ATTACHMENT C

GEOTECHNICAL INVESTIGATION

TABER RESIDENCE
5720 NORTH HIGHWAY 1
LITTLE RIVER, CALIFORNIA

Project Number 12416.02

June 11, 2014

Brunsing Associates, Inc.

GEOTECHNICAL INVESTIGATION

TABER RESIDENCE
5720 NORTH HIGHWAY 1
LITTLE RIVER, CALIFORNIA

Project Number 12416.02
prepared for

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1.0 INTRODUCTION

This report presents the results of the Geotechnical Investigation that Brunsing Associates, Inc. (BAI) has performed for the planned Taber residence at 5720 North Highway 1, Little River, California. The approximate location of the site is shown on the Vicinity Map, Plate 1.

The existing residence was built before 1952, our earliest aerial photograph. The house was partially constructed over a sea cave. We understand the new owner, Taber, wants to remodel or re-locate the existing, dilapidated house.

If the house is remodeled in its existing location, partially over the sea cave, the house may not be safe over a typical (per the California Coastal Commission [CCC]) 75-year lifespan. The cave roof could possibly collapse over the next 75 years, especially considering the effects of sea level rise.

We understand that the areas east and north of the existing house are Environmentally Sensitive Habitat areas (ESHA's). With regard to these ESHA constraints, the best location for the planned house is <u>over</u> the sea cave; the house can be constructed on a bridge that spans the cave with abutments that are safely back of the cave walls.

BAI has reviewed the Topography Map prepared by I.L. Welty and Associates, Inc., dated August 9, 2006. BAI has discussed the project with Bret Taber, owner. The project will consist of a single story residence constructed on a bridge. A topographic map showing our geologic setbacks for a new building area is presented as our Site Geologic Map, Plate 2. Using surveyed points by Welty, and our field data, BAI prepared Geologic Cross Sections A-A', B-B' and C-C' as shown on Plate 3.

The purpose of our investigation was to evaluate the site soil and rock conditions in order to provide conclusions and recommendations regarding project feasibility, structure foundation support, cave wall and bluff setback, and construction considerations. Services were performed in accordance with our Change/Extra Service Order No.1, dated February 18, 2014. Our approach to providing the geotechnical guidelines for the design of the project utilized our knowledge of the soil/geologic conditions in the site vicinity, and experience with similar projects in the area. Field exploration for this investigation was directed toward confirming anticipated soil/geologic conditions in order to provide the basis for our conclusions and recommendations.

2.0 INVESTIGATION AND LABORATORY TESTING

2.1 Published Map Research

As part of our investigation, we initially reviewed the following published geologic maps and references:

- Brunsing Associates, Inc., 2012, Engineering Geologic Reconnaissance, 5720 North Highway 1, Little River, Mendocino County, California

- Hapke, C. J., and Reid, D., 2007, National Assessment of Shoreline Change, Part 4: Historical Coastal Cliff Retreat along the California Coast: United States Geological Survey (USGS) Open File Report (OFR) 2007-1133.
- Jennings, C.W., 1960, Geologic Map of California, Ukiah Sheet: California Division of Mines and Geology (CDMG).
- Jennings, C.W., and Bryant, W.A., 2010, Fault Activity Map: California Geologic Survey, California Geologic Data Map Series, Map No. 6, Scale 1:750,000.
- Johnsson, Mark J. Establishing Development Setbacks from Coastal Bluffs. Proceedings of California and the World Ocean '02. Santa Barbara, 2002.
- Kilbourne, R.T., 1983, Geology and Geomorphic Features Related to Landsliding, Mendocino 7.5 Minute Quadrangle, Mendocino County, California: California Division of Mines and Geology (CDMG), Open File Report 83-15.
- Update to the Sea-level Rise Guidance Document, 2013, Coastal and Ocean Working Group of the California Climate Action Team.

2.2 Field Exploration and Reconnaissance

The field exploration consisted of logging and sampling two test borings with a truck-mounted drill rig on March 7, 2014. The approximate locations of the test borings in relation to existing and planned residence are shown on the Site Geologic Map, Plate 2. The test borings were approximately 19.0 to 19.5 feet in depth. Our Project Geologist logged the test borings and obtained relatively undisturbed tube and bulk samples of the soil/rock materials encountered for visual classification and laboratory testing. The relatively undisturbed samples were obtained using a 3-inch (CA) outside diameter Modified California split-barrel sampler driven by a 140-pound drop hammer. The sampler barrel contained liners for retaining the soil/rock materials. Blows required to drive the sampler were converted to Standard Penetration Test (SPT) blow counts for correlation with empirical test data, using a conversion factor of 0.64. Selected samples were also obtained using a SPT sampler. SPT blow counts provide a relative measure of soil consistency and strength, and are utilized in our engineering analyses.

The logs of the test borings showing the various soil/rock materials encountered and the depths at which samples were obtained, are presented on Plates 5 and 6. The soils are classified in accordance with the Unified Soil Classification System outlined on Plate 7. The soil descriptive properties are presented on Plate 8. Rock descriptive properties are outlined on Plate 9.

Our Engineering Geologist and Geotechnical Engineer performed a geologic/engineering reconnaissance of the site on March 19, 2014 to photograph the site conditions, measure elevations and thickness of cave roof.

2.3 Laboratory Testing

Soil and rock samples obtained during our subsurface exploration were transported to our laboratory and examined to confirm field classifications. Laboratory tests were performed on selected samples to estimate their pertinent geotechnical engineering characteristics. Laboratory testing consisted of moisture content, dry density and unconsolidated-undrained triaxial compression tests.

The test results are presented opposite the samples tested on the test boring logs. A key to test data is provided on Plate 7. In addition, triaxial compression test data test results are presented on Plate 10.

3.0 SITE CONDITIONS

The ocean bluff is approximately 75 to 80 feet in vertical height. The bluff is comprised of moderately hard Franciscan sandstone covered by a few feet of terrace deposits. As indicated on Plate 2, the main sea cave extends back approximately 188 feet from the over-hanging rocks at the cave mouth. Site Photographs A and B, Plate 11, show the main cave mouth (southwest portal) from the bluff top as observed in 2006 and 2014, respectively (vantage points are slightly different). Localized areas of erosion along the blufftop are similar. The cave mouth is approximately 25 to 30 feet high, with a roof thickness of 49 feet, as measured from above with a 100-foot tape measure (see Site Photograph B, Plate 11). The height of the roof within the cave varies from 15 to 25 feet.

The back portion of the main cave has a serious rock fall condition that was noted in 2006. Photographs C and D, Plate 12, show the accumulated boulders that have fallen from the cave roof, as observed in 2006 and 2011. Stationary features common to both photographs have been circled. The rear cave walls and the small rocky/sandy beach at the rear of the cave appear basically the same as in 2006. No evidence of recent rockfalls or cave enlargement was observed. However, open fractures, ¼ to ½-inch wide, within the cave roof indicate that rock falls are continuing periodically. There are minor ground surface undulations within the upper terrace level that may be a result of cave roof settlement; these were noted in 2006 and do not appear to have changed. As can be seen on Plate 2, the main branch of the cave runs directly beneath the existing buildings. The west branch cave connection results in a roughly diamond-shaped part of the parcel southwest of the underlying caves.

One of the most obvious changes to the site that occurred mostly since 2005 (based on the oblique aerial photographs and our own), is the removal of trees to the west and southwest of the house. No surface water was observed in the building areas during our site visits. Minor seepage was observed in the lower bluff bedrock fractures during our reconnaissances.

4.0 SITE GEOLOGY AND SOIL CONDITIONS

The site is underlain by Tertiary-Cretaceous Period sedimentary rocks of the Franciscan Complex Coastal Belt. These rocks primarily consist of well-consolidated sandstone and minor shale. The upper 8.5 to 9.5 feet of the bedrock is yellow-orange brown, intensely to closely fractured, friable to low in hardness and deeply to moderately weathered. The gray sandstone exposed on the lower bluffs at the site is, in general, massive, closely fractured, moderately hard to hard, and little to moderately weathered. Drilling refusal was encountered in hard rock at 19 to 19.5 feet below the ground surface.

The bedrock is capped by about 9 to 9.5 feet of poorly consolidated, Pleistocene terrace deposits. The upper 2.5 to 4 feet of the sands are dark brown to black, very loose, porous and contain some

roots. The lower sands are gray-brown, yellow-brown to orange-brown and very loose to medium dense. Some caving of the terrace deposits occurred during drilling.

No landslides were observed in the project vicinity. Scattered bare scarps (void of vegetation) on the upper bluff face are evidence of minor sloughing.

No evidence of faulting was observed at the property, and none of the published references that we reviewed show faults on, or trending towards, the property. The subject property is within the Coast Ranges geomorphic province, a zone of high seismic activity associated with the active San Andreas Fault system, which passes off the Mendocino coast about 4.6 miles southwest of the site.

5.0 DISCUSSIONS AND CONCLUSIONS

5.1 General

Based upon the results of our investigation, we conclude from an engineering geologic and geotechnical engineering standpoint that the site is suitable for the proposed residence structure designed to span over the cave. The main geotechnical considerations affecting the design and construction of the project are bluff retreat, bluff/slope stability, cave roof collapse, and the potential for strong seismic shaking. These constraints are discussed in the following subsections.

