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GEOTECHNICAL STUDY REPORT

3422 SANTA ROSA AVENUE
SANTA ROSA, CALIFORNIA

Project Number:

4307.01.04.1

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INTRODUCTION

This report presents the results of our geotechnical study for the new commercial development to be constructed at 3422 Santa Rosa Avenue in Santa Rosa, California. The undeveloped property extends over relatively level terrain. The site location is shown on Plate 1, Appendix A.

We understand it is proposed to construct a new commercial development that is comprised of four to five buildings. The new structures will have either concrete slab-on-grade or raised wood floors supported on spread footings or drilled piers.

Actual foundation loads are not known at this time. We anticipate the loads will be typical for the light to moderately heavy type of construction planned. Grading plans are not available, but we anticipate that the planned grading will be the minimum amount needed to construct a level building pad and provide the building site and paved areas with positive drainage.

SCOPE

The purpose of our study, as outlined in our Professional Service Agreement dated November 20, 2018, 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 borings 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 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, porous, compressible 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 B. On December 7, 2018, we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by drilling five borings to depths ranging from about 6 to 21½ feet. The borings were drilled with a track-mounted drill rig equipped with 4-inch diameter, solid stem augers at the approximate locations shown on the Exploration Plan, Plate 2. The boring locations were determined approximately by pacing their distance from features shown on the Exploration Plan and should be considered accurate only to the degree implied by the method used. Our staff engineer located and logged the borings and obtained samples of the materials encountered for visual examination, classification and laboratory testing.

Relatively undisturbed samples were obtained from the borings at selected intervals by driving a 2.43-inch inside diameter, split spoon sampler, containing 6-inch long brass liners, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches. The blows required to drive each 6-inch increment were recorded and the blows required to drive the last 12 inches, or portion thereof, were converted to equivalent Standard Penetration Test (SPT) blow counts using a conversion factor of 0.65 (Burmister, 1948) for correlation with empirical data. Disturbed samples were also obtained at selected depths by driving a 1.375-inch inside diameter (2-inch outside diameter) SPT sampler, without liners or rings, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches, the blows to drive each 6-inch increment were recorded, and the blows required to drive the final 12 inches, or portion thereof, are provided on the boring logs. Disturbed "bulk" samples were also obtained at selected depths from the borings and placed in plastic bags.

The logs of the borings showing the materials encountered, groundwater conditions, converted blow counts, and sample depths are presented on Plates 3 through 7. The soil is described in accordance with the Unified Soil Classification System, outlined on Plate 8.

The boring logs show our interpretation of the subsurface soil and groundwater 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 samples, laboratory test results, and interpretation of drilling and sampling resistance. The location of the soil boundaries should be considered approximate. The transition between soil types may be gradual.

Laboratory Testing

The samples obtained from the borings 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 referenced on the boring logs, and are presented on Plate 8.

SITE CONDITIONS

General

Sonoma 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.

Geology

Published geologic maps (McLaughlin et al., 2008) indicate the property is underlain by undivided Holocene alluvial fan and fluvial terrace deposits. The deposits are shown to comprise gravel, sand, and silt from older Tertiary to Pleistocene non-marine gravel, late Tertiary volcanic rocks, as well as, Franciscan Complex, Coast Range ophiolite, and Great Valley sequence.

Landslides

Published landslide maps (Dwyer, 1976) 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 flat terrain. The vegetation consists of seasonal grasses and weeds. The building site is located southeast corner of the intersection of Santa Rosa Avenue and East Robles Avenue. In general, the ground surface is soft and spongy. This is a condition generally associated with weak, porous surface soil. This typically occurs because the surface soil is weak, porous and compressible. Natural drainage consists of sheet flow over the ground surface that concentrates in man made surface drainage elements such as roadside and gutters.

Subsurface

Our borings and laboratory tests indicate that the portion of the site we studied is blanketed by 2 to 3 feet of weak, porous, compressible, clayey soil. Porous soil appears hard and strong when dry but becomes weak and compressible as its moisture content increases towards saturation. This soil exhibits low to high plasticity (LL = 28.9, 47.3, and 48.5; PI = 13.2, 31.6, and 32.2) and very low to medium expansion potential (EI = 17, 63, and 68). The surface soil is locally covered by about 1 foot of heterogeneous fill. Heterogeneous fill is a material with varying density, strength, compressibility and shrink-swell characteristics that often has an unknown origin and placement history. These surface materials are underlain by medium dense to very dense sand with varying amounts of clay; medium stiff to very stiff clay with varying amounts of sand; and medium dense to very dense clayey gravel with sand.

A detailed description of the subsurface conditions found in our borings is given on Plates 3 through 7, Appendix A. Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled “Minimum Design Loads for Buildings and Other Structures” (2010), we have determined a Site Class of D should be used for the site.

Corrosion Potential

Mapping by the Natural Resources Conservation Service (2018) indicates that the corrosion potential of the near surface soil is high for uncoated steel and moderate for concrete. Performing corrosivity tests to verify these values was not part of our requested and/or proposed scope of work. Should the need arise, we would be pleased to provide a proposal to evaluate these characteristics.

Groundwater

Free groundwater was detected in our borings at depths ranging from 10 to 11 feet below the ground surface at the time of drilling. Fluctuation in the groundwater level typically occurs because of a variation in rainfall intensity, duration and other factors such as flooding and periodic irrigation.

Flooding

Our review of the Federal Emergency Management Agency (FEMA) Flood Zone Map for City of Santa Rosa (No. 06097C0726E) dated December 2, 2008, indicates that the proposed building site is located within Zone “X,” an area determined to be outside the 500-year flood plain. Evaluation of flooding potential is typically the responsibility of the project civil engineer.

