SAN SIMEON EARTHQUAKE
DECEMBER 22, 2003

REPORT ON THE PERFORMANCE OF PUBLIC SCHOOLS

PREPARED BY

DSA

DIVISION OF THE STATE ARCHITECT

MARCH 15, 2004

State and Consumer Services Agency DGS Department of General Services

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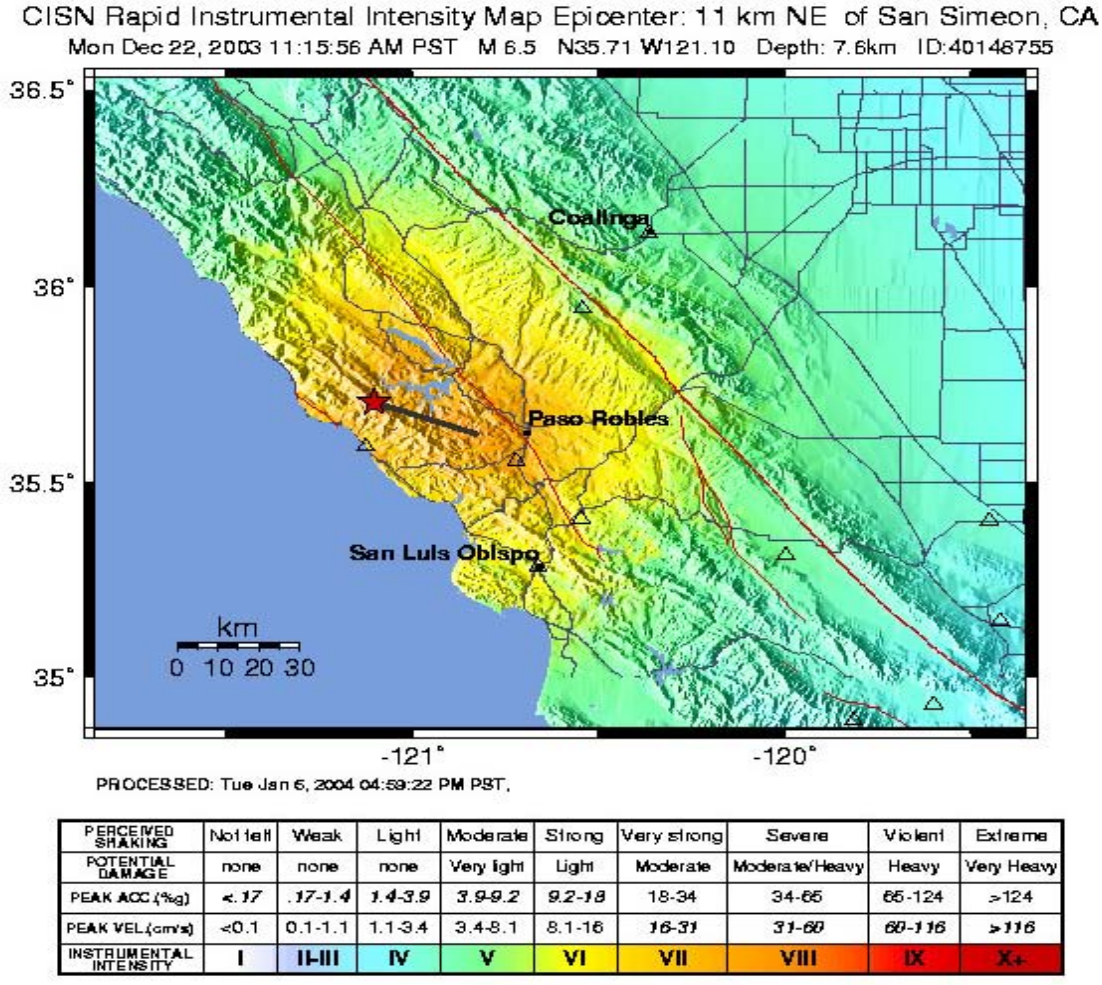
Earthquake Description

A strong earthquake of magnitude 6.5 struck the Central California Coast at 11:15:56 am Pacific Standard Time (PST) on Monday, December 22, 2003. The epicenter was 7 miles Northeast of San Simeon, at a depth of 5 miles. The earthquake was located in a sparsely populated portion of the state producing moderate damage. The largest population centers in the area include Paso Robles (population 26,000), Templeton (population 5000) and San Luis Obispo (population 45000). This earthquake occurred on a small fault which stems off the San Andreas Fault. The fault mechanism is known as a thrust with an assumed rupture zone which propagated from the northwest towards the southeast. It has been estimated that locally the coast range was uplifted approximately 12 inches by this event. Two people were killed and about 40 buildings collapsed , or were severely damaged, in the Paso Robles area, which is located about 24 miles from the epicenter**.** The deaths occurred due to the collapse of an un-reinforced masonry building in the historic section of downtown Paso Robles. Public school buildings performed very well in the earthquake and only non-structural damage was observed.



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 1b. Central Coast Map with portions of San Luis Obispo County

Intensity of Ground Shaking

The largest shaking observed was at a California Geological Survey (CGS) instrumented one-story hospital in Templeton, about 24 miles from the epicenter and about 6 miles south of Paso Robles, where most of the building damage occurred. The hospital reported about 50%g horizontal motion and 30%g vertical motion at ground level. Over one hundred smaller aftershocks, nine of these with magnitudes greater than 4, have been recorded in the three hours following the M6.5 earthquake. The largest of these was a M4.7 earthquake, which occurred about ten minutes after the M6.5 main shock. Aftershocks can be expected to continue in the days, weeks, and months following the earthquake. See Appendix A for more information on the Templeton Hospital.

Previous Earthquakes in the Area

The last major earthquake in this area was the Bryson earthquake in 1952 with a magnitude of 6.2. Other similar earthquakes occurred in 1853 and 1906.

Informational Websites

For information on liquefaction and landslide damage, please refer to the following websites which contain photographs on areas of damage.

Liquefaction and Landslide Damage
http://www.eeri.org/lfe/pdf/usa_san_simeon_photo_log.pdf
http://www.consrv.ca.gov/CGS/geologic_hazards/earthquakes/ground_deformation.ppt

For information on damage to highways and non-school buildings, refer to the websites below at California Department of Transportation and the Earthquake Engineering Research Institute.

Reported Damage to Highways and Non- School Buildings
Highways: http://www.dot.ca.gov/hq/esc/earthquake_engineering/damage_report/EarthquakeNotice.pdf
Non-school buildings: http://www.eeri.org/lfe/pdf/usa_san_simeon_prelim.pdf_goel.pdf

Division of the State Architect Response

The following school and community college districts in San Luis Obispo County were contacted by the DSA, Los Angeles Regional Office on December22, 2003 and December 23, 2003 and the subsequent days following the earthquake.

1. Atascadero Unified School District
2. Cayucos Elementary School District
3. Coast Unified School District
4. Lucia Mar Unified School District
5. Paso Robles Joint Unified School District
6. Pleasant Valley Joint Union Elementary School District
7. San Luis Coastal Unified School District
8. San Luis Obispo Community College
9. San Luis Obispo County Office of Education
10. San Miguel Joint Union Elementary School District
11. Shandon Joint Unified School District
12. Templeton Unified School District

Most of the school districts were closed for winter break, and district personnel could not be reached. Some of the contacts made were through the efforts of San Luis Obispo County Office of Education, courtesy of Mr. Dave Kell, Director Operations.

The DSA, San Francisco Bay Area Regional Office contacted the following school districts in the Monterey County following the earthquake.

1. Bradley Union Elementary School District
2. King City Joint Union High School District
3. Pacific Unified School District
4. San Antonio Union Elementary School District
5. San Ardo Union Elementary School District

These Monterey County schools reported no damage needing DSA evaluation.

The following engineers from the Division of the State Architect visited 24 public schools in San Luis Obispo County after the earthquake during the months of December, 2003 and January, 2004.

1. Mr. James McCarthy, Supervising Structural Engineer, DSA, Sacramento Regional Office.
2. Mr. Shaf Ullah, Supervising Structural Engineer, DSA, Los Angeles Regional Office.
3. Mr. Andy Widjaja, District Structural Engineer, DSA, Los Angeles Regional Office.

The Division of the State Architect notified the Office of Emergency Services of their presence in San Luis Obispo County during the weeks following the earthquake.

