OSHPD/CSMIP

HOSPITAL INSTRUMENTATION

Annual Report

July 1, 2022 through June 30, 2023

HCAI Agreement No. 19-20042
(DOC No. 1019-033R)

California Strong Motion Instrumentation Program
California Department of Conservation
California Geological Survey

715 P Street, MS 1901
Sacramento, California 95814

October 6, 2023

Annual Report

HCAI/CSMIP Hospital Instrumentation by the

California Strong Motion Instrumentation Program

July 1, 2022 through June 30, 2023

I. INTRODUCTION

The California Strong Motion Instrumentation Program (CSMIP) of the California Geological Survey, Department of Conservation, performs installation, maintenance, and data recovery for strong motion instrumentation in hospitals through an interagency agreement with the Department of Health Care Access and Information (HCAI). Funding strong motion instrumentation of hospitals through the interagency agreement is in lieu of normal building-permit fee funding referenced in Chapter 8 of the Public Resources Code.

Hospital buildings have been instrumented under eleven Interagency Agreements: 89-0046 (DOC 1089-025R), 92-3187 (DOC 1092-541R), 95-6011 (DOC 1095-570R), 98-9034 (DOC 1098-701R), 01-2069 (DOC 1001-753R), 04-5072 (DOC 1004-790R), 07-7071 (DOC 1007-911R), 10-1266 (DOC 1010-930R), 13-4097 (DOC 1013-960R), 16-7415 (DOC 1016-990R) and 19-20042 (DOC 1019-033R). The first ten agreements extended from July 1989 through June 2019, each covering a period of three fiscal years. The term of the eleventh interagency agreement 19-20042 (DOC 1019-033R) was originally from February 3, 2020, to February 2, 2023; however, it was later extended through June 30, 2023. The eleventh contract was approved by the Department of General Services (DGS) on March 24, 2020. This Report covers activities performed between July 1, 2022 and June 30, 2023 (FY22-23).

The code requirements regarding the instrumentation of hospitals have recently been updated. Previously, the code stipulated that HCAI was responsible for subsidizing the maintenance of instrumentation installed at hospitals. With the updated requirements, however, the code now requires hospital owners to pay for maintenance. This change is reflected in the most recent interagency agreement between HCAI and CSMIP. When CSMIP discovers maintenance issues with hospital instrumentation, the issues are reported to HCAI. HCAI then either authorizes CSMIP to address the issue or advises the hospital owner that they are responsible for addressing it. If CSMIP performs maintenance on instrumentation that the hospital owner has responsibility for, the hospital owner can be billed to recoup the cost of the work performed.

During FY22-23, CSMIP completed the installation of the instrumentation at both the Miller Children's Hospital in Long Beach and the Presbyterian Intercommunity Hospital in Whittier. These two instrumentation projects were funded by HCAI as part of interagency agreement 19-20042. In addition, there was progress on various owner-funded hospital instrumentation projects as CSMIP continued to provide technical guidance and assistance to the general contractors and structural engineers on other instrumentation projects currently underway.

In addition to new instrumentation projects, CSMIP upgraded the recorders at fourteen stations (hospital buildings and free-fields) with existing instrumentation at no charge for equipment to HCAI. The instrumentation at these stations was upgraded from obsolete recording systems to modern higher resolution recorders capable of real-time data streaming. The funding for these upgrades was provided by CSMIP through its Statewide Seismic Hazard Mitigation BCP Upgrade Project.

II. HOSPITAL INSTRUMENTATION STATUS

Hospital buildings with instrumentation underway are listed in Tables 1, 2, and 3. Like the other hospitals recently instrumented by the CSMIP, the new stations will have near-real-time data communication capability to allow the recorded motion to be automatically transmitted to the CSMIP servers after an earthquake where it will be automatically processed and made available for use in post-earthquake response by the HCAI and the hospital owners.

1) Type 1 - HCAI-Funded Regular Instrumentation of Hospitals (Table 1)

During FY22-23 the installation of the reference free-field station of the Santa Clara Valley Hospital (Replacement Bed Bldg. 1) in San Jose was completed. The sensor marking visit to the Presbyterian Intercommunity Hospital in Whittier occurred on February 16, 2023, and the strong motion instrumentation was completed by CSMIP in June 2023. In addition, the instrumentation of the Miller Children's Hospital in Long Beach was done in late June 2023.

2) Types 2 and 3 - Owner-Funded Instrumentation of Hospitals with CSMIP Guidance and Assistance (Tables 2 and 3)

In addition to the hospital instrumentation funded under the HCAI/CSMIP contract discussed above, a significant component of CSMIP hospital instrumentation work involves detailed technical guidance and assistance with hospital instrumentation projects for which the owner absorbs the capital cost of instrumentation under HCAI regulations. These may be in new hospitals (Type 2), or in existing hospitals being retrofitted (Type 3). Seven CSMIP-assisted hospital instrumentation projects are currently underway.

CSMIP guidance and assistance in the instrumentation of hospitals includes the following steps:

1. Development of the sensor locations or review of the proposed sensor locations from the design structural engineer of record (SE), after study of the structural plans, to ensure enough sensors to characterize the building seismic response. An instrumentation planning meeting or conference call among the SE, architect of record, HCAI and CSMIP staff is held to discuss and develop consensus on sensor locations and number of sensors.
2. Establishment of the specific locations of all sensors, based on detailed study of the architectural plans by the design architect or SE. Sensor locations need to avoid conflict with other non-structural components and sensors need to be accessible after they are installed.

3. Development of the comprehensive, detailed design of the system, called the Technical Specifications Letter (TSL), by CSMIP staff. The TSL is provided to the owner, HCAI, and the contractor, and is included in the plans. It specifies acceptable instruments and approved installation practices as well as details for the locations and interconnection of the components, to result in a well-installed project. The final instrumentation plans are approved by HCAI.
4. Sensor marking field visit by CSMIP staff with representatives of the owner, construction contractor and HCAI Inspector of Record. During this visit the actual sensor locations are approved and physically marked on the structural members. During the subsequent work by the contractor, CSMIP staff approves the submittals, assists with problems and issues as they arise.
5. Acceptance field testing of the completed instrumentation system, some months or years later, by CSMIP staff. If problems are found in the installation or operation, the contractor is called back in for repairs, followed by a repeat of tests. Once the installed system is accepted, HCAI is notified, and CSMIP takes on long-term maintenance of the instrumentation, as well as data recovery and processing, supported by HCAI.
6. CSMIP staff prepare sensor location diagram, building descriptions and station photo for the building, which are made available at the Center for Engineering Strong Motion Data (CESMD) after the instrumentation is completed.

Type 2 Instrumentation Projects

These hospital buildings have base-isolation and/or energy dissipation devices or use an Alternate Method of Compliance (AMOC) in their design. These are required to have owner-paid instrumentation installed during construction per the California Building Code and HCAI regulations. The following progress on Type 2 projects occurred during FY22-23.

