



## GENESIS SOLAR ENERGY PROJECT

### APPENDIX D.1

#### GRAVITY BEDROCK TOPOGRAPHIC MODEL FOR EASTERN CHUCKWALLA VALLEY GROUNDWATER BASIN

---

## 1. GRAVIMETRIC METHODS

A model of the bedrock topography was created using bouguer gravity data compiled by Mariano and others (1986). Eight two-dimensional cross-sections were created to cover the study area. The resulting depth to bedrock determined by the cross-sections was then gridded to provide a contour map of the bedrock topography. The gravity modelling software used was GM-SYS gravity and magnetic modelling software.

Cross-section E is attached as an example of the cross-sections created. For each cross-section, an initial model was constructed as calibrated to known bedrock depths from wells 14 and 17, which are located near the center of the study area. The theoretical response from the initial model (forward model) was then calculated and compared to observed data. Depths to stratigraphic horizons were adjusted to minimize error between the calculated forward model and the observed data. Densities for each of the five hydrostratigraphic units (unsaturated Quaternary Alluvium, saturated Quaternary alluvium, Pliocene Bouse Formation, Miocene Fanglomerate, and bedrock) were taken from a USGS gravity study of the area (Wilson and Owen-Joyce 1994) or were estimated from typical values provided by Sharma (1997) for materials of similar lithologic characteristics to those observed in the study area. The densities for each layer are presented in Table A.

**Table A Stratigraphic description and density used in the gravity model.**

Hydrostratigraphic Layer	Composition	Density (g/cm <sup>3</sup> )
Unsaturated Alluvium	Poorly to moderately consolidated silt, clay, sand and gravel (unsaturated)	1.90
Saturated Alluvium	Poorly to moderately consolidated silt, clay, sand and gravel (saturated)	2.10
Bouse Formation	Interbedded silt, sand and clay, poorly to moderately consolidated	2.10
Fanglomerate	Well-consolidated sand and gravel	2.34
Bedrock	Meta-volcanics, metamorphic and granitic rocks	2.81



## GENESIS SOLAR ENERGY PROJECT

### APPENDIX D.1

#### GRAVITY BEDROCK TOPOGRAPHIC MODEL FOR EASTERN CHUCKWALLA VALLEY GROUNDWATER BASIN

---

Finally, a contour map of the bedrock topography was created by extracting the elevation of the bedrock horizon from each cross-section (as referenced to mean sea level) and creating a plan view grid using the minimum curvature method.

Due to the non-unique nature of gravity data, there are many possible models; however, the model presented conforms to the available information and presents a possible model of the depth to bedrock. Several assumptions were made while creating the bedrock model including:

- a) Bedrock was considered to be a single density, an average throughout the study area; however, due to the wide range of rock types in the basement rocks and the presence of sills, dikes, and metamorphic activity indicate that there is likely some variation in the bedrock density.
- b) Mariano and other (1986) created gravity contours based on available gravity data within the study area; however, these contours were created in areas with sparse data and contours were interpolated over large areas. For this model, it was assumed that these contours were correct and data density was consistent; however, some error may be introduced into the model due to low data density in some areas (in other words, geologic features may change drastically on a much finer scale than was used for gravity sampling).
- c) The geologic model was assumed to have five layers as outline in Table A. Variations within the layers may lead to varying densities within each layer.
- d) Each cross-section was assumed to be a two-dimensional cross-section (varying in the x (distance along the cross-section) and z (depth) directions and extending to infinity in the y (perpendicular to the cross-section) direction).

The final bedrock topography (attached) ranges from -5,320 feet above mean sea level (amsl) in the valley basin to 3,000 feet amsl in the Palen Mountains, where the bedrock outcrops at surface. Away from bedrock outcrops in the mountains, the highest elevation of the bedrock topography is approximately mean sea level. The bedrock is generally deepest in the center of the study area and becomes shallower closer to the mountains. A bedrock ridge trending northeast/southwest occurs through the center of the study area near wells 14 and 17.



