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GEOTECHNICAL STUDY REPORT
MCSWEENEY RESIDENCE
SUNNYSIDE DRIVE (APN 114-101-08)
POINT REYES STATION, CALIFORNIA

Project Number:

4687.01.04.1

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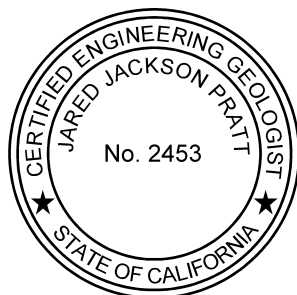
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INTRODUCTION

This report presents the results of our geotechnical study for the residence and ADU (accessory dwelling unit) to be built off Sunnyside Drive, (APN 114-101-08), in Point Reyes Station, California. We understand that a residence and ADU will be built on the undeveloped property. The site location is shown below.



We anticipate the residences will be a one- or two-story, wood-framed structures with structurally supported wood or concrete slab-on-grade floors supported on spread footings. Retaining walls may be needed to provide the necessary level breaks across the building site. Grading plans are not available, but we anticipate that the planned grading will be the minimum amount needed to establish the grades and provide the building sites with positive drainage, and could include cuts and fills on the order of 2 to 5 feet.

SCOPE

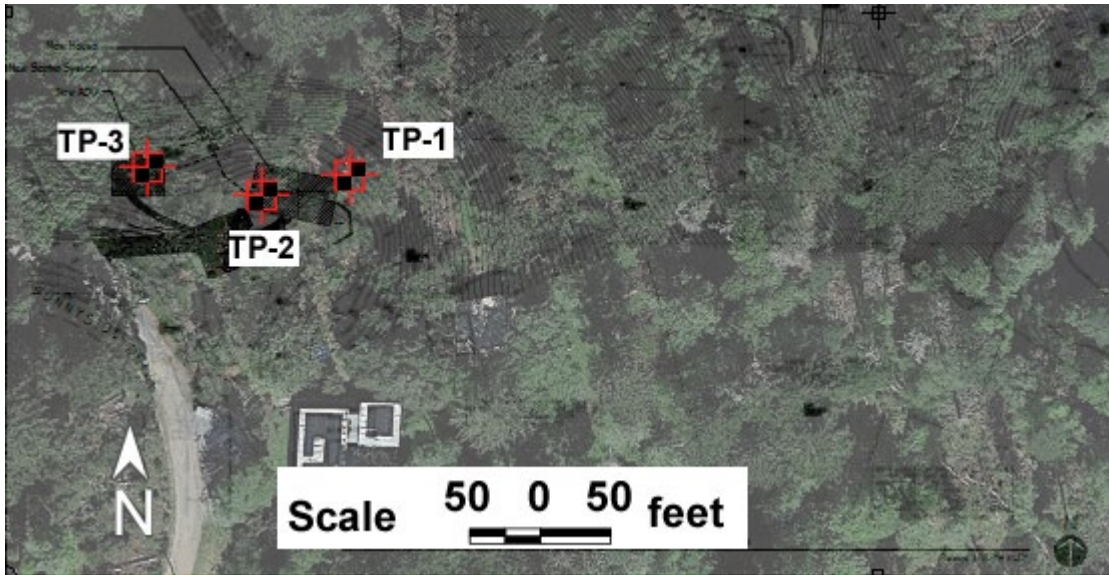
The purpose of our study, as outlined in our Professional Service Agreement dated March 30, 2021, was to generate geotechnical information for the design and construction of the project. Our scope of services included reviewing selected published geologic data pertinent to the site; evaluating the subsurface conditions with test pits and laboratory tests; analyzing the field and laboratory data; and presenting this report with the following geotechnical information:

1. A brief description of the soil, bedrock, and groundwater conditions observed during our study;
2. A discussion of seismic hazards that may affect the proposed improvements; and
3. Conclusions and recommendations regarding:
 - a. Primary geotechnical engineering concerns and mitigating measures, as applicable;
 - b. Site preparation and grading including remedial grading of weak surface soil;
 - c. Foundation type(s), design criteria, and estimated settlement behavior;
 - d. Lateral loads for retaining wall design;
 - e. Support of concrete slabs-on-grade;
 - f. Utility trench backfill;
 - g. Geotechnical engineering drainage improvements; and
 - h. Supplemental geotechnical engineering services.

STUDY

Site Exploration

We reviewed our previous geotechnical studies in the vicinity and selected geologic references pertinent to the site. The geologic literature reviewed is listed in Appendix A. On April 21, 2021, we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by excavating test pits with a track-mounted excavator at the approximate locations shown below. The test pit locations were determined approximately and should be considered accurate only to the degree implied by the method used. Our personnel located and logged the test pits and obtained samples of the materials encountered for visual examination, classification, and laboratory testing.



The summary of our test pits is shown in the **Subsurface** section below. The test pit summary shows our interpretation of the subsurface soil, groundwater, and bedrock conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil and bedrock samples, laboratory test results, and interpretation of excavation resistance. The location of the soil and bedrock boundaries should be considered approximate. The transition between soil and bedrock types may be gradual.

