

BLUFF STUDY REPORT
4677 VIA ROBLADA
HOPE RANCH AREA OF
SANTA BARBARA COUNTY, CALIFORNIA

PROJECT NO.: 301995-001
NOVEMBER 30, 2022
(REVISED OCTOBER 4, 2023)

PREPARED FOR
HR PROPERTY TRUST
ATTENTION: TIM PASQUINELLI
C/O ROBERT GOODWIN

BY
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Project No.: 301995-001
Report No.: 22-11-93

HR Property Trust
Attention: Tim Pasquinelli
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Project: 4677 Via Roblada
Hope Ranch Area of Santa Barbara County, California
Subject: Bluff Study Report

As authorized, Earth Systems Pacific (Earth Systems) has prepared this Bluff Study Report for a proposed future construction at 4677 Via Roblada in the Hope Ranch area of Santa Barbara County, California. The accompanying Bluff Study Report presents the results of our subsurface exploration and laboratory testing programs, and our conclusions and recommendations pertaining to geotechnical aspects of project design. This report completes Phase 1 of the scope of services described within our Proposal No. SBA-21-02-008 dated February 24, 2021, revised March 22, 2022, and authorized by Tim Pasquinelli on May 2, 2022.

We have appreciated the opportunity to be of service to you on this project. Please call if you have any questions, or if we can be of further service.

Respectfully submitted,

EARTH SYSTEMS PACIFIC

Reviewed and Approved



Meng Wei Lu
Project Engineer

10-4-2023



Todd J. Tranby
Engineering Geologist

10-4-2023

Copies: 1 - Client (email)
1 - Project File

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INTRODUCTION

Project Description

This report presents results of a bluff study performed for a proposed future construction at 4677 Via Roblada in the Hope Ranch area of Santa Barbara County, California (see Vicinity Map in Appendix A). Current plans indicate that the proposed future construction will include a new residence with a basement.

Purpose and Scope of Work

The purpose of the bluff study that led to this report was to analyze the soil/bedrock conditions at the project site and to provide bluff study recommendations for design and construction. The soil conditions include surface and subsurface soil types, soil expansion potential, soil strength, slope stability, and the presence or absence of subsurface water. The scope of work included:

- Reviewing historical stereographic aerial photographs of project site.
- Performing a reconnaissance of the project site.
- Drilling, sampling, and down-hole logging two bucket-auger borings to study bedrock, soil, and groundwater conditions.
- Laboratory testing soil samples obtained during the subsurface exploration to determine their physical and engineering properties.
- Analyzing the data obtained.
- Preparing this report.

Site Setting

An existing residence currently occupies the project site. The area surrounding the existing residence is covered by landscaping (planters, lawns, and trees) and hardscaping (walkways and driveways). There is a descending slope (sea cliff or bluff) located about 130 feet south of the existing residence. This descending slope is about 130-foot high and ranges in slope gradient from about 0.7- to 4- horizontal versus 1-vertical.

The geographic coordinates of the proposed future construction are 34.4173° North Latitude and 119.7849° West Longitude.

AERIAL PHOTO REVIEW

An aerial photograph study was performed by Dr. Larry Gurrola (subcontracted geologist) on July 13-14, 2022. The following aerial photographs were reviewed for the subject property:

<u>Date</u>	<u>Flight and Frame Numbers</u>	<u>Scale</u>
1928	C-311 C-Section: A5, A6	18,000
1929	C-430: A8, A9	24,000
1938	C-4950: SF-39, SF-40	1938
1943	BTM-1943: 4B-190, 4B-191	20,000
1944	C-9113: 6-53, 6-54	7,200
1953	GS-YO: 2-112	37,400
1954	BTM-1954: 6K-118, 6K-119	20,000
1956	HA-AN: 1-38, 1-39	9,600
1957	HA-BY: 87, 88	4,200
1961	BTM-1961: 7BB-65, 7BB-66	20,000
1962	HA-OI: 85, 86	12,000
1964	HB-VX: 70, 71	12,000
1965	HB-FV: 88, 89, 90	6,000
1968	HB-LC: 45, 46	12,000
1968	HB-LI: 45, 46	12,000
1969	HB-QD: 17, 18	12,000
1971	HB-SJ: 14, 15	12,000
1973	HB-WL: 40, 41	12,000
1975	HB-XQ: 11, 12	12,000
1992	PW-SB-8: 5 (non-stereo)	24,000
1997	PW-SB-10: 10 (non-stereo)	24,000
2001	CCC-BQK-C: 72-8 (non-stereo)	12,000

Google Earth images dated: 2002-2019, 2020-2022.