For the Cedars-Sinai Medical Center Replacement Hospital in Marina Del Rey, CSMIP has been coordinating with the project design team on the review of submittals for the instrumentation. The sensor marking visit for this project is anticipated to occur during FY24-25. For Scripps Tower II in La Jolla the sensor locations were marked on June 28, 2023. The Technical Specifications Letter was completed and sent to the design team for the UC Irvine Medical Center New Hospital. The sensor marking visit for this project is anticipated in FY23-24.

A kickoff meeting was held in January 2023, with the design team of the UC Davis Health New Hospital in Sacramento. The purpose of the meeting was to review important architectural and structural aspects of the new hospital building with CSMIP and HCAI in preparation for a future instrumentation planning meeting for the project.

The relative displacement sensors at the base of the University Medical Center Replacement Hospital in Loma Linda still need to be installed, which is anticipated to occur during FY23-24. The hospital owner is required to provide brackets and straps for the relative displacement sensors before they can be installed. At the Hollywood Presbyterian Medical Center Acute Care Services Replacement Building in Los Angeles the contractor is coordinating the installation of the sensors with the equipment manufacturer; the buy-off of the instrumentation is anticipated to occur during FY23-24.

Type 3 Instrumentation Projects

These buildings are retrofitted under the Voluntary Seismic Improvement (VSI) regulations. Because of an AMOC design used in their retrofit, these buildings are required to be instrumented at owner expense. St. Bernardine Hospital in San Bernardino is the only Type 3 hospital instrumentation project of the current interagency agreement. During FY21-22 the instrumentation was installed and the buy-off completed at this hospital.

3) Outline of the Report

In Section III of this report, the previously instrumented hospital buildings for which ongoing maintenance was performed throughout FY22-23 are listed. In Section IV, the strong-motion records that were obtained during FY22-23 at instrumented hospitals and their reference free-field sites are listed. A total of 19 earthquakes with magnitude 3.0 or larger were recorded at instrumented hospitals. All recordings can be viewed online and downloaded at **www.strongmotioncenter.org**. The fiscal report is included in Section V.

A total of 85 hospital buildings have been instrumented in the HCAI/CSMIP project through the end of FY22-23. The locations of the 85 hospital buildings are shown on a probabilistic seismic hazard map in Appendix A. The hospital buildings and information about their structural systems are listed in the table in Appendix B. The number of strong-motion recorders at each building and the communication speed are also shown in the table as these will determine how quickly data can be recovered for application after earthquakes.

Table 1

Regular Hospital Buildings (Type 1)
Instrumented under HCAI/CSMIP Hospital Instrumentation Project

(HCAI Funded - HBSB Instrumentation Committee Recommended)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date
Instrumentation Completed or Underway						
1. Long Beach – Miller Children's Hospital (Pediatric Impatient Addition)	14735	IL 050398	2009	4/0	15+FF	6/15/2023
	Steel moment frames [Signed permit and plans received 7/2021; Sensor locations marked 4/21/2022. Installation completed 6/15/2023] Reference free-field station: **Long Beach – East 27 St & Atlantic**, CSMIP Sta. 14731					
2. Whittier – Presbyterian Intercommunity Hospital (Ed Shannon Tower)	14737	HL 000304	2005	4/1	18+FF	6/7/2023
	Steel moment frames [Signed permit and plans received 8/2021; Sensor locations marked 2/16/2023. Installation completed 6/7/2023] Reference free-field station: **Whittier – Washington & Lambert**, CSMIP Sta. 14740					
3. San Jose – I280 & Sth Bascom	57612	--	--	--	3	3/23/2023
	Reference free-field for CSMIP Sta. 57537, **San Jose – Santa Clara Valley Hospital (Replacement Bed Bldg. 1)**					

Table 2

New Hospital Buildings (Type 2) – Assisted Instrumentation Base-Isolated or Alternate Method of Compliance

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date

Instrumentation Completed or Underway

1. Greenbrae (San Rafael) – Marin General Hospital Replacement Building

58M15	I 140004-21	ca. 2019	4/1	16+FF	2/13/2020

Special steel moment frames with SidePlate connections
[TSL completed 5/4/16; Sensor locations marked 11/2/2017; Buy-off 2/13/2020]
Reference free-field station: **San Rafael – Marin Hospital Grounds A**, CSMIP Sta. 58906

2. Loma Linda – University Medical Center Replacement Hospital

23M01	I 150010-36	ca 2021	16/2	42+FF	FY 23-24

Steel BRB and SidePlate moment frames isolated with triple pendulum bearings and viscous dampers.
[TSL completed 4/26/17; Sensor locations marked 9/6/2018, 4/11/2019 and 1/30/2020.
Buy-off of accelerometers 10/21/2020]
Reference free-field station: **Loma Linda – Barton & Anderson**, CSMIP Sta. 23702

3. Los Angeles - Hollywood Presbyterian Medical Center Acute Care Services Replacement Building

24nnn	I 17002-19-02	ca 2022	4/1	16	FY 23-24

Steel moment frames with SidePlate connections
[TSL completed 10/26/17; Sensor locations marked 5/6/2020]
(Pre-existing reference FF station: **Los Angeles – Vermont & Fountain,** CSMIP Sta. 24642)

4. Downey – Kaiser Hospital Tower Expansion

14689	I 160024-19-02	ca 2020	6/partial	16+FF	11/3/2020

Steel moment frames with SidePlate connections.
[TSL completed 5/24/18; Sensor locations marked 10/8/2019; Buy-off 11/3/2020]
Reference free-field station: **Downey – Imperial & Ardis**, CSMIP Sta. 14675

5. Marina Del Rey – Cedars-Sinai Medical Center Replacement Hospital

14nnn	I 180008-19-00	ca 2025	9/0	24+FF	FY 24-25

Steel moment frames with SidePlate connections.
[TSL completed 7/16/21]
(To include a reference free-field station)

6. La Jolla – Scripps Tower II

03nnn	I 190018-37-00	ca 2024	8/1	18	FY 23-24

Steel moment frames with bolted SidePlate connections
[TSL completed 2/8/22; Sensor locations marked 6/28/2023]
(Pre-existing reference FF station: **La Jolla – I5 & Genesee,** CSMIP Sta. 03539)

7. San Diego – Sharp Metropolitan Medical Center New Tower

03nnn	I 210010-37-01	ca 2030	7/0	18+FF	FY 29-30

Steel moment frames with bolted SidePlate connections.
[TSL completed 5/31/22]
(To include a reference free-field station)

Table 2 (continued)

New Hospital Buildings (Type 2) – Assisted Instrumentation Base-Isolated or Alternate Method of Compliance

