TULE WIND PROJECT

TULE WIND PROJECT
SAN DIEGO COUNTY, CALIFORNIA

Geological Hazards Assessment

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January 2010

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Exp. 3-31-11
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GEOLOGICAL HAZARDS ASSESSMENT

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Executive Summary

A wind-to-energy project is proposed in southeastern San Diego County, California, comprising 66 wind turbine tower locations and attendant facilities. This report presents the results of a geologic hazards assessment, including a review of fault rupture hazards, ground shaking hazards, and hazards posed by liquefaction, landsliding, unstable geologic units and soils, and expansive soils.

This assessment is based on published and other publically available information. The site is underlain by crystalline igneous and metamorphic bedrock with generally thin granular soils present. There are no known active faults present in the project area. There are two potentially active faults that are in the immediate vicinity of the project area. Project area seismicity is moderate to high. Local saturated granular soils potentially susceptible to liquefaction may be present, adjacent to several springs within the project area. No unstable geologic units, except on steeper slopes exposing foliated metamorphic rocks such as schists, are present within the project area. No quick clays, peats, or collapsible soils are likely to be present in the project area. No highly plastic clays subject to expansion are known to be present in the project area.

1.0 Description of Proposed Development

The proposed Tule Wind Project is located north of the town of Live Oak Springs in San Diego County, California, approximately 50 miles east of the City of San Diego (Figure 1). The wind project is planned to consist of 66 wind turbines. Figure 2 is a map of the proposed project area and preliminary turbine sites. The proposed wind turbine is a Gamesa model G87 2.0 megawatt (MW) unit. The Gamesa model G87 has turbine blade assemblies that are 87 meters (285 feet) in diameter. The development also includes ancillary facilities such as two meteorological station (Met) towers, an operations and maintenance building, a substation, attendant roads, fencing and other appurtenant improvements.

2.0 Scope of Work

This report constitutes an initial assessment of geologic hazards associated with the proposed development of a 66-tower wind-to-energy production facility. The study has been limited to review and assessment of readily available published and unpublished geological and seismological information. The County of San Diego provides Guidelines for Determining Significance of various issues (http://www.sdcounty.ca.gov/dplu/procguid.html#guide).

The county guidelines include recommendations to address the following geologic hazards:

- Fault rupture
- Ground shaking
- Liquefaction
- Landslides
- Unstable Geologic Unit or Soil
- Expansive soils

The county guidelines also include the following hydrology hazards:

- Flash floods and debris flows
- Alluvial fan floods
- Urbanization
- Landform modification
- Dam failure
- Faulty drainage facilities

The County guidelines also list tsunamis and seiches as possible issues in both the geologic and hydrologic hazards, but as the site is far inland and not adjacent to any large water bodies these are not considered risks for this project.

The tasks completed include:

- Compile and review readily available geological and seismological information, including geologic maps and reports, geophysical reports, topographic maps, wetlands maps, flood maps, proposed development maps/turbine layouts, and aerial photographs.
- Summarize geological/geotechnical conditions.
- Estimate preliminary site seismic parameters per International Building Code procedures.
- Identify and qualify geologic risks.

3.0 Site Geology

The primary reference resource for the geology of the project area is the Preliminary Geologic Map of the El Cajon 30' x 60' Quadrangle, Southern California, Version 1.0, compiled by V.R. Todd (Todd, 2004) issued by the United States Geological Survey (USGS). A fault activity map of California and adjacent areas prepared by the California Geological Survey (formerly the California Division of Mines and Geology) was also consulted, along with various geologic publications pertaining to the site and vicinity (see References).

The project site is in the eastern portion of the Peninsular Ranges physiographic province. In the area surrounding and including the project area, volcanic and marine sedimentary rocks of Triassic and Jurassic age were intruded by dioritic rocks, chiefly tonalite, in Cretaceous time.

3.1 Bedrock Geology

Approximately ninety per cent of the project area is underlain by the La Posta Tonalite unit of early and late Cretaceous age (see geologic map, Figure 3). These crystalline plutonic rocks include primarily hornblende-biotite trondhjemite which is locally foliated near its western edge. This rock body is largely undeformed and inclusion-free.

In the westernmost 10 per cent of the project area a body of metamorphic rocks of Triassic and Jurassic ages is exposed, which include semi-pelitic, pelitic, and quartzitic schists, calc-silicate bearing feldspathic metaquartzite, and minor small pebble metaconglomerate. These rocks also contain layers of sandstone, quartz pebble conglomerate, mudstone, and amphibolite, and are thought to represent metamorphosed submarine fan deposits interlayered with volcanic rocks. These rocks are locally intruded by leucocratic dikes comprising leucogranite, granophyre, alaskite, pegmatite, and aplite, which range in age from late Jurassic to early Cretaceous. A small body of middle to late Jurassic age Harper Creek gneiss is present at the westernmost edge of the project area.

3.2 Surficial Units

Local areas of younger alluvium are present in the project area. These materials are generally composed of sand, silt, and gravel, and occur along modern intermittent drainage courses. Colluvium occurs on east-facing slopes in the western portion of the project area. Colluvium includes sand and gravel as slopewash deposits and debris flows. Some talus (broken rock piles) is also present at the base of local steeper slopes in the western portion of the project area.

Figure 4 shows the mapped soil types as taken in November, 2009 from the United States Department of Agriculture, Natural Resource Conservation Service Soil Survey Geographic (SSURGO) database. Figure 5 shows the Unified Soil Classification System (USCS) soil classifications for the project area and vicinity, taken from the same SSURGO data base. The majority of the area is shown to be underlain by silty sand (SM). Figure 6 shows the approximate thickness of the site soils, also taken from the SSURGO data base. Soils across much of the project area are thin, less than 1 meter, indicating that excavation for foundations and collection systems and roads may require heavy ripping. Based on regional mapping by others, areas of soil in excess of five feet deep are generally restricted to drainage bottoms.

3.3 Faulting

Several unnamed northwest-trending faults, having lengths from a few hundred feet up to 4,000 feet, are mapped in and adjacent to the project area. These faults are generally identified as being of pre-Quaternary age (see Figure 3; see also CDMG, 1994). There are many similar faults in the areas surrounding the proposed development (Todd, 2004) only a few of which are shown on the CDMG 1994 fault activity map. Those shown on the CDMG map are said to be of pre-Quaternary age, except for two of the northwest-trending faults mentioned above, which are said to be of undivided Quaternary age (i.e. between 1.6 million and 200 years old), and which thus must be considered potentially active. Two faults trending nearly east-west are present transecting the northern portion of the project area. These faults have lengths of 2,000 and 1,500 feet, respectively. No age attribution has been published for these small faults.

