Appendix G: Geological Technical Study

GEOLOGICAL TECHNICAL STUDY, ENVIRONMENTAL IMPACT REPORT PACIFIC GAS AND ELECTRIC COMPANY LINE 406 AND LINE 407 PIPELINE PROJECT ESPARTO TO ROSEVILLE, CALIFORNIA

PREPARED FOR:

Michael Brandman Associates
Bishop Ranch 3
2633 Camino Ramon, Suite 460
San Ramon, California 94583

PREPARED BY:

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
5710 Ruffin Road
San Diego, California 92123

September 26, 2008
Project No. 106323001

September 26, 2008
Project No. 106323001

Ms. Chelsea Ayala
Michael Brandman Associates
Bishop Ranch 3
2633 Camino Ramon, Suite 460
San Ramon, California 94583

Subject: Geological Technical Study, Environmental Impact Report
Pacific Gas and Electric Company
Line 406 and Line 407 Pipeline Project
Esparto to Roseville, California

Dear Ms. Ayala:

In accordance with your authorization, we are pleased to present the results of our Geological Technical Study to assist in the preparation of the Pacific Gas and Electric Company proposed Line 406 and Line 407 Pipeline Project (the Project) Environmental Impact Report. This report provides a summary of our findings and conclusions regarding geologic and soils conditions relative to the Project.

We appreciate the opportunity to be of service.

Respectfully submitted,

NINYO & MOORE

Randal L. Irwin, C.E.G. 1521
Chief Engineering Geologist

Gregory T. Farrand, C.E.G. 1087
Principal Geologist

RI/GTF/gg

Distribution: (1) Addressee

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SECTION 1: INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a Geological Technical Study for the Pacific Gas & Electric Company (PG&E) proposed Lines 406 and 407 Pipeline Project (the Project). The purpose of this study was to evaluate the geologic and soils conditions along the pipeline route using available data to assist with the preparation of the Environmental Impact Report (EIR) for the Project. Subsurface exploration and laboratory testing were not included in the scope of this reconnaissance-level evaluation.

SECTION 2: SCOPE OF SERVICES

Ninyo & Moore's scope of services for this evaluation included the following:

- Review of pertinent, available geologic technical literature including topographic and geologic maps and publications, aerial photographs, and reports. Documents pertaining to our evaluation of the study area are listed in the References section of this report.
- Performing a field reconnaissance of the pipeline route by a California certified Engineering Geologist from our firm.
- Compilation and analysis of data obtained, with particular emphasis on potential geologic considerations relative to the Project.
- Preparation of this report presenting our findings and conclusions pertaining to the existing geologic and soils conditions relative to the Project.

SECTION 3: PROJECT DESCRIPTION

PG&E is proposing to construct and operate multiple natural gas transmission pipelines that will cross California's Central Valley. The Project will traverse four counties within the lower Sacramento Valley from Yolo County, just west of Yolo County Road (CR) 85 near the town of Esparto, and extends approximately 37 miles east to the City of Roseville in Placer County. Figure 1 is a map of the study area. Project construction would involve a combination of conventional trenching, horizontal directional drilling (HDD), and hammer boring. The HDD technique is used to tunnel under vertically and/or horizontally large sensitive surface features such as watercourses, levees, and wetlands. There are ten HDD crossings that are planned, among those are for Interstate 5, Interstate 505, and the Sacramento River. Hammer boring is a non-steerable pipeline construction technique that drives pipe for short distances under surface features such as roads.

SECTION 4: GEOLOGY

The following sections present our findings relative to regional geology, site geology, and groundwater.

4.1 - Regional Geology

The Project area is located in the Great Valley province, a northwest-trending asymmetrical structural basin bounded by the Sierra Nevada province to the east and south, the Klamath Mountains to the north, the Cascade Range province to the northeast, and the Coast Ranges province to the west. The Great Valley (comprised of the Sacramento Valley in the north and the San Joaquin Valley in the south) is a nearly flat alluvial plain extending for about 450 miles from the Klamath Mountains south to the Tehachapi Mountains. The northerly portion of the Great Valley, the Sacramento Valley, is drained by the southerly flowing Sacramento River, whereas the San Joaquin

River flows to the north draining the San Joaquin Valley. Both rivers ultimately empty into the San Francisco Bay.

The Great Valley has been filled with a thick sequence of sedimentary rocks of Jurassic to Recent age (the Great Valley Sequence). The sedimentary trough has a long stable eastern shelf supported by the subsurface continuation of the granitic Sierran slope and a short western flank expressed by the upturned edges of the basin sediments (Bailey, 1966). Elevations of the alluvial plain are generally just a few hundred feet above sea level, with extremes ranging from a few feet below sea level to about 1,000 feet above. The only prominent topographic eminence within the central part of the valley is Marysville (Sutter) Buttes, a Pliocene volcanic plug which rises abruptly 2,000 feet above the surrounding valley floor. The study area is located in the southerly portion of the Sacramento Valley of the Great Valley.

