Jim Glomb

Geotechnical and Environmental Consulting, Inc.

152 Weeks Way, Sebastopol, CA 95472 • Phone 707/237-2703
jim@jimglomb.com

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APR 08 2019
Napa County Planning, Building & Environmental Services

April 5, 2019
Project 1505

Mr. and Mrs. Kateley
c/o REB Engineering, Inc.
POB 113
St. Helena, CA 94574

Subject: **Geotechnical Conformance Review**
Proposed Access Road
Grading and Drainage Plan
5700 Dry Creek Road
Napa, CA
APN: 034-030-061

References:

1. REB Engineering, Inc., Grading and Drainage Plans for the Access Road, , Sheets C1 to C15, Latest Revision, dated 4/3/19.
2. Jim Glomb, Geotechnical and Environmental Consulting, Inc., Geotechnical Investigation, Proposed Residence, Swimming Pool, Garage, Shed and Driveway, 5700 Dry Creek Road, Napa, CA, APN: 034-370-040 and 034-030-061, Project 1505, dated 6/11/16.

Dear Mr. and Mrs. Kateley:

As requested, Jim Glomb Consulting, Inc. has performed a geotechnical conformance review of the referenced plans and details related to the proposed Access Road at the subject site.

Upon our review, we find that the geotechnical aspects of the revised plans and details are in general conformance with the recommendations of our referenced geotechnical report, contingent on the following comments:

1. We recommend having a pre-construction meeting, including the Owner, contractor, and the geotechnical consultant to discuss the geotechnical aspects of planned work and scheduling.
2. We reserve the right to modify or supplement the geotechnical recommendations at any time during site development, depending on conditions encountered.
3. Refer to the referenced Geotechnical Investigation for grading and drainage recommendations. In addition we submit the following supplemental comments:

Cutslope Stability

Proposed 1:1 and 1:1.5 cutslopes are in areas previously observed to be generally geologically stable. However, all cutslopes should be observed during grading to assess their geologic stability. In the event that existing or newly graded cutslopes adjacent to roadways are found to be geologically unstable, we may recommend that they be supported by retaining walls, fill buttresses or other stabilization methods. Grading criteria are provided in our geotechnical report.

Our services were performed according to generally accepted geotechnical consulting practices for the geographical area of the subject project at the time this report was prepared. No other representation, express or implied, and no warranty or guarantee is included or intended as to the professional opinions or recommendations provided. We do not guarantee construction, nor do we assume the contractor's primary responsibility to produce a completed project conforming to the project plans and specifications.

We trust this provides the information you require at this time. If you have questions or wish to discuss this further, please call.

Very truly yours,
Jim Glomb Consulting, Inc.

CERTIFIED ENGINEERING GEOLOGIST
JAMES D. GLOMB, JR.
#1154
Exp. 6-30-20
GEOLOGIST
STATE OF CALIFORNIA

4/5/19

Jim Glomb
Engineering Geologist, C.E.G. 1154

REGISTERED PROFESSIONAL ENGINEER
DONALD R. POINDEXTER
GE-690
EXP. 12/31/19
GEOTECHNICAL
STATE OF CALIFORNIA

4/5/2019

Don Poindexter
Consulting Geotechnical Engineer, G.E. 690

Jim Glomb

Geotechnical and Environmental Consulting, Inc.

152 Weeks Way • Sebastopol, CA 95472 • Phone: 707/237-2703
email: jim@jimglomb.com

June 28, 2018
Project 1505

Mr. and Mrs. Kateley
c/o REB Engineering, Inc.
POB 113
St. Helena, CA 94574

RE: **Geotechnical Investigation**
Proposed Residence, Garage, Swimming Pool and Driveway
5700 Dry Creek Road
Napa, CA
APN: 034-370-040 and 034-030-061

Dear Mr. and Mrs. Kateley:

We are pleased to submit our geotechnical investigation report for the planned residence, garage, swimming pool, and driveway at the subject property at 5700 Dry Creek Road in Napa, California. This report updates and supersedes our previous report for this site dated June 14, 2016.

The purposes of our work have been to investigate the soil and geologic conditions of the planned development areas and to provide geotechnical recommendations and design criteria for the proposed construction.

Scope

The scope of our work consisted of:

1. Review of soil and geologic data pertaining to the site and vicinity;
2. Geologic field reconnaissance and mapping of the site and vicinity;
3. Exploration of subsurface conditions by logging and sampling 15 test pits;
4. Classification, description of representative soil samples obtained at the site;
5. Geotechnical analyses of field data; and
6. Preparation of this report with our findings, conclusions and recommendations.

Site Conditions

The proposed home site is located on a ridge top with moderate to steep descending slopes to each side, except for a steep ascending slope nearby on the northeast. A driveway will lead to the site from Dry Creek Road to the southwest. The existing site conditions and the building areas are shown on the Site Plan, Plates 1.0 and 1.1. A Vicinity Map is included as Plate 1.2. The site is currently undeveloped. A rough-graded unpaved access road exists in the approximate location of the planned driveway. The site supports the growth of native grasses, brush and trees.

Proposed Development

Development plans for the proposed project include a residence with an attached garage, a swimming pool, and a ½ mile long driveway access. We understand that the proposed building will be a one-story, wood-frame structure with a slab-on-grade floor and an attached garage with a slab-on–grade floor. A level house pad will be created by lowering the ridge top site by 4 to 6 feet. A swimming pool, possibly with an infinity edge, is planned on the southwest limit of the building site, with a proposed concrete patio terrace between the pool and the residence. The driveway will require cut and fill grading with possible retaining/slough walls at some locations, depending on final grading plans. When the final grading plans are available, we will review them and will make revised or supplemental recommendations, if required.

Soil and Geologic Conditions

Test pits excavated at the site of the proposed residence encountered fill, residual soil and weathered bedrock. The fill consists of up to about 4 feet of dry, loose sandy gravel and gravelly sand on the margins of the proposed home site. Underlying the fill over most of the site is moist, loose to dense gravelly sand that is locally creep prone on the steep margins of the home site. Underlying the fill and residual soil is very weathered, very fractured sandstone and shale bedrock of the Jurassic and Cretaceous age Great Valley Sequence. The bedrock is very fractured, steeply fractured, thin-bedded and folded. Average fracture spacing is ½ to 1-inch. Bedding attitudes are generally inclined favorably in to slope and locally unfavorably out of slope. Residual soil and localized areas of bedrock were observed to be creep prone in test pits T-7, T-8 and T-10, in the area of the proposed pool.

Test pits excavated along the existing road alignment, that is in the approximate location of the proposed driveway, generally exposed weathered, fractured shale bedrock with a thin soil mantle. Locally, unengineered, loose sidecast fills with depths of 2 to 5 feet exist along portions of the downslope sides of the existing roadway.

These materials are described in the test pit logs attached to this report as T-1 through T-15, Plates 2.1 through 2.8. Soils are classified in accordance with the Unified Soil Classification System, presented on Figure 1. The test pits were loosely backfilled and are not suitable for support of structures in their current condition.

Expansion Potential

Reviewed published mapping indicates that soils with Plasticity Indexes ranging from Non-Plastic to 20 may be present at the site and its vicinity, which indicates a range from non-expansive to moderately expansive. A sample of the residual soil from T-7 was tested and the result indicated a Plasticity Index = 22, indicating a moderate expansion potential. Based on site-specific field observations of the physical characteristics of the on-site soil and sandstone and shale bedrock, we judge that these materials have a variable range of low to locally high expansion potential. These characteristics have been taken into consideration in the development of the following conclusions and recommendations.

Groundwater

No free ground water or shallow groundwater table was observed within the exploratory test pits at the time of the explorations. Water levels must be expected to vary due to seasonal changes and physical changes to the site, including landscape irrigation.

Slope Stability

Based on our review of available geologic mapping, no landslides or other geologic hazards are shown on the site or in the immediate vicinity. We observed no indications of slope movement or instability at the time of our site investigation, except for localized shallow sloughing of cut slopes and erosion. Localized soil strata on or near slopes may be creep prone. Creep is an imperceptibly slow movement of soil downhill due to gravity.

Faulting and Seismicity

No evidence of active faulting was observed on the building site or in the test pits. No other geologic hazards are known to exist in the immediate vicinity.

