SURFACE WATER AND RIPARIAN ASSESSMENT – SOUTHERN CALIFORNIA FORESTS

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"Southern California was only marginally suitable for settlement when the first Europeans arrived because of the limited availability of water."

B. Gumprecht: The Los Angeles River: Its Life, Death and Possible Rebirth

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Executive Summary

The National Forests of southern California—the Cleveland, San Bernardino, Angeles and Los Padres--are unique in administering vast tracts of public land immediately adjacent to the second largest metropolitan area in the United States. Because of the intensity of nearby development, demands on National Forest resources, including water, differ drastically from those traditionally seen in National Forest resource management. Local surface water meets only one-half of the demand; consequently any water available from National Forests is critically valued. Recent water shortages in mountain communities adjacent to several of the Forests highlight the importance of water and watershed management. Future demand for water from the Forests will only increase, as the southern California population is projected to increase by 8 million by the year 2020.

Because of the intensive usage of land below the Forest boundaries, many riparian-dependent animal and plant species now only live in refugia habitats on the Forests. Neither the current extent, nor the population trends of many of these species are completely known; inventories need to be completed to better manage these potentially rare, endangered or sensitive species. Habitat fragmentation from water diversions, impoundments and channelization, although more common downstream from the Forest boundaries, nevertheless alters hydrologic regimes and habitats within the Forests.

Surface water dynamics in southern California is conditioned largely by three factors, sporadically extreme precipitation intensities, steep mountain slopes and recurring wildfires. Locations in the San Gabriel Mountains experience the highest daily rainfall of any place in California, with over 26 inches of rain falling in a 24-hour period. When intensive rain falls soon after wildfire tremendous amounts of sediment and debris can be entrained and swept into communities at the toes of the mountains, with ramifications to property and human safety. Although riparian species are probably adapted to these fire-flood sequences, the extreme scope of the October 2003 wildfires, and subsequent flooding in December, implies a need for re-assessment of the more critically rare species inhabiting the 2003 fire zone.

Surface water quality is generally good on the southern California Forests. However, State designation of "impaired" waters in 1998 included streams or lakes on all four Forests. Designations in 2002 probably show increased levels of impairment but assessment of State databases is needed to confirm this supposition. Impairment designation can be costly; State-mandated Forest Service trash clean up of impaired sites on the West Fork of the San Gabriel River is estimated by the State to cost $75,000 annually.

Trash is one of several issues associated with water-related recreation on the Forests. Snowmaking for skiing can draw down groundwater levels and locally influence erosion and streamflow timing and magnitude. "Water play", hiking, camping and other recreational activities can lead to de-vegetation, streambank trampling, soil compaction, and general degradation of riparian and aquatic habitat. Often recreation is concentrated at a few sites, thereby limiting management options.

Although preliminary assessment suggests that several National Forest watersheds and associated groundwater basins in southern California are significantly over-drafted, information is not available to confirm that over-drafting on National Forest System (NFS) lands definitely occurs. Because of extensive interactions between surface and groundwater dynamics, groundwater over-drafting affects surface water resources. As an initial step toward determining over-draft status and to better understand the scope of management options, on-Forest water rights databases need to be completed, validated and assessed to help quantify the magnitude of water withdrawal from NFS lands.

Purpose and Use of Assessment

The purpose of this Assessment is to identify National Forest surface water and riparian issues, water quantity and quality conditions, relevant resources at risk, and advise Forest managers on current surface water and riparian conditions and issues. This Assessment focuses on surface water and riparian issues associated with the Angeles, Cleveland, Los Padres and San Bernardino National Forests in southern California within Region 5, and supports Forest Plan revisions and the relevant Environmental Impact Statement. Premises of this Assessment are that—

- Surface water and riparian resource management in the four Forests complies with all federal, state and local standards and regulations, is consistent with USDA Forest Service watershed management policy, and controls and minimizes water pollution impact from land management activities
- The primary use and management of water on NFS lands is for on-Forest riparian resources and secondarily for non-riparian utilization (e.g., campgrounds, special uses).

Introduction and Relevancy

Water originating on national forests in southern California provides cold, clean water used in a variety of ways to support and nourish natural and human communities. This is one of the founding premises of the formation of the Forest Service (FS), the securing and maintenance of reliable sources of water. Some Forests, such as the Angeles, were especially established by local citizens "primarily for the purpose of watershed protection and the improvement of water-flow conditions" (USDA 1941). Forest Service regional policy advocates the assurance of clean water and healthy watersheds from the mountains to the ocean and the protection and enhancement of water resources as a major management goal for all activities conducted on California's national forests (USDA Forest Service 2002).

National Forests in southern California are unique in the combination of their location in an arid climate adjacent to some of the largest and fastest-growing population centers in the United States. Water derived from NFS lands is the local source, the oasis. Limited water supplies have spurred costly and controversial importation of water in this region for over 100 years; 75% of the State's runoff occurs north of Sacramento while 80% of the demand for water is to the south (Mount 1995). Importation is not an "old" condition. Importation issues continue today with examples of recent national controversy over importation of Colorado River water to the San Diego area and de-watering of surface water during the construction of a multi-billion dollar tunnel-viaduct-reservoir system aimed at assuring adequate water supply within the greater Los Angeles basin.

Human Demand for Water

Demand for water in Southern California for municipal, industrial and agricultural uses will not go away. Senator Diane Feinstein, in a keynote speech at a March 2002 "Water

Summit" in San Jose, California, described water shortage as potentially the next big crisis in the State. Demand for water correlates with population and the economic engine of California's economy—an economy that would be the tenth largest in the world as an independent nation (LAEDC 1997, cited in Newlin 1998).

California's population has jumped from 16 million in the 1960s to 34 million today and is expected to be around 50 million by 2020, with half of that increase anticipated for Southern California. Future water needs in Southern California will increase by 30% solely due to population increases. Forty-five percent of the State's population resides in the greater Los Angeles basin on approximately 6% of California's habitable land with 0.06% of the State's streamflow (Davis 1998). The Santa Ana River watershed headwaters in NFS land in the San Bernardino Mountains. The 4.5 million people in this watershed consume twice the naturally available water (Commission on Geosciences, Environment and Resources 1999).

Recent water shortages have beset mountain communities within and immediately adjacent to NFS lands. In July 2002 the town of Wrightwood, near the borders of the Angeles and San Bernardino Forests, was forced to truck in potable water, and not for the first time. Wells, the traditional domestic water source for Wrightwood, "began yielding less than half their capacity" (Victor Valley Daily Press). By July 31, 2002 town officials declared a local state of emergency because of health concerns and insufficient fire hydrant pressure. Water ultimately was trucked into Wrightwood for several months. Water use restrictions in 2002 were also in place at Big Bear Lake and Idyllwild, enclaves within the San Bernardino NF, where a local reservoir had dried up and the water table had declined as early as late April. Although groundwater was the primary water source associated with the summer 2002 shortages, the intimate connection between ground and surface water can link surface water responses to groundwater withdrawals, and consequently influence surface water availability.

Drought is a common factor in southwestern climatic zones, where many areas have wide variations in annual precipitation patterns. A recent example is the 1999-to-2003 "drought" in much of the Los Angeles basin that included the lowest historically recorded precipitation at many sites in 2002. Precipitation records have been kept for over a hundred years in many of these locations. Definitions of drought can be complex, but they generally address at least four types: meteorological/climatic, agricultural, hydrological, and economic (Maidment 1993). All definitions incorporate some measure of decreasing soil moisture, groundwater tables and streamflows. Hydrological drought is measured by the degree of departure from average annual or monthly low flows over an extended period of time, usually months and sometimes years. Where one drought year follows another changes can occur in channel morphology, function, and riparian community. Drought-caused changes can be much like those observed following a dam closure (e.g., riparian communities expanding on to point bars, floodplains and streambanks), and can occur following several years of extended drought (Maidment 1993).

Riparian and Aquatic Ecosystems

Surface water is a controlling factor in the survival of aquatic and riparian-dependent species in southern California. A variety of salamanders, frogs, toads, invertebrates, fish, birds and plants that directly depend upon water are federally listed as Endangered or Threatened, or are proposed or candidate species for these designations. Because of the relatively low scale and scope of development on NFS lands, some of these species exist only in refugia on forestlands. Threats to the habitat and existence of sensitive aquatic and riparian-dependent species include de-watering, water diversion, water pollution, suction dredging (for mining), hydrologic changes—often as excessive or inadequate releases from reservoirs, habitat fragmentation, channelization, fish passage barriers, and a broad spectrum of recreational activities (e.g., water play--especially during critical lifestages like spawning and egg development, dam building, summer use on major rivers) (USDA Forest Service 2004).

Water Quality

Although the majority of the water produced on the four Forests meets or exceeds Federal and State water quality standards, those waters that do not meet State Regional Water Quality Control Board standards (Clean Water Act, Section 303(d)) are designated by the State as “Impaired”. Impairments are alterations in water quality factors typically associated with temperature, sediment and chemicals. In 1998 there were 34 State-designated impaired stream segments, lakes, or reservoirs on or immediately adjacent to the four forests (State of California 2003). These water bodies are usually found in low elevation areas, with associated floodplains, and have easy vehicle access and high public use rates. A stipulation of section 303(d) requires development and implementation of “Total Maximum Daily Loads” (TMDLs) for each impaired water body as a means of reducing pollution, identifying the source(s) of pollution, quantifying the amount of current impairment (above allowable “loads”), and quantifying a required amount of pollution reduction (e.g., reducing sediment input from roads by 70% in X years). TMDLs in place in southern California are costing the FS thousands of dollars annually. New designations of impaired waters in 2002 could add additional demands on FS resources. State-listed 303(d) impaired waters will be considered during site-specific analysis as projects are proposed.

Water Quality is also impacted by the spillage, illegal dumping and the accidental release of chemicals transported through the national forests on public roadways, railroads, pipelines, etc. These situations do not necessarily result in long-term formal impairment designation, but they do require attention and devotion of NFS resources.

Hazards

The steep topography of southern California mountainous areas, combined with a prevalence for recurring wildfire, intense rainstorms, and erodible soils, has produced repeated and massive floods and debris flows. A wildfire-flood cycle in the chaparral lands of the lower and mid-elevation mountains is common. As (sub)urban development has increased over the last several decades, particularly in the Los Angeles basin, more and more people have placed themselves in harms way, at the base of the mountain fronts on alluvial fans and narrow canyons that are the receiving zones of floods and associated debris flows and torrents. Ill-advised activities in the mountains can be deadly, as recently evidenced by fatalities from debris flows in the San Bernardino Mountains on Christmas Day 2003.

Water Resource Policy and Principal Legislation

Surface water resources are managed through federal, state and local laws and regulations. The California Porter-Cologne Water Quality Control Act is a fundamental State law on water quality. It gives ultimate authority over State water rights and water quality policy to the State Water Resources Control Board. Porter-Cologne also establishes nine Regional Water Quality Control Boards (Regional Boards) to oversee water quality on a day-to-day basis at the local/regional level. These Boards oversee a variety of water quality functions in their respective regions, including preparation and periodical updating of Basin Plans, (water quality control plans). Each Basin Plan establishes: 1) beneficial uses of water designated for each water body to be protected; 2) water quality standards, known as water quality objectives, for both surface water and groundwater; and 3) actions necessary to maintain these standards in order to control non-point and point sources of pollution to the State's waters.

Regional Boards

The planning area for the southern California national forests incorporates seven of the nine Regional Boards (Figure 1), although most involvement is with the Central Coast, Lahontan, Los Angeles, Santa Ana and San Diego Boards.

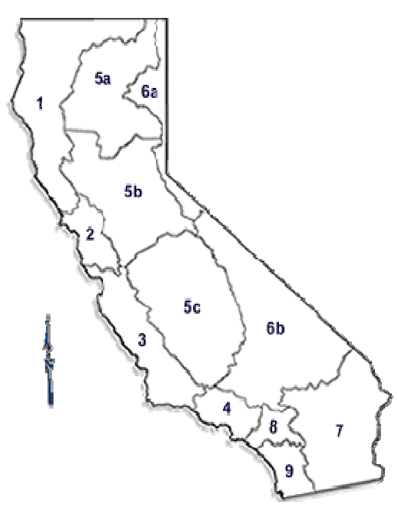


Figure 1. California Regional Water Quality Control Boards (1: North Coast, 2: San Francisco Bay, 3: Central Coast, 4: Los Angeles, 5: Central Valley, 6: Lahontan, 7: Colorado River Basin, 8: Santa Ana 9: San Diego).

The Santa Ana Board’s jurisdiction, for instance, includes much of the Front Country, Mountain Top and San Jacinto areas of the San Bernardino National Forest (Figure 2). The Water Quality section (below) describes the relevancy of the Regional Boards to FS protection of water quality.

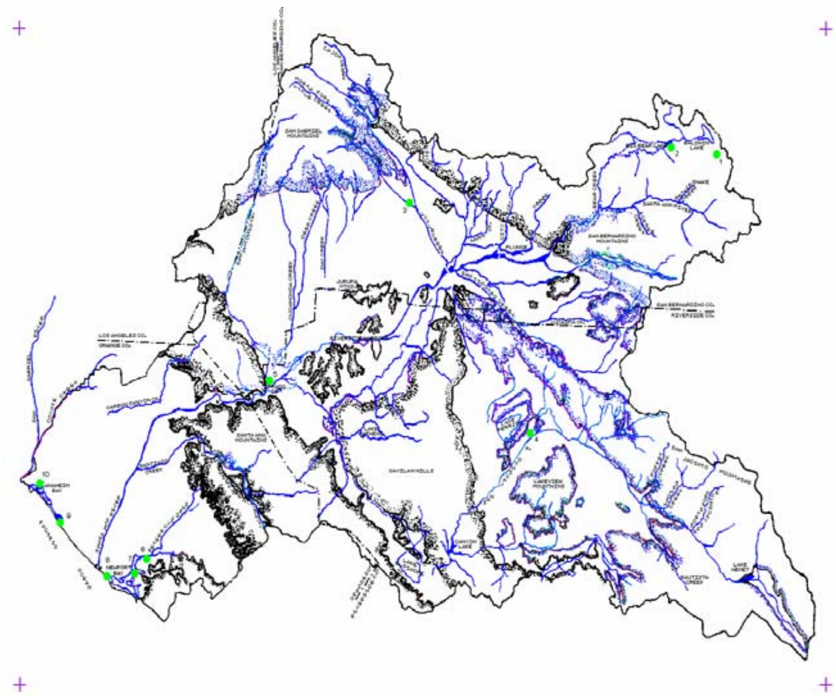


Figure 2. Jurisdiction of the Santa Ana Regional Water Quality Control Board (zoom in to magnify image).

Federal Statutes

A variety of Federal laws provide primary guidance on water resource management.

The *Forest and Rangeland Renewable Resources Planning Act* (RPA)(1974) as amended by the National Forest Management Act (1976), gives direction to "...recognize the fundamental need to protect and, where appropriate, improve the quality of soil, water and air resources."

The *National Forest Management Act* minimum management requirement is to “Conserve soil and water resources and not allow significant or permanent impairment of the productivity of the land”.

The *Organic Administration Act* (1897) recognizes watersheds as systems that have to be managed with care to sustain their hydrologic function. It states that one purpose for establishing national forests is to secure favorable conditions of water flow.

The *Clean Water Act*, a series of Acts from 1948 to 1987, was passed to maintain and restore the chemical, physical, and biological integrity of the nation's waters. It requires compliance with state and federal pollution control measures; no degradation of in-stream water quality needed to support designated uses; control of non-point sources of water pollution through conservation or "best management practices"; federal agency leadership in controlling non-point pollution from managed lands; and rigorous criteria for controlling pollution discharges into waters of the United States.

The *Safe Drinking Water Act* (1976 and associated amendments) requires federal agencies having jurisdiction over any federally owned or maintained public water system to comply with all authorities respecting the provision of safe drinking water. The State of California has primary enforcement responsibility through its drinking water regulations.

Executive Orders 11988 and 11990 direct federal agencies to avoid to the extent possible the impacts associated with the destruction or modification of floodplains and wetlands. Agencies are directed to avoid construction and development in flood plains and wetlands whenever there are any feasible alternatives.

Executive Order 12088 directs federal compliance with pollution control standards.

*36 CFR 32*3 addresses permits for discharges of dredged or fill material into waters of the United States.

The 1998 *Clean Water Action Plan* (CWAP) developed a cooperative approach to watershed protection among federal, state, tribal and local governments. Over 100 actions were assigned to specific federal agencies. Many of these "scale up" assessment of problem areas from localized pollution in segments of water bodies to a larger landscape of watersheds. Restoration is a focus area of CWAP with actions identified to define watershed restoration priorities and action strategies.

Forest Service Regulations

A variety of FS manuals, handbooks, and national or regional supplements provide primary guidance on water resource management.

Water Quality Management for National Forest System Lands in California - Best Management Practices (Sept. 2000) provides standards that must be followed and specifies a range of Best Management Practices (BMPs) to protect water resources during timber management, road and building site construction, mining, recreation, vegetation manipulation, fire suppression and fuels management, and watershed and range management activities.

Forest Service Manual (FSM) 2510 addresses watershed planning.

FSM 2520 offers direction on watershed protection and management, including watershed condition assessment, watershed improvement and monitoring, riparian area management, floodplain management and wetland protection.

FSM 2530 discusses water quality management and *FSM 2540* provides guidance on water uses and development, including water rights and municipal supply watersheds.

Regional Supplements add information on water quality management (R5 Supplement 2500-93-1 to FSM 2530), water uses and developments (R5 Supplement 2500-92-4 to FSM 2540) and riparian area management (R5 Supplement 2500-92-2 to FSM 2526).

Terminology and Definitions

Terminology commonly used in FS management of aquatic and riparian resources is listed below:

Streams:

- Types:
    - *Perennial* - normally flow yearlong, have well-defined channels and often show signs of washing and scour. Perennial streams receive water not only from precipitation, but also from subterranean sources such as springs and seeps. They owe their permanency to the groundwater in the area adjoining the stream being at higher elevation than the streambed.
    - *Intermittent* - generally flow most of the year, but during the dry season may cease to flow because of evapo-transpiration and percolation losses. Intermittent streams may or may not support riparian vegetation. Litter is normally not present in the channels except during the fall of the year, indicating sufficient flow to move debris during the wet season.
    - *Ephemeral* - flow only in direct response to precipitation or melting snow. They are depressions in the ground surface and normally do not develop sufficient water to wash or scour; therefore, forest litter, vegetation or both is usually present in the channel. Ephemeral channels are at all times above the water table.

Lakes, Reservoirs and Ponds:

- Still, non/low flowing, water bodies. Lakes are qualitatively distinguished from ponds by typically being deeper—at higher elevations not freezing to the bottom—that do not have rooted aquatic plants throughout their complete depth.

Springs and Seeps:

- “Points” where subsurface water flows naturally from rock or soil onto the land surface or into stream channels. Seeps are qualitatively distinguished from springs as having lower flows.

Riparian Zone:

- Area around a water body characterized by vegetation dependent on amounts of water greater than surrounding land. The water body itself is included so that water, fish, certain wildlife species, riparian related aesthetics, and riparian related vegetation are incorporated in the riparian zone.

Wetland:
- An area where a water table is at, near, or above the surface or where soils are water-saturated for a sufficient length of time that excess water and resulting low oxygen levels are principal determinants of vegetation and soil development.

Vernal Pool:
- Seasonal depressions covered by shallow water for variable periods from winter to spring, but completely dry for most of the summer and fall. Vernal pools may fill and empty several times during the rainy season.

Tidal Pool:
- A pool of water remaining after a tide has retreated. The Los Padres NF manages coastal tide pools and related features in Monterey County.

Montane Meadow:
- Grass- and herb-dominated vegetation communities within lower and upper montane conifer and mixed hardwood-conifer forests whose size and distribution are generally controlled by local hydrology and soil texture. Montane meadows have shallow depths to groundwater that results in generally poor drainage and saturated soil conditions during the growing season.

Streams are the most common expression of surface water on NFS lands in southern California and the focus of much of this Assessment is on streams and their associated riparian zones. Almost 2,400 miles of streams occur within the Forest Plan Revision planning area, with almost one-half (1,134 miles) on the Los Padres National Forest alone (Stephenson and Calcarone 1999).

Other expressions of surface water, such as lakes and reservoirs, vernal pools, and springs and seeps in particular, are nevertheless important resources, largely because they can harbor populations of rare plant and animal species and can offer otherwise rare recreational opportunities. Lakes and reservoirs occupy over 30,300 acres in the planning area (USDA Forest Service 2004). These are primarily man-made reservoirs formed by dams. The acreage in lakes and reservoirs is small, and in total is barely one-third the area of Lake Tahoe in northern California. Vernal pools form unique habitats especially if they fill and empty several times during the rainy season because only plants and animals that are adapted to this cycle of wetting and drying can survive in vernal pools over time. Springs and seeps occur where water flows to the surface at fractures, joints, fault zones or interfaces of geologic layers of differing permeability to water. Localized (vs. regional) water sources of springs and seeps are aquifers replenished by percolating water. These local springs and seeps can have variable flow quantities contingent upon precipitation. Again, biota associated with the water bodies must be adapted to potentially highly variable water supplies. In some parts of the arid West springs and seeps support Threatened, Endangered and/or Sensitive species (Sada et al. 2001). These biological "hot spots" can be the sole aquatic habitat of some species (e.g., springsnails) in the arid, front country terrain of the San Gabriel and San Bernardino Mountains, and other southern California areas. Basic information about the location, persistence and biota of springs on NFS lands in southern California is unavailable, and no known comprehensive inventories of springs and seeps or vernal pools exist.

Physical Setting and Drivers of Surface Water and Riparian Zone Dynamics

Surface water and riparian zone dynamics in southern California are conditioned by a combination of factors including steep mountain topography that is dominated by chaparral-covered watersheds in the low and mid-elevations, a potential for massive rainfall amounts over short periods of time, recurring wildfires and accompanying floods and debris flows.

Southern California Watersheds

Every drop of rain or "flake" of snow falls onto a watershed. The proverbial raindrop lands on earth, vegetation or a water body and eventually flows downslope across the earth's surface or underground to a creek or small stream, and eventually to the sea. Alternately the drop may evapo-transpire and return to the atmosphere. Depending upon the amount of vegetative cover, precipitation intensity, ground cover, soil type and other factors, the drop may infiltrate the soil or flow overland, potentially eroding soil. The eroded soil may reach a stream or creek channel. Infiltrated water may contribute to land sliding or some other type of mass movement.

The extremely active tectonics of the southern California area results in steep mountain slopes that can control stream location (e.g., the San Gabriel and Big Tujunga River networks) and exacerbate erosive processes. Twentieth-century erosion rates in the San Gabriel Mountains range between 0.9 and 1.6 mm yr^{-1}. These rates are higher than longer-term rates of 0.1 to 1 mm yr^{-1} and compare to locations like the southern Alps of New Zealand where denudation rates exceed 2 mm yr^{-1}. On the scale of thousands of years, shallow landsliding on soil-clad slopes accounts for about one-half of the hillslope erosion, with deep-seated landsliding contributing less than one-third of the total flux. Sediment produced in the San Gabriel Mountains (for instance) does not immediately transport to the base of the range; rather it is stored in smaller headwater channels and moved typically only during infrequent, large storms (Lave and Burbank 2004). However, even with these high rates of down cutting, the San Gabriel Mountains continue to grow steeper and higher with each earthquake.

A watershed is an area of land that catches precipitation that drains or seeps into a marsh, stream, river, lake or groundwater. Watersheds are "nested" so that, for instance, thousands of watersheds of varying sizes reside in the very large Mississippi River watershed that drains one-half of the contiguous area of the United States.

The United States land base is divided and sub-divided into successively smaller watersheds or hydrologic units. The hydrologic units are arranged within each other, from the smallest cataloging units to the largest regions. A unique Hydrologic Unit Code (HUC) consisting of two to eight digit numbers based on several levels of classification in the hydrologic unit system (Seaber et al.1987) identifies each hydrologic unit. The fifth level of classification is the "watershed" unit, which varies in size from 40,000 acres to 250,000 acres. The four southern California Forests include the headwaters for over 100 5th level HUC watersheds (referred to as "watersheds" or "HUCs" throughout the rest of this document) as listed in Table 1 (some of the HUCs include only a small percentage of their land under federal jurisdiction. Table 1 includes all HUCs with even small amounts of FS land. HUCs referenced in the Land Management Plan include those with at least circa 5% of their land under FS jurisdiction). Each 5th level HUC is sub-divided into five to ten 6th level units, each ranging from 10,000 to 40,000 acres in area. Draft 6th level HUCs ("subwatersheds") have been delineated for the four Forests, and the goal for fiscal year 2004 is delineation of smaller 7th and 8th level HUCs that will be the focus of project-level planning and analysis. The 5th level HUCs are the geographical basis for many planning scale decisions on national forests in southern California.

The condition of HUCs has been assessed and several in southern California have been identified as "priority" watersheds. Their "priority" status is determined by each forest to systematically allocate watershed improvement funds. The forests intend to concentrate their watershed improvement efforts in priority watersheds. Watersheds assigned the highest priority are normally those considered to be in relatively good condition with high valued riparian or aquatic ecosystems. Watershed condition, on the other hand, is an appraisal of general watershed health; based in considerations of the degree and recent nature of activities like mining, ski area development, wildland fires, active land sliding, road construction, type and density.

Watershed priority changes through time as watersheds naturally recover from events like wildland fire and earthquakes and new events over take management. And watershed improvement projects decommission roads; improve stream crossings, reduce management-caused surface erosion, etc. The goal is to use these limited resources of the forest's watershed improvement programs to maintain the highest valued watersheds. Table 1 identifies priority watersheds and their associated Place names.

Precipitation

Precipitation is a primary driver of stream flow, and precipitation varies both spatially and temporally in southern California. In southern California, the regional topography, proximity to the Pacific Ocean and the semi-permanent eastern Pacific high-pressure cell are dominant climatic factors. The climate is "Mediterranean"; summers are warm and dry and most rain occurs in winter, although the southerly monsoon in summer produces thunderstorms, particularly over the mountains in the southern portion of southern

California (Fujioka et al. 1999). Most of the precipitation falls as rain although in the higher elevations of the Transverse Ranges snow accounts for up to 80% of the annual precipitation (Minnich 1986, 1989).

The spatial distribution of precipitation in southern California correlates with topography. In the San Bernardino Mountains, 35-40” of precipitation falls in an average year, whereas adjacent lowland areas in the Los Angeles basin receive on average 16”. Similarly, Coast Range locations in the Los Padres National Forest receive over 60” of precipitation annually, but locations immediately leeward receive less than one-half that amount. The annual averages themselves are highly variable from year to year; above-average precipitation occurs in El Niño years, with lower precipitation associated with La Niña events (Fujioka et al. 1999).

Superimposed on these annual spatial variations in precipitation are short-term extremes that can instigate floods and debris flows, and can contribute to landslides. Although even some of the major river systems in southern California almost dry up in summer, massive precipitation amounts can occur in the mountains over short time periods (Lave and Burbank 2004). The San Gabriel Mountains have been described as having “… some of the most concentrated rainfall in the history of the United States” with one inch of rain falling in one minute in 1926 and more water falling in nine days in 1969 than typically falls in New York City in a year (Strong 2002). Five of the 10 greatest recorded daily rainfalls in California occurred in Los Angeles County, with four of those on January 22, 1943, when over 26 inches of rain fell at Hoegees Camp on the Angeles National Forest (the Hoegees Camp record is the seventh highest daily state total in the United States). Another three of the top 10 daily rainfalls in California were on the San Bernardino National Forest, with two of these on January 25, 1969. Seventy-two percent of California’s top 53 greatest daily rainfalls occurred in southern California, and the San Gabriel and San Bernardino Mountains have the greatest concentration of 10+” daily rainfalls in California (Figure 3) (State of California 1997).

Water from these extreme events has to go somewhere. With shallow soils common to the steep fronts of many of the mountain ranges in southern California, relatively little water infiltrates, and instead rapidly runs off. Berg (2002) for instance, described Deer Creek, and other streams at the base of the San Gabriels, as “likely candidates for major flooding” from the combination of “torrential rainfall, seismically shattered rock and forest fires”.