4.2 - Study Area Geology

Based on our literature review, including published geologic maps and available geotechnical reports, the study area is underlain generally by artificial fill, and recent natural surficial deposits of alluvium and basin deposits. In addition, formational units are present along the alignment including the Pleistocene-age Modesto, Turlock Lake, and Red Bluff formations and the Piocene-age Tehama Formation. The following unit descriptions are based on our field observations, published data and the Geotechnical Investigation Report prepared for the Project (Kleinfelder, 2007).

4.2.1 - Artificial Fill

Areas of man-made artificial fill are present along the proposed alignment. These soils occur in areas of existing improvements such as roads, levees, and buried utilities. Also, agricultural fill occurs as plowed topsoil in the agricultural fields. In general, the fill soils are expected to be relatively thin and derived primarily or entirely from the on-site soils. However, thicker fill soils can be expected in the earthen levees present along water courses.

4.2.2 - Alluvium and Basin Deposits

Holocene (or Recent) age alluvium and basin deposits have been mapped as underlying central portions of the pipeline alignment. The alluvium is the result of deposition of the Sacramento River, Cache Creek, and other river systems and typically consists of unconsolidated sand and silt (Kleinfelder, 2007). The basin deposits were deposited in somewhat lower-energy depositional environments and, consequently, consist of silts and clays (i.e., finer-grained materials). The basin deposits are interbedded with alluvial deposits. Other alluvial deposits crossing the alignment have been documented as river bank and as buried stream channel deposits, which include relatively permeable sands and gravels encased in less permeable silts and clays.

4.2.3 - Modesto Formation

Materials of the late Pleistocene-age Modesto Formation are exposed in the western and eastern portions of the alignment (Kleinfelder, 2007). The Modesto Formation typically consists of brown, dark brown to reddish brown moderately cemented silt and clay.

4.2.4 - Riverbank Formation

Materials of the Pleistocene-age Riverbank Formation have been mapped (Wagner et al., 1981) as underlying areas of the easterly portion of the route, east of the Sacramento River. The Riverbank Formation consists of older alluvial deposits composed of gravel, sand, silt, and clay.

4.2.5 - Turlock Lake Formation

Materials of the Pleistocene-age Turlock Lake Formation are exposed on the eastern end of the proposed alignment. The Turlock Lake Formation typically consists of hard cemented yellow brown silts and red brown sands with occasional gravel and clay beds (Kleinfelder, 2007).

4.2.6 - Red Bluff Formation

In the westerly portion of the alignment, the Red Bluff Formation occurs throughout the Dunnigan Hills mostly along ridge tops. The unit consists of distinct bright red to orange clayey gravels and cobbles in a silty or sandy matrix. The Red Bluff Formation overlies the Tehama Formation which is described below.

4.2.7 - Tehama Formation

The Tehama Formation occurs at the far west end of the alignment and throughout the Dunnigan Hills (Kleinfelder, 2007). The Tehama Formation is Pliocene in age and is composed predominantly of cemented sand and silt with varying amounts of gravel and minor clay.

SECTION 5: GROUNDWATER

Where the proposed pipeline alignment crosses rivers, creeks, or areas of standing water, shallow groundwater conditions are expected. In these areas the groundwater level should be at or slightly above (due to capillary action) the elevation of the surface water. Perched groundwater can occur virtually anywhere within the soil profile often occurring at a lower boundary layer of less permeable material (e.g., silt or clay). Perched groundwater is unconfined and separated from an underlying main body of groundwater (the water table) by an unsaturated zone. In agricultural areas, flood irrigation of fields can result in shallow perched groundwater levels that may result buoyant forces on the pipeline (Kleinfelder, 2007). Groundwater was encountered in many of the borings that were drilled for the geotechnical investigation for the Project (Kleinfelder, 2007). Groundwater was found to be shallowest in the central portions or lower valley parts of the alignment with the deeper groundwater levels occurring in the westerly and easterly reaches of the alignment. Groundwater levels may be expected to fluctuate due to seasonal variations, irrigation, and other factors.

SECTION 6: TOPOGRAPHY

As discussed, the proposed pipeline alignment traverses generally in an east-west direction across the lower Sacramento Valley. In general, the Project crosses a combination of flat to undulating and rolling hill topography with corresponding elevations ranging from approximately 15 to 255 feet above mean sea level (MSL). The lower, flatter topography is in the central portions of the Project with the higher, less subdued topography in the west and eastern portions of the Project. Primary drainages in the study area flow generally to the south.

SECTION 7: FAULTING AND SEISMICITY

Based on the tectonic setting and the historical record, the study area is in a region that is characterized by a relatively low to moderate seismicity. Historical earthquakes of magnitude 6.0 or greater with epicenters within approximately 62 miles (100 km) of the study area are shown in the following table.

