FOUNDATION REPORTS
for
BUILDINGS and MISCELLANEOUS STRUCTURES

July 2024

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

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1. INTRODUCTION

This document presents the Department's standard of practice for preparation of the Foundation Report (FR) for buildings and other miscellaneous structures. The project plans and specifications for these facilities are prepared by the Office of Transportation Architecture (OTA). Structures that may require design support from Geotechnical Services include buildings, retaining walls, canopies, material storage bunkers, tanks, power generation equipment, and light towers.

1.1 Reporting for Project Delivery

Buildings and miscellaneous structures are most often funded from the Minor A or B Program and reporting generally occurs only at the design or 1-phase of a project (Work Breakdown Structure 240.80). Planning and preliminary design reports are infrequently requested for buildings. If a Structure Preliminary Geotechnical Report or a Preliminary Foundation Report is requested for a building or other miscellaneous structure, adhere as closely as possible to the format presented in this document.

One foundation report can present foundation recommendations for multiple structures located at a facility such as a maintenance station, CHP inspection facility, or toll plaza. Ancillary structure (i.e., retaining walls) recommendations can be included in the same report (see applicable reporting standard).

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 and numbers 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 parentheses.

1.1.1 Reports Prepared by Caltrans Staff

Foundation Reports are written to the OTA Designer. They are also provided to bidders via the Information Handout. Specifications are prepared by the OTA designer.

Foundation Reports must be prepared using the reporting (MS Word) templates with the subject line of "Foundation Report for *Facility Name*". Do not use the 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.

The Log of Test Borings (LOTB) and/or As-built LOTB are not to be submitted as part of the FR. Microstation LOTB files and scanned copies of the As-built LOTB sheets will be sent to the Office of Transportation Architecture 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 consist of 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 (if applicable), Post Mile (if applicable), and Expenditure Authorization (EA) number.

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

2. FOUNDATION REPORT

The following topics must be addressed in the Foundation Report.

2.1. Introduction

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

Example

Pursuant to the request dated January 20, 2024, this Foundation Report has been prepared for the proposed Little City Maintenance Station. This report is summarizes the investigations performed and provides foundation recommendations for the crew building and the vehicle maintenance building. The recommendations presented in this report are based on the site plans dated January 10, 2024, a subsurface investigation, proposed foundation configurations and load demand information provided by the Office of Transportation Architecture.

2.2. Project Description

Describe the proposed buildings and/or structures. Provide pertinent project information relating to the planned foundation improvements. Report the datum used to reference the elevations.

Example

The proposed improvements are located at the Little City maintenance station on State Route 21 at PM R3.8 (LAT/LONG) and include a new crew building and vehicle maintenance building. All elevations referenced within this report are based on the North American Vertical Datum of 1988 (NAVD 88), unless otherwise noted. To convert an elevation at this site from National Geodetic Vertical Datum of 1929 (NGVD 29) to NAVD 88, add 2.3 feet to the NGVD 29 elevation.

Based on the Site Plan and the Foundation Report request, the proposed buildings will be supported by continuous footings founded below the exterior perimeter walls.

2.3. Exceptions to Policies and Procedures

Discuss exceptions to Departmental policies and procedures relating to the FR. 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 investigation performed to support the geotechnical recommendations. Include the number of boreholes/CPT soundings with maximum depth(s), corresponding elevation(s), and the types of field testing (e.g., in-situ, geophysical).

Example

In February 2024, a subsurface investigation was performed consisting of two hollow stem auger borings drilled to a maximum depth of 40.0 feet (elevation 125 feet). Boring A-24-001 was drilled near the northeast corner of the proposed crew building. Boring A-24-002 was drilled near the southwest corner of the proposed vehicle maintenance building. The As-built LOTB indicates that three borings were drilled to a maximum depth of 45 feet (elevation 120 feet) in April 1988.

2.5. Laboratory Testing Program

Provide an overview of the laboratory testing program, if performed, to support the foundation recommendations. Briefly explain how the tests contributed to report findings (e.g., soil classification, settlement, strength parameters).

Example

During the field investigation, soil samples for particle analysis and Atterberg limits were collected from borings A-24-001 and A-24-002 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.

