SECTION 3: CLIMATE, HYDROLOGY AND WATER USE

3.1 Overview

Watersheds of the Carpinteria Valley are characterized by a Mediterranean climate with highly seasonal rainfall mostly falling between November and April. Annual rainfall averages between 16 inches in the lower watershed, to 30 inches at higher elevations, and falls on short steep catchments with shallow soils and extensive rock outcroppings that produce flashy runoff. The predominantly south facing hillsides, the southwesterly winter storm flow direction, and the steep mountainous terrain can combine to yield significant orographic precipitation (National Oceanic and Atmospheric Administration, 2001). Approximately 90% of the annual runoff occurs in less than 30 days, with over 80% of that coming in January, February and March. Most of the annual precipitation and corresponding runoff occurs in only a few large storms, resulting in high peak flows and rapid return to near base-flow conditions (Beighley et al., 2004). There are significant effects of El Niño (above average warm ocean temperatures in the equatorial Pacific typically producing above average rainfall) and La Niña conditions (unseasonably cold ocean temperatures typically producing below normal rainfall). These conditions occur irregularly every three to seven years and result in high variability within a year and from one year to the next in precipitation, flooding and droughts (Monteverdi and Null, 1997).

3.2 Land Use Summary

Watershed runoff characteristics are directly influenced by climate, soil type and land use. Land use can greatly enhance stream discharge by increasing the extent of impervious surfaces due to pavement and roof tops, elimination of vegetative ground cover, and general soil compaction. Urban areas and greenhouse operations are particularly prone to accelerated runoff with a quick rise and fall of the storm hydrograph or stream stage. Hence, it is important in any hydrologic analysis to incorporate a careful evaluation of land use types as it relates to the hydrologic characteristics of the watershed (Beighley et al., 2003).

Physical characteristics and major land use classes for the Carpinteria Creek Watershed are presented in Table 3.1. The percentages of major land uses for 1929, 1976 and 2002 are from interpretations of high-resolution aerial photographs using the Anderson Land Use Classification system and aggregating by four broad categories (Anderson et al., 1976). The extent of impervious surface for each year was estimated by using a combination of several regional classification schemes (US Department of Agriculture, 1986; USACE, 2000; Southern California Association of Governments, 2003) and field observation (Robinson, 2004). Note that the general land use percentages have not drastically changed over the years due to the historic agricultural development of the Carpinteria Valley and the high percentage of undisturbed areas in the upper watershed. Four dominant land use categories for the Watershed are the riparian corridor and its riverine wetland ecosystem, the undisturbed chaparral and forests from the foothills to the top of the Santa Ynez Mountains at 4672 ft of elevation, the urban corridor adjacent to the coastline, and the agricultural belt in between.

Table 3.1: Land use characteristics for Carpinteria Creek Watershed.

Drainage Area		Max-Elevation		Average Slope	Year	Urban	Agriculture	Chaparral/Forest	Riparian	Impervious
(mi2)	(km2)	(ft)	(m)	(%)		(%)	(%)	(%)	(%)	(%)
15	39	4672	1424	38	2002	3.4	13.9	79.9	2.9	4.3
					1976	2.7	13.5	80.9	3.0	2.6
					1929	0.6	12.4	83.8	3.2	0.9

Note: Water and barren areas are not included in these percentages.

The deep and fertile soils of the coastal plain have been farmed for generations and have seen many changes in crop type from walnuts to row crops to avocados, citrus, sub-tropical fruits of today with some greenhouses. The general trend over the last 80 years has been for a slow migration of agricultural development (avocados and citrus) into the foothills, reducing the extent of chaparral and forest. At the same time, the lower portion of the watershed has experienced a shift from agricultural uses to urban development, predominately within the city limits.

Certain reaches of the stream corridor, have had the riparian forests compromised by urban and agricultural development, where grading and construction have altered or removed the vegetation within close proximity of the channel bank. This in effect breaks the continuity of the riparian corridor and degrades the riverine ecosystem by reducing the shade cover, exposing the stream to direct sunlight (which increases the water temperature), and enhancing erosion and the associated sediment load to the stream. All of these factors can influence the stream hydrology both individually and cumulatively. There has been slow encroachment of low density rural residential development up into the foothills above the northern agricultural fringe. This can be seen in upper Gobernador Canyon (Sheppard's Mesa), the Cate School campus, and above Lillingston Canyon Road to the west.

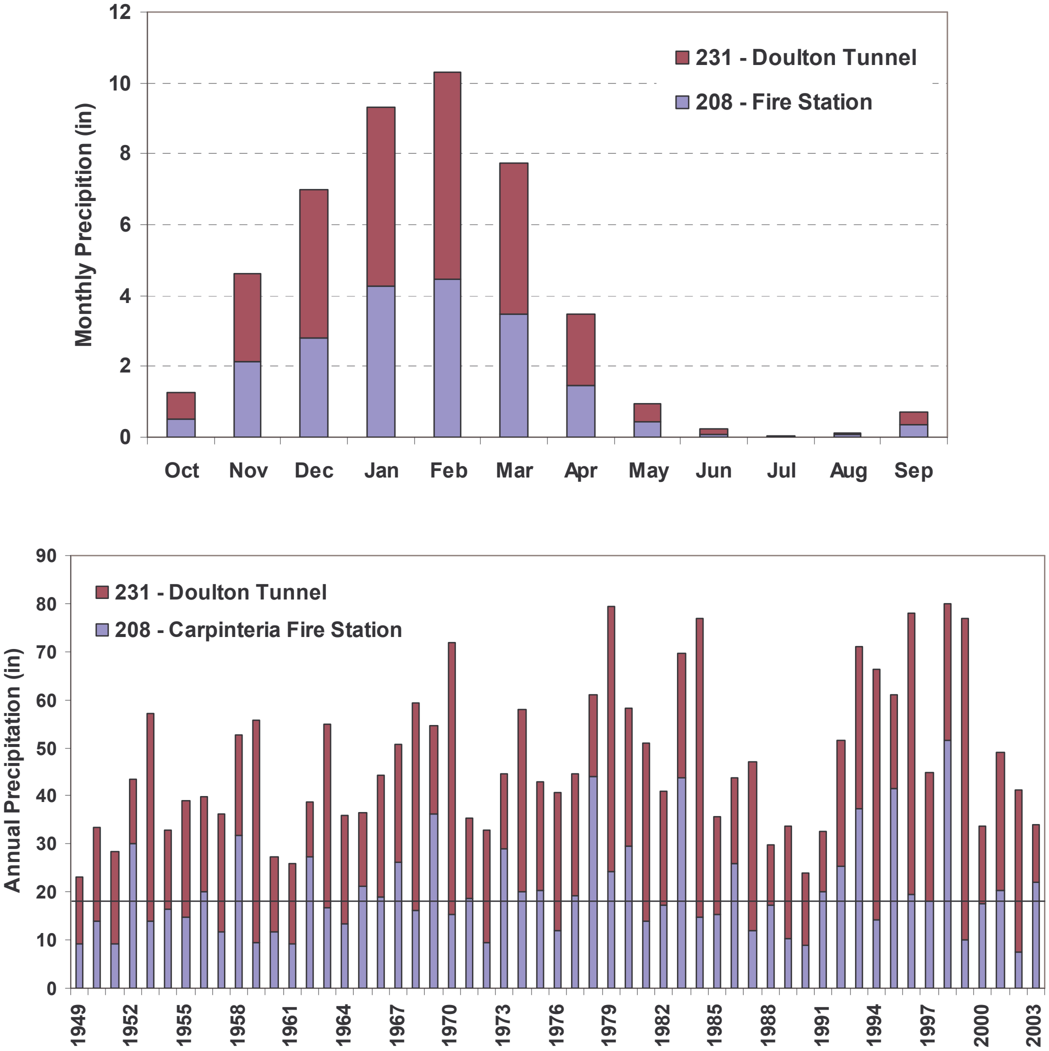
Beneficial and recreational land uses of the creek are many. Within the city limits there are informal trails along the creek and its riparian corridor, a bike path along the western side of the creek between Carpinteria Avenue and U.S. 101 and a footbridge on 8th Street that crosses the entire riparian corridor. These important types of land use create points of access to the creek that serve for recreation, observation of wildlife and aesthetic enjoyment of natural open spaces along the creek. Views of this unique natural resource are also enjoyed from roadways, vehicle bridges, private residences, businesses, Carpinteria State Beach, etc (Padre and Associates, 2002).

