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Appendix 5.4A
Geotechnical Investigation Report

DRAFT
DESIGN LEVEL GEOTECHNICAL INVESTIGATION
ROONEY /SAND HILL
WIND TURBINE PROJECT
ALAMEDA COUNTY, CALIFORNIA

For

VIRACOCHA WIND LLC
C/O SALKA WIND DEVELOPMENT SERVICES VIRACOCHA LLC

July 14, 2023

Job No. 4245.200

BERLOGAR STEVENS & ASSOCIATES

Via E-Mail Only

BERLOGAR
STEVENS &
ASSOCIATES

July 14, 2023
Job No. 4245.200

Mr. Todd Hopper
Viracocha Wind LLC c/o Salka Wind Development Services Viracocha LLC
402 W Broadway, Suite 400
San Diego, CA 92101

Subject: **DRAFT**
Design Level Geotechnical Investigation
Rooney /Sand Hill Wind Turbine Project
Alameda County, California

Dear Mr. Hopper:

This report presents our findings, conclusions and recommendations as a result of our Design Level Geotechnical Investigation for the proposed the proposed Wind Turbine foundations and other project infrastructure in eastern Alameda County, California. The location of the project sites are shown on Plate 1, Vicinity Map. Berlogar Stevens & Associates (BSA) previously provided a Geotechnical Investigation report for Site Grading for Wind Turbine Pads and access roads dated April 04, 2023 (Revised May 11, 2023).
The purpose of our Geotechnical Services was to evaluate the subsurface soil and bedrock conditions and provide geotechnical recommendations for the design and construction of the proposed Wind Turbine project.

PROJECT UNDERSTANDING AND SCOPE OF SERVICES

The Viracocha Hill Wind Project is a proposed wind project located in eastern side of Alameda County between the Tracy and Livermore, California. The Viracocha Hill Wind Project consists, in part, of 20 proposed wind turbines and two substations, as follows:

- On private land – 13 Turbines (Sand Hill)
- On land owned by the City of Santa Clara – 7 Turbines (Rooney)
- Zond Substation
- AML Midway Substation

The purpose of this investigation was to explore and evaluate site soil conditions, geologic hazards, and to develop Design Level Geotechnical and construction recommendations for the Project.

The scope of services for this assessment included the following:

1. Review of readily available geologic and seismic literature pertinent to the project area, including geologic maps and reports, regional fault maps, seismic hazard maps, and aerial photography.

2. Performance of a site reconnaissance to observe the general site conditions.

3. Obtain a Drilling permit for Borings from Zone 7.

4. Coordinate with Underground Service Alert to locate the underground utilities in the vicinity of the proposed explorations.

5. Excavate and log continuous trenches approximately 100 feet long at each Turbine site.
6. Excavate and log 12 test pits to depth of up to about 8 feet below ground surface.

7. Perform two Diamond Core boring to depth of 90 feet below ground surface at two Turbine Sites 22 and 28.

8. Perform 18 Rotary Wash boring to depth of about 60 feet at 18 Turbine Site.

9. Perform 6 Hollow Stem Auger boring at two proposed substations to depth of up to about 35 feet below ground surface.

10. 7. Perform laboratory tests on selected soil samples to perform Compression Strength Tests on Rock Core, Direct Shear and Unit Weight, compaction curve, consolidation test, grain size distribution for the subsurface materials encountered.

11. Perform Electrical Resistivity Testing at multiple locations for Field Measurement of Soil Electrical Resistivity.

12. Perform Thermal Resistivity Testing on multiple disturbed and undisturbed samples at different locations accordance with ASTM D5334.

13. Compile and analyze the available data and the results of our geologic review to evaluate the following:

    a. Subsurface Conditions.
    b. Geologic and seismic hazards present on site including potential for expansive soils, strong ground shaking, faulting, corrosion, and settlement.
    c. Geotechnical design recommendations for wind turbine foundations.
    d. Soil type and seismic coefficients for seismic design conforming Chapter 11 of the American Society of Civil Engineers (ASCE) standard 7-16.

14. Prepare a Design Level Geotechnical Investigation Report presenting our findings, conclusions, and Design Level recommendations for design and construction of the proposed improvements.

PROJECT SITE

The site is located northeast of Livermore, and extends on north and south of Altamont Pass Road as shown on Plate 1, Vicinity Map. The locations of the two proposed substations and 20 wind turbines (including Turbine No. 3, 4, 5, 6, 7, 8, 9, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29) and 1 alternate wind turbine (20A) at the site are shown on Plate 2, Site Plan. The proposed new wind turbines are to be located on ridge tops that generally trend north-northwest. The two proposed substations Zond Substation and AML Midway Substations are located on the western and eastern side of the project site respectively.

GEOLOGY

Regional Geology

The site is located in the Coast Ranges Geomorphic Province of California. The Coast Ranges are characterized by a series of northwest-trending, folded and faulted mountain chains and intervening valleys. Folding and faulting has caused deformation over the past few million years resulting in the pronounced northwest–tending structural grain of the region created by the right-lateral strike-slip relative motions between the Pacific and North American tectonic plates. The majority of active deformation in the San Francisco Bay Area is believed to have occurred over the past few million years.

