Natural Hazard Mapping, Analysis, and Mitigation:
a Technical Background Report in Support of the Safety Element
of the New Riverside County 2000 General Plan

CHAPTER 1: SEISMIC HAZARDS

1.1 Introduction

While the County of Riverside is at risk from many natural and man-made hazards, the event with the greatest potential for loss of life or property and economic damage is an earthquake. This is true for most of southern California, since damaging earthquakes are frequent, affect widespread areas, trigger many secondary effects, and can overwhelm the ability of local jurisdictions to respond. In Riverside County, earthquake-triggered geologic effects include ground shaking, fault rupture, landslides, liquefaction, subsidence, and seiches, all of which are discussed below. Earthquakes can also cause human-made hazards such as urban fires, dam failures, and toxic chemical releases.

Earthquakes are caused by movement of rock along a break called a fault. The movement releases pent-up strain energy in the form of waves, which travel outward in all directions. These seismic waves cause the Earth to vibrate, and this shaking is what we feel in an earthquake.

Most earthquakes occur along plate boundaries. The outer portion of the Earth consists of enormous chunks of rock called plates, which slowly collide, separate, and grind past each other. Frictional forces resist plate movements and the plate edges lock together. Much strain energy builds up as plates keep trying to move. Eventually, frictional forces are exceeded, the locked edges move, and all the stored strain energy is released in seismic waves.

Earthquake risk is very high in the heavily populated, western portion of Riverside County, due to the presence of three of California's most active faults, the San Andreas, the San Jacinto and the Elsinore. Risk is moderate in the eastern portion of the County that includes Blythe.

In California, recent earthquakes in or near urban environments have caused relatively few casualties. This is due more to luck than design. For example, when a portion of the Nimitz Freeway in Oakland collapsed at rush hour during the 1989, M_w 7.1 Loma Prieta earthquake, it was unusually empty because so many were watching the World Series. Nonetheless, California's urban earthquakes have resulted in significant economic losses. Riverside County is at risk from larger, more damaging earthquakes than the moderate-sized, M_w 6.7 Northridge earthquake, which in 1994 caused 54 deaths and $20-$30 billion in damage.

Earthquakes are a fact of life in southern California. Although it is not possible to prevent

them, their destructive effects can be minimized. Comprehensive hazard mitigation programs that include the identification and mapping of hazards, prudent planning, public education, emergency exercises, enforcement of building codes, and expedient retrofitting and rehabilitation of weak structures can significantly reduce the scope of an earthquake disaster. Local governments, emergency relief organizations, and residents must take action, to develop and implement policies and programs that can reduce the effects of earthquakes.

1.1.1 Faults

What is a fault?

Geologists visualize a fault as a plane of breakage between rocks, like a page between thick book covers, which meets the surface at some angle. Most of the major faults in southern California are ***strike-slip***. When a strike-slip fault ruptures in an earthquake, the rocks on either side of the fault move horizontally, in opposite directions. In a ***right lateral strike-slip*** fault movement, rock on the opposite side of the fault moves to the right. Principal faults of the San Andreas system are right lateral strike-slip. There are also ***dip-slip*** faults. With dip-slip earthquakes, the two sides of the fault move up or down relative to each other. When the overhanging side of the fault moves down, by convention it is called a ***normal dip-slip*** fault. When the overhanging side moves up, it is a ***reverse dip-slip*** fault. As always, nature is more subtle than our definitions, and in reality, many faults combine vertical and horizontal motion. These are called ***oblique-slip*** faults.

On average, strike-slip faults are nearly vertical. That is, they meet the horizontal surface of the earth at a 90 degree angle. In contrast, dip-slip faults typically meet the surface at a non-vertical angle, and usually dip from the horizontal in the range of 45 to 60 degrees. ***Thrust*** faults are a particular type of low-angle, reverse fault, which dip 25 to 35 degrees from the horizontal. The San Fernando, Northridge, Whittier Narrows and Sierra Madre earthquakes all occurred on thrust faults. Some faults do not extend all the way to the surface of the earth, and are referred to as "blind". These faults are difficult to detect before they cause an earthquake, although some do bend the surface into characteristic, small hills.

Why do we have faults in southern California?

In southern California, most of the faults have developed to allow for the motion between the North American and Pacific tectonic plates (Atwater, 1970). Most of the major fault zones in southern California are roughly parallel with the plate boundary, and accommodate horizontal motion across right-lateral strike-slip faults. Reverse/thrust faults occur where regions of the crust are pushed together and are thus experiencing compression. In the Transverse Ranges north of Riverside