California Coastline images dated 1972, 1979, and 1987.

The aerial photographs listed in Table 1 were supplemented with Google Earth, California Coastline images, and County of Santa Barbara GIS Mapping tool. The use of stereo and non-stereo aerial photographs permits observation and evaluation of the site conditions for the last 95-year time period, landslide mapping, estimation of erosion and bluff retreat. In addition, the performance of the subject slopes was evaluated following both above average and below average rainfall seasons.

A mirrored stereoscope with 3X magnification was used to view aerial photographs for the subject property in 3-D and to map areas of instability on the subject slopes. Areas of instability such as flows, rock falls, rock topples and slides, in addition to development history of the site vicinity were recorded.

The subject property is situated on an elevated marine terrace (bench feature) where the southern portion of the property forms a coastal sea cliff slope. The sea cliff forms a sub-vertical, approximately 130-foot high, bluff slope that descends to the beach. The relatively flat terrace exhibits a topographic step with a slightly higher ground surface on the landward side and this topographic step is likely a paleo beach shoreline and buried sea cliff.

The bluff slope was mostly absent of vegetation and a gully was present at the top of bluff in the earliest 1920's aeriels. In this period, the elevated terrace area and surrounding vicinity was mostly undeveloped except for the Via Roblada roadway. A few trees were present on the bluff top and a few small gullies on the bluff face in the late 1930's. The eastern portion of Via Roblada (east of the subject site) was developed but the subject property appears to be cultivated for agriculture. The gullies were apparently the result of runoff from the agricultural field.

Agricultural activities continued and were observed on the subject property in the 1940's and 1950's period. An orchard was observed on the higher terrace and a grass field observed on the lower, seaward terrace. A drainage ditch was observed on the lower terrace that apparently drained the fields and directed runoff to the west to a drainage ditch along the west property line. The bluff face remained mostly free of vegetation suggesting the face was actively spalling. The lower terrace was cultivated into small rectangular fields in the late 1950's. Also, an elongate landslide was observed on the eastern portion of the bluff face and embayments formed at the top of bluff appear to be result of active spalling of the bluff face and small rock topples and shallow slides.

A topographically low area which was drained by a former drainage ditch has formed a small area where runoff has collected in 1961 and this area was scarified and graded in 1962, no longer forming a topographic depression. The eastern top of bluff appeared embayed or "scaloped" by recent erosion indicating that shallow slides or rock topples recently occurred in

1967. The western top of bluff appeared embayed in 1968 with recent shallow, rockslides that occurred near the upper portions of the bluff. A small debris cone that was partially vegetated and present on the beach indicated rockslides or topples had occurred in 1969.

The residence on the subject property was observed in 1973 and a swath of ground along the bluff top was grubbed with some grasses and shrubs remaining. The eastern portion of the bluff face was thickly vegetated, however the top of bluff is highly embayed indicating that erosion along occurred in 1987. Evidence of rock falls and topples from near the upper bluff slope was observed in the 1990's to 2000's. Retreat of both headlands and embayments occurred at the top of bluff from about 2011 to 2019, and this period, a few feet to several feet of bluff retreat was estimated.

It is noted that deep seated, large landslides where significant portions of the bluff slid or failed were not observed over the course of the last 95 years. Most of the landslides appear to be rock topples, shallow rockslides, and spalling of the bluff face. A few of the rockslides from the upper portion of the slope appear to have entrained rock materials from the lower slope, and some of these slides and topples produced small debris cones at the base of the slope. Areas immediately above the topples and slides subsequently became over steepened, and ultimately collapsed shortly thereafter.