3.4 Hydrogeologic Conditions

In the crystalline bedrock ground water will only be present in open joints, fractures and local shear zones, there being no primary porosity in the rocks present. Concentrations of ground water may be present adjacent to mapped faults where more fracturing is present and where fault gouge along fault planes and shear zones may cause retardation of lateral and vertical flow of descending meteoric water and ground water. Several mapped springs in the project area probably reflect water being conducted along joint and fracture systems where they intersect the ground surface, and may also include areas where faults cause local retention of ground water (See Figure 3 and U.S.G.S. Sombrero Peak 7.5-minute topographic quadrangle). It is not known whether the mapped springs are perennial or intermittent. Recharge of these systems comes through rainfall and snow melt. Small local bodies of silt, sand, and gravel in intermittent stream drainages may also be seasonally saturated through rainfall and snow melt.

4.0 Geologic Hazards Evaluation

4.1 General Summary of Geologic Risks

Table 1 is a summary of geologic and geotechnical hazards for the site.

Table 1. Summary of Geologic Hazards

Hazard	Present at Site?	Comments
Flooding/High groundwater	Possibly	The proposed turbine sites are situated on generally high ground between drainages, not near springs, and soils present are generally well drained. Flash flooding may be possible in drainages during intense storm events, which may affect access roads and other project constructed features.
Landslides	Possibly	The site has moderate to high relief and generally thin and granular soils. Some bedrock units in the westernmost portion of the project area contain internal foliations and may have planes of weakness. These will need to be investigated and considered when designing cut slopes.
Subsidence – Pumping	No	Project site is underlain by crystalline bedrock capable of resisting subsidence due to withdrawal of ground water. There are no known oil or gas fields in the area.
Subsidence – Mining	Yes	Three mine tunnels, one mine shaft, one quarry, and one prospect have been identified adjacent to the locations of towers N7, N8, P4 and P5, along the southwest boundary of the project area. These may impact foundation elements such as rock anchors and should be investigated.
Subsidence – Caves/Karst	No	There are no rock types present in the project area that are susceptible to dissolution.
Earthquake/Seismicity	Yes	The site is located 7.1 miles southwesterly of the Elsinore Fault Zone, and may experience moderate to high levels of ground shaking during a maximum credible earthquake event on it. Shallow bedrock persists throughout the site which mitigates the more destructive lower frequency ground shaking associated with such events.

Table 1. Summary of Geologic Hazards

Hazard	Present at Site?	Comments
Earthquake/ground rupture	No	There are no known active faults in the project area. One potentially active fault transects a portion of the project area near tower locations B1 through B7. In the absence of an investigation of this fault, tower sites should be no closer than 50 feet from any mapped fault trace.
Liquefaction	Unlikely	Seismicity is moderate to high and soils are generally sandy but probably well graded. Local liquefaction may occur in sandy soils near springs during large earthquake events. No tower sites are proposed for any such areas.
Swelling/shrinking soil	No	High shrink/swell soils have not been identified by others in the project area.
Corrosive soil	Possibly	The soil survey reports generally moderate concrete corrosion and moderate steel corrosion.
Made ground	Unlikely	There are only a few local areas of filled ground within the project boundaries. These can be avoided, removed, or mitigated by removal and recompaction.
Collapsible soil	No	Collapsible deposits have not been identified by others in the project area.
Volcanic activity	No	No current volcanic activity exists in the region.
Extrasensitive (quick) clays	No	Quick clay conditions are not known or likely to be present.

4.2 Soil Conditions

The project site has surficial soils of detrital, colluvial and alluvial origin, consisting primarily of sand, silty sand, and gravel. The generally well-drained soil conditions should provide for a favorable construction condition. However, low areas, areas of springs, and drainage swales should be avoided or mitigated when laying out proposed access roads and turbine locations. In addition, shallow bedrock is present at the project site, which may present rippability issues in excavations for foundations, collection system cables, and roads.

4.3 Fault Rupture

The information on mapped faults presented by San Diego County, the United States Geologic Survey (USGS), and the California Geological Survey (CGS) on-line databases indicates that there are no mapped active faults within the proposed development area. Not all of the mapped faults presented on the geologic map of the El Cajon quadrangle (excerpted in Figure 3; see also Todd, 2004) are shown on the CDMG Fault Activity Map (CDMG, 1994). Those faults presented on the CDMG 1994 map in the area of the project site are shown to be of pre-Quaternary age (CDMG, 1994), with the exception of two northwest-trending faults, one outside the project area to the northeast, and one that transects the project area in the vicinity of tower locations B1 through B7 (see Figure 3). These two faults are listed as “undivided Quaternary” on the CDMG map (from 1.6 million to 200 years in age) and thus must be considered potentially active. In the absence of information regarding the activity status of these faults (such as might be obtained by fault trenching), focused geologic mapping at a scale appropriate to determine whether tower foundations or foundation elements (i.e. rock anchors) are to be constructed astride the latest (onsite) fault should be performed prior to construction, in order to provide for proper risk management.

The nearest active fault is the Elsinore Fault zone, which is located approximately 7.1 miles to the northeast at its nearest point.

Most of the proposed project structures (turbine towers, substation, met towers) are not designed for human occupancy. Only the operations and maintenance building is designed for human occupancy. None of the proposed turbine locations are within 50 ft of the trace of a known active fault or a County-level fault special studies zone. Fault rupture does not appear to be a significant risk to the project.

4.3.1 Ground Shaking

All of San Diego County is located within Seismic Zone 4, which indicates that the site is subject to moderate to severe ground shaking. For the project area, this is attributable to the presence of the Elsinore Fault Zone, approximately 7.1 miles east-northeast of the project site at its nearest point. The Maximum Credible Earthquake for the Temecula segment of the Elsinore Fault Zone is a moment magnitude 6.8 event (Cao et al, 2003). Table 2 contains seismic design parameters derived from the USGS earthquake hazards program (accessed November 11, 2009). Full details of the input parameters used to generate these values are presented in Appendix A. Site class B (rock) was selected for this assessment, which is the appropriate site class for the proposed ridgeline tower locations in the project area.

