Attachment M

GEOTECHNICAL AND GEOLOGIC INVESTIGATION

Proposed New Residence
Vacant Lot on Arbor Lane
APN# 037-123-430
Moss Beach, San Mateo County, California

Prepared for:
Carlos Zubieta Architect
Attn: Carlos Zubieta

July 6, 2016

Attachment M

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July 6, 2016
Job No. 16-4572

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Re: Geotechnical and Geologic Investigation
Proposed New Residence
Vacant Lot on Arbor Lane
APN# 037-123-430
Moss Beach, San Mateo County, California

Dear Mr. Zubieta:

As authorized, we have completed geotechnical and geologic investigations at the site of the planned new residence on the currently vacant lot (APN #037-123-430) on Arbor Lane in Moss Beach, San Mateo County, California. The property is referred to as 199 Arbor Lane on various documents.

The purpose of our study was to provide general geotechnical recommendations and design criteria related to the new residence that is planned at the property. We have also evaluated the geologic setting, as the site is located within a complex geologic area where active ocean bluff retreat is occurring immediately west of the property and a strand of the Seal Cove (San Gregorio) Fault is located immediately offshore west of the site. The primary geologic hazard to the site is coastal bluff retreat. In our opinion, the project is feasible from a geologic and geotechnical viewpoint, provided that the recommendations contained in the report are incorporated into the final plans and followed during construction.

As will be discussed in the accompanying report, it is our basic conclusion that the site is located adjacent to a coastal bluff that has been impacted by bluff erosion which has occurred historically at a reported average rate on the order of 1.25 feet per year (as measured between 1866 and 1971 by Griggs & Savoy, 1985). However, our re-analysis of the published bluff retreat rate as well as further analysis of subsequent aerial photographs, results in our conclusion that a more reasonable average retreat rate is about 0.8 feet per year. The measured average rates of bluff retreat and resulting estimate of bluff retreat impact to the proposed residence are discussed within the body of this report.

We are pleased to have been of service to you on this project, and will be available to review our findings with you and your other consultants at the earliest convenience.

Very truly yours,
MICHELUCCI & ASSOCIATES, INC.

John Petroff Staff Geologist	David F. Hoexter Certified Engineering Geologist #1158 (expires 11/30/17)	Joseph Michelucci Geotechnical Engineer #593 (expires 3/31/17)

REGISTERED PROFESSIONAL ENGINEER JOSEPH M. MICHELUCCI No. GE 000593 Exp. 3/31/17 GEOTECHNICAL STATE OF CALIFORNIA

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GEOTECHNICAL AND GEOLOGIC INVESTIGATIONS

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INTRODUCTION

This report addresses the geotechnical and engineering geologic conditions that occur at the site of the planned new residence on the vacant lot on Arbor Lane (APN# 037-123-430) in Moss Beach, San Mateo County, California (Site Vicinity Map, Figure 1). The property is referred to as 199 Arbor Lane on some documents.

A Regional Geologic Map of the site area is presented as Figure 2. It is noted that the site is located within a sensitive geologic area where bluff retreat/erosion is affecting the cliffs west of the property, and the site is also located within close proximity to a strand of the active Seal Cove (San Gregorio) Fault.

The purpose of our study was to evaluate the soil and geologic conditions that occur at the site, and if found geologically feasible, to provide geotechnical recommendations and design criteria pertaining to building foundations, site grading, retaining walls, drainage, and other items that relate to the site soil and geologic conditions. An overview of the property, including the location of test borings performed in conjunction with our study, is included on the attached Site Plan/Engineering Geologic Map, Figure 3.

DESCRIPTION OF PROJECT

We understand that future development plans will call for the construction of a new 2-story residence. We understand that a reinforced concrete slab-on-grade floor is desired.

SCOPE OF SERVICES

Our study included:

1. Detailed site inspections by our geotechnical and geologic personnel;

2. A review of our files for other projects our firm has completed in the site vicinity;

3. A review of preliminary architectural drawings by Carlos Zubieta Architecture, depicting a plan view of the proposed new residence;

4. Discussions with the architect Carlos Zubieta;

5. A review of available published geologic maps and literature;

6. Stereoscopic interpretation of aerial photographs taken between 1941 and 2005; evaluation of bluff retreat in the site vicinity;

7. The excavation of 3 exploratory test borings with a truck mounted drill rig;

8. The recovery of samples from the borings, and the performance of a variety of engineering tests upon the various soil layers encountered;

9. The performance of engineering geologic and geotechnical engineering analysis utilizing the above items; and,

10. The preparation of this report.

FIELD INVESTIGATION AND LABORATORY TESTS

In order to evaluate the geotechnical engineering characteristics of the soil layers which underlie the site, 3 borings were drilled at the approximate locations indicated on the attached Figure 3. The borings were drilled by Hew Drilling of Palo Alto on April 20, 2016, with hollow stem augering equipment. Relatively undisturbed samples were recovered in thin brass tubes from the borings at selected intervals with a free-falling, 140-pound automatic hammer advancing modified California, and in some cases standard penetration, drive samplers 18 inches into the subsurface soil layers. The brass tube encased samples were labeled in the field and carefully sealed to preserve their in-situ moisture content.

As the borings were excavated, logs of the materials encountered were prepared based upon an inspection of the recovered samples and auger cuttings. The final Boring Logs, as presented on the attached Figures 4 through 6, are based upon the field logs with occasional modifications made upon further laboratory examinations of the recovered samples and laboratory test results.

Laboratory tests were performed upon samples that were extruded from the brass tubes. These tests, which are useful in evaluation of the general strength properties of the materials tested, including the determinations of moisture content, dry density and unconfined compressive strength of selected samples. The results of these tests, along with the resistance to penetration of the sampler, are listed opposite the corresponding sample location on Figures 4 through 6. A Boring Log Key is also included as Figure 7.

We also performed a plasticity index test upon a representative near surface sample from Boring 3. The result of this test, which is useful in evaluating the shrink/swell properties of the soils, is included on Figure 8.

SITE CONDITIONS

The site is located on an elevated bluff adjacent to the Pacific Ocean in Moss Beach, in unincorporated San Mateo County, California. The subject property is accessed at the southeast corner of the cul-de-sac ending of Arbor Lane. It is irregularly shaped and comprises approximately 0.32 acres. The site is essentially flat lying and is bound by a slope down to Dean Creek, an ephemeral creek channel along the south side, and by Fitzgerald Marine Preserve, a natural wildlife preserve to the west and northwest. It should be noted that the subject property does not extend directly to the ocean bluff; an intervening lot extending from the termination of Arbor Lane, reportedly owned by the neighborhood association, is situated between the subject lot and the ocean bluff/beach.

An approximately 35 to 40 foot tall near-vertical bluff exists along the west side of the preserve, and the beach is at the base of the bluff. The slope at the ocean bluff is inclined at approximately 0.53 to 1.0 (feet to feet horizontal to vertical), equivalent to 189 percent at the location of Cross Section A-A' (Figure 9). The maximum ocean bluff slope is approximately 0.2 to 1.0 (feet to feet horizontal to vertical), equivalent to 490 percent. The southerly slope adjacent to the drainage is inclined at approximately 1.56 to 1.0 feet to feet (horizontal to vertical) at the location of Cross Section B-B' (Figure 10), equivalent to 64 percent; and 2.2 to 1.0 feet to feet, equivalent to 46 percent, at the location of Cross Section C-C' (Figure 11).

The topography in the area to be developed with the proposed residence is generally level. Presently, the lot is covered with seasonal low-lying grasses and brush.

There are also two wells that were previously installed on the north end of the property. Well #1 was reportedly completed to approximately 200 feet and the deeper well (Well #2) reportedly extends 550 feet below grade (California Department of Water Resources (CDWR), Well Drillers Log, 1998).

REGIONAL GEOLOGIC SETTING

The site is located within the central region of the Coast Ranges Geomorphic Province, which extends from the Oregon border south to the Transverse Ranges. Sub-parallel, northwest trending mountain ranges and intervening valleys characterize the general topography. The region has undergone a complex geologic history of sedimentation, volcanic activity, folding, faulting, uplift and erosion. The Santa Cruz Mountains are located northeast of the site; the Pacific Ocean is located to the west

The site is located within the Montara Mountain 7.5' Quadrangle. A California Geological Survey (CGS) Seismic Hazard Zone Map has not (to date) been prepared for this quadrangle. The site is not located within a CGS Fault Rupture Hazard Zone.

