FOUNDATION REPORTS
For
EARTH RETAINING SYSTEMS
(ERS)

February 2024

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

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1. INTRODUCTION

The intent of this document is to define the Department's standard of practice for preparation of the Structure Preliminary Geotechnical Report (SPGR), the Preliminary Foundation Report (PFR), and the Foundation Report (FR) for earth retaining systems (ERS).

1.1 Reporting for Project Delivery

Geotechnical investigation and reporting generally occurs at three stages of the project development process:

- A Structure Preliminary Geotechnical Report (SPGR) to support Advanced Planning Studies, performed during the Work Breakdown Structure 150.15 (K Phase).
- A Preliminary Foundation Report (PFR) to support Type Selection, performed during the Work Breakdown Structure 160.10 (0 Phase) or 240.70 (1 Phase).
- A Foundation Report (FR) to support the design and construction of the ERS, performed during the Work Breakdown Structure 240.80 (1 Phase).

Prepare a separate foundation report for each ERS. If requested by the client, multiple ERS may be placed in one report provided that the report is archived separately at each location along with the applicable Log of Test Borings (LOTB).

Prepare reports to succinctly communicate information pertinent to the recommendations in accordance with the report preparation requirements. The following rules must be followed:

- Present specific information that is relevant to the recommendations.
- Reference or cite existing standards, specifications, or policies only when clarifying, modifying, or disallowing the standard, specification, or policy.
- Do not include unsubstantiated disclaimers.
- Provide titles for all figures and tables.
- Tables and figures must be included within the body of the report and located as near as possible to the place where they are first referenced.
- All depth references must have a corresponding elevation in parenthesis.

1.1.1 Reports Prepared by Caltrans Staff

Foundation Reports are written to the Structure Designer, Specification Engineer, and Structure Construction, and are part of the contract.

For reports prepared by Geotechnical Services staff, Foundation Reports must be prepared using the reporting (MS Word) templates with the subject line of "Foundation Report for ERS Name" or "Preliminary Foundation Report for ERS Name" or "Structure

Preliminary Geotechnical Report for ERS Name". Do not include section numbers in the report. First-level section titles presented in this document (e.g., Geotechnical Conditions) must be included in the report. Second-level section titles (e.g., Geology, Surface Conditions) are optional.

Do not include the Log of Test Borings (LOTB) and/or As-built LOTB as part of the FR. The Engineering Graphics Unit will send Microstation LOTB files and scanned copies of the As-built LOTB sheets to the Structure Designer for inclusion within the Contract Plans.

Sign, stamp, and distribute reports in accordance with the *Communications and Reporting* section of the *Offices of Geotechnical Design – Quality Management Plan*.

1.1.2 Reports Prepared by Consultants

Foundation Reports must include the following: cover sheet, table of contents, main contents per this document, and appendices. The cover of the report and any addenda/amendments to the report must include the following information: Caltrans District, County, Route, Post Mile, Structure Number, Structure Name, and Expenditure Authorization (EA) number.

The LOTB and/or As-built LOTB must be submitted as part of the FR. Refer to the *Soil and Rock Logging, Classification, and Presentation Manual* for direction on the preparation of the LOTB and As-built LOTB.

2. STRUCTURE PRELIMINARY GEOTECHNICAL REPORT (SPGR)

The SPGR is required during the early stages of a project to assist Bridge Design in the preparation of an Advanced Planning Study and cost estimate for the District. Often the number, location, and type of ERS are not completely known. As a result, recommendations may be general, and detailed field investigations are usually not warranted. Typical fieldwork consists of a site visit only. The SPGR provides an overview of the existing foundations, site geology, seismic information, and recommendations regarding suitable and unsuitable wall types. If appropriate, the SPGR should also discuss the anticipated field and laboratory work required to support the PFR and FR.

The following topics should be addressed in all Structure Preliminary Geotechnical Reports (SPGR).

2.1 Introduction

Summarize the purpose, scope, and types of work performed to obtain the information supporting the preliminary recommendations. Reference the request memo and applicable plans by date so the reader knows on what plans the recommendations are based. Do not present an exhaustive list of tasks performed, a few sentences are sufficient.

