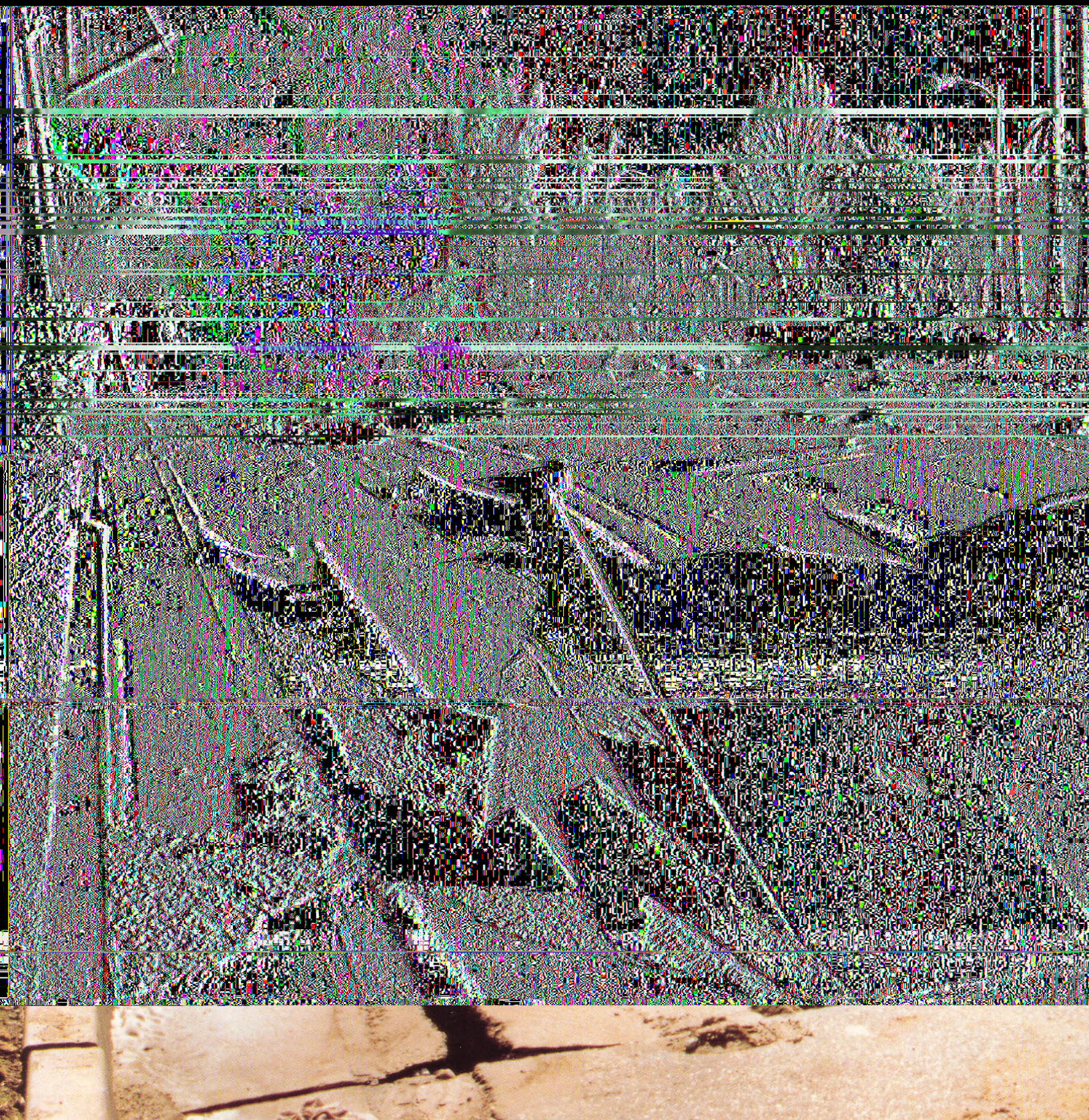

CHAPTER I

Effects of the Northridge Earthquake

At 4:31 a.m. on January 17, 1994, eight miles below the surface of the northwestern end of the San Fernando Valley, an earthquake shattered the early-morning peace for millions of California residents. The magnitude 6.7 earthquake generated intense shaking that, although it lasted for only about nine seconds, caused widespread damage and enormous economic loss. The communities of Northridge, San Fernando, West Hollywood, Santa Clarita, Fillmore, Simi Valley, and Sherman Oaks were generally the hardest hit, but strong shaking and vulnerable buildings caused extensive damage as far away as central Los Angeles, Santa Monica, and Whittier.