Large scale stereo pair aerial photographs dated 1944 were used as a base reference measurement for the estimation of bluff retreat for the last 78 years. A field survey was performed in 2022 and these data were used for the calculated rate of bluff retreat. The rate of retreat is discussed in detail in the Rate of Retreat section.

SOIL/BEDROCK AND GROUNDWATER CONDITIONS

In Borings BA-1 and BA-2, Earth Systems encountered a veneer of soil (about 2 feet in thickness, comprised of silty sand) overlying marine terrace deposits (about 14 feet in thickness, comprised of interbedded sand, silt, and clay), which is underlain by Monterey Formation bedrock (comprised of siltstone, mudstone, and shale).

Testing indicates that anticipated bearing soils lie in the "Very Low" expansion range based on a measured expansion index of 15, although layers of expansive soil/marine terrace were observed during logging of the borings to depths representing the depth of the proposed basement. A version of this classification of soil expansion is incorporated into a Minimum Foundation Design Table, which is included in Appendix C of this report. It appears that soils can be cut by normal grading equipment.

Groundwater was not encountered in either boring BA-1 or BA-2 to a maximum depth of about 71 feet below the existing ground surface. It should be noted that fluctuations in groundwater levels may occur because of variations in rainfall, regional climate, and other factors.

GROSS (GLOBAL) SLOPE STABILITY

Slope stability analyses were performed for Section A-A' shown on the Site Plan/Geologic Map in Appendix A. Section A-A' is believed to be representative of the critical slope condition (height and gradient) for descending slope on the south side of the project site.

Strength Parameters

The unit weights, ultimate shear strengths, and peak shear strengths of the marine terrace deposit (Qt) and Monterey Formation bedrock (Tm) for the slope stability analyses were selected based on results of laboratory testing on samples that were obtained from the project site. The direct shear tests were performed with the samples saturated. The shear data were composited to determine the average shear strength parameters of the relatively undisturbed samples of Monterey Formation bedrock that were tested.

The residual shear strengths of the Monterey Formation bedrock were determined by utilizing a chart developed by Timothy D. Stark; Hangseok Choi; and Sean McCone (May 2005). Using a liquid limit of 93 and a clay fraction of 46.7% (tested from a Monterey Formation bedrock's weak bed sample collected during field exploration), a residual friction angle of 9 degrees with zero cohesion was determined.

Ultimate shear strength parameters were used in the analyses of static conditions, while peak shear strength parameters were used in the analyses of seismic (earthquake, pseudostatic) conditions. Residual shear strength parameters were used in both static and seismic conditions.

Results of the composite shear strength graphs are included in Appendix B. The composited results are summarized in the following table:

Unit	Unit Weight (pcf)	Cohesion (psf)	Friction Angle
Marine Terrace Deposit (Ultimate)	113 (Moist)	0	30
Marine Terrace Deposit (Peak)	113 (Moist)	0	31

Monterey Formation Bedrock (Ultimate)	95 (Moist)	329	34.4°
Monterey Formation Bedrock (Peak)	95 (Moist)	1,021	32.4°
Monterey Formation Bedrock (Residual)	95 (Moist)	0	9°

The ultimate strength parameters for the section shown above yielded a safety factor of smaller than 1.0 under static condition, which intuitively is incorrect because the slope is actually stable, see Appendix D. Hence, it appears that the ultimate strength parameters do not reflect the in-situ condition at the project site.

Consequently, Earth Systems performed back-calculations on ultimate shear strengths to determine strength parameters that yield a safety factor of at least 1.0. These values represent the minimum of potential strength values. The following table presents strength parameters determined, and that are used in the slope stability analyses that follow. It should be noted that because the back-calculated ultimate shear strengths for the marine terrace deposit are higher than the originally composited peak shear strengths, the peak shear strengths used in the analyses were increased to be identical to the back-calculated ultimate shear strengths.