DISCUSSION AND CONCLUSIONS

Seismic Hazards

General

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 and 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 2 to 3 feet of weak, porous, compressible, clayey surface soil and locally about 1 foot of heterogeneous fill;

2. The detrimental effects of uncontrolled surface runoff and groundwater seepage; and

3. The strong ground shaking predicted to impact the site during the life of the project.

Heterogeneous Fill

Heterogeneous fills of unknown quality and unknown method of placement, such as those found at the site, can settle and/or heave erratically under the load of new fills, structures and slabs. Footings and slabs supported on heterogeneous fill could also crack as a result of such erratic movements. Thus, where not removed by planned grading, the heterogeneous fill must be excavated and replaced as an engineered fill if it is to be used for structural support.

Weak, Porous Surface Soil

Weak, porous 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 buildings 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 buildings can be obtained from deep spread footings or a system of grade beams supported on drilled piers 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 interior areas provided that:

1. Wood floors supported on joist above grade are used in interior areas; and

2. The weak soil is removed and recompacted 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 used in the upper 12 inches of the building area and the upper 6 inches of garage and/or exterior slab subgrade must be select, as subsequently described in “Recommendations.” We anticipate that, with the exception of organic matter and of rocks or lumps larger than 6 inches in diameter, the excavated material will be suitable for re-use as general (and select) fill.

Select Fill

The select 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 soil as select fill during grading.

Settlement

If remedial grading is performed and the spread footings and/or drilled piers are installed in accordance with the recommendations presented in this report, we estimate that post-construction differential settlements across the building will be about ½-inch.

Surface Drainage

Because of topography and location, the site will be impacted by surface runoff. 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 and/or slab rock. Therefore, strict control of surface runoff is necessary to provide long-term satisfactory performance of the improvements. It will be necessary to divert surface runoff around improvements, provide positive drainage away from structures. 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.

RECOMMENDATIONS

Seismic Design

Seismic design parameters presented below are based on Section 1613 titled "Earthquake Loads" of the 2016 California Building Code (CBC). Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled "Minimum Design Loads for Buildings and Other Structures" (2010), we have determined a Site Class of D should be used for the site. Using a site latitude and longitude of 38.3939°N and 122.7124°W, respectively, and the Seismic Design Maps from the OSHPD website (https://www.seismicmaps.org), we recommend that the following seismic design criteria be used for structures at the site.

2016 CBC Seismic Criteria	
Spectral Response Parameter	**Acceleration (g)**
S_S (0.2 second period)	1.904
S_1 (1 second period)	0.768
S_{MS} (0.2 second period)	1.904
S_{M1} (1 second period)	1.152
S_{DS} (0.2 second period)	1.270
S_{D1} (1 second period)	0.768

Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris. 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.

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 old fill and weak, porous, compressible surface soil should be excavated to within 6 inches of its entire depth (up to 3 feet in our borings). The excavation of weak, compressible, soil should also extend at least 6 inches below exterior slab subgrade (where planned excavations do not completely remove the weak soil) to allow space for the installation of the select fill blanket discussed in the conclusions section of this report.

The excavation of weak, porous, compressible, 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.

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, meet the criteria set forth herein for select fill, and must be approved by the geotechnical engineer prior to use. We judge the on-site soil is generally suitable for use as general (and select) fill. The suitability of the on-site soil for use as select fill should be verified during grading.

Select Fill

Select 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

In general, imported fill, if needed, should be select. 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 72 hours (3 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 heterogeneous fill and weak, compressible, surface soil 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.

SUMMARY OF COMPACTION RECOMMENDATIONS	
Area	Compaction Recommendation (ASTM D-1557)
Preparation for areas to receive fill	After preparation in accordance with this report, compact upper 6 inches to a minimum of 90 percent relative compaction.
General fill (native or import)	Compact to a minimum of 90 percent relative compaction.
Structural fill beneath buildings, extending outward to 5' beyond building perimeter	Compact to a minimum of 90 percent relative compaction.
Trenches	Compact to a minimum of 90 percent relative compaction. Compact the top 6 inches below vehicle pavement subgrade to a minimum of 95 percent relative compaction.
Retaining wall backfill	Compact to a minimum of 90 percent relative compaction, but not more than 95 percent.
Concrete flatwork and exterior slabs, extending outward to 3' beyond edge of slab	Compact subgrade to a minimum of 90 percent relative compaction. Where subject to vehicle traffic, compact upper 6 inches of subgrade to at least 95 percent relative compaction.
Aggregate Base	Compact aggregate base to at least 95 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. The geotechnical engineer is not responsible for measuring the angles of these slopes.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when the 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

Depending on the planned remedial grading or the interior-area floor system chosen, the structure can be supported on either spread footings or drilled, cast-in-place, reinforced concrete friction piers. Specific recommendations for each alternative are given in the following sections of the report.

Spread Footings

Spread footings should be at least 12 inches wide and should bottom on firm, natural soil or select engineered fill, as applicable, at least 12 inches below pad subgrade. Additional embedment or width may be needed to satisfy code and/or structural requirements. 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 2,000, 3,000, and 4,000 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 or select engineered fill 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.

Drilled Piers

Drilled, cast-in-place, reinforced concrete piers should be used for foundation support where grading is not used to strengthen the weak, compressible surface soil or loose fill. Drilled piers should be at least 12 inches in diameter and should extend at least 8 feet below planned pad elevation. Larger piers and deeper embedment may be needed to resist the lateral forces imposed by earthquakes per the 2013 California Building Code. Piers should be spaced no closer than 3 pier diameters, center to center.

Skin Friction - The portion of the piers extending below the weak surface soil may be designed using an allowable skin friction of 600 psf for dead load plus long term live loads. This value can be increased by ⅓ for total loads, including downward vertical wind or seismic forces. A skin friction value of 400 psf should be used to resist uplift forces. End bearing should be neglected because of the difficulty of cleaning out small diameter pier holes, and the uncertainty of mobilizing end bearing and skin friction simultaneously.