3.3 Precipitation Summary

Carpinteria Valley has a Mediterranean climate, with warm dry summers and cool, wet winters. Rainfall is highly seasonal and varies significantly from year to year, with an annual average rainfall of 20 inches. There is a strong orographic effect from the predominant southwesterly storm direction that pushes storms up against the mountains, and can produce approximately double the annual precipitation in the upper catchments (Figure 3.1). Noteworthy months of record excess precipitation since monitoring began in Carpinteria (1949) were January 1969 (18.3 inches), January 1995 (21.4 inches), and

February 1998 (23.5 inches); all were associated with heavy flooding periods. (Water Resources Division, 2004)

Figure 3.1: Rainfall patterns on the coastal plain (208) and mid elevation (231) sites, demonstrating orographic effects; a) average monthly precipitation showing the seasonality, and b) total annual precipitation for the same sites during common years of record (1949-2003). The line at 17.5 inches represents the median value at the Carpinteria Fire station, 20 inches is the average.



Accurate, well maintained, and calibrated rain gauges are limited in the area and are nonexistent in the higher elevations. Available and reliable rainfall data can be obtained from five stations in the region (Figure 3.2). Table 3.2 lists station characteristics. Online data is available from the County of Santa Barbara (Water Resources Division, 2004) as well as through U.C. Santa Barbara, Santa Barbara Coastal Long Term Ecological Research Project (SBC-LTER, 2004). Several other stations exist but are not included in the table due to irregular data records or inadequate measuring devices. The Precipitation-Elevation Regression and Independent Slopes Model (PRISM) dataset (Daly et al., 1994) produced lines of equal precipitation (isohyets) that give an estimation of the rainfall distribution across the watershed using the rainfall data in closest proximity and scaled by the PRISM ratio (Daly, 1996).

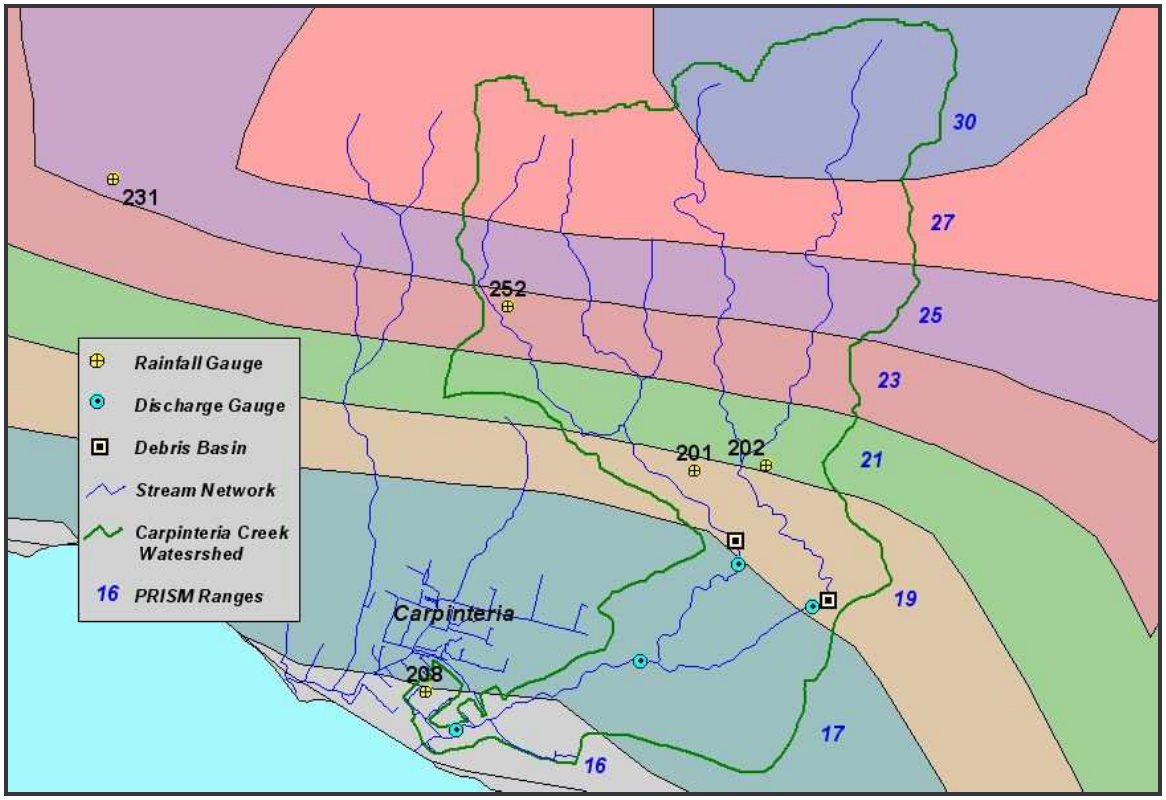


Figure 3.2: Carpinteria Creek Watershed in the Carpinteria Valley, showing the principal drainage network for the valley, rainfall and stream gauging stations and debris basin locations on the creek, as well as lines of equal precipitation (isohyets) and precipitation zone values in inches from the PRISM dataset.

