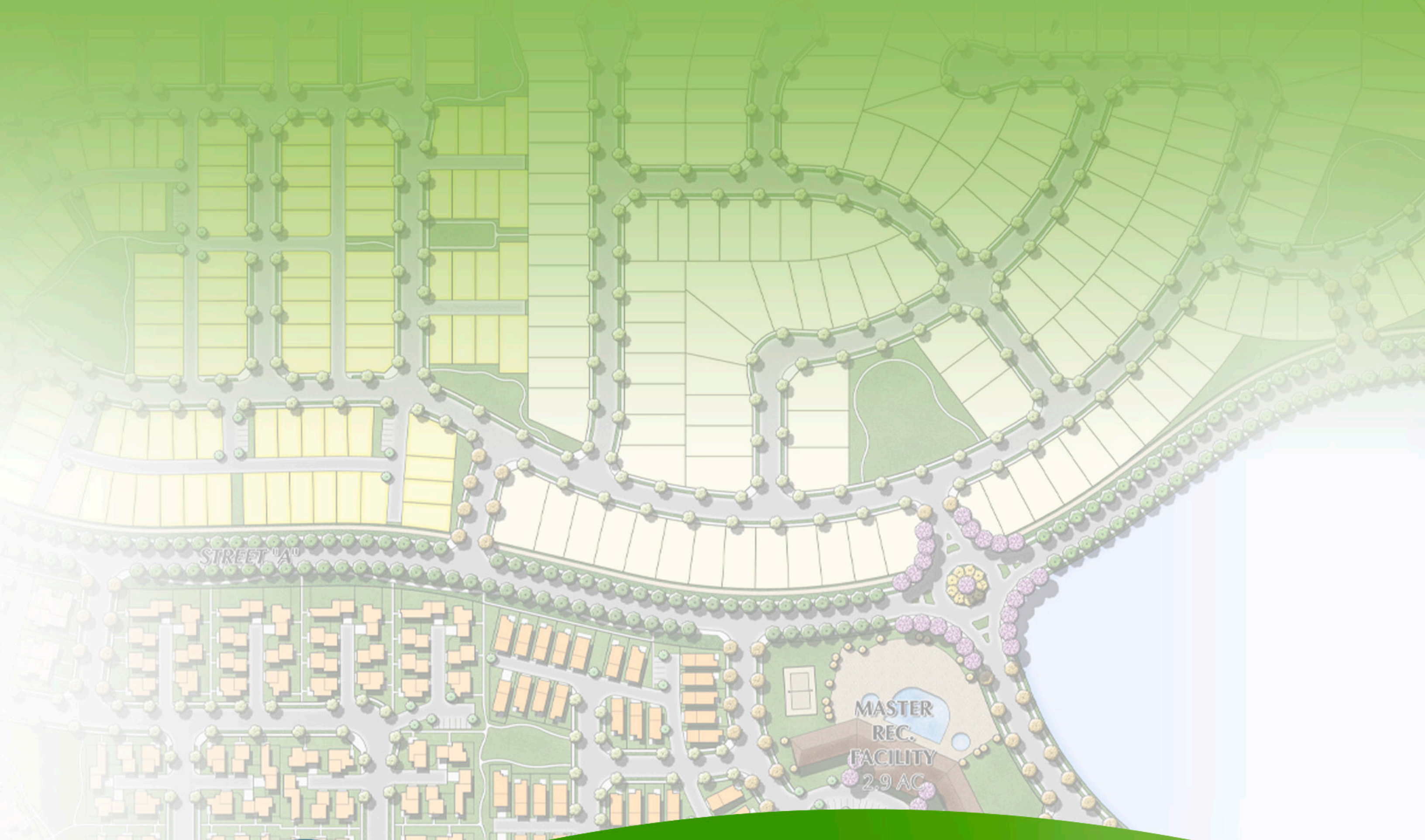

Appendix H:

Safety Element Technical Background Report

(PART 4 of 4)

APPENDIX D
GIS METADATA

DAM FAILURE INUNDATION - DAMS

Coverage Description: Dam Inundation Pathways and Dam locations in Riverside County
Coverage distribution file name: daminund.e00 (dam inundation pathways); dams.e00 (dams and dam characteristics); damtt.e00 (dam inundation travel times)

VITAL STATISTICS: daminund.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	CERES, DMG
Source Media:	Paper maps
Source Projection:	vary
Source Units:	vary
Source Scale:	1:9,600 - 1:126,700
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	Polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: daminund.e00
RECORD LENGTH: 287

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Dam Name	35	C
2	Hazard Rating	10	C
3	Zone	-	I

VITAL STATISTICS: dams.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	CERES, DMG
Source Media:	Paper maps
Source Projection:	vary
Source Units:	vary
Source Scale:	1:9,600 - 1:126,700
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: dams.e00
RECORD LENGTH: 45

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Dam Name	30	C
2	DWR#	10	C
3	Dam Owner	45	C
4	Long	-	F
5	Lat	-	F

VITAL STATISTICS: damtt.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	CERES, DMG
Source Media:	Paper maps
Source Projection:	vary
Source Units:	vary
Source Scale:	1:9,600 - 1:126,700
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	point
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: damtt.e00
RECORD LENGTH: 214

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Dam Name	35	C
2	Hazard Rating	10	C
3	Section #	8	C
4	Wave_tt	-	F
5	Rating#	-	I

Classification of Hazard Rating. Final rating is based on age, construction material, height, and storage capacity vs. drainage area and pathway hazard potential.

1. High (rating 4 - 5)(Red) - Dams that holds back a lake or significant amounts of water year around. These have a large reservoirs and large drainage basins. If construction materials were gravity or hydraulic fill they were automatically put into this category do to potential seismic failure.
2. Moderate (rating 2 - 3)(Orange) - Dams that hold back a lake or significant amounts of water year around. Construction was earth fill materials. These had significant heights and large drainage areas, but the pathway did not immediately flow towards populated areas.
3. Low (rating 1)(Blue) - Not a debris basin but holds water outside the rainy season and are made of rock or earth materials. Usually small impoundments with no direct path to populated areas.
4. Debris basins (Brown) - Only holds water during rainy periods.

The different types of dams in Riverside County and the number of that type are as follows:

- Earth (35)
- Gravity (1)
- Earth and Rock (2)
- Variable Radius Arch (2)
- Hydraulic Fill (1)

California WATER CODE SECTION 6000-6008

6000. Unless the context otherwise requires, the definitions in this chapter govern the construction of this part.

6002. "Dam" means any artificial barrier, together with appurtenant works, which does or may impound or divert water, and which either (a) is or will be 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier, as determined by the department, or from the lowest elevation of the outside limit of the barrier, as determined by the department, if it is not across a stream channel or watercourse, to the maximum possible water storage elevation or (b) has or will have an impounding capacity of 50 acre-feet or more.

6003. Any such barrier which is or will be not in excess of six feet in height, regardless of storage capacity, or which has or will have a storage capacity not in excess of 15 acre-feet, regardless of height, shall not be considered a dam.

6004. (a) No obstruction in a canal used to raise or lower water therein or divert water therefrom, no levee, including but not limited to a levee on the bed of a natural lake the primary purpose of which levee is to control flood waters, no railroad fill or structure, and no road or highway fill or structure, no circular tank constructed of steel or concrete, or both, no tank elevated above the ground, and no barrier which is not across a stream channel, watercourse, or natural drainage area and which has the principal purpose of impounding water for agricultural use shall be considered a dam.

(b) No obstruction in the channel of a stream or watercourse which is 15 feet or less in height from the lowest elevation of the obstruction and which has the single purpose of spreading water within the bed of the stream or watercourse upstream from the obstruction for percolation underground shall be considered a dam.

(c) The levee of an island adjacent to tidal waters in the Sacramento-San Joaquin Delta, as defined in Section 12220, even when used to impound water, shall not be considered a dam and the impoundment shall not be considered a reservoir if the maximum possible water storage elevation of the impounded water does not exceed four feet above mean sea level, as established by the United States Geological Survey 1929 datum.

(d) No noncircular tank, constructed of steel or concrete, or both, that is constructed in a county of the third class by a public agency, under the supervision of a civil engineer registered in the state, that does not exceed 75 acre feet in capacity or 30 feet in height, and no barrier that is not across a stream channel, watercourse, or natural drainage area and that has the principal use as a sewage sludge drying facility shall be considered a dam.

6004.5. "Reservoir" means any reservoir, which contains or will contain the water impounded by a dam.

6005. "Owner" includes any of the following who own, control, operate, maintain, manage, or propose to construct a dam or reservoir:
(a) The state and its departments, institutions, agencies, and political subdivisions.
(b) Every municipal or quasi-municipal corporation.
(c) Every public utility.
(d) Every district.
(e) Every person.
(f) The duly authorized agents, lessees, or trustees of any of the foregoing.
(g) Receivers or trustees appointed by any court for any of the foregoing. "Owner" does not include the United States.

6006. "Alterations," "repairs," or either of them, mean only such alterations or repairs as may affect the safety of the dam or reservoir.

6007. "Enlargement" means any change in or addition to an existing dam or reservoir, which raises or may raise the water storage elevation of the water impounded by the dam or reservoir.

6008. Water storage elevation means that elevation of water surface, which could be obtained by the existing dam or reservoir, as previously operated, were there no outflow and were the reservoir full of water.

Dam Inundation maps were provided by California Office of Emergency Services (OES). The maps were digitized from the set of files, as published and maintained on the CA OES home page, contains images of the maps on file with this office marked "approved." Several dams within Riverside County have inundation maps that have not been officially approved. We have included these if they were released at the time of the project. These maps are intended to be used by state and local officials for the development and approval of dam failure emergency procedures as described in the above referenced Government Code section. The maps are also used to provide information needed to make natural hazard disclosure statements required under recent legislation (AB 1195 Chapter 65, June 9, 1998. Natural Hazard Disclosure Statement).

These maps are maintained on file at the CA OES in accordance with Section 8589.5 of the California Government code (a portion of the Emergency Services Act).

Dam	**map number**	**Scale**	**Analysis By**
Alessandro	1	1:9,600	Neste, Brudin & Stone, Inc.
Alessandro	2	1:9,600	Neste, Brudin & Stone, Inc.
Alessandro	3	1:9,600	Neste, Brudin & Stone, Inc.
Box Springs	1	1:9,600	Neste, Brudin & Stone, Inc.
Box Springs	2	1:9,600	Neste, Brudin & Stone, Inc.
Colorado River	6	1:126,720	Dept. of Interior, Bureau of Reclamation
Colorado River	7	1:126,720	Dept. of Interior, Bureau of Reclamation
Colorado River	8	1:126,720	Dept. of Interior, Bureau of Reclamation
Foster	1	1:6,000	Neste, Brudin & Stone, Inc.
Foster	2	1:6,000	Neste, Brudin & Stone, Inc.
Harrison Street	1	1:9,600	Neste, Brudin & Stone, Inc.
Harrison Street	2	1:9,600	Neste, Brudin & Stone, Inc.
Harrison Street	3	1:24,000	Neste, Brudin & Stone, Inc.
Henry J. Mills	1	1:12,000	Nelson N. Lee
Lake Hemet	1	1:63,360	Neste, Brudin & Stone, Inc.
Lake Hemet	2	1:24,000	Neste, Brudin & Stone, Inc.
Lake Hemet	3	1:24,000	Neste, Brudin & Stone, Inc.

Lake Hemet	4	1:24,000	Neste, Brudin & Stone, Inc.
Lake Hemet	5	1:24,000	Neste, Brudin & Stone, Inc.
Lake Mathews	1	1:24,000	Metropolitan Water District
Lake Mathews	2	1:24,000	Metropolitan Water District
Lee Lake	1	1:24,000	Krieger & Stewart
Mabey Canyon	1	1:24,000	Neste, Brudin & Stone, Inc.
Mary Street	1	1:9,600	Neste, Brudin & Stone, Inc.
Mary Street	2	1:9,600	Neste, Brudin & Stone, Inc.
Mary Street	3	1:9,600	Neste, Brudin & Stone, Inc.
Mockingbird Canyon	1	1:24,000	Robert L. Taylor
Perris	1	1:24,000	Dept. of Water Resourses
Perris	2	1:24,000	Dept. of Water Resourses
Perris	3	1:24,000	Dept. of Water Resourses
Perris	4	1:24,000	Dept. of Water Resourses
Pigeon Pass	1	1:24,000	Neste, Brudin & Stone, Inc.
Pigeon Pass	2	1:24,000	Neste, Brudin & Stone, Inc.
Pigeon Pass	3	1:24,000	Neste, Brudin & Stone, Inc.
Prado	2	1:24,000	US Corps of Engineers
Prado	3	1:24,000	US Corps of Engineers
Prenda	1	1:9,600	Neste, Brudin & Stone, Inc.
Prenda	2	1:9,600	Neste, Brudin & Stone, Inc.
Prenda	3	1:9,600	Neste, Brudin & Stone, Inc.
Railroad Canyon	1	1:63,360	Krieger & Stewart
Robert A. Skinner	2	1:24,000	Nelson N. Lee
Robert A. Skinner	3	1:24,000	Nelson N. Lee
Sycamore	1	1:9,600	Neste, Brudin & Stone, Inc.
Sycamore	2	1:9,600	Neste, Brudin & Stone, Inc.
Tahchevah	1	1:24,000	Neste, Brudin & Stone, Inc.
Vail	1	1:24,000	James M. Montgomery
Vail	2	1:24,000	James M. Montgomery
Vail	3	1:24,000	James M. Montgomery
Wide Canyon	1	1:24,000	Riverside County FCWCD
Woodcrest	1	1:9,600	Neste, Brudin & Stone, Inc.
Woodcrest	2	1:9,600	Neste, Brudin & Stone, Inc.
Woodcrest	3	1:9,600	Neste, Brudin & Stone, Inc.

EARTHQUAKES

Coverage Description: Earthquake epicenters within Riverside County.
Coverage distribution file name: quakes.e00 (represents all earthquakes under 3.0 magnitude); quakes3.e00 (represents all earthquakes over 3.0. in magnitude)

Import Location:

VITAL STATISTICS: quakes.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	See below
Source Media:	Paper maps
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: quakes.e00
RECORD LENGTH: 45,693

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE	
1	Year	-	I	
2	Latitude	-	F	
3	Longitude	-	F	
4	Depth_km	-	I	
5	Magnitude		-	I

VITAL STATISTICS: quakes3.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	
Source Media:	Paper maps
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: quakes3.e00
RECORD LENGTH:

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Year	-	I
2	Latitude	-	F
3	Longitude	-	F
4	Depth_km	-	I
5	Magnitude	-	I

Earthquake locations within Riverside County were acquired from (references):

Earthquake locations for events occurring prior to 1931 (1858 – 1931)
Blake, T. F., 1996, EQFAULT- Computer software for deterministic site parameters, Version 2.20.

Earthquake locations for events occurring between 1932 to 1980
Earthquake data recorded by the Southern California Seismic Network (SCSN), and catalogued by the Southern California Earthquake Center (SCEC), which operated jointly by the Seismological Laboratory at Caltech and the U.S. Geological Survey, Pasadena, California.

Earthquake locations for events occurring between 1981 to 1999
Hauksson, E., 1999 (in press), Crustal structure and seismicity distribution adjacent to the Pacific and North America plate boundary in southern California: submitted to Journal of Geophysical Research, 1999.

FAULTS

Coverage Description: Faults in Riverside County
Coverage distribution file name: faults.e00
Import Location:

VITAL STATISTICS: faults.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	
Source Media:	Paper maps, Mylar maps and reports
Source Projection:	vary
Source Units:	vary
Source Scale:	1:9,600 - 1:126,700
Capture Method:	Digitized

Accuracy: The overall map is good to an accuracy of 1:100,000, although a significant portion of the map is accurate to 1:24,000.

Conversion Software:	MapInfo 6.0
Data Structure:	Vector

ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: faults.e00
RECORD LENGTH: 4,347

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Ltype	35	C
2	Name	50	C
3	Activity	35	C
4	Activity_Zone	-	I

FAULTZONES

Coverage Description: Fault Zones in Riverside County
Coverage distribution file name: apzones.e00 (ap zone polygons); apzonept.e00 (ap zone points); apcounty.e00 (county ap zones); ap-eci.e00 (Earth Consultants proposed areas of concern)
Import Location:

VITAL STATISTICS: apzones.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	State of California, County of Riverside, Earth Consultants
Source Media:	Paper maps, Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: apzones.e00
RECORD LENGTH: 34

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH		TYPE
1	Fault zone	10	C	

The faults shown on this map are typically accurate to within 100 to 500 feet; however, some faults are better constrained than others as a consequence of the geologic field relations (exposures of the fault), or the quality of the geologic maps in which the data were acquired. Most of the faults that are Holocene to Late Quaternary in age are accurate to within 100 to 300 feet because their locations were typically retrieved from detailed (small-scale) geologic maps. However, in regions where these faults are "concealed" by younger sediments, their locations become progressively less accurate.

Many of the Holocene to Late Quaternary age faults are shown to exist under young alluvium due to their potential to rupture to the surface sometime in the future. Alternatively, the older faults (Pre Quaternary) are typically not shown to reside under sediments because of the unlikely possibility that these faults will rupture in the future.

The source map used for this coverage was a 1974 State of California, The Resources agency, Department of Conservation 7.5 minute quadrangle topographic map. This coverage may not show all potentially active faults, either within the special studies zones (see FAULT ZONES) or outside their boundaries. The faults shown on the map were not field checked and the "quality of data used is highly varied.

References for the maps used for fault locations on the final ECI fault location map for Riverside County. This reference list represents the maps that contained data that was eventually used in our fault location map.

<u>Notes:</u> "E-room" data for the San Gorgonio Pass Fault Zone region was used to initiate the data collection. This data was ultimately determined to be from Matti et al, 1992 and Kerry Sieh's student Doug Yule.

Bortugno, E.J., Spittler, T.E., 1986, Geologic Map of the San Bernardino Quadrangle, California Division of Mines and Geology, Regional Geologic Map Series, Map No. 3A (Geology), map scale 1:250,000.

Calzia, J.P., 1988, Mineral resources and resource potential map of the Pyramid Peak roadless area, Riverside County, California: United States Geological Survey, Miscellaneous Field Studies MF-1999, map scale 1:62,500.

Clark, M.M., 1984 (p.4), Map showing recently active breaks along the San Andreas Fault and associated faults between Salton Sea and Whitewater River – Mission Creek, California: U.S. Geological Survey Miscellaneous Investigations Series Map I-1483, 2 sheets scale 1:24,000.

Dibblee, T.W., Jr., 1982, Geologic Quadrangle Maps of the San Jacinto Mountains and vicinity, California: South Coast Geological Society, Geologic Maps SCGS 1, 2, 3, 4 and 5, (15-minute quadrangle maps: Perris, Banning, Palm Springs, Hemet, Idyllwild), map scale 1:62,500.

Fault-Rupture Hazard Zones in California, 1980-1995, issued by the California Division of Mines and Geology, map scale 1:24,000.

Greenwood, Richard B., Morton, Douglas M., Jachens, Robert C., Chapman, Rodger H., 1991, Geology and geophysics of the Santa Ana 1:100,000 quadrangle, Southern California; a progress report: Abstracts with Programs - Geological Society of America, vol. 23, n. 5, p. 478. [This map is also available on the internet: (<u>http://wrgis.wr.usgs.gov/open-file/of99-172/</u>) Open-File Report **99-172**. Preliminary digital geologic map of the Santa Ana 30' x 60' quadrangle, Southern California, version 1.0, Compiled by: D.M. Morton, preparation by: Rachel M. Hauser and Kelly R. Ruppert].

Jennings, C.W., 1967, Geologic Map of California Salton Sea Sheet: California Division of Mines and Geology, Regional Geologic Map Series, GAM-13, map scale 1:250,000.

Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations and ages of recent volcanic eruptions: California Division of Mines and Geology, Geologic Data Map No. 6, map scale 1:250,000.

Hamilton, W.B., 1984, Generalized Geologic map of the Big Maria Mountains region, northeastern Riverside county, southeastern California: U.S. Geological Survey Open File Report 84-407, 7 p., (scale 1:48,000).

Howard, K.A., Allen, C.M., 1988, Geologic Map of the Southern Part of the Dale Lake 15-minute quadrangle, San Bernardino and Riverside Counties, California: United States Geological Society, Open File Report OFR 88-534, map scale 1:62,500.

Howard, K.A., Horringa, E.D., Miller, D.M., Stone, P., 1989, Geologic Map of the eastern parts of the Cadiz Lake and Cadiz Valley 15-minute quadrangles, San Bernardino and Riverside Counties, California: United States Geological Society, Miscellaneous Field Studies Map MF-2086, map scale 1:62,500.

Kennedy, M.P., 1977, Recency and Character of faulting along the Elsinore Fault Zone in Southern Riverside County, California: California Division of Mines and Geology Special Report 131, map scale 1:24,000.

Matti, J.C., Morton, D.M., Cox, B.F., 1992, The San Andreas Fault System in the Vicinity of the Central Transverse Ranges Province, Southern California: United States Geological Survey Open File Report 92-354, map scale 1:250,000.

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

Matti, J.C., Cox, B.F., Powell, R.E., Oliver, H.W., Kuizon, L., 1983, , Mineral resources and resource potential map of the Pyramid Cactus Spring roadless area, Riverside County, California: United States Geological Survey, Miscellaneous Field Studies MF-1650, map scale 1:24,000.

Onderdonk, N.W., Sylvester, A.G., 1998, The Quaternary fault structure of a left-stepover within the San Jacinto Fault Zone, Riverside County, California: Geological Society of America Abstracts with Programs, v. 30, n. 5, p. 57.

Onderdonk, N.W., (personal communication), 1998, Geologic maps of the Hot Springs, Thomas Mountain and Claremont Faults of the San Jacinto Fault Zone, map scale 1:24,000.

Powell, R.E., 1981, Geology of the crystalline basement complex, eastern Transverse Ranges, southern California: Constraints on regional tectonic interpretation [Ph.D. thesis]: Pasadena, California, California Institute of Technology, map scale 1:125,000.

Proctor, R.J., 1968, Geology of the Desert Hot Springs – Upper Coachella Valley Area, California: California Division of Mines and Geology, Special Report 94, 50p, map scale is 1: 62,500.

Rogers, T.H., 1966, Geologic Map of California Santa Ana Sheet: California Division of Mines and Geology, Regional Geologic Map Series, map scale 1:250,000.

Schell, B.A., Schell, W.A., 1994, Blue Cut Fault, Riverside County, California: *in* Murbach, D., and Baldwin, J., (editors), Mojave Desert: South Coast Geological Society Annual Field Trip Guidebook No. 22, pp. 208-221, map scale ~1:350,000.

Sieh, K, Yule, D., 1999 (personal communication).

Sharp, R.V., 1972, Map showing recently active breaks along the San Jacinto Fault Zone between the San Bernardino Area and Borrego Valley, California: United States Geological Survey Miscellaneous Geologic Investigations Map I-675, map scale 1:24,000.

Weber, F.H., Jr. 1977, Seismic hazards related to geologic factors, Elsinore and Chino fault zones, northwest Riverside County, California: California division of Mines and Geology Open-File Report 77-4, 96 p, map scale is 1:2000.

Weldon, R.J., Sheridan, J.M., 1999, (personal communication), Geologic map of the Southeastern Mecca Hills, California, map scale 1:12,000.

VITAL STATISTICS: apzonept.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	State of California, County of Riverside, Earth Consultants
Source Media:	Paper maps, Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: apzonept.e00
RECORD LENGTH: 1,058

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Quad	10	C

VITAL STATISTICS: apcounty.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	County of Riverside
Source Media:	Paper maps, Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: apcounty.e00
RECORD LENGTH: 8

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Fault Zone	10	C

VITAL STATISTICS: ap-eci.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	Earth Consultants
Source Media:	Paper maps, Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: ap-eci.e00
RECORD LENGTH: 55

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	15	C

The source map used for this coverage was a 1974, 1980, 1988, 1993 and 1995 State of California, The Resources agency, Department of Conservation 7.5 minute quadrangle topographic map. This coverage shows the outlines of the special studies area used in the fault coverage.

Uses and Limitations of Seismic Hazard Zone Maps

A Seismic Hazard Zone Map does NOT show areas that automatically should be excluded from development. Instead, it shows areas where the potential for damage from the mapped hazard is great enough so as to make it prudent to conduct geologic investigations to identify and mitigate the hazard prior to development. It is less costly to incorporate hazard mitigation into a structure before it is built than to try to try to later add mitigating features.

Cookie-cutter design of mitigation features is not feasible. The hazards present at each site and the multiplicity of structural configurations makes it impossible to predict how much mitigation will cost. In some areas, it may be possible to adequately mitigate liquefaction hazard by strengthening the foundation to withstand displacements of 11/2 feet, typically costing only $3,000-4,000. Expert engineers indicate that in many locations this simple measure could have reduced the payout for repair of liquefaction damage from an average of $65,000 to $70,000 to about $10,000 to $15,000-a substantial savings. Insurance industry representatives indicate that such potential savings could be passed on to consumers in the form of lower earthquake insurance premiums. However, the cost of mitigation of hazards on sites likely to experience more that 1 foot of liquefaction-caused displacement or having a significant landslide hazard is likely to be much greater.

In the past, land-use planners have often assumed that lower density developments should occur where geologic hazards are present. However, planners may find that the high cost of mitigating liquefaction hazards along streams, bays, canals, and coastal zones requires a higher density of development to be economically feasible.

Other things to note:
1. Seismic Hazard Zone Maps may not show all areas that have the potential for liquefaction, landsliding, strong ground shaking or other earthquake and geologic hazards.
2. A single earthquake capable of causing liquefaction or triggering landslide failures will not uniformly affect the entire area zoned.
3. Seismic Hazard Zone Maps do not show Alquist-Priolo Earthquake Fault Zones. Please refer to the latest Official Maps of Earthquake Fault Zones for disclosures and other actions required by the Alquist-Priolo Earthquake Fault Zoning Act.
4. The identification and location of liquefaction and earthquake-induced landslide hazard areas are based on available data. The quality of data used is varied. The information depicted on the maps has been drawn as accurately as possible at 1:24,000-scale.
5. Information on the Seismic Hazard Zone Maps is not sufficient to serve, as a substitute for the geologic and geotechnical site investigations requires under the Seismic Hazard Mapping Act or the Alquist-Priolo Earthquake Fault Zoning Act.

Alquist-Priolo Maps

Map Name	Date of Map
Alber Hill	1980
Beaumont	1995
Bucksnort Mtn	1974
Cabazon	1995
Cathedral City	1974
Clark Lake NE	1974
Collins Valley	1974
Corona South	1980
Desert Hot Springs	1980
Durmid	1974
El Casco	1995
Elsinore	1980

Frink NW	1988
Hemet	1980
Indio	1974
Joshua Tree South	1993
Lake Mathews	1980
Lake View	1988
Mecca	1974
Mortmar	1974
Murrieta	1990
Myoma	1974
NE Hemet	1974
NE Thousand Palms	1974
NW Idyllwild	1974
Orocopia	1974
Pechanga	1990
Redlands	1977
Salton	1974
San Jacinto	1980
SE Idyllwild	1974
SE Morongo Valley	1974
SE San Gorgonio Mtn	1974
Seven Palms Valley	1980
Sunnymead	1974
SW Idyllwild	1974
SW Lost Horse	1974
SW Morongo Valley	1974
SW Palm Desert	1974
SW San Gorgonio Mtn	1974
Temecula	1990
Thermal Canyon	1974
Whitewater	1995
Wildomar	1980
Yucca Valley South	1993

FLOOD

Coverage Description: Flood plain and zone boundaries in Riverside County
Coverage distribution file name: flood.e00
Coverage Area: Riverside County

VITAL STATISTICS: flood.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	FEMA (Q3), FIRM, USGS and Earth Consultants
Source Media:	Paper maps, Digital files
Source Projection:	vary
Source Units:	vary
Source Scale:	1:4,800 -1:24,000
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector

ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: flood.e00
RECORD LENGTH: 1,567

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Reference	20	C
2	Zone	3	C
3	Subzone	5	C
4	Subzone Description	254	C

Flooding coverage comes from a collection of resources. Federal Insurance Rate Maps (FIRM) maps were compared to the existing County data. The combined maps were then compared to the natural hazard loss estimation methodology software (HAZUS) data set from Federal Emergency Management Agency (FEMA). The United States Geological Survey (USGS) flood prone information was then used to complete the flooding map.

The following procedures were followed during the creation of the Flood and Inundation Susceptibility Map of Riverside County:

- Flood Insurance Rate Maps (FIRM) from the Federal Emergency Management Agency (FEMA) was digitized for unincorporated parts of Riverside County.
  - FEMA has three categories for flood zones:
    - Zone A- Special flood hazard areas inundated by 100-year flood.
      - Subzone A- No base flood elevations determined.
      - Subzone AE- Base flood elevations determined.
      - Subzone AH- Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
      - Subzone AO- Flood depths of 1 to 3 feet (usually sheet flow or sloping terrain); average depths determined for areas of alluvial fan flooding, velocities also determined.
      - Subzones A1-30- Areas of 100-year flood; base flood elevations and flood hazard factors determined.
      - Subzone A99- To be protected from 100-year flood by federal flood protection system under construction; no base elevations determined.
    - Zone B- Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with the average depths less than one (1) foot or where the contributing drainage area is less than one (1) square mile; or areas protected by levees from the base flood.
    - Zone X- Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood
    - Zones X and B are attributed with blue polygons.
    - Zone A is attributed with red polygons.
- HAZUS data obtained from FEMA was then added to the map containing the FIRM data to cover incorporated as well as unincorporated parts of the county that the FIRM data did not cover.
  - FEMA has two categories for flood zones:
    - Zone A- Areas of 100-year flooding. Attributed as red polygons.
    - Zone B- Areas of 500-year flooding. Attributed as blue polygons.
- United States Geological Survey (USGS) 7.5' quadrangle Flood Prone Areas maps were digitized and added to the map to cover areas not mapped by FEMA.
  - The USGS only covers 100-year flooding in its Flood Prone Areas maps. Zone A is defined as flood-prone areas that have a 1 in 100 chance, on the average, of being inundated during any year. Flood prone areas have been delineated without consideration of present or future flood control storage that may reduce flood levels. Four subzones are represented:
    - Subzone L- Approximate area occasionally flooded if levees are breached.
    - Subzone O- Approximate area occasionally flooded.
    - Subzone I- Flood prone area subject to inundation from local thunderstorms.
    - Subzone S- Flood prone areas from sheet flow.

- The current flood map for the county of Riverside was compared to the map compiled by Earth Consultants International (ECI) to insure that all county data was represented in the new map. One small area in the city of Riverside was taken from the county map and added to the new map.
- Areas prone to 100-year flooding were added by ECI on the west side of the Salton Sea and the western parts of Blythe for areas not covered by any of the afore mentioned data sets. It is ECI's opinion that these areas are susceptible to flooding and that the data sets for these areas are missing or nonexistent. The flood level elevations of the surrounding areas, as well as the topography of the areas, were taken into account when designating the two areas as flood prone.

References:

Edwards, K.L., Master Drainage Plan for the Wildomar Area. Riverside County Flood Control and Water Conservation District, Riverside California, August 1980.

Edwards, K.L., Master Drainage Plan for the Sedco Area. Riverside County Flood Control and Water Conservation District, Riverside California, March 1982.

Edwards, K.L., Master Drainage Plan for the Murrieta Creek Area. Riverside County Flood Control and Water Conservation District, Riverside California, March 1986.

FIRM (Federal Insurance Rate Maps)

Number	Name	Scale	Date
060245 2065 B	Panel 2065 of 3600	1:12000	9/30/88
060245 0775 B	Panel 775 of 3600	1:24000	9/30/88
060245 2765 B	Panel 2765 of 3600	1:12000	11/20/96
060245 2770 B	Panel 2770 of 3600	1:12000	9/30/88
060245 2150 B	Panel 2150 of 3600	1:24000	9/30/88
060245 0695 B	Panel 695 of 3600	1:12000	3/22/83
060245 0755 B	Panel 755 of 3600	1:12000	9/30/88
060245 2055 B	Panel 2055 of 3600	1:12000	9/30/88
060245 2130 B	Panel 2130 of 3600	1:12000	9/30/88
060245 2135 B	Panel 2135 of 3600	1:12000	9/30/88
060245 2125 B	Panel 2125 of 3600	1:24000	9/30/88
060245 1555 B	Panel 1555 of 3600	1:12000	3/22/83
060245 0745 B	Panel 745 of 3600	1:12000	9/30/88
060245 2265 B	Panel 2265 of 3600	1:12000	3/22/83
060245 1495 B	Panel 1495 of 3600	1:12000	9/30/88
060245 1480 B	Panel 1480 of 3600	1:12000	9/30/88
060245 1355 B	Panel 1355 of 3600	1:12000	3/22/83
060245 2095 B	Panel 2095 of 3600	1:12000	11/20/96
060245 2300 B	Panel 2300 of 3600	1:24000	3/22/83
060245 1560 B	Panel 1560 of 3600	1:12000	3/22/83
060245 0925 B	Panel 925 of 3600	1:24000	9/30/88
060245 0875 B	Panel 875 of 3600	1:24000	3/22/83
060245 2255 B	Panel 2255 of 3600	1:24000	3/22/83
060245 1585 B	Panel 1585 of 3600	1:24000	9/30/88
060245 1595 B	Panel 1595 of 3600	1:24000	9/30/88
060245 2235 A	Panel 2235 of 3600	1:12000	4/15/80
060245 2180 A	Panel 2180 of 3600	1:12000	4/15/80
060245 1540 A	Panel 1540 of 3600	1:12000	4/15/80
060245 2850 A	Panel 2850 of 3600	1:24000	4/15/80
060245 2875 A	Panel 2875 of 3600	1:24000	4/15/80
060245 3000 A	Panel 3000 of 3600	1:24000	4/15/80
060245 0810 A	Panel 810 of 3600	1:24000	4/15/80
060245 0820 A	Panel 820 of 3600	1:12000	4/15/80
060245 0720 A	Panel 720 of 3600	1:12000	4/15/80

060245 1515 A	Panel 1515 of 3600	1:12000	4/15/80
060245 2270 A	Panel 2270 of 3600	1:12000	4/15/80
060245 1625 C	Panel 1625 of 3600	1:24000	11/20/96
060245 2155 A	Panel 2155 of 3600	1:12000	4/15/80
060245 1450 D	Panel 1450 of 3600	1:24000	11/20/96
060245 3355 D	Panel 3355 of 3600	1:12000	11/20/96
060245 0900 D	Panel 900 of 3600	1:24000	11/20/96
060245 2260 D	Panel 2260 of 3600	1:24000	11/20/96
060245 1580 C	Panel 1580 of 3600	1:12000	11/20/96
060245 0790 C	Panel 790 of 3600	1:12000	11/20/96
060245 1475 C	Panel 1475 of 3600	1:24000	11/20/96
060245 1490 C	Panel 1490 of 3600	1:12000	9/30/88
060245 1360 C	Panel 1360 of 3600	1:12000	11/20/96
060245 2085 C	Panel 2085 of 3600	1:12000	11/20/96
060245 2080 C	Panel 2080 of 3600	1:12000	11/20/96
060245 2070 C	Panel 2070 of 3600	1:24000	11/20/96
060245 2060	Panel 2060 of 3600	1:12000	11/20/96
060245 2090 C	Panel 2090 of 3600	1:12000	11/20/96
060245 2730 C	Panel 2730 of 3600	1:12000	11/20/96
060245 2710 C	Panel 2710 of 3600	1:12000	11/20/96
060245 2050 C	Panel 2050 of 3600	1:24000	11/20/96
060245 0690 C	Panel 690 of 3600	1:12000	11/20/96
060245 2745 C	Panel 2745 of 3600	1:12000	11/20/96
060245 3360 C	Panel 3360 of 3600	1:12000	11/20/96
060245 0225 B	Panel 225 of 3600	1:24000	9/30/88
060245 1380 B	Panel 1380 of 3600	1:12000	11/20/96
060245 0685 B	Panel 685 of 3600	1:12000	11/20/96
060245 0020 B	Panel 20 of 3600	1:12000	11/20/96
060245 1410 B	Panel 1410 of 3600	1:12000	11/20/96
060245 1405 B	Panel 1405 of 3600	1:12000	11/20/96
060245 1370 B	Panel 1370 of 3600	1:12000	11/20/96
060245 1390 B	Panel 1390 of 3600	1:12000	11/20/96
060245 0840 B	Panel 840 of 3600	1:12000	9/30/88
060245 0795 B	Panel 795 of 3600	1:12000	11/20/96
060245 0850 B	Panel 850 of 3600	1:24000	9/30/88
060245 1460 C	Panel 1460 of 3600	1:12000	11/20/96
060245 1455 C	Panel 1455 of 3600	1:12000	11/20/96
060245 2030 C	Panel 2030 of 3600	1:12000	11/20/96
060245 2035 C	Panel 2035 of 3600	1:12000	11/20/96
060245 0710 A	Panel 710 of 3600	1:12000	4/15/80
060245 1385 A	Panel 1385 of 3600	1:12000	4/15/80
060245 1335 A	Panel 1335 of 3600	1:12000	4/15/80
060245 1435 D	Panel 1435 of 3600	1:12000	11/20/96
060245 0670 A	Panel 670 of 3600	1:12000	4/15/80
060245 0065 A	Panel 65 of 3600	1:12000	4/15/80
060245 0045 A	Panel 45 of 3600	1:12000	4/15/80
060751 2745 A	Panel 2745 of 3600	1:12000	11/20/96
060245 0705 A	Panel 705 of 3600	1:12000	4/15/80
060751 2710 A	Panel 2710 of 3600	1:12000	11/20/96
060751 2730 A	Panel 2730 of 3600	1:12000	11/20/96
060751 2740 A	Panel 2740 of 3600	1:12000	11/20/96
060245 0120 A	Panel 120 of 3600	1:12000	4/15/80
060245 0115 A	Panel 115 of 3600	1:12000	4/15/80
060245 0070 A	Panel 70 of 3600	1:12000	4/15/80
060245 0090 A	Panel 90 of 3600	1:12000	4/15/80
060245 0040 A	Panel 40 of 3600	1:12000	4/15/80
060245 0815 A	Panel 815 of 3600	1:12000	4/15/80

060245 0805 A	Panel 805 of 3600	1:12000	4/15/80
060245 0785 A	Panel 785 of 3600	1:12000	4/15/80
060245 0680 A	Panel 680 of 3600	1:12000	4/15/80
060704-0005-D	CATHEDRALCITY	1:12,000	7/7/99
060253-0005-D	HEMET	1:12,000	8/19/97
065074-0020B	MORENO VALLEY	1:12,000	5/17/93
060629-0003D	PALM DESERT	1:6,000	6/18/96
060629-0005-C	PALM DESERT	1:6,000	9/4/86
060259-0003-C	RANCHO MIRAGE	1:4,800	6/18/96
06259-0001-C	RANCHO MIRAGE	1:4,800	6/18/96

