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## PRELIMINARY GEOLOGICAL STUDY REPORT

MARIN CITY PROPERTY  
DONAHUE STREET  
MARIN CITY, CALIFORNIA

**Project Number:**

3427.01.04.1

**Prepared For:**

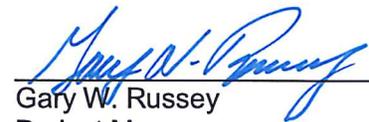
LIBAO Properties LLC  
c/o Jonathan Pearlman  
439 Healdsburg Avenue  
Healdsburg, California 95448

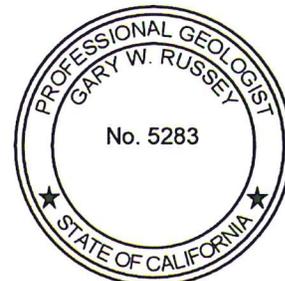
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June 22, 2017

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## **INTRODUCTION**

This report presents the results of our preliminary geological study for the proposed residential development to be constructed at property located adjacent to the terminus of Donahue Street in Marin City, California. The subject property is approximately 50 acres in size of which 5.5 acres will be developed. The project site is designated as APN 052-140-33 and extends over moderately east sloping terrain located below a north – south trending ridgeline. The site location is shown on Plate 1.

We understand that the project will include the construction of 18 residences, new roads and associated infrastructure on the subject property. The purpose of our study as outlined in our proposal dated July 18, 2016 was to evaluate the geologic hazards within the property and comment on the geological feasibility of the project. In addition, we were to recommend the geotechnical services needed for actual development, design and construction of the project.

## **SCOPE**

Our scope of work was limited to a brief site reconnaissance, a review of selected published geologic data pertinent to the site, subsurface exploration with test pits and preparation of this report. Based on the geologic literature review, site reconnaissance and subsurface exploration, we were to develop the following information:

1. A brief description of geologic, surface soil, and groundwater or other conditions observed during our reconnaissance and exploration;
2. Distance to nearby active faults and a discussion of geologic hazards that may affect the proposed project;
3. Our opinion regarding the geological feasibility of the project; and
4. Preliminary conclusions and recommendations concerning;
  - a. Primary geological/geotechnical engineering concerns and possible mitigation measures, as applicable;
  - b. Suitable foundation systems for new structures;
  - c. New roadways; and
  - d. Supplemental geotechnical engineering services.

## **SERVICES PROVIDED**

We reviewed select published geologic information pertinent to the site. A list of the geologic references reviewed are presented in Appendix B. On May 24, 2017, our Certified Engineering Geologist conducted a surficial reconnaissance of the property to observe exposed topographic features, surface soils, rock outcroppings and cut banks. The observed features are shown on the

Exploration Plan and Site Geologic Map, Plate 2. In addition, our Certified Engineering Geologist explored the subsurface conditions by excavating 11 test pits to depths ranging from about 4 to 12 feet. The test pits were excavated with a track-mounted excavator at the approximate locations shown on Plate 2. The test pit locations were determined approximately by pacing their distance from features shown on Plate 2 and should be considered accurate only to the degree implied by the method used. Our Certified Engineering Geologist located and logged the test pits and obtained samples of the materials encountered for visual examination and classification. Disturbed samples were obtained at selected depths from the test pits and placed in plastic bags.

The logs of test pits showing the materials encountered and sample depths are presented on Plates 3 through 8. The soils are described in accordance with the Unified Soil Classification System, outlined on Plate 9. The bedrock has been classified according the Engineering Geology Rock Terms as outlined on Plate 10.

The test pit logs show our interpretation of subsurface soil conditions on the date of exploration and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil samples and interpretation of excavation and sampling resistance. The location of the soil boundaries should be considered approximate. The transition between soil types may be gradual.

## **SITE CONDITIONS**

### **General**

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

### **Geology**

Published geologic maps (Blake et al., 2000) (Rice et al., 1976) indicate the property is underlain by bedrock deposits of the Cretaceous and Jurassic aged Franciscan Complex. The Bedrock is described as Franciscan Melange and is described as consisting of fragmented and sheared Franciscan Complex rocks which could include sandstone, shale, chert, limestone and conglomerate as well as metamorphic serpentine and schists.

### **Landslides**

Published landslide maps (Blake et al., 2000) (Rice et al., 1976) do not indicate large-scale slope instability at the site, and we did not observe active landslides at the site during our study. Mapping by Rice (Rice et al., 1976) indicates a landslide to the east and downslope of the project area. Evidence of this landslide was not observed in our study area.

**Faulting**

The site is not within a current Alquist-Priolo Earthquake Fault Zone for active faults as defined by CGS. However, the site is within an area affected by strong seismic activity. In addition, several northwest-trending Earthquake Fault Zones exist in close proximity to, and within several miles of, the site (Brown, 1970; Helley and Herd, 1977; Bortugno, 1982). The shortest distances from the site to the mapped surface expression of these faults are presented in the table below.