SITE GEOLOGY

The geologic setting of the site area is shown on the attached Regional Geologic Map, Figure 2. As indicated on Figure 2, the site vicinity is primarily underlain by Marine Terrace Deposits (Qmt) (Brabb, Graymer and Jones, 1998; Pampeyan, 1994). These sediments are commonly poorly to moderately consolidated marine, eolian (wind deposited), and alluvial sand, silt, gravel and clay in various proportions and combinations, in distinct to indistinct lenses and beds, and are commonly as much as 40 to 50 feet thick; based on visual observation of the adjacent bluff and on our exploratory borings, we estimate that these sediments are essentially flat-lying and on the order of 50 feet thick in maximum thickness at the site. The Marine Terrace Deposits are underlain by Purisima Formation sediments, consisting of thinly bedded and highly fractured siltstone, shale and sandstone. At greater depth are plutonic rocks known as the Montara Mountain Granite or Quartz Diorite.

The Well #2 drillers log that we reviewed indicates the presence of 5 feet of "topsoil" and apparent terrace deposits consisting of sand and clay and sand to a depth of 45 feet; underlain by gray clay with shells and gray sand to a depth of 145 feet, likely the Purisima Formation; and thence by "granite" (Montara Mountain Granite/Quartz Diorite) to the total depth drilled of 550 feet.

A layer of beach sand mantles the Purisima Formation sediments between the shoreline and the base of the bluff. The occurrence of beach sand varies over the course of the year. Talus or bluff fall material is commonly present at the base of the bluff.

Some artificial fill was also placed in the area of the ephemeral creek channel along the south side of the property. The fill is of unknown origin and composition, although we did observe that there were cobbles and boulders present at the ground surface in the area of the fill.

The nearby Seal Cove Fault is discussed in the Seismic Setting section of this report.

AERIAL PHOTOGRAPHIC INTERPRETATION

Sixteen sets of aerial photographic stereo pairs taken between 1941 and 2005 were interpreted for this investigation. Imagery scales ranged from 1:7,200 to 1:24,000. The photos are referenced at the conclusion of this report. We also viewed and compared periodic imagery from the website NETRonline.com dating from 1946 through 2012.

Arbor Lane is not present in 1941. The site and nearby vicinity are the location of row crops. The ground surface is level, with a slight slope and thus drainage discharge to the northwest towards the ocean bluff. An incised drainage/ephemeral creek is immediately adjacent to the south. The creek bank adjacent to the site is exposed and slopes down to the creek channel; the slope exhibits minor slumping and sloughing of soil but not landsliding or active bluff retreat. The western ocean bluff is near vertical near the subject site with exposed sedimentary bedrock along the beach in the adjacent tidal zone. The adjacent offshore bedrock sedimentary syncline, located in the surf zone, is visible. There are no landslides or rotational failures along the bluff; past bluff retreat appears to be due to periodic sloughing of relatively loose soil.

Subsequent imagery through 2005 indicates periodic sloughing/falling of soil from the exposed ocean bluff face both directly west of the site as well as to the north and the south. The imagery depicts The Strand, a road along the bluff to the south, as it is gradually undercut by ocean bluff retreat until no longer passable by 1969. The imagery also depicts bluff retreat adjacent to the three residences constructed between 1955 and 1969 off of Reef Point Road to the north.

Arbor Lane was constructed between 1969 and 1975, with five residences under or recently constructed near the subject site indicated on the 1975 images; the subject site remains vacant in 1975. Slope protection measures (shotcrete) have been instituted for the Reef Point Road residences. By 1976 there is apparent fill and a culvert near the beach immediately south of the site to convey the lateral drainage flow. The purpose of this fill and culvert is not evident, as there are no indications of erosion or bluff failure along the lateral drainage at this location which would necessitate placement of the fill.

A retaining wall is present by 1991 along the ocean bluff adjacent to the residence north of the adjacent Arbor Lane cul-de-sac (newly constructed in the 1976 imagery). This appears to be the wall which is currently present at this location.

In general, the subject site remains essentially unchanged during the period from 1941 through 2005 (and to the present). The sloping bluff to the south along the lateral drainage is subject to minor sloughing and erosion, and to a growth of dense vegetation, but the top of the bluff does not appear to retreat. However, the aerial imagery indicates periodic retreat of the bluff face and top adjacent to the beach to the west. The western ocean bluff retreat is further discussed in the following section of this report.

OCEAN BLUFF RETREAT

There are no indications of landsliding within or on property adjacent to the subject site. However, the adjacent bluffs to the south along the adjacent lateral drainage (to a minor degree) and to the west along the Pacific Ocean (to a much greater degree) are actively retreating by periodically sloughing along the exposed bluff face.

The southern ephemeral drainage bluff is covered with vegetation and mature trees, and it is not feasible to view the ground surface on aerial photographs. A comparison of the 1997 and 2016 site surveys indicates negligible/minor slope retreat, which, based on the general slope appearance in historic aerial photographs, is applicable to a longer period of time. The southern bluff retreat does not appear to be direct hazard to the proposed residence.

We observed indications of failure of the ocean bluff during the past winter, with debris from the slope present at the base of the slope and a bare "scar" on the bluff face at the location of the debris fall. The failure mechanism of the ocean bluff face appears to be undercutting of the relatively weak, unconsolidated bluff sediments by wave action at the beach level.

We identified one published calculation of average annual ocean bluff retreat at or near the site, prepared by Griggs and Savoy (1985). Griggs & Savoy, as shown on Figure 11.14, estimate an average rate of 15 inches **(1.25 feet) per year** over a 105-year period. This estimate is based on approximate measurements of the distance of prominent rocks shown on a 1866 Coast and Geodetic Survey map (and remaining to the present) to the base of the sea cliff, in comparison to the cliff location on a 1971 map (source of the map not indicated). We obtained a copy of the 1866 map, and measured the magnitude of bluff erosion at three locations adjacent to the subject site, using the current 2016 Google Earth image to compare with the 1866 map. Our three measurements were 144, 133 and 51 feet respectively for the three locations, corresponding to 0.96, 0.89, and 0.34 feet/year for the 150-year intervening period, an average of 109 feet **(0.73 feet/year)**.

We then compared the location of the top edge of the ocean bluff in 1946 and 2012, using downloaded scaled imagery purchased from the website NETR Online/Historic Aerials (http://www.historicaerials.com). We measured at two locations, with magnitudes of retreat of 14 and 26 feet. The average rate of bluff retreat for the 26 feet measurement within this 66 period was approximately **0.40 feet/year.**

We also compared the location of the bluff base as shown on 2005 stereo pair imagery supplied by Pacific Aerial Surveys of Oakland, California with the 1866 survey. Based on measuring from the center of the offshore rocks and from the eastern edge of the rocks, we measured bluff retreat of 80 and 108 feet, respectively, corresponding to average retreat rates of **0.58 and 0.78 feet/year.**

Based on the 2016 topographic survey of the site when compared to the earlier 1997 site survey, the bluff retreat at four representative locations from the north to the south was 8, 16, 12, and 6 feet, an average of 10.5 feet, corresponding to an average retreat rate of 0.55 feet/year.

The western property line is currently located about 30 feet at its closest point from the edge of the ocean bluff. Assuming the most conservative average bluff retreat rate (of Griggs & Savoy), 1.25 feet/year, we would project the bluff to retreat 30 feet to the western property line in approximately 24 years. At this rate, the ocean bluff would retreat to the western building setback line (an additional 30 feet) in approximately 48 years, and to the current closest point of the proposed residence, approximately 17 feet further inland, in approximately 14 additional years, resulting in bluff retreat at the maximum rate of 1.25 feet/year reaching the proposed residence in approximately 62 years.

However, in our opinion, this period of time (62 years), based on the Griggs and Savoy measurement, is unnecessarily conservative inasmuch as our calculations, based on the same 1866 survey as Griggs & Savoy, result in a lower average rate (0.73 versus 1.25 feet/year). Additional calculations based on aerial photographs and site-specific surveys, albeit for shorter periods of time, also result in lower average rates of retreat, ranging from 0.40 to 0.78 feet/year. Thus, the actual rate of retreat is likely to be slower. Utilizing an average retreat rate of 0.78 feet/year, which in our opinion is a more reasonable rate, the ocean bluff retreat would reach the western property line, western building setback line, and closest point of the proposed residence in approximately 38, 76 and 99 years, respectively.