Table 1 – Historical Earthquakes that Affected the Study Area

Date	Magnitude (M)
May 19, 1889	6.0
April 19, 1892	6.4
April 21, 1892	6.2
March 31, 1898	6.2

The 1889 and 1892 historical earthquakes can be attributed to the Great Valley fault system on fault segments, south of the west end of the study area (United States Geological Survey, 2008). The 1898 earthquake occurred in a northeastern part of the San Francisco Bay area,

The pipeline alignment crosses three documented faults; the Great Valley, Dunnigan Hills, and Willows faults. The three faults are thought to exist at depth and do not reach the surface where they cross the proposed alignment (Kleinfelder, 2007). The Great Valley fault is mapped near the westerly end of the alignment; the Dunnigan Hills fault is along the northeasterly side of the Dunnigan Hills, west of Interstate 5; and the Willows fault is in the easterly portion of the alignment between the Sacramento River and Roseville.

Surface expressions of the Willows fault are not apparent. The Willows fault is based largely on a linear differential of measured groundwater levels. Per Jennings (1994), the fault is designated as being pre-Quaternary in age and, accordingly, is not considered active or “potentially active.” The fault is not considered a significant seismic source, nor is it considered capable of resulting in ground surface rupture.

The Dunnigan Hills fault shows evidence of Recent (or Holocene) surface rupture north of the proposed alignment, however, the fault becomes buried in the vicinity of the alignment (Kleinfelder, 2007). Per Hart et al. (1983) the fault is a zone of discontinuous tonal lineaments near the base of the northeast-facing escarpment of the Dunnigan Hills. The fault is not in a State of California designated Earthquake Fault (Alquist-Priolo) Zone. Historical ground surface rupture has not been attributed to the fault.

The Great Valley fault is actually an extensive system of northerly trending, westerly dipping (inclined) thrust faults along the westerly margin of the Sacramento and San Joaquin valleys of the Great Valley. The faults occur at depth and do not “daylight” or intercept the ground surface, accordingly, they have been referred to as “blind” thrust faults. Because the fault does not intercept the ground surface it is not considered to have the potential for ground surface rupture or, subsequently, pipeline rupture. The fault system is considered to be a seismic source that could result in strong ground motions. The pipeline alignment crosses segment 3 of the fault system which could generate an earthquake of magnitude 6.9 (United States Geological Survey/California Geological Survey [USGS/CGS], 2002).

Based on a probabilistic seismic hazard model for California (USGS/CGS, 2002) peak horizontal ground accelerations having a 10 percent probability of exceedance in 50 years can be estimated to be about 0.4g (40 percent of gravity) at the west end of the alignment and about 0.2g at the east end of the alignment. This can be compared to potential ground accelerations having the same probability of occurrence of in excess of 0.7g in the San Francisco Bay area. No portions of the pipeline alignment are in State of California designated Earthquake Fault Zones which are areas that have a relatively high potential ground surface rupture due to faults. The following table lists active faults within approximately 62 miles (100 kilometers) of the study area.

Table 2 – Principal Active Faults

Fault	Distance and Direction (miles)[1]	Maximum Moment Magnitude[2]
Great Valley Segment 3	0(crosses pipeline route)	6.9
Great Valley Segment 4	10 (south)	6.6
Foothills	13 (east)	6.5
Hunting Creek-Berryessa	18 (west)	7.1
Great Valley Segment 2	24 (north)	6.4
Bartlett Springs	26 (northwest)	7.6
Concord	30 (southwest)	6.7
West Napa	32 (southwest)	6.5
Callayomi	34 (northwest)	6.5

Table 2 – Principal Active Faults

Fault	Distance and Direction (miles)[1]	Maximum Moment Magnitude[2]
Great Valley Segment 5	35 (south)	6.5
Great Valley Segment 1	36 (north)	6.7
Maacama	38 (northwest)	7.5
Hayward	43 (southwest)	7.3

Notes:
[1] Blake (2001)
[2] The reported potential maximum magnitudes are Maximum Moment Magnitudes rather than Richter Scale Magnitudes, a scale that is generally no longer used.

Figure 3 is a fault location map for the region. Figure 4 shows potential ground accelerations in the region having a 10 percent probability of being exceeded in 50 years.

7.1 - Liquefaction and Seismically Induced Settlement

Liquefaction is the phenomenon in which loosely deposited, saturated granular soils (located below the water table) with clay contents (particles less than 0.005 mm) of less than 15 percent, liquid limit of less than 35 percent, and natural moisture content greater than 90 percent of the liquid limit 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 grade. 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.

Much of the pipeline alignment crosses earth units that are relatively young, poorly consolidated, with granular soil intervals similar to those described above. Where the pipeline is to be located below the water table and above a depth of 50 feet there is a potential that the pipeline may be constructed in liquefiable soils. Per Kleinfelder (2007) the area most susceptible to liquefaction appears to be the portion of the alignment across the Sacramento Valley between the Dunnigan Hills, on the west and the Natomas East Main Drainage Canal, east of the Sacramento River. Estimated potential settlements are generally on the order of 1 to 2 inches with isolated cases on the order 4 to 8 inches (Kleinfelder, 2007).

SECTION 8: LANDSLIDING

Based on our review of background information, aerial photographs, and geologic field reconnaissance, landslides are not indicated to underlie the pipeline route. Earthquake induced landsliding has the greatest potential in areas of high seismicity and where topography and geologic conditions result in unstable slopes. In general, these conditions do not exist along the pipeline alignment.