Earthquake damage is usually described through losses and descriptions of damaged facilities, but in the end, it is people, businesses, institutions, and government that pay the price. This chapter is an overview of the effect of the Northridge earthquake on people, buildings, lifelines, and the local economy. It is these effects the Commission seeks to reduce in future earthquakes through improved public policy.

Downs, Los Angeles Times

% Fire and water from broken pipes mixed on Balboa Boulevard.

People

Although the number of lives lost in the Northridge earthquake was remarkably low considering the intensity of the earthquake and its location, 57 people died and nearly 9,000 were injured. The numbers of dead and injured were not as high as in some other natural disasters, but the earthquake affected the lives of more people than any previous natural disaster in the United States.

Tobin

Figure 3. Part of "ghost town" created by the earthquake.

The earthquake hit Californians hardest at home. Over 25,000 dwelling units were permanently lost or severely damaged, and over 1,600 homes and apartment buildings were declared uninhabitable. By mid-September the Governor's Office of Emergency Services and the Federal Emergency Management Agency (FEMA) had received over 630,000 phone calls regarding disaster assistance from victims of the Northridge earthquake, more than twice the number received after the previous record holder, Hurricane Andrew. FEMA had also received over 265,000 applications for individual and family grants. The Small Business Administration had conducted over 535,000 interviews with earthquake victims and had approved over 100,000 loans totaling nearly $3.4 billion.

OBS

Figure 4. A red tag on a building after the Northridge earthquake.

Low-cost housing is proving the most difficult to replace. Despite extraordinary city, state, and federal government efforts, including offers of low- and no-interest loans, nine months after the earthquake, repairs have begun on less than half of the 507 buildings that provided 11,000 apartments in the now infamous "ghost towns" (see Figure 3). The owners of the remaining buildings either don't yet know whether they can rebuild or have decided to forfeit their equity and allow lenders to foreclose.

Many of those affected physically, mentally, and economically by the earthquake nevertheless regard themselves as fortunate, knowing that others suffered more, but for some the combined effects of change, fear, grief, and uncertainty on top of the stress of daily life create frustration and anger. Local mental health agencies and community-based groups reported over 1,150,000 crisis counseling interventions, costing over $35 million. Although most victims have adjusted and returned to an appearance of normalcy, for many the trauma continues.

Buildings

The Northridge earthquake was the most expensive earthquake in the history of this country, with losses estimated at $20 billion. The greatest portion of those losses was a direct result of damage to buildings. Over 112,000 structures were damaged in the earthquake. In the City of Los Angeles, over 93,000 buildings were damaged badly enough to require inspection, and nearly 2,000 (including 1,500 residential buildings) of those were red-tagged (Figure 4 is an example), forbidding entry; another 1,000 buildings were red-tagged in other affected communities. Over 8,800 buildings were yellow-tagged as safe only for limited use in Los Angeles; 5,000 more were yellow-tagged in other communities.

Although the earthquake damaged structures of nearly every type, most modern buildings (those built to post-1976 codes) performed significantly better than structures built to prior codes. However, three types of structures built to modern codes had a higher-than-expected frequency of damage:

1. Tilt-up concrete buildings
2. Steel moment-frame buildings
3. Aboveground reinforced concrete parking structures

The most severe damage generally occurred to buildings designed to codes used before 1976. The damaged buildings can be divided into three categories:

1. Buildings constructed with suspect materials and techniques, such as tilt-ups, nonductile concrete frames, and unretrofitted unreinforced masonry (URM).
2. Buildings designed or constructed with irregular configurations—for example, multistory buildings with inadequately braced first stories (like most of the apartment houses that collapsed) and hillside homes.
3. Buildings with poor design, construction, or maintenance.