Note that the calculated rates of bluff edge retreat are based on an assumption that the rate of retreat is constant. However, ocean bluff failures occur episodically and not uniformly through time. Therefore, the measured/calculated rates of retreat must be assumed to be indicative but not strictly representative of the long-term rates. Furthermore, any one-failure episode is likely to involve considerably greater retreat than the average. In other words, an individual failure episode may involve several feet of bluff edge retreat, followed by many years and even decades of no retreat.

We also qualitatively evaluated the ocean bluff seismic stability. A brief evaluation of the geologic literature suggests that ocean bluff failures have occurred along the San Mateo County coast during earthquakes, in particular the 1906, 1957 and 1989 San Francisco, Daly City and Loma Prieta events. The events appear to generally consist of "peeling" or "slumping" of bluff face material similar to undercutting by wave erosion, as opposed to circular or block glide type failures.

At the subject site, earthquake-caused instability would in our opinion be similar in scope to the periodic primarily winter wave undercut failures, and would likely "replace" or occur at the location of an imminent undercutting failure. Seismic bluff failure would thus be incorporated into as opposed to being additive to the long-term bluff retreat.

SEISMIC SETTING

The closest mapped major active fault zone to the site is the Seal Cove Fault Zone, the main active trace of which is located approximately 0.1 miles (0.2 kilometers) to the northeast. The Seal Cove Fault is the northern extension of the San Gregorio Fault, which extends at least to Monterey Bay on the south and northward into the Pacific Ocean west of San Francisco. The fault is well-defined west of the site where it offsets prominent Purissima Formation bedding. The fault is a minimum of 545 feet at its closest location from the site.

The major active trace of the San Andreas Fault is mapped approximately 9.0 miles (14.5 kilometers) also to the northeast. The Hayward Fault and the Calaveras Fault are located further to the northeast. The San Andreas, Seal Cove, Hayward and Calaveras Faults are all part of the major active San Andreas Fault System and the sources of numerous earthquakes which have impacted the San Francisco Bay Area and throughout California. It is highly probable that the site will experience very strong ground shaking in the future during a moderate to large nearby earthquake on one of these or additional active or potentially active faults that are a part of the San Andreas Fault System.

SOIL AND BEDROCK CONDITIONS

We excavated three test borings on the property at the approximate locations shown on the attached Figure 3. In general the materials encountered in the borings were very consistent. The only differences (and very slightly at that) were the depths to the various soil horizons at each boring location.

In Boring 1, The soil encountered in the uppermost 1 ½ feet was interpreted to be artificial fill (soil A) and consisted of soft to medium stiff dark olive brown fine sandy silty clay to clayey silt with rock fragments and rootlets. The fill was underlain by about 1 foot of native soil (soil B) consisting of medium dense very dark brown silty clayey fine to coarse sand with rootlets and weathered granite fragments. The native soil graded to medium stiff to stiff terrace deposits (soil C) consisting of dark yellowish brown to yellowish brown fine to coarse sandy silt to sandy clay with some fine to coarse sandy lenses. At about 6 ½ feet below grade, the terrace deposits were noted to be stiff to very stiff and consisted of mottled light yellowish brown fine to coarse sandy clay to sandy silt containing granite pebbles/fragments and fine to coarse sandy and silty clay lenses (soil D). At about 18 feet below grade, the terrace deposits graded to generally sandy material consisting of light yellowish brown silty fine to medium sand with yellow and yellowish brown mottling (soil E). The sandy terrace deposits extended to a depth of about 36 ½ feet below grade, where very moist, dense to very dense dark greenish gray silty fine to coarse sand containing scattered shale fragments and lenses of coarse sand and gravel was encountered (soil F). Boring 1 was terminated at 41-1/3 feet below grade where refusal was encountered in the dark greenish gray sandy material.

Boring 2, was the deepest of the three borings. As noted, the various soil horizons we encountered were similar to those encountered in Boring 1. In Boring 2, about 1-½ feet of soil A was encountered at the ground surface, which was underlain by about 2 ½ feet of soil B. Clayey terrace deposits (soil C) were encountered beneath soil B, which extended to about 6 ½ feet below grade. Sandier terrace deposits (soil D) were encountered beneath soil C, and at about 18 feet below grade, the terrace deposits grade to predominantly fine to coarse sandy deposits (soil E). At 40 feet below grade, the dense to very dense dark greenish gray sandy material was encountered (soil F). At about 50 feet below grade, we encountered material we are interpreting as Purisima Formation bedrock, which consisted of hard dark gray sandstone and shale; we should point out that this material strongly resembled the bedrock materials exposed on the beach and in the tide pools below the site immediately to the west. Boring 2 was terminated in the Purisima Formation material at a depth of 50-1/6 feet below grade.

Boring 3, was the shallowest of the three borings and was excavated within close proximity to the cul-de-sac ending of Arbor Lane. Again, similar materials were encountered in this boring. Artificial fill (soil A) extended to a depth of 1 ½ feet below grade, and native soil (soil B), which tested to be non plastic in expansion potential, extended to a depth of about 3 ½ feet below grade. Dense to very dense terrace deposits were encountered beneath the topsoil layer; the terrace deposits extended to the depth explored of 21-1/6 feet below grade.

Groundwater was encountered in Boring 1 at about 40 ½ feet below grade and in Boring 2 at about 49 feet below grade at the time of drilling. Based on our review of the available previously excavated well data, stabilized water in the deep well was measured at 38 feet after it was drilled. Groundwater levels, however, tend to fluctuate seasonally, and could rise to shallower depths in the future.

A plan of the general site features is included on Figure 5. For a more complete description of the soil and bedrock layers encountered in the borings, refer to the final Boring Logs included as Figures 4 through 6 and the Boring Log Key included as Figure 7. The results of our plasticity test on the near surface soil sampled in Boring 3 are included on the attached Figure 8.

CONCLUSIONS

Based upon our study, it is our opinion that the project can be developed as planned, provided that the recommendations contained within this report are followed. The primary geotechnical consideration involves the upper 2 to 4 feet of surface soil that was generally weak. This material, is compressible, and thus, consideration should be given to supporting the planned slab on grade floor on drilled reinforced concrete piers that gain support in the strong Marine Terrace Deposits that were encountered below the weak surface soils in our three test borings. In order to fortify the foundation and make it resistant to bluff retreat one day in the distant future causing a catastrophic failure consideration could be given to constructing deep drilled piers along the edge of the structure closest to the bluff and utilizing the slab and more conventional interior and perimeter piers as “tie backs”.

The primary geologic consideration is the rate of ocean bluff retreat, which, based on the most conservative calculated value of 1.25 feet/year, will result in the bluff edge retreating to the proposed residence location in approximately 62 years. However, based on recalculating the published retreat rate and measuring on additional imagery, we conclude that the bluff edge will retreat to the proposed residence location in approximately 99 years.

Specific recommendations follow.

RECOMMENDATIONS

The following recommendations are contingent upon our firm being retained to review the development plans and to observe the geotechnical aspects of construction.

A. Seismic Criteria Per 2013 CBC

As of January 1, 2014, the 2013 CBC is being utilized for projects in California. This new code is based upon the 2012 International Building Code.

It is our opinion that the subject site can be classified as Site Class "D" for the purpose of structural engineering calculations as defined in Section 1613 of the 2013 CBC.

B. Grading

In areas to receive new driveways, patios, or flatwork, the upper 2 to 3 feet of weak surface should be over-excavated exposing strong subgrade soil approved by our representative. The upper 4 to 6 inches of this soil contains organic matter; this material should either be hauled away or stored on the site for possible landscaping purposes. The subgrade should be scarified, brought to a moisture content that will allow proper compaction and then be compacted to a minimum degree of 90 percent, based upon ASTM D1557, latest revision. The existing soil that is free of organics may be recompacted (to a minimum degree of 95 percent) as engineered fill. Any areas to receive flatwork, pavements, or slabs on grade should also be underlain by at least 12 inches of select granular engineered fill (such as class II baserock). The select granular fill should be compacted to a minimum degree of 95 percent, based upon ASTM D1557, latest revision.

C. Drilled Piers

In our opinion the slab on grade should be structural in nature and supported upon drilled piers.

Drilled piers should be designed on the basis of a skin friction value of 500 psf beginning at the top of supporting material. In this case, the top of supporting material should be assumed to begin at a depth of 4 feet, or the top of the marine terrace deposits, whichever is deeper.

Pier depths should be based upon actual design loads. However, as a minimum, the piers should extend 8 feet below the top of supporting material. Therefore, it is anticipated that average pier depths will be on the order of 12 feet below existing grade.