SECTION 9: EXPANSIVE SOILS AND COMPRESSIBLE SOILS

Expansive soils are soils that undergo volumetric change with change in water content. The soil will swell with increase in moisture content and will shrink with decrease in moisture content. Soils with high shrink-swell potential generally contain high percentages of certain clay minerals and can cause extensive damage to surface structures and improvements, especially concrete slabs and flatwork placed on soils at surface grade. Soils in the study area that have a relatively high clay content may be expansive.
Loose or compressible soils may be found in the study area, particularly, with respect to alluvial soils or poorly compacted fill. Compressible soils can be susceptible to settlement when additional loads are placed on them.

SECTION 10: AGRICULTURAL SOILS

From an agricultural perspective, based on Soil Survey information from the United States Department of Agriculture (2008), soils classified as a loam, sand loam or silt loam primarily underlie the pipeline route. A loam is a friable soil containing a relatively equal mixture of sand and silt and a somewhat smaller portion of clay. The term can be modified such as to a sand loam to indicate a predominate constituent. Alluvium is the primary parent material of the agricultural soils delineated in the study area.

SECTION 11: CONCLUSIONS

Based on the results of our study, it is our opinion that construction of the proposed pipeline Project is feasible from a geotechnical perspective. There are no adverse geologic or geotechnical conditions that cannot be mitigated through proper design and construction techniques. The following sections discuss site-specific geologic and geotechnical issues.

11.1 - Geologic and Geotechnical Issues

- The west end of the alignment crosses over Segment 3 of the Great Valley fault system. The fault is classified as a blind thrust fault and although capable of generating strongground motions is not considered to pose a hazard for ground surface rupture. Other portions of the alignment do not cross known active faults. State of California Earthquake faults zones have not been established on the pipeline route.
- There are several active faults in the region, particularly west of the west end of the Project. Accordingly, the study area is subject to ground shaking due to earthquakes. Historically, the study area has experienced a low to moderate seismicity.
- Based on our review of background information landslides have not been reported along the pipeline route. Further, evidence of deep-seated landslides was not observed in our review of aerial photographs or during our field reconnaissance.
- There is a potential for liquefaction to occur along portions of the pipeline alignment as a result of ground shaking during earthquakes. Liquefaction can cause settlement of soils and the structures on which they are built. Because liquefied soils behave as a liquid for a short time, there may also be a tendency for buoyant facilities to float. Liquefiable soils and its effects can be remedied by removal and recompaction, deep foundations extending into underlying competent materials, deep dynamic compaction, vibro-compaction, other soil modifications, and/or structural designs incorporated to withstand the potential effects of liquefied soil conditions. The geotechnical design report for the Project (Kleinfelder, 2007), has provided potential settlements in the case of a strong seismic event capable of causing liquefaction. The majority of the pipeline will be of 30-inch diameter welded steel pipe. Welded steel pipe has a degree of inherent flexibility in it allowing it to withstand some deformations of the adjacent ground. As long as the pipeline is designed and constructed to withstand the indicated

potential dynamic settlements and buoyant tendencies, there will be a less than significant impact due to liquefaction.

- Expansive soils may be present along the pipeline route. In general, expansive soils have little effect on buried pipelines of typical construction. Treatment of expansive soils if present at or near grade of surface improvements may be needed. Treatment of expansive soils might include removal and replacement with non-expansive soils, lime treatment, moisture conditioning, or utilization of special foundations.
- Compressible soils are present in areas along the pipeline route. Buried pipelines typically do not cause underlying soils to settle as they represent less load than the weight of the soil mass removed to place the pipe. Poorly compacted backfill over the newly placed pipe may constitute a compressible soil that may settle in time and/or with the introduction of water. Loads imposed by surface improvements may cause compressible soils to settle. Means to remedy compressible soils include removal and recompaction (to improve their density), surcharging, compaction grouting, deep soil compaction, deep foundations, or foundations specially designed to tolerate the anticipated settlement.
- The Project includes planned HDD crossings beneath several flood control levees. The possible degradation of the integrity and stability of the levees due to the crossings is a consideration. The geotechnical design report for the Project (Kleinfelder, 2007) has provisions to protect the levees, including settlement monitoring during construction and grouting (sealing) the pipeline/boring configuration to prevent water seepage along it. The HDD crossings will beneath the levees and adjoining channels and will have entry and exit points several hundred feet beyond the landsides of the levees. If the recommendations of the geotechnical reports and the requirements of the jurisdictional agencies are followed, the HDD crossings should not have a significant impact to the stability or performance of the flood control levees.
- The HDD technique involves the pumping of drilling fluids under high pressure to drive the drilling bit and circulate out the drill cuttings. The drilling operations may encounter subsurface conditions whereas the pressurized drilling fluids (or “mud”) can propagate fractures in the substrata allowing the drilling mud to migrate away from the borehole. If the drilling mud migrates to the ground surface it is referred to as an inadvertent release or a “frac out.” Inadvertent release of drilling fluids can pose a hazard to the environment. The Project Description indicates that drilling operations would be stopped immediately if a frac out was to occur. A frac out condition may be resolved by reducing the mud system pressure of increasing the mud viscosity. Contingency plans are included in the proposed Project Construction Procedures to clean up inadvertent releases.
- Similar geology and soils conditions exist for the optional pipeline routes that are being considered. Accordingly, the possible alternative alignments should not involve significantly different geology and soils impacts.
- In our opinion the Proponents Environmental Assessment relative to geology and soils issues is an adequate evaluation for the intended purpose. We consider the project feasible from a geotechnical perspective. We concur that there are no geology or soils conditions where mitigation measures are required.