## GENESIS SOLAR ENERGY PROJECT

### APPENDIX D.1

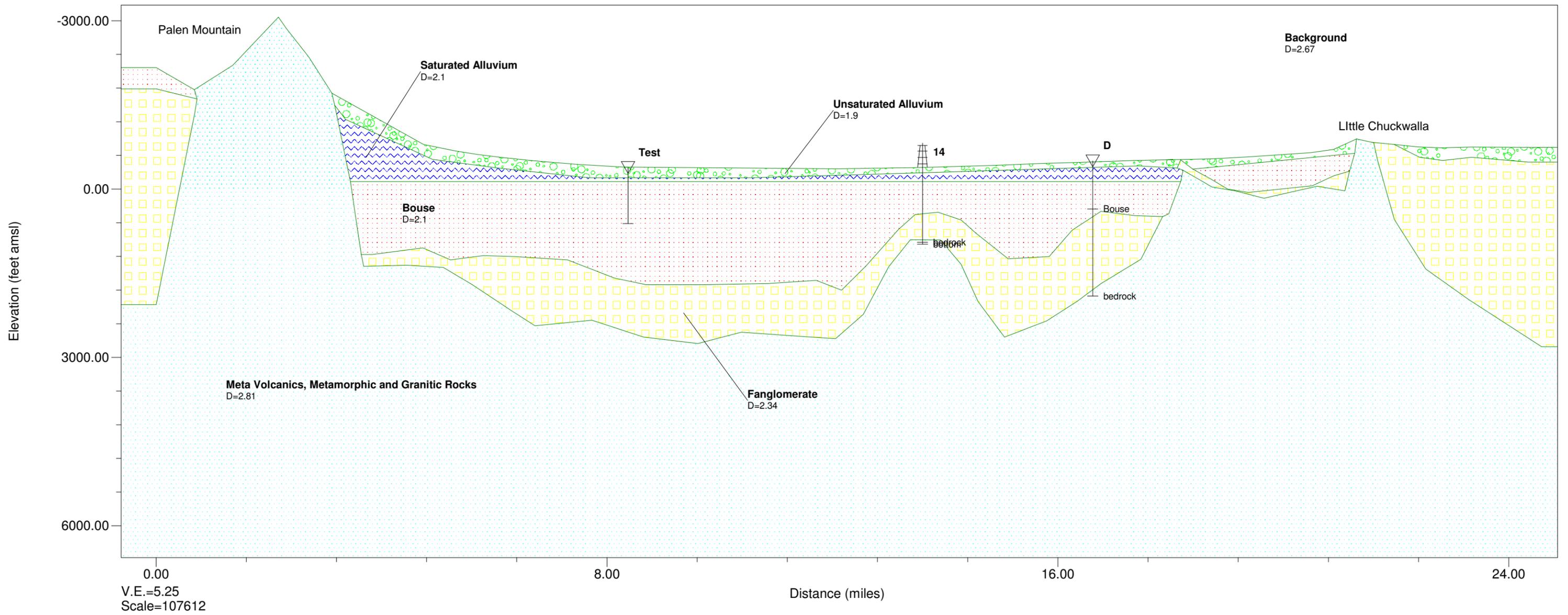
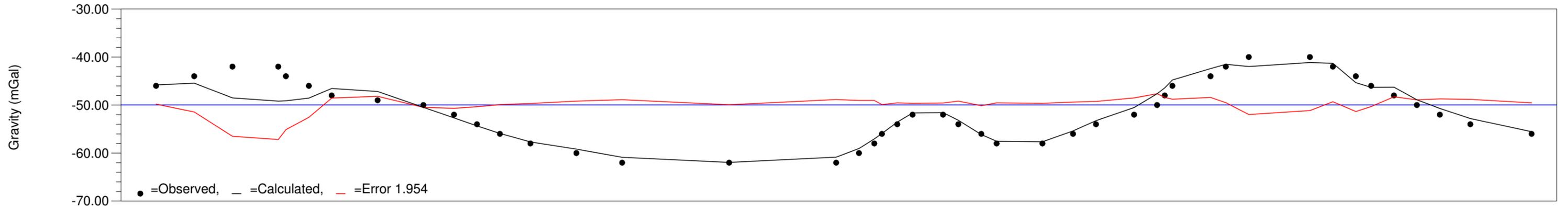
#### GRAVITY BEDROCK TOPOGRAPHIC MODEL FOR EASTERN CHUCKWALLA VALLEY GROUNDWATER BASIN