Table 2. Site Seismic Acceleration Values

Location	Ss/S1[1]	SMs/SM1[2]	SDs/SD1[3]
Northern End of Project Area	1.429/0.519	1.429/0.519	0.953/0.346
Southern End of Project Area	1.283/0.450	1.283/0.450	0.855/0.300

Notes:
1. Ss/S1 are the spectral acceleration response parameters in multiples of the acceleration of gravity (g) for the mapped maximum credible earthquake (MCE) for seismic wave periods of 0.2 seconds (Ss) and 1.0 seconds (S1).

2. SMs/SM1 are the spectral acceleration response parameters in multiples of the acceleration of gravity (g) for the mapped maximum credible earthquake (MCE) adjusted for site conditions, for seismic wave periods of 0.2 seconds (SMs) and 1.0 seconds (SM1).

3. SDs/SD1 are the spectral acceleration response parameters in multiples of the acceleration of gravity (g) used to determine the site seismic design category, calculated as 2/3 of the SMs/SM1 values for periods of 0.2 seconds (SDs) and 1.0 seconds (SD1).

4.3.2 Liquefaction

Liquefaction is a potential risk where loose, saturated sandy soils may be subjected to seismic energy. The County has identified specific soil units that are susceptible to liquefaction risk, including the Mottsville loamy coarse sand (MxA) 0-2 percent slopes. The site contains a Mottsville soil unit (MvC) that is a loamy coarse sand supporting 2 to 9 percent slopes, with a depth to the water table of more than 80 inches (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx). This is a well-drained soil. It does not appear that any of the currently proposed turbine locations are on the Mottsville soil, but proposed site C4 is close to an area of Mottsville soil. It should be noted that this general description – loamy coarse sand, applies to virtually all of the site soil types. Most of the soil types shown in the project area are described as less than 80 inches thick over rock and weathered rock.

There are seven springs located within one mile of a proposed tower site (see Figure 3, and references, U.S.G.S. Sombrero Peak 7.5-minute topographic quadrangle). The closest that any tower location comes to a spring location is approximately 1,000 feet from proposed tower C3. While it is possible that saturated soils exist immediately adjacent to these spring locations, the tower sites are all sufficiently distant from the springs that the risk of liquefaction appears to be low. Still, this should be further evaluated as the project moves forward and site-specific information is generated, including the locations of other project structures like met towers, the operations and maintenance building, substation, and collection system.

4.3.3 Landslides

The project site has areas of steep slopes, greater than 25%. Some bedrock units such as schists have foliations and other planes of weakness that could contribute to instability of constructed cut slopes. There may be local talus deposits which could also impact planned grading. The potential for the presence of existing landslides exists primarily in the westernmost portion of the site, where schists are present. Areas underlain by tonalite (approximately 90 percent of the project area) are considered to be generally free of the potential for landslides.

4.3.4 Expansive Soils

Certain types of clayey soils have a tendency to adsorb water and swell and then shrink as they dry. This can exert considerable pressure on structures, leading to cosmetic and structural damage. The County has identified specific soil units that are susceptible to expansion (shrink-swell) risks (see Figure 6 and references, San Diego County, 2007. None of these specifically-named soils are present at the site. In general, the project area soils are silty sands (Unified Soil Classification System designation SM), not highly plastic clays (designations CH or MH, see Figure 5). Therefore the risk of expansive soils is not considered significant.

4.3.5 Flash Floods and Debris Flows

Debris flows are shallow water-saturated landslides that travel rapidly down slopes carrying rocks, brush, and other debris. Debris flow deposits are present in the project area as described by Todd (2004). The path of a debris flow is determined by local topography, and will typically follow existing drainage patterns. Project facilities will generally be constructed on ridgelines and are not expected to be susceptible to debris flows or flash floods. Although access roads layouts have not been prepared at this stage of conceptual design, any access road alignment crossing these types of drainages must consider the potential for this type of event.

4.3.6 Alluvial Fan Floods

Alluvial fans are generally a desert phenomenon where streams emerge from canyons and deposit sand and rock in a cone-shaped formation fanning out from the canyon mouth. Alluvial fans form in arid and semi-arid environments where steep mountain fronts meet flatter valley floors. The infrequent but intense storms in these environments produce flash floods that can carry heavy debris and sediment loads. No alluvial fans have been identified on the project site.

4.3.7 Urbanization

The conversion of undeveloped, natural areas to urbanized uses throughout San Diego's watersheds can contribute to increased potential for flooding, by increasing the rate and amount of runoff in a watershed and altering drainage patterns. The proposed wind farm will result in a negligible change to the impervious area.

4.3.8 Landform Modification

Any alteration to natural drainage patterns by modifying landforms that control the conveyance of surface water can increase the potential for flooding. The proposed project improvements will not significantly alter the drainage patterns.

4.3.9 Dam Failure

Dam failure inundation is flooding caused by the release of impounded water from failure or overtopping of a dam. The failure of a dam occurs most commonly as a result of inadequate design, neglect, or structural damage caused by earthquakes. There are no dams identified in the project area.

4.3.10 Faulty Drainage Facilities

Drainage facilities including storm drains, culverts, inlets, channels or other of these types of structures are designed to prevent flooding by collecting storm water runoff and directing flows to either the natural drainage course and/or away from urban development. The capacity of a drainage structure can typically be adequately determined by a hydrology and drainage study; however if drainage facilities are not adequately designed or built, or properly maintained, the facilities can overflow or fail, resulting in flooding. The drainage facilities in the project site are limited to small culverts on intermittent streams. Overflow or failure of drainage facilities is not considered a significant risk in the project area.

5.0 Conclusions

As presented by Todd (2004) the project area is almost wholly underlain by crystalline igneous and metamorphic bedrock. Soils within the project area are reported to be generally thin and granular in nature, comprising primarily silty sand. As shown on the State of California fault activity map (CDMG, 1994) there are no known active faults present in the project area. There are two potentially active faults that are in the immediate vicinity of the project area (see Figure 3). As indicated from calculations generated by the California Geological Survey Probabilistic Seismic Hazards Ground Motions web page (see Appendix A) project area seismicity is moderate to high. Local saturated granular soils potentially susceptible to liquefaction may be present adjacent to several springs within the project area. On steeper slopes exposing foliated metamorphic rocks such as schists, slope stability issues may be present within the project area. These rock types will require assessment in the design of cut slopes and other excavations. Based on soil descriptions provided by the USDA (SSURGO data base, see references), no extra-sensitive ("quick") clays, no peats, and no collapsible soils are likely to be present in the project area. Also per information provided by the USDA, no highly plastic clays subject to expansion are known to be present in the project area.

