California Earthquake Authority
South Napa Home Impact Study
Phases 1 and 2 Integrated Findings Report

Executive Summary

Prepared for the California Earthquake Authority (CEA)

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Overview

This report summarizes findings of an in-depth California Earthquake Authority (CEA) research project to survey and analyze what happened to single-family dwellings and homeowners affected by the August 24, 2014 South Napa M6.0 earthquake. Through an online survey, interviews, and home inspections, a large amount of new data were collected about the characteristics of Napa area houses and the effects of the quake. In addition, a new approach to home earthquake vulnerability assessment was piloted. The results show a population widely impacted by a moderate event, and individuals who are resourceful and resilient but faced with many challenges in how to handle earthquake vulnerabilities. Insights gained about the beliefs and experiences of Napa homeowners can help CEA further improve its insurance offerings and mitigation programs, as well as advancing the state-of-the-art in earthquake retrofit performance research.

Study Objectives and Approach

The impetus for this study was to identify pre-event retrofitted houses that were affected by the 2014 Napa quake and to collect data about the extent of damage and other event impacts on local households. Multiple types of data were collected in two phases. Phase 1 involved a general population survey which invited owners of City of Napa single-family houses to share information about their homes and their experiences.

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Recruitment consisted of a short, targeted marketing campaign using door hangers, media placements, community outreach, and a $25 gift card incentive for the first 500 participants. A total of 633 eligible community members completed the online questionnaire between March 1st and 21st, 2015. Respondents answered over 50 questions covering the follow topics: house characteristics; types of damage (if any) to contents, interior and exterior; types of service disruption and durations; whether the house was retrofitted in the past and if so how; financial impacts; and recovery timeframe and actions taken. Definitions, diagrams and photos were provided to help respondents identify features of their houses as accurately as possible.

Additionally, over 300 survey participants volunteered to be contacted about participating in additional research, about 50 of which reported that their house had retrofit work done before the 2014 event.

Phase 2 recruited a subset of those volunteers to participate in in-depth interviews at their house, along with a simultaneous home inspection. This phase had both technical and social science-oriented research goals. The technical objectives were to document with more detail and accuracy the *features, vulnerabilities,* and *outcomes* of a sample of Napa area houses, particularly those with identifiable pre-event retrofit or strengthening work, and to collect information about *costs* of any repairs or subsequent retrofitting related to August 2014 damage. On the social science side, the aims were to investigate the homeowner *beliefs* about earthquake risk and why they do what they do regarding retrofitting and insurance coverage and to document the *experiences* among participating homeowners of the August 2014 event and possible influences on homeowner perceptions, intentions, and recovery behaviors.

Researchers and trained home inspectors conducted 39 site visits between March 7 and April 4, 2016. Each visit lasted one to two hours. Details on the marketing, data collection procedures, survey questions, and interview guide are available in appendices to this report.

A final objective and novel aspect of this study was piloting field use by licensed home inspectors of a relatively new home earthquake assessment methodology. The Federal Emergency Management Agency (FEMA) created an evaluation scoring system, as described in FEMA P-50 *Simplified Seismic Assessment of Detached, Single-Family, Wood-Framed Dwellings* (P-50). This method helps building professionals observe, calculate, and communicate about critical structural and location vulnerabilities of a house through a resulting earthquake hazard "grade." This relatively low cost, standardized, and accessible measure of earthquake risk could, if it can be made available for reasonable cost, be used by homeowners in making better informed purchasing and remodeling decisions.

This study provided an avenue to observe and get feedback from four professional home inspectors, not only to evaluate the form's use in the field, but also to document the characteristics of some of the houses in this study with more certainty.

Data from all sources was compiled and analyzed using Excel and SPSS statistical software to arrive at counts, assess co-occurrence of traits and outcomes, and interpret the qualitative

information and narratives presented by homeowner participants. Products of the research include this final report that integrates findings from both phases and provide recommendations, several re-usable research instruments provided in the appendices, multiple data sets with the survey and interview responses, and the individual photos and aggregate P-50 inspection information about houses in Phase 2. The research protocol and these materials can serve as a model for future studies of this type by CEA.