We also suggest that voluntary consideration be given to deepening the piers along the perimeter of the structure that is closet to the bluff.

In addition to vertical loading, such "bluff' piers should be designed to resist a horizontal "creep" load equal to a fluid weighing 45 pounds per cubic foot, projected over 2-½ pier diameters. The load should begin at the ground surface and extend to a depth of 20 feet. The piers can resist the lateral load through a passive resistance of 350 pounds per cubic foot, projected over 2 pier diameters. The creep load could be transmitted to the interior piers through slab reinforcement. It is suggested that the structural engineer contact us during the design phase, so that a specific lateral load criteria can be developed for each pier location.

Reinforcing for the piers should be determined by the structural engineer based upon anticipated loading.

It is possible that water may accumulate in the pier excavations. Therefore, provisions for casing may be necessary. Any water that accumulates in the piers should be pumped out prior to concrete placement. Alternatively concrete may be placed by the "tremie technique".

D. Slab-On-Grade Construction

The slabs should be reinforced with steel bars and supported upon drilled piers. It is recommended that some type of moisture retardant be provided beneath the slabs. We have included a commonly used treatment on the attached Figure 12, however the project architect, or moisture control consultant should provide the final plan. This is critical as the piers could provide a capillary rise of moisture that could by pass conventional systems.

E. Surface Drainage

We recommend that the site be fine-graded to direct water to flow away from the building foundations. As a general requirement, storm water should not be allowed to pond or flow in concentrated streams or channels on the site. Such ponding or flows and the resulting saturation can weaken the soils and perhaps cause some minor site erosion.

It is further recommended that all roof downspouts be led into tightline disposal pipes that deposit water well away from building foundations and into a suitable disposal area, ideally the street gutter.

F. Review of Plans and Construction Observations

It is recommended that all of the plans related to our recommendations be submitted to our office for review. The purpose of our review will be to verify that our recommendations are understood and reflected on the plans, and to allow us to provide supplemental recommendations, if necessary.

It is important that our firm be retained to provide observation and testing services during construction. Our observations and tests will allow us to verify that the materials encountered are consistent with those found during our study, and will allow us to provide supplemental, on-site recommendations, as necessary.

LIMITATIONS

The conclusions and opinions expressed in this report are based upon the exploratory borings that were drilled on the site, spaced as shown on the Site Plan/Engineering Geologic Map, Figure 3. While in our opinion these borings adequately disclose the soil conditions across the site, the possibility exists that abnormalities or changes in the soil conditions, which were not discovered by this investigation, could occur between borings.

This study was not intended to disclose the locations of any existing utilities, septic tanks, leaching fields, hazardous wastes, or other buried structures. The contractor or other people should locate these items, if necessary.

The passage of time may result in significant changes in technology, economic conditions, or site variations that could render this report inaccurate. Accordingly, neither Carlos Zubieta Architect nor any other party shall rely on the information or conclusions contained in this report after 12 months from its date of issuance without the express written consent of Michelucci & Associates, Inc. Reliance on this report after such period of time shall be at the user's sole risk. Should Michelucci & Associates, Inc. be required to review the report after 12 months from its date of issuance, Michelucci & Associates, Inc. shall be entitled to additional compensation at then-existing rates or such other terms as may be agreed upon between Michelucci & Associates, Inc. and Carlos Zubieta Architect.

This report was prepared to provide engineering opinions and recommendations only. It should not be construed to be any type of guarantee or insurance.

Attachment M

REFERENCES

Aerial Photographs

Black and white (unless otherwise noted) vertical stereo pairs.

Source	Image ID	Date	Scale
Fair	6660-5/6	3/23/41	1:24,000
PAS-AV-	9-16-1/2	7/29/46	1:23,600
PAS-AV-	170-01-21/22	5/6/55	1:10,000
PAS-AV-	933-02-25/26	10/29/69	1:12,000
PAS-AV-	1188-01-27/28	4/28/75	1:12,000
Unk	28965-1/2	3/11/76	1:11,760
PAS-AV-	1356-01-15/16	6/2/77	1:12,000
PAS-AV-	2020-01-28/29	6/19/81	1:12,000
PAS-AV-	2265-01-27/28	6/6/83	1:12,000
PAS-AV-	2670-1-29/30	10/14/85	1:12,000
PAS-SMT-AV-	4075-1-17/18	7/2/91	1:12,000
PAS-SMT-AV-	4515-0201-7/8	8/27/93	1:12,000
PAS-AV-	4916-201-8/9	9/7/95	1:12,000
PAS-AV-	5434-201-6/7	6/23/97	1:12,000
PAS-AV-	6600-201-7/8	8/15/00	1:12,000
PAS-KAV-	9200-71-1/2	10/31/05	1:7,200

Fair – Fairchild Aerial Photography Collection, Whittier College
PAS - Pacific Aerial Surveys, Oakland, California
Unk – unknown
KAV - color

Consultant Reports and Correspondence

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Attachment M

SITE VICINITY MAP*

199 Arbor Lane

Moss Beach, San Mateo County, California

N

SITE

0 400' 800'

Scale

*BASE MAP FROM COUNTY OF SAN MATEO CADASTRAL TOPOGRAPHIC SERIES, SHEETS 9A, 1973, (REVISED 1-1-82).

Job No. **16-4572**	Michelucci & Associates, Inc.	Figure **1**

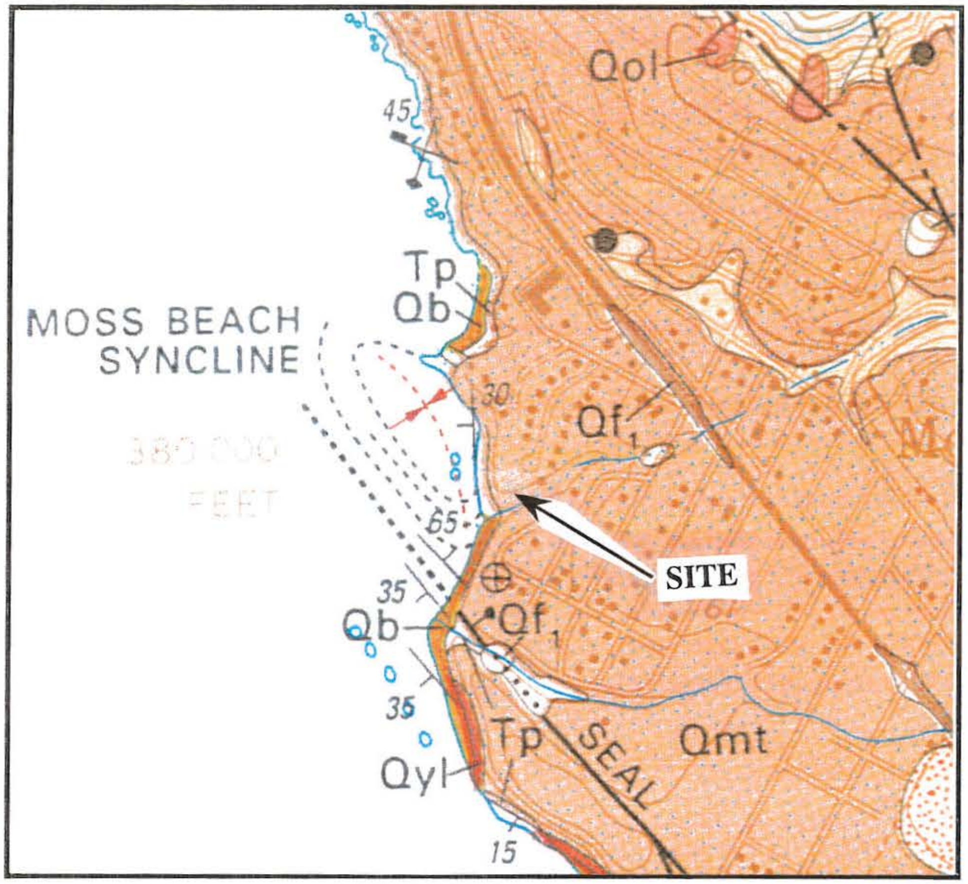
Attachment M

REGIONAL GEOPLOGIC MAP*

199 Arbor Lane

Moss Beach, San Mateo County, California

N



EXPLANATION

Surficial Deposits

- **Qf1** Artificial Fill (Unit 1)
- **Qyl** Younger Landslide Deposit
- **Qol** Older Landslide Deposit
- **Qac?** Coarse Grained Alluvium
- **Qsr** Slope Wash, Ravine Fill, and Colluvium
- **Qb** Beach Deposits
- **Qmt** Marine Terrace Deposits