Lateral Forces - Lateral loads on piers will be resisted by passive pressure on the soil. An equivalent fluid pressure of 350 pcf acting on two pier diameters should be used. Confinement for passive pressure may be assumed from 3 feet below the lowest adjacent finished ground surface.

The piers should be interconnected with grade beams to support building loads and to redistribute stresses imposed by wind or earthquakes. The grade beams should be designed to span between the piers in accordance with structural requirements. The steel from the piers should extend sufficient distance into the grade beams to develop its full bond strength.

Pier Drilling - We encountered groundwater within the planned pier depth during our study. If groundwater is encountered during drilling, it may be necessary to de-water the holes and/or place the concrete by the tremie method. If caving soil is encountered, it may be necessary to case the holes. Difficult drilling may be required to achieve the required penetration. The drilling subcontractor should review this report, become familiar with site conditions as they pertain to his operation and draw his own conclusions regarding drilling difficulty, suitable drill rigs and the need for casing and dewatering prior to bidding.

Concrete - Concrete mix design and placement should be done in accordance with the current ADSC and/or ACI specifications. Concrete should not be allowed to mushroom at the top of the piers or below the bottom of grade beams.

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	14
Active - Sloping Backfill 3:1 or Flatter	53	34
At Rest - Level Backfill	63	35

* 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 or drilled piers, as applicable, 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 on Plate 10, Appendix A. 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 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.

Slab-On-Grade

Provided grading is performed in accordance with the recommendations presented herein, interior and exterior slabs should be underlain by firm, natural soil and/or select engineered fill.

Slab-on-grade subgrade should be rolled to produce a dense, uniform surface. 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.

A vapor barrier should be placed under all slabs-on-grade that are likely to receive an impermeable floor finish or be used for any purpose where the passage of water vapor through the floor is undesirable. RGH does not practice in the field of moisture vapor transmission evaluation or mitigation. Therefore, we recommend that a qualified person be consulted to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person should provide recommendations for mitigation of the potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate.

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 by the City of Santa Rosa, 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. The top 6 inches of trench backfill below vehicle pavement subgrades should be moisture-conditioned as necessary and compacted to at least 95 percent relative compaction. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be attempted.

Geotechnical Drainage

Surface

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 on Plate 11. 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 (see Plate 11). Piped outlets should be provided to allow drainage of the collected water through foundations and discharge into the storm drain system. 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 on Plate 11. 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 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.

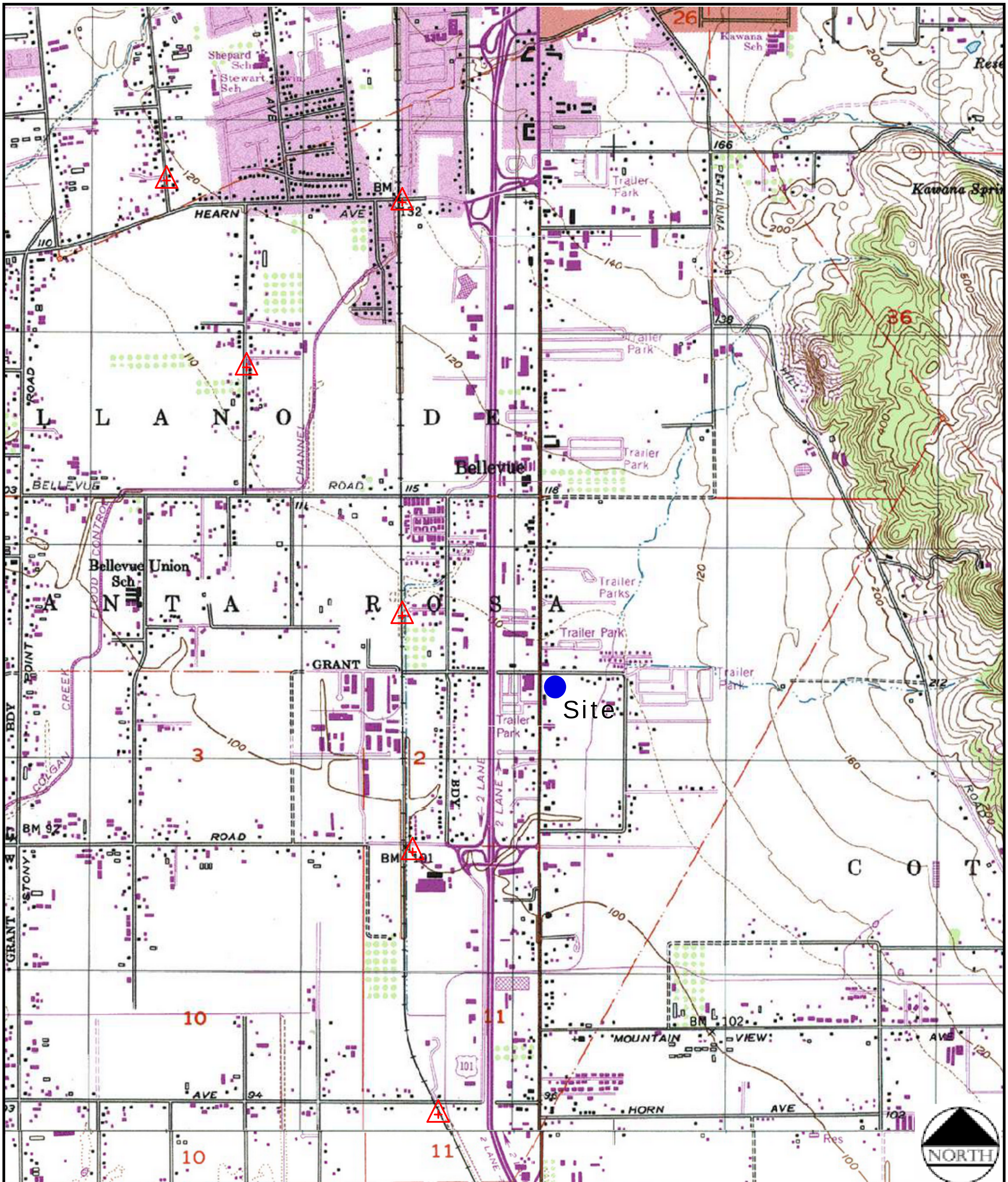
Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding 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 borings represent 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.