2.2 Project Description

Describe the proposed ERS and pertinent project information, such as the reason for constructing the ERS. A table such as the one below may be used to present the information.

<edit column heading to properly identify the location information presented>

Table X: ERS Information Table

ERS ID No.	ERS Type	Begin Station & Offset PM Northing/Easting Latitude/Longitude	End Station & Offset PM Northing/Easting Latitude/Longitude	Length, (feet)	Maximum Design Height (feet)

2.3 Exceptions to Policies and Procedures

List exceptions to Departmental policies and procedures relating to the SPGR. Approved *Request for Exception* forms must be included in the Appendix. Omit this section if there are no exceptions.

2.4 Geotechnical Investigation

Provide an overview of the geotechnical investigation(s) to support the preliminary ERS recommendations.

2.5 Geotechnical Conditions

Present only factual information in this section, not how it relates to design and construction. Discussion of the site geology, geological features, and subsurface conditions as they relate to the ERS design and construction must be placed in the *Foundation Recommendations* section.

2.5.1 Geology

Identify the pertinent geologic map and the prominent geologic unit(s) at the ERS site.

2.5.2 Surface Conditions

Describe site topography, surface water and drainage conditions, cuts and fills, rock exposures, geologic hazards such as landslides and rockfall, structures, and land use history that may affect the proposed ERS.

2.5.3 Subsurface Conditions

Provide a generalized description of the known subsurface conditions. The information included within this section may include:

- Types of soil/rock, depths to generalized layer breaks, and corresponding elevations
- Pertinent soil/rock conditions such as unsuitable materials (collapsible, expansive foundation materials)

Do not re-create an As-built LOTB in detail in this section. A generalized discussion or table is sufficient.

<u>*Example*</u>

The Geologic Map of Santa Ana 30' x 60' Quadrangle shows that the site is underlain by Quaternary alluvium. The topography is relatively flat and the site appears free of geologic hazards.

Based on the 1968 As-built Log of Test Borings located approximately 500 feet from the ERS, the alluvial soil at the site can generally be separated into three units. The upper unit consists of very loose to slightly compact silty sand with gravel that extends from the ground surface to a depth of about 15 feet (~ Elev. 950 feet). The middle unit consists of slightly compact to dense sand to a depth of approximately 35 feet (~ Elev. 930 feet). The lowermost unit consists of dense to very dense gravelly sand and sandy gravel with isolated zones of sandy silt and gravel. This unit extends to the maximum explored depth of the borings, which is approximately 60 feet below the ground surface (~ Elev. 905 feet).

2.6 Groundwater

Report groundwater elevation(s) and dates of measurements. Use of a table is recommended if there are numerous borings and/or measurements.

Table X: Summary of Groundwater Data

Location or Boring ID	Ground Surface Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)	Date Measured

<u>*Example: Groundwater Present*</u>

During the 1998 subsurface investigation at the adjacent bridge, groundwater was encountered in both borings. Groundwater levels varied from elevation 945 feet in

February to elevation 938 feet in August. Recent groundwater measurements by the Department of Water Resources at a well located roughly 1300 feet north of ERS site are generally consistent with the 1998 measurements.

Example: Groundwater Not Present

During the 1998 subsurface investigation at the adjacent bridge, groundwater was not encountered in either boring within the explored depth of 100 feet (~ Elev. 900 feet).

Example: Groundwater Information Not Available

Groundwater information was not available based on the literature search performed.

Example: Groundwater Information Available Nearby

Groundwater measurements available from a DWR monitoring well, located 800 feet northwest of the proposed ERS, had groundwater elevations that varied between 930 feet and 920 feet from 2018 to the present.

2.7 As-Built Foundation Data

Include brief discussion of relevant As-Built foundation data, such as:

- Existing ERS and foundation types
- Construction records such as pile driving logs or settlement monitoring data

Omit this section if there is no As-built foundation data available.

2.8 Scour Data

If the ERS is adjacent to a watercourse, report pertinent scour information, including the potential for scour and the predicted magnitude of scour.

Omit this section if the ERS is not adjacent to a watercourse.

2.9 Corrosion Evaluation

Report and discuss pertinent site corrosion data.