Laboratory Testing

The samples obtained from the test pits were transported to our office and re-examined to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their classification (Atterberg Limits, percent of silt and clay) and expansion potential (Expansion Index - EI). The test results are presented below in the **Subsurface** section.

SITE CONDITIONS

General

Marin County is located within the California Coast Range geomorphic province. This province is a geologically complex and seismically active region characterized by sub-parallel northwest-trending faults, mountain ranges and valleys. The oldest bedrock units are the Jurassic-Cretaceous Franciscan Complex and Great Valley sequence sediments originally deposited in a marine environment. Subsequently, younger rocks such as the Tertiary-age Sonoma Volcanics group, the Plio-Pleistocene-age Clear Lake Volcanics and sedimentary rocks such as the Guinda, Domengine, Petaluma, Wilson Grove, Cache, Huichica and Glen Ellen formations were deposited throughout the province. Extensive folding and thrust faulting during late Cretaceous through early Tertiary geologic time created complex geologic conditions that underlie the highly varied topography of today. In valleys, the bedrock is covered by thick alluvial soil.

Landslides

Published landslide maps (Wentworth et al., 1997) do not indicate large-scale slope instability at the site, and we did not observe active landslides at the site during our study.

Surface

The property extends primarily over relatively level to moderately sloping terrain. In general, the ground surface is soft and spongy. This is a condition generally associated with weak, porous surface soil. Natural drainage consists of sheet flow over the ground surface that concentrates in man-made surface drainage elements such as roadside ditches and natural drainage elements such as swales, ravines, and creeks.

Subsurface

Our test pits and laboratory tests indicate that the portion of the site we studied is blanketed by weak surface soil. This soil exhibits low to moderate plasticity (LL = 36.0; PI = 6.8) and very low expansion potential (EI = 0). Weak surface soils are materials with varying density, strength, compressibility, and shrink-swell characteristics that often has an unknown settlement behavior under new loads. These surface materials are underlain by granite bedrock. A summary of the subsurface conditions found in our test pits is given below. Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-16, titled "Minimum Design Loads and Associated Criteria for Buildings and Other Structures" (2017), we have determined a Site Class of C should be used for the site.

Test Pit #	Depth (ft.)	Description
TP-1	0 - 1	BROWN SILTY SAND WITH GRAVEL (SM) loose to medium dense, moist (porous)
	1 - 3½	YELLOW BROWN GRANITE closely to very closely spaced fractures, firm, weak, moderately weathered No Groundwater encountered
TP-2	0 - 1¾	BROWN SILTY SAND WITH GRAVEL (SM) loose to medium dense, moist (porous)
	1¾ - 3½	YELLOW BROWN GRANITE closely to very closely spaced fractures, firm, weak, moderately weathered No Groundwater encountered
TP-3	0 - 2½	BROWN SILTY SAND WITH GRAVEL (SM) loose to medium dense, moist (porous)
	2½ - 5	YELLOW BROWN GRANITE closely to very closely spaced fractures, firm, weak, moderately weathered No Groundwater encountered

Groundwater

Free groundwater was not observed in our test pits at the time of excavation. On hillsides, rainwater typically percolates through the porous surface materials and migrates downslope in the form of seepage at the interface of the surface materials and bedrock, and through fractures in the bedrock. Fluctuations in the seepage rates typically occur due to variations in rainfall intensity, duration and other factors such as periodic irrigation.

DISCUSSION AND CONCLUSIONS

Seismic Hazards

We did not observe subsurface conditions within the portion of the property we studied that would suggest the presence of materials that may be susceptible to seismically induced densification, liquefaction, or lurching. Therefore, we judge the potential for the occurrence of these phenomena at the site to be low.

Faulting and Seismicity

We did not observe landforms within the area that would indicate the presence of active faults and the site is not within a current Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Therefore, we believe the risk of fault rupture at the site is low. However, the site is within an area affected by strong seismic activity. Therefore, future seismic shaking should be anticipated at the site. It will be necessary to design and construct the proposed improvements in strict adherence with current standards for earthquake-resistant construction.

Geotechnical Issues

General

Based on our study, we judge the proposed improvements can be built as planned, provided the recommendations presented in this report are incorporated into their design and construction. The primary geotechnical concerns during design and construction of the project are:

1. The presence of weak surface soil;
2. The detrimental effects of uncontrolled surface runoff and groundwater seepage on the long-term satisfactory performance of residences given the erosion potential and porous nature of the surface soil; and
3. The strong ground shaking predicted to impact the site during the life of the project.

Weak Surface Soil

Weak surface soil, such as that found at the site, appears hard and strong when dry but will lose strength rapidly and settle under the load of fills, foundations and slabs as its moisture content increases and approaches saturation. The moisture content of this soil can increase as the result of rainfall, periodic irrigation or when the natural upward migration of water vapor through the soil is impeded by, and condenses under fills, foundations, and slabs. The detrimental effects of such movements can be reduced by strengthening the soil during grading. This can be achieved by excavating the weak soil and replacing it as properly compacted (engineered) fill. Alternatively, satisfactory foundation support could be obtained below the weak surface soil.

