

## DOCKETED

<b>Docket Number:</b>	00-AFC-14C
<b>Project Title:</b>	El Segundo Power Redevelopment Project Compliance
<b>TN #:</b>	201185
<b>Document Title:</b>	Condition of Certification GEO-5: Applicant's Final Engineering Geology Report
<b>Description:</b>	N/A
<b>Filer:</b>	Dee Hutchinson
<b>Organization:</b>	Locke Lord LLP
<b>Submitter Role:</b>	Applicant Representative
<b>Submission Date:</b>	11/13/2013 12:31:18 PM
<b>Docketed Date:</b>	11/13/2013



500 Capitol Mall, Suite 1800  
Sacramento, CA 95814  
Telephone: 916-930-2500  
Fax: 916-930-2501  
www.lockelord.com

John A. McKinsey  
Direct Telephone: 916-930-2527  
Direct Fax: 916-720-0443  
jmckinsey@lockelord.com

November 13, 2013

VIA E-FILING

El Segundo Energy Center Petition to Amend (00-AFC-14C)  
Craig Hoffman, Project Manager  
California Energy Commission  
1516 Ninth Street  
Sacramento, CA 95814-5512

Re: El Segundo Energy Center Petition to Amend (00-AFC-14C)  
Condition of Certification GEO-5: Applicant's Final Engineering Geology Report

Dear Mr. Hoffman:

On August 1, 2013, newly constructed Units 5 through 8 of the El Segundo Energy Center ("**ESEC**") began commercial operations. Condition of Certification GEO-5 ("**COC GEO-5**") of the California Energy Commission's final decision (CEC-800-2010-015-CMF) to approve the ESEC Amended AFC (00-AFC-14C) in June 2010 requires El Segundo Energy Center, LLC ("**ESEC LLC**") to provide a final engineering geology report. This report must contain a final description of the ESEC site's geology, any new information disclosed during grading, and the effect of this information on recommendations incorporated into the approved grading plan. Accordingly, ESEC LLC obtained the enclosed Final Engineering Geology Report in which ESEC LLC's engineering geologist provided the requisite site information and concluded that ESEC LLC performed the remedial grading at the site in compliance with the project's geotechnical reports and the requirements of COC GEO-5. ESEC LLC submitted this Report to the ESEC Compliance Project Manager, Mary Dyas, on October 15, 2013. On November 7, 2013, Ms. Dyas notified ESEC LLC that Energy Commission staff had reviewed and accepted the Report.

Pursuant to your request ESEC LLC hereby e-files Applicant's Final Engineering Geology Report for the use of Energy Commission staff in conjunction with the ESEC Petition to Amend (00-AFC-14C).

November 13, 2013

Page 2

Please contact me or my colleague Allison Harris, or George Piantka at NRG Energy directly, if you have any questions about the enclosure.

Locke Lord LLP

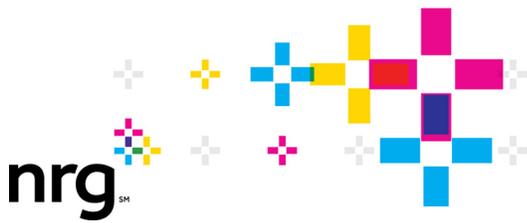


By: \_\_\_\_\_

John A. McKinsey  
Attorneys for El Segundo Energy Center LLC

JAM:awph

Enclosure



**El Segundo Energy Center LLC**  
301 Vista Del Mar Boulevard  
El Segundo, CA 90245  
Phone: 310.615.6028  
Fax: 310.615.6060

October 15, 2013

Ms. Mary Dyas  
Energy Facilities Siting Division  
Docket No. AFC-00-14C  
California Energy Commission  
1516 Ninth Street, MS-15  
Sacramento, CA 95814

**RE: EL SEGUNDO ENERGY CENTER PROJECT  
DOCKET NO. 00-AFC-14C  
CONDITION OF CERTIFICATION, GEO-5,  
FINAL ENGINEERING GEOLOGY REPORT**

Ms. Dyas,

El Segundo Energy Center LLC (ESEC) submits the Final Engineering Geology Report prepared by Ninyo & Moore in compliance with AFC Docket No. 00-14C, Condition of Certification (COCs) GEO-5 for the ESEC Project located at 301 Vista Del Mar, El Segundo, California.

If you have any questions or comments, please do not hesitate to contact me at (760) 710-2156.

Sincerely,

A handwritten signature in cursive script, appearing to read 'George L. Piantka', is written in black ink.