<b>ACTIVE FAULT PROXIMITY</b>		
<b>Fault</b>	<b>Direction</b>	<b>Distance-Miles</b>
San Andreas	W	5
Healdsburg-Rodgers Creek	N	21½
Concord-Green Valley	NE	27
Hayward	NE	11½
West Napa	NE	27
Calaveras	SE	28½
Greenville	E	37.5

**Surface**

The property extends primarily over moderately east sloping terrain. The vegetation consists of dense brush, wooded areas and seasonal grasses. The site is generally undeveloped, however, our site reconnaissance observed evidence of prior grading in several areas. The grading appeared to consist of minor cutting and filling of the existing slopes. The observed cut and fill slopes were covered in well-established vegetation and trees. In general, the ground surface is soft and spongy. This is a condition generally associated with weak and porous surface soils.

Natural drainage consists of overland flow over the ground surface that concentrates on a natural drainage element such as swales and ravines. The drainage trends east towards the San Francisco Bay.

**Subsurface**

Our test pits indicate that the portion of the site we studied is blanketed by 6 inches to 2 feet of weak and porous surface soils. Porous soils appear hard and strong when dry but become weak and compressible as their moisture content increases towards saturation. These soils generally consisted of brown sandy clays which appeared to be of medium plasticity. Medium to high plasticity clays are often potentially expansive and experience shrink and swell within the zone of significant moisture variation (2 to 3 feet below the surface) due to seasonal moisture fluctuations.

The surface soils are locally covered by up to 3 feet 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. The approximate extent of the heterogeneous fill is shown on Plate 2. The fill consisted of sandy clays with gravel to cobble size rocks which appeared to be of medium plasticity and low expansion potential.

Underlying the weak surface soils and heterogeneous fills, our exploration encountered colluvial and residual soil deposits which extended to 4½ to 9½ feet below the surface. These deposits consisted of sandy clays and clayey gravels. The sandy clay deposits appeared to be of moderate to high plasticity and potentially expansive. The clayey gravels appeared generally dense, and fine to coarse with moderate to high plasticity fines which appear to be potentially expansive.

These surface materials are underlain by bedrock deposits of the Franciscan Formation that extend to the maximum depths explored (12 feet). In general, the bedrock consisted of sandstones and sheared shales. The sheared shales appeared soft to firm, friable, and highly weathered with close spaced fractures throughout. The sandstone deposits appeared firm to moderately hard, friable to weak, and highly weathered. The potential bedding and/or shear orientations trended generally north-northwest and dipped steeply to the south and east.

## **DISCUSSION AND CONCLUSIONS**

### **Geologic Hazards**

#### **Fault Rupture**

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. Therefore, we believe the risk of fault rupture at the site is low.

#### **Strong Ground Shaking**

Data presented by the Working Group on California Earthquake Probabilities (2007) estimates the chance of one or more large earthquakes (Magnitude 6.7 or greater) in the San Francisco Bay region within the next 30 years to be approximately 63 percent. Therefore, future seismic shaking should be anticipated at the site. It will be necessary to design and construct the proposed development in strict adherence with current standards for earthquake-resistant construction.

#### **Liquefaction**

Liquefaction is a rapid loss of shear strength experienced in saturated, predominantly granular soils below the groundwater level during strong earthquake ground shaking due to an increase in pore water pressure. The occurrence of this phenomenon is dependent on many complex factors including the intensity and duration of ground shaking, particle size distribution and density of the soil. The site is not located within an area delineated as being susceptible to liquefaction and we did not encounter soils potentially susceptible to liquefaction within our study area. Therefore, we judge that there is a low potential for liquefaction at the site.

### Densification

Densification is the settlement of loose, granular soils above the groundwater level due to earthquake shaking. Densification typically occurs in old fills and in soils that if saturated would be susceptible to liquefaction. Provided foundations are installed as discussed herein, we judge the potential for densification to impact structures at the site is low.

### Lurching

Seismic slope failure or lurching is a phenomenon that occurs during earthquakes when slopes or man-made embankments yield and displace in the unsupported direction. Provided the improvements are sufficiently set back from areas of steep slopes (in excess of 2:1), the foundations are installed as recommended in accordance with a geotechnical engineering study report, and the proposed fills are adequately keyed into underlying bedrock material, as subsequently discussed, we judge the potential for impact to the proposed development from the occurrence of these phenomena at the site is low. However, some of these secondary earthquake effects are unpredictable as to location and extent, as evidenced by the 1989 Loma Prieta Earthquake.

### **Geotechnical Issues**

Based upon the results of our geologic data review, reconnaissance, and subsurface exploration we judge that it is geotechnically feasible to develop the subject property and construct single-family residences, and access roads. The primary geotechnical considerations and potential mitigating measures recommended for building site development and roadway construction are discussed in the following sections of the report. These conclusions are preliminary and will need to be verified or modified during final design following detailed site-specific subsurface exploration, laboratory testing and geotechnical engineering evaluations, as recommended herein.

### Residence Locations

The proposed building envelopes must be located away from unstable areas and steep slopes in order to reduce the risks associated with slope instability. The location of the building envelopes in relation to such areas is shown on Plate 2. Initially, a structural setback of approximately 50-feet from unstable areas and breaks in slope of 2:1 or steeper should be established. A site-specific study should finalize recommended structural set backs.

### Weak, Porous Surface Soils

Weak, porous surface soils, such as those found at the site, appear hard and strong when dry but will lose strength rapidly and settle under the load of fills, foundations, slabs and pavements as their moisture content increases and approaches saturation. The moisture content of these soils can increase as the result of rainfall, periodic irrigation or when the natural upward migration of water vapor through the soils is impeded by, and condenses under fills, foundations, pavements and slabs. The detrimental effects of such movements can be remediated by strengthening the soils during grading. This is typically achieved by excavating the weak soils and replacing them as properly compacted (engineered) fill. Alternatively, foundation support can be obtained by a foundation system that gains support below the weak surface soils.

