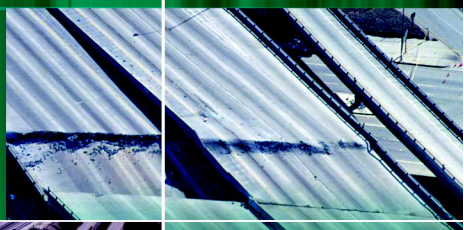
Draft Report

EFFECTS OF CATASTROPHIC EVENTS ON TRANSPORTATION SYSTEM MANAGEMENT AND OPERATIONS

Northridge Earthquake—January 17, 1994



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16. Abstract

This report documents the actions taken by transportation agencies in response to the earthquake in Northridge, California on January 17, 1994, and is part of a larger effort to examine the impacts of catastrophic events on transportation system facilities and services. The findings documented in this report are a result of a detailed literature search on Northridge lessons learned. As part of a larger effort, four case studies will be produced:

- New York City, September 11, 2001
- The Pentagon and the National Capitol Region, September 11, 2001
- Baltimore, Maryland, rail tunnel fire, July 18, 2001
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Foreword

This report was prepared by the U.S. Department of Transportation's (U.S. DOT) John A. Volpe National Transportation Systems Center (Volpe Center) for the U.S. DOT's Intelligent Transportation Systems (ITS) Joint Program Office. The Volpe Center study team consisted of Allan J. DeBlasio, the project manager, Amanda Zamora, Frederick Mottley, and Robert Brodesky from EG&G Technical Services; Margaret E. Zirker and Michelle Crowder from Cambridge Systematics Inc.; and Terrance J. Regan, Kathleen Bagdonas and Dan Morin from Planners Collaborative. Vince Pearce is the U.S. DOT manager of the review.

This report documents the actions taken by transportation agencies in response to the earthquake in Northridge, California on January 17, 1994, and is part of a larger effort to examine the impacts of catastrophic events on transportation system facilities and services. The findings documented in this report are a result of a detailed literature search on Northridge lessons learned. As part of a larger effort, four case studies will be produced:

- New York City, September 11, 2001
- The Pentagon and the National Capitol Region, September 11, 2001
- Baltimore, Maryland, rail tunnel fire, July 18, 2001
- Northridge Earthquake, January 17, 1994.

Each of these events resulted in substantial, immediate, and adverse impacts on transportation, and each has had varying degrees of influence on the longer-term operation of transportation facilities and services in their respective regions. Each event revealed important information about the response of the transportation system to major stress and the ability of operating agencies and their public safety and emergency management partners to respond effectively to a crisis. This report emphasizes the transportation aspects of this catastrophic event and lessons learned that could be incorporated into future emergency response planning.

Contents

Table of Contents

1.0 Introduction 1

2.0 Transportation System Response 3

2.1 Pre-Event 3

2.2 Day of Event 9

2.3 Post-Event 16

2.4 Post-Event Traffic Management Operations 30

3.0 Findings 35

3.1 Advance Preparations and Planning 35

3.2 Institutional Coordination 37

3.3 Guiding Priority: Mobility 39

3.4 Communications 40

3.5 The Role of Advanced Technology 41

3.6 System Redundancy and Resiliency 41

4.0 Conclusions 45

Appendicies

Appendix A: Northridge Earthquake Chronology 47

Appendix B: Northridge Literature Review 53

List of Tables

Table 1. Regional Statistics 4

Table 2. Journey to Work (Mode Split) 4

Table 3. Los Angeles Freeways 5

Table 4. Regional Freeway Management 6

Table 5. Regional Public Transportation 7

Table 6. ADT on I-5/SR-14 Detours 20

Table 7. ADT on I-10 Detours 23

Table 8. Metrolink Ridership 26

Table 9. ADT Comparisons 28

Table 10. Freeway Reconstruction Incentives 34

List of Figures

Figure 1. Northridge Earthquake Freeway Destruction 1
Figure 2. Los Angeles County 3
Figure 3. Pre-Event Transportation Conditions 8
Figure 4. I-5 Damage at Gavin Canyon 11
Figure 5. Damage at I-5/SR-14 Interchange 11
Figure 6. Damage at I-10/La Cienga Boulevard 12
Figure 7. Transportation Conditions – January 17, 1994 13
Figure 8. 1-5 and I-5/SR-14 Interchange Detours 19
Figure 9. I-10 Detours 22
Figure 10. SR-118 Damage and Alignment 24
Figure 11. SR-118 Detours 25
Figure 12. 1993-94 Metrolink Ridership 27
Figure 13. Post-Earthquake Transportation Conditions 29
Figure 14. Demolition of I-10 at La Cienga Boulevard 31
Figure 15. Caltrans Reconstruction Public Outreach 33
Figure 16. Seismic Retrofitting Outreach Program 35
Figure 17. Reconstruction of Los Angeles Freeways 37

1.0 Introduction

On Monday, January 17, 1994, at 4:30 a.m., an earthquake of a magnitude of 6.8 shook Los Angeles, California. While the actual earthquake (and its subsequent aftershocks) lasted only about 1 minute, it damaged 114,000 residential and commercial structures spread over 2,100 square miles, took 72 lives, and significantly impaired the Los Angeles regional transportation system, generating a year's worth of highway work in a single event. Figure 1 gives an example of the level of destruction to the regional freeway network. The Federal Emergency Management Agency (FEMA) reported the Northridge earthquake as one of the largest and most costly federal disasters, with initial cost estimates of total damages at $25 billion.

Figure 1. Northridge Earthquake Freeway Destruction

The highway destruction caused by the earthquake was a significant strain on auto-dependent Southern California. Because the highway system is such an important part of regional mobility, transportation agencies quickly responded to the damage. In fact, the first contracts to rebuild regional highways were in place by 7:00 p.m. on January 17, and crews had already begun to work on debris clearing and demolition. Within 3 days, the Southern California Regional Rail Authority (SCRRA) expanded Metrolink commuter rail service north to Lancaster and west to Ventura County. Bus services were changed, shuttle services were implemented, detours were put in place, and employers offered free shuttle services while federal, state, and local governments partnered to reconstruct the highway system in record time. According to the California Department of Transportation (Caltrans)/Federal Highway Administration (FHWA) *The Lessons Learned from the Northridge Earthquake*, "Everyone involved was driven by the desire to 'be part of the recovery effort,' and 'take pride in showing what we could do.'"

The Northridge Earthquake:

- ***Damaged 114,000 commercial and residential structures***
- ***Took 72 lives***
- ***Caused $25 billion worth of damage.***

2.0 Transportation System Response

Among the agencies cooperating in response to the Northridge destruction was Caltrans. Caltrans led the successful reconstruction effort and made two key decisions quickly after the earthquake: to rebuild the damaged freeways, and to retain traveler mobility and keep traffic flowing as smoothly as possible during the rebuilding efforts. With the lead of Caltrans, this costly disaster became a model of incident management.

2.1 Pre-Event

Los Angeles County

Southern California is a 6-county region spanning 38,000 square miles. In Southern California, Los Angeles County remains one of the region's and the nation's largest counties with 4,081 square miles, an area approximately 800 square miles larger than the combined area of Delaware and Rhode Island. Figure 2 shows an aerial view of Los Angeles County.

Southern California has more than 200 geologic faults long enough to produce earthquakes as large as magnitude 6 on the Richter scale. Between 1980 and January 16, 1994, these faults produced 19 minor earthquakes. Table 1, on the next page, shows other regional statistics.

Regional Transportation

Considered the most extensive highway network in the world, the Los Angeles region has 27 freeways and over 882 centerline miles of highways. There are over 6 million registered vehicles in Los Angeles County alone, and about 90 percent of all regional households have access to a vehicle. The Los Angeles

Figure 2. Los Angeles County

Table 1. Regional Statistics

	Southern California	Los Angeles County	City of Los Angeles
Population	15,600,000	9,312,200	3,624,700
Workers	5,915,600	3,710,500	1,572,000
Area in sq. mi.	38,000	4,081	467
Density of residents per sq. mi.	411	2,282	7,762
Density of workers per sq. mi.	156	909	3,366

Sources: 1990 US Census projections for 1994.

metropolitan area is also one of the most congested in the nation. In 1994, it ranked first among the nation's 68 largest urbanized areas in all ten measures of the Texas Transportation Institute's indices of congestion. The region ranked number one in delays caused by heavy traffic flow and incidents, and number one in annual delays in person-hours per capita. Contributing to the first place ranking were a 41 percent share of daily travel undertaken in congested conditions and an annual congestion cost of $795 per capita.

In Los Angeles County, driving is the overwhelming mode of choice for commuting. Approximately 85 percent of workers commute by personal automobiles, while less than 10 percent rely on public transportation. Motorists make about 23 million vehicle trips daily. Table 2 shows the mode split of commuters in the region.

Table 2. Journey to Work (Mode Split)

	1990 Southern California	1990 Los Angeles County	1990 City of Los Angeles	2000 estimate Los Angeles County
SOV	72%	70%	65%	71%
HOV (2+)	15%	16%	15%	14%
Bus	4%	6%	10%	6%
Subway, rail	<1%	<1%	<1%	<1%
Walk, bicycle	4%	4%	5%	3%
Other*	4%	3%	4%	5%
Total	100%	100%	100%	100%

Source: US Census
**Other includes all other modes of travel including work-at-home.*

Major Freeways

Geographically, Los Angeles is separated from central and northern California by the San Gabriel Mountains to the north and San Bernardino Mountains to the northeast. Access over the mountains is limited to two major freeways: I-5, which runs the length of the state, and SR-14, which provides access to the Antelope Valley. The I-5 corridor is especially important to Northern Californians who depend on I-5 freight movements originating at the Port of Los Angeles destined for the Sacramento area and other cities in northern California. East-west traffic is mainly dependent on I-10. Table 3 summarizes the major Southern California thoroughfares affected by the earthquake.

Freeway Management and Operations

Because the highway system is critical to the people and the economy of the Los Angeles region, the management of the highway network is a cooperative priority, and was so even before the Northridge earthquake. Freeways, highways, and traffic management are handled by both state and local agencies as shown in Table 4 on the next page.

Table 3. Los Angeles Freeways

Arterial	ADT	Description
I-5: The Golden State Freeway	133,000* measured north of SR-14	Primary north/south route in California; connects the Los Angeles basin to Northern California through the San Gabriel Mountains.
State Route (SR) 14: The Antelope Valley Freeway	130,000** measured between San Fernando Road and I-5	Connects the cities of Lancaster and Palmdale with Los Angeles; intersection of I-5 and SR-14 is the busiest on SR-14 with average peak hour traffic counts at 11,500 vehicles.
I-10: The Santa Monica Freeway	261,000** measured east of I-405	Busiest freeway in the world; runs east/west 2,460 miles through 8 states from the panhandle of Florida to the Pacific, where it terminates at the Pacific Coast Highway.
State Route (SR) 118: The Simi Valley Freeway	121,000** measured west of I-405	Runs from I-210 in San Fernando west into Ventura County through the Granada Hills and Mission Hills sections of Los Angeles County.

**May 1993 ADT **January 1993 ADT*

The California Department of Transportation, Caltrans, has run the Los Angeles Traffic Management Center (TMC) from the Caltrans District 7 Office building in downtown Los Angeles since its inception in 1971. (A more detailed description of the Caltrans TMC is provided in Sections 3.2 and 3.5.) At the time of the earthquake, the TMC was being staffed 24 hours a day, 365 days a year with Caltrans and California Highway Patrol (CHP) personnel. Extensive traffic management capabilities were already in place on most of the major freeways well before the earthquake, including speed monitoring loop detectors, closed circuit television (CCTV), on-ramp meters, and permanently mounted variable message signs (VMS). In an emergency, the Caltrans TMC serves as the regional communications hub, providing up-to-date information on closures, detours, and reconstruction activities. This information is distributed through the TMC to public officials, media, and other agencies.

Traffic intersections within the City of Los Angeles are monitored by the LADOT Automated Traffic Surveillance and Control System (ATSAC) in the ATSAC control center located four floors below the street in the Los Angeles City Hall. Constructed for the Olympics in 1984, this system has the ability to adjust signal timing in response to real-time traffic data and monitor key intersections throughout the city. In an area the size of Los Angeles, with a commuting population of over 2 million people daily, traffic control redundancy in the transportation system is extremely important.

The CHP also deploys police officers for a Freeway Service Patrol (FSP), which is operated jointly by CHP, Caltrans, and the Metropolitan Transportation Author-

Table 4. Regional Freeway Management

Agency	Traffic Management	Major Functions
Caltrans District 7	Regional Traffic Management Center (TMC)	Monitors regional traffic operations using cameras and VMS on Caltrans District 7 freeways; responsible for deploying Freeway Management Teams and the CHP Freeway Service Patrol.
Los Angeles Department of Transportation (LADOT)	Automated Traffic Surveillance and Control System (ATSAC)	Monitors traffic at intersections within Los Angeles City Limits; adjusts signal timing in response to real-time traffic flows; responsible for managing the "Smart Corridor" for diverting freeway traffic onto parallel arterials.
California Highway Patrol (CHP)	Freeway Service Patrol	Responds to highway incidents with officers and tow truck crews; removes stranded motorists from freeways; jointly operated by Caltrans, LADOT, and MTA.

ity (MTA), the regional transit agency, from the Caltrans TMC. The goal of the FSP is to reduce travel delays through early detection and clearance of incidents during peak commute hours. The patrol also provides quick-fixing services, like refilling gallons of gasoline, changing flat tires, repairing leaking hoses, and recharging dead batteries. On January 16, the FSP was operating 144 tow trucks on 40 freeway sections covering 381.3 centerline miles of freeways in Los Angeles County. The FSP makes about 220,000 freeway assists annually.

Figure 3 (see next page) shows the pre-earthquake transportation conditions, including traffic volumes and transit daily ridership for the affected area.