The project site is not within a current Earthquake Fault Zone as designated by the State of California. The closest active fault is the West Napa Fault 4.5 kilometers east of the site. Like most of California, the site will be subject to future strong ground shaking from an earthquake. The intensity of future earthquake shaking will depend on the distance from the site to the earthquake focus, magnitude, and the response of the structures to the underlying soil and/or rock.

The subject site was observed to be underlain by bedrock. Field data, and our experience in the site vicinity, as well as the USGS Soil Type and Shaking Hazards mapping, indicate that the site and proximity can be assigned a Site Class C based on average rock properties in the top 100 feet.

The project designers should determine the appropriate Occupancy Category and Seismic Design Category per the 2016 CBC. If requested, we would provide additional seismic design criteria.

Conformance to the above criteria for seismic design does not constitute any kind of guarantee or provide any specific assurance that significant structural damage or ground failure will not occur during a significant seismic event. The primary goal of seismic design is to protect life, and not to avoid all damage, since such design may be economically prohibitive. Following a major earthquake, a building may be damaged beyond repair, yet not collapse.

Liquefaction Potential and Other Seismic Hazards

We did not observe materials or conditions, such as loose, saturated sands, that would be considered to be susceptible to liquefaction within the limited depths explored for this study. Therefore, we judge that the potential for liquefaction is negligible for the subject building area.

In general, we observed no indications of other seismic hazards that would preclude the proposed development of this site as planned.

Conclusions

Based on our field work, literature review and analyses, we conclude that the subject site is suitable for support of the proposed residence, garage, pool, and driveway, subject to the mitigation of certain geotechnical issues. The geotechnical concerns are the presence of deep weak potentially expansive soils and bedrock in the vicinity of the building site, particularly in the area of the planned pool, and the potential for earthquake ground-shaking. There is also a potential for instability on existing and proposed cut slopes in bedrock within the planned road alignment. The existing fill soils on the margins of the road alignment are considered to be unengineered and are potentially unstable. Additional geotechnical concerns are as follows:

1. Planned cuts exposing surface soil and highly weathered bedrock will be subject to erosion and slumping in some areas.
2. Planned fills consisting of onsite fine-grained soil and very weathered bedrock materials will be susceptible to erosion and may require special reinforcement to improve slope stability.
3. Excavations in a few portions of the driveway alignment may encounter very hard bedrock that will be difficult to excavate.
4. Construction of fill along the driveway alignment at a relatively steep gradient may require keyways and horizontal benches into firm bedrock or soils, with subdrains, to help mitigate potential stability problems.
5. Cut/fill transitions within the pavement area should be minimized due to the potential for differential settlement that may stress the pavement. Where they cannot be avoided, subexcavation of firm bedrock and replacement with engineered fill adjacent to the cut/fill transition, as described below, should be performed to reduce the potential for differential settlement.

Discussion of these concerns is incorporated into our recommendations presented below.

Recommendations

The following recommendations should be incorporated into the final design and construction phases of the project.

Site Preparation and Grading

In the event that grading is required the following recommmendatioins would apply.

General

Grading is most economically performed during the summer months when soils are driest. Delays and comparatively expensive construction procedures should be anticipated for site grading performed during the rainy season due to excessive soil moisture and potential problems caused by erosion.

Clearing and Stripping

Areas to be graded or receive improvements should be cleared of roots and organic materials. We anticipate that the required depth of stripping will generally be about 6 to 12 inches. Deeper stripping may be required to remove localized concentrations of organic matter, such as roots or debris. The cleared organic materials should be removed from the site; strippings may be stockpiled for reuse as topsoil in landscaping areas.

Overexcavation

Old fill soils, loose/soft surface soils, expansive native soils and expansive bedrock, if any, should be overexcavated as appropriate for the proposed project. The final depths of overexcavation will depend on the final project design requirements and the condition of materials encountered during construction, as determined by the Geotechnical Consultant. Difficulty in achieving the recommended minimum degree of compaction described below should be used as a field criterion by the Geotechnical Consultant to identify areas of unstable soils that should be removed and replaced with non-expansive, properly moisture conditioned and compacted fill.

Subgrade Preparation

Loose surface soils should be removed from areas designated to receive improvements, engineered fill and/or pavements.

Exposed suitable subgrade designated to support improvements or receive engineered fill should be scarified to a minimum depth of 8 inches, moisture conditioned to within approximately 2 percent of optimum moisture and compacted to at least 90 percent relative compaction in accordance with ASTM test designation D1557. Improvements and fill may be placed directly on exposed competent, non-expansive bedrock, or engineered compacted fill.

General Engineered Fill

Fill material should be approved by the Geotechnical Consultant prior to use. Fill derived from on-site soil, if free of organic materials, is expected to be suitable as engineered fill, excluding any clayey soils or unsuitable bedrock that may be present. Approved on-site or imported soils should be free of rocks or lumps greater than 4 inches in largest dimension and organic materials and have a Plasticity Index of 15 or less.

General engineered fill should be placed in level lifts not exceeding 8 inches in loose thickness. Each lift should be properly moisture conditioned to within approximately 2 percent of optimum moisture and compacted to at least 90 percent relative compaction in accordance with ASTM test designation D1557, except that the upper 6 inches of subgrade fill to be under pavement and aggregate base (CalTrans Class 2) should be compacted to at least 95 percent relative compaction. Fill moisture content and density should be verified by the Geotechnical Consultant. These compaction specifications may be amended, depending on materials encountered during grading.

Fill Slopes

Fill slopes up to 10 feet in height using on-site materials should be constructed at an inclination not exceeding 2:1 without special reinforcement. Fill slopes greater than 10 feet in height may be constructed at an inclination not exceeding 2:1 provided that the fill is constructed as reinforced earth using geogrid reinforcement. These fill slope recommendations are subject to modification, depending on final grading plans.

For reinforcement, we recommend a geogrid such as Mirafi 5XT or equal, with the primary grid direction perpendicular to the surface of the slope. Installation must be in accordance with the manufacturer's recommendations. Preliminarily, we recommend geogrid reinforcement at intervals of 18 inches. We recommend that the geogrids extend into the fill the full width of the fill, with a minimum of 12 feet from the face. We recommend the soil layers be placed and compacted as engineered fill with maximum 6 inches of compacted lift thickness to a minimum of 90 percent relative compaction (ASTM D1557) and within 2 percent of optimum moisture content. Compaction tests are recommended for each lift. Final determination of geogrid spacing and confirmation of fill configuration and stability would be determined at the time of grading, depending on the materials encountered. Additional laboratory testing and analyses may be recommended to confirm stability of slopes, depending on the materials encountered.

All fill placed on slopes steeper than 5:1 should be placed on level keys and benches cut into dense/stiff colluvium or bedrock. Due to the steepness of the driveway, keyways and benches may be required both transverse the full width of the driveway and longitudinally along the base of the fill on the downslope side of the roadway embankment. The keyways should be excavated into competent soil or bedrock a minimum depth of 2 feet and 10 feet wide. Keyways should have a minimum 5 percent downward slope into the back of the keyway towards the subdrain. Horizontal benches should be excavated at maximum vertical intervals of 5 feet. The number of keyways and benches may be reduced for areas along the roadway with less than 24 inches of fill, subject to review at the time of grading by the Geotechnical Consultant. Fill slopes should be overbuilt and trimmed back to expose firm surfaces.

Internal subdrainage will be required to reduce the buildup of hydrostatic pressure behind the fill. At a minimum, subdrains will be required at the backs of keyways and benches at vertical intervals of approximately 10 to 15 feet. In general, the subdrains should consist of a perforated PVC drain pipe or equivalent on approximately 3 inches of drain rock bedding and covered with a minimum of 12 to 24 inches of drain rock. We recommend CalTrans Class 2 Permeable drain rock or, as an alternative, 3/4 to 1 1/2-inch clean drain rock wrapped with a geofabric filter such as Mirafi 140N or equivalent. Clean-outs should be provided for each subdrain. We recommend that the locations of the subdrains be recorded by survey. The Geotechnical Consultant will provide additional recommendations after grading plans are completed and/or in the field during grading for drainage behind fills.