In this portion of the province, regional geologic mapping by (by Dibblee and Minch (2005) and Dibblee (1980) show the site to be underlain be a series of northwest-trending ridges that are underlain by the Panoche formation, a series of deep sea sediments deposited during the Late Cretaceous Period of geologic time, roughly 66 to 100 million years ago. The Panoche formation consists of a thick sequence of clay-rich shales and thick beds of fine-grained sandstone. Near the site, the formation has been divided into two distinct units, a clay-rich shale unit (map symbol “Kp”) in the western two-thirds of the site and a sandstone unit (map symbol “Kps) in the eastern third of the site. Alluvium (map symbol “Qal”) is shown in the valleys between many ridges.

The trend of ridges reflects the underlying northwest strike of the bedrock structure. The Mount Diablo anticline passes through the southwestern portion of the site. West of the axis of the anticline, the bedrock structure dips to the southwest. East of the axis of the anticline, bedrock dips to the northeast. Small isolated folds cause local variations in the northeastern portion of the site. The midway fault and other unnamed faults are shown in the eastern half of the site. None of these faults are considered active seismic sources in the area.

Mapped Landslide Conditions

The site is located in an area of known landslides and relatively high landslide hazards. The site crosses 4 geologic quadrangles and no one source shows landslides for the site as a whole. The Byron Hot Springs and Clifton Forebay quadrangles cover the northern ¾ of the site. The Altamont and Midway quadrangles cover the southern portion of the site. Landslide maps were not located by the Clifton Forebay or Midway quadrangles in the eastern portion of the site. However, as geology is similar, we would expect landslide mapping to be similar to those summarized below.

Regional landslide mapping by the California Division of Mines and Geology (Majmundar, 1991a, 1991b) show several landslide features in the Byron Hot Springs and Altamont quadrangle which includes the majority of the project site. Landslides are generally shown on the flanks of hillsides. Similarly, the Landslide Inventory Map of the Altamont Quadrangle by the Californian Geological Survey (Hayden, 2010) shows several large landslides on the flanks of the hillsides and ridges. The landslide database managed by the California Geological Survey, the "California Landslide Inventory" shows landslides in the Altamont Quadrangle only and reflects the mapping of Hayden noted above. Since, the wind turbine sites are on generally located on ridges and hills top knobs, the mapped landslides do not impact the proposed turbine sites.

Earthquake Faults

The site is in an area of relatively high seismicity due to the proximity of several active faults in the region. Active faults are defined as faults that have demonstrated activity within the Holocene Epoch of geologic time, within the past 11,700 years. There are several active faults in the region, not all of which are listed below. Near the site, the Greenville fault traverses the base of the hills about 3 to 3½ miles to the southwest, the Las Positas fault is located about 5 miles to the southwest, the Hayward fault is located about 21 miles to the southwest and the San Andreas fault is about 40 miles to the southwest.

FIELD EXPLORATION

Field exploration consisted of Drilling one boring at each Turbine Site, 100 feet long continuous trenches, Test Pits, Geophysical Surveys and Vertical Electrical Sounding (VES) survey, which are described below. The locations of the borings, test pits, and trenches are shown on Plate 2, 2A, and 2B, Site Plan, Existing Conditions. The logs for the borings, trenches, the results of the geophysical survey and electrical survey are contained in the Appendices.

Diamond Core Boring–Two diamond core borings were performed at Turbine Site 22 and 28. Permits for drilling were obtained from Zone 7 Water Agency. The drilling locations were marked prior to performing any subsurface activities. Underground Service Alert (USA) was notified as required prior to our initiating the subsurface work.
Two Diamond Core borings were drilled to depths of about 90 feet below the ground surface (bgs) between January 3, 2023 and January 6, 2023, using a truck-mounted rotary wash drill rig.

A Certified Engineering Geologist visually classified the rocks in the field as the drilling progressed and recorded a log of each boring. Visual classification of the soils was made in general accordance with the Unified Soil Classification System (ASTM D2487). The continuous cores were placed in core boxes with depth intervals noted and photographed for further analysis. The core samples were collected and shipped to our lab for lab testing. The photos of the rock core samples along with logs of the borings, which are based on field classifications as well as the results of laboratory tests, are presented in Appendix A. After completion of the borings, the holes were grouted under the supervision of a Zone 7 Water Agency inspector as required.