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 - PLATES

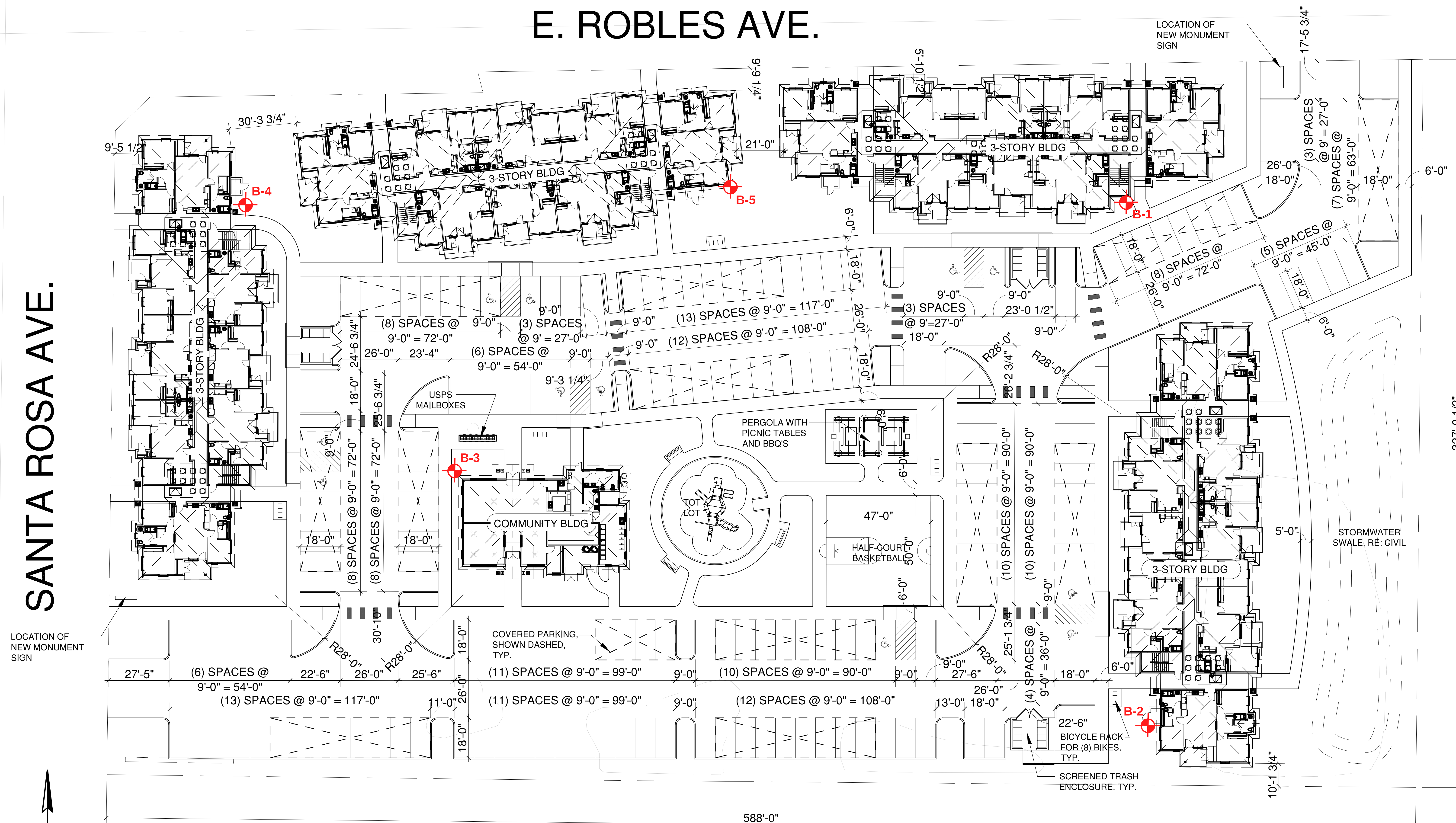
LIST OF PLATES



Reference: Maptech Topoquad, Santa Rosa, California Quadrangle

Scale: 1" = 2000'

RGH CONSULTANTS	SITE LOCATION MAP 3422 Santa Rosa Avenue Santa Rosa, California	PLATE 1
Job No: 4307.01.04.1 / Date: DEC 2018		



EXPLANATION

B-5 Boring Location and Number

40 0 40 feet

Scale: 1" = 40'

Reference: The Redwood Apartments Site Plan by Pacific West Architecture dated Nov. 2018

RGH CONSULTANTS	**EXPLORATION PLAN** 3422 Santa Rosa Avenue Santa Rosa, California		PLATE 2
Job No: 4307.01.04.1	Date: DEC 2018		

Date(s) Drilled **12/7/2018**	Logged By **KU**	Checked By **REP**
Drilling Method **Solid-Stem Auger**	Drill Bit Size/Type **4" drag bit**	Total Depth of Borehole **21 1/2 feet**
Drill Rig Type **Portable Track**	Drilling Contractor **Stapleton**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **11 feet**	Sampling Method(s) **Bulk, Modified California, SPT**	Hammer Data **140lb, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, psf	REMARKS AND OTHER TESTS
	0				DARK BROWN SANDY CLAY (CL), medium stiff to stiff, moist to wet, porous to 2 feet								
			8					68.6	32.2	48.5	63		
			31										
					LIGHT BROWN CLAYEY SAND (SC), dense, moist								
	5												
					LIGHT BROWN CLAYEY SAND WITH GRAVEL (SC), very dense, moist								
			50/6"										
	10				LIGHT GRAY BROWN CLAY WITH SAND (CL), very stiff, wet								
			18										
	15				GRAY CLAY WITH SAND (CH), very stiff, wet								
	20												
			19										
					Boring terminated at 21 1/2 feet. Groundwater encountered at 11 feet								
	25												