Bedrock Deposits

- **Tp** Purisima Formation
- **Km** Granitic Rock Of Montara Mountain

Symbols

- Contact
- Fault (dashed where inferred, dotted where concealed, bar and ball on downthrown side)
- Photo-lineament
- 30 Strike And Dip Of Beds
- Syncline
- Borrow Pit
- Shallow Landslide
- Horizontal Beds

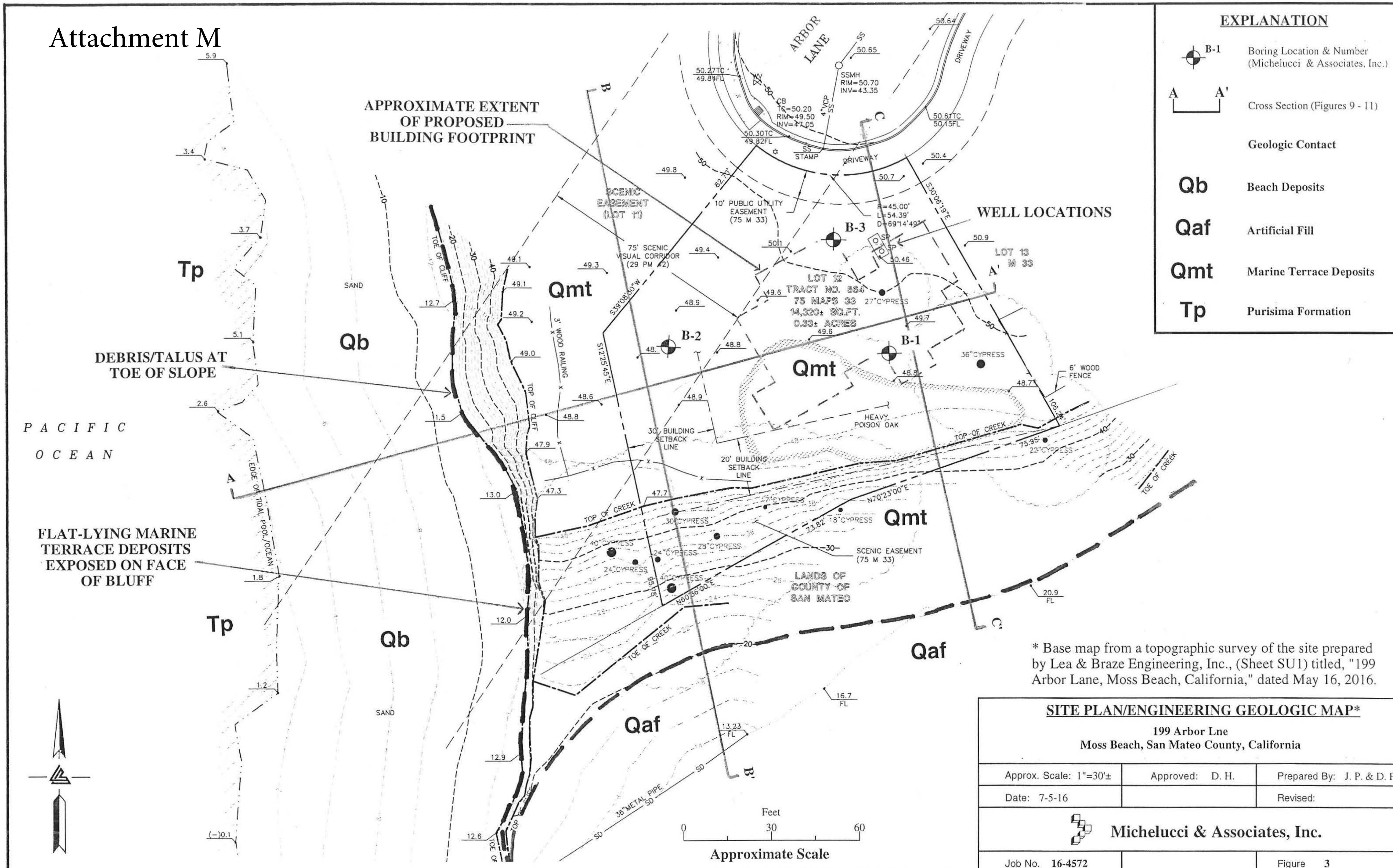
0 1000' 2000'

Approximate Scale

*BASE MAP FROM PAMPEYAN (1994)

Job No. **16-4572**	Michelucci & Associates, Inc.	Figure **2**

Attachment M



Attachment M

Project: **199 Arbor Lane**	**Log of Boring 1**
Project Location: **Moss Beach, CA**	**Sheet 1 of 2**
Project Number: **16-4572**	

Date(s) Drilled **04/20/16**	Logged By **J.P**	Checked By **J.P**
Drilling Method **6" hollow stem**	Drill Bit Size/Type	Total Depth of Borehole **41.3 feet**
Drill Rig Type **CME-75 Truck Rig**	Drilling Contractor	Approximate Surface Elevation
Groundwater Level and Date Measured **Dry**	Sampling Method(s) **2.0", SPT**	Hammer Data **140 lb; Automatic**
Borehole Backfill **Grout**		

Depth (feet)	Material Type	MATERIAL DESCRIPTION	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
0	ML	Soft to medium stiff, dark olive brown, fine sandy silty clay to clayey silt with rock fragments and rootlets, moist. (Disturbed/Cultivated Soil)	1-1 (2.0")	23					
	SM-SC	Medium dense, very dark brown, silty clayey fine to coarse sand, with rootlets and weathered granite fragments. (Native Soil)							
	GL	Medium stiff to stiff, dark yellowish brown to yellowish brown, fine to coarse sandy silt to sandy clay, with lenses of fine to coarse sand. (Marine Terrace Deposits)							
5			1-2 (2.0")	24	113.1	15.4	6272	84.9	
	GL	Stiff to very stiff, light yellowish brown, fine to coarse sandy clay to sandy silt, various colors of mottling and weathered granite pebbles/fragments. (Marine Terrace Deposits)							
10			1-3 (2.0")	19	106.2	18.8	3344	86.3	
		- Fine to coarse sandy and thin silty clayey lenses.	1-4 (SPT)	44					
		- Strong brown and light yellowish brown staining.							
15			1-5 (2.0")	49	119.7	12.9	1809	85.7	
	SM	Dense, light yellowish brown, silty fine to medium sand, with yellow and yellowish brown mottling, moist. (Marine Terrace Deposits)							
20			1-6 (2.0")	40	109.4	19.6		97.9	
			1-7 (SPT)	53					
25			1-8 (2.0")	54	104.8	21.4		95.0	

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Macintosh HD:Users:user:Desktop:Boring Logs:199 Arbor Lane, Moss Beach.bg4[Company (with PI).tpl]

Figure 4

Attachment M

Project: **199 Arbor Lane**
Project Location: **Moss Beach, CA**
Project Number: **16-4572**

Log of Boring 1
Sheet 2 of 2

Depth (feet)	Graphic Log	Material Type	MATERIAL DESCRIPTION	Sample Type	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
		SM	Dense, light yellowish brown, silty fine to medium sand, with yellow and yellowish brown mottling, moist. (Marine Terrace Deposits)								
30					1-9 (2.0")	79	114.1	15.5		88.1	
					1-10 (SPT)	63					
35					1-11 (2.0")	54	96.7	23.9		86.9	
		SM	Dense, dark greenish gray, silty fine to coarse sand with scattered shale fragments, lenses of coarse sand and pebbles/gravel, very moist. (Marine Terrace Deposits) - Water first observed at 40'6"								
40					1-12 (2.0")	52/5"	114.5	14		80.3	
					1-13 (SPT)	52/5"					
			Boring terminated at 41'4"								
45											
50											

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Figure 4

Macintosh HD:Users:user:Desktop:Boring Logs:199 Arbor Lane, Moss Beach.bg4[Company (with PI).tpl]

Project: **199 Arbor Lane**	**Log of Boring 2**
Project Location: **Moss Beach, CA**	**Sheet 1 of 2**
Project Number: **16-4572**	

Date(s) Drilled **04/20/16**	Logged By **J.P**	Checked By **J.P**
Drilling Method **6" hollow stem**	Drill Bit Size/Type	Total Depth of Borehole **50.16 feet**
Drill Rig Type **CME-75 Truck Rig**	Drilling Contractor	Approximate Surface Elevation
Groundwater Level and Date Measured **Dry**	Sampling Method(s) **2.0", SPT**	Hammer Data **140 lb; Automatic**
Borehole Backfill **Grout**		

