

The M_w 6.0 South Napa Earthquake of August 24, 2014

A Wake-up Call for Renewed Investment in Seismic Resilience across California

Working Draft – FINDINGS ONLY

January 7, 2016



Scott Strazzante, The Chronicle
<http://www.sfgate.com/bayarea/article/Woman-hit-by-TV-is-first-Napa-earthquake-death-5746343.php#photo-6766522>



Justin Sullivan/Getty Images
<http://www.latimes.com/opinion/editorials/la-ed-napa-earthquake-20140826-story.html>



Carlos Avila Gonzalez, The Chronicle
<http://www.sfgate.com/bayarea/article/Woman-hit-by-TV-is-first-Napa-earthquake-death-5746343.php#photo-6766620>

Preface

Prepared for and signed by the Commission

May want to include:

- Caveat that although the Commission considered all of the issues raised are important, the Commission judged the following finding and recommendations as the most cost effective and highest priority for consideration by the Governor and the Legislature
- Reference to how the State is still recovering from the 2008 recession, recent fires, and also enduring the worst drought on record

Executive Summary

(Emphasize the prioritized list of findings and recommended actions)

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Introduction

The Magnitude (Mw) 6.0 South Napa earthquake struck at 3:20 am on Sunday, August 24, 2014, approximately 4 miles northwest of American Canyon, 6 miles south-southwest of Napa, and 51 miles west-southwest of Sacramento, California. Two people died and 300 people reported injuries as a result of the earthquake or subsequent clean-up activities.¹

While the earthquake was felt in many parts of central and northern California, building and infrastructure damage was mostly confined to Napa, Solano, and Sonoma counties in the northwestern reaches of the San Francisco metropolitan area. Nearly 2,000 structures sustained moderate to severe damage, with nine fires erupting post-earthquake. Electricity and water services sustained disruptions and there was minor damage to roads, water and natural gas lines and wastewater treatment facilities.

A State Emergency Proclamation was issued for Napa, Solano and Sonoma Counties on August 24, 2014 and, on September 2, 2014, Governor Brown authorized financial assistance through the California Disaster Assistance Act to local agencies and certain nonprofit organizations, and requested that the President issue a federal major disaster declaration. Federal major disaster declarations were granted to portions of Napa and Solano counties on September 11, 2014 (for federal Public Assistance and Hazard Mitigation to qualifying public agencies and non-governmental organizations) and on October 27, 2014 (for federal Individual Assistance). As of January 2016, the federal government has approved approximately \$30.7 million of assistance for these programs.² Total economic losses have been estimated at \$443 million to \$800 million.³

The Mw 6.0 South Napa Earthquake is one of the first damaging earthquakes to strike a major metropolitan area in the State of California in over two decades. The Mw 6.7 Northridge earthquake struck southern California 20 years ago on January 17, 1994, and the Mw 6.9 Loma Prieta earthquake struck the San Francisco Bay Area over 25 years ago on October 17, 1989. These were and remain the most damaging earthquakes to strike the State's two most populous regions in modern times and a great deal of California's earthquake risk reduction policy was derived and implemented in the aftermath of these two disasters. Furthermore, there are now two decades of research and investment in earthquake hazard characterization, building code development, structural and infrastructure retrofits, insurance reform, and emergency management that were tested, in part, by the 2014 earthquake.

¹ K.R. Attfield et al., "Injuries and Traumatic Psychological Exposures Associated with the South Napa Earthquake — California, 2014," *Morbidity and Mortality Weekly Report* 64, no. 35 (September 11, 2015): 975–78.

² Federal Emergency Management Agency FEMA, "Financial Assistance," *California Earthquake (DR-4193)*, January 3, 2016, <https://www.fema.gov/disaster/4193>.

³ Jennifer Huffman, "Top Stories of 2015, No. 1: Earthquake Aftermath," *Napa Valley Register*, December 30, 2015, http://napavalleyregister.com/news/local/top-stories-of-no-earthquake-aftermath/article_bb832e07-78dc-578a-bbde-10cbfegc2a95.html.

On October 8, 2014, the Alfred E. Alquist Seismic Safety Commission (Commission) held a hearing on impacts and lessons learned from the South Napa Earthquake. The mayors of the cities of American Canyon, Napa, and Vallejo, supervisors from the counties of Napa, Solano and Sonoma, and representatives of State Senator Wilke’s office, the California Governor’s Office of Emergency Services (Cal OES) and the Federal Emergency Management Agency (FEMA) were among those who testified at the hearing and identified a number of potential policy considerations and lessons emerging in the first two months following the earthquake.

The Commission subsequently engaged the Pacific Earthquake Engineering Research (PEER) Center, headquartered at the University of California—Berkeley to synthesize and analyze observations and studies resulting over the first year following the earthquake. The intent of this work has not been to develop a compendium of all information known about the South Napa Earthquake but rather to convey priority findings and recommended actions that should be addressed in advance of the next damaging earthquake in California.

As part of its work, PEER was asked to review relevant and transferable lessons from other earthquakes that have occurred in recent years. These include the Mw 7.2 El Mayor Cucapah (Baja California) earthquake of April 4, 2010, the 2010 Mw 8.8 Maule Chile earthquake and tsunami, the 2010-2011 earthquake sequence in Canterbury New Zealand, and the Mw 9.0 Great East Japan earthquake and tsunami of March 2011. Furthermore, the Commission requested that PEER also consider how scientific, engineering and technological advances of the last few decades affected emergency response and recovery following the 2014 South Napa earthquake, including (but not limited to) earthquake detection and notification, disaster damage assessment, seismic performance standards for structures and infrastructure, and recovery coordination and management.

It is important to remind ourselves that over the last two decades, California’s population has grown by over 25% to nearly 39 million⁴ and the State’s economy has tripled with the statewide gross domestic product (GDP) exceeding \$2,300 billion in 2014⁵. A great many of the state’s new residents and businesses have never experienced a major earthquake. Nonetheless, it is almost guaranteed that there will be a major damaging earthquake somewhere in the state within the next 30 years⁶. The South Napa earthquake is our “wake-up call” to renew investment and action to enhance the seismic resilience of communities, businesses, and residents across the State.

⁴ Regional Economic Analysis Project REAP, “Comparative Trends Analysis: Gross Domestic Product Growth and Change, 1987-2014 and Population Growth and Change, 1958-2014,” U.S. Regional Economic Analysis Project, (2015), <https://united-states.reaproject.org/analysis/comparative-trends-analysis/>.

⁵ Ibid.

⁶ Edward H. Field et al., “Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3)—The Time-Independent Model,” USGS Open-File Report, (2013), <http://pubs.usgs.gov/of/2013/1165/>.

Findings and Recommendations

This report’s primary purpose is to summarize the new lessons and seismic policy priorities emerging for the M_w 6.0 South Napa earthquake of August 24, 2014 and to identify existing earthquake preparedness, response, and mitigation policies and practices that may need to be improved or revised based on observations from this earthquake—one of the first to inflict damage on a major metropolitan area in the State of California in over two decades. The findings and recommendations are organized around the five key topical areas of Geosciences, Infrastructure, Buildings, People and Businesses, and Government and Institutions.

1. Geosciences

The M_w 6.0 earthquake occurred within the West Napa Fault zone, which is generally considered to be a relatively minor but active system of faults within the greater and seismically active San Francisco Bay Region. The earthquake originated near the eastern shore of San Pablo Bay and about 1 mile west of the main mapped surface trace of the West Napa fault system;⁷ see Figure 1. Right-lateral rupture propagated mostly northward along the fault zone and up the western edge of Napa Valley, directing the strongest shaking toward the City of Napa. Peak ground accelerations (PGAs) of over 50%g were recorded in and near Napa Valley.⁸ Post-event analyses of ground motion recordings have also shown evidence of a short-duration, near-fault velocity “pulse” occurring in the Napa Valley.⁹ The deep sedimentary basin in the Napa Valley and the alluvial flood deposits in downtown Napa amplified the ground motions.¹⁰

The earthquake did not produce much liquefaction, landsliding or other ground failures, even in areas previously identified as susceptible to ground failure.¹¹ This may partly reflect the low groundwater table caused by drought and late summer timing as well as the short duration of strong shaking.¹² There have also been relatively few aftershocks—an anomaly for earthquakes of this size.¹³

⁷ T.M. Brocher et al., “The Mw6.0 24 August 2014 South Napa Earthquake,” *Seismological Research Letters* 86, no. 2A (April 2015): 309–26, doi:10.1785/0220150004.