Cut Slopes

In general, cut slopes in bedrock and soil should be constructed at an inclination not exceeding 2H:1V. It is possible that localized areas of colluvial soil over the bedrock will require an inclination of 3:1 or flatter and areas of hard, dense bedrock could be left steeper than 2:1, subject to the observations by the Geotechnical Consultant at the time of grading. The tops of cut slopes should be rounded and compacted to reduce the risk of erosion. Existing cut slopes will be evaluated at the time of grading to confirm stability or determine remedial measures, such as cutting back the slope or installing slough walls.

Temporary Slopes

Temporary slopes should be laid back or shored in conformance with OSHA standards. All temporary slopes and shoring design are the responsibility of the contractor.

Finished Slopes

The tops of cut slopes should be rounded and compacted to reduce the risk of erosion. Fill and cut slopes should be planted with vegetation to resist erosion and protected from erosion by other measures as discussed below under Erosion Protection, upon completion of grading. Surface water runoff should be intercepted and diverted away from the tops and toes of cut and fill slopes by using berms or ditches. Subdrains under lined or unlined drainage ditches may be recommended to intercept shallow water seepage.

Rippability

In general, excavations at the site should be excavatable with standard heavy equipment. However, localized very hard bedrock conditions or large boulders may be encountered. These conditions may require extra heavy duty ripping with specialized equipment or blasting.

Erosion Protection

We recommend that the erosion control measures be designed by an experienced civil engineer or erosion control engineer. All cut and fill slope faces should be equipped with erosion protection in the form of synthetic erosion mat such as Tensar TM3000 or equivalent, or as specified by the erosion control engineer. The erosion mat should be installed to the manufacturer's specifications. It is also recommended that all slopes be hydroseeded or planted with vegetation appropriate for erosion protection.

Access Driveway

In addition to the site preparation and grading recommendations provided above, the following recommendations would apply to the planned driveway and parking areas.

Graded Cuts Under Pavement

Planned grading along the pavement alignment may expose weak surface soils at subgrade in some areas. Due to the steepness of the roadway, the pavement section may be vulnerable to downslope creep of any subgrade soils and lateral movement due to traffic. We recommend that the Geotechnical Consultant observe all cut slope subgrade and determine areas where the residual soil must be subexcavated to expose firm bedrock or adequate subgrade soils. Keyways across the roadway with horizontal benches may be recommended where appropriate to provide adequate lateral support for the road section. Shallow subexcavations (less than 12 inches) could be backfilled with compacted base rock or aggregate sub-base materials instead of on-site fill material. Deeper subexcavations would require engineered fill with on-site materials constructed as described above for fill slopes.

Cut/Fill Transitions

We recommend that cut-fill transitions be avoided within the roadway as much as practicable. Where cut/fill transitions occur within the roadway it is recommended that a 10 foot wide by 1 foot deep section of the cut subgrade immediately adjacent to the transition be overexcavated and replaced with engineered fill, or as recommended by the Geotechnical Consultant at the time of grading.

Driveway Pavement

Any proposed new driveway or parking area may be constructed with crushed rock, asphalt concrete, or reinforced concrete surfacing. If pavement is preferred, based on our observations and evaluation, we recommend a minimum pavement section of 2.5 inches of asphalt concrete overlying 8 inches of Class 2 aggregate base rock (AB). If concrete pavement is desired, we recommend a minimum of 8 inches of Class 2 AB under the pavement. The design of concrete pavement is not within our scope of services.

All subgrade areas should be observed by the Geotechnical Consultant. If warranted, R-Value testing may be recommended to confirm or revise the recommended pavement section. If expansive soil or bedrock areas are encountered, a thicker aggregate base layer or alternative pavement sections may be recommended.

We further recommend that the pavement be constructed in accordance with the following criteria:

1. All pavement soil subgrade should be free of organic and perishable material. We recommend that all weak materials be removed from the area of the proposed pavement and replaced with compacted clean fill or crushed rock.
2. The upper 6 inches of subgrade should be moisture-conditioned and compacted to a minimum relative compaction of 95 percent. All pavement subgrade should be stable and "non-pumping" at the time the base rock is placed.
3. Materials of the type and thickness (minimum) specified should be used. All base rock should meet the Standard Specifications of the State of California for Class 2 base rock and be angular in shape.
4. The base rock should be uniformly compacted to a minimum relative compaction of 95 percent at or near optimum moisture content.
5. Asphalt concrete should only be placed during periods of fair weather when the free air temperature is within the prescribed limits as set by Caltrans.
6. All trench backfill material underneath the pavement should be compacted, as previously recommended in this section, to reduce fill settlement and minimize pavement damage that may result from such settlement.
7. Adequate drainage must be provided adjacent to the pavement area to prevent surface water from saturating the pavement subgrade. This is especially important for areas along the driveway and where pavement abuts drainage swales or landscaping.

Driveway Subdrains

Due to the relative steepness of the driveway (up to about 20 percent or more), there is a risk that water will be passing through the pavement base rock and may cause erosion of the subgrade, which could lead to pavement failure. To reduce this risk, we recommend that subdrains be installed laterally across the width of the pavement at a spacing of approximately 50 feet, or as designated by the Geotechnical Consultant. The subdrains should consist of 12-inch wide by 12-inch deep trenches with a minimum 3-inch diameter perforated PVC drain pipe. The subdrain trench should be backfilled with CalTrans Class 2

Permeable drain rock, with the drain pipe about 2 inches from the bottom of the trench. Non-perforated collector pipes should be installed to collect the flow from the drains for delivery to on-site storm drain systems.

Driveway Shoulders

We recommend a minimum roadway shoulder of 3 feet at the tops of fill slopes. The shoulders may be reduced to 2 feet in width; however, this increases the potential for loss of lateral support for the pavement, increasing the risk of differential settlement and cracking, and which would potentially decrease the useful life of the pavement and require more maintenance.

Foundations - Residence and Garage

Based upon the information obtained from our investigation, we recommend a foundation system for the proposed residence and garage comprised of spread footings with slab-on-grade floors. We recommend that the foundations be constructed based on the following design criteria:

DESIGN CRITERIA FOR SPREAD FOOTINGS

Description	Criteria
Width	Minimum 18 inches; Minimum 24 inches for isolated columns.
Embedment	The foundation footings must be embedded a minimum depth of 12 inches into suitable bedrock, or as determined by the Geotechnical Consultant. The bottoms of footings must be stepped, if needed, as required by building codes. See Note 1
Allowable Bearing Capacity	2,500 pounds per square foot (psf). See Note 2
Coefficient of Sliding Friction	0.35 in bedrock

1. Footing embedment depth is measured from the lowest adjacent finished soil grade (or pad grade) or top of suitable bedrock, as applicable, to the bottom of the footing. Footings on or near slopes may have to be deepened to provide adequate lateral support, as determined by the Geotechnical Consultant.

2. The allowable bearing capacity is for dead plus live loads. The bearing capacity may be increased by 1/3 for wind or seismic loads. Lateral structural loads, where applicable, may be countered by a passive resistance of 500 pcf (EFP) commencing below the top of suitable bedrock, excluding fill or residual soils, as applicable.

3. Foundation excavations at the site may be difficult with standard heavy equipment. Localized very hard bedrock conditions or large boulders may be encountered. These conditions may require extra heavy duty or specialized equipment. We should be consulted regarding the use of dowelling to anchor the footings to the bedrock, if warranted.

4. The excavations for footings should be cleaned of loose material and debris prior to placement of concrete. All footing excavations should be observed by a representative of our firm to confirm the suitability of the subsurface conditions for the planned foundation. Overexcavation to remove unsuitable or expansive bedrock may be recommended, if warranted.

Foundations - Pool and Retaining Walls

We recommend that the the planned pool and retaining walls adjacent to the pool be supported by reinforced concrete pier and grade beam foundations, designed and constructed based on the following geotechnical design criteria:

DESIGN CRITERIA FOR DRILLED PIERS

Diameter:	Minimum 18 inches
Depth:	Minimum depth of 10 feet into competent bedrock as determined by the Geotechnical Consultant during drilling. Total depths are estimated to range from 14 to 20 feet. Deeper piers may be required due to subsurface conditions encountered as determined by the Geotechnical Consultant or anticipated pier loadings as determined by the structural designer.
Friction Value:	Maximum friction value of 600 psf within the bedrock, which may be increased by 1/3 for wind and seismic loads. Disregard the overlying soils for support.
Spacing:	Minimum 3 pier diameters center to center; maximum spacing of 8 feet, or as determined by the structural designer.
Lateral Creep:	The piers should be designed for lateral surcharge forces, assumed equivalent to a fluid weighing 60 pounds per cubic foot, against the piers for 2 times the width of the piers within the remnant fill, or residual soils, where present. A depth of 3 feet above the bedrock should be assumed for the creep zone on the terrace side of the pool and 6 feet for the other 3 sides of the pool, subject to review of final development plans. This is waived when fill/residual soils are not present adjacent to the piers.
Lateral Resistance:	Maximum of 500 pcf (EFP) against the individual piers for 1 ½ times the width of the piers within the bedrock. Passive pressures should be disregarded for the residual soils above the bedrock.