5.2 Bluff Stability/Retreat Rate

As previously discussed in our 2012 report, the ocean bluffs at the property are mostly comprised of hard rock. Sea caves have developed from erosion along ancient fault traces and/or along other zones of weakness, such as fractures, joints or bedding planes. This erosion is expected to continue slowly, but may be punctuated by occasional rock falls within the caves. During our 2012 reconnaissance, we observed that continuing, strong wave action within the sea cave has moved much of the rockfall rubble that was observed during our 2006 reconnaissance. Therefore, we are not able to judge whether there has been an increase in the amount of rockfall rubble. Overall, however, we were able to note some of the same boulders and cave wall features, and saw no evidence of recent or imminent rock falls within the caves during our 2012 reconnaissance.

Based upon the vertical aerial photograph analysis, the bluff edges have been eroding at a rate of approximately an inch per year. Comparing the 1979 and 2013 oblique aerial photographs (see Plate 4) it appears possible that a bluff loss of 1 to 3 feet may have occurred. The assumption of a 3 foot bluff loss over 34 years results in a retreat rate of 1.1 inches per year.

BAI's estimated erosion rate is significantly less than the rate given in Open File Report (OFR) 2007-1133 (an average of approximately 16 inches per year) for this region. If the USGS rate were accurate, the bluff edge would have retreated approximately 81.3 feet over the last 61 years, from our earliest, relatively accurate aerial photograph, 1952, up to 2013. Further, the observed erosion over the 34 year time period of the 1979 and 2013 coastline oblique aerial photographs

would have been 45.3 feet, instead of the few feet that is apparent in the photographs. Therefore, the average rates derived from our photographic studies are far more accurate for this site than those given on OFR 2001-1133.

5.3 Sea Cave Roof Collapse

The enlargement of sea caves generally takes place along their long axes as the erosion follows zones of weakness within the hard bedrock. Caves develop along zones of weakness, such as fault or shear zones, bedding planes or unconformities.

Personal observations of sea caves including collapsed sea caves by the undersigned, Erik Olsborg who has been performing ocean bluff studies since the late 1970's, have found that most caves have near vertical sides. Most collapsed sea caves have near vertical sides with very little "rounding" of the upper slopes away from the cave.

The progression of the caves is likely to be most pronounced along their long axes as the erosion follows the generally planar features of faults, joints, or bedding planes. Therefore, the caves are not expected to widen significantly but may lengthen and increase in height as waves reach the inside of the caves.

5.4 Effects of Sea Level Rise

The California Coastal Commission (CCC) recently adopted the March 2013 update to the State of California Sea-Level Rise Guidance Document prepared by the Ocean Protection Counsel (OPC). The OPC report is based upon a 2012 report prepared by the National Academy of Sciences. The OPC report provided sea-level rise projections for the coast south of Cape Mendocino, as follows in Table 1:

Table 1: Sea Level Rise

Time Period	Sea Level Rise (Feet)
2000-2030	0.13 to 0.98
2000-2050	0.39 to 2.0
2000-2100	1.38 to 5.48

The CCC requires a 75-year lifespan for new, coastal house construction or major remodel. According to recent projections, by 2089, the sea level will be as much as 57 inches higher than present.

Using the CCC's economic lifespan of a building of 75 years, we must consider the effects of sea level rise for a structure built circa 2014 through 2089. For this discussion, we will assume a linear rate of sea level rise (which may or may not be the case) in order to estimate a projected sea level rise of approximately 57 inches (4.75 feet) by 2089. Table 2 shows our estimated periodic increase in retreat rate as sea level rises.

Table 2: Bluff Retreat Rate

Years	Span (years)	Cumulative Sea Level Rise (inches)	Retreat Rate (inches per year)	Amount of Retreat (inches)
2014-2030	16	12”	1.1”/yr	17.6
2030-2050	20	24”	2.0”/yr	48
2050-2089	49	57”	3.0”/yr	147

213” = 17.8’

Based upon historic aerial photographs and site observations since 2006, the current historic, average bluff retreat rate appears to be about 1.1 inches per year. Eventually, as the bluff toe and sea cave interiors are continually subject to strong wave activity even during low tides, the retreat rate should increase to approximately three inches per year.

Table 1 sums up the amount of projected retreat using estimated retreat rates over a 75-year span from a time of 2014 construction. Cumulative sea level rise is from 2014. This results in a total bluff retreat of 17.8 feet.

5.5 Settlement

Assuming foundations are designed and constructed in accordance with our recommendations, we estimate that the maximum post-construction settlement due to foundation loads will be less than 1/2 inch. We judge that post-construction differential settlement will be less than 1/4 inch between adjacent foundations.

5.6 Seismicity and Faulting

As is typical of the Mendocino County area, the site will be subject to strong ground shaking during future, nearby, large magnitude earthquakes. The intensity of ground shaking at the site will depend on the distance to the causative earthquake epicenter, the magnitude of the shock, and the response characteristics of the underlying earth materials. Generally, wood-frame structures founded in firm materials, and designed in accordance with current building codes are well suited to resist the effects of ground shaking.

Since the active San Andreas Fault is about 4.6 miles from the site, and no other active faults were observed by us or are shown on published maps in the site vicinity, it is our opinion that the potential for surface fault rupture at this site is very low.

5.7 Tsunami/Storm Waves

As typical of the Mendocino coastal area, the site could be subject to large storm waves or tsunami waves. In February 1960, the Point Cabrillo Light House was damaged by an approximately 60 feet high storm wave. No such waves are recorded at the light house from 1909, the year it was built, to 1960. Nor have such large waves occurred since 1960. Since the property bluffs are approximately 75 to 80 feet in vertical height, impact or inundation from a severe storm surge or tsunami event must be considered a risk for the site, albeit a relatively low

risk. The overall height of the bluffs affords blufftop structures continued protection from storm surges, tsunamis, and wave run-ups, except for extreme events, even considering the projected sea level rise.

5.8 Slope Stability Analysis

Our bluff stability analyses were performed to correspond, as a minimum, to the guidelines by Dr. Mark J. Johnsson, Staff Geologist, California Coastal Commission, "Establishing Development Setbacks from Coastal Bluffs", Proceedings, California and the World Ocean '02, in which he suggests a factor of safety greater than or equal to 1.5 for static conditions and 1.1 for seismic conditions, permanent displacement of less than 50 millimeter (mm), and horizontal seismic coefficient of 0.15g. We also followed the guidelines prepared by (1) American Society of Civil Engineers (ASCE) and Southern California Earthquake Center (SC/EC) "Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Landslide Hazards in California", dated June 2002 and (2) California Geological Survey (CGS) "Guidelines for Evaluating and Mitigating Seismic Hazards in California" dated 2008. The CGS report also suggest slopes that have a pseudo-static factor of safety greater than 1.0 using a seismic coefficient derived from the screening analysis procedure can be considered stable. For our analysis we used a seismic coefficient of 0.259.

Cross section C-C' was created using contours from the Topographic Map prepared by I.L. Welty and Associates dated 8/9/06 and data from our subsurface exploration. The location of this cross-section, used for our stability analysis, is shown on Plate 2. Cross section C-C' is presented on Plate 3. Profile used in our slope stability analysis assumes that the roof cave has collapsed leaving almost vertical bluff face.

Three soil/rock units, with different density and strength parameters, were delineated within the bluff for our stability analysis. Unit "1" is the upper terrace deposit that is very loose to loose silty sand. Unit "2" is deeply weathered sandstone. Unit "3" is the sandstone that is little weathered and hard. Table 3 summarizes soil/rock parameters used.

Table 3: Soil/Rock Parameters

Unit	Wet Density (pcf)	Cohesion (psf)	Friction Angle (ϕ)
1	120	400	0
2	135	1100	0
3	140	4500	0

The above assigned strengths were determined from strength test results obtained from this site and adjacent sites, as well as from back-analysis of the slope stability calculations. The stability of the slope was analyzed using the computer program SLIDE 5.0 version 5.044 by Rocscience, Inc. The results of our stability analyses are presented in Appendix A.

The results of our stability analyses, indicate that the cave walls, without roof, have a safety factor greater than 1.5 for static conditions, and greater than 1.1 for seismic conditions.

6.0 RECOMMENDATIONS

6.1 Site Grading

6.1.1 Clearing and Stripping

Areas to be graded should be cleared of existing vegetation and debris. After clearing, surface soils that contain organic matter should be stripped. In general, the depth of required stripping will be about 4 to 6 inches; deeper stripping and grubbing may be required to remove isolated concentrations of organic matter or roots. The cleared materials should be removed from the site; however, strippings can be stockpiled for later use in landscape areas.

6.1.2 Structural Area Preparation

Within the building areas and non-structural-supported slab areas, weak and porous soils should be removed to a depth of at least 6 to 12 inches, as determined by BAI. Removal of these soils should extend for a minimum distance of about 3 feet beyond the perimeter of the building and exterior concrete slabs and pavement areas. BAI should observe the soils exposed by the recommended excavations. The exposed soils should then be scarified to about six inches deep, moisture conditioned to at least optimum moisture content and compacted to at least 90 percent relative compaction as determined by the ASTM D 1557 test procedure, latest edition.

Fill material, either imported or on-site, should be free of perishable matter and rocks greater than six inches in largest dimension, and have an Expansion Index of less than 40, and should be approved by BAI before being used on site as structural fill.

Fill should be placed in thin lifts (six to eight inches depending on compaction equipment), conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction as determined by the ASTM D 1557 test procedure, latest edition, to achieve planned grades.

6.1.3 Finish Grading

Finished pad surfaces should be graded to drain away from the foundations. A minimum surface drainage gradient of three percent is recommended.