⁸ A.S. Baltay and J. Boatwright, “Ground-Motion Observations of the 2014 South Napa Earthquake,” *Seismological Research Letters* 86, no. 2A (April 2015): 355–60, doi:10.1785/0220140232.

⁹ Jonathan Bray et al., eds., “Geotechnical Engineering Reconnaissance of the August 24, 2014 M6 South Napa Earthquake, GEER Report GEER-037” (Geotechnical Extreme Event Reconnaissance Association, January 8, 2015), http://www.geerassociation.org/GEER_Post%20EQ%20Reports/SouthNapa_2014/index.html.

¹⁰ Brocher et al., “The Mw6.0 24 August 2014 South Napa Earthquake.”

¹¹ Bray et al., “Geotechnical Engineering Reconnaissance of the August 24, 2014 M6 South Napa Earthquake, GEER Report GEER-037.”

¹² Brocher et al., “The Mw6.0 24 August 2014 South Napa Earthquake.”

¹³ Ibid.

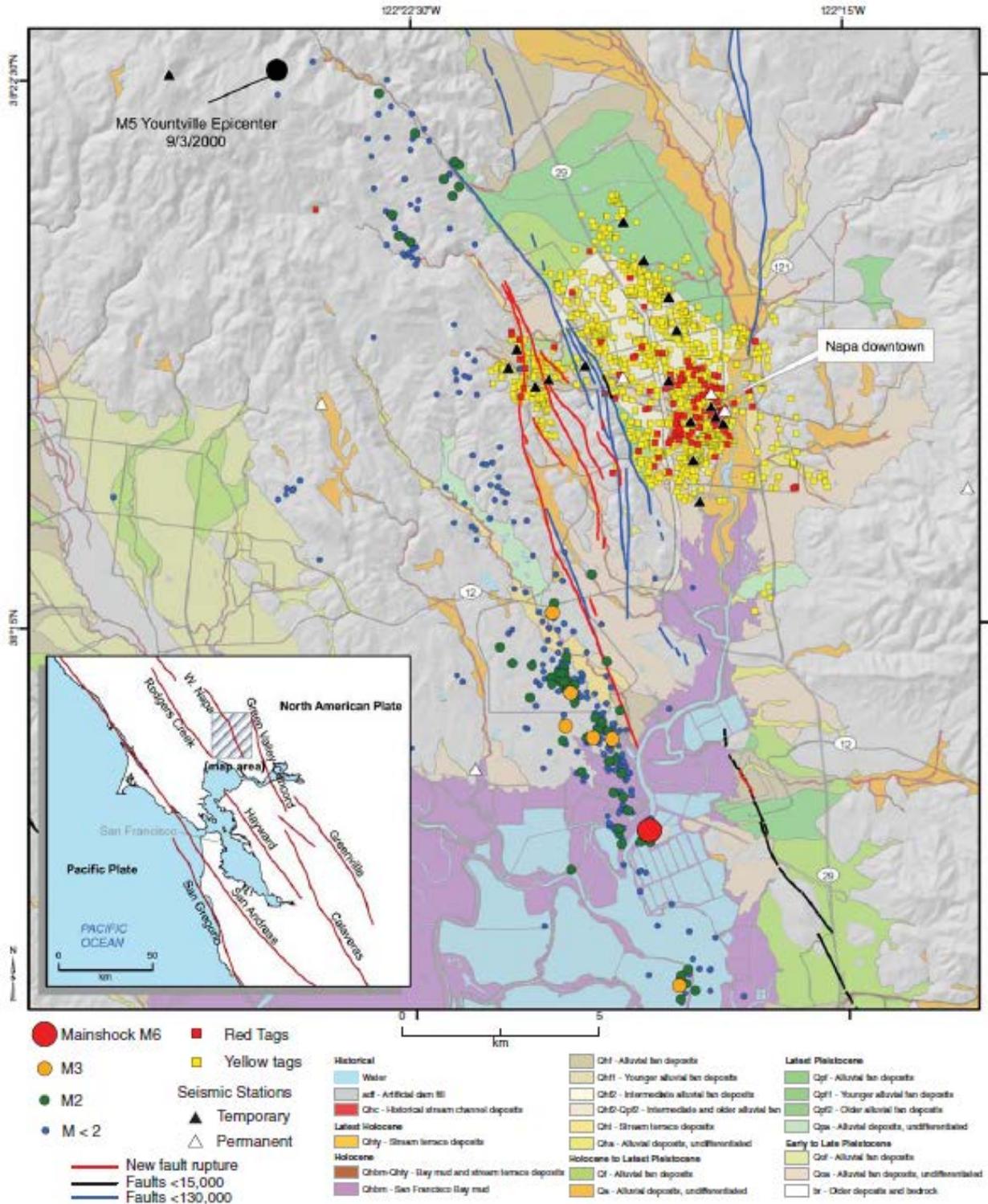


Figure 1. Locations of the mainshock (red dot), aftershocks, surface ruptures (red lines), and locations of permanent (unfilled triangles) and temporary (filled triangles) seismic stations. Locations of red- and yellow-tagged structures are from Boatwright et al. (2015). Surficial geology is from Witter et al. (2006). The inset map shows the location of the major strike-slip faults in the San Francisco Bay area. Source: Brocher et al, 2015

The M6.0 earthquake did produce an unusually large amount of surface rupture, co-seismic displacement, and afterslip.¹⁴ Average co-seismic displacements of 20 inches (50 centimeters (cm)) occurred along up to 9.3 miles (15 kilometers (km)) of the northward surface rupture and another 1.25 miles (2 km) of surface rupture occurred to the southeast in American Canyon.¹⁵ In the first three months following the earthquake, up to 14 inches (35 cm) of afterslip occurred along some portions of the fault and afterslip is forecast to continue for many months or possibly years.¹⁶

Finding 1.1: The South Napa Earthquake is the first earthquake to produce significant surface rupture in Northern California since 1906, and the first surface fault rupture to impact housing in the 40 years of the Alquist-Priolo Earthquake Fault Zoning Act. Pre-earthquake investigations of the West Napa Fault Zone had deemed that a short 5-mile (8 km) segment extending south from the Napa County Airport was sufficiently active and well-defined to be included as an Alquist-Priolo Earthquake Fault Zone. However, nearly all of the 2014 surface rupture occurred northward of the mapped A-P zone—either on fault traces within the West Napa Fault Zone that had not been deemed sufficiently active (within the last 11,000 years) or where no faults had previously been mapped.

The California Geological Survey (CGS) was conducting additional studies on the West Napa Fault Zone when the South Napa Earthquake struck. CGS is now working to include all those traces that had surface rupture in the 2014 earthquake as Alquist-Priolo Earthquake Fault Zones. At the same time, repairs and reconstruction of structures impacted by the 2014 surface rupture are proceeding. The City of Napa has required site-specific geologic investigations before issuing repair permits. It has also been advising that new structural foundations be located away from the fault, when feasible, or it is requiring much stronger, enhanced foundations that can survive some movement.¹⁷

CGS is working to prioritize and complete Earthquake Fault Zone mapping across the state with increased funding in the State's FY2014-15 and subsequent budgets.