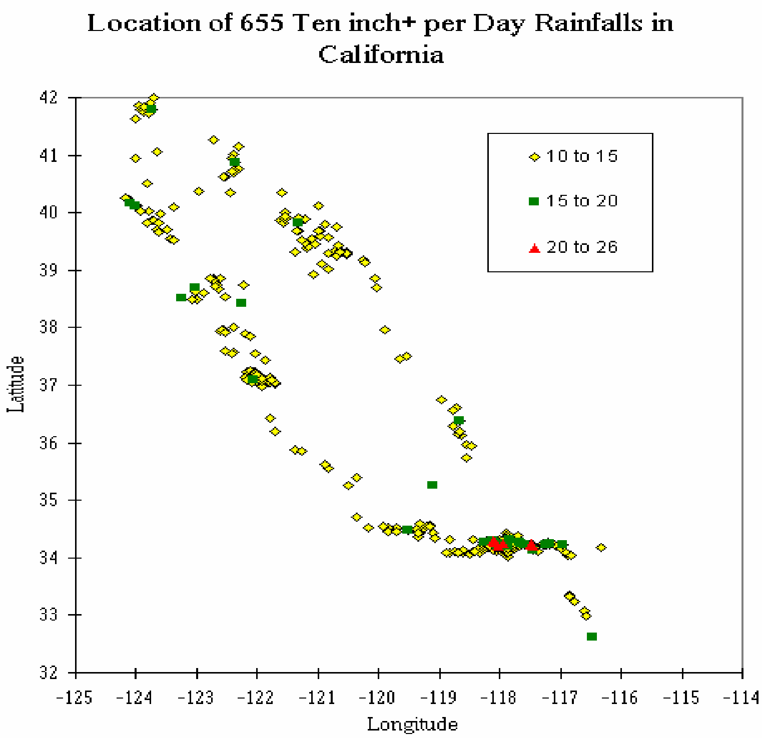


Figure 3. Recorded daily precipitation of ten or more inches, 1871-1998 (Goodridge 1998). The horizontal band of points at 34 degrees latitude is the southern California Transverse Range, including the San Gabriel and San Bernardino Mountains.

Streamflow Regime

Most streams in southern California are dry or have very low flow during summer months. Groundwater recharge in deep pools in streams flowing through bedrock canyons can result in the unusual phenomenon of summer flows at mid-elevations with no flow at higher or lower elevations (Faber et al. 1989, cited in Stephenson and Calcarone 1999). Lower elevation stream reaches, in both private inholdings and on NFS lands, are likely to be diverted or altered. Stephenson and Calcarone (1999) advocated that special attention be paid to hydrologically-intact low-elevation stream systems on public lands as potential locations where historic disturbance regimes and a natural range of variability may be possible to maintain. Many of the important low-elevation stream systems identified by Stephenson and Calcarone (1999) are also “priority” watersheds identified by forest staff (see Watershed section above).

Estimated annual water yields for each hydrologic unit on the southern California forests are given in Table 1. These estimates were calculated by identifying all available USGS stream gage data (USGS 2003), and deleting data from gages that either drained small areas, had appreciable upstream regulation or diversion or whose records were shorter than 10 years duration. The remaining gages were compared spatially and weighted for their representativeness within each HUC and Forest portion of each HUC. Estimates were calculated as weighted mean, median and “drought” flows.

On a unit (per square mile) basis, mean annual flows range from over 2.16 cubic feet/second/sq mile on west-facing coast range watersheds on the Los Padres NF to “desert” watersheds on the Angeles, San Bernardino and Cleveland Forests at about 0.02 cfs/sq mile. These mean annual values compare with flows of 3 to 5 cfs/sq mile, 0.5 to 1 cfs/sq mile, and 0.02 cfs/sq mile for selected watersheds on the California north coast, the central Sierra Nevada and the Mojave Desert, respectively, of sizes similar to those on southern California forests (USGS 2003). From another perspective, rates for individual events or seasonal flows are much higher all across the State. In basins less than 39 square miles in area in the Sierra Nevada Kattelmann (1996) listed maximum discharges during snowmelt ranging from 18 to 73 cfs/sq mile on the western slope and 9 to 18 cfs/sq mile on the eastern slope. Flood flows are often appreciably greater. For instance, many gages recorded peak flood flows on February 23, 1998 in the Cuyama River basin adjacent to the Los Padres Forest between 25 and 120 cfs/sq mile (USGS 2001), and Clapp (1936) listed the January 1, 1934 Los Angeles flood flow at 50 cfs/sq mile.

Flow rates on the four southern California forests follow a similar distribution to flows elsewhere in that the mean values are influenced by a few large values (floods) that shift the means to appreciably greater values than the median flows (Figures 4 and 5). For example, the maximum recorded flows at “dry”, “wet” and “moderately-wet” sites across southern California are typically seven to eight times the mean flows (Figure 6).

Flow rates differ spatially both between and within the Forests. Figures 4 and 5 compare flows between the Forests for solely Forest lands (Figure 5) and the 5th level HUCs. The HUCs typically have their headwaters on NFS land but may extend downslope beyond the Forest boundaries. Both “Forest” and “HUC” flow rates show similar patterns between Forests, with rates decreasing southward for mean, median and 10th percentile flows (the 10th percentile values are flows that would be exceed approximately 90% of the time; hence the 10th percentile flows can be considered dry year values). Forest rates are generally slightly higher than HUC rates but the ratios of mean:median:10th percentile flows remain relatively constant (e.g., the mean HUC rates are 5.2 to 5.7 times the 10th percentile rates for all four Forests). Forest rates on the Angeles and San Bernardino Forests are approximately equal (Figure 5) in contrast to higher HUC flow rates for the Angeles (Figure 4). Water yield values (as annual acre-feet of surface runoff) follow patterns similar to the flow rates (Figures 7 and 8) although yields on the LP are proportionally greater (e.g., mean yield on the Los Padres is about twice the yield for the Angeles, the forest with the next largest yield), and both HUC and forest yields are similar for the Angeles and San Bernardino Forests.

To assess spatial differences in flow within the Forests, the HUCs were subjectively categorized by location with respect to precipitation, a primary determinant of surface flow. HUCs were classified as windward or west, central, and leeward or east, with the anticipation that surface flows would diminish moving from windward to leeward (west to east). This working hypothesis was generally supported by the data; both mean and 10th percentile flows were higher in HUCs located on the windward or west side of each Forest (Figures 9 and 10). This effect was most pronounced on the Los Padres for drought flows, with the windward flows approximately four times the leeward flows (Figure 10).

Wildfire and Flood Cycles

The specific mix of climate and weather, vegetation, and topography and soils in many areas of southern California prompt cycles of wildfire followed by flooding and related debris flows and landslides. If high intensity rain falls soon after wildfires, tremendous resource damage can occur from floods, debris flows and landslides. Because development is extending up the lower bases of the mountain fronts and narrow canyons, where floods and debris flows concentrate, extensive damage, estimated for instance at $1.34 billion with a cost of 11 lives from flooding in 1995 (FEMA 2003), has become common.

Chaparral

Chaparral, a common plant community particularly in the low-to-mid elevation range of mountains of southern California, appears to require fire to trigger regeneration (Ainsworth and Doss 1995). More than simply requiring fire, chaparral species foster fire by having flammable volatile oils, periodical dieback of vegetation (creating fuel), and large surface-to-volume ratios (Barbour et al. 1980, cited in Ainsworth and Doss 1995). Fire adaptation by chaparral species includes fire-induced flowering, bud production and sprouting, incorporation of thick basal bark allowing enough vegetation to survive for post-fire crown sprouting, and production of large quantities of seed that lay dormant until germinated by fire (Barbour et al. 1980, cited in Ainsworth and Doss 1995).

The post-fire successional process may require only 10 years for coastal sage scrub. Herbs that grow immediately after a fire begin to die out after a couple of years as other plants shadow out the herbs, and toxins, released by some chaparral species, take their toll on the herbs. The nitrogen-fixing herbs actually improve conditions for chaparral species. Four to 10 years after the fire, chaparral dominates the landscape and develops conditions favorable to fire (e.g., flammable volatile oils, die-back) to repeat the cycle (Ainsworth and Doss 1995).

Climate and Weather

Two components of southern California climate and weather foster fire-flood cycling: Santa Ana winds and heavy precipitation. Large, long-lived, high pressure air masses centered over the interior west often trigger Santa Ana winds—hot, dry, high-speed winds moving from the desert interior toward the coast—that elevate the potential for wildfire. Santa Anas are particularly relevant when they occur in late summer or autumn. At this time of the year soils and vegetation are as dry as they get and the severity of wildfire is typically heightened. There is also little time for vegetation growth between any later-summer or autumn wildfire before winter rains. The vegetation anchors and stabilizes soil; without it erosion, floods, and debris flows are exacerbated. The “worse case scenario” occurs with the coincidence of wildfire and Santa Ana winds occurring prior to extreme rainfall events (e.g., 10+" in a 24-hr period) on steep, hydrophobic soils. The resulting "firestorms" can create their own weather conditions and fire intensities that may be too intense to control until fuels are consumed, weather conditions change, or the fire reaches the ocean (Ainsworth and Doss 1995). Massive debris flows and flooding can occur in these conditions.

Topography and Soils

Much of southern California is characterized by steeply-sloping mountains separating flat lowlands. This condition is probably epitomized by the San Gabriel and San Bernardino Mountains bordering the greater Los Angeles basin where slopes can range to 70 degrees in steepness (Radtke 1983). These mountain slopes commonly exceed the angle of repose, the slope at which surface soil can be expected to resist excess erosion. These slopes are steep enough to cause movement of detached surface materials downslope by gravity alone, as dry ravel; water and wind erosion isn't needed. The slopes are so steep because of active tectonics that elevate the mountains at a relatively rapid rate, a rate faster than erosional processes are bringing down the mountains. The steepness also accelerates surface flow velocities so that the travel time of water is shorter than in most other areas. This quick travel time concentrates high flow volumes over a short period of time, thereby exaggerating flood peaks. Erosion rates also increase exponentially (not linearly) with flow velocity; the faster water moves over a surface the more energy it has and the more sediment and debris it can carry.

Chaparral binds soil to the steep slopes but post-fire, "top-killed" chaparral does not hold soil nearly as well, and erosion through dry ravel is accelerated. Top kill also exposes the underlying surface soils to increased raindrop splash erosion, an important steep slope soil transport phenomena where soil particles are ejected into the air by raindrop impact and generally travel in a downslope direction. Dry ravel, the gravity-induced downslope movement of surface geologic materials, accounts for at least one-half of all hillslope erosion in some southern California locations—exceeding wet season erosion. Over one-quarter of the watersheds in San Bernardino, Santa Barbara, and Los Angeles Counties are influenced by dry ravel (Rice 1973).

Post-fire erosion is enhanced where hydrophobic soils form. Vaporization of oils, resins and waxy fats in plants during wildfire re-condense in the top inch or two of soil to form a non-wettable soil layer. The condensation occurs because the soil is a good insulator; temperatures an inch or two below the surface remain relatively cool, allowing condensation. The hydrophobic layer is impermeable; it prevents water infiltration through it and slow evaporation in the root zone (Ainsworth and Doss 1995). Hydrophobicity varies with soil type; sandy and sandy loam soils are typically more likely to be hydrophobic than clays (DeBano 1991).

Floods

When "worse-case" conditions occur, post-fire stream flows can be extreme, although first year post-wildfire water yields can vary appreciably both within and between locations as a function of fire severity, geology, soils, topography and proportion of vegetation burned (Robichaud et al. 2000). Increased surface runoff flows decline through time as herbaceous and woody vegetation re-colonize burned landscapes. The recovery period similarly varies with climate, soils, topography, etc. and can range from a few years to decades. Both total water yields and instantaneous peak flows can increase drastically immediately after wildfire, with the latter potentially causing downstream floods and damage to property and human life. Anderson et al. (1976) described peak flow increases up to 2,282 percent for California chaparral. These increases compare to "common", post-fire peak flow increases of 500 to 9,600 percent in chaparral in Arizona, with much lower increases in the conifer zone of the Pacific Northwest (Robichaud et al. 2000). Burned watersheds also generally produce surface flow more quickly from rainfall than unburned catchments (Anderson et al. 1976).

Erosion, Sedimentation, Debris Flows and Landslides

Erosion. Post-fire erosion in chaparral catchments is typically greater than in unburned areas. The accelerated erosion can occur both during the dry and wet seasons. From plot studies at the San Dimas Experimental Watershed in the San Gabriel Mountains, Wohlgemuth (in press) stated that first-year post-wildfire dry season erosion was 2-3 times greater and post-fire wet season erosion was 10-17 times greater than unburned levels. In a grass watershed, post-fire dry season erosion was 9 times greater and post-fire wet season erosion was 375 times greater than comparable unburned values. Other research suggests that accelerated post-wildfire erosion rates may persist for 8-10 years and be 9 to 10 times greater during the first years than pre-burn levels (Ainsworth and Doss 1995). Still other studies (Krammes 1965, Beyers et al. 1998) documented post-wildfire dry ravel erosion from 10-100 times baseline dry-season erosion, with rates returning to baseline levels 2 to 4 years after fire. And Lave and Burbank (2004) believe that anthropogenic fires have accelerated the rate of erosion up to fourfold within small, steep catchments adjacent to populous areas. This abundance of eroded material is the food for debris flows.

In a replicated plot study of wet- and dry-season erosion in mature Southern California chaparral, Beyers et al. (1998) measured hillslope erosion before and after a "hot" prescribed burn. Post-fire erosion rates were monitored for up to 5 years to quantify both fire effects and ryegrass post-burn seeding treatment on sediment movement. Dry ravel erosion during the first post-fire season was 10 to 100 times greater than baseline dry-season dry ravel. (In earlier research, Krammes (1960, cited in Robichaud et al. 2000) determined that up to 90 percent of total first-year post-fire sediment movement could occur as dry ravel before the first germination-stimulating rains occur.) Erosion rates during the first post-fire wet season ranged from slightly less than baseline to over 1,000 times greater. Erosion rates during the following (2^{nd}) dry season were typically less than three fold greater than baseline. Post-burn erosion rates at all sites decreased over time, reaching or dropping below baseline by 2 to 4 years after the prescribed fire, similar to that monitored at the San Dimas Experimental Forest (Wells 1981, cited in Beyers et al. 1998).

Landslides. Landslides are a type of mass movement that can be deep-seated or shallow. Deep-seated landslides occur in a zone below the maximum rooting depth of forest trees and shrubs, to depths of tens to hundreds of feet. The frequency and magnitude of deep-seated slides in southern California is incompletely known. However, a case study in the San Gabriel Mountains identified size and frequency of slides from aerial photos taken in 1928, 1938, 1954 and 1973 as follows (Lave and Burbank 2004):

Aerial Photo Date	**Cumulative Slide Volume (km^2)**	**Number of Slides**
1928	177	60
1938	100	267
1954	1265	815
1973	495	219

The erosion rate from the San Gabriel Mountains slides averaged 0.08 mm yr^{-1} during the twentieth century, but varied considerably within the mountain range—from 0.20 mm yr^{-1} in the Mt. Baldy and Cucamonga sub-blocks of the San Gabriel Mountains to 0.02 mm yr^{-1} in the Western San Gabriel sub-block. Inclusion of larger slides that occurred prior to the 20th century elevate the average erosion rates to 0.28 mm yr^{-1}, with variation from 0.10 to 0.55 mm yr^{-1} among the sub-blocks (Lave and Burbank 2004).

Shallow landslides and soil slips in the San Gabriels are not related to bedrock lithology but rather are slope-dependent and inversely related to the density and size of vegetation (Rice et al. 1969, cited in Lave and Burbank 2004). Erosion from these mass movements is greater than from deep-seated landslides, with basin-wide averages estimated at 2.2, 0.4 and 19 mm for 1965-1966, 1966-1967 and 1968-1969 respectively (Lave and Burbank 2004).

Lave and Burbank (2004) concluded that prior to anthropogenic disturbance, surface and shallow erosion processes were dominant (at least twice as much) relative to deep-seated landsliding. In the 20th century, deep-seated slides contribute approximately one order of magnitude less sediment than sediment captured in debris basins, with shallow slides/soil slips and surface erosion accounting for the bulk of the sediment.

The slope of about one-quarter of the chaparral watersheds in the greater Los Angeles basin exceed the angle of repose, the maximum slope that a particular soil or other earth material assume through natural processes (Radtke 1983). On vegetated slopes anchored by deep-rooted plants the angles of repose can be much steeper. Specific factors that can cause or contribute to landslides are; 1) weakness of the slope material; 2) steep or undermined slopes; 3) unfavorable geologic structural conditions; 4) prolonged precipitation; 5) absence or scarcity of vegetative cover; and 6) ground shaking (Gray 1985). Landslide occurrences in the chaparral landscape are strongly related to the angle of repose for different soils, taking into account cover, root depth, and root strength. Soils slips and landslides account for almost 50% of the total erosion in a watershed (Radtke 1983). Unlike dry creep, these soil mass movements normally occur when the soil is saturated. Although hydrophobic soils, dry ravel and formation of rills and the debris flows associated with these processes account for the majority of post fire erosion, landsliding activity may also increase as a result of fire.

Increases in landslides during the rainy period following a fire could be caused by well-spaced storms that permeate the non-wettable layer and completely recharge the water holding capacity of the soil (Radtke 1983). Once the soil moisture is recharged, a high intensity storm could quickly supersaturate the soil, thereby accelerating wet creep, starting slumps and slides, and greatly increasing overland flow (Radtke 1983). However, post fire landsliding during the first few years following a fire may be greatly reduced on non-wettable soils if high intensity storms follow each other in close order, thereby reducing rainfall penetration through the non-wettable layer. The soil below the non-wettable layer would remain dry, eliminating landslides, but greatly increased overland flow would result in highly visible rill and gully erosion and would increase channel scour (Radtke 1983).

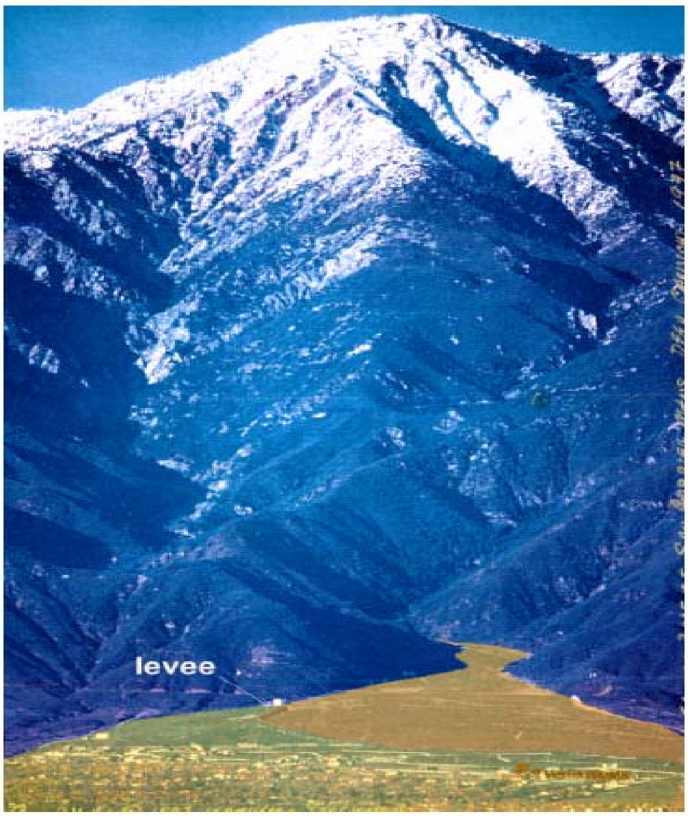
Another possible contributing factor to increased landsliding in the post fire environment is stream channel scour and erosion. This process may remove or over-steepen channel banks and contribute to landsliding of over-steepened slopes along the creek channel, or reactivate previous landslides by removing the toe of the slide (Ainsworth and Doss 1995).

Debris Flows. Debris flows, the torrential, viscous movement of materials ranging from fine sediment, to logs and massive boulders, can occur in flood flows with or without wildfire, although debris flows are exacerbated by wildfire in that the binding influence of vegetation on earth materials is reduced after fire, and consequently more material typically is entrainable post-burn than without fire.

Debris flows can have massive destructive power. They can occur with little warning, on slopes with gradients as low as 5%, and can exert great loads on objects in their paths. Even small debris flows can strip vegetation, block drainages, damage structures, and endanger human life (BAER 2003). These flows deposit miles-wide alluvial fans emanating from canyons at the base of mountain fronts. In the urban/forest interface, unfortunately, these fans continue to be developed with residential housing. A traditional approach to dealing with debris flows on the alluvial fans is construction of debris basins, large excavated areas cut into the fans and braced by low dams (Berg 2002). The clear water, drawn off from the debris basin, is directed away in efficient concrete channels and pipes usually rejoining its parent drainage at a lower gradient and elevation. Los Angeles County alone has 115 debris basins (Lave and Burbank 2004).

The post-fire floods may not simply be the mass of water commonly envisioned as a "flood". Rather the flows "bulk up" and contain tremendous amounts of debris that ranges in size from fine sediment to house-sized boulders. Davis (1977, cited in Ainsworth and Doss 1995) determined that post-fire flows bulked up to 40 to 60% by volume compared to normal flow bulking percentages of 0.5 to 2.5. Los Angeles County Flood Control staff measured post fire sedimentation rates from debris flows of 120,000 cubic yards per square mile (Los Angeles County 1993).

The vast bulk of debris entrained in southern California debris flows stem from a small number of discrete events (US Army 2000). For instance, for the 1978-1979 water year (10/1/78 to 9/30/79) over 99% of the volume of suspended sediment was recorded in San Diego Creek (Orange County) during less than 8% of the time, with over one-half of the sediment produced from one 2-day event (US Army 2000). Similarly, over 60% of the annual suspended sediment load from the Santa Clara River (Ventura County) in water year 1978-1979 was also produced during one 2-day period. The percentage yields may be even greater in wetter years. Over 80% of the annual volume of suspended sediment from San Diego Creek was produced from a single storm event in the 1979-1980 season. The significance of short-duration events as producers of suspended sediment may be greater in smaller watersheds than larger ones (US Army 2000).



Deer Creek, the San Gabriel Mountains and Rancho Cucamonga. The alluvial plain leading from the mouth of the creek, and covering the entire bottom of the photograph, built up from eons of sediment-laden flooding and debris flows. Development in the immediate foreground is within the sediment accumulation zone (Berg 2002).

2003 Wildfires

The Grand Prix/Old wildfire in October 2003 scorched 380,000 acres of the San Gabriel (Angeles National Forest) and western San Bernardino (San Bernardino National Forest) Mountains. Much of the burned topography included very steep, front country watersheds, with 60% to 80% mapped as high or moderate burn severity. About one-half of the burned area in chaparral and grass was hydrophobic; less, about 30% of the desert shrub and hardwood/conifer burn was hydrophobic (BAER 2003).

Debris Flows. Statistical modeling at the watershed scale identified numerous watersheds at risk of future debris flows in the burned area (Cannon et al. 2003). Independent variables included watershed gradient, burn severity, soil properties and precipitation from almost 400 watersheds. Specifically, the probability of debris flow occurrence, for a rainfall of given intensity, was calculated from the--

- Percent of the area burned in each basin at both high and moderate severity
- Measure of sorting of the grain-size distribution of the burned soil
- Percent of soil organic matter (by weight)
- Soil permeability
- Soil drainage
- Percent of the basin with slopes greater than or equal to 30% (Cannon et al. 2003).

Results of the modeling suggested that several watersheds with high burn severity, steep slopes and an accumulation of debris in their channels have a high probability of debris flow occurrence. Specifically, probability of occurrence is a function of rainfall intensity, with 21 of 119 watershed evaluated anticipated to have probabilities greater than 67% of a debris flow occurring in response to a 25-year, one-hour storm (of 1.12 inches). Another 67 watersheds have 33% probability of debris flow occurrence for the 25-year/one-hour storm. These total to almost three-quarters of the watersheds evaluated. Debris flow probability decreases for the more common storm events. At the 2-year, 1-hour storm magnitude of 0.52 inches, no watersheds were predicted to have debris flow potential at the 67% probability level although many basins were predicted to experience debris flows at probabilities greater than 33% (BAER 2003).

The greatest risk is in small watersheds (less then 250 acres) during the earliest post fire recovery period; the risk tends to diminish as the rainy season progresses. Potential debris flow occurrence over the longer term (3 to 5 years) will largely depend on the vegetation recovery. Watersheds and slopes with chaparral type vegetation can be expected to recover in a few years while watersheds and slopes with conifer vegetation may recover after 13 years (BAER 2003).

In late December 2003, debris flows killed 14 individuals at two locations in the San Bernardino Mountains, near Devore and in Waterman Canyon. Waterman Canyon was predicted to have one of the higher risks of debris flows and St. Sophia Camp, where several lives were lost, has a tributary of Waterman Creek running through structures comprising the Camp.

Streamflow. Estimated post-fire flow increases were calculated for three scenarios, 2-, 10- and 25-year post-fire first-year return interval flows, for 42 6th field HUCs (a smaller watershed than 5th field HUCs referred to in much of this document). The estimated flows were based on information and methods developed by Rowe et al. (1949). The estimated mean post-fire flow increases were 2.0, 1.6 and 1.4 times the pre-fire discharges for the 2-, 10- and 25-year events respectively. For individual 6th field

HUCs the estimated maximum increases were 2.7, 2.6 and 2.3 times the pre-fire discharges. For all three return periods, City Creek, in the central San Bernardino Mountains, had the largest estimated flow increases. Coincidentally, City Creek is the only locality on the San Bernardino Forest with a known population of endangered Mountain Yellow-legged frog.

Riparian Zones

Riparian areas contain aquatic and terrestrial ecosystems adjacent to perennial, intermittent and ephemeral streams, meadows, lakes, reservoirs, ponds, wetlands, vernal pools, seeps, springs and other water bodies. Riparian zones link hillslope and aquatic processes and provide habitat and migration corridors for a variety of southern California rare, endangered, threatened and sensitive plants and animals. In many situations the southern California Forests provide refugia riparian habitat that elsewhere has been degraded or destroyed. Riparian areas are magnets for recreationists as well as biota. Land management activities in Forest riparian areas have a great potential to disrupt ecosystem processes and interactions and to produce adverse effects.

Besides providing habitat for sensitive species, riparian areas perform a variety of other functions. For instance, streambanks and near-channel hillslope areas are recruitment zones for woody debris that falls into channels and provides cover for fish and acts as a functional component of channel morphology. Riparian zones may be narrow in bedrock-controlled, steeper sections of tributary channels, but on lower-gradient reaches where sediment deposition occurs as stream energy reduces, floodplains develop. These low-gradient riparian zones are susceptible to erosion and as such are focal points for restoration and stream management (D'Emden 2002). A vital function of riparian zones is the filtering of sediment and chemicals (e.g., nutrients and pesticides) coming from upslope. Many management strategies call for retention of riparian zones at least partially on the basis of filtering benefits. Riparian vegetation cools stream water and riparian zones in general are areas of high microclimatic gradients; relative humidity, air and soil temperature variations are measured in tens of feet in riparian zones rather than hundreds of feet elsewhere. These gradients—based on macroclimate, topographic features and regional location—are potentially important critical habitat determinants. In combination, factors affecting riparian zones, including geology, climate, soil, vegetation, flow regimes and human activity can produce rapidly changing riparian habitat conditions (Platts et al. 1987).

The EIS and Plans provide riparian area protection through Forest Plan standards including the use of a Five-Step Screening Process (Standard No. 39) that delineates Riparian Conservation Areas (RCA) for special management. Specific management considerations within RCAs are described in a Handbook Supplement (No. 1, 2509.22) that delineates stream protection measures.

Riparian-dependent resources include soil and water quality, and a variety of plant and animal species owing their existence to riparian zones. Sensitive biota specific to riparian areas in the four southern California Forests are discussed below.

Plants

Six rare, endangered, threatened or sensitive plant species exist across a range of elevations on the Forests. Another eleven rare plant species are confined to lower elevations. *Boykinia rotundifolia* (round-leaved boykinia), *Hemizonia mohavensis* (Mojave tarplant), *Lilium humboldtii* ssp. *oscellatum* (ocellated Humboldt lily), *Muhlenbergia californica* (California muhly), *Scutellaria bolanderi* spp. *austromontana* (southern skullcap), and *Thelypteris puberula* var. *sonorensis* (Sonoran maiden fern) occupy riparian areas in lower and upper montane conifer habitat, chapparal canyons, seeps, big-leaf maple in mixed evergreen forests, coastal sage scrub, and lower montane coniferous forests at varying elevations. The long-term trends of populations of these species are largely unknown (Stephenson and Calcarone 1999) but their largely refugia status on southern California Forests makes their management on the Forests important.