2.6. 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* and *Notes for Construction* sections, respectively.

2.6.1. Geology

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

2.6.2. 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 structure.

2.6.3. Subsurface Conditions

Provide a generalized description of the 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 (e.g., liquefiable, collapsible/compressible, expansive foundation materials)

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

Example

The "Geologic Map of the San Bernardino Quadrangle" (Bortugno and Spittler, 1998) shows that the maintenance station site is underlain by Quaternary alluvium. The topography is relatively flat, and no geologic hazards have been identified.

The soil borings revealed that the site is underlain by interbedded layers of predominantly dense to very dense poorly-graded sand with silt and well-graded sand with gravel, cobbles, and boulders, to the maximum depth drilled at the site of 40.0 feet (elev. 2377.9 feet). Soil descriptions from the 2024 subsurface investigation are presented on the Log of Test Borings.

At the northeast corner of the maintenance building (Boring A-24-001), very hard boulders up to 2 feet in size were identified. However, larger boulders up to 3 feet were exposed in the adjacent natural slope.

2.7. Groundwater

Report observed groundwater elevation(s) and date(s) of measurements. Use of a table is recommended if there are numerous borings and/or measurements. Discuss surface water conditions that might influence the design or construction of the foundations. The presence of shallow groundwater is of importance for determining the need for a vapor barrier below the slab of occupied space. State the groundwater elevation(s) used for foundation 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

Example

As-built LOTB's from the April 1988 subsurface investigation indicate that groundwater was encountered in several borings at that time and ranged from elevation 2381.9 feet to elevation 2382.2 feet (NAVD88 datum). During the 2024 subsurface investigation groundwater was measured in Boring A-24-001 at elevation 2381.3 feet and in Boring A-24-002 at elevation 2383.9 feet. The groundwater elevation used for design was 2385.0 feet.

2.8. As-built Foundation Data

If not addressed elsewhere in the FR, include discussion of relevant As-built foundation data, such as the type of foundation systems used for existing structures at the site. Include as much specific data as possible: foundation types, elevations, widths, and loading. Discuss the potential of encountering buried obstructions such as abandoned foundations and utilities.

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

2.9. Corrosion Evaluation

Report and discuss pertinent site corrosion data.

Example: Non-Corrosive

Two soil samples were collected for corrosion testing during the 2024 subsurface investigation. Corrosion test results for those samples are shown below in Table 1. Based on current Caltrans' standards, the site is non-corrosive.

Table 1: Soil Corrosion Test Summary

Boring ID	*Elevation (ft)*	*Minimum Resistivity (Ohm-Cm)*	*pH*	*Chloride Content (ppm)*	*Sulfate Content (ppm)*
A-24-001	*2409.2 to 2410.7*	*1544*	*7.24*	*N/A*	*N/A*
A-24-002	*2415.3 to 2416.8*	*683*	*7.94*	*384*	*432*

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. Soil and water are not tested for chlorides and sulfates if the minimum resistivity is greater than 1,500 ohm-cm.

Example: Corrosive

During the 2024 subsurface investigation four soil samples were collected for corrosion testing. Corrosion test results for the samples collected from borings A-24-001 and A-24-002 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.

2.10. Seismic Information

Provide the following:

- Site Classification
- Spectral acceleration for the 0.2 second or short period (S_S)
- Spectral acceleration for the 1 second period (S_1)

Example

In accordance with the 2022 edition of the California Building Code section 1613.2.2., the site is a seismic Site Class D ("Stiff Soil") based on an average SPT blow counts from nearby boreholes. The S_s = 0.75 and the S_1 = 0.3.

The section must address the following seismic hazards:

a. Surface fault rupture (see *Fault Rupture Screening* module)
b. Liquefaction (see *Liquefaction Evaluation* module, CBC, and ASCE 7)
c. Effects of Liquefaction, including
    i. Seismically-induced ground surface settlements
    ii. Lateral spreading (see *Lateral Spreading* module)
d. Seismic slope stability
e. Tsunami risk

Example: No Hazards

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

Example: No Surface Fault Rupture

The building is not located within an Alquist-Priolo Earthquake Fault Zone and therefore, not considered susceptible to surface fault rupture hazards.