### 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, slabs, and pavements. Footings, slabs, and pavements 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.

### Expansive Soil

In addition, localized deposits of potentially expansive soils were encountered at the subject property. Expansive surface soils shrink and swell as they lose and gain moisture throughout the yearly weather cycle. Near the surface, the resulting movements can heave and crack lightly loaded shallow foundations (spread footings) and slabs and pavements. The zone of significant moisture variation (active layer) is dependent on the expansion potential of the soil and the extent of the dry season. The active layer is generally considered to range in thickness from about 2 to 3 feet. The detrimental effects of the above-described movements can be reduced by pre-swelling the expansive soils and covering them with a moisture fixing and confining blanket of properly compacted select fill, consisting of low to non-expansive soils. In building areas, the blanket thickness required depends on the expansion potential of the soils and the anticipated performance of the foundations and slabs. In order to effectively reduce foundation and slab heave given the expansion potential of the site's soils, a blanket thickness of 30 to 36 inches will be needed. In exterior slab and paved areas, the select fill blanket need only be 12 inches thick.

### Foundation Slab and Pavement Support

Satisfactory foundation support on sloping terrain can be obtained from spread footings that bottom at minimum depth on firm bedrock exposed by planned excavations, or in bedrock reached by footings excavated through the creeping soils, or from spread footings supported on buttressed fills of equal thickness. Where the creeping soils are not buttressed or removed by grading the residential footings must be designed to resist creep forces.

If remedial grading is performed, satisfactory foundation support for the proposed development can be obtained from spread footings that bottom on the select, engineered fill. Slab-on-grade floors and pavements can also be satisfactorily supported on the select engineered fill.

As an alternative to remedial grading, satisfactory foundation support can be obtained from drilled piers that gain support below the weak surface soils. Structurally supported wood floors can be used in living areas in conjunction with the piers and grade beams.

If remedial grading is not performed slab-on-grade floors will heave and/or settle and crack, and will not perform satisfactorily in residential living areas. However, wood floors supported above grade on joists that span the grade beams and/or isolated interior piers will perform well and can be used in living areas, as planned. Slab-on-grade floors can be used in garages provided that:

1. The subgrade materials comprise at least 12 inches of select fill and are pre-swelled by soaking prior to installation of the slabs;

2. The slabs are cast separate from foundations and framing to allow differential settlement or heave to occur without distressing the slabs or framing;
3. The slabs are reinforced to reduce cracks;
4. The slabs are grooved to induce cracking in a non-obtrusive manner; and
5. Some heave and cracking is acceptable to the user.

We estimate that the slabs will undergo from 1 to 3 inches of differential heave if they are constructed directly on the expansive soils.

Criteria for the design of the above foundation systems should be developed by a site specific geotechnical study as recommended in the supplemental services section of this report.

#### Downslope Creep

Weak, creep-prone surface soils, such as those found at the project site, tend to naturally consolidate and settle on sloping terrain that is 5:1 (horizontal to vertical) or steeper. Fills and foundations deriving support from these materials will be susceptible and contribute to the downslope creep and settlement unless properly embedded in bedrock or buttressed (keyed, benched, drained and compacted), respectively. The settlement causes cracks in the slabs and structural distress in the form of cracked plaster, and sticky doors and windows. Therefore, it will be necessary to obtain fill and/or foundation support below the creeping soils and design the foundations to resist stresses imposed by the creeping soils.

#### Fill Support

Hillside fills need to be constructed on level keyways and benches excavated entirely on rock. However, regardless of the care used during grading, buttressed fills of uneven thickness such as those typically built on hillsides, will settle differentially. Satisfactory performance of structural elements constructed on hillside fills, such as houses, pools, pool decks, garage slabs and driveways, will require the use of specialized grading techniques. These include excavating all creeping soils, and replacing said materials as a buttressed fill of even thickness or constructing said improvements entirely on cut. Recommendations for maximum fill thickness will be provided in a site specific geotechnical engineering study.

#### Access Roads

The proposed roadway alignment does not traverse across mapped or observed unstable areas. Therefore, we judge its geotechnically feasible to construct the driveway as shown. Final roadway design should include a site-specific study of the alignment, particularly areas of inherent weakness such as steep slopes, swales and ravines. In general, new driveways should be aligned to avoid steep slopes and areas of potential instability in order to reduce construction costs and future maintenance. Since slopes from the existing road to the proposed building sites are generally moderate, we anticipate driveway grading to be geotechnically feasible.

## **Erosion and Site Drainage**

The long-term satisfactory performance of roadways and residential development constructed on hillsides results primarily from strict control of surface runoff and subsurface seepage. The site's surface soils are moderately to well drained and have low to high erosion potential depending on slope inclination. Uncontrolled erosion could induce sloughing or landsliding. Downspouts from the future residences should discharge into closed glued pipes that empty away from unstable areas and into nearby roadway or natural drainages. Discharge for roadway culverts and ditches and downspout points need to be protected against erosion and sloughing by energy dissipators such as rip-rap and gabions, or equivalent protective and energy dissipation measures, as appropriate.