Depth (feet)	Material Type	MATERIAL DESCRIPTION	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
0	ML	Soft to medium stiff, dark olive brown, fine sandy clayey silt with rootlets and rock fragments. (Disturbed/Cultivated Soil)	2-1 (2.0")	18					
	SC	Medium dense, loose, very dark grayish brown to black, clayey fine to coarse sand, with rootlets and granite fragments/pebbles, moist. (Native Soil)							
5	ML-GL	Medium stiff to stiff, brown to dark yellowish brown, fine to coarse sandy clay to sandy silt with medium to coarse sand lenses. (Marine Terrace Deposits)	2-2 (2.0")	21	87.2	26.5	1156	76.8	
10	SC-GL	Stiff to very stiff, light yellowish brown to light olive brown, fine to coarse sandy clay to clayey sand, mottled various colors, strong brown and brownish yellow mottling and weathered granite fragments/pebbles. (Marine Terrace Deposits)	2-3 (2.0")	93	110.9	8.2	1312	42.6	
		- Lenses of fine to coarse sand							
15			2-4 (2.0")	52/5"	121.5	8		55.8	
			2-5 (SPT)	54					
20	SM	Dense, light yellowish brown, silty fine to medium sand, with yellow mottling, moist. (Marine Terrace Deposits)	2-6 (2.0")	65	111.4	14.4		76.0	
25			2-7 (2.0")	74	108.8	17.2		84.7	

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Macintosh HD:Users:user:Desktop:Boring Logs:199 Arbor Lane, Moss Beach.bg4[Company (with PI).tpl]

Project: **199 Arbor Lane**
Project Location: **Moss Beach, CA**
Project Number: **16-4572**

Log of Boring 2
Sheet 2 of 2

Depth (feet)	Graphic Log	Material Type	MATERIAL DESCRIPTION	Sample Type	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
		SM	Dense, light yellowish brown, silty fine to medium sand, with yellow mottling, moist. (Marine Terrace Deposits)								
30					2-8 (2.0")	65	108.8	9.5		46.9	
35					2-9 (2.0")	68	104.8	16.3		72.3	
40		SM	Dense, dark greenish gray, silty fine to medium sand with scattered shale fragments, damp. (Marine Terrace Deposits)		2-10 (2.0")	51/4"	96.1	13.6		48.7	
45					2-11 (2.0")	51/6"	108.3	13.8		66.9	
50			Hard, dark gray, sandstone and shale bedrock. (Purisima Formation)		2-12 (SPT)	53/2"					
			Boring terminated at 50'2"								

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Figure 5

Macintosh HD:Users:user:Desktop:Boring Logs:199 Arbor Lane, Moss Beach.bg4[Company (with PI).tpl]

Project: **199 Arbor Lane** Project Location: **Moss Beach, CA** Project Number: **16-4572**	# Log of Boring 3 **Sheet 1 of 1**

Date(s) Drilled **04/20/16**	Logged By **J.P**	Checked By **J.P**
Drilling Method **Continuous flight 6"**	Drill Bit Size/Type	Total Depth of Borehole **21.16 feet**
Drill Rig Type **CME-75 Truck Rig**	Drilling Contractor	Approximate Surface Elevation
Groundwater Level and Date Measured **Dry**	Sampling Method(s) **2.0", SPT**	Hammer Data **140 lb; Automatic**
Borehole Backfill **Grout**		

Depth (feet)	Graphic Log	Material Type	MATERIAL DESCRIPTION	Sample Type	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
0		ML	Soft to medium stiff, dark olive brown, abundantly fine to medium sandy silt, with rootlets and rock fragments. (Disturbed/Cultivated Soil)								
		SC	Medium dense, dark brown, clayey fine to coarse sand with rootlets and weathered granite fragments/pebbles. (Native Soil)		3-1 (2.0")	19					Non-plastic
		SM	Stiff, light yellowish brown to light olive brown, fine to coarse silty clay to sandy silt with lenses of fine to coarse sand, granite pebbles and mottled various colors. (Marine Terrace Deposits)								
5					3-2 (SPT)	13					
10					3-3 (SPT)	19					
15					3-4 (SPT)	41					
		SM-SC	Dense, light yellowish brown, silty clayey fine to medium sand, with yellow mottling, moist. (Marine Terrace Deposits)								
20					3-5 (SPT)	36/2"					
25											

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Macintosh HD:Users:user:Desktop:Boring Logs:199 Arbor Lane, Moss Beach.bg4[Company (with PI).tpl]

Figure 6

Attachment M

Project: **199 Arbor Lane**	Key to Log of Boring
Project Location: **Moss Beach, CA**	**Sheet 1 of 1**
Project Number: **16-4572**	

Depth (feet)	Graphic Log	Material Type	MATERIAL DESCRIPTION	Sample Type	Sample Number	Driving Resistance, blows/ft	Dry Unit Weight, pcf	Water Content, %	UC, psf	Deg. of Saturation (%)	PI, %
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 Depth (feet): Depth in feet below the ground surface.
2 Graphic Log: Graphic depiction of the subsurface material encountered.
3 Material Type: Type of material encountered.
4 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
5 Sample Type: Type of soil sample collected at the depth interval shown.
6 Sample Number: Sample identification number.
7 Driving Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
8 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
9 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
10 UC, psf: Unconfined compressive strength, in pounds per square foot.
11 Deg. of Saturation (%): Deg. of Saturation (%)
12 PI, %: Plasticity Index, expressed as a water content.

FIELD AND LABORATORY TEST ABBREVIATIONS

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

MATERIAL GRAPHIC SYMBOLS

AF

Low plasticity PEAT (OL)

Silty SAND (SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler

Bulk Sample

3-inch-OD California w/ brass rings

CME Sampler

Grab Sample

2.5-inch-OD Modified California w/ brass liners

Pitcher Sample

2-inch-OD unlined split spoon (SPT)

Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)

Water level (after waiting)

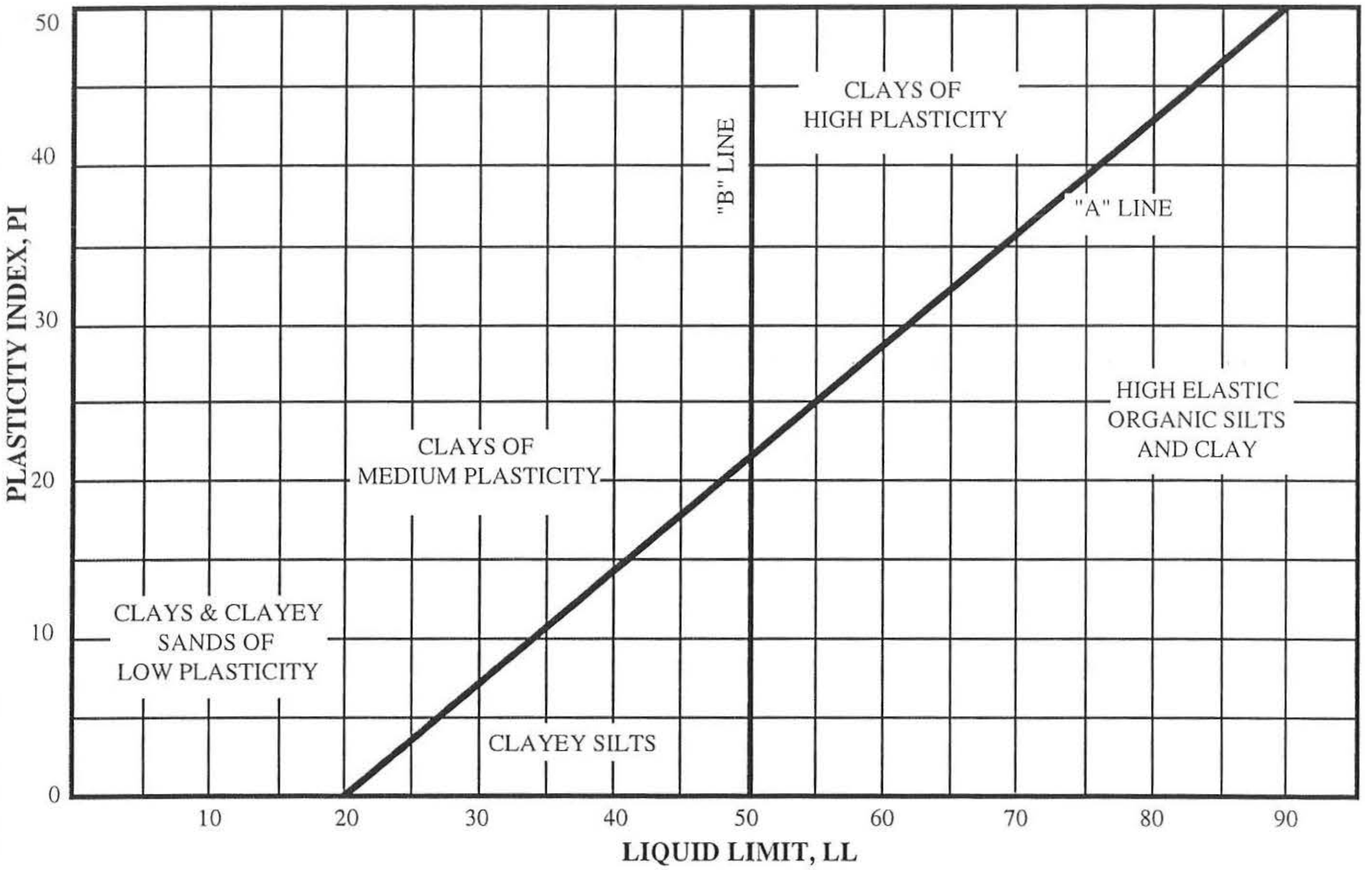
Minor change in material properties within a stratum