Rotary Wash Boring–Eighteen rotary wash borings were performed at Turbine Site 3, 4, 5, 6, 7, 8, 9, 17, 18, 19, 20 (between 20 and 20a), 21, 23, 24, 25, 26, 27, and 29. Permits for drilling were obtained from Zone 7 Water Agency. The drilling locations were marked prior to performing any subsurface activities. Underground Service Alert (USA) was notified as required prior to our initiating the subsurface work. The borings were drilled to depths of about 60 feet below the ground surface (bgs) between April 17, 2023 and April 27, 2023, using a truck-mounted drill rig. A member of our staff visually classified the rocks in the field as the drilling progressed and recorded a log of each boring. Visual classification of the soils was made in general accordance with the Unified Soil Classification System (ASTM D2487). A standard penetration sampler was driven into the underlying soil to a depth of 18 inches with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the last 12 inches of the 18-inch drive are shown as blows per foot on the boring logs. The logs of the borings, which are based on field classifications as well as the results of laboratory tests, are presented in Appendix B. After completion of the borings, the holes were grouted under the supervision of a Zone 7 Water Agency inspector as required.

Note: For Turbine 23, sampling of the top 5 feet was conducted using a 2.5-inch inside diameter Modified California sampler with stainless steel liners, to obtain undisturbed sample at depth of 3 to 4.5 feet for thermal analysis.

Hollow-Stem Augers Boring– Six borings were drilled on the proposed substations (3 on each site) to depth of about 30 feet below the ground surface (bgs) (or refusal depth) on March 15 and 16, 2023, using a truck-mounted drill rig equipped with hollow-stem augers. A member of our staff visually classified the soils in the field as the drilling progressed and recorded a log of each boring. Visual classification of the soils was made in general accordance with the Unified Soil Classification System (ASTM D2487). Sampling was conducted using a 2.5-inch inside diameter Modified California sampler with stainless steel liners. The sampler was driven into the underlying soil to a depth of 18 inches with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the last 12 inches of the 18-inch drive are shown as blows per foot on the boring logs. The logs of the borings, which are based on field classifications as well as the results of laboratory tests, are presented in Appendix C.
After completion of the borings, the holes were grouted under the supervision of a Zone 7 Water Agency inspector as required. The approximate locations of the borings are shown on the attached Site Plan, Plate 2.

Trenching– A continuous trench approximately 100 feet long was excavated and logged at each Turbine site. The trenches were oriented approximately across bedrock structure and was extend approximately 2 feet into bedrock. The approximate Trench locations are shown on the Site Plan and the Trench Logs are presented in Appendix D.

Test Pits– Eight test pits (TP-1 to TP-8) were excavated with rubber tire backhoe to depths of up to 8 feet below the ground surface (bgs) along the proposed roads in February 2023. The approximate Test Pit locations are shown on the Site Plan. Materials encountered in the Test Pits were visually classified in the field and a log was recorded. Bulk samples were collected from the Test Pits at various depths. The site plan shows the location of the test pits. The test pits were loosely backfilled and wheel rolled. The test pit logs are presented in Appendix E.
In addition to the above test pits, four more test pits (TP-9 to TP-12) were excavated on June 8, 2023 (one at each proposed substation and Turbine No. 23 and 5). The purpose of these test pits was to collect bulk samples for thermal resistivity testing.

Geophysical Survey–Norcal Geophysical Consultant Inc. performed twenty multichannel analysis of surface waves (MASW) soundings at each Turbine location. An MASW survey measures the shear wave velocities (Vs) of the subsurface as a function of depth. The survey method is a sounding, producing one-dimensional (1-D) data. The geophysical survey was performed on January 17 through 18, and April 17 through 19, 2023. The work was completed in two phases based on weather delay. The results of the geophysical survey, descriptions of the MASW methodology, the data acquisition and analysis procedures and the instrumentation that are used for the MASW survey are provided in Appendix F.
Electrical Survey–Norcal Geophysical Consultant Inc. performed Vertical Electrical Sounding (VES) survey at Turbine No. 5, Turbine No. 23, AML-Midway Substation, and Zond Substation. A VES survey measures the electrical resistivity (ER) of the subsurface as a function of depth. The VES survey, using the Wenner 4-Pin method, measures the Electrical Resistivity (ER) of the shallow sub-surface. The survey method is a sounding, producing one-dimensional (1-D) data. The electrical survey was performed on May 30, 2023. The results of the electrical survey, descriptions of the VES methodology, the data acquisition and analysis procedures and the instrumentation that are used for the VES survey are provided in Appendix G.

LABORATORY TESTING

Laboratory tests were performed on selected soil samples to evaluate their physical characteristics and engineering properties. Geotechnical laboratory tests, including moisture content, dry density, Atterberg Limits and grain size, Unconfined Compressive Strength (ASTM D-2166), Direct Shear, Triaxial (CU), consolidation testing, corrosion testing. Results of laboratory tests are presented in Appendix H.

THERMAL RESISTIVITY TESTING

Thermal Resistivity Testing on 7 samples at different locations (Turbine No. 5, 23, and the two substations) accordance with ASTM D 5334-14 and applicable portions of IEEE Std 422-03 and Specifications for Collection and Substation Geotechnical Exploration (P&E Revision A, December 16, 2022). For the undisturbed samples, thermal resistivity was performed at one percent intervals of moisture content from 1 percent to as-found percent.
Four thermal resistivity testing was performed on bulk samples at Turbine No. 23 and the two substations. For the bulk samples, the optimum moisture content and maximum dry density was determined by standard Proctor analysis (ASTM D1557B), and the thermal resistivity was performed at samples compacted to 90% of the maximum dry standard Proctor density (D1557) with the optimum water content and as progressively one percent intervals of moisture content from 1 percent to as-found percent. Results of the thermal resistivity tests and associated compaction curve (ASTM D1557) tests are presented in Appendix I.