Survey Findings

House Characteristics and Damage Experiences

Houses with a wide range of characteristics were represented in the study. Although not a random sample, self-reported house features were consistent with US Census data about typical housing characteristics in the Napa area. Modest sized, pre-1960 wood frame houses with a standard height cripple wall and stucco exterior predominated. Raised perimeter concrete was the most reported foundation type (58%). Most respondents said they have one or more garages (91%), with some having very large garages (three or more cars) and a fraction had living spaces above the garage (14%). About two thirds of the houses had chimneys (67%), about half of which were described as masonry.

Survey findings echo results of other studies of the South Napa quake in showing widespread life interruption for local homeowners, with severe and long lasting effects on a significant subset. Only nine percent reported experiencing little to no damage, and a majority faced some monetary impacts of a thousand dollars or more and time consuming clean-up of toppled or broken contents.

Homeowners described many different of types of damage. Most notable was non-structural damage (e.g., contents, minor wall cracking), with over half experiencing things like broken or violently displaced furniture, broken bottles and household items, or falling objects. Over half of respondents mentioned internal wall cracks. Thirty-nine injuries were reported, primarily from broken glass on the floor.

The era built stood out as the house characteristics most associated with worse outcomes. Pre-1950 houses experienced damage at higher rates than newer houses, particularly to chimneys and outside wall surfaces. About half of the pre-1950 houses in the survey reported having chimney damage. Almost one out of three houses built before 1950 received a yellow or red tag from a city building department housing inspection, indicating a potential entry or exit safety hazard. Among houses built pre-1950, one out of four homeowners (37/144) said total repairs exceeded $25,000.

In terms of utilities disruption, 94% of survey respondents said they had some loss of services, including electricity (78%), land line phone and internet (27%), gas supply (27%), or water (23%). For the most part, these impacts were short lived. In more than half of the houses, services were running again after one to three days.

In contrast, many respondents spent a substantial amount of time on clean-up and repairs. Just under half of survey respondents (48%) said these activities took over a week, and twenty percent said important repairs were still not finished seven months later.

Homeowners also faced challenges in coping, making decisions and trying to carry out repairs, which contributed to these sometimes lengthy recovery timelines. About half of respondents sought assistance information or recovery help, including calling or visiting a FEMA center or applying for a Small Business Administration (SBA) loan. Many commented on the shock and trauma they felt after going through this event. Thirteen percent reported considering selling or relocating, including owners of houses that had no damage or were already retrofitted. About 24% sought information about strengthening their house to avoid future damage, again also people who own retrofitted houses.

Overall, the survey findings demonstrate how costly and time consuming it can be to handle the damage as well as painful life disruption that can happen in a relatively moderate local quake. It also documented a high proportion of un-retrofitted houses with features linked to higher vulnerability. This reality of reality was not in the minds of most Napa homeowners prior to this event. It is likely that many Californians are in the same position.

Retrofit Prevalence and Performance

In the survey, about one in ten Napa homes had earthquake upgrades done prior to the 2014 quake. The most frequently reported types of retrofit work in the survey were anchoring (bolting), chimney removal, and addition of plywood or Oriented Strand Board (OSB) to the "basement" or cripple walls.

Unfortunately for the study aims, 29% of survey respondents skipped the retrofit status question entirely or answered 'Do Not Know', suggesting that numerous owners lack information about the earthquake vulnerabilities of their homes. Even among participating homeowners that *did* think their house was retrofitted, many were only able to share vague and unconfident descriptions about what had been done previously and when. This led to questions about how well homeowners were able to self-identify their house's retrofit status, which limited the opportunity to investigate retrofit performance in this study.

Through the approach of community-based research, this study was able to identify a number of pre-event retrofitted single-family homes that had little to no damage; these are retrofit success stories from the 2014 Napa event. Successful retrofits – those that reduce damage from

what would have occurred otherwise -- are harder to detect than tragedies, which are more visible and salient. Social norms may even encourage those who fair better than others to keep quiet on the sidelines while those more in need are cared for. Several homeowners in this study were motivated to do retrofit work in the 2000s after the Napa area experienced another significant quake in 2000, but didn't want to sound boastful.