## **Groundwater**

Free groundwater seeps or springs were not observed during our reconnaissance. On hillsides, rainwater typically percolates through the porous topsoil and migrates downslope in the form of seepage at the interface of the topsoil and bedrock, and through fractures in the bedrock. Fluctuations in the seepage rates typically occur due to variations in rainfall and other factors such as periodic irrigation.

## **Supplemental Services**

We should perform a detailed geotechnical study prior to the design and construction of the residences and roadways. The study should include test borings or backhoe pits, laboratory testing and engineering analyses. The geotechnical study should address specific design and locating aspects of each planned residential location and the access road, and the data generated should be incorporated into project plans. The plans should then be reviewed by the geotechnical engineer and /or engineering geologist prior to receiving bids for planned work.

## **LIMITATIONS**

This report has been prepared by RGH for the exclusive use of LIBAO Properties LLC and their consultants to evaluate the geotechnical feasibility of residential development within the proposed subdivision.

Our services consist of professional opinions and conclusions developed in accordance with generally accepted geological/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 development, the results of our field reconnaissance, data review, and professional judgment. As such, our conclusions and recommendations should be considered preliminary and for feasibility and planning purposes only. A site specific subsurface study, such as recommended herein, may reveal conditions different from those encountered in our preliminary test pits and inferred by surface observation and data review only. Such site specific subsurface study may warrant a revision to our preliminary conclusions.

Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration on May 24, 2017, and may not necessarily be the same or comparable at other times.

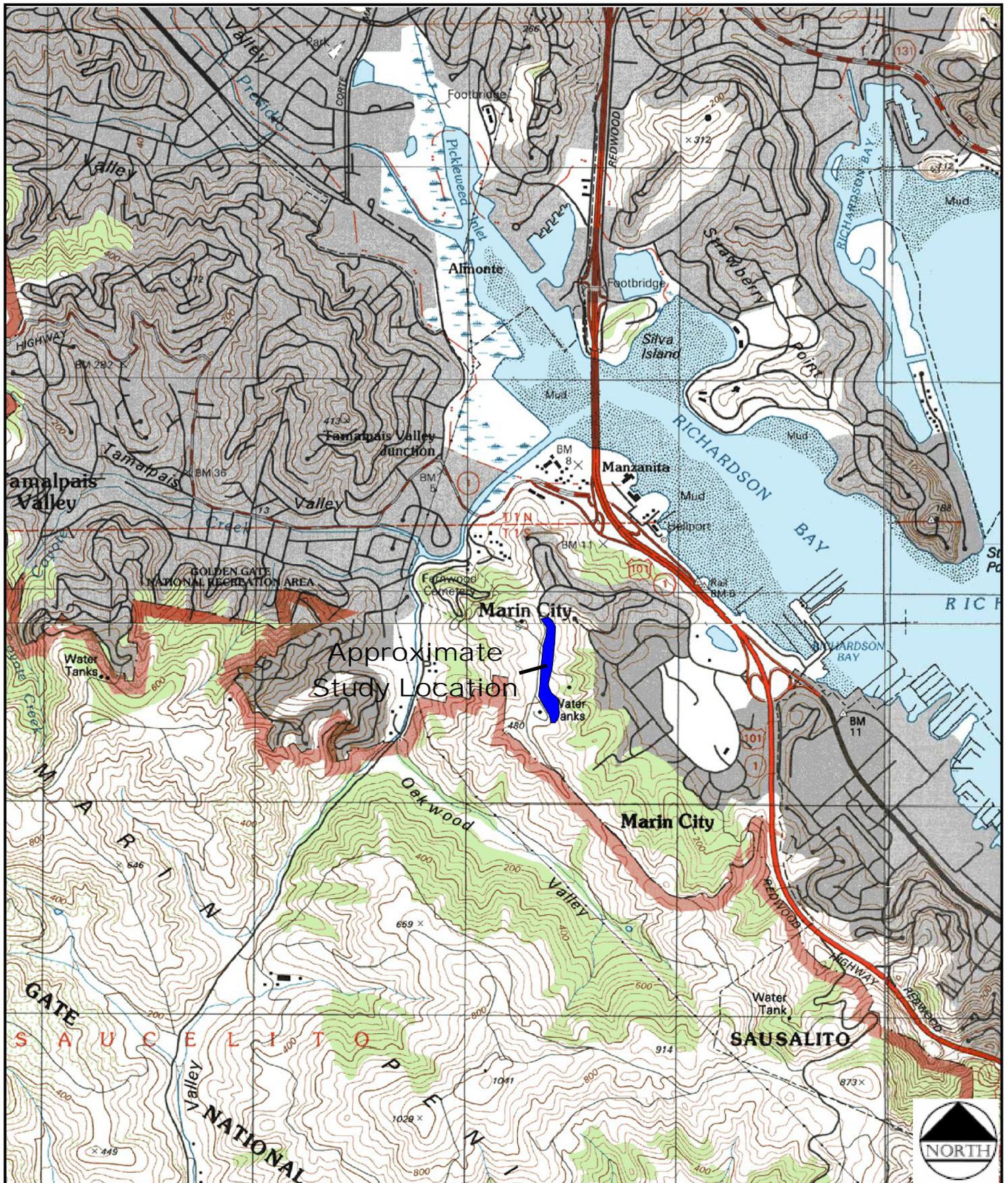
It should be understood that slope failures including landslides, debris flows and erosion are on-going natural processes which gradually wear away the landscape. Residual soils and weathered bedrock can be susceptible to downslope movement, even on apparently stable sites. Such inherent hillside and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

The scope of our services did not include a site specific geotechnical engineering study, an environmental assessment or a study of the presence or absence of 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.