USGS Flood Prone Areas Maps

Name	Scale	Date
Alberhill	1:24,000	1973
Beaumont	1:24,000	1975
Blythe	1:24,000	1974
Blythe NE	1:24,000	1975
Desert Hot Springs	1:24,000	1971
El Casco	1:24,000	1976
Fontana	1:24,000	1976
Guasti	1:24,000	1977
Indio	1:24,000	1976
Lake Mathews	1:24,000	1974
McCoy Wash	1:24,000	1975
Mecca	1:24,000	1973
Mortmar	1:24,000	1976
Oasis	1:24,000	1976
Palm Springs	1:24,000	1973
Palo Verde	1:24,000	1976
Rancho Mirage	1:24,000	1976
Redlands	1:24,000	1975
Ripley	1:24,000	1975
San Jacinto	1:24,000	1976
Seven Palms Valley	1:24,000	1971
Sitton Peak	1:24,000	1974
Steele Peak	1:24,000	1974
Sunnymead	1:24,000	1974
Temecula	1:24,000	1973
Thermal Canyon	1:24,000	1973
Whitewater	1:24,000	1971
Wildomar	1:24,000	1973
Yucaipa	1:24,000	1976

GEOLOGY - GENERAL GEOLOGY AND ENGINEERING GEOLOGY

Coverage Description: Geologic Units and Engineering Geologic Materials of Riverside County
Coverage distribution file name: geology.shp
Import Location:

VITAL STATISTICS: geology.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	State of California, USGS
Source Media:	Paper maps, Digital, Mylar
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: geology.shp
RECORD LENGTH: 6,703

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Area	-	F
2	Perimeter	-	F
3	Geology	-	I
4	Geology_ID	-	I
5	Ptype	35	C
6	Etype	35	C
7	Description	250	C

Map Name	Work Space File Name	Projection	Digitizing Geocoding Error	Scale
Preliminary Geologic Map of the Blythe 30' by 60' Quadrangle, CA and AZ	Geology	UTM NAD 83 Zone 11	0.005	1:100,000
Geologic Map of California, Salton Sea Sheet	SaltonSea250	UTM NAD 27 Zone 11	.002-.01	1:250,000
Geologic Map of California, Santa Ana Sheet	SantaAna250	UTM NAD 27 Zone 11	.002-.004	1:250,000
Distribution and Geologic Relations of Fault Systems in the Vicinity of the Central Transverse Ranges, Southern California	Transverse	UTM NAD 83 Zone 11	.006-.017	1:250,000
Geologic Map of California, San Bernardino Quadrangle	SanBern250	UTM NAD 27 Zone 11		1:250,000
Geologic Map of the Big Maria Mountains NE Quadrangle, Riverside County, California, and Yuma County Arizona	Big Maria-NE	UTM NAD 27 Zone 11		1:24,000
Geologic Map of California, Needles Sheet	Needles	UTM NAD 27 Zone 11		1:250,000
Digital map of the Santa Ana Sheet, California – provided by Dr. Morton of the USGS	Santa Ana Geology			1:100,000

Explanation of geologic and engineering geology unit symbols:

There are many ways to group rock and sediments with similar characteristics. For planning purposes, it is most appropriate to group features based on engineering properties, that is, the characteristics that have most importance to the built environment. For this report, more that 60,000 polygons *(area features)* were digitized from the geologic map data outlined above (Table 2-1) for Riverside County. These diverse geologic units were combined based on similar engineering properties. The properties were assigned based on the units' descriptions in the literature that accompanies the geologic maps (Table 2-1). Thus the assignments include many assumptions. The map is meant to provide general guidance to support land use decisions and policies. It should not replace or preclude site-specific observation and testing.

The general explanation of geologic and engineering geology unit symbols included with the digital data is as follows:

- The PType (petrologic type) was taken from the geologic maps at the time of digitization. 'Petrologic' includes the type of rock or sediment and its history of formation.
- The description for each of the PTypes was reviewed from the legend or other supporting literature.
- An abbreviated code of engineering attributes, named EType (engineering type), was created based on the Ptype analyses.

A matrix was developed to convert the geologic units (PType) to engineering type (Etype) based on:

•Rock Type (sedimentary, igneous, metamorphic);
•Age (Holocene, Holocene-Pleistocene, Pleistocene, Tertiary-Pleistocene, Tertiary or older);
•Degree of Consolidation (unconsolidated, weakly consolidated, moderately consolidated, indurated, deeply weathered, friable);

•Depositional Environment (alluvial, eolian, marine, lucustrine);
•Texture (fine, coarse, undifferentiated);
•Structure (massive, bedded, slide complex, foliated, fractured).

Ptype	Etype	Description
E	SEDTINDmaub	Eocene, marine sedimentary rocks, interbedded massive friable sandstones, siltsones, mudstones, and conglomerates.
gr	IGp	Mesozoic granitic rocks undifferentiated, granite, alaskite, quartz monzonite, granodiorite, quartz diorite, diorite, aplite and pegmatite dikes.
gr-m	IGMETfol	Pre Cenozoic, granitic and metamorphic rocks, mixed rocks consisting of strongly foliated migmatites, including bodies of schist and quartz diorite, undifferentiated.
gr?	IGp	Mesozoic granitic rocks undifferentiated, granite, alaskite, quartz monzonite, granodiorite, quartz diorite, diorite, aplite and pegmatite dikes.
Jbc	METfol	Bedford Canyon Formation (Jurassic) - Interlayered argillite, slate, graywacke, impure quartzite, and small masses of limestone; slightly metamorphosed.
Jbc?	METfol	Bedford Canyon Formation (Jurassic) - Interlayered argillite, slate, graywacke, impure quartzite, and small masses of limestone; slightly metamorphosed.
Jbm	METm	Marble (limestone) - Fine-grained limestone marble; gray-weathering.
Jhd	IGp	(Jurassic) Hornblende diorite and minor gabbro.
JKgd	IGp	(Jurassic or Cretaceous) granodiorite.
Jp	IGpfol	Plutonic, porphyritic granitoid rocks mostly medium- to coarse-grained, strongly foliated to unfoliated porphyritic granodiorite.
Jpgb	IGp	Hornblende gabbro.
Jpgd	IGpfol	Foliated granodiorite and diorite.
JTRs	METSEDm	Sedimentary rocks (Jurassic and Triassic), variably metamorphosed, sedimentary rocks: quartzite, conglomerate (quartzite, carbonate, granitic).
JTRu	IGSED	Volcanic and sedimentary rocks, undivided (Jurassic and Triassic).
jTRv	IGvMETfol	Jurassic and/or Triassic metavolcanic rocks; flow breccia, dacite, tuff, possibly including some plutonic rocks.
Ju	SEDmMETfol	Upper Jurassic marine, interbedded argillite, slate, quartzite, graywacke, conglomerate, and recrystallized limestone, can be metamorphosed.
Jv	IGvMETfol	Jurassic volcanic rocks: primarly rhyolitic to dacitic, massive quartz phorphry, commonly foliated and metamorphosed to greenschist to lower amphibolite facies.
Katg	IGp	Granodiorite of Arroyo del Toro pluton (Cretaceous) - Biotite-hornblende granodiorite; light gray, medium-grained, massive, homogeneous.
Kba	IGpfol	Amphibolitic gabbro of Box Springs plutonic complex (Cretaceous) - Hornblende-gabbro; dark gray to black, fine- to medium-grained, foliated.
Kbfg	IGpfol	Rocks of Box Springs plutonic complex (Cretaceous) - Biotite granodiorite and

tonalite;		foliated.
Kbfgi tonalite;	IGp	Rocks of Box Springs plutonic complex (Cretaceous) - Biotite granodiorite and contains abundant mesocratic inclusions.
Kbft	IGpfol	Tonalite of Box Springs plutonic complex (Cretaceous) - Biotite-hornblende tonalite; light-to medium-gray, medium- to coarse-grained, foliated.
Kbg	IGpfol	Rocks of Box Springs plutonic complex (Cretaceous) - Biotite granodiorite and subordinate tonalite; light gray, porphyritic, foliated.
Kbhg	IGp	Rocks of Box Springs plutonic complex (Cretaceous) - Granodiorite and subordinate tonalite; porphyritic, compositionally heterogeneous.
Kbhg1	IGpfol	Rocks of Box Springs plutonic complex (Cretaceous) - Granodiorite; porphyritic, has pronounced layering, heterogeneous grain size.
Kbht	IGpfol	Tonalite of Box Springs plutonic complex (Cretaceous) - Biotite tonalite; light-gray, inequigranular, medium- to coarse-grained, foliated. Heterogeneous composition.
Kbpg	IGp	Monzogranite of Bernasconi Pass (Cretaceous) - Biotite and biotite-hornblende monzogranite; pale tan to tan when weathered, medium-grained, hypidiomorphic-granular or porphyritic.
Kbpm Monzogranite	IGp	Migmatitic rocks within monzogranite of Bernasconi Pass (Cretaceous) - containing abundant masses of mafic rock.
Kbt	IGpfol	Tonalite of Box Springs plutonic complex (Cretaceous) - Biotite tonalite; massive, but some has faint, regular layering.
Kcg	IGp	Monzogranite of Cajalco pluton (Cretaceous) - Hornblende-biotite monzogranite and lesser granodiorite; fine- to medium-grained.
Kcgb	IGp	Granodiorite and gabbro, undifferentiated of Cajalco pluton (Cretaceous) - Intermixed granodiorite and gabbro.
Kcgd	IGp	Granodiorite of Cajalco pluton (Cretaceous) - Biotite and hornblende-biotite monzogranite and granodiorite; medium-grained.
Kcgq	IGp	Granodiorite and quartz-latite, undifferentiated of Cajalco pluton (Cretaceous) – Intermixed granodiorite and quartz latite porphyry; near-equal amounts of each.
Kct	IGp	Tonalite of Cajalco pluton (Cretaceous) - Biotite-hornblende tonalite, massive.
Kcto rock,	IGp	Tourmalinized monzogranite and granodiorite (Cretaceous) - Massive tourmaline commonly contains minor amounts of quartz and felsic minerals.
Kd	IGp	Diorite, undifferentiated of southern California batholith (Cretaceous) - Mainly hornblende diorite; fine- to medium-grained, massive.
Kd(s)	IGp	Diorite, undifferentiated of southern California batholith (Cretaceous) - Mainly hornblende diorite; fine- to medium-grained, massive. Submerged in Perris Reservoir.

Kdqd (Cretaceous)	IGp	Diorite and quartz diorite, undifferentiated of southern California batholith - Mainly mixed biotite-hornblende quartz diorite and hornblende diorite.
Kdvg	IGp	Granodiorite to tonalite of Domenigoni Valley pluton (Cretaceous) - Hornblende-biotite granodiorite to tonalite; contains equant mafic inclusions.
Kg	IGp	Granitic dikes of southern California batholith (Cretaceous) - Variety of leucocratic granitic dikes composed mainly of quartz and alkali feldspars.
Kgaa	IGp	Anorthositic gabbro of Green Acres gabbroic complex (Cretaceous) - Gabbro; abundant plagioclase of labradorite to anorthite composition. Leucocratic, gray-weathering.
Kgab	IGp	Heterogeneous mixture of olivine, pyroxene, and hornblende gabbros of Green Acres gabbroic complex (Cretaceous) - Olivine-pyroxene-hornblende gabbro; variable composition.
Kgah	IGp	Hornblende-rich gabbro of Green Acres gabbroic complex (Cretaceous) - Hornblende gabbro; fine- to medium-grained, melanocratic.
Kgam gabbro.	IGpMET	Metagabbro of Green Acres gabbroic complex (Cretaceous) - Metamorphosed Occurs as small masses included within mixed granitic rocks.
Kgao	IGp	Olivine gabbro of Green Acres gabbroic complex (Cretaceous) - Olivine-gabbro; predominatly coarse-grained.
Kgat	IGp	Troctolite of Green Acres gabbroic complex (Cretaceous) - Subporphyritic troctolite; contains large phenocrysts of anorthitic plagioclase.
Kgb to	IGp	Gabbro of southern California batholith (Cretaceous) - Hornblende gabbro; medium- very coarse-grained, commonly weathers brown.
Kgbf	IGp	Fine-grained hornblende gabbro, Rail Road Canyon area (Cretaceous) - Hornblende gabbro; fine-grained dikes, sills, and small plutons.
Kgct	IGp	Coarse-grained biotite-hornblende tonalite of Gavilan ring complex (Cretaceous) – Biotite-hornblende tonalite; coarse-grained to extremely coarse-grained.
Kgd	IGp	Granodiorite, undifferentiated of southern California batholith (Cretaceous) – Intermediate composition granitic rocks, mainly biotite-hornblende and biotite granodiorite.
Kgg	IGp	Hypersthene monzogranite of Gavilan ring complex (Cretaceous) - Hypersthene monzogranite; black, massive, weathers dark brown.
Kgh	IGp	Hypabyssal tonalite of Gavilan ring complex (Cretaceous) - Tonalite and subordinate granodiorite; fine-grained to nearly aphanitic, massive.
Kght	IGp	Heterogeneous tonalite of Gavilan ring complex (Cretaceous) - Biotite-hornblende tonalite; admixed with biotite hornblende granodiorite.
KgMz	IGpMETfol	Intermixed Mesozoic schist and Cretaceous granitic rocks (Mesozoic) – Heterogeneous mixture of schist and granitic rocks.

Kgp	IGpMETfol	Gneissic porphyritic granite (Cretaceous), distinctly to indistinctly foliated and lineated, medium- to coarse-grained.
KgPz	IGpMETfol	Intermixed Rocks (Cretaceous and Paleozoic?) - Intermixed Paleozoic (?) schist and gneiss and Cretaceous granitic rocks, mostly of tonalite and granodiorite composition.
Kgr	IGp	Granophyre (Cretaceous) - Granophryic-textured granitic rock; pale gray, aphanitic-to very fine-grained.
Kgt	IGp	Massive-textured tonalite of Gavilan ring complex (Cretaceous) - Biotite-hornblende tonalite, hypersthene-bearing; massive, relatively heterogeneous composition, brown-weathering.
Kgtf	IGpfol	Foliated tonalite of Gavilan ring complex (Cretaceous) - Biotite-hornblende tonalite; medium-grained, foliated.
Kgti	IGp	Tonalite containing abundant mesocratic inclusions of Gavilan ring complex (Cretaceous) - Biotite-hornblende tonalite; relatively fine-grained.
Kgu	IGp	Granite, undifferentiated of southern California batholith (Cretaceous) - Granite; leucocratic, fine- to coarse-grained, massive.
Khg	IGp	Heterogeneous granitic rocks of southern California batholith (Cretaceous) - Includes heterogeneous, compositionally diverse granitic rocks mostly of tonalitic and granodioritic composition.
Khg(s)	IGp	Heterogeneous granitic rocks of southern California batholith (Cretaceous) - Includes heterogeneous, compositionally diverse granitic rocks mostly of tonalitic and granitic composition.
Khqd	IGp	Hypersthene quartz diorite (Cretaceous) - Hypersthene-biotite quartz diorite; fine- to medium-grained, massive.
KJma	METSEDcb	Quartzite, minor chert and quartzite clasts conglomerate interbedded with mudstone and siltstone (Cretaceous or Jurassic).
KJmb	METSEDfb	Mudstone and siltstone interbedded with quartzite and limestone (Cretaceous or Jurassic).
KJmc	IGvSEDudb	Volcanic lithic sandstone, siltstone, mudstone and minor conglomerate (Cretaceous or Jurassic).
KJmd	IGvSEDfb	Phyllitic shale and silty to sandy shale, interbedded with minor volcanic-lithic sandstone and conglomerate containing clasts of quartzite and volcanic rocks.
KJme	IGvSEDfb	Phyllitic shale and arkosic and volcanic lithic sandstone, minor conglomerate. Calcareous shale near the top. (Createaceous or Jurassic).
KJqm	IGp	Quartz Monzonite of Pleasant View Ridge (Cretaceous or Jurassic).
Kl	SEDTMCmud	Ladd Formation (Upper Cretaceous) - Conglomerate, sandstone, siltstone, and shale; marine and locally nonmarine.
Klbc	SEDTMCmcb	Baker Canyon Conglomerate Member of Ladd Formation (Upper Cretaceous) – Conglomerate, conglomeratic sandstone and pebble conglomerate; marine and locally

		nonmarine.
Klct sphene-	IGp	Tonalite of Lamb Canyon (Cretaceous) - Hornblende-biotite tonalite; massive, bearing.
Klhs	SEDTMCmfb	Holz Shale Member of Ladd Formation (Upper Cretaceous) - Sandstone, siltstone and shale; entire unit is marine. Unit subdivided where sandstone and conglomerate predominate.
Klmc	IGp	Comb-layered (Cretaceous) - Gabbro, comb-layered. Found along south margin of Lakeview Mountains pluton.
Klmg	IGp	Hypersthene-hornblende gabbro (Cretaceous) - Hypersthene-hornblende gabbro; forms small masses in Lakeview Mountains.
Klml	IGp	Leucocratic rocks of Lakeview Mountains pluton (Cretaceous) - Plagioclase-quartz rock; white. Occurs as localized elongate masses.
Klmm	IGp	Melanocratic rocks of Lakeview Mountains pluton (Cretaceous) - Melanocratic and hypermelanic rock consisting primarily of biotite and hornblende. Occurs as lenticular masses.
Klmt	IGpfol	Tonalite of Lakeview Mountains pluton (Cretaceous) - Biotite-hornblende tonalite containing no potassium-feldspar; medium- to coarse-grained, massive to foliated.
Klmtg	IGp	Lakeview Mountains tonalite and granodiorite, undifferentiated (Cretaceous) – Intermixed tonalite and granodiorite.
Klst	IGpfol	La Sierra Tonalite (Cretaceous) - Biotite-hornblende tonalite; medium-gray, weak to strong alteration.
Klt	IGpfolfract	Tonalite near mouth of Laborde Canyon (Cretaceous) - Biotite-hornblende tonalite; medium-grained, foliated, intensely fractured.
Kmeg	IGpfol	Granite of Mount Eden (Cretaceous) - Granite; white to gray, leucocratic, medium-to coarse-grained, massive to foliated.
Kmf	SEDTINDmudb	McCoy Mountains Formation, member F, (Cretaceous), fine- to coarse-grained sandstone and conglomerate, interbedded with shale.
Kmg	SEDTINDmudb	McCoy Mountains Formation, member G, (Cretaceous), shale, sandstone and conglomerate (quartzite and carbonate). Upper fine-grained arkosic to volcanic lithic sandstone.
Kmh	SEDTINDmudb	McCoy Mountains Formation, member H, (Cretaceous), fine-grained arkosic sandstone, conglomeratic sandstone, and shale.
Kmhg	IGp	Mount Hole Granodiorite (Cretaceous) - Hornblende-biotite granodiorite; pale gray, massive.
Kmi	SEDTINDmcb	McCoy Mountains Formation, member I, (Cretaceous), medium- to coarse-grained arkosic and micaceous sandstone, conglomeratic sandstone and conglomerate.
Kmi?	SEDTINDmcb	McCoy Mountains Formation, member I, (Cretaceous), medium- to coarse-grained arkosic and micaceous sandstone, conglomeratic sandstone and conglomerate.