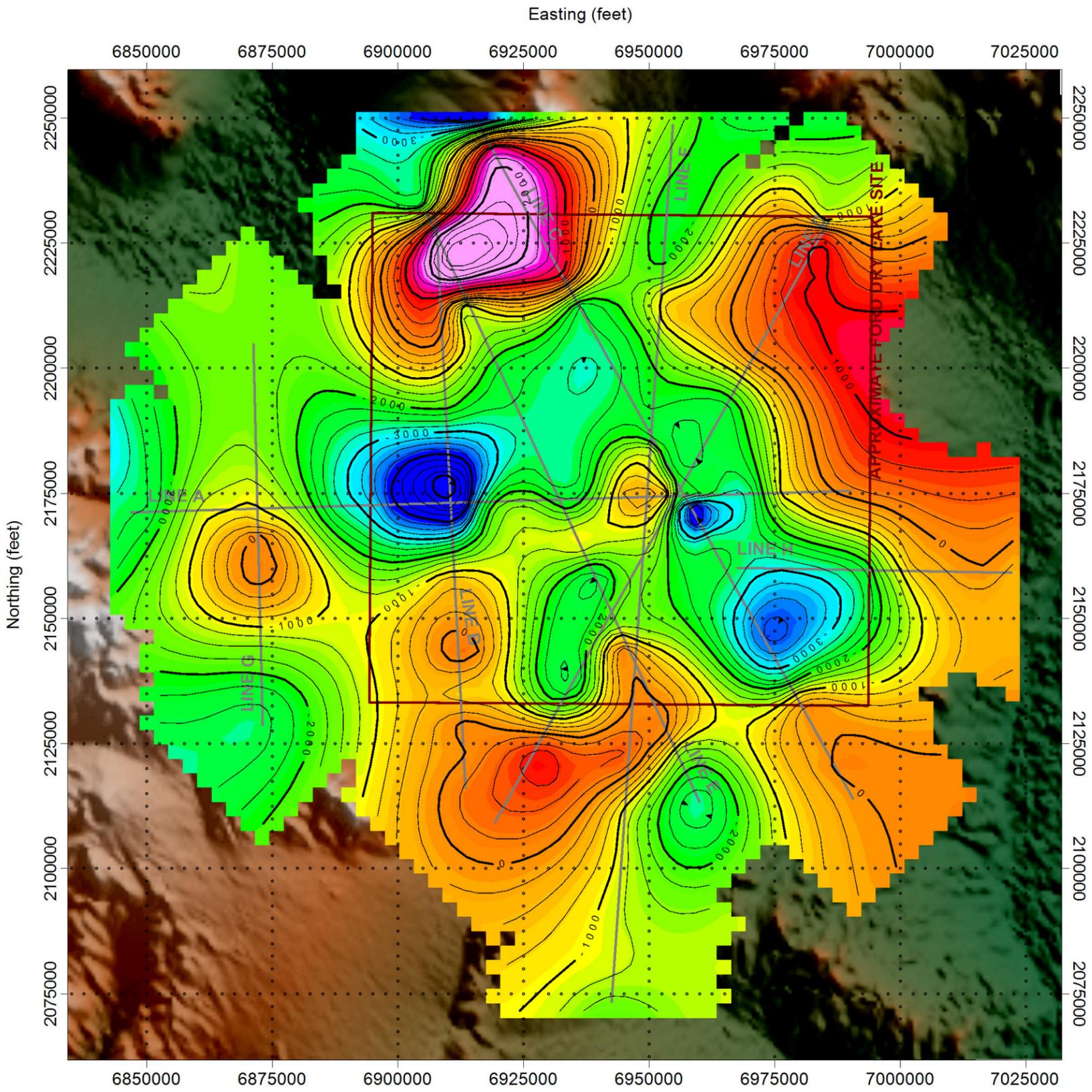
---

## 2. REFERENCES

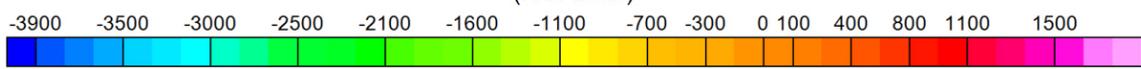
- Mariano, J., Helferty, M.G., Gage, T.B., 1986. Salton Sea and El Centro Bouguer Map. *In* Bouguer and Isostatic Residual Gravity Maps of the Colorado River Region, including the Kingman, Needles, Salton Sea, and El Centro Quadrangles. USGS Open-File Report 86-347.
- Sharma, P.V., 1997. Environmental and Engineering Geophysics. 1<sup>st</sup> ed. Cambridge University Press. Cambridge, UK. p. 17.
- Wilson, R.P., and Owen-Joyce, S.J., 1994. Method to Identify Wells that Yield Water that Will be Replaced by Colorado River Water in Arizona, California, Nevada, and Utah. U.S. Geological Survey, Water Resources Investigation Report 94-4005. 36 pages.

# Line E Gravity Model



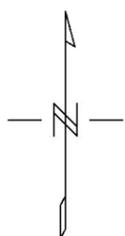


**Bedrock Topography**  
(feet amsl)

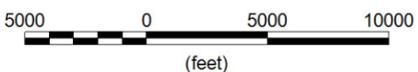


**LEGEND**

-  Contour Interval 1000 feet above sea level
-  Contour Interval 250 feet above sea level



Scale 1:300000



(feet)  
NAD83 / California CS83 zone 6

**PRELIMINARY**

Infrastructure & Environment

**WORLEYPARSONS  
GENESIS PROJECT  
FORD DRY LAKE SITE  
BEDROCK TOPOGRAPHY MODEL**



**WorleyParsons**  
resources & energy

<b>AUG 2009</b> date	<b>K.A.H.</b> edited by	<b>K.A.H.</b> drawn by	Approved
<small>PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO CONTRACT. FILE: J:\WP0159000\Geophysics\gravity\oasis\maps\bedrock_topography_CS6_2.map</small>			

PROJECT NUMBER:  
**WP0159000**

FIGURE:  
**2**