Example: No information available

Historical corrosion data is not available. For preliminary design purposes, the site should be considered non-corrosive based on the presence of predominantly cohesionless material. Corrosion samples will be obtained during the design phase to evaluate the corrosion potential of the site.

<u>Example: Non-Corrosive</u>

Three soil samples and one water sample were collected for corrosion testing during the 2023 subsurface investigation. Corrosion test results for those samples are shown below in Table 1. Based on current Caltrans standards, the site is non-corrosive.

<u>Example: Corrosive</u>

During the 2023 subsurface investigation, four soil samples were collected for corrosion testing. Corrosion test results for the samples collected from borings RC-23-001 and RC-23-002 are shown below in Table 1. Due to chloride content being greater than 500 ppm in two of the samples tested, the site is corrosive based on current Caltrans standards, and corrosion mitigation is required.

Table 1: Soil Corrosion Test Summary

Boring ID	*Elevation (feet)*	*Minimum Resistivity (Ohm-Cm)*	*pH*	*Chloride Content (ppm)*	*Sulfate Content (ppm)*	*Corrosive?*
RC-23-001	*15.8 to 14.3*	*1544*	*7.24*	*N/A*	*N/A*	*No*
RC-23-001	*-4.2 to -3.2*	*683*	*7.94*	*384*	*432*	*No*
RC-23-002	*-69.1 to -70.6*	*73*	*6.86*	*850*	*1500*	*Yes*
RC-23-002	*-104.1 to -105.6*	*78*	*7.71*	*1000*	*1600*	*Yes*

Caltrans currently defines a corrosive environment as an area where the soil has either a chloride concentration of 500 ppm or greater, a sulfate concentration of 1500 ppm or greater, or has a pH of 5.5 or less. With the exception of MSE, soil and water are not tested for chlorides and sulfates if the minimum resistivity is greater than 1,500 ohm-cm.

2.10 Seismic Information

Report all information required in Section 2.10.1 in the SPGR. Referencing a Seismic Report that was delivered separately is not acceptable.

2.10.1 Ground Motion Hazard

Include the following information:

a. Ground Motion Parameters table
b. State how the estimated time-average shear wave velocity V_{S30} was determined (e.g., CPT, SPT correlations, or geophysics).
c. A statement of whether the K_h used in the standardized ERS designs is applicable to the site.

<u>Example</u>

Table 1 presents the ground motion parameters.

Table 1: Ground Motion Parameters

Site Parameters			*Design Ground Motion Parameters[1] (Return Period = 975 years)*	
Latitude (degrees)	*Longitude (degrees)*	*Shear-Wave Velocity[2] V_{S30}, (m/sec)*	*Horizontal Peak Ground Acceleration (g)*	*Deaggregated Mean Earthquake Moment Magnitude for PGA*
XXX.XXXX	*XXX.XXXX*	*XXX.X*	*X.XX*	*X.XX*

1. *Based on Caltrans web tool ARS Online (Version 3.xx)*
2. *Shear wave velocity determined by <edit as appropriate>*

2.10.2 Other Seismic Hazards

Discuss the potential for the following seismic hazards:

a. Surface fault rupture (see *Fault Rupture Screening* module)
b. Liquefaction (see *Liquefaction Evaluation* module)
c. Seismically induced total and differential ground settlements
d. Lateral spreading (see *Lateral Spreading* module)
e. Seismic slope instability

Example

The ERS is not located within an Alquist-Priolo Earthquake Fault Zone or within 1000 feet of any unzoned Holocene fault. Therefore, the ERS is not considered susceptible to surface fault rupture hazards.

The project site is not located within a mapped seismic (liquefaction) hazard zone and therefore the ERS is not susceptible to liquefaction, seismic total or differential ground settlement, seismic down drag, or lateral spreading.

The project site and the adjacent areas are relatively flat. Hence, the site will not experience slope instability during the design seismic ground motion event.

2.11 Geotechnical Recommendations

Provide preliminary recommendations for the ERS, including:

- ERS types considered, and advantages and disadvantages of each
- Recommended ERS and alternatives
- ERS location (begin and end station, if available) and geometry (length, height)
- Description of external loadings (surcharge, landslide, groundwater)

- Description of site constraints (environmental, right-of-way, utilities, traffic, construction, etc.)