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date
8. Irvine – UC Irvine Medical Center New Hospital						
	13nnn	I 210005-30-03	ca 2024	7/0	15+FF	FY 23-24
	Steel buckling restrained braced frames [Instrumentation planning meeting held 12/21/21; TSL completed 3/9/23] (To include a reference free-field station)					
9. Sacramento – UC Davis Health New Hospital						
	67nnn	I 210013-34-05	ca 2030	14/1	nn+FF	FY 29-30
	Steel moment frames with SidePlate connections. [Kickoff meeting with design team held 1/30/23] (To include a reference free-field station)					

Table 3

Existing Hospital Buildings (Type 3) – Assisted Instrumentation Voluntary Seismic Improvement (VSI) Projects

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Design	No. of Stories	No. of Sensors	Installation Date
Instrumentation Completed						
1. San Bernardino – St. Bernardine Hospital (Central Tower)						
	23697	IL 082842-36	1972	6/0	12+FF	1/26/2022
	Steel moment frames (retrofit: add exterior steel frames with viscous dampers)					
	[TSL completed 12/1/16; Sensor locations marked 3/18/21; Buy-off 1/26/22]					
	Reference free-field station: **San Bernardino – St. Bernardine Hosp Grounds**, CSMIP Sta. 23727					

III. HOSPITAL INSTRUMENTATION MAINTENANCE

During FY22-23, CSMIP technical staff performed periodic maintenance of the strong-motion instrumentation installed in the 83 previously instrumented hospital buildings, 64 of which have an associated free-field instrument. With the addition of two newly instrumented hospital buildings, a total of 85 buildings will be maintained during the next fiscal year (FY23-24).

The 83 hospital buildings instrumented as of the beginning of FY22-23 (buildings with an associated reference free-field station are indicated by an *), are listed alphabetically by city below:

1. Alameda - Alameda Hospital *
2. Bakersfield - Kern County Hospital *
3. Berkeley - Alta Bates Hospital
4. Burlingame - Mills Peninsula Hospital *
5. Castro Valley - Sutter Eden Medical Center *
6. Colton - Arrowhead Regional Medical Center (base-isolated) *
7. Crescent City - Sutter Coast Hospital *
8. Downey - Kaiser Hospital Tower Expansion *
9. Downey - PIH Health Medical Center (VSI) *
10. El Centro - El Centro Regional Medical Center *
11. Encino - Encino Hospital (VSI) *
12. Escondido - Palomar West Medical Center, Central Plant
13. Escondido - Palomar West Medical Center, Main Tower *
14. Eureka - St. Joseph Hospital *
15. Fairfield - North Bay Medical Center *
16. Fremont - Kaiser Hospital *
17. Fremont - Washington Hospital (base isolated) *
18. Gilroy - St. Louise Hospital *
19. Greenbrae - Marin General Hospital Replacement Building *
20. Hemet - Hemet Valley Medical Center *
21. Indio - JFK Memorial Hospital *
22. Irvine - Kaiser Sand Canyon Hospital *
23. King City - Mee Hospital *
24. La Jolla - Scripps Memorial Hospital (VSI) *
25. La Jolla - UCSD Hospital *
26. La Jolla - UCSD Jacobs Medical Center
27. Lancaster - Antelope Valley Hospital *
28. Los Angeles - Children's Hospital
29. Los Angeles - Good Samaritan Hospital
30. Los Angeles - Hollywood Presbyterian Medical Center, Doctor's Tower (VSI)
31. Los Angeles - Hollywood Presbyterian Medical Center, South Wing (VSI) *
32. Los Angeles - LAC+USC Hospital D&T (base-isolated) *
33. Los Angeles - LAC+USC Hospital Inpatient Bldg
34. Los Angeles - MLK Hospital (base-isolated) *
35. Los Angeles - USC Hospital (base-isolated)
36. Los Angeles - USC Hospital Addition
37. Mammoth Lakes - Mammoth Hospital *

38. Moreno Valley - Riverside County Hospital *
39. Murrieta - Rancho Springs Medical Center *
40. Newport Beach - Hoag Hospital West Tower *
41. Newport Beach - Hoag Hospital East Tower (base-isolated)
42. Novato - Community Hospital *
43. Oakland - Kaiser Hospital
44. Ontario - Kaiser Hospital *
45. Oxnard - St. John's Medical Center *
46. Palm Springs - Desert Hospital
47. Palmdale - Palmdale Regional Medical Center *
48. Palo Alto - Lucile Packard Children's Hospital Stanford *
49. Redlands - Community Hospital (VSI) *
50. Riverside - Community Hospital (VSI) *
51. Salinas - Natividad Medical Center *
52. San Bernardino - Community Hospital *
53. San Bernardino - St. Bernardine Hospital (VSI) *
54. San Diego - Sharp Memorial Hospital (VSI) *
55. San Diego - UCSD Medical Center *
56. San Francisco - CPMC Cathedral Hill Hospital
57. San Francisco - General Hospital (base-isolated) *
58. San Francisco - Kaiser Hospital
59. San Francisco - St. Luke's Hospital
60. San Francisco - UCSF Hospital *
61. San Francisco - UCSF Mission Bay Hospital *
62. San Jose - O'Connor Hospital *
63. San Jose - Santa Clara Valley Hospital Bed Bldg 1
64. San Jose - Santa Clara Valley Hospital Bldg K
65. San Pedro - Providence LCOM Medical Center Bldg 1T (VSI) *
66. San Pedro - Providence LCOM Medical Center Bldg 2 (VSI)
67. San Rafael - Marin General Hospital West Wing *
68. Santa Ana - Orange County Global Med Center (VSI) *
69. Santa Barbara - Cottage Hospital *
70. Santa Clara - Kaiser Hospital *
71. Santa Maria - Marian Hospital *
72. Santa Monica - St. John's Hospital (base-isolated) *
73. Santa Rosa - Kaiser Hospital *
74. Simi Valley - Simi Valley Hospital *
75. Stanford - 7-story Hospital (base-isolated) *
76. Stanford - University Hospital *
77. Sylmar - Olive View Hospital *
78. Templeton - Twin Cities Hospital *
79. Torrance - Providence LCOM Medical Center (VSI)*
80. Valencia - Mayo Hospital *
81. Ventura - Community Memorial Hospital *
82. Ventura - Ventura County Hospital *
83. Walnut Creek - Kaiser Hospital

In addition to periodic maintenance, CSMIP upgraded the recorders, without charge to HCAI, at the following fourteen hospitals and free-field stations. The instrumentation at these stations was upgraded from obsolete recording systems to modern higher resolution recorders capable of real-time data streaming. The funding for these upgrades was provided by CSMIP through its Statewide Seismic Hazard Mitigation BCP Upgrade Project.