**APPENDIX A - PLATES**

**LIST OF PLATES**

Plate 1	Site Location Map
Plate 2	Exploration Plan
Plates 3 through 8	Log of Test Pits TP-1 through TP-11
Plate 9	Soil Classification
Plate 10	Engineering Rock Classification



Reference: Maptech Topoquad, Point Bonita, California Quadrangle

Scale: 1" = 2000'

**RGH**  
CONSULTANTS

**SITE LOCATION MAP**

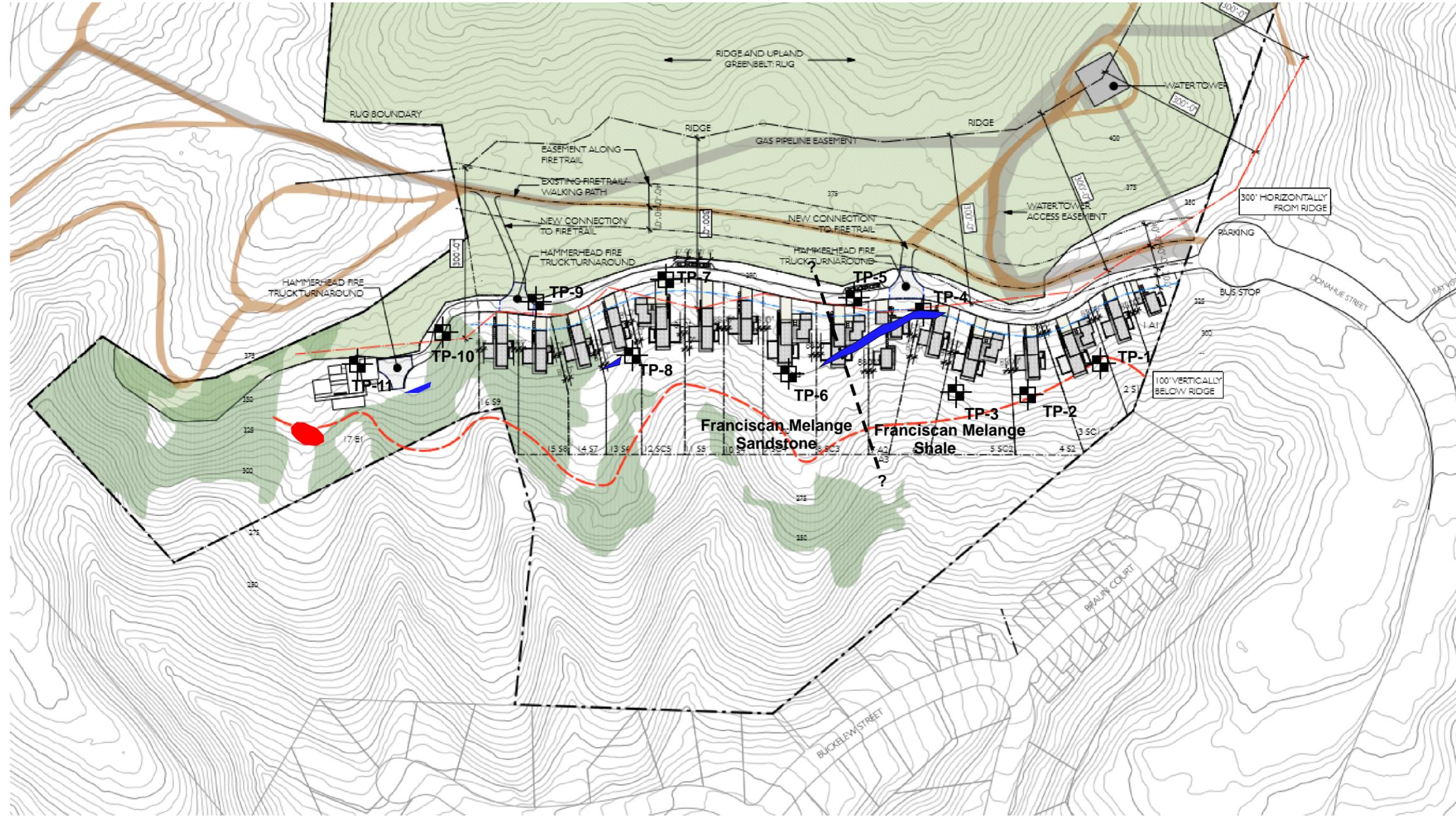
Marin City Property  
Donahue Street  
Marin City, California

PLATE

1

Job No: 3427.01.04.1

Date: JUNE 2017



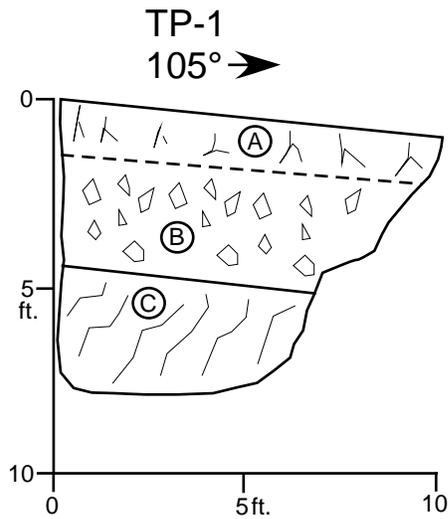
**EXPLANATION**

- 
 TP-1  Approximate Test Pit Location and Number
-  Approximate Location of Existing Fill
-  Geologic Contact Dashed Where Approximate, Queried Where Unknown
-  Approximate Area of Local Steep Slopes in Excess of 2:1