Foundation and Slab Support - After remedial grading, satisfactory foundation support for the residence can be obtained from spread footings bottomed on the engineered fill. Interior slab-on-grade floors and exterior slabs can also be satisfactorily supported on the engineered fill.

As an alternative to the extensive grading required to strengthen the weak surface soil, satisfactory foundation support for the residence can be obtained from deep spread footings that gain support below the weak surface materials. With this alternative, it will not be necessary to remove and recompact the weak surface materials within living areas provided that:

1. Wood floors supported on joist above grade are used in living areas; and
2. The weak soil is removed and recompactd for a depth of at least 12 inches in garage, exterior concrete slab-on-grade and paved areas.

On-Site Soil Quality

All fill materials must be approved by the geotechnical engineer. We anticipate that, with the exception of organic matter and of rocks or concrete debris larger than 6 inches in diameter, the excavated material will be suitable for re-use as engineered fill.

Engineered Fill

Engineered fill can consist of approved on-site soil or import materials with a low expansion potential. The geotechnical engineer must approve the use of on-site or import soil as engineered fill during grading.

Settlement

Since all foundations will bear on engineered fill, undisturbed bedrock, or firm native soil, we estimate that post-construction differential settlements across the building should be about ½ inch.

Surface Drainage

Surface runoff typically sheet flows over the ground surface but can be concentrated by the planned site grading, landscaping, and drainage. The surface runoff can pond against structures and seep into the crawl space or slab rock. Therefore, strict control of surface runoff is necessary to provide long-term satisfactory performance. It will be necessary to divert surface runoff around slopes and improvements, provide positive drainage away from structures, and install energy dissipaters at discharge points of concentrated runoff. This can be achieved by constructing the building pad several inches above the surrounding area and conveying the runoff into man made drainage elements or natural swales that lead downgradient of the site.

Groundwater

We anticipate that rainwater will percolate through the topsoil and migrate downslope at the interface of the topsoil and bedrock and through fractures in the bedrock and seep into the crawl space. Therefore, it will be necessary to intercept, collect and divert groundwater outside of the proposed improvements. This can be accomplished by installing perimeter foundation drains as recommended herein.

RECOMMENDATIONS

Seismic Design

Seismic design parameters presented below are based on Section 1613 titled “Earthquake Loads” of the 2019 California Building Code (CBC). Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-16, titled “Minimum Design Loads and Associated Criteria for Buildings and Other Structures” (2017), we have determined a Site Class of C should be used for the site. Using a site latitude and longitude of 38.0750°N and 122.8402°W, respectively, and the OSHPD Seismic Design Maps website (<https://seismicmaps.org>), we recommend that the following seismic design criteria be used for applicable structures at the site.

2019 CBC Seismic Criteria	
Spectral Response Parameter	Acceleration (g)
S _s (0.2 second period)	2.411
S ₁ (1 second period)	1.011
S _{MS} (0.2 second period)	2.893
S _{M1} (1 second period)	1.415
S _{DS} (0.2 second period)	1.929
S _{D1} (1 second period)	0.943

Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris, including that left by the removal of obsolete structures. Trees and shrubs that will not be part of the proposed development should be removed and their primary root systems grubbed. Cleared and grubbed material should be removed from the site and disposed of in accordance with County Health Department guidelines. We did not observe septic tanks, leach lines or underground fuel tanks during our study. Any such appurtenances found during grading should be capped and sealed and/or excavated and removed from the site, respectively, in accordance with established guidelines and requirements of the County Health Department. Voids created during clearing should be backfilled with engineered fill as recommended herein.

Stripping

Areas to be graded should be stripped of the upper few inches of soil containing organic matter. Soil containing more than two percent by weight of organic matter should be considered organic. Actual stripping depth should be determined by a representative of the geotechnical engineer in the field at the time of stripping. The strippings should be removed from the site, or if suitable, stockpiled for re-use as topsoil in landscaping.

Excavations

Following initial site preparation, excavation should be performed as recommended herein. Excavations extending below the proposed finished grade should be backfilled with suitable materials compacted to the requirements given below.

Weak Surface Soil - Within building areas, where spread footings bottomed at minimum depth are chosen for foundation support, and within fill and interior slab-on-grade areas, the weak surface soil should be excavated to within 6 inches of its entire depth (up to 2½ feet in our pits). The excavation of weak soil should also extend at least 12 inches below exterior and garage slab subgrade to allow space for the installation of engineered fill. The excavation of weak surface materials should extend at least 5 feet beyond the outside edge of the exterior footings of the proposed buildings and 3 feet beyond the edge of exterior slabs. The excavated materials should be stockpiled for later use as compacted fill, or removed from the site, as applicable.

Excavation Safety - At all times, temporary construction excavations should conform to the regulations of the State of California, Department of Industrial Relations, Division of Industrial Safety or other stricter governing regulations. The stability of temporary cut slopes, such as those constructed during the installation of underground utilities, should be the responsibility of the contractor. Depending on the time of year when grading is performed, and the surface conditions exposed, temporary cut slopes may need to be excavated to 1½:1, or flatter. The tops of the temporary cut slopes should be rounded back to 2:1 in weak soil zones.