George L. Piantka, PE  
Director, Environmental Business  
NRG West Region

Enclosures: Final Engineering Geology Report, prepared by Ninyo & Moore, dated October 7, 2013

Cc: Joni Boren, Delegate CBO Office  
File

October 7, 2013  
Project No. 206954003

Mr. Marc Kodis  
NRG El Segundo Power, LLC  
301 Vista del Mar  
El Segundo, California 92127

Subject: Final Engineering Geology Report  
Units 5 through 8  
NRG El Segundo Power Redevelopment Project  
El Segundo, California

Dear Mr. Kodis:

In accordance with your request, we have provided geotechnical consultation services during construction of the NRG El Segundo Power Redevelopment Project in El Segundo, California. Our services have generally included providing as-needed consultation with the design team, geotechnical observation during grading and construction of Units 5 through 8, and preparation of responses to requests for information, technical memoranda, and geotechnical reports.

Our geotechnical observations during construction were provided on an as-needed, part time basis. Observation and testing services during placement of compacted fill at the site were provided by Signet Testing and RMA Group and were not a part of the services provided by Ninyo & Moore. However, our services did include periodic observations during backfilling of remedial grading excavations for the various foundations. Following remedial grading, letters were prepared for the major structure foundations documenting our geotechnical observation of the foundation excavations. Our previous geotechnical evaluation reports, review comment response letters, plan and calculation review letters, and geotechnical observation letters are included in the attached list of references.

It is our understanding that a final engineering geology report is needed as part of the final closing documents for the project to be in general compliance with Conditions of Certification GEO-5 presented in the California Energy Commission for El Segundo Power Redevelopment Project, Application for Certification (00-AFC-14) dated February 2005. The following sections include a final description of the site geology and a summary of earthwork activities that were observed by representatives of Ninyo & Moore.

## **SITE DESCRIPTION**

The site for Units 5 through 8 is located within the existing NRG El Segundo Power Plant at 301 Vista Del Mar in El Segundo, California. The new gas turbine units were constructed within the area and footprint of the decommissioned Units 1 and 2, which were demolished. The area of construction was situated on relatively level terrain near the southern end of El Segundo Beach. The site elevation ranges from approximately 18 to 20 feet above mean low level water (MLLW).

The area of the new gas turbine units and the related structures is roughly rectangular in shape, and is bordered by existing plant facilities to the north, the existing Unit 3 Power Plant to the south, the Pacific Ocean to the west, and by an ascending slope and Vista Del Mar to the east. The slope ascends approximately 50 to 60 feet to Vista del Mar at inclinations ranging from approximately 1¾:1 to 2:1 (horizontal to vertical). Vista del Mar is a four-lane roadway that extends in the north-south direction at elevations ranging from approximately 74 to 90 feet above MLLW.

## **GEOLOGY AND SUBSURFACE CONDITIONS**

### **Regional Geology**

The site is located within the Los Angeles Basin, which is bounded on the north by the Transverse Ranges geomorphic province (Norris and Webb, 1990). The Los Angeles Basin has been divided into four blocks, which are generally separated by prominent fault systems: the northwestern block, the southwestern block, the central block, and the northeastern block. The project area is located within the southwestern block, which is bounded on the east by the onshore segment of the Newport-Inglewood fault zone. The southwestern block includes anticlinal and synclinal structural features within the basement rocks that are overlain by younger sedimentary rocks and alluvium.

The Los Angeles Basin is traversed by several major active faults. The Palos Verdes and Newport-Inglewood fault zones are major active faults within the southwestern block of the Los Angeles Basin. Our review of geologic literature indicates that a segment of the Palos

Verdes fault is located about 3 miles southwest of the site. The on-shore segment of the Newport-Inglewood fault is located approximately 6 miles northeast of the site.

### **Site Geology**

Following remedial grading activities, the site is generally underlain by engineered fill, Holocene-age eolian deposits and older alluvium. After demolition of Units 1 and 2, remedial grading activities included removal of older, undocumented fill materials to competent eolian deposits or older alluvium. Where the removal of older fill materials did not achieve the depths of overexcavation recommended in our geotechnical evaluation reports, additional excavation of the native soils were performed to provide the recommended thicknesses of compacted fill below the various foundations. Where deeper demolition activities extended below groundwater, the excavations were backfilled with sand-cement slurry. In general, the limits of overexcavation extended laterally beyond the improvements to a distance equal to the depth of overexcavation unless restricted by existing underground pipes or structures that cannot be moved or demolished. The overexcavation bottoms were observed by a representative of Ninyo & Moore. Placement and compaction of fill materials were observed and tested by representatives of Signet Testing and RMA Group.

The engineered fill material was derived from older fill materials and the native eolian and older alluvial deposits. These materials generally consisted of poorly graded sand and silty sand. The native soils were generally as encountered in our previous borings at the site. Eolian deposits encountered during grading and encountered in our previous borings generally consisted of poorly graded sand. The older alluvium generally consists of poorly graded sand, sand with silt, and silty sand.