Subgrade soil should be finished true to line and grade to present a smooth, firm, and unyielding surface. Finished surfaces should be maintained moist and free of shrinkage cracks until covered by permanent construction. Pad surfaces allowed to dry out and crack should be re-moisture conditioned to near optimum moisture content and re-compacted prior to foundation and concrete slab-on-grade installation.

6.2 Bluff and Sea Cave Setbacks

We estimate that the estimated bluff retreat rates presented in Table 2 should be used for bluff setback determination. Based upon a period of 75 years, considered by the CCC to be the

economic lifespan of a house, and the projections of increased retreat rates resulting from sea level rise, plus a safety factor of 2, this retreat rate would result in a bluff edge setback of 36 feet.

Setbacks from sea caves are determined differently. For a previous project (2001), which had a similar sea cave with several entrances, the CCC approved a cave wall setback of 10 feet. This same setback should apply for this project. However, considering the recent projections of sea level rise, an increased cave wall setback of five feet, for a total of 15 feet, should be used. The resulting foundation setback from the cave walls should be at least 15 feet.

6.3 Foundation Support

6.3.1 Drilled Piers

The bridge supporting the planned residence should span from abutment to abutment, gaining no support from the underlying soil/rock within the cave roof. The bridge abutments can be supported on a system of drilled cast-in-place concrete (C-I-P C) piers interconnected with grade beams. Drilled piers should be at least 18 inches in diameter and penetrate suitable supporting bedrock. Resulting pier depths should be a minimum of about 25 feet below the existing ground surface; actual pier lengths should be determined by a structural engineer. Drilling of the lower few feet of the pier holes may require coring.

Spacing for the piers should be no closer than 3 pier diameters, center to center. Support for the piers may be gained from skin friction resistance equal to 600 pounds per square foot of pier surface area for dead plus long-term live downward loads. For the total downward load design, including wind or seismic forces, increase downward capacity by one-third. Uplift frictional capacity for piers should be limited to 2/3 of the allowable downward capacity. Both downward and uplift frictional capacity should be neglected in the upper 5 to 6 of loose sand.

When final pier depths have been achieved, as verified by BAI, the bottoms of the pier holes should be thoroughly cleaned of loose material. BAI should observe the drilling and final clean out of the pier holes, prior to the placement of reinforcing steel and/or concrete.

If groundwater is encountered during construction, the pier holes should be dewatered prior to placement of reinforcing steel and concrete. Alternatively, if more than six inches of ground water has entered the pier hole, concrete can be tremied into place with and adequate head to displace water or slurry. Concrete should not be placed by freefall in such a manner as to hit the sidewalls of the excavation.

Caving was encountered in our test boring B-1. The driller should be prepared to case pier holes where caving occurs. If used, the casing would need to be withdrawn from the pier holes as the pier concrete is placed.

6.3.2 Lateral Loads

Resistance to lateral loads can be obtained using passive earth pressure against the face of piers. An allowable passive pressure of 250 psf per foot of depth is appropriate for

foundation elements. Passive pressure should be neglected within the upper five to six feet of loose sand. Passive pressure can be projected over two pier diameters, however, should not be used below depths of about 7 pier diameters from top of piers.

6.4 Seismic Design Criteria

The structures should be designed and constructed to resist the effects of strong ground shaking (on the order of Modified Mercalli Intensity IX) in accordance with current building codes. The California Building Code (CBC) 2013 edition indicates that the site classification for the property is Site Class D. The following seismic design parameters are appropriate for the site:

Site Class = D
Mapped Spectral Response Acceleration at 0.2 sec Ss = 1.679g
Mapped Spectral Response Acceleration at 1.0 sec S1 = 0.774g
Design Spectral Response Acceleration at 0.2 sec SD_S = 1.119g
Design Spectral Response Acceleration at 1.0 sec SD1 = 0.774g
Seismic Design Category = E

6.5 Concrete Slab Floor Support

We are uncertain of the bridge design, including elevation (at, above or below existing grades) at this time. A structural-supported concrete slab can be used (i.e., the slab is supported by and able to span between, interconnecting foundation elements without gaining support from underlying soil). Over-excavation of the near-surface weak and porous soil zone is not required for a structural slab. However, topsoil containing organics should be removed beneath the planned slab (as much as four inches to six inches in depth below existing ground surface).

The concrete slab floors should be underlain by at least four inches of clean, free-draining gravel or crushed rock, graded in size from 1-1/2 or 3/4 inches maximum to 1/4 inches minimum, to act as a capillary moisture break. An underslab drain should be constructed as shown on the attached Plate 13. Underslab drain lines should be spaced no more than 20 feet apart. Underslab drain outlets should be constructed through the footings/stem walls by placing 2-inch or 4-inch sleeves within the forms at or below ground level prior to concrete placement.

Where migration of moisture through the floor slab would be detrimental to its intended use, the installation of a vapor retarder membrane should be considered. The moisture/vapor retarder geomembrane, placed upon the gravel layer, should be at least 15 mils thick (i.e., Stego ® Wrap 15-mil Class A, Carlisle RMB 400 15-mil Class A, or equivalent), installed in accordance with the manufacturer's specifications to prevent moisture migration through the seams. With a 15-mil minimum thickness membrane, the 2 inches of wetted sand typically placed upon the membrane may be omitted. Construction of moisture/vapor retarders does not guarantee the prevention of moisture moving through the floor slab. However, this provision should substantially reduce the potential for moisture-vapor problems on the floors and/or future mold and mildew problems.

6.6 Site Drainage

Because surface and/or subsurface water is often the cause of foundation or slope stability problems, care should be taken to intercept and divert concentrated surface flows and subsurface seepage away from the building foundations. Drainage across the lot should be by sheet-flow. Surface grades should maintain a recommended three percent gradient away from building foundations.

7.0 ADDITIONAL SERVICES

Prior to construction, BAI should review the final grading and foundation plans, and soil related specifications for conformance with our recommendations.

During construction, BAI should be retained to provide periodic observations, together with field and laboratory testing, during site preparation, placement and compaction of fills, if required, and foundation construction. Foundation excavations should be reviewed by BAI while the excavation operations are being performed. Our reviews and tests would allow us to verify conformance of the work to project guidelines, determine that soil conditions are as anticipated, and to modify our recommendations, if necessary.

8.0 LIMITATIONS

This geotechnical investigation was performed in accordance with the usual and current standards of the profession, as they relate to this and similar localities. No other warranty, expressed or implied, is provided as to the conclusions and professional advice presented in this report. Our conclusions are based upon reasonable geological and engineering interpretation of available data.

The samples taken and tested, and the observations made, are considered to be representative of the site; however, soil and geologic conditions may vary significantly between test borings and across the site. As in most projects, conditions revealed during construction excavation may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by BAI, and revised recommendations be provided as required.

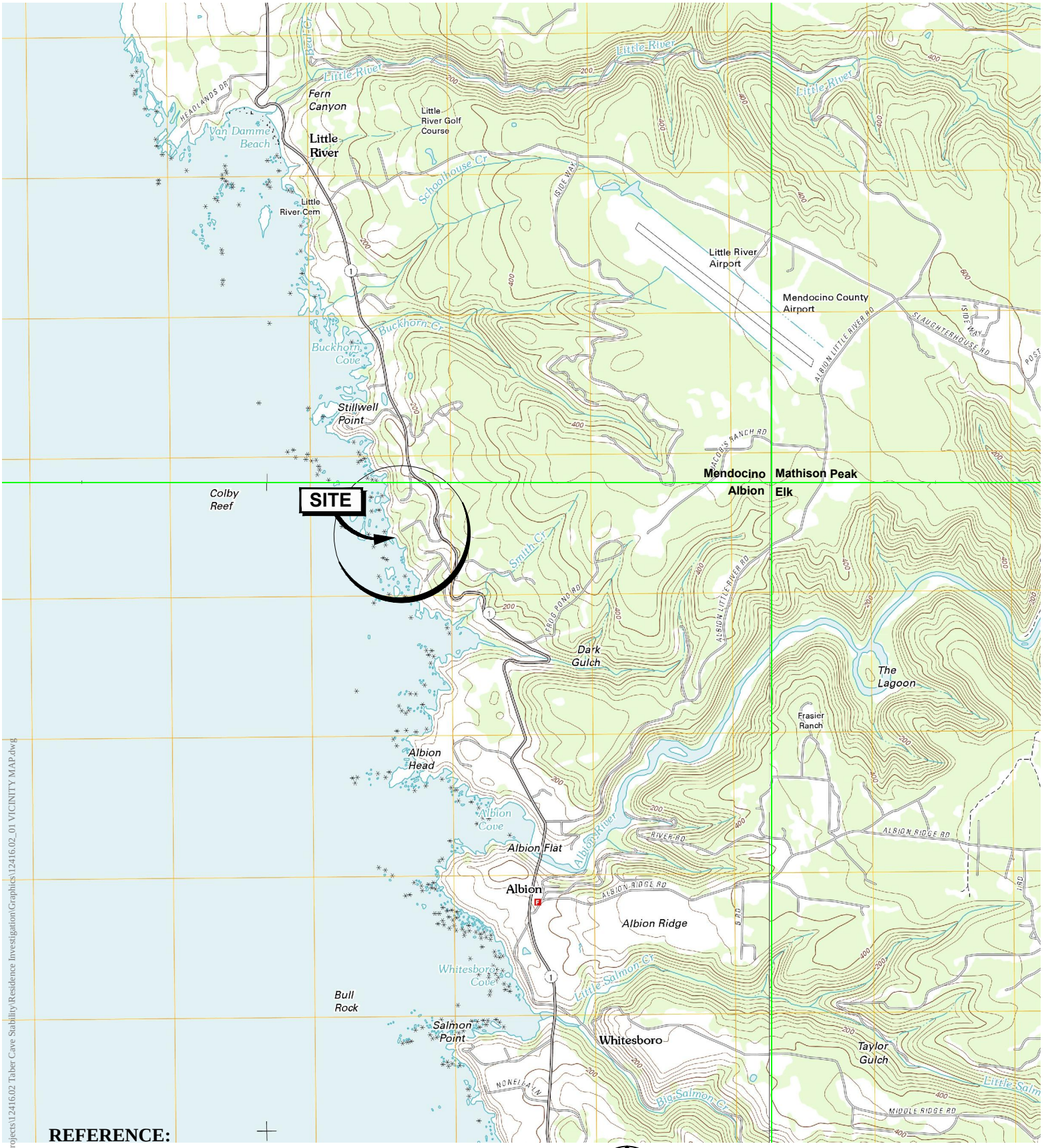
This report is issued with the understanding that it is the responsibility of the Owner, or his/her representative, to insure that the information and recommendations contained herein are brought to the attention of all other design professionals for the project, and incorporated into the plans, and that the Contractor and Subcontractors implement such recommendations in the field. The safety of others is the responsibility of the Contractor. The Contractor should notify the owner and BAI if he/she considers any of the recommended actions presented herein to be unsafe or otherwise impractical.