Fill Quality

All fill materials should be free of perishable matter and rocks or lumps over 6 inches in diameter and must be approved by the geotechnical engineer prior to use. We judge the on-site soil is generally suitable for use as fill but we should verify its suitability during grading.

Import Fill

Import fill should be free of organic matter, have a low expansion potential, and conform in general to the following requirements:

SIEVE SIZE	PERCENT PASSING (by dry weight)
6 inch	100
4 inch	90 – 100
No. 200	10 – 60

Liquid Limit – 40 Percent Maximum
Plasticity Index – 15 Percent Maximum

Material not conforming to these requirements may be suitable for use as import fill; however, it shall be the contractor's responsibility to demonstrate that the proposed material will perform in an equivalent manner. The geotechnical engineer should approve imported materials prior to use as compacted fill. The grading contractor is responsible for submitting, at least 3 business days in advance of its intended use, samples of the proposed import materials for laboratory testing and approval by the soils engineer.

Fill Placement

The surface exposed by stripping and removal of weak surface soil and loose fill should be scarified to a depth of at least 6 inches, uniformly moisture-conditioned to near optimum and compacted to at least 90 percent of the maximum dry density of the materials as determined by ASTM Test Method D-1557. Approved fill material should then be spread in thin lifts, uniformly moisture-conditioned to near optimum and properly compacted. All structural fills, including those placed to establish site surface drainage, should be compacted to at least 90 percent relative compaction.

Permanent Cut and Fill Slopes

In general, cut and fill slopes should be designed and constructed at slope gradients of 2:1 (horizontal to vertical) or flatter, unless otherwise approved by the geotechnical engineer in specified areas. Where steeper slopes are required, retaining walls should be used. Fill slopes should be constructed by overfilling and cutting the slope to final grade. "Track walking" of a slope to achieve slope compaction is not an acceptable procedure for slope construction. Permanent cut slopes should be observed in the field by the geotechnical engineer to verify that the exposed soil/bedrock conditions are as anticipated. The geotechnical engineer is not responsible for measuring the angles of these slopes. Denuded slopes should be planted with fast-growing, deep-rooted groundcover to reduce sloughing or erosion.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when on-site soil is usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in on-site soil. Special and relatively expensive construction procedures, including dewatering of excavations and importing granular soil, should be anticipated if grading must be completed during the winter and early spring or if localized areas of soft saturated soil are found during grading in the summer and fall.

Open excavations also tend to be more unstable during wet weather as groundwater seeps towards the exposed cut slope. Severe sloughing and occasional slope failures should be anticipated. The occurrence of these events will require extensive clean up and the installation of slope protection measures, thus delaying projects. The general contractor is responsible for the performance, maintenance and repair of temporary cut slopes.

Foundation Support

Provided the weak surface soil is removed or strengthened by remedial grading as recommended herein, the proposed structure can be supported on continuous and isolated spread footings that bottom on firm, natural soil, engineered fill, or undisturbed bedrock. Alternatively, where raised wood floors are used, deepened spread footings can be used that gain support below the weak soil.

Spread Footings

Spread footings should be at least 12 inches wide and should bottom on firm, natural soil, compacted fill, or undisturbed bedrock, as applicable, at least 12 inches below pad subgrade (lowest adjacent grade). Additional embedment or width may be needed to satisfy code and/or structural requirements. On ungraded sloping terrain, the footings should be stepped as necessary to produce level tops and bottoms. Footings should be deepened as necessary to provide at least 7 feet of horizontal confinement between the footing bottoms and the face of the nearest slope. Confinement in bedrock can be reduced to 5 feet.

The bottoms of all footing excavations should be thoroughly cleaned out or wetted and compacted using hand-operated tamping equipment prior to placing steel and concrete. This will remove the soil disturbed during footing excavations, or restore their adequate bearing capacity, and reduce post-construction settlements. Footing excavations should not be allowed to dry before placing concrete. If shrinkage cracks appear in soil exposed in the footing excavations, the soil should be thoroughly moistened to close all cracks prior to concrete placement. The moisture condition of the foundation excavations should be checked by the geotechnical engineer no more than 24 hours prior to placing concrete.

Bearing Pressures - Footings installed in accordance with these recommendations may be designed using allowable bearing pressures of 2000, 3000, and 4000 pounds per square foot (psf), for dead loads, dead plus code live loads, and total loads (including wind and seismic), respectively.

Lateral Pressures - The portion of spread footing foundations extending into firm natural soil, compacted fill, or undisturbed bedrock may impose a passive equivalent fluid pressure and a friction factor of 350 pcf and 0.35, respectively, to resist sliding. Passive pressure should be neglected within the upper 6 inches, unless the soil is confined by concrete slabs or pavements.