### **GROUNDWATER**

Groundwater encountered during construction generally ranged from approximately 7 to 11 feet below the ground surface. Groundwater was encountered in our previous borings at depths of approximately 11 to 21 feet below the ground surface. Historic high groundwater is reportedly 5 to 10 feet below the ground surface (California Division of Mines and Geology [CDMG], 1998).

Fluctuations in groundwater levels may occur due to tidal fluctuations, variations in precipitation, ground surface topography, subsurface stratification, local irrigation, and other factors which may not have been evident at the time of grading or our previous field evaluation.

### **FAULTING AND SEISMICITY**

The subject site is not located within a State of California Earthquake Fault Zone (formerly known as an Alquist-Priolo Special Studies Zone) (Hart and Bryant, 1997). However, the site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion in the project area is considered significant during the design life of the proposed structure. The active Palos Verdes fault is located approximately 3 miles southwest of the site.

Table 1 lists selected principal known active faults that may affect the subject site and the maximum moment magnitude ( $M_{max}$ ) as published by Cao, et al. (2003) for the California Geological Survey. The approximate fault-to-site distances were calculated using the computer program FRISKSP (Blake, 2001).

**Table 1 – Principal Active Faults**

<b>Fault</b>	<b>Approximate Fault-to-Site Distance <sup>1</sup> miles (kilometers)</b>	<b>Maximum Moment Magnitude <sup>2</sup> (<math>M_{max}</math>)</b>
Palos Verdes	3.2 (5.2)	7.3
Newport-Inglewood (Los Angeles Basin)	6.2 (10.0)	7.1
Santa Monica	9.3 (14.9)	6.6
Malibu Coast	10.4 (16.8)	6.7
Hollywood	12.1 (19.5)	6.4
Puente Hills Blind Thrust	12.6 (20.2)	7.1
Northridge	16.8 (27.0)	7.0
Verdugo	20.4 (32.8)	6.9
Sierra Madre	24.8 (39.9)	6.7
San Andreas – Whole M-1a	47.7 (76.8)	8.0
<b>Notes:</b> <sup>1</sup> Blake, 2001 <sup>2</sup> Cao, et al., 2003		

The principal seismic hazards at the subject site are surface ground rupture, ground shaking, seismically induced liquefaction, and various manifestations of liquefaction-related hazards

(e.g., dynamic settlements and lateral spreading). A brief description of these hazards and the potential for their occurrences on site are discussed in the following sections.

### **Ground Rupture**

Based on our review of the referenced literature and our site reconnaissance, no active faults are known to cross the project site. Therefore, the probability of damage from surface fault rupture is considered to be low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

### **Ground Motion**

The 2010 California Building Code recommends that the design of structures be based on the horizontal peak ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for  $PGA_{MCE}$  is approximately 2,475 years. The probabilistic  $PGA_{MCE}$  for the site was calculated as 0.65g using the United States Geological Survey (USGS, 2013) ground motion calculator (web-based). The design PGA was estimated to be 0.43g using the USGS ground motion calculator. These estimates of ground motion do not include near-source factors that may be applicable to the design of structures on site.

### **Liquefaction**

Liquefaction is the phenomenon in which loosely deposited, saturated granular soils (located below the water table) undergo rapid loss of shear strength due to development of excess pore pressure during strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to rapid rise in pore water pressure and it eventually causes the soil to behave as a fluid for a short period of time. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below the ground surface. Liquefaction is also known to occur in relatively fine-grained soils (i.e., sandy silt and clayey silt) with a plasticity index (PI) of less than 12 and an in-place moisture content greater than 85 percent of the liquid limit and sensitive silts and clays with a PI greater than 18. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Based on our review of the State of California Seismic Hazards Zones map (CDMG, 1999), the subject site is not located in a mapped liquefaction hazard zone. However, the beach located less than 100 feet to the west of the site is mapped as being susceptible to liquefaction during a seismic event (CDMG, 1999). Accordingly, liquefaction potential of subsurface soils was previously evaluated using the soil sampler blow counts recorded at various depths in our exploratory borings and our laboratory test results. The liquefaction analysis was based on the National Center for Earthquake Engineering Research (NCEER) procedure (Youd, et al., 2001) developed from the methods originally recommended by Seed and Idriss (1982) using the computer program LiquefyPro (CivilTech Software, 2008). A historic high groundwater table located at a depth of 5 feet below the existing ground surface was used in our evaluation. Our liquefaction analysis indicated that the some of the granular soil layers (relatively loose to medium dense ones) occurring below the historic high groundwater level up to a depth of approximately 20 feet below the ground surface are susceptible to liquefaction during the design seismic event. The susceptibility to liquefaction is more pronounced in near-surface granular soil layers up to about a depth of 10 feet due to the presence of the previously existing relatively loose fill and/or eolian deposits. The relative density of soils improves below a depth of about 10 feet; the relative density improves significantly below a depth of about 20 feet.