The Division of the State Architect did not receive any requests from the Office of Emergency Services or the Department of General Services for inspections, as part of the Standardized Emergency Management System (SEMS), which is activated after a declared disaster.
The Division of the State Architect did not post any school buildings during this event.
The only school building posted unsafe, with a red placard, was the Flamson Middle School auditorium. This posting was done by the school district inspector.

Earthquake Damage to Public Schools (K-12) and Community Colleges

A. Structural Damage

The Division of the State Architect structural engineers did not observe any structural damage to any of the school buildings that were visited by them. The facilities personnel from various school districts did not report any structural damage to any of their school buildings to the Division of the State Architect.

There may be some minor structural damage to some of the school buildings, but it was not obvious and would have required the removal of finishes and opening up of the concealed areas, for closer observation, in order to ascertain the full extent of the damage. The school districts were advised to retain the services of consulting structural engineers if they

suspected any structural damage to any of their facilities, and have the consultants do an in depth investigation, and report to DSA and the School District, any damages uncovered.

B. Non-Structural Damage

There was significant non-structural damage to school facilities as observed by the Division of the State Architect and reported by the school districts. The damage was mainly to wall finishes, ceilings, roof tiles, bookcases, wall mounted televisions, light fixtures, seismic joints between buildings, concrete slabs on grade and asphalt paving.

The cracks in the plaster in ceilings and exterior walls was a common occurrence in buildings on most campuses. The cracks varied from hairline to deep gashes where pieces of plaster fell to the floor. Lightweight tiles in suspended ceilings in rooms came down with some damage to the T-bar grid system and light fixtures. Sprinkler head rings came loose and fell on to the floor. A wall-mounted television disengaged from its support bracket and at another school a television set fell off the cabinet it was on. Roof tiles on one of the buildings were shifted in a serpentine pattern, broken in places, slipped to the edge but did not fall. The seismic joint covers and the adjoining finishes were damaged due to the movement of the buildings. The contents of cabinets, books on shelves, and bookcases fell to the floors at several schools. The lack of bracing and safety wires for pendant mounted light fixtures installed before code changes in the 1970's, resulted in the light fixtures falling down in multi-use and gymnasium buildings. There was cracking in asphalt paving and concrete slabs on grade at some of the sites. A rather large oak tree at one of the schools had to be removed after it split at the trunk and posed a danger of toppling and injuring students.

The non-structural damage is evident from the assortment of pictures from various schools, included in this report (See pages 9-36).

C. Flamson Middle School

Flamson Middle School in Paso Robles suffered severe cracking to plaster assemblies. (See Appendix B for more information.)

<u>Office of Public School Construction (OPSC) Relocatables</u>

Paso Robles Unified School District closed the Flamson Middle School classroom/auditorium building taking several classrooms out of service. OPSC provided 19 emergency relocatables to temporarily replace those classrooms. These buildings were installed in early February and were immediately put to use.

AB300 Survey (Seismic Safety Inventory of California Public Schools)

In response to Assembly Bill 300 (Corbett, Chapter 622, Statutes of 1999), DSA conducted a survey of all public school projects to identify vulnerable non-wood frame buildings which were designed and built before major changes to the California Building Code which became effective July 1, 1978. This survey identified approximately 16,000 vulnerable buildings. 56 of these buildings were identified in San Luis Obispo County. Only one of these buildings experienced any evidence of structural damage. The gymnasium at Attascadero High School suffered possible damage to a wood ledger. The Attascadero Gym was built under DSA application number 24555. The Flamson Middle school two story building which suffered significant non structural damage was not evaluated in the AB300 survey since this building was constructed prior to 1933 and thus DSA had no original drawings or applications on the original construction.

Conclusions

The performance goals for the construction of new school buildings is stated in Section 4-301, Part 1, Title 24 of the California Building Code (CBC); "School buildings constructed pursuant to these regulations are expected to resist earthquake forces generated by major earthquakes of the intensity and severity of the strongest experienced in California without catastrophic collapse, but may experience some repairable architectural or structural damage."

There were no collapses of school buildings, thus the goal was achieved. Although this earthquake was quite strong, it was not "… of the intensity and severity of the strongest experienced in California."

Recommendations

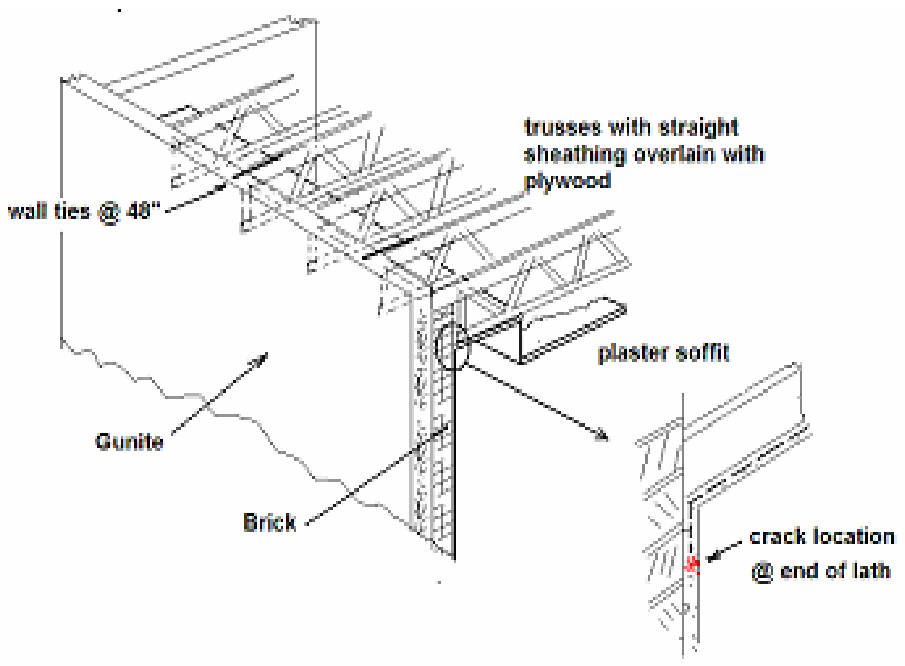
Many school buildings constructed before significant building code changes of the late 1970's are located near faults that can generate much stronger ground motion than the San Simeon earthquake did. Buildings constructed according to out-dated codes and located near faults should be evaluated for their capacity to resist expected earthquake forces. Those found wanting should be retrofitted. The good performance of the Flamson Middle School building is an example of the benefits of structural retrofitting.

Damage to Public Schools

Paso Robles

Flamson Middle School

The most publicized damage to schools in the San Simeon earthquake occurred at Flamson Middle School in Paso Robles. The two story classroom building pictured was originally constructed in 1924 and was seismically retrofitted in 1959. The original un-reinforced masonry was strengthened with exterior reinforced gunite and the original straight sheathed wood floors were strengthened with plywood diaphragms. Out-of-plane wall ties were also added to the building. (See Appendix B for a detailed report on the Falmson Middle School.)



Condition @ East Wall – Flamson Middle School

The building suffered some significant plaster cracking in several locations. At the second-story east wall under the truss bottom chords, a horizontal crack was observed. The crack followed the ending of the plaster lath, which reinforced the horizontal ceiling assembly. This crack may have been due to motion of the ceiling system, or from restraint of the wall deformations by the plaster assembly.

A plaster crack ran in a horizontal direction approximately 4 inches below the plaster soffit. The school district staff removed plaster to allow the inspection of the structure behind the crack area.

The Flamson MS auditorium had sustained plaster cracking at the proscenium arch partition wall. The stage area beyond also had ceiling plaster spalls, possibly due to light fixture and rigging motions during the earthquake. The north and south auditorium walls had hairline cracking, which showed a previous window in-filled with brick. The exterior of these walls also showed hairline cracks, which ran horizontally along the wall. The auditorium had received a red placard from the school district's building inspector due to the falling hazard associated with the plaster assembly. The partition wall system appeared to be restraining the exterior masonry walls, and may be solidly tied to a roof truss above, thus causing this wall to behave as a shear wall.

Also at Lewis Middle School in Paso Robles, an addition had some cracking at a tie in to a taller building.

Ledger splits were observed at the Lewis Middle School gym roof framing. Often post-earthquake inspections will reveal cracks that appear to be earthquake related. Closer inspection of these wood splits showed paint in the crack. Therefore the cracks occurred prior to the earthquake.