Retaining Walls

Retaining walls constructed at the site must be designed to resist lateral earth pressures plus additional lateral pressures that may be caused by surcharge loads applied at the ground surface behind the walls. Retaining walls free to rotate (yielding greater than 0.1 percent of the wall height at the top of the backfill) should be designed for active lateral earth pressures. If walls are restrained by rigid elements to prevent rotation, they should be designed for "at rest" lateral earth pressures.

Retaining walls should be designed to resist the following earth equivalent fluid pressures (triangular distribution):

EARTH EQUIVALENT FLUID PRESSURES		
Loading Condition	Pressure (pcf)	Additional Seismic Pressure (pcf)*
Active - Level Backfill	42	24
At Rest - Level Backfill	63	75

* If required

These pressures do not consider additional loads resulting from adjacent foundations or other loads. If these additional surcharge loadings are anticipated, we can assist in evaluating their effects. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an additional surcharge pressure equivalent to two feet of additional backfill.

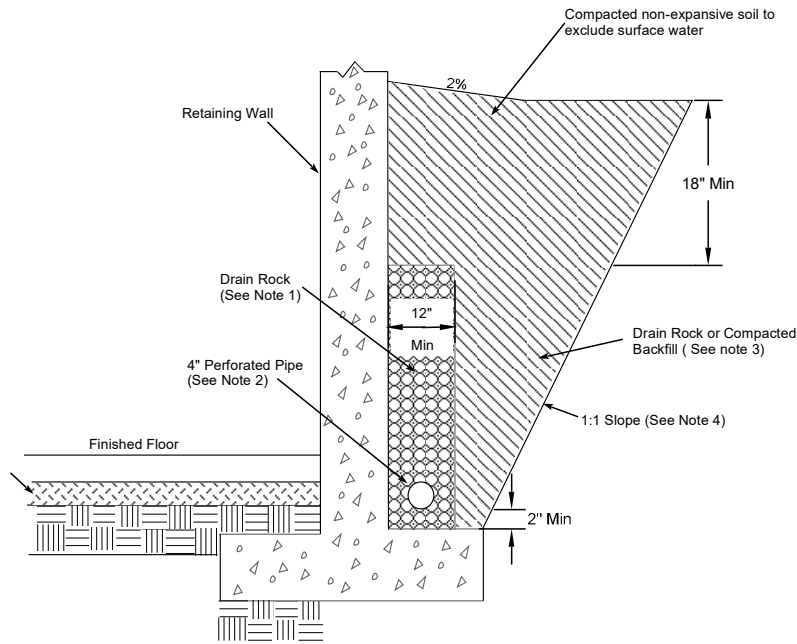
Retaining walls will yield slightly during backfilling. Therefore, walls should be backfilled prior to building on, or adjacent to, the walls. Backfill against retaining walls should be compacted to at least 90 and not more than 95 percent relative compaction. Over-compaction or the use of large compaction equipment should be avoided because increased compactive effort can result in lateral pressures higher than those recommended above.

Foundation Support

Retaining walls should be supported on spread footings designed in accordance with the recommendations presented in this report. Retaining wall foundations should be designed by the project civil or structural engineer to resist the lateral forces set forth in this section.

Wall Drainage and Backfill

Retaining walls should be backdrained as shown below. The backdrains should consist of 4-inch diameter, rigid perforated pipe embedded in Class 2 permeable material. The pipe should be PVC Schedule 40 or ABS with SDR 35 or better, and the pipe should be sloped to drain to outlets by gravity. The top of the pipe should be at least 8 inches below the lowest adjacent grade. The Class 2 permeable material should extend to within 1½ feet of the surface. The upper 1½ feet should be backfilled with compacted soil to exclude surface water. Expansive soil should not be used for wall backfill. Where expansive soil is present in the excavation made to install the retaining wall, the excavation should be sloped back 1:1 from the back of the footing or grade beam. The ground surface behind retaining walls should be sloped to drain. Where migration of moisture through retaining walls would be detrimental, retaining walls should be waterproofed. A detail showing the retaining wall elements is shown below.



Notes:

1. Drain rock should meet the requirements for Class 2 Permeable Material, Section 68, State of California "Caltrans" Standard Specification, latest edition. Drain rock should be placed to approximately three-quarters the height of the retaining wall.
2. Pipe should conform to the requirements of Section 68 of State of California "Caltrans" Standards, perforations placed down, sloped at 1% for gravity flow to outlet or sump with automatic pump. The pipe invert should be located at least 8 inches below the lowest adjacent finished surface.
3. During construction the contractor should use appropriate methods such as temporary bracing and/or light compaction equipment to avoid overstressing the walls. Non-expansive soils to be used as backfill.
4. Slope excavation back at a 1:1 gradient from the back of footing where expansive materials are exposed.