Regional Public Transportation

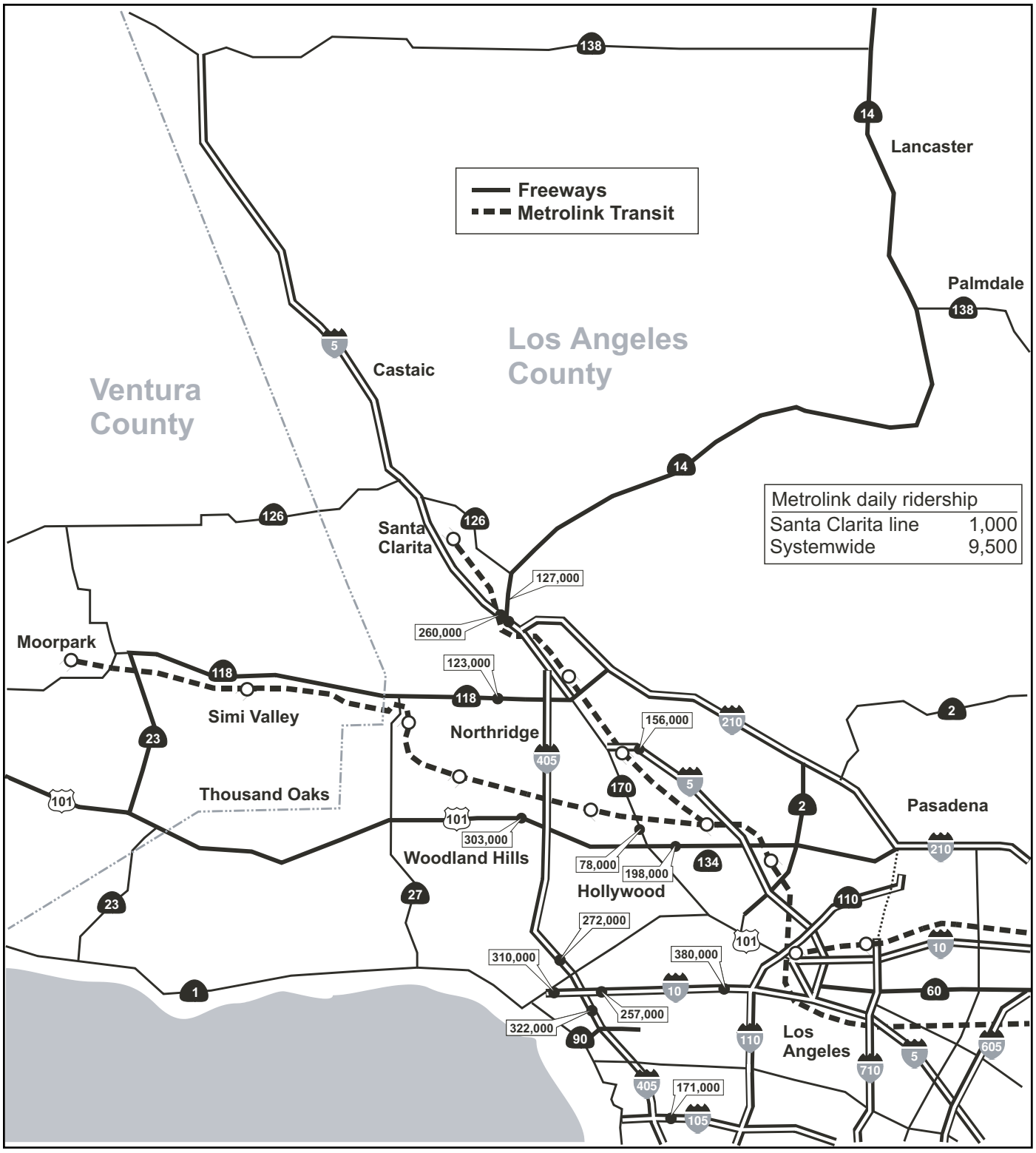
The MTA and the Southern California Regional Rail Authority (SCRRA) provide the majority of public transportation in the Los Angeles region. On a typical workday, about 6.5 percent of all commuters utilize public transportation services. Table 5 shows the transit options available at the time of the Northridge earthquake. Figure 3 shows Metrolink lines and pre-earthquake transit ridership.

In the early 1990's, it seemed that Los Angeles County might lead the region in building and encouraging alternative transportation to relieve regional congestion. In early 1994, prior to the Northridge earthquake, ridership on MTA subway and light rail lines as well as Metrolink commuter trains was approaching 100,000 total riders per day. Between 1985 and 1995, however, annual passenger miles traveled dropped 35 percent despite the opening of three new lines.

Table 5. Regional Public Transportation

Transit Agency	Ridership	Services Provided (1994)
Metropolitan Transportation Authority (MTA)	Light Rail/Subway: 32,462 total riders per day* Bus: 940,000*	Blue Line light rail (above-ground street car), operating from Los Angeles to Long Beach; Red Line subway segment operating from downtown Los Angeles to Wilshire; extensive bus service operating 1,900 buses daily.
Metrolink: Southern California Regional Rail Authority (SCRRA)	9,500 total riders per day	Commuter rail services operated through a three-county joint venture (Los Angeles, Ventura, and Orange Counties); 5 lines, 350 miles, 39 stations.

**Based on FTA 1995 FTA ridership data, which is approximately equivalent to pre-earthquake ridership.*



Basemap source: Caltrans

Figure 3. Pre-Event Transportation Conditions

Importance of Intermodal Freight Movements

The Los Angeles area is a critical intermodal transfer point for the west-to-east movement of goods across the United States. The Port of Los Angeles is the busiest intermodal freight port in the United States and among the 10 busiest ports in the world, with over 3,000 vessels arriving per year. The port handles over 5 million 20-foot equivalent containers per year. From the port, chemicals, manufactured goods, fruits and vegetables, and other items are transferred to rail cars and trucks and shipped throughout California and the rest of the United States. Trucks leaving the port are typically headed for the major Southern California interstates, I-5 and I-10, for distribution of goods throughout the country.

2.2 Day of Event

By 4:31 a.m. on the day of the Northridge earthquake, the "event" itself was already over. Fourteen minutes later, after both the City and the County of Los Angeles's Emergency Operations Centers (EOCs—see Page 35, Section 3.1 for a full discussion of EOC activities) were activated, FEMA responded, and government officials began making decisions on what should happen next. The following is a chronology of the key events that occurred on the day of the earthquake, including the key steps in post-event decisionmaking on January 17.

Chronology of Events—January 17, 1994

Time	Elapsed Time	Event/Actions Taken
4:30 a.m.:	0 minutes	An earthquake of a magnitude of 6.8 occurred in the Los Angeles area, centered in Northridge. Damage spread over 2,100 square miles and through three different counties.
4:31 a.m.:	[1 min.]	5.9 aftershock.
4:35 a.m.:	[5 min.]	Los Angeles City and County Emergency Operations Centers are activated.
4:45 a.m.:	[15 min.]	FEMA response began.
5:45 a.m.:	[1 hr. 15 min.]	Los Angeles Mayor Riordan declared a state of emergency.
6:00 a.m.:	[1 hr. 30 min.]	FEMA Headquarters Emergency Support Team was activated.
6:45 a.m.:	[1 hr. 45 min.]	As many as 50 structural fires were reported, in addition to numerous ruptures in water and natural gas mains. Power outages reported citywide.
9:05 a.m.:	[4 hr. 35 min.]	California Governor Pete Wilson declared a State of Emergency.
9:45 a.m.:	[4 hr. 45 min.]	All active fires were under control.
2:08 p.m.:	[9 hr. 38 min.]	President Clinton declared a national disaster for Los Angeles County.
7:00 p.m.:	[14 hr. 30 min.]	First of several contracts put in place and crews began work on debris clearance and highway demolition.

By 5:45 a.m., the mayor of Los Angeles had declared a state of emergency in the city, while Caltrans began sending out its own traffic management teams to assess the damage to the regional transportation system. Power outages were widespread, communications were impaired, structures were damaged, water and gas mains were ruptured, and four critical Southern California freeways (I-5, SR-14, I-10, and SR-118) were severely crippled.

I-5 Damage

The most severe damage caused by the Northridge earthquake was on I-5. I-5, the main north/south artery in Southern California connecting the Los Angeles basin to Northern California, had collapsed at both the interchange with SR-14 (which connects the cities of Lancaster and Palmdale with Los Angeles) and on top of Old Road at the Gavin Canyon underpasses. I-5 also suffered damage north of the I-5/SR-14 interchange, effectively closing the main highway link over the mountains. Figure 4, on the next page, shows the damage at the Gavin Canyon interchange.

SR-14 Damage

The connector at the I-5/SR-14 interchange in Sylmar collapsed. This connector was the only freeway link over the mountains to Lancaster and Palmdale. Except for the extensive damage at the interchange, SR-14 to the north was unaffected. Figure 5, on the next page, shows an aerial view of the damage at the I-5/SR-14 interchange.

I-10 Damage

The major east/west freight corridor (the highly traveled Santa Monica Freeway) was destroyed at four overpasses: La Cienega, Venice, Washington, and Fairfax Streets. Structural damage to buildings, roads, and utilities also occurred in the I-10 corridor connecting Los Angeles and Santa Monica, with the most severe damage in Northridge. Figure 6, on page 12, shows the damage at I-10 and La Cienga Boulevard.

Figure 4. I-5 Damage at Gavin Canyon

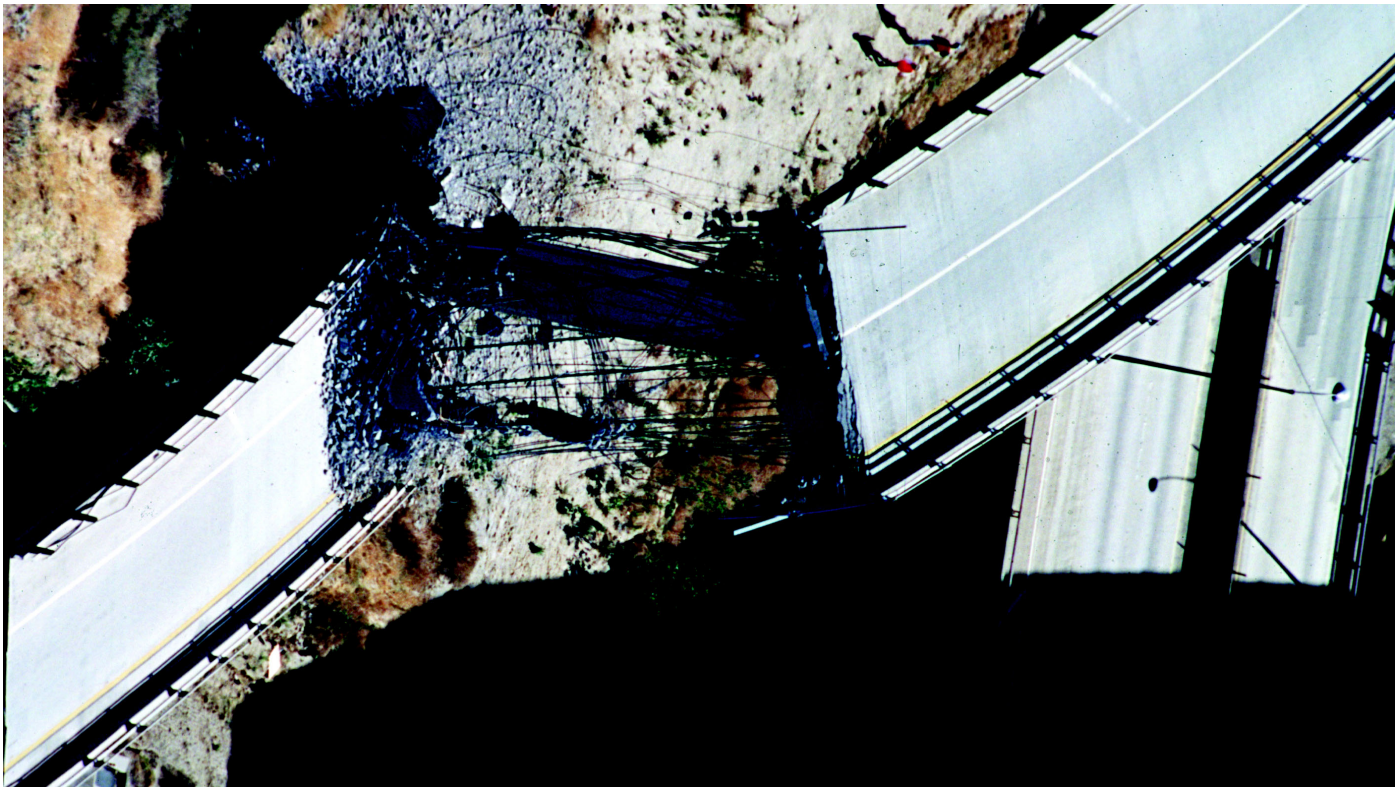


Figure 5. Damage at I-5/SR-14 Interchange

Figure 6. Damage at I-10/La Cienga Boulevard

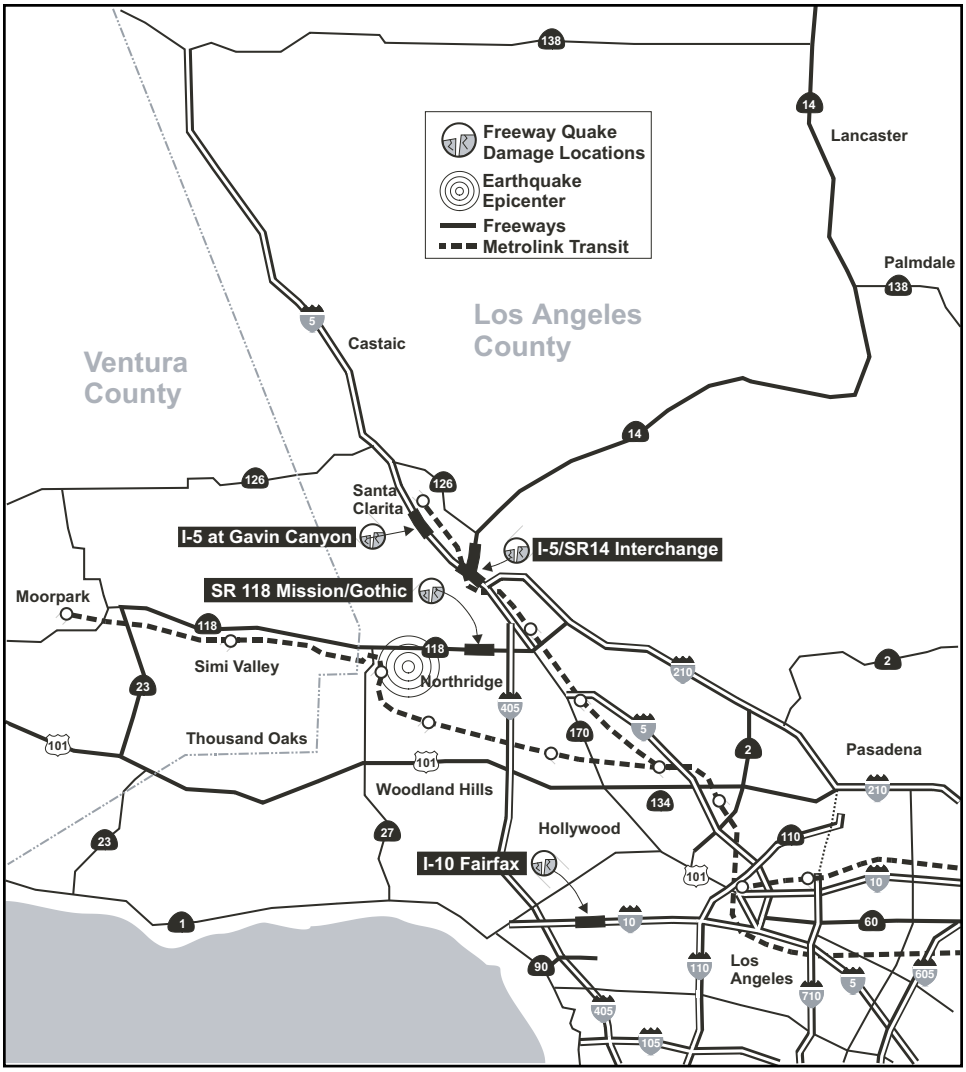
Even before Emergency Relief funds were in place, Caltrans acted quickly to ensure the safety of the public.