2.12 Additional Field Work and Laboratory Testing

Describe the anticipated scope and types of fieldwork and testing that may be required to complete the geotechnical investigation. Discuss the potential need for entry permits, task orders, groundwater monitoring, access road construction, lane closures, etc.

2.13 Report Distribution

The SPGR must be addressed to the Bridge Designer and copies provided to:

- District Project Manager
- Project Liaison Engineer
- District Materials Engineer
- District Environmental Planning (optional)

2.14 Appendix

Reports prepared by consultants must include the following:

- Appendix I: Site Map showing project location
- Appendix II: As-built Log of Test Borings (if available)

3. PRELIMINARY FOUNDATION REPORT (PFR) and FOUNDATION REPORT (FR)

The PFR is prepared after completion of the SPGR and Advanced Planning Study, and prior to Structure Type Selection. The ERS location, type, height, and length will be better defined, and the site investigation must be complete.

The FR expands on data provided in the PFR and updates the foundation recommendations based on final design details provided by Bridge Design. The FR becomes part of the contract documents via its inclusion in the Information Handout per Standard Special Provision 2-1.06B, “Supplemental Project Information.”

The following topics must be addressed in the Preliminary Foundation Report and Foundation Report.

3.1 Introduction

Summarize the scope and types of work performed to obtain the information supporting the foundation recommendations.

Foundation Report only: Include a statement that the current report supersedes all previous reports (referenced by title and date).

<u>Example: Preliminary Foundation Report</u>

Per the request dated November 25, 2023, this Preliminary Foundation Report has been prepared for the proposed ground anchor wall. The recommendations presented in this report are based on the draft layout plan dated October 15, 2023, and a subsurface investigation consisting of borings along the wall layout line.

<u>Example: Foundation Report</u>

Per the request dated October 7, 2023, this Foundation Report has been prepared for the proposed ground anchor wall. The recommendations presented in this report are based on the layout plan dated September 15, 2023, and a subsurface investigation.

This Foundation Report supersedes the Preliminary Foundation Report for (ERS Name) dated (Date) and the Structure Preliminary Geotechnical Report for (ERS Name) dated (Date).

3.2 Project Description

Describe the proposed ERS and pertinent project information, such as the reason for constructing the ERS. A table such as the one below may be used to present the information.

<edit column heading to properly identify the location information presented>

Table X: ERS Information Table

ERS ID No.	ERS Type	Begin Station & Offset PM Northing/Easting Latitude/Longitude	End Station & Offset PM Northing/Easting Latitude/Longitude	Length, (feet)	Maximum Design Height (feet)

3.3 Exceptions to Policies and Procedures

Discuss exceptions to Departmental policies and procedures relating to the PFR/FR. Approved Request for Exception forms must be included in the Appendix. Omit this section if there are no exceptions.

3.4 Geotechnical Investigation

Provide an overview of the geotechnical investigation(s) performed to support the ERS recommendations including the number of boreholes/CPT soundings, with maximum depth(s), corresponding elevation(s), and the types of field and/or downhole testing (e.g., in-situ, geophysical).

Example

Geotechnical Investigation was done by reviewing the as-built borings from the 1966 investigation of the adjacent bridge and by drilling three borings along the proposed wall layout line in November 2023. The 1966 foundation investigation consists of one 3-inch mud rotary boring and eight 1-inch driven soil tube borings. In June 2023, three mud rotary borings were drilled to a maximum depth of 50 feet (~ Elev. 230 feet) using a CS2000 drill rig. Standard Penetration Test (SPT) testing was performed at regular intervals to evaluate the engineering properties of the earth materials. The type(s) and location(s) of field testing are shown on the LOTB sheets.

3.5 Laboratory Testing Program

Provide an overview of the laboratory testing program, if performed, to support the ERS recommendations. Briefly explain what the tests were used for (e.g., soil classification, settlement, strength parameters).

