David Magney Environmental Consulting

CITY OF OJAI URBAN WATERSHED ASSESSMENT AND RESTORATION PLAN

(CDFG CONTRACT NO. PO250014)

Prepared for:

CITY OF OJAI

and

CALIFORNIA DEPARTMENT OF FISH AND GAME

With Assistance from:

HAWKS & ASSOCIATES

DMEC Mission Statement:

To provide quality environmental consulting services with integrity that protect and enhance the human and natural environment.

August 2005

City of Ojai Urban Watershed Assessment and Restoration Plan

(CDFG Contract No. PO250014)

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Cover Photograph:

San Antonio Creek (Reach 1) along Creek Road near its confluence with Del Norte Creek (photograph taken on 3 December 2004).

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EXECUTIVE SUMMARY

The City of Ojai received a grant from the California Department of Fish and Game (CDFG) to prepare a comprehensive assessment and restoration plan for the watersheds that drain through the city limits. David Magney Environmental Consulting (DMEC), Hawks & Associates, and Concerned Resource & Environmental Workers (C.R.E.W.) have been contracted by the City to conduct the Ojai Basin streams characterization and assessment, and to make recommendations on how stream habitats within the City could be protected or restored.

The Ventura River system is ranked as the third most endangered river in the United States and is designated as critical habitat for Southern California Steelhead Trout (*Oncorhynchus mykiss irideus* [a southern California Ecologically Significant Unit or ESU]), a federally listed endangered species (American Rivers [website] 2000). The river once had a large Steelhead population spawning in the upper reaches of its tributaries, including the larger San Antonio Creek watershed in the foothills of the Ojai Valley; however, Steelhead populations have declined over the years, largely due to the impact of human activities.

The predominant known problems, in regard to Steelhead habitat within the streams of the City of Ojai, include the following: fish passage, water quality, spawning habitat, and deficient stream flows. A primary purpose of the proposed assessment and restoration plan is to identify specific problems of the Ojai creeks relevant to Steelhead Trout, and develop a plan to restore fish habitat and to address the land use issues that adversely affect that habitat and the ecological health of the watersheds. The objectives of this assessment and restoration plan are to: (1) conduct a baseline assessment of the City of Ojai urban watershed; (2) identify and prioritize limiting factors to increasing Southern Steelhead populations; (3) determine and analyze the root causes of these limitations; and (4) develop specific recommendations for restoration actions.

A total of twenty-five (25) subwatersheds (approximately 2,795 acres) that support the Ojai Basin Watershed have been delineated, all but one of which are part of the San Antonio Creek watershed. The primary subwatersheds of the City of Ojai and Ojai Valley included in this study are Stewart Canyon Creek, Fox Canyon Barranca, and a portion of Thacher Creek, which are all tributaries to San Antonio Creek. Within those subwatersheds, a total of 16 creeks flow through the City of Ojai, totaling approximately 86,905 feet (35,179 meters; 16.5 miles) of creek channels. Biologists delineated 51 distinct reaches making up those 16 creeks of Ojai. Eight (8) out of the 51 stream reaches that were delineated within the City of Ojai are determined to be potentially suitable Steelhead habitat, and they include:

- Fox Canyon Reach 1;
- Ojai Reach 1;
- Post Office Reach 1;
- San Antonio Reach 1, 2, and 3; and
- Stewart Canyon Reach 1 and 5.

Actions that can be taken to restore and enhance Steelhead habitat conditions include the following:

- Remove barriers to fish migration where feasible;
- Establish minimum-width buffers between urban land uses and streams;
- Restore native riparian vegetation along streams;
- Preserve upland portions of the watershed;
- Eradicate invasive exotic plants and aquatic animals;
- Follow NOAA and CDFG fish passage guidelines at stream crossings;
- Minimize impervious surfaces on all parcels;
- Educate land owners; and
- Establish regular water quality monitoring stations.

INTRODUCTION

BACKGROUND

The City of Ojai has received a grant from the California Department of Fish and Game (CDFG) to prepare a comprehensive assessment and restoration plan for the watersheds that drain through the city limits (CDFG Contract Number po250014). These watersheds include Stewart Canyon, Fox Canyon, and portions of San Antonio and Thacher Creeks. Thacher, Stewart Canyon, and Fox Canyon Creeks are all tributaries to San Antonio Creek, which is a major tributary to Ventura River.

One of the major problems with watershed management, within Ojai as well as in California in general, is the impacts to fish habitat. The Ventura River system has been ranked as the third most endangered river in the United States during a recent survey (American Rivers [website] 2000). The Ventura River and its tributaries (along with other coastal streams in Ventura County) have been designated as critical habitat for Southern California Steelhead Trout (*Oncorhynchus mykiss irideus* [a southern California Ecologically Significant Unit or ESU]), a federally listed endangered species. In the past, the river had a large Steelhead population, which spawned in the upper reaches of its tributaries, including the larger San Antonio Creek watershed in the foothills of the Ojai Valley. However, Steelhead populations have declined over the years, largely due to the impact of human activities. Some of those activities and their impacts include:

- Urban development leading to increases in impervious surfaces and associated runoff;
- Modifications to the creek channel and banks for flood control and construction of creek crossings that form barriers to upstream passage;
- Increased sediment and other polluted runoff from urban development leading to degraded water quality; and
- Surface and groundwater withdrawals that have significantly decreased historical perennial surface flows in the creeks of the Ojai Valley.

The predominant known problems, in regards to Steelhead habitat within the streams of the City of Ojai, include the following:

- **Fish Passage** is limited on San Antonio Creek at the Soule Park Golf Course and further upstream in Soule Park (*Soule Park is on Thacher Creek to the east*) by road crossings. Stewart and Fox Canyons also have major fish barriers at flood control structures located within city limits.
- **Water Quality** is adversely impacted by urban runoff and stagnation related to the intermittent nature of flows in the watersheds.
- **Spawning and Rearing Habitat** is diminished as pools are filled and riffles choked with fine sediment from upland erosion.
- **Deficient Stream** flow is a problem endemic to many southern California streams due to climate, but the situation is made worse by urbanization, loss of open space, and water withdrawals (both surface and groundwater).

The City is acting at the request of several concerned groups and individuals who desire to improve the quality of the riparian systems traversing the City. These groups have already undertaken and completed a number of small stream improvement projects, but now desire to enlarge their efforts in a more comprehensive and systematic way.

David Magney Environmental Consulting (DMEC), Hawks & Associates, and Concerned Resource & Environmental Workers (C.R.E.W.) have been contracted by the City to conduct the Ojai Basin streams characterization and assessment, and to make recommendations on how stream habitats within the City could be protected or restored.

PROJECT OBJECTIVES

A primary purpose of the proposed assessment and restoration plan is to identify specific problems of the Ojai creeks relevant to Steelhead Trout, and develop a plan to restore fish habitat and to address the land use issues that adversely affect that habitat and the ecological health of the watersheds.

The objectives of this assessment and restoration plan are to:

- Conduct a baseline assessment of the City of Ojai urban watershed;
- Identify and prioritize limiting factors to increasing Southern Steelhead populations;
- Determine and analyze the root causes of these limitations; and
- Develop specific recommendations for restoration actions.

Some of the most significant issues that are addressed in this report to achieve the above objectives include the following:

- Historical conditions and significant developments influencing the watershed over time;
- Watershed hydrology, including the range of flows and temporal distribution;
- Physical characteristics of the stream channels (e.g. gravel size, canopy, pools, riffles, runs);
- Riparian vegetation characteristics (e.g. habitat classification, dominant species, structural diversity, canopy density, invasive exotic species);
- Location and severity of fish passage barriers;
- Water quality, sources and types of pollution, sediment, and turbidity;
- Basic physical parameters of streams and water (e.g. temperature, dissolved oxygen, *p*H, salinity);
- Watershed physical characteristics;
- Current and future land use practices that are detrimental or beneficial to riparian ecosystems;
- Land ownership along the riparian corridors and stakeholders in habitat restoration;
- Functional fish habitat limiting factor analysis;
- Restoration to improve watershed conditions; and
- Implementation of activities that deserve highest priority.

SOUTHERN STEELHEAD

Steelhead Trout are an important and valued resource to California's citizens and are an important component of the vast biodiversity of the State. Like many of California's Southern Steelhead resources, Steelhead are declining, which is only one aspect of the present statewide decline in biodiversity, caused by California's burgeoning human population and the ever-increasing demand on natural resources.

The following five subsections discuss Southern Steelhead in regard to their (1) general status and distribution, (2) life history, (3) habitat requirements, (4) stock characteristics, and (5) existence within the Ventura River system as summarized from the CDFG's *Steelhead Restoration and Management Plan for California* (CDFG 1996).

Status and Distribution

Rough estimates place the total statewide population at 250,000 adults, less than half the population of 30 years ago. The decline of Southern Steelhead appears to be part of a more prevalent coast-wide Steelhead decline. The major factor causing the decline in California is freshwater habitat loss and degradation, which is a result of three primary factors: inadequate stream flows, blocked access to historic spawning and rearing areas due to dams, and human activities that discharge sediment, pollution, and debris into watercourses.

Southern Steelhead Trout (occurring south of San Francisco Bay) were formerly found in coastal drainages as far south as the Santo Domingo River in northern Baja California and were present in many streams and rivers of southern California. Today, San Mateo Creek on the Orange/San Diego County line is the southernmost stream containing a known spawning population, with Malibu Creek in Los Angeles County being the main southernmost Steelhead Trout stream south of the Santa Clara River. Southern Steelhead are the most jeopardized of all California Steelhead populations. Population numbers have declined drastically in nearly all streams where they exist, and runs have been extirpated from many others. Of 122 streams south of San Francisco known to have a Steelhead population, 20% of the streams had populations with significant decline from historical levels; 47% had populations with reduced production from historical levels; and 33% no longer supported populations (Titus et al. 1994). Major adverse impacts to Southern Steelhead are from urbanization and water impoundment and diversion.

There is little information regarding historical run size of Steelhead in the Santa Clara River system, although Hubbs (1946) reported that there were "large and consistent runs into Ventura and Santa Clara Rivers." Moore (1980a) estimated the historical run size in the Santa Clara River system to be around 9,000 fish by comparing it with the Ventura River system. During the course of a two-year study beginning in 1982, Puckett and Villa (1985) documented the presence of six adult Steelhead in the Santa Clara River. In 1994, one adult Steelhead and 83 outmigrating smolts were observed at the Vern Freeman Diversion Facility (CDFG 1994).

Major impacts to Southern Steelhead populations are a result of urbanization and watershed disturbances, blocked access to headwater spawning and rearing areas, and partial and total dewatering of streams by water diversions and groundwater pumping. Those stocks, south of and including the Santa Ynez River, have been impacted most greatly and are the most imperiled.

Water development appears to be the primary cause of localized extinctions and decline in numbers within Southern Steelhead populations. Titus et al. (1994) found that 35% of the Southern Steelhead populations reviewed were negatively impacted by water diversions, 24% by dams lacking functional fishways, 18% by artificial barriers other than dams (impassable culverts and bridge supports), and 5% from stream channelization. Overall, 21% of the 165 populations reviewed were impacted by blocked access to spawning and rearing tributaries due to main stem impediments.

Most remaining Southern Steelhead stocks are on the verge of extinction. Perhaps the most striking aspect of the decline of Southern Steelhead is that, in a span of a few decades, the known southern limit of Steelhead in North America has moved several hundred miles northward from the Santo Domingo River in northern Baja California to Malibu Creek in Los Angeles County (with the exception of the newly discovered San Mateo Creek population). Reduction in population and localized extinctions continue to creep northward and are concomitant with urban development and an increasing demand on water resources (Titus et al. 1994).

Life History

Steelhead Trout are the anadromous form of Rainbow Trout, a salmonid native to western North America and the Pacific coast of Asia. In North America, Steelhead are found in Pacific Ocean drainages from southern California to Alaska. In California, known spawning populations are found in coastal rivers and streams predominantly from Malibu Creek in Los Angeles County to the Smith River near the Oregon border, and in the Sacramento River system.

Steelhead are similar to some Pacific salmon in their ecological requirements. They are born in fresh water, then they emigrate to the ocean where most of their growth occurs, and finally they return to freshwater to spawn. Unlike Pacific Salmon, Steelhead do not necessarily die after spawning. Post-spawning survival rates are generally quite low and vary considerably between populations.

In California, most Steelhead spawn from December through April in small streams and tributaries where cool, well-oxygenated water is available year-round. The female selects a site where good intergravel flow exists, then digs a redd and deposits eggs while an attendant male fertilizes them. The eggs are then covered with gravel when the female begins excavation of another redd just upstream. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of Steelhead eggs in hatcheries takes about 30 days at 51ºF (Leitritz and Lewis 1980). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed up or slow down this time (Shapovalov and Taft 1954). The newly emerged fry move to the shallow, protected areas associated with the stream margin (Royal 1972, Barnhart 1986). They soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954). Most juveniles inhabit riffles but some of the larger ones will inhabit pools or deeper runs (Barnhart 1986).

The life history of Steelhead differs from that of Pacific salmon principally in two aspects: (1) juvenile Steelhead have a longer freshwater rearing requirement (usually from one to three years); and (2) both adult and juvenile Steelhead are much more variable in the amount of time they spend in fresh and salt water. Throughout their range, Steelhead typically remain at sea for one to four growing seasons before returning to fresh water to spawn (Burgner et al. 1992). However, some individuals will remain in a stream, mature, and even spawn without ever going to sea. Others will migrate to sea at less than a year old, and some will return to fresh water after less than one year in the ocean.

Lack of genetic differences indicates that substantial gene flow exists in anadromous and resident forms. It is not uncommon in anadromous salmonids for males to mature as parr, and then assume a resident life style (Titus et al. 1994). The variability in life history patterns probably confers a survival advantage, especially in unstable, variable climatic and hydrographic conditions, such as in southern California environments at the southernmost limit of Steelhead distribution. The major river systems in this area are subject to extreme variations in rainfall, which can result in high volume, flash flood runoff, or droughts lasting several years. It is common for the lower reaches of many southern rivers to become intermittent during the dry season. Juvenile Steelhead rearing in the perennial headwaters of these rivers at times have no access to the ocean for several years. In addition, sufficient flow is needed to breach sandbars, which close the mouths of most coastal streams. When a storm event provides sufficient flow, a brief window of opportunity is created to allow movement of Steelhead between their marine and fresh water environments. This life history flexibility to survive, and possibly spawn, until the next storm event opens a migration corridor, has allowed Steelhead to exist in the suboptimal environments existing along their southern margin range.

Southern California Stock

In addition to Southern Steelhead tolerance to the harsh environmental conditions of southern California, including warmer waters, drought, natural disaster, and extremely variable habitat conditions, the location of Southern Steelhead populations on the periphery of the Steelhead range suggest that these fish contain unique genetic adaptations. Mitochondrial and nuclear DNA analysis has shown that Southern Steelhead are genetically distinct from northern populations (Nielsen 1994).

For example, the warmer more productive waters of the Ventura River result in a more rapid growth of juveniles, compared to the more northerly populations (Moore 1980b). This relatively high growth rate allows juvenile Southern Steelhead to achieve smolt size and emigrate to the ocean after only one year in fresh water, a relatively short time period compared to more northerly populations in California and the Pacific Northwest where two- and three-year old smolts predominate (Withler 1996).

In addition to their tolerance of warmer water, Southern Steelhead migration is contingent upon rainfall and stream flow much more than northerly populations of Steelhead. Average annual rainfall is substantially lower and more variable in Southern California, which results in the formation of sand bars across the mouths of streams, and, in some cases, the complete dewatering of the lower reaches during the dry season. Southern Steelhead are more dependent on storm events to open migration corridors than are more northerly populations.

Natural disasters such as droughts, floods, and fire are common occurrences in Southern California, and in such a natural disaster prone environment, severe habitat alteration and localized extinction of Rainbow Trout populations were probably natural and recurring events. The ability to rapidly recolonize affected habitat, when suitable conditions are reestablished, is an adaptation to the periodic unsuitability of habitat in an unstable environment. Steelhead from unaffected populations in nearby stream systems can serve as source populations for recolonization. Adult Steelhead are known to stray from their natal streams to spawn in nearby streams, and, in hydrologically variable streams (such as those in southern California), straying is likely to be more prevalent than in less variable streams (Quinn 1984).

Southern California is at the southern periphery of Steelhead natural range, hence environmental conditions that are suboptimal for Rainbow Trout may exist more frequently than in areas further north. Ecological theory suggests that in environments near the limits of a species' range, physiological, behavioral, and dispersal mechanisms may exist to allow the persistence of populations in an environment that may be suboptimal.

Conditions in marginal habitats may be extreme, and these unavoidable adverse conditions may select for more extreme genetic characteristics (such as high thermal tolerance) in a population occupying such habitat (Thorpe 1994). The warm water temperatures of southern California streams, in some cases much higher than the preferred range for Rainbow Trout, suggests that they can withstand higher temperatures. Southern Steelhead populations may be particularly important as genetic stocks, since these populations are better adapted to warmer water conditions than more northerly populations (Swift et al. 1993).

The Ventura River

The San Antonio Creek watershed studied for this project is a major tributary to the Ventura River system. The Ventura River discharges to the Pacific Ocean near the west end of the City of San Buenaventura. It flows in a southerly direction, terminating in a small estuary that is subject to tidal influence when not closed by a sand bar. The following summarizes Southern Steelhead within the Ventura River from CDFG's *Steelhead Restoration and Management Plan for California* (1996).

The Ventura River at one time probably supported one of the largest runs of Southern Steelhead on the south coast (Point Conception to San Diego County). Restoring Steelhead runs in this river will be crucial to restoring the Southern Steelhead stocks. The river still has adequate habitat to sustain Steelhead populations, and it has had good winter flows in certain years, especially 1992 and 1993. There were several reports of adult Steelhead observed on the river in 1993, including several that were observed at Soule Golf Course in 1998 and downstream in San Antonio Creek in 2004. Suitable Steelhead habitat in this system exists in the main stem and in Matilija, North Fork Matilija, San Antonio, and Coyote Creeks.

The major obstacle to Steelhead restoration in the Ventura River system is blocked access to headwaters and excessive water diversion. The Robles Diversion, built by the U.S. Bureau of Reclamation in 1958 and operated by the Casitas Municipal Water District (District), is the largest diversion on the river. It functions to divert water from the Ventura River to Casitas Reservoir located at Coyote Creek, a tributary to the Ventura River. The diversion dam is approximately 14 miles upstream from the ocean and is the only major barrier on the lower river. The District has a flow release requirement of 20 cfs for downstream users. The Diversion can cause substantial dewatering of a portion of the river, and the diversion Dam was a substantial barrier to migration before the construction of a fish latter.

When the Robles Diversion was being planned in 1956, CDFG and the District discussed the installation of a fish passage facility at the Diversion to accommodate Steelhead migration. Initially, CDFG had taken the position that a ladder was necessary, but later reversed its position, requiring only that a provision be made in the initial construction of the diversion facility to accommodate the construction of a ladder in the future if found necessary (CDFG 1956). Now it is realized that the installation of a fish passage facility at the Robles Diversion Dam is key to rehabilitating Steelhead runs in the Ventura River system. In April 1992, CDFG submitted a proposal to the Wildlife Conservation Board to fund construction of a dam fishway, which was constructed in 2003.

Prior to the completion of the Matilija Dam in 1948, Steelhead had access to about ten miles of spawning habitat in Matilija Creek and its tributaries. About 50% of the Steelhead entering the Ventura River spawned above the current site of the Matilija Dam (Clanton and Jarvis 1946). A trap-and-truck facility was constructed several years after dam completion to transport adult Steelhead upstream of the dam. The operation trapped only seven adult Steelhead and lasted for only one year.

Large cracks in the concrete of the Matilija Dam generated concern about its integrity. Consequently, the dam has been notched several times to reduce the amount of water it can impound. Because of reduction in effective height of the dam and accumulation of sediment in the reservoir, capacity has been reduced to about 1,000 acre-feet. The dam is essentially ineffective for flood control and has limited value as water supply storage (Wetlands Research Associates 1992). The Ventura County Flood Control District and the U.S. Army Corps of Engineers proposed the removal of the Matilija Dam 2001; however, approval is still pending on environmental review. A Matilija Dam Ecosystem Restoration Feasibility Study has recently been conducted to explore alternative dam removal methods. The removal of the dam will open up 30 miles of prime Steelhead spawning and rearing habitat, including all upstream tributaries.