1. The design and reinforcement requirements for the pool and retaining wall foundations should be as recommended by the project structural designer in accordance with applicable current CBC or ACI standards.

2. The exterior and interior piers should be connected together by grade beams, tie beams, or other structural elements, as determined by the structural designer particularly in the upslope-downslope direction.

3. The top of the portion of pier embedded in bedrock should have a horizontal confinement of at least 10 feet, or as designated by the Geotechnical Consultant during construction. This may result in the piers being deeper.

4. It should be noted that the bedrock may be difficult to drill in some areas and specialized extra heavy-duty equipment or specialized methods may be necessary to obtain the required depths.

5. The bottoms of the pier excavations should be free of loose cuttings or slough prior to placement of reinforcement and concrete. The concrete must be placed by tremie hose methods due to the depths of the piers.

6. It is possible that some or all pier holes may encounter ground water. In such cases, the water should be removed by pumping or the pier concrete should be tremied to "float" the water above the concrete. The tremie hose should maintain a minimum 5-foot head of concrete at all times during hose removal.

7. We recommend that forms be used to shape the tops of piers to prevent "mushrooming" of excess concrete at the surface. In addition, all excess concrete along the bases of the grade beams must be trimmed.

Retaining Walls

Depending on final improvement designs, it is possible some exterior retaining walls not connected to the pool may be supported on spread footings, in accordance with the criteria presented above, where shallow bedrock is available, or as determined by the Geotechnical Consultant. Reinforced concrete retaining walls for any portions of the planned improvements on or near slopes, or as determined by the Geotechnical Consultant, should be supported on drilled pier foundations designed in accordance with the recommendations presented above, subject to the following additional comments.

Lateral Pressures

Retaining walls supporting level backfill should be designed on the basis of an active earth pressure of 60 pounds per cubic foot (equivalent fluid weight). Retaining walls supporting sloping backfill at an inclination no steeper than 2 (horizontal) to 1 (vertical) should be designed on the basis of an active earth pressure of 80 pounds per cubic foot (equivalent fluid weight). The above design pressures are applicable to cantilever walls that are free to rotate at least 0.005 radian. Walls not capable of this movement should be assumed rigid and designed for higher at-rest pressures of 80 pcf (level backfill) and 100 pcf (2:1 maximum backslope). See Swimming Pool section below for lateral loads for the pool.

Appropriate lateral surcharge loading should be applied if adjacent foundations, structures, fills, or traffic loading will be present within a 1.5 (horizontal) to 1 (vertical) imaginary plane projected up from the lower rear corner or down from the downslope leading bottom edge of the footing. The retaining walls for the driveway or parking area should be designed for an additional 2 feet of retained earth to accommodate traffic and parking surcharges.

We can provide additional specific surcharge analysis if necessary once the surcharge loads other than traffic and parking (if any) have been identified.

Seismic Loadings

For seismic loadings on the retaining wall, where applicable, based on the results of our investigation of site conditions, the dynamic lateral loading can be assumed as a lateral force (P_E) in units of pounds per linear foot of wall length, as in:

$$\mathbf{P_E = 10 \times H^2}, \text{ Where: } H = \text{retaining height of wall in feet}$$

The location of the force P_E is at a distance of 0.6H above the base of the retaining wall.

Backfill

Only non-expansive granular backfill is recommended behind the retaining walls. On-site clayey soils or clayey bedrock, if encountered, are not suitable as backfill behind the retaining walls. Wall backfill should be spread in level lifts not exceeding 8 inches in thickness. Each lift should be compacted to not less than 90 percent relative compaction, per ASTM test designation D1557, or as designated by the Geotechnical Consultant. Retaining walls will yield slightly during backfilling. Therefore, walls should be properly braced during the backfilling operations. Over-compaction within 5 feet of the retaining wall must be avoided to prevent potential stress or damage to the wall. The contractor is responsible for preventing damage to the retaining walls.

Retaining Wall Drainage

Retaining walls should be fully backdrained. The backdrains should consist of a 4-inch diameter, rigid perforated pipe surrounded by a drainage blanket. The pipe should slope to drain by gravity to appropriate outlets. Accessible subdrain cleanouts should be provided and maintained on a routine basis. The drainage blanket should consist of clean, free-draining crushed rock or gravel, wrapped in a filter fabric such a Mirafi 140N. Alternatively, the drainage blanket could consist of Caltrans Class 2 "Permeable Material" or a prefabricated drainage structure such as Mirafi Miradrain. The top of the drain pipe should be at least 8 inches below lowest adjacent grade. The drainage blanket should be at least 1 foot in width and extend to within 1 foot of the surface. The uppermost 1 foot should be backfilled with compacted native soil to reduce infiltration of surface water for exterior retaining walls.

A drainage swale is recommended at the top of the backfill behind the retaining wall to control and remove surface water from upslope, where applicable.

Where migration of moisture through retaining walls would be detrimental or undesirable, retaining walls should be treated with appropriate moisture/vapor control methods and materials as specified by the project architect or structural engineer.

Swimming Pool and Deck (Concrete Terrace)

We recommend that the pool be designed in accordance with the foundation criteria provided above, and subject to the following supplemental comments.

1. We recommend that the pool walls be designed for a minimum lateral earth pressure of 80 pounds per cubic foot (equivalent fluid weight). This lateral pressure is based on assumed at-rest conditions to limit the potential for lateral movement of the pool walls. Higher lateral pressures would apply for adjacent surcharges or slopes. The pool floor must be a structural slab supported by the drilled piers. Therefore, a soil bearing pressure at the bottom of the pool structure would not be applicable.

2. The use of an "infinity edge" for the pool is not recommended unless the Owner accepts that periodic maintenance, adjustments or repairs of "infinity edges" may be required due to possible differential settlement or shrink/swell action within expansive soils or bedrock at the site.

3. If potentially expansive soil or bedrock is encountered under the pool bottom, grade beams or tie beams, or under other retaining wall foundations or grade beams, we recommend overexcavation and removal of the unsuitable materials to a depth of up to 18 inches, or as determined by the Geotechnical Consultant, followed by backfill with compacted Class 2 permeable drain rock to help reduce the effects of the potentially highly expansive bedrock. In the absence of expansive bedrock, we recommend placing a minimum 6-inch thick drainage blanket of Class 2 permeable drain rock under the pool floor.

4. We recommend installation of an underdrain system at the low end of the pool excavation, or along the length of the pool if the floor is level, consisting of a 4-inch diameter perforated PVC pipe in a 12 in. x 12 in. trench filled with Class 2 permeable drain rock and with a gravity flow outlet located away from improvements. This trench would be below the drainage blanket or backfilled overexcavation discussed above. The outlet should have a grill and be protected from damage by placement of a cover of riprap, concrete box, or similar means.

5. The surface of the subgrade and any fill intended to support any concrete decking must be compacted to a minimum of 90 percent of maximum dry density per ASTM D1557. Over-compaction within 5 feet of the pool walls must be avoided to prevent potential stress or damage to the pool walls. The contractor is responsible for preventing damage to the pool walls.

6. The native soils should be pre-wetted before the gunite or shotcrete is applied and before placement of any fill, if applicable. Alternatively, if the pool walls are constructed as cast-in-place retaining walls, a MiraDrain or similar drainage product is recommended to separate the pool walls from the adjacent ground and provide drainage.

7. Deck slabs should be a minimum thickness of 4 inches. Thicker slabs would tend to reduce the potential for cracking. The slab thickness and reinforcement should be determined by the structural designer. In general, the reinforcement should be draped or supported by concrete dobies to attain its greatest efficiency in minimizing the cracking of the slabs. Crack control joints should be located as directed by the structural designer. We recommend that the exterior perimeter of any concrete deck have a thickened edge or footing. Deck slabs must be supported on a prepared subgrade of non-expansive engineered fill, after removal of weak or expansive materials as described above, as applicable.