Example

During the 2023 field investigation, soil samples were collected from borings RC-23-001 and RC-23-002 for soil classification and liquefaction evaluation. A *summary of the test results is provided in the Appendix, and the test sample locations are shown on the Log of Test Borings.*

3.6 Geotechnical Conditions

Present only factual information in this section, not how it relates to design and construction. Discussion of the site geology, geological features, and subsurface conditions as they relate to the foundation design and construction must be placed in the *Foundation Recommendations*, *Notes for Specifications*, and/or *Notes for Construction* sections.

3.6.1 Geology

Identify the pertinent geologic map and the prominent geologic unit(s) at the ERS site.

3.6.2 Surface Conditions

Describe site topography, surface water and drainage conditions, cuts and fills, erosion, pavement distress, geologic hazards such as landslides and rockfall, structures, and land use history that may affect the proposed ERS.

3.6.3 Subsurface Conditions

Provide a generalized description of the known subsurface conditions. The information included within this section may include:

- Types of soil/rock, depths to generalized layer breaks, and corresponding elevations
- Pertinent soil/rock conditions such as unsuitable materials (collapsible, expansive foundation materials) or rock rippability.

Do not re-create the LOTB(s) in detail in this section. A generalized discussion or table is sufficient.

<u>Example</u>

The Geologic Map of Santa Ana 30' x 60' Quadrangle shows that the site is underlain by Quaternary alluvium. The topography is relatively flat, and the site appears free of geologic hazards.

Based on the 2023 site investigation, the alluvial soil at the site can generally be separated into three units. The upper unit consists of very loose silty sand with gravel that extends from the ground surface to a depth of about 15 feet (~ Elev. 950 feet). The middle unit consists of dense sand to a depth of about 35 feet (~ Elev. 930 feet). The lowermost unit consists of dense to very dense gravelly sand and sandy gravel with isolated zones of sandy silt and gravel. This unit extends to the *maximum explored depth of approximately 60 feet below the ground surface (~ Elev. 905 feet).*

3.7 Groundwater

Report groundwater elevation(s) and dates of measurements. Use of the following table is recommended if there are numerous borings and/or measurements. Include discussions relating to the presence of wet or saturated soil when groundwater measurements were not made. Discuss surface water conditions that might influence the design or construction of the foundations. State the groundwater elevation(s) used for analyses and design.

Table X: Summary of Groundwater Data

Location or Boring ID	Ground Surface Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)	Date Measured

<u>Example</u>

As-built LOTB from the April 1968 subsurface investigation of the adjacent bridge indicate that groundwater was encountered in several borings at that time and ranged from elevation 19.0 feet to elevation 21.2 feet (NAVD88 datum). During the 2023 subsurface investigation, groundwater was measured in Boring RC-23-001 at elevation 15.3 feet, and in Boring RC-23-002 at elevation 13.9 feet. The groundwater elevation used for design was 21 feet.

3.8 As-Built Foundation Data

Include a brief discussion of <u>relevant</u> As-Built foundation data, such as:

- Existing ERS and foundation types
- Construction records such as pile driving logs or settlement monitoring data

Omit this section if there is no As-built foundation data available.

3.9 Scour Data

If the ERS is adjacent to a watercourse, report the pertinent scour information, including the potential for scour and the predicted magnitude of scour. This information may come from hydraulics reports, geotechnical investigations, BIRIS records, etc.

If the field investigation reveals geologic information that contradicts the hydraulics report, discuss the findings and provide pertinent information to the hydraulics report author so that the scour recommendations can be re-evaluated.

Omit this section if the ERS is not adjacent to a watercourse.

Example: Scour Data Available

The ERS site is underlain by alluvial soil, which are considered potentially scourable. The Structure Hydraulics Branch provided scour information in a report dated June 21, 2023, which states the Long Term (Degradation and Contraction) scour extends to elevation 2285 feet, and the Short Term (Local) scour depth is 3 feet.

Example: Scour Data Unavailable

The ERS is adjacent to the Russian River. BIRIS records do not identify any historic scour issues. The Structures Hydraulics Branch has not yet provided a Hydraulic Report to this Office.

3.10 Corrosion Evaluation

Include and update the corrosion data from the SPGR based on new findings and field investigations. If corrosion testing was not completed during the geotechnical investigation, provide justification for the corrosion recommendations.