Liquefaction-susceptible soil layers encountered during our previous subsurface evaluation are located outside the footprints of Units 5 through 8. However, based on interpolation of soil layers between the exploratory borings, the relatively uniform depositional characteristics of the eolian deposits and older alluvium, and our knowledge about site geology, we anticipate that the liquefaction susceptibility of soils underlying the new plant units will be consistent with those occurring outside the footprints of these units.

The more susceptible soil layers (i.e., up to about 10 feet below the ground surface) were removed from within the area of the new gas turbine improvements and replaced as engineered fill that are not susceptible to liquefaction. The impacts of liquefaction in less susceptible soils occurring below the remedial grading zone are relatively insignificant.

Liquefaction is, therefore, not a design consideration for the proposed gas turbine improvements.

### **Dynamic Settlement of Saturated Soils**

As a result of liquefaction, the structures may be subject to several hazards, including liquefaction-induced settlement. In order to estimate the amount of post-earthquake settlement, the method proposed by Tokimatsu and Seed (1987) was used in which the seismically induced cyclic stress ratios and corrected N-values are related to the volumetric strain of the soil. The amount of soil settlement during a strong seismic event depends on the thickness of the liquefiable layers and the density and/or consistency of the soils.

Under the previous conditions, a post-earthquake total settlement of up to about 2 inches was calculated for areas outside of the footprints of the new gas turbine improvements. Based on the guidelines presented in CDMG Special Publication 117 (1997) and assuming relatively uniform subsurface stratigraphy across the site, we estimate differential settlement on the order of 1 inch or less over a horizontal distance of 20 feet within the same area. Due to the variation in liquefaction susceptibility of soils and the remedial grading procedures that were performed at the site, the potential for the occurrence of liquefaction-induced dynamic settlement is negligible within the foundation area of the new improvements.

### **Ground Subsidence**

The potential for ground subsidence, sand boils, and/or seismically induced bearing failure is considered to be negligible within the footprint of the proposed improvements. There is, however, a potential for ground subsidence in areas that are outside of the proposed improvements.

### **Lateral Spreading**

Lateral spreading of the ground surface during an earthquake usually takes place along weak shear zones that have formed within a liquefiable soil layer. Lateral spread has generally been observed to take place in the direction of a free-face (i.e., retaining wall, slope, channel, etc.) but has also been observed to a lesser extent on ground surfaces with gentle slopes. An empirical model developed by Youd, et al. (2002) is typically used to predict the

amount of horizontal ground displacement within a site. For sites located in proximity to a free-face, the amount of lateral ground displacement is strongly correlated with the distance of the site from the free-face. Other factors such as earthquake magnitude, distance from the earthquake epicenter, thickness of the liquefiable layers, and the fines content and particle sizes of the liquefiable layers also affect the amount of lateral ground displacement. Based on the relative density of the potentially liquefiable soil layers, the project site is not considered susceptible to significant seismically induced lateral spread.

### **Landslides and Slope Stability**

Landslides may be induced by strong vibratory motion produced by earthquakes. Research and historical data indicate that seismically induced landslides tend to occur in weak soil and rock on sloping terrain. The process for zoning earthquake-induced landslides incorporates expected future earthquake shaking, existing landslide features, slope gradient and strength of earth materials on the slope.

The project area is not mapped in an area considered susceptible to seismically induced landslides (CDMG, 1999). However, the approximately 70-foot-high slope that ascends from the project area to Vista Del Mar is located in an area considered susceptible to seismically induced landslides. The stability of this slope was previously evaluated which indicated that the static and pseudo-static factors of safety of the slope are adequate in its current configuration (Ninyo & Moore, 2007a).

### **Tsunamis**

Tsunamis are long wavelength seismic sea waves (long compared to ocean depth) generated by the sudden movements of the ocean floor during submarine earthquakes, landslides, or volcanic activity. Based on our review of the tsunami inundation map prepared by the California Emergency Management Agency (2009), the site lies adjacent to an area identified as susceptible to tsunamis inundation. The areas of construction are approximately 20 feet or more above mean sea level. Furthermore, a rip-rap berm and sea wall have been constructed between the beach and the plant facilities.

## CONCLUSIONS

Based on our observations during grading and construction, it is our opinion that the remedial grading for the project was performed in general accordance with the geotechnical reports for the project (References) and the applicable provisions of the Geology section of the Conditions of Certification presented in the California Energy Commission for the El Segundo Power Redevelopment Project, Application for Certification (00-AFC-14) dated February 2005.