RIVERINE WETLAND FUNCTIONS

Since the functions of wetlands can be complex and sometimes difficult to accurately assess, a wetland assessment model is often very useful to objectively demonstrate how proposed projects may in fact improve (or degrade) wetland functions. The functions of wetlands considered under these assessments are based on a rapid assessment method currently under development nationwide by the Corps and EPA, known as the Hydrogeomorphic (HGM) approach (Smith et al. 1995). The HGM approach depends on development of local models for each biogeographic region for each general wetland type: riverine, estuarine, lacustrine fringe, depressional, slope, and flat. The channels of San Antonio Creek and its tributaries are considered Riverine wetlands under the HGM wetland assessment approach.

Three regional riverine wetland HGM models have been developed and are undergoing field-testing in California coastal areas that may be applicable to the San Antonio Creek watershed region:

- Draft Guidebook to Hydrogeomorphic Functional Assessment of Riverine Waters/Wetlands in the Santa Margarita Watershed (Santa Margarita HGM) (Lee et al. 1997, 2003);
- Draft Guidebook to Functional Assessments in 3rd and 4th Order Riverine Waters/Wetlands of the Central California Coast (Central Coast HGM) (Lee et al. 1996); and
- Draft Guidebook for Reference-Based Assessment of the Functions of Riverine Waters/Wetlands Ecosystems in the South Coast Region of Santa Barbara County, California (Santa Barbara South Coast HGM) (Lee et al. 2001).

The three riverine models listed above identify fourteen critical functions that streams such as San Antonio Creek fulfill:

1. Maintenance of characteristic channel dynamics;
2. Dynamic surface water storage and energy dissipation;
3. Long-term surface water storage;
4. Dynamic subsurface water storage;
5. Nutrient cycling;
6. Detention of imported elements and compounds;
7. Detention of particulates;
8. Organic carbon export;
9. Maintain characteristic plant community;
10. Maintain characteristic detrital biomass;
11. Maintain spatial structure of habitat;
12. Maintain interspersion and connectivity;
13. Maintain taxa richness of aquatic macroinvertebrates; and
14. Maintain spatial distribution of vertebrates.

The HGM functional assessment approach is used to determine the index for each function for both pre- and post-project conditions. The wetland functions can be grouped into three general functions: hydrologic (Functions 1-4 above), biochemical (Functions 5-8 above), and habitat (Functions 9-14 above).

Riverine wetlands in the San Antonio Creek Watershed can be characterized as performing various hydrology/geomorphology, biogeochemistry, plant habitat, and wildlife habitat functions (Table 1, Ecosystem Functions of Riverine Wetlands). The performance of these functions is largely dependent upon the maintenance of natural channel morphology and native plant communities. A substantial portion of the native vegetation outside of the existing streams and lowlands has been altered by development projects, which have had negative effects on the overall ecosystem function of San Antonio Creek, its tributaries, and its associated riparian wetlands. Mitigation of these impacts is needed to restore wetland functionality to watershed streams.

The HGM model considers the state of twenty-eight (28) variables that are assessed in various combinations to measure the level of functioning for each of the fourteen (14) wetland functions, to obtain an index score for each function. Each index is scaled based on reference standards that were established for the Santa Barbara South Coast region, located in Santa Barbara County (Lee et al. 2001). Lee et al. (2001) cautions, however, that the model may not be accurate in all aspects outside the reference domain, the Santa Barbara County south coast region. With this caveat in mind, the Santa Barbara South Coast HGM model is applicable for most projects, restoration efforts, or mitigation requirements that may be associated with this Cit of Ojai Urban Watershed Assessment and Restoration Plan.

This model provides a systematic method to measure the relative change in wetland functions a proposed project will have, identify those specific variables and functions that are expected to change, and provide permitting agencies a relative numerical measurement of pre-project (baseline) and post-project conditions (usually two projects with variations). The benefits of using the HGM model are that project comparisons are relative to baseline conditions, and should be valid and stable from that perspective.

Table 1. Ecosystem Functions of Riverine Wetlands

Function	Definition
Hydrology/Geomorphology	
Maintain Alluvial Corridor Integrity	Maintenance of physical attributes and processes that result in characteristic channel width, depth, slope, and roughness.
Maintain Surface Water Hydrology	Maintenance of a characteristic hydrograph, including the amount and time of water delivery to the channel network.
Maintain Subsurface Water Hydrology	Maintenance of surface and ground water interactions between the channel and the local and regional aquifers.
Sediment Mobilization, Transport, and Storage	Maintenance of a characteristic sediment regime through the maintenance of a hydrograph and sediment delivery to the stream network.
Biogeochemistry	
Element and Compound Cycling	Abiotic and biotic processes that convert elements and compounds from one form to another.
Organic Carbon Export	Export of dissolved and particulate carbon, primarily through leaching and flushing.
Plant Habitat	
Maintain Native Plant Association	Maintenance of characteristic plant associations in terms of species composition of trees, saplings, seedlings, shrubs, and herbs.
Maintain Spatial Structure of Plant Association	Maintenance of the structural characteristics required for supporting native plant habitat and their animal associates.
Maintain Characteristic Detrital Biomass	The production, accumulation, and dispersal of dead plant biomass of all sizes. The sources may be up slope, up gradient, or on site.
Maintain Interspersion and Connectivity for Plant Populations	Maintenance of characteristic spatial relationships between plant habitats such that native plant species are capable of completing their life cycles.
Wildlife Habitat	
Maintain Native Vertebrate Associations	Maintenance of the diversity, density, and spatial distribution of aquatic and terrestrial vertebrates.
Maintain Native Invertebrate Associations	Maintenance of the diversity, density, and spatial distribution of aquatic and terrestrial invertebrates.
Maintain Interspersion and Connectivity for Animal Populations	Maintenance of characteristic spatial relationships between animal habitats such that native animal species are capable of completing their life cycles.

PROJECT AREA

The project area includes the entire San Antonio Creek watershed. The focus of this project is on the limits of the City of Ojai, which occupies an area of 4.5 square miles and is the smallest and slowest growing City in Ventura County (Figure 1, Project Location Map). The creek portions occurring within the immediate City limits were all walked, characterized, and sampled for stream and fish habitat characterizations and water quality assessments. Creeks outside of or upstream from the City of Ojai were delineated for this report; however, no field studies or surveys were conducted in these portions of the streams (Figure 2, Aerial Photograph with Delineated Ojai Valley Streams).

Figure 1. Project Location Map

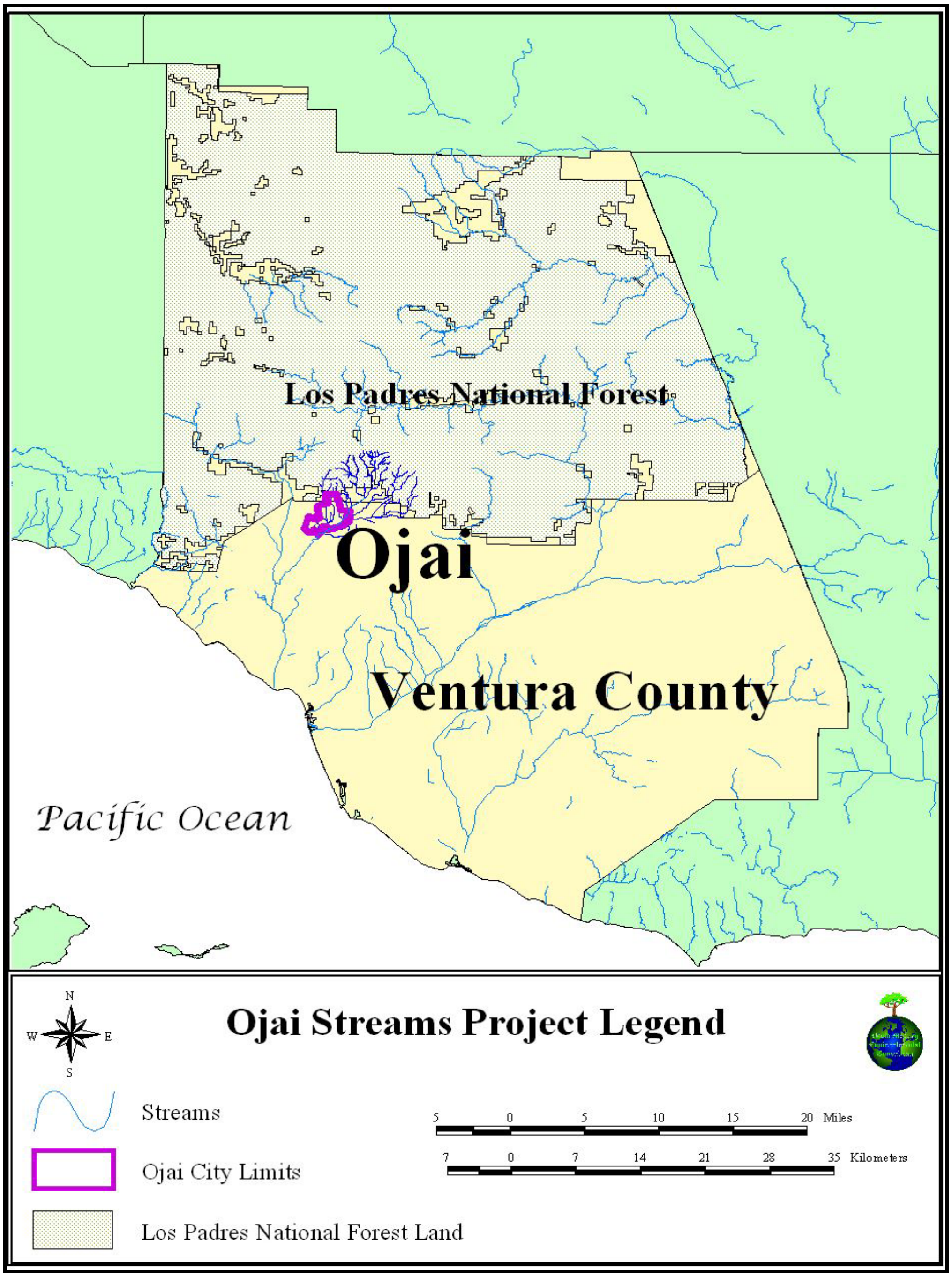
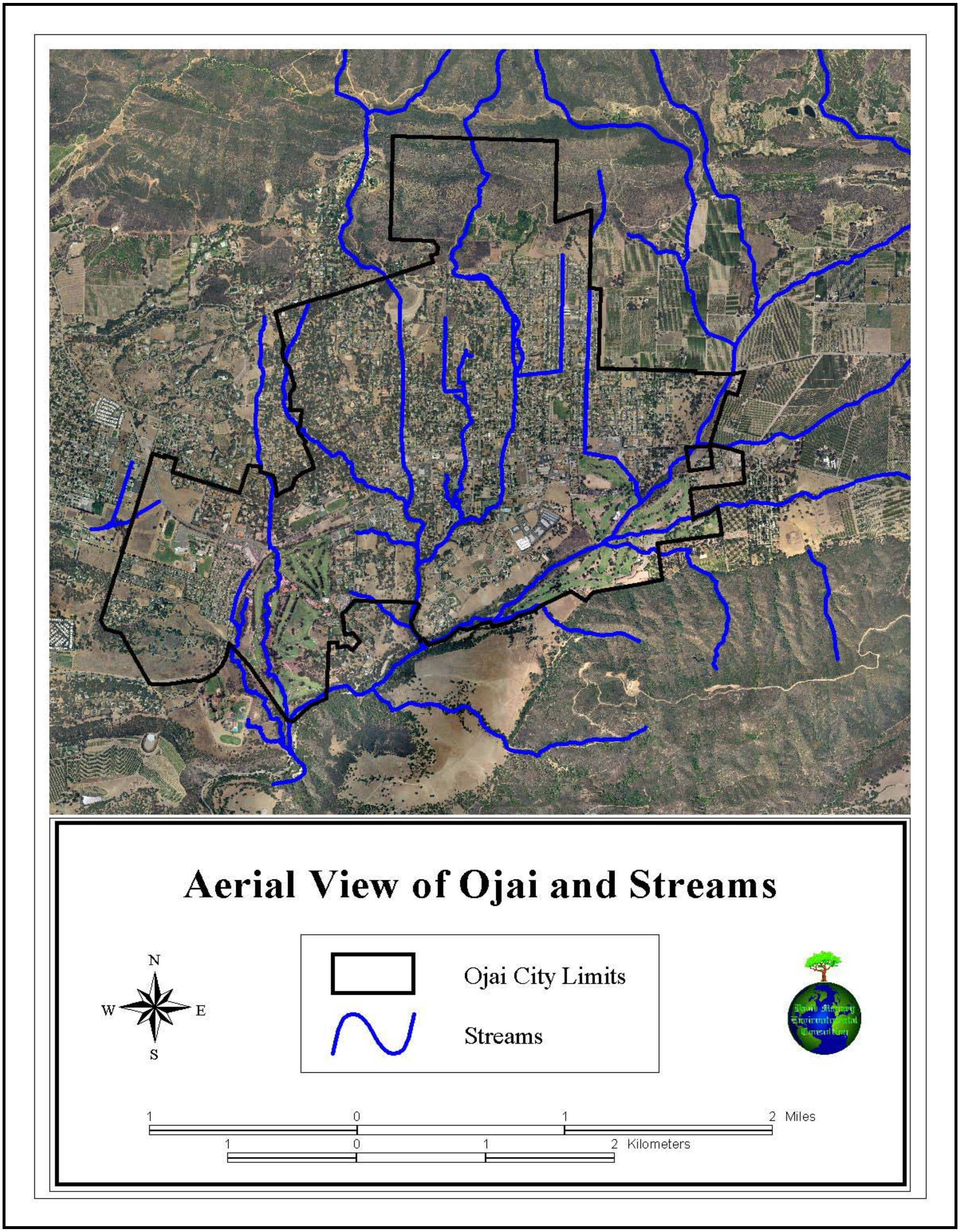


Figure 2. Aerial Photograph with Delineated Ojai Valley Streams



CITY OF OJAI HISTORICAL CONDITIONS

Prior to European settlement, which began in the late 1700s, the Ojai Valley, and area now occupied by the City of Ojai, was undeveloped except for relatively small Chumash villages. There was no man-made impervious cover in the streams or terrestrial lands. Ojai was settled by Americans in the 1880's, primarily with small farms and ranches, dominated by dryland crops, walnut orchards, and later, citrus orchards. The town of Nordhoff was soon established to provide the needs of the local farmers and ranchers, and resort hotels nearby. The name of the town was changed from Nordhoff to Ojai in 1917. The City of Ojai was formally incorporated on 5 August 1921.

As the city grew, urban development expanded around the city core centered along Ojai Avenue. Water diversions and water wells were first dug in the 1880s, and expanded with the growing population and crops. Surface flows in the creeks were perennial to intermittent for most reaches of streams within the City, at least for the larger streams. Nearly all the small streams were ephemeral, containing surface flows either during and shortly after heavy rainstorms, or for weeks to a few months duration during heavier then average rainfall seasons. Many water wells were artesian in the late 1800s. Groundwater levels dropped as withdrawals, primarily for irrigation purposes, increased in the Ojai Valley.

The City population was fairly stable until the 1940s, growing primarily in the 1960s and 1970s, slowing considerably by the late 70s due to restrictions placed on development as traffic congestion became high, and air quality poor. The City of Ojai has grown on average only about one percent per year since, to a current population of approximately 8,000 persons.

The population of the Ojai Valley has grown similarly to that of the City; however, the population has increased at a greater rate in the unincorporated areas of the valley until the late 1990s. The current population of the entire Ojai Valley (which includes the communities of Meiners Oaks, Mira Monte, Oak View, and Casitas Springs) is about 30,000 individuals.

Many anecdotal accounts have noted the presence of Southern Steelhead Trout using several of the streams flowing through Ojai. Specifically, Steelhead Trout have been reported to have been caught from Ojai Creek at Ojai Avenue as late at the 1940s, and have been observed regularly in San Antonio Creek.

Much of the surface water within the City was funneled into urban drainages, converting natural drainages into floodwater conveyance conduits, largely during the 1970s. Ventura County Flood Control District (now the Ventura County Watershed Protection District) constructed, and maintains, many of the drainages within the City (e.g. Fox Canyon Barranca from west of North Montgomery Street, south to Fox Street, Stewart Canyon Creek debris basin and culvert under Cañada Street south to south of the Ojai Bike Trail).

As the City became more urbanized, with paved streets, curbs, flood drains and culverts, water quality into local streams decreased as more pollutants typical from urban areas were washed down the drains to more natural streams downstream.

OJAI VALLEY AND CITY STREAMS

The major subwatersheds of the San Antonio Creek Watershed, the City of Ojai, and the Ojai Valley are Stewart Canyon Creek, Fox Canyon Barranca (Creek), a portion of San Antonio Creek, and a portion of Thacher Creek. Thacher Creek, Stewart Canyon Creek, and Fox Canyon Barranca are all tributaries to San Antonio Creek. San Antonio Creek originates in Senior Canyon on the southerly slopes of the Topatopa Mountains in the northeast quadrant of the basin; it has a drainage area of 135 square kilometers and an average gradient of approximately 11 meters per kilometer. Other major tributaries to San Antonio Creek include Gridley, Reeves, and Lion Creeks. San Antonio Creek is major tributary to the Ventura River system, and joins the Ventura River 13 kilometers upstream from the rivers mouth in Casitas Springs. (Moore 1980b.)

All subwatersheds included in this study are shown in Figure 3, Ojai Basin Subwatersheds, and are listed below in Table 2, Subwatersheds Studied for the Ojai Streams Assessment. All creeks studied within these subwatersheds are shown in Figure 4, Ojai City Streams, and are listed below in Table 3, Creeks Studied for the Ojai Streams Assessment. Tables 2 and 3 also indicate whether each subwatershed and creek is included in or out of the City limits or both. (Refer also to Appendix D, Small Scale Topographic Maps of Ojai Stream Drainages within the north, south, east, and west portions of the City limits.)