Example: Non-Corrosive

Three soil samples and one water sample were collected for corrosion testing during the 2023 subsurface investigation. Corrosion test results for those samples are shown below in Table 1. Based on current Caltrans standards, the site is non-corrosive.

Example: Corrosive

During the 2023 subsurface investigation, four soil samples were collected for corrosion testing. Corrosion test results for the samples collected from borings RC-23-001 and RC-23-002 are shown below in Table 1. Due to the chloride content being greater than 500 ppm in two of the samples tested, the site is corrosive based on current Caltrans standards, and corrosion mitigation is required.

Table 1: Soil Corrosion Test Summary

Boring ID	*Elevation (feet)*	*Minimum Resistivity (Ohm-Cm)*	*pH*	*Chloride Content (ppm)*	*Sulfate Content (ppm)*	*Corrosive?*
RC-23-001	*15.8 to 14.3*	*1544*	*7.24*	*N/A*	*N/A*	*No*
RC-23-001	*-4.2 to -3.2*	*683*	*7.94*	*384*	*432*	*No*
RC-23-002	*-69.1 to -70.6*	*73*	*6.86*	*850*	*1500*	*Yes*
RC-23-002	*-104.1 to -105.6*	*78*	*7.71*	*1000*	*1600*	*Yes*

Caltrans currently defines a corrosive environment as an area where the soil has either a chloride concentration of 500 ppm or greater, a sulfate concentration of 1500 ppm or greater, or has a pH of 5.5 or less. With the exception of MSE, soil and water are not tested for chlorides and sulfates if the minimum resistivity is greater than 1,500 ohm-cm.

3.11 Seismic Information

Update the seismic information required for the SPGR based on new findings and/or investigations. Summarize analyses and findings.

3.11.1 Ground Motion Hazard

Include the following information:

a. Ground Motion Parameters table
b. State how the estimated time-average shear wave velocity V_{S30} was determined (e.g., CPT, SPT correlations, or geophysics).
c. A statement of whether the K_h used in the standardized ERS designs is applicable to the site.

Table X: Ground Motion Parameters

Site Parameters			Design Ground Motion Parameters[1] (Return Period = 975 years)	
Latitude (degrees)	Longitude (degrees)	Shear-Wave Velocity[2] V_{S30}, (m/sec)	Horizontal Peak Ground Acceleration (g)	Deaggregated Mean Earthquake Moment Magnitude for PGA
XXX.XXXX	XXX.XXXX	XXX.X	X.XX	X.XX

1. Based on Caltrans web tool ARS Online (Version 3.xx)
2. Shear wave velocity determined by SPT correlations

3.11.2 Other Seismic Hazards

The section must include information on the following seismic hazards:

a. Surface fault rupture (see *Fault Rupture Screening* module)
    - State whether the hazard exists
    - Provide calculated offset if requested
b. Liquefaction (see *Liquefaction Evaluation* module)
    - State whether the hazard exists
    - Provide horizontal and vertical limits
    - Provide calculated total ground settlements
c. Lateral spreading (see *Lateral Spreading* module)
    - State whether the hazard exists
    - Provide lateral displacement
    - Provide other information as requested
d. Seismic slope instability
    - State whether the hazard exists
    - Provide factor of safety

<If requested by Bridge Design, provide mitigation recommendations for specific seismic hazards in the *Recommendations* section>

<u>Example: No Hazards</u>

The site has been determined not to have potential for surface fault rupture, liquefaction, lateral spreading, or seismic-induced slope failure.

<u>Example: No Surface Fault Rupture</u>

The ERS is not located within an Alquist-Priolo Earthquake Fault Zone or within 1000 feet of any unzoned Holocene fault. Therefore, the ERS is not considered susceptible to surface fault rupture hazards.

<u>Example: Surface Fault Rupture</u>

The ERS is located within the active Hayward fault zone (north section). The Hayward fault lies within the ERS alignment and is approximately perpendicular to the ERS.