## LIMITATIONS

The field observations presented in this report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in this area. No warranty, expressed or implied, is made regarding the opinions expressed in this report.

We appreciate this opportunity to be of service on this project.

Sincerely,  
**NINYO & MOORE**



Michael Putt, PG, CEG  
Senior Geologist

MLP/SG/CAP/sc

Attachments: References

Distribution: (1) Addressee (electronic)  
(1) Mr. Tod Iltis (electronic)



Soumitra Guha, PhD, PE, GE  
Principal Engineer



## REFERENCES

- Blake, T.F., 2001, FRISKSP (Version 4.00) A Computer Program for the Probabilistic Estimation of Peak Acceleration and Uniform Hazard Spectra Using 3-D Faults as Earthquake Sources.
- California Department of Conservation, Division of Mines and Geology, 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California, Special Publication 117, dated March 13.
- California Department of Conservation, Division of Mines and Geology, State of California, 1998, Seismic Hazard Evaluation of the Venice 7.5-Minute Quadrangle, Los Angeles County, California: Open-File Report 98-27.
- California Department of Conservation, Division of Mines and Geology, State of California, 1999, Seismic Hazard Zones Official Map, Venice Quadrangle, 7.5-Minute Series: Scale 1:24,000, Open-File Report 98-27, dated March 25.
- California Emergency Management Agency, 2009, Tsunami Inundation Map for Emergency Planning, State of California ~ County of Los Angeles, Venice Quadrangle, dated March 1.
- Cao, Tianqing, Bryant, William A., Rowshandel, Badie, Branum, David, and Wills, Christopher J., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, dated June.
- CivilTech Software, 2008, Liquefy Pro (Version 5.5j), A computer program for liquefaction and settlement analysis.
- Hart, E.W., and Bryant, W.A., 1997, Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zone Maps: California Department of Conservation, Division of Mines and Geology, Special Publication 42, with Supplements 1 and 2 added in 1999.
- Hartley, J.D., and Duncan, J.M., 1987, E' and Its Variation with Depth: American Society of Civil Engineers (ASCE), Journal of Transportation Engineering, Vol. 113, No. 5, dated September.
- Idriss, I.M. and Boulanger, R.W., 2008, Soil Liquefaction during Earthquakes, Earthquake Engineering Research Institute Monograph No. MNO-12.
- Jennings, C.W., and Bryant, W.A., 2010, Fault Activity Map: California Geological Survey, California Geologic Data Map Series, Map No. 6, Scale 1:750,000.
- Ninyo & Moore, 2006, Limited Geotechnical Evaluation, NRG Power Redevelopment Project, El Segundo, California, dated November 10, Project No. 206954001.
- Ninyo & Moore, 2007a, Supplemental Geotechnical Evaluation, NRG El Segundo Power Redevelopment, El Segundo, California, dated April 6, Project No. 206954002.
- Ninyo & Moore, 2007b, Geotechnical Evaluation, NRG El Segundo Power Redevelopment, 301 Vista del Mar, El Segundo, California, dated April 26, Project No. 206954002.

- Ninyo & Moore, 2008a, Response to Review Comment, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated January 23, Project No. 206954002.
- Ninyo & Moore, 2008b, Seismic Design Parameters, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated March 17, Project No. 206954002.
- Ninyo & Moore, 2008c, Site Specific Health and Safety Plan, El Segundo Power Redevelopment Project, 301 Vista Del Mar, El Segundo, California, Dig Alert Ticket No. A82051203, dated July 29, Project No. 207487001.
- Ninyo & Moore, 2008d, Supplemental Geotechnical Recommendations, New Communications Building at NRG El Segundo, Los Angeles, California 90045, dated August 12, Project No. 206954002.
- Ninyo & Moore, 2009, Access Road Improvements, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated February 23, Project No. 206954002.
- Ninyo & Moore, 2010a, Geotechnical Evaluation, NRG El Segundo Tank Relocation Project, El Segundo, California, dated July 14, Project No. 206954003.
- Ninyo & Moore, 2010b, Geotechnical Considerations for Demolition, NRG El Segundo Plant Units 1 and 2, El Segundo, California, dated August 4, Project No. 206954003.
- Ninyo & Moore, 2010c, Supplemental Geotechnical Recommendations, NRG El Segundo Tank Relocation Project, El Segundo, California, dated September 3, Project No. 206954003.
- Ninyo & Moore, 2010d, Geotechnical Evaluation, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 9, Project No. 207487001.
- Ninyo & Moore, 2010e, Response to Review Comment, NRG El Segundo Tank Relocation Project, El Segundo, California, dated October 28, Project No. 206954003.
- Ninyo & Moore, 2011a, Grading Plan Review, NRG El Segundo Tank Relocation Project – South Area Grading, El Segundo, California, dated February 3, Project No. 206954003.
- Ninyo & Moore, 2011b, Site Specific Health and Safety Plan, El Segundo Power, Redevelopment Project, 301 Vista Del Mar, El Segundo, California, Dig Alert Ticket No. A10530325, dated February 23, Project No. 206954003.
- Ninyo & Moore, 2011c, Geotechnical Evaluation, NRG El Segundo Seawall, El Segundo, California, dated March 9, Project No. 206954003.
- Ninyo & Moore, 2011d, Supplemental Geotechnical Recommendations for Transformer Pad Foundation, NRG El Segundo Relocation Project, El Segundo, California, dated April 1, Project No. 206954003.
- Ninyo & Moore, 2011e, CBO Package No. 204, Geotechnical Review of Structural Calculations for Water Storage Tank, NRG El Segundo Tank Relocation Project, El Segundo, California, dated April 13, Project No. 206954003.

