

**DEPARTMENT OF CONSERVATION****CALIFORNIA GEOLOGICAL SURVEY**

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INTERNATIONAL**

February 28, 2008

Ms. Karen Van Dorn  
Senior Architect  
Division of the State Architect  
1515 Clay Street, Suite 1201  
Oakland, California 94612

**Subject: Engineering Geology and Seismology Review  
College of Marin – Science, Math and Central Plant Complex  
835 College Avenue, Kentfield, California  
DSA Facility 21-C1 DSA Application No. 01-109358**

Dear Ms. Van Dorn:

In accordance with your request and transmittal of documents on January 8, 2008, the California Geological Survey (CGS) has reviewed the engineering geology and seismology aspects of the consulting report prepared for the Science, Math and Central Plant Complex (SMCPC) at College of Marin in Kentfield, California. According to the consultant's project description, the proposed construction will be a one to three-story, T-shaped, steel frame structure approximately 38,000 square feet in plan view. The consultant's project scope included development of a site specific response spectrum. This review was performed in accordance with Title 24, California Code of Regulations, 2001 California Building Code (CBC) and followed CGS Note 48 Guidelines. We reviewed the following consulting report:

**Geotechnical Investigation, College of Marin, Math Science Building, Kentfield, California:**  
Miller Pacific Engineering Group, 504 Redwood Blvd., Suite 220, Novato, CA 94947; telephone (415) 382-3444; report dated November 7, 2007; Company Project no. 739.11; 25 pages, Figures 1-9, Appendices A – D.

The consultant drilled a number of test borings. The borings encountered alluvial deposits that range from less than 5 to about 25 feet in thickness at the building site. Bedrock of the Franciscan Formation consisting of fractured sandstone and shale was encountered beneath the alluvium. The alluvial deposits consist of soft to medium stiff clays with interbedded well-graded sand and clayey sand. Groundwater was encountered at depths of 9 to 11 feet.

The most significant geologic hazards identified by the consultant are the potential for strong seismic ground motion and the potential for both static and seismically-induced differential settlement across the site due to the variations in soil thickness and soil strength. The consultant indicates that differential settlement could result from consolidation under new loads or from

seismically-induced consolidation. The consultant's analyses of these hazards are addressed below.

### **Probabilistic Seismic Hazard Analysis**

The consultant provides probabilistic estimates of peak ground acceleration for the Upper Bound Earthquake (PGA<sub>UBE</sub> - 10 percent chance of exceedance in 100 years) and the Design Basis Earthquake (PGA<sub>DBE</sub> - 10 percent chance of exceedance in 50 years) in accordance with Title 24 requirements. The consultant's estimates (PGA<sub>UBE</sub> = 0.59g; PGA<sub>DBE</sub> = 0.51g) appear to be reasonable based on comparison with California Geological Survey State-Wide Model (from Peterson and others, 1996, CGS Open-File Report 96-08; updated by Cao and others, 2003).

### **Site Specific Response Spectrum and Time History Analysis**

The consultant provides a site-specific response spectrum to be used in structural analysis. To develop the response spectrum, the consultant first developed a target spectrum for DBE ground motion using FRISKSP. The consultant then selected and adjusted seven earthquake time history records to correlate with the target spectrum. The consultant then ran a SHAKE2000 analysis to determine soils amplification of the rock motions. Finally, the consultant provides the recommended response spectrum based on the average of the seven ground motion records that were output from the SHAKE2000 program.

Based on our review, the consultant **has not provided enough data to evaluate the time history analysis or the SHAKE ground-motion model**. In the attachment to this letter, CGS requests additional information documenting the records, and the effects of the scaling and site modeling on those records.