Table 3.2: **Precipitation gauges for the Carpinteria Valley.**

Code	Owner Operator*	Name	Elevation (ft)	(m)	Status	Period of Record (Start)	(End)	Type
231	Co-SB	Doulton Tunnel	1775	541	online	1926	--	Tipping Bucket w/ Data Logger
208	Co-SB	Carpinteria Fire Station	15	5	online	1949	--	Tipping Bucket w/ Data Logger
252	Co-SB	Edison Trail	1650	503	offline	1999	2003	Storage Gauge w/ Data Logger
201	SBC-LTER	Upper Gobernador Creek	1159	353	online	2003	--	Tipping Bucket w/ Telemetry
202	SBC-LTER	Upper Carpinteria Creek	1109	338	online	2003	--	Tipping Bucket w/ Telemetry

* Co-SB: County of Santa Barbara
SBC-LTER: Santa Barbara Coastal LTER, UC Santa Barbara

3.4 Stream Discharge Summary

There are five stream gauging stations that measure flow on Carpinteria Creek (Table 3.3), one operated by the USGS near Hwy 192 Bridge, a parallel gauge at the same location operated by the County of Santa Barbara (County), and three by U.C. Santa Barbara (SBC-LTER). SBC-LTER installed gauges are at the outlet just above the tidal influence and one on each of the main tributaries in the upper watershed (Figure 3.2, and Figure 3.3). The USGS facility has the longest recorded discharge record (1941 to the present) and is a low-profile constructed weir with a bubbler and telemetry system for online/real-time data access (US Geological Survey, 2004). The County gauge at that same site has a pressure transducer and telemetry system that facilitates data collection for flood analysis. SBC-LTER gauging stations consist of a pressure transducer fixed to the channel bottom and a staff gauge on the side of the channel for visual observation of stage.

Table 3.3: Stream discharge gauging stations on Carpinteria Creek.

Code	Owner Operator*	Location	Distance to Outlet (mi)	(km)	Status	Period of Record (Start)	(End)	Type
CP00	SBC-LTER	8th Street Footbridge	0.4	0.6	online	2001	--	Natural channel w/ PT**
11119500	USGS	Hwy 154 + creek	2.3	3.7	online	1941	--	Weir w/ Bubbler +Telemetry
550	Co-SB	Hwy 154 + creek	2.3	3.7	online	1999	--	Weir w/ PT+Telemetry
CP05	SBC-LTER	Upper Carp. Creek	3.5	5.6	online	2002	--	Natural channel w/ PT
GB04	SBC-LTER	Upper Gob. Creek	3.7	6.0	offline	2002	2003	Natural channel w/ PT

* USGS: U.S. Geological Survey
Co-SB: County of Santa Barbara
SBC-LTER: Santa Barbara Coastal LTER, UC Santa Barbara
** PT: Pressure Transducer

Figure 3.3: Two of the four gauging locations on Carpinteria Creek, 8th Street Footbridge and the USGS station near Hwy 192 Bridge. Both have staff gauges at the deepest point of the channel at a determined cross-section.

Stream discharge follows the seasonal rainfall pattern of a Mediterranean climate, where during the Water Year (WY), October 1st through September 30th, stream levels rise and fall very quickly and runoff is characteristically flashy (Figure 3.4). Often, several rainstorms in sequence are needed before soils are sufficiently saturated to produce upper watershed flow following the six to nine month dry season. In contrast, urban areas, and agricultural areas with hard surfaces inhibit infiltration and enhance rapid runoff even during minor rainfall events. Hence, discharge and runoff in the lower reaches of the watershed is created by most rainfall events regardless of soil moisture conditions.