SECTION 12: LIMITATIONS

The field evaluation and geotechnical analyses presented in this report have been conducted in accordance with current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No warranty, implied or expressed, is made regarding the conclusions, recommendations, and professional opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered. Our preliminary conclusions and recommendations area based on an analysis of the observed conditions and the referenced background information.

The purpose of this study was to evaluate geologic and geotechnical conditions within the project site and to provide a geotechnical reconnaissance report to assist in the preparation of environmental impact documents for the project. The report is not intended for design or construction purposes.

SECTION 13: REFERENCES

Bailey, E.H., 1966, Geology of Northern California: California Division of Mines and Geology, Bulletin 190.

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 Division of Mines and Geology, 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California: Special Publication 117.

California Division of Mines and Geology, 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada: International Conference of Building Officials.

California Geological Survey, 2002, California Geomorphic Provinces, Note 36.

California Geological Survey, 2008, Probabilistic Seismic Hazards Assessment (Web site, accessed August, 2008).

Harden, D.R., 1998, *California Geology*: Prentice Hall, Inc.

Hart, E.W., Bryant, W.A., and Smith, T.C., 1983, Summary Report: Fault Evaluation Program, 1981-1982 Area (Northern Coast Ranges Region): California Division of Mines and Geology, Open-File Report 83-10 SF.

Hart, E.W., and Bryant, W.A., 1997, Fault-Rupture Hazard Zones in California: California Division of Mines and Geology, Special Publication 42 (Supplements 1 and 2 added 1999).

Jennings, C.W., 1994, Fault Activity Map of California and Adjacent Areas with Locations and Ages of Recent Volcanic Eruptions: California Division of Mines and Geology, Geologic Data Map No.6, Scale 1:750,000.

Kleinfelder, 2007, Geotechnical Investigation Report, Proposed PG&E Line 406/407 Gas Transmission Pipeline Esparto to Roseville, Yolo, Sutter, and Placer Counties, California: volumes 1 through 11.

Norris, R.M., and Webb, R.W., 1990, Geology of California: John Wiley & Sons, Inc.

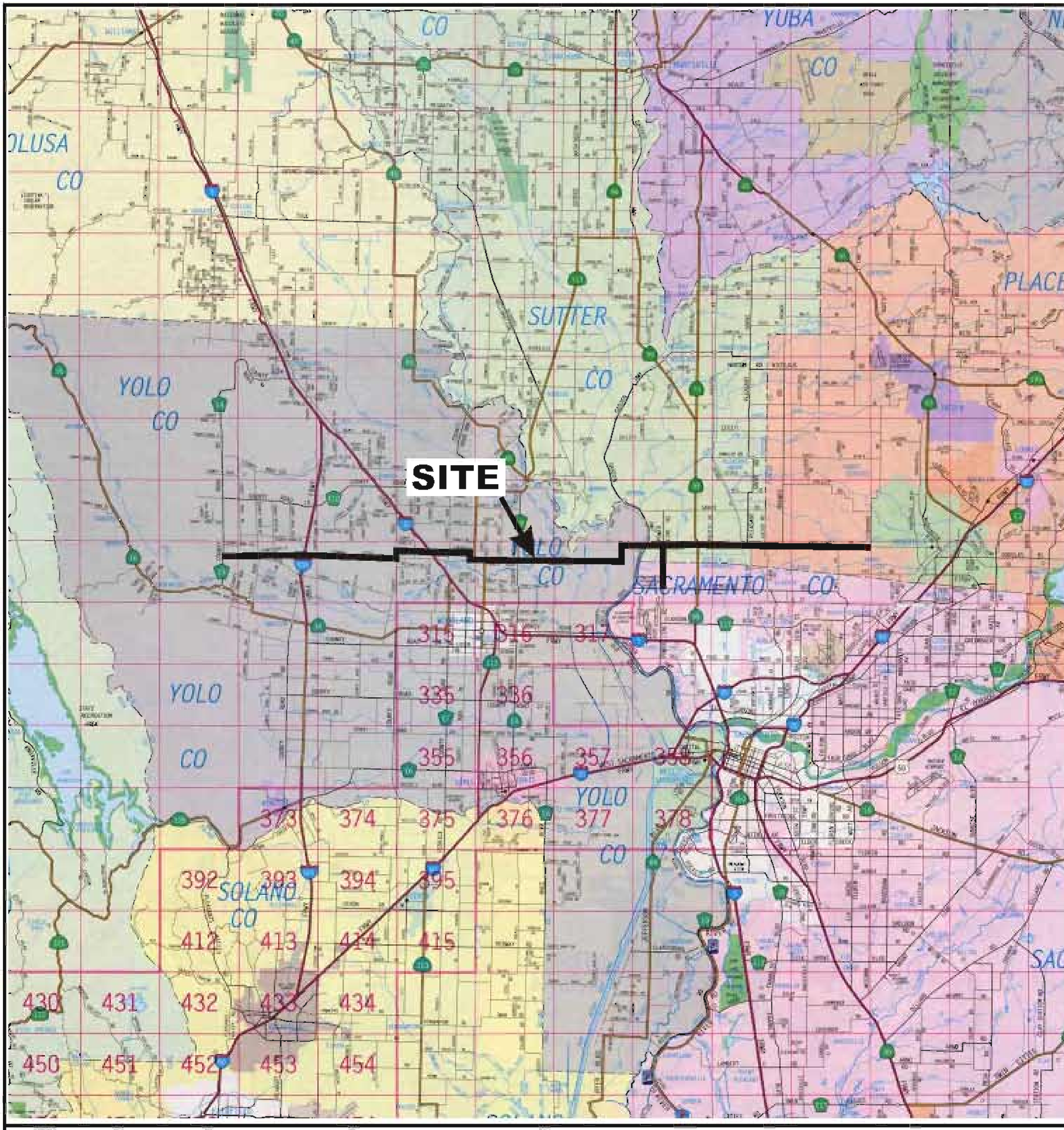
United States Department of Agriculture (USDA), 2008, Web Soil Survey (accessed August, 2008).