Cracking of the plaster assembly at the Paso Robles High School administration wing was observed

T-bar cross runner popped loose at Paso Robles High School.

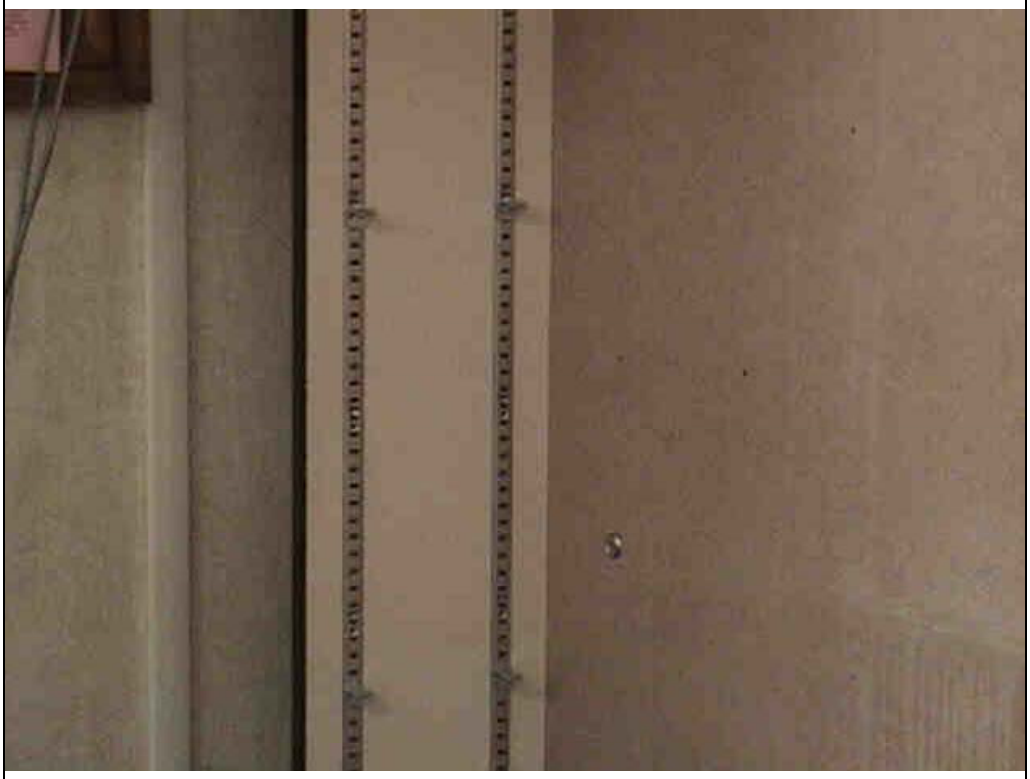
Picture provided by school district.

HVAC grill fell out at Paso Robles High School.

Picture provided by school district.

Contents fallen off shelving at Paso Robles High School.

Picture provided by school district.



Anchorage at Paso Robles High School with adjustable shelves fallen off.

Picture provided by school district.

TV fallen off at Paso Robles High School, doors swung open.

Picture provided by school district.

Roof tiles at Liberty Continuation School had
been removed after the earthquake because many of the barrel shaped tiles had come unseated at their overlaps with the adjacent tile. The tiles appeared to have been supported off a continuous wire coming from the ridge. During the earthquake, the tiles shifted laterally and grout pockets in the top courses became disconnected from the tile top course. These chunks of grout slid down the roof onto a horizontal flat band and thus never fell off the roof.

Left: Close up of TV support bracket at Liberty School.

Below: Disengagement of the TV support bracket.

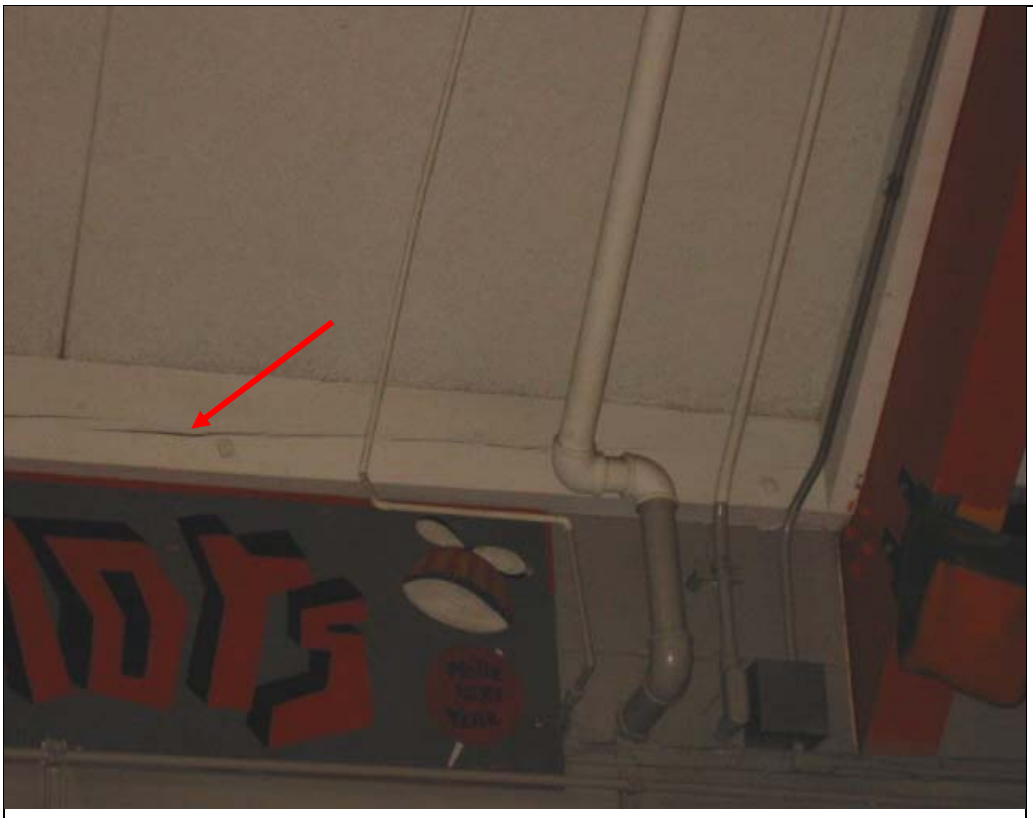
Pictures provided by school district.

At the Cuesta College Weight room Bldg, acoustical ceiling panels disengaged from the runners

Atascadero

The loading dock at Atascadero High School had the ½ inch layer of plaster come off the concrete wall during the earthquake. It was observed that this plaster layer had no lath attachment and appeared to be applied over a moisture proofing layer which caused a lack of bond.

Cracking of the suspended soffit system in the multi purpose room at San Benito Elementary in Attascadero was observed. These appeared to be sheet rock cracks and were considered to be non-structural.



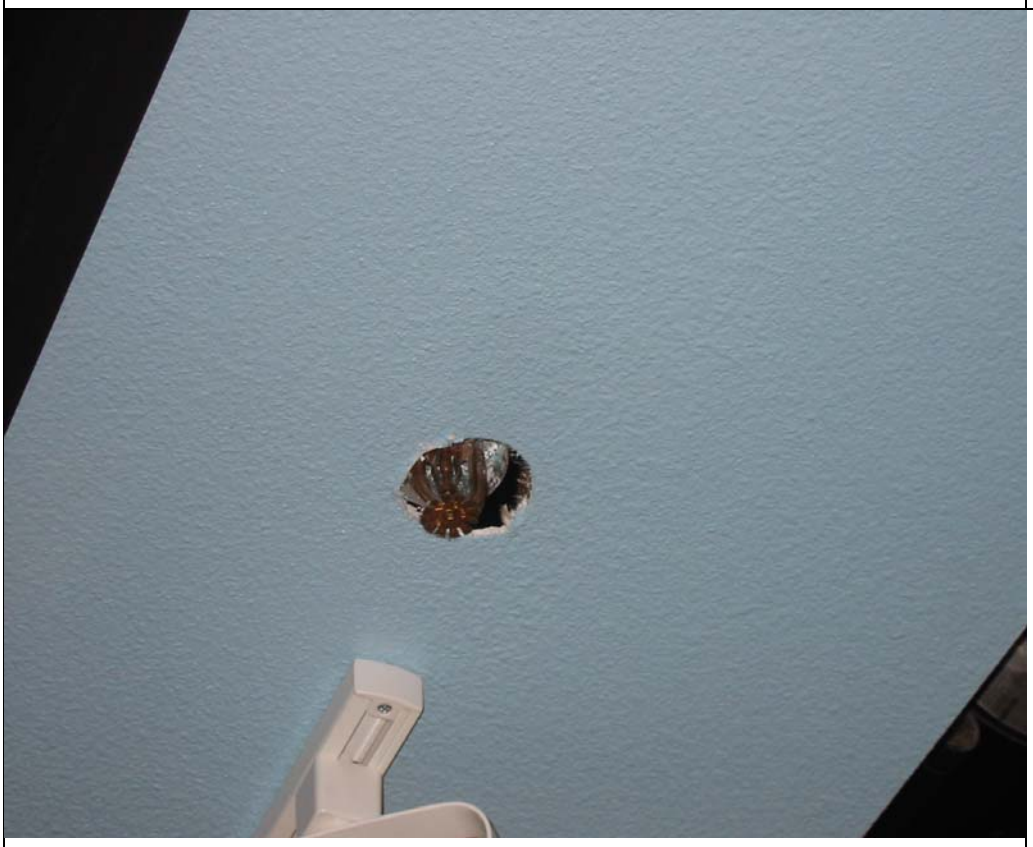
Ledger cracking was observed at the Atascadero High School gym building at the roof connections

