CHAMBERS GROUP

February 8, 2021

Alissa Sanchez
Ormat Nevada, Inc.
801 Main Street
Centro, CA 92243

Subject: Geotechnical Feasibility Study Applicability

Dear Ms. Sanchez,

Petra Geosciences, Inc. prepared a Geologic/Geotechnical Feasibility Study for the Brawley Solar Project (proposed Project) on February 3, 2011. This study analyzed the Project Site in its entirety.

On February 3, 2021, Chambers Group reached out to Alan Pace, one of the prepares of the original feasibility study to confirm that the findings in the previously prepared report have not meaningfully changed. Mr. Pace responded with: "Petra conducted a feasibility-level investigation for the Brawley Solar Facility project. Petra Job No. 320-10 dated February 3rd, 2011. The conditions noted in the 2011 study have not significantly changed since the preparation of this email."

Based on geological conditions and confirmation from Petra Geosciences, the February 3, 2011 Geologic/Geotechnical Feasibility Study would still apply to the proposed Project and could and should be used during CEQA compliance to describe the existing conditions and potential impacts from the Project to the environment specific to geology and soils.

If you have any questions, please do not hesitate to contact Project Manager, Victoria Boyd at (760) 685-4838 or vboyd@chambersgroupinc.com.

Sincerely,

CHAMBERS GROUP, INC.

Victoria Boyd

Victoria Boyd
Project Manager

Riverside County

38655 Sky Canyon Drive, Suite A
Murrieta, California 92563
951-600-9271

PETRA

past + present + future
it's in our science

Engineers, Geologists
Environmental Scientists

February 3, 2011
J.N. 320-10

Mrs. Charlene Wardlow
ORMAT
6225 Neil Road
Reno Nevada, 89511

Subject: **Geologic/Geotechnical Feasibility Study; Brawley 190-Acre Photovoltaic Site, Located Approximately 2 ½ miles Northwest of the City of Brawley, Imperial County, California**

Dear Mrs. Wardlow;

Petra Geotechnical, Inc. (Petra) is pleased to submit this geologic/geotechnical feasibility report for the subject photovoltaic (PV) site located at the northwest corner of Best and Ward Roads in the Brawley area of Imperial County, California. Figure 1 depicts the site location with respect to the surrounding area. As we understand, the proposed development will consist of a solar farm and associated improvements such as access roads and maintenance buildings. In addition to the solar farm, the ultimate development is understood to include six geothermal wells and appurtenant facilities. The purpose of this study is to obtain available geotechnical and geologic information on the nature of the current soil conditions and to evaluate the potential geologic hazards or constraints that may impact the development of the subject property, specifically with respect to the PV solar farm. Geotechnical and geologic issues pertaining to the development of the geothermal wells and facilities will be addressed in a separate report.

This report presents the findings and opinions regarding the feasibility of the proposed project with respect to the geologic and geotechnical factors that may impact site development. This report is based on review of available geologic maps and data, site reconnaissance, and drilling and sampling of near surface soils for preliminary laboratory testing. This work was performed in accordance with our Proposal No. 1260-10, dated August 5, 2010.

LOCATION AND SITE DESCRIPTION

The subject site consists of approximately 190 acres within the northern part of the Imperial Valley, Imperial County, California, approximately 2.5 miles north of the town of Brawley (see Figure 1). The project site is accessed by a dirt road in the central portion of the site, adjacent to Best Road. This road is also currently utilized for access to the waste water treatment plant to the southwest. The property is bounded by the paved Best Road to the east, by the unpaved Ward Road and an active drainage channel to the south, by another active drainage channel to the north, and by several ponds related to an existing waste water treatment plant to the west. The western property boundary is delineated by an approximately 20- to 30-foot high natural slope that descends to the treatment ponds. The New River is also located just west of the property. Vacant farmed property is generally located to the south, east and north. During our site investigation, a contractor was observed constructing pipelines in the southern portion of the site.

The topography of the site is nearly level to very gently sloping to the south-southwest at an approximate elevation of 140 to 150 feet below mean sea level (msl). The surface of the majority of the site is currently in a farmed/tilled condition; however some areas are also covered with a light to heavy growth of brush and several stands of small trees. Notable improvements with the property included several abandoned buildings in the southeast corner of the site and along the eastern property line near the center of the site. Although not observed, underground storage tanks may also be present in the vicinity of these structures. A north-south trending Pacific Railroad easement bisects the central portion of the property. Existing above-ground steel pipelines are located just east of the rail lines and near the eastern property line in the southeast quadrant of the site. Several dirt paths and abandoned concrete-lined irrigation V-ditches are also located throughout the site. Overhead electric/utility poles are present along the eastern and northern property lines. The irrigation channel along the southern property line is unlined, however the channel along the northern properly line is concrete-lined and eventually drains into an underground culvert-type structure located near the property line several hundred feet south of the northwest property corner.

FIELD EXPLORATION AND LABORATORY TESTING

Our site reconnaissance and subsurface exploration program was performed under the direction of an engineering geologist from Petra on December 2, 2010. The exploration involved the excavation of four 8-inch diameter exploratory hollow-stem auger borings to a maximum depth of approximately 51.5 below existing grade (Borings B-1 through B-4). Earth materials encountered within the exploratory borings were classified and logged by an engineering geologist in accordance with the visual-manual procedures of the Unified Soil Classification System. The approximate locations of the exploratory borings are shown on Figure 2 and descriptive logs are presented in Appendix A.