6.0 References

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USGS, 1959 (photorevised 1975); Sombrero Peak 7.5-minute topographic quadrangle; 1:24,000-scale.

FIGURES

Preliminary Turbine Location (10/13/2009 Coord.)

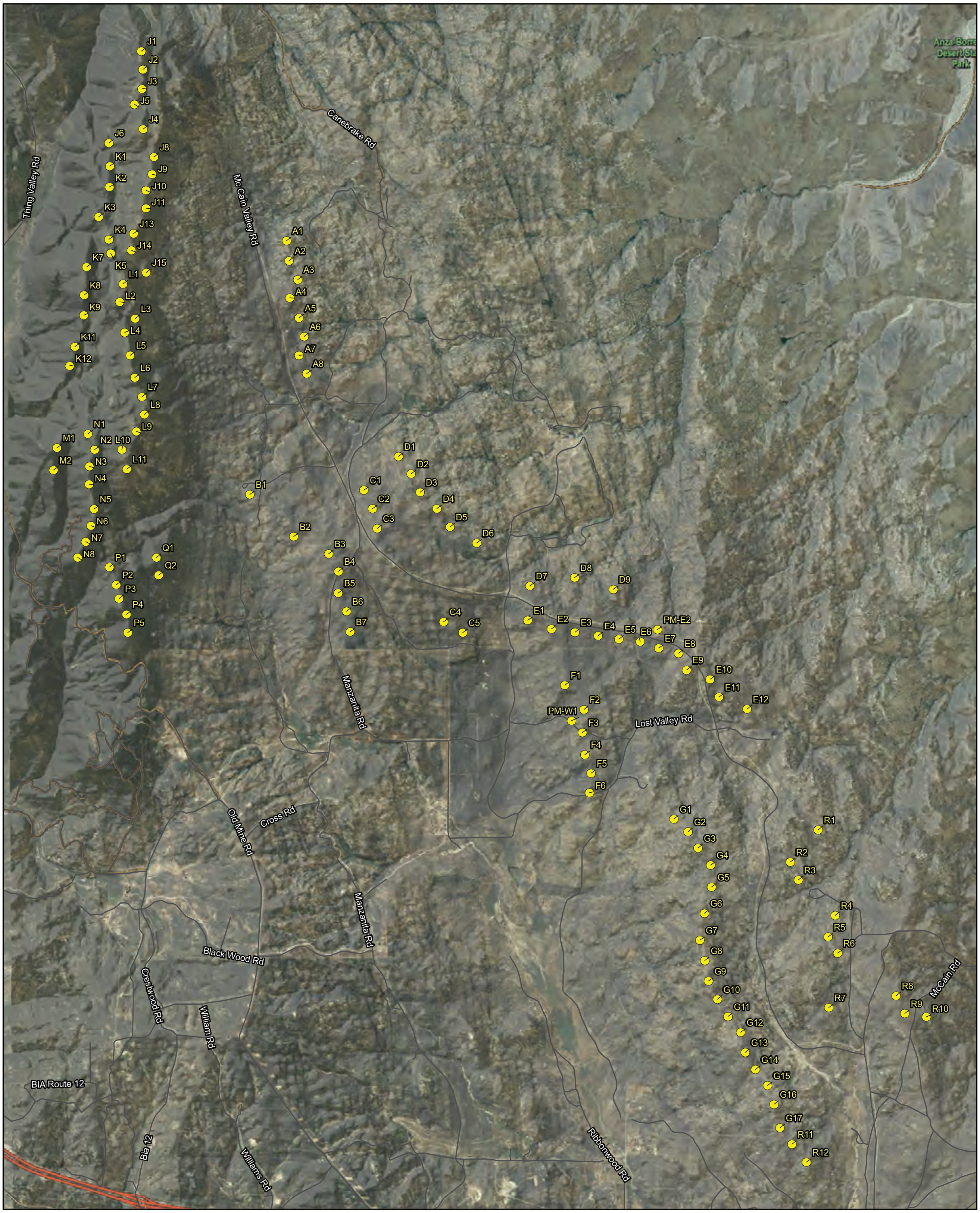
N

Miles
6 0 6

Kilometers
10 0 10

Figure 1

SITE LOCATION
Tule Wind Project
Iberdrola Renewables
San Diego Co., CA



Imagery Source: 2009 ESRI, i-cubed, GeoEye

Preliminary Turbine Location (10/13/2009 Coord.)