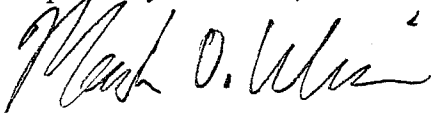
### **Differential Settlement**

The consultant estimates that up to one-inch seismically-induced differential settlement and an additional one-inch of compression-induced differential settlement could occur at the building site. These estimates are not supported by quantitative analyses, however, the consultant states that differential settlement of less than one inch is required for the structural design. To mitigate differential settlement, the consultant recommends that the building be supported on drilled piers with a minimum embedment of 5-feet into weathered bedrock. The consultant's recommendations appear reasonable for the site conditions. The consultant includes a lateral pier analysis to calculate deflection and induced moment with depth. CGS does not have geotechnical engineers on staff and is not qualified to evaluate the results of the lateral pier analysis.

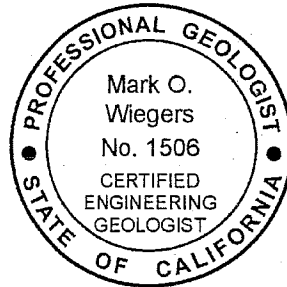
The consultant concludes that there are no other significant geologic hazards and provides adequate information to support these conclusions.

*Based on our review, CGS requests that additional information be provided by the consultant to complete the engineering geology and seismology review for this project.* The applicant should be reminded that one copy of all supplemental documents should be submitted to DSA, and one copy directly to CGS. Supplemental documents should include the DSA application number. If you have any further questions about this review letter, please telephone the undersigned at (707) 576-2205.

Respectfully submitted,



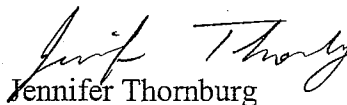
Mark O. Wiegiers  
Associate Engineering Geologist  
PG 4157, CEG 1506



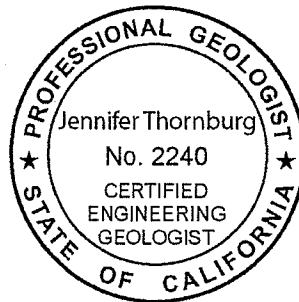
Reviewed by,



Badie Rowshandel, Ph.D., P.E.  
Senior Seismologist & Research Engineer  
RCE 45313



Jennifer Thornburg  
Senior Engineering Geologist  
RG 5476, CEG 2240



***Enclosures:***

Note 48 Checklist Review Comments Keyed to: *Note 48 - Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings*

***Copies to:***

Scott Stephens, *Registered Geotechnical Engineer* and Stephen Korbay, *Certified Engineering Geologist*  
Miller Pacific Engineering Group, 504 Redwood Blvd., Suite 220, Novato, CA 94947

V-Anne Chernock, *Director of Facilities*  
College of Marin, 835 College Avenue, Kentfield, CA 94904

Frank Fung,  
ED2 International, Architects and Planners, 945 Bryant Street, Suite 300, San Francisco, CA 94103

## Note 48 Checklist Review Comments

In the numbered paragraphs below, this review is keyed to the paragraph numbers of California Geological Survey Note 48 (January, 2004 edition), *Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings*. The checklist can be found on the CGS web site at the following address:

[http://www.consrv.ca.gov/cgs/information/publications/cgs\\_notes/note\\_48/note\\_48.pdf](http://www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_48/note_48.pdf)

### Project Location

1. Site Location: Adequately addressed
2. Boreholes: Adequately addressed.
3. Site Coordinates: Adequately addressed: N37.9557; W122.5506.

### Engineering Geology

4. Regional Geology and Fault Maps: Adequately addressed.
5. Geologic Map of Site: Adequately addressed.
6. Subsurface Geology at Site: Adequately addressed.
7. Geologic Cross Sections: Not provided but not critical to this project.
8. Evaluation of Active Faulting & Coseismic Deformation: Adequately addressed.
9. Seismic Hazard Zones: The site is in an area not yet zoned by CGS for liquefaction or earthquake-triggered landslide hazards.
10. Landslides: Adequately addressed. The site is flat with no apparent landslides.
11. Geotechnical Laboratory Testing: Adequately addressed.
12. Expansive Soils: Adequately addressed. Soils have a low expansion potential.
13. Geochemistry of the Geologic Subgrade: Adequately addressed. Consultant provides test results that show that the soils have a low potential for sulfate attack on concrete and a moderate potential for corrosion to ferrous metal in contact with soils (pipes and culverts). The consultant includes a corrosion report with corrosion control recommendations.
14. Flooding: Adequately addressed. Flood potential is low. The site is outside of the FEMA designated 100-year floodplain.