A bookcase fell over at Atascadero HS and some classrooms sustained damage to T-bar ceiling assemblies. This damage had been repaired by 12/31/03.

Pictures provided by school district.

Morro Bay

Tectum panels at Del Mar Elementary school in Morro Bay were observed to be coming loose under the soffit area.

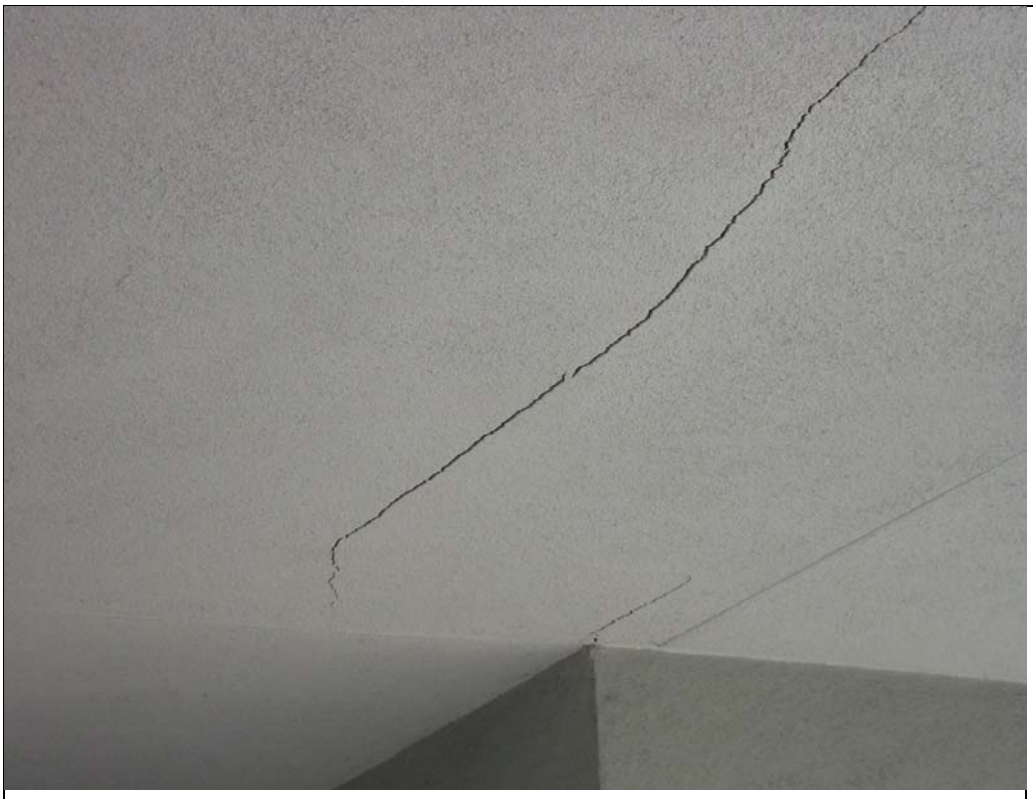


Sprinkler head finishing rings held in place by friction came off during the quake at Del Mar Elementary.

San Luis Obispo

A wide flange beam seat caused a spall at this support. This occurred at a corner condition on the structure at Los Ranchos Elementary School in San Luis Obispo.

Plaster control joints separated in the same area at Los Ranchos Elementary.



Plaster cracks at a re-entrant corner were observed at Los Ranchos Elementary School.

The joint at the addition to an existing building separated at San Luis Obispo High School. There was some evidence that this separation was pre-existing. The same building was observed to have loose roof tiles in need of repair.

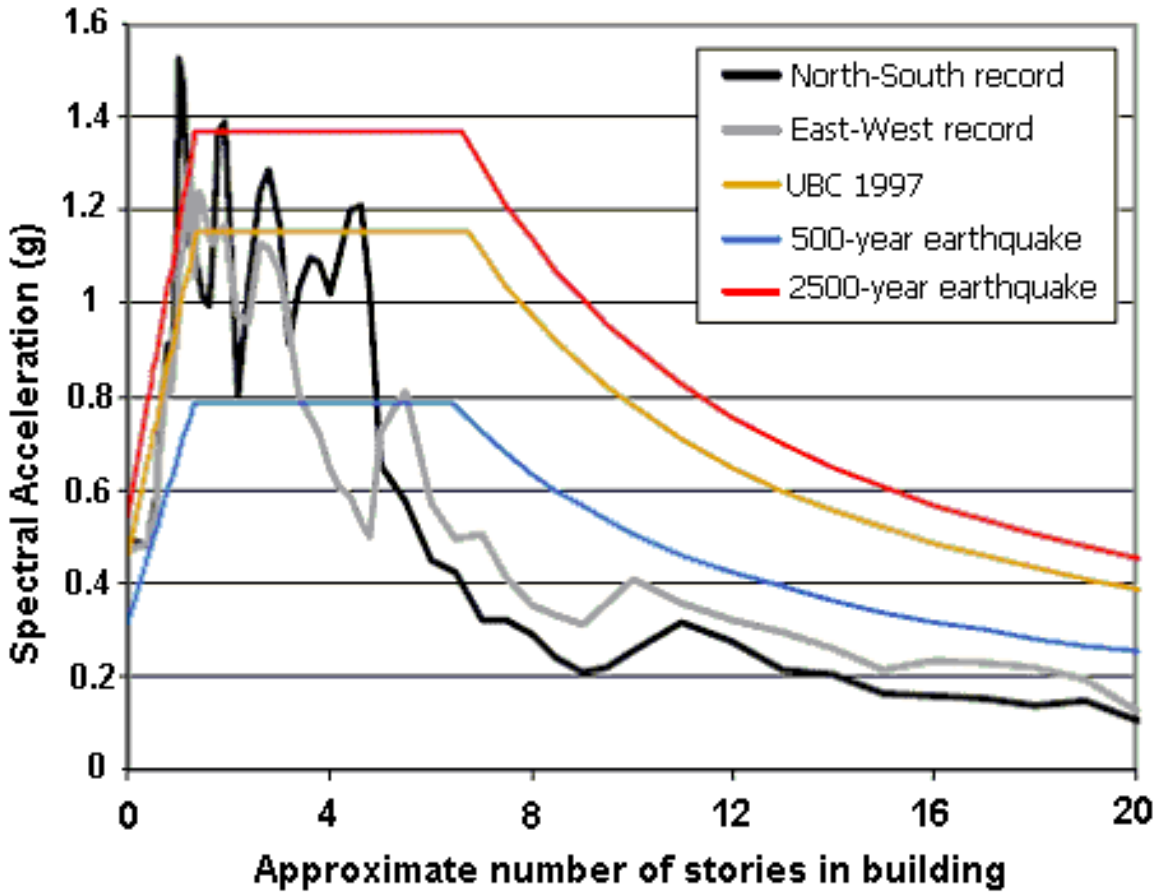
Templeton

A pendant mounted light at the Templeton Middle School gym had fallen during the earthquake. It was observed that the school district had installed safety cables on the remaining lights.