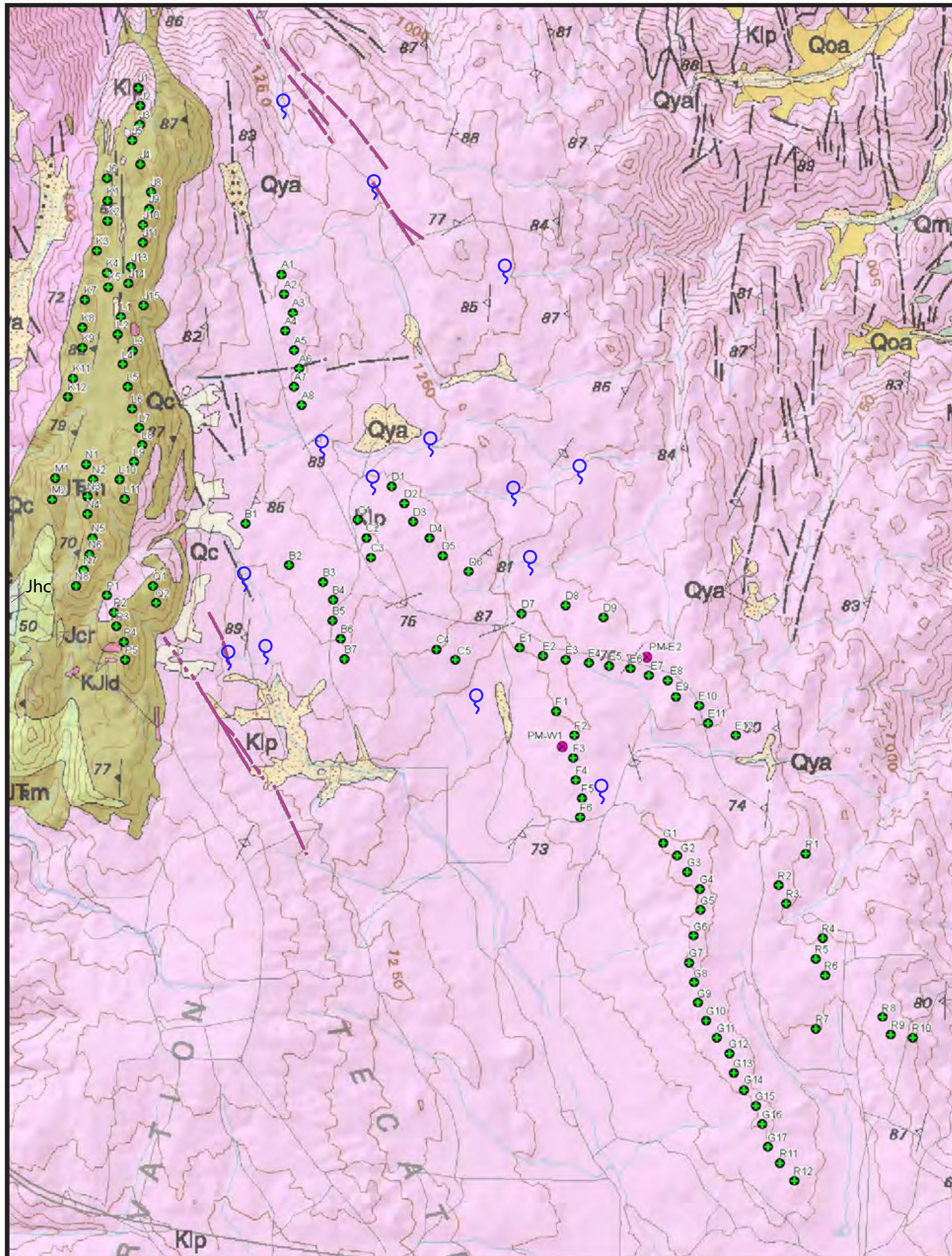
N

Feet
4,000 0 4,000

Meters
1,200 0 1,200

Figure 2

SITE LAYOUT
Tule Wind Project
Iberdrola Renewables
San Diego Co., CA



EXPLANATION

Qya — **Young alluvium (Holocene)**—Sand, silt, and gravel in modern streambeds and washes. Includes recent material accumulated on active alluvial fans

Qc — **Colluvium (Holocene and Pleistocene)**—Sand and gravel of slopewash, debris-flow, and talus deposits. Grades locally into younger alluvium (Qya) and older alluvium (Qoa)

Qoa — **Older alluvium (Holocene and Pleistocene)**—Sand, silt, and gravel; moderately dissected terraces in stream valleys. Well to poorly bedded, unconsolidated. In places, modern streams incise older alluvium to as much as 15 m. In some areas, older alluvium grades into younger alluvium

KJld — **Leucocratic dikes (Late Cretaceous and Late Jurassic)**—Leucogranite, granophyre, alaskite, pegmatite, and aplite; found cutting plutonic units in quadrangle. Includes dikes of at least three ages

Klp — **Tonalite of La Posta (Early and Late Cretaceous)**—Hornblende-biotite trondhjemite in western part, and biotite trondhjemite and granodiorite in eastern part. Unit is leucocratic, homogeneous, largely undeformed, and inclusion-free, but locally, pluton margins are moderately to strongly foliated. Color index from 6 to 15

Jcr — **Granodiorite of Cuyamaca Reservoir (Late and Middle Jurassic)**—Biotite and hypersthene-biotite granodiorite and tonalite; also contains actinolitic amphibole. Fine to medium grained, strongly foliated, locally mylonite gneiss. Average color index is 25

J̄Tm — **Metasedimentary and metavolcanic rocks (Jurassic and Triassic)**—Interlayered semi-pelitic, pelitic, and quartzitic schists; calcsilicate-bearing feldspathic metaquartzite; and minor small-pebble metaconglomerate. Includes layers of sandstone, quartz-pebble conglomerate, mudstone, and amphibolite. Interpreted to be metamorphosed submarine fan deposits and intercalated volcanic rocks; equivalent to the Julian Schist of Hudson (1922)

Jhc — **Gneiss of Harper Creek (Late and Middle Jurassic)**—Gneissic to mylonitic biotite granodiorite and tonalite, and lesser monzogranite. Fine- to medium-grained; strongly foliated. Average color index is 22. Contains muscovite, cordierite, sillimanite, and garnet, and abundant, inclusions. Isoclinal folded in places

Contact —Solid where accuracy of location ranges from well located to approximately located; dashed where very poorly located or inferred. Color change without a contact shown is a scratch boundary

70

Fault —Solid where accurately located, dashed where approximately located, dotted where concealed. Arrow and number indicate direction and amount of dip.

Quaternary fault - age undi erentiated (CDMG - Fault Activity Map of California and Adjacent Areas (1994)

Spring (Approximate)

Strike and dip of bedding

Horizontal

20 Inclined

Strike and dip of foliation, primary igneous

50 Inclined

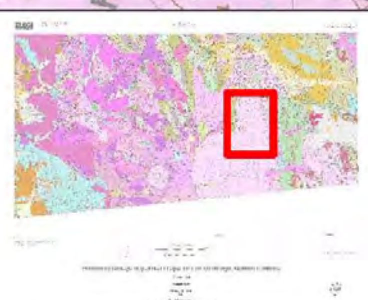
Vertical

Strike and dip of foliation, metamorphic

50 Inclined

Vertical

Geology from Todd, V.R., 2004, Geologic Map of El Cajon 30'x 60' Quadrangle, Southern California