Disturbed bulk samples and relatively undisturbed ring samples of soil materials were collected for classification, laboratory testing and engineering analyses. Disturbed bulk samples were collected from the drill rig cuttings and sealed in plastic bags for transport to our in-house laboratory. Undisturbed samples were obtained using a 3-inch outside diameter modified California split-spoon soil sampler lined with brass rings. The soil sampler was driven with successive 30-inch drops of a free-fall, 140-pound automatic trip hammer. The central portions of the driven-core samples were placed in sealed containers and transported to our laboratory for testing. The number of blows required to drive the split-spoon sampler 18 inches into the soil were recorded for each 6-inch driving increment; however, the number of blows required to drive the sampler for the final 12 inches was noted in the boring logs (Appendix A) as *Blows per Foot*.

To provide a preliminary evaluation the engineering properties of the near surface soils underlying the subject site, select laboratory tests were performed on samples considered representative of the materials encountered. Preliminary laboratory tests included the determination of in-situ moisture content and dry density, expansion potential, soluble sulfate and chloride content, pH, and minimum resistivity. A description of laboratory test procedures and summaries of the test data are presented in Appendix B and the moisture/density test data is included on the borings logs in Appendix A.

FINDINGS

Regional Geology

The proposed solar farm site is located within northern portion of the Imperial Valley, which is part of the Salton Trough geomorphic province of California. The Salton Trough encompasses the Coachella, Imperial and Mexicali Valleys, which extend from northeast of Palm Springs near San Gorgonio Pass to the Gulf of California. The geologic structure of the trough is a result of extensional forces within the earth's crust. The Imperial Valley is bounded by the Chocolate Mountains to the northeast, the Salton Sea to the north, the Peninsular Ranges to the southwest, and Mexicali Valley to the south. Lacustrine and alluvial sediments are the dominant geologic units of the Imperial Valley. Unexposed succession of Tertiary- and Quaternary-aged sedimentary rocks lies below the alluvial and lake sediments ranging in depth from 11,000 feet or more at the margins to more than 20,000 feet in the central portion of the Salton Trough. Basement rocks consisting of Mesozoic granite and probably Paleozoic metamorphic rocks are estimated to exist at depths between 15,000 and 20,000 feet.

The watershed of the Salton Trough empties into the Salton Sea at the lowest part of the basin. This basin was periodically filled with water to form the ancient Lake Cahuilla, depending on which side of its delta the Colorado River would drain. The sediments of the delta form a topographic high that separates the Salton basin, which is below sea level, from the Gulf of California.

Local Geology and Subsurface Conditions

The site is essentially within the floodplain of the New River and is generally underlain by Quaternary lake deposits. The western boundary of the site (descending slope) is the former bank of the New River. In addition a topsoil/tilled horizon and minor amounts of undocumented artificial fill were observed at the surface of the site and the soil units are discussed as follows.

Undocumented artificial fill on the site is related to the boundary roads and paths, the adjacent drainage channels, and the railway that bisects the site. The fill within these areas consists of local lean to fat clay derived from the native lake deposits, described below. The surface of the vast majority of the property is mantled by a 1-to 1.5-foot thick horizon of topsoil and/or tilled soil related to the previous agricultural usage. These soils are predominantly silts and clays.

Young lake deposits are the dominant geologic unit below the site. Based on the data obtained from the borings, the predominate soil types consist of silts and clays with occasional interbeds of silty sand.

Seismic Setting

The Salton Trough is a seismically active area and in particular within the Imperial Valley with numerous northwest-trending active faults. The closest active faults in proximity to the site include: the Brawley Seismic Zone, approximately 2.4 miles to the west; the Imperial fault, approximately 8.3 miles to the south; the Superstition Hills fault, approximately 11.9 miles to the southwest; the Superstition Mountain fault, approximately 14.5 miles to the southwest; the Elmore Ranch fault, approximately miles 15.8 to the west; and the San Andreas fault zone, approximately 25.5 miles to the northwest. An "active" fault is defined as a fault that has had displacement within the Holocene epoch, or last 11,000 years. A "potentially active" fault is a fault that does not have evidence of movement within the last 11,000 years, but has moved within the last 1.6 million years.

The site is not located within a *Fault Hazard Zone*, as defined by the state of California in the Alquist-Priolo Earthquake Fault Zoning Act and no faults are know to project through the project site.

Groundwater

Groundwater was encountered at approximately 42 feet below existing grade at B-1 in the western end of the site and perched groundwater was encountered at approximately 12 feet below grade at B-4 in the northeast corner of the site. In addition water is channeled within the drainage ditches/channels along the northern and southern property lines just below the surface elevation of the site.

GEOLOGIC HAZARDS

The following section discuses various potential geologic hazards with respect to the proposed 190-acre solar farm site. The issues addressed include fault ground rupture, strong seismic shaking, liquefaction and other earthquake-induced ground hazards, slope stability, subsidence and flooding.

Fault Rupture

The site is not located within a currently designated State of California Alquist-Priolo Earthquake Fault Zone (Hart, 1999). In addition, no known active faults have been identified on the site. While fault rupture would most likely occur along previously established fault traces, fault rupture could occur at other locations. However, the potential for active fault rupture at the site is considered to be very low

Seismic Shaking

The site is located within an active tectonic area with several significant faults capable of producing moderate to strong earthquakes. The Imperial fault, the Superstition Hills fault and the Superstition Mountain fault are all in close proximity of the site and capable of producing strong ground motions. Historically, the Imperial fault generated the 1979 and 1940 earthquakes and the Elmore Ranch fault generated the November 23, 1987 earthquake that is thought to have triggered the November 24, 1987 earthquake that occurred on the Superstition Hills and Wienert faults. Table 1 lists select recorded earthquakes felt at the site area.

Based on probabilistic analysis from the California Geological Survey web site, the peak ground acceleration at the site is estimated to be approximate 0.48g, based on a probability of 10 percent in 50 years.

