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SYNOPSIS A site specific risk zoning study was conducted on a Junior College Campus near Eureka, California, USA to evaluate the potential seismic/geologic hazards due to the presence of a 1 km wide low angle thrust fault system. Issues addressed to determine the level of risk at any location on the campus include: landsliding, earthquake ground shaking, ground surface rupture and deformation, lateral spreading, liquefaction, differential settlement, and tsunamis. Based on these potential hazards, a micro-zonation model was developed based on 13 different zones and 5 levels of risk. Information for use in this model was collected using a combination of paleo-seismic trenches, geophysical surveys and soil borings. This information was then combined to develop a map of risk zones within the campus. This map provides site specific land use recommendations to assist the college in locating appropriate sites for future campus expansion.

INTRODUCTION

LACO ASSOCIATES evaluated the potential for geologic/seismic hazards that may affect the Eureka campus of the College of the Redwoods (Figures 1 and 2). Geologic/seismic hazards that have a potential to affect portions of the campus include: landsliding, earthquake ground shaking, ground surface rupture, ground deformation, liquefaction, differential settlement, and tsunamis.

Evaluating the geologic/seismic hazards, and developing an appropriate land-use plan to assist planners in reducing potential risks on the campus required addressing the following concerns: 1) potential for local and regional seismic events, 2) earthquake recurrence intervals, 3) what effects seismic events might have on the campus, 4) where ground surface rupture might occur, 5) where other seismically induced ground failures might occur, and 6) formulation of strategies to mitigate the observed hazards.

GEOLOGIC AND SEISMIC SETTING

College of the Redwoods is located within the fold and thrust belt associated with the Cascadia Subduction Zone (Figure 1). The Cascadia Subduction Zone is a convergent margin in which the oceanic crust of the Gorda Plate is being subducted beneath the edge of the North American continent.

College of the Redwoods is located within the Little Salmon fault Alquist-Priolo Fault Hazard Zone. The Little Salmon thrust fault is within the fold and thrust belt.

SUBSURFACE INVESTIGATIONS

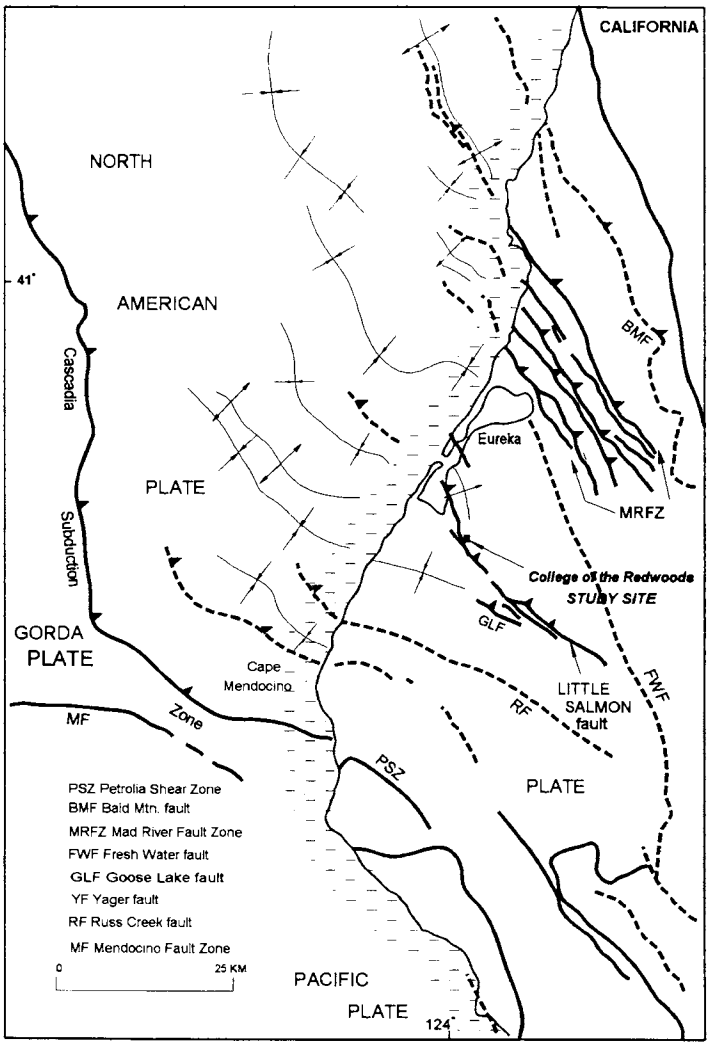
Evaluation of the subsurface geological conditions beneath the campus is based on information developed from several sources, including: geotechnical borings (Harding and Associates, 1965 and LACO ASSOCIATES, 1989), fault studies by Woodward-Clyde Consultants (1980), and fault paleo-seismic investigations conducted on the campus (LACO ASSOCIATES, 1989,1993). A geophysical survey was also undertaken as an additional means of locating potentially hazardous faults on the campus.