8. The top of any compacted fill under the deck, the deck surface, and adjacent landscape ground surfaces must be sloped to drain away from the pool perimeter. In addition, area drains and swales must be provided as needed to remove runoff from the pool perimeter and vicinity.

9. All concrete pool shells, including gunite and shotcrete, may be subject to fine, hairline shrinkage cracks and may be porous and contain voids, allowing for seeps of water and leaks from the pool. Differential movements of the pool should be anticipated due to the presence of potentially expansive soils or bedrock that could require periodic maintenance and repair.

10. Additional recommendations may be provided after review of pool area design and related development plans.

Slabs on Grade

At the time the building site grading begins, we recommend that we observe the anticipated subgrade materials and obtain samples for expansion potential testing, if warranted. If subgrade soils or bedrock is found to be potentially expansive, we recommend overexcavation to a depth to be determined, at least 12 inches below proposed design footing bottoms, followed by backfilling with approved engineered fill, or as determined by the Geotechnical Consultant.

We recommend that any slab-on-grade floors be a minimum thickness of 5 inches. Thicker slabs are recommended for floor areas that may be subject to heavy traffic, equipment, or storage loads. The slab thickness and reinforcement should be determined by the structural designer. In general, the reinforcement should be draped or supported by concrete dobies to attain its greatest efficiency in minimizing the cracking of the slabs. Crack control joints should be located as directed by the structural designer.

In place of the typical minimum 10-mil thick visqueen moisture vapor barrier, we recommend installation of a product from Stego Industries called Stego 15-mil Wrap Vapor Barrier to reduce the potential for moisture vapor to migrate through the floor slab. The Stego 15-mil vapor barrier must be installed in accordance with the manufacturer's recommendations, including use of Stego tape on all seams and Stego mastic to seal the perimeter of the floor membrane to the adjacent concrete foundation elements and at utility penetrations. Information regarding Stego Industries is available at their website. We recommend a layer of heavy duty geofabric such as Mirafi 500X be placed under the Stego Wrap and on top of the gravel layer for added protection from damage during installation.

This installation should help to significantly reduce the potential for moisture vapor transmission upward through the floor slabs. There may be other suitable products available as well, such as TenCate Mirafi NT 100 (17 mils thick) or pond liner materials. If you have any concerns regarding the potential for migration of moisture through the floor slabs or if further protection against slab moisture penetration is desired, we recommend that the owner contact a consultant that is expert in moisture barrier issues.

Differential Settlements

The design of the structures, including framing and structural connections, must consider the potential for differential settlement across the width or length of the structure on the order of about 1/2 inch with a total differential movement of up to about 1 inch. No significant additional differential movement due to potential seismic activity should be anticipated due to subsurface conditions.

The potentially expansive subsurface earth materials at this site, which are typical of the area in which the residence is located, may cause minor differential movement in the residence, regardless of the measures taken to reduce such movement. Such movement usually causes cracks in foundations, on interior walls, ceilings and tile or concrete floors and on exterior stucco-covered walls, primarily at corners of doors and windows and at high stress points at structural connections. Differential movement of the foundation may cause uneven floor levels over time. This is a normal condition for construction of residences in potentially expansive soils and bedrock.

Site Drainage

An experienced drainage design professional should design an appropriate site drainage system considering the local hydrology and the proposed improvements. We do not provide drainage design as part of the scope of this study. However, we submit these general recommendations as guidelines.

Foundation Drains

We recommend that foundation drains be placed along the perimeter of the building envelope and under the interior area floor slabs. The drains should consist of a minimum 12-inch wide trench, at least 12 inches deep below the adjacent building pad grade, or as limited by site topography, as determined by the project drainage designer. A 4-inch diameter rigid perforated pipe, consisting of PVC Schedule 40, ABS SDR-35 or better, and sloped to drain to outlets, should be placed at the bottom of the trench. The trench should be backfilled with clean free-drained crushed rock, wrapped in a filter fabric such as Mirafi 140N or Class 2 permeable drain rock without the filter fabric. The top 6 inches should consist of compacted on-site soil, sloped to drain away from the foundation, where exposed in exterior areas.

Surface Drainage

Surface waters must not be allowed to pond or saturate soil adjacent to the structure foundation. Irrigation of planting next to the foundation must be kept to the minimum necessary for maintaining landscaping. Hardscape, such as planter boxes or walkways, must be drained away from the structure and constructed in a way that does not trap water near the foundation. Excessive irrigation of landscaping anywhere near the structure must be prevented.

We recommend the use of continuous roof gutters and downspouts. We recommend that all water flow from downspouts be directed away from the structures within non-perforated solid PVC Schedule 40, ABS SDR-35 or better, drain pipes preferably to a storm drain system or swale as far from the structural foundation as feasible. Drainage swales, drop inlets and storm drain systems should be provided to remove surface water from the perimeter of the building, as determined by the project civil engineer, architect or others responsible for drainage design. The 2016 CBC requires a minimum slope gradient downward away from the structure of 6 inches in 10 feet, or into a drainage swale. The perimeter drainage swale flow line should be a minimum of 6 inches below the structural pad grade or as much as practicable given site topography.

Drain Outlets

The potential for erosion, future landslides or slope instability can be significantly reduced by proper collection and disposal of surface water runoff. Drains should flow by gravity to suitable outlets downslope and well away from structural foundations. Drains should not discharge onto active creep zones or landslides. Drains should not be allowed to cause erosion, ground soaking or ponding. Energy dissipators, such as riprapped stilling basins, may be required to reduce erosion where subdrains or culverts discharge into natural, unlined drainage ways. Exposed outlets should have grills and be protected from damage by placement of a cover of riprap, concrete box, or similar means.

General

Subdrains and downspout drains must not be combined, but may share the same trench. All buried drains should have suitable, accessible cleanouts to facilitate cleaning and maintenance. Additional drainage recommendations may be provided based on our review of site development and foundation plans or during construction.

Miscellaneous Flatwork

Miscellaneous flatwork slabs should be a minimum thickness of 5 inches and should be underlain be a minimum 4-inch thick cushion of pea gravel or clean, crushed rock having no fines on a prepared subgrade. Flatwork reinforcement and crack control design should be provided by the structural designer.

Where expansive soil or bedrock is encountered, we recommend that miscellaneous exterior flatwork be placed on at least 12 inches of non-expansive engineered fill. Deeper subexcavation may be recommended, depending on the materials encountered.

Utility Trenches

Utility trenches that parallel the sides of the structures should be placed so that they do not extend below a line sloped down and away at a 2:1 (H:V) slope from the bottom outside edges of the perimeter footings or grade beams, as applicable.

All trenches should be backfilled with native soils compacted uniformly to the relative compaction specified above for fill. Jetting of backfill is not recommended as it may result in an irregular and unsatisfactory degree of compaction. If local building codes require the usage of sand as the trench backfill, all utility trenches entering the building must be provided with impervious seals of either cohesive soil or lean concrete where the trenches pass under the building perimeter. Each impervious plug should extend two feet into, and out of, the building perimeter.

Maintenance

Periodic land maintenance will be required. It should be noted that some vertical displacement (differential settlement) of exterior flatwork, decks, sidewalks and pavements should be expected. We recommend maintaining proper site drainage and controlling irrigation of landscaping to reduce the amount of vertical displacement that may occur. Drains should be checked frequently, and cleaned and maintained as necessary.
The slopes in the vicinity of the structures should be monitored. Routine maintenance of slopes should be anticipated. If signs of surficial soil instability occur, they should be promptly evaluated by the Geotechnical Consultant.

Supplemental Services

Plan Review

Jim Glomb Consulting recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. When tentative grading plans and or building plans are prepared for the site they should be forwarded to this office for review and additional geotechnical studies, if indicated.

Construction Observations

We recommend having a pre-construction meeting, including the Owner, contractor, and the Geotechnical Consultant to discuss the planned work and scheduling. In addition, we should be retained to observe geotechnical construction, particularly site grading and excavation of foundations, as well as to perform appropriate field observations. If, during construction, subsurface conditions different from those described in this report are observed, or appear to be present beneath excavations, we should be advised at once so that these conditions may be reviewed and our recommendations reconsidered.