In spite of the good performance of most buildings, the economic losses were high. The damage to nonstructural elements—heating and air conditioning systems, lighting fixtures, suspended ceilings, partitions, and equipment—was costly. Nonstructural damage is a significant matter because the value of these elements generally ranges from slightly over half of a single-family dwelling's cost to as much as 80 percent of the total cost of many large buildings. Nonstructural items make possible a building's function, and nonstruc-tural damage can disable buildings that are otherwise safe to occupy. Some hospitals had to close after the earthquake, even though they had suffered only minor structural damage, because of damage to sprinkler systems, power systems, and other vital equipment.

Fires

The earthquake caused relatively few fires, although the most spectacular, the fire at a break in a natural-gas transmission line on Balboa Boulevard, was shown so often on television that it gave the perception of a more pervasive problem. Good fortune played a critical role in keeping fires from spreading: there was no wind, and the area was not experiencing a dry spell. Another major factor, which was not a matter of luck, was the high level of planning and training in local fire departments and utilities, and the earthquake risk-mitigation programs of many businesses and governments.

Nevertheless, there were several problem areas:

- A number of fires in mobile home parks were caused when mobile homes fell from their supports and severed natural-gas connections. In all, 172 mobile homes were destroyed by fire. These mobile home fires were all too predictable; they remain a constant threat throughout the state.
- Communications failures hampered the response of emergency responders.
- Damage to water delivery systems seriously limited the efforts of firefighters.

Lifelines

Lifelines—transportation systems, communications, and water, gas, and electric utilities—suffered extensive damage. The effect of individual lifeline failures and combined failures is both direct (gas fires) and indirect (interference with emergency response). The combined loss of water pressure, electrical power, emergency power, and communications, coupled with significant gas-related fires, presents a clear and unacceptable hazard with far-reaching implications for emergency response and disaster recovery. Only good fortune prevented an even greater disaster.

Transportation Systems

Despite the retrofits and improvements in design that were made between the 1971 San Fernando earthquake and this 1994 event, some freeway overpasses collapsed and other portions of the highway system failed. Most of the bridges that

SAFETY EVALUATION CLASSIFICATIONS

Damaged buildings are rapidly evaluated after an earthquake to determine whether continued use is appropriate or whether hazardous conditions are present that should limit entry. More detailed evaluations generally follow, and with better information, the rating often changes. The ratings for buildings correspond to the color of the placard posted on the structure by the inspector to signify its condition (ATC, 1989):

Green: The building is posted as *Inspected*. Buildings in this category have no apparent hazard though repairs may be required. There is no restriction on use or occupancy.

Yellow: The building is posted as *Limited-Entry*. Buildings in this category are believed to have a dangerous condition, especially in an aftershock. Entry is limited to the owner for emergency purposes, but continuous usage and public entry are not allowed.

Red: The building is posted as *Unsafe*. Buildings in this category are believed to represent a life-threatening hazard or may be in imminent danger of collapse from an aftershock. Entry is limited to authorities only.

were severely damaged were designed prior to the changes instituted as a result of the San Fernando (1971) and Loma Prieta (1989) earthquakes. Bridges designed and built after the late 1970s performed relatively well. The direct cost to repair damaged freeway structures was over $350 million.

Emergency and normal communications systems were disrupted by damage, loss of electrical power, increased call volume, and call convergence.

Communications

Communications failures during this disaster resulted in breakdowns in service, misunderstandings, lack of information for making decisions, and, in some cases, loss of lives and property. Emergency and normal communications systems were disrupted by damage, loss of electrical power, increased call volume, and call convergence into and out of the affected area. The disruption ranged from delayed dial tones to nonfunctional radio systems. Cellular phones worked well, but experienced overload. Radio communication among various police and fire agencies was hampered by too few mutual-aid channels, incompatibility of dissimilar radio systems, and the use of exclusive frequency bands.

Many hospital radios and phones did not work, requiring the Los Angeles Fire Department to send runners and fire units to determine the status of hospitals; paramedic and emergency medical services in the San Fernando Valley had communications problems; the Los Angeles County Medic Alert Center broke down; the Hospital Emergency Administrative Radio system was inoperable in the area of greatest earthquake impact; Reddi-Net, a computerized system owned by the Hospital Council of Southern California that links 86 hospitals, failed. Equipment damage and lack of employee training took their toll.