Not to Scale

Slab-On-Grade

Provided grading is performed in accordance with the recommendations presented herein, interior, exterior, and garage slabs should be underlain by firm, natural soil, compacted fill, or undisturbed bedrock. Slab-on-grade subgrade should be rolled to produce a dense, uniform surface. The future expansion potential of the subgrade soil should be reduced by thoroughly presoaking the slab subgrade prior to concrete placement. The moisture condition of the subgrade soil should be checked by the geotechnical engineer no more than 24 hours prior to placing the capillary moisture break. The slabs should be underlain with a capillary moisture break consisting of at least 4 inches of clean, free-draining crushed rock or gravel (excluding pea gravel) at least ¼-inch and no larger than ¾-inch in size. Interior slabs subject to vehicular traffic may be underlain by Class 2 aggregate base. The use of Class 2 aggregate base should be reviewed on a case by case basis. Class 2 aggregate base can be used for slab rock under exterior slabs. Interior area slabs should be provided with an underdrain system. The installation of this subdrain system is discussed in the "Geotechnical Drainage" section.

Slabs should be designed by the project civil or structural engineer to support the anticipated loads, reduce cracking and provide protection against the infiltration of moisture vapor. Garage slabs should be separated from foundations and framing elements with low friction material.

A vapor barrier should be incorporated into the floor slab design in all areas where moisture-sensitive floor coverings, coatings, underlayments, adhesives, moisture sensitive goods, humidity-controlled environments, or climate-cooled environments are anticipated initially, or in the future. Vapor barrier should consist of a minimum 15 mil extruded polyolefin plastic (no recycled content or woven materials permitted); permeance as tested before and after mandatory conditioning (ASTM E1745 Section 7.1 and Sub-paragraphs 7.1.1 – 7.1.5): less than 0.01 perms [grains/(ft² per hour in Hg)] and comply with the ASTM E1745 class a requirements. The vapor barrier should also meet paragraph's 8.1 and 9.3 of ASTM E1745; subsequent documentation should be provided by the vapor barrier manufacturer. Install vapor barrier in accordance with ASTM E1643, including proper perimeter seal.

Utility Trenches

The shoring and safety of trench excavations is solely the responsibility of the contractor. Attention is drawn to the State of California Safety Orders dealing with "Excavations and Trenches."

Unless otherwise specified, on-site, inorganic soil may be used as utility trench backfill. Where utility trenches support pavements, slabs, and foundations, trench backfill should consist of aggregate baserock. The baserock should comply with the minimum requirements in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base. Trench backfill should be moisture-conditioned as necessary, and placed in horizontal layers not exceeding 8 inches in thickness, before compaction. Each layer should be compacted to at least 90 percent relative compaction as determined by ASTM Test Method D-1557. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be attempted.

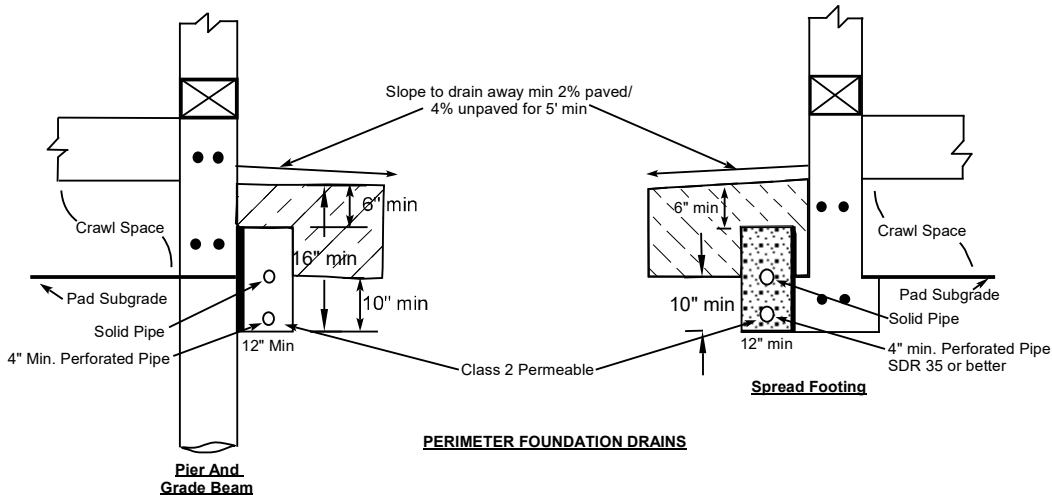
Geotechnical Drainage

Surface water should be diverted away from slopes and foundations. Surface drainage gradients should slope away from building foundations in accordance with the requirements of the CBC or local governing agency. Where a gradient flatter than 2 percent for paved areas and 4 percent for unpaved areas is required to satisfy design constraints, area drains should be installed within the rear and side yard swales with a spacing no greater than about 20 feet. Roofs should be provided with gutters and the downspouts should be connected to closed (glued Schedule 40 PVC or ABS with SDR of 35 or better) conduits discharging well away from foundations, onto paved areas, erosion resistant natural drainages or into the site's surface drainage system. Roof downspouts and surface drains must be maintained entirely separate from the slab underdrains recommended hereinafter.

Water seepage or the spread of extensive root systems into the soil subgrade of footings and slabs could cause differential movements and consequent distress in these structural elements. Landscaping should be planned with consideration for these potential problems.