United States Geological Survey/California Geological Survey, 2002, Probabilistic Seismic Hazard Assessment (PSHA) Model: Revised April 2003.

United States Geological Survey, 2008, Earthquake Hazards Program - Northern California: web site (accessed September, 2008).

Wagner, D.L., Jennings, C.W., Bedrossioan, T.L., and Bortugno, E.J., 1981, Geologic Map of the Sacramento Quadrangle, California: California Division of Mines and Geology, Scale 1:250,000.

Wagner, D.L., and Bortugno, E.J., 1982, Geologic Map of the Santa Rosa Quadrangle, California: California Division of Mines and Geology, Scale 1:250,000.



REFERENCE: 2005 THOMAS GUIDE FOR SAN DIEGO COUNTY, STREET GUIDE AND DIRECTORY,

0 8 16
APPROXIMATE SCALE IN MILES

N

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.
Map © Rand McNally, R.L.07-S-129

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Ninyo & Moore		STUDY AREA	FIGURE
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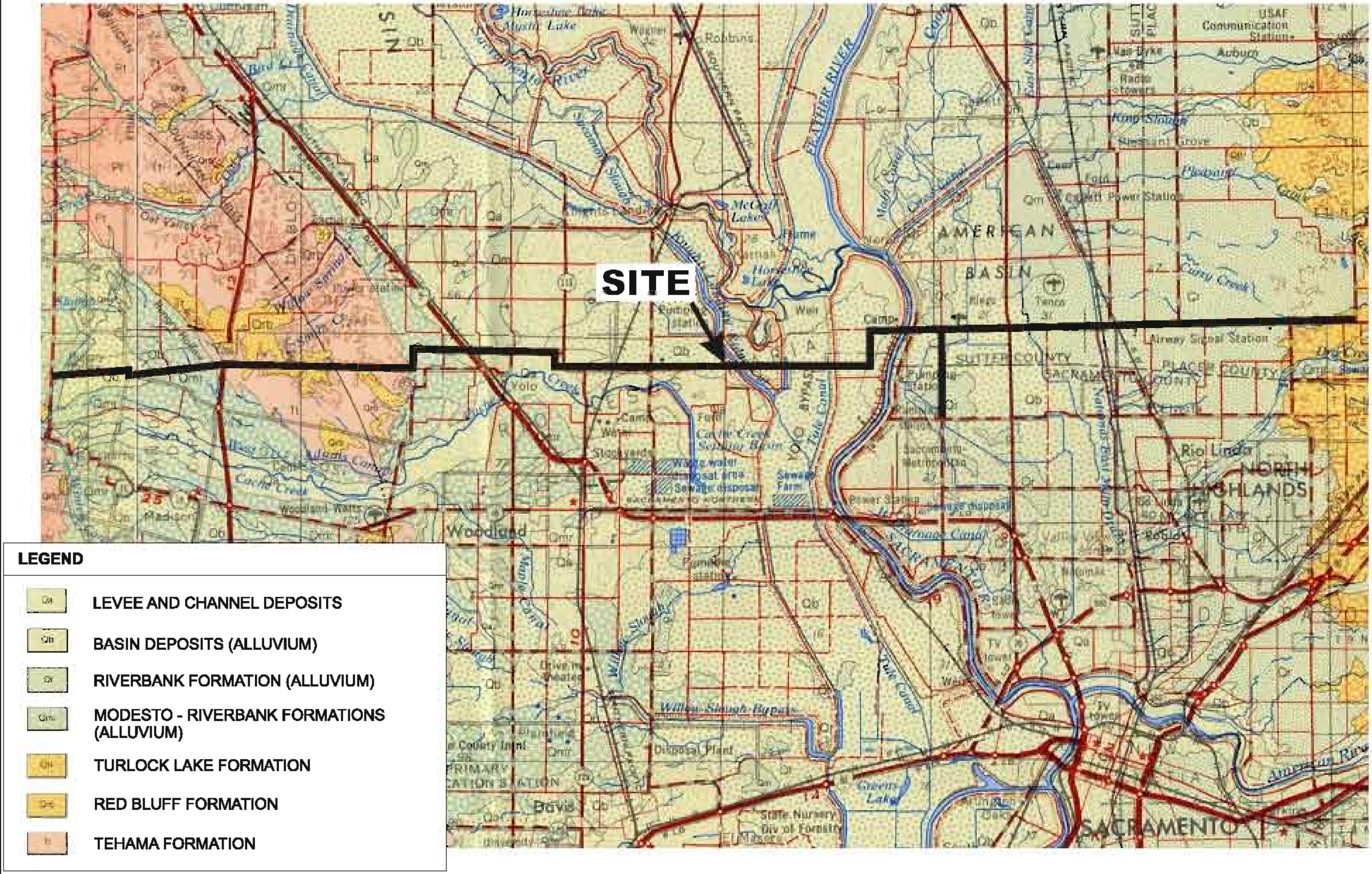