<u>Example: Liquefaction</u>

Due to the presence of loose to medium dense alluvial material and shallow groundwater beneath the site, the potential for soil liquefaction is present at the site. Liquefiable zone elevations and predicted settlement are summarized in Table 1.

Table 1: Liquefaction Potential at Retaining Wall 3

Location	*Liquefaction Elevation (feet)*	*Estimated Seismic-induced Settlement (inches)*
Station 0+00 to 0+50	*Elev. 20 to 15* *Elev. 0 to -10*	*3*
Station 0+50 to 0+80	*Elev. 10 to -5*	*4*
Station 0+80 to 1+30	*Elev. 20 to 10*	*3*

<u>Example: Lateral Spreading Potential (PFR)</u>

Due to the presence of liquefiable soils at shallow depths and relatively high design horizontal peak ground acceleration, an initial lateral spreading hazard assessment was performed by assigning residual shear strength to liquifiable layers. Based on the analysis, there is no liquefaction induced flow failure potential, but a lateral spreading induced permanent displacement of XX inches is expected. If this displacement is not acceptable, mitigation using piles or ground improvement should be considered. Geotechnical recommendations for a selected mitigation strategy will be presented in Foundation Report if requested by Bridge Design.

<u>Example: Seismic Slope Stability</u>

Seismic slope stability analyses were performed to evaluate the overall stability. The pseudo static analysis with a horizontal seismic coefficient (kh) equal to 0.15g was performed.

Two-dimensional slope stability analyses were performed. The analyses found the minimum value of factor of safety at the ERS to be approximately 1.25 (resistance factor = 0.8), which meets the accepted minimums for stable abutment slopes (per AASHTO LRFD).

3.12 Geotechnical Recommendations

Provide complete and concise recommendations by addressing the applicable topics of this section. At the beginning of the recommendations section, present the following:

1. Identify ERS addressed in this section
2. Considerations and/or constraints (e.g., environmental, right-of-way, permitting, CMGC, ABC) that influenced the ERS type selection.
3. Description of the ERS
    a. Location (begin and end station, length, and alignment)
    b. Design Height (maximum and minimum)
    c. Describe the representative cross-sectional geometry and external loads. Reference the plan sheets when possible.
4. Geotechnical design parameters

a. Soil and rock parameters used for geotechnical analyses, using the Design Parameters table below. If applicable, provide parameters for short term and long-term design. Use multiple tables if design parameters vary along the wall length.
b. Groundwater conditions used for both short term and long-term analyses, including results of seepage or flow analyses.
c. Description of external loads (surcharge, landslide)
    i. Surcharge load locations, magnitudes, types (line, uniform, etc.) and inclinations
    ii. Landslide geometry (depth, location), failure mode, and material properties (strength parameters, unit weights). For structures that stabilize slopes, provide maps and cross sections of the slope modeling.

Table X: Design Parameters (Station x to Station y)

Layer No.	Layer boundaries	Group Name	Engineering Parameters
1	Finished grade to elev. 300	Silty Sand (fill)	Φ = 34 degrees, γ = 120 pcf
2	Elev. 285 to 300	Silty Sand	Φ = 33 degrees, γ = 113 pcf
3	Elev. 272 to 285	Poorly-graded Sand	Φ = 34 degrees, γ = 120 pcf
4	Elev. 250 to 272	Silty Sand	Φ= 34 degrees, γ = 114 pcf

If the earth pressures were generated using the generalized limit equilibrium method omit the *Design Parameters* table and include the two following tables:

- *Active Lateral Earth Pressures* table

Table X: Active Lateral Earth Pressures

Layer	Depth (ft)	Unit Weight (pcf)	Vertical Stress (psf)	Static K_a	Static σ_h (psf)	Seismic K_{ae}	Seismic σ_h (psf)
1							
2							

- *Passive Lateral Earth Pressures* table

Table X: Passive Lateral Earth Pressures

Layer	Depth (ft)	Unit Weight (pcf)	Vertical Stress (psf)	Static K_p	Static σ_h (psf)	Seismic K_{pe}	Seismic σ_h (psf)
1							
2							

Refer to the *Reporting* section of the following modules for reporting requirements of specific wall types.