TABLE 1
Significant Historic Earthquakes

Earthquake Events	Moment Magnitude (Mw)
El Mayor/Cucapah Mexicali (April 4, 2010)	7.2
Superstition Hills (Nov. 24, 1987)	6.6
Elmore Ranch (Nov. 23, 1987)	6.2
Mexicali (June 9, 1980)	6.1
Imperial Valley (Oct. 15, 1979)	6.4
Borrego Mountain (April 8, 1968)	6.5
Imperial Valley (May 18, 1940)	6.9
Laguna Salada (Feb. 23 1892)	7.0

Liquefaction Potential

Loosely compacted/deposited granular soils located below the water table can temporarily loose strength through the process of liquefaction during strong earthquake-induced ground shaking. When solid particles in a saturated soil consolidate into a tighter package as a result of vibration due to an earthquake, the non-compressible pore water between the particles will be squeezed out. If the soil has a high permeability, a sufficient amount of water will drain out of the pores to maintain inter-granular stresses and, thereby, the soil's shear strength. However, if the permeability is relatively low, then the water will not drain away quickly enough and pore water pressures will build as a result. If the pore water pressure rises to a level such that the shear strength of the soil becomes zero, then liquefaction is said to have occurred. Factors known to influence liquefaction potential include soil type and depth, grain size, relative density, ground-water level, degree of saturation, and both intensity and duration of ground shaking.

Based on our observations of site soils encountered during drilling the exploratory borings, the potential for liquefaction at the site is considered to be very low. This is based on the predominate types of soils encountered in the borings, fine-grained silts and clays, and the lack of a shallow groundwater table. However, additional analysis is warranted during the design level geotechnical investigation of the site to evaluate the potential for differential settlement during a major seismic event.

Secondary Effects of Seismic Activity

Secondary effects of seismic activity normally considered as possible hazards to a site include several types of ground failure, as well as earthquake-induced flooding. Various general types of ground failures, which might occur as a consequence of severe ground shaking at the site, include landsliding, ground subsidence, ground lurching and lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, subsoils and groundwater conditions, in addition to other factors. Based on the site conditions and gentle to relatively flat topography across the majority of the site, landsliding, ground subsidence, ground lurching and lateral spreading are considered unlikely at the site.

Seismically induced flooding that might be considered a potential hazard to a site normally includes flooding due to tsunami or seiche (i.e., a wave-like oscillation of the surface of water in an enclosed basin that may be initiated by a strong earthquake) or failure of a major reservoir or retention structure upstream of the site. No major reservoir is located near, or upstream of the site so the potential for seiche or inundation is considered negligible. Because of the inland location of the site, flooding due to a tsunami is also considered negligible at the site.

Landslides and Slope Instability

No landslides exist within or near the site. Based on the relatively flat topography across the site and areas to the north, east and west of the site, the potential for landsliding is considered negligible. However there is a potential for general slope instability within the descending slope along the western boundary of the site. The southern portion of this slope appears to have been recently graded, however the northern portion appears to be natural and also in a somewhat over-steepened condition. In addition we observed some minor slumping within localized areas of this natural descending slope as well as several other areas that are heavily eroded. Based on the topography of the site, runoff water is allowed to freely drain over the top of this slope. A detailed site plan showing the existing topography was not available at the time of this study, however we tentatively estimate this slope to be approximately 20 to 30 feet in height.

Areal Subsidence

The site is not known to be located in an area with potential for ground subsidence due to withdrawal of fluids.

Flooding and Erosion

Sheet flooding and local erosion may be possible at this site. The site is mapped within Zone X by FEMA's Flood Insurance Rate Maps indicating the area has a low to moderate risk.

Expansive Soils

Expansive soils generally result from specific clay minerals that expand in volume when saturated and shrink in volume when dry. Expansive soils can severely impact the performance of slabs or structures with shallow foundations. Expansive soils are know to be present throughout the Imperial Valley and our preliminary laboratory testing encountered medium to highly expansive soils within the upper 5 feet of the project site.

Preliminary Soil Corrosivity Screening

As part of this investigation, a representative sample of near-surface soils was subjected to several screening tests in order to provide a general assessment of soil corrosivity. The results of these tests are provided in Appendix B.

The following sections of this report present our geotechnical engineering interpretation of current codes and specifications that are commonly used in our industry in conjunction with limited laboratory testing for corrosive potential. It should be noted that Petra Geotechnical, Inc. does not practice corrosion engineering; therefore, the opinions and engineering judgment provided herein should be considered as general guidelines only. It is recommended that the project design professional (i.e., the architect and/or structural engineer) consider retaining a qualified corrosion engineer to conduct additional sampling and testing of near-surface soils during the final stages of site grading to provide a complete assessment of soil corrosivity. Recommendations to mitigate the detrimental effects of corrosive soils on concrete and buried metallic building materials (such as copper and ductile iron) placed in contact with site soils should be provided by the corrosion engineer as deemed appropriate.

Soluble Sulfate and Soil pH - The results of our laboratory testing performed in accordance with California Test Method No. 417 indicate onsite near-surface soils contain a water-soluble sulfate content of 0.267 percent. According to Table 4.2.1 of the ACI 318-08, the soils are thus categorized as Exposure Class S2 with respect to soluble sulfates and, therefore, a **Severe** exposure to sulfates may be expected for concrete placed in contact with these soil materials.

Based on section 1904.3 of the 2010 CBC, concrete that will be exposed to sulfate-containing soils shall comply with the provisions of the American Concrete Institute (ACI) Standard 318-05, Section 4.3. According to Table 4.3.1 of the ACI 318-05, to reduce the potential for concrete deterioration, sulfate resistant cement should be used in all concrete that may be in contact with on-site soils. Further, careful control of the maximum water-cement ratio and the minimum concrete compressive strength is also necessary in order to provide proper resistance against deterioration due to sulfates.