Kmj	SEDTINDmcb	McCoy Mountains Formation, member J, (Cretaceous), medium- to coarse-grained arkosic to volcanic lithic sandstone and conglomerate (granitic and volcanic) interbedded.
Kmk	SEDTINDmfb	McCoy Mountains Formation, member K, (Cretaceous), fine-grained, arkosic and volcanic-lithic sandstone, phyllitic shale and minor conglomerate (volcanic and granitic in composition).
Kml	SEDTINDmcb	McCoy Mountains Formation, member L, (Cretaceous), arkosic sandstone, conglomerate (quartzite, volcanic, granitic), and minor shale.
Kmp	IGpfol	Micropegmatite granite (Cretaceous) - Micropegmatitic granite; leucocratic, has pale pink tint.
Kmpc	IGpfol	Micropegmatite and granodiorite of Cajalco pluton, undifferentiated (Cretaceous) – Micropegmatitic granite and granitic rocks of the Cajalco pluton, undifferentiated.
Kmrg	IGp	Granite of Mount Rubidoux (Cretaceous) - Fayalite-hypersthene-biotite-hornblende granite; coarse-grained, black, massive.
Kp	IGp	Granitic pegmatite dikes (Cretaceous) - Pegmatitic textured granitic dikes; leucocratic, most are roughly tabular bodies; occur in Lakeview Mtns pluton, Box Springs plutonic complex.
Kpvg	IGp	Monzogranite to granodiorite of Paloma Valley Ring Complex (Cretaceous) - Biotite monzogranite, and less abundant hornblende-biotite granodiorite; gray, medium-grained, hypidiomorphic-granular, massive.
Kpvgb	IGp	Granodiorite and gabbro, undifferentiated, of Paloma Valley Ring Complex (Cretaceous) - Mixed biotite granodiorite and hornblende gabbro.
Kpvgr	IGp	Granophyre of Paloma Valley Ring Complex (Cretaceous) - Porphyritic granophyre; gray, very fine-grained.
Kpvt	IGpfol	Tonalite of Paloma Valley Ring Complex (Cretaceous) - Biotite-hornblende tonalite; foliated.
Kqd	IGp	Quartz diorite, undifferentiated of southern California batholith (Cretaceous) - Mainly biotite-hornblende quartz diorite; coarse-grained.
Krct	IGpfol	Tonalite of Reinhardt Canyon pluton (Cretaceous) - Biotite-hornblende tonalite; gray, medium-grained, most is well foliated.
Krg	IGpfol	Granite of the Riverside area (Cretaceous) - Leucocratic biotite granite; medium- to coarse-grained, massive to faintly foliated.
Ksmg	IGp	Monzogranite of Squaw Mountain (Cretaceous) - Biotite monzogranite; coarse-grained, moderately leucocratic, massive.
Ksv	METSEDIGv	Intermixed Estelle Mountain volcanics of Herzig (1991) and Mesozoic sedimentary rocks (Mesozoic) - Predominantly Mesozoic metasedimentary rocks, but including some volcanic rocks.
Kt	IGp	Tonalite, undifferentiated of southern California batholith (Cretaceous) - Mainly biotite-hornblende tonalite not associated with specific plutons.

Ktbh	IGpfol	Tonalite of Bernasconi Hills (Cretaceous) - Biotite-hornblende tonalite; gray, medium-grained, hypidiomorphic-granular, massive to indistinctly foliated.
Ktcg	IGp	Monzogranite of Tres Cerritos (Cretaceous) - Biotite monzogranite; leucocratic, medium- to coarse-grained, subporphyritic.
Ktd	IGp	Tonalite dikes of Mount Rubidoux (Cretaceous) - Mafic-rich tonalite; fine- to medium-grained.
Ktm (Cretaceous)	IGp	Tonalite and mafic rocks, undifferentiated of southern California batholith - Mainly biotite-hornblende tonalite containing subequal amounts of mafic inclusions. Inclusion borders mostly gradational and ill-defined.
Ktr	SEDTWCacm	Trabuco Formation (Upper Cretaceous) - Conglomerate locally interbedded with sandstone and siltstone; brown to maroon, massive, unfossiliferous, nonmarine.
Kts	IGp	Tonalite of Slaughterhouse Canyon (Cretaceous) - Biotite-hornblende tonalite; dark gray, fine-grained, massive.
Kvem andesite;	IGv	Estelle Mountain volcanics of Herzig (1991) (Cretaceous) - Rhyolite and rare heterogeneous mix of extrusive and volcaniclastic rocks.
Kvr	IGv	Rhyolite of Estelle Mountain volcanics of Herzig (1991) (Cretaceous) - Rhyolite; relatively homogeneous extrusive rocks.
Kvs	IGv	Intermixed Estelle Mountain volcanics of Herzig (1991) and Cretaceous (?) sedimentary rocks - Rhyolitic volcanic rocks and Mesozoic sedimentary rocks. Tectonically and probably stratigraphically mixed.
Kvsp	IGvfract	Santiago Peak Volcanics (Cretaceous) - Andesitic basalt, andesite, dacite, and rhyolite; mainly extrusive rocks, but some associated volcaniclastic rocks.
Kvspi	IGp	Intrusive rocks associated with Santiago Peak Volcanics (Cretaceous) - Hypabyssal dikes, sills and small intrusions.
Kvt gray,	IGpfol	Val Verde Tonalite of Val Verde pluton (Cretaceous) - Biotite-hornblende tonalite; medium grained, foliated.
Kvti	IGp	Inclusion-rich tonalite of Val Verde pluton (Cretaceous) - Tonalite; contains abundant melanocratic inclusions, most with compositionally gradational borders.
Kvtk	IGp	Potassium feldspar-bearing tonalite of Val Verde pluton (Cretaceous) - Biotite-hornblende tonalite; contains small amounts of potassium feldspar, heterogeneous.
Kwl	SEDTMCud	Williams and Ladd Formations, undifferentiated (Upper Cretaceous) - Sandstone, conglomerate and siltstone.
Kwsr	SEDTWCmc	Schulz Ranch Sandstone Member of Williams Formation (Upper Cretaceous) – Sandstone, coarse-grained; marine.
landslide	landslide	Mapped landslides.
ls	METSEDud	Metasedimentary (prebatholitic) rocks of uncertain composition. Part of (ms)

		limestone and marble.
m	MET	Paleozoic (?) Marble: Coarse- to very coarse-grained marble bodies.
m1	METfol	Sheared and deformed metamorphic rocks of uncertain age, (Precambrian to Mesozoic), gneissic in part cataclastically deformed, (Mesozoic and Pre Mesozoic).
m2	METfol	Sheared and deformed metamorphic rocks of uncertain age, (Precambrian to Mesozoic), mylonitic rocks (Mesozoic?).
Mc	SEDTaudb	Unnamed (Miocene) continental deposits, sandstone, conglomerate, siltstones, and mudstones, minor limestone, commonly interbedded with volcanic flows and tuffs.
MCs	METSEDb	(Mississippian to Cambrian) sedimentary rocks: variably metamorphosed massive limestone and marble, massive limestone and dolimitic limestone, thinly banded limestone.
Mib	IGv	Miocene shallow intrusive rocks, basaltic.
ms	METSEDfol	Metasedimentary (prebatholithic) rocks of uncertain age; quartzite, phyllite,and schist.
mss part	METSED	Metaquartzite, marble, and pelitic gneiss and schist, (Paleozoic and Precambrian) of San Bernardino Mnt block (sbb).
mv	METIGv	Pre Cretaceous metavolcanic rocks, undifferentiated metavolcanic amphibolites in Ramona quadrangle.
Mzd	IGpfol	Diorite of Transverse Ranges (Mesozoic) - Hornblende-biotite diorite and quartz diorite; medium- to coarse-grained, massive to incipiently foliated.
Mzdc	MET	Marble associated with metadunite (Mesozoic) - Silicate-bearing marble; pale gray, coarse-grained, spatially associated with dunite.
Mzds altered	METfol	Metadunite and serpentinite (Mesozoic) - Talc-bearing olivine dunite and dunite to magnesite-bearing serpentinite; brown-weathering.
Mzdx	METfol	Amphibole and pyroxene-bearing rocks associated with metadunite-serpentinite (Mesozoic) - Heterogeneous mixture of amphibolite, pyroxenite and altered schist.
Mzg	METSED	Graywacke (Mesozoic) - Predominately lithic metagraywacke.
Mzgp	METSEDfol	Intermixed graywacke and phyllite (Mesozoic) - Intermixed lithic metagraywacke and phyllite.
Mzi	METfol	Interlayered phyllite (or schist) and quartzite (Mesozoic) - In low metamorphic grade rocks, relatively pure quartzite interlayered with phyllite. In higher grade metamorphic rocks, quartzite interlayered with biotite schist.
Mzm	MET	Marble (Mesozoic) - Light colored tremolite and diopside-bearing marble and calc-silicate rock.
Mzmg	IGp	Mylonitic and cataclastic granitic rocks of Transverse Ranges (Mesozoic) - Cataclastic granodiorite, tonalite and quartz diorite, fine- to coarse-grained.
Mzp	METfol	Phyllite (Mesozoic) - Phyllite, black, fissile.

MzPfg METfol Fine-grained gneiss, (Mesozoic or Proterozoic), quartzofeldspathic gneiss.

MzPgn METfol Gneissic rocks, undivided (Mesozoic and Proterozoic) - Strongly foliated and lineated mylonitic and augen gneiss.

Mzq METSED Quartz-rich rocks (Mesozoic) - Impure quartzite and quartz-rich metasandstone.

Mzqg METSED Intermixed quartzite and graywacke (Mesozoic) - Intermixed impure quartzite and
lithic

metagraywacke.

Mzs METfol Schist (Mesozoic) - Wide variety of fissile schist including andalusite biotite schist, cordierite biotite schist, sillimanite biotite schist, and less commonly garnet-bearing schist.

Mzu METSEDfol Mesozoic metasedimentary rocks, undifferentiated (Mesozoic) - Quartz-bearing metasedimentary rocks, chiefly biotite schist; includes unknown Mesozoic metasedimentary rocks.

Oc SEDTWCaud (Oligocene), nonmarine.

Pc SEDTWCaud Undivided (Pliocene) nonmarine, conglomerate, sandstone, siltstone, shale.

Pc? SEDTWCaud Undivided (Pliocene) nonmarine, conglomerate, sandstone, siltstone, shale.

PCc IGpMET Precambrian igneous and metamorphic rocks complex, intimate mixture of Precambrian plutonic rocks (diorite-granite), and Precambrian metamorphics
including

migmatites.

pCg IGp Granitic rocks.

pCgr IGpfol Undivided (Precambrian) granitic rocks, plutonic igneous rocks, granite to diorite and gabbro, generally slightly to highly foliated gneiss.

PCs METSED Sedimentary rocks (Permian to Cambrian); PPs and MCs together.

Pgn METfol Gneiss and amphibolite (Proterozoic).

Pml SEDTMCmfb (Middle to lower Pliocene), marine, interbedded claystone, siltstone and sandstone, abundant oystershell reefs, some pebble conglomerate.

Pmlc SEDTMCaudb (Middle to lower Pliocene), nonmarine, interbedded conglomerate, breccia,
sandstone,

and siltstone with clasts of gneiss.

PP METSED Paleozoic marine metasedimentary rocks, including metadolomite, marble and quartzite.

Ppg IGpMETfol Porphyritic granite and augen gneiss, (Proterozoic), coarse-grained, variably foliated and metamorphosed plutonic rocks.

PPls METSEDTINDm Paleozoic marine, sedimentary and metasedimentary rocks, limestone member, marble localy cherty and fossiliferous.

PPs METSEDTINDm Sedimentary rocks, (Permian to Pennsylvanian), variably metamorphosed

sedimentary		rocks; cherty to noncherty limestones, dolomite, marble, and quartz sandstone.
prb	IGpMETfol	Peninsular ranges block (Mesozoic, Paleozoic, and Precambrian?) granitoid rocks and prebatholithic metasedimentary rocks moderate to pronounced foliation.
ps	METfol	Pelona Schist (Cretaceous and Paleocene), massive amphibole, minor quartzite, metamorphic age = Paleocene, protolith age unknown.
Pv	IGv	Pliocene volcanic undifferentiated, rhyolite, andesite, basalt, and pyroclastic rocks.
Pvb	IGv	Pliocene volcanic basalt flows.
Pza	METfol	Amphibolite (Paleozoic?) - Black hornblende-plagioclase amphibolite.
Pzc	METfol	Calc-silicate rocks (Paleozoic?) - Heterogeneous, massive to well-layered calc-silicate rocks.
Pzm	MET	Marble (Paleozoic?) - Marble; white to light-gray, locally bluish-gray, and blue, coarse- to extremely coarse-grained.
Pzms rock,	METfol	Marble and schist, undifferentiated (Paleozoic?) - Intermixed marble, calc-silicate and biotite schist.
Pzq	METfol	Impure quartzite (Paleozoic?) - Quartzite; impure, light-gray to light-greenish-gray, fine-to medium-grained, layered to massive.
Pzs to	METfol	Biotite schist (Paleozoic?) - Biotite schist and biotite-quartz-feldspar schist; medium- dark-gray, fine-grained.
Pzu	METfol	Paleozoic (?) rocks, undifferentiated - Biotite schist, quartzite, gneiss, and lesser amounts of hornblende gneiss, marble and associated skarn and calc-silicate rock.
Q	SEDHUCaud	Alluvium, unconsolidated, poorly-sorted stream, fan and basin deposits, clay to boulder size.
Qa	SEDHUCaud	Axial channel deposits (late Holocene) - Active and recently active fluvial deposits restricted to canyon floors; gravel, sand and silt, unconsolidated.
Qaf	SEDHUCaud	Artificial fill (Recent) - Deposits of fill resulting from human construction or mining activities; most large deposits mapped, but in some areas, no deposits are shown.
Qal	SEDHUCaud	Alluvium, (Holocene), river and stream fill, fan deposits, unconsolidated.
Qc	SEDPUCaud	Pleistocene nonmarine sedimentary deposits, undeformed or slightly deformed dissected alluvial fan deposits.
Qco	SEDPUCaud	Pleistocene nonmarine sedimentary deposits extensively folded, faulted, and dissected alluvial fan deposits.
Qcol	SEDPUCaud	Pleistocene nonmarine sedimentary deposits, undeformed or slightly deformed dissected alluvial fan deposits.
Qdf	SEDPMCaud	Deposits of older dissected alluvial fans (Pleistocene), surfaces moderately to well dissected soil profiles, well developed argillic horizons.

Qdf?	SEDPMCaud	Deposits of older dissected alluvial fans (Pleistocene), surfaces moderately to well dissected soil profiles, well developed argillic horizons.
Qf	SEDHUCaud	Alluvial fan deposits (late Holocene) - Deposits of active and recently active alluvial fans and headward drainages of fans; bouldery, cobbly, gravelly, sandy, or silty.
Qfa	SEDHUCaf	Alluvial fan deposits (late Holocene) - Deposits of active and recently active alluvial fans and headward drainages of fans; dominantly sand; unconsolidated.
Qfag	SEDHUCac	Alluvial fan deposits (late Holocene) - Deposits of active and recently active alluvial fans and headward drainages of fans; dominantly sandy gravel; unconsolidated.
Qfgs	SEDHUCaf	Alluvial fan deposits (late Holocene) - Deposits of active and recently active alluvial fans and headward drainages of fans; dominantly gravelly silt; unconsolidated.
Ql	SEDHMClf	Lacustrine deposits (late Holocene) - Clay, silt and fine-grained sand; unconsolidated to moderately consolidated.
Qls	landslide	Landslide deposits (late Holocene) - Active or recently active landslides; unconsolidated to consolidated. Includes many early Holocene landslides that in part have been reactivated during late Holocene
Qlv	SEDHUClf	Lacustrine and fluvial deposits (late Holocene) - Mixed lacustrine and fluvial deposits. Clay, silt and fine-grained sand; unconsolidated to moderately consolidated.
Qo	SEDPWCaud	Older alluvium, dissected alluvial deposits (Pleistocene).
Qoa	SEDPWCaud	Old axial channel deposits (late to middle Pleistocene) - Gravel, sand and silt; gray, unconsolidated to indurated.
Qoa1	SEDPWCaud	Old axial channel deposits, Unit 1 (middle Pleistocene) - Gravel, sand and silt; gray, unconsolidated to indurated. Old part of Qoa.
Qoaa	SEDPWCaud	Old axial channel deposits (late to middle Pleistocene) - Gravel, sand and silt; gray, unconsolidated to indurated.
Qoaag	SEDPWCaud	Old axial channel deposits (late to middle Pleistocene) - Gravel, sand and silt; gray, unconsolidated to indurated.
Qoag	SEDPWCaud	Old axial channel deposits (late to middle Pleistocene) - Gravel, sand and silt; gray, unconsolidated to indurated.
Qoc	SEDPWCcc	Old colluvium deposits (late to middle Pleistocene) - Cobble- to boulder-colluvium; indurated.
Qocb	SEDPWCcc	Old colluvium deposits (late to middle Pleistocene) - Cobble- to boulder-colluvium; indurated. Dominantly boulders.
Qocg	SEDPWCcc	Old colluvium deposits (late to middle Pleistocene) - Cobble- to boulder-colluvium; indurated. Dominantly gravels.
Qof	SEDPWCaf	Old alluvial fan deposits (late to middle Pleistocene) - Sandy alluvium; reddish brown, indurated; surface of most fans slightly dissected.
Qof1g	SEDPWCac	Old alluvial fan deposits, Unit 1 (middle Pleistocene) - Sandy alluvium; reddish brown, indurated, surface of most fans slightly dissected. Dominantly gravel. Old part of Qof.

Qofa	SEDPWCaf	Old alluvial fan deposits (late to middle Pleistocene) - Sandy alluvium; reddish brown, indurated, surface of most fans slightly dissected.
Qofag	SEDPWCac	Old alluvial fan deposits (late to middle Pleistocene) - Sandy gravel alluvium; reddish brown, indurated, surface of most fans slightly dissected.
Qofb	SEDPWCac	Old alluvial fan deposits (late to middle Pleistocene) - Bouldery alluvium; reddish brown, indurated, surface of most fans slightly dissected.
Qofc brown,	SEDPWCaf	Old alluvial fan deposits (late to middle Pleistocene) - Clayey alluvium; reddish indurated, surface of most fans slightly dissected.
Qofg	SEDPWCac	Old alluvial fan deposits (late to middle Pleistocene) - Gravelly alluvium; reddish brown, indurated, surface of most fans slightly dissected.
Qofva	SEDPHMCaf	Old alluvial fan deposits and young alluvial valley deposits (late Pleistocene) - Sandy alluvium; reddish brown, moderately indurated. Has thin, discontinuous cover of Qyv.
Qols	SEDPsc	Old landslide deposits (late to middle Pleistocene) - Rock debris; most is fragmented, unconsolidated to consolidated.
Qova	SEDPUCaf	Old alluvial valley deposits (late to middle Pleistocene) - Sandy alluvium on valley floors; gray, unconsolidated to indurated.
Qowa	SEDPUCaf	Old alluvial wash deposits (late to middle Pleistocene) - Sand and gravelly sand flanking Santa Ana River.
Qp	SEDTPaud	(Plio-Pleistocene), nonmarine, silt, sand, gravel, and conglomerate (commonly volcanic composition, may be weakly indurated and tilted or deformed).
Qpf?	SEDPWCaf	Pauba Formation (Pleistocene) - Siltstone and sandstone. Two informal members.
Qpff	SEDPWCaud	Fanglomerate member of Pauba Formation (Pleistocene) - Fanglomerate and mudstone; grayish-brown, poorly sorted, well-indurated.
Qpfs	SEDPWCaf	Sandstone member of Pauba Formation (Pleistocene) - Sandstone containing sparse cobble- to boulder-conglomerate beds; brown, cross-bedded, moderately well-indurated.
Qpv	IGv	Pleistocene volcanics, rhyolite, andesites, basalts, and pyroclastics.
Qpvb	IGv	Pleistocene volcanic, basalt (flows and minor andesite and pyroclastic, members of Qpv).
Qr	SEDPDWud	Regolith (Pleistocene) - Deeply weathered rock and soil regolith.
Qra	SEDHUCaf	River Alluvium, flood-plain silt, fine sand and subordinate coarser sediments.
Qs	SEDHUCef	Wind blown sand (Quaternary), unconsolidated sand dunes and sheets.
Qsc	SEDHUCaud	Stream channel deposits (Holocene), (Whitewater river deposits).
Qt	SEDPMCaud	(Quaternary) nonmarine terrace, local stream terrace deposits, extensively dissected and locally folded.