Rare plants found in low-elevation riparian habitats include *Artemisia palmeri* (San Diego sagewort), *Astragalus deanei* (Dean's milk-vetch), *Cirsium loncholepis* (La Graciosa thistle), *Dodecahema leptoceras* (slender-horned spineflower), *Dudleya densiflora* (San Gabriel Mountains dudleya), *Eriastrum densifolium* ssp. *sanctorum* (Santa Ana River woolystar), *Ericameria palmeri* ssp. *palmeri* (Palmer's goldenbush), *Hemizonia floribunda* (Tecate tarplant), *Hemizonia pungens* ssp. *laevis* (smooth tarplant), *Pedicularis dudleyi* (Dudley's lousewort) and *Rorippa gambellii* (Gambel's water cress). These plants are found in riparian zones in coastal sage, sandy washes, back dunes, sandy stream terraces, alluvial fans and benches, serpentine chaparral, and cliffs, rock crevices and step canyon walls. These plant populations are generally trending downward (Stephenson and Calcarone 1999), and similar to the higher-elevation species, their largely refugia status on southern California Forests makes their management on the Forests important.

Almost 40 rare, or potentially at-risk, fish, amphibians, reptiles, birds, mammals and invertebrates exist in or adjacent to southern California Forests. These animals are found in aquatic, riparian or aquatic/upland habitats.

Fish

Rare fish include *Lampetra tridentata* (Pacific lamprey), *Oncorhynchus mykiss* (Southern steelhead), *Gila bicolor mohavensis* (Mojave tui chub), *Gila orcutti* (Arroyo chub), *Rhinichthys osculus* (Santa Ana speckled dace), *Catostomus santaanae* (Santa Ana sucker), *Gasterosteus aculeatus williamsoni* (Unarmored threespine stickleback), *Gasterosteus aculeatus microcephalus* (Partially armored threespine stickleback) and *Eucyclogobius newberryi* (Tidewater goby). The vulnerability of these species on NFS lands ranges from moderate to high (Stephenson and Calcarone 1999).

Of these fish, steelhead have probably garnered the most attention. Their decline in central and southern coastal California results from in-stream water developments causing inadequate flows, flow fluctuations, de-watering and blockages of parts of streams and rivers (NMFS 1997a, cited in Stephene and Calcarone 1999). Impassable barriers separate spawning and rearing sites on upper-elevation NFS lands from the ocean. Efforts are underway to remove some of the barriers (e.g., in the Matillija Creek drainage).

Amphibians and Reptiles

Six rare amphibians and three rare reptiles use water and upland habitats near water courses in the mountains of southern California. *Taricha torosa torosa* (Coast Range newt), occur along low-elevation, coastal streams on the Los Padres Forest, and in more inland areas on the other Forests. *Spea [Scaphiopus] hammondii* (Western spadefoot toad) occur on the Cleveland, San Bernardino and Los Padres Forests and potentially on the Angeles Forest (Stephenson and Calcarone 1999). These toads are typically found below 3,000 ft elevation in relatively flat or low-gradient topography supporting shallow ephemeral pools. *Bufo californicus* (Arroyo southwestern toad) are found on all four Forests although they are more common on the Cleveland and Los Padres Forests (Stephenson and Calcarone 1999). Threats to Arroyo toads include adverse flow fluctuations from dam releases, predatory, non-native species (e.g., bull frogs), warm-water fish that feed on toad larvae, and introduced plants that form dense masses that both reduce available surface water and modify habitat by stabilizing stream terraces (and deepening flood channels) (Stephenson and Calcarone 1999). *Rana aurora draytonii* (California red-legged frog) are now extirpated from the Cleveland and San Bernardino Forests although several dozen populations exist, mostly in low-elevation streams, on the Los Padres Forest in areas characterized by dense, shrubby riparian vegetation. *Rana boylii* (Foothill yellow-legged frog) now are known to occur on southern California Forests only in coastal drainages along the southern Monterey coast. *Rana muscosa* (Mountain yellow-legged frog) are found in the San Gabriel, San Bernardino, and San Jacinto Mountains and potentially Palomar Mountain. This frog species may have been extirpated from 99 percent of its historic southern California range (Jennings and Hayes 1994, cited in Stephenson and Calcarone 1999).

Clemmys marmorata pallida (Southwestern pond turtle) are relatively abundant, particularly north of the Santa Clara River on the Los Padres Forest, typically below 4,000 ft elevation where persistent deep pools exist. Two rare snakes, *Thamnophis sirtalis* spp. (South coast red-sided garter snake) and *Thamnophis hammondii* (Two-striped garter snake), occur—or may occur—on southern California Forest lands. The Two-striped garter definitely inhabits Forest streams up to 7,000 ft elevation in the San Jacinto Mountains. The more reclusive South coast red-sided garter had not recently been sighted on NFS lands although it may occupy marshy, perennial water sites along low-elevation streams on any or all of the four Forests (Jennings and Hayes 1994, cited in Stephenson and Calcarone 1999). The vulnerability of all of these rare amphibians and reptiles is considered moderate or high.

Birds

V*ireo bellii pusillus* (Least Bell's vireo) and *Empidonax traillii extimus* (Southwestern willow flycatcher) are both formally designated as endangered species. Inventory and monitoring activities for these species are underway on the relevant Forests. The flycatcher is the more rare of these two species with only a few pair observed through the late 1990s except for one population on the Cleveland National Forest (Stephenson and Calcarone 1999). Because of their rarity Stephenson and Calcarone (1999) recommended site-specific management of this species, specifically to control brood parasitism by the brown-headed cowbird. The low-elevation riparian habitat preferred by the Least Bell's vireo is relatively uncommon on southern California Forests. No breeding pairs had been identified on the San Bernardino Forest through Stephenson and Calcarone's 1999 report. However, one breeding pair was confirmed in 2003 in Little Sand Canyon in the San Bernardino Mountains front country (Romich 2004). Unfortunately, this breeding site was burned in the October 2003 wildfires.

Besides the Least Bell's vireo and Southwestern willow flycatcher, a coarse screen survey in 1998 identified eleven other riparian bird species as rare or potentially at risk. These species are *Accipiter cooperi* (Cooper's hawk), *Coccyzus americanus occidentalis* (Yellow-billed cuckoo), *Cypseloides niger* (Black swift), *Tachycineta bicolor* (Tree swallow), *Catharus ustulatus* (Swainson's thrush), *Cinclus mexicanus* (American dipper), *Vireo gilvus* (Warbling vireo), *Dendroica petechia brewsteri* (Yellow warbler), *Geothlypis trichas* (Common yellowthroat), *Icteria virens* (Yellow-breated chat) and *Carduelis lawrencei* (Lawrence's goldfinch). Most of these species also occupy low-elevation riparian zones (Stephenson and Calcarone 1999).

Haliaeetus leucocephalus (Bald eagle) and *Pandion haliaetus* (Osprey) both frequent southern California reservoirs. Nesting of these species is uncommon and by the late 1990s had been documented only at Lake Casitas and Lake San Antonio (Osprey) and Lake San Antonio and other lakes near Los Padres Forest (Bald eagle). Bald eagles, however, winter in numbers at Big Bear Lake in the San Bernardino Mountains, and at other large reservoirs in southern California (Stephenson and Calcarone 1999).

Population trends for these bird species are largely unknown although the Southwest willow flycatcher, Least Bell's vireo and Lawrence's goldfinch are believed to be declining, and the Yellow warbler and Bald eagle stable (Stephenson and Calcarone 1999).

Invertebrates

Stephenson and Calcarone (1999) identify three riparian invertebrate species as rare or potentially at risk in the mountains of southern California. One of these, *Cicindela tranquebarica virudissima* (Greenest tiger beetle) was found by the US Fish and Wildlife Service to be synonymous taxonomically with the less rare *C. t. vibex*. The other two rare invertebrates, *Diplectronan California* (California diplectronan caddisfly) and *Euphyes vestries harbisoni* (Harbison's dun skipper) occur on the San Bernardino and Cleveland Forests respectively. The skipper may be more abundant than the caddisfly although very little information exists on the distribution of the caddisfly. Population trends for these species are unknown (Stephenson and Calcarone 1999).

Mammals

As of the late 1990s the Western red bat (*Lasiurus blossevillii*) was the only mammal species on the TES, California or FS lists. This species is a FS Region 5 Sensitive Species and a California Species of Special Concern. The Western red bat was found during the breeding season on all four Forests. Little information is available for this species and it's population trend is unknown (Stephenson and Calcarone 1999).

Surface Water Quality

Watershed Condition

Watershed conditions, or watershed health, on the four southern California Forests vary depending upon amount of disturbance that has occurred within each watershed and the effect of disturbances on the natural integrity of the watershed as a whole. The 5th level HUCs on the southern California Forests have been assigned a watershed condition rating based on disturbance and overall watershed health criteria identified in a watershed condition rating methodology (Table 1 and Figure 11) (USDA Forest Service 2000).

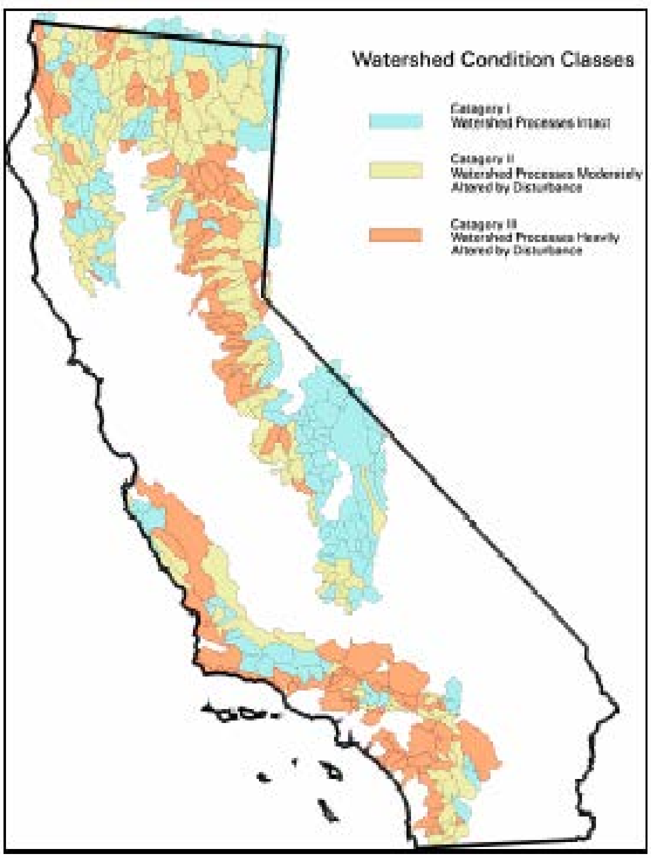


Figure 11. Preliminary Watershed Condition ratings for 5th field HUCs on FS lands in California (from USDA Forest Service 2000).

This methodology segregates watersheds into three categories: “watershed processes intact”, “watershed processes moderately altered by disturbances”, and “watershed processes heavily altered by disturbance”, based upon nine indicators. The indicators assess road hazard potential, surface erosion, mass wasting, floodplain connectivity, water quality, water quantity/flow regime, stream corridor vegetation, stream channel condition and native aquatic faunal integrity. Disturbances including location of FS and non-FS roads within the watershed, mining, recreation, grazing and special-uses can adversely affect a watershed's condition. The severity of effects is influenced in part by the local terrain, fire regime, precipitation, and potential geological hazards. Changes in watershed condition are reflective of changes in the long-term reliability of a watershed to provide the expected water quality and quantity. Watersheds with a condition rating of poor frequently contain only a small amount of NFS land relative to the total watershed acreage. Most of the conditions leading to the poor ratings were associated with high road densities, agriculture and urban developments within the floodplains below NFS lands (USDA Forest Service 2004).

Beneficial Uses of Waters of the State of California

Beneficial Uses are formally described uses of waters of the State of California for the benefit of people and/or wildlife. Each Regional Water Quality Control Board lists Beneficial Uses, typically for each water body, for its jurisdiction. The beneficial uses are generally similar among the various Regional Boards; the uses for the Santa Ana Board are listed below as an example--

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Service Supply
- Industrial Process Supply
- Groundwater Recharge
- Navigation
- Freshwater Replenishment
- Hydropower Generation
- Recreation (both water contact and non-water contact)
- Commercial and Sport Fishing
- Cold and Warm Water Habitat
- Wildlife Habitat
- Preservation of Biological Habitats of Special Significance
- Preservation of Rare, Threatened, or Endangered Species
- Migration of Aquatic Organisms
- Spawning, Reproduction, and/or Early Development
- Marine Habitat
- Shellfish Harvesting
- Estuarine Habitat

Some of these Uses (e.g., estuarine habitat, shellfish harvesting, marine habitat) are of little direct relevance to NFS resource management. Beneficial use designations can vary at small geographical scales. The Santa Ana Basin Plan (State of California 1995), for instance, listed Municipal/Domestic Supply, Groundwater Recharge, Hydropower Generation, Recreation, Cold Freshwater Habitat and Wildlife Habitat as the only Uses for Mountain Home Creek in the San Bernardino Mountains. Spawning, Reproduction and Early Development are added for Mountain Home Creek--East Fork and Falls Creeks, and Hydropower Generation is deleted for Monkey Face and Alger Creeks.

Water Quality Standards and Impaired Waters

Water bodies identified by the State as not meeting water quality objectives or "standards" with respect to the designated Beneficial Uses may be deemed "impaired" by the State. The "impairment" designation carries the leverage of federal and state statutes that can encumber NFS management to address the impairment (e.g., impairment for "trash" on the East Fork of the San Gabriel River) through the establishment of Total Maximum Daily Loads.

Standards (Water Quality Objectives)

A multitude of State water quality standards are in place. They incorporate a variety of parameters (e.g., algae, un-ionized ammonia, chemical oxygen demand, boron, etc.) for each of several environments (e.g., enclosed bays and estuaries, inland surface waters, groundwaters), sometimes split out by Beneficial Use and degree (e.g., acute (1-hr) and chronic (4-day) un-ionized ammonia objectives for water bodies designated with cold freshwater habitat).

Although NFS management must consider all relevant standards, the commonly applicable standards relate to inland surface waters and address bacteria (coliform), sediment, total dissolved solids, temperature and turbidity. The standards are in either narrative or numeric formats. For example, increases in turbidity, a measure of light scattered due to particulates in water, "which result from controllable water quality factors shall comply with the following:"

Natural Turbidity	Maximum Increase
0-50 NTU (Nephelometric Turbidity Units)	20%
50-100 NTU	10 NTU
> 100 NTU	10%

In addition "[A]ll inland surface waters of the region shall be free of changes in turbidity which adversely affect beneficial uses." This standard combines numeric with narrative criteria.

Impaired Waters and Total Maximum Daily Loads

A stipulation of section 303(d) of the federal Clean Water Act requires development and implementation of "Total Maximum Daily Loads" (TMDLs) for each impaired water body as a vehicle for reducing pollution, identifying the source(s) of pollution, quantifying the amount of current impairment (above allowable "loads"), and quantifying a required amount of pollution reduction (e.g., reducing sediment input from roads by 70% in X years). Impaired waters are identified by each state on a two-year cycle (although there was a 4-year hiatus from 1998 to 2002 as US EPA regulations were reviewed). Watersheds containing impaired waters designated in 1998 are shown in Figure 12. Table 2 lists the pollutants and their sources for each impaired water body. That table also notes whether each 1998 impaired water body was also designated as impaired in 2002.

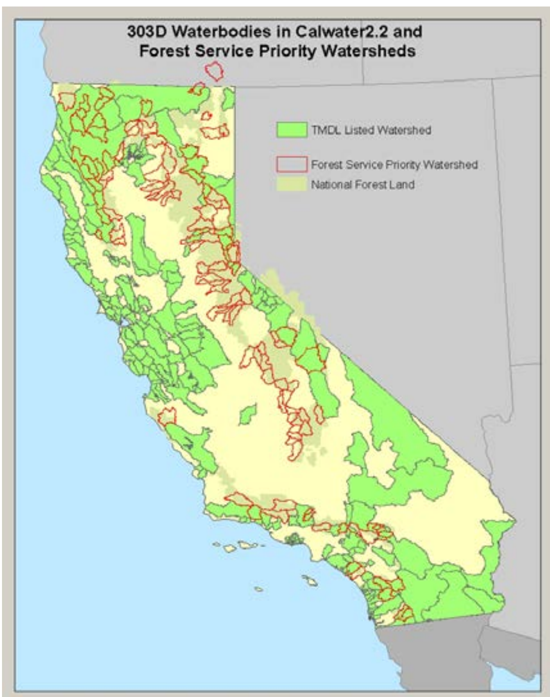


Figure 12. California watersheds with 303(d) listed (impaired) water bodies, FS priority watersheds and NFS land boundaries.

The number of impaired waters in 1998 and 2002 is listed below by Forest--

	Number of Impaired Waters	
Forest	**1998**	**2002**
Cleveland	4	4
San Bernardino	14	13
Angeles	7	6
Los Padres	9	9

The 2002 listing above is incomplete in that new waters listed in 2002 are not known; the table only deletes the few 1998 impaired waters known to have been de-listed in 2002.

A variety of pollutants and sources are listed by the State for the 1998 impaired waters on southern California Forests. Pollutants listed include pathogens (including coliform), nutrients, metals, algae, sedimentation/siltation, fish barriers and metals. Most pollutant sources for the 1998 listed waters are either non-point or unknown (Table 2). Although some of the listed waters clearly are affected by activities downstream from the Forest boundaries, several listed waters are entirely on NFS lands.

Impairment listing, and the consequent development of a TMDL, can impact NFS management. The recently-completely East Fork San Gabriel River "trash" TMDL requires that the FS meet the numeric target of zero trash for the 5+ miles of impaired stream. To meet the target the TMDL recommends that the FS—

- Provide trash and hot coal receptacles
- Provide at least one full-time person at each of four identified sites on each weekend day and holiday to direct picnickers
- Collect litter each weekend day and holiday
- Provide litter abatement signs
- Enforce existing anti-litter laws (State of California 2000).

In addition, "The US Forest Service must conduct monitoring at locations downstream of each of the four informal recreational areas" (State of California 2000). The TMDL estimates that costs to the FS will approximate $75,000 per year.

Impaired Waters and Watershed Condition. Hypothetically, watersheds heavily altered by disturbance would contain more impaired water bodies than watersheds with moderate or minimal disturbance. The following table lists the percent of (a) HUCs in each condition class having impaired waters, (b) all HUCs with impaired waters by condition class, (c) all HUCs having impaired waters and (d) impaired water bodies (stream segments or lakes) by condition class:

Condition Class	% of HUCs	% of HUCs in Condition Class with Impaired Waters	% of all HUCs having Impaired Waters	% of all Impaired Water Bodies
I	40	10	4.2	12
II	34	15	5.3	27
III	24	39	9.5	61

For example, 40% of the HUCs are in Condition Class I. Ten percent of these HUCs have one or more impaired waters. The 10% rated Class I equate to 4.2% of all HUCs and the Class I HUCs have 12% of all impaired waters.

The more disturbed watersheds have more impaired waters than the less disturbed watersheds. Even though watersheds in the most disturbed class (III) are appreciably fewer in number than watersheds in the other classes, the Class III watersheds include the majority of the individual impaired waters.

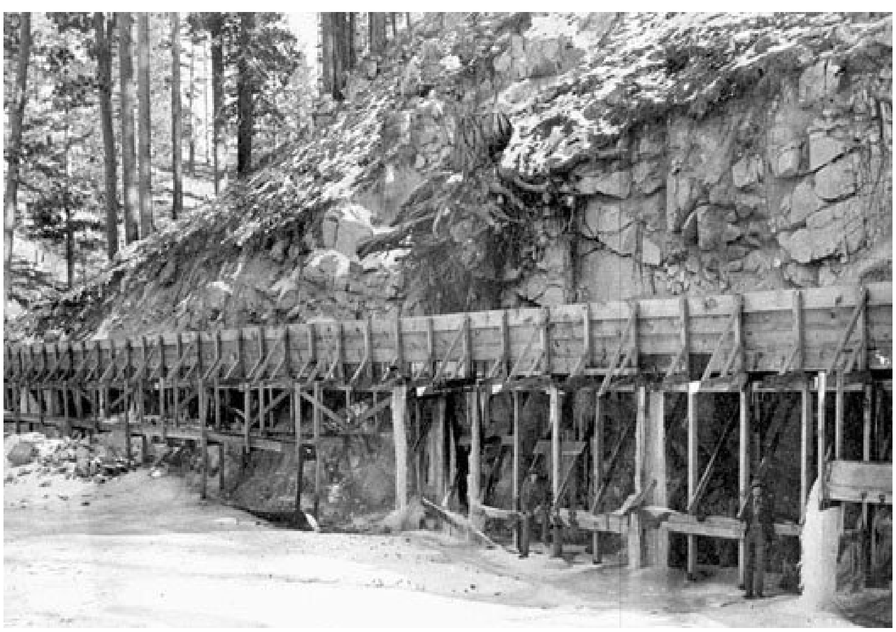
Other Water Quality Effects

Erosion and sedimentation are major consequences of wildfire in the mountains of southern California, but other changes can also occur. Removal of vegetation by fire, harvesting, and insect outbreaks temporarily interrupts chemical uptake by vegetation, with consequential impacts on mineralization, microbial activity, nitrification and decomposition. These processes increase levels of inorganic ions in soil that can leach to streams by subsurface water flows (DeBano et al. 1998, cited in Robichaud et al. 2000). Nitrate nitrogen is highly mobile and often increases in streamflow after wildfire (Robichaud et al. 2000).

Elevated levels on nitrate from wildfire may be compounded in streams in the southern California mountains, particularly in the San Gabriel and San Bernardino Mountains, that are experiencing the highest recorded baseline stream nitrate concentrations of any undisturbed forest or shrubland watersheds in North America (Fenn and Poth 1999). These exceptional levels of nitrate in surface waters exceed public drinking water standards in several cases and the high nitrate levels correlate with locations of high atmospheric deposition of nitrogen. Although the "piggybacked" elevation of nitrate in streams induced by atmospheric deposition and wildfire is not obviously amenable to management, it is a real water quality concern.

Connectivity

Under natural conditions, riverine aquatic and riparian habitats form a longitudinal continuum from headwaters to mouth (ridge to ocean). Impoundments, diversions and channelization break the continuity, alter hydrologic regimes, and fragment habitats.



Water diversion flume, Lake Arrowhead, early 1900s (The Photoworks 2004).

Impoundments and Diversions

Dams and reservoirs are ubiquitous in southern California. One classification of impoundments separates them as hydroelectric-power and non-hydro power facilities. The hydroelectric-power impoundments are typically associated with Federal Energy Regulatory Commission (FERC) projects. Non-hydroelectric facilities are often constructed for flood control, irrigation or water retention. FERC impoundments on or very near NFS lands institute more FS involvement than non-FERC facilities, and typically offer more options for FS input to the dynamics of impoundment operations through 4 (e) license conditions. Table 3 lists selected characteristics of the largest impoundments and reservoirs on the four southern California forests and Appendix I characterizes impoundments and reservoirs on and immediately downstream from the four southern California forests. Lave and Burbank (2004) list sediment production and fire frequency for debris dams and basins in, and at the foot of, the San Gabriel Mountains.

All major mountain streams in southern California have dams or diversions along them (Stephenson and Calcarone 1999). Many impoundments are on NFS lands, typically at relatively low elevations in front country topography. Some dams exist at higher elevations, particularly in the Mountain Top area of the San Bernardino National Forest. Besides facilities on major rivers, numerous springs and small streams are diverted or dammed, often for water supply and/or flood control (Stephenson and Calcarone 1999).

Summary statistics of reservoirs and impoundments on NFS land in the four southern California Forests is given below:

Forest	No. in Forest	Capacity (acre-ft)	No. with > 50,000 A-F Capacity	No. with > 20,000 A-F Capacity	Drainage Basin Area (sq miles)	No. with Basin Area > 10 sq mi	No. with Basin Area > 100 sq mi
Angeles	18	673,355	2	6	1198	12	4
Cleveland	7	203,334	2	5	762	6	3
Los Padres	9	109,137	1	1	493	3	1
San Bernardino	16	421,989	4	5	410	5	1

Source: Information Center for the Environment (1997)

The Angeles and San Bernardino Forests have the greatest number and total capacity of reservoirs. The Los Padres generally has less reservoir capacity than any of the other four Forests.

Five impoundments are listed in the California Rivers Assessment (Information Center for the Environment 1997) as being “owned” by the USDA FS. Two of these are on the Angeles, two on the Los Padres, and one on the San Bernardino National Forest. The capacity of the reservoirs behind these dams ranges from 15 to 600 acre-feet and total

815, and they drain a total of 17.3 square miles. In combination, these impoundments are minor in comparison to the totality of impoundments existing on the Forests.

One ramification of the damming and diversions is reduction in the extent and distribution of native freshwater habitats. Faber et al. (1989, cited in Stephenson and Calcarone 1999) estimated damming and diversions have eliminated over 95% of the riparian habitat in floodplain zones in southern California. Most of this is presumably at urbanized lower elevations. Habitat is lost directly by inundation by reservoirs created behind impoundments.

Eastwood Dam, Big Bear 1925 (The Photoworks 2004).

Flow modification has a variety of impacts. Diversions remove water, with a variety of consequences to riverine systems, including potential narrowing of wetted channels and alteration of hydraulic forces that maintain channel systems in a natural form. Reservoirs also typically retain or reduce the magnitude of flood flows, thereby changing the magnitude and timing of downstream flows (Coastal Conservancy 2001). One common result is the near-total depletion of sand and fine gravel immediately downstream of the impoundment. Lack of sediment can influence the reproductive success of aquatic organisms and alter channel maintenance capabilities. Sudden, large water releases can wash and scour away an entire year's reproductive effort for native fish and amphibian species. On the other hand, long-term, low-magnitude releases tend to increase the likelihood of introduction and maintenance of habitats for exotic predators like bullfrogs and sunfish, habitats that historically would have dried up completely in summer (Sweet 1992, cited in Stephenson and Calcarone 1999).

The modified flows stemming from diversions and impoundments seldom match the natural regimes that biota evolved under. Winter and spring flood peaks are not recreated and therefore channel scouring and sediment transport is minimized. Although relatively constant flows typically degrade downstream habitats, Stephenson and Calcarone (1999) identified situations where biotic survivorship increased when flows on Piru Creek were shifted to constant releases during summer and spring months, as opposed to natural flows that fluctuated dramatically on a daily or weekly basis.

Stephenson and Calcarone (1999) urged advocacy by resource management agencies in working with flood and water control agencies on the timing, magnitude and duration of flows, in particular to reduce the occurrences of large, rapid changes in the volumes of summer and spring releases.

Channelization

Channelization is the straightening, widening, deepening, or relocating of existing stream channels for flood control, drainage improvement, navigation and reduction of channel migration potential (Brookes 1990, cited in US EPA 1993). The Los Angeles River is described by Pitzer (2003) as "… the most unique waterway in California and perhaps the world because of the degree to which it has been transformed by human hands." The paving of the lower portion of the Los Angeles River is one of the latest examples of channelization that began in southern California in the late 1870s and early 1880s with redirection of flows on the Oxnard Plain to Mugu Lagoon to reduce crop loss from flooding (USDC National Marine Fisheries Service undated). Most of the Los Angeles River is paved; with exceptions only in sections where a soft bottom would remain because of a high groundwater table (Pitzer 2003).

Impacts of channelization are many and varied and include—

- Reduced groundwater recharge (before channelization of the Los Angeles River 80% of the rainwater would penetrate the aquifer; afterwards penetration was 8% (Pitzer 2003))
- Removal of water from streamside wetlands, which themselves absorb flows and act as relief valves for excess water (US EPA 1993)
- Destruction or degradation of fish habitat (USDI Fish and Wildlife Service 1999, cited in USDC National Marine Fisheries Service undated, US EPA 1993)
- Reduced capacity of natural systems to filter pollutants from surface waters
- Altering in-stream water temperature (US EPA 1993)
- Altering rates and paths of sediment erosion, transport and deposition (US EPA 1993)
- Increased movement of non-point source pollutants from the upper reaches of watersheds into coastal waters (US EPA 1993).

Although most channelization occurs in the lowlands downstream of NFS lands, the impacts of lowland channelization tend to leave FS lands as refugia for species that would otherwise range to lower elevations (e.g., fragmentation) and thereby reduce the range of management option on NFS lands.

Water Rights

Water use in and adjacent to the four Southern California National Forests is greater than the locally available water. This fact is exemplified in the adjudication of water supplies in many watersheds in southern California and the declaration that water from many watersheds is also fully appropriated. This section describes the adjudicated and fully appropriated watersheds and compares estimates of surface water available to the amount of water currently allocated in formally-documented water rights.