For concrete that is expected to have a **Severe** exposure to sulfates, Table 4.3.1 of ACI Standard 318-05 indicates that Type V cement should be used, and that the maximum water-cement ratio should not exceed 0.45. In addition, the concrete compressive strength should not be less than 4,500 pounds per square inch.

Soluble Chloride - The results of tests performed in accordance with California Test Method No. 422 indicate that onsite soils contain water-soluble chloride concentrations on the order of 262 parts per million (ppm). According to Table 4.2.1 of the ACI 318-08, concrete that is exposed to moisture but not to external sources of chloride should be categorized as Exposure Class Low with respect to chlorides and, therefore, a Low exposure to chlorides may be expected for concrete placed in contact with the onsite soil materials.

Section 1904.4 of the 2010 CBC requires that reinforcement in concrete be protected from exposure to chlorides in accordance with Section 4.4 of ACI 318; however, Section 4.4 of ACI 318-08 is related to freeze-and-thaw conditions that are not applicable to the subject project. Therefore, no protection against chloride content is expected to be required. Further, according to Table 8.22.1 of Caltrans BDS no minimum concrete cover is specified when chloride concentration is less than 500 ppm.

Resistivity - The minimum soil resistivity was determined in accordance with California Test Method No. 643 and was found to be 120 ohm-cm. This result indicates that onsite soils are severely corrosive to ferrous metals and copper. As such, any ferrous metal or copper components of the proposed buildings within the site (such as cast iron pipes, ductile iron pipes, copper tubing, etc.) that are expected to be buried in direct contact with site soils need to be protected against the detrimental effects of severely corrosive soil materials.

CONCLUSIONS AND RECOMMENDATIONS

General Feasibility

Based on our preliminary assessment of potential geologic hazards and soil conditions, development of the subject property is considered feasible for a geotechnical standpoint. We recommend that a detailed geotechnical investigation be conducted when site plans are developed to prepare site specific grading and foundation recommendations that are appropriate for the proposed construction. However, there are several geologic/geotechnical issues that require consideration for the development of the proposed project and are discussed further below.

Slope Stability

Based current conditions of the existing descending slope along the western property boundary, there is a potential for slope instability. Based on the intended use of the site, grading of this slope is not considered cost effective or necessary. At this time we recommend that any permanent structural improvements near the top of slope along the western property line be tentatively setback by a 3:1 (horizontal: vertical) projection from the existing toe-of-slope. This would include the placement of geothermal wells. Non-permanent structures such as access roads and fencing would be permitted within this zone. Based on our observations we anticipate the slope to be on the order of 20 to 30 feet in height, therefore a 60- to 90-foot setback would be warranted. In addition we recommend that an earthen drainage berm be constructed along the top of this slope to prevent surface water from flowing over this slope and to channel any water towards the appropriate drainage facilities. We recommend that a more detailed slope stability analysis be performed during the subsequent design phase geotechnical investigation.

Liquefaction Potential

Although there is a very low potential for earthquake-induced liquefaction to affect the site, further evaluation and analysis is warranted during the design phase geotechnical investigation to confirm that no specialized foundation design is needed.

Aerial Subsidence

The general area is not experiencing subsidence that would typically be attributed to the extraction of groundwater. The solar farm is not expected to exacerbate or otherwise trigger significant subsidence. However, the operation of six geothermal wells throughout the site could potentially result in subsidence if large quantities of groundwater are extracted with a resulting lowering of the water table. Because the specifics of the geothermal process and their impact on the groundwater levels are not a part of this study, the issue of potential subsidence related to the operation geothermal wells should be addressed.

Solar Panel Foundations

The soil conditions are such that the proposed solar panels may be supported on a variety of foundation systems. The near surface native soils were observed to consist primarily of clay and silt. Results of our laboratory testing indicate that near surface onsite soils exhibit an Expansion Index ranging from 72 to 102 (a medium to high expansion potential). These soils should thus be considered as "Expansive" per Section 1803.5.3 of the 2010 California Building Code (CBC).

The foundation system for the proposed solar panels is anticipated to consist of cast-in-drilled-hole (CIDH) concrete piles supporting steel pipe columns. Remedial grading is generally not required, as piles may be drilled to various depths to accommodate the vertical and lateral capacities needed. Test piles will be required to verify design vertical bearing capacities, both down-force and pullout, and lateral bearing capacity.

Other possible foundation systems could include conventional shallow spread footings and a variety of deep foundations, driven steel piles, and drilled helical anchors. Each of these foundation types has both merits and drawbacks with respect to ease and speed of installation, and cost.

More detailed geotechnical studies will be required to more fully evaluate the final foundation recommendations, or if other foundation options are considered.

Equipment Slabs

Portland Cement Concrete (PCC) slabs will be used for support of appurtenant structures, such as Inverter Transformers and PV Interconnection Switch Gear. Conventional spread footings or structural slabs are assumed for the support of these slabs. Due to the variable density of the near surface soils, an anticipated over-excavation that will provide a three-foot blanket of fill below proposed bottom of footing, extending laterally a minimum of five feet beyond the footprint of the slabs should be assumed. Localized regions may be encountered which require a deeper over-excavation. The excavated alluvial soils are anticipated to be suitable for use as compacted fill beneath the equipment slabs, provided any deleterious materials (vegetation, rocks in excess of 6 inches in largest dimension, etc.) are removed: however, if used, expansive soil will have to be considered in the foundation/slab design. Consideration should also be given to replacement of the slab subgrade soils with select non-expansive materials.

Corrosive Soils

Results of our preliminary laboratory screening tests indicate that near surface onsite soils are considered severely corrosive to both concrete materials and metallic elements. Petra does not practice corrosion engineering; therefore a qualified corrosion specialist should be consulted to mitigate severely corrosive soils.