Unit	Unit Weight (pcf)	Cohesion (psf)	Friction Angle
Marine Terrace Deposit (Ultimate)	113 (Moist)	100	34°
Marine Terrace Deposit (Peak)	113 (Moist)	100	34°
Monterey Formation Bedrock (Ultimate)	95 (Moist)	515	35°
Monterey Formation Bedrock (Peak)	95 (Moist)	1,021	32.4°
Monterey Formation Bedrock (Residual)	95 (Moist)	0	9°

Slope Stability Analyses Criteria

The stability of Section A-A' was analyzed using the SLIDE2 program for anisotropic material with circular and planar types of failures because Monterey Formation bedrock's apparent dip for Section A-A' is calculated to be about 42 degrees along the slope. Hence, along bedding failures should be considered. Spencer's method was used to analyze the slope. Approximately 112,200 circular-type and 50,000 planar-type failure surfaces were analyzed during each solution.

A seismic coefficient of 0.15 g was used for the pseudostatic analyses performed, and a minimum safety factor of 1.10 is required by the County of Santa Barbara. For gross static stability, the County of Santa Barbara requires a minimum safety factor of 1.50.

Results of Slope Stability Analyses

The slope stability plots and printouts are included in Appendix D. The following table summarizes the minimum safety factors that were computed for gross (global) stability analyses of Section A-A' using the back-calculated shear strengths mentioned earlier:

Cross-Section Analyzed	Case	Minimum Safety Factor
A-A'	Static, Circular	1.018
A-A'	Seismic, Circular, $k=0.15g$	1.057
A-A'	Static, Planar	1.008
A-A'	Seismic, Planar, $k=0.15g$	1.056

Failure surfaces with safety factors less than 1.50 (for static conditions) and 1.10 (for seismic conditions) were found. The unacceptable failure surfaces reached into the property pad to a maximum distance of about 117 feet behind the top of slope, which is considered the slope stability setback line. See Site Plan/Geologic Map in Appendix A.

BUILDING CODE SETBACK

The foundation system the proposed future construction should satisfy the minimum setback clearances from descending slopes in accordance with Section 1808.7 of the 2019 CBC. Because this slope appears to be steeper than 1H:1V, any inhabited structures should be setback from the top of slope a distance equal to the full height to the slope divided by three ($H/3$), measured from an imaginary plane projected from the toe of the slope at an angle of 45 degrees from vertical. In general, when adjacent slopes are steeper than 3-horizontal versus 1-vertical, foundations should be setback from descending slopes by a distance equal to the slope height divided by three ($H/3$). The setback from descending slopes should not be less than 5 feet and need not exceed 40 feet. See the Slope Setbacks for Foundations on or Adjacent to Slopes in Appendix C. Because the slope on the southwest side of the project site appears to have a height of about 130 feet, a building code setback of 40 feet will be needed.

RATE OF RETREAT

An analysis of the rate of retreat was performed to determine the amount of bluff retreat of the southern slope of the subject property. The analysis was performed along two survey transects located within the property limits and the transect with the highest amount of retreat was used to calculate a rate of retreat. It is necessary to utilize the same geographic reference point to accurately determine the amount of retreat that has occurred for a given time period, in this case, 78 years. Horizontal distances were measured from the geographic reference points to the top of bluff along the survey.

The earliest measurements of the distance to top of bluff on the eastern side of the property were made on large scale 1944 aerial photos and a field survey was performed in November 2022. Therefore, the amount of bluff top retreat was estimated for a 78-year period between 1944 and 2022.

Utilizing the distance to the bluff top in 1944 photos as a base reference and utilizing the field measurements, the estimated total amount of retreat from 1944 to 2022 is approximately 38.5 feet which is rounded up to 39 feet. Therefore, the long-term rate of retreat for the eastern survey is approximately 0.50 feet per year (6 inches per year). It is well established that bluff retreat is episodic in nature and does not occur on an annual basis, that is, 6 inches of retreat every year (Johnson, 2003). Rather, bluff retreat occurs episodically, which results in a few feet to several feet of the bluff top lost due to erosion, rock topples, and slides. The total amount of bluff retreat is measured for a specific time period and divided by the time period that the retreat occurred to establish an average rate of retreat. This rate of retreat is applied to the County of Santa Barbara's 100 year required development setback from the top of bluff, that is the rate of retreat is multiplied by 100 years to determine the required erosion setback.