SR-118 Damage

SR-118, just north of Northridge (the earthquake epicenter), had sustained extensive damage. The eastbound roadway had collapsed completely at two separate places in the Granada Hills area over the intersections of Gothic Avenue and San Fernando Mission Boulevard. Additional damage over Balboa Boulevard and other areas along SR-118 closed the entire section of highway between I-405 and I-210 in both directions. At all these locations, closures were immediate and no freeway traffic was able to pass through the damaged zones. Figure 7, on the next page, shows the transportation conditions that prevailed the day of the earthquake.

Day-1 Response Actions

By 2:08 p.m., Caltrans had completed an initial damage assessment, all subsequent hazards such as earthquake-related fires were extinguished, and President Clinton had declared a national disaster in Los Angeles County. The Federal Highway Administration (FHWA) reacted immediately to the declaration by releasing Emergency Relief (ER) funds to Caltrans and good-faith agreements to completely fund the rebuilding of the highway network. (The ER program is explained in detail on Page 37, in Section 3.2.) Even before ER funds were in place, Caltrans acted quickly to ensure the safety of the public. Knowing that obstructions and debris must be cleared, damaged facilities shored, and detours established, Caltrans made "handshake" agreements with contractors on work and tentative payment methods. And, by 7:00 p.m. that first night, the first contracts were in place and work had already begun on I-5 and I-10 demolition.



Basemap source: Caltrans

Figure 7. Transportation Conditions – January 17, 1994

Caltrans took critical action to rebuild the highway system and provide mobility on the day of the attack:

- ***Caltrans used emergency contracting procedures to immediately begin debris removal and demolition activities.*** Because of the media coverage on the freeway damage, Caltrans' experience dealing with disasters, and its relationship with local contractors, Caltrans was able to mobilize a demolition contractor and crew at each of the four major damage locations.

- ***Caltrans implemented initial detours.*** Initially, Caltrans maintenance superintendents established detours in conjunction with Caltrans Traffic and Structures sections using maps from the District 7 management plan. These detours were only designed for incident response but proved effective in the initial incident management and contracting efforts.

Detours added as much as 50 miles to trips, underscoring the importance of implementing additional measures to handle traffic throughout the duration of the reconstruction period.

Day-1 Mobility Decisions

Immediately following the earthquake, Caltrans sent traffic management teams to inspect immediately recognizable hazards and implement initial closures and detours on local streets. These teams were in the field on January 17 directing traffic, but because the earthquake occurred early in the morning, there was very little traffic on the roadways at the time. Also, because January 17 was Martin Luther King Day, a national holiday, roadway volumes were lower than on a typical workday. Overall, area traffic volumes were substantially lower the week following the earthquake as people made alternative travel or work plans, which aided the recovery effort.

The Caltrans TMC served as the center of initial decision-making efforts by the traffic management teams, and on the day of the earthquake, all coordination of traffic operations was handled there. The TMC used backup electrical generators for power and relied on landline telephones for primary communications. The FSP also was run out of the Caltrans TMC. While the TMC was very functional, its technological capabilities were limited for real-time decision-making purposes. Many of the areas affected by the earthquake did not have ITS technologies in place in 1994. The same was true for the LADOT's ATSAC. On the day of the earthquake, Caltrans and the LADOT immediately began strategizing about ways to upgrade facilities to handle the overload on the Caltrans TMC and ATSAC.

For the motorists that were driving that day, initial detours allowed the regional highway network to continue to function while decisions about alternative transportation routes were being made. Originally, motorists that were in or destined for areas outside of the Los Angeles basin were encouraged to circumvent the area completely. Recommended detours, however, added as much as 50 miles to trips, underscoring the importance of implementing additional measures to handle traffic throughout the duration of the reconstruction period.

The media played a large role in both disseminating detour information on the day of the earthquake and discouraging motorists from driving if at all possible. During the 6-1/2 hours of news programming on the day of the Northridge earthquake, there were pictures showing the damaged freeway segments in 31 percent of the news programming; 18 percent of the television stories were directly about the downed freeway segments. This day-1 news coverage may have helped travelers with their alternate route planning, but more likely the news of heavy damage throughout the Los Angeles freeway system encouraged people to curtail their travel plans for at least the first few days.

Reconstruction Begins On Day 1

Early in the morning on January 17, the Executive Director of Caltrans and the District 7 Regional Administrator started the chain of emergency field responses. Within hours, FHWA field representatives were working with Caltrans on reviewing and approving all reconstruction efforts. At the same time, several contractors who had prior experience with disaster recovery began to mobilize manpower, equipment, and demolition supplies directly to the damaged freeway locations, where they were prepared to work around the clock.

Using emergency contracting procedures, under orders to immediately begin debris removal and demolition activities, Caltrans paid the demolition contractors for actual costs of materials, labor, and equipment with an agreed profit. The contractors started work based on these informal contracts. By day's end, demolition work was started at these locations:

- **I-5:** Demolition activities started at Gavin Canyon overpasses; completed in 10 days with round-the-clock operations.
- **I-10:** Demolition activities started at Fairfax Boulevard, La Cienga Boulevard, and Washington overpasses; Fairfax Boulevard demolition was completed in three 24-hour days.
- **I-5/SR-14 Antelope Freeway Interchange:** Contracts for demolition in place on January 17; demolition activities then began January 17 and were completed on March 17 with round-the-clock operations.

2.3 Post-Event

Restoring Regional Mobility

Primary traffic management strategies:

- ***Created alternate routes and detours for I-10, I-5, SR-14, and SR-188 freeways***
- ***Implemented freeway demand-reduction measures.***

During the first week following the Northridge earthquake, many businesses and schools were closed, which significantly decreased the demand on the freeway network. Many people also stayed at home that week to repair their own earthquake damage. After the first week after the earthquake, people began to return to their jobs and traffic volumes were steadily increasing. Early rough estimates indicated that repairs would take from 6 months to a year. While contract incentives made it likely that the freeway repair might be expedited, Caltrans knew that mitigation measures had to be implemented quickly to balance capacity and demand. Two primary measures were used to reduce strain on the highway network:

- Created alternate routes and detours for I-10, I-5, SR-14, and SR-188 freeways
- Implemented freeway demand-reduction measures.

The use of local streets proved to be the most effective way to handle freeway detours. The damaged freeway segments were far enough apart that detour routes could be designed for each site exclusively without overlapping detour routes and related congestion at other damage locations. For the initial detour routes, Caltrans and the LADOT re-timed traffic signals at 300 intersections and installed 1,000 directional signs and 7,500 parking signs. (Other traffic operations initiatives are described in the Post-Event Traffic Operations section of this report.) Caltrans also developed a transportation management plan (TMP) to handle traffic until the damaged freeway sections were reopened. They also implemented an Emergency Detour Management Center (see page 30 for a full discussion of the Center) with emergency communications equipment, helicopter surveillance, and traffic performance acquisition data as well as enhanced tow service, construction zone speeding enforcements, and park-and-ride lots.

In some corridors, separate detours were implemented for high-occupancy vehicles (HOVs—2 or more persons per vehicle) and single-occupancy vehicles (SOVs).

The FSP was also on the scene, having covered the 1-10 corridor and SR-118 before the earthquake. They did not cover the I-5/SR-14 corridor prior to the earthquake, but extended service to it there-after. They reported one of the detours for 1-5 and SR-14, Old Road, as having the highest number of traffic incidents during reconstruction as a result of the limited number of parallel arterials in the area.

Chronology of Events

Day 2 **January 18, 1994**	All I-5 lanes completely shut down between Roxford Street and north to Lyons Avenue in Santa Clarita; I-5 trucks-only lanes were undamaged and remain open. All SR-14 Lanes were closed. Local streets used as detours. All I-10 lanes closed between Centinela and Washington Blvd. Local streets used. All SR-118 lanes closed between Tampa Avenue and I-210. Local streets used. FEMA Special Facility Tele-registration Center is activated.
Day 5—Friday, **January 21, 1994**	I-10 northbound and southbound connectors to I-405 were opened.
Day 9—Tuesday, **January 25, 1994**	Metrolink ridership hit 22,000 boardings per day, (normal average: 1,000 per day) along the new extension of the Santa Clarita rail line serving areas surrounding earthquake-damaged roads.
Day 12—Friday, **January 28, 1994**	The southbound SR-14 to southbound I-5 truck bypass opened with one HOV and one mixed-flow lane. I-5 detour route was opened using a reconstructed frontage road.
End of January	Lane capacity in the damaged roadway corridors is restored to 70 percent of the pre-earthquake level.
Early February	Regular system of detours and emergency express bus service are in operation.
Day 20—February 5, 1994	Construction on I-10 Santa Monica Freeway begins. Construction on Camarillo Metrolink begins.
Day 36 **February 21, 1994**	Westbound SR-118 was reconstructed and restriped to provide three eastbound and three westbound lanes, replacing the detours on local streets.
Day 85 **April 11, 1994**	I-10 Santa Monica Freeway opens 74 days ahead of schedule.
Day 121—May 17, 1994	I-5 Golden State Freeway at Gavin Canyon opens.
Day 173—July 8, 1994	The I-5/SR-14 Interchange re-opened 3 weeks ahead of schedule (2 ramps at the SR-14/I-5 Interchange re-open: southbound SR-14-southbound I-5 and northbound SR-14-northbound I-5).
Day 230 **September 3, 1994**	SR-118 Simi Valley Freeway westbound lanes opened more than 2 weeks ahead of schedule.
Day 234 **September 7, 1994**	September 7, 1994- eastbound SR-118 lanes re-open to traffic.
Day 293 **November 4, 1994**	The remaining two ramps at SR-14/I-5 interchange opened to traffic (southbound SR-14-northbound 1-5 and southbound I-5-northbound SR-14).

The media played a large role in disseminating detour information in the days and weeks following the Northridge earthquake.

The media played a large role in disseminating detour information in the days and weeks following the Northridge earthquake. Daily press conferences were held by members of Caltrans and FHWA to discuss the progress of the rebuilding efforts, the status of detours in the area, and how to advise commuters to avoid earthquake damage. Newspaper inserts and brochures were also used to inform travelers of other options.

I-5 and SR-14 Detours

I-5 is the primary north-south route through central California. It connects the Los Angeles area with the San Fernando Valley. Average daily traffic on I-5 before the earthquake was about 133,000 vehicles (measured north of SR-14).

The Northridge earthquake damaged I-5 in two major places. At the Gavin Canyon underpass, the freeway collapsed on top of the Old Road, closing down the highway from Roxford Street to Lyons Avenue, a distance of about 7 miles. Initial detours using local streets in this area were established in just a few hours following the earthquake and were improved and changed within two weeks.

Old Road, which runs parallel to I-5, was established as a detour on January 29 to move traffic around the damaged bridges at Gavin Canyon. Caltrans crews established this 3-mile detour from Calgrove Boulevard to the I-5 truck stop just north of the I-5/SR-14 interchange. Two mixed-flow lanes were provided in each direction. Figure 8 shows the I-5 detour at Gavin Canyon.

While the Old Road detour did remove all traffic from the freeway at Gavin Canyon, the four-lane arterial used was the only parallel route available for detours and was not adequate for peak period demands. Metrolink service does not extend past the I-5/SR-14 interchange, so utilizing public transit to get around the I-5 damage was not an option. Consequently, peak period travel times skyrocketed during reconstruction, with motorists experiencing individual delays of as much as 1 hour in January and February. By March, traffic conditions had stabilized, with average delays only at 10-15 minutes during the morning commute and 5-10 minutes during the afternoon as motorists became familiar with the detour routes and adjusted their travel times accordingly. During the off-peak, there was no travel delay and the detour only added an extra 2 minutes to normal driving times. Weekday traffic volumes on the Old Road Detour ranged between 88,000 and 97,000 until reconstruction was complete in mid-May and traffic flow was restored.

SR-14 connects the northern Los Angeles County cities of Lancaster and Palmdale with the rest of the Los Angeles region. Average daily traffic on SR-14 (measured between San Fernando Road and the I-5 junction) was about 130,000 vehicles before the earthquake. Damage to the SR-14 freeway occurred at the interchange of I-5 and SR-14 in the Santa Clarita area, where all four connectors between the two roadways were either damaged or destroyed.

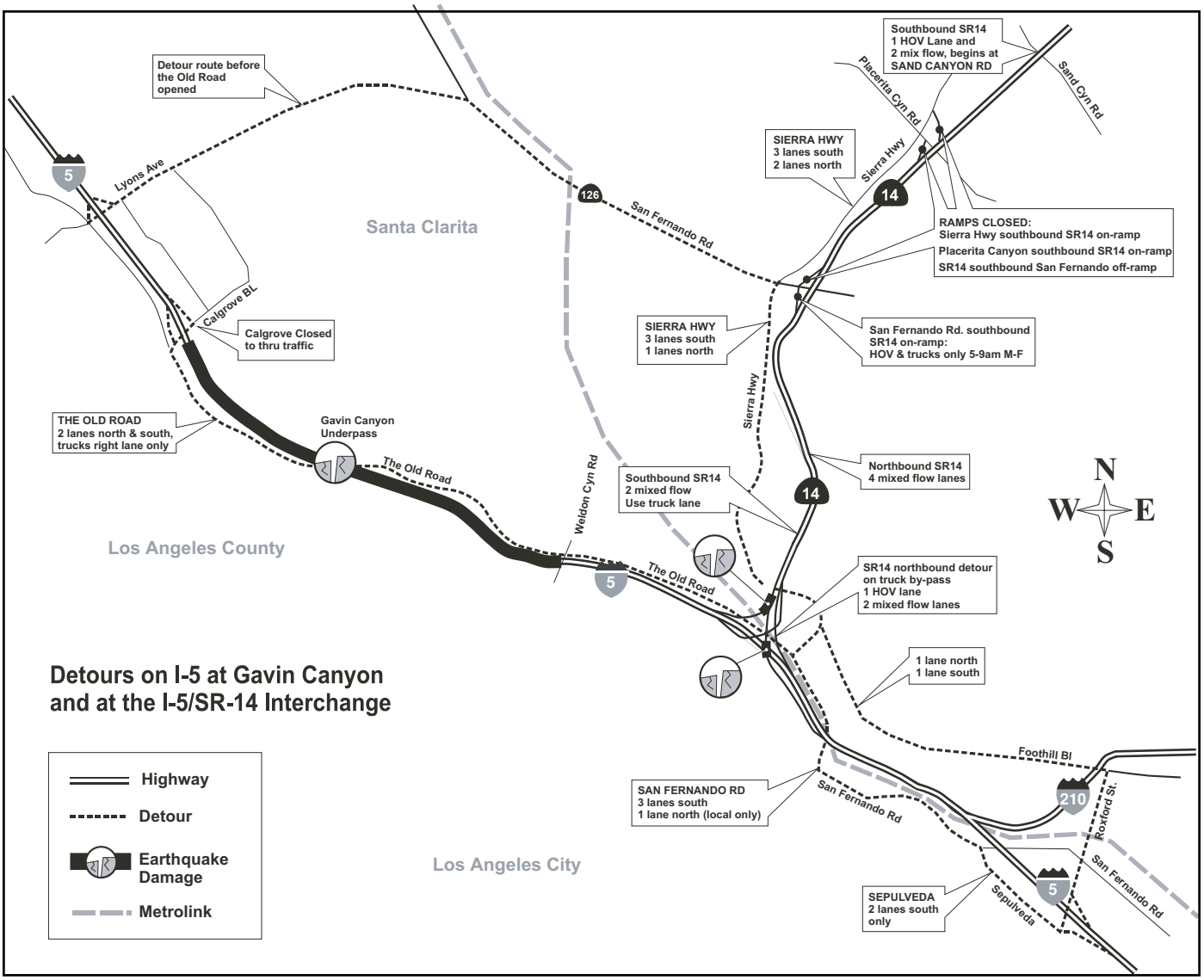


Figure 8. 1-5 and I-5/SR-14 Interchange Detours

Initial detours, set up just hours after the earthquake, at the SR-14/I-5 interchange had southbound I-5 traffic diverted at Lyons Avenue to San Fernando Road. Traffic then returned to the interstate at Roxford Avenue. Northbound traffic used Foothill Boulevard as the main detour route. Additionally, a lane in each direction on SR-14 was set up using the right shoulder of the undamaged truck lanes connecting I-5 and SR-14. During peak periods, these detours were changed to one-ways to accommodate the large amount of traffic.