Strong Seismic Related Ground Motions

The site is located in a seismically active area of Southern California and will likely be subjected to very strong seismically-related ground shaking during the anticipated life span of the project. Structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the provisions of the 2010 CBC.

Conduit Trenches

We anticipate that the solar panels will be connected by buried conduit. Most of the alluvial deposits at the site should present little difficulty with regard to conduit installation, anticipated to be approximately 2 feet deep. On-site soils may be used as trench backfill. Due to the poor drainage characteristics of the soils, buried conduit may be subject to saturated conditions during the lifetime of the proposed solar facility. The thermal conductivity of the on-site soils and anticipated bedding materials should be evaluated in the design of the conduit trenches with respect to heat dissipation.

Flooding and Drainage

The potential for localized flooding may exist within the site. A detailed drainage study should be performed by the project civil engineer.

Additional Work

As previously stated, this study addresses the general feasibility of the proposed photovoltaic site with respect to geologic and geotechnical constraints. Additional studies are recommended to more thoroughly address specific aspects of the development, such as remedial grading and foundation design.

REPORT LIMITATIONS

This report is based on the existing condition of the subject property and the preliminary geologic/geotechnical field data as described herein. The materials encountered within the project site and utilized in our preliminary laboratory testing are believed representative of the total project area, and the conclusions and recommendations contained in this report are presented on that basis. However, soils can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. As stated, when site plans have been developed, additional subsurface investigation and geotechnical testing and analysis, will be necessary. This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and in the same time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

We sincerely appreciate this opportunity to be of service. Please do not hesitate to call the undersigned if you have any questions regarding this report.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

Alan Pace
Associate Geologist
CEG 1952

Grayson R. Walker, GE
Principal Engineer
GE 871
2/3/11

REGISTERED PROFESSIONAL ENGINEER
GRAYSON R. WALKER
No. 871
EXP. 3-31-2011
GEOTECHNICAL
STATE OF CALIFORNIA

Attachments: References
Figure 1 – Site Location Map
Figure 2 – Exploration Location Map
Appendix A – Exploration Logs
Appendix B – Laboratory Test Data

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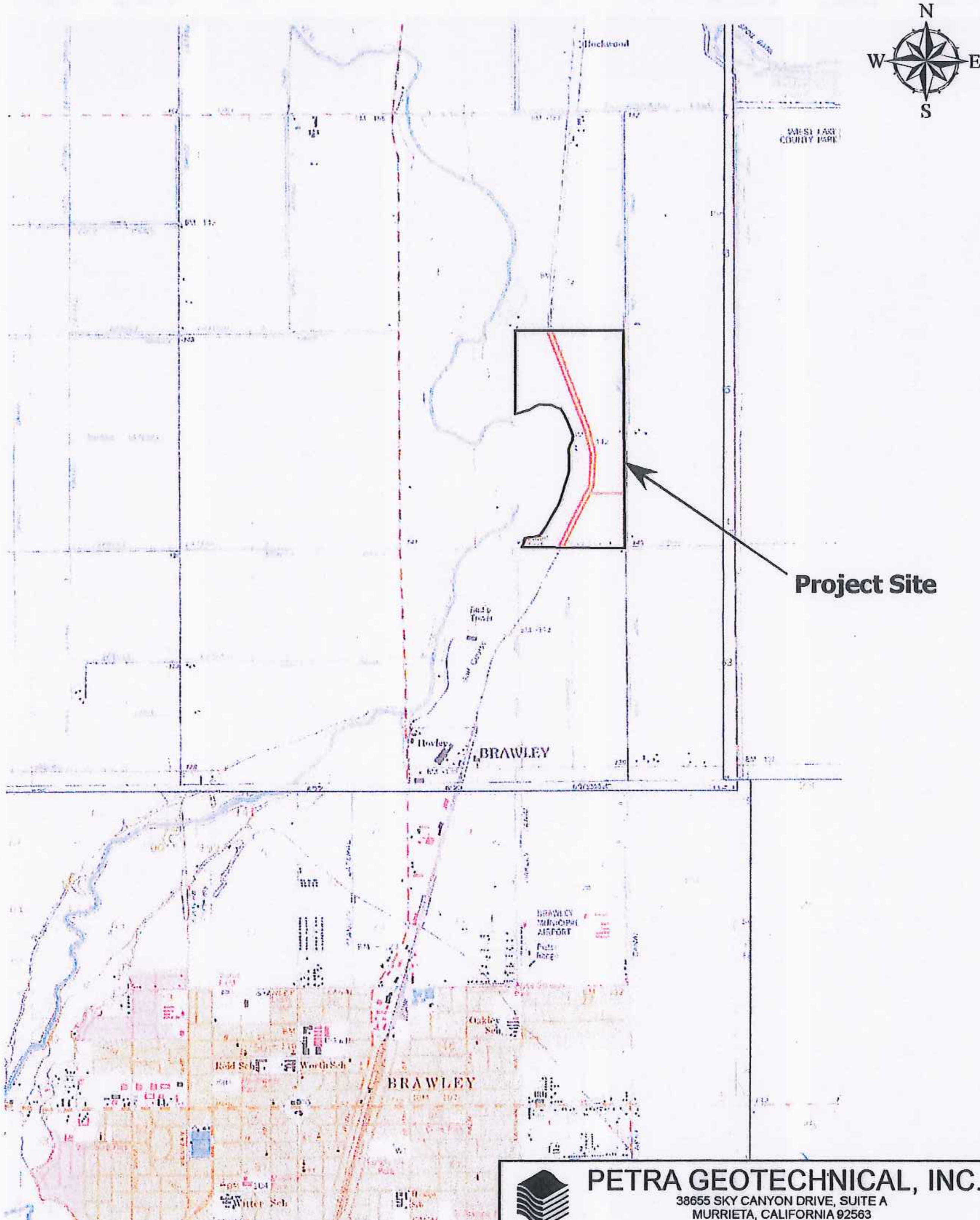