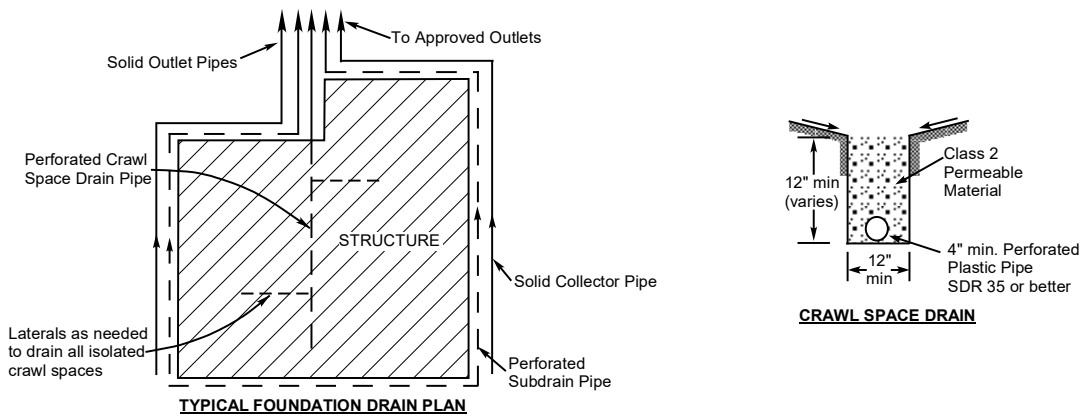
Perimeter Foundation Drains

Where interior crawl spaces are lower than adjacent exterior grade, subdrains should be installed adjacent to perimeter foundations, except on the downhill side, to prevent surface runoff from entering the crawl space. Foundation drains should consist of trenches that are at least 10 inches below the crawl space surface and are sloped to drain by gravity. Four-inch diameter perforated pipe sloped to drain to outlets by gravity should be placed in the bottom of the trenches. The top of subdrain pipes should be at least 6 inches lower than the adjacent crawl space. The perimeter subdrain trenches should be backfilled to within 6 inches of the surface with Class 2 permeable material. The upper 6 inches should be backfilled with compacted soil to exclude surface water. An illustration of this system is shown below. Where perimeter foundation drains are not used, water ponding in the crawl space should be anticipated. Where retaining walls are used for perimeter foundations, retaining wall backdrains may be used in lieu of foundation drains.



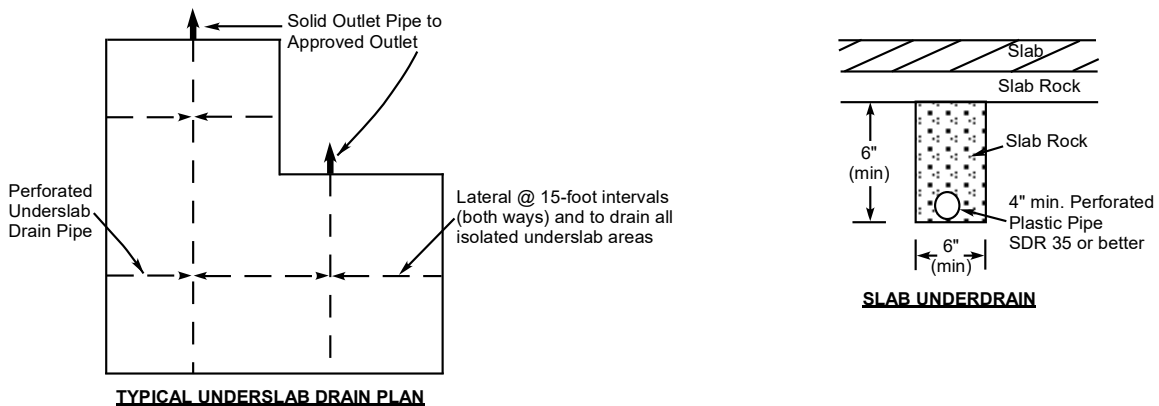
Crawl Space Drains

Crawl spaces are inherently damp and humid. In addition, groundwater seepage is unpredictable and difficult to control and, regardless of the care used in installing perimeter foundation drains, can find its way into crawl spaces. The ground surface within the crawl space should be sloped to drain away from foundations and toward a 12-inch square drain trench that is excavated through the longitudinal axis of the crawl space. A 4-inch diameter perforated drain pipe (SDR 35 or better) should be embedded in Class 2 permeable materials near the bottom of the trench. The drain rock should extend to the surface of the crawl space. Piped outlets should be provided to allow drainage of the collected water through foundations and discharge into the storm drain system. An illustration of this system is shown below. Additional protection against water seepage into crawl spaces can be obtained by compacting fill placed adjacent to perimeter walls to at least 90 percent relative compaction.