On January 28, two lanes of SR-14 opened for southbound traffic connecting to southbound I-5. Caltrans used the undamaged southbound truck bypass to make one mixed-flow lane and one HOV lane. Later, it was restriped to make two mixed-flow lanes and one HOV lane. Figure 8 shows the detour at the I-5/SR-14 interchange.

A temporary HOV lane was put in place on southbound SR-14. A northbound HOV lane was established using the right shoulder area of the truck lanes. The temporary HOV lanes relieved congestion in the area as the average hourly volume for the southbound and northbound lanes was about 1,800 vehicles and 1,450 vehicles, respectively. Motorists also saved time by using the HOV detours, with average delays ranging from 5 to 20 minutes.

Due to limited alternative routes on arterials and local streets, daily traffic volumes soared on two local roads parallel to I-5 in the vicinity of the SR-14 interchange. Table 6 shows ADTs on Foothill Boulevard to the east and San Fernando Road to the west of SR-14/I-5.

Peak period delays on SR-14 were as high as 40 minutes immediately following the earthquake. By early February, travel times had stabilized due to the improved detour routes and delays dropped by 20 minutes and 10 minutes for northbound and southbound travelers, respectively.

The total detour volume for all I-5/SR-14 northbound detours was about 10,500 vehicles per hour. This included SOV lanes, HOV lanes, truck lanes, and all local road detours, and constituted 102 percent of the pre-earthquake volume in the same area. The southbound detour volume was about 12,000 vehicles per hour. This was about 88 percent of the pre-earthquake volume on the parallel arterial.

On I-5, 56 percent of all commuters changed their departure times throughout the day to avoid congestion. Of commuters departing for work between 6 a.m. and 8 a.m., 40 percent shifted departure times to either before 6 a.m. or after 8 a.m.

Before the earthquake, the northernmost Metrolink station was near the I-5/SR-14 interchange at the Santa Clarita station. Ridership there was only about 1,000 boardings per day. After the earthquake, in order to alleviate some of the congestion on the detour routes, Metrolink (on January 21) expanded service into Lancaster and Palmdale. By January 25, daily ridership went up to 22,000 boardings, which made Metrolink and Caltrans officials hopeful that freeway congestion could be reduced by transit ridership. However, just one week later, ridership fell to about 13,000 boardings per day and continued to steadily

Table 6. ADT on I-5/SR-14 Detours

Arterials Used as Alternative Routes	Pre-Earthquake Daily Traffic Volume	April 19, 1994 Daily Traffic Volume
Foothill Boulevard parallel to I-5	5,200	16,700
San Fernando Road at Sepulveda Boulevard	3,900	22,100

decrease over the reconstruction period. By July, average ridership on the Santa Clarita line was about 3,800 passengers. Metrolink continued to provide a valuable option to commuters in the SR-14 region following the earthquake and, at its peak, accounted for 10 percent of all trips made along this corridor.

I-10 Detours

I-10 runs east-west between Florida and Santa Monica, California. The I-10 corridor through Los Angeles (The Santa Monica Freeway) is known as the busiest freeway in the world with average daily traffic about 261,000 vehicles (measured east of I-405). The Northridge earthquake significantly damaged I-10 at the bridges over Fairfax Avenue, and Washington, Venice, and La Cienega Boulevards. The damaged section stretched over 9.4 miles between the San Diego Freeway and the Harbor Freeway. This area of I-10 had five lanes in each direction east of the earthquake damage and four lanes in each direction west of the damage. Peak period traffic in this area is evenly split in each direction.

Detours on I-10 were implemented January 25 and revised on February 1 to increase efficiency. Separate detours were implemented for HOVs and SOVs. HOVs were given preferential treatment and were allowed to stay on the freeway as far as the interchange closest to the closure site and reenter immediately past the closure. SOVs had to exit two exits upstream (before the closure site) and reenter two exits downstream (past the closure site). HOV detours were also closer to the freeway than SOV detours. SOV detours were, on average, about 5 miles longer than the HOV detours.

Figure 9, on the next page, shows the detour routes near the I-10 damage. Westbound HOV traffic exited the freeway at Washington Boulevard then followed Apple Street across Washington and Venice Boulevards. Traffic was able to reenter the freeway using the unused eastbound ramps to move under the construction and over Ballona Creek. This HOV detour required the use of 0.5 miles of already congested city streets.

Mixed-flow traffic exited the freeway at La Brea Avenue and then used Venice Boulevard, Cadillac Avenue, crossed La Cienega Boulevard, and then reentered the freeway at the La Cienega westbound on ramp. This detour used close to 3 miles of city streets. Eastbound HOV detour routes were more complicated. Eastbound traffic had to share the roadway space with local traffic. HOV traffic exited the freeway at La Cienega Boulevard to Washington Boulevard and then reentered the freeway at the eastbound on ramp at Washington Boulevard. The eastbound HOV detour used about 0.8 miles of city streets. The eastbound mixed-flow traffic exited at Robertson Boulevard to Venice Boulevard to National Boulevard and then to Jefferson Boulevard. It then followed Jefferson Boulevard to La Brea Avenue where it reentered the freeway. This detour also used about 3 miles of city streets.

Motorists had many options on this stretch of road. They could continue to maneuver around the damage on the detour routes. They could switch to parallel freeways such as I-405, which opened before the earthquake. They could also use parallel arterials that were not officially designated as detour routes. Forming carpool groups to utilize the new HOV detours, or shifting to transit were also options. Most motorists, however, chose to remain in their own vehicles and adapt to the changing transportation environment rather than change their mode of travel.

Increases in transit usage in the I-10 damaged segment were minimal due to extensive parallel arterials. Daily bus ridership only rose by about 2,000 passengers in this area and remained consistent throughout the reconstruction process. By the middle of March, MTA officials began to scale back some of the newly added bus routes in the area due to the lack of ridership.

Providing an HOV-specific detour route increased commuter carpooling, although this increase was not significant. HOV volumes during the peak hour ranged from 1,000 to 1,300 vehicles during reconstruction and were about the

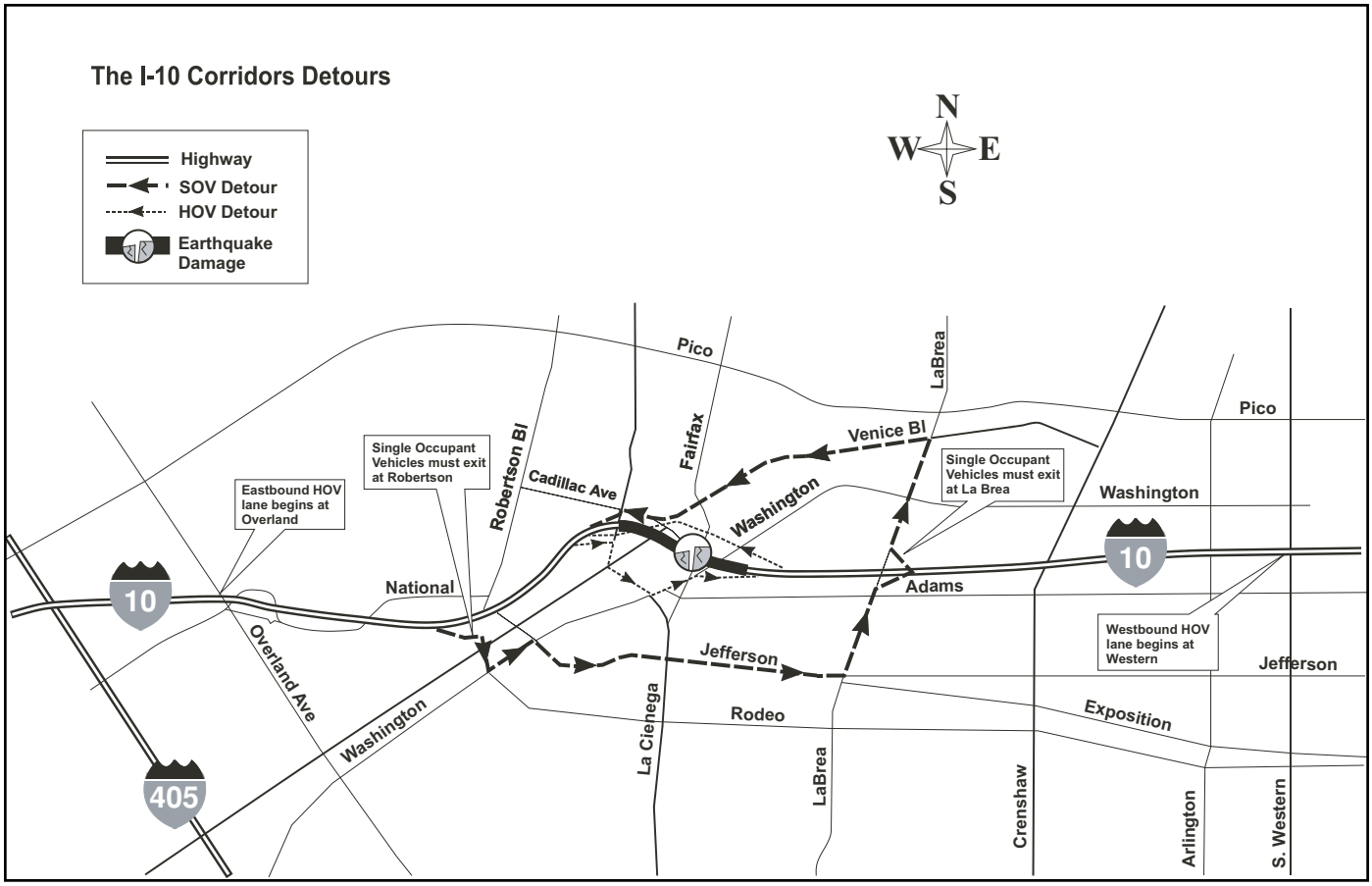


Figure 9. I-10 Detours

same prior to the earthquake. The reluctance of drivers to take advantage of ridesharing may be due to the fact that drivers did not see a significant time difference in using the HOV detour.

Between January 17 and February 1, daily traffic volumes on I-10 dropped drastically until the primary detours were established. Once the detours opened, volumes began climbing steadily, stabilizing at about 42 percent of pre-earthquake ADT. Table 7 shows the distribution of traffic on I-10 detours following the earthquake during peak hours.

Table 7. ADT on I-10 Detours

Alternative	Percent of ADT
Primary I-10 detour	42%
I-105 (parallel freeway)	2%
Other streets	41%
Trips eliminated (transit, telecommuting, and/or ridesharing)	15%

LADOT's "Smart Corridor" project on I-10, while only in the test phase in 1994, helped divert freeway traffic to detours as it was specifically designed to divert traffic from I-10. Smart Corridor uses the technology of the LADOT's ATSAC to monitor traffic flow. If there is heavy congestion or if there is an accident that backs up traffic on I-10, controllers within the ATSAC TMC can guide motorists off of the freeway and onto parallel arterial streets using VMS and hihway advisory radio (HAR). Those drivers detoured off the freeway are guided through the parallel streets and back onto the freeway past the area of congestion. For the Northridge detours, the Smart Corridor's fixed VMSs provided the way to communicate detour information with travelers. Moreover, the Smart Corridor technologies on I-10 allowed the LADOT to monitor the overall traffic situation and respond appropriately.

Variable message signs provided a way to communicate detour information with travelers.

SR-118 Detour

SR-118 runs through the northern section of Los Angeles County and into the Simi Valley section of Ventura County. The Northridge earthquake affected this freeway at a few locations but the worst damage was between I-405 and I-210, which resulted in complete closure of this section of roadway. Pre-earthquake average daily traffic in the area just to the east of the closure (measured west of I-405) was 121,000 vehicles per day.

Immediately following the earthquake, local street detours were implemented relatively easily due to the arterial network in the area. Traffic signals were re-timed to reflect the changes. By February 21, repairs had been completed to

the westbound SR-118 lanes. The westbound freeway section was set up to provide three lanes in each direction with a concrete barrier separation. This became the main SR-118 detour route. Figure 10 shows the SR-118 damage and alignment.

Figure 11, on the next page, shows the SR-118 detour. Because the junction of I-405 and SR-118 required closing, the I-405 north/southbound to westbound SR-118 detour required drivers to get off at Nordoff Street or Devonshire Street to Tampa Avenue. The westbound SR-118 detour took motorists to the exit at Rinaldi Street, onto Reseda Boulevard, and then to the SR-118 on-ramp. Some of the local street detours were carrying as many as 30,000 more vehicles a day. Peak period delays on the detour routes were as high as 30 minutes. Once the westbound SR-118 freeway detour opened, almost all delays were eliminated.

Until February 18, daily volumes recorded on SR-118 west of I-405 were less than 50 percent of the pre-earthquake volumes as motorists were looking for alternative routes. After the westbound lanes of the SR-118 were reopened, traffic stabilized at just over 110,000 vehicles per day (March 1994). The remaining 11,000 vehicles (from the pre-earthquake ADT of 121,000) continued to use parallel arterials.