Met Tower

Turbine

N

0 0.5 1 2

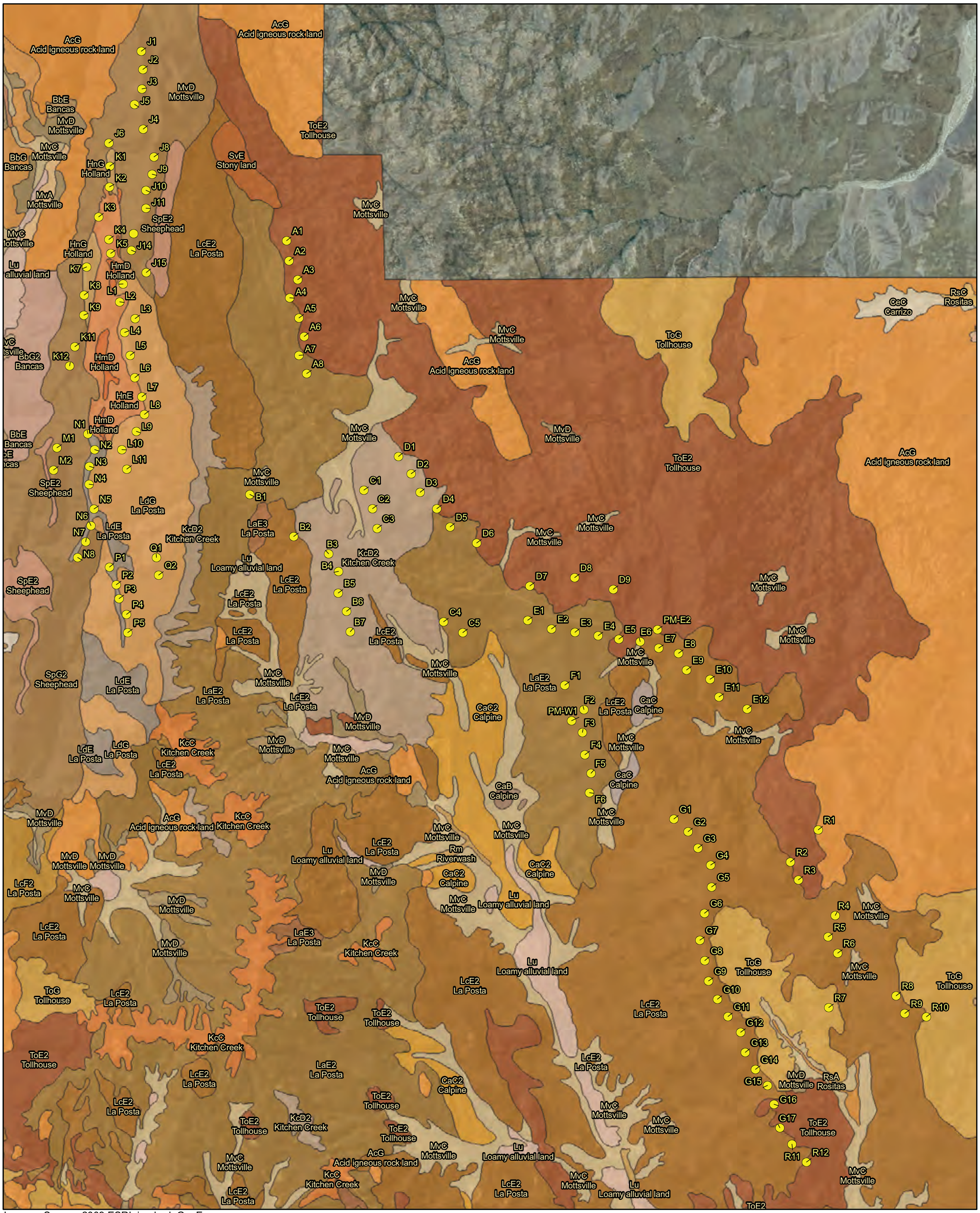
Miles

Tule Power Wind Project

Figure 3
Preliminary Geologic Map of El Cajon 30' x 60' Quadrangle

Map Prepared by: HDR for IBERDROLA RENEWABLES

Map information was compiled from the best available sources. No Warranty is made for its accuracy or completeness.
Data Sources: Geologic Base Map from USGS,
Project Features from Iberdrola Renewables
Data is UTM meters, NAD83, zone 11



Imagery Source: 2009 ESRI, i-cubed, GeoEye
Data Source: USDA NRCS SSURGO Database

Preliminary Turbine Location (10/13/2009 Coord.)