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Job No: 4307.01.04.1 | Date: DEC 2018

LOG OF BORING B-1
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
3

Date(s) Drilled: **12/7/2018**	Logged By: **KU**	Checked By: **REP**
Drilling Method: **Solid-Stem Auger**	Drill Bit Size/Type: **4" drag bit**	Total Depth of Borehole: **13 1/2 feet**
Drill Rig Type: **Portable Track**	Drilling Contractor: **Stapleton**	Approximate Surface Elevation: **Existing Ground Surface**
Groundwater Level and Date Measured: **10 feet**	Sampling Method(s): **Modified California, SPT**	Hammer Data: **140lb, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, psf	REMARKS AND OTHER TESTS
	0				Artificial Fill with 2" Cobbles over 8-12" Concrete								
					DARK BROWN SANDY CLAY (CL), stiff, moist to wet, porous to 2 1/2 feet								
			13					73.4	31.6	47.3	68		
					LIGHT BROWN CLAYEY SAND (SC), medium dense, moist								
	5		27										
					GRAY/BROWN CLAYEY SAND (SC), very dense, wet								
			52										
	10				▽								
					LIGHT BROWN CLAY WITH SAND (CH), very stiff, wet								
			21										
					Boring terminated at 13 1/2 feet. Groundwater encountered at 10 feet								
	15												
	20												
	25												

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Job No: 4307.01.04.1 | Date: DEC 2018

LOG OF BORING B-2
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
4

Date(s) Drilled **12/7/2018**	Logged By **KU**	Checked By **REP**
Drilling Method **Solid-Stem Auger**	Drill Bit Size/Type **4" drag bit**	Total Depth of Borehole **10 1/2 feet**
Drill Rig Type **Portable Track**	Drilling Contractor **Stapleton**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **No Groundwater Encountered**	Sampling Method(s) **Modified California, SPT**	Hammer Data **140lb, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, psf	REMARKS AND OTHER TESTS
	0				DARK BROWN SANDY CLAY (CL), medium stiff to very stiff, moist, porous to 2 1/2 feet								
			6										
			29		LIGHT BROWN CLAYEY SAND (SC), medium dense to dense, moist to wet								
	5												
					LIGHT BROWN SANDY CLAY (CH), stiff, moist to wet								
			65/6"		GRAY CLAYEY GRAVEL WITH SAND (GC), very dense, moist								
	10		42/6"										
					Boring terminated at 10 1/2 feet No groundwater encountered								
	15												
	20												
	25												

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Job No: 4307.01.04.1 | Date: DEC 2018

LOG OF BORING B-3
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
5

Date(s) Drilled: **12/7/2018**	Logged By: **KU**	Checked By: **REP**
Drilling Method: **Solid-Stem Auger**	Drill Bit Size/Type: **4" drag bit**	Total Depth of Borehole: **13 1/2 feet**
Drill Rig Type: **Portable Track**	Drilling Contractor: **Stapleton**	Approximate Surface Elevation: **Existing Ground Surface**
Groundwater Level and Date Measured: **No Groundwater Encountered**	Sampling Method(s): **Modified California, SPT**	Hammer Data: **140lb, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, psf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL), medium stiff to stiff, moist, porous to 2 1/2 feet								
			5					60.1	13.2	28.9	17		
			50/4"		LIGHT BROWN CLAYEY SAND (SC), very dense, moist								
	5												
					BROWN SANDY CLAY (CH), medium stiff to very stiff, moist								
			8										
	10												
			19										
					Boring terminated at 13 1/2 feet No groundwater encountered								
	15												
	20												
	25												

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Job No: 4307.01.04.1 Date: DEC 2018

LOG OF BORING B-4
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
6

Date(s) Drilled **12/7/2018**	Logged By **KU**	Checked By **REP**
Drilling Method **Solid-Stem Auger**	Drill Bit Size/Type **4" drag bit**	Total Depth of Borehole **6 feet**
Drill Rig Type **Portable Track**	Drilling Contractor **Stapleton**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **No Groundwater Encountered**	Sampling Method(s) **Modified California**	Hammer Data **140lb, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, psf	REMARKS AND OTHER TESTS
	0				DARK BROWN SANDY CLAY (CH), soft to stiff, moist to wet, porous to 3 feet								
			3										
	5		29		BROWN CLAYEY GRAVEL WITH SAND (GC), medium dense to very dense, moist								
					Boring terminated at 6 feet, drilling refusal at 6 feet No groundwater encountered								
	10												
	15												
	20												
	25												

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Job No: 4307.01.04.1 | Date: DEC 2018