Changes in the condition of a site can occur with the passage of time, whether they are due to natural events or to human activities on this, or adjacent sites. In addition, changes in applicable or appropriate codes and standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, this report may become invalidated wholly or partially

by changes outside of our control. Therefore, this report is subject to review and revision as changed conditions are identified.

The recommendations contained in this report are based on certain specific project information regarding type of construction and current building location, which have been made available to us. If conceptual changes are undertaken during final project design, we should be allowed to review them in light of this report to determine if our recommendations are still applicable.

ILLUSTRATION



REFERENCE:
Albion, Mendocino, Elk, and Mathison Peak Quadrangle
7.5-Minute Series, USGS 2012

Latitude: 39.246644
Longitude: -123.781011

NORTH

APPROXIMATE SCALE (FEET)
0 1500 3000 6000

L:\Geotech Projects\12416.02 Taber Cave Stability\Residence Investigation\Graphics\12416.02_01 VICINITY MAP.dwg

5/13/2014 3:38:20 PM save date
6/11/2014 3:01:01 PM plot date

Brunsing Associates, Inc.
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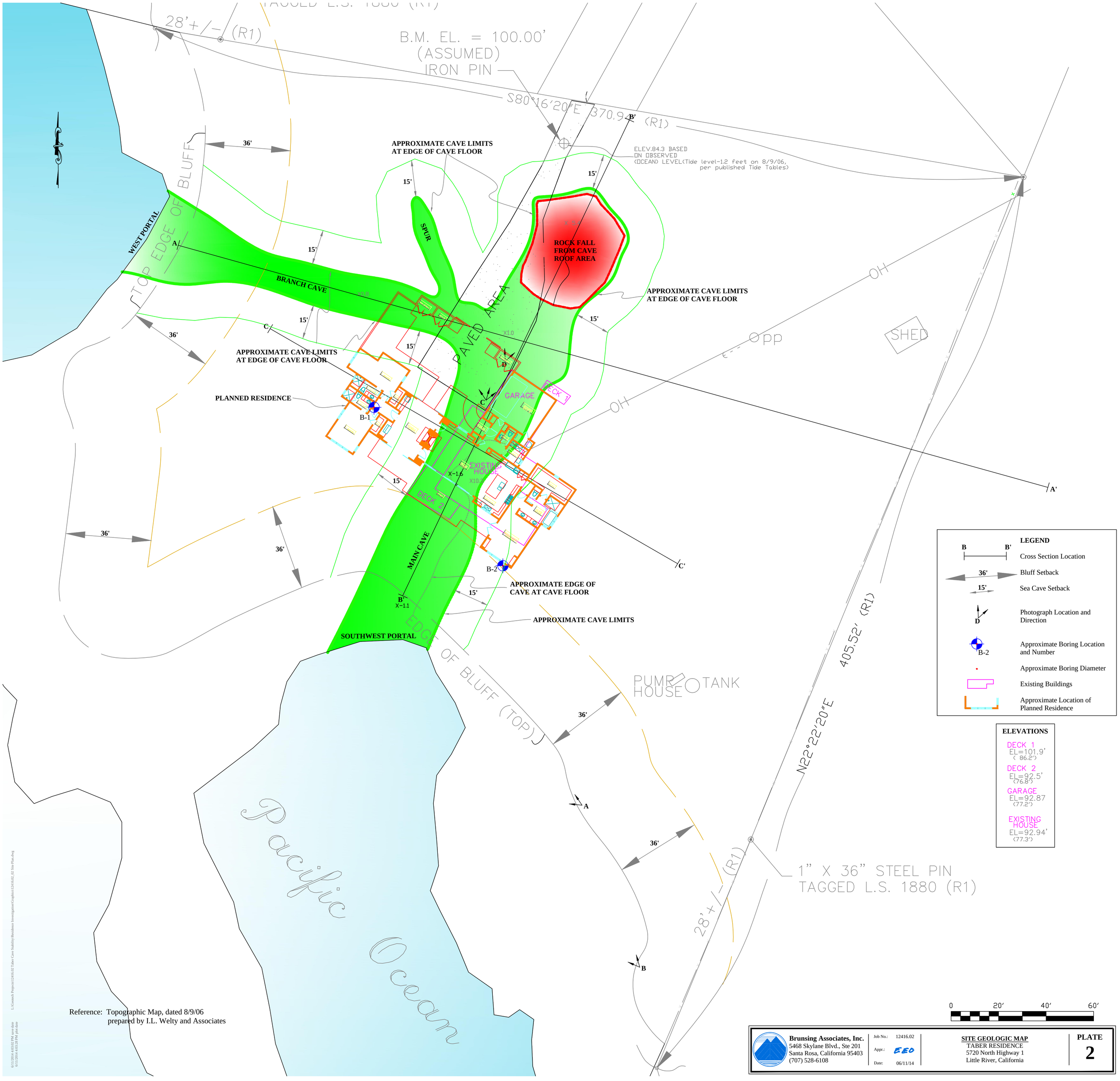
Job No.: 12416.02
Appr.: KKC
Date: 06/11/14

VICINITY MAP
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE
1



Reference: Topographic Map, dated 8/9/06
prepared by I.L. Welty and Associates

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L:\Geotech Projects\12416.02 Taber Cave Stability\Residence Investigation\Graphics\12416.02_02 Site Plan.dwg

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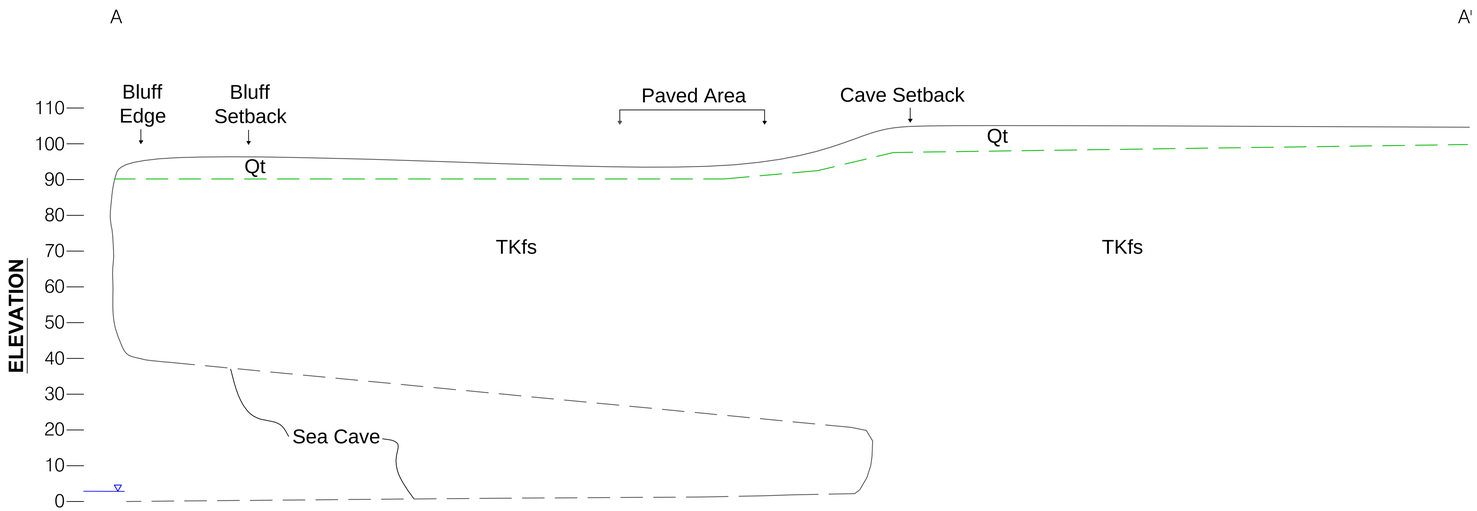
SITE GEOLOGIC MAP
TABER RESIDENCE
5720 North Highway 1
Little River, California