Finding 1.2: Afterslip on the West Napa fault following the 2014 earthquake produced further damage and necessitated a regional-scale geologic investigation, on-going monitoring, and technical guidance for federal, state and local governments, utilities, and property owners to better characterize both the short- and long-term risks for buildings and infrastructure due to afterslip.¹⁸ Within the first week following the South Napa earthquake, a multi-agency, state-federal, cost-sharing agreement was reached to acquire airborne LiDAR of the affected region which was utilized by state and federal agencies to assess ground deformation and its potential impacts and risks to buildings and infrastructure in the most critical areas of interest but sufficient funding was not available to

¹⁴ Ibid.

¹⁵ Bray et al., "Geotechnical Engineering Reconnaissance of the August 24, 2014 M6 South Napa Earthquake, GEER Report GEER-037."

¹⁶ K.W. Hudnut et al., "Key Recovery Factors for the August 24, 2014, South Napa Earthquake," Open-File Report (Ontario, CA: U.S. Geological Survey, October 1, 2014), <http://pubs.usgs.gov/of/2014/1249/>.

¹⁷ Rong-Gong Lin II and Rosanna Xia, "Napa's Surprise Fault Line Triggers Earthquake Study of the Region," *Los Angeles Times*, December 26, 2014, <http://www.latimes.com/local/california/la-me-quake-napa-fault-20141226-story.html>.

¹⁸ Hudnut et al., "Key Recovery Factors for the August 24, 2014, South Napa Earthquake."

complete a comprehensive survey of the region. Following the 2010-2011 Canterbury earthquake sequence in New Zealand, liquefaction, rockfalls, and other ground failures across the metropolitan region necessitated large-scale geologic investigations, funded by the national government, to better characterize future risks and mitigation options for buildings and infrastructure in these areas.¹⁹

Finding 1.3: The South Napa earthquake identified some critical gaps in mapping coverage and guidance that affect the abilities of city, county and state agencies to identify and map seismic hazard zones and mitigate seismic hazards to protect public health and safety in accordance with the provisions of the Seismic Hazard Mapping Act of 1990. In the San Francisco Bay Area, CGS has prepared State seismic hazard zone maps for liquefaction and earthquake-induced landslide hazards in San Francisco and parts of Alameda, Santa Clara, and San Mateo counties. Gaps remain in portions of Alameda, Santa Clara, Marin, Sonoma, Napa, and Solano counties. Hazard zone maps for tsunami and seiche (also called for by the Act when appropriate hazard information and funding are available) have not yet been developed. CGS is in the process of developing appropriate information that will make it possible to map tsunami hazards across the state in the near future.

The Seismic Hazard Mapping Act recommends that the criteria for delineating State seismic hazard zones be updated as, and when, the understanding of seismic phenomena and the methods used to assess their likelihood and potential impacts on the built environment improve. The last update of this publication was conducted in 2004. The State’s guidance for the site-specific investigations and analysis of hazards, mitigation of hazards, and review of site-specific investigation reports for State seismic hazard zones was last updated in 2008.

Finding 1.4: Investments in strong motion instrumentation and earthquake alerting systems, applications of advance remote sensing techniques such as Light Detection and Ranging (LIDAR), and activation of the California Earthquake Clearinghouse all were demonstrably valuable in assisting damage assessment and emergency response, even following this more moderate 6.0 earthquake.

The prototype earthquake early warning system developed by the U.S. Geological Survey (USGS), University of California–Berkeley (UC Berkeley), Caltech and partners successfully delivered the first ShakeAlert to prototype users in Berkeley and San Francisco in 5.1 seconds after the earthquake’s origination, providing about 10 seconds of warning prior to the onset of the strongest shaking at those locations (intensity IV).²⁰ The first location, magnitude, focal mechanism, and ShakeMap ground shaking intensity map were reported four minutes after the earthquake’s origin, and this data was then used to produce the first ShakeCast estimates of infrastructure fragility for the California Department of Transportation (Caltrans) to use in prioritizing infrastructure investigations within 11 minutes and the first Prompt Assessment of Global Earthquakes for Response (PAGER) alert of probable fatalities and economic loss 13 minutes after the earthquake.²¹ ShakeMap and other

¹⁹ Nick Rogers et al., “Geotechnical Aspects of Disaster Recovery Planning in Residential Christchurch and Surrounding Districts Affected by Liquefaction,” *Earthquake Spectra* 30, no. 1 (February 2014): 493–512, doi:<http://dx.doi.org/10.1193/021513EQS029M>.

²⁰ Brocher et al., “The Mw6.0 24 August 2014 South Napa Earthquake.”

²¹ Ibid.

earthquake information products were updated as additional strong-motion recordings were retrieved. Within 12 hours of the earthquake, the California Earthquake Clearinghouse was physically established at a Caltrans facility in Napa and it provided logistics support to early post-earthquake investigations including obtaining access to restricted areas, coordinating overflights, LiDAR and field surveys of fault surface rupture, ground deformation and building and infrastructure impacts, and linking investigators with agencies and organizations responsible for emergency response and recovery.²²

²² A. Rosinski et al., “California Earthquake Clearinghouse After-Action Report: South Napa Earthquake” (California Geological Survey and Earthquake Engineering Research Institute, April 17, 2015), http://www.eqclearinghouse.org/2014-08-24-south-napa/files/2015/04/California_Earthquake_Clearinghouse_After_Action_Report-South_Napa_Earthquake-2015.04.17.pdf.

2. Infrastructure

Many regional rail, air and road-based transportation systems initially shutdown for safety inspections but most resumed service shortly with little to no substantial damage. Otherwise, most of the service disruptions and damage to infrastructure systems caused by the 2014 South Napa earthquake were confined to portions of Napa, Solano and Sonoma Counties. Mutual aid in making repairs and restoring system services were provided through the mutual aid systems of the California Utilities Emergency Association (CUEA) and Pacific Gas & Electric (PG&E)²³, and the California Water/Wastewater Agency Response Network (CalWARN)²⁴.

Power outages affected approximately 76,000 customers.²⁵ Downed wires and subsequent wire-to-wire contact in the distribution system caused most of the outages. The peak customer outage period occurred around 3.75 hours after the earthquake and over 99% of customers had power restored within 26 hours.²⁷ Power outages also had cascading impacts on other infrastructure systems. Telecommunications system outages were linked in large part to power outages which impacted service equipment and cell towers.

The main causes of physical damage to infrastructure systems were surface fault rupture and ground shaking effects on older and less ductile system components. For example, all of the 11 sewer main breaks in the Napa Sanitation District system occurred in brittle asbestos cement pipe and most were near the fault.²⁸ The City of Napa's water system was one of the most damaged infrastructure systems, with 241 water leaks reported in the six months following the earthquake.²⁹ A seismically-unanchored 67-foot diameter steel tank located near the fault rupture—one of 12 holding tanks in the city's water distribution network—also sustained significant damage and all the water drained out due to a nearby pipe break.³⁰ Approximately three-quarters of the water main breaks were in old cast iron pipe.³¹ Roads, highways and two natural gas transmission pipelines serving the northern Bay Area were also impacted by surface rupture and afterslip in the West Napa fault zone.³²

While the Napa Sanitation District's wastewater treatment operations performed quite well in the earthquake, the system was subsequently disrupted for two days due to an inflow of considerable

²³ California Governor's Office of Emergency Services Cal OES, "After Action Report: 2104-08-24 Napa Earthquake, Executive Summary" (California Governor's Office of Emergency Services, 2015), <http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/16%20Napa%20Earthquake%202014%20Executive%20Summary.pdf>.

²⁴ Earthquake Engineering Research Institute EERI, "EERI Special Earthquake Report, M6.0 South Napa Earthquake of August 24, 2014," October 2014, <http://www.eqclearinghouse.org/2014-08-24-south-napa/preliminary-reports/>.