Qt-Qal	SEDPHMCaud	(Quaternary) nonmarine terrace, local stream terrace deposits, extensively dissected and locally folded to Alluvium, (Holocene), river and stream fill.
QTa	SEDTPHUCaud	Alluvial fan and fluvial (Quaternary and Tertiary?), unconsolidated to weakly consolidated. Fan: angular, poorly sorted gravels and sands. Fluvial: commonly cross-bedded.
QTc	SEDTPINDac	Conglomeratic sedimentary rocks of Riverside West 7.5' quadrangle (early Pleistocene to late Pliocene?) - Conglomerate, nonmarine. Upper part contains boulders from Peninsular Ranges; lower part contains cobbles from San Bernardino Mtns.
QTcw	SEDTPINDac	Conglomerate unit of Wildomar area (Pleistocene and late Pliocene) - Conglomerate; cobbles and boulders.
QTdf	SEDTPWCaud	Dissected fan deposits (Quaternary or Tertiary), weakly consolidated, gravel and sand (local), fluvial deposits (Quaternary or Tertiary), weakly consolidated, gravel.
QTdfs	SEDTPWCaud	Dissected fan deposits (Quaternary or Tertiary), weakly consolidated, gravel and sand (local), fluvial deposits (Quaternary or Tertiary), weakly consolidated, gravel.
QTfg	SEDTPWCac	Fluvial gravel, primarily rounded gravel.
QTfs	SEDTPWCaf	Fluvial sand, primarily well-sorted sand and minor rounded gravel, common cross bedding.
QTn	SEDPINDac	Late Cenozoic sedimentary rocks of Norco area (early Pleistocene to late Pliocene?) – Conglomerate and conglomeratic sandstone in Norco area, nonmarine. Contains cobbles derived locally and from Transverse Ranges.
QTs	SEDPINDac	Unnamed late Cenozoic sedimentary rocks in Riverside and Corona areas (early Pleistonce to late Pliocene?) - Sandstone and conglomerate, nonmarine. Contains clasts from San Bernardino Mtns. and local clasts southeast of Riverside.
QTst	SEDTPWCaud	San Timoteo Formation, nonmarine sandstone, siltstone, conglomerate, and shale; forms extensive badlands topography (Pleistocene and Pliocene).
Qtsta	SEDPMCac	Conglomeratic sandstone beds of San Timoteo beds of Frick (1921) (Pleistocene) – Locally derived conglomeratic sandstone; nonmarine.
QTstu	SEDPMCacb	Upper member of San Timoteo beds of Frick (1921) (Pleistocene) - Interbedded sandstone and conglomerate;nonmarine; gray, coarse-grained, moderately indurated.
QTsw	SEDPMCaf	Sandstone unit of Wildomar area (Pleistocene and late Pliocene) - Sandstone; pale yellow-green, moderately-indurated.
QTt	SEDPMCac	Conglomerate of Temescal area (early Pleistocene to late Pliocene?) - Cobble conglomerate on Paleocene (?) surface.
Qvoa	SEDPMCaud	Very old axial channel deposits (middle to early Pleistocene) - Gravel, sand and silt; reddish-brown, well-indurated, surfaces well-dissected.
Qvoaa	SEDPMCaf	Very old axial channel deposits (middle to early Pleistocene) - Gravel, sand and silt; reddish-brown, well-indurated, surfaces well-dissected. Dominantly sand.
Qvoaac	SEDPMCaf	Very old axial channel deposits (middle to early Pleistocene) - Gravel, sand and silt;

		reddish-brown, well-indurated, surfaces well-dissected. Dominantly sandy clay.
Qvoag	SEDPMCac	Very old axial channel deposits (middle to early Pleistocene) - Gravel, sand and silt; reddish-brown, well-indurated, surfaces well-dissected. Dominantly gravel.
Qvof	SEDPMCaud	Very old alluvial fan deposits (middle to early Pleistocene) - Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected.
Qvof1	SEDPMCaud	Very old alluvial fan deposits, Unit 1 (early Pleistocene) - Gravel, sand and silt; reddish-brown, fan surfaces well-dissected. Old part of Qvof.
Qvof1a	SEDPMCaf	Very old alluvial fan deposits, Unit 1 (early Pleistocene) - Gravel, sand and silt; reddish-brown, fan surfaces well-dissected. Old part of Qvof. Dominantly sand
Qvof1g	SEDPMCac	Very old alluvial fan deposits, Unit 1 (early Pleistocene) - Gravel, sand and silt; reddish-brown, fan surfaces well-dissected. Old part of Qvof. Dominantly gravel.
Qvofa	SEDPMCaf	Very old alluvial fan deposits (middle to early Pleistocene) - Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected. Dominantly sand.
Qvofag	SEDPMCac	Very old alluvial fan deposits (middle to early Pleistocene) - Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected. Dominantly sandy gravel.
Qvofc	SEDPMCaf	Very old alluvial fan deposits (middle to early Pleistocene) - Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected. Dominantly clay.
Qvofg	SEDPMCac	Very old alluvial fan deposits (middle to early Pleistocene) - Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected. Dominantly gravel.
Qvols	SEDPMCsc	Very old landslide deposits (middle to early Pleistocene) - Rock debris; moderately well- to well-consolidated. Almost no primary landslide morphology preserved.
Qvsc	SEDHUCaud	Active valley deposits (late Holocene) - Active and recently active fluvial deposits along valley floors; gravel, sand and silt, unconsolidated.
Qw	SEDHUCaud	Wash deposits (late Holocene) - Alluvium in active and recently active washes; bouldery to sandy, unconsolidated.
Qwa	SEDHUCaf	Wash deposits (late Holocene) - Alluvium in active and recently active washes; dominantly sand, unconsolidated.
Qwag	SEDHUCaud	Wash deposits (late Holocene) - Alluvium in active and recently active washes; dominantly sandy gravel, unconsolidated.
Qya	SEDPHUCaud	Young axial channel deposits (Holocene and late Pleistocene) - Gravel, sand and silty alluvium; gray, unconsolidated.
Qyaa	SEDPHUCaf	Young axial channel deposits (Holocene and late Pleistocene) - Gravel, sand and silty alluvium; gray, unconsolidated. Dominantly sand.
Qyaag	SEDPHUCac	Young axial channel deposits (Holocene and late Pleistocene) - Gravel, sand and silty alluvium; gray, unconsolidated. Dominantly sandy gravel.
Qyag	SEDPHUCac	Young axial channel deposits (Holocene and late Pleistocene) - Gravel, sand and silty alluvium; gray, unconsolidated. Dominantly gravel.
Qye	SEDPHUCef	Young eolian deposits (Holocene and late Pleistocene) - Very fine- to medium-grained

		sand, unconsolidated; dune morphology apparent.
Qyf	SEDPHUCaud	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated
Qyf1a	SEDPHUCaf	Young deposits of alluvial fans, Unit 1 (early Holocene and late Pleistocene) - Sandy alluvial fan deposits, may contain boulders; unconsolidated. Oldest Qyf unit.
Qyf1g Gravelly	SEDPHUCac	Young deposits of alluvial fans, Unit 1 (early Holocene and late Pleistocene) - alluvial fan deposits, may contain boulders; unconsolidated. Oldest Qyf unit.
Qyf1gs Gravelly	SEDPHUCaf	Young deposits of alluvial fans, Unit 1 (early Holocene and late Pleistocene) - silt alluvial fan deposits, may contain boulders; unconsolidated. Oldest Qyf unit.
Qyf2	SEDHUCaud	Alluvial fan deposits (Holocene) with slightly to moderately dissected surfaces and soil profiles lacking argillic horizons.
Qyf3gs	SEDHUCaf	Young deposits of alluvial fans, Unit 3 (late and middle Holocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly gravelly sand.
Qyf4 mixtures,	SEDHUCaud	Young deposits of alluvial fans, Unit 4 (late Holocene) - Gravel, sand and silt, some contain boulders; unconsolidated. Most recent Qyf unit.
Qyf4gs	SEDHUCaf	Young deposits of alluvial fans, Unit 4 (late Holocene) - Gravelly silt alluvial fan deposits, some contain boulders; unconsolidated. Most recent Qyf unit.
Qyfa	SEDPHUCaf	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly sand.
Qyfag	SEDPHUCaf	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly sandy gravel.
Qyfbg	SEDPHUCac	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly bouldery gravel.
Qyfg	SEDPHUCac	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly gravel.
Qyfga	SEDPHUCaf	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly gravelly sand.
Qyfgs	SEDPHUCaf	Young alluvial fan deposits (Holocene and late Pleistocene) - Gravel, sand and silt, mixtures, some contain boulders; unconsolidated. Dominantly gravelly silt.
Qyls	SEDPHUCsc	Young landslide deposits (Holocene and late Pleistocene) - Rock debris and rubble, unsorted. All or parts of many Qyls landslides subject to renewed movement; primary landslide morphology typically preserved.
Qyls?	SEDPHUCsc	Young landslide deposits (Holocene and late Pleistocene) - Rock debris and rubble, unsorted. All or parts of many Qyls landslides subject to renewed movement; primary landslide morphology typically preserved.
Qyv1a	SEDPHUCaf	Young alluvial valley deposits, Unit 1 (early Holocene and late Pleistocene) - Silty to sandy alluvium west of Casa Loma Fault; gray, unconsolidated. Dominantly sand.

Qyva alluvium	SEDPHUCaf	Young alluvial valley deposits (Holocene and late Pleistocene) - Silty to sandy on valley floors; gray, unconsolidated. Dominantly sand.
Qyvca alluvium	SEDPHUCaf	Young alluvial valley deposits (Holocene and late Pleistocene) - Silty to sandy on valley floors; gray, unconsolidated. Dominantly clayey sand.
Qyvcs alluvium	SEDPHUCaf	Young alluvial valley deposits (Holocene and late Pleistocene) - Silty to sandy on valley floors; gray, unconsolidated. Dominantly clayey silt.
Qyvsa alluvium	SEDPHUCaf	Young alluvial valley deposits (Holocene and late Pleistocene) - Silty to sandy on valley floors; gray, unconsolidated. Dominantly silty sand.
Qyvsc alluvium	SEDPHUCaf	Young alluvial valley deposits (Holocene and late Pleistocene) - Silty to sandy on valley floors; gray, unconsolidated. Dominantly silty clay.
Qywa dominantly	SEDPHUCaf	Young alluvial wash deposits (Holocene and late Pleistocene) - Deposits of sand flanking active Santa Ana River; unconsolidated.
Qywag dominantly	SEDPHUCaf	Young alluvial wash deposits (Holocene and late Pleistocene) - Deposits of sandy gravel flanking active Santa Ana River; unconsolidated.
sbb	IGMET	Granitoid, prebatholithic, sedimentary, metasedimentary, and metaplutonic rocks of Mesozoic, Paleozoic and Precambrian age (San Bernardino Mnts. block).
sgb	IGMET	Granitoid, prebatholithic, metasedimentary, and metaplutonic rocks of Mesozoic, Paleozoic and Precambrian age (San Gabriel Mtns. block).
QTdfs	SEDTPWCaud	Dissected fan deposits (Quaternary or Tertiary), weakly consolidated, gravel and sand (local), fluvial deposits (Quaternary or Tertiary), weakly consolidated.
Tbt	SEDTINDud	Tufa, thin (<2m) locally extensive sheets of limestone coating Miocene and older bedrock units; locally includes conglomerates.
Tbx	SEDTMCsc	Sedimentary breccia - unbedded, unsorted deposits of angular gravel and slideblock; interpreted as landslide deposits. Largest slide block shown.
Tc	SEDTINDmf	Capistrano Formation (early Pliocene and Miocene) - Marine sandstone. Includes one member and two facies.
Tcg	SEDTINDac	Conglomerate in the Lake Mathews area (Miocene?) - Cobble conglomerate; coarse-grained sandstone matrix, massively bedded, indurated. Lacks red rhyolite clasts of Tcgr.
Tcga	SEDTMCac	Conglomerate at Arlington Mountain (Paleogene?) - Cobble conglomerate; composed of exotic welded tuff clasts.
Tcgr	SEDTINDac	Rhyolite-clast conglomerate of Lake Mathews area (Miocene?) - Cobble conglomerate; coarse-grained sandstone matrix, massively bedded, indurated. Cobble clasts are red rhyolite.

Tch	SEDTMCmac	Sandstone and conglomerate in southeastern Chino Hills (early Pliocene and Miocene) - Sandstone and conglomerate; marine and nonmarine.
Tep	SEDTMCac	Sandstone of Elsinore Peak (Paleogene?) - Sandstone and pebbly sandstone.
Tf	SEDTMCmud	Fernando Formation (Pliocene) - Siltstone, sandstone, pebbly sandstone, and conglomerate; marine. Includes two members separated by regional erosional unconformity.
Tfbx	SEDTMCsc	Fanglomerate, sedimentary breccia and slide block, undivided (Miocene and Oligocene).
Ti	IGp	Tertiary intrusive.
TiB	IGp	Felsic intrusive rocks (Miocene and Oligocene?), fine-grained, hypabyssal, probable rhyolitic to dacitic.
Tl-Ql?	SEDTPWClfb	Lake deposits of Tertiary or Quaternary age? Lake deposits, interbedded fossiliferous shale and sandstone to playa deposits.
Tlm	SEDTafm	Lake Mathews Formation (Miocene) - Mudstone, minor conglomerate, and poorly bedded sandstone; massively bedded, nonmarine.
Tlm?	SEDTafm	Lake Mathews Formation (Miocene) - Mudstone, minor conglomerate, and poorly bedded sandstone; massively bedded, nonmarine.
Tmea	SEDTMCac	Arkosic sandstone member of Mount Eden Formation of Fraser (1931) (Miocene) – Nonmarine sandstone, pebbly sandstone and conglomerate, coarse-grained, thick-bedded.
Tmeb	SEDTMCac	Tonalite boulder breccia of Mount Eden Formation of Fraser (1931) (Miocene) – Tongues of monolithologic tonalite boulder breccia in Tmea.
Tmec	SEDTMCac	Conglomeratic sandstone member of Mount Eden Formation of Fraser (1931) (Miocene) - Nonmarine coarse-grained and pebbly sandstone, and conglomerate; massive to indistinctly bedded.
Tmels	SEDTMCaud	Lower sandstone member of Mount Eden Formation of Fraser (1931) (Miocene) – Nonmarine sandstone, pebbly sandstone and minor limestone.
Tmem	SEDTINDaffract	Mudrock member of Mount Eden Formation of Fraser (1931) (early Pliocene and Miocene) - Nonmarine mudrock, dark gray-green, hackly fracturing to locally fissile.
Tmeus	SEDTINDafbfract	Upper sandstone member of Mount Eden Formation of Fraser (1931) (early Pliocene and Miocene) - Nonmarine sandstone, fissle to hackly fracturing mudrock; pale brown, well-sorted, thin-to medium-bedded, indurated.
Tns	SEDTUCaud	Sandstone of Norco area (Pliocene) - Sandstone containing local conglomerate lenses; greenish-yellow, unconsolidated.
TP	SEDTMCmudb	Puente Formation (early Pliocene and Miocene) - Marine shale, siltstone, sandstone, and conglomerate. Includes four members.
Tps	SEDTMCmfb	Soquel Member of Puente Formation (Miocene) - Predominately sandstone and siltstone.

Tpsc	SEDTMCmcm	Sycamore Canyon Member of Puente Formation (early Pliocene and Miocene) – Predominately sandstone and pebble conglomerate.
Tpy	SEDTMCmfb	Yorba Member of Puente Formation (Miocene) - Predominately siltstone and sandstone.
TRd	IGpMETfol	Triassic? diorite and gabbro; locally metamorphosed to amphibolite.
TRgd	IGpfol	Mount Lowe granodiorite, foliated, monzonite to diorite.
TRqm	IGp	Triassic quartz monzonite and monzodiorite.
Tsa	SEDTMCmfb	Santiago Formation (middle Eocene) - Sandstone and conglomerate, marine and nonmarine.
Tsb	SEDTMCsc	Slide blocks, (Miocene and Oligocene?), angular blocks and slabs. (Mesozoic? and Paleozoic) carbonate rocks and quartzite, (interpretation: landslides).
Tsi	SEDTDWamud	Silverado Formation (Paleocene) - Sandstone, siltstone and conglomerate; nonmarine and marine. Much of unit is thoroughly weathered.
Tstd	SEDTMCaf	Beds of San Timoteo beds of Frick (1921) (Pliocene) - Highly deformed sandstone, pebbly sandstone and conglomerate in Tstm; restricted to western part; nonmarine.
Tstl fine-	SEDTMCaf	Lower member of San Timoteo beds of Frick (1921) (Pliocene) - Sandstone, gray, grained, well-sorted; contains subordinate pebble lenses; nonmarine. Moderately weathered.
Tstlc	SEDTMCafb	Beds of San Timoteo beds of Frick (1921) (Pliocene) - Interval of claystone, shale, siltstone, and very fine-grained sandstone in Tstl; nonmarine.
Tstm	SEDTINDac	Middle member of San Timoteo beds of Frick (1921) (Pliocene) - Sandstone and conglomerate; contains abundant red-hued stratigraphic intervals; nonmarine.
Tt	SEDTMCmud	Topanga Formation (middle Miocene) - Marine sandstone, siltstone and locally conglomerate.
Tta	SEDTINDaf	Temecula Arkose (Pliocene) - Sandstone, medium- to coarse-grained, indurated, fluvial.
Tv	IGv	Tertiary volcanic.
Tvep	IGv	Basalt of Elsinore Peak (Miocene) - Vesicular basalt flows.
Tvh	IGv	Basalt of Hogbacks (Miocene) - Remnant of a channel-filling basalt flow.
Tvs	SEDTmudb	Vaqueros and Sespe Formations, undifferentiated (early Miocene, Oligocene and late Eocene) - Interbedded sandstone and conglomerate; marine and nonmarine.
Tvsr	IGv	Santa Rosa basalt of Mann (1955) (Miocene) - Vesicular basalt flows.
Tvss	SEDTmudb	Vaqueros, Sespe, Santiago, and Silverado Formations, undifferentiated (early Miocene, Oligocene and Paleocene) - Sandstone, siltstone, and conglomerate; nonmarine and marine.

Tvt	IGv	Basalt of Temecula area (Miocene) - Vesicular basalt flows.
ub	IGp	Mesozoic ultrabasic intrusive rocks; pyroxenite, hornblendite, metaperidotite, and metapyroxenite.
water	water	water body

GROUNDWATER - SHALLOW

Coverage Description: Depth to Groundwater in Riverside County
Coverage distribution file name: gwcntrs.e00 (groundwater contours); gwwells.e00 (groundwater wells)
Import Location: Only that area where groundwater exists within the upper 400 feet was mapped.

VITAL STATISTICS: gwcntrs.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	
Source Media:	Paper maps, reports
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: gwcontrs.e00
RECORD LENGTH: 243

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Depth_to_GW	-	I

VITAL STATISTICS: gwwells.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	SAWPA, USGS, and Western Municipal Water District
Source Media:	Paper maps, Digital, repots
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: gwwells.e00
RECORD LENGTH: 1,114

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Well_ID	10	C
2	City	10	C
3	Site	10	C
4	Long	-	F
5	Lat	-	F
6	Well_Elev	-	F
7	Depth_To_GW	-	F
8	Elev_of_GW	-	F
9	Well_Depth	-	I
10	Date	-	D

Groundwater was mapped using data from the Regional Water Quality board, SAWPA, and USGS reports on groundwater within Riverside County. The groundwater is reported as the highest recorded elevation. Groundwater is only mapped in areas where sufficient data was available. There could be areas of perched water that have not been mapped throughout the county. Contours were created based on data collected from the various water districts through Santa Ana Watershed Project Authority. Reports located at the Regional Water Quality board were used to augment the data collected from the various water districts. All data was analyzed for highest historical recorded elevation. This data should be only considered for regional analysis only.