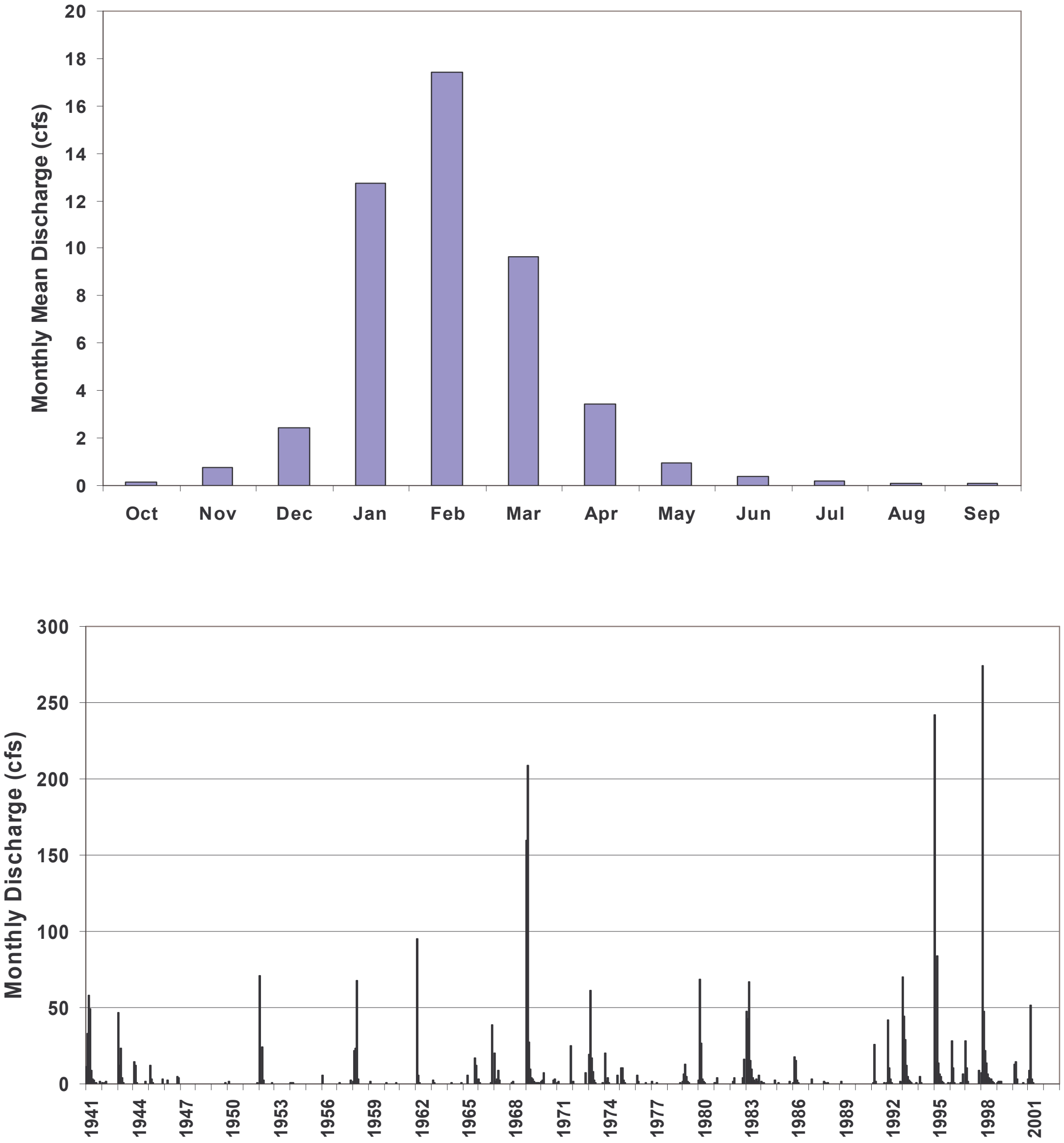


Figure 3.4: Carpinteria Creek monthly stream discharge characteristics at the USGS 11119500 gauge (Hwy 192 and the creek), a) average monthly discharge and b) annual totals from 1941 to the present.

Significant runoff occurs once the watershed is fully saturated and infiltration rates are low. Although large rainfall events often occur at the beginning of the Water Year, six months of preceding dry weather enables soils to absorb the majority of what falls and very little runoff is generated, resulting in small changes in stream height. A storm of similar magnitude that occurs in February or March, on the other hand, can produce high runoff, due to the saturated soil conditions. Annual discharge patterns are extremely varied and are linked to large fluctuations in annual rainfall. The region is subject to irregular periods of drought and flooding mostly associated with El Niño/La Niña events. The distribution of annual stream flow data for Carpinteria Creek from 1941 to the present can be seen in Figure 3.4b. Again, the USGS gauge is the only long-term discharge record on the stream.

There are two debris basins on the principal tributaries of Carpinteria Creek just above the agricultural fringe (Figure 3.2). Both were constructed by United States Army Corp of Engineers in 1971, are now owned by the Santa Barbara County Flood Control District and are similar in size and capacity. The Gobernador basin is just below the confluence of Steer and El Dorado creeks, has a design capacity of 46,500 cubic yards (yd^3), was completely full in 1998 when it was last cleaned. Prior that 1998, the Gobernador basin had 30,000 yd^3 of sediment remove following the 1995 El Niño season. The Lillingston basin on Carpinteria Creek is below upper Carpinteria and Sutton creeks, and has not been maintained for years because of lack of road access. Both debris basins continue to serve as sediment and debris traps, reduce peak flows and elongate the storm hydrograph. The basins also serve as grade stabilization structures.

To further illustrate the variability in year-to-year stream discharge, instantaneous maximum peak flow data is presented in Figure 3.5. Annual maximum peak flow varied from 0.8 to 8880.0 cubic feet per second (cfs) recorded on December 27th, 1971. This high discharge value has an associated uncertainty of +/- 25% because of large debris flows from a wildfire that occurred during the previous summer.

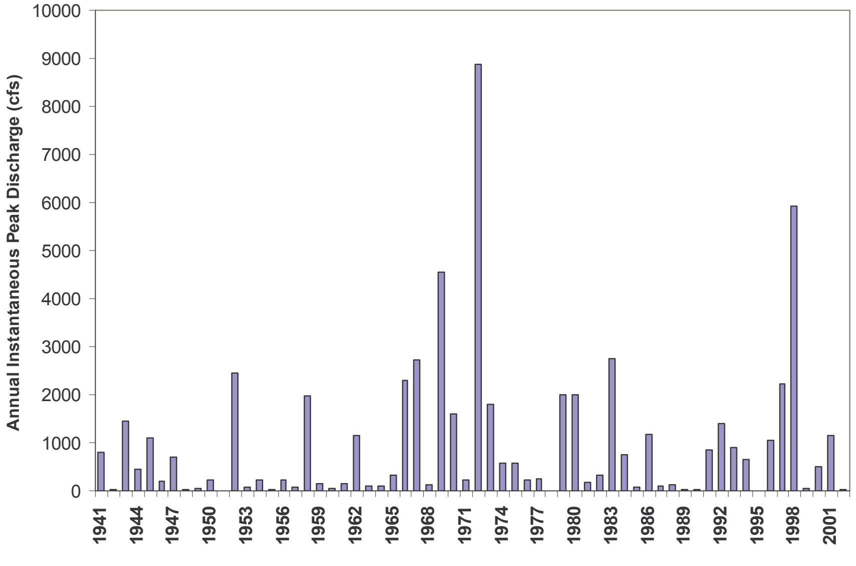


Figure 3.5: Annual instantaneous maximum peak discharge on Carpinteria Creek **at the USGS Gauging Station, 11119500 for the available data record from the USGS (1941-2001). All other values have a stated uncertainty of +/- 10% (Meyer, 2004; US Geological Survey, 2004).**

Stream hydrographs are curves showing the rise and fall of the stream over time. In a multi-land use watershed such as Carpinteria Creek, it is common to have a bimodal storm hydrograph (two peaks), the first peak coming from the urban/impervious surface rapid flush and the second and larger peak, from the upper reaches of the watershed when full basin flow occurs. The lag time between the two peaks varies depending on the preceding soil moisture conditions (Beighley et al., 2004). Figure 3.6 shows nested hydrographs for the four gauging stations on Carpinteria Creek during the largest storm of WY 2003. The first small peak on the outlet hydrograph (8th Street Footbridge) is the urban flush followed by the full basin flow peak several hours later.