We recommend that the installation of all drainage features, including subdrains, be observed at the time of construction to confirm that the geotechnical drainage recommendations are followed. Typically, the geotechnical consultant is asked to confirm, in writing, at the completion of construction, that the drainage features are in accordance with the approved construction documents and the recommendations of the geotechnical consultant. We will be unable to issue such a document if we have not observed the construction of the pertinent components of the drainage features.

To allow proper scheduling so that our personnel are present at the jobsite when needed, we require that you notify us at least 4 working days before work requiring our presence will be performed.

Changed Site Conditions

The recommendations made in this report are contingent upon our notification and review of the changed conditions. If more than 1.5 years have elapsed between the submittal 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 of this report may no longer be valid or appropriate. In such case, we recommend that we review this report to determine the applicability of the conclusions and recommendations considering the time elapsed or changed conditions. The recommendations made in this report are contingent upon such a review. These services are performed on an as-requested basis and are in addition to this geotechnical investigation. We cannot accept responsibility for conditions, situations or stages of construction that we are not notified to observe.

Limitations

This report has been prepared for the exclusive use of Mr. and Mrs. Kateley and their consultants for the proposed project described in this report. Our services consist of professional opinions and conclusions developed by a certified engineering geologist and a geotechnical engineer in accordance with generally-accepted engineering geologic and geotechnical engineering principles and practices. We provide no other warranty, either expressed or implied. Our conclusions and recommendations are based upon the information provided us regarding the proposed construction 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. Site conditions and cultural features described in the text of this report are those existing at the time of our field work and may not necessarily be the same or comparable at other times.

The Owner is advised that all concrete construction, including floor slabs, footings, decks, walkways, pools, and retaining walls, is subject to minor shrinkage and cracking, which are not indicative of loss of structural integrity or geotechnical issues. Proper concrete mix design, moisture control, and construction methods should help reduce the potential for shrinkage and cracking.

The scope of our services did not include an environmental assessment or an investigation of the presence or absence of hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air, on or below, or around the site, nor did it include an evaluation or investigation of the presence or absence of wetlands.

We trust this provides the information you require at this time. If you have questions or wish to discuss this further, please call.

Very truly yours,
Jim Glomb Consulting, Inc.

6/28/18

Jim Glomb
Engineering Geologist, C.E.G. 1154

6/28/2018

Don Poindexter
Geotechnical Engineer, G.E. 690

Attachments: References
Site Plan, Plates 1.0 and 1.1
Vicinity Map, Plate 1.2
Logs of Test Pits, Plates 2.1 through 2.8
Soil Classification Chart, Figure 1

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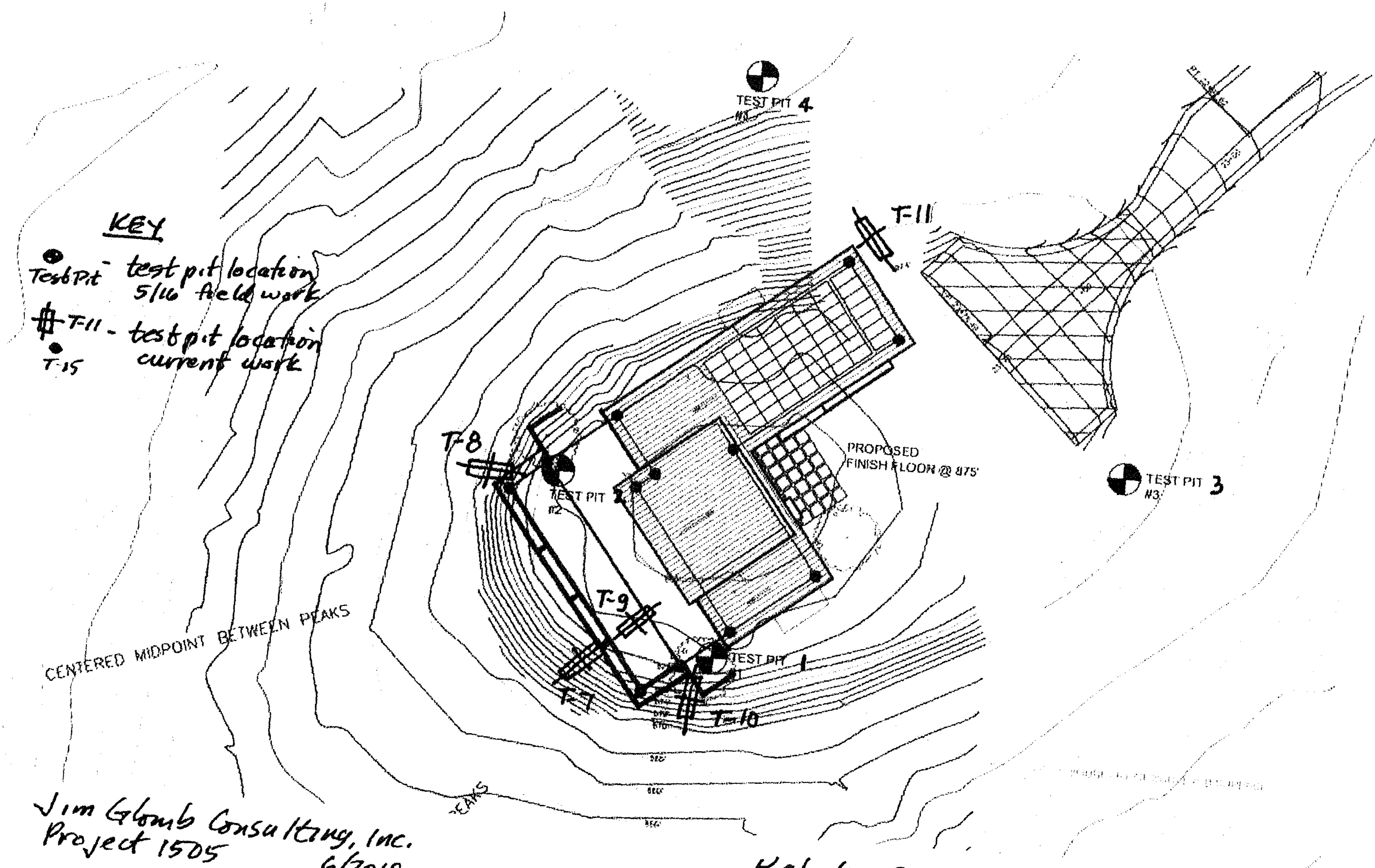
SITE PLAN