SURFACE AND SUBSURFACE CONDITIONS

The Site Plan shows the existing topography of the site as provided by dk Consulting. The physical site characteristics are described as follows:

- Several miles of existing gravel access roads provide access to the existing wind turbines. These access roads connect to Altamont Pass Road.
- Grasses and weeds cover the hillsides, with some small, sporadic bushes. Limited rock outcrops are visible mostly along the ridge tops.
- Remnants of smaller wind turbines are located on the ridge tops along the access roads. The existing wind turbine foundations and underground utilities outside the grading limits will remain.
- The proposed new wind turbines are to be located on ridge tops that generally trend north-northwest.

Alluvium mantles the lower, flatter lying valleys of the site with some colluvium located in drainages between hillsides. On the Sand Hill area (Turbine No. 17 to 29), dry-moist, med-stiff silty and sandy clay are dominant in the approximately upper 2 feet. The silty-sandy clay surface soil is generally underlain by a 7 to 15 feet of sandstone layer (up to 30 feet thick in some locations). The sandstone is generally underlain by claystone and sandstone to depth of 60 feet.
On the Rooney Ranch area (Turbine No. 3 to 9), dry soft to stiff silty-sandy clay, are dominant in the approximately upper 2 to7 feet. The silty-sandy clay surface soil is generally underlain by claystone layer to the explored depth of 60 feet.
At AML substation, the upper 5 feet is generally clay stone (in boring B-3 we did not find clay stone). The clay stone layer is generally underlain by sandstone layer.
At Zond substation, the upper 13 to 24 feet is generally medium dense Silty Clayey Sand. The Silty Clayey Sand layer is underlain by bedrock (claystone and sandstone)
For more detailed subsurface information please refer to Boring Logs and trench logs presented in Appendices A to D.

GROUNDWATER

No ground water was encountered during our geotechnical exploration.

GEOLOGIC HAZARDS

SURFACE FAULT GROUND RUPTURE

We have reviewed the Alquist-Priolo Earthquake Fault Zone maps issued by the California Geological Survey (formerly the California Division of Mines and Geology). These maps were issued in response to the Alquist-Priolo Act. The Turbine Sites and the proposed substation sites are not located within a designated State of California Alquist-Priolo Earthquake Fault Zone for active faults as shown on Plate 5. The Rodgers Creek Fault is mapped approximately 1,000 feet northeast of the project site.

SEISMICITY AND SEISMIC GROUND SHAKING

Based on historic activity, the potential for future strong ground motion at the site is considered significant. The peak ground acceleration (PGA) associated with the Maximum Considered Earthquake Geometric Mean (MCEG) was calculated in accordance with the American Society of Civil Engineers (ASCE) 7-16 Standard. The measured average 100 ft shear wave velocity values ranged from 1,050 to 1,730 ft/sec. These values are in the range of Site Class C (very dense soil and soft rock) and D (stiff soil) (ASCE 7-16). Table below shows the recommended site class and associated measured average 100ft shear wave velocity for each Turbine site.

Turbine No.	Lat	Long	Shear Wave Velocity (100ft) ft/s	Site Class
3	37.743660°	-121.655488°	1599	C
4	37.741140°	-121.655806°	1662	C
5	37.739640°	-121.653110°	1476	C
6	37.736755°	-121.652220°	1401	C
7	37.733373°	-121.651283°	1482	C
8	37.737823°	-121.644018°	1275	C
9	37.732439°	-121.642925°	1527	C
17	37.774336°	-121.617123°	1334	C
18	37.771522°	-121.616188°	1162	D
19	37.769667°	-121.613202°	1257	C
20	37.766851°	-121.611393°	1232	C
20a	37.766451°	-121.611048°		
21	37.765243°	-121.610310°	1173	D
22	37.761318°	-121.607580°	1339	C
23	37.759959°	-121.603995°	1395	C
24	37.757776°	-121.601539°	1552	C
25	37.755067°	-121.608696°	1671	C
26	37.753797°	-121.599593°	1049	D
27	37.754561°	-121.594164°	1729	C
28	37.748321°	-121.610581°	1457	C
29	37.743305°	-121.611697°	1285	C

For Zond and AML Midway Substation, based on the boring logs and interpretation from OpenSHA (CGS/Wills Site classification Map 2006, and Wald & Allen 2008) and California conservation maps (https://maps.conservation.ca.gov/cgs/DataViewer/), we estimate the Site Class C should be used for seismic analysis.

Design of the proposed improvements should be performed in accordance with the requirements of the governing jurisdictions and applicable building codes and standards. The Seismic analysis results including the MCEG peak ground acceleration with adjustment for site class effects for each Turbine Site and the two Substations are presented in Appendix J.