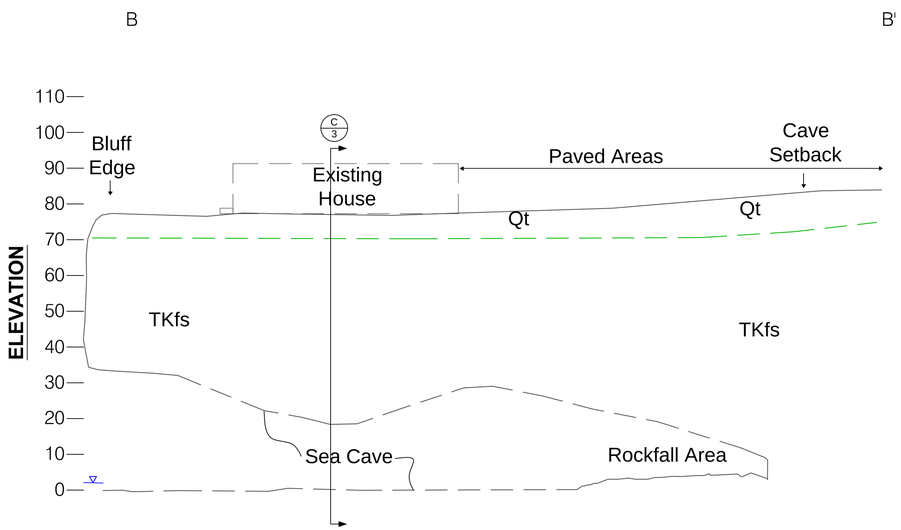
PLATE
2

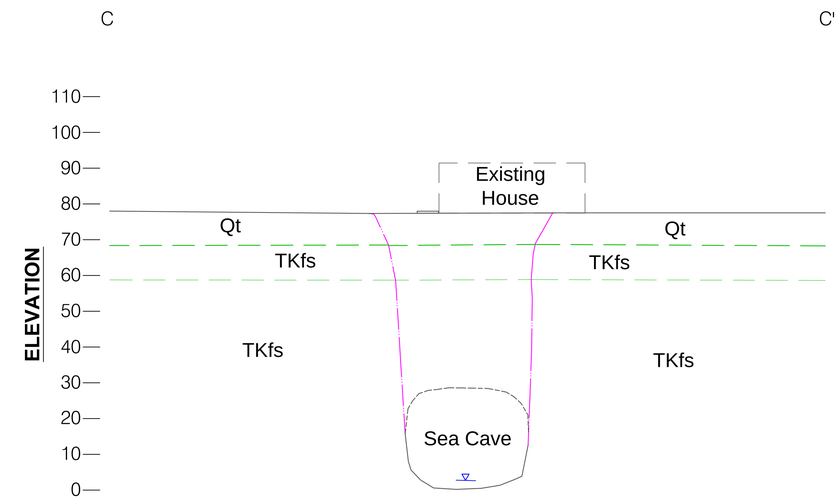
Geologic Cross Sections A - A', B - B' and C - C'



LEGEND

Qt	Pleistocene Terrace Deposits (silt, sand, gravel, clay)
TKfs	Cretaceous-Tertiary Franciscan Complex (sandstone, shale)
	Approximate Geologic Contact
	Approximate Ground/Cave/Cave Roof Surface
	Predicted Walls After Roof Collapses





REFERENCE: Profile based on Topographic Survey dated 08-09-06, by I.L. Welty & Associates.

APPROXIMATE SCALE (FEET)
0 10 20 40

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GEOLOGIC CROSS SECTIONS
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 3

1979 COASTLINE OBLIQUE AERIAL PHOTOGRAPH
Date of photograph October 5, 1979

2013 COASTLINE OBLIQUE AERIAL PHOTOGRAPH
Date of photograph September 27, 2013

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6/11/2014 3:17:34 PM save date
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Reference:
California Coastal Records project, www.californiacoastline.org, by permission.

Brunsing Associates, Inc. 5468 Skylane Blvd., Ste 201 Santa Rosa, California 95403 (707) 528-6108	Job No.: 12416.02 Appr.: EEO Date: 06/11/14	**1979 and 2013 COASTLINE OBLIQUE AERIAL PHOTOGRAPHS** TABER RESIDENCE 5720 North Highway 1 Little River, California	**PLATE** **4**

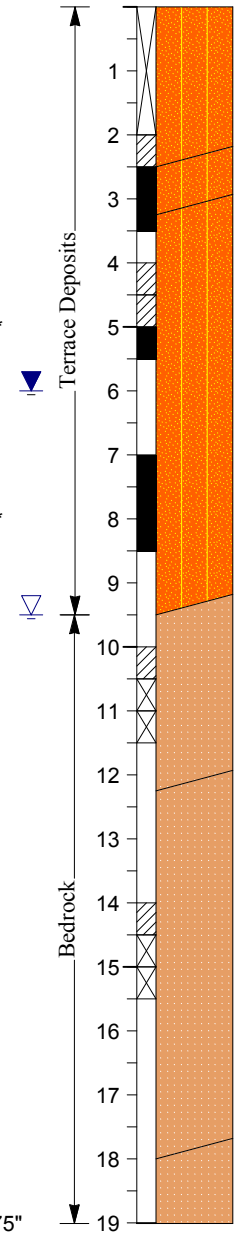
Log of Boring B-1

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 3/7/14 **Logged By:** SCL

Elevation: 76.5 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot
	CA			6**
Tx 2529 (864)	CA	13.8	119	12**
	CA			26**
	SPT			24
	SPT			11
	SPT			50/0.75"



DARK BROWN SILTY SAND (SM)
very loose, wet
porous, with rootlets

GRAYISH BROWN SILTY SAND (SM)
loose, wet
YELLOW-BROWN SILTY SAND (SM)
loose to medium dense, wet to saturated

ORANGE-BROWN SANDSTONE
intense fracturing, friable, deep weathering

ORANGE-BROWN CRUSHED SANDSTONE
close fracturing, friable, moderate weathering

DARK GRAY SANDSTONE
little fracturing, hard, little weathering

Notes:
1. Water encountered at 9.5 feet during drilling
2. Caved to 9 feet after completion of drilling
3. Water measured at 6 feet, 2 hours after completion of drilling
4. Drilled to practical refusal
5. Backfilled with spoils

* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations surveyed using hand level and elevations shown on Plate 2.

Scale: 1" = 3'

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Date: 06/11/14

LOG OF BORING B-1
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 5
SHEET 1 of 1

BORING LOG 1 PER PAGE, 12416.02 GINT.GPJ, 6/11/14

Log of Boring B-2

Equipment: Mobile B-53; 6-inch solid-stem flight auger

Date: 3/7/14 **Logged By:** SCL

Elevation: 75.8 feet ***

Laboratory Tests	Sampler Type*	Moisture Content (%)	Dry Density (pcf)	Blows/foot	Depth (ft.)	Sample	
							VERY DARK BROWN-BLACK SILTY SAND (SM) very loose, wet porous
	CA			3**	3		VERY DARK BROWN-BLACK SILTY SAND (SM) very loose, wet
Tx 2763 (720)	CA	16.6	105	4**	5		ORANGE-BROWN SILTY SAND (SM) very loose to loose, wet
							ORANGE-BROWN SILTY SAND (SM) medium dense, wet
Tx 2719 (1152)	CA	18.3	110	17**	8		
					9		ORANGE-BROWN SILTY SANDSTONE with black oxide staining close fracturing, friable, deep weathering
Tx 3033 (1584)		13.7	120		10		
	CA			53/9"**	11		BROWN-ORANGE BROWN SILTY SANDSTONE moderate fracturing, low hardness, moderate weathering
	SPT			71/10.5"	15		GRAY-BROWN SHALE intense fracturing, moderate hardness, moderate weathering
	SPT			59/6"	19		GRAY SANDSTONE oxide staining on fractures intense fracturing, moderate hardness, moderate weathering

Terrace Deposits: 1–9

Bedrock: 9–19

Notes:
1. Water measured at 15 feet after completion of drilling
2. No caving
3. Drilled to practical refusal
4. Backfilled with spoils

* See Soil Classification Chart & Key to Test Data
** Equivalent "Standard Penetration" Blow Counts.
*** Elevations surveyed using hand level and elevations shown on Plate 2.