Slab Underdrains

Where interior slab subgrades are less than 6 inches above adjacent exterior grade and where migration of moisture through the slab would be detrimental, slab underdrains should be installed to dispose of surface and/or groundwater that may seep and collect in the slab rock. Slab underdrains should consist of 6-inch wide trenches that extend at least 6 inches below the bottom of the slab rock and slope to drain by gravity. The slab underdrain trenches should be spaced no further than 15 feet, both ways. Additional drain trenches should be installed, as necessary, to drain all isolated under slab areas. Four-inch diameter perforated pipe (SDR 35 or better) sloped to drain to outlets by gravity should be placed in the bottom of the trenches. Slab underdrain trenches should be backfilled to subgrade level with clean, free draining slab rock. An illustration of this system is shown below. If slab underdrains are not used, it should be anticipated that water will enter the slab rock, permeate through the concrete slab and ruin floor coverings.



Maintenance

Periodic land maintenance, especially on hillsides, will be required. Surface and subsurface drainage facilities should be checked frequently and cleaned and maintained as necessary or at least annually. A dense growth of deep-rooted ground cover must be maintained on all slopes to reduce sloughing and erosion. Sloughing and erosion that occurs must be repaired promptly before it can enlarge.

Supplemental Services

Pre-Bid Meeting

It has been our experience that contractors bidding on the project often contact us to discuss the geotechnical aspects. Informal contacts between RGH Consultants (RGH) and an individual contractor could result in incomplete or misinterpreted information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project owner or their designated representative. After consultation with RGH, the project owner or their representative should provide clarifications or additional information to all contractors bidding the job.

Plan and Specifications Review

Coordination between the design team and the geotechnical engineer is recommended to assure that the design is compatible with the soil, geologic and groundwater conditions encountered during our study. RGH recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. In the event we are not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

Construction Observation and Testing

Prior to construction, a meeting should be held at the site that includes, but is not limited to, the owner or owner's representative, the general contractor, the grading contractor, the foundation contractor, the underground contractor, any specialty contractors, the project civil engineer, other members of the project design team and RGH. This meeting should serve as a time to discuss and answer questions regarding the recommendations presented herein and to establish the coordination procedure between the contractors and RGH.

In addition, we should be retained to monitor all soil related work during construction, including:

- Site stripping, over-excavation, grading, and compaction of near surface soil;
- Placement of all engineered fill and trench backfill with verification field and laboratory testing;
- Observation of all foundation excavations; and
- Observation of foundation and subdrain installations.

If, during construction, we observe subsurface conditions different from those encountered during the explorations, we should be allowed to amend our recommendations accordingly. If different conditions are observed by others, or appear to be present beneath excavations, RGH should be advised at once so that these conditions may be evaluated and our recommendations reviewed and updated, if warranted. The validity of recommendations made in this report is contingent upon our being notified and retained to review the changed conditions.

If more than 18 months have elapsed between the submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at, or adjacent to, the site, the recommendations made in this report may no longer be valid or appropriate. In such case, we recommend that we be retained to review this report and verify the applicability of the conclusions and recommendations or modify the same considering the time lapsed or changed conditions. The validity of recommendations made in this report is contingent upon such review.

These supplemental services are performed on an as-requested basis and are in addition to this geotechnical study. We cannot accept responsibility for items that we are not notified to observe or for changed conditions we are not allowed to review.

LIMITATIONS

This report has been prepared by RGH for the exclusive use of the property owner and their consultants as an aid in the design and construction of the proposed improvements described in this report.

The validity of the recommendations contained in this report depends upon an adequate testing and monitoring program during the construction phase. Unless the construction monitoring and testing program is provided by our firm, we will not be held responsible for compliance with design recommendations presented in this report and other addendum submitted as part of this report.

Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding the proposed construction, the results of our field exploration, laboratory testing program, and professional judgment. Verification of our conclusions and recommendations is subject to our review of the project plans and specifications, and our observation of construction.

The **Subsurface** section of this report represents the subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration and may not necessarily be the same or comparable at other times.

It should be understood that slope failures including landslides, debris flows and erosion are on-going natural processes which gradually wear away the landscape. Residual soil and weathered bedrock can be susceptible to downslope movement, even on apparently stable sites. Such inherent hillside and slope risks are generally more prevalent during periods of intense and prolonged rainfall, which occasionally occur, in northern California and/or during earthquakes. Therefore, it must be accepted that occasional, unpredictable slope failure and erosion and deposition of the residual soil and weathered bedrock materials are irreducible risks and hazards of building upon or near the base of any hillside or any steeper slope area throughout northern California. By accepting this report, the client and other recipients acknowledge their understanding and acceptance of these risks and hazards, and the terms and conditions herein.

The scope of our services did not include an environmental assessment or a study of the presence or absence of toxic mold and/or hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or study for the presence or absence of wetlands. These studies should be conducted under separate cover, scope and fee and should be provided by a qualified expert in those fields.

APPENDIX A - REFERENCES

American Society of Civil Engineers, 2017, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-16.

Bryant, W.A., and Hart, E.W., Interim Revision 2007, Fault-Rupture Zones in California; California Geological Survey, Special Publication 42, p. 21 with Appendices A through F.

California Building Code, 2019, California Building Standard Commission.

Wentworth et al., 1997, Summary Distribution of Slides and Earth Flows in Marin County, California: U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 97-745C, Sheet 4 of 11, Scale 1:125,000.

APPENDIX B - DISTRIBUTION

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