Appendix A – Templeton Report

INSTRUMENTATION OF ONE STORY HOSPITAL IN TEMPLETON

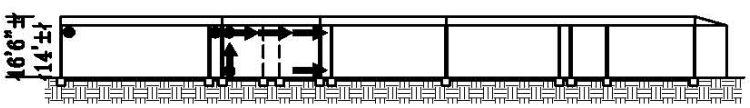
An irregularly shaped one story wood frame hospital in Templeton was instrumented with 9 seismographs and a free field station to measure ground and building motions. See the sensor location plan on the next page. The figure below shows response spectra computed from the recorded motion along with the building design response spectra for this site based on the 1997 Uniform Building Code (UBC), the 500 year return period earthquake, and the 2500 year return period event. For one and two story buildings, the motion at the site from the earthquake exceeded the 1997 UBC requirements. The figure makes assumptions with respect to building period as correlated to number of stories. This building suffered no observed damage due to this earthquake.



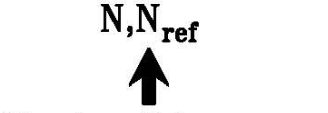
Appendix A – Templeton Report, continued

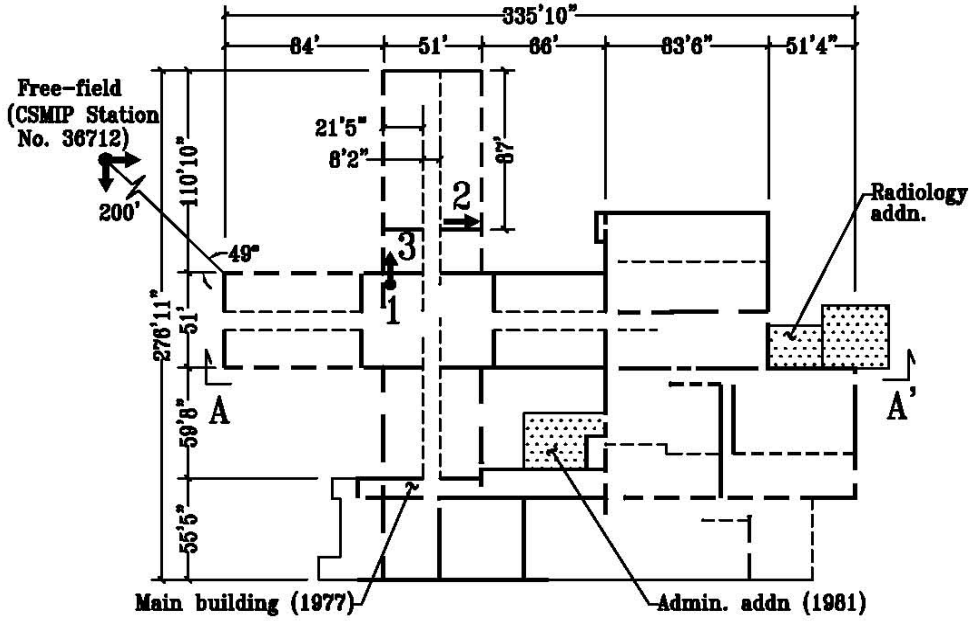
Templeton - 1-story Hospital
(CSMIP Station No. 36695)

SENSOR LOCATIONS

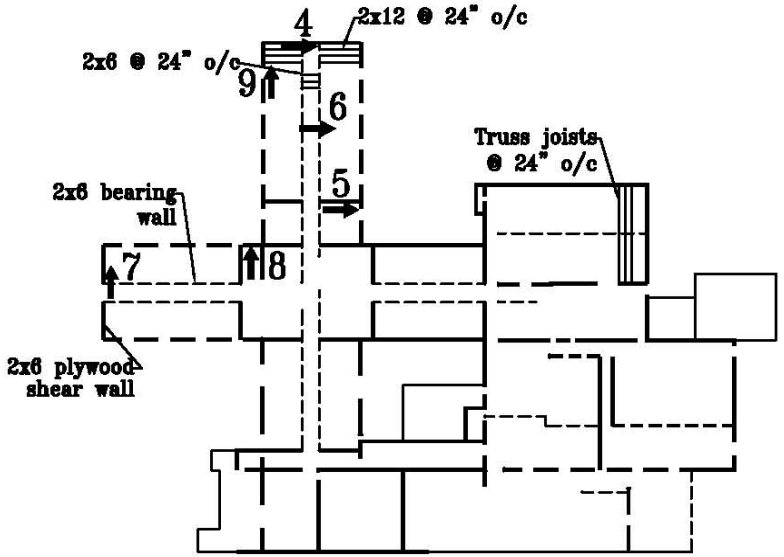


W/E Elevation
(Section A-A')





1st Floor Plan



Roof Plan

02/15/95

Appendix B – Flamson Report

Central California/San Simeon Earthquake
Preliminary Report – Public Schools

George H. Flamson Middle School
Paso Robles Joint Unified School District

Brief Event Description:

A magnitude 6.5 earthquake occurred in Central California on December 22, 2003 at 11:15 a.m. Pacific Standard Time. The epicenter was located approximately 6 miles Northeast of San Simeon in the County of San Luis Obispo and the hypo central depth was about 5 miles. The quake caused 2 deaths and the collapse of 40 non-school buildings. In general, the public school buildings performed very well during this event.

George H. Flamson Middle School:

This school is located in the city of Paso Robles, which is approximately 24 miles east of the earthquake epicenter. The school site is west of the 101 Freeway at 655 24th Street in Paso Robles. The campus originally housed Paso Robles High School but was later converted to middle school use.

The main structure is the two story Administration/Classroom/Auditorium building and is located in the southeast corner of the school site. The structure has approximately 31,000 square feet of floor area. The building was constructed in 1924, prior to the Field Act. Its structural rehabilitation and retrofit in 1959 was certified by the Division of the State Architect (DSA) then known as the Office of Architecture and Construction.

The original construction consisted of unreinforced brick walls and wood roof and floors with a 6 inch reinforced concrete slab in the hallway of the second floor, and steel roof trusses supporting the wood roof framing of the auditorium.

As part of the 1959 retrofit the unreinforced brick walls were strengthened with 4 inch thick reinforced gunite walls. This retrofit also provided plywood diaphragms to floor and roof to strengthen them, and, most importantly, wall ties were installed to prevent them from pulling away from the floors and roof, the most common failure mode for unreinforced masonry buildings.

The building underwent alterations in 1979 and 1987, and these alterations were mostly non-structural such as the architectural finish, interior partitions, ceilings, mechanical, plumbing and electrical work. All of the alteration work was certified by the DSA.

DSA Response

The school was visited by Structural Engineers from the Division of the State Architect (DSA) on December 30, 2003, January 8, 2004 and again on January 21, 2004. The following DSA engineers, consultants and school officials were present during these reconnaissance surveys:

Appendix B – Flamson Report, continued

December 30, 2003

Patrick J. Sayne, Superintendent of Paso Robles USD
Joey Iffert, Director of Facilities, Paso Robles USD
David Keil, Director of Operations, San Luis Obispo Co. Office of Education
Antoine Samra, Consulting Structural Engineer, T.S.A. Structural Engineers
James McCarthy, Supervising Structural Engineer, DSA, Sacramento Regional Office

January 8, 2004:

Gary Hoskins**,** Assistant Superintendent Business Services, Paso Robles Joint USD
Joey Iffert**,** Director of Facilities, Paso Robles Joint USD
James McCarthy**,** Supervising Structural Engineer, DSA, Sacramento Regional Office
Shaf Ullah**,** Supervising Structural Engineer, DSA, Los Angeles Regional Office
Andy Widjaja**,** District Structural Engineer, DSA, Los Angeles Regional Office

January 21, 2004:

Gary Hoskins**,** Assistant Superintendent Business Services, Paso Robles Joint USD
Joey Iffert**,** Director of Facilities, Paso Robles Joint USD.
Antoine Samra**,** Consulting Structural Engineer, T.S.A. Structural Engineers
Shaf Ullah**,** Supervising Structural Engineer, DSA, Los Angeles Regional Office
Andy Widjaja**,** District Structural Engineer, DSA Los Angeles Regional Office.
Donald Jephcott**,** Chief Structural Engineer, DSA (Retired).