FALL 1998 COOPERATIVE WELL MEASURING PROGRAM, STEVEN E. MAINS, Geo-hydrologist, Regional Programs & Projects, and Western Municipal Water District. Western Municipal Water District distributed groundwater data in the Fall, 1998 Cooperative Well Measurement Report. This report includes data from 56 agencies for over 2,300 wells. This report contains water levels from monitoring wells at selected service stations within Riverside and San Bernardino Counties. The report includes abandoned or destroyed wells. The rationale for this is that knowing if a well did exist at a specific location, a well log may be available and historical data on water levels and water quality may be found. Please note that because the data are shown to two decimal places, this does not imply that degree of accuracy. Due to a flaw in the computer spreadsheet program (or my abilities to use it), we are unable to intermix varying number of decimal points. Many measuring point elevations are estimated from topographic maps and may be 5 to 10 feet in error. Also many agencies supply data using airlines that may have an accuracy of +/- several feet. California Regional Water Quality Control Board, Santa Ana Region; Leaking Underground Storage Tank Information System (LUSTIS).

Case No.	Site Name
083301358T	Stearns Downtown Liquor
083302925T	Mobil S5 #18-D3H
083302039T	Alameda Management #542 Tesoro
083300337T	Sears Service Center
083300039T	Arco Service Station (Gasup)
083301226T	Mobil SS #18-465
083301291T	Texaco/Former Gulf Oil
083301901T	Fastrip #16
083300601T	Exxon Service Station #2899
083303149T	Mobil SS #18-D9M
083300084T	Campbell Oil Company
083300247T	Mobil SS #18-D8H
083300511T	Texaco SS (Former Exxon SS)
083302230T	Circle K Store #0911
083302519T	Texaco Service Station
083303273T	Thrifty #342 / Arco #9712
083302389T	Arco Service Station #5168
083302721T	US Army (Camp Anza) Tank C2-A
083302407T	Georgia Pacific Corp.
083301613T	Indian Hills Country Club
083302686T	Bourns Inc.
083302339T	Inland Frame & Design
083300766T	Mobil Bulk Plant
083300182T	Hamblins Body & Paint Shop
083300478T	ROHR Industries Inc.
083302723T	US Army (Camp Anza) Tank B10
083301173T	Fairmount Park Golf Course
083300500T	Devoe Marine Coating Company
083301920T	"Parflite, Inc. / Texaco"
083302500T	Riverside Air Service
083302038T	Riverside Marketing / Texaco SS
083302534T	Arco Service Station #1941
083302378T	Unocal Service Station #5714
083302835T	Unocal Service Station #5714

083301831T	Shearer's Serv U Self
083300737T	Prudential Overall Supply Co.
083301716T	NewCo
083300158T	"Fleetwood Homes of CA., Inc."
083302866T	Alvord Unified School District
083301259T	Johnson Machinery
083301649T	M.W.D. Lake Mathews
083301196T	Mobil SS #18-182
083302111T	Alameda Management #503
083302778T	Mobil SS #18-H59
083302647T	Texaco Service Station
083301604T	Riverside Partners
083303117T	Unocal Service Station #6975
083302338T	La Sierra Soft Touch
083300401T	Texaco Service Station
083301395T	"Humphries, Clarence, Real Prop"
083302829T	Chevron S S #5520
083301311T	Wall's Hauling Service
083303276T	L V W Brown Estates
083300131T	E-Z Serve Station #0090/Unocal
083301765T	Pepsi-Cola West
083302211T	Riverside Landfill
083301717T	Cal Target / Pronto Marketing
083302877T	Texaco Service Station
083302540T	Unocal Service Station #3779
083301863T	USA Gasoline #240
083302548T	Brookhurst Mill
083301853T	Chevron S S #4702
083302914T	Texaco Service Station
083301223T	Arco Service Station #1916
083301964T	National Convenience Stores
083301612T	Thrifty Oil SS #340
083300823T	Unocal Service Station #0014
083302651T	Southland #16652
083302900T	G & K Petro Inc.
083301728T	Slamal Property
083301758T	Las Plumas Lumber Co.
083300480T	Certain-Teed Corporation
083300106T	Cheveron S S #7743
083302352T	Mission Carwash / Koin Karwash
083302467T	Stop-N-Go (Circle K)
083302177T	Circle K Store
083302618T	Cheveron S S #2987
083300621T	Mobil SS #18-HTY
083302921T	Mobil SS #18-HTY
083302569T	Unocal Service Station
083302233T	Mobil SS #18-FNY
083302275T	Unocal Service Station #2865
083301028T	Exxon Service Station #1776
083303186T	Thrifty #335 / Arco #9705
083302608T	Mobil SS
083303187T	Thrifty #339 / Arco #9709
083302639T	Unocal Service Station #6216
083301507T	Thirfty Oil SS #337
083301644T	Chevron S S #3563
083300977T	Orange Heights
083300965T	Thrifty Oil SS #352

083301506T	Arco Service Station #3033
083301314T	Circle K Store #0552
083300034T	Cheveron S S #0070
083301107T	Circle K Store #0604
083300483T	Chevron S S #3540
083302056T	"Lake Elsinore, City of"
083302648T	Thrifty Oil SS #348
083302975T	Circle K Store #0912
083301187T	Arco Service Station #1807
083301895T	Chevron S S #7568
083301646T	Thrifty Oil SS #338
083301335T	Circle K Store #0339
083300828T	Thrifty Oil SS #351
083301719T	Arco Service Station #1250
083302114T	Circle K Store #0575
083301200T	Arco Service Station #1841

References:

Dibblee, T.W., Burnham, W.L. and Dutcher, L.C., Geologic Map of the San Timoteo-Smiley Heights Area, Upper Santa Ana Valley, Southern California, Showing Water Levels for 1967., 1968.

Moreland, J.A., Map of the Eastern Part of the Upper Santa Margarita River Watershed, Riverside and San Diego Countys, California, 1972.

Moyle, W.R, 1973, Map of the Santa Rosa Rancho and Vicinity Riverside and San Diego Counties, California, Showing Reconnaissance Geology and Location of Wells and Springs.

USGS Water Resources Investigation Report 88-4029.

USGS Water Resources Investigation Report 94-4127. Beneath Various Land Uses, Riverside and San Bernardino Counties, CA 1991-93.

USGS Water Resources Investigation Report 98-4102. Geohydrology of the Winchester Subbasin, Riverside County, California.

Williams, Daniel. Groundwater Modeling Moreno and Perris Valley, March 1998.

HIGHFIRE

Coverage Description: Area of high probability for occurrence of wildfires in Riverside County
Coverage distribution file name: fire.e00
Import Location:

VITAL STATISTICS: highfire.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	State of California, USGS,
Source Media:	Paper maps, Digital, Mylar
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: fire.e00
RECORD LENGTH: 414

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	-	I
2	Fire_Hazard	15	C

AREAS OF THE COUNTY WHERE, DUE TO VEGETATION COMMUNITY TYPE AND SLOPE, THERE IS A HIGH PROBABILITY FOR OCCURRENCE OF WILDFIRES. THESE AREAS HAVE BUILDING RESTRICTIONS AS TO MATERIALS USED IN CONSTRUCTION.

Very high:
Fuel load heavy and slope over 40%, (average of 36.96 tons/acre), Predominant fuel type: Woods-brushwood including timber, woodland, large brush types over 6 feet in height and crown density >20%

High:
Medium fuel load and slope over 40%, (average of 17.33 tons/acre), Predominant fuel type: Scrub including brush and other perennial shrubs less than 6 feet in height and crown density of >20%

Or

Heavy fuel load, (average of 36.96 tons/acre), Predominant fuel type: Woods-brushwood including timber, woodland, large brush types over 6 feet in height and crown density >20%

Moderate:
Light fuel load and slope over 60%, (average of 2.22 tons/acre), Predominant fuel type: Grasslands including grass, annual herbs, weeds, small shrubs

Or

Medium fuel load and slope under 40%, (average of 17.33 tons/acre), Predominant fuel type: Scrub including brush and other perennial shrubs less than 6 feet in height and crown density of >20%

Low:
Light fuel load and slope over 40%, (average of 2.22 tons/acre), Predominant fuel type: Grasslands including grass, annual herbs, weeds, small shrubs

Very Low:
Light fuel load, (average of 2.22 tons/acre), Predominant fuel type: Grasslands including grass, annual herbs, weeds, small shrubs

None:
No fuel load, Developed areas with no natural vegetative fuel type

Determination for fire hazard potential was accomplished by evaluating vegetation density and type, slope, and their relation to urbanization. Vegetation data was obtained from the California Gap Analysis Project ñ University of California Santa Barbara. These data consist of land coverage and vegetation information for the state of California, including canopy dominant species, canopy density, presence of regional endemic species, and inclusion of wetland habitats. All reference and attribute information for this dataset may be found at this website: http://www.biogeog.ucsb.edu/projects/gap/data/meta/landcovdd.html#section1

Evaluation of the California Gap Analysis vegetation data was performed by identifying the primary, secondary and tertiary vegetation community type for each polygon and then assigning a rating for the potential for fire hazard based on fuel loading, in accordance with the HUD Study System (1973) and the Bates Bill Process (AB337, 1992). These initial assignments of fuel hazard ratings for grasslands, shrublands, and woodlands consisted of light, medium, and heavy, respectively. These ratings were then normalized based on the primary, secondary and tertiary type of vegetation communities. Some of these data were modified based on their slope angle and whether they occurred in highly urbanized areas. Slopes of 0-40%, 41-60%, and over 60% were used because an increased slope is recognized as a greater fire spreading potential characteristic. This modification to the fuel hazard ratings produced fire hazard potential ratings consisting of none, very low, low, moderate-low, moderate, high, and very high.

Listing by Natural Data Base Riverside	California Gap Analysis Project Descriptions	HUD Study System	Bates Bill Proces	Wildfire Potential	Wildfire Potential Rating
11100	URBAN OR BUILT-UP LAND	0	0	low	2
11200	AGRICULTURAL LAND	0	0	low	2
11210	ORCHARDS AND VINEYARDS	0	0	low	2
11520	PERMANENTLY-FLOODED LACUSTRINE HABITAT	0	0	none	0
11730	SANDY AREAS OTHER THAN BEACHES	0	0	none	0
11740	BARE EXPOSED ROCK	0	0	none	0
11750	STRIP MINES, QUARRIES AND GRAVEL PITS	0	0	none	0
22000	DESERT DUNES	0	0	none	0
32300	VENTURAN COASTAL SAGE SCRUB	8	2	high	4
32300	VENTURAN COASTAL SAGE SCRUB	8	2	high	4
32500	DIEGAN COASTAL SAGE SCRUB	8	2	high	4
32700	RIVERSIDEAN SAGE SCRUB	8	2	high	4
33100	SONORAN CREOSOTE BUSH SCRUB	8	2	low	2
33200	SONORAN DESERT MIXED SCRUB	8	2	low	2
34100	MOJAVE CREOSOTE BUSH SCRUB	8	2	low	2
34210	MOJAVE MIXED WOODY SCRUB	8	2	low	2
34220	MOJAVE MIXED STEPPE	8	2	moderate-	3
34240	MOJAVE MIXED WOODY AND SUCCULENT SCRUB	8	2	low	2
34300	BLACKBUSH SCRUB	8	2	low	2
35210	BIG SAGEBRUSH SCRUB	8	2	low	2
36110	DESERT SALTBUSH SCRUB	8	2	low	2
37120	SOUTHERN MIXED CHAPARRAL	8	2	high	4
37200	CHAMISE CHAPARRAL(CHAMISAL)	8	2	high	4
37300	REDSHANK CHAPARRAL	8	2	high	4
37400	SEMI-DESERT CHAPARRAL	8	2	high	4
37510	MIXED MONTANE CHAPARRAL	8	2	high	4
37530	MONTANE CEANOTHUS CHAPARRALS	8	2	high	4
37810	BUCK BRUSH CHAPARRAL	8	2	high	4
37830	HOARY-LEAFED CHAPARRAL	8	2	high	4
37840	BIG POD CHAPARRAL	8	2	high	4
37900	SCRUB OAK CHAPARRAL	8	2	high	4
37A00	INTERIOR LIVE OAK CHAPARRAL	8	2	high	4
37B00	UPPER SONORAN MANZANITA CHAPARRAL	8	2	high	4
37G00	COASTAL SAGE-CHAPPARAL SCRUB	8	2	high	4
42110	VALLEY NEEDLEGRASS GRASSLAND	1	1	very high	5
42200	NON-NATIVE GRASSLAND	1	1	very high	5
46000	ALKALI PLAYA	0	0	very low	1
52410	COASTAL AND VALLEY FRESHWATER MARSH	1	2	low	2
61310	SOUTHERN COAST LIVE OAK RIPARIAN FOREST	16	3	moderate-	2

61330	SOUTHERN COTTONWOOD-WILLOW RIPARIAN	16	3	moderate-	2
62200	DESERT DRY WASH WOODLAND	16	3	low	2
62400	SOUTHERN SYCAMORE-ALDER RIPARIAN	16	3	low	2
63310	MULE FAT SCRUB	8	2	moderate	3
71160	COAST LIVE OAK WOODLAND	16	3	moderate-	3
71182	DENSE ENGELMANN OAK WOODLAND	16	3	moderate-	3
72200	MOJAVEAN PINYON AND JUNIPER WOODLANDS	16	3	moderate-	4
72300	PENINSULAR PINYON AND JUNIPER WOODLANDS	16	3	moderate-	4
81310	COAST LIVE OAK FOREST	16	3	moderate-	4
81320	CANYON LIVE OAK FOREST	16	3	moderate-	4
84140	COULTER PINE FOREST	16	3	high	4
84150	BIGCONE SPRUCE-CANYON OAK FOREST	16	3	high	4
84210	WESTSIDE PONDEROSA PINE FOREST	16	3	high	4
84230	SIERRAN MIXED CONIFER FOREST	16	3	high	4
85210	JEFFREY PINE-FIR FOREST	16	3	high	4
85320	SOUTHERN CALIFORNIA WHITE FIR FOREST	16	3	high	4
86500	SOUTHERN CALIFORNIA SUBALPINE FOREST	16	3	high	4
99999	No secondary or tertiary type	0	0	NA	0

References:
Detailed descriptions of the rating systems may be found at http://www.prefire.ucfpl.ucop.edu/fire_map.htm
Those rating systems used for comparison by ECI are described in detail in the following paragraphs.

HUD Study System
As a result of concerns over fire hazards in California, in April of 1973 the California Department of Forestry and Fire Protection (CDF) published a report funded by the Department of Housing and Urban Development (HUD) under agreement with the Governor's Office of Planning and Research. This CDF report was prepared by Roger Helm, Barritt Neal, and Leroy Taylor. Similar to other studies, it came as a response to a disaster; in this case the 1970 wildfires which burned over 580,000 acres in 773 fires from September 22 through October 4, 1970. This study uses fuel loading, fire weather, and slope as the three rating factors. It combines fuel loading based on United States Geological Survey (USGS) life forms, fire weather based on the California Wildland Fire Danger Rating System (CWFDRS), and three slope classes also taken from CWFDRS.
These criteria are described below:

FUEL LOADING:
Fuel loading includes three classes. *Light* fuels occupy the uncolored areas on the USGS maps and represent flammable grass and annual herbs. *Medium* fuels are shown as "scrub" on the USGS maps and include brush and other perennial shrubs less than six feet in height and having a crown density of 20 percent or more. *Heavy* fuels are shown as "woods-brushwood" on the USGS maps and include the heavier brush species, woodland types, and timber types over six feet in height and having a crown density of 20 percent or more.

Light (grass): average of 2.22 tons/acre Fuel Severity Factor = 1
Medium (scrub): average of 17.33 tons/acre Fuel Severity Factor = 8
Heavy (woods-brushwood): average of 36.96 tons/acre Fuel Severity Factor =16

The vegetative types were accurate to the nearest acre. This system was used because the three types listed above could easily be determined from the USGS maps, and they represented a fairly accurate description of fuels found in California without having to undertake a major vegetation mapping project. The alternatives considered included the 1946 Weislander and Jensen system found in Forest Survey Release Number 4, the 1960 Cooperative Soil Vegetation Survey maps which were not available for the entire state, and the U.S. Forest Service Region V fuel type maps.

FIRE WEATHER SEVERITY:

Fire Weather also includes three classes. Each class is related to the frequency of critical fire weather days occurring in each of the state's Fire Danger Rating Areas over a 10-year period. The *Low* class (Class I) includes all those Fire Danger Rating Areas which have experienced fire weather in the "very high" or "extreme" ranges an annual average of less than one day, the *High* class (Class II) an annual average of 1 to 9.5 days, and the *Extreme* class (Class III) an annual average of more than 9.5 days. Each USGS topographic map in the state is keyed to one of the Fire Danger Rating Areas and assigned that Area's critical fire weather frequency classification.

I (<1 day per year) Fire Weather Severity Factor = 1
II (1-9.5 days per year) Fire Weather Severity Factor = 2
III (>9.5 days per year) Fire Weather Severity Factor = 8

These ratings were listed for 354 stations throughout California, and averaged from adjacent stations for 151 Fire Danger Rating Areas. The periods from June through December were analyzed over a ten-year period, and each area was ranked using the scale above. It was found that 75% of the 678 fires of over 300 acres in size from 1959-69 occurred in areas where the Fire Weather Severity ranking was III, and 79% of the 109 fires of over 5,000 acres in size during the same period occurred in the same areas. The HUD Study System used California's Interagency Wildland Fire Danger Rating System (WFDRS) to describe the collection of weather information and the calculation of the various factors as described under Fire Weather Severity above.

SLOPE:
Slope also includes three classes: 0-40 percent, 41-60 percent, and over 60 percent. Each class is assigned a value, derived from the WFDRS. Slope is recognized by this system as having an effect on fire behavior similar to the effect of wind; i.e., an increase in slope produces an increase in the rate of fire spread. The system therefore assigns values to slope, which modify the various fire danger indexes accordingly.

I (>40%) Slope Severity Factor = 1.0
II (41-60%) Slope Severity Factor = 1.6
III (>60%) Slope Severity Factor = 2.0

A slope class is used because it often determines how a wildland fire is fought, and by using the WFDRS it can be directly correlated to wind speed equivalents, which is a critical factor.

Fire Hazard Severity Scale:
As shown above, each class of fuel loading, fire weather, and slope is assigned a severity factor. The values are multiplied in a matrix form to produce a Fire Hazard Severity Scale. The scale was determined by multiplying the three factors together to determine a numerical rating. The gaps between the numerical categories below are due to the limitations of the factor values, from which only certain numbers can result.

Moderate Hazard 1 - 12.8 Points
High Hazard 16 - 32 Points
Extreme Hazard 51 - 256 Points

Due to fiscal and time constraints a map of California showing the three classes wasn't prepared. HUD did list the Critical Fire Weather Frequency Class for each of the USGS Quads for California, and the Fuel Loading is taken directly from the Quads. The slope can be either mechanically calculated or automatically calculated with a software program containing the USGS Quads (e.g. TopoScout).

Bates Bill Process
As described in Chapter II, the Bates Bill (AB 337) was a direct result of the great loss of homes and lives in the Tunnel Fire of 1991 in the Oakland/Berkeley Hills. CDF, given the responsibility but not the resources to carry out the state mandate, formed a working group to determine how to proceed. The group, comprised of state and local representatives, decided upon a workable system involving fuel, topography (slope), weather, and dwelling density as the foundation for the system, and added additional mitigation factors both plus and minus to adjust the score upward or downward. The basic system had a four-point minimum score with a thirteen-point maximum. The raters (in almost all cases one local representative and one CDF or Contract County representative) had the opportunity to adjust the score down by one point for certain mitigation measures. They also had the option of

increasing the score by one point for certain factors known to contribute to fire spread. To qualify as a Very High Fire Hazard Severity Zone (VHFHSZ), an area had to score 10 or more points. Potentially, the range of scores (including the mitigating factors) could range from a low of 1 to a high of 16. The recommended system was given an extensive field test by different members of the working group, and was then implemented. A copy of the rating form is found below.