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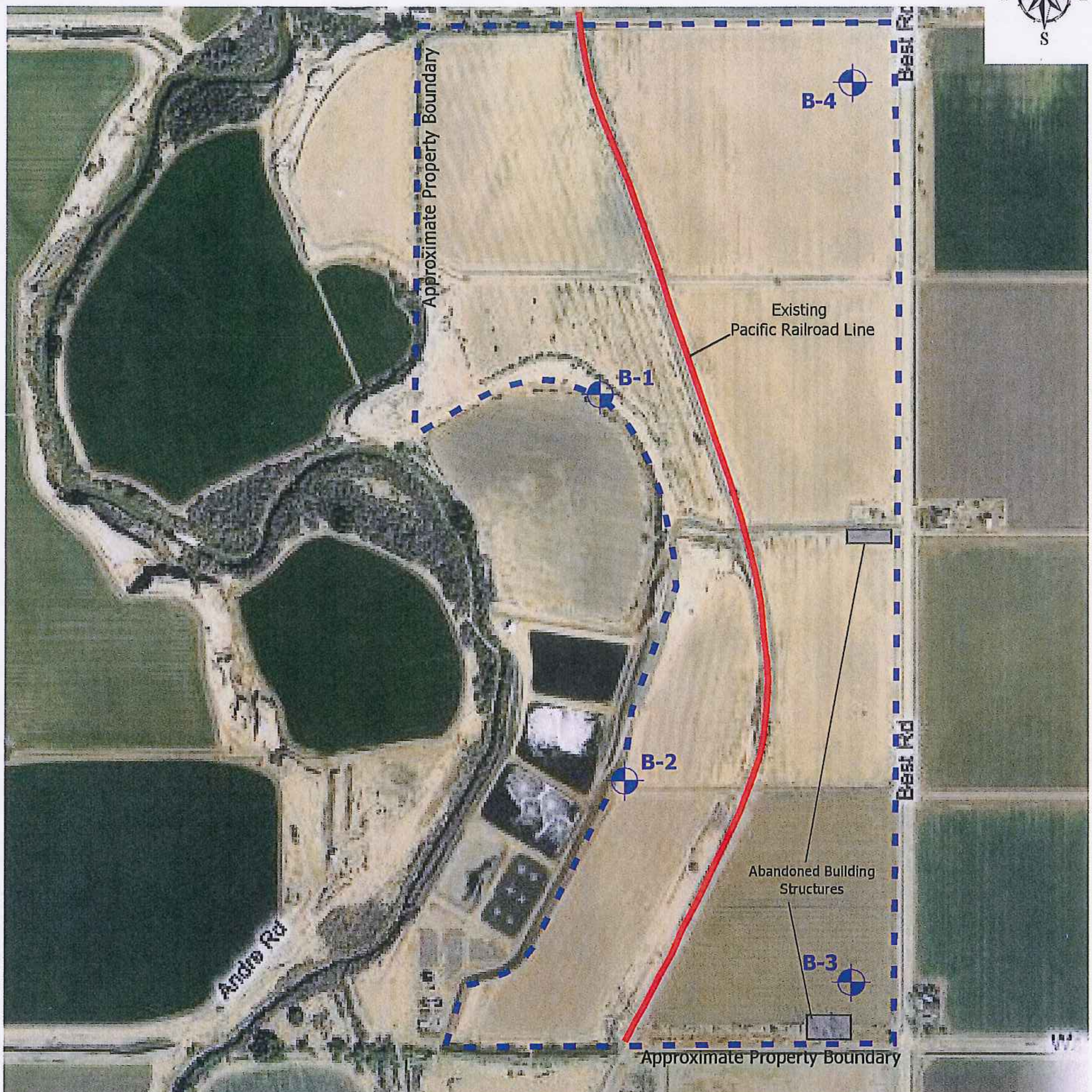
COSTA MESA MURRIETA PALM DESERT SAN DIEGO SANTA CLARITA

SITE LOCATION MAP

Ormat Jimemz 190-Acre Site
Brawley Area
Imperial County, CA

DATE: Dec. 2010	J.N.: 320-10	Fig. 1
DWG BY: DLJ	SCALE: None	



B-4 Approximate Geotechnical Boring Location

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PHONE: (951) 600-9271
COSTA MESA MURRIETA PALM DESERT SAN DIEGO SANTA CLARITA

EXPLORATION MAP

Ormat Jimemz 190-Acre Site
Brawley Area
Imperial County, CA

DATE: Dec. 2010	J.N.: 320-10	Fig. 2
DWG BY: DLJ	SCALE: None	

APPENDIX A

EXPLORATION LOGS

PETRA

Key to Soil and Bedrock Symbols and Terms

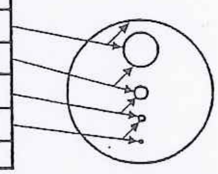
PETRA

Unified Soil Classification System

Major Division				Symbol	Description
Coarse-grained Soils > 1/2 of materials is larger than #200 sieve	The No. 200 U.S. Standard Sieve is about the smallest particle visible to the naked eye	GRAVELS more than half of coarse fraction is larger than #4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
			Gravels with fines	GM	Silty Gravels, poorly-graded gravel-sand-silt mixtures
				GC	Clayey Gravels, poorly-graded gravel-sand-clay mixtures
		SANDS more than half of coarse fraction is smaller than #4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines
				SP	Poorly-graded sands, gravelly sands, little or no fines
			Sands with fines	SM	Silty Sands, poorly-graded sand-gravel-silt mixtures
				SC	Clayey Sands, poorly-graded sand-gravel-clay mixtures
Fine-grained Soils > 1/2 of materials is smaller than #200 sieve		SILTS & CLAYS Liquid Limit Less Than 50		ML	Inorganic silts & very fine sands, silty or clayey fine sands, clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts & clays of low plasticity
		SILTS & CLAYS Liquid Limit Greater Than 50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic silts and clays of medium-to-high plasticity
Highly Organic Soils				PT	Peat, humus swamp soils with high organic content

