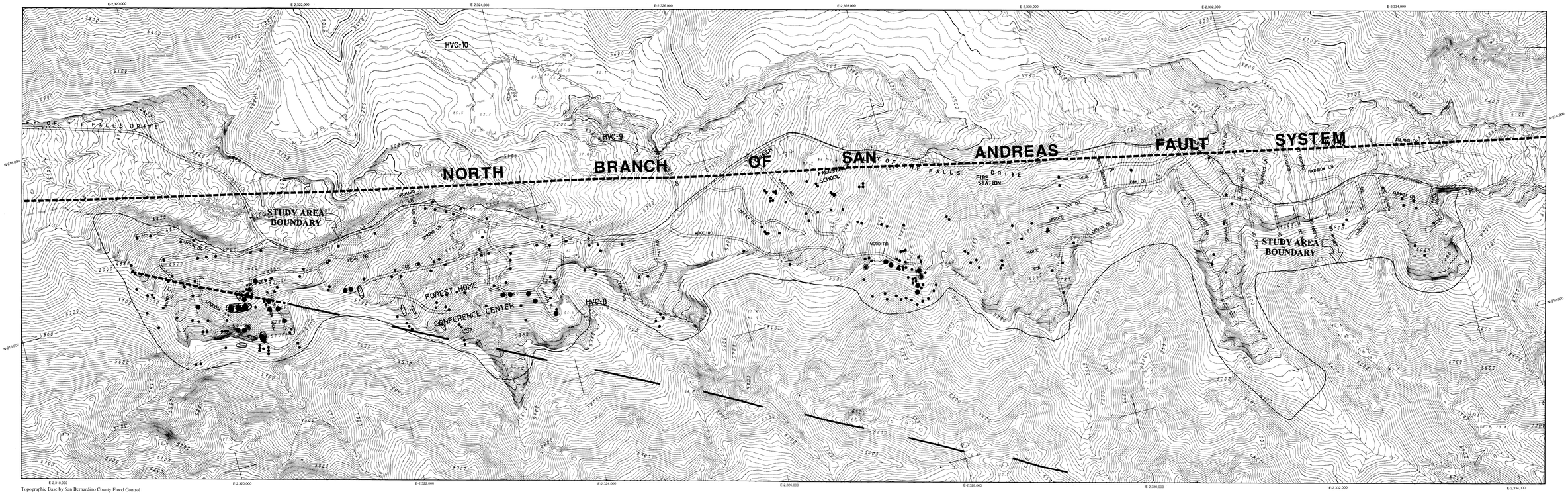

Topographic Base by San Bernardino County Flood Control

SCALE 1:4800

0 400 800 1200 1600 2000 Feet

DATUM IS MEAN SEA LEVEL
CONTOUR INTERVAL 4 AND 20 FEET

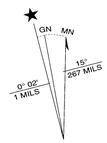

PLATE A-1

MAP SHOWING DISTRIBUTION OF LARGE ROCKFALL BOULDERS IN THE FOREST FALLS AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ROCKFALL AND STREAM-RELATED DEBRIS-FLOW HAZARDS OF THE FOREST FALLS AREA, SAN BERNARDINO COUNTY, CALIFORNIA

Landslide Hazard Identification Map No. 43

by

Siang S. Tan and Desmond G. Giffen

1995

EXPLANATION

Introduction

Plate A-1 shows the distribution of large boulders believed to have been emplaced by rockfalls. The map provides basic input for Plate A-2 which depicts areas that are susceptible to rockfalls, especially earthquake-triggered rockfalls.

Rockfall is the collapse of bedrock from very steep slopes. It is the most rapid form of slope failure and is most common in mountainous areas. Abundant rockfalls are commonly triggered simultaneously by strong earthquake shaking, often causing life-threatening situations.

The Forest Falls area was affected by a series of rockfalls triggered by the M_w6.4 Big Bear earthquake of June 28, 1992 at 8:05 a.m. (3 hours after the M_w7.3 Landers earthquake). As a result, large boulders cut paths in several places down the southern slope of the area and came to rest near homes, outbuildings, water tanks, and other structures close to the base of the slope. The earthquake shook loose boulders of granitic rock; some with diameters of 8 to 30 feet. The boulders weigh between 50 to 250 tons and have volumes ranging between 500 to 3,000 cubic feet.

Previous Work

Plate A-1 updates unpublished work by Siang S. Tan and Allan G. Barrows (Division of Mines and Geology) in July 1992. The work was undertaken in response to a request for an assessment of rockfall hazards by San Bernardino County officials after the Big Bear earthquake of June 28, 1992. Field surveys included plotting the locations of large boulders and determining the potential source areas for rockfall.