1. Fairfield – North Bay Medical Center Free-Field
2. Los Angeles – Good Samaritan Hospital
3. Los Angeles – LAC+USC Hospital D&T
4. Los Angeles – LAC+USC Hospital Grounds
5. Los Angeles – USC Hospital
6. Newport Beach – Hoag Hospital East Tower
7. Newport Beach – Hoag Hospital West Tower
8. Oxnard – St. John's Medical Center
9. Oxnard – St. John's Medical Center Free-Field
10. Palmdale – Palmdale Regional Medical Center Grounds
11. San Francisco – Kaiser Hospital
12. San Jose – O'Connor Hospital
13. Santa Rosa – Kaiser Hospital
14. Stanford – University Hospital Free-Field

CSMIP also performs monitoring and data recovery for the code-type instrumentation systems (three tri-axial accelerographs) in the following four hospitals without charge to HCAI:

1. Los Angeles – White Memorial Hospital (7-story)
2. Pasadena – Huntington Memorial Hospital (7-story)
3. Downey – Kaiser Hospital (6-story)
4. Los Angeles – Kaiser LAMC Sunset Hospital (7-story)

IV. STRONG-MOTION RECORDS FROM HOSPITALS

From July 1, 2022 to June 30, 2023 a total of 19 earthquakes with magnitude 3.0 or larger were recorded at the instrumented hospitals. The hospitals, and the maximum accelerations recorded at the hospital buildings (base and superstructure) and at their reference free-field stations (ground), are listed below for these earthquakes.

M3.6 Bayside Earthquake of August 13, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	17.6	0.8	0.4	1.5

M4.4 Santa Rosa Earthquake of September 13, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Santa Rosa – Kaiser Hospital (Sta. 68669)	4-story moment steel frames	1.8	--	14.4	36.7

M4.1 Fortuna Earthquake of October 23, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	22.9	--	1.6	4.5

M5.1 Alum Rock Earthquake of October 25, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Salinas – Natividad Medical Center (Sta. 47796)	3-story chevron-braced steel frames	68.2	0.9	0.9	4.1
Gilroy – Gilroy Hospital (Sta. 57200)	2-story steel moment frames	31.8	1.4	1.4	4.3
Santa Clara – Kaiser Hospital (Sta. 57251)	3-story chevron braced steel frames	29.1	--	0.6	1.8
Fremont – Kaiser Hospital (Sta. 57301)	2-story steel moment frames	37.9	--	0.4	1.3
San Jose – Kaiser Hospital (Sta. 57495)	4-story steel moment frames	23.2	No FF	0.8	2.8
San Jose – O'Connor Hospital (Sta. 57594)	5-story eccentric braced steel frames	23.6	1.2	0.8	2.0
San Francisco – Kaiser Hospital (Sta. 58718)	6-story concrete shear wall and braced steel frames	85.9	No FF	0.3	2.7

M3.6 El Cerrito Earthquake of December 17, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Alameda – Alameda Hospital (Sta. 58396)	3-story steel moment frames	17.8	1.7	2.6	8.3

M4.0 Hydesville Earthquake of December 20, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	21.3	--	0.8	3.8

M6.4 Ferndale Earthquake of December 20, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	37.3	30.9	23.3	136.2

M4.3 Ferndale Earthquake of December 20, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	30.9	--	1.4	4.4

M3.3 Union City Earthquake of December 21, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure

Fremont – Kaiser Hospital (Sta. 57301)	2-story steel moment frames	8.7	--	0.6	1.5

M3.3 Hydesville Earthquake of December 21, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	21.7	--	1.6	3.5

M4.2 Hydesville Earthquake of December 24, 2022

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	27.6	--	0.9	2.1

M5.3 Rio Dell Earthquake of January 1, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	44.1	2.9	1.8	6.3

M4.2 Malibu Beach Earthquake of January 25, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Santa Monica – St John's Hospital (Sta. 24202)	5-story concentrically braced steel frames (isolated)	26.4	--	1.6	2.7

M3.2 Fortuna Earthquake of January 27, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	21.8	--	1.6	5.4

M4.5 Ferndale Earthquake of March 21, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Eureka – St Joseph Hospital (Sta. 89770)	4-story concrete shear walls	33.2	1.1	1.1	3.5

M4.2 Palomar Observatory Earthquake of Mar 31, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
Hemet – Valley Hospital (Sta. 12267)	4-story concrete shear walls	41.1	1.7	0.9	2.4

M4.4 Tres Pinos Earthquake of April 4, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure

Salinas – Natividad Medical Center (Sta. 47796)	3-story chevron-braced steel frames	30.1	0.8	0.7	2.2
Gilroy – Gilroy Hospital (Sta. 57200)	2-story steel moment frames	34.2	--	0.6	1.5
Santa Clara – Kaiser Hospital (Sta. 57251)	3-story chevron braced steel frames	84.4	--	0.5	2.6

M4.1 Heber Earthquake of Apr 29, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
El Centro – Community Hospital (Sta. 01699)	1-story tube braces and concrete block walls	8	7.9	5.5	17.7

M3.7 Heber Earthquake of Apr 29, 2023

Name of Hospital	Type of Structure	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
			Ground	Base	Structure
El Centro – Community Hospital (Sta. 01699)	1-story tube braces and concrete block walls	8.4	4.1	4.6	13.8

The strong-motion records are made available rapidly after an earthquake by the CSMIP Strong-motion Automated Recovery and Analysis (SARA) system, and posted in the Internet Quick Reports at the web site of the Center for Engineering Strong Motion Data (CESMD), at **https://www.strongmotioncenter.org**.

The largest earthquake and the largest acceleration recorded by an instrumented hospital during FY22-23 was from the M6.4 Ferndale earthquake of December 20, 2022. This earthquake was recorded by only one hospital station, the 4-story St Joseph Hospital in Eureka, which is located at an epicentral distance of approximately 37 kilometers. The largest acceleration recorded at the St Joseph Hospital from this earthquake is 1.36g. This acceleration was recorded at the Elevator Room floor of the building which experienced amplification of almost 6.0x the acceleration recorded at the base. The accelerations recorded at each instrumented level of the building from this earthquake are plotted in Figure 1.

The St Joseph Hospital building in Eureka is a 4-story reinforced concrete structure. The lateral force resisting system consists of 10" thick reinforced concrete shear walls along the perimeter and interior of the building and flat concrete slabs which serve as the horizontal diaphragm. The building is instrumented with 11 accelerometers located at the base and upper floor levels and 3 accelerometers at a reference free-field site.

Other notable records from FY22-23 include those from the Kaiser Hospital in Santa Rosa to the M4.4 Santa Rosa earthquake of September 13, 2022, and those from the Community Hospital in El Centro to the M4.1 Heber earthquake of April 29, 2023. The maximum accelerations recorded by these buildings in response to these earthquakes are 0.37g and 0.18g and can be seen in Figures 2 and 3, respectively.

V. Real Time Strong Motion Data Stream

In response to the HCAI request, CSMIP started a pilot project on streaming data in real time to the HCAI Earthworm system for one hospital. As a requirement for this project, CSMIP upgraded the recording system of the station Santa Rosa Kaiser Hospital under the California Statewide Strong Motion Instrumentation Upgrade Project. Currently data from this station is being streamed in real time. In addition, CSMIP is preparing to stream data in real time for the station Lancaster, Antelope Valley Hospital.