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		>12"	>12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19"	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized to
Fines		Passing #200	<0.0029"	Flour-sized and smaller



Laboratory Test Abbreviations

MAX	Maximum Dry Density	MA	Mechanical (Partical Size) Analysis
EXP	Expansion Potential	AT	Atterberg Limits
SO4	Soluble Sulfate Content	#200	#200 Screen Wash
RES	Resistivity	DSU	Direct Shear (Undisturbed Sample)
pH	Acidity	DSR	Direct Shear (Remolded Sample)
CON	Consolidation	HYD	Hydrometer Analysis
SW	Swell	SE	Sand Equivalent

Modifiers

Trace	< 1 %
Few	1 - 5%
Some	5 - 12 %
Numerous	12 - 20 %

Sampler and Symbol Descriptions

- ▽ Approximate Depth of Seepage
- ▼ Approximate Depth of Standing Groundwater
- ■ Modified California Split Spoon Sample
- ▨ Standard Penetration Test
- ▒ Bulk Sample
- ☒ No Recovery in Sampler

Bedrock Hardness

Soft	Can be crushed and granulated by hand; "soil like" and structureless
Moderately Hard	Can be grooved with fingernails; gouged easily with butter knife; crumbles under light hammer blows
Hard	Cannot break by hand; can be grooved with a sharp knife; breaks with a moderate hammer blow
Very Hard	Sharp knife leaves scratch; chips with repeated hammer blows

Notes:
Blows Per Foot: Number of blows required to advance sampler 1 foot (unless a lesser distance is specified). Samplers in general were driven into the soil or bedrock at the bottom of the hole with a standard (140 lb.) hammer dropping a standard 30 inches. Drive samples collected in bucket auger borings may be obtained by dropping non-standard weight from variable heights. When a SPT sampler is used the blow count conforms to ASTM D-1586

EXPLORATION LOG

Project:	**Brawley - Jimemz**	Boring No.:	**B-1**
Location:	**Top of Western Descending Slope (North End)**	Elevation:	**N/A**
Job No.: **320-10**	Client: **Ormat**	Date:	**12/2/10**
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By:	**DLJ**

Depth (Feet)	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0	**LACUSTRINE DEPOSITS (Ql)** Sandy SILT (SM): gray, dry, very stiff; trace fine sand.							
2			40	■		12.0	99.3	
4	Clayey SILT (ML): dark brownish gray, moist, hard.		54	■		16.2	107.1	
6			55	■		18.8	104.3	
10	SILT with Sand (ML): brownish gray, moist, stiff; trace clay.		25	■		12.7	103.7	
14	Silty SAND (SP): pale yellow, moist, medium dense; fine sand, poorly graded, trace rootlets.							
15			18	■		3.8	108.8	
19	CLAY (CH): dark reddish gray, very moist, firm; plastic, laminated, with iron staining.							
20			11	■		28.8	94.4	
24								

PLATE A-1

EXPLORATION LOG

Project: **Brawley - Jimemz**		Boring No.: **B-1**	
Location: **Top of Western Descending Slope (North End)**		Elevation: **N/A**	
Job No.: **320-10**	Client: **Ormat**	Date: **12/2/10**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **DLJ**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		dark gray, very moist, stiff; highly plastic.		20	■		28.7	94.9	
26									
27									
28									
29									
30				15	■		29.7	95.3	
31									
32									
33									
34									
35				20	■		28.8	94.1	
36		minor iron staining.							
37									
38									
39									
40				27	■		20.1	104.7	
41		Sandy SILT (ML): grayish brown, very moist, stiff; some clay.	∇						
42									
43		Silty SAND (SM): grayish brown, saturated; fine, poorly graded, laminated.							
44									
45				25	■		24.9	101.8	
46									
47									
48									
49									

EXPLORATION LOG

Project: Brawley - Jimemz	Boring No.: B-1
Location: Top of Western Descending Slope (North End)	Elevation: N/A
Job No.: 320-10 — Client: Ormat	Date: 12/2/10
Drill Method: Hollow-Stem Auger — Driving Weight: 140 lbs / 30 in	Logged By: DLJ

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
51		dark yellowish brown, saturated, loose.		11	X				
		Total Depth 51.5 Feet Groundwater Encountered between 41 and 44 feet during Drilling Groundwater at 34 Feet after 10 minute wait Boring Backfilled with Cuttings.							

EXPLORATION LOG - V2 320-10.GPJ PETRA.GDT 12/13/10

PLATE A-3

EXPLORATION LOG

Project: **Brawley - Jimemz**		Boring No.: **B-2**	
Location: **Top of Western Descending Slope (South End)**		Elevation: **N/A**	
Job No.: **320-10**	Client: **Ormat**	Date: **12/2/10**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **DLJ**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0–2		**ARTIFICIAL FILL (Af)** SILT (ML): dry, loose.							
2		**LACUSTRINE DEPOSITS (Ql)** Clayey SILT (MH): dark gray, slightly moist, very stiff.		40			19.1	108.1	EI, Chem.
5				27			18.6	98.2	
6		SILT with Sand (ML): gray, dry, very stiff; laminated.							
10		CLAY (CH): dark grayish brown, moist, very stiff; trace silt, some iron staining, plastic.		26			25.4	98.2	
15		Silty CALY (CL): dark brownish gray, moist, very stiff.		29			23.0	100.5	
19		Silty SAND (SM): dark yellowish brown, very moist, medium dense; fine, poorly graded.							
20				13			22.6	97.6	
24		CLAY (CH): dark grayish brown, moist, stiff; plastic.							