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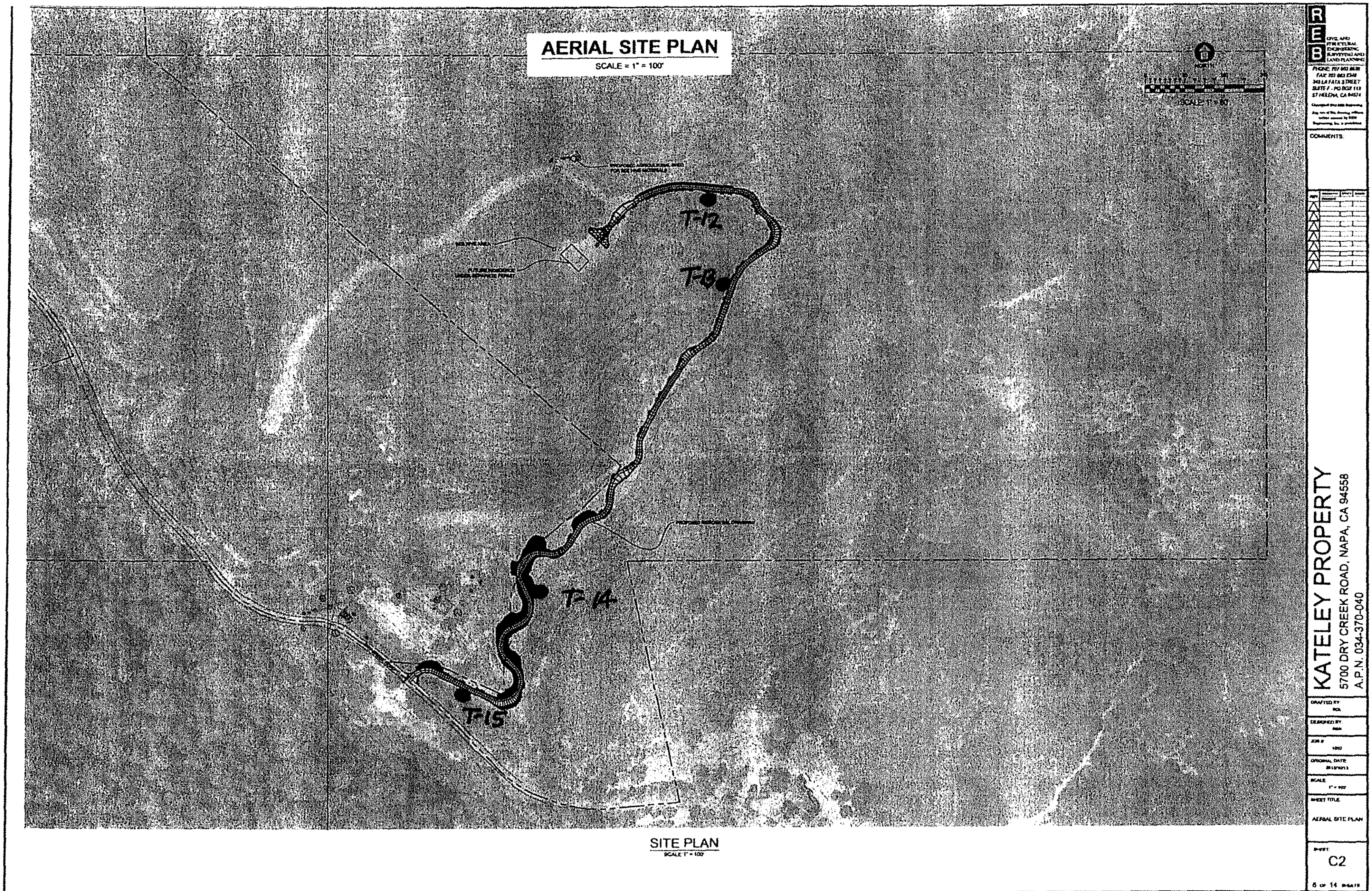
Kateley Residence

Plate 1-0



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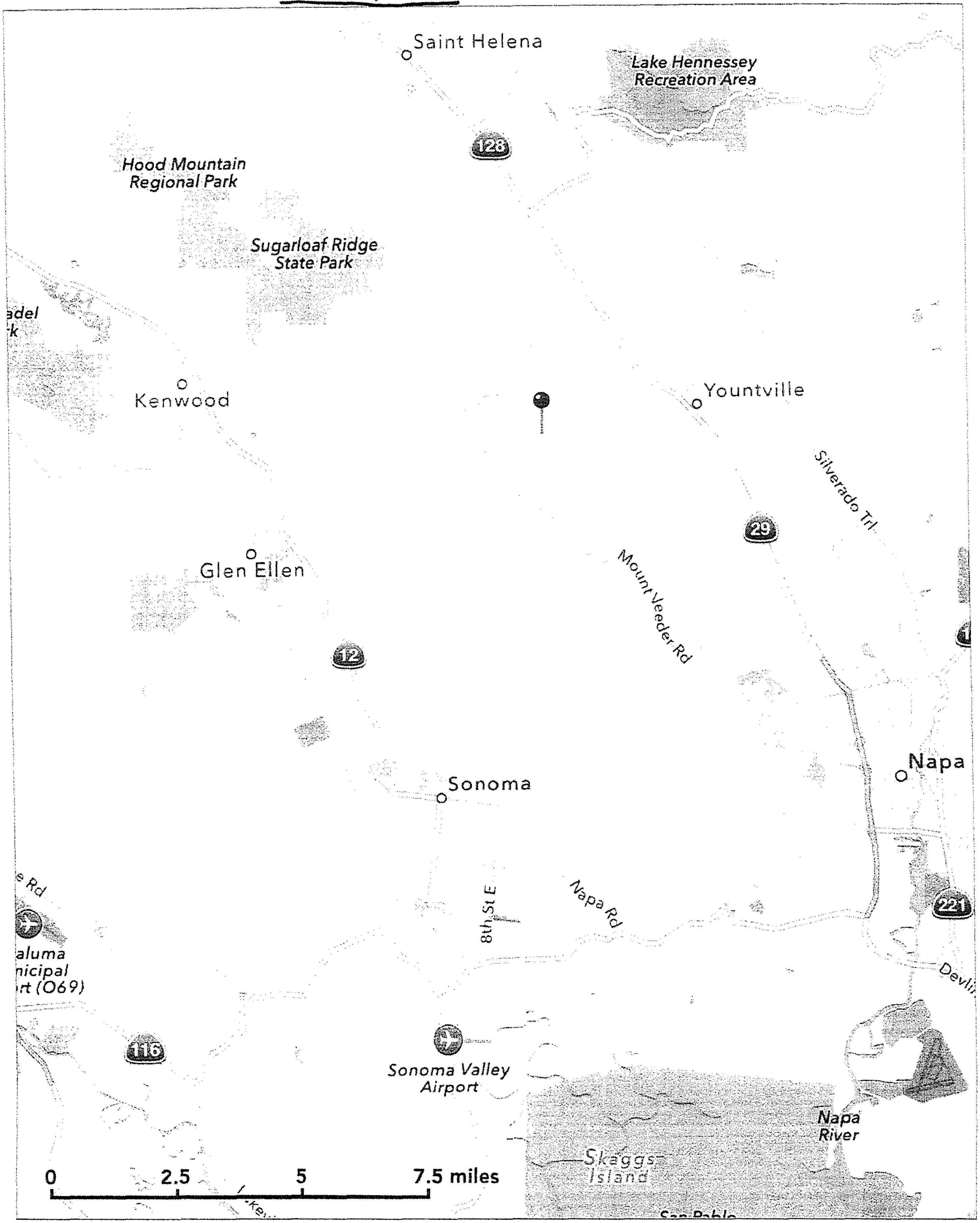
Kateley Residence

Plate 1.1

VICINITY MAP

near Sonoma — California



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Kateley Residence

Plate 1.3 1 of 1

LOGS OF TEST PITS

Date: 5/12/16 *Surface gradient:* level *Pit orientation:* N19W	*Pit dimensions:* 2 x 20 x 8 *Groundwater depth:* none enc.	*Logged by:* J. Glomb *Contractor:* Gerne *Equipment:* backhoe	Test Pit T-1

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2							GC	@0-4' Lt. brn. Sandy Gravel:	
3								dry to sl. moist, loose,	
4								w/ few roots	
5								Fill	
6	■								
7								@4-8' Lt. org. brn. Very Weathered	
8								Sandstone/Shale: moist to	@4' bdg:
9								Very moist, v. fractured,	N18E, 24SE
10								avg. fr. spcg. 1/4-1/2", v.	
11								friable, w/ clay film on	@6' bdg:
12								fracts. and interbeds	N21E, 48SE
13									
14								Bedrock	
15									

Date: 5/12/16 *Surface gradient:* level *Pit orientation:* N63W	*Pit dimensions:* 2 x 20 x 7 *Groundwater depth:* none enc.	*Logged by:* J. Glomb *Contractor:* Gerne *Equipment:* backhoe	Test Pit T-2

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2							GC	@0-2.5' Lt. brn. Sandy Gravel:	
3								dry, loose, w/ few roots	
4								Fill	
5									
6								@2.5-7' Lt. org. brn. Sandstone:	@5' bdg:
7								v. highly weathered, v. fract.,	N45-50W,
8								steep fracts. predominate,	10-35NE
9								fracts. sl. open, w/ silty	
10								clay film on fracts., bdg.	
11								variable w/ predom. in-to-	
12								slope dips	
13								Bedrock	
14									
15									

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LOGS OF TEST PITS

Date: 5/12/16 Surface gradient: level Pit orientation: N4W	Pit dimensions: 2x23x7 Groundwater depth: none enc.	Logged by: J. Glomb Contractor: Gerne Equipment: backhoe	Test Pit T- 3