Observed Damage

The observation of damage pertains to the auditorium and the Administration/Classroom wings of the two story building.

The north and south auditorium walls have hairline cracks both on the inside as well as the outside which run in both directions. Some of these may have been from shrinkage and creep, and also due to infill at openings. The west exterior wall appears to have some hairline cracks along the pilasters.

The proscenium arch suffered significant plaster damage at the ends which shows as cracks and spalls. The wall is a non-structural element of wood construction. The debris on the stage also suggests that plaster, from the ceiling above, loosened, due to shaking of the rigging and lighting equipment, and fell down as small pieces.

The east wall on the second floor hallway of the Administration/Classroom wing has vertical cracks approximately 1/16”to 1/8’ wide in the gunite. It appears that the cracks may have been existing hairlinecracks that were worsened during the earthquake, from movement due to out-of-plane forces.

The junction of ceiling and wall has severe plaster damage along the east wall inside the classrooms. It appears that the plaster damage resulted from the movement of the wall due to out-of-plane forces. Similar cracking is also observed along a portion of the west wall in classrooms.

The exterior and interior gunite /concrete walls have hairline cracks which may have been caused partly by shrinkage and creep of the concrete of the original construction.

Appendix B – Flamson Report, continued

The extensive cracking and damage to the plaster in the auditorium and classrooms posed a hazard from falling and even collapse of non-structural elements, and prompted school officials to "red tag" the auditorium and close the building for an indefinite period.

Some of the other buildings on the campus have plaster cracks and minor damage to the ceilings.
No significant structural damage was observed.

Conclusions:

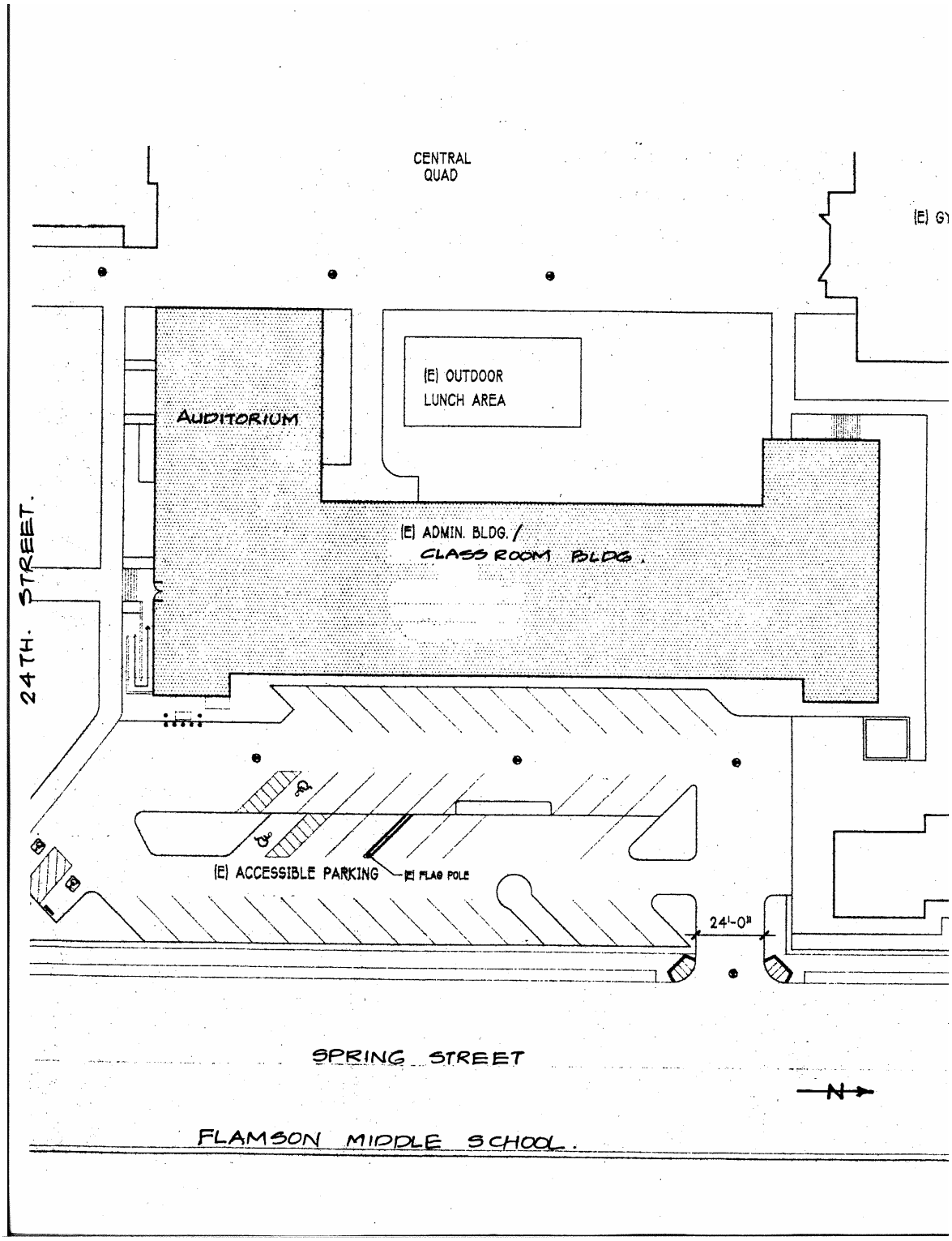
It appears that the two story Administration/Classroom/Auditorium building suffered minor to significant non-structural damage. Because many of the structural systems were not visible during the site visits, it is possible that structural damage may have occurred to these systems. The school district has retained the services of a consulting structural engineer to make an in-depth investigation of the building and identify, in a report to the School District and DSA, any deficiencies uncovered.

It is clear that the retrofit of the building in 1959 accomplished exactly what it was intended to do: to resist earthquake forces generated by major earthquakes and avoid catastrophic collapse. It is reasonable to say that without the retrofit, the structure may well have collapsed during this earthquake.

Attachments:
Earthquake Shake Map—Event Intensity
Building Site Plan
Damage Pictures

Appendix B – Flamson Report, continued

BUILDING SITE PLAN



Appendix B – Flamson Report, continued

DAMAGE PICUTRES

FLAMSON M.S.
Paso Robles
Classroom Bldg.
01/08/2004

The View of Flamson MS.

FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/08/2004

Plaster cracks in the wall.

Appendix B – Flamson Report, continued

DAMAGE PICUTRES

FLAMSON M.S.
Paso Robles
Classroom Bldg.
01/08/2004

Cracks in wall plaster

FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/08/2004

Cracks in wall plaster.

Appendix B – Flamson Report, continued

DAMAGE PICUTRES

FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/08/2004

Cracks in wall plaster.

FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/08/2004

Cracks in wall plaster.

Appendix B – Flamson Report, continued

DAMAGE PICUTRES

	**FLAMSON M.S.** **Paso Robles** **Classroom Bldg.** **01/08/2004** Plaster cracks on the gunite in the corridor.
	**FLAMSON M.S.** **Paso Robles** **Classroom Bldg.** **01/08/2004** Plaster cracks on the gunite in the corridor.

Appendix B – Flamson Report, continued

DAMAGE PICUTRES

FLAMSON M.S.
Paso Robles
Classroom Bldg.
01/08/2004

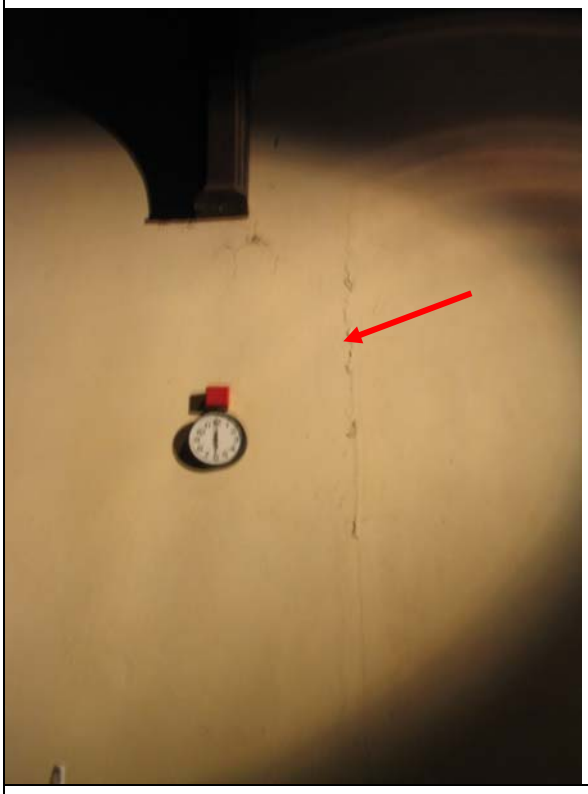
Cracks in wall plaster and suspended ceiling damage.