### Seismology & Calculation of Earthquake Ground Motion

15. Evaluation of Historic Seismicity: *Additional information requested*. The consultant states that the main seismic sources are a M=7.4 earthquake on the San Andreas Fault and a M=6.7 earthquake on the Hayward Fault. Current publications available to CGS indicate that the 1906 earthquake on the San Andreas Fault was Mw=7.8 and maximum magnitude of the Hayward Fault is considered to be at least Mw=6.9. The consultant is requested to review the magnitude potential of the main faults.
16. Probabilistic Seismic Hazard Analysis (PSHA) Methodology: Adequately addressed.
17. Upper-Bound Earthquake Ground Motion: Adequately addressed.

18. Design-Basis Earthquake Ground Motion: Adequately addressed.
19. Classify the Geologic Subgrade: Adequately addressed. Soil Profile Type  $S_c$ .
20. Near-Source Coefficients: Adequately addressed. The consultant reports  $N_a = 1$  and  $N_v = 1.12$ .
21. Peak Ground Acceleration: Adequately addressed. PGA obtained by the consultants using the PSHA method:  
Upper-Bound Earthquake ground-motion, 10% exceedance in 100 years Peak Ground Acceleration, **PGA<sub>UBE</sub> = 0.59g**  
Design-Basis Earthquake ground-motion, 10% exceedance in 50 years Peak Ground Acceleration, **PGA<sub>DBE</sub> = 0.51g**

Independent calculation by the California Geological Survey of the ground-motion using the California Geological Survey State-Wide Model (from Peterson and others, 1996, CGS Open-File Report 96-08; updated by Cao and others, 2003), for Type  $S_c$ , indicates that the above values are reasonable and appropriate.

22. Normalized Spectral Acceleration: Adequately addressed. The consultant developed a target spectrum for DBE ground motion (10% probability of exceedance in 50 years) using FRISKSP, then selected and adjusted seven earthquake time history records to correlate with the target spectrum. The development of this target spectrum appears to be appropriate for the site.
23. California Seismic Zone 3 or 4: Adequately addressed. The consultants report the site lies within Zone 4 and that  $Z=0.40$ .
24. Scaled Time-Histories of Earthquake Ground Motion: ***Additional information requested.***  
Based on the site location, it appears that the main hazard at the site is produced by a  $M_w=7.8$  strike slip earthquake on the San Andreas Fault at the distance of 12 km. It is not clear why the consultant considers the seismic hazard from the  $M=6.7$  Hayward Fault at a distance of 16 km to be equally significant at this site. It is recommended that strong motion records within  $\pm 0.5$  of target magnitude be selected. Since there are only a few records with a magnitude as high as  $M7.9$  the choice is limited, however, there are records from Denali ( $M7.9$ ), Landers ( $M7.3$ ), Hector ( $M7.1$ ) and Kocaeli ( $M7.3$ ) that could be considered. It is hard to justify use of Chalfant Valley ( $M6.2$ ) and Imperial Valley ( $M6.5$ ) records.

It is not possible to effectively review the scaled time histories unless the initial time histories are also presented. Also, the scaled time histories cannot be effectively reviewed when they are all plotted together on one figure. CGS requests that the spectral accelerations for each record be plotted separately, along with the target spectrum, both before and after scaling. Please show:

- Initial records, including plots of time versus acceleration, velocity, and displacement.
- The initial spectra relative to target spectrum.
- Scaled time histories (plots of time versus acceleration, velocity, and displacement).