VI. FISCAL REPORT

The current contract was executed on March 24, 2020, around the time that COVID pandemic restrictions started. Because of the field work limitations and challenges with COVID, such as access to the hospitals, the major repairs and new instrumentation projects of the hospitals that were planned for FY19-20 and FY20-21were postponed.

A summary of the budget and expenditures is as follows:

Total amount of Agreement (March 24, 2020 – June 30, 2023)		$1,133,700.00
	Amendment to 6/30/23	$160,000.00
	Reverted by HCAI	($263,059.33)
	Total	$1,030,640.67
1)	Budgeted for FY19-20	$377,900.00
	Expended March to June 2020	($17,256.69)
	Reverted by HCAI	($263,059.33)
	Remaining amount from Year 1	$97,583.98
2)	Budgeted for FY20-21	$377,900.00
	Expended in FY20-21	($177,064.79)
	Remaining amount from FY20-21	$200,835.21
3)	Budgeted for FY21-22	$377,900.00
	Expended in FY21-22	($639,146.40)
	Remaining amount from FY21-22	($261,246.40)
4)	Using FY 22-23 Amendment amount and Remainder of Contract Funds	$197,172.79
	Expended in FY 22-23	($197,172.79)
	Remaining amount from FY21-22	$0.00

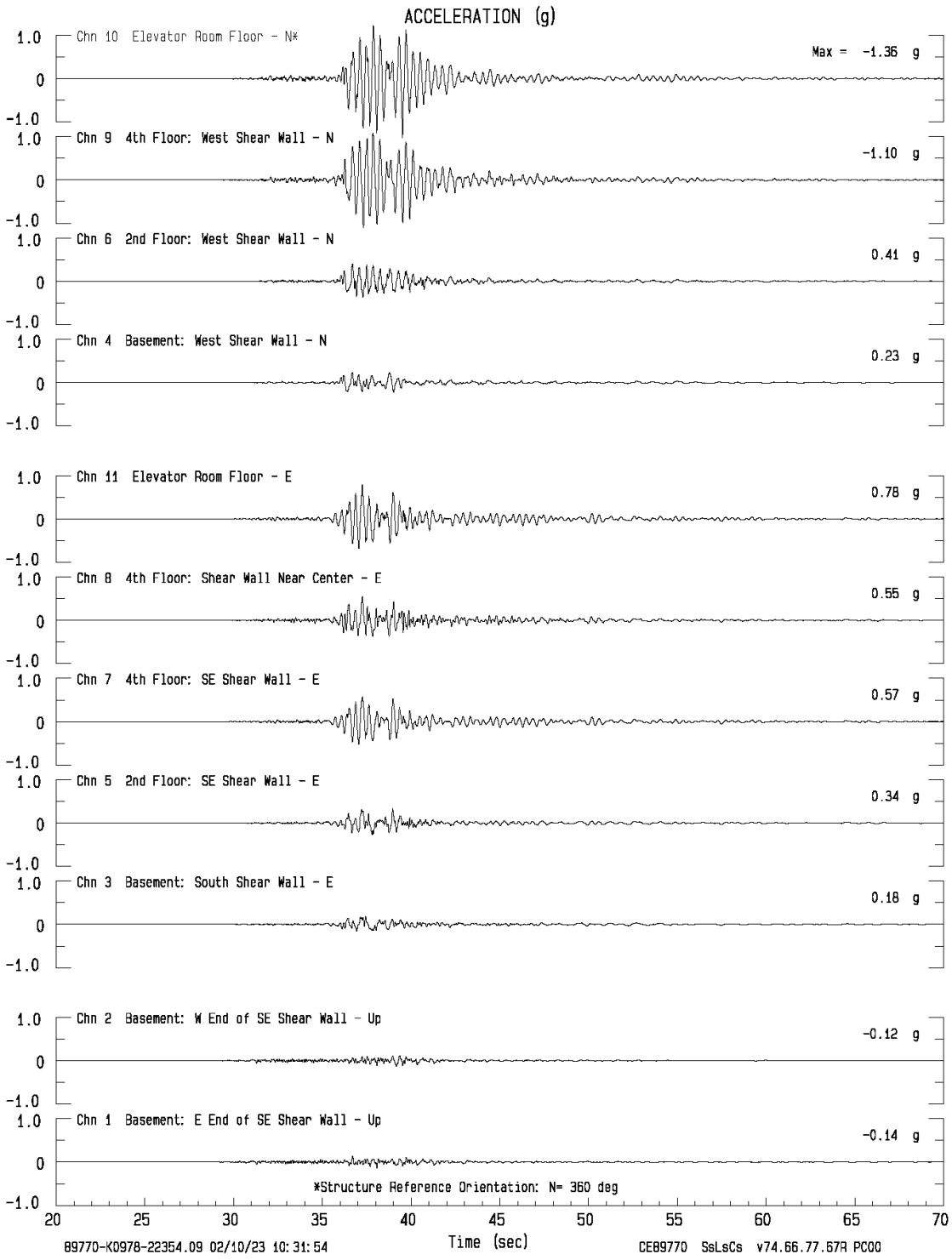


Figure 1. Accelerations recorded at the St Joseph Hospital in Eureka during the M6.4 Ferndale earthquake of December 20, 2022.