Example: Surface Fault Rupture

The building is located within the active Hayward fault zone (north section). The Hayward fault lies outside of the building footprint. Per the attached Fault Rupture Report dated November 15, 2023, the fault could experience up to 2 feet of lateral offset and up to 0.79 feet of vertical offset.

Example: Liquefaction

Due to the presence of loose to medium dense alluvial material and high groundwater beneath the site, the potential for soil liquefaction under strong ground shaking is present. The liquefiable zone elevations at locations within the project limits are provided below in Table 1.

Table 1: Liquefaction Potential at Little City Maintenance Station

Location	*Liquefaction Elevation (ft)*	*Estimated Seismic-induced Settlement (in)*
NE corner of crew building	*Elev. 20 to 15 and Elev. 0 to -5*	*3*
Center of crew building	*Elev. 10 to -5*	*4*
SW corner of crew building	*Elev. 20 to 10*	*3*

Example: Lateral Spreading Potential

It is anticipated that lateral spreading may occur at the proposed location of the crew building. Mitigation of this settlement may include the use of deep foundations or ground improvement.

Example: Seismic Settlement

Liquefaction-induced settlement of the ground surface is estimated to range from 3 to 5 inches. Mitigation of this settlement may include the use of deep foundations or ground improvement.

2.11. Geotechnical Recommendations

Provide complete and concise foundation recommendations by addressing the topics in the applicable portions of this section. Discuss the recommended foundations and any special considerations (e.g., ground improvement, liquefaction) that influence their design and selection.

Example: Shallow Foundations

At the Crew Building and the Vehicle Maintenance Building, continuous footings are recommended. The subsurface information gathered for the site indicates that the footings will be founded in alluvial soil. The following foundation recommendations were designed in accordance with the 2022 California Building Code.

Example: Deep Foundations

Based on the subsurface information gathered at the site, driven precast concrete piles (Alt. "X") are recommended at both the Crew Building and Vehicle Maintenance Building. The following foundation recommendations were designed in accordance with the 2022 California Building Code.

2.11.1 Spread Footings and Continuous Footings

Present and/or discuss the following:

1. A description of the material on which the footing is to be placed.
2. The soil or rock strength parameters and unit weight used for the bearing resistance calculations.
3. The immediate settlement and long-term settlement values.
4. The coefficient of friction for sliding.
5. The lateral bearing pressure.
6. Report the footing recommendations using the following table:

Table 1: Footing Design Recommendations for Crew Building

Footing Type	*Footing Width (feet)*	*Minimum footing embedment below grade (feet)*	*Approximate Footing Elevation (feet)*	*Ultimate Soil Pressure (psf)*	*Allowable Soil Pressure (psf)*
Continuous	*2.0*	*1.5*	*7.24*	*3300*	*1100*
Continuous	*3.0*	*2.0*	*6.74*	*4200*	*1400*
Square	*6.0*	*2.0*	*6.74*	*5100*	*1700*
Square	*8.0*	*2.0*	*6.74*	*6600*	*2200*

Note: The allowable soil pressure may be increased by 33% for load combinations that include short term or transient loads used in the alternative basic load combinations of Section 1605.2.

Provide the following (applicable) information to aid in preparation of the contract plans.

1. Location of footings adjacent to existing footings or utilities

   Example

   Avoid transferring load from proposed foundations to existing foundations by configuring their bearing surfaces below an imaginary 1.5 horizontal to 1 vertical plane that is projected upward from the bearing surface of the edge of the existing footing.

2. Footings below groundwater level

   Example

   Groundwater will be encountered during construction of the continuous footings at the location of the proposed Crew Building. Dewatering is anticipated for construction.

3. Footing below groundwater level – seal course recommended

   Example

   Groundwater will be encountered during construction of the pump station. A two-foot-thick seal course is recommended for construction.

4. Footings with sub-excavation and replacement with structure backfill

   Example

   At the Vehicle Maintenance Building, unsuitable native soils were identified in the subsurface investigation and possibly underlie the proposed continuous footing. Therefore, it is recommended that the native materials be removed to a depth of 2.0 feet below the bottom of footing and be replaced with structure backfill compacted to 95% relative compaction, or concrete to the bottom of footing elevation. The bottom of sub-excavation elevation is listed in Table 1. The excavation should extend 2 feet horizontally from both sides of the footing.