The following background on the regional condition in the Forest Falls area comes from Tan (1990). A "Special Note for Area 4" [most susceptible to landslides] summarizes the conditions:

> "The extremely steep and high slopes...on the mountain range south of Forest Falls...are highly susceptible to debris flows, rock slides, **rock falls**...due to (a) nearly vertical slopes; (b) high slope relief (up to 5,000 feet); (c) presence of colluvium, landslide deposit, rock debris, and (d) seasonal water saturation of these loose deposits resulting from annual snowfall and rainy periods. Developments at the toe/base of these very steep and high relief slopes, such as the Forest Falls community, may be subject to these potential hazards..."

Methods

In response to a request from the County of San Bernardino, additional studies were performed, including mapping of rockfall boulders and aerial photograph analysis of potential rockfall source areas. Field surveys were made to plot large boulders, both those emplaced by the Big Bear earthquake and by previous seismic events, or possibly, by rock debris flows/floods. Potential source areas for large blocks high on the southern slope of Mill Creek canyon that could contribute to hazardous rockfall were also identified.

The large boulders shown on the map are not well rounded. We infer they originated from cliffs of bare, jointed or fractured, generally massive, essentially unweathered granitic rock. The top of the most prominent cliff is typically 800 to 1000 feet above the residential district. During strong earthquake shaking, blocks are loosened from the steep cliff face and fall. During the Big Bear earthquake, blocks came from gurt way up the slope (see Photos 4 and 5 in Barrows, 1993). The source area is designated on Plate A-2 as Area IIA. Apparently, blocks of rock that originate at higher elevations (higher than 1000 feet above the impacted areas at the base of the slope) break into smaller fragments during the fall.

Acknowledgments

We would like to acknowledge the contributions and guidance of Allan G. Barrows (Division of Mines and Geology). We would also like to thank Wessly A. Reeder, San Bernardino County geologist for suggesting this study and providing advice.

Geologic References

Barrows, A.G., 1993, Rockfalls and surface effects other than faulting, Landers and Big Bear earthquakes: CALIFORNIA GEOLOGY, v. 46, no. 1, p. 17-22.

California Division of Mines and Geology, 1974, Official map of the earthquake fault zone of the SW1/4 of 15 minute San Gorgonio Mountain Quadrangle, delineated in compliance with the Alquist-Priolo Earthquake Fault Zoning Act, scale 1:24,000.

Dibblee,T.W., Jr., 1964, Geologic map of the San Gorgonio Mountain Quadrangle, San Bernardino and Riverside counties, California: U.S. Geological Survey Miscellaneous Geologic Investigation Map I-431, scale 1:62,500

Matti, J.C., Cox, B.F., and Iverson, S.R., 1983, Mineral resource potential map of Raywood Flat roadless areas, San Bernardino and Riverside counties, California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-1563-A, scale 1:62,500.

Reeder, W.A., 1993, Seismically-induced rockfall in the Forest Falls area of the San Bernardino Mountains as a result of the Landers earthquake sequence, *in* Reynolds, R.E., compiler, Landers: earthquakes and aftershocks: San Bernardino County Museum Association Quarterly, v. 40, no.1, p. 56-60.

Tan, S.S., 1990, Landslide hazards in the Yucaipa and Forest Falls quadrangles, San Bernardino County, California: California Division of Mines and Geology Open-File Report 90-5, scale 1:24,000.

Tan, S.S. and Barrows, A.G., 1992, Rockfall hazard in Forest Falls and vicinity, San Bernardino County, California: California Division of Mines and Geology, unpublished memo, scales 1:24,000 and 1:5,000.

SYMBOLS

- Rockfall boulders with diameters measuring between 5 and 8 feet,
- Rockfall boulders with diameters measuring greater than 8 feet.
- Rockfall boulders, with diameters measuring greater than 8 feet, interpreted to have been deposited as a result of the June 28, 1992 Big Bear earthquake.
- Group of rockfall boulders with diameters measuring greater than 5 feet. Due to the large number of rockfall boulders in each group, individual boulders were not plotted.
- Faults considered to have been active during Quaternary time, and officially delineated in compliance with Alquist-Priolo Earthquake Fault Zoning Act; dashed where approximately located, small dashes where concealed.

NOTE: This is not an Official Seismic Hazard Zone Map under the provisions of Chapter 7.8 of the California Public Resources Code.

INDEX MAP