Table 2. Subwatersheds Studied for the Ojai Streams Assessment

Subwatershed Name	In the City of Ojai?
Ayers	In and Out
Black Mountain	In and Out
Back Mountain (West)	Out
West Black Mountain	Out
Camp Comfort	In
Del Norte	In and Out
Dennison Park	Out
Fox Canyon Barranca	In and Out
Gridley Canyon	In and Out
Gridley Canyon (East)	Out
Happy Valley Drain	In
Ladera Ranch	In and Out
Mira Monte	In
Upper Ojai (North)	Out
Reeves	Out
Reeves (West)	Out
Lower San Antonio	In
Senior Canyon	Out
Stewart Canyon	In and Out
Thacher Canyon	Out
Lower Thacher	In and Out
Upper Thacher	Out
Upper Thacher (Northeast)	Out
Upper Thacher (Northwest)	Out
Villanova	In

Table 3. Creeks Studied for the Ojai Streams Assessment

Creek Name	In the City of Ojai?
Arbolada Creek	In
Ayers Creek	In and Out
Del Norte Creek	In and Out
Fox Canyon Barranca	In and Out
Grandview-Park Drain	In
Happy Valley Drain	Out
Ojai Creek	In
Nordhoff (Ojai Meadows) Drain	In
San Antonio Creek	In and Out
Stewart Canyon Creek	In and Out
Thacher Creek	In and Out
East End Creek	In
Grandview Drain	In
Oak Creek	In
Post Office Creek	In
Soule Park Creek	In and Out
West Soule Park Creek	In and Out
Villanova Creek	In and Out

Figure 3. Ojai Basin Subwatersheds

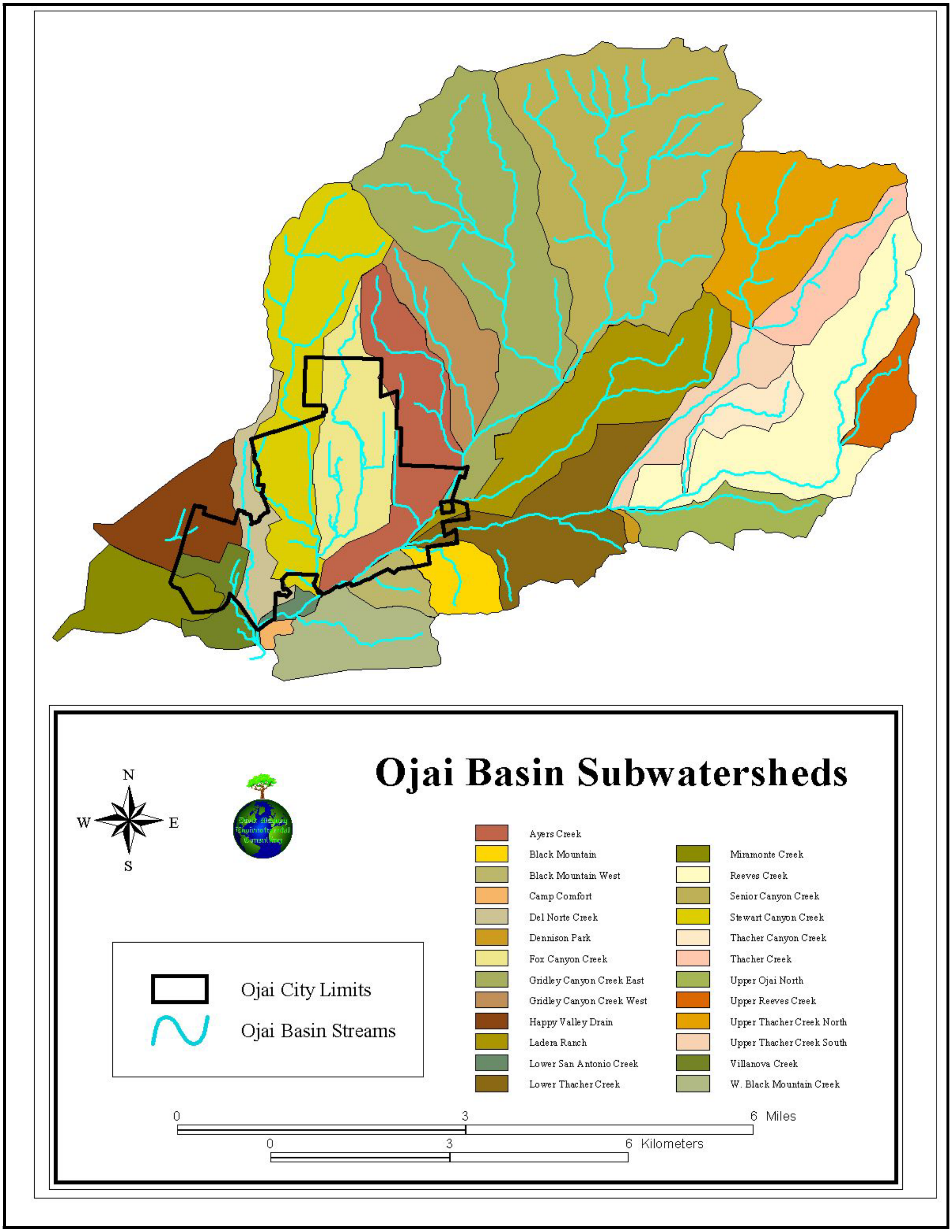
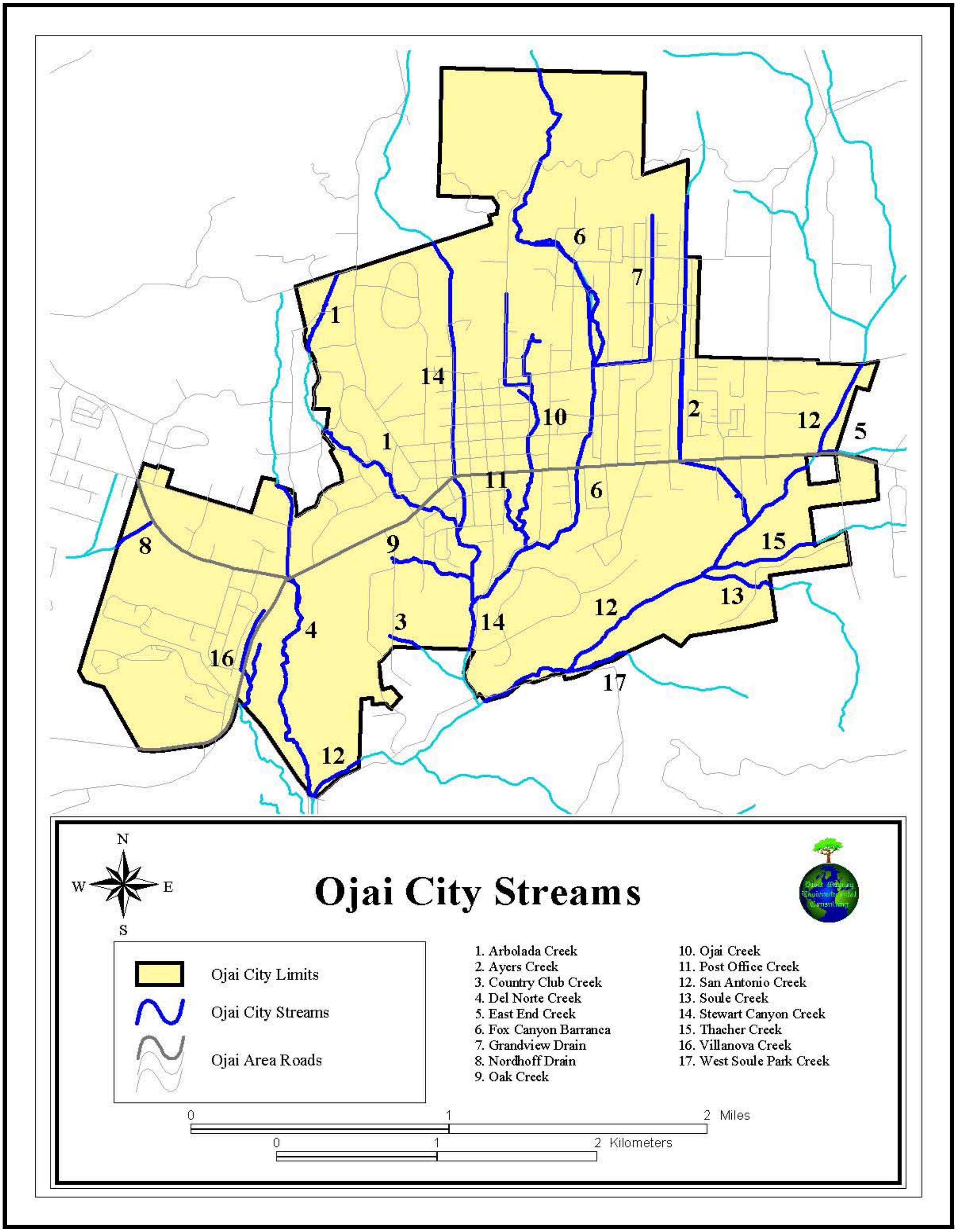


Figure 4. Ojai City Streams



METHODS

This section discusses the methods used to characterize the stream reaches within the City of Ojai and to measure the Ojai streams water quality. A search was conducted to ensure that relevant information was obtained in order to identify data gaps, review archival aerial photographs and historical records, and familiarize the biologists with past conditions within the study area.

STREAM HABITAT CHARACTERIZATION

Stream habitat characterization studies are useful for determining the level of functional habitat for target species, such as Southern Steelhead. Habitat characterization studies determine the existing hydrological, biological, and environmental conditions and expose the barriers and limiting factors for fish and other wildlife species inhabiting the streams of Ojai.

Conventional field surveys were conducted to assess and characterize the stream habitats for the creeks shown in Figure 5, Map of Water Quality Sampling Stations. The portion of the watershed within the City of Ojai was analyzed for suitability of habitat for spawning, rearing, and migration for Southern Steelhead Trout by mapping and characterizing the instream and adjacent habitats along each stream within the City. Each stream was divided into reaches - based on habitat consistency, changes in those habitats, and fish barriers – and biologists walked the entire length of each stream to map, characterize, and assess their suitability for spawning, rearing, and migration for Steelhead.

In addition to the stream classification, habitat typing, and instream shelter inventory conducted for this study, biologists also assessed the human element in the watershed, focusing on land use practices that impact the watershed. An effort was made to identify practices that are detrimental to healthy watersheds, such as manure from horses and smaller pets that are known to be the primary source of water pollution in many communities. Beneficial land use practices were also highlighted in this study, such as erosion and sediment control on public and private land. This assessment attempts to trace links between watershed conditions and land use practices.

Biologists conducted stream habitat characterizations on 27 May, 7 and 8 June, 13 and 19 August, and 10 September 2004. The general stream characterizations were based on assessments of the following parameters:

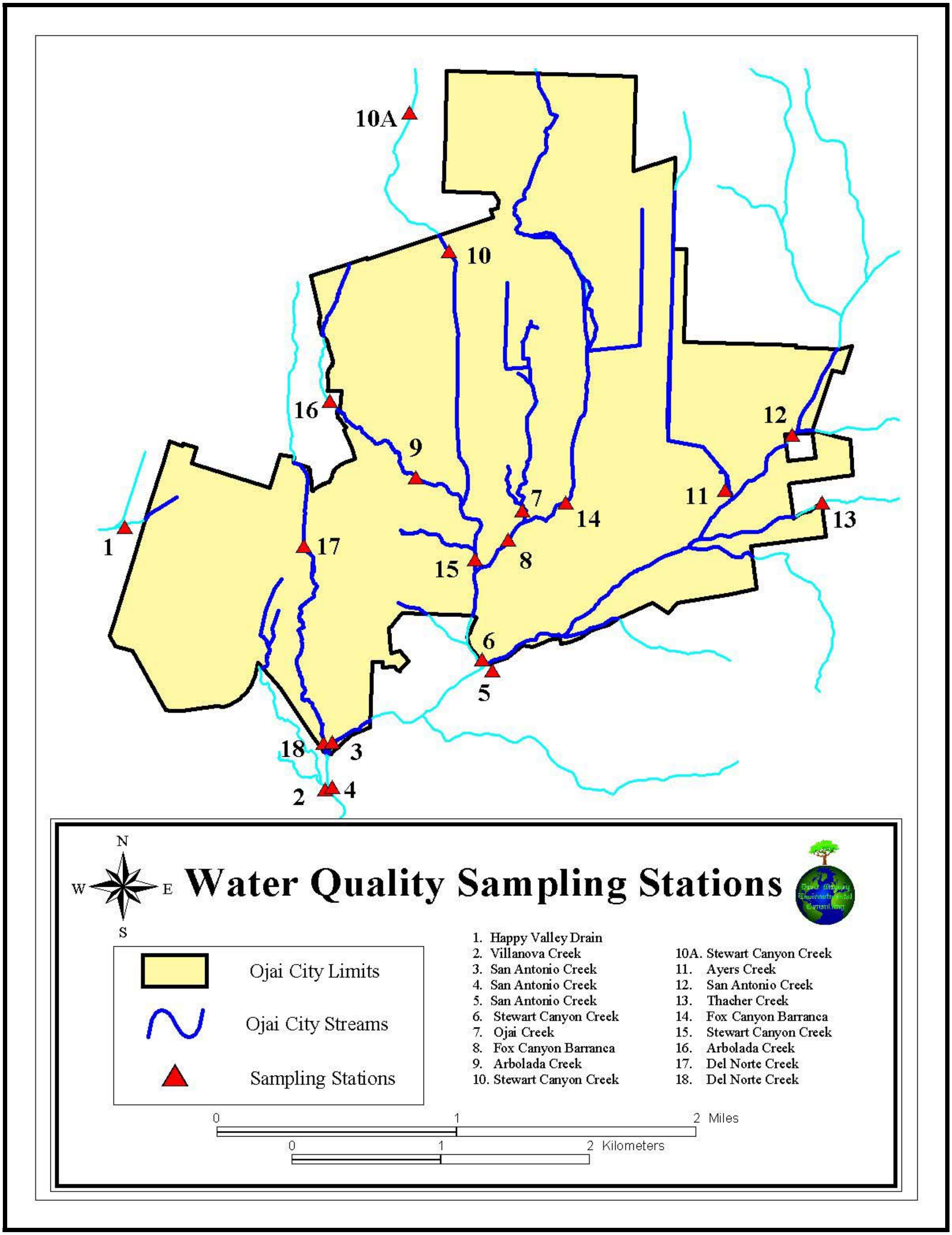
- General flow conditions
- Channel morphology
- Stream type (pool/riffle/run)
- Water depth and width
- Velocity and discharge
- Inundated (yes/no)
- Instream descriptions and cover type (root wads, canopy, logs, etc.)
- Riparian habitat (plant community)
- Shading (percent cover)
- Substrate composition and particle size
- Potential spawning and rearing (yes/no)

Table 4, Stream Habitat Characterization Field Trips Summary, lists the streams surveyed, shows the dates the streams were surveyed, and lists the biologists that characterized the streams.

Table 4. Stream Habitat Characterization Field Survey Summary

Stream Name	Date	Biologist	Location/Direction
Arbolada Creek	27-May-04	Batchelor, Niessen	North of Ojai Avenue north to Fairview Road
	8-Jun-04	Batchelor, Castle	From Ojai Avenue to its confluence with Stewart Canyon Creek
Ayers Creek	27-May-04	Magney	North of Ojai Avenue north to the City limits
	13-Aug-04	Batchelor, Niessen	From west edge of golf course to its confluence with San Antonio Creek
Del Norte Creek	27-May-04	Batchelor, Niessen	From Fairview Road south to Ojai Avenue
	19-Aug-04		From Ojai Avenue south through golf course to its confluence with San Antonio Creek
	10-Sep-04		Between SR 150 and golf course (on S side of SR33/ SR150 intersection and north of Ojai Bike Path)
	10-Sep-04		At 33/150 intersection north of golf course
Fox Canyon Barranca	27-May-04	Magney	North of Ojai Avenue, from Grand Avenue north to the City limits
	8-Jun-04	Batchelor, Castle	From Grand Avenue south to Creek Road
	10-Sep-04	Batchelor, Niessen	From near Pleasant Road to culvert at Grand Avenue
Grandview-Park Drain	27-May-04	Magney	Pleasant Street between Grandview and Park (downstream end)
Happy Valley Drain	8-Jun-04	Batchelor, Castle	From its confluence with Ojai Meadow Creek to State Route (SR) 33
Oak Creek	10-Sep-04	Batchelor, Niessen	East side Country Club Drive at the Inn & Spa entrance
Ojai Creek	27-May-04	Magney	Small drainage above Olive Street
	27-May-04		From Grand Avenue north to near top of hill
	13-Aug-04	Batchelor, Niessen	From SR 150 south to the south side of the Ojai Bike Path
Ojai Meadows Drain	8-Jun-04	Batchelor, Castle	From its confluence with Happy Valley Drain to SR 33
Post Office Creek	10-Sep-04	Batchelor, Niessen	From just south of the Ojai Post Office to just south of Montgomery Street
San Antonio Creek	7-Jun-04	Batchelor, Castle	From the southern end of Camp Comfort to its intersection with Ojai Avenue
Stewart Canyon Creek	27-May-04	Magney	From Highway (SR) 150 north to City limits
	8-Jun-04	Batchelor, Castle	From Ojai Avenue south to its confluence with Fox Canyon Barranca
Thacher Creek	8-Jun-04	Batchelor, Castle	From Ojai Ave. south to its confluence with San Antonio Creek
Villanova Creek	13-Aug-04	Batchelor, Niessen	From SR 33 south to its confluence with San Antonio Creek (Hermosa & Creek Road intersection)
	10-Sep-04		Culvert exit on the east side of Hermosa Road

Figure 5. Map of Water Quality Sampling Stations in Ojai



WATER QUALITY SAMPLING

Water quality assessment data are needed to determine water chemistry and other specific conditions of the streams and drainages that may affect the quality of habitat for aquatic life, including Southern Steelhead Trout. Water quality was sampled at nineteen (19) stations along various streams in the City of Ojai. Stations were designated based on their location and orientation to adjacent or upstream variables such as golf courses and horse corrals, influences from the City runoff, and input from tributaries.

The general quality of the streams were based on assessments of the following parameters: Conductivity and Specific Conductance; Temperature; Dissolved Oxygen and Carbon Dioxide; Turbidity; *p*H; Salinity; and Total Coliform Bacteria.

The water quality sampling equipment, used for measuring these parameters include:

Conductivity (not temperature compensated) (µS, mS) and **Temperature** (°C) were measured with YSI Model 85 Handheld Digital Meter and Smart Water Analysis Laboratory LaMotte CON 5 Meter.

Specific Conductance (temperature compensated conductivity) (µS, mS) and **Salinity** (ppt) were measured with the YSI Model 85 Handheld Digital Meter.

Dissolved Oxygen was measured with the YSI Model 85 Handheld Digital Meter as mg/L or percent (%) saturation and/or the Smart Water Analysis Laboratory LaMotte Dissolved Oxygen Test Kit. This test kit uses the azide modification of the Winkler Method for determining dissolved oxygen. Instead of measuring dissolved oxygen as mg/L or % saturation, this test determines it as Total Dissolved Solids (TDS) or parts per million (ppm).

Carbon Dioxide was measured with the Smart Water Analysis Laboratory LaMotte Alkalinity/Carbon Dioxide Test Kit. This test determines Carbon Dioxide as TDS/ppm.

Turbidity was measured using the Orbeco-Hellige Model 966 Turbidimeter. The Turbidimeter measures the clarity or cloudiness of any type of colorless fluid by measuring the amount of light reflected at a 90° angle by any particles suspended in the fluid, and comparing it to the light scattered by a standard reference suspension. As a true nephelometer, it tests at the officially mandated 90° angles between its photo-detector and incident light beam. Its direct-reading LCD display gives results over three turbidity ranges: 0-20.00, 0-200.0, and 0-1000. It measures in NTUs (or nephelometric turbidity units) and in FTUs (Formazin Turbidity Units). Test resolution is 0.01 NTU in the lowest range.

***p*H** (0-14) was measured with the YSI Model 85 Handheld Digital Meter and/or the Smart Water Analysis Laboratory LaMotte *p*H 5 Meter.

The presence of **Total Coliform Bacteria** was tested using the LaMotte Model TC-5 Coliform Indicator Test Kit. This coliform test kit provides a test tube method to indicate the presence of Total Coliform Bacteria in a drinking water supply via a coliform-indicating test tablet, a gelling substance, and a *p*H indicator. The tablet neutralizes water samples containing chlorine that tends to suppress coliform bacteria growth, and provides growth-supporting nutrients for coliform bacteria. If coliform organisms are present in the sample (a positive result), the bacteria metabolizing the nutrients in the tablet will generate gases. The gasses will be trapped in the gelling substance causing the gel to rise in the tube. The *p*H indicator changes color from red to yellow, indicating coliform bacteria activity.

Figure 5 provides the station locations as well as the streams studied for this project. Some creek/drainage names were invented for the sake of discussion. The station number, creek name, station location, and date sampled are listed in Table 5, Ojai Basin Streams Water Quality Sampling Sites, for each sampling station (following page).

DETERMINING LIMITING FACTORS

Since restoring and improving instream and adjacent habitats for Southern Steelhead in the City of Ojai will vary considerably from site to site, the Limiting Factor Analysis will be used to identify restoration projects for implementation as part of the restoration plan. Environmental factors considered to limit Southern Steelhead natural production include the following:

- **Deficient stream flow**: In general, ephemeral drainages are a limiting factor to the spawning and rearing activities of Steelhead. Steelhead prefer to spawn in perennial streams since generally one to three years is required for offspring to mature and reach the ocean (if ever). However, Steelhead can spawn in intermittent streams, and the juveniles will survive if they can migrate to perennial reaches to oversummer. Streams with flows fewer than five months out of the year are considered a limiting factor for Steelhead; however, reaches with flows most of the year, had to contain additional habitat requirements for Steelhead to be considered potential spawning and rearing habitat.
- **Poor water quality**: Steelhead require cool, clear, well-oxygenated freshwater water flows for survival. Several parameters were studied during the water quality assessment including velocity, pH, dissolved oxygen as mg/L, temperature, conductivity, salinity, and turbidity. Stream reaches with water quality measurements below the Steelhead threshold (as discussed in detail in the Water Quality subsection of the Existing Conditions section of this report), were considered to be a limiting factor for Steelhead.
- **Fish passage barriers:** Steelhead require unobstructed streams for migration to upper stream reaches where potential spawning and rearing habitat exists. Steelhead generally require a 1.25:1 pool-to-jump ratio in order to jump a barrier; with sufficient pool depth, an adult Steelhead can jump up to 6 to 9 feet (Gunther 2000, Herron et al. 2004). Creek reaches containing barriers with a pool-to-jump ratio less than 1.25:1 were considered a limiting factor for Steelhead.
- **Lack of deep pools:** Pools include large woody debris, large substrate particles such as large cobble, boulders, or some geomorphic feature that would support a pool. Juvenile Steelhead generally prefer to inhabit riffles and pools, and as stated above for fish passage barriers, Steelhead generally require a 1.25:1 pool-to-jump ratio in order to jump a barrier. Creek reaches containing pools with a pool-to-jump ratio less than 1.25:1 were considered to be a limiting factor for Steelhead.
- **Lack of spawning substrate:** Adult Steelhead have been reported to spawn in substrates from 0.2 to 4.0 inches in diameter (Reiser and Bjornn 1979). Steelhead utilize mostly gravel-sized material for spawning; however, they will also use mixtures of sand-gravel and gravel-cobble. Fry and juvenile Steelhead prefer cobbles, which is slightly larger than the gravels preferred by adults for spawning (Bovee 1978). The gravel must be highly permeable to keep incubating eggs well oxygenated, and should contain < 5% sand and silt. Creek reaches containing no gravel or cobbles or contained gravels or cobbles with silt or sand were considered to be a limiting factor for Steelhead.
- **Lack of shade canopy:** Percent shading is recorded as the estimated amount of shade or cover created by the canopy of the surrounding riparian vegetation. Proper shade aids in the cooling of water to provide cooler temperatures for Steelhead migration, spawning, and rearing activities. As temperatures rise, fish have increasing trouble extracting oxygen from water, while at the same time the amount of oxygen in the water decreases. Creek reaches containing shading of less than 76% were considered to be a limiting factor for Steelhead.
- **Excessive sediment yield (high turbidity levels):** Turbidity is a measure of the amount of sediment in the water column. Over the long term, sediment settles on the bottom and fills the interstices (spaces and cracks) between streambed gravels and rocks decreasing the amount of desirable spawning habitat as well as habitat required by smaller organisms (insects) which are a vital source of food for fish. Over the short term, turbidity reduces the ability of fish to see and feed. Water quality begins to degrade by suspended sediment between turbidities of 3 and 5 NTU, and impacts on Steelhead begin to be noticeable above 25 NTU. Since the EPA has suggested a turbidity limit of 1.9 NTU for streams in this region, creek reaches containing turbidity measurements higher than 1.9 NTU were considered to be a limiting factor for Steelhead.
- **Lack of instream cover:** Instream cover is composed of elements within a stream channel that provide aquatic vertebrate species protection from predation, reduce water velocities so as to provide resting areas, and reduce intraspecific competition through increased living space within the stream (Hamilton and Bergersen 1984). Instream cover is recorded as objects under water providing shade and resting areas, including over-hanging vegetation, submerged boulders, logs, root wads, submerged vegetation, and undercut banks. Creeks with fewer than three instream cover types is considered a limiting factor specifically to Steelhead rearing and a potential limiting factor for resting migrating Steelhead.