Adjudicated and Appropriated Basins

Much of the water in southern California is accounted for legally in "adjudicated" watersheds or "fully appropriated" stream reaches. These vehicles are both expressions of demand for water outstripping supply.

In adjudicated basins landowners or other parties turn to the legal system to settle disputes over the quantity of surface and groundwater that can be extracted by each landowner. Because surface-groundwater interactions impact surface water availability and potential use, adjudication influences surface water management and dynamics. The courts analyze available data and determine who can extract surface and groundwater and the amount that can be extracted each year. Typically a court-appointed "watermaster" oversees the court decision. Water extraction boundaries in adjudicated basins are defined by the courts. In most adjudicated basins the court decision limits the amount of water that can be extracted. Some adjudication decisions require water users to report the amount of both surface and groundwater used (State of California 2001).

Adjudicated basins can cover significant acreages. The San Gabriel adjudicated basin, for instance, stretches from southern Pasadena to east of San Dimas and from the Puente Hills to the San Gabriel Mountains. NFS lands can be included in adjudicated basins and adjudicated status complicates FS management. Fourteen of the 18 adjudicated basins statewide are in southern California and about 10 percent of the 5^{th} level HUCs associated with the southern California Forests are part of adjudicated basins (Table 1). Although most of the adjudicated portions of NFS lands are at the toes of the front ranges of the San Gabriel and San Bernardino Mountains, at the fringes of suburban developments, their designation as adjudicated complicates management options for both surface and groundwaters.

Whereas adjudicated basins relate primarily to groundwater extraction, fully appropriated status is a broader determination that prohibits the State Water Resources Control Board from accepting any new applications to appropriate water (e.g., water rights) from the listed watercourse. Fully appropriated status also refers to specific reaches of streams, whereas adjudication addresses entire watersheds. Appropriation decisions can be amended wherein the Board reviews records to determine if any new water (e.g., increased releases of treated wastewater, increased runoff from urbanization or dam/reservoir construction) allow more appropriation. Over 35% of the 5^{th} level HUCs have fully appropriated stream reaches on NFS lands (Table 1). These reaches range from individual spring source areas to the entire network of main channels and tributaries comprising the Santa Ana River system. Fully appropriated status limits options for NFS management of water.

Comparison of Available and Appropriated Water

A concern is that water well withdrawals, surface water diversions and other removals of water from lands administered by the four southern California Forests in combination are "mining" or "over-drafting" the water resource. Over-drafting would compromise NFS mandates to protect water and related resources. This concern manifests itself specifically when permits for water diversions, transmissions and related uses come up for renewal. There's uncertainty about whether permit renewal will compromise water availability and permit renewal decisions are therefore, often based on limited and less than complete information.

Because little is known about the magnitude and availability of groundwater resources in southern California, the confidence level for decisions on permit renewals has been low. As part of the development of the southern province DEIS, and Forest Plan Revision, the potential for over-draft of water was addressed by comparing estimates of obligated water allocations (from formal water rights) with estimates of surface water yields from each 5th field HUC existing on the four Forests. This is a first approximation; the surface water yields are proxies for surface and ground water availability. "Yield" refers to surface water availability and "over-draft" refers to the condition of greater allocation (per formal water rights) than yield. Below we—

1) Estimate mean annual water yield from each 5th field Hydrologic Unit (HUC[1]) that includes NFS land within the four Southern California Forests (objective 1).
2) Estimate mean annual water yield for the NFS lands (only) within each 5th field HUC in the four Southern California Forests (objective 2).
3) Determine the amount of water obligated through water rights within the four Southern California Forests (objective 3).
4) Identify HUCs with potential over-drafting of water, as identified by the sum of the water allocation from the water rights being greater than the mean annual water yield (objective 4).

[1] HUCs used in this analysis are current as of spring 2003. "New" 5th field HUCs delineated after spring 2003 are not included. The 5th field HUCs included herein are those that are at least partially within the administrative boundaries of the four southern California Forests. A distinction is made in the results between the entire HUC and the NFS lands within a HUC.

Methods

Yield determination is not straightforward for a variety of reasons. Ideally yields could be determined from long-term ($\geq$ 10 yr) records from streamflow gages located at the base/outlet of each HUC that drained only the HUC with un-diverted, un-regulated flows (objective 1), and at the base/outlet of the Forest portion of each HUC (objective 2). Unfortunately, these situations seldom existed. Many gage records are less than 10 years long. Some HUCs (e.g., Upper San Diego, Upper Cottonwood) have no streamflow gages within them; other HUCs have numerous gages (e.g., 35 in Middle Santa Ana, 12 in Solvang), with many that measure canals or other diversions. Some HUCs drain other HUCs so that gages within a HUC may not represent that HUC but instead represent some, all, or more than one or more adjacent HUCs. Some gages drain small sub-catchments of unknown representativeness to either an entire HUC or the Forest portion of a HUC. Many gages are located below diversions or below areas of streamside water pumping or regulation. Records from these gages do not represent “natural”, unimpaired flow regimes.

Streamflow Data Sources. Over 490 stream gages were identified, and mapped by HUC, by Angeles NF GIS staff (Marilyn Porter). Mean annual flow, record length, years of record and drainage area were included for each gage in the spreadsheet prepared by Ms. Porter. We classified the location of most of the 490 gages with respect to NFS lands within each HUC as (a) within the Forest portion of the HUC, (b) 0.1 to 10 miles from the nearest Forest boundary, and (c) greater than 10 miles from the nearest Forest boundary. We also quantified the flow rate (as cubic feet per square mile per year) for each gage and assessed the status of each gage record for flow regulation, diversion or pumping upstream of the gage (this was easier said than done because Internet-available information is available only from 1994 through 2002. Because many gages ceased operation prior to 1994 several trips to the Water Resources Institute at the University of California, Berkeley were required to summarize hardcopy records of gage operation). Each gage record was classified for upstream impairment into one of four possible categories: (a) no regulation/ pumping/ diversion, (b) minimal impairment, (c) some impairment, and (d) appreciable impairment.

HUC mean annual flow rate was determined usually as the mean flow rate from the most representative gage in each HU, or less frequently as the mean flow rate from adjacent HUCs (for HUCs without gages), or the mean flow (or less frequently still the weighted mean) of two or more relevant gages. Criteria used to assess representativeness of each gage was record length, drainage area with respect to HUC area, impairment, and physiographic similarly between the HUC and the gage drainage area (i.e. if proxy gage records had to be used in the absence of gages within a HUC, ideally the proxy gage(s) location would drain an area of similar geomorphology and climate to the HUC).

Metrics. Forest mean annual flow rate (within each HUC) was determined ideally from gages within the Forest portion of each HUC or less ideally from gages outside the Forest or within the Forest portion of an adjacent HUC. Because often either a very small portion of a HUC was within a national forest (e.g., Aliso/Laguna, Chalone, Clark Valley HUCs) or the entire HUC was within a national forest (e.g., Baldwin/Bear, Big Sur), the mean annual Forest flow rate defaulted to the HUC flow rate. Also often there was no gage information for the forested portion of a HUC so the Forest mean annual flow rate defaulted to the mean annual flow rate for its HUC. The rationale for the determination of each HUC and Forest flow rate are documented in a separate report not included here.

Drought conditions are expected to result in a larger portion of more permitted special use withdrawals and on-Forest pressure for withdrawal of Forest water than during normal or wet conditions. The mean flow estimates do not represent drought conditions and are actually biased toward wetter-than-average conditions because streamflow occurrence is typically skewed toward a relatively few high flow occurrences that shift the mean annual yield toward the high end of the range of annual flows. To address drought conditions, we calculated median and 10th percentile flows. The median flow is the middle value in the sorted set of flow values, above and below which lie an equal number of values. The 10th percentile flow indicates that 10 percent of the individual annual flows are below the given value (e.g., if the 10th percentile flow is 10 cubic feet per second per square mile, then 10 percent of the flows will be below 10 cfs/sq mile and 90 percent above 10 cfs/sq mile).

Water Rights Data Sources. Two sources of water rights information are available for addressing objective 3. The State of California documents privately-held rights and some federally-held rights throughout the State. FS records include some federally-held rights not necessarily listed in the State database but few privately-held rights. A database of State water rights was obtained. This database was described by State staff as extending beyond the administrative boundary of each of the four southern California Forests because it was not possible to segregate rights spatially precisely on the sub-Section scale of the Forest boundaries. Consequently the database used for the results shown in Table 4 covers some indeterminate area extending beyond the Forest boundaries partially into HUCs that extend beyond the Forest boundaries.

The State provided the water rights database in Rich Text Format (rtf). This format is not amenable to quantitative analysis; it is essentially a word processing format. Significant time and effort was required by Plan Revision staff to “parse” the data fields in the four rtf files (one for each Forest) to transform the information into an Access database. Independently, the R5 Regional Office commissioned an Enterprise Team to visit each southern California Forest and document each water right existing in the Forest files. These two datasets, “State” and “R5”, were compared, and rights from the R5 file were added to those in the State file to create a single, comprehensive water rights file.

The comprehensive water rights file contains several water rights parameters. We chose the field labeled “Maximum Direct Diversion” as best representing potential maximum removal of water from a HUC. Metrics for Maximum Direct Diversion were either cubic feet per second (cfs), acre-feet (A-F) or gallons per day (GPD). The Maximum Direct Diversion values were standardized to A-F and summed for each HUC. The number of water rights with Maximum Direct Diversion values “owned” by each Forest summed for each HUC, and the percentage of both the total number of rights per HUC and the amount of water per HUC owned by each Forest were determined.

To address objective 4, the sum of the Maximum Direct Diversion values (A-F) for each HUC was compared (as a percent) to the mean annual flow yield for each HUC. Percentages greater than 100 were flagged as candidate over-draft HUCs. The water rights for these “over-draft” HUCs were reviewed to identify the larger sources of potential over-drafting (Table 4).

Results and Interpretation

The results of this analysis can be used to identify watersheds in which future work on water issues may need to be concentrated.

Almost 2300 water rights were identified in 110 HUCs; over 1750 of these had Maximum Direct Diversion values. For several reasons several HUCs (e.g., Aliso/Laguna, Bautista/Potrero) had no water rights listed within the geographical area comprising the two water rights databases. Some of these "no rights" HUCs had very little area within any Forest. For these HUCs the spatial coverage of the State water rights database probably included a very small portion of the HUC and consequently no water rights. Also some of the "no rights" HUCs are relatively small and have little development—reasons for anticipating few or no water rights within these HUCs.

Another 530 water rights did not have Maximum Direct Diversion values listed. The database does typically list "Maximum Storage" values for many of these rights. Those values are not addressed here.

Twelve HUCs have total water allocations (based on the water rights data) over 300% of their mean annual water yields (Table 4 orange cells in the "Total Water Right Allocation as % of Annual MEAN Flow/HUC" column). These HUCs are interpreted as probably currently being in an over-draft condition during normal precipitation conditions. Another five HUCs have allocation-to-yield percentages between 100 and 300 (Table 4 yellow cells in the "Total H2o Right Allocation as % of Annual Flow/HU column). These HUCs are interpreted as possibly currently being in an over-draft condition during normal precipitation conditions. Because of limitations inherent in this analysis and the available data (discussed below), we believe that the resolution of the results equates to approximately a 300% "error" envelope. The allocation-to-yield percentages denoted by the yellow HUCs in Table 4 are, therefore, interpreted to be within the error bounds of the analysis and therefore possibly (but not probably) over-drafted. We believe that the high allocation-to-yield percentages for the orange-colored HUCs point to potentially "real" over-draft conditions.

More HUCs are over-drafted in comparison to the median and 10th percentile flows. Fifteen HUCs have total water allocations over 300% of their median annual water yields and 33 HUCs similarly have total water allocations over 300% of their 10th percentile annual water yields. Nine of the HUCs having water rights allocations greater than 300% of the mean annual flow are predominantly on NFS lands. Most of these are on the San Bernardino and Angeles National Forests (e.g., Lytle Creek, Big Tujunga, Little Rock, Middle and Upper Santa Ana, Upper San Jacinto) although both the Cleveland and Los Padres Forests each have one HUC in this situation.

Most of the "over-draft" HUCs have one or at most a few water rights allocating large amounts of water (often over 95% of the water in these HUCs is allocated to one organization, typically a water district). "Over-draft" HUCs under mean flow conditions (the most liberal) occur in all four Forests although almost one-half (5 of 12) are on the San Bernardino National Forest. Most (9 of 12) of the mean-flow over-draft HUCs have water right allocations greater than 100,000 A-F, and only over-draft HUCs have allocations greater than 100,000 A-F.

In two of the over-draft HUCs, Big Tujunga and Upper Salinas, a Forest holds the dominant rights. Forest rights in the other over-draft HUCs contribute insignificantly to the over-draft.

Considerations

Several aspects of this analysis limit the applicability of the results:

- There is an "apples and oranges" aspect to the comparison of water allocation from the water rights information and the water yield values from the streamflow gage records. The yield values are spatially based on individual HUCs and the Forest portion within each HUC. Unfortunately, the water rights information is not based on either of these spatial designations, but is based on an indeterminate geographical area intermediate between the HUC and Forest-within-HUC areas. Consequently the water rights water allocation matches the water yield data only for HUCs that are entirely within a Forest. A better approach would identify water rights only from the Forest portion of each HUC, or from each entire HUC, or both separately.
- Some of the records are from gages with impaired flows, flows impacted by regulation, diversion and pumping upstream of the gages. Flows documented in these records are not directly comparable to the unimpaired flows measured at gages with un-regulated/pumped/diverted upstream environments. However, flow regulation and diversion realistically do occur on Forest and non-Forest lands, so inclusion of the impaired flows is the reality of current management conditions both on and off-Forest.
- The annual water yield calculations may be imprecise because of limitations in the availability of streamflow gage records representative of the HUCs. These limitations are discussed above in the Methods section, Objectives 1 and 2. The magnitude of this imprecision varies for different HUCs, as documented for each HUC in a spreadsheet not included herein.
- The annual time scale for the analysis masks the ground and surface water dynamics that play out over varying time scales. Groundwater recharge and ground-surface water interactions are not confined to a yearly time frame. The analysis described here is simplistic in not addressing potential multi-year effects.

Recreation

The four southern California Forests administer one of the largest tracts of publicly-administered open space in the United States immediately adjacent to a massive urban population center. Because of the semi-arid and warm climate of the population centers, water on the Forests draws large numbers of recreationists, sometimes in summer at magnitudes greater than the "carrying capacity" of the resource. Projections are for increased use of water resources by recreationists on the Forests. Although a variety of recreational activities can influence water resources, day-use activities predominate and include lake and stream-based water play, snow play, skiing, and camping.

Generic impacts of recreationists to water resources include trampling and degradation of riparian and aquatic species habitat, and other activities that threaten water quality, especially in popular locations. Water diversions that benefit recreationists could be increased if adequate levels of flow were ensured.

The impairment of the East Fork San Gabriel River by "trash" is a case study illustrating one type of effect directly related to concentrated "water play" on the Angeles National Forest (see section above entitled Impaired Water and Total Maximum Daily Loads). As noted above, estimated annual cost to the FS is $75,000 to ameliorate the E. Fork San Gabriel River trash pollution. Another example of potential ecosystem effects of recreation is the ramifications of a recent informal proposal for expanded snowmaking at Snow Valley ski area in the San Bernardino Mountains.

Snowmaking: A Ski Area Water Resource Issue

Snow making in areas like those of southern California where annual precipitation is low and the amount of snow needed to maintain a viable industry is high, can create unique hydrologic conditions. Recently a ski area on the San Bernardino National Forest proposed to increase its snowmaking capacity. Ramifications of this proposal are discussed below as an example of potential impacts of snowmaking on NFS resources.

Water losses from snow-making via evaporation and sublimation can be segregated into "initial losses", occurring during the actual snowmaking operation between ejection of the water or ice from the snowmaking gun and deposition onto the snow or ground surface, and "watershed losses" occurring during the period between deposition and snowmelt while the man-made snow forms a snowpack. Although no measurements of either type of loss are available for California, initial losses ranging from 5-14% were determined for ski areas in Colorado (Eisel et al. 1990), Santa Fe, New Mexico (Smart 1984) and through calculations from basic physics (Alfio Bucceri, Pers. comm. 2000). Watershed loss estimates, ranging from 7-33%, were cited from the same three sources. Other sources list combined initial and watershed losses ranging from 13-39% for Snow Valley, Heavenly Valley (Lake Tahoe area) and locations in Colorado (Eisel et al. 1988, Sherri Hazelhurst, Lake Tahoe Basin Management Unit, Pers. comm. 10/2000, Greg Kuyumjian, Santa Fe National Forest, Pers. comm. 10/2000, Eisel et al. 1990). These are potentially significant water loss amounts that could locally lower groundwater tables and/or affect surface water resources. Some minor water gain can occur over a snowpack from atmospheric condensation. This interaction is very complex but any gains from condensation are expected to be considerably smaller than the losses incurred in the initial manufacturing of the snow.

Besides water losses through evaporation and sublimation, other potential hydro-botanical effects of snowmaking stem from substantially increasing (above natural precipitation) water deposited in the area of the snowmaking (135 acres at Snow Valley). It is estimated that about 356 acre-feet of water will ultimately be used in making snow at Snow Valley.

Potential effects include--

- Extended duration of the snowpack for an unknown number of days
- Increased peak streamflows
- Changed rates of soil erosion, mass movement, or soil creep
- Elevationally-shifted plant distributions
- Locally changed surface water chemistry (to the extent that the groundwater source of the snowmaking differs in chemistry from the surface waters)

To begin to put some numbers onto these potential ramifications, the Snow Valley snow-making target area, approximately 135 acres in size, receives approximately 31" total annual precipitation on average (San Bernardino County Flood Control District 2003). Liberally assuming all of this precipitation falls as snow, it is comparable to 31 inches (356 acre-ft of water on 135 acres of land) of <u>additional</u> snow water equivalent that would result (in total including snowmaking already permitted and underway) from the anticipated project. The total result of the snowmaking would appear to approximately double the amount of snow (and therefore water) on the 135 acres. This doubling would be reduced by the initial and watershed losses. Assuming 25% initial manufacturing and snowpack watershed loss, approximately 24" of water (356/135*12*.75) would be added to the 135 acres. (Note that the preceding estimations are based on a possibly unrealistic "worse case" in which all 135 acres experience snowmaking at the maximum potential rate.)

The consequences of adding 24" of water to the 135 acres should be considered both locally, at the scale of the project itself (e.g., the 135 acres), and more broadly (e.g., at the sub-watershed or watershed scales). Mass movement, soil erosion, soil creep and plant distributions probably respond at the local scale (but may contribute cumulatively to a larger geographical scale), while peak streamflow increases are more directly a function of watershed-scale processes. The distribution of the 135 acres may also influence potential mass movement, soil creep and/or plant distribution effects (if the 135 acres are aggregated in one contiguous area ramifications may differ from a distribution spread out over a greater area—e.g., as a network of ski trails versus a single open slope). Assuming the 135-acre target area occupies one watershed within the 1512-acre Snow Valley basin, flow effects from significantly increasing water on the 135 acres would be ameliorated to some degree by "dilution" from the other 1377 acres in the watershed. On the other hand, if the 135 acres is a single sub-watershed, then potential effects to that one sub-watershed could be appreciable.

In summary, potential effects of water withdrawal for snowmaking may precipitate a variety of ecosystem changes.

Opportunities for Water Yield Improvement

Because vegetation "drinks" water, speculation on increasing water yield by removing vegetation is common in wildland resource management. Theoretically, vegetation and snowpack manipulation can increase runoff from small watersheds by reducing losses due to evapo-transpiration and rain and snow interception by vegetation canopies. Although specific options for water yield improvement through vegetation manipulation in southern California were not researched, research results from elsewhere are relevant to southern California.

Hauling Logs to Talmadge mill, Big Bear, circa 1915

Several factors enhance the potential for water yield increase from vegetation manipulation. Per Kattelmann et al. (1983), these include--

- Sufficient precipitation, implying yield augmentation is optimized at higher elevations
- Sufficient pre-removal canopy cover (at least 40% canopy density for forest management to optimize snow redistribution and shading in the Sierra Nevada (Richards 1959))
- Sufficient vegetation removal, with clear-cutting offering the greatest potential yield improvement
- Location of treatments close to or crossing riparian zones, or at the base of a slope near a stream where residual trees below the harvest area will not transpire much of the "excess" water (Kattelmann 1996)
- Available downstream reservoir capacity for capturing and retaining augmented flows
- Opportunities for treating large expanses of land
- Low percentage of precipitation relative to streamflow
- Prevalence of deep soils

In southern California, land areas with high precipitation and sufficient vegetation canopy density are limited. Furthermore, practical considerations limit the real-world potential for water yield augmentation in most situations. Vegetation manipulation is less feasible on steep slopes thereby reducing the land area for treatment. Environmental constraints, either by formal restrictions on harvesting (e.g., in designated wilderness), or by a preponderance of public opinion, remove land from the harvest base, or preclude clear-cutting, and therefore lower the potential for water yield increases.

Although yield increases have been estimated at up to 50% in total watershed conversion experiments in northern California (Burgy 1968, Burgy and Papzafiriou 1974), the constraints listed above combine to drastically reduce the operational potential for yield increases. Kattelmann et al. (1983) concluded that water yield increases on the order of ½ to 2% (or approximately 0.6 cm of water) may be achievable, under intensive forest watershed management in the Sierra Nevada. Similarly, recent model estimates of potential yield increases from vegetation management in northern Sierra Nevada are described as "slight" for most alternatives (USDA Forest Service 1999). Yield increases of this magnitude are commonly un-measurable with currently available stream gaging techniques that are described as optimally quantifying "true" flow to +/- 5%.

The potential for managed water yield improvement on southern California Forests is further compromised by the cyclic recurrence of wildfire that has periodically reduced evapo-transpiration and increased flows periodically, especially in front country chaparral environments. Consequently, downstream water resource management is already conditioned to some level of natural augmentation thereby narrowing options for managed augmentation.

Ziemer (1986) concluded that while water yield enhancement might be theoretically possible; in forests like those in southern California large-scale (watershed size) projects would prove to be impractical.

Suction Dredging

Suction dredging, typically for gold placers, has become more practical with technological advances. Although suction dredging is a small-scale and localized activity, ramifications are wide-ranging and are summarized here.

Suction dredging for gold in stream channels uses high-pressure water pumps to vacuum streambed material and pass it over a sluice box to sort out denser material, including gold. Tailings from the suction operation are discarded over nearby streambed areas. Boulders and in-channel woody debris are (re)moved to expedite the dredging.

Dredging can cause a variety of biological and physical effects. Direct mortality of aquatic organisms, including benthic invertebrates, trout eggs and larvae of other fish, can occur from entrainment into the suction dredge (Griffith and Andrews 1981). The degree of mortality depends at least partially on the age and maturity of the eggs and larvae, and adult fish may not always be killed (Harvey and Lisle 1998). Other potential effects include—

- Decreased benthic invertebrates from exposure of new substrate and deposition of tailings (Harvey and Lisle 1998)
- Spawning reductions from repositioning of spawning gravels, deposition of tailings onto spawning gravels, and scouring of critical streambed zones (Harvey and Lisle 1998)
- Reduced cover for fish from removal or repositioning of in-channel woody debris (Berg et al. 1998)
- Reduced ability of salmonids to capture prey because of elevated concentrations of suspended sediment generated in the dredging operation (Berg and Northcote 1985).
- Changes in lateral and vertical streambed geometry, creating opportunities for excessive stream migration.

Dredging effects may not all be detrimental. Potential positive effects include—

- Temporary pool formation or deepening providing refuge from predators
- Deep scouring that can intersect cool subsurface flows creating pockets of cool water during summer.
- The returned gravels, having been washed, can provide attractive spawning areas and streambed habitat.

Mining operations on the southern California Forests span a variety of types and contexts. The scale of gold mining is much reduced from historic levels, although gold mining continues in several pebble plain complexes. There is also a potential for areas under limestone mining claims in the northeastern portion of the San Bernardino Mountains to be activated in the future (USDA Forest Service 2004).

Historic and abandoned mining and petroleum extraction can result in acid mine drainage or release of toxic materials to ground and surface waters. Although most of the highest priority abandoned mines and oil fields have been reclaimed, some still need hazard mitigation. Placer mining has produced appreciable accumulations of sediment, particularly into Piru, Plaskett, Mill, San Francisquito Creeks and the San Gabriel, Big Sur and Little Sur Rivers (USDA Forest Service 2004).

Conclusions

Surface water is a vital resource in southern California—for domestic and industrial use, recreation, and ecosystem sustenance. National Forests are the majority source of locally-derived surface water. Local water meets less than one-half of the demand, consequently any water available from National Forests is critically valued. Although the quality of the surface waters from the southern California Forests is generally good, “impaired” water bodies exist on the Forests and impairment designations have increased from past years. National Forest staff will continue working with State and local entities to remediate water quality impairment and meet their obligations, potentially at exacerbated cost to the Forest Service.

Groundwater is probably being over-drafted, both on the Forests and in the surrounding lowland urban areas. Because of extensive interactions between surface and groundwater dynamics, groundwater over-drafting affects surface water resources. Although preliminary assessment suggests that several watersheds are significantly over-drafted, information is not available to confirm that over-drafting on NFS lands definitely occurs. As an initial step toward determining over-draft status and to better understand the scope of management options, water rights databases need to be completed, validated and assessed to help quantify the magnitude of water withdrawal from NFS lands.

Riparian areas on national forests in southern California provide refugia habitat for an array of plant and animal species. The status of many of these species is unknown and although they are probably adapted to fire-flood sequences, the sheer magnitude of the October 2003 wildfires as well as the anticipated continued fuel buildup in southern California, and subsequent flooding, implies a need for re-assessment of the more critically rare species.