- Conventional Retaining Walls
- Mechanically Stabilized Embankments (Caltrans Pre-Designed)
- Mechanically Stabilized Embankments (Non-Standard Design)
- Soil Nail Walls
- Non-Gravity Cantilever Retaining Walls
- Ground Anchor Earth Retaining Systems

Recommendations for ERS not addressed in a module should include all information necessary to prepare a design that complies with LRFD specifications.

3.13 Notes for Specifications

Omit this section for the Preliminary Foundation Report.

This section provides recommendations to the Specifications Engineer for inclusion and editing of Standard Special Provisions and NSSPs. Refer to the *Geotechnical Notes for Specifications* module for guidance on how to prepare this report section.

3.14 Notes for Construction

Omit this section for the Preliminary Foundation Report.

Notes for Construction are written to State construction personnel and contractors. Specific geologic conditions that are relevant to construction inspection should be cited in this section to ensure that the intent of the geotechnical design is met and construction is successful.

Address topics when applicable, such as:

1) Include the following instructions to request footing inspections by the Geoprofessional.

Example

The ERS footing excavation is to be inspected and approved by the Office of Geotechnical Design X, Branch Y. The inspection will be made after the excavation has been completed to the bottom of footing elevation and prior to placing concrete or rebar in the excavations. It is requested that the Structures Representative provide the Office of Geotechnical Design X, Branch Y a one-week notification to perform the inspections.

(Note: If sub-excavation and replacement are required, modify the above example to require the inspection to be performed when the contractor completes the sub-excavation and prior to replacement.)

3.15 Report Distribution

Reports must be addressed to the Structure Designer and copies provided to:

- District Project Manager
- Project Liaison Engineer (PFR only)
- District Environmental Planning (optional, PFR only)
- Structures Office Engineer (FR only)
- District Materials Engineer

3.16 Appendices

The Preliminary Foundation Report and Foundation Report appendices provide detailed information supporting foundation type selection, analyses, and recommendations. Reports prepared by Geotechnical Services staff must include the following (in the order presented, numerated as Appendix I, Appendix II, …), if produced during the investigation:

- Laboratory Test Data (including Corrosion Test Report) – Organized by test type. In addition to the raw laboratory test results, organize and provide summary tables and graphs developed for the interpretation of laboratory test results.
- Field-generated Geologic Map and Cross-Sections: Do not include copies of published maps.
- Geophysical Test Reports
- Fault Rupture Report
- Pile Drivability Study
- Soil parameters for lateral analysis and/or P-Y Curves
- Approved "Request for Exception" forms

Optional

- Photos relevant to the investigation findings, design recommendations, and construction. Photos that illustrate content presented in the text should be embedded in the report if feasible.

Reports prepared by consultants must include the following (in the order presented, numerated as Appendix I, Appendix II, …):

All Foundation Reports:

- Appendix I: Site Map showing project location
- Appendix II: Log of Test Borings (including As-built LOTB)
- Appendix III: Calculation Package
- The objectives of each calculation, such as time rate of settlement or bearing resistance.
- List calculation assumptions
    - The geotechnical model used for each calculation.
    - The equations used and meaning of the terms used in the equations
    - Copies of the curves or tables used in the calculations and their source.
    - The load and resistance factors, or factors of safety, used for the design
    - If the calculations are performed using computer spreadsheets – step-by-step calculations for one example to demonstrate the basis of the spreadsheet. A computer spreadsheet is not a substitute for the step-by-step calculation.
    - Summary of the calculation results that form the basis of geotechnical recommendations, including a sketch of the design, if appropriate.

If produced during the investigation:

- Laboratory Test Data (including corrosion) – Organized by test type. Summarize and provide summary tables and graphs developed for the interpretation of laboratory test results.
- Field-generated Geologic Map and Cross-Sections: Do not include copies of published maps.
- Geophysical Test Reports
- Fault Rupture Report
- Pile Drivability Study
- Data acquired from field testing such as Pressuremeter, Dilatometer, in-situ Vane Shear Tests, slope inclinometer.
- Approved "Request for Exception" forms

Optional:

- Photos relevant to the investigation findings, design recommendations, and construction. Photos that illustrate content presented in the text should be embedded in the report if feasible.