Each stream reach was evaluated for habitat parameters directly and indirectly associated with the above listed limiting environmental factors, and those that fall outside acceptable conditions for Steelhead are identified as a limiting factor. The reaches consisting of one or more habitat limiting factors are assigned specific recommendations for restoration and a feasibility assessment.

Data for each limiting factor were gathered along each reach of the Ojai streams. These data were used here to identify opportunities and constraints to improve habitat conditions for Southern Steelheaderies as well as other wildlife. It should be noted that simply eliminating, or mitigating for, existing limiting factors may not restore the fishery; however, it is a reasonable tool for identifying areas of the City streams that may inhibit or limit the use or passage by Southern Steelhead Trout, and that successful recolonization of each stream in Ojai may not be practical.

Table 5. Ojai Basin Streams Water Quality Sampling Station

Station No.	Dates Sampled	Stream or Drainage Name	Directions
1	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 3 Dec. 2004 5 Jan. 2005	Happy Valley Drain (Reach 1)	Just upstream of confluence with Nordhoff Drain
2	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 5 Jan. 2005	Villanova Creek (Reach 1)	Lower end of Villanova Creek at Hermosa Road, just upstream of San Antonio Creek
3	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 5 Jan. 2005	San Antonio Creek (Reach 1)	Just upstream from its confluence with Del Norte Creek.
4	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 9 Dec. 2004 5 Jan. 2005	San Antonio Creek (Reach 1)	Below confluence of Stewart Canyon Creek under Creek Road bridge at Hermosa Road
5	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 9 Dec. 2004 5 Jan. 2005	San Antonio Creek (Reach 2)	Below confluence of Fox Canyon Barranca below Creek Road bridge
6	4 & 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 9 Dec. 2004 5 Jan. 2005	Stewart Canyon Creek (Reach 1)	Upstream of narrow bridge on Creek Road (at 10 mph curve)
7	4 & 23 Feb. 2004 3 Mar. 2004 20 Oct. 2004 9 Dec. 2004 5 Jan. 2005	Ojai Creek (Reach 1)	Upstream of confluence with Fox Canyon Barranca, north of South Montgomery Street, near lower Libbey Park Tennis Courts
8	4 & 23 Feb. 2004 3 Mar. 2004 20 Oct. 2004 9 Dec. 2004 5 Jan. 2005	Fox Canyon Barranca (Reach 1)	Upstream of creek confluence near intersection of Ventura Street and South Montgomery Street-Buckboard Lane bridge at Montgomery Street

Table 5. Ojai Basin Streams Water Quality Sampling Sites (continued)

Site No.	Dates Sampled	Stream or Drainage Name	Directions
9	4 Feb. 2004 23 Feb. 2004 3 Mar. 2004 20 Oct. 2004 7 Dec. 2004 5 Jan. 2005	Arbolada Creek (Reach 3)	Lower end of Arbolada Creek, near business building on corner of Ojai Avenue and Bristol Street
10	4 Feb. 2004 23 Feb. 2004 3 Mar. 2004	Stewart Canyon Creek (Reach 5)	Inflow into Stewart Debris Basin at top of Signal Street at Pratt Trail Head
10A	20 Oct. 2004 7 Dec. 2004 5 Jan. 2005	Stewart Canyon Creek (Reach 5)	Where the Foothill Road bridge crosses Stewart Canyon Creek, upstream from Station 10
11	4 Feb. 2004 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 5 Jan. 2005	Ayers Creek (Reach 1)	Drainage at the end of Fairway Lane (it drains south to San Antonio Creek)
12	4 Feb. 2004 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 5 Jan. 2005	San Antonio Creek (Reach 3)	Under bridge on Ojai Avenue between Gridley Avenue and Boardman Road
13	4 Feb. 2004 23 Feb. 2004 2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 6 Jan. 2005	Thacher Creek (Reach 1)	Under bridge on Boardman Road south of entrance to Soule Park
14	2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 6 Jan. 2005	Fox Canyon Barranca (Reach 1)	At south end of Fox Street under walking bridge on Athletics Club facility premises
15	2 Mar. 2004 20 Oct. 2004 8 Dec. 2004 6 Jan. 2005	Stewart Canyon Creek (Reach 1)	Upstream from confluence with Fox Canyon Barranca (west of Ventura Street)
16	20 Oct. 2004 8 Dec. 2004 9 Jan. 2005	Arbolada Creek (Reach 3)	North of 509 Palomar Road on the west side
17	20 Oct. 2004 8 Dec. 2004 9 Jan. 2005	Del Norte Creek (Reach 2)	North of intersection of Ojai Avenue and Del Norte Street
18	9 Dec. 2004 9 Dec. 2004 6 Jan. 2005	Del Norte Creek (Reach 1)	Lower end of Del Norte Creek near Hermosa Road, just upstream of San Antonio Creek

EXISTING CONDITIONS

This section discusses the existing conditions of both the physical and biological environments of the streams of Ojai. The physical environment of the Ojai streams includes topography, landscape, altitude, hydrology, substrate, climate, and rainfall of subwatersheds and stream reaches. This section also discusses the land use activities adjacent to the Ojai streams, as well as the barriers causing habitat degradation and limiting factors to the survival, migration, and spawning of Southern Steelhead Trout.

PHYSICAL ENVIRONMENT OF OJAI BASIN STREAMS

The Ventura River basin forms part of the Western Transverse Ranges of southern California (Hickman 1993) and is characterized by steep, coastal, mountainous and narrow canyons, which converge to form a comparatively broad, level central valley. The ratio of mountainous and foothill area to valley area is greater than six to one. The crest of the mountains along the boundary of the watershed commonly rises to over 1,524 meters, and in a few areas, it rises to a height of 1,828 meters. Much of the river basin lies within the Los Padres National Forest. (Moore 1980b.)

Climate and Rainfall

The climate of the Ventura River basin is characterized by two distinct seasons: a cool, wet winter from November through April; and a warm, dry summer from May through October (Bailey 1966). The majority of the precipitation falls as rain during the months of December through March in most years, with annual precipitation varying considerably from year to year. The average annual rainfall for the basin also varies, ranging from 400 milimeters (mm) near the river's mouth at the Pacific Ocean, to approximately 1,020 mm in the Mountainous areas of the basin. The average annual rainfall for the entire basin is approximately 56 centimeters (cm). Snow is common during the winter months in the higher elevations; however, the snow does not normally contribute significantly to the annual stream run-off (U.S. Army Corps of Engineers 1971). (Moore 1980b.)

Photograph 1 *(left). Overflow of Thacher Creek on Ojai Avenue during winter storm event (5 January 2005).*
Photograph 2 *(right) San Antonio Creek during winter storm event (9 January 2005).*

The climate of the South Coast, from Point Conception to Ventura, is generally Mediterranean typified by relatively mild winters, hot dry summers, and coastal fog during the early days of summer. Rain generally occurs only between the months of November to March, and temperatures at lower elevations are almost always above freezing. High-pressure systems, which develop over Utah and Nevada, are strong enough to keep the weather of the South Coast warm and sunny for much of the summer and fall. They also keep rain away and there is little summer precipitation.

The upper watershed may have summer daytime temperatures of 85-100ºF, while the coastal regions will generally be about ten to fifteen degrees cooler. Fall daytime temperatures generally are 70-90ºF in the inland areas, but considerably colder at night. In the fall, Santa Ana winds blow hot and dry from the desert. These warm winds and the prevalent dry conditions often combine to exacerbate natural wild fires, which are a natural part of the ecosystem. Winter is characterized by periodic bouts of heavy rainfall, often several inches in each storm. The upper mountainous regions of watersheds see more rainfall than the lower coastal areas, as Pacific storms are uplifted over the coast range. The foothills, on average, see about 560 to 740 mm (22 to 29 inches) of rain a year, while amounts near the ocean are closer to 380 mm (15 inches). Snow can fall at upper elevations during particularly cold winter storms. (Leydecker and Grabowsky 2004.)

Hydrology

The main stem of the Ventura River is classified as an interrupted stream, made up of perennial reaches with intervening intermittent reaches. The Ventura River generally maintains a perennial surface flow approximately 10 kilometers from its headwaters to the Robles Diversion Dam. The next 12.8 kilometers, from the Robles Diversion Dam to the confluence of San Antonio Creek, is intermittent carrying surface flows for short periods during and following major rainstorms. The 3.2 kilometers from the confluence of San Antonio Creek to Foster Park maintains a perennial surface flow, with some desiccation occurring in the Foster Park area during drought years as a result of municipal groundwater extraction. Surface flow in this reach of the river is made up of flows from San Antonio Creek, Live Oak Acres Creek, several small springs, and rising groundwater.

Of special significance is a geologic discontinuity or natural obstruction in the Ventura River alluvium in the vicinity of Casitas Springs. This feature obstructs the sub-surface flow in the Ventura River above the confluence of San Antonio Creek causing groundwater to rise and flow as a surface stream. This rising groundwater contributes to the perennial surface flow below the confluence of San Antonio Creek (Casitas Municipal Water District and City of San Buenaventura 1978). The lower 9.6 kilometers of the river, from Foster Park to the Pacific Ocean, also normally maintains a perennial surface flow, but is augmented by the discharge from the Ojai Valley Sanitary District's sewage treatment plant. (Moore 1980b.)

Subwatersheds

A total of twenty-five (25) subwatersheds (approximately 2,795 acres) that support the Ojai Basin Watershed have been delineated. The City of Ojai and Ojai Valley primary subwatersheds included in this study are Stewart Canyon Creek, Fox Canyon Barranca, and a portion of Thacher Creek, which are all tributaries to San Antonio Creek. San Antonio Creek originates in Senior Canyon on the southerly slopes of the Topatopa Mountains in the northeast quadrant of the basin. San Antonio Creek joins the Ventura River 13 kilometers upstream from the river's mouth in Casitas Springs.

Within the 25 subwatersheds, a total of 16 creeks flow through the City of Ojai, which totals approximately 86,905 feet (35,179 meters; 16.5 miles) of creek channels. Table 6, Summary of Ojai Basin Streams Hydrology, shows the hydrology for Ojai creeks, within the Ojai Basin Watershed.

Table 6. Summary of Ojai Basin Streams Hydrology[1]

Creek Name	Reach	QBF	Q2	Q50	R Code	Area	VC Node	VCQ50	VC Area	VCcfs/ac	Q2/Q50
Ayers Creek	1	26.1	52.1	400.9	AR1	207	562C	397	205	1.9	0.13
	2	17.7	35.5	295.7	AR2	156	561CD	309	163	1.9	0.12
	3	37.2	74.3	743.3	AY1	376	20AE	680	344	2.0	0.1
	4	33.0	65.9	659.0	AY2	323	18AC	611	299	2.0	0.1
	5	8.6	17.2	214.8	AY3	99	1A	217	100	2.2	0.08
Del Norte Creek	1	32.5	65.1	591.8	DN1	418	646B	538	380	1.4	0.11
	2	22.1	44.1	367.8	DN2	238	644B	408	264	1.5	0.12
	3	14.4	28.8	239.6	DN3	153	640BC	285	182	1.6	0.12
Fox Canyon Creek	1	116.4	232.7	1790.0	FX1	1042	625C	1778	1035	1.7	0.13
	2	82.3	164.5	1370.9	FX2	764	612C	1344	749	1.8	0.12
	3	59.6	119.3	1084.4	FX3	583	601CD	1103	593	1.9	0.11
	4	22.3	44.6	495.4	FX4	266	578CD	555	298	1.9	0.09
	5	18.3	36.6	457.3	FX5	242	576C	480	254	1.9	0.08
Ojai Creek	1	33.5	67.1	447.0	OJ1	224	622DF	465	233	2.0	0.15
	2	24.9	49.8	332.2	OJ2	168	619D	346	175	2.0	0.15
	3	18.8	37.6	250.7	OJ3	119	617DE	198	94	2.1	0.15
San Antonio Creek	1	869.1	1738.2	17382.2	SA1	21555	635AD	16375	20306	0.8	0.1
	2	735.1	1470.2	16335.5	SA2	17133	521A	16570	17379	1.0	0.09
	3	484.2	968.4	10760.2	SA3	9339	463BC	10562	9167	1.2	0.09
	4	408.6	817.3	10216.1	SA4	7630	403B	10283	7680	1.3	0.08
Stewart Canyon Creek	1	259.2	518.5	4320.7	ST1	2858	630B	4230	2798	1.5	0.12
	2	106.0	212.0	2355.1	ST2	1423	563BC	2327	1406	1.7	0.09
	3	88.4	176.8	2209.7	ST3	1203	552B	2206	1201	1.8	0.08
Thacher Creek	1	298.2	596.4	6626.7	TH1	6593	162A	6875	6840	1.0	0.09
Villanova Creek	1	23.4	46.7	389.4	VN1	214	651F	313	172	1.8	0.12
	2	20.3	40.6	270.8	VN2	144	650F	220	117	1.9	0.15
	3	16.7	33.4	208.9	VN3	111	649F	155	82	1.9	0.16

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[1] Hydrology is based on a hydrology study performed by Ventura County Watershed Protection District with appropriate adjustments. Since the reaches identified in this report do not always correspond with the nodes used in the County Hydrology, the above table was developed to make the appropriate adjustments.

Legend: QBF = Bankfull Discharge
Q2 = Peak flow for the 2-year storm
Q50 = Peak flow for the 50-year storm
R-CODE = Reach Code (2 letter acronym for the creek plus 1 digit starting downstream)
AREA = Watershed area above downstream end of reach in acres
VCNODE = Identifier used in County Hydrology study
VCQ50 = Peak flow for the 50-year storm according to County hydrology
VCAREA = Area used in County Hydrology
VCCFS/AC = Peak flow per unit acre from County Hydrology
Q2/Q50 = Ratio of 2-year to 50-year peak flow based on estimation of percent imperviousness and County "hydrology multipliers"

Table 7, Area of Subwatersheds Upstream from the City of Ojai; Table 8, Area of Subwatersheds in The City of Ojai; and Figure 6, Ojai Basin Subwatershed Areas, provide the acres of subwatersheds in and out of the City. Table 9, Length of Creeks and Their Tributaries Upstream from Ojai City Limits, provides the total distance of all creeks (including tributaries) outside the City limits. Table 10, Summary of Creek Lengths within the City of Ojai, gives total creek lengths, distance of each creek underground and aboveground, and distance of general imperviousness.

Table 7. Area of Subwatersheds Upstream from the City of Ojai

Subwatershed Name	Acres
Ayers	742.6
Black Mountain	328.7
Del Norte	181.1
Dennison Park	29.3
Fox Canyon	125.0
Gridley Canyon	2,832.1
Gridley Canyon (East)	700.3
Ladera Ranch	1,469.9
Upper Ojai (North)	518.2
Reeves	1,831.9
Reeves (West)	345.6
Senior Canyon	3,689.5
Stewart Canyon	1,178.4
Thacher Canyon	310.1
Lower Thacher	1,137.9
Upper Thacher	496.2
Upper Thacher (Northeast)	567.2
Upper Thacher (Northwest)	1,309.4
Total:	**17,965.0**

Table 8. Area of Subwatersheds in the City of Ojai

Name of Creek	Acres
Ayers	451.0
Black Mountain	32.5
Back Mountain (West)	57.2
West Black Mountain	0.4
Camp Comfort (Drains to Ventura River)	0.4
Del Norte	230.5
Fox Canyon Barranca	911.0
Gridley Canyon	16.1
Happy Valley Drain	151.0
Ladera Ranch	38.6
Mira Monte (Drains to Ventura River)	91.6
Lower San Antonio	10.9
Stewart Canyon	608.0
Lower Thacher	47.3
Villanova	148.3
Total:	**2,794.9**

Figure 6. Ojai Basin Subwatershed Areas

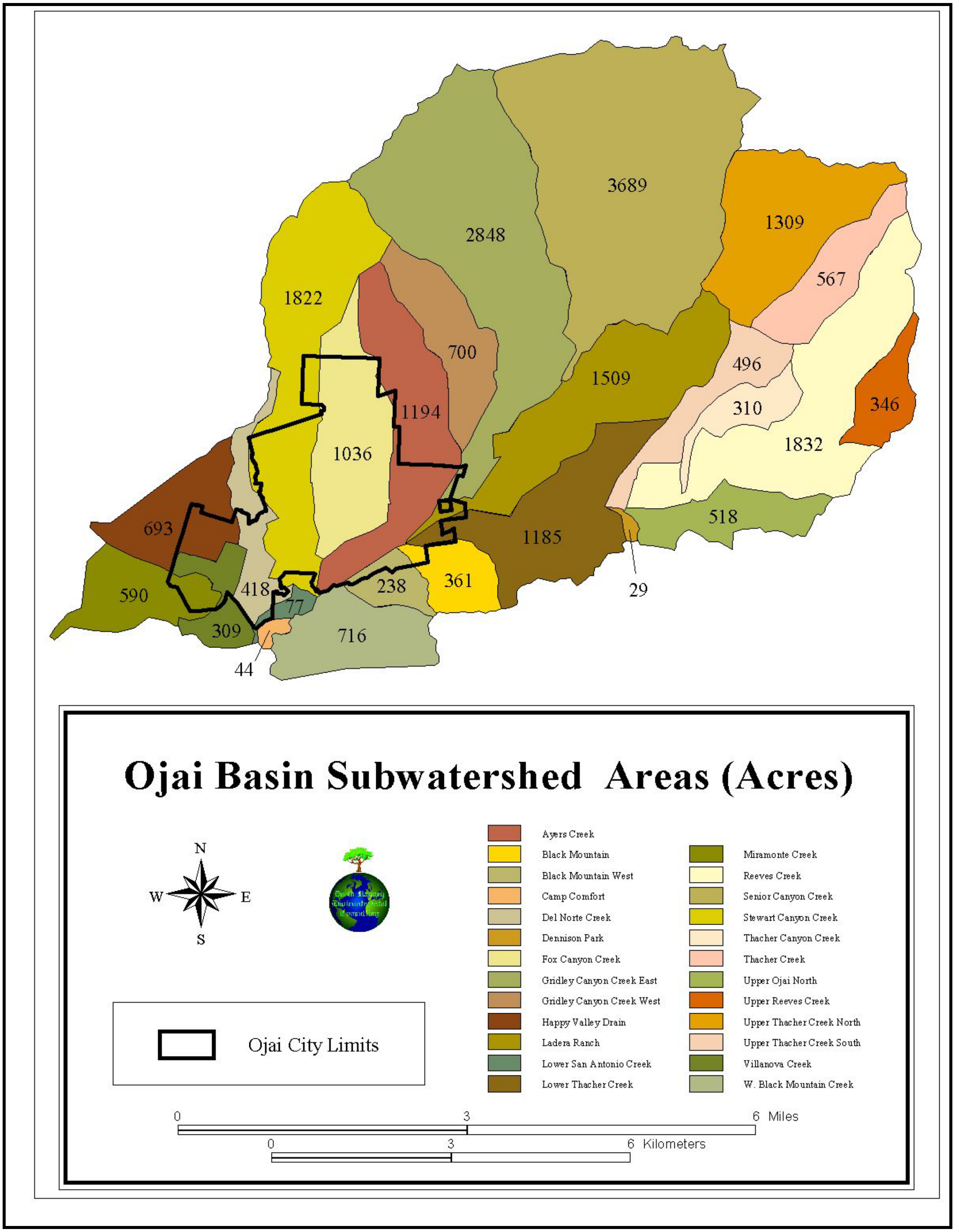


Table 9. Length of Creeks and their Tributaries Upstream from Ojai City Limits

Creek Name	Feet	Miles
Ayers	873	0.4
Del Norte	4162	0.8
Fox Canyon Barranca	3452	0.7
San Antonio	218,881	41.5
Soule Park	4513	0.9
Stewart Canyon	29,116	5.5
Thacher	121,936	23.1
West Soule Park	2,840	0.5
Total:	**386,773**	**73.3**