²⁵ This is about 1.4% of the 5.1 million customers in Pacific Gas & Electric's regional electric system.

²⁶ John Eiding, ed., "South Napa M 6.0 Earthquake of August 24, 2014" (G&E Engineering Systems, March 17, 2015), <http://www.geengineering.com/ewExternalFiles/NAPA%202014%20Rev%201.pdf>.

²⁷ Ibid.

²⁸ EERI, "EERI Special Earthquake Report, M6.0 South Napa Earthquake of August 24, 2014."

²⁹ Eiding, "South Napa M 6.0 Earthquake of August 24, 2014."

³⁰ EERI, "EERI Special Earthquake Report, M6.0 South Napa Earthquake of August 24, 2014."

³¹ Ibid.

³² Eiding, "South Napa M 6.0 Earthquake of August 24, 2014."

quantities of wine spilled from damaged barrels. The wine's acidity disrupted normal anaerobic bacterial processes in the treatment plant's digester; remediation that involved blowing air into the digester took 24 hours to complete.³³ No untreated water or solids were released.

Finding 2.1: The 2014 South Napa earthquake demonstrated the long-term benefits of the \$12 billion state highway bridge earthquake strengthening program which has screened and retrofitted (as needed) more than 2,200 structures statewide to prevent collapse during future earthquakes. Prior to August 2014, all 412 State-owned highway bridges in Solano, Napa, and Sonoma Counties had been screened and 54 bridges had been retrofitted.³⁴ All State bridge retrofits performed well and were able to carry traffic after the 2014 earthquake. The 33-span Napa River Bridge on Route 37 was extensively retrofitted in 1996 after suffering damage in the 1989 Loma Prieta earthquake; no serious damage occurred in the 2014 earthquake and it was reopened to traffic shortly after inspection.³⁵ Also as a more specific comparison, the State-owned Sonoma Creek Bridge which had a substructure retrofit in 1999 had no damage while the nearby Napa Slough Bridge (a similar bridge without a substructure retrofit) had serious damage to the pile extensions.³⁶ New bridges, including the new Carquinez Bridge, which registered high peak ground accelerations at its base³⁷, also performed well.

Finding 2.2: The South Napa earthquake highlighted the vulnerability of natural gas transmission and distributions systems to earthquake-related ground failures. While the earthquake did not break any gas lines, Pacific Gas & Electric Company (PG&E) has accelerated its gas pipeline replacement program in the area—work that wasn't planned for another three to five years.³⁸ Following the August 24th earthquake, PG&E temporarily decommissioned and replaced about 7,000 feet of one of the major natural gas transmission pipelines that serves the northern San Francisco Bay Area and traverses the south end of the West Napa fault zone.³⁹ It also installed 7,600 feet of new gas distribution lines serving approximately 150 homes in the Browns Valley neighborhood and other rural areas near the fault zone.⁴⁰

Finding 2.3: The South Napa earthquake highlighted the vulnerability of water and wastewater systems to earthquake related ground failures, the additional fire hazards that earthquake-related water system failures can pose, and the fiscal challenges that public agencies face in improving the seismic resiliency of these systems, both pre- and post-earthquake. The City of Napa's water system sustained more than \$6.4 million in damage from the August 24, 2014 earthquake, subsequent

³³ EERI, "EERI Special Earthquake Report, M6.0 South Napa Earthquake of August 24, 2014."

³⁴ California Department of Transportation Caltrans, "Bridge Investigation Team Report for the August 24, 2014 South Napa Earthquake," n.d.

³⁵ EERI, "EERI Special Earthquake Report, M6.0 South Napa Earthquake of August 24, 2014."

³⁶ Caltrans, "Bridge Investigation Team Report for the August 24, 2014 South Napa Earthquake."

³⁷ The high frequency instrumented motions are believed to have been caused by motions of the bridge, and were not a true representation of the free field ground motions. Ibid.

³⁸ Noel Brinkerhoff, "PG&E Expands Post-Quake Gas Line Replacement," *Napa Valley Register*, October 16, 2014, http://napavalleyregister.com/news/local/pg-e-expands-post-quake-gas-line-replacement/article_1282c27f-5e97-5fef-9f2d-dod4d39b79a6.html.

³⁹ Eidinger, "South Napa M 6.0 Earthquake of August 24, 2014."

⁴⁰ Brinkerhoff, "PG&E Expands Post-Quake Gas Line Replacement."

aftershocks and ground settlement.⁴¹ In the immediate response period, the City of Napa continued pushing water through the damaged system to maintain fire-fighting and other critical functionality.⁴² This resulted in an estimated total loss of 100 acre-feet of water (about 7% of monthly water usage)⁴³ but water was available for firefighting at all but one of the nine post-earthquakes.⁴⁴ The city spent \$860,000 making emergency water system repairs in the first week following the earthquake. Assistance was provided through CalWARN by crews from other local water and wastewater agencies in the San Francisco Bay Area. On-going afterslip and ground settlement have caused multiple ruptures in certain areas.⁴⁵ The city appealed to FEMA to fund full replacement rather than repairs at 17 sites since “the system is not in the same condition as it was before”.⁴⁶

⁴¹ City of Napa, “Update on 2014 South Napa Earthquake Recovery,” April 21, 2015, <http://www.napa-ca.gov/sirepub/pubmtgframe.aspx?meetid=274&doctype=agenda>.

⁴² SPA Risk LLC, “24 August 2014 South Napa Mw 6 Earthquake - Reconnaissance Report,” September 26, 2014.

⁴³ City of Napa, “City of Napa Drought Response Water Use vs. Base Year 2013” (City of Napa Public Works Department, October 2015), <http://www.cityofnapa.org/images/publicworks/Water/Conservation/Progress%20October%202015.pdf>.

⁴⁴ SPA Risk LLC, “24 August 2014 South Napa Mw 6 Earthquake - Reconnaissance Report.”

⁴⁵ Howard Yune, “City Seeks \$12 Million in Aid for Quake Repairs,” *Napa Valley Register*, April 22, 2015, http://napavalleyregister.com/news/local/city-seeks-million-in-aid-for-quake-repairs/article_30648155-8403-5010-bfbf-a81ca9cd9e97.html.

⁴⁶ Ibid.

3. Structures

Building damage in the 2014 South Napa earthquake correlates in great part with the pattern of ground shaking intensities; building age and the depth to bedrock also intensified building damage.⁴⁷ The vast majority of building damage occurred in the City of Napa and was densely concentrated (more than 100 red- or yellow-tagged structures per square kilometer (about 245 acres)) in a 1.5-mile wide by 1-mile long kidney-shaped area that extends to the northwest and southwest of the Napa's downtown; see Figure 1. This part of the city is older—much of it developed before 1950—and also resides atop a deep basin of sedimentary deposits more than 0.6 miles (1,000 meters) thick. In downtown Napa, city officials worked with private property owners to secure structures and install scaffolding and fencing barricades to prevent further damage and associated hazards.

In many respects, the South Napa earthquake offers a valuable accounting of the current state of earthquake structural resilience in California. Within the diverse inventory of structures subjected to moderately strong ground motions, there is strong evidence of the effectiveness of decades of improvements in seismic code provisions, as well as key legislation like the 1933 Field Act for school seismic safety, 1972 Hospital Seismic Safety Act, and the 1986 unreinforced masonry (URM) law. Relatively modern structures (built according to 1998 or later editions of the *California Building Standards Code*) had little to no structural damage, all of which was generally repairable.⁴⁸

Within the inventory, however, there is also strong evidence of important gaps. Even in this more moderate seismic event, some older structures (built without modern seismic design requirements) sustained serious life-threatening structural and nonstructural damage, and a significant cohort of more modern buildings sustained extensive nonstructural damage.⁴⁹ While most of the damage has been repairable, a few buildings have been closed for more than a year now. In some instances, the damage levels are so great that the buildings have been uninhabitable while being repaired and a few may even be uneconomic to repair. It is a sobering reminder that the code emphasis on ductility and protecting life safety does not necessarily ensure community resilience even in moderately strong earthquakes. Furthermore, post-earthquake investigations have also cautioned that the near-fault velocity pulses observed in the ground motion records might have had an even greater impact on Napa's building stock if it had included taller and more flexible structures.⁵⁰

Finding 3.1: The South Napa earthquake helped to identify some important gaps in building safety evaluations and procedures to barricade unsafe areas that should be addressed statewide before the next major earthquakes strikes. Building safety evaluations were conducted by local building department staff along with volunteers, mutual aid, and state personnel following the general

⁴⁷ J. Boatwright et al., "The Distribution of Red and Yellow Tags in the City of Napa," *Seismological Research Letters* 86, no. 2A (April 2015): 361–68, doi:0.1785/0220140234.