CRITERIA - CLASSIFICATION POINTS

A. Fuel (NFPA 299). For each zone a fuel hazard rating shall be assigned. Where fuel types vary within a zone, the rating assigned for the zone shall be that which best represents the predominant fuel type.

1. Small, light fuels (Grass, Weeds, Shrubs) +1
2. Medium fuels (Brush, Large Shrubs, Small Trees) +2
3. Heavy fuels (Timber, Woodland, Large Brush, or Heavy Planting of Ornamentals) +3

B. Topography—Slope (NFPA 299 and FEMA). For each zone a Slope Hazard Rating shall be assigned. Where slopes vary within an area, the rating for the area shall be that which best represents the predominant slope range.

1. Flat to Mild Slope (0-9.9%) +1
2. Mild to Medium Slope (10-19.9%) +2
3. Medium to Moderate Slope (20-39.9%) +3
4. Moderate to Extreme Slope (40% +) +4

C. Dwelling Density (1991 Census or a local ordinance with higher standards). For each zone a dwelling rating shall be assigned. A check with each area for local ordinances regarding swelling density must be accomplished before setting this factor.

1. Low (less than one structure per 10 acres) +1
2. Medium (one structure per 5 to 10 acres) +2
3. High (one structure per 0 to 5 acres) +3

D. Weather (instructions for zoning fire hazard severity in State Responsibility lands in California). The ratings (EXH 1) show what each county is rated. This information is obtained for each county by using the Burning Index (BI). Weather is a major part of the BI system. The information for developing BI systems came from weather stations throughout the state.

1. Moderate +1
2. High +2
3. Very High +3

By adding the highest number for the four factors, you will have a total of 13 points. The point spread between ten (10) and thirteen (13) points represents the combination of factors needed to make up a Very High Fire Hazard Severity Zone.

MITIGATION MEASURES

These mitigation measures are points, plus or minus, that a local agency may use to mitigate a rating within its area, and could cause a higher or lower rating for the benefit of the local agency.

FACTORS—MINUS POINTS

1. Infrastructure—meets or exceeds minimums of ISO 8, NFPA 1231, PUC 103, or PRC 4290 -1
2. Housing or roofing ordinances (Class A, B, or better roof), sprinklers required, firesafe construction fuel modification, local option -1
3. PRC 4291 Ordinance or better (Natural Resource Protection) -1

OTHER FACTORS—PLUS

1. Rough topography with steep canyons or draws that would impede responding personnel and equipment. +1

2. Area with a history of high fire occurrence, related to surrounding areas, because of heavy lightning, railroad fires, debris burning, arson, etc. +1
3. Area subject to severe fire weather such as strong winds and lightning, and has constant seasonal weather patterns that contribute to increased fire activity. +1
4. Heavy concentration of flammable ornamentals or vegetation introduced by humans +1

TOTAL POINTS______________ VERY HIGH FIRE HAZARD SEVERITY ZONE? YES / NO
DESCRIPTION OF ZONE:
1. LATITUDE AND LONGITUDE____
2. TOWNSHIP, SECTION, RANGE____
3. NARRATIVE OF ZONE____

____

____

DATE__________________ SIGNATURE OF RATER______________________________

This rating system appears to be reasonable, and could be adopted as is, or with minor modifications, in most of California. Modifications might include reducing the minimum size of the area rated from 640 acres to perhaps 320 acres or even smaller, such as a subdivision. The weather component could be adjusted to reflect local conditions rather than county-wide conditions, which in some cases result in coastal areas rated too high and other areas too low. The fuel types on the rating form are easy to determine using the descriptions provided. The slope percent may require some field work with an abney or other device, or one could locate a county map showing these slope classes through the USGS, one's county or local planning department, or on the CDF Home Page (http://www.fire.ca.gov). Ordinances for adoption of state mandates are found in the Appendix.

In summary, the Bates system with or without modification does work, and has the advantage of being applicable statewide. A disadvantage is that a large number of local agencies decided not to acknowledge it. This means that the actual number of Very High Fire Hazard Severity Zones should be much higher than the number identified as part of the original Bates review. If fuels, topography, and weather with these criteria could be mapped using remote sensing to assure objectivity and uniformity, this system could produce a much more accurate hazard assessment. The information could then be used by local agencies, perhaps with additional criteria, to achieve hazard maps that are useful to individual jurisdictions.

LANDSLIDE HAZARD AREA

Coverage Description: Landslide Susceptible areas in Riverside County
Coverage distribution file name: Landslide.shp; Landman.e00 (Slope instability zones)
Import Location:

VITAL STATISTICS: landslide.shp

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	Geology and DEM (slope)
Source Media:	Created from Geology and Slope Maps
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: landslide.shp
RECORD LENGTH: 515,899

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	-	I
2	Susptibility	30	C

VITAL STATISTICS: landman.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	Same as above
Source Media:	Same as above
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector

ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: landman.e00
RECORD LENGTH:

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	-	I
2	Description	50	C

Earthquake-Induced Landslides and Earthquake-Induced Landslide Hazard Zones

Earthquakes have caused rockfalls, rock avalanches, debris flows, bluff collapse, and other types of potentially damaging landslide movements. The photo to the right shows a home that was undermined by a landslide triggered by the 1994 Northridge earthquake (LA Times Photo). Landslides were widespread during the 1906 San Francisco earthquake. Landslides tend to occur in loosely consolidated, saturated soils on sloping terrain. Landslides also tend to form distinctive landforms (scarps, troughs, disrupted drainages, etc.) that can be recognized by most trained geologists. Other types of oversteepened slopes (cliffs, stream banks, saturated soil-filled swales, man-made cuts and fills, etc.) are often prone to collapse when shaken by an earthquake. Research has shown that landslide deposits and certain geologic formations and other earth materials are prone to landslide failure. Water often is a contributing factor to landslide movement; thus springs, seeps, and man-introduced water sources (lawn watering, leach fields, storm drains, and water lines) can influence landslide creation, movement, and extent of damage.

These are the procedures followed during the creation of the Landslide and Slope Instability Map of Riverside County:

- Created a slope map for Riverside County by creating a grid map of the United States Geological Survey (USGS) Digital Elevation Model (DEM) for the county in Vertical Mapper. A 60m-grid cell size was used.
- Created a grid map of the Engineering Geology map in Vertical Mapper using a 60m-grid cell size.
- Queried both grid maps for areas that meet the parameters for slope instability and landslide susceptibility.

References:

CDMG Special Publication 117 (http:///www.consrv.ca.gov/dmg/pubs/sp/117/)

Randall W. Jibson, Edwin L. Harp and John A. Michael, A Method for Producing Digital Probabilistic Seismic Landslide Hazard Maps: An Example from the Los Angeles California, Area. USGS Open File Report 98-113, 1998.

Sadler, Peter, M. and Morton, Douglas, M., Landslides in a Semi-Arid Environment with emphasis on the Inland Valleys of Southern California. Inland Geological Society, 1989.

Landslide Susceptible e-types from Engineering Geology Map

SEDmMETfol
METSEDud
METSEDfol
METSEDb
METIGv
METfol
IGvMETfol
IGpMETfol
IGMETfol
IGvfract
IGpfolfract
IGpfol
SEDTWCaud
SEDTUCaud
SEDTPWClfb
SEDTPWCaud
SEDTPaud
SEDTmudb
SEDTMCud
SEDTMCmudb
SEDTMCmud
SEDTMCmfb
SEDTMCmcb
SEDTMCaudb
SEDTMCaud
SEDTMCafb
SEDTMCaf
SEDTINDmudb
SEDTINDmfb
SEDTINDmf
SEDTINDmcb
SEDTINDaffract
SEDTINDafbfrac
SEDTaudb
SEDTafm
SEDPWCaf
SEDPDWud
METSEDfb
METSEDcb
IGvSEDudb
IGvSEDfb
SEDTaud
SEDTMCmb

Soil Classification for soils

Soils susceptible to disrupted soil slide	***Suscetpible to Soils slumps or soil block slides***
SEDPHUCac	SEDPHUCef
SEDHUCac	SEDPHUCaud
SEDHMClf	SEDPHUCaf
	SEDHUClf
	SEDHUCef
	SEDHUCaud
	SEDHUCaf
	SEDPHUCef
	SEDPHUCaud

Lithologies in Existing Landslides

SEDTMCsc
SEDPsc
SEDPMCsc
SEDPHUCsc
landslide

Lithologies Susceptible to Bedrock Slides

METSEDTINDm
METSEDm
METSEDIGv
METSED
METm
MET
IGpMET
IGMET
IGv
IGSED
IGp

SEDTWCmc
SEDTMCmcm
SEDTMCmac
SEDTMCac
SEDTINDud
SEDTINDmaub
SEDTINDaf
SEDTINDac
SEDTDWamud

Slope Map Classifications

Class	***Slope Angle (°)***
1	0 to 4.99
2	5 to 9.99
3	10 to 14.99
4	15 to 19.99
5	20 to 29.99
6	30 to 39.99
7	40 to 50

Landslide Susceptibility Zones

Data Source		Susceptible e-types	Engineering Geology Soil #1	Soil #2	Bedrock
	1	-	-	-	-
	2	-	-	2	-
Slope	3	6	-	3	-
Class	4	6	4	3	-
	5	7	4	3	-
	6	8	4	3	-
	7	9	4	3	5

Landslide Susceptibility Zones Explanation

9	Very High
8	High
7	Moderate-High
6	Moderate-Low
5	Bedrock Slides
4	Disrupted Soil Slide
3	Soil Slumps
2	Soil Block slides

Management Zones

- Derived using landslide.e00
- Buffer zones: .1 to .5 miles

Landslide e00 (zones)	Landslide e00 (susceptibility)	Landman (zone)
9	Very High	9
8	High	9
7	Moderate-High	9
6	Moderate-Low	9
5	Bedrock Slides	9
4	Disrupted Soil Slide	1
3	Soil Slumps	1
2	Soil Block slides	1

- Management zones (landman zones)
  - 1 High susceptibility for soil slumps and block slides
  - 9 Moderate to high slope instability
  - 100 Previously mapped landslides

LIQUEFACTION

Coverage Description: Liquefaction Hazards in Riverside County
Coverage distribution file name: lique.e00
Import Location:

VITAL STATISTICS: lique.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	Geology and Groundwater
Source Media:	Created from Geology and Groundwater Maps
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: lique.e00
RECORD LENGTH: 5,012

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	-	I
2	Susceptibility	254	C
3	Definition_1	254	C
4	Definition_2	254	C
5	Definition_3	254	C
6	Definition_4	254	C

Areas of the County where a potential for liquefaction exists, therefore these areas have requirements or liquefaction reports prior to approval of certain projects.

The source of this information is the 2000 Riverside County Seismic Safety Element Technical Report, prepared by Earth Consultants International for the County of Riverside.

Liquefaction and Liquefaction Hazard Zones

Liquefaction is a process by which water-saturated materials (including soil, sediment, and certain types of volcanic deposits) lose strength and may fail during strong ground shaking. Liquefaction is defined as "the transformation of a granular material from a solid state into a liquefied state as a consequence of increased pore-water pressure" (Youd, 1973, p. 1). Liquefaction occurs worldwide, commonly during moderate to great earthquakes. In California, liquefaction-related ground failures occurred in 1857 (Fort Tejon earthquake), 1906 (San Francisco earthquake), 1933 (Long Beach earthquake), 1971 (San Fernando earthquake), 1973 (Point Mugu earthquake), 1979 and 1981 (Imperial Valley earthquakes), 1989 (Loma Prieta earthquake), and 1994 (Northridge earthquake), and others. Four kinds of ground failure commonly result from liquefaction: lateral spread, flow failure, ground oscillation, and loss of bearing strength.

Lateral Spread
Lateral displacement of surficial blocks of sediment as the result of liquefaction in a subsurface layer is called a lateral spread. Once liquefaction transforms the subsurface layer into a fluidized mass, gravity plus inertial forces that result from the earthquake may cause the mass to move downslope towards a cut slope or free face (such as a river channel or a canal). Lateral spreads most commonly occur on gentle slopes that range between 0.3° and 3°, and commonly displace the surface by several meters to tens of meters. Such movement typically damages pipelines, utilities, bridges, and other structures having shallow foundations. During the 1906 San Francisco earthquake, lateral spreads causing displacement of only a few feet damaged every major pipeline that broke. Thus, liquefaction compromised the ability to fight the fires that caused about 85 percent of the damage to San Francisco.

Flow Failure
The most catastrophic mode of ground failure caused by liquefaction, flow failure usually occurs on slopes greater than 3°. The flows are principally liquefied soil or blocks of intact material riding on a liquefied subsurface zone. Displacements are commonly tens of meters, but in favorable circumstances, has displaced material tens of miles at velocities of tens of miles per hour. The extensive damage to Seward and Valdez, Alaska, during the 1964 Alaska earthquake was caused by submarine flow failures.

Ground Oscillation
When liquefaction occurs at depth but the slope is too gentle to permit lateral displacement, the soil blocks that are not liquefied may decouple from one another and oscillate on the liquefied zone. The resulting ground oscillation may be accompanied by the opening and closing of fissures and sand boils, potentially damaging structures and underground utilities.

Loss of Bearing Strength
When a soil loses strength and liquefies, loss of bearing strength may occur beneath a structure, possibly causing the building to settle and tip. If the structure is buoyant, it may float upward. During the 1964 Niigata, Japan, earthquake, buried septic tanks rose as much as 3 feet and structures in the Kwangishicho apartment complex tilted as much as 60°.

Research into the process and consequences of liquefaction in past earthquakes have linked liquefaction to certain hydrologic and geologic settings, characterized by water-saturated, cohesionless, granular materials situated at depths of less than 50 feet. In simplified terms, the procedure used to delineate areas having significant potential for liquefaction requires development of a liquefaction susceptibility map and a liquefaction opportunity map. The former depicts areas where the geology and hydrology are favorable for liquefaction, and the latter summarizes information about the potential for strong earthquake shaking. When considered together, the two maps determine the liquefaction potential- the relative likelihood that an earthquake will cause liquefaction in an area. The following areas are those identified as being favorable for liquefaction:

1. Areas known to have experienced liquefaction during historic earthquakes.

2. Areas of uncompacted fills containing liquefaction susceptible material that are saturated, nearly saturated, or may be expected to become saturated.
3. Areas where sufficient existing geotechnical data and analyses indicate that the soils are potentially liquefiable.
4. Areas containing young (less than 15,000 years) soils where there is limited or no geotechnical data.

GUIDELINES FOR DELINEATING LIQUEFACTION HAZARD ZONES

Introduction
California Department of Conservation, Division of Mines (DMG) is the principal State agency charged with implementation of the provisions of the 1990 Seismic Hazard Mapping Act. These guidelines are developed to assist DMG in mapping Liquefaction Hazard Zones (LQ-Zones). The zones establish where site-specific geotechnical investigations must be conducted to assess liquefaction potential and, if required, provide technical basis to mitigate the liquefaction hazard.

Liquefaction Mapping Criteria

Liquefaction Hazard Zones are areas meeting one or more of the following criteria:
1. Areas known to have experienced liquefaction during historic earthquakes.

Field studies following past earthquakes indicate liquefaction tends to recur at many sites during successive earthquakes (Youd, 1984). There are many published accounts of liquefaction occurrences and these areas so delineated should be included in the Liquefaction Hazard Zones.

2. All areas of uncompacted fills containing liquefaction susceptible material that are saturated, nearly saturated, or may be expected to become saturated.

In some areas there has been a practice of creating useable land by dumping artificial fill on tidal flats or in large deep ravines. Standard geologic criteria are of little use in characterizing soils within these fills which are less homogeneous than natural deposits. There is no reason to assume lateral stratification in these fills and the validity of extrapolating subsurface data is questionable. Evidence for filling can be found using maps showing old shorelines, comparing old and modern topographic maps, by studying logs of boreholes, and by obtaining reports or original plans of specific projects involving reclaimed land.

3. Areas where sufficient existing geotechnical data and analyses indicate that the soils are potentially liquefiable.

The vast majority of liquefaction hazard areas are underlain by recently deposited sand and/or silty sand. These deposits are not randomly distributed, but occur within a narrow range of sedimentary and hydrologic environments. Geologic criteria for assessing these environments are commonly used to delineate bounds of susceptibility zones evaluated from other criteria, such as geotechnical analysis (Youd, 1991). Ground water data should be compiled from well logs and geotechnical borings. Analysis of aerial photographs of various vintages may delineate zones of flooding, sediment accumulation, or evidence of historic liquefaction. The Quaternary geology should be mapped and age estimates assigned based on ages reported in the literature, stratigraphic relationships and soil profile descriptions. In many areas of Holocene and Pleistocene deposition, geotechnical and hydrologic data are compiled. Geotechnical investigation reports with Standard Penetration Test (SPT) and/or Cone Penetration Test (CPT) and grain size distribution data can be used for liquefaction resistance evaluations.

For sand and silty sand, there are at present two accurate and reliable in-situ approaches available for quantitative evaluation of the soil's resistance to cyclic pore pressure generation and/or liquefaction. These are: (1) correlation's and analyses based on in-situ Standard Penetration Test (SPT) (ASTM D1586) (ASTM, 1990) data, and (2) correlation's and analyses based on in-situ Cone Penetration Test (CPT) (ASTM D3441) (ASTM, 1990) data.

Seed, et al. (1984, 1985, 1986), provide guidelines for performing "standardized" SPT, and also provide correlation's for conversion of penetration resistance's obtained using most of the common alternate combinations of equipment and procedures in order to develop equivalent "standardized" penetration resistance's-- (N1)60. This "standardized" penetration resistance can then be used as a basis for evaluation of liquefaction resistance.

Cone penetration test (CPT) tip resistance (qc) may also be used as a basis for evaluation of liquefaction resistance, either by direct empirical comparison between qc-values to "equivalent" SPT resistance and use of correlation's between (N1)60 data and case histories of seismic performance (Robertson, et al., 1985; Seed and De Alba, 1986) .

In addition to sandy and silty soils, some gravelly soils are potentially vulnerable to liquefaction. At present, the best available technique for quantitative evaluation of the liquefaction resistance of this type of deposits involve correlation and analysis based on in-situ penetration resistance measured using the very large scale Becker Hammer system (Harder, 1988).

The correlation's of Seed et al. (1985), and the (N1)60 data can be used to assess liquefaction susceptibility. Since geotechnical analyses are usually made using limited available data the susceptibly zones should be delineated by use of geologic criteria. Geologic cross sections, tied to boreholes and/or trenches, should be constructed for correlation purposes. The units characterized by geotechnical analyses are correlated with surface and subsurface units and extrapolated for the mapping project.

Liquefaction opportunity is a measure, expressed in probabilistic terms, of the potential for ground shaking strong enough to generate liquefaction. Analyses of in-situ liquefaction resistance require assessment of liquefaction opportunity. The minimum level of seismic excitation to be used for such purposes with LQ-Zones will be that level defined by M7.5-weighted peak ground surface acceleration (PGA) for UBC S2 soil conditions with a 10% probability of accedence over a 50-year period.

1. Areas where geotechnical data are insufficient.
In areas of limited or no geotechnical data, susceptibility zone are identified by geologic criteria as follows:
* (a) Areas containing soil deposits of late Holocene age (current river channels and their historic floodplains, marshes and estuaries), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.10 g and the water table is less than 40 feet below the ground surface; or
* (b) Areas containing soil deposits of Holocene age (less than 11,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.20 g and the historic high water table is less than or equal to 30 feet below the ground surface; or
* (c) Areas containing soil deposits of latest Pleistocene age (between 11,000 years and 15,000 years), where the M7.5-weighted peak acceleration that has a 10% probability of being exceeded in 50 years is greater than or equal to 0.30 g and the historic high water table is less than or equal to 20 feet below the ground surface.