Table 10. Length of Creeks and their Tributaries within the City of Ojai

Creek Name	Feet	Miles
Arbolada Creek	5,758.6	1.1
Ayers Creek	10,196.5	1.9
Del Norte Creek	7,927.9	1.5
East End Creek	339.1	0.1
Fox Canyon Barranca	17,425.5	3.3
Grandview-Park Drain	4,160.4	0.8
Nordhoff Drainage	837.1	0.2
Oak Creek	1,719.7	0.3
Ojai Creek	8,017.7	1.5
Post Office Creek	1,035.8	0.2
San Antonio Creek	12,095.6	2.3
Soule Park Creek	1,560.7	0.3
West Soule Park Creek	1,304.6	0.2
Stewart Canyon Creek	9,002.9	1.7
Thacher Creek	2,445.1	0.5
Villanova Creek	3,077.9	0.6
Total:	**86,905.3**	**16.5**

Habitat Characterization of Stream Reaches

Of the 16 creeks flowing through the City of Ojai, 51 distinct reaches were delineated within those creeks (Figure 7, Delineation of Ojai City Stream Reaches). This subsection discusses the results of the stream habitat characterization study conducted throughout the streams of Ojai. The findings for each of the primary stream characterization parameters (Appendix A provides an example Stream Characterization and Water Quality Sampling Field Data Sheet), of each stream reach, are presented below. A discussion of these parameters and results and how they ultimately affect Steelhead habitat, as well as other aquatic and terrestrial wildlife in the area, is also provided. Based on the analysis of the stream characterization results, the limiting factors are indicated to aid in identifying restoration projects for implementation as part of the restoration plan presented in the following section. Each stream reach is evaluated for each habitat parameter, and those that fall outside acceptable conditions for Steelhead are identified as a limiting factor.

General Flow Conditions

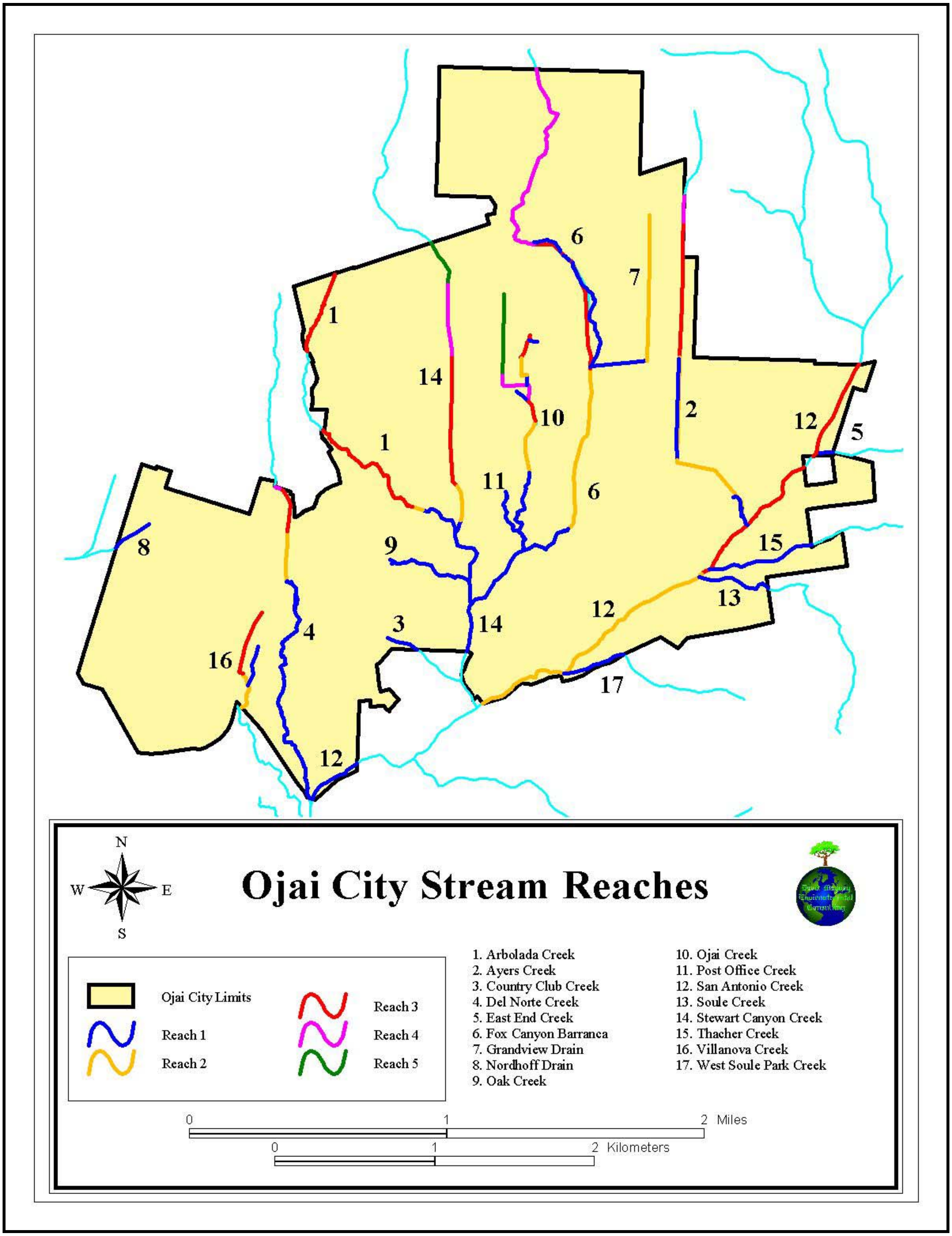
The streams of Ojai can be generally classified as having the following flow conditions: perennial, intermittent, and/or ephemeral. Perennial flow conditions include those channels where the gradient is low, water velocity is slow, and water is usually always flowing year-round. Intermittent flow conditions include channels with flowing water for part of the year (typically through the winter and spring months); however, when water is not flowing, it may remain in isolated pools, or surface flows may be absent. Ephemeral flow conditions are those channels that become inundated with flowing surface water only during periodic/seasonal rain or flood events.

Table 11, Stream Characterization Results for Flow Conditions, Channel Morphology, and Stream Type, presents the flow conditions of specific reaches within the streams of Ojai. In general, Steelhead are most likely expected to migrate and occupy the perennial channels of San Antonio and Stewart Canyon Creeks over the other creeks in the City of Ojai. (Note: A Steelhead approximately 12 inches long was observed in Stewart Canyon Creek on 5 December 2004.) The creek flow conditions is summarized as the following:

- San Antonio and Stewart Canyon Creeks are predominantly perennial with intermittent reaches upstream.
- Fox Canyon Barranca is perennial in the lower reaches, and becomes intermittent/ephemeral upstream.
- Nordhoff Drain and Thacher Creek are both entirely intermittent.
- East End, Grandview-Park, Oak, Post Office, Soule Park, West Soule Park, and Villanova Creeks are all ephemeral drainages.
- Arbolada, Ayers, Del Norte, and Ojai Creeks are intermittent (lower reaches) and ephemeral (upstream).

Flow conditions of streams initiate all other activities as far as Steelhead are concerned. If flows are present within an ephemeral stream, and Steelhead are able to migrate up that stream, then the flow condition of an ephemeral creek is not a limiting factor for migration. However, since (1) spawning occurs only between December and April where water is present year-round, (2) it takes approximately 30 days for the eggs to hatch (estimated in hatcheries at 51°F [Leitritz and Lewis 1980]), (3) fry emerge 4 to 6 weeks after hatching, and (4) rearing generally occurs over 1 to 3 years in freshwater, it can generally be determined that most ephemeral drainages are a limiting factor to the spawning and rearing activities of Steelhead (CDFG 1996). Based on these requirements, Steelhead prefer to spawn only in perennial streams since the duration of generally one to three years is required for offspring to mature enough and to reach the ocean (if ever). However, steelhead can spawn in intermittent streams and the juveniles will survive if they can migrate to perennial reaches to oversummer.

Figure 7. Delineation of Ojai City Stream Reaches



Channel Morphology

Natural channel morphology is the path carved by water flows and this morphology is significantly influenced by the sediment load carried by those flows. Natural channel morphology is maintained by bankfull discharge (Wolman and Leopold 1957). The bankfull discharge typically is considered as discharge that, on the average and over many years, performs the most work on stream systems. The primary geomorphic response to that stream work is sediment transport, and therefore, channel morphology maintenance. Small discharges occur frequently but move small amounts of sediment; large discharges move large amounts of sediment but occur infrequently. The moderate discharges occur moderately frequently and move moderate amounts of sediment. These discharges typically dominate sediment transport and channel morphology maintenance over long periods. (Wolman and Miller 1960.)

***Photograph 3**. San Antonio Creek above Grand Avenue showing natural channel morphology finding its course (4 February 2005).*

Fluvial geomorphologists have long recognized the unique geomorphic responses to episodic flood/high-sediment flux events. Short-term variations in flow can result in a channel morphology that is adjusted to high flows but is not in equilibrium with subsequent low flows (Schumm and Lichty 1963). For example, the channel morphology created during high flows on alluvial fans may be completely reconfigured during low-flow events. The result is that subsequent high flows may not follow the previous paths and kinetic energy may be dissipated in previously unaffected areas (Dawdy 1979).

Table 11 presents the findings for morphology within the primary streams reaches within Ojai that were walked by biologists during the streams habitat characterization assessment. Natural channel morphology is vital for fish passage, spawning, and rearing. The natural creek channels (95 to 100 percent natural) with well-defined bed and banks (in some reaches) include: Arbolada, East End, Nordhoff, Oak, Post Office, San Antonio, Soule Park, West Soule Park, and Thacher Creeks. The predominantly impervious/compacted (unnatural) creek channels (0 to 55 percent natural) limiting fish passage include Ayers, Del Norte, Fox Canyon, Grandview-Park, Ojai, Stewart Canyon, and Villanova Creeks. Although most of Stewart Canyon Creek is impervious, Reaches 1 and 5 have favorable stream morphology characteristic. (See Table 25, Percent Impervious Cover Summary for Creeks within the City of Ojai, for more detailed account of percent impervious cover.)

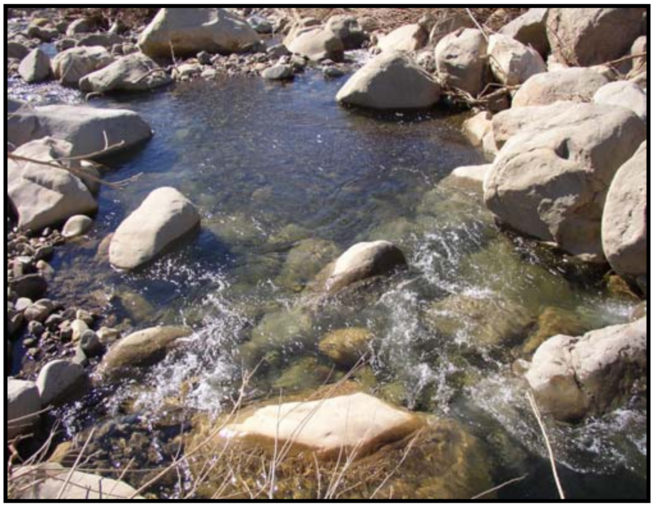
Stream Type

Stream type was recorded for each characterized stream reach. Stream type refers to the natural transitions a creek makes as water flows over various substrates, sediment deposits, and slopes. For this study, a stream was determined to consist of a run, riffle, or pool stream type, or a combination of the three. Most juveniles inhabit riffles but some of the larger ones will inhabit pools or deeper runs (Barnhart 1986)

The general structure of a pool includes large woody debris, large substrate particles such as large cobble, boulders, or some geomorphic feature that would support a pool. The pool usually forms a basin in which a variety of material may enter the pool to provide a range of cover. The velocity of stream flow in a pool may be reduced to near still water. The dominant substrate usually consists of sand and silt particles; however, pools may include gravel, cobble, and boulders depending upon the peak flow rate for that subwatershed. Finally, pools contain a hydraulic control at the tail crest of the pool.

Riffles are generally characterized by shallow reaches with swiftly flowing, turbulent water. Substrate materials may be exposed, and they usually consist of sand, gravel, cobble, and boulder particles; however, riffles may include silt, depending on flow rates.

Flatwater runs include habitat characterized by reduced flows around structures. These are fairly shallow areas and may consist of uniformed and non-uniformed substrate.



Photograph 4 *(left). San Antonio Creek showing a riffle-pool-riffle stream type.*
Photograph 5 *(right). San Antonio Creek showing a run stream type. Photos taken on 4 February 2005.*

Table 11 summarizes the general stream types for the reaches within the Ojai streams. The predominant stream types are riffles and runs; however, it should be noted that in addition to natural runs, the reaches with significant lengths of culverts and channelization were classified as runs also. Again, juvenile Steelhead generally prefer to inhabit riffles and pools; therefore, an example of a limiting factor for rearing juvenile Steelhead is where those streams, shown in Table 11, have channelized reaches that force the water to flow in shallow runs.

Table 11. Stream Characterization Results for Flows, Morphology, and Stream Type

Creek Name	Reach No.	Flow Conditions	Channel Morphology	Stream Type
Arbolada	**1**	Intermittent	Natural bed/banks, sinuous, with human-placed boulders	Run
	2	Ephemeral	Concrete/metal pipe; underground	Run
	3	Ephemeral	Variable, alternating from natural channel to channelized with placed rocks, to lawns; sinuous through yards	Riffle, Run
Ayers	**1**	Intermittent	Natural bottom, highly disturbed, straightened	Riffle, Run
	2	Ephemeral	Underground pipe; underground pipe	Run
	3	Ephemeral	Paved ditch; paved ditch	Run
	4	Ephemeral	Soft bottom ditch; soft bottom ditch	Run
	A-1	Ephemeral	Undergrounded by culvert, ditch draining water from pipe to main channel, undergrounded again opening to filled/cemented drainage	Run
	B-1	Ephemeral	Concrete/asphalt-lined ditch	Run
Del Norte	**1**	Intermittent	Natural bed and banks, defined channel, low sinuosity, undergrounded twice	Pool, Riffle, Run
	2	Ephemeral	Man-laid natural rock (boulder walls/banks), some standing water, back yards, along Del Norte Street	Riffle, Run
	3	Ephemeral	High-density polyethylene pipe; underground (at cemetery)	Run
	4	Ephemeral	Natural bottom, incised, man-laid rock on banks	Pool, Riffle, Run
	A-1	Ephemeral	Natural bed and banks, defined channel, low sinuosity, undergrounded twice	Pool, Riffle, Run
	B-1	Ephemeral	Natural, straight	Run
East End	**1**	Ephemeral	Natural	.
Fox Canyon	**1**	Perennial	Defined, natural channel, sinuous, natural	Pool, Riffle, Run
	2	Intermittent	Undergrounded/channelized by concrete	Run
	3	Ephemeral	Cement channel	Run
	4	Ephemeral	Natural, high-gradient, steep banks	Riffle
	A-1	Ephemeral	Culverts and natural channel stretches, disturbed, through yards	Run
	B-1	Ephemeral	Incised natural channel	Riffle, Run
Grandview-Park	**1**	Ephemeral	Cement	Run
	2	Ephemeral	Asphalted drainage, bed and banks	Run
Nordhoff	**1**	Intermittent	Natural, defined channel, straight, narrow	Run
Oak	**1**	Ephemeral	Natural bed/banks, +/- straight	Riffle, Pool
Ojai	**1**	Intermittent	Variable from culverts and cement/rip rap channelization to natural bed/banks, natural bed/banks, defined channel, sinuous	Pool, Riffle, Run
	2	Intermittent	Cement	Run
	3	Intermittent	Mixed Compacted	Run
	4	Intermittent	Cement, underground	Run
	5	Intermittent	Rock-lined ditch, grouted	Run

Table 11. Stream Characterization Results Flows, Morphology, and Stream Type (continued)

Creek Name	Reach No.	Flow Conditions	Channel Morphology	Stream Type
Ojai (continued)	**A-1**	Ephemeral	Mixed Compacted	Run
	B-1	Ephemeral	Metal pipe, underground	Run
	B-2	Ephemeral	Above ground gutter	Pool, Riffle
	B-3	Ephemeral	Upper portion of reach is lawn/irrigation runoff, lower is dry swale with ill-defined banks	Pool, Riffle
	A of B-1	Ephemeral	Upper portion of reach is lawn/irrigation runoff, lower is dry swale with ill-defined banks	Pool, Riffle
Post Office	**1**	Ephemeral	Variable from natural, defined bed/banks to road culverts, sinuous; filled areas, and channelized with concrete rip rap	Pool, Riffle, Run
San Antonio	**1**	Perennial	Natural ill-defined bed/banks, low sinuosity, braided throughout with cobble bars and some rock riprap	Pool, Riffle
	2	Intermittent	Natural, defined channel, wide floodplain area, low sinuosity, braided (burn area)	Pool, Riffle, Run
	3	Intermittent	Natural bed/banks, defined channel, low sinuosity	Pool, Riffle
Soule Park	**1**	Ephemeral	Natural bed/banks, defined channel	.
West Soule Park	**1**	Ephemeral	Natural bed/banks, defined channel	.
Stewart Canyon	**1**	Perennial	Natural bed/banks, defined channel	Pool, Riffle
	2	Perennial	Channelized, cement rock rip rap on bed/banks	Pool, Riffle
	3	Intermittent	Channelized, concrete channel	Run
	4	Intermittent	Channelized, concrete channel	Run
	5	Intermittent	Natural bed/banks, defined channel	Pool, Riffle, Run
Thacher	**1**	Intermittent	Predominantly natural bed/banks, braided, low sinuosity, braided, good potential ponding (area of channelization, fencing/concrete	Pool, Riffle, Run
Villanova	**2** Note: Reach 1 is outside the City limits	Ephemeral	Natural bed/banks, sinuous	Pool
	3	Ephemeral	Compacted/filled soil	Run
	B-1	Ephemeral	Natural bed/banks, defined channel	Riffle, Pool

Inundation

Inundation is a parameter that indicates whether the stream being sampled or characterized actually has water present within its channel or not (whether water is present/flowing). Refer to Table 12, Stream Characterization Results for Inundation, Water Depth and Width, Velocity, Discharge, and Stream Type, for inundation results for specific reaches within the Ojai streams. Table 12 indicates the months that water was observed flowing, and/or is expected to flow, in each creek.

Stewart Canyon Creek has water flows year round, San Antonio Creek has flows almost year round, and Fox Canyon Barranca has flows almost year round in its first reach. Most remaining creeks have water flows during most of the winter and spring months. As discussed in General Flow Conditions (above) long periods of inundation is required for spawning and rearing activities. Streams that are not inundated year round are a limiting factor to rearing; however, streams inundated for only the winter and spring months are not limiting factors to Steelhead migration as long as portions of the stream are perennial. Streams which support Steelhead, but are intermittent, exist in the Santa Monica Mountains, where Steelhead persist as long as some portion of the stream has water year round.

Water Depth and Width

Water depth and water width were measured at each water quality sampling station during each sampling session. Water quality sampling stations were designated at specific locations in the primary Ojai creeks; therefore, not all creeks were measured for water width and depth.