Positive outcomes among retrofitted houses were not universal, however. Results were mixed, but retrofitted houses experienced worse outcomes in aggregate for a number of outcome variables. For instance, retrofitted properties had a higher rate of yellow tagging (21%), compared to fourteen percent among non-retrofitted properties and about fifteen percent of all houses for which retrofit status was reported. Among the 312 houses of known retrofit status with one or more chimneys, the 38 retrofitted properties with chimneys had higher rates of experiencing chimney damage. Four times the rate of retrofitted properties compared to retrofitted ones had a porch slip sideways. The only property in the study with a porch roof collapse had been retrofit previously.

Despite these observations, it is inappropriate to conclude that retrofitted properties performed worse than other non-retrofitted ones in the Napa area in the 2014 event. A large number of factors could have contributed to these counterintuitive results. The first issue is that the survey, and especially the interview data subset, are not random samples. There might have been self-selection into the study by owners of properties that performed relatively worse (than others in the community) because these owners especially wanted to tell their story.

Another issue, potentially exacerbated in a non-random sample, would be any undocumented dissimilarities between non-retrofitted and retrofitted houses that also relate to earthquake performance. Data was collected about some factors such as age, cripple wall height and exterior materials. However, the large number of potential control and damage outcome variables might preclude the use of inferential statistics or multivariate regression, unless the sample size is very large. Other factors could have been owner misunderstanding of the retrofit status of their property, poor or differing quality of workmanship among reported pre-event retrofit work, or misreporting retrofit work done *after* August 2014 as having been done before it.

A particularly important reality to consider is that a wide variety of seismic upgrade work could have led an owner to identify their house as "retrofitted." A simple categorical classification of retrofit status (i.e., a house is either retrofitted or not) is undoubtedly inadequate to understand how such work can improve outcomes for a house. For example, "retrofitted" houses may have still experienced severe damage because the *type* of retrofit work (e.g., cripple wall anchoring) that had been done was weakly if at all related to the *type* of damage (e.g., porch or chimney separation).

This issue invites several fundamental questions: What is a "retrofit?" What is good "performance?" What types of damage should different types of retrofit work be expected to reduce? These questions must be addressed if the issue of retrofit performance is to be usefully

investigated, especially if a goal is for the findings to be understandable to the public. Implications for the type of research approaches that would be advisable in future studies of the empirical, *in situ* performance of single-family home retrofits are addressed in the Recommendations section below.

Interview and Site Visit Findings

Homeowner Backgrounds, Beliefs and Behavior about Mitigation

Participants showed a high degree of awareness *in general* about earthquakes and other natural hazard risks of home ownership. The interview sample was mostly middle-aged and born in in California or moved here decades ago. Interviewees seemed to associate living in California for a long time with being well-informed and wizened about the chances of a large earthquake.

This high awareness about earthquake likelihood contrasted strongly, however, with low rates of mitigation action-taking and lack of knowledge about retrofit concepts and the status of their properties. Few interviewees said earthquake retrofit was a factor in their home search.

Homeowners held a spectrum of views about retrofitting, with most having *generally* positive impressions. People mentioned benefits such as peace of mind and avoidance of minor damage or reduced chances of extreme loss. Those who were emotionally invested in their property, for instance who had invested decades in restoring a historic home, seemed especially interested in protecting their homes. About a fifth of retrofitters reported doing the work themselves or with the help of friends and family, which would reduce out of pocket costs.

On the negative side, doubts and confusion existed about whether or not retrofitting is "worth it." Skeptics focused on uncertainty or low probability of benefits. Interviewees did not think that retrofitting a house would increase its appraised or resale value. It is possible that cost concerns might cause people who otherwise think retrofitting is a good idea to personally, or even publicly, emphasize drawbacks or dismiss it. Many said they'd like to retrofit but simply felt it was unaffordable.

Overall, this study affirmed that many homeowners are interested in retrofitting but face multiple deterrents and barriers to doing so. This suggests people need help getting through the challenges of committing to and completing a retrofit project, not just basic information about the reasons to do it.