Reference: "Marin City Libao Development" by Elevation Architects, May 27, 2017

Scale: 1" = 200'

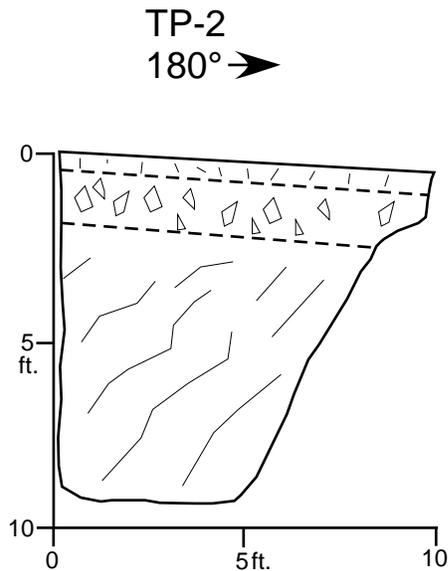
	<b>EXPLORATION PLAN</b> Marin City Property Donahue Street Marin City, California	PLATE <b>2</b>
	Job No: 3427.01.04.1    Date: June 2017	



Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel.

Ⓑ ORANGE-BROWN CLAYEY GRAVEL (GC), dense, moist, fine to coarse grained with few roots.

Ⓒ GRAY BROWN SHEARED SHALE, soft to firm, friable, highly weathered.

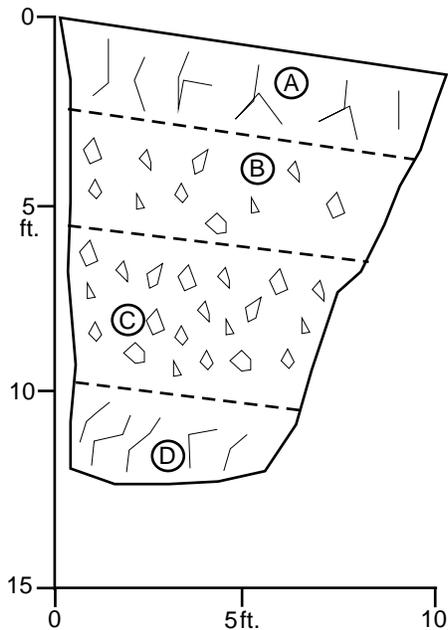


Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel.

Ⓑ ORANGE-BROWN CLAYEY GRAVEL (GC), dense, moist, fine to coarse grained with few roots.

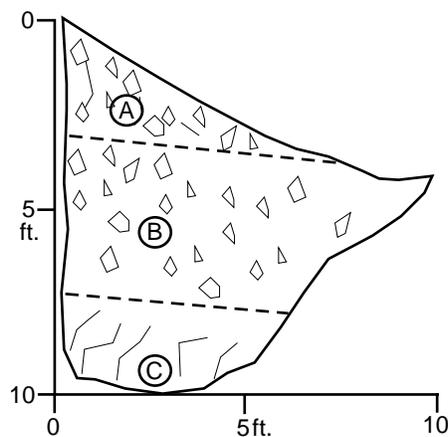
Ⓒ GRAY BROWN SHEARED SHALE, soft to firm, friable, highly weathered with clay pockets, wet.

TP-3  
95° →



- Ⓐ DARK BROWN SANDY CLAY (CL), soft, moist, porous with roots and gravel.
- Ⓑ ORANGE-BROWN SANDY CLAY (CL), stiff to very stiff, moist with gravel.
- Ⓒ ORANGE-BROWN SANDY CLAY (CH), very stiff, moist with abundant gravels.
- Ⓓ GRAY BROWN SHEARED SHALE, soft to firm, friable, highly weathered.

TP-4  
75° →



- Ⓐ DARK BROWN SANDY CLAY (CL), stiff, dry, porous with roots and abundant gravel to cobble size rocks. (FILL)
- Ⓑ ORANGE-BROWN SANDY CLAY (CH), very stiff, moist, with abundant gravels.
- Ⓒ GRAY BROWN SHEARED SHALE, soft to firm, friable, highly weathered with clay pockets, wet.