The Quaternary geology may be taken from existing maps, where available, and hydrologic data should be compiled. Application of these criteria allows compilation of hazard maps which are useful for preliminary evaluations, general land-use planning and delineation of special studies zones where site-specific studies may be required before major development is approved (Youd, 1991).

Liquefaction

The following procedures were used during the creation of the Liquefaction Susceptibility Map for the county of Riverside:

- Vertical Mapper was used to grid the Groundwater and Engineering Geology maps at a cell size of 60m.
- An abbreviated code of engineering attributes (e-types) was created by reviewing the descriptions of the petrologic types (p-types) in the legends and supporting materials of the geologic maps of the area.
- The e-types in the Engineering Geology table were separated into three different liquefaction-potential categories:

Liquefaction-potential Categories

High	Moderate	Low
Dark yellow Etypes	Light yellow and Dark Orange Etypes	*Light yellow*
SEDPHUCef	*SEDPHUCac*	*SEDTWCacm*
SEDPHUCaud	*SEDHUCac*	*SEDTPWCac*
SEDPHUCaf	*SEDHMClf*	*SEDTPINDac*
SEDHUClf	*SEDTPWCaf*	*SEDPWCcc*
SEDHUCef	*SEDTPHUCaud*	*SEDPWCac*
SEDHUCaud	*SEDPWCaud*	*SEDPMCacb*
SEDHUCaf	*SEDPUCaud*	*SEDPMCac*
	SEDPUCaf	*SEDPINDac*
	SEDPMCaud	
	SEDPMCaf	
	SEDPHMCaud	
	SEDPHMCaf	
	SEDHPMCar	

- The depth to groundwater data from the Groundwater table was separated into five different categories:

Depth-to-groundwater Categories

- **High:** depth less than 30
- **Moderate:** 30 to 50 feet depth to groundwater
- **Low:** 50 to 100 feet depth to groundwater
- **Deep groundwater:** depths greater than 100 feet to groundwater
- **No Data:** no groundwater data found

- Engineering types (e-types) and depth to groundwater data in the Engineering Geology and Groundwater tables were compared to create the liquefaction categories.

General Liquefaction Potential Zones for Riverside County

Rank	Ground Water Depth#	General+ Sediment Type	Recommended Policies*	
	General Construction	Critical Facilities		
High	< 30 feet	very susceptible	study required	study required
Moderate	< 30 feet	susceptible	study required	study required
	30-50 feet	very susceptible	study required	study required
Low	> 30 feet	susceptible	none	study required
Very Low	30-50 feet	susceptible	none	study required
	50-100	very susceptible	none	study required
Extremely Low	50-100 feet	susceptible	none	study required

None	> 100 feet	susceptible	none	none
	no data	bedrock	none	none

*: Ground shaking potential in easternmost Riverside County is considered below the threshold for liquefaction, and site-specific investigations should not be required for general construction projects
#: Ground water depth is based on the historic high measurement
+: Very susceptible sediment type includes generally granular Holocene sediments; susceptible includes generally granular Pleistocene sediments.

Recommended hazard mitigation policies for proposed projects in Riverside County based on the detailed liquefaction mapping may be summarized as follows:

- ***General Construction***: special site-specific liquefaction hazard studies should be required in all areas mapped as "Shallow Ground Water, Susceptible Sediments" with the exception of the Blythe (Uniform Building Code Zone 3) region.
- ***Critical Facilities/Lifelines***: special site-specific liquefaction hazard studies should be required in all areas of susceptible sediments, including the Blythe (Uniform Building Code Zone 3) region.

1. Very High Liquefaction - Groundwater is 0-30 feet from the surface and the sediments are composed of Holocene-age fine-grained unconsolidated sediments.
2. High Liquefaction - Groundwater is 0-30 feet from the surface and the sediments are Holocene coarse-grained or Pleistocene fine-grained or groundwater is 30-50 feet from the surface and the sediments are Holocene fine-grained.
3. Moderate Liquefaction - Groundwater is 0-30 feet from the surface and the sediments are composed of Pleistocene coarse-grained or groundwater is 30-50 feet from the surface with sediments of Holocene coarse-grained or Pleistocene fine-grained sediments or groundwater is 50-100 feet from the surface with Holocene fine-grained sediments or groundwater is >100 (or no data) with Holocene fine-grained sediments.
4. Low Liquefaction - Groundwater is 30-50 feet from the surface and the sediments are Pleistocene coarse-grained or groundwater is 50-100 feet from the surface with sediments of Holocene coarse-grained or Pleistocene fine-grained or groundwater is >100 feet (or no data) with sediments composed of Holocene coarse-grained or Pleistocene fine-grained.
5. Very Low Liquefaction - Groundwater is 50-100 feet below surface with sediments of Pleistocene coarse-grained or groundwater is >100 feet (or no data) with sediments of Pleistocene coarse-grained.

Map defined color scheme.

High groundwater - dark yellow = very high
High groundwater - light yellow = high
High groundwater - dark orange = high
High groundwater - light orange = moderate

Medium groundwater - dark yellow = high
Medium groundwater - light yellow = moderate
Medium groundwater - dark orange = moderate
Medium groundwater - light orange = low

No groundwater - dark yellow = moderate
No groundwater - light yellow = low
No groundwater - dark orange = low
No groundwater - light orange = very low

STREAMS, RIVERS AND CANALS

Table Description:
Table distribution file name: Rivers.shp
Import Location:

VITAL STATISTICS: Rivers.shp

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	US Census Bureau Tiger files
Source Media:	Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polylines
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polylines
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: rivers.shp
RECORD LENGTH: 4,927

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Name	30	C
2	CSCC	3	C
3	Smart_Label	35	C

Subsidence Hazard

Coverage Description: Subsidence Hazard Map of Riverside County
Coverage distribution file name: subside.e00
Import Location:

VITAL STATISTICS: subside.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	Geology, County Reports, USGS
Source Media:	Paper
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: subside.e00
RECORD LENGTH: 3,286

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Zone	-	I
2	Susceptibility	25	C

SUBSIDENCE AND UNSTABLE SOILS

Certain areas of Riverside County are prone to regional downwarping and rapid subsidence. Withdrawal of underground fluids, and tectonic elevation changes produced during extremely large earthquakes are most important in terms of potential causes. This section focuses on land subsidence initiated exclusively by the withdrawal of oil and water. Consistent with non-earthquake-related geologic hazards, a review of collapsible and expansive soils is also presented to emphasize that potential geologic impacts, as well as geotechnical constraints, can largely be avoided through adequate planning and investigation.

Subsidence Caused by Ground Water Withdrawal

Subsidence caused by ground water withdrawal is documented throughout the southwestern United States in areas such as the San Joaquin, Santa Clara, Temecula, and San Jacinto Valleys in California, and the Phoenix and Tucson Basins in Arizona. There are several areas in Riverside County that are also potentially sensitive to withdrawal of ground water. Depending on the depth and mechanical properties of the aquifer and overlying sediment, alluvial areas such as the Salton Sea (in Riverside County) can subside if ground water management resources are not managed properly. Hydrocompaction is a common cause of subsidence and has resulted in extensive fissuring of the ground surface in many agricultural areas of the Southwest (Holzer and Clark, 1981).

Subsidence was identified as an issue in the Antelope Valley as early as 1956 by Miller (1966) and appears to continue today. The U.S. Geological Survey Water Resources Division is currently studying subsidence and ground fissuring on the Edwards Air Force Base (Bill McKafery, 1990 Personal Communication). Considering the ongoing rapid growth in the area, subsidence is also a critical issue in the remainder of Antelope Valley. Severe damage to urban development could result if ground fissures develop in response to subsidence, and alarmingly, such ground rupture has been documented in the Antelope Valley. T.L Holzer and M.M. Clark (1981), in an unpublished report for the Soil Conservation Service, described an arcuate earth fissure approximately 600 meters long and up to 2.3 meters deep about 11 kilometers east-northeast of Lancaster. Additional fissuring north of Quartz Hill and in other localized areas is also reported but no regional studies have been conducted to determine the extent of the potential problem (Bill McKafery, 1990 Personal Communication). If several jurisdictions are utilizing a continuous ground water aquifer resource in the Antelope Valley, and ground water extraction is found to be the cause, subsidence management would require regional cooperation among these agencies.

Collapsible Soils

Collapsible soils are low density, silty to very fine-grained, predominantly granular soils, containing minute pores and voids. When saturated, these soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. A rise in the ground water table or an increase in surface water infiltration, combined with the weight of a building or structure, can initiate rapid settlement and cause foundations and walls to crack. Collapsible soils generally result from rapid deposition close to the source of the sediment where the materials have not had contact with enough moisture to form a compact soil after their deposition. Collapsible soils are associated with recently deposited Holocene alluvium in arid and semi-arid environments. They also coincide with other Holocene alluvium and older unconsolidated sediments with the same properties. Collapsible soils are most commonly associated with wind laid sands and silts, and mudflow sediments deposited during flash floods.

Collapsible soils exist in the Antelope Valley and many other alluvial areas of the County, including the Santa Clarita Valley. Although also found in the northern canyons of the Repetto and Whittier Hills, including such areas as Hacienda Heights and Rowland Heights, collapsible soils indigenous to these areas may not collapse unless they are subject to excessive loads (greater than 2 to 3 feet of overburden). In the Antelope Valley, collapsible soils may fail with a minimal amount of increased overburden. The rapid increase in population and building activity in the Antelope and Santa Clarita Valley necessitates awareness of this problem by public officials, consultants, developers, future homeowners, and contractors. The raw data for mapping this hazard exists in the form of Bureau of Reclamation Soil Survey Maps and Quaternary sediment mapping performed by Ponti and Burke (1980). While the mapping of collapsible soils is beyond the scope of this project, a future study should be directed at preparing a collapsible soils distribution map, especially for the Antelope Valley.

Expansive Soils

Expansive soils, more commonly referred to as adobe, swell when they become wet and shrink when they dry out. Consequences of this expansion and contraction are cracked building foundations and, sometimes, severe structural distress of buildings themselves. The economic impact on the private sector and public property due to expansive soils is an ongoing problem in Riverside County. Although expansive soils are now routinely alleviated through the County Building Code, problems related to past inadequate codes constantly appear. Expansive soils can result in cracked foundations, interior and exterior wall separations, disjointed slabs or porch steps, tilted posts or fences (soil creep), and sometimes ruptured utilities.

Although their occurrence in the County is often associated with geologic units having marginal stability characteristics, the distribution of expansive soils can be widely dispersed. They can occur in hillside areas as well as low lying alluvial basins. Determination of the origin of structural distress in an existing structure requires assessment not only of expansive soils but also recognition of the impact of poor compaction practices, settlement, and landsliding. Once verified, mitigation can be achieved through reinforcement of the existing foundation, or alternatively, through the excavation and removal of the expansive soils material in the effected area. Moisture control and modified drainage can also minimize the effects of expansive soils. For new development, future problems with expansive soils can be largely prevented through proper site investigation, soils testing, foundation design, and quality assurance during grading operations.

Conclusions

Subsidence related to ground water withdrawal, or tectonic strain, is an ongoing phenomenon in the Riverside County.

- Prudent ground water management practices need to be followed in Temecula, Riverside, and other valleys in the County. Future objectives in areas proven sensitive to subsidence include:

  - Increased level mg for vertical changes in elevation and mapping of ground fissures;

  - synthesis of well data and gravity, seismic, and other geophysical methods to characterize the underlying aquifer; and

  - cooperation of involved ground water jurisdictions to prevent or mitigate subsidence in an alluvial basin.

- Increased awareness of collapsible and expansive soils by public officials, consultants, developers future homeowners, and contractors will encourage proper investigation, foundation design, and use of drought resistant landscaping to mitigate potential problems before they occur.

- Expansive soils are widely distributed in Riverside County. Proper site investigation, soil testing, foundation design, and enforcement of construction grading practices, as defined in the County Building Code, are the most efficient planning tools for locating, assessing the severity of, and mitigating expansive soils in a proposed development.

- Existing County programs for managing hazards such as expansive and collapsible soils should be regularly reevaluated for improvements.

Subsidence analysis and prediction

Surface Classification - In order to facilitate the subsidence analysis and prediction, the ground surface of the study area was divided into three categories based upon the information shown on the map:

1 Areas of documented subsidence
2 Areas of potential subsidence
3 Areas of low to no potential for subsidence

References:

Ikeharn, Marti, E., Predmore, Steven K., and Swope, Daniel J., Geodetic Network to Evaluate Historical Changes and to Monitor Land Subsidence in Lower Coachella Valley, California. USGS Water Resources Investigation Report 97-4237

Dibblee, Thomas, W., Geologic Map of the Perris Quadrangle, California. SCGS-1, 1981.

QUADS - 7.5 MINUTE

Coverage Description: USGS Quad map boundaries for 7.5 minute series maps
Coverage distribution file name: quad75.e00
Import Location:

VITAL STATISTICS: quad75.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	USGS
Source Media:	Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: quad75.e00
RECORD LENGTH: 153

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	CO_Index	3	I
2	Quad_Name	32	C

CO-INDEX#
The county index number is the number that the county has assigned to the quad sheet.

QUAD-NAME
The quad name is the name (shown at the bottom of each sheet) that U.S.G.S gives to the quad sheet. For example:
PERRIS
RIVERSIDE EAST
STEELE PEAK

NOTE: U.S.G.S. publishes a series of maps showing a variety of different topological features in 15 an 7.5 minute (longitude and latitude) sizes.

WATER BODIES

Coverage Description: This layer contains water bodies and rivers for the County
Coverage distribution file name: lake_region.shp
Import Location:

VITAL STATISTICS: lake_region.shp

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	US Census Bureau Tiger files and reports
Source Media:	Digital and paper
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: lake_region.shp
RECORD LENGTH: 494

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Name	30	C
2	CSCC	3	C
3	Smart_Label	30	C

WIND HAZARD AREA

Coverage Description: Wind Hazard Areas in Riverside County
Coverage distribution file name: wind.e00
Import Location:

VITAL STATISTICS: wind.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	STATSGO, USGS and NOAA
Source Media:	Digital and paper
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:100,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector

ARC/INFO Coverage Type:	Polygons
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	polygons
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: wind.e00
RECORD LENGTH: 205

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE	
1	MUID	7	C	
2	IDS		3	C
3	Soil_Name	100	C	
4	WER	7	I	

Wind-induced soil movement, or wind erosion, is a common and serious environmental problem attracting global attention. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. It mostly affects dry, sandy soils in flat, bare areas, but wind erosion may occur anywhere that soil is loose, dry, and finely granulated. It causes soil loss, dryness, deterioration of soil structure, nutrient and productivity losses, air pollution, and sediment transport and deposition. The presence of dust particles in the air is a source of several major health problems. Atmospheric dust causes respiratory discomfort, may carry pathogens that cause eye infections and skin disorders, and reduces highway and air _ traffic visibility. Dust storms can cause additional problems. Buildings, fences, roads, crops, trees and shrubs can all be damaged by blowing soil, which acts as an abrasive.

Soil movement is initiated as a result of wind forces exerted against the surface of the ground. For each specific soil type and surface condition there is a minimum velocity required to move soil particles. This is called the threshold velocity. Once this velocity is reached, the quantity of soil moved is dependent upon the particle size, the cloddiness of particles, and the wind velocity. Suspension, saltation, and surface creep are the three types of soil movement, which occur during wind erosion (Figure 2-10). While soil can be blown to virtually any height, over 93% of soil movement takes place within one meter of the ground.

Wind and wind-blown sand are an environmentally limiting factor throughout much of Riverside County. Approximately 20% of the land area of Riverside County is vulnerable to "high" and "very high" wind erosion susceptibility (Figure 2-11). The Coachella Valley, the Santa Ana River Channel in northwestern Riverside County, and the community of Hemet are zones of high wind erosion susceptibility.

A digital Wind Erosion Susceptibility Map was prepared as part of this study. The wind hazard map is generally considered accurate to 1:100,000, and is presented in Plate 2-5 at a scale of 1:250,000.

Map information for the STATSGO data base was captured as 1:250,000 scale USGS topographic quadrangle units in a Universal Transverse Mercator ground based system. The horizontal datum reference system was the North American Datum of 1927 which is based upon the Clarke 1866 spheroid. The topographic quadrangle units were projected into an Albers Equal Area projection and merged into statewide coverage. Wind data was taken from the United States Department of Agriculture State Soil Geographic (STATSG0) Data Base (http://www.gisdatadepot.com/catalog/US/61069/group23.html). STATSGO included a soils map of the state of California that was refined for Riverside County only. These data included a classification of the soil within each polygon for wind erodibility. This wind erodibility number was used to assign each polygon a WER (Wind Erodibility Rating). WER classification was assigned as follows:

1 = Very Highly erodible
2 = High erodibility
3 = Moderate erodibility
4 = Low erodibility
5 = Water

References:
USDA Natural Resources Conservation Service, April 1996, Soil Quality Information Sheet
Soil Quality Resource Concerns: Soil Erosion
USDA Natural Resources Conservation Service, 1998, Keys to Soil Taxonomy: Eighth Edition

weg 1
Wind Erodibility Group 1
Surface texture - VFS,FS,S,COS. Percent aggregates - 1, Wind erodibility index 310 t/a/y.

weg 2
Wind Erodibility Group 2
Surface texture - LVFS,LFS,LCOS,Sapric material. Percent aggregates - 10, Wind erodibility index - 134 t/a/y.

weg 3
Wind Erodibility Group 3

Surface texture - VFSL,FSL,SL,COSL. Percent aggregates - 25, Wind erodibility index - 86 t/a/y.

weg 4
Wind Erodibility Group 4
Surface Texture - C,SIC,noncalcareous CL,SICL(>35% CLAY). Percent aggregates - 25, Wind erodibility index 86 t/a/y.

weg 4L
Wind Erodibility Group 4L
Surface texture – calcareous L/SIL/CL,SICL. Percent aggregates - 25, Wind Erodibility index - 86 t/a/y.

weg 5
Wind Erodibility Group 5
Surface textue – noncalcareous L/SIL(<20% CLAY),SCL,SC. Percent aggregates - 40, Wind erodibility index 56 t/a/y.

weg 6
Wind Erodibility Group 6
Surface texture – noncalcareous L/SIL(>20% CLAY),CL(<35% CLAY). Percent aggregates - 45, Wind erodibility index - 48 t/a/y.

weg 7
Wind Erodibility Group 7
Surface texture - SI,noncalcareous SICL(<35% CLAY). Percent aggregates 50, Wind erodibility index –38 t/a/y.

weg 8
Wind Erodibility Group 8
Erosion not a problem.

WIND STATIONS

Coverage Description: Wind Stations in Riverside County
Coverage distribution file name: windstat.e00
Import Location:

VITAL STATISTICS: windstat.e00

Datum:	NAD 83
Projection:	State Plane Feet - Zone VI
Units:	Decimal Degrees
Source:	NOAA
Source Media:	Digital
Source Projection:	vary
Source Units:	vary
Source Scale:	vary
Capture Method:	Digitized
Accuracy:	The overall map is good to an accuracy of 1:24,000.
Conversion Software:	MapInfo 6.0
Data Structure:	Vector
ARC/INFO Coverage Type:	Points
ARC/INFO Precision:	Single
ARC/INFO Tolerances:	degrees of longitude/latitude
Number of Features:	points
Data Updated:	Last update July 2000

DATA DICTIONARY:

DATAFILE NAME: windstat.e00
RECORD LENGTH: 69

Non-standard POLYGON attribute fields:

COLUMN	ITEM NAME	WIDTH	TYPE
1	Year	-	I
2	Month	-	I
3	Day	-	I
4	Time_CST	4	C
5	Sequence	-	I
6	US_Office	3	C
7	Fatalities	-	I
8	Injuries	-	I
9	Wind_MPH	-	I
10	Wind_Comments	7	C
11	Damage	40	C