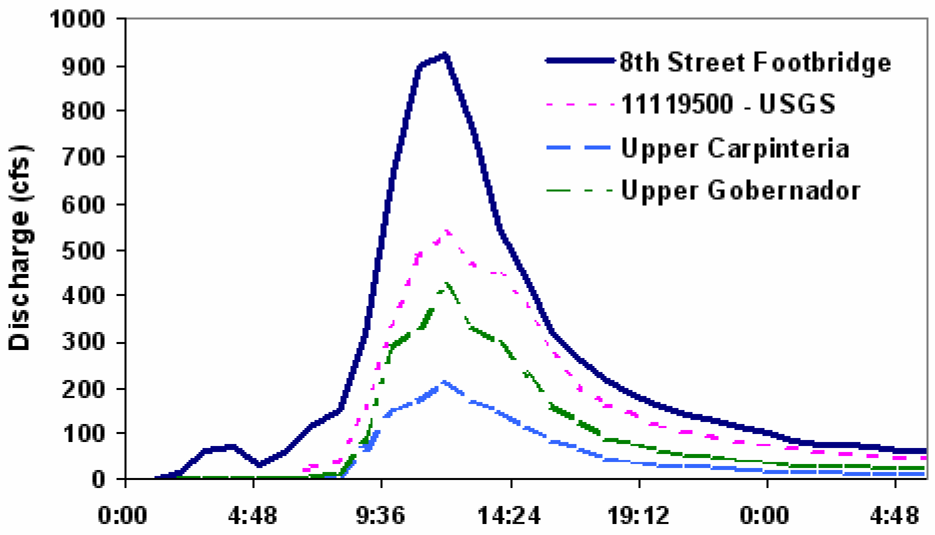


Figure 3.6: Nested stream hydrographs during the March 15, 2003 storm where over five inches of rainfall fell on the basin.

Low flow conditions on Carpinteria Creek occur between rainy periods and throughout the dry season of the year. The upper reaches of the creek are fed by springs and seeps from groundwater basins that maintain perennial stream flow at approximately 0.5 cfs year round. The last half-mile of the stream just before the outlet at Carpinteria State Beach Park also exhibits perennial flow from shallow unconfined aquifers and flows from urban and agricultural runoff (between 0.5 and 1.0 cfs). In between and across the majority of the coastal plain, the creek is intermittent where deep alluvial deposits, hundreds of feet thick, and fractured bedrock enable high permeability. Long-term residents claim that the number of days with flow across the entire coastal plain has diminished over the years and speculate the cause to be loss of riparian habitat and increased usage of groundwater resources across the Carpinteria Valley.

3.5 Channel Modification Assessment

Carpinteria Creek channel throughout the coastal plain has been routinely maintained since the late 1950s by the Santa Barbara County Flood Control District (Flood Control

District) for flood water conveyance. Stretches of the creek included in the maintenance program are from the ocean to the confluence of Gobernador and upper Carpinteria Creek at Casitas Pass Road, and from the confluence to the debris basin on Gobernador Creek. Maintenance has entailed mechanical modification of the channel bottom and banks for efficient passage of storm flow to protect developed areas, roads and bridges down stream and to reduce flood hazards resulting in damage to life, property and public infrastructure. Residual infrastructure from historic bridges and flood protection can still be seen in or near the channel such as bank protection structures (pipe and wire revetments and rip rap), lateral in stream grade stabilizers, at-grade concrete road crossings and abandoned bridge abutments.

From the 1960s thru the mid 1980s, the Flood Control District routinely ran a bulldozer up the creek to clear obstructions and push streambed material into eroded banks. Clearing of vegetation, debris and sediment was usually done from toe-of-bank to toe-of-bank with some clearing a few feet up from the toe of bank. There was also hand clearing of excessive vegetation and debris when machinery wasn't necessary to achieve the goal of minimizing in-stream vegetation build-up. Sections of the creek that aggraded significantly due to sediment deposition were desilted. Past and present maintenance on Carpinteria Creek occurs on a frequency of once every 2-3 years, depending on the observed condition of the creek, the availability of funds, the degree of the flood hazard and the associated environmental impact (Treiberg, 2004).

The District modified its maintenance policy in the late 1980s and completed a Program EIR for County-wide routine creek maintenance activities 1992. The Maintenance Program includes various desilting, channel shaping, spraying of Aquamaster™ or Roundup™ (both glyphosate products), and channel clearing activities. Each year, District staff walk down the creek, prepare a maintenance plan, conduct public workshops, and complete CEQA environmental review for planned maintenance work. The annual routine maintenance plan includes an addenda for each creek requiring maintenance and includes a description of the need, the work to be performed, the presence of sensitive biological resources, potential impacts of the activities on biological resources, engineering analysis to justify maintenance and compensatory habitat creation for impacted riparian habitat as a result of any scheduled maintenance mitigation measures to reduce impacts. The District document impacts and mitigation of each maintenance activity and confirm that all planned activities are consistent with the adopted Program EIR. (Santa Barbara County Flood Control District, 2001).

The most important change from the previous channel maintenance policy, prior to the 1991 Program EIR, was that only obstructive vegetation can be removed and bulldozers are only rarely used to achieve that goal. If there was no obstructive vegetation in the streambed, no maintenance is conducted. Therefore, the frequency of maintenance has been reduced and only conducted on reaches that need it as opposed to bulldozing the entire length of the creek. The Program EIR was further updated in 2001 to include endangered species added to the list since 1992, express the importance of riverine wetlands and riparian corridors as natural water quality filters, improve analysis procedures and standard maintenance practices, and include bio-technical bank stabilization techniques.

Debris basin maintenance is conducted on an as-needed basis, typically after severe storm events and wildfires, and is not included in the Annual Routine Maintenance Plan. A Debris Basin Maintenance Plan and set of CEQA Addenda were prepared by the District in 1996 to address maintenance activities in the Gobernador debris basin, but the Lillingston Canyon debris basin was not mentioned.

3.6 Flood History

The Carpinteria Valley experiences irregular flooding during extreme peak flow events. Areas impacted by flooding are usually restricted to the low laying regions that fall inside the 100-year floodplain (defined as the area that would typically be inundated by flood waters once in 100 years) or are just above constriction points along channel networks, for example just north of U.S. 101 (Figure 3.7). The first documented flood in the Santa Barbara area was described by Franciscan Friars in 1832 (History Across America, 2003). Floods in 1914 and 1916 caused appreciable damage, particularly at the outlet of Carpinteria Creek. Significant flooding events since the installation of the USGS gauging station on Carpinteria Creek in 1941 (US Geological Survey, 2004) are shown in Table 3.4.

Table 3.4: Peak stream discharge for the highest years on record at the USGS gauging station just upstream of the Highway 192 bridge.

Year	Peak Flow (cfs)
1952	2440
1967	2720
1969	4560
1972	8880
1983	2750
1998	5930

Figure 3.7: FEMA Flood Map showing the 100-year (brown) and 500-year floodplain (light brown) within or near the Carpinteria Creek Watershed. Also depicted are wells. The small circular dots indicate location of private wells.

