JDH Corrosion Consultants
Incorporated

December 4, 2006

TRC Lowney
405 Clyde Avenue
Mountain View, CA
94043-2209

Attention: **Mr. Brian Hubel, P.E.**

Subject: **Soil Resistivity Measurements**
Russel Energy Center, Hayward, CA

Dear Mr. Hubel,

Pursuant to your request, **JDH Corrosion Consultants, Inc.**, has completed the soil resistivity measurements at the referenced site. Results are included herein for your consideration.

PROJECT BACKGROUND

The soil resistivity measurements were obtained for the purpose of designing an electrical grounding system for the renovated site, by others.

In-Situ Soil Resistivity Testing

The in-situ resistivity of the soil was measured at six (6) locations in the project site, as shown in figure1 attached. In-situ soil resistivity measurements were conducted using the Wenner four-electrode method, (ASTM G-57) utilizing a Digital Soil Resistance Meter, Model 4500, manufactured by AEMC. The Wenner method involves the use of four metal probes or electrodes, driven into the ground along a straight line, equidistant from each other. An alternating current from the Soil Resistance Meter is induced in the soil. The current creates a voltage gradient that is proportional to the average resistance of the soil mass to a depth equal to the distance between probes. Resistance measurements were conducted with probe spacings of 2.5, 5.0, 10.0, 15.0, 20, 30, 40, and 50-feet at each location. The resistivity of each layer of soil was then calculated using the Barnes Method as follows:

$\rho_{b-a} = KR_{(b-a)}$

where;

ρ_{b-a}	=	soil resistivity of layer depth b-a (ohm-cm)
a	=	soil depth to top layer (ft)
b	=	soil depth to bottom layer (ft)
R_a	=	soil resistance read at depth a (ohms)
R_b	=	soil resistance read at depth b (ohms)
R_{b-a}	=	resistance of soil layer from a to b (ft)
K	=	layer constant = $60.96\pi(b-a)$ (cm)

and $\frac{1}{R_{b-a}} = \frac{1}{R_a} - \frac{1}{R_b}$

The results are included in the data table attached.

LIMITATIONS

The test results contained in this report are based on the information and assumptions referenced herein. All services provided herein were performed by persons who are experienced and skilled in providing these types of services and in accordance with the standards of workmanship in this profession. No other warrantees expressed or implied are provided.

We appreciate the opportunity to be of service to **TRC Lowney** on this project and trust that you find the measurements and calculations satisfactory.

If you have any questions concerning the contents of this report or if we can be of any additional assistance, please do not hesitate to contact us at (925) 927-6630.

Sincerely,

Mohammed Ali

Mohammed Ali, P.E.
JDH CORROSION CONSULTANTS, INC.
Senior Corrosion/Electrical Engineer

Client: *TRC Lowney*
Project: *Russel Energy Center*
Location: *Hayward, Ca*
Date: *12/4/2006*
Subject: *In-Situ Soil Resistivity Data*

*Test	Location	Resistance Data From AEMC Meter								Soil Resistivities (ohm-cm)								Barnes Layer Analysis (ohm-cm)							
#	Description	2.5	5	10	15	20	30	40	50	2.5	5	10	15	20	30	40	50	0-2.5'	2.5-5'	5-10'	10-15"	15-20'	20-30'	30-40'	40-50'
1	N/S	1.287	0.814	0.296	0.199	0.17	0.075	0.056	0.045	616	1559	567	572	488	215	161	129	616	1060	445	581	1117	257	423	439
	E/W	1.264	0.109	0.293	0.195	0.121	0.075	0.055	0.05	605	209	561	560	348	215	158	144	605	57*	NA	558	305	378	395	1053
2	N/S	2.92	1.34	0.703	0.359	0.235	0.128	0.084	0.059	1398	2566	1346	1031	675	368	241	169	1398	1186	1416*	702	651	538	468	380
	E/W	2.65	1.557	0.601	0.524	0.268	0.131	0.075	0.055	1269	2982	1151	1505	770	376	215	158	1269	1807	937	3916	525	491	336	395
3	N/S	0.929	0.743	0.195	0.181	0.142	0.11	0.091	0.079	445	1423	373	520	408	316	261	227	445	1777	253	2414	631	935	1009	1147
	E/W	1.243	0.582	0.211	0.183	0.141	0.113	0.098	0.087	595	1115	404	526	405	325	282	250	595	524	317	1320	588	1090	1414	1484
4	N/S	9.45	1.258	0.306	0.267	0.349	0.418	0.243	0.2	4524	2409	586	767	1003	1201	698	575	4524	695	387	2006	NA	NA	1112	2164
	E/W	5.12	0.999	0.313	0.252	0.219	0.316	0.465	0.385	2451	1913	599	724	629	908	1336	1106	2451	594	436	1238	1601	NA	NA	4285
5	N/S	2.77	0.55	0.265	0.365	0.055	0.021	0.105	0.073	1326	1053	507	1048	158	60	302	210	1326	329	490	NA	62*	65*	NA	459
	E/W	1.599	0.558	0.285	0.297	0.205	0.24	0.165	0.037	766	1069	546	853	589	689	474	106	766	410	558	NA	634	NA	1011	91*
6	N/S	6	2.23	0.35	0.206	0.066	0.129	0.435	0.235	2873	4270	670	592	190	371	1250	675	2873	1699	398	479	93*	NA	NA	979
	E/W	5.9	2.31	0.43	0.269	0.17	0.224	0.091	0.262	2825	4424	823	773	488	643	261	753	2825	1818	506	686	442	NA	293	NA
	Average at depth	1641	1082	473	1390	722	615	718	1279																

* Outliers removed from data set for averaging purposes

N

0' ENG 1' ARCH 2'

SCALE:

1

5

6

4

3

1

2

APPROXIMATE IN-SITU RESISTIVITY & SOIL SAMPLE LOCATIONS.

WENNER 4-PIN TEST METHOD USED FOR IN-SITU SOIL RESISTIVITY MEASUREMENTS FOR LOCATIONS 1 THROUGH 6.

REV	DESCRIPTION	DATE	ENG	CHK

CATHODIC PROTECTION

TRC LOWNEY
Hayward, CA
Russel Energy Center

IN-SITU SOIL RESISTIVITY LOCATIONS

ENG: MA CAD: SC CHK: MA DATE: 12/4/2008 JOB: 250382. FILE: 250182.

JDH Corrosion Consultants Incorporated

FIG-1

SHEET 1 OF 1