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Table 1. Priority Status, Condition Rating, Estimated Annual Flow Rates and Yields and Related Characteristics of 5th Level HUCs, Southern California Forests and Adjoining Areas

Forest / HUC5 ID No.	HUC5 Name	Place Names	Priority[1]	Condition Rating[2]	Est. % of HUC Area in Forest	HUC5 Area (acres)	Adjudi-cated	Fully Appropriated
Los Padres								
1803000306	Buena Vista	Mount Pinos, Mutau-Hungry Valley		II	30	261,526		Unnamed spring/Cuddy Creek source
1806000401	Upper San Juan Crk	Avenales, Cuyama/Hwy 166, Ponzo-La Panza, Rockfront		I	20	129,344		
1806000402	Lower San Juan Crk			II	13	150,764		
1806000404	Lower Estrella River	Black Mtn		I	2	177,597		
1806000501	Upper Salinas	Avenales, Black Mtn, Cuesta, Pozo-La Panza		II	60	71,764		
1806000502	Paso Robles	Cuesta		I	7	188,062		Salinas R from Santa Margarita Reservoir down to confluence with Nacimiento R
1806000503	Huerhuero Creek	Black Mtn		I	4	102,815		
1806000504	Nacimiento	Big Sur, Ventana		I	5	207,843		
1806000505	San Antonio	Arroyo Seco/Indians, Ventana		I	15	207,093		
1806000509	Chalone	Arroyo Seco/Indians		I	0.05	199,205		
1806000510	Arroyo Seco	Arroyo Seco/Indians, Big Sur, Ventana	X	I	50	194,487		
1806000601	Palo Corona/Little Sur	Big Sur, Ventana		I	30	69,760		
1806000602	Big Sur	Big Sur, Ventana	X	II	100	37,392		
1806000603	S Monterey Coastal	Big Sur, Ventana	X	I	85	86,445		
1806000604	N SLO Coastal	Big Sur, Cuesta		I	10	192,459		
1806000605	S SLO Coastal	Cuesta		I	7	174,546		Upstream from mouth of San Luis Obispo Crk
1806000606	Arroyo Grande Creek	Cuesta		I	30	97,848		Upstream from mouth of Arroyo Grande Creek, Upstream from confluence of Lopez Crk & Arroyo Grande Crk
1806000701	Upper Cuyama	Cuyama/Hwy 166, Hwy 33, Mt Pinos, San Rafael, Sespe		II	90	190,693		
1806000702	Cuyama Valley	Cuyama/Hwy 166, Hwy 33, Mt Pinos, San Rafael		II	45	188,188		
1806000703	Morales/Taylor	Colson, Cuyama/Hwy 166, San Rafael		I	20	110,773		
1806000704	Lower Cuyama	Colson, Cuyama/Hwy 166, Rockfront		III	40	111,059		
1806000705	Alamo	Avenales, Cuyama/Hwy 166, Rockfront		II	80	56,414		
1806000706	Huasna	Avenales, Cuesta, Cuyama/Hwy 166, Rockfront		II	33	75,822		
1806000801	Sisquoc	Cuyama/Hwy 166, Colson, Figeroa-Santa Ynez, San Rafael	X	I	85	184,277		

Forest / HUC5 ID No.	HUC5 Name	Place Names	Priority[1]	Condition Rating[2]	Est. % of HUC Area in Forest	HUC5 Area (acres)	Adjudi-cated	Fully Appropriated
1806000802	La Brea	Colson, Cuyama/Hwy 166, San Rafael		I	80	60,708		
1806000803	Santa Maria	Colson		I	3	189,220		
1806001001	Upper Santa Ynez	Figueroa-Santa Ynez	X	I	100	138,514		
1806001002	Middle Santa Ynez	Figueroa-Santa Ynez, San Rafael, Santa Barbara Front	X	II	65	129,282		
1806001003	Solvang	Figueroa-Santa Ynez, Santa Barbara Front		I	15	156,478		
1806001201	Upper Carmel	Ventana		II	50	80,083		
1806001301	W Santa Barbara Coast	Santa Barbara Front		II	25	139,387		Upstream from mouth of San Jose Creek
1806001302	E Santa Barbara Coast	Figueroa-Santa Ynez, Ojai Front, San Rafael, Santa Barbara Front		II	50	100,687		
1807010101	Ventura River	Hwy 33, Ojai Front, San Rafael, Santa Barbara Front	X	II	60	144,957		Santa Ana C upstream from Lk Casitas, Cozy Dell Cyn upstream from confluence with Ventura R, Reeves C upstream from confluence with Thatcher Ck
1807010207	Lower Piru	I-5 Corridor, Santa Clara Canyons		II	80	82,459		
1807010209	Sespe Creek	Hwy 33, Ojai Front, San Rafael, Sespe	X	I	95	172,306		
1807010210	Santa Paula	Ojai Front, Sespe		II	25	85,795		
Angeles								
1807010201	Soledad	Angeles High Country, Angeles Uplands (West), Front Country, Liebre-Sawmill, Mojave Front Country, Santa Clara Canyons, Soledad Front Country		III	40	181,462		
1807010202	Bouquet	Liebre-Sawmill, Santa Clara Canyons, Soledad Front Country	X	III	75	46,768		
1807010203	San Francisquito	Liebre-Sawmill, Santa Clara Canyons	X	III	80	31,841		
1807010204	Elizabeth	Liebre-Sawmill, Santa Clara Canyons		I	95	45,987		
1807010205	Castaic	I-5 Corridor, Liebre-Sawmill, Santa Clara Canyons		I	85	53,156		
1807010206	Upper Piru	I-5 Corridor, Liebre-Sawmill, Santa Clara Canyons	X	II	86	186,703		
1807010208	Middle Santa Clara	I-5 Corridor, Santa Clara Canyons		II	4	146,914		
1807010501	Upper Los Angeles	Angeles High Country, Angeles Uplands (West), Front Country, Soledad Front Country		III	10	213,501	X	
1807010502	Big Tujunga	Angeles High Country, Angeles Uplands (East & West), Big Tujunga Canyon, Front Country, Soledad Front Country	X	III	90	113,630	X	North Canyon/Big Tujunga Wash upstream

Forest / HUC5 ID No.	HUC5 Name	Place Names	Priority[1]	Condition Rating[2]	Est. % of HUC Area in Forest	HUC5 Area (acres)	Adjudi-cated	Fully Appropriated
1807010503	Arroyo Seco	Angeles Uplands (West), Front Country		I	65	21,209		Arroyo Seco, upstream from confluence with LA River
1807010504	Whittier Narrows	Angeles Uplands (West), Front Country, San Gabriel Canyon		III	25	83,136	X	
1807010601	W Fork San Gabriel R	Angeles High Country, Angeles Uplands (East & West), Front Country, San Gabriel Canyon		I	100	67,044	X	San Gabriel R Watershed
1807010602	Upper San Gabriel River	Angeles High Country, Angeles Uplands (East), Front Country, San Gabriel Canyon	X	II	100	60,027	X	San Gabriel R Watershed
1807010603	Covina	Angeles Uplands (East), Front Country, San Gabriel Canyon		III	25	157,300	X	San Gabriel R Watershed
1807020308	Chino Creek	Angeles High Country, Angeles Uplands (East), Front Country		II	25	80,954	X	W Fork Palmer Canyon, Mouth of Santa Ana R upstream
1809020601	Quail Lake	I-5 Corridor, Liebre-Sawmill, Santa Clara Canyons		I	4	196,647		
1809020606	Rodgers Lake	Liebre-Sawmill		I	0.04	540,622		
1809020607	Amargosa	Liebre-Sawmill, Santa Clara Canyons, Soledad Front Country		III	15	23,705		
1809020608	Little Rock	Angeles High Country, Mojave Front Country, Soledad Front Country		I	95	44,744		
1809020609	Big Rock	Angeles High Country, Mojave Front Country		I	60	38,716		Unnamed spring/Big Rock Creek
1809020610	Sheep	Angeles High Country, Mojave Front Country		III	90	15,122		Mescal Crk upstream from Rogers Lake Basin
1809020611	Rock Creek	Mojave Front Country, Soledad Front Country		III	0.03	168,686		
1809020804	Swarthout	Angeles High Country, Mojave Front Country		III	70	16,000		Le Montaine Creek
San Bernardino								
1807020201	Upper San Jacinto	Anza, Garner, Idyllwild, Monument		III	85	125,920		Mouth of Santa Ana R upstream, Upstream from confluence of Bautista Canyon & San Jacinto R, Strawberry Creek, Unnamed spring
1807020202	Bautista/Potrero	Anza, Garner		I	30	117,810		Mouth of Santa Ana R upstream, Upstream from confluence of Bautista Canyon & San Jacinto R
1807020301	Upper Santa Ana	Back Country, Big Bear, San Bernardino Front Country, San Gorgonio	X	I	100	58,766		Mouth of Santa Ana R upstream

Forest / HUC5 ID No.	HUC5 Name	Place Names	Priority[1]	Condition Rating[2]	Est. % of HUC Area in Forest	HUC5 Area (acres)	Adjudi-cated	Fully Appropriated
1807020302	Baldwin/Bear	Arrowhead, Back Country, Big Bear, San Bernardino Front Country, San Gorgonio		III	100	57,520		Mouth of Santa Ana R upstream, Unnamed springs @ S 22, T2N, R1W, Van Dusenh Canyon @ Baldwin Lk
1807020303	Middle Santa Ana	Arrowhead, Big Bear, Cajon, San Bernardino Front Country, San Gorgonio	X	III	55	184,582	X	Mouth of Santa Ana R upstream
1807020304	San Timoteo	San Bernardino Front Country		II	10	76,726		Mouth of Santa Ana R upstream
1807020305	Lytle Creek	Cajon, Front Country, Lytle Creek, Mojave Front Country, San Bernardino Front Country	X	II	85	86,105		Mouth of Santa Ana R upstream
1807020306	Santa Ana Inland Empire	Front Country, Lytle Creek		I	12	233,340	X	Mouth of Santa Ana R upstream
1807030202	Cahuilla	Anza, Garner		I	13	100,805		
1809020801	Holcomb	Arrowhead, Back Country, Big Bear, Desert Rim	X	III	100	30,467		
1809020802	Deep Creek	Arrowhead, Back Country, Big Bear, Desert Rim, San Bernardino Front Country, Silverwood	X	III	95	56,308		
1809020803	W Fork Mojave	Arrowhead, Cajon, San Bernardino Front Country, Silverwood		III	75	48,206		Mojave R System
1809020805	El Mirage	Cajon, Mojave Front Country, Silverwood		III	1	515,222		
1810010001	Lucerne	Back Country, Big Bear, Desert Rim		II	55	33,714		Unnamed spring, Arrastre Canyon
1810010002	Lucerne Lake	Desert Rim		II	0.01	267,787		
1810010003	Arrastre	Back Country, Big Bear, Desert Rim, San Gorgonio		I	70	42,900		
1810010004	Pipes Creek	Back Country, San Gorgonio		I	30	25,823		
1810010005	Melville Lake	Back Country, Desert Rim		II	1	150,395		
1810020001	San Gorgonio	Idyllwild, Monument, San Bernardino Front Country, San Gorgonio		II	45	130,428		Confluence of Whitewater R and Salton Sea upstream
1810020002	Upper Whitewater	San Bernardino Front Country, San Gorgonio		I	25	105,534		Confluence of Whitewater R and Salton Sea upstream
1810020004	Palm Canyon	Anza, Garner, Idyllwild, Monument		I	40	100,773		
1810020005	Deep Cyn	Anza, Monument		I	50	34,882		
1810020007	Martinez Canyon	Monument		I	50	32,280		
1810020008	Clark Valley	Monument		I	2	90,167		
1810020009	Coyote Cr.	Anza, Monument		I	1	212,084		
1810020011	San Felipe				1	127,748		
Cleveland								
1807020203	Lower San Jacinto	Anza		II	5	249,634		Mouth of Santa Ana R upstream
1807020307	Temiscal Wash	Elsinore		II	15	185,159		Mouth of Santa Ana R upstream
1807020309	Lower Santa Ana	Elsinore, Silverado		III	25	124,170		Mouth of Santa Ana R upstream
1807030101	Aliso/Laguna	Aguanga, Silverado		II	0.02	40,456		

Forest / HUC5 ID No.	HUC5 Name	Place Names	Priority[1]	Condition Rating[2]	Est. % of HUC Area in Forest	HUC5 Area (acres)	Adjudi-cated	Fully Appropriated
1807030102	San Juan Creek	Elsinore, San Mateo, Silverado	X	III	45	114,107		
1807030104	San Mateo Canyon	Elsinore, San Mateo	X	I	55	85,959		
1807030105	San Onofre/Las Plugas	Elsinore		II	0.04	65,785		
1807030201	Upper Temecula	Aguanga, Palomar		I	43	104,906		Upstream from mouth of Santa Margarita R
1807030203	Lower Temecula	Aguanga		II	10	30,105		Upstream from mouth of Santa Margarita R
1807030204	Murrieta Creek	Elsinore		II	1	142,787		
1807030205	Santa Margarita	Elsinore, San Mateo		II	0.07	478,295		
1807030301	Headwaters San Luis Rey	Aguanga, San Dieguita/Black Mtn., Palomar	X	I	40	133,061		
1807030302	Middle San Luis Rey	Aguanga, Palomar, San Dieguito/Black Mtn	X	II	30	109,996		Upstream from confluence of San Luis Rey R & unnamed stream @ Sec 30, T10S, R2E
1807030401	Upper Santa Ysabel	San Dieguito/Black Mtn, Upper San Diego River		III	1	35,241		
1807030402	Middle Santa Ysabel	San Dieguito/Black Mtn	X	III	30	127,875		
1807030405	Upper San Diego	Upper San Diego River, Interstate 8 Corridor		II	80	119,667		San Diego R system
1807030406	San Vicente	Upper San Diego River		II	7	47,973		
1807030407	Lower San Diego River	Upper San Diego River		II	2	111,962		
1807030408	Upper Sweetwater	Interstate 8 Corridor, Laguna		II	4	63,087		Sweetwater R upstream from Sweetwater Reservoir
1807030409	Lower Sweetwater	Interstate 8 Corridor, Pine Creek Landscape		II	1	53,881		
1807030414	Dulzura	Pine Creek Landscape		III	1	63,725		
1807030501	Upper Cottonwood	Interstate 8 Corridor, Laguna, Morena, Pine Creek Landscape	X	III	85	89,053		
1807030502	Pine Valley	Interstate 8 Corridor, Laguna, Morena, Pine Creek Landscape	X	III	100	69,210		
1807030503	Lower Cottonwood	Pine Creek Landscape		III	5	54,036		
1807030504	Potrero	Morena		III	0.02	69,597		
1810020006	Coachella Valley			I	0.5	646,874		

[1] X signifies priority watershed. Priority status was identified through Interdisciplinary Team (IDT) analysis.

[2] Ratings: I = "properly functioning", II = "functioning at risk", III = "impaired" (USDA Forest Service 2000). Initial ratings from the Angeles and Cleveland were Arbaic numbers (e.g., 2.33); they were rounded to Roman numerals. Ratings determined by IDT analysis.

Table 1 - continued

HUC5 Name	Rate for HUC (CFS/sq mi)			Forest Rate (CFS/sq mi)			Yield for HUC (acre-ft)			Yield for Forest (acre-ft)		
	Mean	Median	10th %ile	Mean	Median	10th %ile	Mean	Median	10th %ile	Mean	Median	10th %ile
Los Padres												
Buena Vista	0.053	0.030	0.019	0.081	0.066	0.038	18064	12098	7216	7174	5843	3328
Upper San Juan Crk	0.037	0.017	0.008	0.037	0.017	0.008	5460	2540	1225	1092	508	245
Lower San Juan Crk	0.027	0.003	0.000	0.027	0.003	0.000	4681	594	0	608	77	0
Lower Estrella River	0.028	0.003	0.000	0.028	0.003	0.000	5577	691	63	112	14	1
Upper Salinas	0.263	0.127	0.018	0.320	0.160	0.025	24126	11909	1799	15580	7771	1202
Paso Robles	0.274	0.125	0.012	0.320	0.160	0.025	58940	27131	2830	4763	2376	368
Huerhuero Creek	0.062	0.001	0.000	0.148	0.054	0.008	7655	355	75	690	250	39
Nacimiento	0.863	0.742	0.359	1.170	0.884	0.328	206563	176044	84036	13759	10396	3859
San Antonio	0.404	0.278	0.051	1.056	0.831	0.241	117488	84476	18620	37107	29213	8452
Chalone	0.384	0.320	0.122	1.480	1.265	0.332	86763	72120	27624	167	143	37
Arroyo Seco	0.678	0.572	0.183	1.480	1.265	0.332	237410	202110	56688	162839	139204	36573
Palo Corona/Little Sur	2.160	1.665	0.536	2.160	1.665	0.536	170449	131379	42276	51135	39414	12683
Big Sur	2.162	1.665	0.536	2.162	1.665	0.536	91459	70421	22661	91459	70421	22661
S Monterey Coastal	2.162	1.665	0.536	2.162	1.665	0.536	211441	162802	52388	179725	138382	44530
N SLO Coastal	1.074	0.953	0.242	0.819	0.598	0.187	228280	199710	51515	17826	13011	4081
S SLO Coastal	0.287	0.069	0.013	0.308	0.091	0.018	56994	13963	2655	4257	1263	252
Arroyo Grande Creek	0.193	0.085	0.036	0.530	0.300	0.130	32545	16566	7099	17595	9946	4323
Upper Cuyama	0.057	0.035	0.017	0.057	0.035	0.017	12259	7490	3612	11034	6741	3251
Cuyama Valley	0.037	0.017	0.008	0.037	0.017	0.008	7943	3696	1782	3575	1663	802
Morales/Taylor	0.060	0.020	0.007	0.060	0.020	0.007	7530	2543	821	1506	509	164
Lower Cuyama	0.106	0.026	0.003	0.106	0.026	0.003	13273	3287	366	5309	1315	146
Alamo	0.076	0.010	0.004	0.086	0.000	0.000	5352	140	48	4387	12	0
Huasna	0.152	0.054	0.005	0.152	0.054	0.005	13073	4659	456	4314	1537	150
Sisquoc	0.173	0.072	0.012	0.173	0.072	0.012	11912	4912	835	10125	4175	710
La Brea	0.072	0.007	0.000	0.072	0.007	0.000	4967	475	0	3974	380	0
Santa Maria	0.061	0.022	0.005	0.061	0.027	0.007	13109	4786	1035	392	175	46
Upper Santa Ynez	0.405	0.216	0.052	0.405	0.216	0.052	63449	33876	8137	63449	33876	8137
Middle Santa Ynez	0.244	0.063	0.003	0.244	0.063	0.003	35611	9166	375	23147	5958	244
Solvang	0.141	0.034	0.003	0.141	0.034	0.003	24972	6089	592	3746	913	89
Upper Carmel	1.328	0.337	0.045	1.494	0.135	0.018	127833	21356	2844	67685	6102	813
W Santa Barbara Coast	0.192	0.120	0.024	0.343	0.194	0.031	36211	21835	4002	13520	7632	1208
E Santa Barbara Coast	0.331	0.143	0.023	0.516	0.269	0.146	48242	23463	9623	29365	15294	8291
Ventura River	0.407	0.135	0.033	0.562	0.250	0.081	81955	33389	10139	55279	24563	7983
Lower Piru	0.159	0.054	0.023	0.159	0.054	0.023	14876	5065	2120	11901	4052	1696
Sespe Creek	0.511	0.263	0.074	0.511	0.263	0.074	99590	51329	14381	94611	48763	13662
Santa Paula	0.455	0.211	0.056	0.455	0.211	0.056	44200	20484	5458	11050	5121	1365
	Rate for HUC (CFS/sq mi)			Forest Rate (CFS/sq mi)			Yield for HUC (acre-ft)			Yield for Forest (acre-ft)		

	Rate for HUC (CFS/sq mi)			Forest Rate (CFS/sq mi)			Yield for HUC (acre-ft)			Yield for Forest (acre-ft)		
HUC5 Name	**Mean**	**Median**	**10th %ile**	**Mean**	**Median**	**10th %ile**	**Mean**	**Median**	**10th %ile**	**Mean**	**Median**	**10th %ile**
Angeles												
Soledad	0.119	0.039	0.012	0.119	0.039	0.012	24428	7919	2470	9771	3168	988
Bouquet	0.084	0.023	0.006	0.084	0.023	0.006	4426	1242	314	3319	931	235
San Francisquito	0.110	0.027	0.008	0.110	0.027	0.008	3963	955	272	3171	764	217
Elizabeth	0.101	0.026	0.010	0.101	0.026	0.010	5241	1341	541	4979	1274	514
Castaic	0.119	0.027	0.005	0.119	0.027	0.005	7175	1638	281	6098	1393	239
Upper Piru	0.262	0.096	0.035	0.262	0.096	0.035	55288	20373	7477	47548	17521	6430
Middle Santa Clara	0.063	0.024	0.003	0.250	0.110	0.030	11638	4540	755	1663	730	201
Upper Los Angeles	0.223	0.146	0.047	0.357	0.155	0.025	57119	35513	10852	8630	3735	595
Big Tujunga	0.209	0.063	0.018	0.209	0.063	0.018	26890	8133	2344	24201	7320	2110
Arroyo Seco	0.504	0.231	0.078	0.630	0.288	0.097	14064	6429	2161	9829	4493	1511
Whittier Narrows	0.538	0.340	0.124	0.695	0.335	0.129	54290	31837	11811	16330	7869	3041
W Fork San Gabriel R	0.628	0.340	0.145	0.628	0.340	0.145	47641	25815	11011	47641	25815	11011
Upper San Gabriel River	0.837	0.481	0.213	0.837	0.481	0.213	56852	32633	14459	56852	32633	14459
Covina	0.269	0.115	0.014	0.483	0.230	0.075	57426	25544	5218	21477	10240	3319
Chino Creek	0.917	0.639	0.277	1.389	0.988	0.460	94797	66492	29544	31809	22616	10525
Quail Lake	0.018	0.001	0.000	0.023	0.002	0.000	4119	281	0	204	14	0
Rodgers Lake	0.000	0.000	0.000	0.001	0.001	0.001	72	72	42	0	0	0
Amargosa	0.045	0.006	0.001	0.045	0.006	0.001	1209	161	13	181	24	2
Little Rock	0.329	0.195	0.067	0.329	0.195	0.067	16664	9890	3369	15831	9396	3201
Big Rock	0.772	0.403	0.192	0.772	0.403	0.192	33797	17632	8405	20278	10579	5043
Sheep	0.770	0.403	0.192	0.770	0.403	0.192	13171	6887	3283	11854	6198	2955
Rock Creek	0.001	0.001	0.000	0.002	0.001	0.000	191	134	19	0	0	0
Swarthout	0.772	0.403	0.192	0.772	0.403	0.192	13967	7287	3473	9777	5101	2431
San Bernardino												
Upper San Jacinto	0.171	0.063	0.037	0.171	0.063	0.037	24417	8907	5316	20754	7571	4519
Bautista/Potrero	0.019	0.002	0.000	0.012	0.000	0.000	2236	202	4	498	19	0
Upper Santa Ana	0.276	0.117	0.053	0.276	0.117	0.053	18348	7797	3513	18348	7797	3513
Baldwin/Bear	0.533	0.307	0.090	0.533	0.307	0.090	34689	19981	5880	34689	19981	5880
Middle Santa Ana	0.074	0.025	0.005	0.570	0.337	0.170	72424	41028	19967	65431	38645	19502
San Timoteo	0.012	0.004	0.001	0.389	0.086	0.003	4308	1036	67	3377	748	25
Lytle Creek	0.248	0.108	0.043	0.248	0.108	0.043	24157	10484	4197	20533	8911	3568
Santa Ana Inland Empire	0.257	0.071	0.022	0.873	0.507	0.181	87413	32529	10810	27637	16057	5746
Cahuilla	0.055	0.032	0.011	0.055	0.032	0.011	6259	3684	1243	814	479	162
Holcomb	0.533	0.307	0.090	0.533	0.307	0.090	18374	10584	3115	18374	10584	3115
Deep Creek	0.533	0.307	0.090	0.533	0.307	0.090	33958	19560	5756	32260	18582	5468
W Fork Mojave	0.403	0.163	0.023	0.403	0.163	0.023	21974	8881	1262	16480	6660	946
El Mirage	0.071	0.033	0.016	0.484	0.189	0.070	43795	20219	9540	2818	1099	407
Lucerne	0.269	0.154	0.045	0.269	0.154	0.045	10269	5856	1723	5648	3221	948
Lucerne Lake	0.001	0.000	0.000	0.005	0.000	0.000	164	0	0	0	0	0

HUC5 Name	Mean	Median	10th %ile	Mean	Median	10th %ile	Mean	Median	10th %ile	Mean	Median	10th %ile
Arrastre	0.032	0.008	0.000	0.032	0.008	0.000	1543	386	13	1080	270	9
Pipes Creek	0.024	0.006	0.000	0.024	0.006	0.000	710	174	6	213	52	2
Melville Lake	0.001	0.000	0.000	0.005	0.000	0.000	100	0	0	9	0	0
San Gorgonio	0.258	0.192	0.110	0.635	0.480	0.274	63083	47502	27070	42147	31891	18178
Upper Whitewater	0.189	0.100	0.048	0.189	0.100	0.048	22522	11923	5731	5630	2981	1433
Palm Canyon	0.136	0.055	0.024	0.320	0.156	0.078	23948	10919	5169	14612	7131	3543
Deep Cyn	0.074	0.019	0.001	0.074	0.019	0.001	2916	745	45	1458	372	23
Martinez Canyon	0.052	0.013	0.001	0.052	0.013	0.001	1887	459	28	944	230	14
Clark Valley	0.021	0.016	0.006	0.021	0.016	0.006	2126	1640	648	43	33	13
Coyote Cr.	0.025	0.015	0.007	0.025	0.015	0.007	6117	3635	1674	61	36	17
San Felipe	0.003	0.003	0.001	0.003	0.003	0.001	494	434	154	5	4	2
Cleveland												
Lower San Jacinto	0.028	0.006	0.001	0.064	0.026	0.012	8507	1877	432	906	366	165
Temiscal Wash	0.061	0.036	0.018	0.067	0.040	0.019	13035	7709	3755	2119	1253	610
Lower Santa Ana	0.164	0.068	0.021	0.619	0.173	0.035	38986	13239	3409	21753	6078	1232
Aliso/Laguna	0.097	0.038	0.001	0.305	0.174	0.078	4454	1737	42	3	2	1
San Juan Creek	0.204	0.075	0.027	0.305	0.174	0.078	32191	15443	6459	17692	10116	4534
San Mateo Canyon	0.117	0.006	0.001	0.144	0.051	0.009	12846	2973	483	7720	2727	456
San Onofre/Las Plugas	0.074	0.014	0.002	0.074	0.014	0.002	5514	1027	125	2	0	0
Upper Temecula	0.053	0.030	0.011	0.053	0.030	0.011	6304	3549	1305	2711	1526	561
Lower Temecula	0.057	0.016	0.007	0.057	0.016	0.007	1958	561	235	196	56	23
Murrieta Creek	0.061	0.012	0.004	0.061	0.012	0.004	9833	1924	648	98	19	6
Santa Margarita	0.057	0.027	0.011	0.057	0.027	0.011	30680	14786	5879	21	10	4
Headwaters San Luis Rey	0.264	0.081	0.015	0.264	0.081	0.015	39722	12265	2270	15889	4906	908
Middle San Luis Rey	0.125	0.095	0.029	0.563	0.285	0.122	31877	18924	7059	21001	10638	4547
Upper Santa Ysabel	0.141	0.031	0.005	0.141	0.031	0.005	5640	1238	186	56	12	2
Middle Santa Ysabel	0.085	0.015	0.002	0.113	0.023	0.002	13456	2522	243	4894	983	69
Upper San Diego	0.253	0.167	0.099	0.253	0.167	0.099	34265	22625	13342	27412	18100	10673
San Vicente	0.187	0.117	0.064	0.187	0.117	0.064	10138	6330	3496	710	443	245
Lower San Diego River	0.124	0.066	0.030	0.124	0.066	0.030	15660	8380	3833	313	168	77
Upper Sweetwater	0.254	0.082	0.007	0.254	0.082	0.007	18109	5836	473	724	233	19
Lower Sweetwater	0.171	0.141	0.063	0.171	0.141	0.063	10433	8601	3810	104	86	38
Dulzura	0.202	0.122	0.001	0.202	0.122	0.001	14578	8774	37	146	88	0
Upper Cottonwood	0.066	0.025	0.007	0.066	0.025	0.007	6649	2543	728	5652	2162	618
Pine Valley	0.160	0.054	0.007	0.160	0.054	0.007	12517	4189	542	12517	4189	542
Lower Cottonwood	0.049	0.005	0.000	0.049	0.005	0.000	3024	318	5	151	16	0
Potrero	0.044	0.005	0.000	0.044	0.005	0.000	3501	361	1	1	0	0
Coachella Valley	0.024	0.012	0.002	0.201	0.121	0.017	18237	9328	1276	735	444	61

Table 2. 1998 and 2002 Impaired Water Bodies (2002 listing is not comprehensive; the 2002 entries only update the Status of 1998 impaired waters. There are other 2002 impaired waters not listed.)