Interpretation of geotechnical boring logs allowed the development of simplified geologic profiles based on soil type. These simplified profiles were used to evaluate the potential response of various regions of the campus to both static and seismic loading. The potential responses of interest were settlement, liquefaction, and lateral spreading. Incorporating the simplified geologic profiles, along with the potential acceleration and duration of strong ground motion, allowed the delineation of areas of the campus which would be at risk during a seismic event.

CRITERIA FOR ESTABLISHING RISK ZONES

The purpose of developing criteria for establishment of risk zones (micro-zonation, Figure 2) is to provide protection to the integrity of campus structures under static and seismic loading by avoiding potentially hazardous areas. Risks to the structural integrity of a building under static loading conditions are differential settlement and slope instability. Under seismic (cyclic) loading, risk to struc-

Fig. 1. Principal geologic structures of the Eel River basin and adjacent region (modified after Clarke, 1992)



tural integrity include liquefaction, ground surface tilting or warping (surface deformation), lateral spreading, ground surface rupture, and earthquake-induced slope instability.

Criteria utilized to establish risk zones at the College of the Redwoods campus are shown in Figure 2. Development of these criteria involved integration of a variety of geologic/seismic and geotechnical information.

Data utilized to establish the levels of potential risk to the long-term structural integrity of a building at any particular location on the campus are outlined above. Detailed information is required to describe the regional geologic/seismic setting and to relate that information to the site to estimate potential frequency and intensity of seismic events (Chaney et al., 1991). Site-specific information on soil conditions is necessary to estimate how subsurface material will respond to static and cyclic loading.

On the campus, within the Little Salmon fault zone, assessment of the potential for ground surface rupture was accomplished by a direct-observation investigation of the subsurface stratigraphy. Avoidance of faults which offset the observed stratigraphy was determined to be the best option for mitigation of surface rupture hazards.

ASSIGNMENT OF THE RISK ZONES

Only preliminary risk zones can be establish based on available information. Areas with high and low to medium risks of liquefaction and/or settlement are delineated on Figure 2. Areas where faults are interpreted to intercept the ground surface, or where faults have been observed in the shallow (<20') subsurface, are shown on Figure 2 and indicate areas where the risk of ground rupture is potentially very high.

CONCLUSIONS

Regarding the overall campus evaluation, the risk zones map (Figure 2) will serve as a guide for campus planning by identifying various relative hazard probability zones, based on preliminary investigations. The limitations of the data used for the zonation does not appear to be a significant concern for planning purposes, provided that the hazard zonation categories are regarded as indicating probable conditions within the zone (as opposed to absolute indication of hazards).

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Figure 2. Preliminary Risk Map of College of The Redwoods