Electricity

About two million customers in the Los Angeles area lost electric power following the earthquake. Although power to most customers was restored, those near the epicenter, including hospitals and police and fire stations, were without power. Electric utilities made significant progress in "hardening" their generating and distribution facilities as a result of lessons learned in the San Fernando, Loma Prieta, and other earthquakes, but this event presented new problems. For the first time, transmission towers were toppled at a few locations. Power was restored to most of the region within one day and the hardest-hit areas within three days.

Gas

Damage to natural-gas transmission and distribution systems caused fires, including a spectacular fire on a major thoroughfare, and interrupted service. The earthquake demonstrated that some older pipelines are vulnerable to failure in areas of ground deformation, but that newer pipelines faired well. Because gas-related fires are a major source of losses, efforts to minimize losses and control leaks are important.

Water

Damage to the area's water supply systems, from northern California and the Colorado River, as well as to distribution lines interrupted supplies and hampered fire fighting. The earthquake damaged five major aqueducts, disrupting the supply from the north. These pipelines serve treatment facilities that prepare water for the areas of Santa Clarita, Simi Valley, and San Fernando Valley. As was the case following the 1971 San Fernando earthquake, significant repairs were also required on local water distribution systems. Water was unavailable to some of the areas hardest hit by the earthquake for several weeks.

The Economy

The $20 billion in losses that often has been quoted as the cost of the Northridge earthquake covers, primarily, the physical damage to structures and lifelines. It does not include many of the costs related to loss of use, loss of business, loss of productivity, and relocation of businesses. Though they are significant, these losses are often overlooked. It was estimated that the loss of use of parts of the transportation system following the earthquake cost $500 million in delays and lost productivity.

Overall productivity losses in the Los Angeles

area in the days following the earthquake were estimated at $1 billion (Romero, 1994). Indirect economic effects such as loss of tax revenue, short- and long-term loss of productivity, and ripple effects such as foreclosures, abandonment of equity, and redistribution of commercial activities are extremely difficult to calculate with any degree of accuracy. Such imprecision doesn't lessen the impact, especially to the victims.

Loss of businesses is creating major problems in some areas, where these businesses provided both needed services and jobs. Although some businesses, trades, and professions are seeing an increase in demand for their services and products, fueled in part by government grants, low-interest loans, and other assistance, many small businesses remain closed or are struggling because the nearby residential properties that housed their normal customer base remain vacant. Nine months after the earthquake, nearly 50 percent of the small businesses in the most heavily affected area of Northridge were still not open. The commercial district in Fillmore and many commercial properties in communities from the San Fernando Valley to Santa Monica still awaited repairs.

Insured losses exceeded insurance industry expectations, illustrating the importance of reducing earthquake risk. The California Department of Insurance estimates that over 300,000 claims for earthquake damage repair had been filed as of October 1, 1994. The size of individual claims from the Northridge earthquake has been, on average, two or three times greater than claims from previous earthquakes. Insurance companies expect to pay approximately $11 billion in claims, and some have been driven to the brink of insolvency. Many insurance companies, believing their earthquake insurance risk exceeds their ability to pay future claims, have moved to limit the number of policies written for earthquake and homeowners' coverage in California. Lasting effects will be felt in terms of the availability of insurance, the amount paid for premiums, and the quality of coverage.

Conclusions

The Northridge earthquake was shocking—but predictable. The intense shaking caused severe damage—damage that could have been much worse. Many owe their lives and lack of injuries to the earthquake's timing. Thinking of the consequences if it had struck when schools, workplaces, and freeways were at capacity should force all Californians to new awareness and resolve. As it is, the millions of people affected will recover in time. Debts are being paid. Recovery should, indeed *must*, bring such healing, but it should not cause us to forget.

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The Northridge earthquake was a reminder. It showed us—again—how devastating even a moderate urban earthquake can be. Scientists also remind us that California's urban areas will continue to experience such earthquakes. Some of them will be just as intense as Northridge—but may last longer, causing a wider area of damage and destruction. They may occur at times when freeways, office buildings, and schools are filled with people.

The recommendations in this report propose actions so that California will be less vulnerable to such events.