- Ninyo & Moore, 2011f, CBO Package No. 201, Geotechnical Review of Foundation Design Calculations for Condensate Tank, NRG El Segundo Tank Relocation Project, El Segundo, California, dated April 15, Project No. 206954003.
- Ninyo & Moore, 2011g, Supplemental Geotechnical Recommendations for Retaining Wall, NRG El Segundo Relocation Project, El Segundo, California, dated May 12, Project No. 206954003.
- Ninyo & Moore, 2011h, Geotechnical Recommendations for New Parking and Construction Trailers, Chevron South Marine Terminal Property, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated May 13, Project No. 206954003.
- Ninyo & Moore, 2011i, Supplemental Geotechnical Recommendations, New Parking and Construction Trailers, Chevron South Marine Terminal Property, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated May 17, Project No. 206954003.
- Ninyo & Moore, 2011f, CBO Package No. U-204, Geotechnical Observation of the Foundation Excavation, Unit 5 Heat Recovery Steam Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated June 9, Project No. 206954003.
- Ninyo & Moore, 2011k, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation, Unit 6 Air Cooled Heat Exchanger and BOP Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 5, Project No. 206954003.
- Ninyo & Moore, 2011l, Chief Building Official (CBO) Package No. U-230, Geotechnical Observation of the Foundation Excavation, Unit 6 Boiler Feed Pump, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 5, Project No. 206954003.
- Ninyo & Moore, 2011m, Chief Building Official (CBO) Package No. U-256, Geotechnical Observation of the Foundation Excavation, Unit 6 Air Cooled Heat Exchanger PCC/BOP and Plant PCC, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 5, Project No. 206954003.
- Ninyo & Moore, 2011n, Chief Building Official (CBO) Package No. U-268, Geotechnical Observation of the Foundation Excavation, Unit 6 Air Cooled Heat Exchanger, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 5, Project No. 206954003.
- Ninyo & Moore, 2011o, Chief Building Official (CBO) Package No. U-269, Geotechnical Observation of the Foundation Excavation, Unit 6 Air Compressor Skid, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 5, Project No. 206954003.
- Ninyo & Moore, 2011p, Responses to Geotechnical Peer Review Comments, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 12, Project No. 207487001.
- Ninyo & Moore, 2011q, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation, Unit 8 Air Cooled Heat Exchanger and BOP

- Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 15, Project No. 206954003.
- Ninyo & Moore, 2011r, Chief Building Official (CBO) Package No. U-230, Geotechnical Observation of the Foundation Excavation, Unit 8 Boiler Feed Pump, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 15, Project No. 206954003.
- Ninyo & Moore, 2011s, CBO Package No. 204, Geotechnical Observation of the Foundation Excavation for Water Storage Tank, NRG El Segundo Tank Relocation Project, El Segundo, California, dated August 17, Project No. 206954003.
- Ninyo & Moore, 2011t, CBO Package No. U-204, Geotechnical Observation of the Foundation Excavation. Unit 7 Heat Recovery Steam Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 23, Project No. 206954003.
- Ninyo & Moore, 2011u, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation. Unit 6 Steam Turbine Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 23, Project No. 206954003.
- Ninyo & Moore, 2011v, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation, Unit 7 Gas Turbine Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 23, Project No. 206954003.
- Ninyo & Moore, 2011w, Chief Building Official (CBO) Package No. U-215, Geotechnical Observation of the Foundation Excavation, Unit 6 Steam Turbine Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 23, Project No. 206954003.
- Ninyo & Moore, 2011x, Chief Building Official (CBO) Package No. U-273, Geotechnical Observation of the Foundation Excavation, Unit 6 Steam Turbine Lube Oil Skid and Cooler, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 23, Project No. 206954003.
- Ninyo & Moore, 2011y, Chief Building Official (CBO) Package No. U-224, Geotechnical Observation of the Foundation Excavation, Unit 6 Steam Turbine Power Control Center, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 25, Project No. 206954003.
- Ninyo & Moore, 2011z, Chief Building Official (CBO) Package No. U-224, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Power Control Center, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 25, Project No. 206954003.
- Ninyo & Moore, 2011aa, Chief Building Official CBO Package No. U-231, Geotechnical Observation of the Foundation Excavation, Unit 6 Steam Turbine Generator Step-Up

- Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 25, Project No. 206954003.
- Ninyo & Moore, 2011ab, Seawall Plan Review, NRG El Segundo Seawall, El Segundo, California, dated August 29, Project No. 206954003.
- Ninyo & Moore, 2011ac, Chief Building Official (CBO) Package No. U-206, Geotechnical Observation of the Foundation Excavation, Unit 7 Combustion Turbine Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011ad, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011ae, Chief Building Official (CBO) Package No. U-215, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011af, Chief Building Official (CBO) Package No. U-231, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Generator Step-Up Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011ag, Chief Building Official (CBO) Package No. U-256, Geotechnical Observation of the Foundation Excavation, Unit 8 Air Cooled Heat Exchanger PCC/BOP and Plant PCC, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011ah, Chief Building Official (CBO) Package No. U-268, Geotechnical Observation of the Foundation Excavation, Unit 8 Air Cooled Heat Exchanger, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011ai, Chief Building Official (CBO) Package No. U-273, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Lube Oil Skid and Cooler, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 7, Project No. 206954003.
- Ninyo & Moore, 2011aj, Chief Building Official (CBO) Package No. U-260, Geotechnical Observation of the Foundation Excavation, Unit 5 HRSG Blowdown Slump Tank, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 21, Project No. 206954003.
- Ninyo & Moore, 2011ak, Resistivity Survey Results, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 23, Project No. 207487001.
- Ninyo & Moore, 2011al, Chief Building Official (CBO) Package No. U-260, Geotechnical Observation of the Foundation Excavation, Unit 7 HRSG Blowdown Slump Tank, NRG

- El Segundo Power Redevelopment Project, El Segundo, California, dated September 28, Project No. 206954003.
- Ninyo & Moore, 2011am, Chief Building Official (CBO) Package No. U-209, Geotechnical Observation of the Foundation Excavation, Unit 7 Auxiliary and Gas Turbine Generator Step-Up Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated October 3, Project No. 206954003.
- Ninyo & Moore, 2011an, Chief Building Official (CBO) Package No. U-223, Geotechnical Observation of the Foundation Excavation, Unit 7 Gas Turbine Power Control Center & Medium Voltage Switchgear, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated October 3, Project No. 206954003.
- Ninyo & Moore, 2011ao, Chief Building Official (CBO) Package No. U-210, Geotechnical Observation of the Foundation Excavation, Unit 6 Steam Turbine Clean Drains, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated November 22, Project No. 206954003.
- Ninyo & Moore, 2011ap, Chief Building Official (CBO) Package No. U-206, Geotechnical Observation of the Foundation Excavation, Unit 5 Combustion Turbine Generator, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated November 31, Project No. 206954003.
- Ninyo & Moore, 2011aq, Chief Building Official (CBO) Package No. U-210, Geotechnical Observation of the Foundation Excavation, Unit 8 Steam Turbine Clean Drains, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated December 12, Project No. 206954003.
- Ninyo & Moore, 2012a, Chief Building Official (CBO) Package No. U-209, Geotechnical Observation of the Foundation Excavation, Unit 5 Auxiliary and Gas Turbine Generator Step-Up Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated January 12, Project No. 206954003.
- Ninyo & Moore, 2012b, Chief Building Official (CBO) Package No. U-223, Geotechnical Observation of the Foundation Excavation, Unit 5 Gas Turbine Power Control Center & Medium Voltage Switchgear, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated January 12, Project No. 206954003.
- Ninyo & Moore, 2012c, Chief Building Official (CBO) Package No. 206, Geotechnical Observation of the Foundation Excavation, Perimeter Wall, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated January 19, Project No. 206954003.
- Ninyo & Moore, 2012d, Entry Road Stability, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated February 10, Project No. 206954003.
- Ninyo & Moore, 2012e, Supplemental Geotechnical Recommendations for Retaining Wall, NRG El Segundo Relocation Project. El Segundo, California, dated May 10, Project No. 206954003.