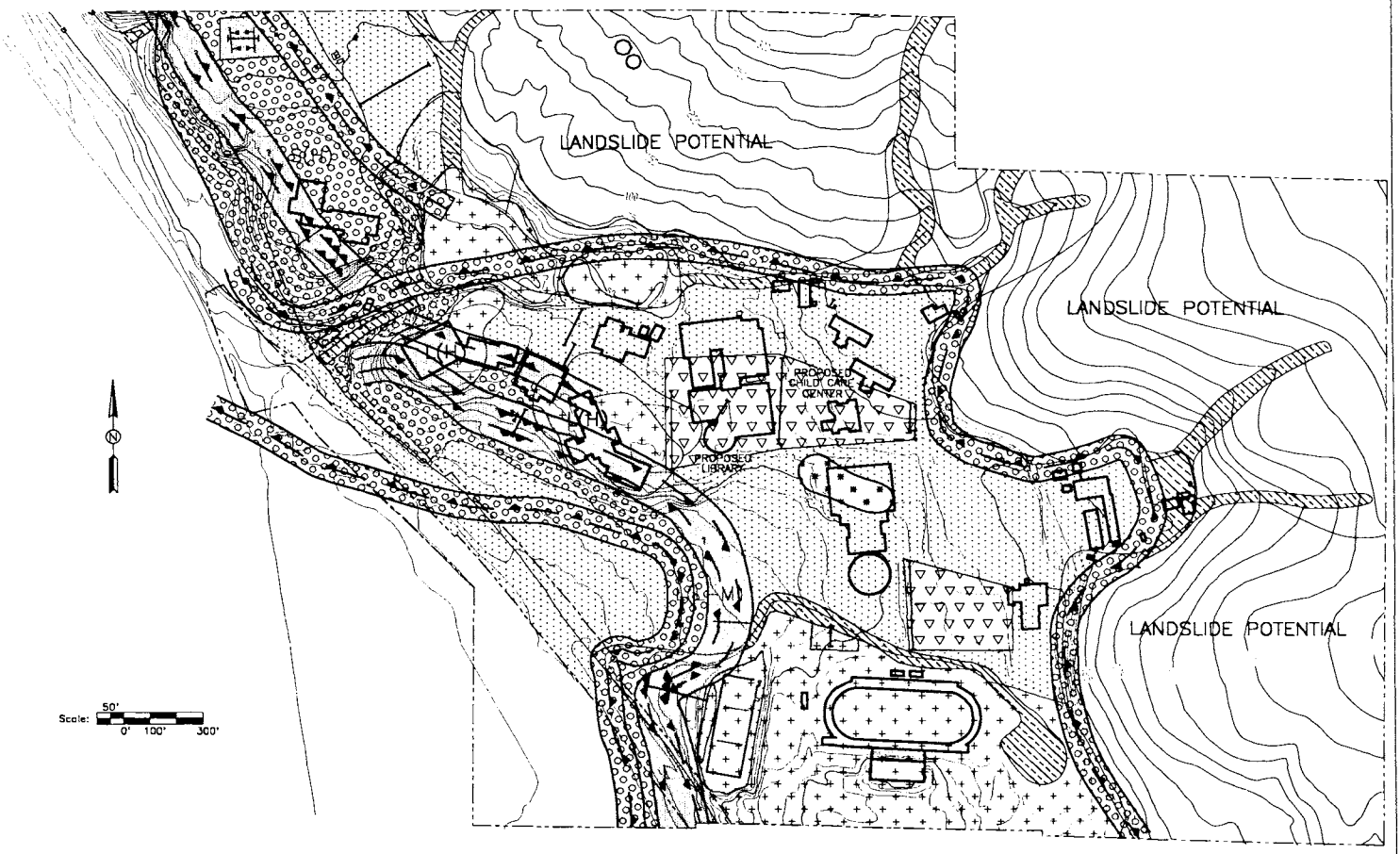

Table 1 – Criteria for Establishing Risk Zones

ZONE	EFFECT	SURFACE CAUSE	WORK NEEDED
	Site Trenched, Significant Faulting or Surface Deformation	Surface Faulting Event Accompanied by Co-Seismic Ground Deformation.	**VERY HIGH RISK** Site not Buildable Within 50' of Fault Trace.
	Fault Projected, (Strike & Dip) from trench site	Surface Faulting Event/ Ground Deformation.	**VERY HIGH RISK** Site not Buildable Within 50' of Projected Fault. Any Proposed Building Site should be Investigated for Fault Hazard (trenched).
	Site Trenched, Significant Surface Deformation Observed. No Fault Observed.	Surface Faulting Event Accompanied by Co-Seismic Ground Deformation.	**HIGH RISK** Possible Building Site. Requires Geotechnical Investigation and Structural Engineering.
	Not Trenched, Fault Inferred – Based on Geology and Geomorphology	Surface Faulting Event Accompanied by Ground Deformation.	**HIGH RISK** Requires both Fault and Geotechnical Investigations. Building Site Status Unknown.
	Significant Settlement and/or Differential Settlement (Based on Borings)	Consolidation of Fine Grained Alluvium.	**HIGH RISK** Requires Geotechnical Investigation. Possible Building Site.
	Significant Liquefaction (Based on Borings)	Loss of Soil Strength in Loose Saturated Sands or Silts during Seismic Loading.	**HIGH RISK** Requires Geotechnical Investigation. Possible Building Site.
	Active Stream Channel, Inner Gorge Flood Hazards	Flood, Liquefaction, Rapid Sediment Discharge Hazard.	**HIGH RISK** Requires Geotechnical, Fault, & Hydrolic Investigations.
	Low to Moderate Settlement, Liquefaction or Lateral Spreading (Based on Borings)	Loss of Soil Strength During Seismic Loading.	**LOW TO MODERATE RISK** Requires Geotechnical Investigation. Possible Building Site.
	Slopes Susceptible to Landsliding (Based on Geology and Topography and Possible Borings)	Slopes Susceptible to Loss of Soil Strength During Seismic Loading, Construction Loading, or Saturated Conditions.	**LOW TO MODERATE RISK** Requires Geotechnical Investigation. Possible Building Site.
	Site Trenched and Documented Lack of Faulting		Building Site if other Risk Zones are Mitigated.

LEGEND

Thrust Faults, Dashed where Projected

Normal Faults

Trench – Fault Exploration Site