⁴⁸ Applied Technology Council ATC, "Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake" (Federal Emergency Management Agency, February 2015), <https://www.fema.gov/media-library/assets/documents/103966>.

⁴⁹ Ibid.

⁵⁰ Ibid.

procedures of ATC-20-1 *Field Manual: Postearthquake Safety Evaluation of Buildings* (2005).⁵¹ Using the state's Standardized Emergency Management System (SEMS) protocol, requests for assistance were made to Cal OES by Napa County for the cities of American Canyon and Napa, and the County itself, and Solano County for the City of Vallejo and the County itself. Sonoma County did not request assistance. Safety evaluations for healthcare facilities were managed by the Office of Statewide Health Planning and Development (OSHPD) and mobile home inspections were managed by the State Department of Housing and Community Development (HCD). The Napa Valley Unified School District used its own team and did not request assistance from the State Architect or Cal OES. Local officials worked with private property owners to secure buildings and install fencing and other barricades both to prevent further damage as well as injuries.

Potential guidance needs raised by assessments of the 2014 South Napa earthquake safety evaluation processes⁵² include: challenges faced by smaller jurisdictions with limited staff and training; formal authorization of the postearthquake safety evaluation process (recommended ordinance language); developing a plan for the orderly assignment of evaluation personnel and quality assurance; consistent use and communication of placard terminology; consistency in safety evaluations, re-evaluations and placard placement on a structure; and best practices for evaluation data management, integration and communication.

Requirements in California Building Code Chapter 33, Safeguards During Construction, apply only to stable buildings under construction and not unstable, damaged buildings. Potential guidance needs raised by assessments of the building stabilization, barricading and stabilization efforts following the 2014 South Napa earthquake⁵³ include: insufficient setbacks in barricades around damaged buildings including sidewalks, streets, and adjacent structures; and varying unengineered and unanchored approaches to scaffolding around a building.

Finding 3.2: The City of Napa's program to seismically retrofit unreinforced masonry buildings was successful in reducing damage and the risk to life safety posed by URM buildings. FEMA funded a post-earthquake evaluation of 68 buildings located within a 1,000 foot radius of a ground motion recording station in downtown Napa (station N016 located on Main Street).⁵⁴ Within that group, there were twenty-eight (28) URM buildings, of which 20 had been seismically strengthened, seven had not, and one's condition was unknown. Of the retrofitted buildings, 16 (80%) buildings sustained only minor to no structural damage and four (20%) sustained moderate to heavy damage; comparatively, five (70%) of the seven unretrofitted URM buildings were posted UNSAFE or RESTRICTED USE. The study also found that a variety of retrofit approaches were used, with partial retrofits less successful in limiting damage compared to more comprehensive upgrades.

⁵¹ Applied Technology Council ATC, "Field Manual: Postearthquake Safety Evaluation of Buildings," 2nd Edition (Applied Technology Council, 2005).

⁵² ATC, "Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake"; City of Napa, "South Napa Earthquake After Action Report" (City of Napa Fire Department, May 22, 2015), <http://cityofnapa.org/images/fire/documents/NapaCITYearthquakeAAR.pdf>.

⁵³ ATC, "Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake."

⁵⁴ Ibid.

While no URMs collapsed in the 2014 Earthquake, there were masonry, parapet and wall-related collapses onto streets, sidewalks and even other buildings. Stone masonry walls and parapets were more likely to sustain damage than those made of brick masonry.⁵⁵ Life loss and injuries could have been much higher if the earthquake had occurred at a busier time of day with more people in and around vulnerable URM buildings. Thirty-nine (39) fatalities were caused by URM building damage in the February 22, 2011 earthquake in Christchurch, New Zealand.⁵⁶ Subsequent analyses of URM building damage in Christchurch also found that earthquake-strengthened URM buildings sustained much less damage than URMs that had not been retrofitted or only had partial retrofits.⁵⁷

Finding 3.3: While modern buildings generally met or exceeded code performance standards in the M6.0 earthquake, damage to non-structural components was the greatest contributor to property losses. Nonstructural components include architectural, mechanical, electrical and plumbing systems as well as building contents. Damage to sprinkler system piping and heads resulted in major interior building damage and flooding. There were also significant and widespread nonstructural component failures in the detailing for story drift that also impacted exterior cladding, glazing, and interior partitions, as well as suspended ceiling, ceiling lighting, and rooftop piping and conduits.⁵⁸ In some cases, the collapse of interior partitions, ceiling lighting, and interior furnishings and equipment blocked doorways and egress routes. The level of non-structural damage in some commercial buildings, winery and manufacturing facilities, public and private schools, healthcare facilities and government buildings was extensive and resulted in building closures and costly repairs. The damage could have been life threatening if some buildings had been occupied at the time of the earthquake.

Finding 3.4: There was generally good performance across a range of wood-frame residential construction vintages and styles; the vast majority of damage was caused by two well-known seismic deficiencies of unbraced chimneys and cripple walls foundations. Many unreinforced masonry chimneys of varying ages and styles failed, sometimes causing significant collapse hazards by falling onto exterior areas or into the interiors of homes. To assist homeowners and localities, FEMA funded the development of a recovery advisory on the *Repair of Earthquake-Damaged Masonry Fireplace Chimneys, FEMA DR-4193-RA1* (2015).⁵⁹ Many homes with unbraced cripple walls suffered large horizontal displacements and were even jolted off their foundations. The 2012 edition of the International Existing Building Code provides guidance on retrofitting cripple walls four feet or less in

⁵⁵ Ibid.

⁵⁶ Lisa Moon et al., “The Demise of the URM Building Stock in Christchurch during the 2010–2011 Canterbury Earthquake Sequence,” *Earthquake Spectra* 30, no. 1 (February 1, 2014): 253–76, doi:10.1193/022113EQSo44M.

⁵⁷ Ibid.

⁵⁸ ATC, “Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake.”

⁵⁹ Federal Emergency Management Agency FEMA, “Repair of Earthquake-Damaged Masonry Fireplace Chimneys,” FEMA Recovery Advisory (Washington, D.C.: Federal Emergency Management Agency, February 1, 2015), <https://www.fema.gov/media-library-data/1439241984631-3b4c44f900c8893449327foe764ef849/FEMAP-1024RA1.pdf>.

height. FEMA funded a recovery advisory on Earthquake Strengthening of Cripple Walls in Wood-Frame Buildings, FEMA DR-4191-RA2 (2015)⁶⁰ to advise on retrofitting taller cripple walls.

Fault rupture and afterslip associated with the South Napa earthquake affected residential construction for the first time in California since the 1971 San Fernando earthquake. Recommendations to improve fault mapping, land use planning and mitigation approaches for both new and existing structures and infrastructure is discussed in the Geoscience section of this report.