LOG OF BORING B-5
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
7

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 Dry Density (pcf): Dry density, in pcf.
8 Water Content (%): Water content, percent.
9 % <#200 Sieve: % <#200 Sieve
10 PI, %: Plasticity Index, expressed as a water content.
11 LL, %: Liquid Limit, expressed as a water content.
12 Expansion Index (EI): Expansion Index (EI)
13 UC, ksf: Unconfined compressive strength, in kips per square foot.
14 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Portland Cement Concrete
Clayey GRAVEL (GC)
Clayey SAND (SC)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Bulk Sample
2.5-inch-ID Modified California w/ brass liners
2-inch-OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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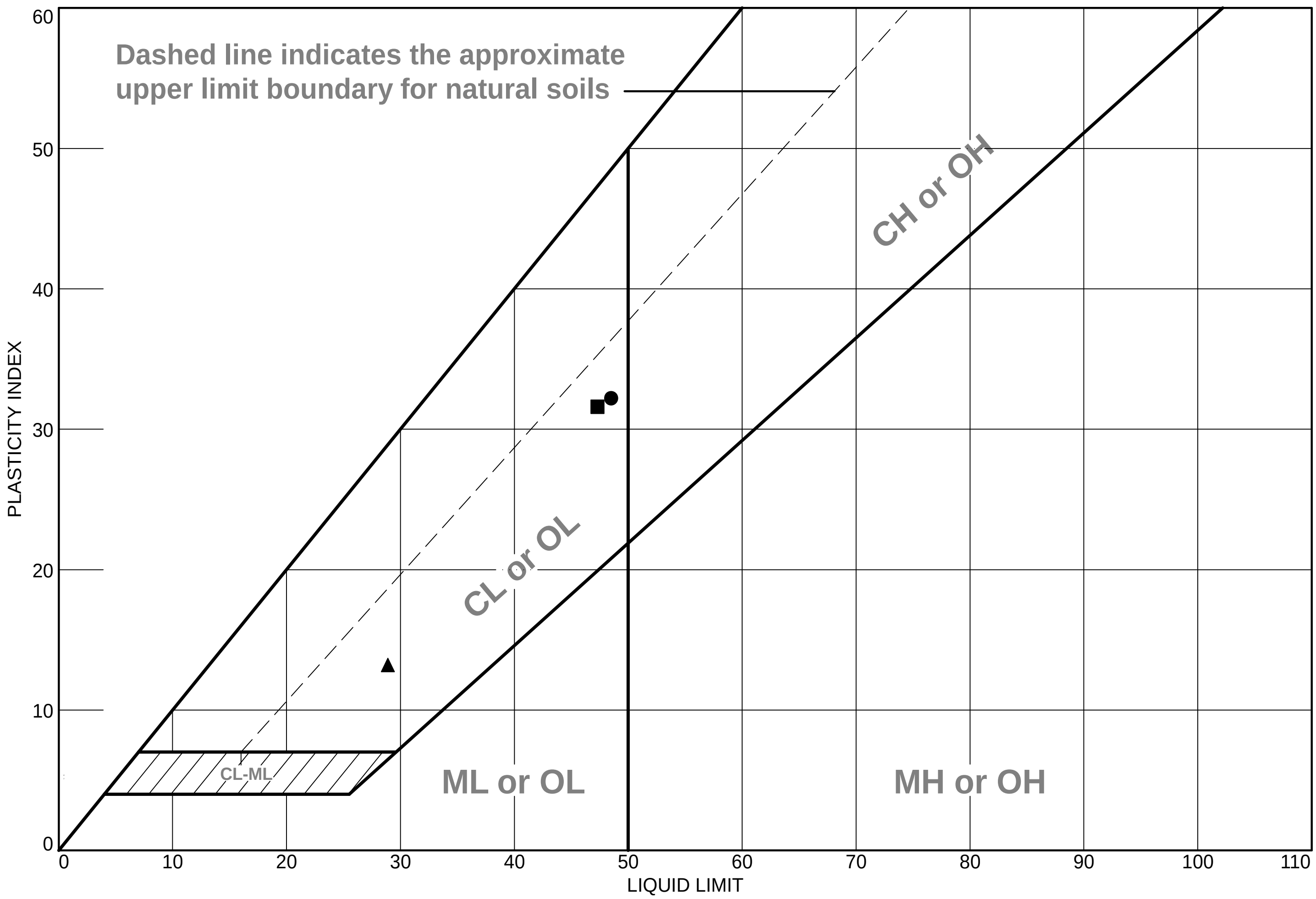
SOIL CLASSIFICATION AND KEY TO TEST DATA
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
8

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Brown Sandy Clay (CL)	48.5	16.3	32.2		68.6	CL
■	Brown Sandy Clay (CL)	47.3	15.7	31.6		73.4	CL
▲	Brown Sandy Clay (CL)	28.9	15.7	13.2		60.1	CL

Project No. **Client:**

Project:

● **Source of Sample:** B-1 **Depth:** 1.5' & 2.0'
■ **Source of Sample:** B-2 **Depth:** 2.5' & 3.0'
▲ **Source of Sample:** B-4 **Depth:** 2.5' & 3.0'

Tested By: SCW **Checked By:** SEF

Remarks:
● Expansion Index= 63 (Medium)
■ Expanion Index= 68 (Medium)
▲ Expansion Index= 17 (Very Low)