Based on a rate of retreat of 0.50 feet per year, the estimated amount of retreat of the subject property in 100 years is 55 feet. However, we anticipate that the construction of new home will require $2\frac{1}{2}$ years to build, so $2\frac{1}{2}$ years is added to the 100 years development setback which equals $102\frac{1}{2}$ years for the development setback. Therefore, a rate of retreat of 0.5 feet per year multiplied by $102\frac{1}{2}$ years equals 51.25 feet which is rounded up to 52 feet.

The estimated amount of 52 feet of retreat in 102 ½ years does not account for accelerated rates of bluff retreat due to sea level rise. The following section presents the analysis that accounts for accelerating sea level rise and estimates the increased rates of bluff retreat in Santa Barbara for the next 100-year period.

SEA LEVEL RISE AND RATE OF RETREAT

Due to climatic changes over the past 100 years, average worldwide sea level has been rising approximately 1 to 2 millimeters per years since the end of the “Little Ice Age” in the 19th century (USGS, 2000 and Douglas, 1995). This rise is not globally uniform and there is considerable debate regarding the accuracy of predicted future sea level changes. However, there is general scientific consensus that sea levels will rise at an accelerating rate in the coming decades. A recently adopted California Coastal Commission guidance document, the “Sea Level Rise Policy” dated November 7, 2018 contains future sea level rise projections under various time scales and risk scenarios, which were developed in a 2017 report by the California Ocean Protection Council under direction of the State of California (OPC, 2017).

For Santa Barbara (see Table G-8 in Appendix E), the projected sea level rise (SLR) at the year 2100 is 3.1 feet in the “Low Risk Aversion” category, which is defined as 17 percent likely that sea level rise will exceed the 3.1 feet estimate. In the “Medium – High Risk Aversion” category, an estimate of 0.5 percent probability that sea level rise will be higher than 6.6 feet at the year 2100. The 2018 state guidance recommends that the “Medium-High Risk” category be used for establishing setbacks for residential development given the uncertainty of the sea level rise projections, the limitation of adaptation options, and the potential risk to life and property. The sea level rise projections are presented in 10-year increments (see Table G-8 in Appendix A) and have utilized this data for 20 year “periods” to estimate accelerated rate of sea cliff retreat, as described below.

Projected Coastal Bluff Retreat

The future rate of coastal bluff retreat is estimated by application of a percentage increase to the site-specific historical retreat rate shown in Appendix B, estimated as described above, based on the increase in the rate of bluff retreat determined by the U.S. Geological Survey’s Coastal Storm Modeling System also known as CoSMoS. This widely recognized model simulates coastal hazards that predicts ocean wave data input, storm surge, tides, and sea level rise.

The CoSMoS model (current version is CoSMoS 3.0) includes a shoreline hazard map with various historic and projected bluff edge retreat rates at noted transect locations. The transects with numerical identifiers are separated roughly 300 feet horizontally along the coastline in the Hope Ranch area. The CoSMoS transect number 4061 is located within the subject property limits near the eastern property line. The aerial photography rate of retreat transect line presents the increase of bluff retreat based on various amounts of sea level rise (see Appendix B). The data for this transect lists the historical sea cliff retreat rate at 0.19738 meters per year (0.65 feet per year). The reported CoSMoS historical retreat rate is based on the USGS's evaluation of historic regional topographic maps and regional aerial imagery (Hapke and Reid, 2007). This retreat rate uses 19th century coast surveys and early 1928 aerial photos that typically have a degree of error associated with them due to spatial distortions and surveys were based on outdated coordinate systems. This is the reason that site specific surveys are performed to estimate a site specific rate of retreat, in this case, 0.5 feet per year for the subject property.