The following creeks were assigned water sampling stations to monitor water quality as well as water width, depth, velocity, and discharge (see also Table 16, Ojai Stream Reaches with Corresponding Water Quality Sampling Stations, in the Water Quality Section below):

- Arbolada Creek (2 stations)
- Ayers Creek (1 station)
- Del Norte Creek (2 stations)
- Fox Canyon Barranca (2 stations)
- Happy Valley Drain (1 station outside of the City limits)
- Ojai Creek (1 station)
- San Antonio Creek (4 stations)
- Stewart Canyon Creek (4 stations)
- Thacher Creek (1 station)
- Villanova (1 station)

These measurements were monitored at the sampling stations to observe fluctuations of stream depth, width, velocity, and discharge at single points within the creeks over several dates, and to detect changes throughout the four seasons.

The preferred depth for Steelhead spawning is approximately 14 inches and ranges from 6 to 24 inches. Fry prefer water approximately 8 inches in depth and utilize water 2 to 14 inches deep, while parr prefer a water depth of 10 inches, but utilize water 10 to 20 inches deep (Bovee 1978). In natural channels, water depth usually does not hinder adult migration because adult Steelhead normally migrate during high flows. Depth can become a significant barrier or impedance in streams that have been altered for flood control purposes, especially those that do not have a low flow channel. It has been reported that 7 inches is the minimum depth required for successful migration of adult Steelhead (Thompson 1972) although the distance fish must travel through shallow water areas is also a critical factor. Optimum depths for migration of adult Steelhead range from 18-61 cm (Bovee 1978). Excessive water velocity and obstacles, which impede the swimming and jumping ability, are more significant in hindering or blocking migration (Barnhart 1986). (CDFG 1996.)

Table 12 provides the average water depths and widths for specific reaches of the Ojai streams over six separate sampling dates. Appendix B, Ojai Streams Water Quality Sampling Results, provides all water width and depth data collected during each of the six dates on which the water quality sampling portion of this study were conducted. Water widths and depths of the streams were also measured at each water quality sampling station in order to determine the estimated water velocity and discharge of each creek.

Average water *width* was narrowist at Del Norte Creek Reach 1 (2.75 ft., or 33 in.), and was the widest at San Antonio Creek Reach 3 (18 ft., or 216 in.).

San Antonio Creek Reach 3 had the shallowest average *depth* measurement of 0.26 ft. (approximately 3 in.). Ayers Reach 1 (0.34 ft.), Ojai Reach 1 (0.32 ft.), San Antonio Reach 2 (0.35 ft.), Stewart

Canyon Reach 1 (0.33 ft.), and Thacher Reach 1 (0.39 ft.) also had shallow depth measurements of approximately 3.5 inches. Arbolada Reach 3 (2.14 ft., or 26 in.), Del Norte Reach 1 (2 ft., or 24 in.) and Reach 2 (1.92 ft., or 23 in.), Fox Canyon Reach 1 (1.3 feet, or 16 in.), and San Antonio Reach 1 (0.73 ft., or 9 in.) had the deepest measurements.

Based on these measurements, Arbolada, Del Norte, Fox Canyon, and San Antonio Creeks have water depth measurements that could potentially support Steelhead spawning, fry and parr development, and migration, that is if water is present long enough throughout the year, and if all other environmental and biological conditions are also supportive to Steelhead requirements. All other stream reaches have too shallow of flows that potentially limit these vital Steelhead activities.

Velocity and Discharge

Water velocities of 10 to 13 feet per second (fps) begin to hinder the swimming ability of adult Steelhead and may retard migration (Reiser and Bjornn 1979). Steelhead spawn in areas with water velocities ranging from 1 fps to 3.6 fps, but prefer velocities of about 2 fps (Bovee 1978). The ability to spawn in higher velocities is a function of size: larger Steelhead can establish redds and spawn in faster currents than smaller Steelhead (Barnhart 1986). (CDFG 1996.)

As with water depth and width, stream velocity and discharge were also measured at each water quality sampling station (listed above under Water Depth and Width) over six sampling The water quality stations were designated based on their location and orientation to adjacent or upstream variables such as golf courses and horse corrals, influences from the City runoff, and input from tributaries. Habitats varied between stations; however, the stations were selected to be representative of the reach in which each station is located.
Discharge was determined by multiplying average stream depth by stream width, and then by stream velocity. Table 12 shows the average water velocity and discharge measurements for specific reaches within the Ojai streams. Appendix B, Ojai Streams Water Quality Sampling Results, provides all water velocity and discharge data collected during the water quality sampling portion of this study.

In general, average water velocity measurements within the creeks of Ojai are relatively low at around 1 fps. Water velocity averages throughout the streams of Ojai range from 0.21 fps (discharge of 0.35 cfs) at Ayers Creek Reach 1, to 1.66 fps (discharge of 2.32 cfs) at Stewart Canyon Creek Reach 1. All creek reaches are below the 10 fps threshold for hindering Steelhead swimming ability. Approximately 1/4 of the creek reaches within Ojai have favorable average velocity measurements for Steelhead spawning as they are within the 1 to 3 fps threshold.

The creek reaches that were sampled and were determined to have an average water velocity between the favorable 1 and 3 fps include: Del Norte Reach 2 (1.47 fps); Fox Canyon Reach 1 (generally favorable based on two station's averages - 0.1 to1.08 fps), San Antonio Reach 1, 2, and 3 (1.18 to 1.34 fps); and Stewart Canyon Reach 1 (generally favorable based on three station's averages – 0.53 to 1.66 fps). In addition to the sampled creek reaches, the creek reaches expected to have favorable velocity during the winter and spring months include Fox Canyon Reach 2 and 3, and Stewart Reach 2, 3, 4, and 5.

The creeks reaches that were sampled and were determined to have water velocity measurements of less than 1 fps include Ayers Reach 1 (0.21 fps), Thacher Reach 1 (0.5 fps), Fox Canyon Reach 1 (0.6 fps), and Ojai Reach 1 (0.66 fps). These creek reaches may be limiting to Steelhead spawning. No creek reaches are determined to limit Steelhead migration since no stream reaches had velocity measurements above 3.33 fps.

Table 12. Stream Characterization Results for Inundation, Water Depth and Width, Velocity, Discharge, and Stream Type[2]

Creek Name	Reach No.	Months Inundated (water present)	Average Water Depth (feet)	Average Water Width (feet)	Average Velocity (fps)	Average Discharge (cfs)
Arbolada	**1**	Jan, Feb, Mar, Oct, Nov, Dec	.	.	Not favorable	.
	2	Jan, Feb, Mar, Oct, Nov, Dec	.	.	Not favorable	.
	3[3]	Jan, Feb, Mar, Oct, Nov, Dec	0.28	2.45	0.43 Not favorable	0.25
Ayers	**1**	Jan, Feb, Mar, Apr, Oct, Nov, Dec	0.34	4.25	0.21 Not favorable	0.35
	2	Jan, Oct, Dec	.	.	Not favorable	.
	3	Jan, Feb, Mar, Oct, Dec	.	.	Not favorable	.
	4	Jan, Feb, Mar, Oct, Dec	.	.	Not favorable	.
	A-1	Jan, Apr, Oct, Dec	.	.	Not favorable	.
	B-1	Jan, Oct, Dec	.	.	Not favorable	.
Del Norte	**1**	Jan, Feb, Apr, Sep, Oct, Nov, Dec	2	2.75	0.89 +/- Favorable	6.39
	2	Jan, Feb, Oct, Dec	1.92	3.25	1.47 Favorable	39.08 (this number is high due to Jan measurement)
	3	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	4	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	A-1	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	B-1	Jan, Feb, Sep, Oct, Dec	.	.	Not favorable	.
East End	**1**	Jan, Oct, Dec	.	.	Not favorable	.
Fox Canyon	**1**	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	1.3	6.39	1.08 at Station 8, 0.1 at Station 14; Generally favorable	3.51
	2	Jan, Feb, Jun, Oct, Nov, Dec	.	.	Favorable	.
	3	Jan, Feb, Oct, Dec	.	.	Favorable	.
	4	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	A-1	Jan, Oct, Nov, Dec	.	.	Not favorable	.
	B-1	Jan, Oct, Dec	.	.	Not favorable	.
Grandview-Park	**1**	Jan, Mar, Oct, Dec	.	.	Not favorable	.
	2	Jan, Mar, Oct, Dec	.	.	Not favorable	.
Nordhoff	**1**	Jan, Feb, Mar, Oct, Nov, Dec	.	.	Not favorable	.
Oak	**1**	Jan, Feb, Oct, Nov, Dec	.	.	Not favorable	.
Ojai	**1**	Jan, Feb, Sep, Oct, Nov, Dec	0.32	4.03	0.66 Not favorable	0.8
	2	Jan, Feb, Oct, Nov, Dec	.	.	Not favorable	.
	3	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	4	Jan, Feb, Oct, Dec	.	.	Not favorable	.
	5	Jan, Feb, Mar, Oct, Dec	.	.	Not favorable	.

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[2] Refer to Table 5 and Figure 5 for station locations, and Table 16 for creek reaches with corresponding stations.

[3] Arbolada Creek Reach 3 contains two water quality sampling stations (Stations 9 and 16). Since Station 16 (1) was only sampled once (dry at all other attempts), (2) had unusually high flows due to flood event in October 2004, and (3) is outside of the City limits, Station 16 was not factored into the velocity and discharge results for Arbolada Creek Reach 3.

Table 12. Stream Characterization Results for Inundation, Water Depth and Width, Velocity, Discharge, and Stream Type (continued)[4]

Creek Name	Reach No.	Months Inundated (water present)	Average Water Depth (ft)	Average Water Width (ft)	Average Velocity (fps)	Average Discharge (cfs)
Ojai (continued)	**A-1**	Jan, Oct, Dec	.	.	Not favorable	.
	B-1	Jan, Oct, Dec	.	.	Not favorable	.
	B-2	Jan, Oct, Dec	.	.	Not favorable	.
	B-3	Jan, Oct, Dec	.	.	Not favorable	.
	A of B-1	Jan, Oct, Dec	.	.	Not favorable	.
Post Office	**1**	Jan, Feb, Oct, Nov, Dec	.	.	Not favorable	.
San Antonio	**1**	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	0.72	12.98	1.34 at Station 3, 1.18 at Station 4; Favorable	14.41
	2	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	0.35	11.68	1.3 Favorable	5.82
	3	Jan, Feb, Oct, Nov, Dec	0.26	18	1.34 Favorable	6.96
Soule Park	**1**	.	.	.	.	.
West Soule Park	**1**	.	.	.	.	.
Stewart Canyon	**1**	Year Round	0.33	4.83	0.71 at Station 6, 0.53 at Station 15; Generally Favorable	2.32
	2	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	.	.	Generally Favorable for Reaches 2, 3, & 4[5]	.
	3	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	.	.		.
	4	Jan, Feb, Mar, Dec	.	.		.
	5	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	.	.	1.66 at Station 10A, Favorable	.
Thacher	**1**	Jan, Feb	0.39	6	0.5 Not favorable	1.17
Villanova Note: Reach 1 is outside the City limits	**2**	Jan	.	.	Not favorable	.
	3	Jan	.	.	Not favorable	.
	B-1	Jan	.	.	Not favorable	.

Instream Description and Cover Type

Instream cover is composed of elements within a stream channel that provide aquatic vertebrate species protection from predation, reduce water velocities so as to provide resting areas, and reduce intraspecific competition through increased living space within the stream (Hamilton and Bergersen 1984). Instream assessments provide information regarding organisms, organic matter, and inorganic materials occupying aquatic habitats of the Ojai streams. Cover type specifically relates to what type of shelter is available within the immediate water channel, as apposed to cover or shade made by riparian vegetation. Instream cover is recorded as objects under water providing shade and resting areas, including over-hanging vegetation, submerged boulders, logs, root wads, submerged vegetation, and undercut banks.

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[4] Refer to Table 5 and Figure 5 for station locations, and Table 16 for creek reaches with corresponding stations.

[5] Water velocity may be adequate for fish habitat here; however, the imperviousness of the substrate in these creek reaches are not suitable for spawning and rearing, and may create an impediment to fish migration since no resting pools exist throughout these reaches.

Photograph 6. *Stewart Canyon Creek showing root wads and logs as functional instream cover for Steelhead (5 January 2005). A Southern Steelhead was observedat this location in December 2004.*

Table 13, Stream Characterization Results for Instream, Cover Type, Riparian Habitat, and Percent Shading, provides a list of instream descriptions and cover type findings for specific reaches within the Ojai streams. Based on the findings from the streams habitat characterization study, the creek reaches with 5 to 6 instream cover types (optimal conditions) include: Ayers Reach 1, Del Norte Reach 1, Fox Canyon Reach 1, Ojai Reach 1, San Antonio Reach 1 and 2, and Stewart Canyon Reach 1 and 5.

The creek reaches with 4 to 3 instream cover types (satisfactory conditions) include: Arbolada Reach 2 and 3, Del Norte Reach 2 and 4, Post Office Reach 1, San Antonio Reach 3, and Thacher Creek Reach 1. All remaining creek reaches have 2 to 0 instream cover types (unfavorable instream conditions). Inadequate instream cover is a limiting factor specifically to Steelhead rearing and a potential limiting factor for resting migrating Steelhead.

Riparian Habitat

The predominant plant community observed throughout the creeks of Ojai is Coast Live Oak Riparian Woodland. This plant community includes important canopy contributor such as Arroyo Willow (*Salix lasiolepis*), White Alder (*Alnus rhombifolia*), Fremont Cottonwood (*Populus fremontii* ssp. *fremontii*), Valley Oak (*Quercus lobata*), and California Sycamore (*Platanus racemosa*). Predominant shrub and herbaceous plants observed in this plant community include Pacific Blackberry (*Rubus ursinus*), Western Poison Oak (*Toxicodendron diversilobum*), Mugwort (*Artemisia douglasiana*), and Mulefat (*Baccharis salicifolia*). Unfortunately, this habitat type is significantly influenced by escaped ornamental plant species that become highly invasive and create competitive conditions for the less-hearty, more-desirable native riparian species. Refer to the Habitat Descriptions subsection for the classification and detailed description of all the riparian and aquatic habitats and plant communities observed during the stream characterization studies and water quality surveys.

***Photograph** 7 (left). San Antonio Creek showing functional riparian habitat consisting of predominantly native plant species (17 June 2004). **Photograph 8** (right). Fox Canyon Barranca showing poor quality stream habitat dominated by invasive exotics and ornamental plant species, such as Peruvian Peppertree and Mexican Fan Palm (27 November 2004).*

Table 13, provides a summary of the predominant plant communities by creek and stream reach. By far, San Antonio, Fox Canyon, lower Stewart Canyon, and lower Ojai Creeks have the most favorable and functional riparian plant communities of all the Ojai creeks. Other creek reaches inhabited by favorable riparian habitat include all Del Norte Creek reaches, Grandview-Park Reach 2, Stewart Canyon Reach 5, Thacher Reach 1, and Villanova Creek Reach 2. However, these creek reaches are influenced by invasive exotic plant species as well. All other creek reaches are either significantly out-competed by introduced ornamental and naturalized plant species, or are completely channelized.

Percent Shading

Percent shading is recorded as the estimated amount of shade or cover created by the canopy of the surrounding riparian vegetation. Shade is an important component of Steelhead habitat requirements, as specific temperatures are required for survival. Proper shade aids in the cooling of water to provide cooler temperatures for Steelhead migration, spawning, and rearing activities. As temperatures rise, fish have increasing trouble extracting oxygen from water, while at the same time the amount of oxygen in the water decreases. As temperature increases, dissolved oxygen usually decreases, and visa versa. Temperature was measured during water quality sampling; therefore, this parameter is discussed in detail in the following subsection, Water Quality Sampling Results.

Shading of the creeks was variable. Most of the streams' canopies were composed of both broad-leaved, winter-deciduous trees, such as California Sycamore (*Platanus racemosa*), Arroyo Willow (*Salix lasiolepis*), and Fremont Cottonwood (*Populus fremontii*), and evergreen trees, such as Coast Live Oak (*Quercus agrifolia*). Percent shading also includes invasive exotic plant species. Table 13 provides the general estimated percent shading results for specific reaches within the Ojai streams.

The creek reaches with abundant shading between 76% and 90% include the following:

- Arbolada Reach 1
- Del Norte Reach 4
- Fox Canyon Reach 1 and B-1
- Oak Reach 1
- Ojai Reach 1 and 3
- Post Office Reach 1
- San Antonio Reach 1, 2, and 3
- Stewart Canyon Reach 1 and 5
- Villanova Reach 2

The creek reaches with shading between 40% and 75% include the following:

- Arbolada Reach 3
- Ayers Reach 1, 3, 4, and A-1
- Del Norte Reach 1, 2, A-1, and B-1
- East End Reach 1
- Fox Canyon Reach 2, 4 and A-1
- Grandview Reach 2
- Ojai Reach A-1
- Thacher Reach 1
- Villanova Reach 3

Creek reaches with little to no shading by riparian vegetation may be a limiting factor to Steelhead in general (including all life histories), as shading aids in controlling temperatures from increasing beyond threshold levels. Therefore, the Ojai stream reaches that have less than 40% shading create a limiting factor for migrating, spawning, and rearing Steelhead.

Table 13. Stream Characterization Results for Instream, Habitat, and Shading

Creek Name	Reach No.	Instream Description	Instream Cover[6]	Riparian Habitat	% Shade
Arbolada	**1**	.	OV	Coast Live Oak Riparian Woodland with significant ornamentals	90
	2	Concrete/Metal Pipe	OV, SB, RW	.	100
	3	Leaf Litter, lawn, herbaceous vegetation	OV, L, RW	Disturbed Coast Live Oak Riparian Woodland, backyards, ornamentals	55
Ayers	**1**	Leaf litter, herbaceous vegetation	OV, SB, L, RW, SV, UB	Arroyo Willow Riparian Woodland, Toyon, Prunus, Palm	70
	2	Underground pipe	.	None	100
	3	Paved ditch	OV	None	50
	4	Soft bottom ditch	OV	None	50
	A-1	Cement, herbaceous vegetation	Cement, OV	Palustrine Emergent (Umbrella Sedge, Watercress, Willow-herb) with scattered Oak, Eucalyptus, Acacia, Walnut, Toyon	75
	B-1	Cement	None	None	0
Del Norte	**1**	Water striders and other aquatic insects, pollywogs, Mint, algae, Watercress, Cattail	OV, SB, L, RW, SV, UB	Arroyo Willow Riparian Woodland, Eucalyptus, Coast Live Oak Riparian Woodland, Cattail, ornamentals, Pacific Blackberry, Western Poison Oak, Giant Reed, Periwinkle, Smilo Grass	70
	2	Leaf litter, herbaceous vegetation	OV, RW, Eucalyptus stump	Coast Live Oak-Valley Oak Riparian Woodland	60
	3	High-density polyethylene pipe	None	Underground	100
	4	Leaf litter, herbaceous vegetation	OV, RW, UB	Coast Live Oak Riparian Woodland, Pacific Blackberry, ornamentals	80
	A-1	Aquatic insects, pollywogs, algae	None	Arroyo Willow Riparian Woodland, Eucalyptus, Coast Live Oak Riparian Woodland, Cattail, ornamentals, Pacific Blackberry, Western Poison Oak, Giant Reed, Periwinkle, Smilo Grass	70
	B-1	Periwinkle, Umbrella Sedge	OV	Coast Live Oak Riparian Woodland	70
East End	**1**	Leaf litter, herbaceous vegetation	OV	Riparian patches (Mulefat, Arroyo Willow) through orchards	40
Fox Canyon	**1**	Algae, fish, insects, pollywogs	OV, SB, L, RW, SV, UB	Coast Live Oak Riparian Woodland, Willow, Alder, Toyon, Western Poison Oak, Walnut, Mulefat, Pacific Blackberry	90
	2	Algae, trash	OV	Ornamentals	40

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[6] Instream Cover Types: OV = Over-hanging Vegetation; SB = Submerged Boulders; L = Logs; RW = Root Wads; SV = Submerged Vegetation; UB = Undercut Banks

Table 13. Stream Characterization Results for Instream, Habitat, and Shading (continued)