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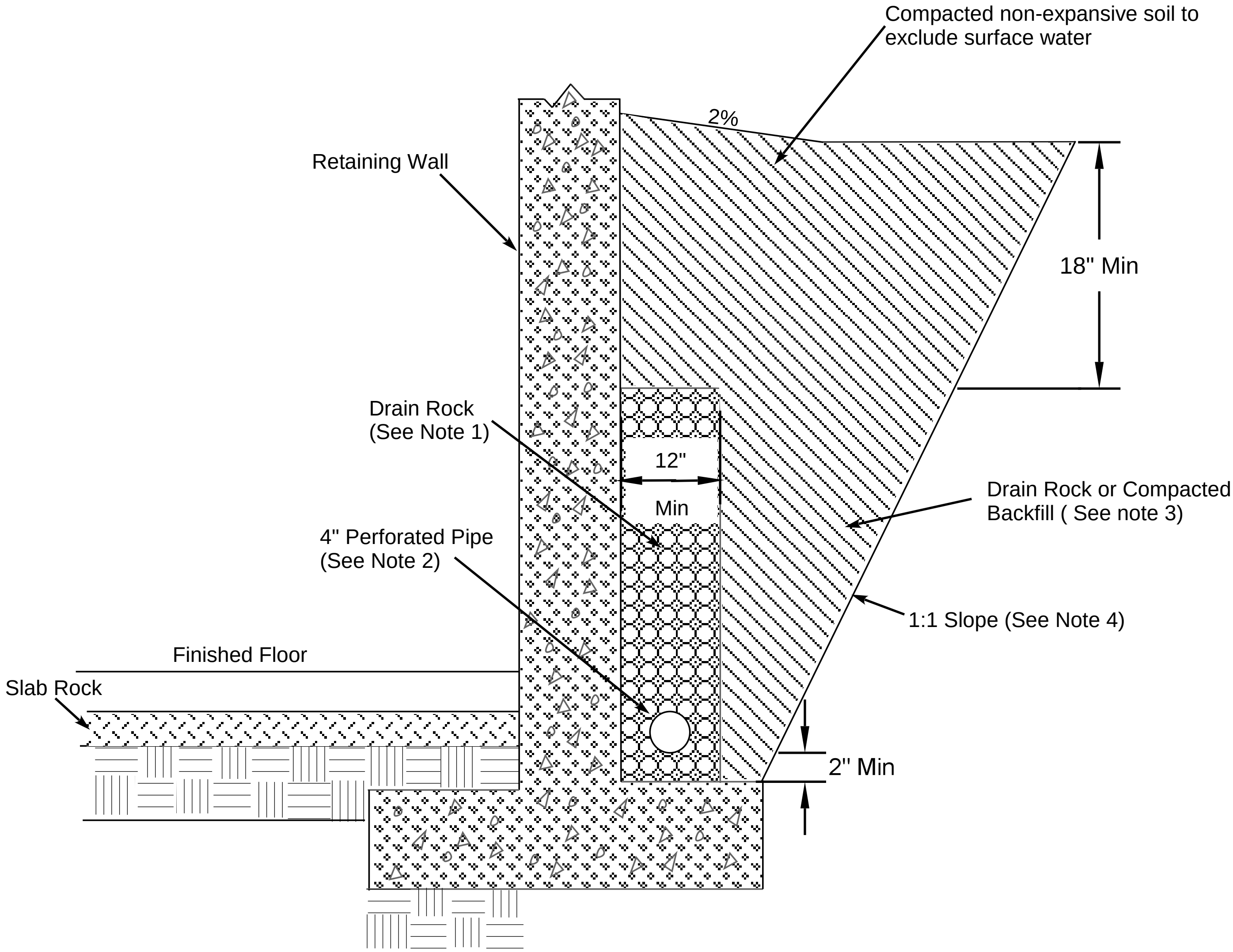
CLASSIFICATION TEST DATA
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
9



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.

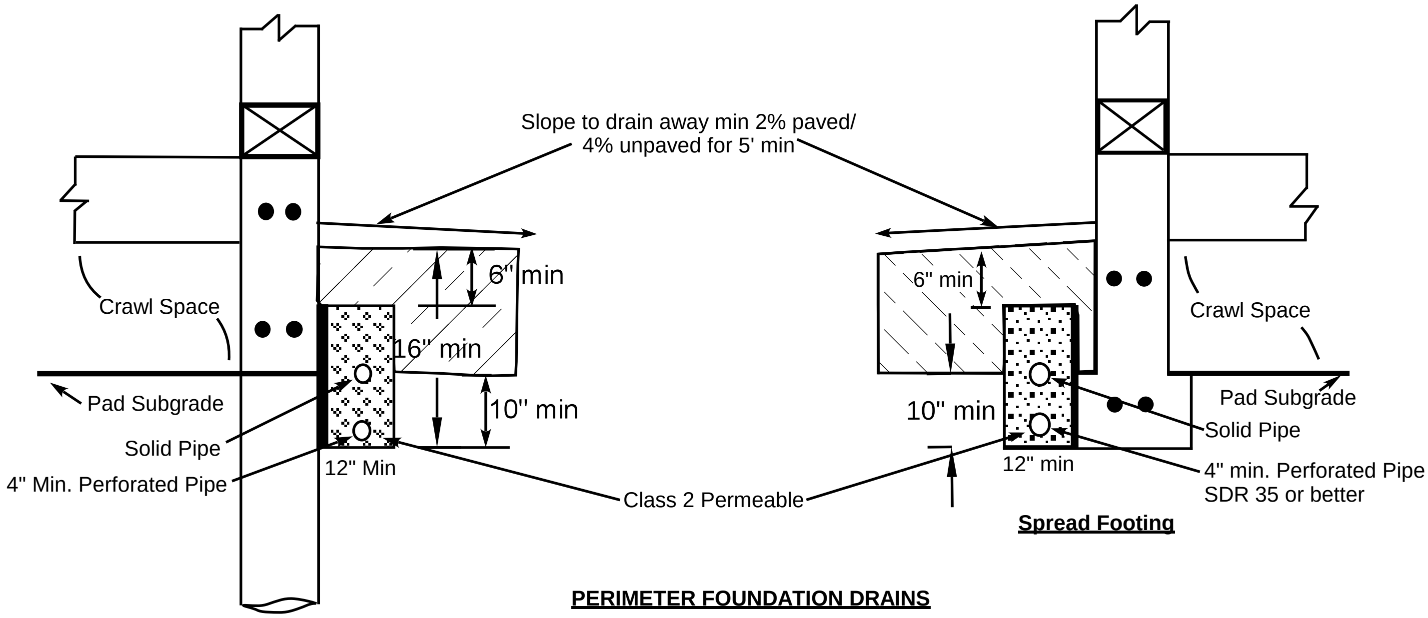
2. Pipe should conform to the requirements of Section 68 of State of California "Caltrans" Standards, perforations placed down, sloped at 1% for gravity flow to outlet or sump with automatic pump. The pipe invert should be located at least 8 inches below the lowest adjacent finished surface.