Scale: 1" = 3'

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LOG OF BORING B-2
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 6
SHEET 1 of 1

BORING LOG 1 PER PAGE, 12416.02 GINT.GPJ, 6/11/14

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (Less than 5% fines)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (Greater than 12% fines)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS (Less than 5% fines)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (Greater than 12% fines)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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 SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMOUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

KEY TO TEST DATA

LL - Liquid Limit
PI - Plasticity Index
Consol - Consolidation
EI - Expansion Index
SA - Sieve Analysis
Sample Retained
Sample Recovered, Not Retained
Bulk Sample
Sample Not Recovered
CA - California Modified Split Barrel Sampler 3.0-inch O.D.
CM - California Modified Split Barrel Sampler 2.5-inch O.D.
SPT - California Split Barrel Sampler 2.0-inch O.D.
SH - Shelby Tube
RC - Rock Coring
Recovery - Percent Core Recovered
RQD - Rock Quality Designation (length of core pieces >= 4-inches / core length)

	Shear Strength, psf	Confining Pressure, psf	
Tx	320	(2600)	- Unconsolidated Undrained Triaxial
TxCU	320	(2600)	- Consolidated Undrained Triaxial
DS	2750	(2600)	- Consolidated Drained Direct Shear
FVS	470		- Field Vane Shear
UC	2000		- Unconfined Compression
PP	2000		- Field Pocket Penetrometer
Sat			- Sample saturated prior to test

Groundwater Level Reading
Second Groundwater Level Reading

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SOIL CLASSIFICATION CHART & KEY TO TEST DATA

TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 7

SOIL CLASSIFICATION CHART COLOR, 12416.02 GINT.GPJ, 6/11/14

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	Standard Penetration Test Blow Count (blows per foot)
Very loose	4 or less
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	More than 50

CONSISTENCY OF FINE-GRAINED SOILS

Consistency	Identification Procedure	Approximate Shear Strength (psf)
Very soft	Easily penetrated several inches with fist	Less than 250
Soft	Easily penetrated several inches with thumb	250 to 500
Medium stiff	Penetrated several inches by thumb with moderate effort	500 to 1000
Stiff	Readily indented by thumb, but penetrated only with great effort	1000 to 2000
Very stiff	Readily indented by thumb nail	2000 to 4000
Hard	indented with difficulty by thumb nail	More than 4000

NATURAL MOISTURE CONTENT

Dry	No noticeable moisture content. Requires considerable moisture to obtain optimum moisture content* for compaction.
Damp	Contains some moisture, but is on the dry side of optimum.
Moist	Near optimum moisture content for compaction.
Wet	Requires drying to obtain optimum moisture content for compaction.
Saturated	Near or below the water table, from capillarity, or from perched or ponded water. All void spaces filled with water.

* Optimum moisture content as determined in accordance with ASTM Test Method D1557, latest edition.

Where laboratory test data are not available, the above field classifications provide a general indication of material properties; the classifications may require modification based upon laboratory tests.

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SOIL DESCRIPTIVE PROPERTIES
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 8

Generalized Graphic Rock Symbols

Claystone	Siltstone	Tuff (Volcanic Ash)
Shale	Chert	Andesite
Sandstone	Serpentine	Basalt
Conglomerate	Greenstone	Schist

Stratification

Bedding of Sedimentary Rocks	Thickness of Beds
Massive	No apparent bedding
Very thick bedded	Greater than 4 feet
Thick bedded	2 feet to 4 feet
Thin bedded	2 inches to 2 feet
Very thin bedded	0.5 inches to 2 inches
Laminated	0.125 inches to 0.5 inches
Thinly laminated	less than 0.125 inches

Fracturing

Fracturing Intensity	Fracture Spacing
Little	Greater than 4 feet
Occasional	1 foot to 4 feet
Moderate	6 inches to 1 foot
Close	1 inch to 6 inches
Intense	0.5 inches to 1 inch
Crushed	less than 0.5 inches

Strength

Soft	Plastic or very low strength.
Friable	Crumbles by hand.
Low hardness	Crumbles under light hammer blows.
Moderate hardness	Crumbles under a few heavy hammer blows.
Hard	Breaks into large pieces under heavy, ringing hammer blows.
Very hard	Resists heavy, ringing hammer blows and will yield with difficulty only dust and small flying fragments.

Weathering

Deep	Moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many extensively coated fractures.
Moderate	Slight decomposition of minerals, little disintegration, moderate discoloration, moderately coated fractures.
Little	No megascopic decomposition of minerals, slight to no effect on cementation, slight and intermittent, or localized discoloration, few stains on fracture surfaces.
Fresh	Unaffected by weathering agents, no disintegration or discoloration, fractures usually less numerous than joints.

ROCK DESCRIPTIVE PROPERTIES COLOR, 12416.02 GINT.GPJ, 6/11/14

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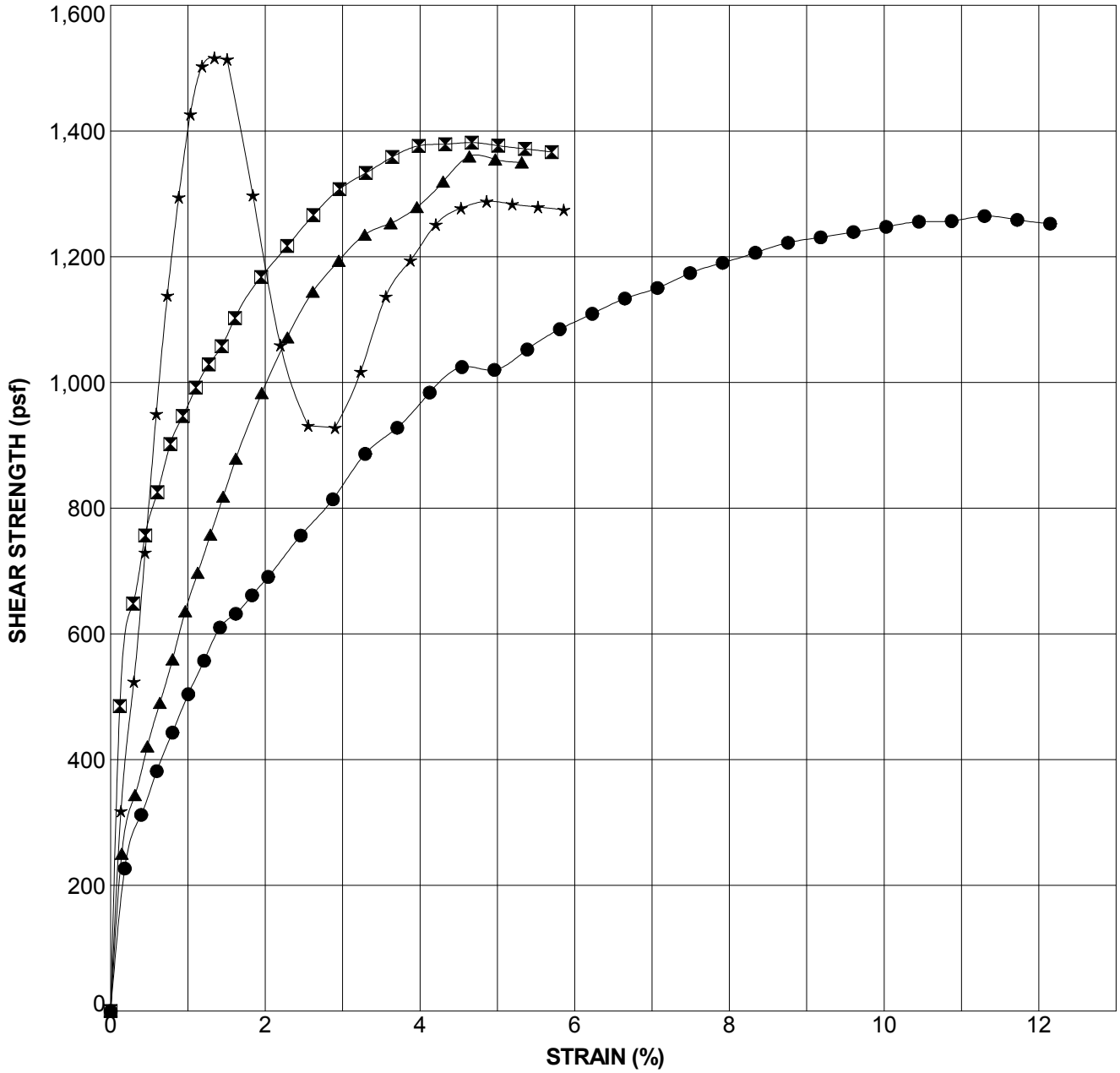
ROCK DESCRIPTIVE PROPERTIES
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 9



Sample Source	Classification	Confining Pressure (psf)	Ultimate Strength (psf)	Strain (%)	Dry Density (pcf)	Moisture Content (%)
● B-1 at 5 ft	YELLOW-BROWN SILTY SAND (SM)	864	1265	11.3	119	13.8
⊠ B-2 at 4.75 ft	ORANGE-BROWN SILTY SAND (SM)	720	1382	4.7	105	16.6
▲ B-2 at 8 ft	ORANGE-BROWN SILTY SAND (SM)	1152	1360	4.6	110	18.3
★ B-2 at 10.5 ft	BROWN-ORANGE BROWN SILTY SANDSTONE	1584	1517	1.3	120	13.7

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UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS
TABER RESIDENCE
5720 North Highway 1
Little River, California