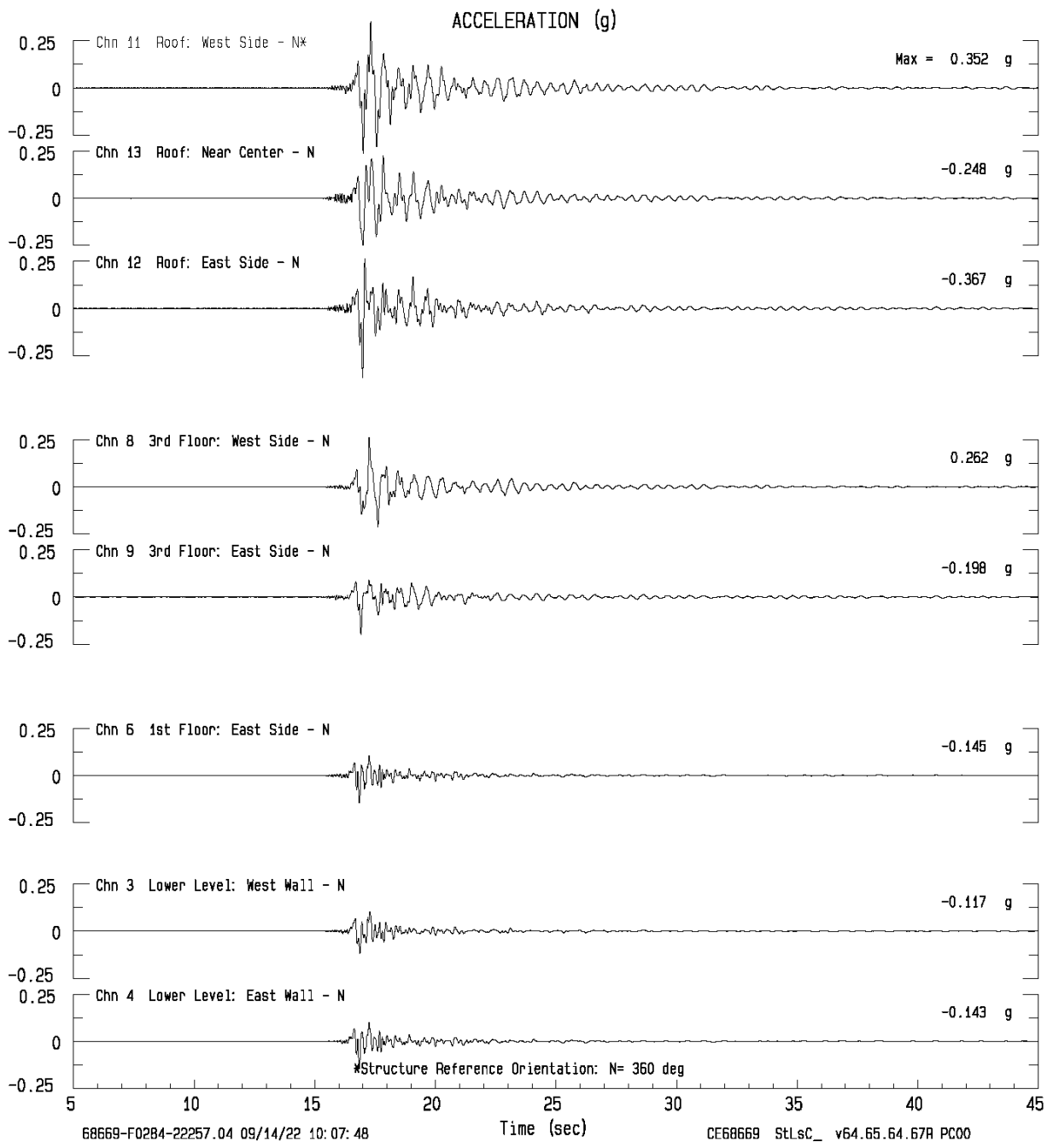


Figure 2. Accelerations recorded at the Kaiser Hospital in Santa Rosa during the M4.4 Santa Rosa earthquake of September 13, 2022.

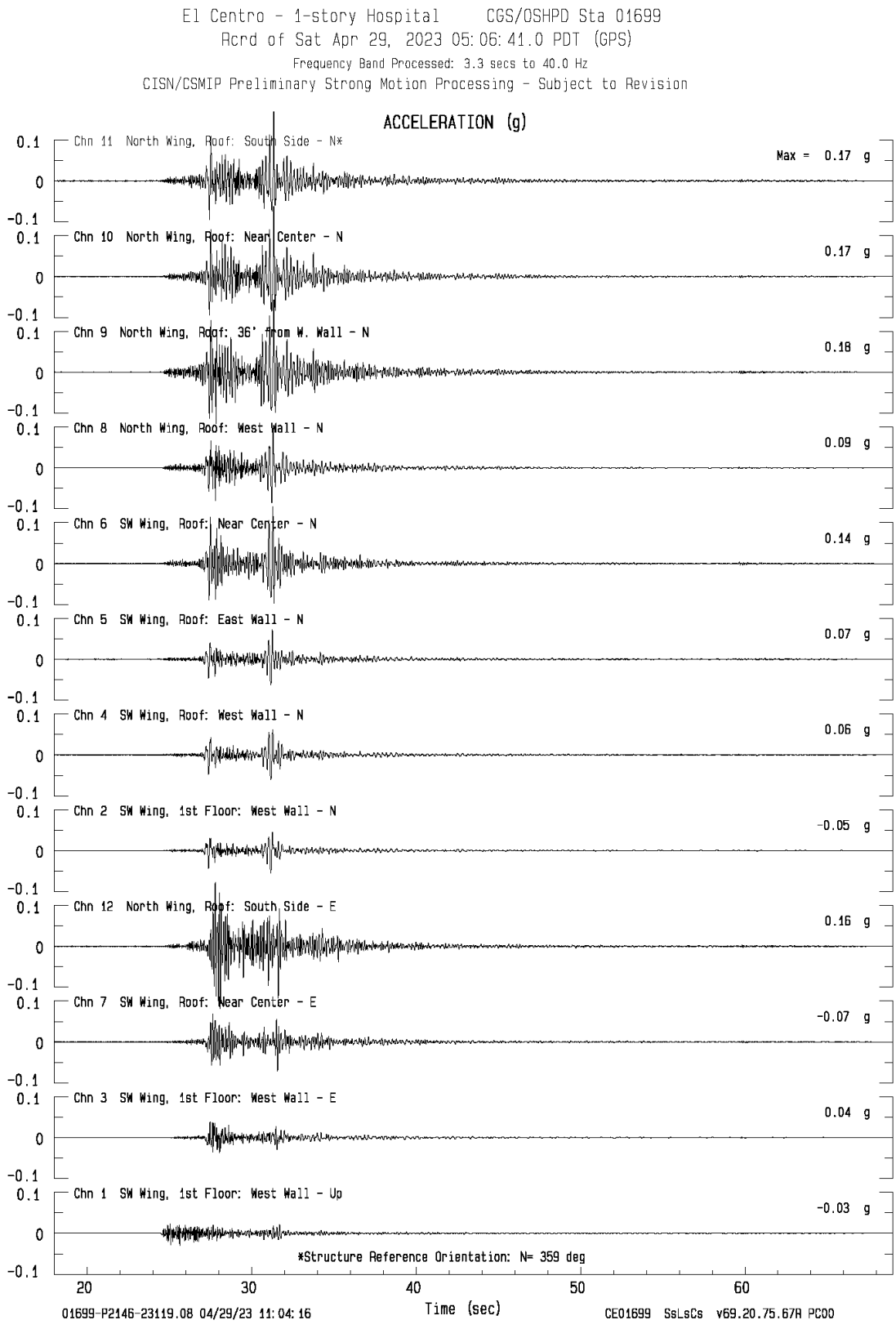
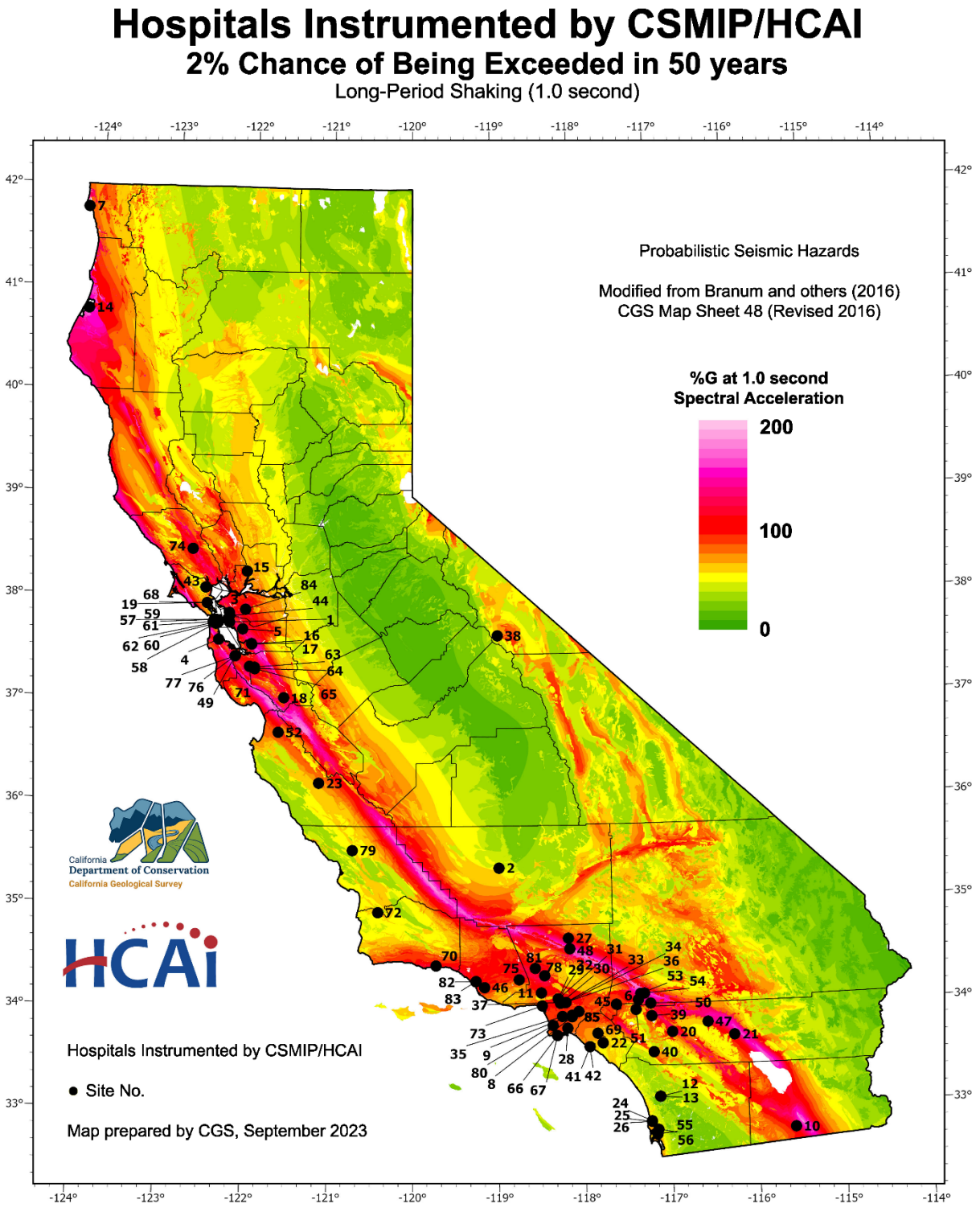