Inferred/gradational contact between strata

? Queried contact between strata

GENERAL NOTES

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



CLASSIFICATION TEST RESULTS

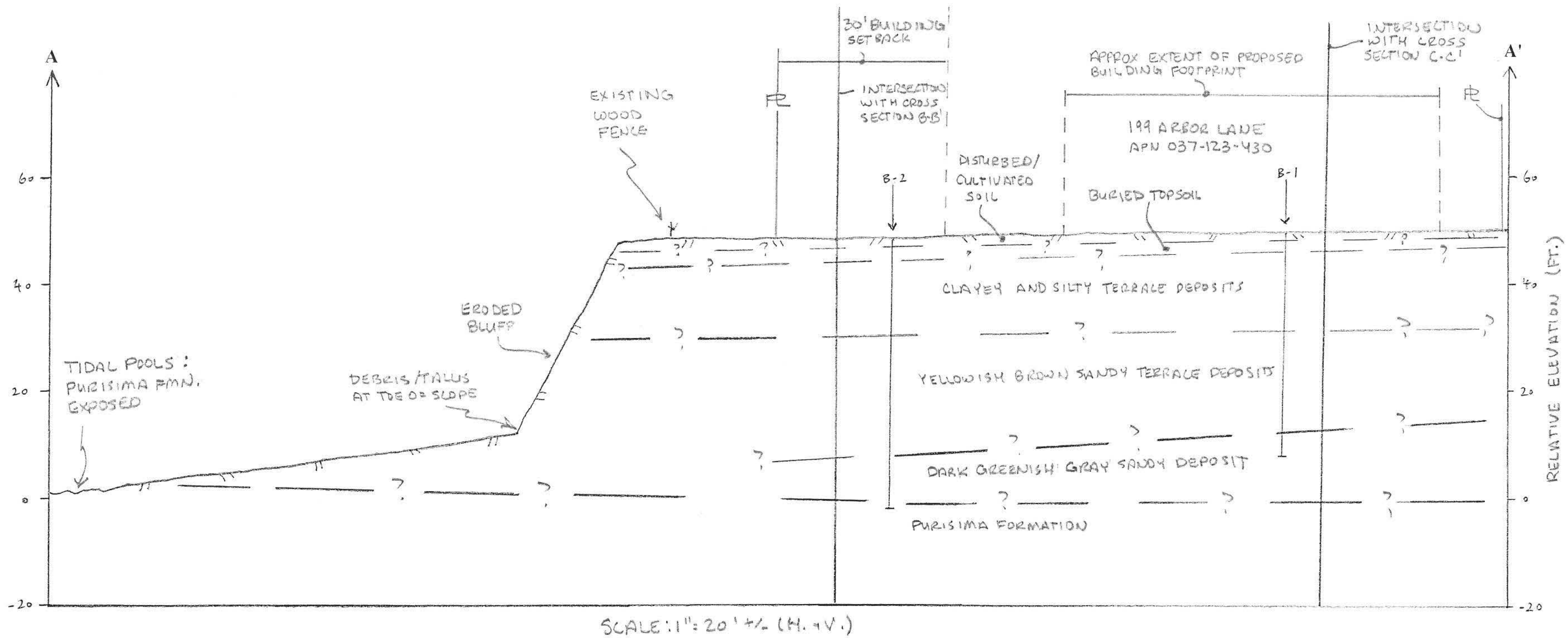
SAMPLE IDENTIFICATION			ATTERBERG LIMITS			GRAIN SIZES % DRY WT.			
SAMPLE	LETTER DESIGNATION	DESCRIPTION	LIQUID LIMIT	PLASTICITY INDEX	SHRINKAGE LIMIT	SAND	SILT	CLAY	COLLOIDAL
3-1	--	Dark yellowish brown to brown silty clayey fine sand with pebbles (**Native Soil**)	**NON PLASTIC**			--	--	--	--

PLASTICITY CLASSIFICATION

Job No. **16-4572**	Michelucci & Associates, Inc.	Figure **8**

Attachment M

CROSS SECTION A-A'



* Existing topography based on topographic contours shown on a topographic survey of the site prepared by Lea & Braze Engineering, Inc., (Sheet SU1) titled, "199 Arbor Lane, Moss Beach, California," dated May 16, 2016.

CROSS SECTION A-A'*

199 Arbor Lane
Moss Beach, San Mateo County, California

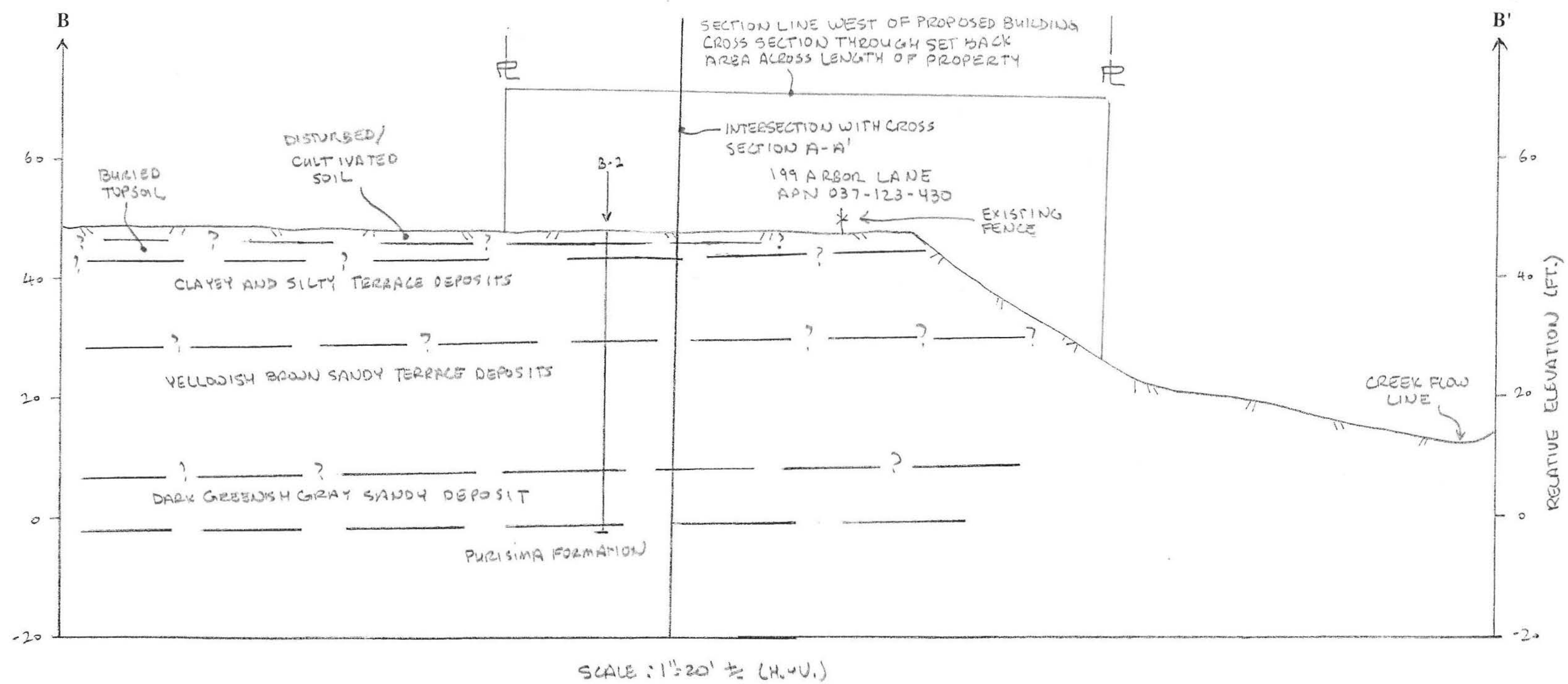
Scale: 1"=20'± (H. & V.)	Approved: J. M.	Prepared By: D. F. & J. P.
Date: 7-5-16		Revised:

Michelucci & Associates, Inc.