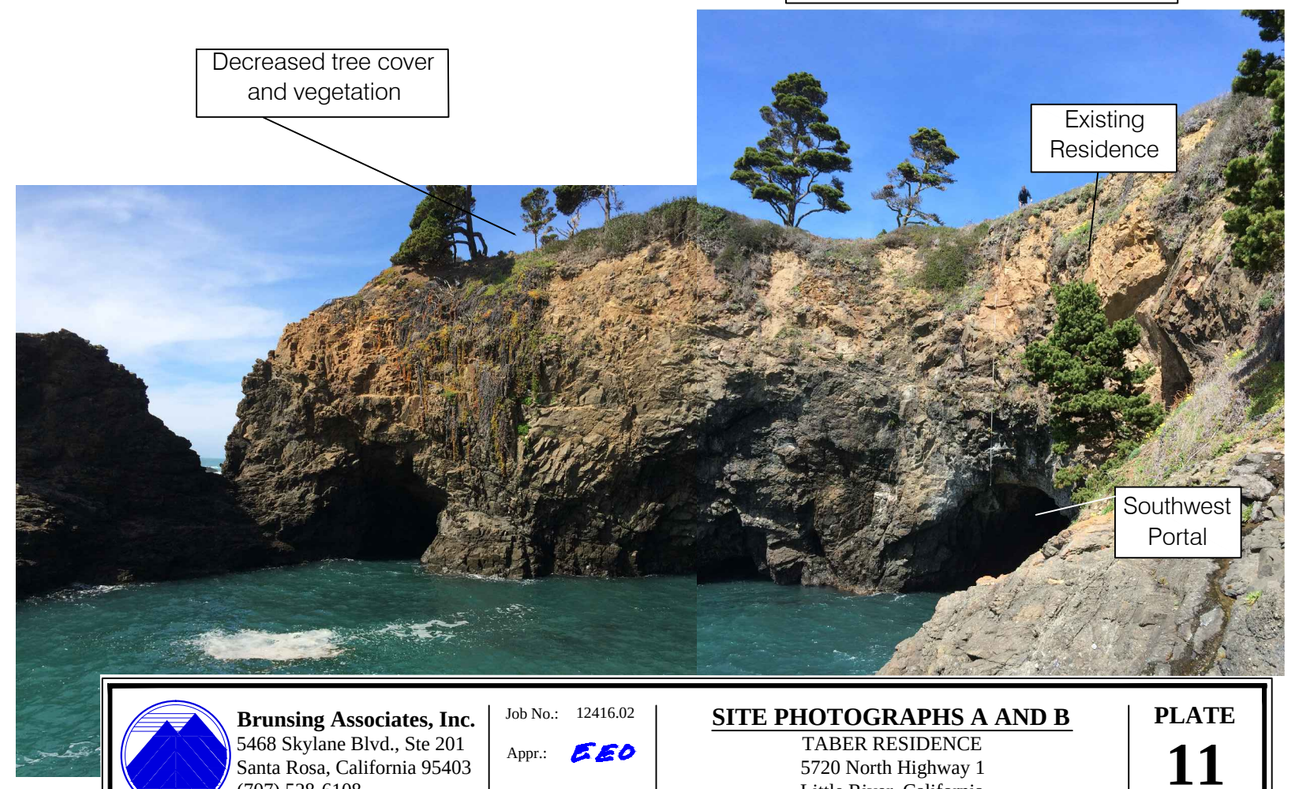
PLATE 10

SITE PHOTOGRAPH A

Looking northwest from bluff edge
June 16, 2006

SITE PHOTOGRAPH B

Measuring the rock thickness over the cave roof
March 19, 2014



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SITE PHOTOGRAPHS A AND B
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 11

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SITE PHOTOGRAPH C
Looking north in main sea cave at rock fall area, June 16, 2006

SITE PHOTOGRAPH D
Looking north in main sea cave at rock fall area, October 25, 2011

Both photographs are taken at the back of the main cave (rockfall area indicated on Plate 2).
Comparable, grossly unchanged features of the cave wall are circled.

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SITE PHOTOGRAPHS C AND D
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 12

L:\Geotech Projects\12416.02 Taber Cave Stability\Residence Investigation\Graphics\12416.02_12 Site Photographs C and D.dwg
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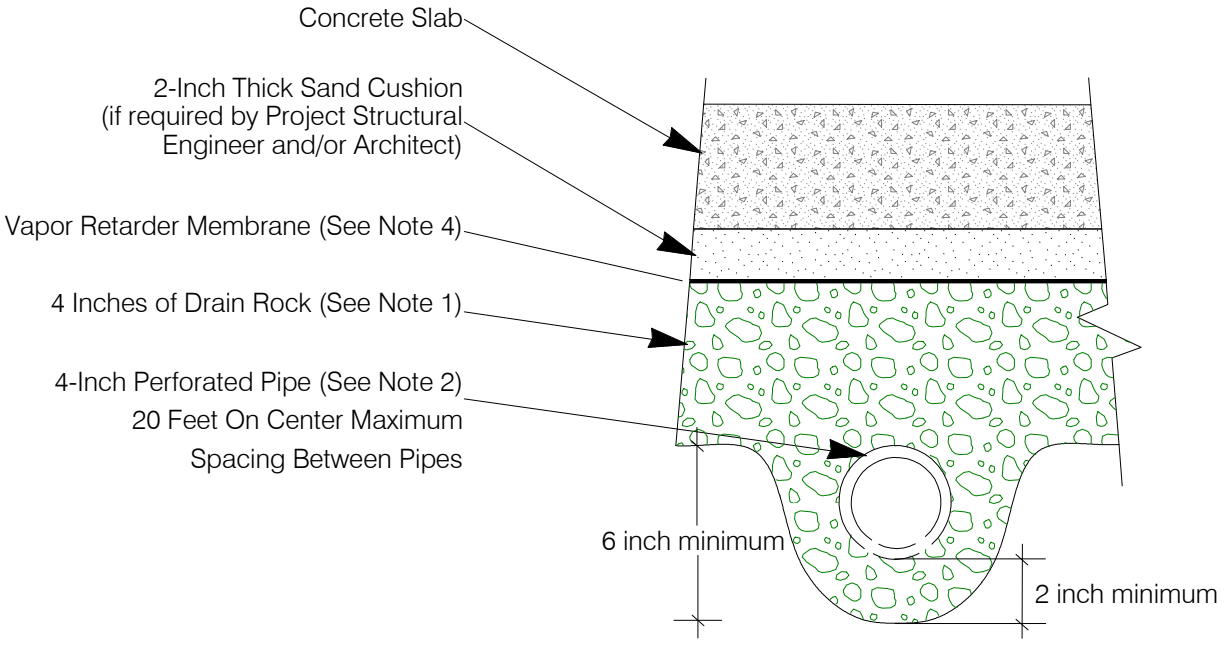

NOT TO SCALE

NOTES:

1. Drain rock should be clean, free-draining material graded in size between the No.4 and 3/4 inch sieves.
2. Pipe should be SDR 35 or equivalent, perforations placed down, sloped at least 1 percent to gravity outlet, or sump with automatic pump.
3. A clean-out pipe with cap should be installed at the up-slope end of perforated pipe.
4. Vapor retarder should be at least 15-mils thick and installed in accordance with the manufacturer's specifications.

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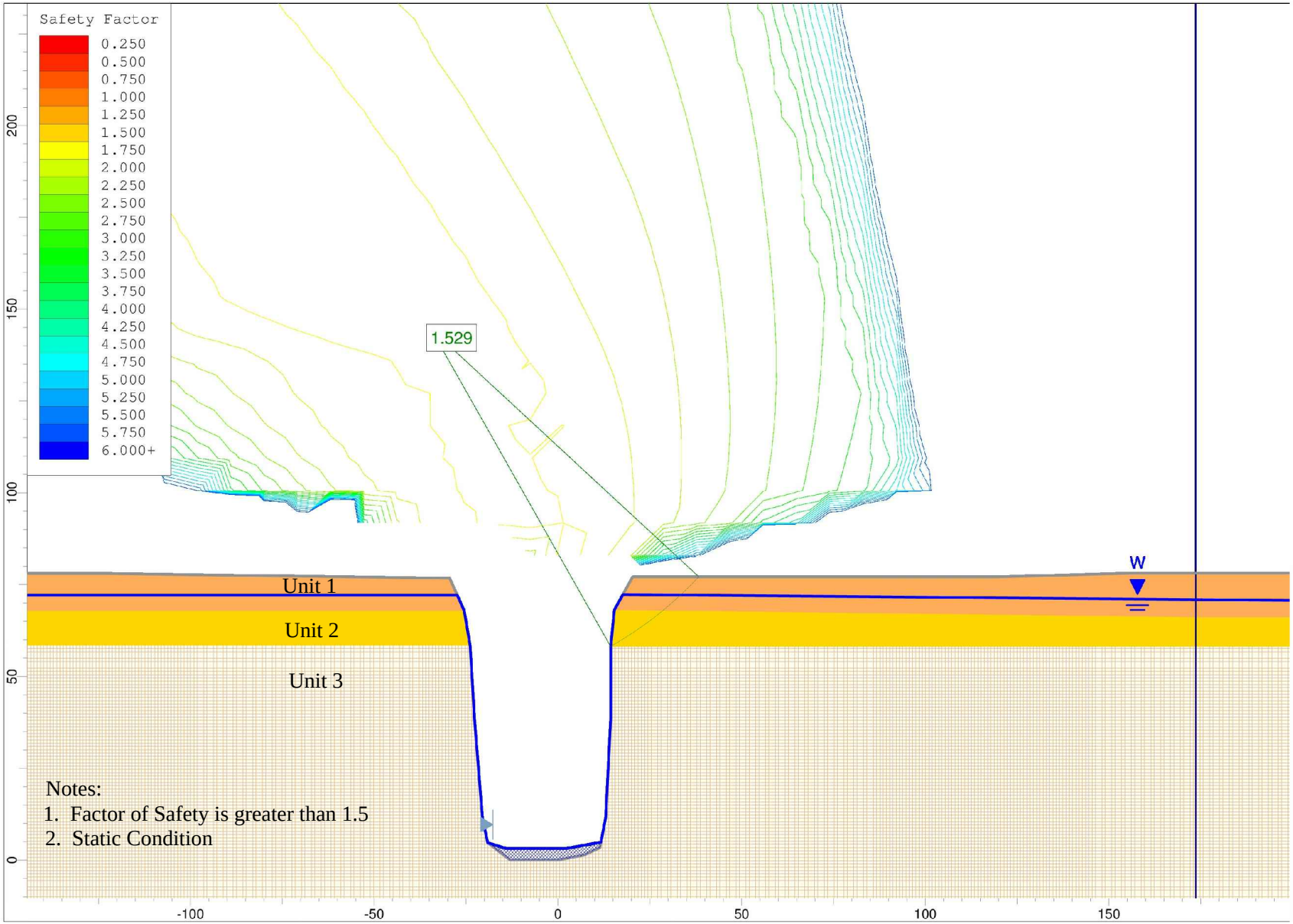
UNDERSLAB DRAINAGE DETAILS
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE 13