Following the South Napa earthquake, the California Earthquake Authority (CEA) conducted an online survey of Napa city residents to document how their homes performed in the earthquake; 633 residents responded.⁶¹ Of these 28% reported chimney damage and 15% reported that their home had been yellow- or red-tagged. Older houses (built pre-1950) experienced higher rates of tagging and more severe types of damage than newer homes. Only 12% of respondents reported that their homes had been retrofitted before the Napa earthquake. Of those respondents with homes that were not retrofitted, More than half expressed interest in retrofitting their property but were “confused about what’s involved” (39%) or “want to but it's too expensive” (46%).

Finding 3.5: The significant damage to manufactured housing in the August 24, 2014 South Napa earthquake was almost exclusively associated with support systems rather than the homes themselves. Similar damage causes were observed in past California earthquakes, including the 1994 Northridge and 2003 San Simeon earthquakes.⁶² Since the 1994 Northridge earthquake, wind tie-down systems (referred to as ETS) are required on all newly installed or relocated manufactured homes in the state. Since the early 1980s, the *California Code of Regulations* (Title 25, Chapter 2, Article 7.5) has also specified minimum requirements for the installation of earthquake-resistant bracing systems (ERBS); but installation is voluntary, not mandatory. ETS and ERBS are the predominant types of seismic support systems in use in California; however, a significant number of manufactured homes across the state only have gravity support systems.⁶³ Post-earthquake surveys of 11 mobile home parks in the City of Napa found that the majority of manufactured homes were installed before ETS were required and few had voluntarily installed ERBS.⁶⁴

⁶⁰ Federal Emergency Management Agency FEMA, “Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings,” FEMA Recovery Advisory (Washington, D.C.: Federal Emergency Management Agency, April 2015), <https://www.fema.gov/media-library-data/1439242021425-3b4c44f900c8893449327foe764ef849/FEMAP-1024RA2.pdf>.

⁶¹ California Earthquake Authority CEA, “A Year After South Napa Earthquake, Damage Proves Widespread and Costly,” Press Release (California Earthquake Authority, August 24, 2015), http://www.earthquakeauthority.com/media/Lists/Press%20Releases/Attachments/48/Napa%20Anniversary%20Press%20Release_FINAL.docx.pdf.

⁶² ATC, “Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake.”

⁶³ Ibid.

⁶⁴ Ibid.

4. People and Businesses

The 2014 South Napa earthquake struck during the early Sunday morning hours of a busy summertime weekend. In this instance, the timing of the earthquake was fortuitous as most residents and tourists were in homes and hotel facilities, which both performed well structurally in the earthquake. They were not close to commercial, industrial and public facilities that did not withstand the ground shaking as well. As previously noted, if the earthquake had occurred at a different time when more people were in and around significantly damaged structures, casualties could have been far greater. Instead, the two reported deaths occurred from in-home injuries caused by falling objects and debris.⁶⁵ The 300 reported injuries were generally split between in-home injuries caused by falling objects and debris, and injuries sustained later during clean-up.⁶⁶

Four emergency shelters were opened in Napa and Solano Counties, two of which remained open for two weeks after the earthquake and housed 53 individuals.⁶⁷ The American Red Cross, Salvation Army, and Voluntary Organizations Active in Disaster (VOAD) supplied food and drinking water to more than 2,000 individuals.⁶⁸ A rapid household assessment of public health conducted in Napa and Solano counties shortly after the earthquake found that 20% of all surveyed households had one or more traumatic psychological exposures which were used to guide mental health resource allocations and public education efforts.⁶⁹

Individual and Household Recovery. Joint federal, state and local preliminary assessments estimated 131 homes with major damage or destroyed and 1,875 homes with minor damage.⁷⁰ The rapid household assessment of public health conducted in Napa and Solano counties estimated that 12,669 households — 42% of all Napa residences — were damaged enough to require repairs, but only 4% were significant enough that residents left their home in the week after the quake due to damage.⁷¹ They also found that 30% households expected that the financial burden of repairs would be “a little difficult,” while 10% or 3,001 households said repairs would be “very difficult” to afford.⁷² The CEA’s post-earthquake online survey of Napa city residents found that 37% percent of respondents had household damage costs over \$5,000, with 13% of those having costs over

⁶⁵ Howard Yune, “Family Makes the Case for a Second Napa Earthquake Fatality,” *Napa Valley Register*, September 24, 2014, http://napavalleyregister.com/news/local/family-makes-the-case-for-a-second-napa-earthquake-fatality/article_oed1554d-bf78-5776-82ce-e247ad7cff54.html.

⁶⁶ Attfield et al., “Injuries and Traumatic Psychological Exposures Associated with the South Napa Earthquake — California, 2014.”

⁶⁷ Governor Edmund G. Brown Jr., “Governor Brown Requests Presidential Major Disaster Declaration,” Office of Governor Edmund G. Brown Jr., (September 2, 2014), <https://www.gov.ca.gov/news.php?id=18680>.

⁶⁸ Ibid.

⁶⁹ Attfield et al., “Injuries and Traumatic Psychological Exposures Associated with the South Napa Earthquake — California, 2014”; California Department of Public Health CDPH and Napa County Public Health NCPH, “Community Assessment for Public Health Response (CASPER) Following the August 24, 2014 South Napa Earthquake, Napa and American Canyon. California - September 2014,” January 22, 2015.

⁷⁰ Cal OES, “After Action Report: 2104-08-24 Napa Earthquake, Executive Summary.”

⁷¹ Kevin Courtney, “Survey Reveals More Trauma after August Earthquake,” *Napa Valley Register*, March 16, 2015, http://napavalleyregister.com/news/local/survey-reveals-more-trauma-after-august-earthquake/article_1ba5a2be-5f85-581d-9a53-edd44eb53fb5.html.

⁷² Ibid.

\$25,000.⁷³ Forty-seven percent (47%) of the CEA's post-earthquake online survey said their house repairs took over a week to complete, including 20% with repairs still unfinished six months after the earthquake.⁷⁴

Estimates are that only as much as 6% of affected households had residential insurance coverage; numbers as low as 3% have also been offered when considering the full range of impacted residents, including renters and migrant workers.⁷⁵ But, even so, residential damage levels generally were not high enough to meet the 10% and 15% deductible requirements of the CEA residential policies.⁷⁶ As of August 2015, the CEA had paid \$3 million in claims to hundreds of CEA policyholders affected by the earthquake.⁷⁷

As of January 2016, FEMA has approved 4,265 Individual Assistance applications, providing over \$10.35 million in housing assistance and \$1 million in other needs assistance.⁷⁸ Extension of the Presidential disaster declaration to provide Individual Assistance also allowed impacted residents and businesses to apply for low-interest disaster loans through the U.S. Small Business Administration (SBA). As of August 2015, the SBA had approved \$26 million in disaster loans to help 805 homeowners.⁷⁹

In addition to insurance, FEMA Individual Assistance, and SBA loans, residents also used personal savings, refinanced and applied for a home equity or new loan for repairs, considered selling their home or relocating, and received help from a community organization.⁸⁰

The Napa Valley Vintners trade association donated \$10 million to the Napa Valley Community Foundation to create a Napa Valley Community Disaster Relief Fund to help local residents and businesses impacted by the earthquake.⁸¹ In the first year following the earthquake, the Foundation awarded an estimated \$6.4 million to 1,300 Napa County households, small businesses and nonprofits. The funds have been available for one-time immediate needs as well as short term assistance for things like temporary housing; basic needs (food, water, etc.); medical care and

⁷³ CEA, "A Year After South Napa Earthquake, Damage Proves Widespread and Costly."

⁷⁴ Ibid.

⁷⁵ "Earthquakes - Going Forward, Lessons Learned from Napa" (Sacramento, California: Assembly California Legislature, October 20, 2014), <http://assembly.ca.gov/sites/assembly.ca.gov/files/Earthquakes.pdf>.

⁷⁶ Kathleen Pender, "Quake Insurance No Big Help Because so Few Have It," *San Francisco Chronicle*, August 28, 2014, <http://www.sfgate.com/business/networth/article/Quake-insurance-no-big-help-because-so-few-have-it-5711650.php>.