1998 Forest and Water Body	1998 Pollutant/ Stressor	1998 Source	1998 Priority	1998 Start Date (month & year)	1998 End Date	2002 Listed (1=yes)
Cleveland NF Impaired Water Bodies						
Rivers - Water Body Name						
Santiago Creek, Reach 4 80112000	Salinity/TDS/ Chlorides	Unknown	Low	0108	0111	1
Silverado Creek 80112000	Pathogens, Salinity/ TDS/Chlorides	Unknown	Low	0108	0111	1
Aliso Creek 90113000	High Coliform Count	Nonpoint/Point source	Medium	0797	0701	1
San Juan Creek, Lower 90120000	High Coliform Count	Nonpoint/Point source	Low	0700	0710	1
San Bernardino NF Impaired Water Bodies						
Rivers - Water Body Name						
Coachella Valley Storm Channel 71947000	Bacteria	Unknown	Low	2004	2009	1
Green Valley Lake Creek 62820000	Priority Organics	Hazardous waste, Land disposal	Low	Not listed	Not listed	1
Mojave River 628.200?	Priority Organics		High	Not listed	Not listed	0
Grout Creek 80171000	Metals, Nutrients	Unknown nonpt	Medium	0102	0105	1
Knickerbocker Creek 8017100	Metals, Pathogens	Unknown nonpt	Medium	0103	0105	1
Lytle Creek 80141000	Pathogens	Unknown nonpt	Low	0108	0111	1
Mill Creek Reach 2 80158000	Pathogens	Unknown nonpt	Low	0108	0111	1
Mountain Home Creek 80158000	Pathogens	Unknown nonpt	Low	0108	0111	1
Mountain Home Creek, East Fork 80158000	Pathogens	Unknown nonpt	Low	0108	0111	1
Rathbone (Rathbun) Creek[1] 80171000	Nutrients	Snow skiing & Unknown Nonpt	Medium	0102	0105	1
Rathbone (Rathbun) Creek 80171000	Sedimentation/ Siltation	Snow skiing	Medium	0102	0105	1
Summit Creek 8017100	Nutrients	Construction/ Land Development	Medium	0102	0105	1
Lakes - Water Body Name						
Big Bear Lake 8017100	Cooper, Mercury, Metals, Noxious aquatic plants, Nutrients, Sedimentation/Siltation	Resource extraction, Construction/ Land development, Unknown pt, Snow skiing, Unknown nonpt	Medium	0102	0105	1
Fulmor, Lake 80221000	Pathogens	Unknown nonpt	Low	0108	0111	1
Angeles NF Impaired Water Bodies						
Rivers - Water body Name						
Mint Canyon Creek Reach 1 (Confl to Rowler Cyn) 40351000	Nitrate and Nitrite	Nonpoint	Medium	Not Listed	Not Listed	1

1998 Forest and Water Body	1998 Pollutant/ Stressor	1998 Source	1998 Priority	1998 Start Date (month & year)	1998 End Date	2002 Listed (1=yes)
Monrovia Canyon Creek 40531000	Lead	Nonpoint	Low	Not Listed	Not Listed	1
San Gabriel River, East Fork 405.43	Trash	Nonpoint	High	Not Listed	Not Listed	0
Lakes - Water Body Name						
Crystal Lake 40543000	Organic enrichment/Los dissolved oxygen	Nonpoint	Low	Unlisted	Unlisted	1
Elizabeth Lake 40351000	Eutrophic, Organic enrichment/Low dissolved oxygen, pH, Trash	Nonpoint	Medium and Low	Unlisted	Unlisted	1
Lake Hughes 40351000	Algae, Eutrophic, Fish kills, Odors, Trash	Nonpoint	Low and Medium	Unlisted	Unlisted	1
Munz Lake 40351000	Eutrophic, Trash	Nonpoint	Low	Unlisted	Unlisted	1
Los Padres NF Impaired Water Bodies						
Rivers - Water Body Name						
Chorro Creek 31022012	Metals, Nutrients, Sedimentation	Mine Tailings, Resource Extraction, Agriculture, Ag storm runoff, Irrigated Crop Production, Municipal pt sources, Agriculture, Ag storm runoff, Channel erosion, Channelization, Construction/Land Development, Erosion/siltation, Golf course, Hydromodification, Irrigated crops, Natural sources, Nonpt, Range land, Resource extraction, Road construction, Streambank modification/Destabilization, Upland grazing	High	0696	400	1
Arroyo Burro Creek 31532010	Pathogens	Nonpoint, Urban Runoff/Storm Sewers	Medium	0406	0411	1
Carpinteria Creek 31534020	Pathogens	Agriculture, Septage disposal, Nonpoint	Low	0406	0411	1
Mission Creek 31532011	Pathogens, Unknown toxicity	Septage disposal, Urban runoff/Storm sewers	Low	0406	0411	1
San Antonio Creek (Santa Barbara Co 31531011)	Sedimentation/ Siltation	Agriculture, Nonpoint	Low	0406	0411	1
Matilija Creek Reach 1 (Jct. With N. Fork to Reservoir) 40220012	Fish barriers	Dam construction/ operation	Low	Unlisted	Unlisted	1
Matilija Creek Reach 2 (Above Reservoir) 40220010	Fish barriers	Dam construction/ operation	Low	Unlisted	Unlisted	1

1998 Forest and Water Body	1998 Pollutant/ Stressor	1998 Source	1998 Priority	1998 Start Date (month & year)	1998 End Date	2002 Listed (1=yes)
Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd) 40220021	Pumping, Water diversion	Nonpoint	Low	Unlisted	Unlisted	1
Lakes - Water Body Name						
Matilija Reservoir 40220012	Fish barriers	Dam construction/ operation	Low	Unlisted	Unlisted	1

[1] Rathbone (Rathbun) Creek is impaired for different sources for different pollutants. It is therefore listed twice. Other impaired water bodies may have multiple pollutants but the same source for the multiple pollutants.

Sources:

1) TMDLs Completed-1, Staff Report Vol. 1. Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments. 2/03, State Water Resour. Control Brd.

2) 2002 information is from 2/4/03 SWRCB approved list. EPA 6/5/03 and 7/25/03 letters to Celese Cantu (SWRCB) from Alexis Strauss lists several waters EPA wants listed--that the State's 2/4/03 document had de-listed. None of these additional "re-listed" impaired waters were on the Forests.

Table 2 - continued

1998 Forest and Water Body	2002 Pollutant(s)	2002 Priority	2002 Source	2002 Est. Size Affected	2002 Proposed Completion Date
Cleveland NF Impaired Water Bodies					
Rivers - Water Body Name					
Santiago Creek, Reach 4 80112000	Same as 98	Low	Unknown	14 miles	---
Silverado Creek 80112000	Same as 98	Low	Unknown NPS	11 miles	---
Aliso Creek 90113000	Bacteria Indicators	Med	Urban runoff/ storm sewers, unknown pt, NPS	19 miles	---
San Juan Creek, Lower 90120000	Bacteria Indicators	Med	Same as 98	1 mile	---
San Bernardino NF Impaired Water Bodies					
Rivers - Water Body Name					
Coachella Valley Storm Channel 71947000	Pathogens	Med	Same as 98	69 miles	---
Green Valley Lake Creek 62820000	Same as 98	Med	Unknown	3.8 miles	---
Mojave River 628.200?	Water body not listed in 2002	Water body not listed in 2002	"After reviewing the available data and information and the RWQCB documentation for this recommendation, SWRCB staff concludes that the water body should be removed from the section 303(d) list because while pollutants were present in groundwater portion of this intermittent stream, listings are limited to surface waters. The staff confidence that surface water quality standards were exceeded is low. A TMDL is not applicable." (Staff Report Vol. I, Revision of the Clean Water Act section 303(d) list of water quality limited segments. p. Deletions-29. www.swrcb.ca.gov/tmdl/docs/staff_report_303d_vol1_101502.pdf Accessed on-line 6/13/03) Several reaches of the Mojave River are on the State's Monitoring list for 2002.		
Grout Creek 80171000	Same as 98	Metals=med, Nutrients=high	Same as 98	3.5 miles	2004
Knickerbocker Creek 8017100	Same as 98	Metals=med, Pathogens= high	Same as 98	2 miles	2004

1998 Forest and Water Body	2002 pollutant	2002 priority	2002 Source	2002 Est. Size Affected	2002 Proposed Completion Date
Lytle Creek 80141000	Same as 98	Low	Same as 98	41 miles	---
Mill Creek Reach 2 80158000	Same as 98	Low	Same as 98	12 miles	---
Mountain Home Creek 80158000	Same as 98	Low	Same as 98	3.7 miles	---
Mountain Home Creek, East Fork 80158000	Same as 98	Low	Same as 98	5.1 miles	---
Rathbone (Rathbun) Creek[1] 80171000	Same as 98	High	Same as 98	4.7 miles	2004
Rathbone (Rathbun) Creek 80171000	Same as 98	High	Snow skiing & Unknown Nonpt	4.7 miles	2004
Summit Creek 8017100	Same as 98	High	Same as 98	1.5 miles	2004
Lakes - Water Body Name					
Big Bear Lake 8017100	Same as 98	Copper & mercury: medium. High: the rest	Same as 98	2865 acres	2004
Fulmor, Lake 80221000	Same as 98	Low	Same as 98	4.2 acres	---
<u>Angeles NF Impaired Water Bodies</u>					
Rivers - Water body Name					
Mint Canyon Creek Reach 1 (Confl to Rowler Cyn) 40351000	Same as 98	High	Same as 98	8.1 miles	2003
Monrovia Canyon Creek 40531000	Same as 98	High	Same as 98	3.4 miles	2003
San Gabriel River, East Fork 405.43	Not listed in '03. TMDL approved '00	Not listed in '03. TMDL approved '01	San G Riv, East Fork not listed in '02; other reaches of San G Riv are listed. "East Fork San Gabriel River Trash" TMDL listed completed 2000[2]		
Lakes - Water Body Name					
Crystal Lake 40543000	Same as 98	Med	Same as 98	3.7 acres	---
Elizabeth Lake 40351000	Same as 98	Med	Same as 98	123 acres	---
Lake Hughes 40351000	Same as 98	Med	Same as 98	21 acres	---
Munz Lake 40351000	Same as 98	Med	Same as 98	6.6 acres	---

1998 Forest and Water Body	2002 pollutant	2002 priority	2002 Source	2002 Est. Size Affected	2002 Proposed Completion Date
<u>Los Padres NF Impaired Water Bodies</u>					
Rivers - Water Body Name					
Arroyo Burro Creek 31532010	Same as 98	Low	Same as 98	6.1 miles	---
Carpinteria Creek 31534020	Same as 98	Low	Agriculture, land disposal, septage disposal	5.8 miles	---
Chorro Creek 31022012	Fecal Coliform, nutrients, sedimentation/ siltation	Low: fecal coliform High: nutrients & sedimentation/siltation	Coliform: Unknown; Nutrients: municipal point, agriculture, irrigated crops, ag-storm runoff; Sedimentation/siltation: ag, irrigated crops, range grazing (riparian &/or upland), grazing (upland), ag-storm runoff, construction/land development, road construction, hydromodification, channelization, streambank modification/destabilizaiton, channel erosion, erosion/siltation, natural sources, golf course activities, NPS	14 miles	2002
Mission Creek 31532011	Same as 98	Low	Urban runoff/storm sewers, transient encampments	8.6 miles	---
San Antonio Creek (Santa Barbara Co 31531011)	Same as 98 + boron	Low	Same as 98	6.5 miles	---
Matilija Creek Reach 1 (Jct. With N. Fork to Reservoir) 40220012	Same as 98	Low	Dam construction	0.63 miles	---
Matilija Creek Reach 2 (Above Reservoir) 40220010	Same as 98	Low	Dam construction	15 miles	---
Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd) 40220021	Same as 98 + toxicity	Med	Same as 98	19 miles	---
Lakes - Water Body Name					
Matilija Reservoir 40220012	Same as 98	Low	Dam construction	121 acres	---

The blue-green cells identify changes from 1998.

[2] Further documentation re San Gabriel River East Fork: "After reviewing the available data and information and the RWQCB documentation for this recommendation, SWRCB staff conclude that the water body should be placed on the TMDLs Completed List because a TMDL has been developed for the water body-pollutant combination. The TMDL has been approved by USEPA." (Staff Rept Vol 1, 2/03, p. Delections-21)

Table 3. Miscellaneous Characteristics of the Five Largest Reservoirs (by area) on the Four Southern California Forests

Forest	Dam Name	Owner	Stream Dammed	Latitude	Longitude	Capacity (Acre-Feet)	Basin Area (Square Miles)	Area of Reservoir (Acres)	Dam Volume (Cubic Yards)	Year Built
Angeles	Castaic	State Dept Of Water Resources	Castaic Creek	34.52	-118.603	323700	153.7	2235	44000000	1973
	Pyramid	State Dept Of Water Resources	Piru Creek	34.645	-118.763	180000	293	1360	6952000	1973
	Bouquet Canyon	City Of Los Angeles	Bouquet Creek	34.54	-118.383	36505	13.6	628	2966000	1934
	San Gabriel No 1	LA Co Dept Of Public Works	San Gabriel Rv	34.207	-117.858	44183	205	560	10600000	1938
	Elderberry Forebay	City Of Los Angeles	Castaic Creek	34.562	-118.628	28400	81.6	450	5896950	1974
Cleveland	Henshaw	Vista Irrigation District	San Luis Rey Rv	33.24	-116.762	50000	207	2000	500000	1923
	El Capitan	City Of San Diego	San Diego Rv	32.883	-116.81	112800	190	1562	2679680	1934
	Morena	City Of San Diego	Cottonwood Cr	32.685	-116.55	50206	114	1475	335300	1912
	Barrett	City Of San Diego	Cottonwood Cr	32.678	-116.67	44755	252	891	139569	1922
	Sutherland	City Of San Diego	Santa Ysabel Cr	33.118	-116.787	29000	54	550	51500	1954
Los Padres	Santa Felicia	United Water Cons Dist	Piru Creek	34.462	-118.752	100000	421.4	1240	3700000	1955
	Juncal	Montecito Water District	Santa Ynez Rv	34.492	-119.507	6140	13.9	138	40000	1930
	Matilija	Ventura County Fcd	Matilija Creek	34.485	-119.307	1800	55	86	47825	1949
	Eagle Ranch	Helen M Smith	Hale Creek	35.413	-120.678	300	1.39	19	58000	1974
	Glen Anne	U S Bureau Of Reclamation	W Fk Glen Anne Cyn	34.483	-119.879	500	0	16	328000	1953
San Bernardino	Bear Valley	Big Bear Municipal Wd	Bear Creek	34.242	-116.977	74000	48.22	2649	4684	1911
	Cedar Springs	State Dept Of Water Resources	Wfk Mojave Rv	34.307	-117.312	78000	34	990	7630000	1971
	Lake Arrowhead	Arrowhead Lake Association	Little Bear Cr	34.262	-117.167	48000	6.85	780	1300000	1922
	Lake Hemet	Lake Hemet Mun Water Dist	Tr San Jacinto R	33.665	-116.705	14000	67	470	32320	1895
	Lake Gregory	San Bernardino Co Reg Pk Div	Houston Creek	34.243	-117.263	2100	2.8	88	154000	1938

Source: Information Center for the Environment (1997)

Table 4. Summary of HUC Water Yields & Water Allocations for the Four Southern California National Forests

HUC5 Name	Forest 1=LP 2=Ang 3=San B 4=Clev	Estimated HUC Flows (acre-ft) Annual Mean	Mean Annual Flow of Forest Land within HUC	Annual Median	Annual 10th %ile	Total # Rights in State & NRIS Databases[1]	# Rights w/ Max Dir Div (all Forest & partial HUC)	Annual Water Right Allocation--All Forest & Partial HUC (max dir diverted A-F)	Total H2o Right Allocation as % of Annual MEAN Flow/HUC
Alamo	1	5,352	4,387	140	48	37	11	2,225	42
Aliso/Laguna	4	4,454	3	1,737	42	5	0		
Amargosa	2	1,209	181	161	13	13	12	11	0.9
Arrastre	3	1,543	1,153	386	13	15	15	8.8	0.6
Arroyo Grande Creek	1	32,545	17,595	16,566	7,099	13	2	22,446	69
Arroyo Seco (Ang)	2	14,064	9,829	6,429	2,161	6	6	1,457	10
Arroyo Seco (LP)	1	237,410	162,839	202,110	56,688	30	29	774	0.3
Baldwin/Bear	3	34,689	34,485	19,981	5,880	82	82	49	0.1
Bautista/ Potrero	3	2,236	498	202	4	3	2	29,684	1,327
Big Rock	2	33,797	20,278	17,632	8,405	17	17	3,682	11
Big Sur	1	91,459	91,459	70,421	22,661	11	11	24	0.0
Big Tujunga	2	26,890	24,201	8,133	2,344	61	58	266,523	991
Bouquet	2	4,426	3,319	1,242	314	23	23	28	0.6
Buena Vista	1	18,064	7,100	12,098	7,216	45	44	392	2
Cahuilla	3	6,259	814	3,684	1,243	2	2	2.7	0.0
Castaic	2	7,175	6,098	1,638	281	2	2	3.6	0.0
Chalone	1	86,763	167	72,120	27,624	0	0		
Chino Creek	2	94,797	31,809	66,492	29,544	16	15	35,515	37
Clark Valley	3	2,126	46	1,640	648	0	0		
Coachella Valley	4	18,237	735	9,328	1,276	2	2	7,242	40
Covina	2	57,426	21,477	25,544	5,218	54	31	679,132	1,183
Coyote Cr.	3	6,117	61	3,635	1,674	1	1	0.3	0.0
Cuyama Valley	1	7,943	5,748	3,696	1,782	23	23	22	0.3
Deep Creek	3	33,958	32,260	19,560	5,756	39	36	142	0.4
Deep Cyn	3	2,916	1,458	745	45	1	1	6.5	0.2
Dulzura	4	14,578	146	8,774	37	2	0		
East Santa Barbara Coast	1	48,242	29,365	23,463	9,623	45	37	25,366	53
El Mirage	3	43,795	2,818	20,219	9,540	15	0		

HUC5 Name	Forest 1=LP 2=Ang 3=San B 4=Clev	Estimated HUC Flows (acre-ft) Annual Mean	Mean Annual Flow of Forest Land within HUC	Annual Median	Annual 10th %ile	Total # Rights in State & NRIS Databases[1]	# Rights w/ Max Dir Div (all Forest & partial HUC)	Annual Water Right Allocation--All Forest & Partial HUC (max dir diverted A-F)	Total H2o Right Allocation as % of Annual MEAN Flow/HUC
Elizabeth	2	5,241	4,942	1,341	541	15	15	3,682	70
Headwaters San Luis Rey	4	39,722	15,889	12,265	2,270	24	10	2,193	5.5
Holcomb	3	18,374	18,266	10,584	3,115	18	18	22	0.1
Huasna	1	13,073	4,314	4,659	456	33	2	2.9	0.0
Huerhuero Creek	1	7,655	690	355	75	24	9	255	3.3
La Brea	1	4,967	3,974	475	0	5	4	1.3	0.0
Little Rock	2	16,664	15,831	9,890	3,369	11	9	90,509	543
Lower Cottonwood	4	3,024	151	318	5	4	2	8.6	0.3
Lower Cuyama	1	13,273	5,309	3,287	366	29	18	12	0.1
Lower Estrella	1	5,577	112	691	63	2	1	7.2	0.1
Lower Piru	1/2	14,876	11,901	5,065	2,120	10	9	16	0.1
Lower San Diego River	4	15,660	313	8,380	3,833	0	0		
Lower San Jacinto	4	8,507	847	1,877	432	5	4	1,465	17
Lower San Juan Crk	1	4,681	608	594	0	28	13	68	1.5
Lower Santa Ana	4	38,986	21,753	13,239	3,409	17	12	23,242	60
Lower Sweetwater	4	10,433	104	8,601	3,810	1	0		
Lower Temecula	4	1,958	196	561	235	0	0		
Lucerne	3	10,269	5,663	5,856	1,723	20	18	794	8
Lucerne Lake	3	164	0	0	0	1	0		
Lytle Creek	3	24,157	20,533	10,484	4,197	32	31	118,093	489
Martinez Canyon	3	1,887	913	459	28	1	1	0.2	0.0
Melville Lake	3	100	17	0	0	0	0		
Middle San Luis Rey	4	31,877	21,001	18,924	7,059	87	78	165,849	520
Middle Santa Ana	3	72,424	65,431	41,028	19,967	72	69	15,111,302	20,865
Middle Santa Clara	2	11,638	1,663	4,540	755	6	5	9	0.1
Middle Santa Ynez	1	35,611	23,147	9,166	375	39	13	32	0.1
Middle Santa Ysabel	4	13,456	4,894	2,522	243	17	5	22	0.2
Morales/Taylor	1	7,530	1,506	2,543	821	25	22	414	5.5
Murrieta Creek	3/4	9,833	80	1,924	648	0	0		
Nacimiento	1	206,563	13,759	176,044	84,036	4	4	4.1	0.0
North SLO Coastal	1	228,280	17,826	199,710	51,515	30	13	4,401	1.9
Palm Canyon	3	23,948	14,612	10,919	5,169	9	6	10,137	42

HUC5 Name	Forest 1=LP 2=Ang 3=San B 4=Clev	Estimated HUC Flows (acre-ft) Annual Mean	Mean Annual Flow of Forest Land within HUC	Annual Median	Annual 10th %ile	Total # Rights in State & NRIS Databases[1]	# Rights w/ Max Dir Div (all Forest & partial HUC)	Annual Water Right Allocation--All Forest & Partial HUC (max dir diverted A-F)	Total H2o Right Allocation as % of Annual MEAN Flow/HUC
Palo Corona/Little Sur	1	170,449	51,135	131,379	42,276	63	58	10,357	6.1
Paso Robles	1	58,940	4,763	27,131	2,830	62	12	18,851	32
Pine Valley	4	12,517	11,695	4,189	542	25	20	37	0.3
Pipes Creek	3	710	227	174	6	1	1	0.8	0.1
Potrero	4	3,501	1	361	1	0	0		
Quail Lake	2	4,119	204	281	0	9	9	48	1.2
Rock Creek	2	191	0	134	19	4	4	23	12
Rodgers Lake	2	72	0	72	42	0	0		
San Antonio	1	117,488	37,107	84,476	18,620	16	14	1,476	1.3
San Felipe	3	494	5	434	154	21	19	760	154
San Francisquito	2	3,963	2,593	955	272	8	8	24	0.6
San Gorgonio	3	63,083	42,147	47,502	27,070	27	23	59,390	94
San Juan Creek	4	32,191	17,692	15,443	6,459	28	27	75	0.2
San Mateo Canyon	4	12,846	7,720	2,973	483	9	6	34	0.3
San Onofre/ Las Plugas	4	5,514	2	1,027	125	0	0		
San Timoteo	3	4,308	3,377	1,036	67	15	9	10,155	236
San Vicente	4	10,138	710	6,330	3,496	1	0		
Santa Ana Inland Empire	3	87,413	27,637	32,529	10,810	27	9	734	0.8
Santa Margarita	4	30,680	21	14,786	5,879	6	3	5.4	0.0
Santa Maria	1	13,109	392	4,786	1,035	3	1	0.2	0.0
Santa Paula	1	44,200	11,050	20,484	5,458	7	6	10	0.0
Sespe Creek	1	99,590	94,611	51,329	14,381	12	12	2,945	3.0
Sheep	2	13,171	11,854	6,887	3,283	16	15	4,356	33
Sisquoc	1	11,912	10,125	4,912	835	22	20	16	0.1
Soledad	2	24,428	9,771	7,919	2,470	46	45	3,021	12
Solvang	1	24,972	3,746	6,089	592	32	31	647	2.6
South Monterey Coastal	1	211,441	179,725	162,802	52,388	95	90	1,006	0.5
South SLO Coastal	1	56,994	4,257	13,963	2,655	84	45	13,153	23
Swarthout	2	13,967	9,755	7,287	3,473	22	18	13,802	99
Temiscal Wash	4	13,035	1,926	7,709	3,755	23	18	20,294	156
Upper Carmel	1	127,833	67,685	21,356	2,844	10	8	45,616	36
Upper Cottonwood	4	6,649	3,853	2,543	728	36	33	54	0.8

HUC5 Name	Forest 1=LP 2=Ang 3=San B 4=Clev	Estimated HUC Flows (acre-ft): Annual Mean	Mean Annual Flow of Forest Land within HUC	Annual Median	Annual 10th %ile	Total # Rights in State & NRIS Databases[1]	# Rights w/ Max Dir Div (all Forest & partial HUC)	Annual Water Right Allocation--All Forest & Partial HUC (max dir diverted A-F)	Total H2o Right Allocation as % of Annual MEAN Flow/HUC
Upper Cuyama	1	12,259	11,034	7,490	3,612	32	31	937	7.6
Upper Los Angeles	2	57,119	8,630	35,513	10,852	11	8	15	0.0
Upper Piru	2	55,288	47,548	20,373	7,477	42	41	2,477	4.5
Upper Salinas	1	24,126	15,580	11,909	1,799	43	12	133,763	554
Upper San Diego River	4	34,265	27,073	22,625	13,342	19	16	3,675,010	10,725
Upper San Gabriel River	2	56,852	56,852	32,633	14,459	8	7	2,902	5.1
Upper San Jacinto	3	24,417	20,754	8,907	5,316	45	39	74,649	306
Upper San Juan Crk	1	5,460	1,756	2,540	1,225	26	7	40	0.7
Upper Santa Ana	3	18,348	18,392	7,797	3,513	14	11	579,235	3,157
Upper Santa Ynez	1	63,449	63,449	33,876	8,137	13	10	218,648	345
Upper Santa Ysabel	4	5,640	58	1,238	186	7	1	13,756	244
Upper Sweetwater	4	18,109	724	5,836	473	8	5	4.4	0.0
Upper Temecula	4	6,304	2,711	3,549	1,305	14	11	38	0.6
Upper Whitewater	3	22,522	5,630	11,923	5,731	5	4	28,236	125
Ventura River	1	81,955	55,279	33,389	10,139	33	29	35,492	43
West Fk Mojave	3	21,974	16,480	8,881	1,262	46	41	18,991	86
West Fork San Gabriel River	2	47,641	47,641	25,815	11,011	25	23	81	0.2
West Santa Barbara Coast	1	36,211	13,520	21,835	4,002	31	22	32,024	88
Whittier Narrows	2	54,290	16,330	31,837	11,811	21	14	41	0.1

[1] Includes all known rights, many with maximum direct diversion and/or maximum storage values and a few with neither.

[2] No flow estimated.

Sources: State & NRIS Water Rights databases. See Table 1 for flows.