Creek Name	Reach No.	Instream Description	Instream Cover[7]	Riparian Habitat	% Shade
Fox Canyon (continued)	**3**	Cement	None	None	0
	4	Leaf litter, herbaceous vegetation	OV, SB	Sycamore Riparian Woodland, Willow, Mulefat, California Rose, Pacific Blackberry	60
	A-1	Leaf litter, Periwinkle, trash	Culverts, OV	Coast Live Oak Riparian Woodland, ornamentals, Ceanothus, Sumac, Man-root	70
	B-1	Leaf litter, herbaceous vegetation	OV	Coast Live Oak Riparian Woodland	90
Grandview-Park	**1**	Cement	None	None	0
	2	Leaf Litter	OV	Coast Live Oak Riparian Woodland	50
Nordhoff	**1**	Leaf litter, herbaceous vegetation	OV, RW	Freshwater Marsh, Eucalyptus Grove, Mulefat, Annual Grassland	40
Oak	**1**	Annual grasses	OV	Coast Live Oak-Willow Riparian Woodland, ornamentals, Annual Grassland	90
Ojai	**1**	Algae, moss, leaf litter, insects, Goldfish, Mosquitofish,	OV, SB, RW, SV, UB	Coast Live Oak-Sycamore-Willow Riparian Woodland, Walnut, Western Poison Oak, Pacific Blackberry, ornamentals	80
	2	Cement	None	Underground	100
	3	Mixed Compacted	OV	None	80
	4	Cement, underground	None	None	100
	5	Rock-lined ditch, grouted	None	None	0
	A-1	Mixed Compacted	OV	None	45
	B-1	Metal pipe, underground	None	None	100
	B-2	Annual grasses	None	Annual Grassland	0
	B-3	Annual grasses	None	Annual Grassland	0
	A of B-1	Annual grasses	None	Annual Grassland	0
Post Office	**1**	Leaf litter, cement, Raccoon prints	OV, SB, RW, Culverts	Coast Live Oak-Valley Oak-Sycamore Riparian Woodland with Pacific Blackberry dominant below, Eucalyptus, Western Poison Oak, Hollyleaf Cherry	90
San Antonio	**1**	Algae, insects	OV, SB, RW, UB, L	Willow-Sycamore Riparian Woodland, Pacific Blackberry, Western Poison Oak, Giant Reed	80
	2	Algae, insects, fish	OV, SB, RW, SV, UB	Willow-Walnut-Alder-Sycamore Riparian Woodland, Pacific Blackberry, Mulefat, Western Poison Oak, Giant Reed, Scalebroom Scrub	80
	3	Algae, insects, fish	OV, RW, SB	Willow-Sycamore-Alder Riparian Woodland, Mulefat, Scalebroom	80
Soule Park	**1**	.	.	.	.
West Soule Park	**1**	.	.	.	.
Stewart Canyon	**1**	Algae, insects, Duck Weed, Treefrog	OV, SB, RW, SV, L	Coast Live Oak-Walnut Riparian Woodland, ornamentals	85
	2	Trash, Lemna, herb veg, algae, insects, pollywogs	SV	None (Channelized/Rock rip-rap)	0
	3	Cement	None	Underground	100
	4	Cement	None	None	0
	5	Algae, insects, pollywogs	OV, SB, RW, SV, L	Willow-Sycamore Riparian Woodland	80
Thacher	**1**	Cement slabs, herbaceous vegetation, leaf litter	OV, RW, UB	Willow-Alder Woodland, Coast Live Oak Riparian Woodland, Walnut, Mulefat Scrub, Backyard Coast Live Oak trees, ornamentals	60
Villanova Note: Reach 1 is outside the City limits	**2**	Leaf litter, algae, insects	OV, RW	Coast Live Oak-Willow Riparian Woodland, Mulefat, Western Poison Oak	90
	3	Compacted soil	OV	None	60
	B-1	.	OV	Ornamentals	30

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[7] Instream Cover Types: OV = Over-hanging Vegetation; SB = Submerged Boulders; L = Logs; RW = Root Wads; SV = Submerged Vegetation; UB = Undercut Banks

Substrate Composition and Particle Size

Approximately 85% of the Ventura River basin is composed of relatively impervious deposits (not to be confused with huma-induced impervious surfaces) (Turner 1971, U.S. Army Corps of Engineers 1940). The exposed rock material is sedimentary in origin and is generally easily eroded. The primary geologic formations include well-cemented and interbedded sandstones, shales, and conglomerates, which produce little water except along joints and fractures. The streambed of the lower 2/3 of the Ventura River widens to a relatively broad plain composed of pervious materials that are subject to high percolation. These materials consist of alluvial deposits of silt, sand, gravel, cobbles, and boulders common to southern California coastal streams. (Moore 1980b.)

The study area lies within the Western Transverse Ranges of California, which are mountain ranges notable for their easily eroded sedimentary rocks. These ranges have been produced by clockwise crustal rotations between the Pacific and North American tectonic plates. The same plate movements that produce the infamous San Andreas Fault and California's largest earthquakes have rotated and uplifted our coastal mountains. These plates are still uplifting, at rates of 1 to 3 cm per year. Regional tectonics have produced numerous faults and folds and some of the youngest sedimentary rocks have been deformed until they stand nearly vertical. The rocks near the surface are usually recent sedimentary layers of marine origin (Cenozoic, younger than 65 million years old) including hard sandstones alternating with weak shales and mudstones. The surrounding geology is responsible for much of the character of our local streams, as steep mountains with easily eroded rocks yield "flashy" creeks with huge sediment loads (per unit area, some of the highest in the world). Fragile marine sediments create hard water, or cause high background conductivities and total dissolved solids (high in sulfate, calcium, magnesium and chloride). (Leydecker and Grabowsky 2004.)

Adult Steelhead have been reported to spawn in substrates from 0.2 to 4.0 inches in diameter (Reiser and Bjornn 1979). Based on the Bovee (1978) classification, Steelhead utilize mostly gravel-sized material for spawning; however, they will also use mixtures of sand-gravel and gravel-cobble. Fry and juvenile Steelhead prefer approximately the same size of substrate material (cobbles), which is slightly larger than that preferred by adults for spawning (gravel) (Bovee 1978). The gravel must be highly permeable to keep the incubating eggs well oxygenated, and should contain less than 5% sand and silt. (CDFG 1996.)

Photograph 9 *(left), Boulders in San Antonio Creek (17 June 2004).* ***Photograph 10*** *(middle), Cobbles in Fox Canyon Barranca (27 May 2004).* ***Photograph 11*** *(right), Gravels in Arbolada Creek (1 February 2005).*

Table 14, Stream Characterization Results for Substrate Composition and Particle Size, gives the substrate (rock, soil, cement, and/or lawn) and provides the visually estimated particle size class (boulder, cobble, gravel, sand, and/or silt) for specific reaches within the Ojai streams.

A summary of the substrate composition classes are listed below with the Ojai stream reaches that consist of that particular substrate or mix of substrates:

- **Cement, Culvert, or Pipe:** Arbolada Reach 1 and 2; Del Norte Reach 3; Grandview-Park Reach 2; Ayers Reach 2, 3, A-1, and B-1; Fox Canyon Reach 2 and 3; Ojai Reach 2, 4, 5, A-1, and B-1; and Stewart Canyon Reach 2, 3, and 4.
- **Mixed Rock, Soil, Lawn, Cement, and/or Compacted:** Arbolada Reach 3; Del Norte Reach 1, 4, and A-1; Ojai Reach 1 and 3; and Villanova Reach 3.
- **Rock:** Ayers Reach 1; Del Norte Reach 2; Fox Canyon Reach 1, 4, and B-1; San Antonio Reach 1, 2, and 3; Stewart Canyon Reach 1; Thacher Reach 1; and Villanova Reach 2.
- **Rock, Soil:** Arbolada Reach 1; Del Norte Reach B-1; East End Reach 1; Fox Canyon Reach A-1; Nordhoff Reach 1; Oak Reach 1; Post Office Reach 1; Soule Park Reach 1; West Soule Park Reach 1; Stewart Canyon Reach 5; and Villanova Reach B-1.
- **Soil/Fines:** Ayers Reach 4 and Ojai Reach B-2, B-3, and A of B-1.

The stream reaches, listed under Cement, Culvert, or Pipe, have severely limiting substrate (fish barriers and modifications) for Steelhead migration, spawning, and rearing.

For the creek reaches generally containing natural sediment deposits, particle size is summarized below by three primary classes:

1. **Mix of Boulder, Cobble, Gravel, Sand, and Silt:** Arbolada Reach 1 and 3; Del Norte Reach 1, 4, and A-1; Fox Canyon Reach 1, 4, and B-1; Ojai Reach 1; San Antonio Reach 1, 2, and 3; Thacher Reach 1; and Stewart Canyon Reach 1 and 5.
2. **Predominantly Cobble, Gravel, and Sand (no Boulder):** Del Norte Reach B-1; East End Reach 1; Nordhoff Reach 1; Oak Reach 1; and Villanova Reach 2.
3. **Predominantly Boulder, Cobble, and Sand (no Gravel):** Ayers Reach 1; Del Norte Reach 2; Fox Canyon Reach A-1; and Post Office Reach 1.

Based on the above natural particle size summary, the creek reaches listed under Number 1 contain sediment particles that have potential to support Steelhead spawning and/or rearing activities. The creek reaches listed under Number 2 also contain sediment particles that could potentially support Steelhead spawning; however, minimal amounts of boulders are present in these creeks, which limit the amount of instream cover for Steelhead rearing. The creek reaches listed under Number 3 contain sediment particles that would likely support Steelhead rearing activities. Since minimal amounts of gravel are present in the creeks of Number 3, the potential for Steelhead spawning is low.

Table 14. Stream Characterization Results for Substrate Composition and Particle Size

Creek Name	Reach No.	Substrate Composition	Particle Size
Arbolada	**1**	Rock, Soil	Boulder, Cobble, Gravel
	2	Concrete/Metal Pipe	N/A
	3	Rock, Soil, Lawn	Boulder, Cobble, Gravel, Sand
Ayers	**1**	Rock	Boulder, Cobble, Sand
	2	Underground pipe	N/A
	3	Paved ditch	N/A
	4	Soft bottom ditch	N/A
	A-1	Cement	N/A

Table 14. Stream Characterization Results Substrate Composition & Particle Size (continued)

Creek Name	Reach No.	Substrate Composition	Particle Size
Ayers (continued)	**B-1**	Cement	N/A
Del Norte	**1**	Rock, Soil, Cement	Boulder, Cobble, Gravel, Sand, Silt
	2	Rock	Boulder, Cobble, Silt
	3	High-density polyethylene pipe, underground	N/A
	4	Rock (some cement)	Boulder, Cobble, Gravel
	A-1	Rock, Soil, Cement	Boulder, Cobble, Gravel, Sand, Silt
	B-1	Rock, Soil	Cobble, Sand
East End	**1**	Rock, Soil	Cobble, Gravel, Sand
Fox Canyon	**1**	Rock	Boulder, Cobble, Gravel, Sand
	2	Cement	N/A
	3	Cement	N/A
	4	Rock	Boulder, Cobble, Gravel, Sand
	A-1	Rock, Soil	Boulder, Cobble
	B-1	Rock	Boulder, Cobble, Gravel, Sand, Silt
Grandview-Park	**1**	Cement	N/A
	2	Asphalt	N/A
Nordhoff	**1**	Rock, Soil	Cobble, Gravel, Sand, Silt
Oak	**1**	Rock, Soil	Cobble
Ojai	**1**	Rock, Cement, Soil	Boulder, Cobble, Gravel, Sand
	2	Cement	N/A
	3	Mixed Compacted	N/A
	4	Cement, underground	N/A
	5	Rock-lined ditch, grouted	N/A
	A-1	Mixed Compacted	N/A
	B-1	Metal pipe, underground	N/A
	B-2	Soil/Fines	Silt
	B-3	Soil/Fines	Silt
	A of B-1	Soil/Fines	Silt
Post Office	**1**	Rock, Soil	Boulder, Cobble, Sand
San Antonio	**1**	Rock	Boulder, Cobble, Gravel
	2	Rock	Boulder, Cobble, Gravel, Sand
	3	Rock	Boulder, Cobble, Gravel
Soule Park	**1**	Rock, Soil	.
West Soule Park	**1**	Rock, Soil	.
Stewart Canyon	**1**	Rock	Boulder, Cobble, Gravel, Silt
	2	Cement	Boulder, Silt
	3	Cement	N/A
	4	Cement	N/A
	5	Rock, Soil	Boulder, Cobble, Gravel, Sand
Thacher	**1**	Rock	Boulder, Cobble, Gravel, Sand
Villanova Note: Reach 1 is outside the City limits	**2**	Rock	Cobble, Gravel, Sand
	3	Compacted soil	N/A
	B-1	Rock, Soil	Sand, Silt

Potential for Spawning and Rearing

Each creek reach has been designated as either having the potential, or not having the potential, to provide suitable spawning and rearing habitat for Steelhead. These findings are based on all parameters measured and all data collected during the water quality sampling sessions and the streams characterization study.

In addition to having favorable results for the measured parameters, water flows must be present more or less year round for successful completion of significant life histories, including adult migration, redd development, spawning activities, egg incubation, fry emergence, and rearing activities. For example, spawning typically occurs only during the months of December through April, eggs take approximately 30 days to hatch (depending on temperature [Leitritz and Lewis 1980]), the emergence of Steelhead fry occurs approximately 45 to 75 days following egg fertilization (Raleigh et al. 1984), and rearing generally takes one to three years before moving to the ocean water (CDFG 1996).

As part of the Steelhead habitat characterization study, inundated areas along the Ojai stream course that had adequate riffles and pools, as well as instream cover, were assumed to provide suitable for Steelhead juveniles and fry. Therefore, if a stream reach contains suitable spawning and rearing substrate (in addition to favorable shade, instream cover, and riparian habitat), and if that stream reach would likely be inundated for a prolonged period (at the very least, throughout the winter and spring seasons of any given year), it is considered to have potentially suitable spawning and/or summer rearing habitat for Steelhead.

Table 15, Stream Characterization Results for Spawning and Rearing Potential, lists whether or not the potential for spawning and/or rearing is present for specific Ojai stream reaches. Eight (8) out of the 51 stream reaches, that were delineated within the City of Ojai, are determined to be potentially suitable Steelhead habitat, and they include:

- Fox Canyon Reach 1;
- Ojai Reach 1;
- Post Office Reach 1;
- San Antonio Reach 1, 2, and 3; and
- Stewart Canyon Reach 1 and 5,

Water Quality

Stormwater pollution occurs when rainwater washes over city streets, parking lots, rooftops, and lawns and transports toxic chemicals, disease-causing organisms, and trash into waterways and onto beaches. This soup of oil, grease, and various other pollutants can pour into rivers, streams and oceans either via storm drains or directly (such as from roads next to streams or water bodies). This is an increasing problem in California, leading to beach closures, human health impacts associated with drinking water quality and skin exposure, and the fouling of aquatic ecosystems.

Table 15. Stream Characterization Results for Spawning and Rearing Potential

(Refer to map on page 32 for stream reach locations.)

Creek Name	Reach No.	Spawning and Rearing Potential Present?	Creek Name	Reach No.	Spawning and Rearing Potential Present?
Arbolada	**1**	No	***Ojai***	**1**	**Yes**
	2	No		**2**	No
	3	No		**3**	No
Ayers	**1**	No		**4**	No
	2	No		**5**	No
	3	No		**A-1**	No
	4	No		**B-1**	No
	A-1	No		**B-2**	No
	B-1	No		**B-3**	No
Del Norte	**1**	No		**A of B-1**	No
	2	No	***Post Office***	**1**	**Yes**
	3	No	***San Antonio***	**1**	**Yes**
	4	No		**2**	**Yes**
	A-1	No		**3**	**Yes**
	B-1	No	***Soule Park***	**1**	No
East End	**1**	No	***West Soule Park***	**1**	No
Fox Canyon	**1**	**Yes**	***Stewart Canyon***	**1**	**Yes**
	2	No		**2**	No
	3	No		**3**	No
	4	No		**4**	No
	A-1	No		**5**	**Yes**
	B-1	No	***Thacher***	**1**	No
Grandview-Park	**1**	No	***Villanova*** Note: Reach 1 is outside the City limits	**2**	No
	2	No		**3**	No
Nordhoff	**1**	No		**B-1**	No
Oak	**1**	No			

Vegetation removal also has been correlated with increases in dissolved ion concentrations in stream water. For example, the conversion of chaparral to grassland, a typical response to extensive grazing and fuel (fire) hazard brush clearance, can increase nitrate concentrations in stream water (Davis 1984). Deforestation has been linked to increases in the concentrations of most major ions (Likens et al. 1970). Phosphorus typically enters aquatic ecosystems attached to suspended sediments so phosphorus concentrations can increase concomitant with increased sediment input. Finally, irrigation return flow typically contains high concentrations of organic and inorganic chemical constituents.

The key ecosystem responses to poor water quality are increased primary productivity where the concentrations of nutrients, such as nitrate and phosphorus are elevated, and reduced primary productivity where the concentrations of many other organic and inorganic chemical constituents are elevated (Welch 1980). Increased primary productivity in the water column, most notably through algal blooms, can rapidly deplete dissolved oxygen and cause shifts in aquatic species compositions and, in extreme cases, can result in the complete elimination of aquatic macroinvertebrates and vertebrates. Decreased primary productivity clearly represents a reduction in the energy harvested from solar radiation and input into local food webs (Welch 1980). Functioning riparian ecosystems can moderate the effects of poor water quality through direct uptake by vegetation and/or by chemical transformations that render chemical constituents insoluble (Peterjohn and Correl 1984).

Water quality sampling was conducted at nineteen (19) stations along several Ojai streams. Table 16, Ojai Stream Reaches with Corresponding Water Quality Sampling Stations, indicates the stream reaches in which the water quality sampling stations occur. Not all reaches were sampled for water quality; however, the water quality stations were determined and designated based on their location in relation to tributary confluences and downstream of significant inlets that may modify the quality of the stream water.

The water quality sampling data were collected at the 19 stations to determine water chemistry and the condition of the streams and drainages that may influence habitat function for Southern Steelhead and other aquatic wildlife. Tables 17A & 17B, Summary of the Ojai Basin Streams Water Quality Sampling Results (Stations 1-9 & Stations 10-18, respectively), provide the averages from the data collected at all 19 sampling stations for all days that data were collected on. The addition of Station 10A makes the total number of stations 19 instead of 18. Appendix B, Ojai Streams Water Quality Sampling Results, provides all specific data collected at each of the 19 sampling stations for each separate date on which water sampling was conducted.

Photograph 12. *Freshly painted "Don't Dump" sign on a Daly Road curb.*

The following subsections present (1) a discussion and definition of the water quality parameters sampled in the field; (2) significant Steelhead requirements and thresholds that are compared to our findings; (3) the results and conclusions of the water quality sampling conducted throughout the streams of Ojai, and (4) the limiting factors based upon the water quality sampling results. Each stream reach is evaluated for each habitat parameter, and those that fall outside acceptable conditions for Steelhead are identified as a limiting factor. Definitions and thresholds for the parameters presented below are summarized from the ChannelKeeper Ventura Stream-Team's Annual Report: *The State of the Ventura River* (Leydecker and Grabowsky 2004). (Note: All water sampling findings are presented in Appendix B, Ojai Streams Water Quality Sampling Results).

Table 16. Ojai Stream Reaches with Corresponding Water Quality Sampling Stations

Creek Name	Reach No.	Water Quality Station
Arbolada Creek	3	9
		16-not in the City
Ayers Creek	1	11
Del Norte Creek	1	18
	2	17
East End Creek	-	No station established
Fox Canyon Barranca	1	8
		14
Grandview-Park Drain	-	No station established
Happy Valley Drain	1	1-not in the City
Nordhoff Drainage	-	No station established
Oak Creek	-	No station established
Ojai Creek	1	7
Post Office Creek	-	No station established
San Antonio Creek	1	3
		4-not in the City
	2	5-not in the City
	3	12
Soule Park Creek	-	No station established
West Soule Park Creek	-	No station established
Stewart Canyon Creek	1	6-not in the City
		15
	5	10
		10A-not in the City
Thacher Creek	1	13
Villanova Creek	1	2-not in the City

Several parameters were studied during the water quality assessment. Tables 17A & 17B show specific parameters (including velocity, *p*H, dissolved oxygen as mg/L, temperature, conductivity, salinity, and turbidity) with measurement ranges and averages in red-, green-, and blue-colored fonts indicating low, favorable, and high measurements (respectively). These specific parameters are the more vital parameters for Steelhead survival, and they are the parameters discussed in the following subsections. Dissolved oxygen as percent saturation, dissolved oxygen as parts per million, specific conductance (conductivity measured at 25°C), carbon dioxide (directly adversely related to dissolved oxygen levels), and coliform bacteria are supplemental parameters studied to provide additional information regarding the condition of the creeks and aquatic environments of Ojai. However, reference is made to specific conductance and carbon dioxide in the following discussions. Although coliform bacteria was tested for the presence or absence of it within the Ojai streams, this parameter was not tested in a way that determines specific levels of the bacteria in each creek of Ojai. Therefore, no threshold for fish survival is discussed in terms of coliform, and it is not highlighted in the table(s) below; however, coliform bacteria is generally discussed in the results subsections below.