The California Coastal Commission (CCC, 2018) "Sea Level Rise Policy Guidance" projections for the Santa Barbara area are used in conjunction with the CoSMoS projections. The CACC guidance projects the upper limit of sea level rise to be 1.1 feet (0.34 meter) at year 2040 under the "Medium-High Risk Aversion" category (see Table G-8 in Appendix A). The CoSMoS model at transect number 4061 (see Appendix B) shows that for a sea level that has risen by 0.25 meter (the closest value to the 0.34 meter rise projected at 2040 by the 2018 CACC document), the sea cliff retreat rate is by that time forecast to increase to 0.23931 meters per year (1.1 feet per year). The comparison of the projected future CoSMoS retreat rate at 2040 to the historical CoSMoS retreat rate (.239 m/yr minus .197 m/yr) shows an increase rate of retreat equivalent to 0.042 m/year. An increase from 0.19757 m per year to 0.239 m per year (0.042/0.197) is equivalent to a 21.3 percent increase in the CoSMoS model retreat rate. The increase of 21.3% is then applied to the site-specific historical retreat rate of 0.55 ft/year to derive a new retreat rate of 0.67 feet per year. The new retreat rate for the 17 year period from 2023 to 2040 is calculated to be 10.4 feet which is the estimated amount of retreat due to sea level rise for this time period. The percentage increase of the rate of retreat for the subsequent 20-year period from 2040 to 2060 is estimated to be 56.9% and percentage increase for the 2060 to 2080 period is 201%.

Since there is considerable debate among scientists of the predicted amount of sea level rise and associated increase in the bluff erosion rate, we use the conservative yet reasonable

percentage increase of 201% for the remaining period from year 2080 to 2025½. The incremental changes in sea level (CACC, 2018) at Santa Barbara and the corresponding sea cliff retreat rate percentage change we use in our analysis are summarized in the following matrix. Also included is the incremental percentage change in retreat rate applied to the site-specific historical retreat rate and the resulting total horizontal cliff edge retreat for the noted time period increment.

Applying the site-specific historical retreat rate of 0.50 feet/year for the subject property and accounting for predicted sea level rise, the total estimated amount of retreat for the next 102 ½ years is approximately 92 feet.

CoSMoS Historical Retreat Rate (baseline) = 0.19738 meters per year (=0.65 feet per year) for CoSMoS Site specific rate of retreat = 0.50 feet per year. Transect Station 4061 located on the subject property: 4677 Via Roblada, Santa Barbara.					
Time Increment (Years)	Change in Sea Level (meters/feet) CACC Medium- High Risk Aversion	Percentage Increase in Retreat Rate from CoSMoS Historical Rate	Site Specific Historical Retreat Rate (ft/year)	Projected Average Site Specific Annual Retreat Rate (ft/year)	Incremental Estimated Retreat (feet)
2023-2040 (17 years)	0.34 m (1.1 ft)	21.3%	0.50	0.61	10.4
2040-2060	0.76 m (2.5 ft)	56.9%	0.50	0.78	15.6
2060-2080	1.31 m/ 4.3 ft	201.0%	0.50	1.0	20.0
2080-2100*	1.31 m/ 4.3 ft	201.0%	0.50	1.0	20.0
2100-2120*	1.31 m/ 4.3 ft	201.0%	0.50	1.0	20.0
2120-2125½ *	1.31 m/ 4.3 ft	201.0%	0.50	1.0	5.5

* We use the estimated percentage increase of the 2060 -2080 time period for the period from 2080 to 2125½ for the estimated amount of retreat for the next 102½ years.

Total Retreat at year 2125 ½ = 91.5 feet = 92 feet

CONCLUSIONS AND RECOMMENDATIONS

Based on the established slope stability setback of 117 feet, the building code (Section 1808.7 of the 2019 CBC) setback of 40 feet, and the bluff retreat setback of 92 feet, it appears that the total cumulative setback from the bluff edge should be 209 feet, which is the summation of a slope stability setback of 117 feet and a bluff retreat setback of 92 feet. Any proposed future construction should be built northeast of this 209-foot setback zone. See Site Plan/Geologic Map in Appendix A.

The proposed basement is located approximately 109 feet from the closest potential slope failure surface with a factor-of-safety of 1.5 and the top of bluff is 117 feet from the same point. 1.5 is the minimum acceptable factor-of-safety. The basement is well beyond this potential failure surface. Hence, it has no influence on slope stability and will not change the location of the potential minimum factor-of-safety failure surface.