Seismic Hazards

LIQUEFACTION

Liquefaction is the temporary transformation of saturated, loose to medium dense, sandy soils into a viscous liquid during strong ground shaking from a major earthquake. The borings from this predominantly encountered bedrock and the alluvial soils overlying the bedrock generally consisted of stiff cohesive soils. Based on the type of materials encountered and the depth to bedrock, it is our opinion that the potential for liquefaction to occur at the site is low to nil.

LATERAL SPREADING

Lateral spreading is lateral movement of liquefiable soil towards a free face (such as an incised river channel or open body of water) during a seismic event. It is our opinion that the potential for liquefaction is low to nil thus it is our opinion that the potential for lateral spreading is also low to nil.

SEISMIC SETTLEMENT

Settlement of the ground surface can also occur as a result of seismic settlement (i.e. “shakedown” when loose, unsaturated, sandy soils are subjected to strong seismic shaking). Materials encountered in our borings generally consisted of bedrock and stiff cohesive soils. Based on this it is our opinion that the potential for seismic settlement is low to nil.

SEISMICALLY INDUCED SOIL EJECTA

During a seismic event where, liquefiable soils are located need the ground surface soil ejecta such as sand boils may occur. It is our opinion that the potential for liquefaction is low to nil thus it is our opinion that the potential for seismically induced soil ejecta is also low to nil.

GROUND SURFACE RUPTURE

Ground surface rupture is an offset of the ground surface when fault rupture extends to the Earth's surface. The site is not located within a mapped fault zone, thus it is our opinion that the potential for ground surface rupture at this site is low.

CORROSIVITY

Four samples at locations of Turbine 6, 19, 24, and 29 were and at the depth of between 2 and 4 feet collected and corrosivity testing including pH, redox, sulfide, chloride and resistivity were performed. The samples were classified as moderately to mildly corrosive to all buried iron and steel based on the resistivity values. All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.
The results of the corrosion testing and a brief evaluation are presented in Appendix K.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the information collected during this investigation and the results of our analyses, it is our opinion that proposed Wind Turbines and Substations can be constructed from a geotechnical engineering perspective, provided that the conclusions and recommendations in this geotechnical investigation are incorporated into the project design.

GRADING

Our Geotechnical Investigation Report for Site Grading for construction of the wind turbine pads and the access road of 20 wind turbines were submitted to you dated April 04, 2023 (Revised May 11, 2023) as presented in Appendix L.
The recommendations in the Geotechnical Investigation Report and the Remedial Grading Plan are preliminary and are subject to modification during grading based on BSA field observations of geological conditions exposed in keyways, bench keys and cut slopes.

UTILITY TRENCH EXCAVATION AND BACKFILL

Excavations should conform to applicable State and Federal industrial safety requirements. Where trench excavations are more than 5 feet deep, they should be sloped and/or shored. Trench walls should be sloped no steeper than 1½ H:1V in dry granular soils, and no steeper than 1H:1V in dry cohesive soils. We do not expect seepage or groundwater, however, flatter trench slopes may be required if seepage is encountered during construction or if exposed soil conditions differ from those encountered by the test pits and borings.

Materials quality, placement procedures and compaction operations for utility pipe bedding and shading materials should meet applicable agency requirements. Utility trench backfill above the shading materials may consist of native soils processed to remove rubble, rock fragments over 4 inches in largest dimension, rubbish, vegetation and other undesirable substances. Backfill materials should be placed based on our recommendations provided in our Geotechnical Investigation Report for Site Grading dated April 04, 2023 (Revised May 11, 2023).

FOUNDATIONS

Foundations should be designed in accordance with structural considerations and our geotechnical recommendations. In addition, requirements of the governing jurisdictions, practices of the Structural Engineers Association of California, and applicable building codes should be considered in the design of the structures. The foundation design parameters presented in this report are not intended to preclude differential movement of soils. Minor cracking (considered tolerable) of foundations may occur.

WIND TURBINE FOUNDATIONS

We understand that the wind turbine foundations will consist of large concrete mats and pedestals that will resist overturning by mass. Although foundation designs were not available for this report, we understand that typically these foundations will be approximately 60 feet in diameter and will be bear approximately 20feet below grade.

Foundations should be designed in accordance with structural considerations and our geotechnical recommendations. In addition, requirements of the governing jurisdictions and applicable building codes should be considered in the design of the structures.

The rigid mats with minimum embedment depth of 20 feet and minimum diameter of 60 feet may be designed to impose a maximum average bearing pressure of 7,500 pounds per square foot (psf) for dead-plus-live loads. The allowable bearing capacity may be increased to 10,000 psf in areas of loading concentration.

These values may be increased by one-third when considering transient loads, such as seismic. A lateral friction coefficient of 0.3 between the bottom of the foundation and the soil can be used for design. Passive pressures on the sides of the mat slab can be taken as equivalent to the pressure developed by a fluid having a weight of 300 pounds per cubic foot (pcf).