Several studies have been conducted on the South Coast to better delineate the 100-year floodplain and the potential risk of flooding for emergency management and evaluation of the flood insurance program (Department of Conservation, 1969; Emergency Management Agency, 1982). The 1982 study calculated flood frequencies, which are presented in Table 3.5. Data for Franklin Creek, the adjacent creek to the west, have been included for comparison between a highly impacted stream, and Carpinteria Creek watershed that is dominated by natural vegetation or orchard crop agriculture. Using these figures, the record peak flow from the 1972 storm (8880 cfs) produced approximately the 50-year discharge event for Carpinteria Creek.

Table 3.5: Flood frequency for Carpinteria and Franklin creeks. Franklin Creek watershed is substantially smaller and highly urbanized with industrial agriculture, residential and commercial land uses (Emergency Management Agency, 1982).

	Drainage Area		Peak Discharge (cfs):			
Watershed	(mi^2)	(km^2)	10-year	50-year	100-year	500-year
Carpinteria Creek	15.1	39.2	2,750	8,000	12,000	21,000
Franklin Creek	4.5	11.6	1,100	2,700	10,000	16,800

3.7 Prediction of Storm Water Runoff

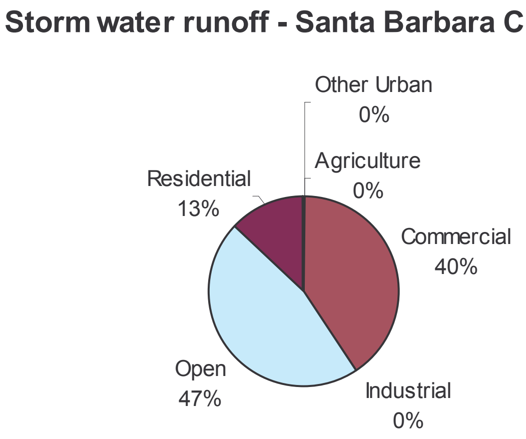
Estimating peak storm discharges is crucial for flood protection, bridge sizing, and fish passage assessment. Stream discharge levels vary considerably from year to year depending on the frequency and intensity of winter storms, making it difficult to predict storm runoff for a watershed. The watershed response to any given storm is highly variable with many factors contributing to the amount and timing of discharge. Precipitation can be double in the upper watershed compared to the area south of Highway 192, making the extrapolation of rainfall data over the entire watershed difficult. Soil types and soil moisture conditions govern runoff, where wetting of the soils is necessary to have significant stream flow. Prediction of runoff from a given storm requires tracking days since the last rainfall event, soil moisture conditions, intensity of predicted rainfall, and extent of impervious surfaces in the area adjacent to the creek (California Department of Transportation, 2003). In a Mediterranean climate, this is particularly challenging and is currently under study at U.C. Santa Barbara (Beighley et al., 2003; Robinson et al., 2003). Fish passage would be limited to the period when flows decline after a storm, and when flow velocity, debris, and sediment loads have subsided. The number of days annually that fish can cross the coastal plain to reach the upper watershed is subject to the same historic storm flow variability that is characteristic of this type of climate.

The flashy nature of South Coast streams, the strong local orographic effects on precipitation combined with changes in land use also affect the prediction of storm runoff. As open field and orchard agriculture convert to greenhouses or residential developments and low density residential developments push up further into the foothills, peak storm runoff will increase and occur in a shorter period of time, due to the increase in impervious surfaces and loss of soil moisture retention, in effect shortening the periods when fish passage is possible. Urbanizing the watershed increases the risk of higher flow events but decreases infiltration, which reduces any perennial flows (Beighley et al., 2003; California Department of Transportation, 2003).

The Southern California Coastal Waters Project (SCCWP) developed a storm water mass emissions model for the Southern California Bight, including Santa Barbara County. The Gap analysis program (GAP) statewide data set was used to determine land use classifications in Santa Barbara County. PRISM rainfall data was used, and the effects of both large and small storm events were removed from the storm water runoff model. For Santa Barbara County, the majority of the runoff came from commercial and open spaces (Figure 3.8).

3.8 Hydrologic Soil Conditions

The loosely consolidated soil material between the ground surface and underlying impervious bedrock plays an important role in watershed hydrology. Infiltrated rain water percolates down through the unsaturated zone where it can be taken up by plants, recharge an underlying aquifer, or travel back to the surface in the case of a road “switch back” or stream bank.



	Acre feet runoff
Agriculture	123
Commercial	20,607
Industrial	-
Open	23,806
Residential	6,622
Other Urban	
Total	51,158

Figure 3.8 SCCWRP modeling of storm water runoff by land use type for Santa Barbara County. Open space is defined as open areas, tree cover and bare areas.

The dynamics of soil porosity highly influences the adjacent stream hydrology. High infiltration rates result in low surface runoff while fully saturated soils can greatly increase surface runoff potential.

The Soil Survey of Santa Barbara (USDA SCS, 1981) and the Soil Survey Geographic (SSURGO) Data Base for Santa Barbara County (USDA NRCS, 1995) provide soils data for the Carpinteria Creek Watershed. The SSURGO coverage indicates that upland areas in this region are generally characterized by thin soils over weathered bedrock and -occasional rock outcroppings, while the coastal plain tends to have deeper, well drained, and fertile soils with no known bedrock layers in the upper six feet of soil. Deep alluvial deposits dominate in this region and are characterized as fertile soils with good infiltration capacity resulting in low runoff potential except under highly saturated conditions. Examples of these types of soils in the lower watershed are Orthents, Milpitas stony fine sandy loam, Elder sandy loam, Todos clay loam, Milpitas-Positas fine sandy loams, Goleta fine sandy loams, Metz loamy sand, Camarillo Variant fine sandy loams and Aquents. Table 3.6 lists the predominant soil types found in the Carpinteria Creek Watershed, as shown in Figure 3.9. Vegetative cover can increase infiltration of surface water. Increased infiltration can benefit the stream flow if non-pervious soil layers dip towards the creek at elevations above the bottom of the creek bed. Infiltrated water that does not end up in the creek will be perched in buried sediment layers below the ground and be considered ground water. Water bearing sediments and strata can be found throughout the coastal plain of the Carpinteria Valley in both confined and unconfined conditions. Confined conditions would not benefit from water recharge from above, but unconfined aquifers would. A representation of the rock formations that underlie the soils in the Carpinteria Creek Watershed and the fault lines that dissect them is shown in Figure 1.3.