FLAMSON M.S.
Paso Robles
Classroom Bldg.
01/08/2004

Cracks in wall plaster.

Appendix B – Flamson Report, continued

DAMAGE PICUTRES



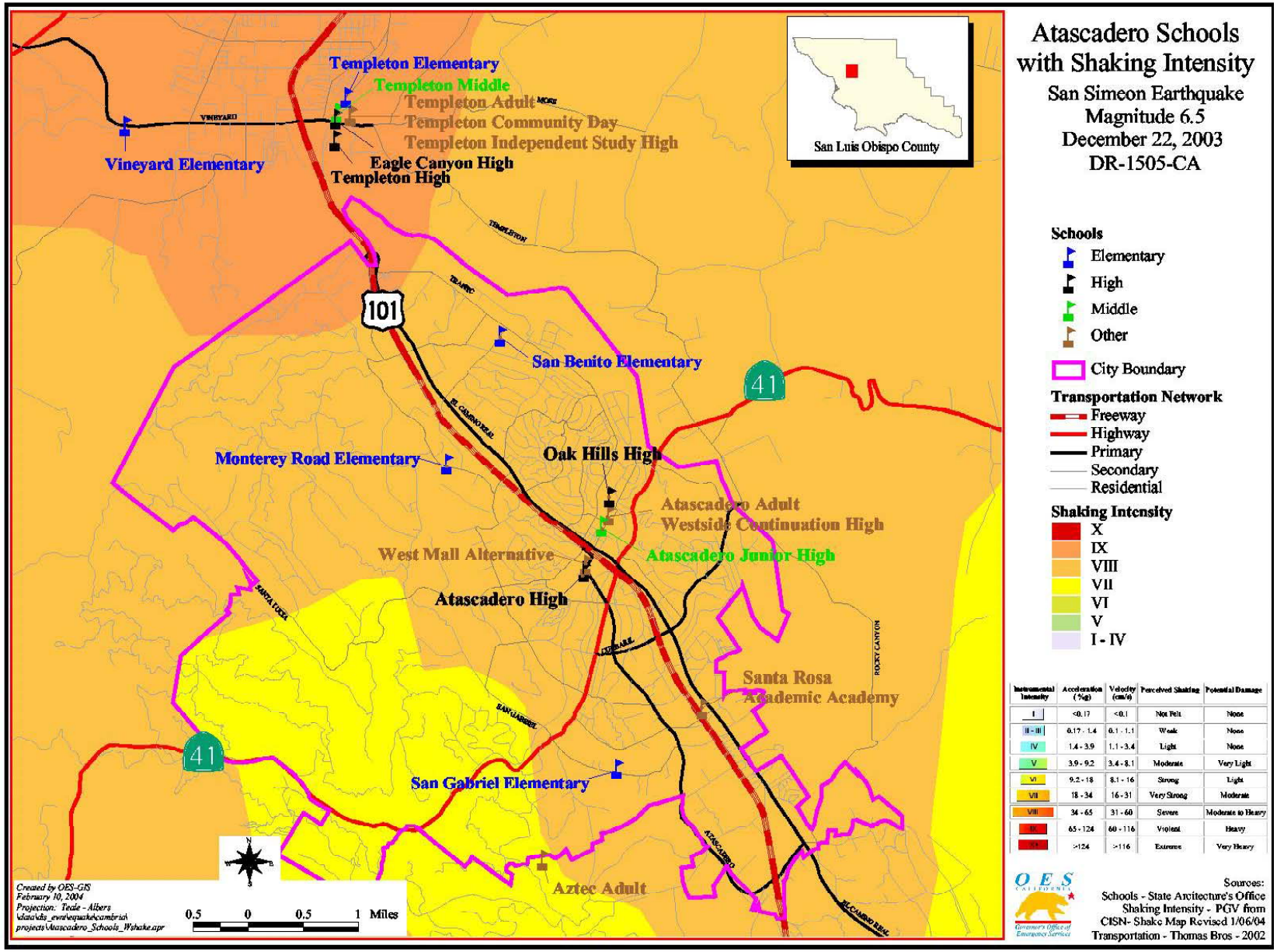
FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/21/2004

Plaster cracks in the infill wall.

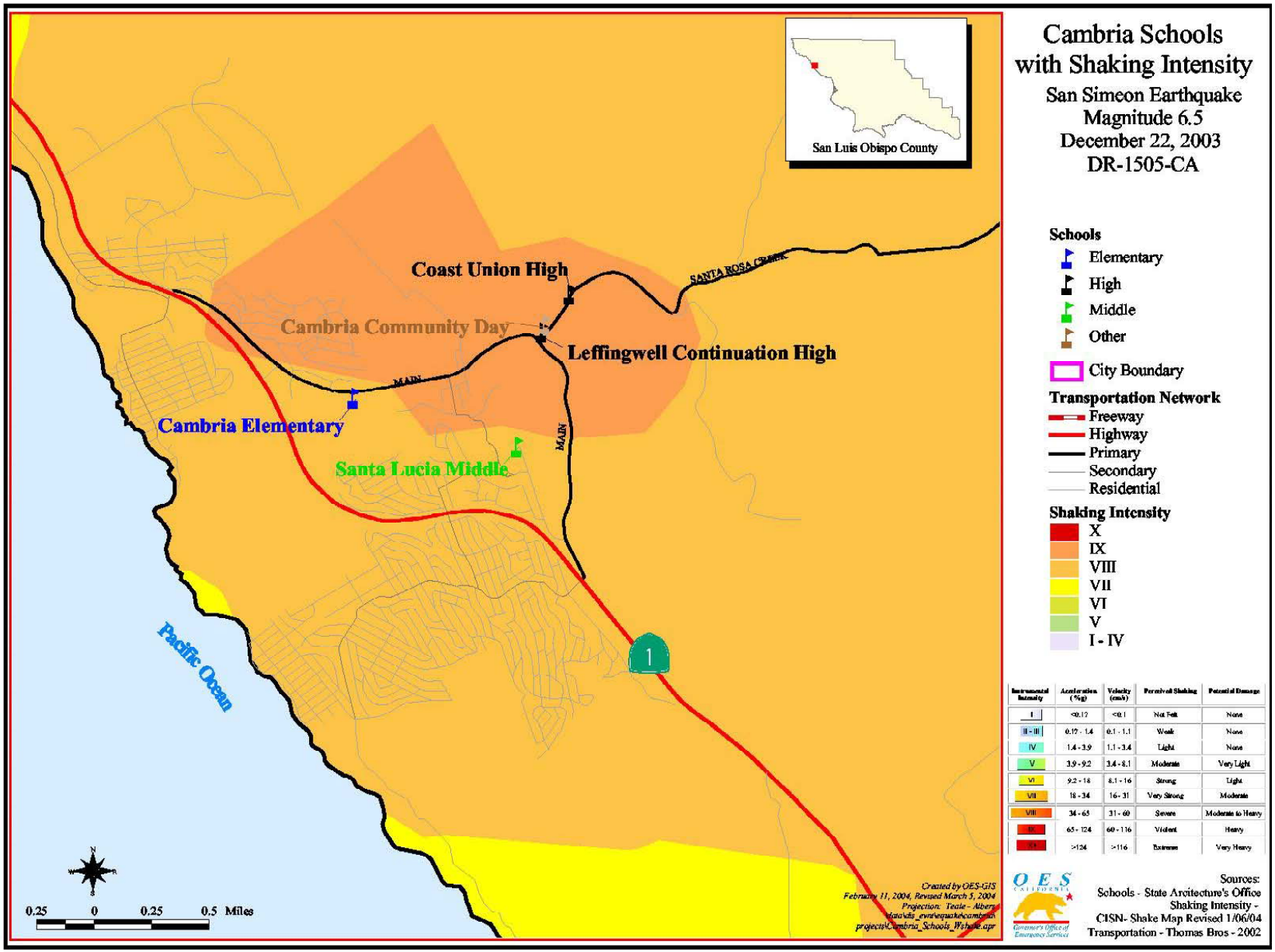
FLAMSON M.S.
Paso Robles
Auditorium Bldg.
01/21/2004

Cracks in wall plaster.