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APPROXIMATE SCALE

0 4 8 MILES

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

REFERENCES: WAGNER ET AL., 1981; AND WAGNER AND BORTUGNO, 1982.

Ninyo & Moore		GENERALIZED GEOLOGIC MAP	FIGURE
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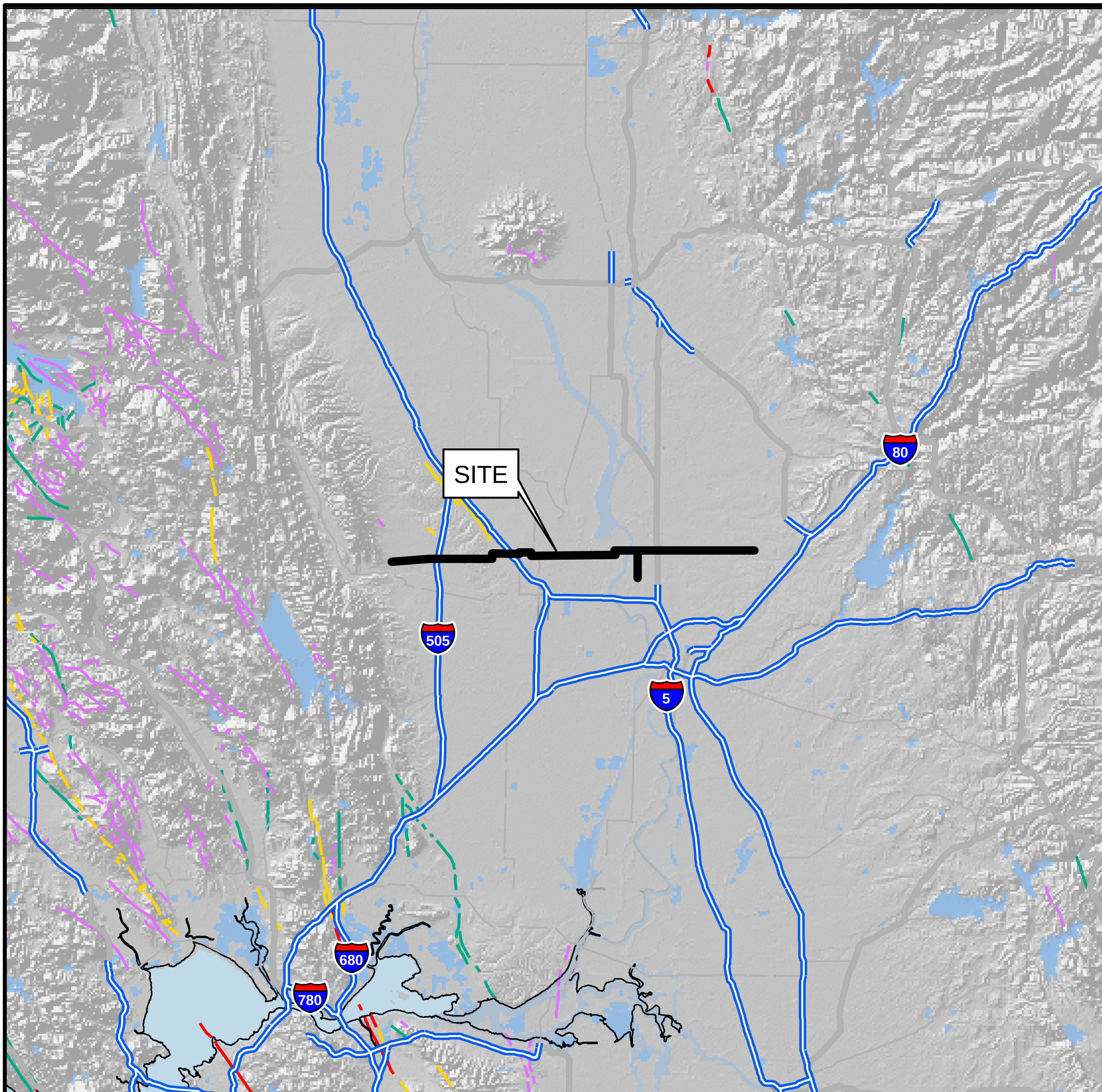
fig 2 106323001 geologic