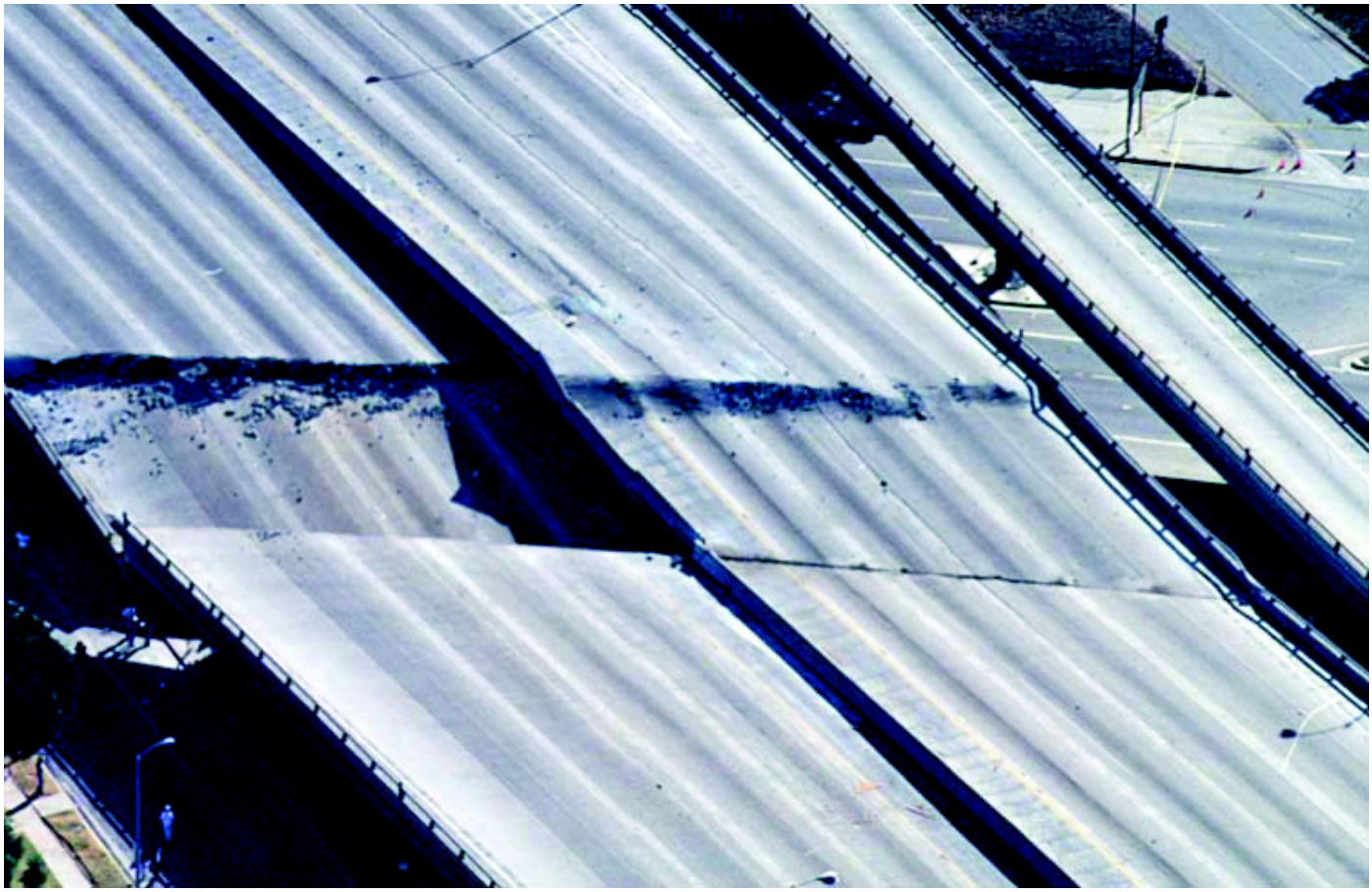


Figure 10. SR-118 Damage and Alignment

Metrolink in this area was not used as a viable transportation option, since the Ventura County line ran further south than the damaged areas. Ridership on the Ventura County line only increased by about 1,000 riders from the time before the earthquake to the time following. The area also has an extensive parallel arterial system, so motorists did not have to leave their cars and changes modes of transportation.

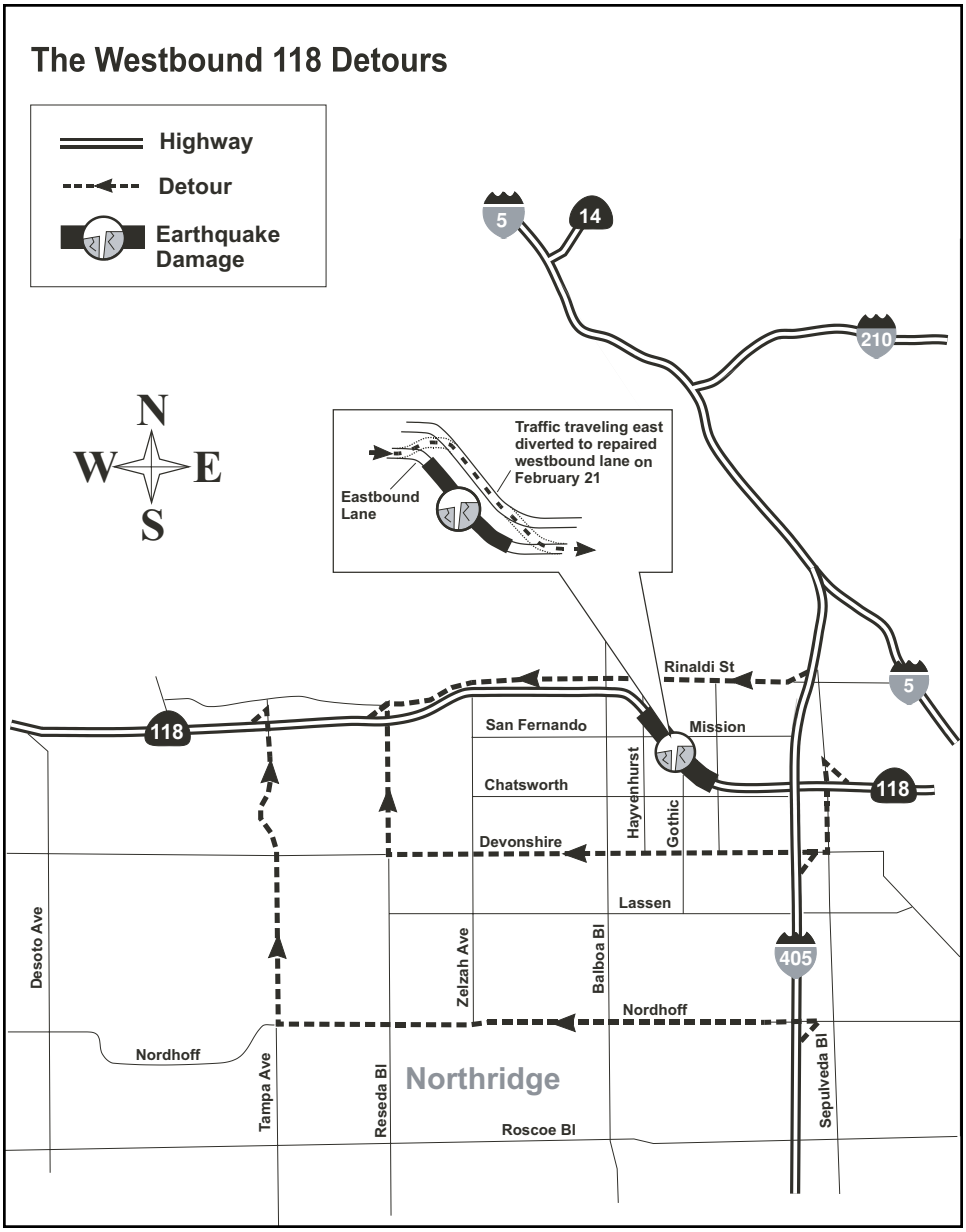


Figure 11. SR-118 Detours

Providing Travel Options

Strategies to encourage alternative transportation use including transit, HOV, and telecommuting were implemented within days of the disaster.

In order to completely restore regional mobility, transportation agencies understood that highway detours would not be enough. The Los Angeles region would have to begin to utilize alternate transportation modes (like transit, HOV, and telecommuting), which would be difficult in the auto-dependent region. Transit agencies reacted quickly to the potential demand increases. Three days after the earthquake, the SCRRA Board agreed to extend Metrolink commuter rail service north to Lancaster and west to Ventura County (through an agreement with the Southern Pacific Railroad) in an effort to provide mobility options to commuters. The Ventura County extension included the Moorpark stop shown in Figure 12. Metrolink also purchased new rail cars to increase existing service headways. Within 1 week, Metrolink had increased service on the Santa Clarita Line from 14 to 23 trains per day in order to accommodate a ridership increase from approximately 850 riders to 22,000 riders per day. Metrolink also decreased its ticket prices by about 50 percent for the Lancaster Station extension and 25 percent for the Santa Clarita Station.

Six of the bus transit systems operating in Los Angeles County added new emergency services, including new routes and revisions of existing schedules and services. Most of the bus service changes were implemented on routes on or near I-10. Three new park-and-ride lots also were created at strategic locations to encourage carpools and transit use. These lots were either newly constructed or leased, and were located in the vicinity of the I-5/SR-14 interchange.

Local agencies also developed a multi-faceted public awareness campaign to disseminate traveler information.

Caltrans, the MTA, Metrolink, LADOT, and other local agencies also developed a multi-faceted public awareness campaign to disseminate traveler information. The agencies put together a unified Commuter Action Plan to provide accurate information on alternative transportation options for residents and workers in the earthquake-affected areas through the use of newspaper, radio, and television public announcements. With the slogan "Together, We'll All Get Moving Again," the agencies also published an 8-page comprehensive newspaper offering regional transportation and commuter information for bus and rail routes and schedules, carpool partners, vanpools, park-and-ride lots and telecommuting centers, and a 1-800-COMMUTE number to disseminate information via telephone.

Table 8. Metrolink Ridership

Transit Agency	Pre-January 17 Ridership	Post-January 17 Peak Ridership	1995 Ridership
Metrolink lines:			
Total Ridership	9,551	31,276	16,600
Santa Clarita Line	1,017	21,952	3,000
Ventura County Line	2,154	3,050	3,000

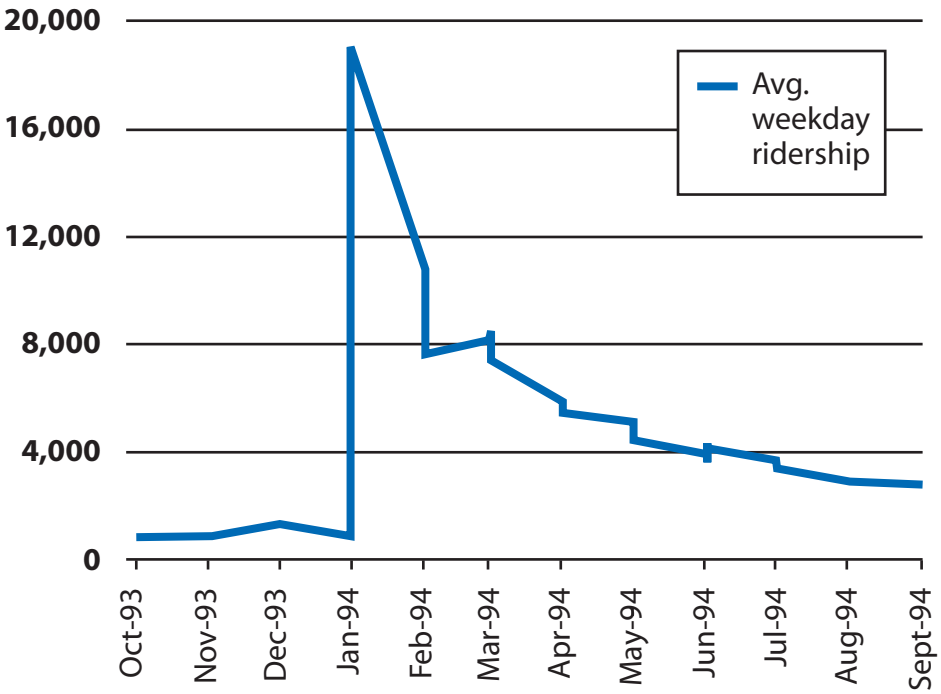


Figure 12. 1993-94 Metrolink Ridership

Table 8, on the previous page, shows the effects of the highway demand reduction measures implemented to encourage transit use on Metrolink lines. Ridership skyrocketed during reconstruction to 300 percent of pre-earthquake ridership levels. Figure 12 shows Metrolink ridership on the Santa Clarita Line. The opening of the new Metrolink lines kept ridership in 1995 slightly higher than pre-earthquake ridership; however, it is interesting to note that even at its peak, Metrolink ridership represented only about 4 percent of the total commuting trips in Los Angeles County. There was little change in MTA bus, subway, and light rail ridership during reconstruction.

Telecommuting and ride sharing also were encouraged after the Northridge earthquake. Although only about 7,000 people bought GTE and Pacific Bell telecommuting technologies for their homes following the Northridge earthquake, 90 percent of these people were still using telecommuting services in August 1994. Ridesharing did have an initial impact as a result of the HOV strategy; however, because of the relatively small time savings offered by the HOV detours, the increase in HOV vehicles was relatively minor. During the reconstruction period, HOV volumes ranged from 1,000 to 1,300 vehicles, although HOVs represented a higher proportion of the total average daily vehicle counts because of the overall lower traffic volume. After the reopening of I-10 on April 12, 1994, peak hour HOV volumes ranged from 1,200 to 1,500.

The media helped to communicate mobility information to travelers above and beyond informing motorists of detours, particularly by covering the expanded Metrolink service. Most commuters learned about Metrolink for the

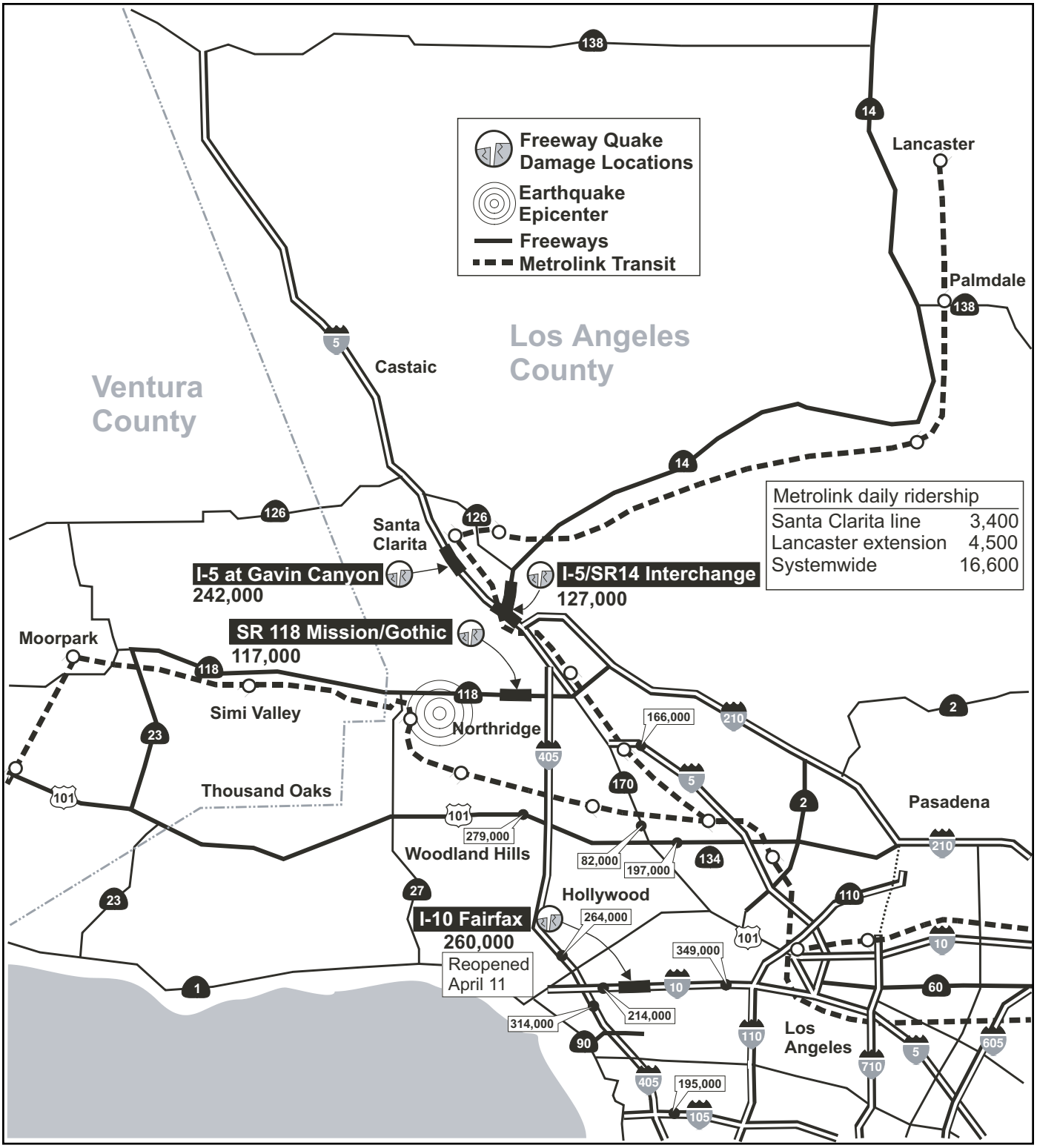
first time as a result of the news coverage following the earthquake. A study done by The Journal of Transportation and Statistics indicated that the news coverage helped *increase Metrolink ridership*.