Each foundation excavation should be inspected by qualified geotechnical personnel and approved prior to placing reinforcing steel and concrete. We estimate that the approximate differential settlement is about 0.5 inches. The dry backfill density of 100 pcf (assumes compaction achieves at least 90% of maximum dry density) can be used for analysis.

AML SUBSTATION FOUNDATIONS

Based on the results of our field and laboratory evaluations, it is our opinion that the proposed substations can be supported on shallow spread footings. Foundations should be designed in accordance with structural considerations and the following recommendations. In addition, requirements of the governing jurisdictions and applicable building codes should be considered in the design of the proposed structures.

Spread footings should bear at a depth of 24 inches or more below the adjacent finished grade, on moisture-conditioned compacted subgrade as described in this report. Footings should have a width of 18 inches or more. Spread footings should be reinforced in accordance with the recommendations of the structural engineer.

Spread footings may be designed using a net allowable bearing capacity of 2,500 psf for static conditions provided that the recommended remedial grading is performed. The allowable bearing capacity may be increased by one-third when considering loads of short duration such as wind or seismic forces. Total and differential static and dynamic settlement of up to about 1 inch over a horizontal distance of 30 feet, respectively, may occur.

Foundations bearing on moisture-conditioned, compacted subgrade and subject to lateral loadings may be designed using an ultimate coefficient of friction of 0.3 (total frictional resistance equivalent to the coefficient of friction multiplied by the dead load). A passive resistance value of 300 psf per foot of depth can be used. The lateral resistance can be taken as the sum of the frictional resistance and passive resistance, provided that the passive resistance does not exceed one-half of the total allowable resistance. The passive resistance may be increased by one-third when considering loads of short duration such as wind or seismic forces. The foundations should preferably be proportioned such that the resultant force from lateral loadings falls within the middle one-third of foundation foot print.

ZOND SUBSTATION FOUNDATIONS

Significant structures should be supported on deep foundations to mitigate static settlement due to the soft and weak silty/clayey sand layer on site, and to mitigate concerns related to shallow dynamic settlement. To reduce the potential for settlement, the foundations should be extended to bedrock.

The proposed substations may be supported on reinforced concrete piers that are cast in drilled holes. To mitigate concerns related to liquefaction and reduce the potential degree of settlement, the drilled piers should bear on bedrock. To check for suitable bearing conditions, the drilled piers should be extended 5 feet into the bedrock. Bedrock was encountered in the borings for this study at depths that ranged from approximately 15 feet below the ground surface to approximately 30 feet below the ground surface. Variation in the depth to bedrock over the site should be anticipated. The depth to bedrock may exceed this range over portions of the site. BSA should observe pier drilling to evaluate the subsurface conditions exposed and check for suitable bearing conditions.

The piers should be designed to resist the appropriate load combinations for downward and upward vertical loading, neglecting the potential vertical support provided by pile caps, grade beams, or structural slabs.

The drilled piers should be designed for an allowable skin friction to vertical downward of 80 psf in bedrock, assuming no skin friction in the overlying weak soils. Uplift resistance should be designed for an allowable skin friction of 400 psf in bedrock. The allowable side friction may be increased by one-third for alternative basic load combinations with loads of short duration such as wind or seismic loads. The spacing between adjacent piers should be equivalent to three pier diameters or more to mitigate reduction in axial resistance due to group effects.

A lateral bearing pressure of 100 pounds per square foot (psf) per foot depth up to 1,500 psf may be used to evaluate resistance to lateral loads and overturning moments in accordance with Section 1807 of the California Building Code with a one-third increase for wind or seismic loading conditions.

Drilled pier excavations should be cleaned of loose material prior to pouring concrete. Drilled pier excavations that encounter groundwater or cohesionless soil may be unstable and may need to be stabilized by temporary casing or use of drilling mud. Standing water should be removed from the pier excavation or the concrete should be delivered to the bottom of the excavation, below the water surface, by tremie pipe. Casing should be removed from the excavation as the concrete is placed. Concrete should be placed in the piers in a manner that reduces the potential for segregation of the components.

ADDITIONAL GEOTECHNICAL ENGINEERING SERVICES

Prior to construction, our firm should be provided the opportunity to review the plans and specifications to determine if the recommendations of this report have been implemented in those documents. We would appreciate the opportunity to meet with the contractors prior to the start of site grading, and underground utility installation to discuss the procedures and methods of construction. This can facilitate the performance of the construction operation and minimize possible misunderstanding and construction delays.

To a degree, the performance of the proposed project is dependent on the procedures and quality of the construction. Therefore, we should provide observations of the contractor's procedures, the exposed soil conditions, and field and laboratory testing during site preparation and grading, placement and compaction of fill, underground utility installation, and foundation construction. These observations will allow us to check the contractor's work for conformance with the intent of our recommendations and to observe any unanticipated soil conditions that could require modification of our recommendations.