EXPLORATION LOG - V2 320-10.GPJ PETRA.GDT 12/13/10

PLATE A-4

EXPLORATION LOG

Project: Brawley - Jimemz			Boring No.: B-2
Location: Top of Western Descending Slope (South End)			Elevation: N/A
Job No.: 320-10	Client: Ormat		Date: 12/2/10
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in		Logged By: DLJ

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Core	Bulk	Laboratory Tests: Moisture Content (%)	Dry Density (pcf)	Other Lab Tests
				13			29.1	92.7	
26									
27									
28									
29									
30		reddish brown.		21			24.8	98.4	
31									
		Total Depth 31.5 Feet No Groundwater Encountered Boring Backfilled with Cuttings.							

EXPLORATION LOG - V2 320-10.GPJ PETRA.GDT 12/13/10

EXPLORATION LOG

Project: **Brawley - Jimemz**		Boring No.: **B-3**	
Location: **Southeast Corner of Site**		Elevation: **N/A**	
Job No.: **320-10**	Client: **Ormat**	Date: **12/2/10**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **DLJ**	

Depth (Feet)	Lithology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0–3		**LACUSTRINE DEPOSITS (Ql)** Silty CLAY (CL): dark brown, dry, very stiff.		27	■		15.5	94.5	
3–9		SILT with Sand (ML): light gray, moist, very stiff; trace clay, laminated.		26	■		20.3	99.4	
9–19		CLAY (CH): dark grayish brown, moist, stiff; laminated, plastic.		20	■		27.3	98.2	
15		reddish gray, with iron staining.		25	■		24.8	101.1	
19–21.5		Silty SAND (SM): grayish brown, wet, medium dense; fine, poorly graded.		19	■		23.9	96.3	

Total Depth 21.5 Feet
No Groundwater Encountered
Boring Backfilled with Cuttings.

PLATE A-6

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EXPLORATION LOG

Project: **Brawley - Jimemz**		Boring No.: **B-4**
Location: **Northeast Corner of Site**		Elevation: **N/A**
Job No.: **320-10**	Client: **Ormat**	Date: **12/2/10**
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **DLJ**

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		TOPSOIL							
1		Silty CLAY (CL): dark grayish brown, slightly moist, loose; tilled.							
		LACUSTRINE DEPOSITS (Ql)							
2		Silty CLAY (CL): dark grayish brown, slightly moist, very stiff; laminated.		43			19.3	106.6	EI
3									
4									
5		Silty CLAY (CH): dark grayish brown, slightly moist, very stiff; laminated, plastic.		20			21.9	99.4	
6									
7									
8									
9									
10		Silty SAND (SM): brown, slightly wet, loose; fine, poorly graded.		11			28.1	96.1	
11									
12		encountered grounwater between 12 to 13 feet.	▽						
13									
14									
15		medium dense, saturated.		15			26.4	95.9	
16									
17									
18									
19									
20		loose.		11			29.6	94.1	
21		CLAY (CH): dark grayish brown, moist.							
		Total Depth 21.5 Feet Groundwater Encountered Between 12 and 13 Feet Boring Backfilled with Cuttings.							

PLATE A-7

APPENDIX B

LABORATORY TEST DATA

PETRA

APPENDIX B

LABORATORY TEST PROCEDURES

Soil Classification

Surficial soils encountered within the hand auger excavations were classified and described using the visual-manual procedures of the Unified Soil Classification System, and in general accordance with Test Method ASTM D 2488.

In-Situ Moisture and Density

Moisture content and unit dry density of in-place soil were determined in representative strata. Test data are summarized in the boring logs, Appendix A.

Expansion Potential

Expansion index tests were performed on selected samples of onsite soil in accordance with Test Method ASTM D4829. The expansion potential classification was determined on the basis of the expansion index value. The result of this test is presented on Plate B-1.

Chemical Analyses

Chemical analyses were performed on a selected sample of on-site soil to determine water-soluble sulfate and chloride content. These tests were performed in accordance with California Test Method Nos. 417 and 422, respectively. Test results are presented on Plate B-1.

Resistivity and pH

Resistivity and pH tests were performed on selected sample of on-site soil to provide a preliminary evaluation of its corrosive potential to concrete and metal construction materials. These tests were performed in accordance with California Test Method Nos. 532 and 643, respectively. The results of these tests are included in Plate B-1.

EXPANSION INDEX TEST DATA

Boring/Depth (feet)	Soil Type	Expansion[1] Index	Expansion[2] Potential
B-2 @ 0-5	Dark gray clayey SILT(MH)	72	Medium
B-4 @ 1-5	Dark grayish brown silty CLAY (CH)	102	High

CORROSIVITY TEST DATA

Boring/Depth (feet)	Sulfate[3] (%)	Chloride[4] (ppm)	pH[5]	Resistivity[5] (ohm-cm)	Corrosivity Potential
B-2 @ 0-5	0.268	262	6.9	120	concrete: severe steel: severe

(1) PER ASTM D4829
(2) PER 2007 CBC Section 1802.3.2
(3) PER CALIFORNIA TEST METHOD NO. 417
(4) PER CALIFORNIA TEST METHOD NO. 422
(5) PER CALIFORNIA TEST METHOD NO. 643
(5) PER CALIFORNIA TEST METHOD NO. 643