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.

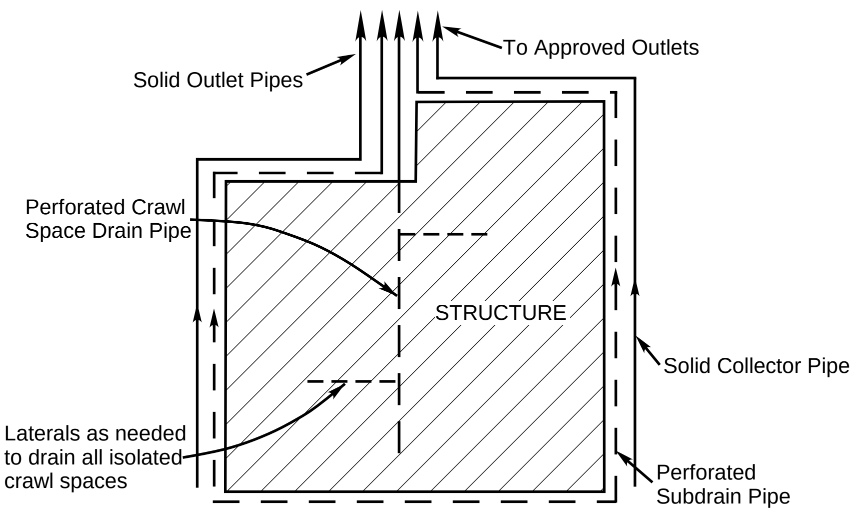
4. Slope excavation back at a 1:1 gradient from the back of footing where expansive materials are exposed.

Not to Scale

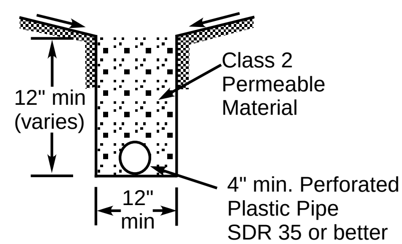
RGH CONSULTANTS	**RETAINING WALL BACKDRAIN ILLUSTRATION** 3422 Santa Rosa Avenue Santa Rosa, California	PLATE **10**
Job No: 4307.01.04.1 Date: DEC 2018		



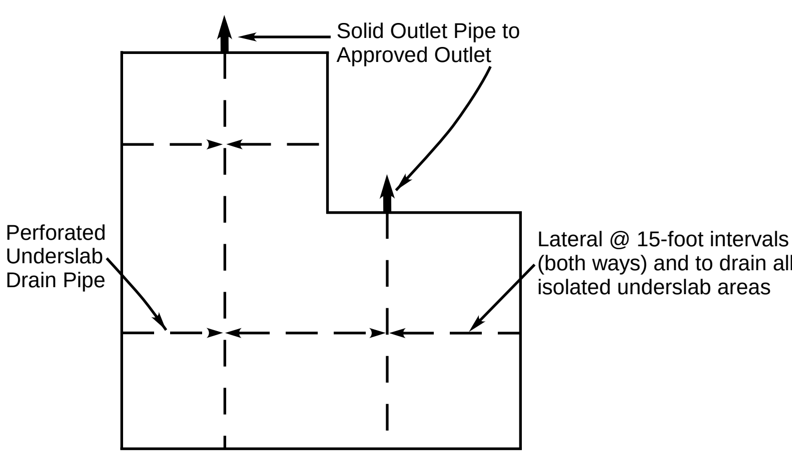
PERIMETER FOUNDATION DRAINS



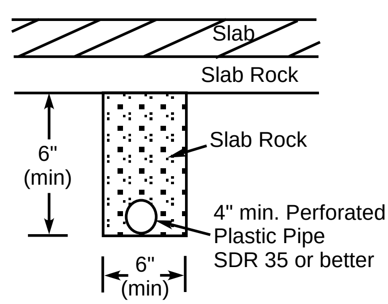
TYPICAL FOUNDATION DRAIN PLAN



CRAWL SPACE DRAIN



TYPICAL UNDERSLAB DRAIN PLAN



SLAB UNDERDRAIN

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Job No: 4307.01.04.1 | Date: DEC 2018

TYPICAL SUBDRAIN DETAILS
3422 Santa Rosa Avenue
Santa Rosa, California

PLATE
11

APPENDIX B - REFERENCES

American Society of Civil Engineers, 2010, Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-10.

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.

Burmister, D.M., 1948, The Importance and Practical Use of Relative Density in Soil Mechanics: Proceedings of ASTM, v. 48:1249.

California Building Code, 2016, California Building Standard Commission.

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McLaughlin, R.J., Langenheim, V.E., Sarna-Wojcicki, A.M., Flek, R.J., McPhee, D.K., Roberts, C.W., McCabe, C.A., and Wan, E., 2008, Geologic and Geophysical Framework of the Santa Rosa 7.5' Quadrangle, Sonoma County, California, U.S. Geological Survey, Open-File Report 2008-1009, 51 p., 3 plates, Scale 1:24,000.

Natural Resources Conservation Service, United States Department of Agriculture, accessed December 18, 2018. Web Soil Survey, available online at http://websoilsurvey.nrcs.usda.gov/.

U.S. Department of Homeland Security, Federal Emergency Management Agency, accessed December 17, 2018, Flood Insurance Rate Map, City of Santa Rosa, Community Panel Number 06097C0726E. FEMA Flood Map Service Center, available online at https://msc.fema.gov/portal/home.

APPENDIX C - DISTRIBUTION

Pacific West Communities, Inc. (3,e)
c/o TK Development
Attention: Ken Koss
6891 East Dorado Court
Tucson, AZ 85715-4755
sylken1@sbcglobal.net

REP:TAW:ku:ejw

s:\project files\4251-4500\4307\4307.01.04.1 3422 santa rosa avenue\gs report.doc