⁷⁷ CEA, "A Year After South Napa Earthquake, Damage Proves Widespread and Costly."

⁷⁸ FEMA, "Financial Assistance," 201.

⁷⁹ Richard Freedman, "The Napa Earthquake -- A Year Later," *Times-Herald*, August 24, 2015, <http://www.timesheraldonline.com/general-news/20150824/the-napa-earthquake-a-year-later/1>.

⁸⁰ CEA, "A Year After South Napa Earthquake, Damage Proves Widespread and Costly."

⁸¹ Napa Valley Vintners, "Napa Valley Vintners Establishes Community Disaster Fund for Earthquake Relief," Press Release, August 27, 2014, https://napavintners.com/press/press_release_detail.asp?ID_News=600224.

counseling; and repairs to houses, businesses and churches.⁸² Yet, at the one year mark, the South Napa Earthquake Recovery Group estimated that 356 families in Napa County still faced \$3.3 million in unmet disaster-related repair costs.⁸³

The South Napa Earthquake Recovery Group is a collection of agencies including area churches, the American Red Cross, the city and county of Napa, Fair Housing Napa Valley, the Salvation Army and other nonprofits that formed in early 2015 and works to match disaster recovery resources with earthquake survivors who have long-term unmet needs. The United Methodist Committee on Relief provided a \$100,000 grant in start-up funding to the Vallejo Earthquake Recovery Group and the South Napa Earthquake Recovery Group to hire professional case managers to train and lead volunteer in assisting community members with long-term unmet financial not covered by FEMA, SBA or insurance, as well as other material and emotional needs related to the disaster.⁸⁴ By the end of 2015, the group had received over 4,000 requests for help including 46 homeowners that applied for \$10,000 housing repair grants and 39 families assisted by volunteers with smaller repairs; another 75 homes are on the waiting list.⁸⁵ The Napa Valley Community Foundation has committed \$1 million to help special needs families.⁸⁶

The cities of American Canyon, Napa, and Vallejo have also worked to expand their housing programs for low-income residents and provide limited funding for earthquake repairs. The City of Napa's Emergency Home Repair Program is for low-income owners of conventional homes, manufactured homes, condominiums and townhouses and provides grants for repairs, including windows, doors, leaking roofs, plumbing and electrical problems.

Business Recovery. Early federal, state and local preliminary assessments estimated 28 businesses with major damage and 337 businesses with minor damage.⁸⁷ This is a fairly low number in comparison to the 24,000 business establishments listed in the U.S. Census (2013)⁸⁸ for the three-county impact area. However, there were concentrated impacts in older business districts of the cities of Napa, Sonoma and Vallejo and among the region's vintners. Focused attention by City of Napa building officials and business owners helped to get 90% downtown businesses reopened within a week, and a tourist industry collaborative led an active media and social media campaign

⁸² Jennifer Huffman, "Community Foundation Planning More Earthquake Aid," *Napa Valley Register*, August 7, 2015, http://napavalleyregister.com/news/local/community-foundation-planning-more-earthquake-aid/article_5469b27c-0c9a-53b9-8117-528ab34191c8.html.

⁸³ Ibid.

⁸⁴ Rosemarie Kempton, "Efforts Continue to Help Napa Quake Victims," *Napa Valley Register*, December 28, 2015, http://napavalleyregister.com/news/local/efforts-continue-to-help-napa-quake-victims/article_e39a6b04-ac07-5446-82a6-d5d7bac64354.html.

⁸⁵ Ibid.

⁸⁶ Ibid.

⁸⁷ Cal OES, "After Action Report: 2104-08-24 Napa Earthquake, Executive Summary."

⁸⁸ U.S. Census Bureau, "2013 County Business Patterns (NAICS)," 2013, <http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl>.

that is credited with substantially increasing tourism and hotel revenues in Napa in the year following the earthquake.⁸⁹

By the one-year anniversary of the earthquake, 95% of downtown businesses were reportedly reopened, many back in historic structures that have undergone extensive seismic upgrades as part of their repair.⁹⁰ These include the historic Vintner's Collective and Napa Steam Laundry buildings. As of August 2015, the SBA had approved \$6.2 million to 92 businesses for property damage.⁹¹

Estimates of business insurance coverage have been mixed. Properties in high seismic hazard areas with commercial mortgage-backed securities loans are generally required to carry earthquake insurance or seismically strengthen the property. It has been estimated that there was \$620 million worth of commercial mortgage-backed securities loans affected by South Napa earthquake, over one-third of which were for hotel and retail properties with most loans having been issued quite recently (within 2013-2014). Thus, at least some of the new hotel and retail developments in and around Napa may have had insurance. However, the California Department of Insurance estimated that less than 5% of homeowners and businesses in the region had earthquake insurance.⁹²

There have also been a few significant business closures as owners were unable to afford the high-costs of extensive repairs, the added expense of building code upgrades, and replacing damaged stock. These include the McCaulou's department store in downtown Napa and a Safeway grocery store—leaving downtown Napa without a full-service supermarket.⁹³ Some major redevelopments are already being proposed on the former sites of earthquake-damaged businesses.

At least 120 of the Napa Valley's 500 wine production facilities reported some damage to tanks, barrels or buildings, most of it caused by the tumbling barrels.⁹⁴ Wineries reported wine losses from as little as 0.5% (bottles and some barrels) to as high as 15% (barrel stack collapse).⁹⁵ Because the earthquake occurred approximately two weeks into the autumn harvest and crush operations, many barrel stacks and tanks were not yet full, minimizing the total wine lost. The vast majority of wineries did not have earthquake insurance; it reportedly costs about three times as much as property insurance and has a high deductible—typically 15% of the total value of the property and all its contents.⁹⁶

Finding 4.1: Deaths and injuries sustained in the South Napa earthquake point to continuing gaps in public awareness and education on earthquake safety and preparedness. Public reactions during and

⁸⁹ Freedman, "The Napa Earthquake -- A Year Later."

⁹⁰ Ibid.

⁹¹ Ibid.

⁹² Brown Jr., "Governor Brown Requests Presidential Major Disaster Declaration."

⁹³ Huffman, "Top Stories of 2015, No. 1: Earthquake Aftermath."

⁹⁴ Peter Fimrite, "Small Wineries Suffer Big Losses in Napa Quake," *San Francisco Chronicle*, August 30, 2014, <http://www.sfgate.com/wine/article/Small-wineries-suffer-big-losses-in-Napa-quake-5724465.php>.

⁹⁵ ATC, "Performance of Buildings and Nonstructural Components in the 2014 South Napa Earthquake."

⁹⁶ Joel Stein, "A Quake Reminds Napa Winemakers of California's Faults," *Bloomberg Business*, August 28, 2014, <http://www.bloomberg.com/bw/articles/2014-08-28/napa-winemakers-forgo-quake-insurance-face-cleanup-costs>.

immediately following the 2014 earthquake, and the resulting deaths and injuries, illustrate the ongoing confusion or lack of knowledge about appropriate earthquake safety behavior and the relatively inexpensive household and business preparedness actions that can be undertaken, such as seismic anchoring of interior furnishings.⁹⁷ A rapid household assessment of public health conducted in Napa and Solano counties shortly after the earthquake also found that well over half of the respondents in the cities of Napa and American Canyon did not have emergency supplies.⁹⁸

Finding 4.2: Support people with Access and Functional Needs (AFN) during disasters needs greater emphasis in emergency planning.

Finding 4.3: The eight-week time delay in the federal decision as to whether the Individual Assistance program would be extended to residents of impacted areas in Napa and Solano Counties under the Presidential major disaster declaration hindered community recovery.

Finding 4.4: The Local Assistance Center established by Napa County and the City of Napa is an effective model in integrating government, insurance, and non-profit assistance for residents and should be implemented in future disasters.