Soil Map Unit

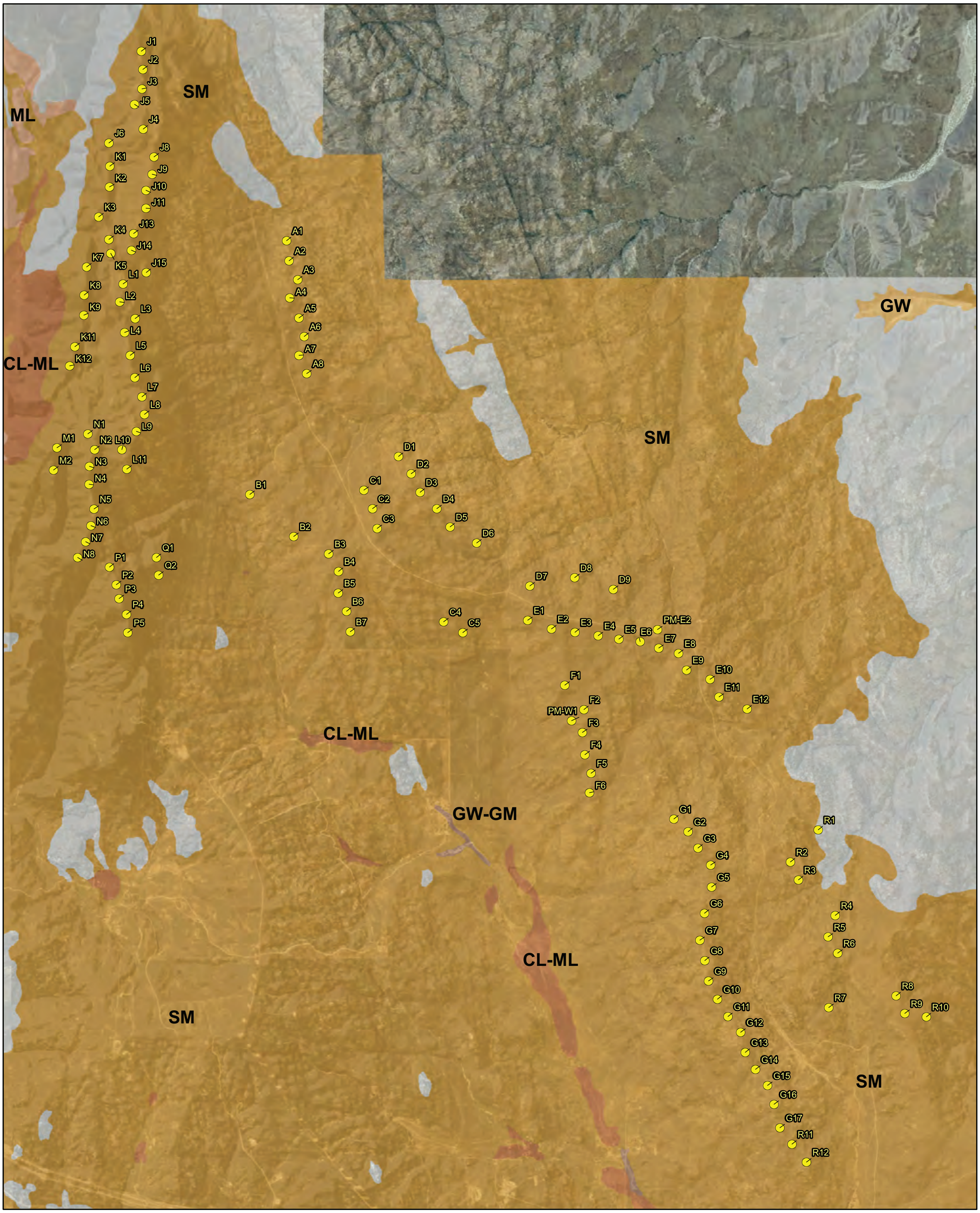
N

Feet
4,000 0 4,000

Meters
1,200 0 1,200

Figure 4

SOIL MAP
Tule Wind Project
Iberdrola Renewables
San Diego Co., CA



Imagery Source: 2009 ESRI, i-cubed, GeoEye

Preliminary Turbine Location (10/13/2009 Coord.)

Unified Soil Classification

- Undefined
- CL-ML
- GW
- GW-GM
- ML
- SM

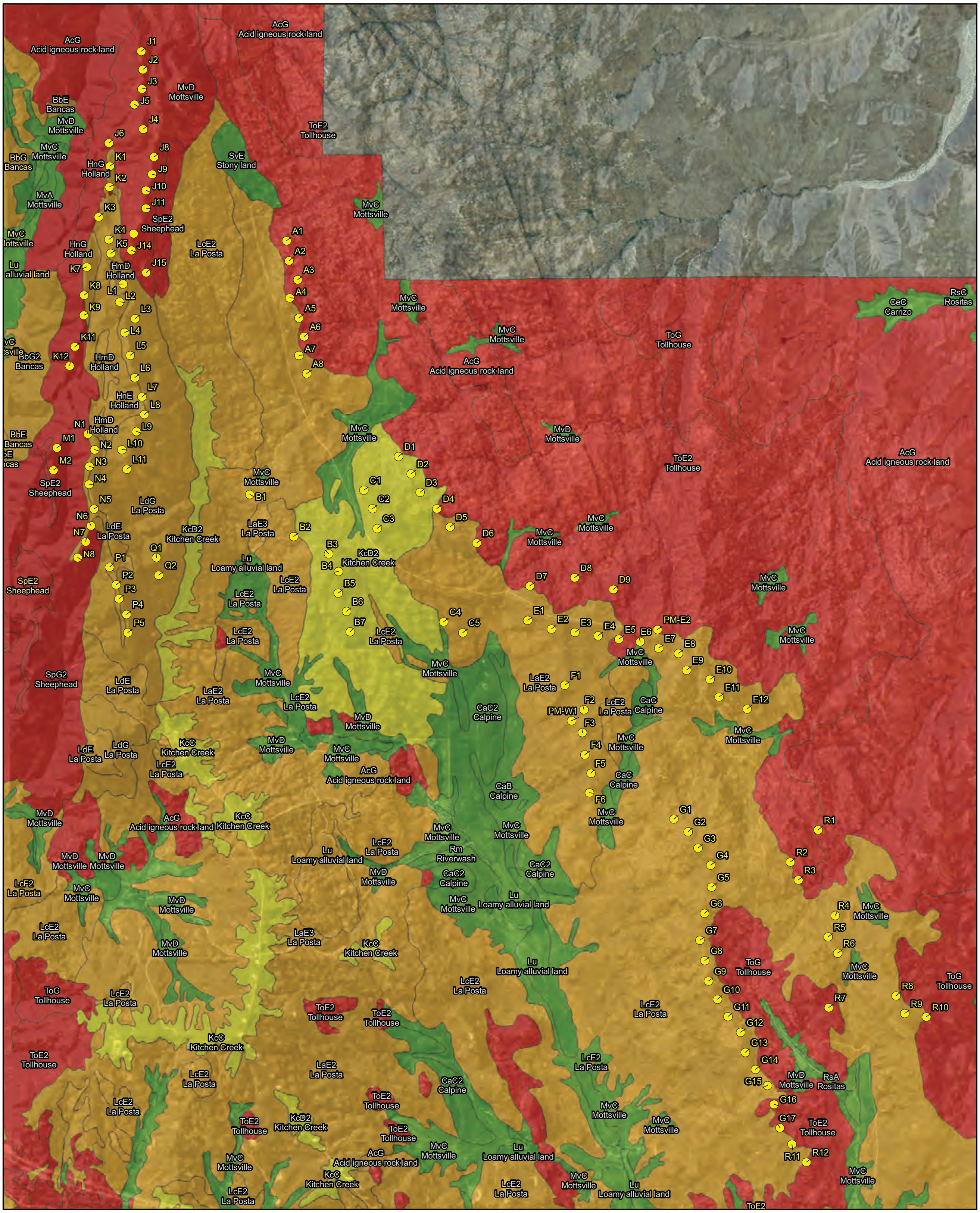
N

Feet
4,000 0 4,000

Meters
1,200 0 1,200

Figure 5

UNIFIED SOIL CLASSIFICATION
Tule Wind Project
Iberdrola Renewables
San Diego Co., CA



Imagery Source: 2009 ESRI, i-cubed, GeoEye
Data Source: USGS SSURGO Database

- Preliminary Turbine Location (10/13/2009 Coord.)
- Unspecified/Greater than 150 cm
- 0 - 50 cm
- 50 - 100 cm
- 100 - 150 cm