Job No. **16-4572**		Figure 9

Attachment M

CROSS SECTION B-B'

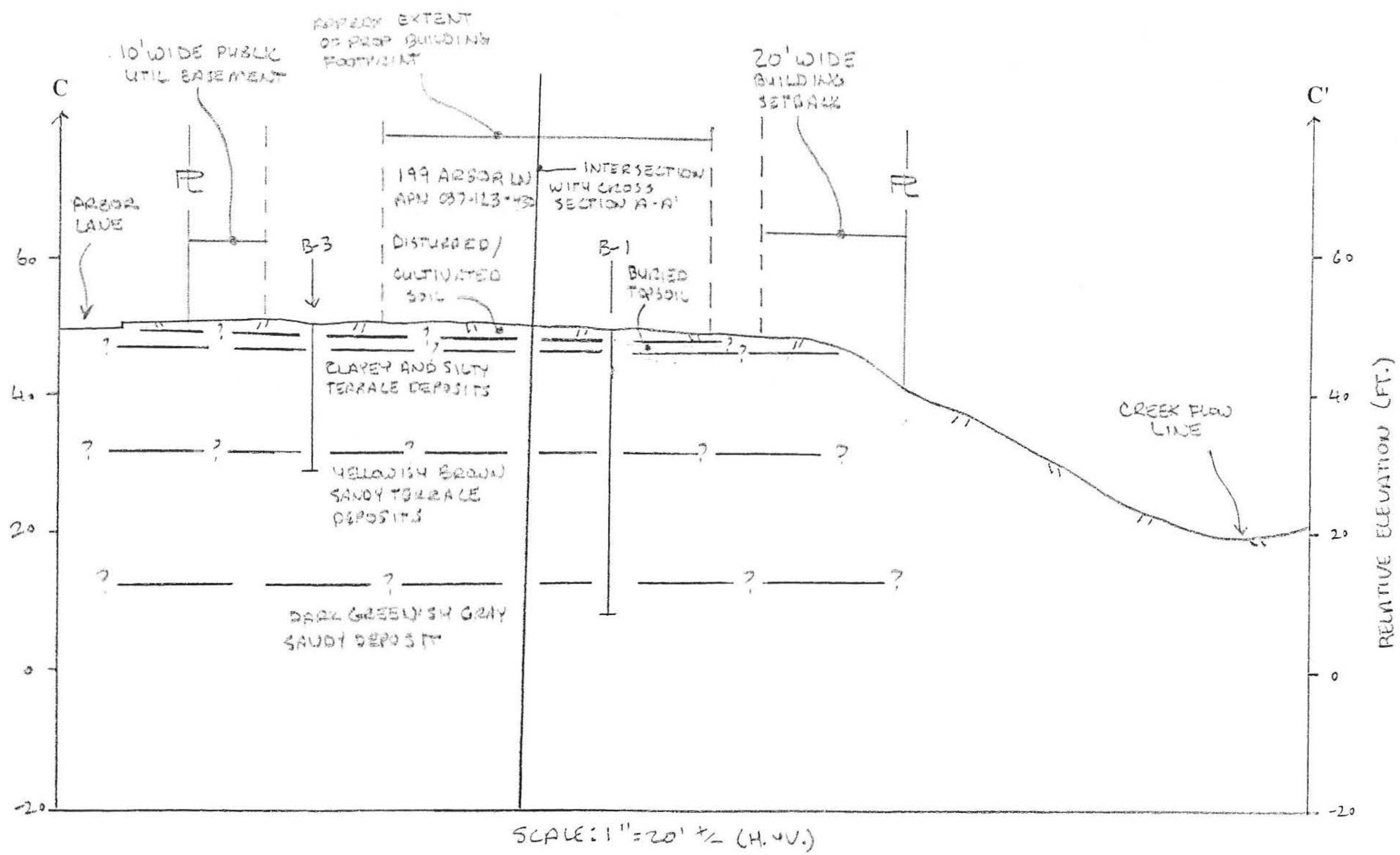


* Existing topography based on topographic contours shown on a topographic survey of the site prepared by Lea & Braze Engineering, Inc., (Sheet SU1) titled, "199 Arbor Lane, Moss Beach, California," dated May 16, 2016.

CROSS SECTION B-B'* **199 Arbor Lane** **Moss Beach, San Mateo County, California**		
Scale: 1"=20'± (H. & V.)	Approved: J. M.	Prepared By: D. F. & J. P.
Date: 7-5-16		Revised:
Michelucci & Associates, Inc.		
Job No. 16-4572		Figure 10

<u>CROSS SECTION C-C'</u>

Attachment M



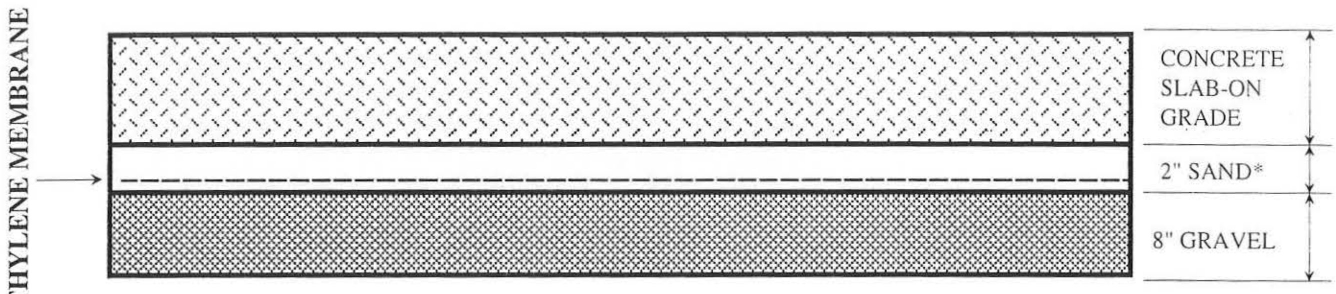
* Existing topography based on topographic contours shown on a topographic survey of the site prepared by Lea & Braze Engineering, Inc., (Sheet SU1) titled, "199 Arbor Lane, Moss Beach, California," dated May 16, 2016.

<u>CROSS SECTION C-C'*</u> **199 Arbor Lane** **Moss Beach, San Mateo County, California**		
Scale: 1"=20'± (H. & V.)	Approved: J. M.	Prepared By: D. F. & J. P.
Date: 7-5-16		Revised:
Michelucci & Associates, Inc.		
Job No. **16-4572**		Figure 11

Attachment M

MOISTURE RETARDANT BENEATH CONCRETE SLABS

TYPICAL SECTION



* or pea gravel

A. MATERIALS

The mineral aggregate for use under floor slabs shall consist of clean rounded gravel and sand. The aggregate shall be free from clay, organic matter, loam, volcanic tuff, and other deleterious substances.

B. GRADATIONAL REQUIREMENTS

The mineral aggregate shall consist of such sizes that the percentage composition by dry weight as determined by laboratory sieve (U.S. Series) will conform to the following gradation:

	Percentage Passing	
Sieve Size	**Gravel**	**Sand**
1"	**100**	
3/4"	**90-100**	
No. 4	**0-5**	**100**
No. 50		**0-30**

NOTES:

1. The polyethylene membrane should be adequately thick so that it will not be easily damaged during construction. It should be adequately detailed so that there are little or no openings around plumbing at conduit points and near foundations. The membrane should be adequately lapped and sealed at any seams.

2. The sand covering is not a part of the moisture retardant treatment. It is a normally used optional component that gives some protection to the membrane and also aids in curing the concrete. Pea gravel may be used as a substitute for sand.

3. The final moisture retardant detail is to be determined by the project architect.