LIMITATIONS

The conclusions and recommendations presented in this report are based upon the project information provided to us, information obtained from published geologic reports, subsurface conditions encountered at the boring locations and professional judgment. Site conditions described in this report are those existing at the times of our field explorations and are not necessarily representative of such conditions at other locations or times. The boring and test pit logs show subsurface conditions at the locations and on the dates indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. The locations of the field explorations were estimated by pacing from existing surface features at the site; they should be considered approximate only.

The information provided herein was developed for use by Viracocha Wind (C/O Salka Wind Development Services Viracocha) for the project as described herein. In the event that changes in the nature, design or location of the proposed project are planned, if subsurface conditions differ from those described in this report, or revisions are made to the Building Code that are related to Geotechnical Engineering, the conclusions and recommendations in this report shall be considered invalid, unless the changes are reviewed and the conclusions and recommendations are confirmed or modified in writing by BSA. In light of this, there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years from the date of this report be considered a reasonable time for the usefulness of this report.

This geotechnical investigation has been conducted, and the opinions, conclusions and recommendations presented in this report were developed, in accordance with accepted geotechnical engineering practices that exist in the project area at the time this report was prepared. No warranty, expressed or implied, is offered, inferred or made, by or through our performance of professional services.

Please contact the undersigned if you have any questions regarding the contents of this report.

Respectfully submitted,

BERLOGAR STEVENS & ASSOCIATES

DRAFT

Abbas Abdollahi
Principal Engineer

DRAFT

Frank Berlogar
RCE 20383

AA/FB:mc

Attachments:

Plate 1 – Vicinity Map
Plate 2 – Site Plan
Plate 3– Geology Map

Appendix A– Diamond Coring Logs
Appendix B– Rotary Wash Logs
Appendix C– Hollow Stem Logs
Appendix D– Trench Logs
Appendix E– Test Pits
Appendix F– Geophysical Survey
Appendix G– Electrical Resistivity Test
Appendix H– General Lab Test
Appendix I– Geothermal Resistivity and Related Compaction Test
Appendix J – Seismic Analysis Results
Appendix K – Corrosion Test
Appendix L – Geotechnical Investigation Report for Site Grading

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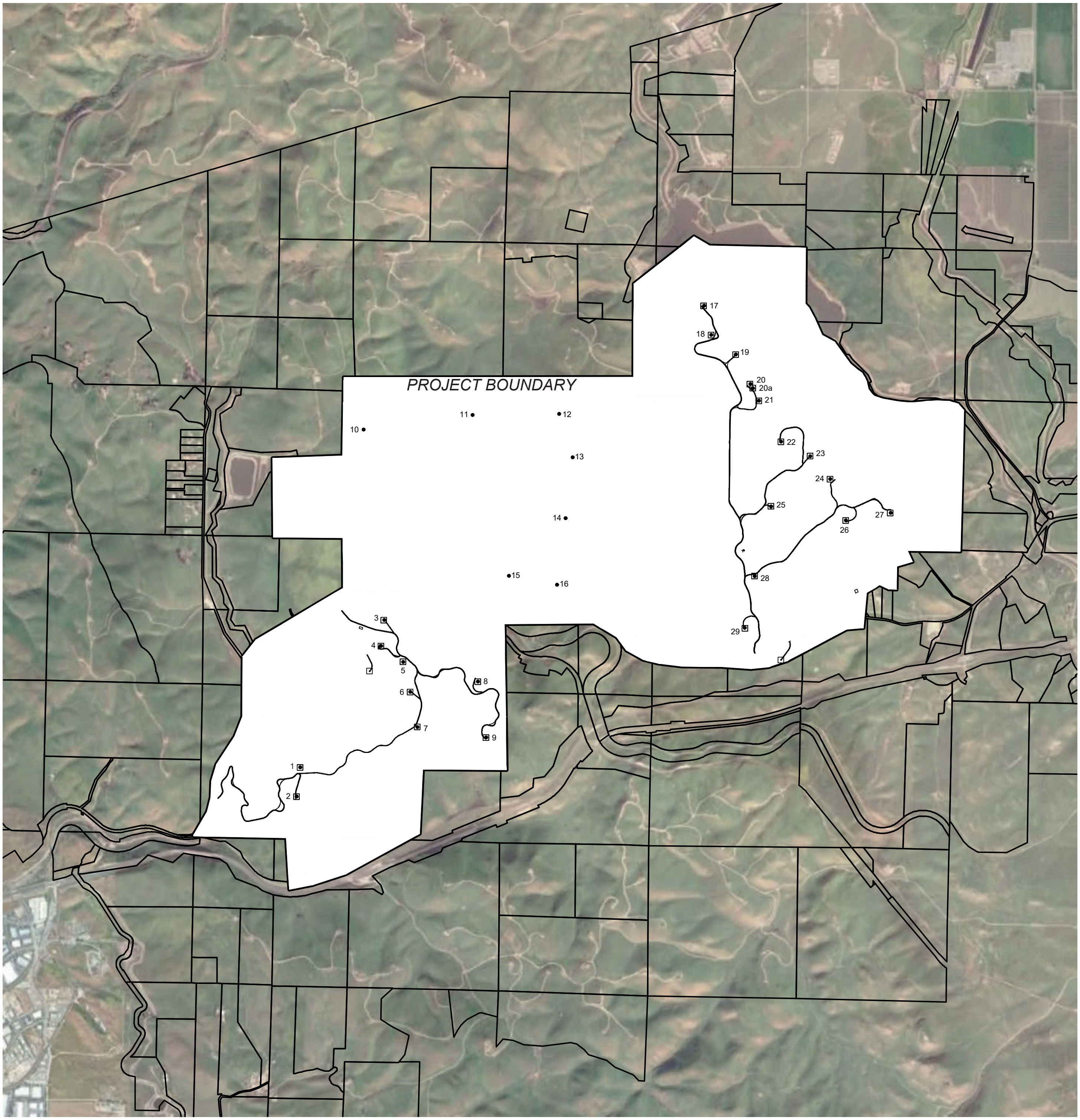
PLATES