Figure 3. Accelerations recorded at the Community Hospital in El Centro during the M4.1 Heber earthquake of April 29, 2023.

Appendix A


Hospitals Instrumented by CSMIP/HCAI
2% Chance of Being Exceeded in 50 years
Long-Period Shaking (1.0 second)
Probabilistic Seismic Hazards
Modified from Branum and others (2016)
CGS Map Sheet 48 (Revised 2016)
%G at 1.0 second
Spectral Acceleration
200
100
0
California
Department of Conservation
California Geological Survey
HCAI
Hospitals Instrumented by CSMIP/HCAI
Site No.
Map prepared by CGS, September 2023

Appendix B

BUILDINGS INSTRUMENTED BY CSMIP/HCAI

10/1/2023

Site No. on Map	CSMIP Sta. No.	Station Name	No. of Stories	No. of Sensors	No. of Rcrdrs	Recov. Speed	FEMA-310 Bldg Type	SMIAC Bldg Type
1	58396	Alameda - Alameda Hospital	3/0	12+FF	1	M	S1L	K1
2	34234	Bakersfield - Kern County Hospital	4/1	12+FF	1	L	C2M	H2b
3	58496	Berkeley - Alta Bates Hospital	2/1	12	1	L	S2L	I1c
4	58390	Burlingame - Mills Peninsula Hospital (isolated)	6/0	27+FF	1	M	IM	Q2
5	58494	Castro Valley - Sutter Eden Medical Center	6/1	19+FF	1	M	S2M	I2a
6	23788	Colton - San Bernardino Co. Med. Center (isolated)	6/0,4/0,2/0	27+FF	2	L	IM	Q2
7	99261	Crescent City - Sutter Hospital	1/0	10+FF	1	L	S2L	I1c
8	14689	Downey - Kaiser Hospital Tower Expansion	6/partial	16+FF	1	M	S1M	J2b
9	14646	Downey - PIH Health Hospital (VSI)	4/1	12+FF	1	M	C2M	G2b
10	01699	El Centro - Community Hospital	1/0	12+FF	1	H	S2L	I1b
11	24648	Encino - Encino Hospital (VSI)	4/1	12+FF	1	H	RM2M	F2a
12	13476	Escondido - PMC West Hospital Central Plant	2/0	6	1	M	C2L	H1f
13	13473	Escondido - PMC West Hospital (Main Tower)	11/1	12+FF	1	M	S1H	K3a
14	89770	Eureka - St. Joseph Hospital	4/1	11+FF	1	L	C2M	G2d
15	68032	Fairfield - NorthBay Medical Center	3/0	12+FF	1	L	S2L	I1d
16	57301	Fremont - Kaiser Hospital	2/0	15+FF	1	L	S1L	K1
17	57643	Fremont - Washington Hospital (isolated)	3/1	24+FF	1	M	IL	Q1
18	57200	Gilroy - St. Louise Hospital	2/0	10+FF	1	L	S1L	K1
19	58M15	Greenbrae - Marin General Hospital Replacement Building	4/1	16+FF	1	H	S1M	J2b
20	12267	Hemet - Valley Hospital	4/1	10+FF	1	L	C2M	G2d
21	12759	Indio - JFK Hospital	1/0	8+FF	1	H	W1	A1
22	13439	Irvine - Kaiser Sand Canyon Hospital	6/partial	15+FF	1	M	S2M	I2b
23	47231	King City - Mee Hospital	2/0	10+FF	1	L	S2L	I1c
24	03538	La Jolla - Scripps Memorial Hospital	7/1	12+FF	1	M	S1M	J2b
25	03233	La Jolla - UCSD Hospital	2/0	16+FF	1	L	S1L	J1b
26	03593	La Jolla - UCSD Jacobs Medical Center	10/2	24	1	M	S1H	K3a
27	24609	Lancaster - Antelope Valley Hospital	5/0	12+FF	1	H	S1M	K2
28	14735	Long Beach - Miller Children's Hospital	4/0	15+FF	1	H	S1M	J2b
29	24397	Los Angeles - Childrens Hospital	7/1	12	1	L	S1M	K2
30	24713	Los Angeles - Good Samaritan Hospital	8/1	15	1	H	S2H	I3b
31	24662	Los Angeles - Hollywood Presbyterian MC S. Wing (VSI)	4/1	12+FF	1	M	C2M	H2b
32	24682	Los Angeles - Hollywood Presbyterian MC Drs Tower (VSI	10/2	15	1	M	S1H	J3b
33	24250	Los Angeles - LAC+USC Hospital D&T Bldg (isolated)	6/0	20+FF	1	H	IM	Q2
34	24248	Los Angeles - LAC+USC Hospital IP Bldg	9/0	12	1	L	S2H	I3b
35	14724	Los Angeles - MLK Hospital (isolated)	5/1	21+FF	2	L	IM	Q2
36	24605	Los Angeles - USC Hospital (isolated)	7/1	24	1	H	IH	Q3
37	24260	Los Angeles - USC Hospital Addition	9/1	12	1	L	S2H	I3b
38	54331	Mammoth Lakes - Mammoth Hospital	1/0	10+FF	1	L	S2L	I1b
39	13213	Moreno Valley - Riverside County Hospital	3/1	12+FF	1	L	S1L	K1
40	13601	Murrieta - Rancho Springs Medical Center	2/0	9+FF	1	M	C1L	L1
41	13291	Newport Beach - Hoag Hospital East Tower (isolated)	7/1	27	1	H	IM	Q3
42	13589	Newport Beach - Hoag Hospital West Tower	11/0	18+FF	1	H	C2H	H3a
43	68430	Novato - Community Hospital	2/0	12+FF	1	M	S2L	I1b
44	58590	Oakland - Kaiser Hospital	12/1	18	1	M	S2H	I3b
45	23416	Ontario - Kaiser Hospital	5/partial	18+FF	1	M	S2M	I2b
46	25949	Oxnard - St. Johns Hospital	4/1	16+FF	1	H	S1M	K2
47	12299	Palm Springs - Desert Hospital	4/1	13	1	L	S1M	K2
48	24457	Palmdale - Palmdale Regional Hospital	5/0	16+FF	1	M	C2M	H2d
49	58604	Palo Alto - Lucile Packard Childrens Hospital Stanford	6/2	21	2	M	S2M	J2a
50	23548	Redlands - Community Hospital (VSI)	2/1	9+FF	1	M	C2L	H1c
51	13633	Riverside - Community Hospital (VSI)	6/1	12+FF	1	M	C2M	G2e