GIS DATA SOURCE: CALIFORNIA GEOLOGICAL SURVEY (CGS); ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI)
REFERENCE: JENNINGS, 1994, FAULT ACTIVITY MAP OF CALIFORNIA AND ADJACENT AREAS

LEGEND

FAULT ACTIVITY:

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)

N

APPROXIMATE SCALE

0 15 30 MILES

Ninyo & Moore

FAULT LOCATION MAP

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GEOLOGICAL TECHNICAL STUDY
PG&E LINE 406 AND LINE 407 PIPELINE PROJECT

FIGURE

3

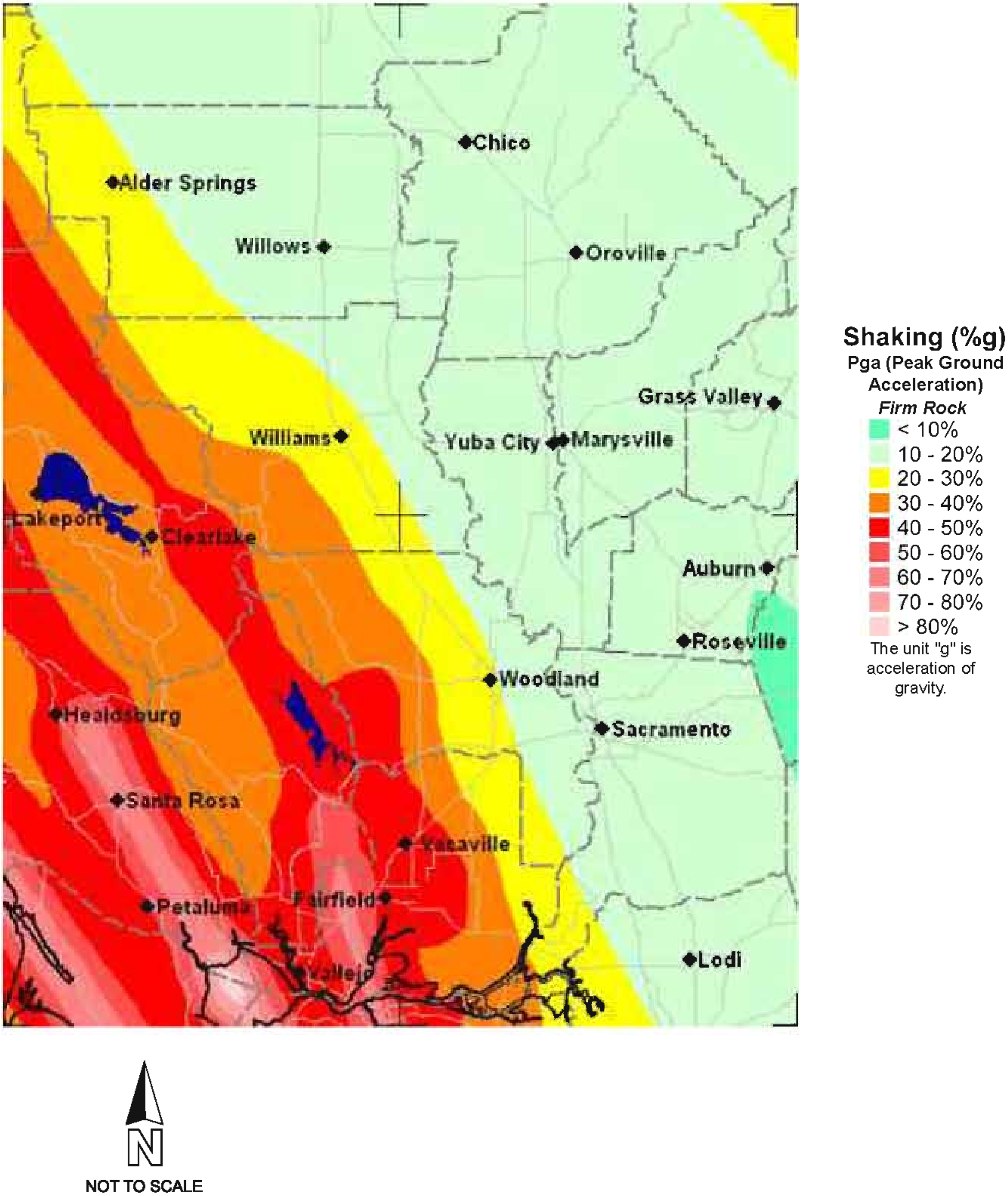

fig 4 106323001 peak accel

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 2008.

Ninyo & Moore		PEAK GROUND ACCELERATION 10% OF BEING EXCEEDED IN 50 YEARS	FIGURE
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