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2							GC	@0-4' Lt. brn. Sandy Gravel: loose to dense, dry <u>Fill</u>	
3									
4									
5									
6									
7								@4-7' Dk. gray brn. Shale: v. fract., weathered steeply fract., bedding indistinct <u>Bedrock</u>	@5' fracts: N30E & N30W, vert
8									
9									
10									
11									
12									
13									
14									
15									

Date: 5/12/16 Surface gradient: 3.5:1 Pit orientation: N15W	Pit dimensions: 2x16x5 Groundwater depth: none enc.	Logged by: J. Glomb Contractor: Gerne Equipment: backhoe	Test Pit T- 4

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2							SM	@0-4' Rd. brn. sl. gravelly Silty Sand: loose to med. dense w/ abundant roots <u>Residual Soil</u>	
3									
4									
5									
6									
7								@4-5' Yel. gray brn. very weathered Shale/Sandstone: v. fract., avg. fr. spcg. 1/4-1/2" <u>Bedrock</u>	
8									
9									
10									
11									
12									
13									
14									
15									

LOGS OF TEST PITS

Date: 5/12/16 Surface gradient: 2:1 Pit orientation: N72E	Pit dimensions: 2x 10x4 Groundwater depth: none enc.	Logged by: J. Glomb Contractor: Gerne Equipment: backhoe	Test Pit T-5

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Index	Dry density (PCF)	Field moisture (% dry wt	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2								C0-4' Rd. brn. very weathered Sandstone/Shale: v. fract., fracts. slightly open, blocky fract. Bedrock	C2' bdg: N18E, 14SE
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Date: 5/12/16 Surface gradient: 1:1 Pit orientation: N60W	Pit dimensions: 2x8x3 Groundwater depth: none enc.	Logged by: J. Glomb Contractor: Gerne Equipment: backhoe	Test Pit T-6

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2								C0-3' Dk. gray Shale: very fractured, v. weathered, friable, slough on slope surface Bedrock	C2' fracts: EW, 50N EW, 45N N54W, 22NE
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

LOGS OF TEST PITS

Date: 5/25/18 *Surface gradient:* 2:1 *Pit orientation:* —	*Pit dimensions:* 2x16x13 *Groundwater depth:* ne	*Logged by:* J. Glomb *Contractor:* Guerne *Equipment:* backhoe	Test Pit T-7

Depth (ft.)	Samples Bulk	Samples Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							SW	(0-3' Lt. brn. Gravelly Sand:	
2								dry, loose	
3								Fill	
4								(3-11.5' Brn. Gravelly Sand	
5								and Clay: moist,	
6	■			22				creep prone	
7								Residual Soil	
8									
9								(11.5-13' Gray brn. Clayey Shale:	
10								well bedded, dips ±30°	
11								downslope, v. fractured,	
12								closed fract., mod. hard	
13								Bedrock	
14									
15									

Date: 5/25/18 *Surface gradient:* 2:1 *Pit orientation:* —	*Pit dimensions:* 2x12x10 *Groundwater depth:* ne	*Logged by:* J. Glomb *Contractor:* Guerne *Equipment:* backhoe	Test Pit T-8

Depth (ft.)	Samples Bulk	Samples Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							GW	(0-4' Brn. Sandy Gravel:	
2								moist, loose	
3								Fill	
4								(4-8.5' Gray brn. Shale and Gravel:	
5								v. fract., open fract.,	
6								creep prone	
7								Residual Soil	
8									
9								(8.5-10' Gray shale: very	(8' bdg:
10								blocky fract., fracts.	N45W, 48 NE
11								steep, sl. open, avg. fr.	(into slope)
12								spacing 1/2-1", bedding	
13								variable, folded	
14								Bedrock	
15									

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LOGS OF TEST PITS

Date: 5/25/18 Surface gradient: level Pit orientation: —	Pit dimensions: 2x 16x 11.5 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: back hoe	Test Pit T-9

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							SW	c0-3' Rd. brn. Clayey Gravel: moist, dense Residual Soil	
2									
3									
4									
5								c3-11.5' Org. brn. Shale: very weath., v. fract., 1/2-1" spcg., w/ clay-lined fractures and occassional clay beds Bedrock	c8' bdg.: dips into slope c±28
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Date: 5/25/18 Surface gradient: 4:1 Pit orientation: —	Pit dimensions: 2x 16x 12.5 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T- 10

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft²)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1								c0-3' Rd. brn. Clayey Gravel: moist, loose to med. dense Fill	
2									
3									
4								c3-12' Org. brn. Very Fractured Shale: w/ clay lining fracts. creep prone, caving	
5									
6									
7									
8									
9									
10								c12-12.5' Gray Clayey Shale: closed fractured, bedding dips into slope c± 10°-20° Bedrock	
11									
12									
13									
14									
15									

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LOGS OF TEST PITS

Date: 5/25/18 Surface gradient: 3:1 Pit orientation: —	Pit dimensions: 2x 14 x 10 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T- 11

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							SW	(0-2' Brn. Gravelly Sand:	
2								moist, loose	
3								Fill	
4								(2-4' Brn. Gravelly Sand:	
5								moist, loose to med. dense	
6								creep prone Residual Soil	
7									
8								(4-10' Gray Shale: v. weath.,	
9								v. fract., closed fractured,	
10								avg. fr. spcg. 1/2", bedding	
11								dips in to slope @ ± 20-25°	
12								Bedrock	
13									
14									
15									

Date: 5/25/18 Surface gradient: level Pit orientation: —	Pit dimensions: 2 x 6 x 3 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T- 12

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							GW	(0-2' Gray brn. Sandy Gravel:	
2								dry loose	
3								Fill	
4								(2-3' Gray Shale: v. fract.,	
5								v. creep prone	
6								Bedrock	
7									
8									
9									
10									
11								note: pit located on outboard	
12								side of driveway	
13									
14									
15									

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LOGS OF TEST PITS

Date: 5/25/18 Surface gradient: level Pit orientation: —	Pit dimensions: 2 x 6 x 4 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T-13

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							GW	C0-2' Gray brn, sandy	
2								Gravel: moist, loose	
3									
4								Fill	
5								C2-4' Dk gray fractured	
6								Shale: mod. hard	
7								Bedrock	
8									
9									
10									
11									
12								note: pit located on outboard	
13								side of driveway	
14									
15									

Date: 5/25/18 Surface gradient: level Pit orientation: —	Pit dimensions: 2x8x6 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T-14

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							GW		
2								C0-5' Gray brn. Sandy	
3								Gravel: dry, loose	
4								Fill	
5								C5-6' Gray Shale: very	
6								weath., v. fract.	
7								Bedrock	
8									
9									
10									
11								note: fill on outboard side	
12								of driveway	
13									
14									
15									

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LOGS OF TEST PITS

Date: 5/25/18 Surface gradient: level Pit orientation: —	Pit dimensions: 2x 6 x 5 Groundwater depth: ne	Logged by: J. Glomb Contractor: Guerne Equipment: backhoe	Test Pit T- 15

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1							SW	0-4' Gray brn. Sandy Gravel: dry, loose <u>Fill</u>	
2									
3									
4									
5								4-5' Gray shale: weath., fract. <u>Bedrock</u>	
6									
7									
8									
9									
10									
11								note: pit on outboard side of driveway	
12									
13									
14									
15									

Date: Surface gradient: Pit orientation:	Pit dimensions: Groundwater depth:	Logged by: J. Glomb Contractor: Equipment:	Test Pit T-

Depth (ft.)	Samples: Bulk	Samples: Tube	Pocket pen (tons/ft^2)	Plasticity Index	Dry density (PCF)	Field moisture (% dry wt)	Soil type USCS	Geologic/Engineering Description and Remarks	Geologic Attitudes
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

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UNIFIED SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			TYPICAL NAMES	
COARSE GRAINED SOILS More than Half > #200 sieve	**GRAVELS** More than half coarse fraction is larger than No. 4 sieve	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravels with over 12% fines	GM	Silty gravels, poorly graded gravel-sand silt mixtures
			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sands, poorly graded sand-silt mixtures
			SC	Clayey sands, poorly graded sand-clay mixtures
FINE GRAINED SOILS More than Half < #200 sieve	**SILTS AND CLAYS** Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

Jim Glomb
Geotechnical and Environmental Consulting, Inc.
152 Weeks Way, Sebastopol, CA 95472 • Phone 707/237-2703
email: jim@jimglomb.com

Figure 1