	20	25.5	21.6	1.21	26.1				3182			228
3	11.5	15	12.5	2	20	SPT	125	1562.5	1563	20	25.3	27.9	1.13	31.6				3158			232
4	15.0	19	16	2	34	MC	125	2000	2000	22	27.9	26.5	1.00	26.5				3490			247
5	19.0	23	21	1	33	MC	125	2625	2563	21	27.1	25.7	0.88	22.7		22.7	37				244
6	23.0	28	26	1	29	SPT	125	3250	2876	29	36.6	47.6	0.83	39.7		39.7	39				258
7	28.0	31.5	31	1	24	MC	125	3875	3189	16	19.7	19.7	0.79	15.6		15.6	35				249
8	31.5	35	32.5	1	18	SPT	125	4062.5	3283	18	22.7	27.6	0.78	21.6		21.6	36				254
9	35.0	36.5	36	1	13	SPT	125	4500	3502	13	16.4	18.8	0.76	14.2		14.2	34				250
10	36.5	38.0	37.5	1	45	MC	125	4687.5	3596	29	37.0	37.0	0.75	27.6		27.6	37				272
11	38.0	44.0	41	1	37	MC	125	5125	3815	24	30.4	30.4	0.72	22.0		22.0	36				271
12	44.0	47.0	46	1	20	SPT	125	5750	4128	20	25.3	30.7	0.70	21.3		21.3	35				271
13	47.0	51.0	51	1	61	SPT	125	6375	4441	61	77.1	100.2	0.67	67.2		67.2	41				307

Note:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner), C_N (Overburden) are per Youd 2001
2. For fine-grained materials, the correlation between blow-counts and shear is based on NAVFAC DM 7.1.
3. The phi angle was estimated based on Meyerhof (1956).
4. Residual Strength (Sr) is based on Caltrans "Guidelines on Foundation Loading and Deformation Due to Liquefaction Induced Lateral Spreading", Caltrans 2011
5. The Vs were correlated based on N_{60} for Soil Types 1,3, 4; based on N_{60} or c_{lab} for Soil Type 2 and based on Sr for Soil Types 5 & 6 per Caltrans Guidelines (2012).
6. Spreadsheet Revision Date: 10/29/13

SOIL STRENGTH PARAMETERS & V_{s30}

Calc By: J. Zhang
Date: 12/16/19

PROJECT NAME: ***Mirada Road Bridge***
PROJECT NO.: ***2019-147-GEO***
STRUCTURE:
BORING NO.: ***R-17-007B (WRECO 2017)***

SOIL GROUPS
1. SANDS & GRAVELS
2. CLAYS AND PLASTIC SILTS
3. NON TO LOW PLASTIC SILTS
4. YOUNG SEDIMENTARY ROCKS
5. LIQUEFIABLE SANDS (RESIDUAL STRENGTH)
6. LIQUEFIABLE SILTS (RESIDUAL STRENGTH)

BOREHOLE DIA (in)= 4 | *HAMMER ENERGY =* 76% | Nd 26 | V_{sd} (m/s) *234*
GW DEPTH (ft)= 20 | *DRILLING RODS (Y/N)=* Y | N_{30} 31 | V_{s30} (m/s) *285*

Correlation: 1) Caltrans

Sample No	Layer Thickness from	Layer Thickness to	Sample Depth (ft)	Soil Type	Field Blow Count	Sampler Type	Unit Weight (pcf)	σ_v (psf)	σ_v' (psf)	SPT-$N_{eq.}$	N_{60} CE Corr.	N_{60} CR,CB,CS Corr.	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	Correlated Strength Parameters ϕ (°)	c (psf)	S_r (psf)	Lab Test Results c (psf)	Vs (m/s)
1	0.0	8.0	5	1	26	MC	125	625	625	17	21.4	16.0	1.70	27.2		27.2	40				171
2	8.0	13.0	11	1	31	MC	125	1375	1375	20	25.5	21.6	1.21	26.1		26.1	39				209
3	13.0	18	16	1	20	MC	125	2000	2000	13	16.4	15.6	1.00	15.6		15.6	36				219
4	18.0	21.5	21	1	34	MC	125	2625	2563	22	27.9	26.5	0.88	23.4		23.4	37				245
5	21.5	23	22.5	1	33	SPT	125	2812.5	2657	33	41.7	51.5	0.87	44.7		44.7	40				256
6	23.0	28	26	1	29	SPT	125	3250	2876	29	36.6	47.6	0.83	39.7		39.7	39				258
7	28.0	31.5	31	1	24	SPT	125	3875	3189	24	30.3	39.4	0.79	31.2		31.2	38				260
8	31.5	34	32.5	1	18	MC	125	4062.5	3283	12	14.8	14.8	0.78	11.5		11.5	34				244
9	34.0	38	36	1	13	SPT	125	4500	3502	13	16.4	18.8	0.76	14.2		14.2	34				250
10	38.0	43.0	41	1	45	SPT	125	5125	3815	45	56.9	73.9	0.72	53.5		53.5	40				288
11	43.0	46.5	46	1	37	MC	125	5750	4128	24	30.4	30.4	0.70	21.1		21.1	35				276
12	46.5	48.0	47.5	1	20	SPT	125	5937.5	4222	20	25.3	30.6	0.69	21.1		21.1	35				273
13	48.0	51.5	51	1	61	SPT	125	6375	4441	61	77.1	100.2	0.67	67.2		67.2	41				307

Note:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner), C_N (Overburden) are per Youd 2001
2. For fine-grained materials, the correlation between blow-counts and shear is based on NAVFAC DM 7.1.
3. The phi angle was estimated based on Meyerhof (1956).
4. Residual Strength (Sr) is based on Caltrans "Guidelines on Foundation Loading and Deformation Due to Liquefaction Induced Lateral Spreading", Caltrans 2011
5. The Vs were correlated based on N_{60} for Soil Types 1,3, 4; based on N_{60} or c_{lab} for Soil Type 2 and based on Sr for Soil Types 5 & 6 per Caltrans Guidelines (2012).
6. Spreadsheet Revision Date: 10/29/13