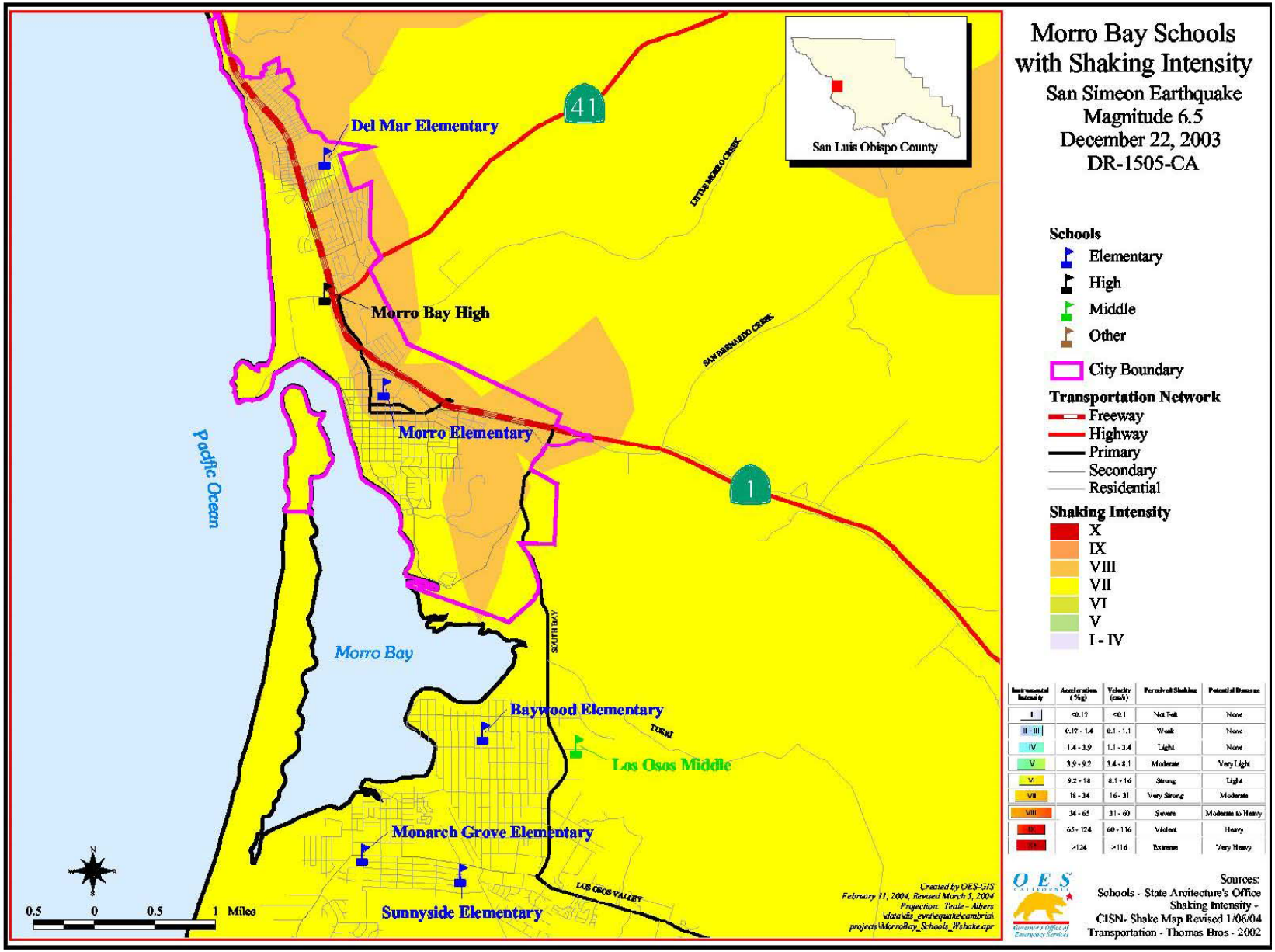
Appendix C – Shake Map - Atascadero



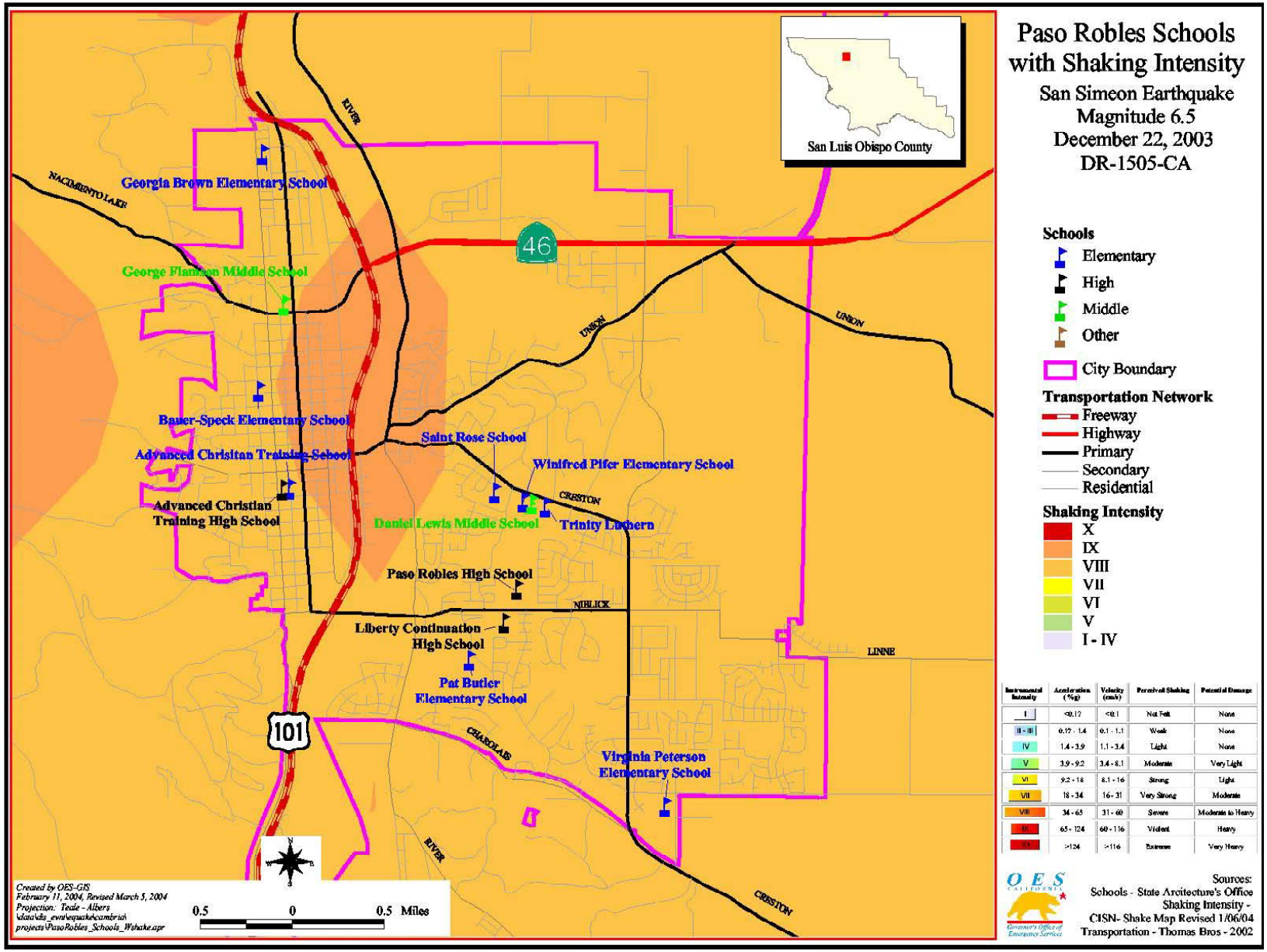
Appendix C – Shake Maps - Cambria



Appendix C – Shake Map - Morro Bay



Appendix C – Shake Map - Paso Robles



Appendix C – Shake Map - San Luis Obispo