Finding 4.5: The 2014 South Napa earthquake provides an opportunity to review impediments to resident and business recovery and how these might be more effectively addressed in state emergency proclamation provisions. Under the provisions of section 8571 of the California Government Code, during a state of emergency, the Governor may suspend any State statute, orders, rules, or regulations of any state agency which the Governor determines would in any way prevent, hinder, or delay the mitigation of the effects of the emergency. On September 2, 2014, Governor Brown issued Executive Order 8-24-14 which, for impacted residents and businesses, suspended State fees and requirements on replacing vital records, such as birth certificates, drivers' licenses and vehicle registration, manufactured home registrations, and eased a number of other State statutes, orders, rules, or regulations. The Executive Order also permitted the Department of Alcoholic Beverage Control the discretion to waive the 500 foot limitation and 180-day time period, as well as transfer fees, in section 24081 and 24082 of the Business and Professions Code for any businesses that have been forced to relocate as a result of the earthquake. The Department of Alcoholic Beverage Control shall further have the discretion to waive transfer fees beyond the time limitations set forth in Business and Professions Code sections 24081 and 24082. The Governor's Executive Order also included a request that the Franchise Tax Board and Board of Equalization consider using their

⁹⁷ Enhancing curricula for public and private schools on earthquake and building safety to better prepare our citizens to live safely with earthquakes and reinvigorate efforts to provide clear, concise, comprehensive, and frequent earthquake safety information to the general public were key recommendations in the Commissions' findings and recommendations from the 2003 Mw 6.5 San Simeon earthquake. California Seismic Safety Commission, "Findings and Recommendations from the San Simeon Earthquake of December 22, 2003" (California Seismic Safety Commission, May 5, 2004), http://www.seismic.ca.gov/pub/CSSC_2004-02_FindingsSanSimeonEarthquake.pdf.

⁹⁸ Attfield et al., "Injuries and Traumatic Psychological Exposures Associated with the South Napa Earthquake — California, 2014."

administrative powers to provide individuals impacted by the earthquake with extensions for any filing, or with relief from penalties and assessments, as appropriate; a Senate Bill for tax relief was approved by the Legislature and Governor in September 2015.⁹⁹ Reports of contractor licensing violations, scamming operations and resource inflation all occurred following the 2014 earthquake.

Finding 4.6: The 2014 South Napa earthquake highlights the significant gaps in earthquake insurance coverage for both homeowners and businesses and the need to improve both the affordability and terms of insurance coverage and plan for housing and business recovery funding needs ahead of a major urban earthquake in the state.

⁹⁹ Melissa Murphy, “Earthquake Relief Bill Approved by Governor,” *The Reporter*, September 2, 2015, <http://www.thereporter.com/article/NG/20150902/NEWS/150909972#>.

5. Government and Other Institutions

The earthquake resulted in wide-ranging response and recovery activities for the State, impacted counties and cities, and a host of special districts and community organizations. Many dozens more organizations and thousands of individuals supported the response; many continue to support the recovery efforts.

Local emergency proclamations were made in the cities of American Canyon, Napa, and Vallejo, and the cities of Napa and Vallejo activated their emergency operations centers (EOCs). Napa and Solano counties also proclaimed local emergencies and activated their EOCs. Sonoma County proclaimed a local emergency but did not activate its EOC. The Governor proclaimed a State of Emergency for Napa, Solano, and Sonoma counties on August 24, 2014 and Cal OES activated the State Operations Center, the coastal Regional Emergency Operations Center, and implemented the State's Emergency Operations Plan. State and local government emergency mutual aid, including firefighting, law enforcement, medical, and public health emergency responders were also deployed. On September 2, 2014 the Governor issued Executive Order B-24-14 authorizing financial assistance through the California Disaster Assistance Act to local agencies and certain nonprofit organizations. Federal major disaster declarations were granted to portions of Napa and Solano counties on September 11, 2014 (for federal Public Assistance and Hazard Mitigation to qualifying public agencies and non-governmental organizations) and on October 27, 2014 (for federal Individual Assistance).

As of January 2016, FEMA has obligated nearly \$19.33 million in Public Assistance grants to qualifying public agencies and organizations.¹⁰⁰ Of this, \$4.74 million has been awarded for emergency related work, like time and expenses for mutual aid and costs of emergency repairs to the damaged water system. As well, nearly \$13.72 million has been awarded for permanent repairs to public buildings and infrastructure.

Finding 5.1: The state's Standardized Emergency Management System (SEMS) was effective in mobilizing a multi-jurisdictional, multi-level emergency response following the August 24, 2014 earthquake. Many local emergency personnel reported that the SEMS training they received in the past was a key factor to their successful response to the earthquake. The 2014 response identified several areas for improvement for SEMS-related planning and training.¹⁰¹ The City of Napa credited their experience of managing flood disaster as helping to improve their earthquake response. This earthquake provides a good opportunity to consider how smaller jurisdictions can more effectively scale up to manage a large-scale disaster response.

Finding 5.2: The South Napa earthquake offers important lessons in emergency communication, both among first responders and with the public, to be gleaned for future training and emergency response efforts. Gaps in official notifications, training for Public Information Officers (PIOs), and the establishment of a Joint Information Center were among the issues in after action analysis of the

¹⁰⁰ FEMA, "Financial Assistance."

¹⁰¹ Cal OES, "After Action Report: 2104-08-24 Napa Earthquake, Executive Summary"; City of Napa, "South Napa Earthquake After Action Report."

earthquake response.¹⁰² The 2014 earthquake also highlighted the importance of social media and real time communication and information sharing, both in situational awareness and response operations.

Finding 5.3: The 2014 earthquake identified some important issues in the coordination of damage assessment and declaration processes for federal Public Assistance and local government assistance under the authority of the California Disaster Assistance Act that need to be addressed ahead of a major urban earthquake in the state.

Finding 5.4: Lessons on debris management from the 2014 Napa earthquake and other recent earthquakes need to be studied with guidance developed for improving debris management planning and implementation following future earthquake disasters.

Finding 5.5: The 2014 earthquake highlighted significant gaps in contingency planning at many key government and critical facility operations. The operations of many government agencies and critical community-serving facilities, such as schools and hospitals, were impacted by structural and non-structural damage. Many local agencies did not have plans or procedures to address dual operations of response and recovery-related efforts and normal day-to-day business operations simultaneously. Contingency planning requirements and training need to be strengthened and more comprehensively address personnel, records, facility safety and management.

Finding 5.6: The seismic performance standards for correctional facilities and requirements for correctional facilities in disaster response and recovery need further study. The Napa County jail suffered damage that affected the operations of the facility and compromised the safety of occupants. The County transferred 70 to 75 inmates to Solano County. Existing State law restricts transfers of inmates from a county jail only to a contiguous county—a limitation which would be difficult to meet if multiple facilities are impacted, in larger disasters or in more populous areas. The state, cities and counties should review existing plans for disaster implementation and recovery at correction facilities.

Finding 5.7: More advance planning and training for post-disaster recovery is needed at both the state and local levels. In 2014, Cal OES launched its development of the California Disaster Recovery Framework that will address the governance and structure for state agencies in coordinating and supporting disaster recovery. It is consistent with the administrative guidance provided in the National Disaster Recovery Framework developed by FEMA (2011).¹⁰³ The level of planning for post-disaster recovery by local governments throughout the state is quite varied. In particular, more emphasis is needed on planning for and managing long-term recovery.

¹⁰² Cal OES, “After Action Report: 2104-08-24 Napa Earthquake, Executive Summary”; City of Napa, “South Napa Earthquake After Action Report.”

¹⁰³ Federal Emergency Management Agency FEMA, “National Disaster Recovery Framework: Strengthening Disaster Recovery for the Nation” (Federal Emergency Management Agency, September 2011), <http://www.fema.gov/pdf/recoveryframework/ndrf.pdf>.

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