UNDERSLAB DRAINAGE DETAILS, 12416.02 GINT.GPJ, 6/11/14

APPENDIX A



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APPROXIMATE SCALE (FEET)

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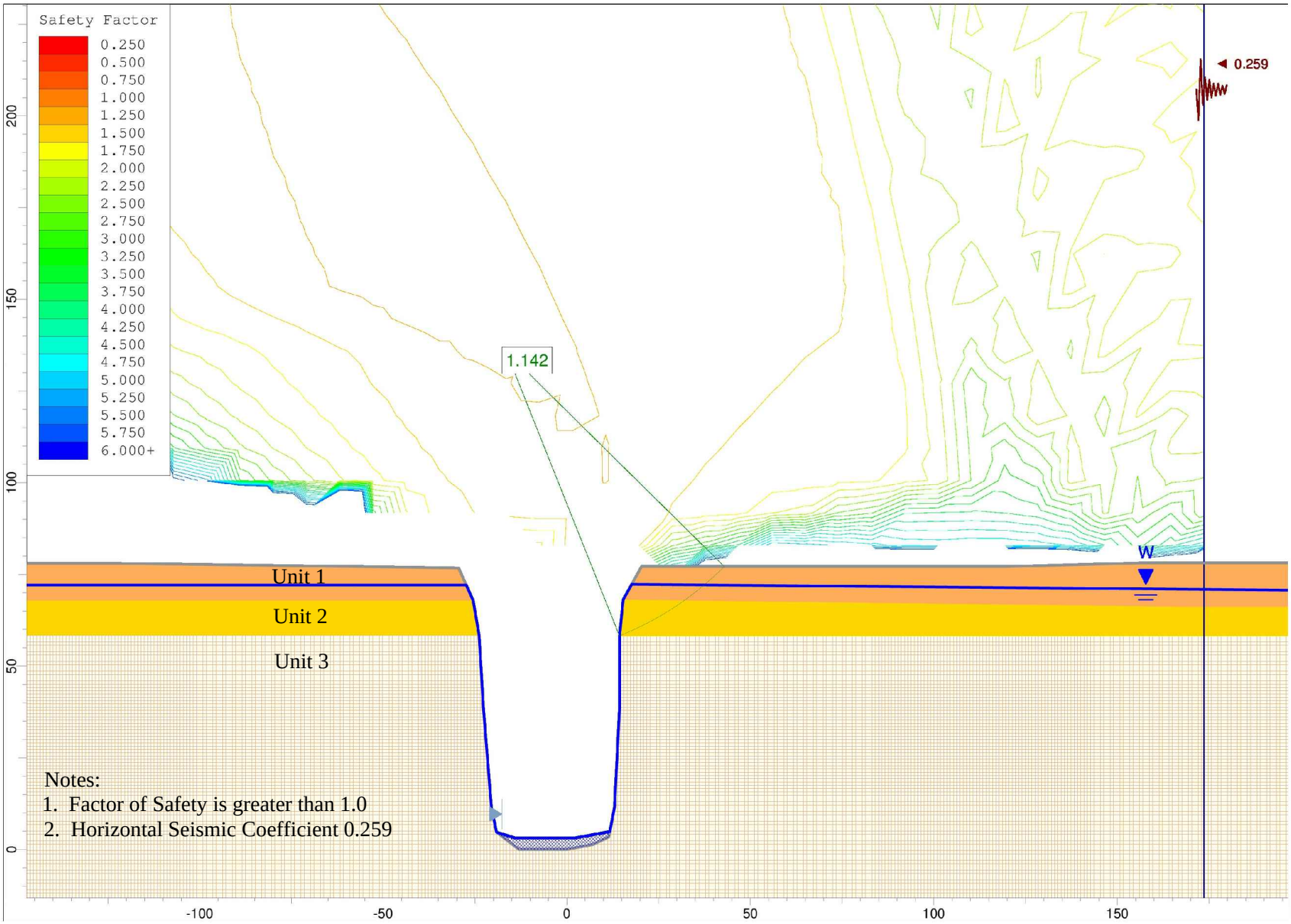
STATIC SLOPE STABILITY CROSS SECTION C-C'
TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE
A1



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APPROXIMATE SCALE (FEET)

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SEISMIC SLOPE STABILITY CROSS SECTION C-C'

TABER RESIDENCE
5720 North Highway 1
Little River, California

PLATE
A2

Brunsing Associates, Inc.

January 12, 2015 12416.02

Mr. Bret Taber
P. O. Box 1477
Martinez, CA 94553

RE: Response to Comments, Proposed Taber Residence, 5720 North Highway 1, Little River, Mendocino County, California, CDP 24-2014

Dear Mr. Taber:

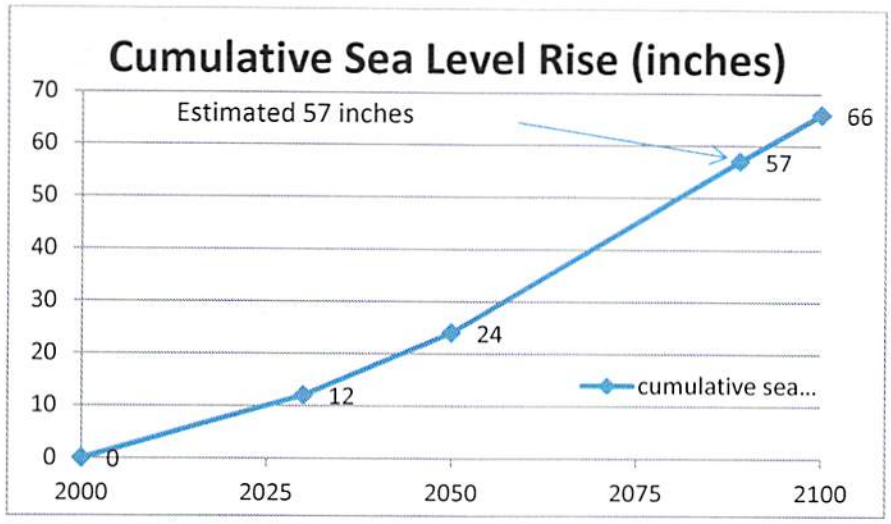
This letter is in response to California Coastal Commission (CCC) comments on your permit application, CDP 24-2014 in their letter dated November 7, 2014. These comments came as a follow-up to our site meeting on July 31, 2014. Brunsing Associates, Inc. (BAI) previously prepared a geotechnical investigation report dated June 11, 2014. The report provided setbacks from the ocean bluff and sea cave walls and stated that building a bridge over the sea cave to support a house was feasible.

Our response to the CCC comments are as follows:

- Calculations used to determine cave wall setbacks – No calculations were made to determine cave wall setbacks. From our observations over the years, the ocean bluffs in the Little River area are comprised of relatively-hard, Franciscan Complex bedrock that stand near vertical. Nearly all collapsed sea caves that we are aware of have near-vertical side slopes. Except in areas of erodible Pleistocene terrace deposits, we have observed very little rounding of the upper portions of ocean bluffs or collapsed sea caves. Therefore, since this is a hard rock site, the 15-feet setback from the sea cave walls should be more than adequate over the life of the project (75 years).
- Calculations used to determine future sea level rise projections – We did no calculations of our own with regard to sea level rise projections. We simply accepted the data (adopted by the CCC) presented in the March 2013 update to the State of California Sea-Level Rise Guidance Document prepared by the Ocean Protection Counsel (OPC). The OPC report is based upon a 2012 report prepared by the National Academy of Sciences. The OPC report provided sea-level rise projections for the coast south of Cape Mendocino, as follows in Table 1 and illustrated in the graph below:

Table 1: Sea Level Rise Projections using Year 2000 as the Baseline

Time Period	Sea Level Rise (Feet)
2000-2030	0.13 to 0.98
2000-2050	0.39 to 2.0
2000-2100	1.38 to 5.48



Using the CCC's economic lifespan of a building of 75 years, we considered the effects of sea level rise for a structure built circa 2015 through 2090. For this discussion, we have assumed a linear rate of sea level rise (which may or may not be the case) in order to estimate a projected sea level rise of approximately 57 inches (4.75 feet) by 2090.

- Project Plan Review – We have reviewed Sheets S1, Conceptual Foundation Plan and Sheet S2, Keyplan, for the Taber residence. The plans show the conceptual foundation for the bridge that will support the planned residence. The bridge abutment piers conform to the foundation recommendations presented in our geotechnical investigation report. The bridge abutment locations are in conformance with our recommended ocean bluff and cave wall setbacks. The cave roof will provide support for the necessary construction equipment to be used for the bridge building operations.
- Bluff Protective devices – The completed house, supported on the planned bridge should be safe for at least the next 75 years, even in the event of a cave roof collapse. No bluff/cave protective devices should be required for the lifetime of the house.
- Subsurface Drainage – The bridge piers and concrete beams will not interfere with groundwater flow. The widely-spaced piers and shallow concrete beams should not form any kind of barrier to groundwater flow. Groundwater within the bedrock fractures will continue to flow around and in between the piers as is currently happening.

Respectfully submitted,

PROFESSIONAL GEOLOGIST
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