- Ninyo & Moore, 2012f, Chief Building Official (CBO) Package No. U-212, Geotechnical Observation of the Foundation Excavation, Unit 5 Gas Turbine Low Voltage Transformer, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated May 29, Project No. 206954003.
- Ninyo & Moore, 2012g, Chief Building Official (CBO) Package No. U-222, Geotechnical Observation of the Foundation Excavation, Fuel Gas Compressor Building, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated June 4, Project No. 206954003.
- Ninyo & Moore, 2012h, Chief Building Official (CBO) Package No. U-265, Geotechnical Observation of the Foundation Excavation, Fuel Gas Compressors, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated June 4, Project No. 206954003.
- Ninyo & Moore, 2012i, Chief Building Official (CBO) Package No. U-267, Geotechnical Observation of the Foundation Excavation, Fuel Gas Equipment, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated June 4, Project No. 206954003.
- Ninyo & Moore, 2012j, Review of CBO Package Nos. CBO-U-502 & CBO-U-506, NRG El Segundo Power Redevelopment, dated June 19, Project No. 206954003.
- Ninyo & Moore, 2012k, Chief Building Official (CBO) Package No. U-201, Geotechnical Observation of the Foundation Excavation, Seawall, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated June 22, Project No. 206954003.
- Ninyo & Moore, 2012l, Chief Building Official (CBO) Package No. U-229, Geotechnical Observation of the Foundation Excavation, Unit 6 Deaerator, Drain Tanks, and Condensate Extraction Pumps, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated July 24, Project No. 206954003.
- Ninyo & Moore, 2012m, Chief Building Official (CBO) Package No. U-229, Geotechnical Observation of the Foundation Excavation, Unit 8 Deaerator, Drain Tanks, and Condensate Extraction Pumps, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated July 24, Project No. 206954003.
- Ninyo & Moore, 2012n, Chief Building Official (CBO) Package No. 503, Geotechnical Observation of the Foundation Excavation, 230kV Interconnection Station – Drilled Piers, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated July 27, Project No. 206954003.
- Ninyo & Moore, 2012o, Chief Building Official (CBO) Package No. U-221, Geotechnical Observation of the Foundation Excavation, Seawall North Wall Extension, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated July 31, Project No. 206954003.
- Ninyo & Moore, 2012p, Chief Building Official (CBO) Package No. 502, Geotechnical Observation of the Foundation Excavation, 230kV Transmission Line – Drilled Piers,

- NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 10, Project No. 206954003.
- Ninyo & Moore, 2012q, Chief Building Official (CBO) Package No. U-269, Geotechnical Observation of the Foundation Excavation, Unit 8 Air Compressor Skid, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated August 17, Project No. 206954003.
- Ninyo & Moore, 2012r, Chief Building Official (CBO) Package No. U-286, Geotechnical Observation of the Foundation Excavation, Nitrogen Storage Tank and Nitrogen Vapor Skids Foundation, NRG El Segundo Power Redevelopment Project, El Segundo, California, dated September 25, Project No. 206954003.
- Norris, R.M. and Webb, R.W., 1990, *Geology of California*: John Wiley & Sons, 541 pp.
- Peterson, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Lienkaemper, J.J., McCrory, P.A., and Schwartz, D.P., 1996, Probabilistic Seismic Hazard Assessment for the State of California: California Department of Conservation, Division of Mines and Geology Open File Report 96-08.
- Seed, H.B., and Idriss, I.M., 1982, Ground Motions and Soil Liquefaction During Earthquakes, Volume 5 of Engineering Monographs on Earthquake Criteria, Structural Design, and Strong Motion Records: Berkeley, Earthquake Engineering Research Institute.
- Tokimatsu, K., and Seed, H.B., 1987, Evaluation of Settlements in Sands Due to Earthquake Shaking, *Journal of Geotechnical Engineering*, ASCE, 113(8), 861-878.
- United States Geological Survey, 1964 (Photorevised 1981), Venice, California Quadrangle Map, 7.5 Minute Series: Scale 1:24,000.
- United States Geological Survey, 2009, Earthquake Ground Motion Parameter Java Application, Java Ground Motion Parameter Calculator - Version 5.1; <http://earthquake.usgs.gov/research/hazmaps/design/>.
- Youd, T.L., and Idriss, I.M. (Editors), 1997, Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt Lake City, Utah, January 5 through 6, 1996, NCEER Technical Report NCEER-97-0022, Buffalo, New York.
- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., and Stokoe, K.H., II., 2001, Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, *Journal of Geotechnical and Geoenvironmental Engineering*: American Society of Civil Engineering 124(10), p. 817-833.
- Youd, T.L., Hansen, C.M., and Bartlett, S.F., 2002, Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement, *Journal of Geotechnical and Geoenvironmental Engineer*, Vol. 128, No. 12, American Society of Civil Engineers, December 1.