Table 4 - continued

HUC5 Name	Total H2o Right Allocation as % of Annual MEDIAN Flow/HUC	Total H2o Right Allocation as % of Annual 10th %ile Flow/HUC	# FS Rights	H2o Allocation in FS Rights (max dir div A-F)	% FS Rights of Total # Rights with Direct Diversion	% FS Allocation of Total H2o Allocation	Comment
Alamo	1,585	4,624	11	2,225	100	100	
Aliso/Laguna	0	0					
Amargosa	7	82	0	0	0	0	
Arrastre	2	66	15	9	100	100	
Arroyo Grande Creek	135	316	1	3	50	0	Over 99% of h2o allocated to SLO Cnty FC&WCD
Arroyo Seco (Ang)	23	67	5	9	83	1	
Arroyo Seco (LP)	0	1	22	765	76	99	
Baldwin/Bear	0	1	14	12	17	25	
Bautista/ Potrero	14,698	763,690	1	0	50	0	Over 99% of h2o allocated to Eastern Muni. WD
Big Rock	21	44	5	30	29	1	
Big Sur	0	0	4	15	36	63	
Big Tujunga	3,277	11,370	22	266,465	38	100	Over 99% of h2o allocated to Angeles NF (Baughman Spg on Mill Crk)
Bouquet	2	9	14	23	61	84	
Buena Vista	3	5	26	327	59	83	
Cahuilla	0	0	1	2	50	69	
Castaic	0	1	2	4	100	100	
Chalone	0	0					
Chino Creek	53	120	11	39	73	0	
Clark Valley	0	0					
Coachella Valley	78	568	0	0	0	0	
Covina	2,659	13,015	10	13	32	0	88% of total h2o allocated to G. McGarigle (137559 a-f), LA Cnty Flood Control (220818 a-f), Monrovia Nursery (119459 a-f) & San Gabriel River Water Committee (119459 a-f)
Coyote Cr.	0	0	1	0	100	100	
Cuyama Valley	1	1	21	21	91	94	
Deep Creek	1	2	14	27	39	19	
Deep Cyn	1	14	0	0	0	0	
Dulzura	0	0					
East Santa Barbara Coast	108	264	0	0	0	0	
El Mirage	0	0					

HUC5 Name	Total H2o Right Allocation as % of Annual MEDIAN Flow/HUC	Total H2o Right Allocation as % of Annual 10th %ile Flow/HUC	# FS Rights	H2o Allocation in FS Rights (max dir div A-F)	% FS Rights of Total # Rights with Direct Diversion	% FS Allocation of Total H2o Allocation	Comment
Elizabeth	275	680	9	3,632	60	99	
Headwaters San Luis Rey	18	97	4	728	40	33	
Holcomb	0	1	18	22	100	100	
Huasna	0	1	2	3	100	100	
Huerhuero Creek	72	339	6	254	67	100	
La Brea	0	--[2]	4	1	100	100	
Little Rock	915	2,686	8	9	89	0	99+% of total h2o allocated to Palmdale Irrigation Dist
Lower Cottonwood	3	163	1	1	50	8	
Lower Cuyama	0	3	18	12	100	100	
Lower Estrella	1	11	1	7	100	100	
Lower Piru	0	1	7	10	78	64	
Lower San Diego River	0	0					
Lower San Jacinto	78	339	0	0	0	0	
Lower San Juan Crk	12	--	13	68	100	100	
Lower Santa Ana	176	682	5	10	42	0	93+% of total h2o allocated to Serrano Water Dist
Lower Sweetwater							
Lower Temecula							
Lucerne	14	46	5	2	28	0	
Lucerne Lake	--	--					
Lytle Creek	1,126	2,814	12	20	39	0	Over 99% of total h2o allocated to S CA Edison (69504 a-f), W San Bernardino Cnty Water Dist (5068), Fontana Union Water Comp (43440 a-f)
Martinez Canyon	0	1	1	0	100	100	
Melville Lake	--	--					
Middle San Luis Rey	876	2,349	1	2	1	0	Over 61% of total h2o allocated to 2 irrigation districts
Middle Santa Ana	36,831	75,682	9	28	13	0	Over 99% of total h2o allocated to S CA Edison & San Bernardino Valley Muni WD
Middle Santa Clara	0	1	2	2	40	24	
Middle Santa Ynez	0	8	7	19	54	61	
Middle Santa Ysabel	1	9	5	22	100	100	
Morales/Taylor	16	50	12	405	55	98	
Murrieta Creek							

HUC5 Name	Total H2o Right Allocation as % of Annual MEDIAN Flow/HUC	Total H2o Right Allocation as % of Annual 10th %ile Flow/HUC	# FS Rights	H2o Allocation in FS Rights (max dir div A-F)	% FS Rights of Total # Rights with Direct Diversion	% FS Allocation of Total H2o Allocation	Comment
Nacimiento	0	0	4	4	100	100	
North SLO Coastal	2	9	1	0	8	0	
Palm Canyon	93	196	2	1	33	0	
Palo Corona/Little Sur	8	24	6	44	10	0	
Paso Robles	69	666	1	1	8	0	
Pine Valley	1	7	18	21	90	59	
Pipes Creek	0	14	1	1	100	100	
Potrero	0	0					
Quail Lake	17	--	0	0	0	0	
Rock Creek	17	121	0	0	0	0	
Rodgers Lake	0	0					
San Antonio	2	8	11	1,475	79	100	
San Felipe	175	494	1	0	5	0	Over 95% of h2o allocated to 1 private right
San Francisquito	2	9	3	6	38	26	
San Gorgonio	125	219	3	16	13	0	Over 85% of h2o allocated to Coachella Valley WD
San Juan Creek	0	1	17	61	63	82	
San Mateo Canyon	1	7	6	34	100	100	
San Onofre/ Las Plugas	0	0					
San Timoteo	980	15,088	0	0	0	0	Over 71% of h2o allocated to Beaumont-Cherry Valley W D
San Vicente	0	0					
Santa Ana Inland Empire	2	7	2	2	22	0	
Santa Margarita	0	0	0	0	0	0	
Santa Maria	0	0	1	0	100	100	
Santa Paula	0	0	0	0	0	0	
Sespe Creek	6	20	2	44	17	1	
Sheep	63	133	3	9	20	0	
Sisquoc	0	2	20	16	100	100	
Soledad	38	122	13	21	29	1	
Solvang	11	109	24	606	77	94	
South Monterey Coastal	1	2	20	14	22	1	
South SLO Coastal	94	495	3	1,449	7	11	
Swarthout	189	397	2	12	11	0	
Temiscal Wash	263	540	0	0	0	0	82+% of h2o allocated to Elsinore Valley Muni. WD
Upper Carmel	214	1,604	5	4	63	0	
Upper Cottonwood	2	7	27	45	82	83	

HUC5 Name	Total H2o Right Allocation as % of Annual MEDIAN Flow/HUC	Total H2o Right Allocation as % of Annual 10th %ile Flow/HUC	# FS Rights	H2o Allocation in FS Rights (max dir div A-F)	% FS Rights of Total # Rights with Direct Diversion	% FS Allocation of Total H2o Allocation	Comment
Upper Cuyama	13	26	29	935	94	100	
Upper Los Angeles	0	0	2	0	25	1	
Upper Piru	12	33	24	1,018	59	41	
Upper Salinas	1,123	7,436	10	125,076	83	94	Over 93% of h2o allocated to 1 FS right, on Arroyo Seco R
Upper San Diego River	16,243	27,545	8	12	50	0	Over 98% of h2o allocated to La Mesa Irrig. Dist.
Upper San Gabriel River	9	20	4	6	57	0	
Upper San Jacinto	838	1,404	16	50	41	0	Over 99% of h2o allocated to 2 water districts
Upper San Juan Crk	2	3	7	40	100	100	
Upper Santa Ana	7,429	16,489	7	31	64	0	Over 99% of h2o allocated to San Bernardino Valley Muni. WD
Upper Santa Ynez	645	2,687	4	2	40	0	Over 99% of h2o allocated to Stan Water Resources Control Brd
Upper Santa Ysabel	1,111	7,385	0	0	0	0	All water allocated to City of San Diego
Upper Sweetwater	0	1	4	3	80	57	
Upper Temecula	1	3	3	1	27	2	
Upper Whitewater	237	493	1	0	25	0	Over 99% of h2o allocated to S CA Edison
Ventura River	106	350	0	11	0	0	
West Fk Mojave	214	1,505	8	7	20	0	
West Fork San Gabriel River	0	1	23	81	100	100	
West Santa Barbara Coast	147	800	2	157	9	0	Over 54% of h2o allocated to US Bur Rec
Whittier Narrows	0	0	6	25	43	62	

Figure 4. HUC Streamflow Rates, Weighted by HUC Area

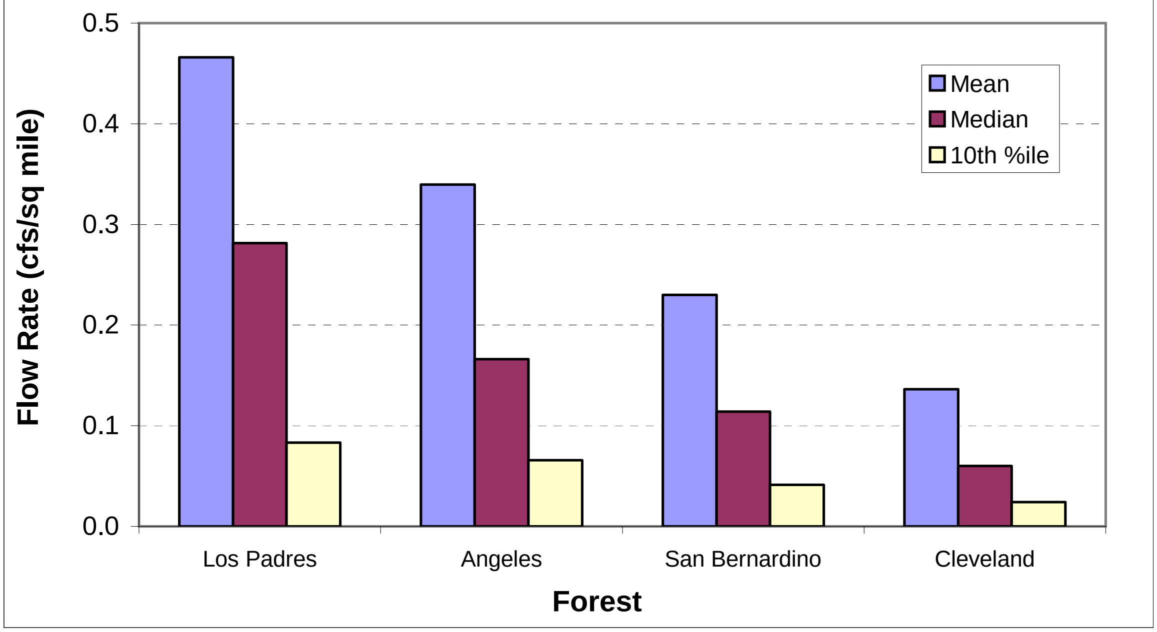


Figure 5. Forest Streamflow Rates, Weighted by HUC Area

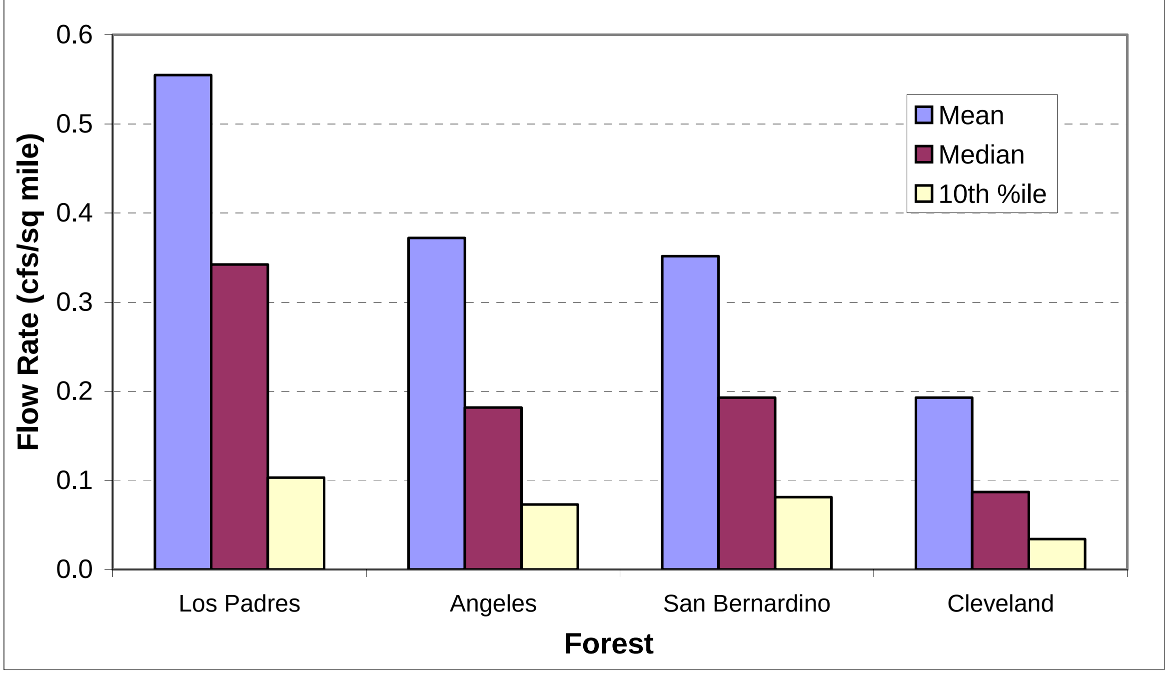


Figure 6a. Annual Flows at 3 "Moderately-Wet", Un-regulated/ Un-diverted Southern California Stream Gages, with Percentiles

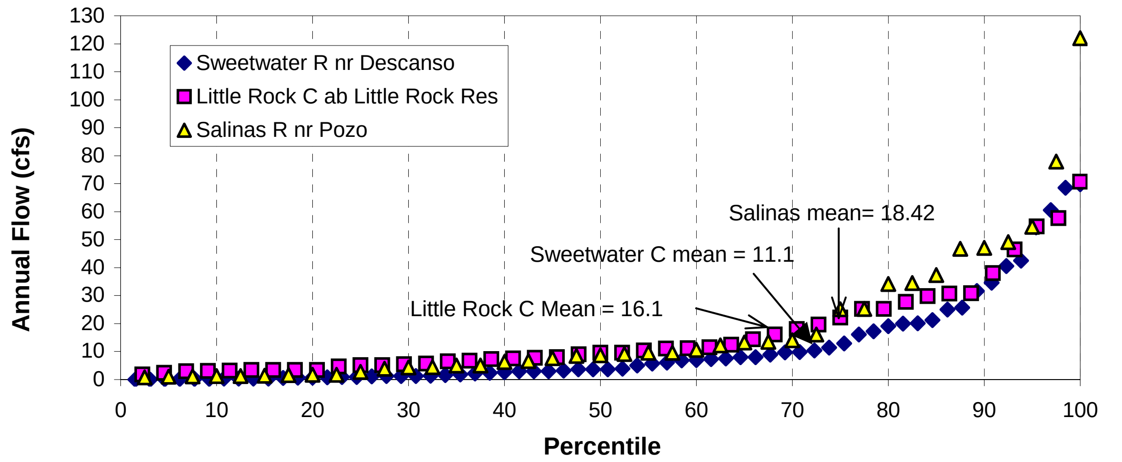


Figure 6b. Annual Flows at 3 "Wet", Un-regulated/diverted Southern California Stream Gages, with Percentiles

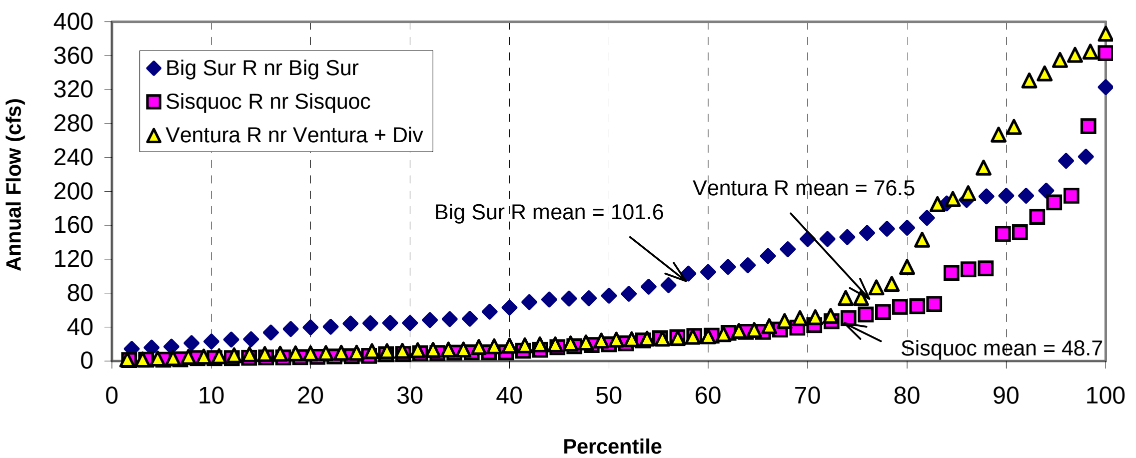
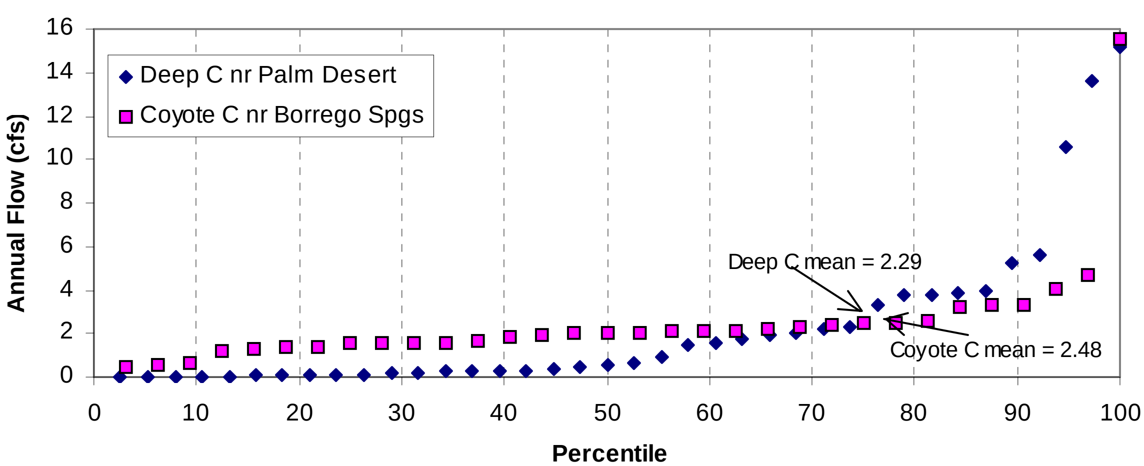


Figure 6c. Annual Flows at 2 "Dry", Un-regulated/diverted Southern California Stream Gages, with Percentiles



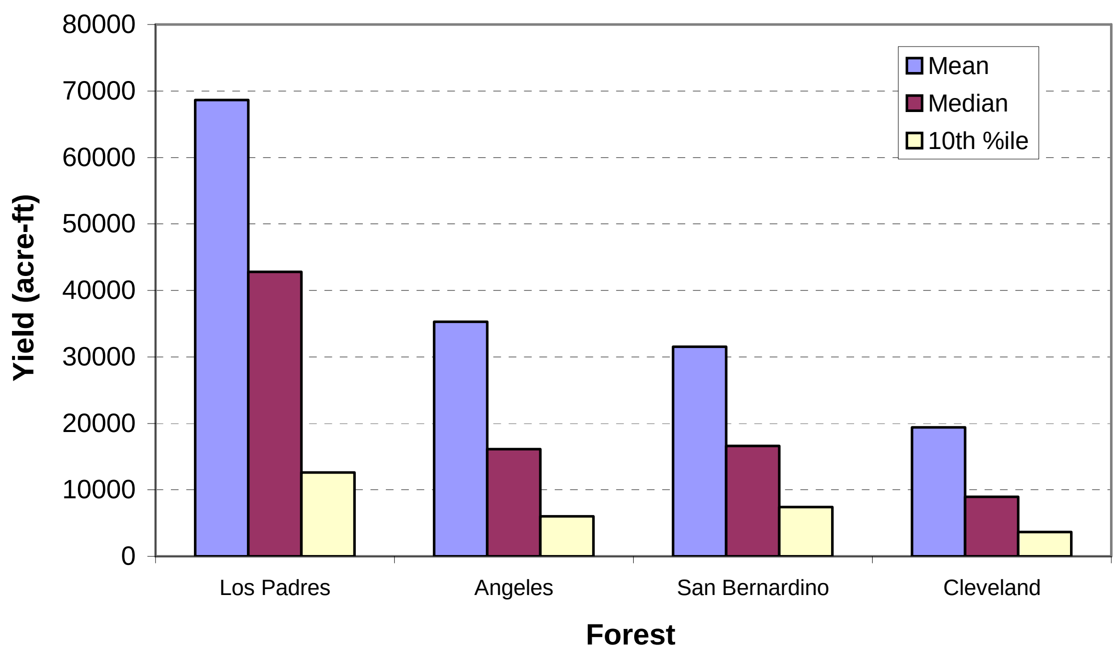


Figure 7. HUC Water Yield, Weighted by HUC Area

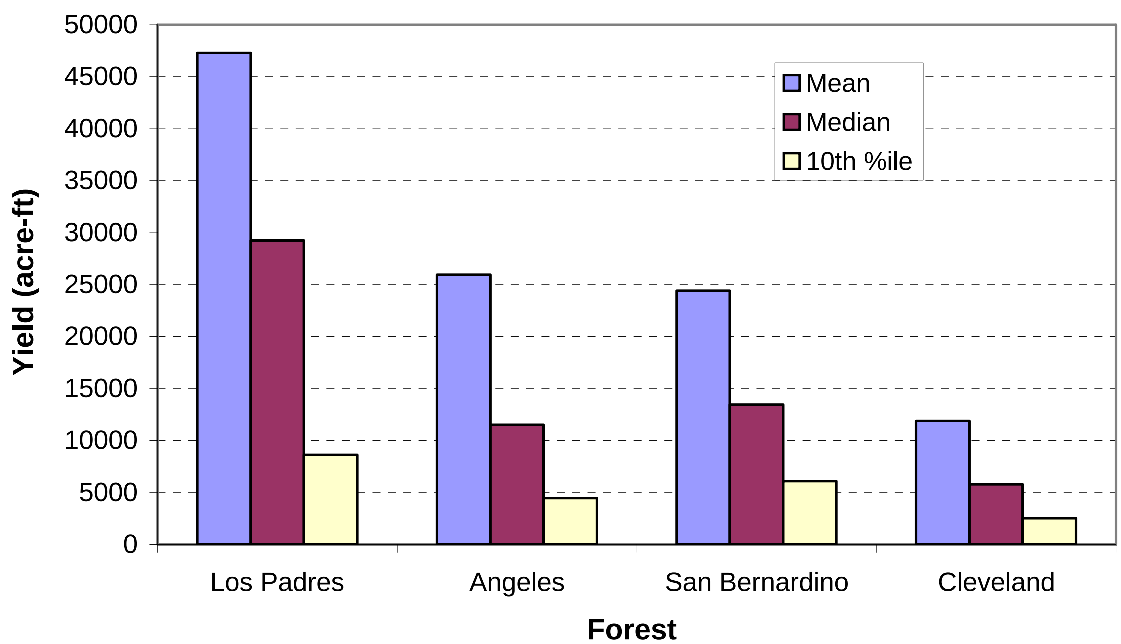


Figure 8. Forest Water Yield, Weighted by HUC Area

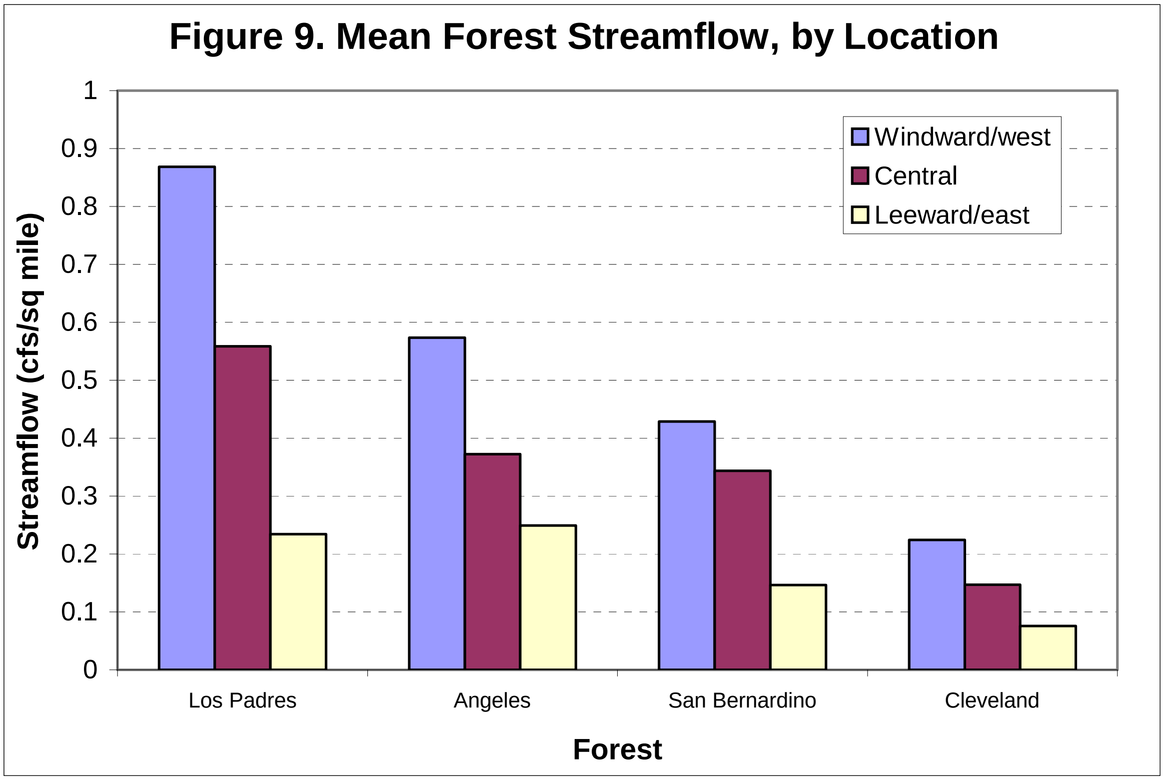


Figure 9. Mean Forest Streamflow, by Location
Streamflow (cfs/sq mile)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Windward/west
Central
Leeward/east
Los Padres
Angeles
San Bernardino
Cleveland
Forest

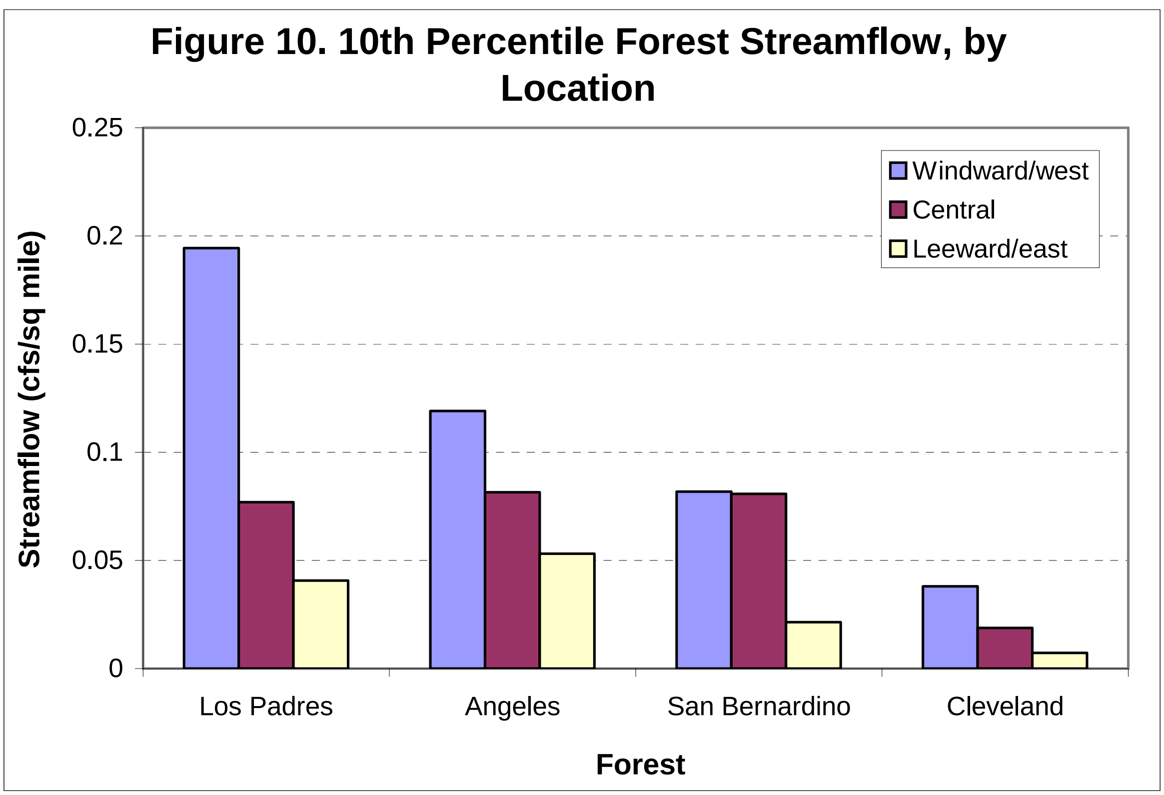


Figure 10. 10th Percentile Forest Streamflow, by Location
Streamflow (cfs/sq mile)
0.25
0.2
0.15
0.1
0.05
0
Windward/west
Central
Leeward/east
Los Padres
Angeles
San Bernardino
Cleveland
Forest

Appendix I. Miscellaneous Characteristics of Reservoirs on or near National Forests in Southern California

Dam Name:	Castaic	Pyramid	Bouquet Canyon	San Gabriel No 1	Elderberry Forebay	Morris	Fairmont	Cogswell	Littlerock	Big Tujunga No 1	Dry Canyon
Forest:	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles
Location:	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest
DWR Dam Number:	1-058	1-066	6-031	32-019	6-049	32-040	6-008	32-005	57-000	32-006	6-005
Owner:	State Dept Of Water Resources	State Dept Of Water Resources	City Of Los Angeles	LA Co Dept Of Public Works	City Of Los Angeles	LA Co Dept Of Public Works	City Of Los Angeles	LA Co Dept Of Public Works	Little Rock Creek Id	LA Co Dept Of Public Works	City Of Los Angeles
County:	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles
Stream Dammed:	Castaic Creek	Piru Creek	Bouquet Creek	San Gabriel Rv	Castaic Creek	San Gabriel Rv	Antelope Valley	W Fk San Gabriel R	Littlerock Cr	Big Tujunga Cr	Dry Canyon Cr
National Dam ID:	CA00044	CA00052	CA00088	CA00200	CA01080	CA00216	CA00071	CA00190	CA00237	CA00191	CA00068
Latitude:	34.52	34.645	34.54	34.207	34.562	34.173	34.687	34.245	34.485	34.293	34.482
Longitude:	-118.603	-118.763	-118.383	-117.858	-118.628	-117.88	-118.427	-117.965	-118.022	-118.187	-118.527
Dam Type:	ERTH	ERRK	ERTH	ERRK	ERTH	GRAV	HYDF	ROCK	GRAV	VARA	HYDF
Capacity (Acre-Feet):	323700	180000	36505	44183	28400	27500	7507	8969	4600	5750	1140
Basin Area (Square Miles):	153.7	293	13.6	205	81.6	210	2.64	38.4	63.7	82	4.5
Area of Reservoir (Acres):	2235	1360	628	560	450	420	172	146	126	83	58
Parapet:	No Wall	No Wall	No Wall	No Wall	No Wall	No Wall	No Wall	Structural Impound Wall	No Wall	Structural Impound Wall	Structural Impound Wall
Parapet Wall Height (Ft above Crest):	340	386	190	320	179	245	121	266	124	208	66
Elevation of Crest (Ft Above Sea Level):	1535	2606	3008	1481	1550	1175	3043	2412	3286	2308	1520
Crest Length (Ft):	5200	1080	1180	1520	1935	750	4300	585	576	505	780
Crest to Lower Outside Limit of Dam (Ft):	340	386	190	320	179	245	121	266	124	208	66
Freeboard, Vertical Distance (Ft):	20	58	15	28	20	23	9	27	16	18	8.6
Operating Freeboard (Ft):	0	27	0	0	0	5	0	0	0	0	18
Crest Width (Ft):	40	30	50	40	25	20	16	18	7	8	20
Dam Volume (Cubic Yards):	44000000	6952000	2966000	10600000	5896950	513956	696300	1044945	25200	79293	360000
Year Built:	1973	1973	1934	1938	1974	1935	1912	1935	1924	1931	1912