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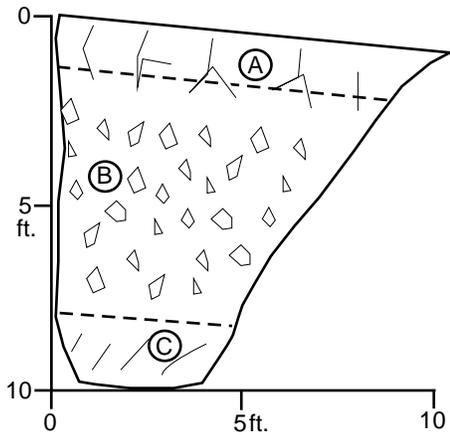
**LOG OF TEST PITS TP-3 AND TP-4**

Marin City Property  
Donahue Street  
Marin City, California

PLATE

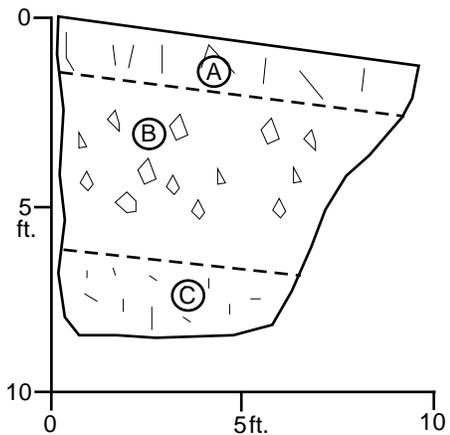
**4**

TP-5  
135° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel.
- Ⓑ ORANGE-BROWN CLAYEY GRAVEL (GC), dense, moist, fine to coarse grained with few roots.
- Ⓒ GRAY BROWN SHEARED SHALE, soft to firm, friable, highly weathered, with abundant clay pockets and very close fractures

TP-6  
56° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel.
- Ⓑ ORANGE-BROWN SANDY CLAY (CL), stiff, moist, some sandstone gravels.
- Ⓒ ORANGE BROWN SANDSTONE, firm, friable, highly weathered. with close fractures

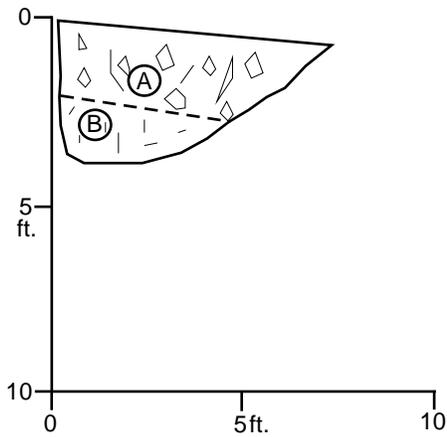
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**LOG OF TEST PITS TP-5 AND TP-6**  
Marin City Property  
Donahue Street  
Marin City, California

PLATE

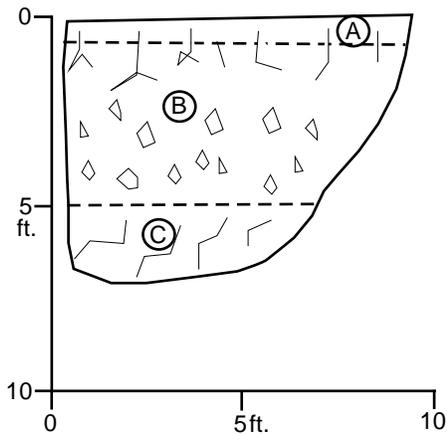
**5**

TP-7  
80° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel.
- Ⓑ ORANGE BROWN SANDSTONE, moderately hard, weak, highly weathered, with close fractures

TP-8  
90° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel. (FILL)
- Ⓑ ORANGE-BROWN SANDY CLAY (CL), stiff to very stiff, moist, with sandstone gravels.
- Ⓒ ORANGE BROWN SANDSTONE, moderately hard, weak, highly weathered, with close fractures.

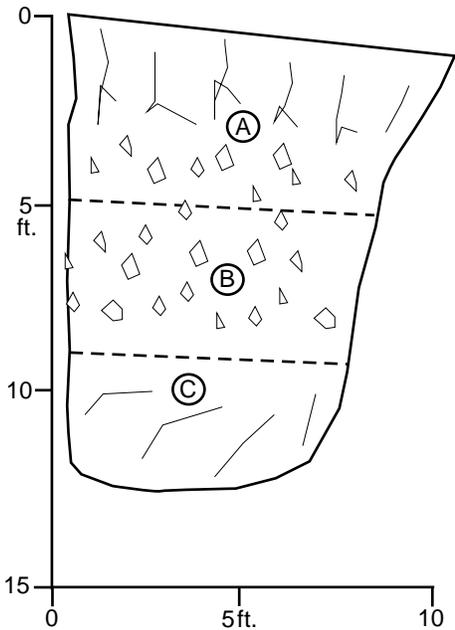
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**LOG OF TEST PITS TP-7 AND TP-8**  
Marin City Property  
Donahue Street  
Marin City, California

PLATE

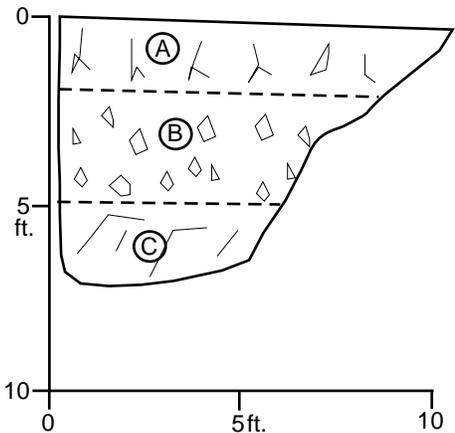
**6**

TP-9  
265° →



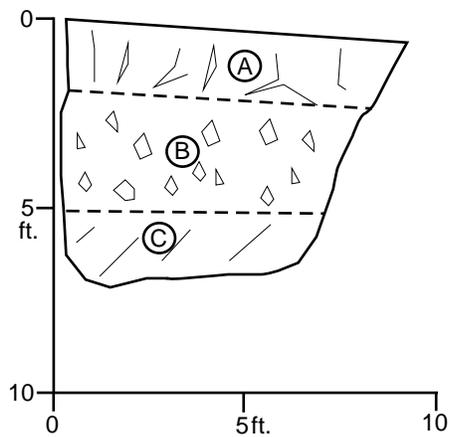
- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel. (FILL)
- Ⓑ ORANGE-BROWN SANDY CLAY (CH), stiff to very stiff, moist, with sandstone gravels.
- Ⓒ ORANGE BROWN SANDSTONE, moderately hard, weak, highly weathered, with close fractures.