Homeowner retrofit stories collected in this study are an important source of information about the specific difficulties owners experience. Retrofitting is often linked to events, such as the discovery of earthquake vulnerabilities during home purchase, other major renovation

work, or after a damaging earthquake event that caused fear or necessitated removal, replacement, or repairs. Different types of information could be helpful in these different situations. For instance, owners could benefit from empowerment in looking for and negotiating over seismic issues when buying a home, cost-effective ways to incorporate seismic improvements into other renovation projects, or how to plan for and carry out incremental retrofitting work over time. Owners that are ready to embark on a project need technique for finding qualified contractors, avoiding scams, or supervising workmanship quality in progress.

Earthquake Insurance Perceptions and Behavior

Homeowner perspectives towards earthquake insurance were investigated through five questions in the survey and expanded discussion and hypothetical questions during the interviews. About ten percent of participating homeowners carried earthquake insurance at the time of the 2014 Napa event, which is in line with CEA statewide rates. Respondents with CEA earthquake policies were specifically excluded from the interview research in Phase 2, but a handful of interviewees had insurance in the past or currently with non-CEA partner companies.

Interviewed homeowners showed high *general* awareness of the existence of earthquake insurance but a low level of knowledge about specifics, especially newer policy options. For example, most interviewees erroneously thought that deductible levels are fixed at ten percent and did not know that renter's or contents coverage were available. Only a small fraction of homeowners recalled the annual mandatory offer sent by their insurance company.

Homeowners relied mainly on word of mouth for information about insurance and to derive their impressions of its usefulness and affordability. This means that out of date or incomplete information can easily spread and perpetuate in a community, especially in the wake of an event when the earthquakes come up more in conversation. Only a few sought personalized information about earthquake insurance, despite being in an area affected by significant quakes in both 2000 and 2014.

Fifty-one respondents in the survey reported submitting a claim, which is the majority of respondents that had earthquake insurance. Very few received a payout. Ninety-seven homeowners in the survey said they sought out information about earthquake insurance since August 2014.

Interviewees were asked about what would make insurance for earthquake losses more appealing, and where homeowners like them would most likely turn for more information. There was strong interest in contents coverage and policy offerings more seamlessly integrated with and comparable to the terms of their homeowners' policy. As for information sources, participants emphasized internet sites but also suggested the local newspaper and partnering with local organizations and businesses in the community that do related work. In the Napa case, that could include vintner, historic preservation, school, and environmental groups.

Findings on Field Use of FEMA P-50 Form

Four California Real Estate Inspection Association (CREIA) member home inspectors participated in completing FEMA P-50 forms for 39 homes during the Phase 2 site visits. Home Inspectors used the P-50 form to collect thorough data about the characteristics and vulnerabilities of the inspected houses. Important insights from this effort included how to make P-50 home evaluations easier for home inspectors to use and the importance of developing an evaluation service that is affordable and attractive to the public. For instance, more careful training and practice in calculating the Seismic Hazard score is needed, and the order of data entry should be changed to match the typical sequence of a home inspection visit. This speaks to the importance of CEA's efforts to create an automated application for the P-50 form.

Homeowner interviews identified a high level of interest in affordable, high quality, third-party assessment of seismic vulnerabilities and potential mitigation steps. Participating home inspectors discussed practical barriers to bringing that kind of service to market during a two-hour focus group. Inspectors felt pricing would need to be a fraction of the cost that home owners are already accustomed to paying for inspections at time of sale. Also, inspectors need to be able to obtain professional insurance for this different kind of inspection. Overall, inspectors seemed optimistic that if practices are sufficiently standardized and inspectors can be uniformly trained and evaluated on their abilities to deliver the service, insurers will be willing to underwrite inspectors and willing inspectors will be able to carry out consistent and high quality evaluations.

Recommendations for Future Retrofit Performance and Homeowner Earthquake Impact Research

This study adds richness to our understanding of the impacts of earthquakes on single family houses and homeowners in Napa. Results may be indicative of perspectives and challenges faced in other areas of the state. Also, a new approach was pioneered in the form of a voluntary post-event survey combined with site visits with a home inspection and qualitative interview. These methods provided important details about both damaged and undamaged houses and how a significant event influenced homeowner thinking.