The lawn area in front of the proposed residence will be enclosed by a low wall that will retain a maximum of 3 feet of fill near the residence and about 2 feet of fill at the seaward limit of this area. The seaward limit of the enclosed area is about 80 to 90 feet from the top of bluff. In the area between the top of bluff and the enclosed area no fill will be placed, and the amount of cutting is limited in area and less than 0.5 feet in depth and can be ignored. We compared the volume of material captured by the minimum factor of safety (1.5) failure surface and estimate it to be about 9,980 cubic feet per lateral foot of bluff. The amount of fill added to the yard area is about 120 cubic feet per lateral foot of bluff. This equates to about a 1.2% increase in the weight of the potential slide mass. Although this would shift the minimum factor-of-safety line closer to the residence, that change is probably less than 2 feet and would not change the conclusion of our report with regard to slope stability.

The proposed basement will have no effect of bluff retreat caused by erosion because there is no relationship between the bluff retreat process and the existence of a basement over 200 feet from the top of the bluff. Nor will the thin veneer of fill placed in the yard between the residence and the top of bluff influence the geologic process of bluff retreat because there is no mechanistic relationship between the process and the fill.

The construction is not thought to have a negative impact on the current ground water regime. The proposed basement and service tunnels will be constructed with drains that will collect

excess groundwater and direct it to sumps so that it can be disposed of properly and, thereby, reducing any impact groundwater may have on erosion or stability.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

The analyses and recommendations submitted in this report are based in part upon the data obtained from the on-site borings. The nature and extent of variations between and beyond the points of exploration may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

The scope of services did not include any environmental assessment or investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater or air, on, below, or around this site. Any statements in this report or on the soil boring logs regarding odors noted, unusual or suspicious items or conditions observed, are strictly for the information of the client.

Findings of this report are valid as of this date; however, changes in conditions of a property can occur with passage of time whether they are because of natural processes or works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur whether they result from legislation or broadening of knowledge. Accordingly, findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of 1 year.

In the event that any changes in the nature, design, or location of the proposed future construction and/or other improvements are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing.

This report is issued with the understanding that it is the responsibility of the Owner, or of his representative to ensure that the information and recommendations contained herein are called to the attention of the Architect and Engineers for the project and incorporated into the plan and that the necessary steps are taken to see that the Contractor and Subcontractors carry out such recommendations in the field.

As the Geotechnical Engineers for this project, Earth Systems has striven to provide services in accordance with generally accepted geotechnical engineering practices in this community at this time. No warranty or guarantee is expressed or implied. This report was prepared for the exclusive use of the Client for the purposes stated in this document for the referenced project only. No third party may use or rely on this report without express written authorization from Earth Systems for such use or reliance.

It is recommended that Earth Systems be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications. If Earth Systems is not accorded the privilege of making this recommended review, it can assume no responsibility for misinterpretation of the recommendations contained herein.

BIBLIOGRAPHY

California Building Standards Commission, 2019, California Building Code, California Code of Regulations Title 24.

California Coastal Commission, 2018 "Sea Level Rise Policy Guidance," Science Update adopted – November 7, 2018

California Ocean Protection Council, 2017, "Rising Seas in California: An Update on Sea Level Rise Science," April 2017.

County of Los Angeles Department of Public Works, 2013, Manual for Preparation of Geotechnical Reports, July 1.

Dibblee, Jr., Thomas W., and Helmut E. Ehrenspeck, 1987, Geologic Map of the Goleta Quadrangle, Santa Barbara County, California, Dibblee Foundation Map No. DF-07.

Douglas, B.C.: 1995, Global Sea Level Change: Determination and interpretation, Revs. Geophys. (supp.), pp. 1425-1432.

NOAA, 2006, "Mean Sea Level Trend, 9410660 Los Angeles, California," http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=9410660.

Norris, R.M., 1995, "Southern Santa Barbara County, Gaviota Beach to Rincon Point," in "Living with the California Coast," Duke University Press.

United States Geological Survey (USGS), 2009, Geological Map of the Santa Barbara Coastal Plain Area, Santa Barbara County, California.

United States Geological Survey (USGS), 2014, "Coastal Storm Modelling System (CoSMoS)," for the Southern California Bight, Version 3.0.