BASE: GOOGLE EARTH, FEBRUARY 2022 (AERIAL)
TOPOGRAPHY: DK ENGINEERING, 2022-10-31

VICINITY MAP

ROONEY / SAND HILL WIND TURBINE SITES

ALAMEDA COUNTY, CALIFORNIA

FOR

VIRACOCHA WIND LLC

Berlogar Stevens & Associates

SOIL ENGINEERS * ENGINEERING GEOLOGISTS

EXPLANATION

APPROX. 100' TRENCH LOG LOCATION (BSA: October, 2022)

TP-8 APPROX. 20' TEST PIT LOCATION (BSA: February, 2023)

TP-12 APPROX. 15' TEST PIT LOCATION (BSA: June, 2023)

29 WIND TURBINE SITE

SITE PLAN

ROONEY RANCH & SAND HILL WIND TURBINE SITES

ALAMEDA COUNTY, CALIFORNIA

FOR

VIRACOCHA WIND LLC

Berlogar Stevens & Associates

SOIL ENGINEERS * ENGINEERING GEOLOGISTS

JOB NUMBER: 4245.200 DATE: 7-12-23 DRAWN BY: MV

BASE: 4245.200_4.3.2023

EXPLANATION

B-3 BORING LOCATION (BSA: March 16, 2023)

TP-10 15' TEST PIT LOCATION (BSA: June 8, 2023)

AML SUBSTATION

ROONEY RANCH & SAND HILL WIND TURBINE SITES

ALAMEDA COUNTY, CALIFORNIA
FOR
VIRACOCHA WIND LLC

Berlogar Stevens & Associates

SOIL ENGINEERS * ENGINEERING GEOLOGISTS

DRAWN BY: MV
DATE: 7-12-23
JOB NUMBER: 4245.200

BASE: AERIAL ACCESSED VIA NEARMAP, 6/2022

EXPLANATION

B-3 BORING LOCATION (BSA: March 16, 2023)

TP-11 15' TEST PIT LOCATION (BSA: June 8, 2023)

ZOND SUBSTATION

ROONEY RANCH & SAND HILL WIND TURBINE SITES

ALAMEDA COUNTY, CALIFORNIA
FOR
VIRACOCHA WIND LLC

Berlogar Stevens & Associates
SOIL ENGINEERS * ENGINEERING GEOLOGISTS

BASE: AERIAL ACCESSED VIA NEARMAP, 6/2022

EXPLANATION

Qa	ALLUVIUM
Qc	COLLUVIUM
Qls	LANDSLIDE RUBBLE
Tbr	BRIONES SANDSTONE, MARINE CLASTIC, LITHIFIED, MAIN PART, LOCALLY CALLED CIERBO, LIGHT GRAY, MEDIUM GRAINED TO LOCALLY PEBBLY, ARKOSIC, LOCALLY FOSSILIFEROUS.
Kp	PANOCHE FORMATION, CLAY SHALE OR CLAYSTONE, MARINE CLASTIC, LITHIFIED, DARK GRAY, BEDDED, MICACEOUS, INCLUDES FEW TO MANY THIN LAYERS OF FINE GRAINED ARKOSIC SANDSTONE.
Kps	PANOCHE FORMATION, SANDSTONE, MARINE CLASTIC, LITHIFIED, LIGHT GRAY TO LIGHT BROWN TAN, BEDDED, MEDIUM GRAINED, ARKOSIC.
29	WIND TURBINE SITE

BASE INFORMATION:
PORTION OF GEOLOGIC MAPS OF THE ALTAMONT, BYRON SPRINGS AND CLIFTON FOREBAY QUADRANGLES, CONTRA COSTA AND ALAMEDA COUNTY. BY: THOMAS W. DIBBLEE, JR., 2006. DF-243, DF-197, DF-195.

REGIONAL GEOLOGIC MAP

ROONEY RANCH & SAND HILL WIND TURBINE SITES

ALAMEDA COUNTY, CALIFORNIA
FOR
VIRACOCHA WIND LLC

Berlogar Stevens & Associates
SOIL ENGINEERS * ENGINEERING GEOLOGISTS

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