Post-Earthquake Conditions

Table 9 shows the traffic volumes on the damaged freeway segments before the Northridge earthquake, during reconstruction, and post-construction. Figure 13, on the following page, shows post-event transportation conditions on a regional map. The post-construction ADTs show that after reconstruction, freeway traffic immediately returned to about 95 percent of pre-earthquake levels for the I-10, I-5, and SR-14 damaged corridors. SR-118 traffic volumes were significantly reduced on the day of the earthquake with some local streets carrying 30,000 or more vehicles until the main freeway detour was established. On February 21, the freeway detour opened, providing three travel lanes in each direction, and the ADT on SR-118 quickly rose to pre-earthquake levels.

Table 9. ADT Comparisons

Freeway	Pre-Quake ADT	Reconstruction ADT	Post-Construction ADT	Reopening Date
I-10	261,000	110,000	250,000	Reopened 4/12/94- traffic stabilized by June 1994.
I-5	133,000	88,000	127,000	Reopened 5/17-5/18/94.
SR-14	130,000	108,000	125,000	Reopened 7/8/94.
SR-118	121,000	110,000	120,000	Westbound lanes reopened 2/24/94; Eastbound lanes reopened 5/13/94.



Basemap source: Caltrans

Figure 13. Post-Earthquake Transportation Conditions

2.4 Post-Event Traffic Management Operations

Following the earthquake, a $12.64 million design-build contract was put into place to install new traffic monitoring and commuter information equipment to areas that were affected by freeway damage but were not covered by the existing traffic operations equipment. (Design-build contracting is explained more thoroughly in the Rebuilding the Transportation Network section of this report.) The contract between Caltrans and National Engineering Technology was agreed to on January 20, 1994.

The new field operations equipment included:

- 8 VMSs
- 9 HAR installations
- 7 CCTV locations
- 2 CCTV communication links
- 20 vehicle detector system locations
- 2 video image-processing locations.

The establishment of the Emergency Detour Management Center, which was later re-named the Earthquake Planning and Implementation Center (EPI-Center), was also part of this contract. Housed within the Caltrans district office in Los Angeles, it was built in order to maintain and monitor the new field equipment. The Emergency Detour Management Center also took some of the burden off of the existing Caltrans TMC by solely focusing on the earthquake affected areas and detour routes.

Where parallel arterials were used for detours, the number of incidents was significantly lower than areas where freeway capacity was simply reduced (lane closures).

The FSP also took an active role in managing post-earthquake congestion by providing 13 additional roving tow trucks to earthquake-affected areas. The deployment included extended peak schedules to all regular beats patrolled by the officers as well as two new beats for the I-5 and SR-14 detours. (A beat is a regular route followed by CHP patrol officers.) Following the Northridge earthquake (January 17 to May 1994), 90 percent, or about 15,000, of all assists made by the FSP were on beats covering the damaged freeway areas. The I-5 beat had the highest number of assists due to the few parallel alternative routes available for travelers. The comparisons of pre-earthquake and post-earthquake incidents on the damaged freeways show that where parallel arterials were used for detours, the number of incidents was significantly lower than areas where freeway capacity was simply reduced (lane closures).

Rebuilding the Transportation Network

Rebuilding the Los Angeles regional freeway network required a sustained effort by Caltrans and unprecedented cooperation between local, state, and federal government agencies. Through demolition, construction bidding, and reconstruction, the agencies involved exercised innovative solutions to existing "red tape" problems to restore the highway network.

The demolition of damaged highway infrastructure started on January 17, 1994, and operated around the clock until completion, using non-competitive bid contractors in all but one case. The demolitions of I-10 and I-5 damaged infrastructure were both started on January 17 and completed in 3 and 10 days, respectively, while the demolition of the I-5/SR-14 Interchange, which sustained significantly more damage, was started on January 18 and completed on March 17, 1994. Figure 14 shows the demolition of I-10 at La Cienga Boulevard.

Rebuilding the Los Angeles regional freeway network required a sustained effort by Caltrans and unprecedented cooperation between local, state, and Federal Government agencies.

Figure 14. Demolition of I-10 at La Cienga Boulevard

In the first days following the earthquake, Caltrans and FHWA discussed bidding, and eventually signed a memorandum of understanding (MOU) on January 26, 1994, which outlined the three bidding procedures:

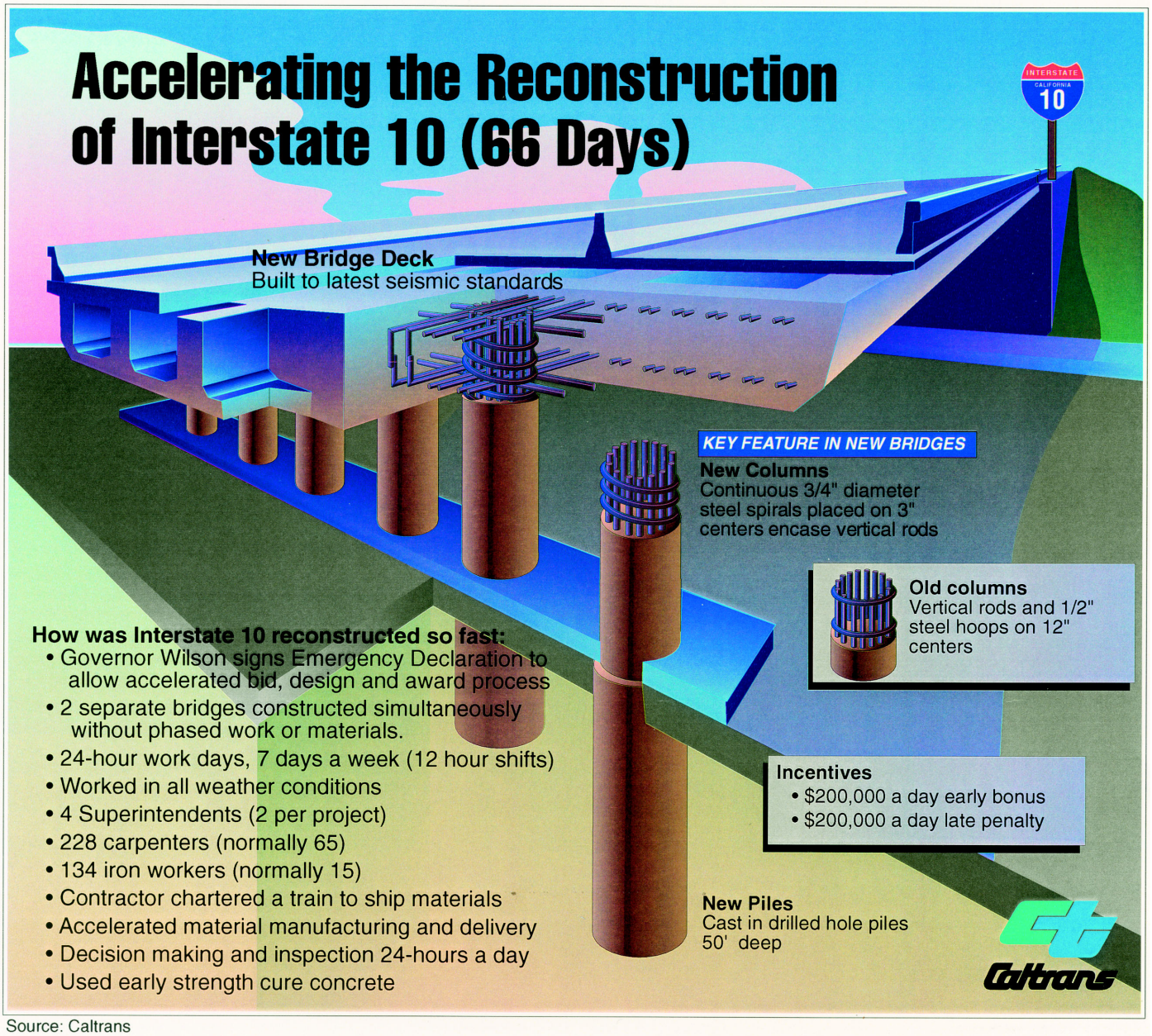
1. A+B bidding
2. Invitation-to-bid procedures
3. Design-build bidding.

A+B bidding is a "cost-plus-time" bidding procedure that selects the lowest bidder based on a combination of the contract bid items (A) and the amount time (B) needed to complete the project or a critical portion of the project. A+B bidding is used to motivate the contractor to minimize the overall time on high priority and high usage projects. This encourages contractors to finish early by offering bonuses (incentives) for early completion and assessing fines (disincentives) for late completion.

Invitational bidding was another procedure used to expedite contract administration by FHWA and Caltrans. This concept was used for those projects that had high user delay costs and an urgent need for early completion. These projects were expected to have short time frames for Caltrans to prepare the bid packages, greatly expedited advertising periods for the contractors to submit bids, and one-day bid openings and awards. Limiting the number of bidders on these critical projects allowed Caltrans to provide packages to the contractors quickly and answer questions. The MOU, signed on January 26, 1994, between Caltrans and FHWA, outlined the criteria to be used for the invitation-to-bid approach. Caltrans Headquarters Structures Division identified contractors to be on a "short list" for the invitational bidding based on internal criteria. Caltrans used the invitation-to-bid approach on 8 of the 10 A+B earthquake reconstruction contracts.

Design-build construction is another contracting mechanism that allows initial construction to begin before final drawings for design are approved. Following the Northridge earthquake, Caltrans had 70 design engineers in place and ready to being work on plans for the damaged freeway sections. Contractors submitted technical proposals for construction work, and those proposals that met the minimum technical guidelines were allowed to participate in the price proposal section of the bidding.

The use of ER funds (see page 38 for a more complete discussion) allowed for non-competitive bidding for work and contracts either negotiated or by force accounts as best suited by public health and safety. ER projects are exempt from regional planning and transportation improvement plan (TIP) and air quality conformity requirements as long as the damaged structures are replace in-kind, i.e. not significantly different from the original structure, and in-place, i.e., in the same place as the original structure.



Source: Caltrans

Figure 15. Caltrans Reconstruction Public Outreach

The use of ER funds and innovative contracting procedures allowed for the expedited rebuilding of the Los Angeles regional transportation network. The closure of some of the most heavily traveled roadways, including I-10, was costing the community about $1 million a day, reinforcing the need for the construction process to be done as quickly as possible. For the major reconstruction projects, the time period from advertising to awarding the contract ranged from 3 to 30 days. Construction on I-10 and SR-118 began in late January and early February 1994. The demolition of the old I-5/SR-14 Interchange was complete on March 17, 1994, and construction on the new infrastructure started shortly thereafter.

Table 10. Freeway Reconstruction Incentives

Freeway Segment	Work began	Work Finished	Incentive-Disincentive	Bonus
I-10	February 5, 1994	April 11, 1994 74 days early	$200,000/day	$14.8 million
SR-14/I-5 Interchange*	March 19, 1994	July 8, 1994 35 days early	$100,000/day	$3.5 million
SR-14/I-5 Interchange**	July 9, 1994	November 4, 1994 on schedule	$20,000/day	N/A
I-5 at Gavin Canyon	January 29, 1994	May 17, 1994 Southbound; May 18, 1994 Northbound 33 days early	$150,000/day	$4.95 million
SR-118 Eastbound	February 10, 1994	May 13, 1994 8 days early	$50,000/day	$400,000

** South SR-14 to South I-5; North SR-14 to North I-5.*
*** South SR-14 to North I-5; South I-5 to North SR-14*

Construction on three of the four Los Angeles freeways was completed ahead of schedule. Table 10 shows the construction schedule for the major damaged freeway segments and the monetary incentives for early completion. Figure 15 shows part of the public outreach campaign used by Caltrans to tout the rapid reconstruction of I-10.