- The scaled spectra relative to target spectrum.
- Show that the square root of the sum of the squares (SRSS) of the pairs of horizontal components exceeds the level required by the California Building Code in the period range appropriate for the structure.

SHAKE2000 Site Response Model: *Additional information is requested.* The consultants have provided adequate documentation in Table B-2 of the soil profile and properties used in the SHAKE2000 model. However, they should provide records and spectra showing how the model affects the ground motion records. Similar to above, the consultants should show:

- Final time history records (plots of time versus acceleration, velocity, and displacement).
- The final spectra relative to the rock target spectrum as well as the recommended design spectrum. As with the initial and scaled spectra, these should be plotted individually so that they are more readily reviewed.

### **Liquefaction Analysis**

25. Geologic Setting: Adequately addressed. The consultant did not encounter saturated sandy soils below the water table but did encounter some sandy lenses above the water table. The consultant concludes that there could be discontinuous saturated sandy lenses and that liquefaction potential is low to moderate at the site.
26. Liquefaction Methodology: Adequately addressed. A liquefaction analysis was not performed because there were no saturated granular deposits encountered in borings.
27. Liquefaction Calculations: Adequately addressed. A liquefaction analysis was not performed because there were no saturated granular deposits encountered in borings.
28. Seismic Settlement of the entire Soil Column: Adequately addressed. The consultant estimates that the site is subject to up to 1-inch of unsaturated differential seismic settlement.
29. Lateral Spreading due to Liquefaction: Adequately addressed – low potential.
30. Remedial Options for Liquefaction: Adequately addressed. The consultant recommends that the building be supported on drilled piers with a minimum embedment of 5-feet into weathered bedrock. The consultant's recommendations appear reasonable for the site conditions.
31. Acceptance Criteria for Liquefaction Remediation: Should be provided when final foundation alternative is selected.

### **Exceptional Geologic Hazards or Site Conditions:**

32. Phase I & II Environmental Site Assessment Work: Not addressed by the consultants, and therefore not reviewed.

33. Hazardous Materials: Not addressed by the consultants, and therefore not reviewed.
34. California Environmental Quality Act: Not addressed by the consultants, and therefore not reviewed.
35. Ground-Water Quality: Not addressed by the consultants, and therefore not reviewed.
36. On-Site Septic Systems: Not addressed by the consultants, and therefore not reviewed.
37. Non-Tectonic Faulting and Hydrocollapse of Alluvial Fan Soils: Adequately addressed
38. Regional Subsidence: Adequately addressed.
39. Volcanic Eruption: Not applicable.
40. Tsunami or Seiche: Adequately addressed.
41. Asbestos in serpentine terrain: Adequately addressed. No asbestos-bearing geologic materials were encountered at the site.
42. Radon-222 gas: Not addressed by the consultants, and therefore not reviewed.
43. Other Geologic Hazards: None known.

### **Site Grading Plan Review & Foundation Plan Review**

44. Areas of Cut and Fill, Preparation of Ground: Adequately addressed.
45. Geologic and Geotechnical Inspections and Problems Anticipated During Grading: Adequately addressed.
46. Subdrain Plans for Ground Water and Surface Water: Not addressed by the consultants, and therefore not reviewed.
47. Cut-Fill Prisms: Not applicable.
48. Deep Foundation Plans: Adequately addressed.
49. Retaining Walls and Engineered Fill Buttresses: Adequately addressed.

### **Report Documentation**

50. Geology, Seismology, and Geotechnical References: Adequately addressed.
51. Certified Engineering Geologist: signature, valid license number: Adequately addressed. Stephen Korbay, Certified Engineering Geologist 916.
52. Registered Geotechnical Engineer: signature, valid license number & seal: Adequately addressed. Scott Stephens, Registered Geotechnical Engineer 2398.