Appendix B

BUILDINGS INSTRUMENTED BY CSMIP/HCAI

10/1/2023

Site No. on Map	CSMIP Sta. No.	Station Name	No. of Stories	No. of Sensors	No. of Rcrdrs	Recov. Speed	FEMA-310 Bldg Type	SMIAC Bldg Type
52	47796	Salinas - Natividad Medical Center	3/0	15+FF	1	L	S2L	I1b
53	23634	San Bernardino - Community Hospital	5/0	12+FF	1	M	S1M	K2
54	23697	San Bernardino - St. Bernardine Medical Center	6/0	12+FF	1	H	S1M	J2a
55	03546	San Diego - Sharp Memorial Hospital (VSI)	8/1	15+FF	1	M	C2H	H3b
56	03743	San Diego - UCSD Hospital	11/1	12+FF	1	H	C1H	M3
57	58640	San Francisco - CPMC Cathedral Hill Hospital	12/2	24	1	H	S1H	K3a
58	58574	San Francisco - General Hospital (isolated)	7/2	24+FF	2	M	IM	Q2
59	58718	San Francisco - Kaiser Hospital	6/0	18	1	H	C2M	H2d
60	58649	San Francisco - St. Luke's Hospital	6/1	16	1	M	S2M	I2b
61	58257	San Francisco - UCSF Hospital	15/1	16+FF	1	L	U	U
62	58572	San Francisco - UCSF Mission Bay Hospital	6/0	18+FF	1	M	S2M	I2b
63	57594	San Jose - O'Connor Hospital	5/0	16+FF	1	H	S2M	I2c
64	57495	San Jose - Santa Clara Valley Hospital (Bldg K)	4/1	15	1	M	S1M	K2
65	57537	San Jose - Santa Clara Valley Hospital (Bed Bldg 1)	7/1	20+FF	1	M	S1M	K2
66	14535	San Pedro - Providence LCOM Hosp (Bldg 1T) (VSI)	5/partial	12+FF	1	M	S2M	I2d
67	14536	San Pedro - Providence LCOM Hosp (Bldg 02) (VSI)	4/1	12	1	M	C2M	H2d
68	58755	San Rafael - Marin General Hospital	5/1	12+FF	1	L	S1M	J2b
69	13611	Santa Ana - Orange County Global Medical Center (VSI)	1/0	6+FF	1	M	S2L	I1a
70	25777	Santa Barbara - Cottage Hospital	3/1	9+FF	1	H	C2L	H1e
71	57251	Santa Clara - Kaiser Hospital	3/1	18+FF	1	L	S2L	I1b
72	26470	Santa Maria - Marian Hospital	4/partial	12+FF	1	M	S2M	I2c
73	24202	Santa Monica - St. John's Hospital (isolated)	5/1	24+FF	2	L	IM	Q2
74	68669	Santa Rosa - Kaiser Hospital	4/1	13+FF	1	H	S1M	K2
75	24104	Simi Valley - Simi Valley Hospital	2/1	12+FF	1	L	S1L	K1
76	58623	Stanford - 7-story Hospital (isolated)	7/1	34+FF	1	M	IM	Q2
77	58055	Stanford - University Hospital	3/1	12+FF	1	L	S1L	K1
78	24514	Sylmar - Olive View Medical Center	6/0	13+FF	1	L	UM	R
79	36695	Templeton - Twin Cities Hospital	1/0	9+FF	1	H	W1	A1
80	14529	Torrance - Providence LCOM Hospital (VSI)	4/2	21+FF	2	M	C2M	H2d
81	24344	Valencia - Mayo Hospital	2/partial	12+FF	1	M	S1L	K1
82	25594	Ventura - Community Memorial Hospital	6/1	24+GA	2	M	S2M	I2b
83	25744	Ventura - County Hospital	4/1	12+FF	3	VL	C2M	H2b
84	58199	Walnut Creek - Kaiser Hospital	3/1	16	1	L	S1L	K1
85	14737	Whittier - Presbyterian Intercommunity Hospital	4/1	18+FF	1	H	S1M	J2b