3.0 Findings

3.1 Advance Preparations and Planning

Experience with previous earthquakes has significantly strengthened the preparedness of the California transportation system for seismic activity. After the damage and destruction to several bridges and overpasses during the 1989 Loma Prieta earthquake in Northern California, the California State Legislature enacted a plan for seismically retrofitting vulnerable bridges and overpasses throughout the state, and, prior to the Northridge earthquake, 122 state bridges in the Los Angeles region (out of 456 in the region designated)

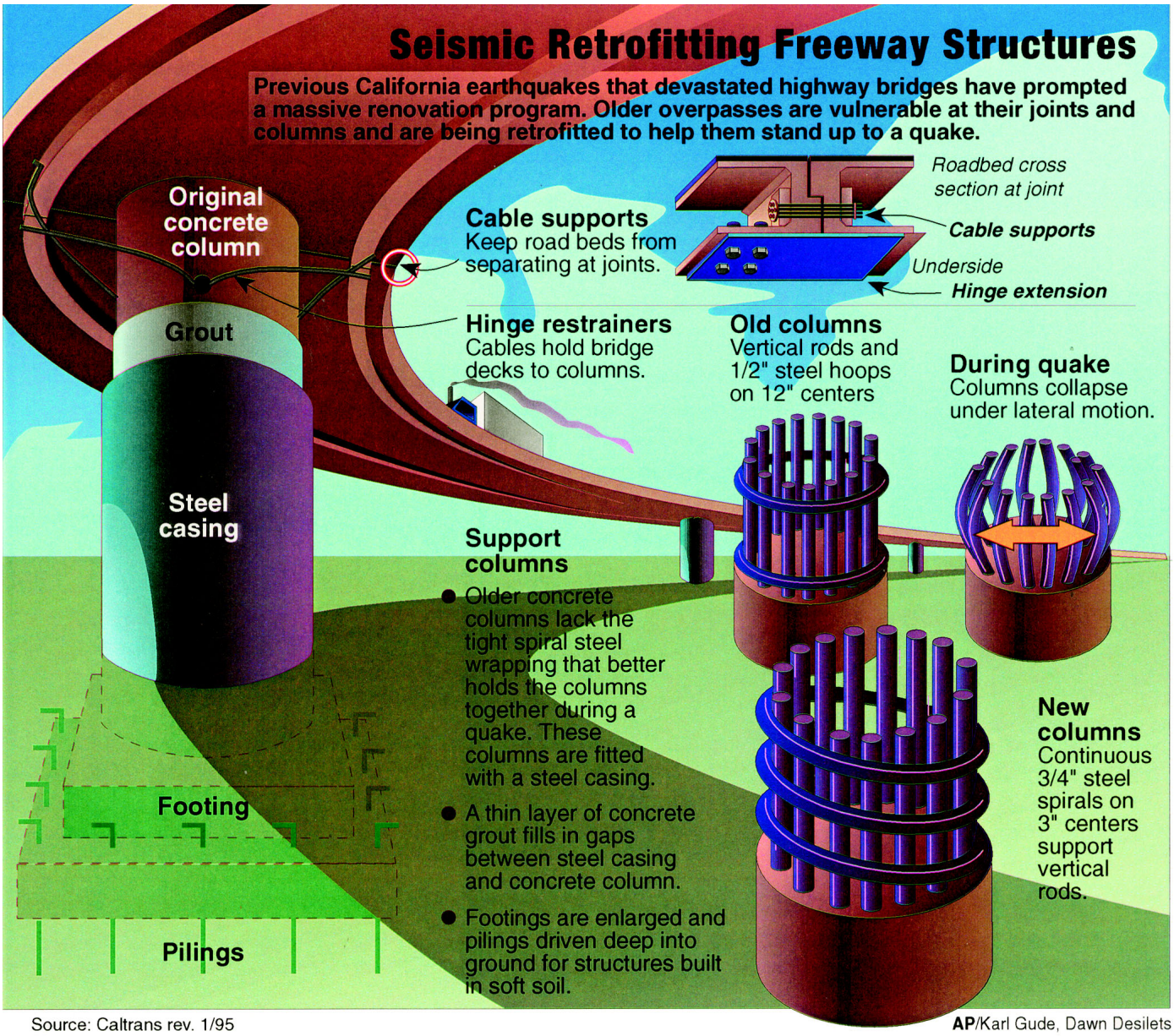


Figure 16. Seismic Retrofitting Outreach program

had already been retrofitted. Consequently, none of these bridges were damaged during the Northridge earthquake.

After the Northridge earthquake, Caltrans continued its bridge retrofitting program and implemented an extensive public outreach program to gain support for additional bridge retrofitting. Figure 16, on the previous page, shows an example of the seismic retrofitting process presented to the public.

But seismic activity is just one in a number of events for which the Los Angeles region must prepare. Los Angeles hosted the 1984 Summer Olympics and has many large-scale entertainment and sporting events each year, all requiring significant traffic management and emergency preparedness. Los Angeles and the rest of the State of California also must plan for significant environmental emergencies. In fact, in the 1970s, fire officials developed the Incident Command System (ICS), now widely adopted across the country, in response to a series of major fires in Southern California. At that time, municipal, county, state, and federal fire authorities collaborated to address severe recurring problems that occurred when fighting forest fires. From non-standard terminology to a lack of integrated communication systems, the ICS addressed issues that enabled consolidated action plans to be developed.

The result was a comprehensive model for effective incident management. By applying a common organizational structure and key management principles in a standardized way, ICS has evolved into an "all-risk" system appropriate to all types of emergencies that has been adopted by FEMA for use by communities to better prepare for emergency situations. ICS was used after the Northridge earthquake, with FEMA coordinating the Federal emergency response.

In times of crisis, both the City and County of Los Angeles activate their Emergency Operations Centers (EOC), built after the 1992 Los Angeles riots. The EOCs were activated at 4:35 a.m., 5 minutes after the Northridge earthquake. The centers, originally built to withstand a nuclear blast, are intended to facilitate interagency decisionmaking and information flow. They accomodate utility representatives and representatives from various City of Los Angeles departments including public works, fire, police, building and safety, transportation (LADOT), city administration, and the mayor's office. Also represented at the EOCs are the Los Angeles County Sheriff's Department, the MTA, the CHP, and Caltrans.

Caltrans has run the Los Angeles TMC from its office in downtown Los Angeles since its inception in 1971. Staffed 24 hours a day, the TMC includes computer-aided dispatch, VMS, and live CCTV updates, as well as other traffic management technologies. TMC staff is responsible for sending out the FSP to respond to traffic incidents as they occur.

3.2 Institutional Coordination

Traffic Management

A team of traffic engineers from Caltrans developed the Traffic Management Plan (TMP) to coordinate all traffic operations for the region. The TMP set in motion many different measures, with its top priority to organize and identify the detours that were to be set in place. It also planned for transit adjustments to handle the new influx of ridership.

The Caltrans TMC was the initial site of traffic management following the earthquake. Besides its traffic monitoring capabilities (VMS, CCTV, and traffic counters), the TMC deployed the FSP, which is jointly run by Caltrans, the LADOT, and the CHP. As was discussed earlier, directly following the earthquake, the FSP deployed 157 tow trucks to the regional freeway system and extended their regular peak commute hours. The tow trucks were equipped with radios and a mobile traffic data terminal, which allowed the drivers to communicate with dispatchers at the TMC. In January 1994, the freeway service patrol assisted about 1,250 motorists. That number peaked at about 4,100 in March 1994, or 14,898 total motorists from January to May 1994.

Reconstruction

In managing the damage to the transportation system in Los Angeles, Caltrans took the lead on coordinating the transportation response with the LADOT, CHP, and FHWA. Working with the FHWA and regional transit agencies as well as the LADOT, Caltrans assessed the damage on the day of the earthquake and quickly set up detours around the damage. Caltrans then worked closely with the FHWA to rebuild the highway network.

Federal, state, local, industry leaders, and officials took a "hands-on role" in the stages of recovery. The early presence and participation of the Secretary of the USDOT, the FHWA Administrator, the Governor of California, the Director of Caltrans, the Mayor of Los Angeles, leadership within industry and the private sector, and many others, set a tone of commitment to the public. It demonstrated that government would work with the private sector to expedite the reconstruction effort.

The decision to replace damaged facilities in-kind and in-place also helped expedite the reconstruction efforts. This minimized the environmental and right-of-way impacts of recovery reconstruction and was possible because of the use of ER funds for reconstruction. It also facilitated the use of as-built plans and other available historical data for expediting the re-design process. Figure 17 shows the reconstruction of the regional freeway network.

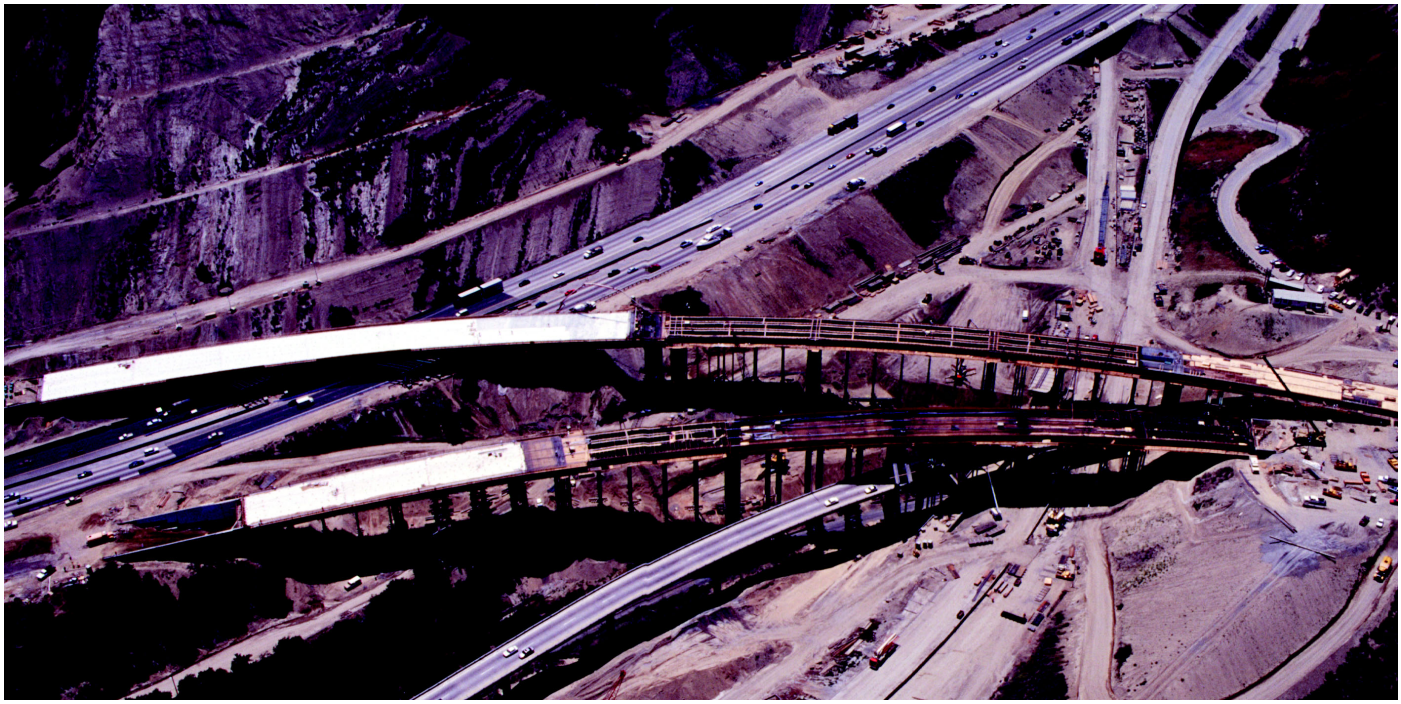


Figure 17. Reconstruction of Los Angeles Freeways

The Role of FEMA

FEMA coordinated the response of the 27 federal agencies involved in the Northridge earthquake using the FEMA ICS. With the coordination of agencies, services were provided quickly, decisions were made based on need and without the usual formal process, and financial challenges were overcome. FEMA positioned emergency equipment and supplies for the state's use at a nearby Air Force base and opened an Earthquake Service Center with representatives of all disaster assistance agencies to aid victims. Coordinating with other federal agencies, FEMA helped make some of the big decisions involving transportation, expediting the loan process for victims, and disseminating useful information to the residents of Los Angeles County.

The Role of the FHWA

An established relationship and partnership existed among Caltrans, the FHWA, and the construction industry. The relationship and partnership was grounded in the Federal-Aid Highway Program and the extensive experience that FHWA and Caltrans had in cooperatively administering and implementing the highway program.

In July 1977, Congress authorized a special program from the Highway Trust Fund for repair of damaged roadways—the ER Program. The ER program funds are available for use by the FHWA to help with the repair or reconstruction of federally funded roadways that are damaged as a result of a natural disaster or catastrophic failure from an external cause. Damage, however, must to be severe, must occur over a large area, and must result in unusually high expenses to the state highway agency. FHWA can provide up to $100 million in ER funds to a state for each natural disaster and if a disaster exceeds the $100

million state limit, Congress may allow for an increase. The cap was raised to $100 million in 1987 following many large-scale disasters, such as the Mt. St. Helens volcano in 1982.

Following the Northridge earthquake, FHWA initially released $45 million to begin work on clearing debris and demolition. The $100 million funding limit was soon reached due to the amount of damage, and additional funds were made available based on damage and reconstruction estimates. Although transit costs are generally not covered under FHWA ER funds, approximately $9.3 million was set aside to help expand Metrolink commuter rail service in order to replace some of the commuting capacity lost with the damaged freeways. FHWA ER funds released for the Northridge earthquake totaled $350 million.

3.3 Guiding Priority: Mobility

The dependence of the Los Angeles population on the highway network underscored the importance of transportation agencies to restore regional mobility. Because the earthquake occurred in the early morning hours of the Martin Luther King holiday when traffic volume was extremely light, emergency response needs were limited, and agencies were able to focus rather quickly on mobility decisions. In a report published after a review of transportation decisions made in response to the earthquake, the Transportation Research Circular (published by the Transportation Research Board and the National Research Council) reported several mobility findings:

- Providing immediate transportation solutions took precedence over the opportunity to change motorist behavior.
- Stabilization of traffic conditions took several weeks to several months.
- Where sufficient alternate routes existed, motorists continued driving; where convenient detours were not available, transit options became much more attractive.
- Availability of accurate traffic data was critical in developing emergency detours.
- Areas with well-developed traffic management centers were able to accommodate sudden traffic changes more easily.

3.4 Communications

In the hours following the earthquake, cellular phones and radios were the only means of communication for emergency personnel.

Communication immediately after the Northridge earthquake was very difficult for both emergency workers and residents. Power was out for most of the area, which affected the operation of the central phone system. There were numerous fires at electrical stations and telephone switching stations. One reason for phone service failure after the earthquake was that the system itself was overwhelmed. There were many phones off the hook, either knocked off by the earthquake or because of the volume of calls. The system will automatically turn itself off when a certain percentage of phones are off the hook, to limit the amount of damage done to switching stations and allow for faster service restoration.

In 1994, the use of cellular phones was just starting to become widespread. During the 1989 Loma Prieta earthquake, cell phones were some of the only communications tools working and proved invaluable. In the first hours following the Northridge earthquake, with landlines out, cellular phones and radios were the only means of communication into and out of the earthquake area for emergency personnel. However, communication in the canyon areas was intermittent due to terrain and limited coverage, and it was very difficult to get a signal for a cell phone or a radio. Since much of the earthquake damage occurred there, the surrounding terrain hindered communications during the initial stage of recovery. Other communication tools were used extensively, such as pagers, FAX machines, and electronic data sharing via computer. Another source of communications was the use of helicopter surveillance to find areas of congestion and problems and transfer the information to commuters via radio, television, or signage on the highways.

Caltrans implemented an extensive public information campaign to keep the public informed about construction activities.

As noted earlier, the media was essential in getting transportation-related information to the people in the Los Angeles area. Daily press conferences and bilingual information hotline was established to give that gave out detailed transportation information.

Caltrans also implemented an extensive campaign to keep the public informed about construction activities. Cooperating with the LADOT and CHP, Caltrans produced about 200 each of Los Angeles County Road Closures Reports and Special Bulletins. In addition, a brochure *Accelerate, Caltrans' Action Plan to Get All Our Freeways Moving Again*, was distributed in Los Angeles are newspapers on March 27 and mailed to non-subscribing households that same week. Over 2.6 million copies of *Accelerate* were distributed by June 1994.

3.5 The Role of Advanced Technology

As has been already discussed, the Caltrans TMC served as the center of decision-making efforts by the traffic management teams after the 1994 Northridge earthquake. Extensive traffic management capabilities were already in place on most of the major freeways well before the earthquake, including speed monitoring loop detectors, CCTV, on-ramp meters, and permanently mounted VMS. The TMC used backup electrical generators for power and relied on landline telephones for primary communications.