Table 1: Little City Maintenance Station – Bottom of Sub-Excavation Elevation

Support Location	*Bottom of Sub-Excavation Elevation (feet)*
Vehicle Maintenance Building	*4334.4*

2.11.2 Deep Foundations

Include the Foundation Design Recommendations table and Pile Data Table. These tables have been modified from those found in Memos to Designers 3-1 to reflect Allowable Stress Design practice, not Load and Resistance Factor Design.

<Include "Total Permissible Pile Settlement" column and applicable Notes, if provided by OTA>

Table 1: Little City Maintenance Station – Foundation Design Recommendations

Location	Pile Type	Cut-off Elevation (feet)	Allowable Load per Pile (kips)	Total Permissible Pile Settlement (inches)	Ultimate Geotechnical Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)	Required Driving Resistance (kips)
					Compression (FS = 2.0)	Tension (FS = 2.0)			
Crew Building	HP 14X89"	100	140	1	240	0	50 (a)	50	280

Notes:

1) *Design tip elevations are controlled by: (a) Compression, (b) Tension, (c) Settlement, respectively.*
2) *The specified tip elevation must not be raised above the design tip elevations for Tension and Settlement.*
3) *The required driving resistance is equal to the ultimate resistance needed to support the load plus driving resistance from the unsuitable soil layers (very soft, liquefiable) which do not contribute to the design resistance. Unsuitable soil layers extend to elevation 90 feet.*

Table 2: Little City Maintenance Station – Pile Data Table

Location	Pile Type	Ultimate Geotechnical Resistance (kips)		Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Required Driving Resistance (kips)
		Compression	Tension			
Crew Building	HP 14X89"	240	0	50 (a)	50	280

Notes:

1) *Design tip elevations for are controlled by: (a) Compression, (b) Tension, (c) Settlement*
2) *The specified tip elevation must not be raised above the design tip elevations for Tension and Settlement.*
3) *Unsuitable soil layers (very soft, liquefiable) that do not contribute to the ultimate geotechnical resistance exist to elevation 90 feet.*

Incorporate appropriate report content from *Foundation Recommendations* section of the *Foundations Reports for Bridges* module. This includes considerations for pile modification from the standard plan details, pile acceptance criteria, and predrilling limits.

2.11.3 Concrete Slabs on Grade

State the bottom of slab elevation and provide the applicable modulus of subgrade reaction for the slab foundation soil that incorporates the footing dimensions: k_s, $k_{s,rect}$ or $k_{s,cont}$.

The recommendation for a vapor barrier beneath occupied buildings is provided by Geotechnical Services (GS) in the Foundation Report.

2.11.4 Retaining Walls and Earth Retaining Systems (ERS)

Refer to the applicable design module and/or the *Foundation Reports for Earth Retaining Systems* module for reporting requirements.

2.11.5 Site Grading

Provide recommendations for cut slope and fill slopes in accordance with the applicable module. Provide recommendations as to the suitability of on-site materials for use as structure backfill.

2.11.5 Radio Communications Towers and Infrastructure

Provide information requested by OTA.

2.12. Notes for Construction

Incorporate appropriate report content from the *Notes for Construction* section of the *Foundations Reports for Bridges* module. This includes considerations for shallow foundation excavation inspections, pile modification from the standard plan details, pile acceptance criteria, or predrilling limits.

2.13. Report Distribution

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

- District Project Manager
- District Materials Engineer

2.14. Appendices

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, …):

- Appendix I: Site Map showing project location

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
- 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, …).

- Appendix I: Site Map showing project location

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
- 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.

Additionally, the following must be submitted individually (i.e., not attached to the report) for all Foundation Reports:

1. Log of Test Borings (including As-built LOTB) and Test Boring Layout sheets
2. Calculation Package
    - The objectives of each calculation, such as bearing resistance or time rate of settlement.
    - Calculation assumptions
    - Geotechnical model used for each calculation
    - 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.
3. Comment Matrix with consultant responses