Table 3.6: Soil types found in the Carpinteria Creek Watershed.

Map Symbol	Soil Series	Average Slopes	Comment	"K" factor	Lower Carpinteria	Upper Carpinteria	Gobernador	Summary
					acres			
AC	Aquents and fill areas	-		0.00	2	0	0	2
BcC	Baywood loamy sand	2-9%		0.15	16	0	0	16
Cb	Camarillo variant, fine sandy loam	-		0.32	36	0	0	36
EaB	Elder sandy loam	2-9%		0.32	19	0	0	19
Eb	Elder-Soboba complex	2-9%		0.32	1	55	85	141
GbG	Gaviota rock outcrop complex	50-75%		0.43	0	95	86	181
GcA	Goleta fine sandy loam	0-2%		0.32	570	0	2	572
GdA	Goleta loam	0-2%		0.32	113	0	0	113
LbG	Lodo rock outcrop complex	50-75%		0.20	1	1302	1598	2901
LcG	Lodo-Sespe complex	50-75%		0.20	0	419	289	708
MbH	Maymen rock outcrop complex	50-100%		0.24	0	607	59	666
Mc	Metz loamy sand	-		0.15	150	1	0	151
MdD	Milpitas Stony fine sandy loam	9-15%		0.24	7	0	0	7
MdE	Milpitas Stony fine sandy loam	15-30%		0.24	60	10	3	73
MdF	Milpitas Stony fine sandy loam	30-50%		0.24	4	0	0	4
MeC	Milpitas-Positas fine sandy loams	2-9%		0.24	151	32	0	183
MeD2	Milpitas-Positas fine sandy loams	9-15%	Eroded	0.24	37	50	146	233
MeE2	Milpitas-Positas fine sandy loams	15-30%	Eroded	0.24	124	12	0	136
MeF2	Milpitas-Positas fine sandy loams	30-50%	Eroded	0.24	104	0	0	104
OAG	Orthents	50-75%		0.00	47	92	123	262
Rb	Rock outcrops-Maymen complex	75-100%		0.00	0	623	2570	3193
TbE2	Todos clay loam	15-30%	Eroded	0.28	0	18	0	18
TdF2	Todos-Lodo complex	30-50%	Eroded	0.28	0	80	12	92
Water				0.00	2	0	0	2
Total					1444	3397	4971	9812

Notes: Slopes are determined by dividing the vertical “rise” by the horizontal distance “run”. A 100% slope is equivalent to a 45° angle.
“K” factors are a measure of the soils potential to erode. The larger the “K” factor the greater the potential for that soil type to erode.
Source: SCS, 1981.

Insert **Figure 3.9 Soil Types in Carpinteria Creek Watershed**

3.9 Evaporation and Transpiration

Evapotranspiration data (ETo), which is a combination of evaporation and plant transpiration, is available for this region through the California Irrigation Management Information System (CIMIS) online and real-time dataset (Table 3.7) (California Department of Water Resources, 2004). ETo values fluctuate on a 24-hour basis depending on the sunlight, temperature, wind, type and density of plant cover, rate of plant photosynthesis and respiration, and extent of impervious surfaces. High ETo rates related to hot days, windy conditions and active plant growth reduce soil moisture content, which can result in increased infiltration and reduced runoff. For that reason vegetative cover throughout the watershed is important, even when it is non-crop vegetation.

Table 3.7: Recent CIMIS meteorological data at the Goleta foothills Station (#94) that is in relatively close proximity to the Carpinteria Valley.

Month Year	Tot ETo (in)	Tot Precip (in)	Avg Sol Rad (Ly/Day)	Avg Vap Pres (mBars)	Avg Max Air Tmp (F)	Avg Min Air Tmp (F)	Avg Air Tmp (F)	Avg Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Dew Point (F)	Avg Wind Speed (mph)	Avg Soil Temp (F)
Mar-03	4.61	4.61	479	9.7	68.1	52.2	60.1	73	42	57	43.1	4.9	58.2
Apr-03	4.73	2.25	511	9.8	65.2	50	57	79	48	62	43.5	5.9	59.7
May-03	5.07	2.01	542	13	69.2	51.9	59.8	89	59	74	51.2	4.4	62.8
Jun-03	3.4	0.32	402	15	69.3	55	61.1	94	67	82	55.4	3.1	64.7
Jul-03	6.05	0.05	586	17.1	81.6	60.4	69.5	90	53	71	58.8	3.7	70.2
Aug-03	6.45	0	591	15.8	81.8	61.2	71	83	44	62	56.9	3.6	71.3
Sep-03	4.34	0.16	471	16.3	76	57.3	64.9	93	59	79	57.7	3.4	69.5
Oct-03	3.49	0.62	345	13.8	76.8	58.6	66.6	84	48	66	52.5	3.2	65.9
Nov-03	2.36	1.22	270	9.4	65.8	51.6	57.8	74	43	57	41.5	3.4	56.8
Dec-03	1.89	2.98	202	8.4	62	49.2	55.2	75	38	57	38.5	3.8	52
Jan-04	2.32	0.51	260	8.3	63	48.7	55.3	77	39	57	38.8	3.6	51.3
Feb-04	2.45	7.11	282	8	60.7	47.7	54.1	73	44	57	37.4	4.9	52.1
Totals/Avgs	**47.16**	**21.84**	**412**	**12**	**70**	**53.7**	**61**	**82**	**49**	**65**	**47.9**	**4**	**61.2**

3.10 Surface Water and Groundwater Supply

Understanding sources of municipal and agricultural water supply is important when evaluating water inputs and outputs in a watershed. This is particularly true during the dry season when discharge from urban and agricultural areas make up most of the stream flow. Drawdown of aquifers can reduce groundwater discharge into creeks and cause extended periods with no stream flow.

The regional water purveyors for the South Coast are the U.S. Bureau of Reclamation (USBR) and the Central Coast Water Authority (CCWA). USBR runs the Cachuma Project (Cachuma Reservoir) on the Santa Ynez River. CCWA is responsible for State Water Project allocations. Delivery of water from both purveyors to individual water districts on the South Coast is facilitated by COMB (Cachuma Operation and Maintenance Board) via the Tecolote Tunnel and South Coast Conduit.

