on natural slopes.

- Places where surface runoff of water is channeled, such as along roadways and below culverts.

Where one debris flow has occurred, others will inevitably follow. Much of the County of Riverside is underlain by alluvial fans, deposits that have been shed from streams exiting mountain ranges. These fans and stream washes are evidence of many debris flows in the recent geologic record. In the smallest, most common events, the impact to the County is from boulders transported onto roadways and improvements.

Occasionally, catastrophic debris flow events occur. The greatest southern California debris flow events of the 20th century occurred in 1934, 1938, 1969 and 1978, but there is generally a destructive event each decade. A significant debris flow occurred on July 11, 1999 in the community of Forest Falls, located along the south side of a Mill Creek Canyon in the southeastern part of the San Bernardino Mountains. High-intensity, short-duration rainfall caused the debris flow that resulted in loss of life and property, damaging over 30 homes and numerous automobiles.

Numerous man-made controls have been constructed to reduce the impact of these events on the County. The County operates more than 40 dams, and several hundred miles of levees and storm drains (Riverside County Flood Control and Water Conservation District, 2000).

Without the presence of extensive flood control devices, including large debris catchment basins, the areas downgradient or downstream from unstable slope areas shown on Plate 2-3 may be subject to catastrophic debris flow inundation. Mitigation of debris flow potential should first focus on these areas and geotechnical studies should address the hazard in these zones.

Specific areas susceptible to debris flows are not shown at the scale of the GIS landslide and slope stability map. However, debris flow potential should be evaluated on a site-specific basis for all development areas downgradient from canyons, alluvial fans and swales.

2.3.4 Development of a GIS Landslide and Slope Instability Map

As a major component of this project, we developed digital landslide and slope

instability maps (Plate 2-3: Landslide and Slope Instability Map) for Riverside County. The mapping is based on slope steepness (Plate 2-2) and engineering geology characteristics (Plate 2-1: Engineering Geologic Materials Map).

To make the Landslide and Slope Instability Map of Riverside County (Plate 2-3), the following steps were taken:

- Created a slope map for Riverside County by producing a grid map of the U. S. Geological Survey (USGS) Digital Elevation Model (DEM). Vertical Mapper© was used, with grids of 30 meters per side (Plate 2-2).

- Created a grid map of the Engineering Geologic Materials Map (Plate 2-1). Vertical Mapper© was used, with 30 meter grid cells.

- Queried the two grid maps for areas that met parameters for slope instability and landslide susceptibility, as outlined by the flow chart presented in Figure 2-5.

- Drew Landslide Hazard Management Zone boundaries around highly susceptible areas.

Insert Figure 2-5: Flow Chart Illustrating Methodology to Produce Slope Instability Map and Hazard Management Zones