Dam Name:	San Dimas	Fairmont No 2	Big Dalton	Big Santa Anita	Little Dalton Debris Basin	Drinkwater	Brown Mtn Barrier	San Antonio	Thompson Creek	Puddingstone Div (Db)	Live Oak
Forest:	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles
Location:A28	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	32-010	6-053	32-000	32-002	32-028	6-016	9000-341	9000-023	32-015	32-016	32-007
Owner:	LA Co Dept Of Public Works	City Of Los Angeles	LA Co Dept Of Public Works	LA Co Dept Of Public Works	LA Co Dept Of Public Works	City Of Los Angeles	Forest Service	Corps Of Engineers	LA Co Dept Of Public Works	LA Co Dept Of Public Works	LA Co Dept Of Public Works
County:	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles	San Bernardino	Los Angeles	Los Angeles	Los Angeles
Stream Dammed:	San Dimas Creek	Tr Antelope Vy Cr	Big Dalton Wash	Trib Rio Hondo	Lit Dalton Can	Offstream	Arroyo Seco	San Antonio Creek	Thompson Creek	San Dimas Creek	Live Oak Creek
National Dam ID:	CA00195	CA01295	CA00187	CA00188	CA01154	CA00077	CA82421	CA10023	CA00198	CA00199	CA00192
Latitude:	34.155	34.705	34.17	34.183	34.157	34.53	34.239	34.157	34.14	34.132	34.133
Longitude:	-117.772	-118.435	-117.808	-118.018	-117.837	-118.522	-118.178	-117.68	-117.71	-117.782	-117.745
Dam Type:	GRAV	ERTH	MULA	VARA	ERTH	ERTH	GRAV	ERTH	ERTH	ERTH	GRAV
Capacity(Acre-Feet):	1534	493	1290	858	234	92	600	9285	543	195	239
Basin Area(Square Miles):	15.9	0.08	4.3	10.8	3.3	0.03	15	111	3.46	18.5	2.3
Area of Reservoir(Acres):	36	28	26	17	8	4	0	793	345	16	12
Parapet:	Structural Impound Wall	No Wall	Structural Impound Wall	Structural Impound Wall	No Wall	No Wall	No Wall	N/A	No Wall	No Wall	Structural Impound Wall
Parapet Wall Height(Ft above Crest):	131	24	153	225	71	105	81	160	66	34	76
Elevation of Crest(Ft Above Sea Level):	1481	3040	1714	1328	1200	2060	0	2260	1648	1164	1506
Crest Length(Ft):	340	4437	480	612	543	448	120	3850	1500	825	303
Crest to Lower Outside Limit of Dam(Ft):	131	24	153	225	71	105	81	160	66	34	76
Freeboard, Vertical Distance(Ft):	19	5	8	12	14	5	0	22	13.7	11	9
Operating Freeboard(Ft):	0	0	74	0	38	0	0	0	0	0	0
Crest Width(Ft):	11	30	1	7	20	26	0	0	15	15	6
Dam Volume(Cubic Yards):	41286	0	45049	76184	691000	107000	0	6050000	196931	89611	11735
Year Built:	1922	1982	1929	1927	1960	1923	1942	1956	1928	1928	1922

Dam Name:	Big Dalton Db	Sawpit	Sawpit Db	Wilson Db	Deer Canyon Db	Morgan Debris Basin	Blanchard Db	Pickens M1	Henshaw	El Capitan
Forest:	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Angeles	Cleveland	Cleveland
Location:A28	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	In Forest	In Forest
DWR Dam Number:	32-030	32-012	32-031	32-035	87-011	32-039	32-025	9000-340	69-002	8-007
Owner:	LA Co Dept Of Public Works	LA Co Dept Of Public Works	LA Co Dept Of Public Works	LA Co Dept Of Public Works	San Bernardino Co Fc Dist	LA Co Dept Of Public Works	LA Co Dept Of Public Works	Forest Service	Vista Irrigation District	City Of San Diego
County:	Los Angeles	Los Angeles	Los Angeles	Los Angeles	San Bernardino	Los Angeles	Los Angeles	Los Angeles	San Diego	San Diego
Stream Dammed:	Big Dalton Wash	Sawpit Creek	Sawpit Wash	Wilson Canyon	Deer Creek	Morgan Canyon Crk	Blanchard Can	Mullaly Branch	San Luis Rey Rv	San Diego Rv
National Dam ID:	CA01156	CA00196	CA01157	CA01162	CA01231	CA01385	CA01151	CA82427	CA00283	CA00111
Latitude:	34.155	34.175	34.168	34.33	34.173	34.141	34.253	34.239	33.24	32.883
Longitude:	-117.832	-117.987	-117.992	-118.445	-117.57	-117.82	-118.27	-118.217	-116.762	-116.81
Dam Type:	ERTH	CORA	ERTH	ERTH	ERTH	ERTH	ERTH	GRAV	HYDF	HYDF
Capacity(Acre-Feet):	193	406	152	84	24	21	26	16	50000	112800
Basin Area(Square Miles):	2.9	3.27	2.87	2.6	3.71	0.6	0.5	0.3	207	190
Area of Reservoir(Acres):	10	9	6	5	3	2	1	0	2000	1562
Parapet:	No Wall	Structural Impound Wall	No Wall	No Wall	No Wall	Structural Impound Wall	No Wall	No Wall	Non-Structural Wall	No Wall
Parapet Wall Height(Ft above Crest):	59	150	82	50	78	37	35	27	123	237
Elevation of Crest(Ft Above Sea Level):	1148	1378	1000	1543	2677.5	1169.9	2065	0	2740	770
Crest Length(Ft):	840	527	520	666	1857	380	925	104	650	1170
Crest to Lower Outside Limit of Dam(Ft):	59	150	82	50	78	37	35	27	123	237
Freeboard, Vertical Distance(Ft):	16.5	18	18	17	19.5	7.9	11.5	0	50	20
Operating Freeboard(Ft):	0	68	42	0	0	0	0	0	0	0
Crest Width(Ft):	20	8	20	20	20	20	20	0	20	26
Dam Volume(Cubic Yards):	557000	56239	200000	155000	379000	0	83000	0	500000	2679680
Year Built:	1960	1927	1955	1961	1980	1962	1966	1965	1923	1934

Dam Name:	Morena	Barrett	Sutherland	Lake Loveland	Pacoima	Henry Jr	Santiago Creek	Lake Cuyamaca	Lee Lake	Corte Madera
Forest:	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland
Location:A28	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	8-005	8-000	8-010	2020-002	32-008	841-000	75-000	1076-000	818-002	837-000
Owner:	City Of San Diego	City Of San Diego	City Of San Diego	South Bay Irrigation Dist	LA Co Dept Of Public Works	Mrs Charlotte Frye	Serrano Id & Irvine Ranch Wd	Lake Cuyamaca Rec & Park Dist	Elsinore Valley Mun Wd	Rancho Corte Madera Inc
County:	San Diego	San Diego	San Diego	San Diego	Los Angeles	San Diego	Orange	San Diego	Riverside	San Diego
Stream Dammed:	Cottonwood Cr	Cottonwood Cr	Santa Ysabel Cr	Sweetwater Rv	Pacoima Creek	Skye Valley	Santiago Creek	Boulder Creek	Temescal Creek	Tr Pine Valley Cr
National Dam ID:	CA00110	CA00106	CA00114	CA00776	CA00193	CA00777	CA00298	CA00907	CA00766	CA00774
Latitude:	32.685	32.678	33.118	32.782	34.335	32.713	33.785	32.988	33.75	32.777
Longitude:	-116.55	-116.67	-116.787	-116.792	-118.395	-116.652	-117.723	-116.577	-117.445	-116.578
Dam Type:	ROCK	GRAV	MULA	VARA	VARA	VARA	ERTH	ERTH	ERTH	ERTH
Capacity(Acre-Feet):	50206	44755	29000	25400	3777	196	25000	1000	1100	325
Basin Area(Square Miles):	114	252	54	98	27.8	9.3	63.1	12	53	2.5
Area of Reservoir(Acres):	1475	891	550	454	68	22	650	110	70	69
Parapet:	Structural Impound Wall	Structural Impound Wall	Structural Impound Wall	Structural Impound Wall	Structural Impound Wall	No Wall	No Wall	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	181	161	162	203	365	33	136	17	47	16
Elevation of Crest(Ft Above Sea Level):	3053	1625	2074	1366	2015.8	2470	810	4628	1153	3942
Crest Length(Ft):	550	750	1020	614	640	249	1425	1027	520	200
Crest to Lower Outside Limit of Dam(Ft):	181	161	162	203	365	33	136	17	47	16
Freeboard, Vertical Distance(Ft):	14	18	17	11	65	3	20	9	16	8.5
Operating Freeboard(Ft):	0	10	0	0	0	0	16	3	0	0
Crest Width(Ft):	20	15	2	8	10	3	10	10	15	7
Dam Volume(Cubic Yards):	335300	139569	51500	67000	226110	2295	789000	39306	0	3500
Year Built:	1912	1922	1954	1945	1929	1929	1933	1968	1919	1919

Dam Name:	Oak Street	Portola	Thing Valley	Mabey Canyon	Trabuco	Agua Tibia	Case Springs	Santa Felicia	Juncal	Matilija
Forest:	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Cleveland	Los Padres	Los Padres	Los Padres
Location:A28	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	In Forest	In Forest	In Forest
DWR Dam Number:	1003-010	2013-002	856-000	1003-009	2030-002	849-000	9000-133	1005-000	34-002	86-000
Owner:	Riverside County Fcwcd	Santa Margarita Water Dist	Bruce Barnes	Riverside County Fcwcd	Trabuco Canyon Water Dist	Albert S Bradford	U S Marine Corps	United Water Cons Dist	Montecito Water District	Ventura County Fcd
County:	Riverside	Orange	San Diego	Riverside	Orange	San Diego	San Diego	Ventura	Santa Barbara	Ventura
Stream Dammed:	Oak Street Cr	Canada Gobernadora	La Posta Creek	Mabey Creek	Trib Dove Creek	Offstream	Trib San Onofre Cr	Piru Creek	Santa Ynez Rv	Matilija Creek
National Dam ID:	CA01179	CA01183	CA00786	CA01103	CA01241	CA00783	CA10133	CA00805	CA00211	CA00312
Latitude:	33.845	33.633	32.787	33.852	33.643	33.36	33.45	34.462	34.492	34.485
Longitude:	-117.595	-117.575	-116.383	-117.608	-117.562	-117.013	-117.422	-118.752	-119.507	-119.307
Dam Type:	ERTH	ERTH	ERTH	ERTH	ERTH	ERTH	ERTH	ERTH	VARA	VARA
Capacity(Acre-Feet):	138	586	98	68	138	62	60	100000	6140	1800
Basin Area(Square Miles):	6.02	0.18	10.4	1.5	0.05	0.1	0	421.4	13.9	55
Area of Reservoir(Acres):	36	20	7	5	5	4	0	1240	138	86
Parapet:	No Wall	No Wall	No Wall	No Wall	No Wall	No Wall	N/A	Structural Impound Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	36	53	45	46	108	35	25	213	160	163
Elevation of Crest(Ft Above Sea Level):	1034	946	4540	1146	1280	1175	0	1078.3	2230	1138
Crest Length(Ft):	2000	1200	680	520	620	1053	600	1275	430	620
Crest to Lower Outside Limit of Dam(Ft):	36	53	45	46	108	35	25	213	160	163
Freeboard, Vertical Distance(Ft):	12	10	10	8	5.5	3.4	0	23.3	6	43
Operating Freeboard(Ft):	0	0	0	0	0	0	0	0	15	0
Crest Width(Ft):	30	20	16	20	20	15	0	30	6	8
Dam Volume(Cubic Yards):	200000	206500	46800	92000	166000	40000	0	3700000	40000	47825
Year Built:	1979	1980	1961	1974	1984	1947	1900	1955	1930	1949

Dam Name:	Eagle Ranch	Glen Anne	Rancho Del Ciervo	Senior Canyon	Lower Abbott Lake	Pendola Debris	Twitchell	Lopez	Salinas	Bradbury
Forest:	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres
Location:A28	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	Major reservoir downstream	Major reservoir downstream	Major reservoir downstream	Outside of Forest, downstream from boundary
DWR Dam Number:	747-000	9000-156	752-000	1761-000	9000-310	9000-218	9000-197	1055-000	9000-202	9000-136
Owner:	Helen M Smith	U S Bureau Of Reclamation	Cavalletto Ranches	Senior Canyon Mutual Water Co	Forest Service	Forest Service	U S Bureau Of Reclamation	San Luis Obispo Co Fcwcd	Corps Of Engineers	U S Bureau Of Reclamation
County:	San Luis Obispo	Santa Barbara	Santa Barbara	Ventura	Monterey	Santa Barbara	San Luis Obispo	San Luis Obispo	San Luis Obispo	Santa Barbara
Stream Dammed:	Hale Creek	W Fk Glen Anne Cyn	Tr San Jose Cr	San Antonio Creek	Arroyo Seco Fk	Agua Caliente	Cuyama River	Arroyo Grande Cr	Salinas River	Santa Ynez River
National Dam ID:	CA01101	CA10156	CA00719	CA01019	CA10310	CA10218	CA10197	CA00887	CA10202	CA10136
Latitude:	35.413	34.483	34.475	34.472	36.233	34.513	34.983	35.188	35.333	34.583
Longitude:	-120.678	-119.879	-119.82	-119.193	-121.475	-119.575	-120.317	-120.487	-120.501	-119.98
Dam Type:	ERTH	ERTH	ERTH	ERTH	ERTH	GRAV	ERTH	ERTH	VARA	ERTH
Capacity(Acre-Feet):	300	500	165	73	100	59	240000	52500	26000	205000
Basin Area(Square Miles):	1.39	0	0.76	0.05	0.5	0	1135	70	111	417
Area of Reservoir(Acres):	19	16	8	5	0	0	3700	950	793	3100
Parapet:	No Wall	N/A	No Wall	No Wall	N/A	N/A	N/A	No Wall	N/A	N/A
Parapet Wall Height(Ft above Crest):	55	95	65	76	10	14	211	166	135	201
Elevation of Crest(Ft Above Sea Level):	1448	402	378.9	1296	0	0	692	536	1325	766
Crest Length(Ft):	370	240	758	970	300	230	1804	1120	308	3350
Crest to Lower Outside Limit of Dam(Ft):	55	95	65	76	10	14	211	166	135	201
Freeboard, Vertical Distance(Ft):	6	17	6	4	0	0	40.5	16	24	46
Operating Freeboard(Ft):	0	0	0	0	0	0	5.5	0	0	5.5
Crest Width(Ft):	14	30	10	15	0	6	30	40	8	40
Dam Volume(Cubic Yards):	58000	328000	86700	5600	0	0	5833000	3538000	60000	6695000
Year Built:	1974	1953	1938	1964	UNKNOWN	1966	1958	1969	1942	1953

Dam Name:	Casitas	Gibraltar	Alisal Creek	Los Padres	Righetti	Lauro	Edwards Res	Stewart Can Db	Santa Monica Db	Black Rock Cr
Forest:	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres	Los Padres
Location:A28	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	9000-139	11-000	756-000	642-004	743-000	9000-164	757-000	86-009	2010-000	643-000
Owner:	U S Bureau Of Reclamation	City Of Santa Barbara	The Alisal Ranch	Calif-american Water Co	Ernest R Righetti	U S Bureau Of Reclamation	Timothy M Doheny	Ventura County Fcd	Santa Barbara County Fcwcd	White Rock Club Inc
County:	Ventura	Santa Barbara	Santa Barbara	Monterey	San Luis Obispo	Santa Barbara	Santa Barbara	Ventura	Santa Barbara	Monterey
Stream Dammed:	Coyote Creek	Santa Ynez Rv	Alisal Creek	Carmel River	W Corral De Piedra	Diablo Creek	Tr Gato Cr	Tr San Antonio Cr	Santa Monica Cr	Nfk Black Rock Cr
National Dam ID:	CA10139	CA00138	CA00731	CA00692	CA00725	CA10164	CA01240	CA01159	CA01134	CA00693
Latitude:	34.371	34.527	34.547	36.385	35.247	34.454	34.49	34.458	34.422	36.41
Longitude:	-119.335	-119.687	-120.135	-121.667	-120.585	-119.725	-119.977	-119.25	-119.525	-121.772
Dam Type:	ERTH	CORA	ERTH	ERTH	ERTH	ERTH	ERTH	ERTH	ERTH	ERRK
Capacity(Acre-Feet):	254000	9998	2342	3100	940	640	596	67	79	30
Basin Area(Square Miles):	41.2	214	7.8	44.9	4.5	0	0.45	1.9	3.8	3.32
Area of Reservoir(Acres):	2700	335	97	67	28	22	18	13	5	4
Parapet:	N/A	Structural Impound Wall	No Wall	No Wall	No Wall	N/A	No Wall	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	279	169	93	148	83	109	120	34	102	57
Elevation of Crest(Ft Above Sea Level):	585	1405.3	615	1058	581.5	567	962	934	407	2200
Crest Length(Ft):	2000	600	1100	570	1200	540	462	1263	467	100
Crest to Lower Outside Limit of Dam(Ft):	279	169	93	148	83	109	120	34	102	57
Freeboard, Vertical Distance(Ft):	18	5.3	15	18	6.5	18	7	13.6	16	15
Operating Freeboard(Ft):	6.3	2	0	0	0	8.3	0	0	0	9
Crest Width(Ft):	40	7	30	12	16	30	20	20	26	68
Dam Volume(Cubic Yards):	9310000	75000	250000	463130	146700	469000	224887	0	214800	10000
Year Built:	1959	1920	1971	1949	1966	1952	1985	1963	1978	1925

Dam Name:	Anola	Romero Can Cr #18	Bear Valley	Cedar Springs	Lake Arrowhead	Lake Hemet	Lake Gregory	Palo Verde	New L Arrowhead	Green Val Lake
Forest:	Los Padres	Los Padres	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino
Location:A28	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest
DWR Dam Number:	9000-732	9001-049	2015-000	1-063	805-000	817-000	1803-003	860-000	1803-002	804-000
Owner:	U S Bureau Of Reclamation	Usce-santa Barbara Co Fcwcd	Big Bear Municipal Wd	State Dept Of Water Resources	Arrowhead Lake Association	Lake Hemet Mun Water Dist	San Bernardino Co Reg Pk Div	Palo Verde Ranch Homeowners	County Of San Bernardino	Green Valley Mutual Water Co
County:	Ventura	Santa Barbara	San Bernardino	San Bernardino	San Bernardino	Riverside	San Bernardino	San Diego	San Bernardino	San Bernardino
Stream Dammed:	Tr Santa Ana Creek	Romero Canyon Cr	Bear Creek	Wfk Mojave Rv	Little Bear Cr	Tr San Jacinto R	Houston Creek	Sweetwater Rv	Little Bear Cr	Green Valley Cr
National Dam ID:	CA00732	CA10049	CA00757	CA00049	CA00759	CA00763	CA00224	CA00789	CA01124	CA00758
Latitude:	34.437	34.445	34.242	34.307	34.262	33.665	34.243	32.812	34.262	34.238
Longitude:	-119.335	-119.592	-116.977	-117.312	-117.167	-116.705	-117.263	-116.727	-117.165	-117.082
Dam Type:	ERTH	ERTH	GRAV	ERRK	HYDF	GRAV	ERTH	ERTH	ERTH	MULA
Capacity(Acre-Feet):	30	0	74000	78000	48000	14000	2100	730	1970	250
Basin Area(Square Miles):	0.05	0	48.22	34	6.85	67	2.8	54	0.07	1.2
Area of Reservoir(Acres):	2	0	2649	990	780	470	88	39	31	22
Parapet:	No Wall	N/A	No Wall	No Wall	No Wall	Structural Impound Wall	No Wall	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	38	38	80	236	190	135	90	67	225	56
Elevation of Crest(Ft Above Sea Level):	800	0	6743.2	3378	5116	4341.5	4530	1810	5125	6750
Crest Length(Ft):	313	420	360	2235	720	324	475	410	1300	425
Crest to Lower Outside Limit of Dam(Ft):	38	38	80	236	190	135	90	67	225	56
Freeboard, Vertical Distance(Ft):	4	0	7	23	9	7.5	13	20	10	3
Operating Freeboard(Ft):	0	0	0	0	8	5	10	13.7	0	0
Crest Width(Ft):	30	0	1	42	140	7	40	16	26	2
Dam Volume(Cubic Yards):	16000	0	4684	7630000	1300000	32320	154000	75000	2800000	1500
Year Built:	1924	1972	1911	1971	1922	1895	1938	197O	1976	1925

Dam Name:	Grass Valley	Foster	Hall Mill	Cedar Lake	Glen Martin	Min Hot Springs L	Mojave	Tahchevah	Devil Cyn 2nd Ab	Devils Can Dyke 1 (Db)
Forest:	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino
Location:A28	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	805-002	827-000	9001-768	802-000	800-000	1801-000	9000-021	1003-013	1-088	17-002
Owner:	Arrowhead Lake Association	Idyllwild Co Water Dist	Forest Service	First Congr Church Of LA	Glen Martin Properties Co	Campus Crusade For Christ Intl	Corps Of Engineers	Riverside County Fcwcd	State Dept Of Water Resources	City Of San Bernardino
County:	San Bernardino	Riverside	Riverside	San Bernardino	San Bernardino	San Bernardino	San Bernardino	Riverside	San Bernardino	San Bernardino
Stream Dammed:	Grass Valley Cr	Lily Creek	Efk Indian Creek	Talmadge Creek	Mountain Home Cr	Trib East Twin Cr	W Fk Mojave Rv	Tachevah Creek	Offstream	Devils Canyon Dike 1
National Dam ID:	CA00760	CA00769	CA00768	CA00756	CA00754	CA01026	CA10021	CA01170	CA01364	CA00150
Latitude:	34.263	33.757	33.8	34.232	34.143	34.187	34.343	33.832	34.204	34.19
Longitude:	-117.217	-116.725	-116.783	-116.94	-116.987	-117.263	-117.233	-116.592	-117.343	-117.333
Dam Type:	ERTH	ERTH	ERTH	VARA	ERTH	ERTH	ERTH	ERTH	ERTH	ROCK
Capacity(Acre-Feet):	243	56	40	30	33	37	89700	650	980	79
Basin Area(Square Miles):	2.6	0.85	1.5	0.5	0.3	0.04	0	3.2	0.55	6.3
Area of Reservoir(Acres):	20	6	4	3	2	2	0	60	34	13
Parapet:	No Wall	No Wall	N/A	No Wall	No Wall	Non-Structural Wall	N/A	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	35	38	40	28	55	54	204	42	77	15
Elevation of Crest(Ft Above Sea Level):	5152	5812	5331	7101	5636	1841	3170	582	1940	1635
Crest Length(Ft):	170	277	310	220	302	200	2200	3600	370	3290
Crest to Lower Outside Limit of Dam(Ft):	35	38	40	28	55	54	204	42	77	15
Freeboard, Vertical Distance(Ft):	10	7	7.6	0	6	4.4	21	16.5	9	3
Operating Freeboard(Ft):	0	0	0	0	0	0	0	0	0	0
Crest Width(Ft):	10	12	40	2	10	60	20	20	32	12
Dam Volume(Cubic Yards):	12700	21157	16000	650	48390	29000	5247000	0	90000	33339
Year Built:	1964	1945	1949	1928	1950	1967	1971	1964	1995	1934

Dam Name:	Grass Valley	Foster	Hall Mill	Cedar Lake	Glen Martin	Min Hot Springs L	Mojave	Tahchevah	Devil Cyn 2nd Ab	Devils Can Dyke 1 (Db)
Forest:	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino
Location:A28	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	In Forest	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	805-002	827-000	9001-768	802-000	800-000	1801-000	9000-021	1003-013	1-088	17-002
Owner:	Arrowhead Lake Association	Idyllwild Co Water Dist	Forest Service	First Congr Church Of LA	Glen Martin Properties Co	Campus Crusade For Christ Intl	Corps Of Engineers	Riverside County Fcwcd	State Dept Of Water Resources	City Of San Bernardino
County:	San Bernardino	Riverside	Riverside	San Bernardino	San Bernardino	San Bernardino	San Bernardino	Riverside	San Bernardino	San Bernardino
Stream Dammed:	Grass Valley Cr	Lily Creek	Efk Indian Creek	Talmadge Creek	Mountain Home Cr	Trib East Twin Cr	W Fk Mojave Rv	Tachevah Creek	Offstream	Devils Canyon Dike 1
National Dam ID:	CA00760	CA00769	CA00768	CA00756	CA00754	CA01026	CA10021	CA01170	CA01364	CA00150
Latitude:	34.263	33.757	33.8	34.232	34.143	34.187	34.343	33.832	34.204	34.19
Longitude:	-117.217	-116.725	-116.783	-116.94	-116.987	-117.263	-117.233	-116.592	-117.343	-117.333
Dam Type:	ERTH	ERTH	ERTH	VARA	ERTH	ERTH	ERTH	ERTH	ERTH	ROCK
Capacity(Acre-Feet):	243	56	40	30	33	37	89700	650	980	79
Basin Area(Square Miles):	2.6	0.85	1.5	0.5	0.3	0.04	0	3.2	0.55	6.3
Area of Reservoir(Acres):	20	6	4	3	2	2	0	60	34	13
Parapet:	No Wall	No Wall	N/A	No Wall	No Wall	Non-Structural Wall	N/A	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	35	38	40	28	55	54	204	42	77	15
Elevation of Crest(Ft Above Sea Level):	5152	5812	5331	7101	5636	1841	3170	582	1940	1635
Crest Length(Ft):	170	277	310	220	302	200	2200	3600	370	3290
Crest to Lower Outside Limit of Dam(Ft):	35	38	40	28	55	54	204	42	77	15
Freeboard, Vertical Distance(Ft):	10	7	7.6	0	6	4.4	21	16.5	9	3
Operating Freeboard(Ft):	0	0	0	0	0	0	0	0	0	0
Crest Width(Ft):	10	12	40	2	10	60	20	20	32	12
Dam Volume(Cubic Yards):	12700	21157	16000	650	48390	29000	5247000	0	90000	33339
Year Built:	1964	1945	1949	1928	1950	1967	1971	1964	1995	1934

Dam Name:	Day Creek Db	Dunn Ranch	Small Canyon
Forest:	San Bernardino	San Bernardino	San Bernardino
Location:A28	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary	Outside of Forest, downstream from boundary
DWR Dam Number:	87-012	1812-000	87-000
Owner:	San Bernardino Co Fc Dist	Agri-empire, a Calif Corp	San Bernardino Co Fc Dist
County:	San Bernardino	Riverside	San Bernardino
Stream Dammed:	Day Creek	Tr Hamilton Cr	Tr City Creek
National Dam ID:	CA01232	CA01302	CA00314
Latitude:	34.175	33.566	34.147
Longitude:	-117.542	-116.619	-117.2
Dam Type:	ERTH	ERTH	ERTH
Capacity(Acre-Feet):	140	90	20
Basin Area(Square Miles):	5.06	0.2	0.88
Area of Reservoir(Acres):	13	7	2
Parapet:	No Wall	No Wall	No Wall
Parapet Wall Height(Ft above Crest):	90	44	68
Elevation of Crest(Ft Above Sea Level):	2562	142.5	1825
Crest Length(Ft):	975	425	245
Crest to Lower Outside Limit of Dam(Ft):	90	44	68
Freeboard, Vertical Distance(Ft):	20	5	8
Operating Freeboard(Ft):	0	0	0
Crest Width(Ft):	20	15	15
Dam Volume(Cubic Yards):	600000	50000	62000
Year Built:	1988	1987	1957