N

Feet
4,000 0 4,000

Meters
1,200 0 1,200

Figure 6

DEPTH TO WEATHERED BEDROCK
Tule Wind Project
Iberdrola Renewables
San Diego Co., CA

APPENDIX A

Site Seismic Information

Conterminous 48 States
2006 International Building Code
Latitude = 32.83
Longitude = -116.37
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B - Fa = 1.0 ,Fv = 1.0
Data are based on a 0.009999999776482582 deg grid spacing

Period (sec)	Sa (g)	
0.2	1.429	(Ss, Site Class B)
1.0	0.519	(S1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.83
Longitude = -116.37
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class B - Fa = 1.0 ,Fv = 1.0

Period (sec)	Sa (g)	
0.2	1.429	(SMs, Site Class B)
1.0	0.519	(SM1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.83
Longitude = -116.37
Design Spectral Response Accelerations SDs and SD1
SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class B - Fa = 1.0 ,Fv = 1.0

Period (sec)	Sa (g)	
0.2	0.953	(SDs, Site Class B)
1.0	0.346	(SD1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.76
Longitude = -116.28
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B - Fa = 1.0 ,Fv = 1.0
Data are based on a 0.009999999776482582 deg grid spacing

Period (sec)	Sa (g)
0.2	1.283 (Ss, Site Class B)
1.0	0.450 (S1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.76
Longitude = -116.28
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class B - Fa = 1.0 ,Fv = 1.0

Period (sec)	Sa (g)
0.2	1.283 (SMs, Site Class B)
1.0	0.450 (SM1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.76
Longitude = -116.28
Design Spectral Response Accelerations SDs and SD1
SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class B - Fa = 1.0 ,Fv = 1.0

Period (sec)	Sa (g)
0.2	0.855 (SDs, Site Class B)
1.0	0.300 (SD1, Site Class B)

California Geological Survey

Probabilistic Seismic Hazards Mapping Ground Motion Page

User Selected Site

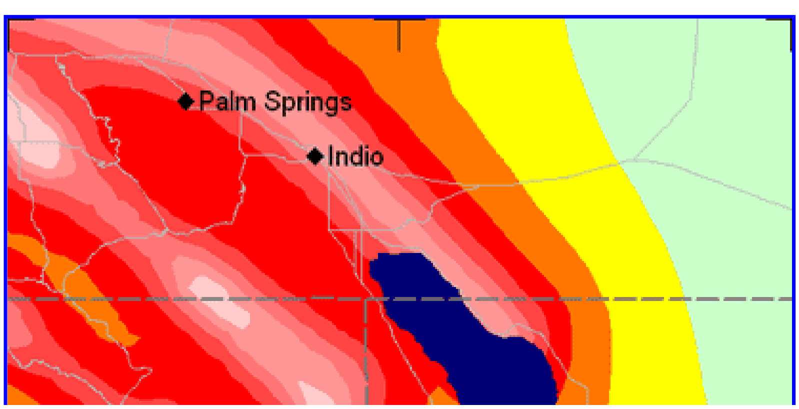
Longitude	-116.32
Latitude	32.8

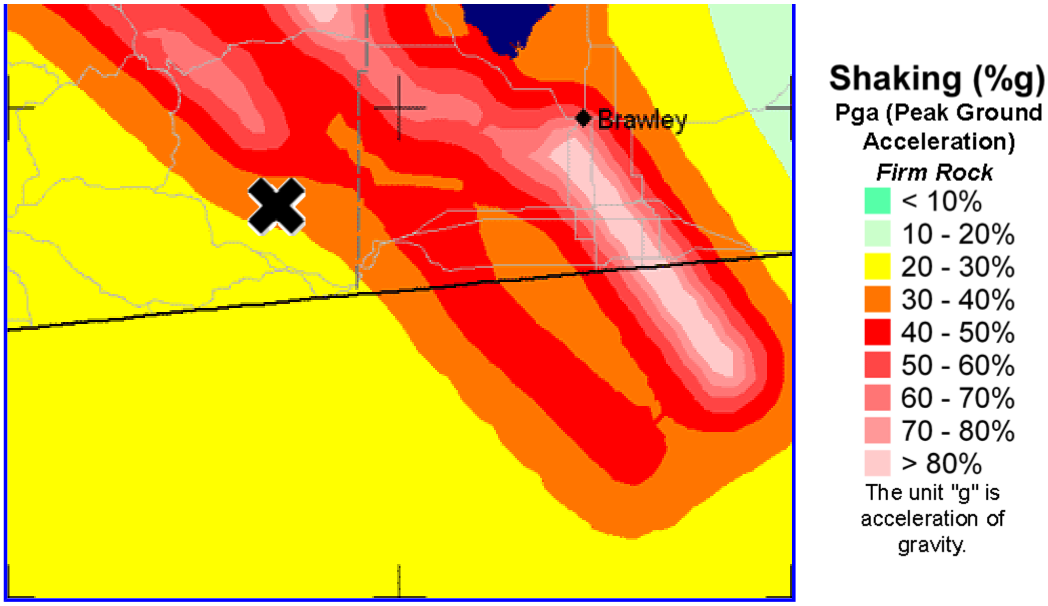
Ground Motions for User Selected Site

Ground motions (10% probability of being exceeded in 50 years) are expressed as a fraction of the acceleration due to gravity (g). Three values of ground motion are shown, peak ground acceleration (Pga), spectral acceleration(Sa) at short (0.2 second) and moderately long (1.0 second) periods. Ground motion values are also modified by the local site soil conditions. Each ground motion value is shown for 3 different site conditions: firm rock (conditions on the boundary between site categories B and C as defined by the building code), soft rock (site category C) and alluvium (site category D).

Ground Motion	Firm Rock	Soft Rock	Alluvium
Pga	0.327	0.342	0.374
Sa 0.2 sec	0.784	0.826	0.901
Sa 1.0 sec	0.282	0.353	0.437

NEHRP Soil Corrections were used to calculate Soft Rock and Alluvium.
Ground Motion values were interpolated from a grid (0.05 degree spacing) of calculated values. Interpolated ground motion may not equal values calculated for a specific site, therefore these values are not intended for design or analysis.





***Click here** to return to the statewide PSHA map or enter new coordinates below:*

Longitude: Latitude: Submit

Please enter coordinates as Decimal Degrees
Example: Longitude -122.0017 Latitude 36.9894

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