Although the TMC was able to initially deploy the FSP and serve as an emergency command center for the regional highway network, it quickly became evident that the existing TMC could not handle all the unprecedented congestion generated by an earthquake, as it was already operating at capacity. The TMP recognized this, and with federal emergency relief funding of $12.64 million, implemented the Earthquake Planning and Implementation Center (EPI-Center). The 2000-square-foot EPI-Center opened on April 17, 1994, and acted as a hub for many advanced technologies that facilitated the traffic management in the disaster areas. Connected with the TMC, the EPI-Center is used only when an earthquake occurs to relieve some of the burden on the TMC. The goal of the EPI-Center was to focus on communication between transportation and emergency officials and commuters, relaying important information directly to those affected. The EPI-Center was vital in coordinating the traffic management deployments and giving traffic engineers accurate and immediate information. This allowed them to make better decisions and to collect information about the changes in the traffic behavior during a disaster.

An Earthquake Planning and Implementation Center, connected to Caltrans's Traffic Management Center, coordinates communication among transportation and emergency officials and the public.

Since the 1994 Northridge earthquake, the TMC has updated the means by which they relay traffic information. Cable TV is now being used, real-time traffic information is available on the Internet, and Teletext, a scrolling sign placed at key points in the freeway system, updates commuters to potential back-ups.

3.6 System Redundancy and Resiliency

Highways

In an area the size of Los Angeles (about 9,000,000 people in 1994) redundancy in the transportation system is extremely important, especially for work commutes. LADOT's "Smart Corridor" project has identified these parallel arterials as an important option for commuter traffic. The Santa Monica Freeway (I-10) Smart Corridor was designed to help ease the congestion on this extremely busy roadway. When the Northridge earthquake hit in 1994, the Smart Corridor project was still being tested on I-10.

Pre-identified arterial detour routes were important for maintaining commuter mobility after the disaster.

This system has the ability to divert freeway traffic onto the arterial streets during times of heavy congestion. Having these arterials available for detours following the Northridge earthquake was a tool that the transportation agencies were able to use to help relieve some of the post-earthquake traffic burden.

Transit

An extensive existing transit system also provided critical commuter options.

In addition to roadway redundancy, having a reliable and extensive public transportation system alleviated some of the initial congestion caused by reconstruction. With an already extensive bus system, the LACMTA increased Metrobus service following the earthquake to respond to the demands of commuters. Metrolink, though still in its infancy, extended lines further into northern Los Angeles County and into neighboring Ventura and Orange counties.

During construction, transit use tripled on MTA and Metrolink rail and bus lines (on average); however, 1-year later, transit use fell to pre-earthquake ridership levels.

Telecommuting

Telecommuting during the time following the Northridge earthquake became another important option for affected commuters. Caltrans, the MTA, Metrolink, the City of Los Angeles, and other local agencies developed the Commuter Action Guide to encourage alternative transportation. The Commuter Action Guide gave valuable advice to those wanting to learn how to set up telecommuting program; this information was also available by calling 1-800-COMMUTE, the hotline for commuters. Pacific Bell and GTE were two communications companies that set up telecommuting centers to help their customers.

Pacific Bell set up an Emergency Telecommuting Relief Package on January 20, for their customers. Installation charges were waived for all businesses and individuals who had proof that their commute to work was made worse by the highway damage. This package also included Centrex business telephone service, Integrated Services Digital Network (ISDN), and voice mail. Pacific Bell also had a $1 million loan program for equipment including modems and terminal adaptors for small businesses, schools, and non-profit organizations.

Local telecommunications companies offered free and discounted services to encourage telecommuting.

GTE also had similar services available. They waived basic monthly phone rates for up to 90 days for people affected by the earthquake. They also offered free services for 1 year to earthquake victims who transferred a number to a new location, re-established phone service at their existing location, or used the remote call-forwarding feature. GTE's telecommuting package included a second phone line, three-way calling, call waiting, voicemail, and for businesses, the addition of a toll-free line. They also had ISDN capabilities and other data communications technologies. The charges for setting up the telecommuting

package were waived through February. GTE also established teams to educate customers on the different telecommuting options and also promoted the benefits of telecommuting during this time.

Ninety percent of those surveyed who signed up for packages (random sampling of 1,300 customers) were still working from home in August. Telecommuting proved to be an important option for those affected by the Northridge earthquake and also aided the reconstruction efforts by having those people off the roads. Telecommuting might be an important option for businesses to have in the case of any future emergency situations.

Intermodal Freight

Detour routes were improved over time to better accommodate freight mobility needs.

The redundant highway network proved effective for the intermodal freight movements in Southern California. Initially, congestion and circuitous routing did impair freight transfer. Public officials, however, moved quickly to restore facilities after the earthquake and were quick to make changes to solutions that were not working. The initial detour for I-5, for example, directed truckers on a circuitous route to the 101 Freeway. But during the first few weeks, more direct detours were implemented. With the implementation of the Old Road detour, trucking through the I-5 corridor returned to "almost exactly its pre-earthquake patterns."

The reconstruction of the highway network and related detours had little financial impact on the trucking industry. A study undertaken by the California State Polytechnic University indicated that revenues declined by 0.2 percent in the first quarter FY '94 while first quarter costs increased by 3.5 percent. Moreover, some trucking companies gained customers as a result of the earthquake as there was a need to transfer or deliver goods so that these customers could resume normal operations.

The rerouting and rescheduling strategies of trucks due to the freeway detours and changing customer base following the Northridge earthquake were made on an ad hoc basis rather than as a part of pre-arranged earthquake responses. Only 15 percent of the trucking companies surveyed in the study by the California State Polytechnic University had plans to prepare for future earthquakes.

4.0 Conclusions

The Northridge earthquake caused extensive damage to the freeway system in Los Angeles County, California, shutting down four major freeways (I-5, SR-14, I-10, and SR-118) in some of their busiest locations. The damage required decision makers in the Los Angeles region, the State of California, and the federal government to make decisions with respect to the challenges that the region would face. Caltrans played a key role in decision making for the region and made two key decisions quickly after the earthquake: to rebuild the damaged freeways, and to retain traveler mobility and keep traffic flowing as smoothly as possible during reconstruction.

The 1994 Northridge earthquake generated the equivalent of nearly a year's worth of highway projects in a single event. While freeway damage was extensive, an earthquake of the same magnitude with an epicenter closer to urban Los Angeles could have caused much more extensive damage and loss of life. Because the Northridge earthquake occurred on a holiday, traffic volumes were significantly lower on that Monday compared with those of a normal workday, giving transportation agencies time to deal with the regional freeway destruction. The media discouraged people from driving through various forms of news coverage during the week following the earthquake, and many people stayed home to repair damage further reducing travel demand. By the time commuters returned to normal work schedules, detours had been implemented, alternative commuting modes had been publicized, and much of the demolition of the damaged freeways and initial construction had already begun.

Transportation officials can learn from the successes of the Northridge transportation response from the following six lessons:

- ***Advance preparations mitigated damaged:*** None of the 122 state bridges that were retrofitted in Los Angeles County as a result of the program begun in response to the 1989 Loma Prieta earthquake were damaged during the Northridge earthquake.
- ***Redundant arterials provided traveler mobility:*** The extensive highway network in the region allowed vehicles to be diverted off of I-10 and SR-118 to local streets to retain traveler mobility and safety with minimal delay. Where parallel arterials were limited or non-existent (near the I-5 and SR-14 damaged sections), detours were more difficult to implement and travel times were greatly increased during the reconstruction period.
- ***Traffic management centers provided operations:*** Caltrans and the LADOT both had TMCs operating in Los Angeles County before the earthquake.

- ***Public transportation and other mode alternatives provided travelers with commuting options:*** Transit agencies reacted quickly to the possibility of increased demand by extending transit lines and increasing transit frequency. SOV restrictions also encouraged travelers to find alternatives to commuting alone. Telecommuting also provided an alternative to the daily commute. These actions provided the traveling public with alternatives to travel, but it should be noted that traffic volumes returned to normal almost immediately after the freeways were opened to regular traffic.
- ***Innovative contract bidding and construction methods minimized construction time and increased accountability:*** The use of A+B bidding (including incentives and disincentives) and other contracting mechanisms like design-build construction allowed for close coordination and transparency between the FHWA, Caltrans, and construction contractors.
- ***The multimodal response did not change traveler behavior:*** Before the Northridge earthquake, transportation options were available, but not widely used. Metrolink commuter rail and MTA subway, light rail, and bus services provided commuting options to the region. During construction, transit use tripled on MTA and Metrolink rail and bus lines (on average); however, at its peak, Metrolink ridership represented only about 4 percent of the total commuting trips in Los Angeles County. One year after the Northridge earthquake, transit use fell to (approximately) pre-earthquake ridership levels.

Appendix A: Northridge Earthquake Chronology

Day 1 – Monday, January 17, 1994

4:30 a.m.:	An earthquake of a magnitude of 6.8 occurs in the Los Angeles area, centered in Northridge. Damage spreads over 2,100 square miles and through three different counties.
4:31 a.m.:	5.9 aftershock.
4:35 a.m.:	Emergency Operations Center is activated.
4:45 a.m.:	FEMA Response begins.
5:35 a.m.:	Region IX Regional Operations Center is activated.
5:45 a.m.:	Mayor Riordan declares a state of emergency.
6:00 a.m.:	FEMA Headquarters Emergency Support Team is activated.
6:45 a.m.:	As many as fifty structure fires have been reported, in addition to numerous ruptures in water and natural gas mains. Power outages reported citywide.
9:05 a.m.:	California Governor Pete Wilson declares a State of Emergency.
9:45 a.m.:	All active fires were under control.
2:08 p.m.:	President Clinton declares a national disaster for Los Angeles County.
7:00 p.m.:	Disaster Field Office is opened.
7:00 p.m.:	First of several contracts are in place and crews begin to work on debris clearance and highway demolition.

Other Day 1 Events

March Air Force Base is designated as the Federal Mobilization Center.

U.S. Public Health Service deploys four Disaster Medical Assistance Teams to the disaster area.

FEMA deploys two urban search and Rescue teams.

American Red Cross sets up 26 shelters; Salvation Army sets up 5 shelters.

EPA responds to investigate a 200,000-gallon oil spill into the Santa Clarita River.

Many major freeways and roadways are partially or completely closed, diverting massive amounts of vehicles onto adjacent streets.

Within hours of the earthquakes, existing Emergency Operations Centers set up initial detours for the damaged roadways.

Caltrans Traffic Management Plan (TMP) is set in motion to organize
detours, plan for transit adjustments, and deploy ITS technologies controlled by the Earthquake Planning and Implementation Center (EPI-Center).

Caltrans decides to take two arterials parallel to a damaged roadway, re-stripe them and operate them one-way only during peak periods, open truck bypass lanes to all traffic, and add an HOV lane in each direction.

Day 2 – Tuesday, January 18, 1994

All I-5 lanes are closed except northbound I-5 to northbound SR-14 truck lanes.

All SR-14 Lanes are closed. Local streets are used as detours.

All I-10 lanes are closed between Centinela and Washington Blvd. Local streets are used as detours.

All SR-118 lanes are closed between Tampa Ave and I-210. Local streets are used as detours.

The Mobil Emergency Response System (MERS) arrives in southern California with 28 telecommunication specialists.

FEMA Special Facility Tele-registration Center is activated.

Day 3 – Wednesday, January 19,1994

Casualty Information Center reported 2,400 injuries treated and released at area hospitals, 526 hospitalized, and 40 deaths.

President Clinton arrives in Los Angeles.

Los Angeles Mayor Riordan declares a curfew.

Caltrans and National Engineering Technology agree to design-build contract for new traffic operations technologies.

Tele-registration lines are expanded from 57 to 336 lines.

Metrolink enhances services to handle immediate increase in ridership, including using buses and taxis as shuttles to

Metrolink stations, adding three park-and-ride lots with 900 new spaces near a damaged interchange, enhancing routes and schedules for rail and bus service, allowing bicycles on Metrolink rail.

Metrolink adds parking spaces at Santa Clarita station and increases number of trains during peak rush hours.

A new station is opened in Northridge on the Metrolink Ventura rail line and 2 new stations are added to the end line.

Six LA County bus systems add new routes, modify existing routes, and extend schedules in areas affected by damaged roadways.

Day 5 – Friday, January 21, 1994

I-10 northbound and southbound connectors to I-405 are opened.

Metrolink rail opens 2 (of 4) new stations (eventually with 7 new trains), extending the Santa Clarita line to service commuters in an area along one damaged freeway corridor.

Day 9 – Tuesday, January 25, 1994

Metrolink ridership hits 22,000 boardings per day, up from the normal average of 1,000 per day, along the new extension of the Santa Clarita rail line serving areas surrounding earthquake-damaged roads. (Ridership decreased steadily during road reconstruction, and leveled off at 4,500 upon completion of road repairs.)

Day 10 – Wednesday, January 26, 1994

Demolition of the I-5 Gavin Canyon structures is complete.

Day 12 – Friday, January 28, 1994

The southbound SR-14 to southbound I-5 truck bypass opens one HOV and one mixed-flow lane.

I-5 detour route is opened using a reconstructed frontage road.

Day 13 – Saturday, January 29, 1994

The Old Road detour opens two lanes in each direction through Gavin Canyon.

Day 15 – January 31,1994

Sierra Highway is restriped for three southbound lanes and one northbound lane.

San Fernando Road also begins operating three south-bound lanes and one northbound lane.

Sepulveda Blvd operats as a one-way street between San Fernando
and I-5.

End of January 1994

Lane capacity in the damaged roadway corridors is re-stored to 70 percent of the pre-earthquake level.

Along one damaged freeway corridor, 4 new commuter rail stations have been opened, extending commuter rail service along the Santa Clarita line for 50 miles.

January/February 1994

Commuter express bus services between Santa Clarita and downtown LA are rerouted to compliment Metrolink, but no additional services are provided.

Early February 1994

Regular system of detours and emergency express bus service are in operation. A fifth new station is added to the Santa Clarita Metrolink line.

Day 20 – February 5, 1994

Construction on I-10 Santa Monica Freeway begins.

Construction on Camarillo Metrolink begins.

Day 23 – February 8, 1994

For SR-118, all lanes remain closed from Roseda Blvd to I-405.

Local streets were used as detours for this closed segment.

Day 28 – February 13, 1994

Metrolink Princess Station Opens

Day 29 – February 14, 1994

Camarillo commuter rail station construction is complete.

Day 34 – February 19, 1994

SR-118 detour opens.

Day 36 – February 21, 1994

Westbound SR-118 is reconstructed and restriped to provide three eastbound and three westbound lanes, replacing the detours on local streets.

Day 46 – March 3, 1994

MTA is asked to submit strategies for further traffic reduction.

Day 60 – March 17, 1994

Demolition of the I-5/SR-14 interchange is complete.

Day 63 – March 20, 1994

A 5.3 aftershock causes new damage.

April 1994

Commuter bus service is expanded; 3 new express routes are added.

Day 85 – April 11, 1994

I-10 Santa Monica Freeway opens 74 days ahead of schedule.

Day 121 – May 17, 1994

I-5 Golden State Freeway at Gavin Canyon opens.

Mid-May 1994

Major portions of the most heavily damaged freeways reopen to traffic.

Day 173 – July 8, 1994

The I-5/SR-14 freeway interchange re-opens three weeks ahead of schedule.

July 1994

Some mainline freeway connectors reopen.

Day 230 – September 3, 1994

SR-118 Simi Valley Freeway opens more than two weeks ahead of schedule.

November 1994

Last connector ramps reopen.

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