A major take-away is how little understanding many homeowners have about earthquake retrofitting and insurance, and the importance of social influences on retrofit and insurance perceptions and behavior. The case studies conducted in Phase 2 also shed light on challenges for households to invest in mitigation even if they want to, and the many, sometimes lengthy

aftershocks earthquakes can create in peoples' lives. It is sobering to consider that the South Napa earthquake of 2014 is just one event that created shaking across a limited area.

The full report discusses several broad, long term priorities for improving future field research into retrofit prevalence and performance. The most important step is to develop knowledge and consensus around the set of measurable house characteristics that are the major risk indicators, a typology of retrofit features and their expected benefits, and a typology and system for measuring outcomes for homeowners and houses that covers a wide range of earthquake impacts. Ideally, these essential building blocks of retrofit research should draw upon and be usable by disciplines and ultimately communicable to multiple audiences. Researchers should continue to seek ways to involve the public more in earthquake recovery and retrofit performance research, because the outcomes of importance go beyond fallen bricks, porch slips, and dollars spent to the psychological, financial security, and collective actions of all people and businesses that earthquakes affect.

On a more detailed level, some specific limitations of this study can be addressed through alternative research design features. Increasing the sample size of houses under study, either by surveying in many locations or more houses in a single community, will enable more use of statistical inference. Randomly selecting the set of houses to study will provide more accurate rate information about beliefs and behavior as well as reduce the chances of selection bias. It may also reduce overall survey costs by shifting budget from marketing to strategic survey recruitment.

A key to understanding the benefits of retrofitting in practice is to collecting longitudinal (time series) data, namely, to do before and after studies of the same houses. This will require creating data bases of houses, collecting initial data and then tracking the retrofit and maintenance status and the state of the house and household over time. When doing this, it is also advisable to include both retrofitted and non-retrofitted houses, because the latter are much more numerous and serve as important controls.

Not all of the above design features can be used in every future study, but some of them can be used in combination, or in multiple studies of different types, to powerful effect. If study of retrofit performance is approached using diverse types of data and methods, we are more likely to grasp the full range of issues at play and more reliably advance our state of understanding.

Another outcome from this study are action opportunities for CEA as it continues to refine its portfolio of programs to motivate interest and action-taking about household earthquake resilience. Discussions with homeowners suggest some messages that could be effective in motivating and *sustaining* attention to earthquakes and the search for personalized risk information. Recommendations are to:

- Point out how common and significant non-structural and contents damage can be.
- Show data about the length of time that critical repairs can take.

- Gently share stories about the psychological trauma that earthquake survivors go through.
- Urge people to make *their own* informed decisions rather than relying on others.
- Point out helpful actions homeowners might be able to do for themselves or get "in-kind" help to do from a friend, neighbor or family member.
- Tap into the emotional connection people have with their houses and neighborhoods.
- Convey more nuance as to what constitutes a retrofit and what different retrofit work is supposed to do.
- Encourage owners to develop a retrofit plan and to carry out incremental projects.
- Use straightforward, everyday language while still treating owners with respect.
- Strive to increase the frequency of encounters people have with the topic and the number of sources from which they receive information.

For owners who are already interested in retrofitting or insurance, the communication need is more about helping people make conscious decisions and follow through. Because earthquake resilience decisions are heavily influence by social networks and information exchange, CEA has the opportunity to leverage these processes in getting more accurate information across to more people. To do that, CEA can:

- Capitalize on information flow in existing social networks where trust is high and related issues are already discussed.
- Maintain frequent communication efforts using a balance of both traditional and digital media.
- Seed the community with well-informed, local communicators and give those leaders the resources they need to become effective advocates.
- Publicly reward and recognize owners that successfully complete retrofit projects.

Bottom line, Napa area homeowners who took the time and energy to share their experiences have helped to demonstrate that while owners face many challenges, there are also numerous opportunities to help them progress through different steps towards their resilience end-goals. Through its mitigation research program, CEA is better poised to realize its mission to assist in that important process.