The Carpinteria Valley Water District (CVWD) receives 50 to 70% of its water supply (Table 3.8) from the Cachuma Project. Their annual allocation of Cachuma Project water is 2,813 acre feet per year (AFY) but can receive as much as an additional 400 AFY from exchanges with other Cachuma Project members such as the Santa Ynez Water Conservation District, Improvement District #1 that regularly exchanges State Water for Cachuma water entitlements for geographic reasons. The CVWD's State Water allotment began in 1997 and supplies 2,000 AFY with an additional 200 AFY drought buffer. A study conducted by the California Department of Water Resources states that there is 75% reliability in delivery for all entitlements, hence for planning purposes the CVWD only relies on that percentage (1650 AFY). The remaining water supply comes from water pumped from local groundwater basins. Allocations of State Water are not predicted to change for the next 20 years (Carpinteria Valley Water District, 2001; Carpinteria Valley Water District, 2004).

Table 3.8: Water supply for the Carpinteria Valley Water District. All units are in acre-feet per year.

Water Supply Sources	2000	2005	2010	2015	2020	2025
USBR - Cachuma Project	2813	2813	2813	2813	2813	2813
CCWA -State Water Project	1000	1650	1650	1650	1650	1650
Local groundwater	2400	3000	3000	3000	3000	3000
Total Supply	6213	7463	7463	7463	7463	7463
Total Demand	4300	4714	4811	4909	5010	5113
Difference	1913	2749	2652	2554	2453	2350

The projected population growth for the Carpinteria Valley (Table 3.9) is based on a California Department of Finance projection of 1% increase per five years up to 15,900 at which point the city will reach build out. From approximately 2010 onward, population will increase from redevelopment of exiting units and higher persons per household ratios. The consolidated City growth rate was estimated to be 0.7% per five-year period. The unincorporated areas will see an increase in development pressure, hence carry a 1.2% population growth rate per five years. Water demand (Table 3.8) will increase accordingly, but the District does not project any deficit through 2025 (Carpinteria Valley Water District, 2004).

Table 3.9: Population estimates for the Carpinteria Valley (Carpinteria Valley Water District, 2001 and 2004).

Location	2000	2005	2010	2015	2020	2025
City of Carpinteria 1	15200	15770	15928	16087	16248	16410
Unincorporated Areas 2	2700	2750	2805	2861	2918	2976
Total	**17900**	**18520**	**18733**	**18948**	**19166**	**19386**

Water use in the Carpinteria Valley can be divided into several categories (Table 3.10). New connections to the CVWD delivery system have been at a rate of 0.4% per year since 1994. Increased efficiencies in household and commercial plumbing networks, more drought tolerant landscaping, education, and higher water rates have decreased per capita water demand by 20% from 1988 (Carpinteria Valley Water District, 2001; Carpinteria Valley Water District, 2004). The latest imposed rate increases (July, 2004) should continue this trend.

Table 3.10: Past, present and projected water use for the Carpinteria Valley Water District. All units are in acre-feet per year.

Water Use Sectors	1990	1995	2000	2005	2010	2015	2020	2025
Residential	1584	1686	1741	1777	1813	1850	1888	1927
Commercial	829	404	386	394	402	410	419	427
Industrial	150	132	131	134	136	139	142	145
Institutional + governmental	133	121	132	135	137	140	143	146
Agriculture *	3824	2074	2230	2276	2322	2370	2419	2468
Total	**6520**	**4417**	**4620**	**4716**	**4810**	**4909**	**5011**	**5113**

* Agricultural water does not include water that is privately pumped.

Carpinteria Valley is fortunate to have ample groundwater supply from the Carpinteria Groundwater Basin, extending from near the Ventura County line on the east to Toro Canyon on the west. The sequence of confined aquifers is hydro-geologically divided by the Rincon Creek fault (running east-west through southeastern corner of the City) into two storage units (1 and 2). The superior of the two in water quality and storage capacity is Unit 1; the CVWD has five production wells in this unit. It is located to the north of the Rincon Creek fault and extends to the base of the Santa Ynez Mountains. The size of the basin is approximately 12 square miles with a storage capacity of 575,000 acre feet and a safe yield of 5,000 AFY (Geotechnical Consultants Inc., 1986). Safe yield is the amount of water that can be withdrawn each year that will be replaced by average annual rainfall. In 1996 through State Assembly Bill 3030, the CVWD assumed the role of manager of the Carpinteria Groundwater Basin where they facilitate and track water table heights, groundwater quality, abandoned well destruction, educational efforts and a well inventory database.

Recharge zones for all aquifers of Unit 1 are in the adjacent mountains and foothills, depending on the exposure of the upturned, water bearing, and stratigraphic units. The CVWD does not actively manage any of the recharge zones. Just over half of the groundwater supply used in Carpinteria Valley is extracted by local private pumps (amount estimated by land use type by CVWD), the rest is extracted by CVWD's five active wells: Lyons at 800 gallons per minute (gpm), Smillie at 200 gpm; Foothill at 400 gpm; El Carro at 800 gpm; and Headquarters at 1,400 gpm that came online in July, 2004. Projected groundwater production from 2005 to 2009 is estimated to be 1,800 acre-feet from District pumping and 2,500 acre-feet from private pumping, with no injection and a net annual total of 4,300 acre-feet. The total is below safe yield estimates (Carpinteria Valley Water District, 2003; Carpinteria Valley Water District, 2004).

Careful management of groundwater resources is not only important for municipal supply but for groundwater discharge to streams, specifically during dry periods of the year.

3.11 Water Rights Summary

Stream water rights are protected by law and are an important part of the hydrologic characterization of a watershed both in use and water quality protection. California State water rights have a unique and complex legal code. The two common types for stream and ground waters are Riparian and Appropriate Rights. Each is associated with proximity to the water source and under the jurisdiction of the State Water Resources Control Board (Klamath Resource Information System, 2004). They dictate where and how much stream water extraction can take place which is significant for the preservation of down stream aquatic and riparian ecosystems.

3.12 Springs and Wells

There are many springs and seeps in the Carpinteria Valley and the adjacent mountains. USGS topographic 1:24,000 quadrangle maps (White Ledge Peak and Carpinteria Quadrangles) show several in Carpinteria Creek Watershed, although long term residents state that there are more. Fresh water springs in the upper reaches of both principal tributaries to Carpinteria Creek provide perennial flow, sufficient to support a healthy fish population (Stoecker et.al., 2002). Oil seeps, a type of petroleum spring, can be found in the lower reaches adjacent the Carpinteria State Beach and in the southeastern corner of the Concha Loma neighborhood.

There are over 90 private wells in the Carpinteria Creek Watershed (Figure 3.7). Some are inactive or abandoned and most are tapping shallow unconfined aquifers for agricultural use (CVWD Well Inventory Database, 2004). Smillie is the only one of the five CVWD operated wells located in the watershed, near the confluence of Upper Carpinteria and Gobernador creeks.