TP-10  
75° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel. (FILL)
- Ⓑ ORANGE-BROWN SANDY CLAY (CL), stiff to very stiff, moist, with sandstone gravels.
- Ⓒ ORANGE BROWN SANDSTONE, friable, weak, highly weathered, with close fractures.

TP-11  
65° →



- Ⓐ BROWN SANDY CLAY (CL), stiff, dry, porous with roots and gravel. (FILL)
- Ⓑ ORANGE-BROWN SANDY CLAY (CL), stiff to very stiff, moist, with sandstone gravels.
- Ⓒ ORANGE BROWN SANDSTONE, friable, weak, highly weathered, with close fractures.

**RGH**  
CONSULTANTS

**LOG OF TEST PIT TP-11**

Marin City Property  
Donahue Street  
Marin City, California

PLATE

**8**

**UNIFIED SOIL CLASSIFICATION SYSTEM**

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS	
			GRAPH	LETTER		
<b>COARSE GRAINED SOILS</b>  MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	<b>GRAVEL AND GRAVELLY SOILS</b>  MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	<b>CLEAN GRAVEL</b>  (LITTLE OR FINES)		<b>GW</b>	WELL-GRADED GRAVEL, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
				<b>GP</b>	POORLY-GRADED GRAVEL, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		<b>GRAVEL WITH FINES</b>  (OVER 12% OF FINES)		<b>GM</b>	WELL-GRADED GRAVEL, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
				<b>GC</b>	CLAYEY GRAVEL, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES	
	<b>SAND AND SANDY SOILS</b>  MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	<b>CLEAN SANDS</b>  (LITTLE OR NO FINES)		<b>SW</b>	WELL-GRADED SAND, GRAVELLY SAND, LITTLE OR NO FINES	
				<b>SP</b>	POORLY-GRADED SAND, GRAVELLY SAND, LITTLE OR NO FINES	
		<b>SANDS WITH FINES</b>  (OVER 12% OF FINES)		<b>SM</b>	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES	
				<b>SC</b>	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES	
		<b>SILTS AND CLAYS</b>  LIQUID LIMIT LESS THAN 50			<b>ML</b>	INORGANICS SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
					<b>CL</b>	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			<b>OL</b>	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
<b>SILTS AND CLAYS</b>  LIQUID LIMIT GREATER THAN 50				<b>MH</b>	ORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	
			<b>CH</b>	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
			<b>OH</b>	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS		
<b>HIGHLY ORGANIC SOILS</b>				<b>PT</b>	PEAT, HUMUS, SWAMP SOILS AND OTHER SOILS WITH HIGH ORGANIC-CONTENTS	

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LAYERING

MASSIVE	Greater than 6 feet
THICKLY BEDDED	2 to 6 feet
MEDIUM BEDDED	8 to 24 inches
THINLY BEDDED	2½ to 8 inches
VERY THINLY BEDDED	¾ to 2½ inches
CLOSELY LAMINATED	¼ to ¾ inches
VERY CLOSELY LAMINATED	Less than ¼ inch

JOINT, FRACTURE, OR SHEAR SPACING

VERY WIDELY SPACED	Greater than 6 feet
WIDELY SPACED	2 to 6 feet
MODERATELY SPACED	8 to 24 inches
CLOSELY SPACED	2½ to 8 inches
VERY CLOSELY SPACED	¾ to 2½ inches
EXTREMELY CLOSELY SPACED	Less than ¼ inch

HARDNESS

Soft - pliable; can be dug by hand

Firm - can be gouged deeply or carved with a pocket knife

Moderately Hard - can be readily scratched by a knife blade; scratch leaves heavy trace of dust and is readily visible after the powder has been blown away

Hard - can be scratched with difficulty; scratch produces little powder and is often faintly visible

Very Hard - cannot be scratched with pocket knife, leaves a metallic streak

STRENGTH

Plastic - capable of being molded by hand

Friable - crumbles by rubbing with fingers

Weak - an unfractured specimen of such material will crumble under light hammer blows

Moderately Strong - specimen will withstand a few heavy hammer blows before breaking

Strong - specimen will withstand a few heavy ringing hammer blows and usually yields large fragments

Very Strong - rock will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments

DEGREE OF WEATHERING

Highly Weathered - abundant fractures coated with oxides, carbonates, sulphates, mud, etc., thorough discoloration, rock disintegration, mineral decomposition

Moderately Weathered - some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition

Slightly Weathered - a few stained fractures, slight discoloration, little or no effect on cementation, no mineral composition

Fresh - unaffected by weathering agents; no appreciable change with depth

## **APPENDIX B - REFERENCES**

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**APPENDIX C - DISTRIBUTION**

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