Table 17A. Summary of the Ojai Basin Streams Water Quality Sampling Results (Stations 1 through 9)[8]

Site ID Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Drainage/Creek Name	**Happy Valley**	**Villanova**	**San Antonio**	**San Antonio**	**San Antonio**	**Stewart**	**Ojai**	**Fox Canyon**	**Arbolada**
Average (and Range) for Each Parameter									
Average Depth (ft)	0.42 (0.31-0.63)	0.69 (o.5-1.75)	0.97 (0.31-2)	0.49 (0.31-0.67)	0.35 (0.22-0.5)	0.92 (0.36-2.67)	0.32 (0.14-0.5)	0.25 (0.14-0.33)	0.28 (0.19-0.42)
Water Width (ft)	2.45 (2-2.75)	10.64 (4-14.75)	10.67 (5-16)	15.3 (6.5-17.33)	11.68 (6-15)	10.08 (8-12)	4.03 (2-5.17)	4.85 (2.5-5.17)	2.45 (1.5-3.75)
Stream Velocity (ft/sec)	**0.77** **(0.38-1.67)**	**1.24** **(0.42-2)**	**1.83** **(0.5-3.33)**	**1.18** **(0.33-2)**	**1.3** **(0.83-1.67)**	**0.71** **(0.56-1.11)**	**0.66** **(0.5-1.25)**	**1.08** **(0.77-1.43)**	**0.43** **(0.1-1.11)**
Discharge (cfs)	0.68 (.29-1.29)	14.12 (0.89-59.5)	22.64 (1.44-68.8)	8.55 (1.78-15.5)	5.82 (1.98-12.5)	6.5 (1.91-16.1)	0.8 (0.04-3.13)	1.41 (0.32-2.36))	0.25 (0.11-0.63)
***p*H (0-14)**	**7.2** **(6.77-7.63)**	**7.85** **(7.65-8.24)**	**7.83** **(7.65-8.03)**	**7.82** **(7.71-7.97)**	**7.88** **(7.53-8.11)**	**7.84** **(7.55-8.02)**	**7.52** **(7.24-7.67)**	**7.6** **(7.35-7.83)**	**7.59** **(7.33-7.89)**
Dissolved Oxygen (mg/L)	**5.34** **(1.26-8.08)**	**8.34** **(3.81-12.78)**	**8.69** **(5.94-10.68)**	**7.9** **(5.44-10.57)**	**8.52** **(6.35-11.02)**	**8.83** **(6.3-11.08)**	**7.62** **(4.03-10.7)**	**6.79** **(3.7-11.65)**	**5.2** **(0.43-11.01)**
Dissolved Oxygen (%)	45.42 (10.2-74)	52.7 (1.8-123.6)	87.4 (79.4-95.6)	70.52 (53.4-95.3)	81.55 (60-101.4)	82.52 (57.5-108)	71.02 (38.9-101)	76.72 (34.3-110.6)	47.57 (3.8-99.3)
Dissolved Oxygen (ppm)	8.2 (8.2)	9.6 (9.6)	6 (6)	5.6 (5.6)	9.6 (9.6)	8.88 (8.88)	10 (10)	7.6 (7.6)	4.4 (4.4)
Temperature (°C)	**11.2** **(6.9-15.5)**	**12.68** **(10.6-15.7)**	**12.98** **(10.5-15.9)**	**13.2** **(10.6-15.9)**	**12.07** **(9.7-14.4)**	**12.35** **(9.8-15.3)**	**14.28** **(13-16.1)**	**13.38** **(11.6-15.8)**	**12.3** **(9.1-16.1)**
Conductivity (µS)	**295.3** **(82.9-495)**	**875.67** **(499-1492)**	**748.3** **(99.8-1505)**	**904.83** **(553-1487)**	**975** **(638-1426)**	**964.83** **(675-1447)**	**871** **(407-1525)**	**853.9** **(190.5-1319)**	**1370.75** **(915-1633)**
Specific Conductance (µS)	398 (250-543)	1099 (756-1360)	734.67 (762-1327)	1042.75 (767-1214)	1115.25 (632-1464)	1299.75 (910-1475)	1190.25 (585-1474)	1322 (1117-1529)	1906 (1261-2319)
Salinity (ppt)	**0.17** **(0.1-0.2)**	**0.4** **(0.2-0.7)**	**0.62** **(0.4-0.8)**	**0.38** **(0.1-0.6)**	**0.38** **(0.2-0.7)**	**0.52** **(0.1-0.7)**	**0.44** **(0.2-0.7)**	**0.26** **(0.1-0.5)**	**0.57** **(0.2-1.2)**
Carbon Dioxide (ppm)	14.6 (5-21)	10.17 (6-15)	10.58 (8-14)	9.08 (6-11)	9.33 (6-12)	10.17 (7-13)	15.08 (9-21)	13.83 (11-20)	14.2 (9-21)
Turbidity (NTU)	**30.74** **(11.1-59.8)**	**2.39** **(0.2-5)**	**2.77** **(0.1-4)**	**2.13** **(0.1-3.3)**	**8.08** **(1.2-28.8)**	**9** **(0.6-35.5)**	**4.29** **(2-10.3)**	**12.92** **(3-56.4)**	**3.92** **(2.4-5.4)**
Coliform Bacteria	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive

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[8] **Red** = low measurements; **Green** = favorable measurements; **Blue** = high measurements (as compared to the thresholds discussed in the following results subsections). The red, green, and blue fonts indicate the specific parameters that are vital for Steelhead survival, and they are the parameters discussed in detail in the following subsections. The remaining parameters are supplemental studies conducted to provide additional information regarding the condition of the creeks and aquatic environments of Ojai.

Table 17B. Summary of the Ojai Basin Streams Water Quality Sampling Results (Stations 10 through 18)[9]

Site ID Number	**10**	**10A**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Drainage/Creek Name	**Stewart**	**Stewart**	**Ayers**	**San Antonio**	**Thacher**	**Fox Canyon**	**Stewart**	**Arbolada**	**Del Norte**	**Del Norte**
Average (and Range) for Each Parameter										
Average Depth (ft)	0	0.25 (0.11-0.39)	0.34 (0.19-0.42)	0.26 (0.19-0.33)	0.39 (0.39)	2.73 (0.94-4)	0.41 (0.19-0.67)	4 (4)	1.92 (0.33-5)	2 (0.33-3.67)
Water Width (ft)	0	5 (2-8)	4.25 (3-5)	18 (13-23)	6 (6)	14.25 (6-19)	4.67 (3-7)	7 (7)	3.25 (0.5-7)	2.75 (2.5-3)
Stream Velocity (ft/sec)	0	**1.66 (1.33-2)**	**0.21 (0.16-0.25)**	**1.34 (1.25-1.43)**	**0.5 (0.5)**	**0.1 (0.1)**	**0.53 (0.33-0.71)**	**3.33 (3.33)**	**1.47 (0.4-3.33)**	**0.89 (0.67-1.11)**
Discharge (cfs)	0	3.26 (0.29-6.24)	0.35 (0.09-0.53)	6.96 (3.09-10.84)	1.17 (1.17)	2.63 (2.63)	1.39 (0.25-3.33)	93.33 (93.33)	39.08 (0.07-116.55)	6.39 (0.55-12.23)
***p*H (0-14)**	0	**7.35 (7.2-7.5)**	**7.91 (7.82-8.03)**	**8.4 (8.23-8.57)**	**8.34 (8.34)**	**8.15 (8.08-8.26)**	**8.1 (8.05-8.15)**	**7.73 (7.73)**	**7.8 (7.7-7.9)**	**7.76 (7.76)**
Dissolved Oxygen (mg/L)	0	**4.99 (4.99)**	**8.34 (6.16-9.61)**	**11.48 (11.48)**	**11.62 (11.62)**	**8.04 (5.66-9.68)**	**10.65 (10.01-11.3)**	0	**6.33 (6.33)**	**8.46 (6.49-10.44)**
Dissolved Oxygen (%)	0	50.4 (50.4)	77.05 (62.5-91.6)	101.8 (101.8)	93.9 (93.9)	75.27 (55.4-89.4)	98.5 (98.5)	0	0	93.7 (93.7)
Dissolved Oxygen (ppm)	0	12.1 (12.1)	10 (10)	9.1 (9.1)	0	5.5 (5.5)	11.9 (11.9)	0	6.9 (6.9)	0
Temperature (°C)	0	**16.45 (14.4-18.5)**	**14.57 (13.5-16.8)**	**14.4 (10.3-18.5)**	**7.7 (7.7)**	**14.57 (11.3-18.5)**	**14.57 (12-17.3)**	**14.5 (14.5)**	**13.77 (10.7-16.1)**	**9.95 (9.8-10.1)**
Conductivity (µS)	0	**776.5 (578-975)**	**921.5 (560-1335)**	**766 (478-1054)**	**475 (475)**	**1151.5 (931-1433)**	**1232 (613-1738)**	0	**953.5 (622-1285)**	**735.5 (314-1157)**
Specific Conductance (µS)	0	705 (705)	1812.5 (1693-1932)	664 (664)	710 (710)	1482.5 (1202-1763)	768 (768)	0	0	1630 (1630)
Salinity (ppt)	0	**0.3 (0.3)**	**0.63 (0.1-0.9)**	**0.3 (0.3)**	**0.3 (0.3)**	**0.53 (0.2-0.9)**	**0.35 (0.3-0.4)**	0	**0.3 (0.3)**	**0.55 (0.3-0.8)**
Carbon Dioxide (ppm)	0	75 (14-136)	10.12 (6-17)	6.5 (6-7)	8 (8)	7.87 (5-10)	6.33 (6-13)	6 (6)	13.83 (5-18.5)	15 (14-16)
Turbidity (NTU)	0	**2.67 (2-3.35)**	**28.47 (3-83.6)**	**6.32 (5-7.64)**	**9 (9)**	**7.22 (2-15.2)**	**6.97 (2-16.7)**	**246 (246)**	**67.18 (1.9-194)**	**2.55 (2.1-3)**
Coliform Bacteria	0	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive

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[9] **Red** = low measurements; **Green** = favorable measurements; **Blue** = high measurements (as compared to thresholds discussed below). See the footnote above for Table 17A.

Conductivity and Specific Conductance

Water is one of the most efficient solvents in the natural world and has the ability to dissolve many solids. Many of these solids carry an electrical charge when put into solution. For example, chloride, nitrate, and sulfate carry negative charges, while sodium, magnesium, and calcium have a positive charge. These dissolved substances increase water's *conductivity* – its ability to conduct electricity. Therefore, measuring conductivity of water indirectly indicates the amount total dissolved solids (TDS). It is not a perfect measure as some substances - particularly organic compounds like oil, alcohol, or sugar - are poor conductors. Each stream tends to have a relatively consistent range of conductivity that, once established, can be used as a baseline for future comparisons. Conductivity tends to decrease in the winter when heavy rainfall and runoff increase the amount of fresh, lower conductivity, water flow. With more water, mineral concentrations are more dilute. On the other hand, in late summer and fall, especially during periods of drought, dissolved solids become more concentrated, raising conductivity.

Conductivity is affected by temperature: the warmer the water, the higher the conductivity. Conductivity readings are based on the current temperature at which the reading is taken. A Specific Conductance reading is reported as conductivity at 25 degrees Celsius (25°C). The basic unit of measurement is the siemen. Conductivity is measured in micro-siemens per centimeter (µS/cm) or milli-siemens per centimeter (mS/cm).

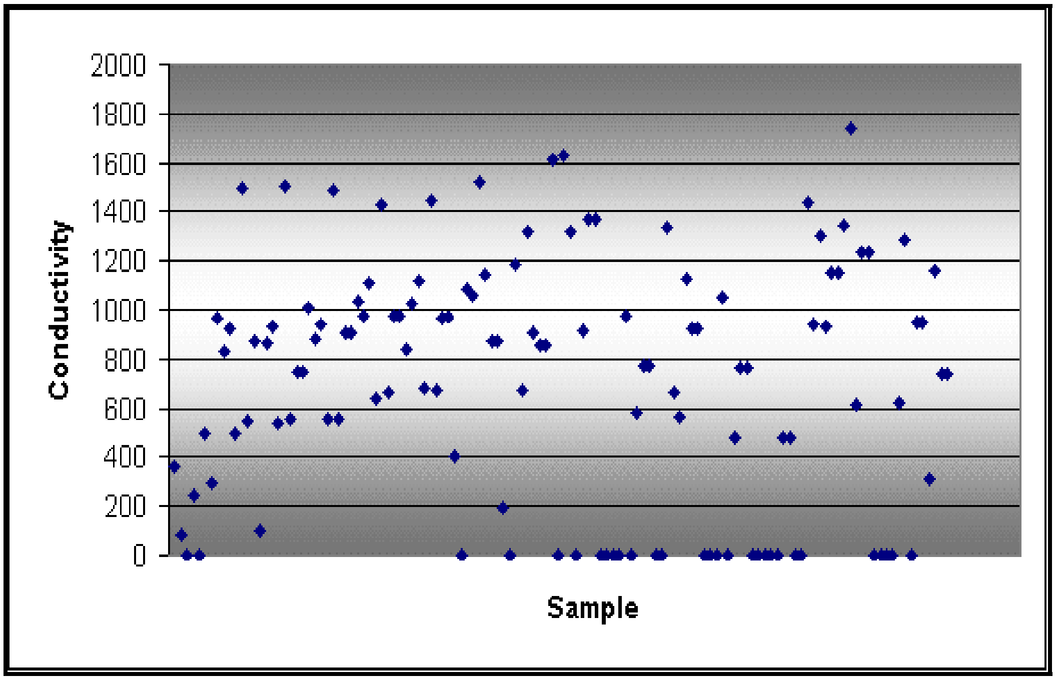
THRESHOLDS

Distilled water has conductivity in the range of 0.5 to 3 µS/cm. The conductivity of rivers in the United States generally ranges from 50 to 1,500 µS/cm. Drinking water usually has to meet a standard of 1,000 mg/L TDS and a maximum conductivity of 1,600 µS/cm. Conductivity in the Ventura River is usually above 1,000 µS/cm because of high mineral content in the easily eroded marine sediments that form coastal mountains. In spite of the 1,600-µS/cm limit, high conductivity waters are not necessarily bad for wildlife and human health. As long as acceptable reasons exist for higher values, as they are in this case, higher mineral content may even be beneficial. Increased values of conductivity in the Ventura River are generally caused by (1) increasingly depleted groundwater inflows, (2) enhanced uptake by growing riparian vegetation, and (3) a relative increase in evaporation as dry-season river flows diminish. Measurements **above 1,000 µS/cm as a lower limit and 1,600 µS/cm will be used as an upper limit for conductivity thresholds** since these are the normal conductivity standards for the Ventura River and drinking water.

RESULTS

The range of conductivity throughout the 19 stations sampled (excluding zero values from dry creeks) over several days is between 82.9 µS/cm at Station 1 (Happy Valley Reach 1) and 1,738 µS/cm at Station 15 (Stewart Canyon Reach 1). The stations with average conductivity values that fall into the favorable conductivity range include only Station 9 (Arbolada Reach 3), Station 14 (Fox Canyon Reach 1), and Staion 15 (Stewart Canyon Reach 1). All other stations have average conductivity values that fall below or rise above the favorable threshold range for conductivity. Refer to Tables 17A & 17B (above), and Appendix B, Ojai Streams Water Quality Sampling Results, for all survey data results. Figure 8, Scatter Plot of Conductivity Results for the Ojai Streams, shows the conductivity pattern of all samples taken at all stations over several dates from the creeks of Ojai. (Note: samples with a measurement of "0 µS/cm" are readings from dry creeks.)

Figure 8. Scatter Plot of Conductivity Results for the Ojai Streams



Temperature

Temperature is the simplest parameter to measure, yet one of the most important. The expected annual pattern is that the temperature rises from winter lows to summer highs, and then decreases in early fall. Temperatures often increase above 24°C in summer and rarely drop below 11°C in winter.

THRESHOLDS

Important threshold temperatures for Steelhead include the following:

- Above 24°C leads to death;
- 20-24°C is the upper limit of tolerance (juveniles show stress, adults inactive and will not spawn, problems extracting oxygen from water [above 21°C] (Hooper 1973);
- Below 16°C (10-15°C is optimum) indicates good dry season (summer) conditions; and
- Below 11°C in winter is excellent for spawning and incubation.

The temperature milestones used here are for Trout and Steelhead, as warm-water fish have greater tolerance for higher temperatures. As temperatures rise, fish have increasing trouble extracting oxygen from water, while at the same time the amount of oxygen in the water decreases. However, Southern Steelhead have evolved in what are essentially warm-water rivers and streams, and probably have greater tolerance for higher temperatures than their more northern cousins. Fish are not passive participants, but free to seek out conditions that are more favorable. Deeper water is usually cooler water; however, higher flows of the lower streams also keep temperatures low even though the water is at a lower elevation and more exposed to sunlight.

Other optimal water temperatures for various life stages of Steelhead are (Bovee 1978, Reiser and Bjorn 1979, Bell 1986):

- Adult migration = 8ºC to 11ºC
- Spawning = 4ºC to 11ºC
- Incubation and emergence = 9ºC to 11ºC
- Fry and juvenile rearing = 13ºC to 16ºC
- Smoltification = <14ºC

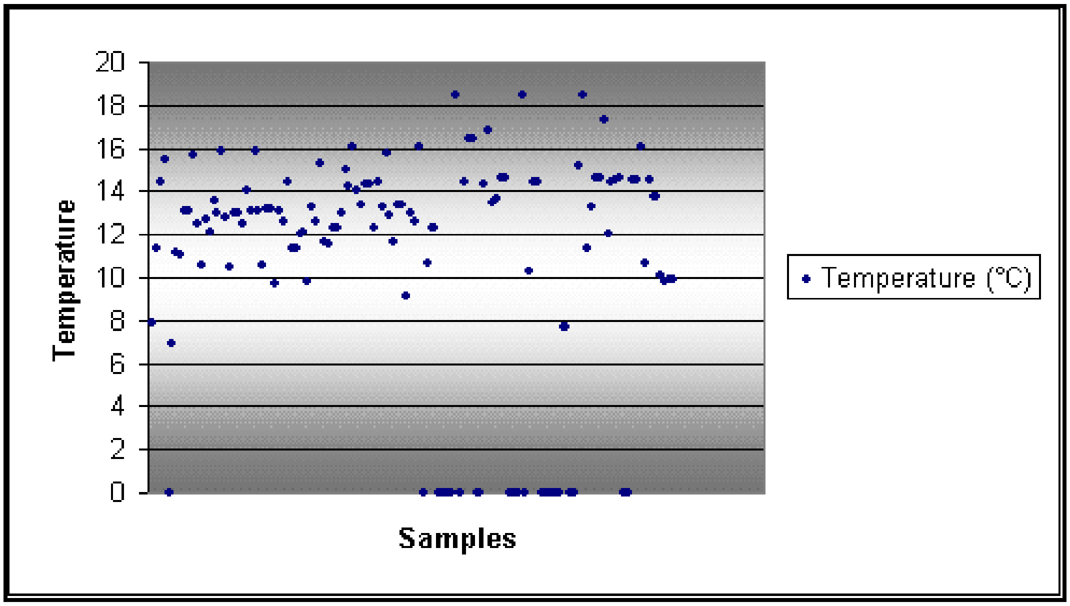
Optimal temperature requirements of Steelhead may vary depending on season, life stage, and stock characteristics. In California, low temperatures are not as much of a concern as high temperatures, especially the high temperatures that occur during adult migration, egg incubation, and juvenile rearing. However, Steelhead of southern coastal streams are known to exist in relatively high temperature regimes, some of which exceed preferred temperatures for considerable lengths of time.

Based on the important and optimal thresholds listed above, a **range between 4ºC and 16ºC will be used as the threshold for favorable temperatures** throughout the creeks of Ojai.

RESULTS

The range in temperature throughout the 19 stations sampled (excluding zero values from dry creeks) is between 6.9ºC at Station 1 (Happy Valley Reach 1) and 18.5ºC (Fox Canyon Reach 1 and San Antonio Reach 3). The stations with average temperatures between 6ºC and 16ºC include all stations except Station 10A (Stewart Canyon Reach 5) (Tables 17A & 17B; Appendix B). The individual temperature measurements collected throughout the creeks of Ojai over several dates are generally favorable for Steelhead, except for some high (over 16ºC) temperatures collected at Station 10A (Stewart Canyon Reach 5), 11 (Ayers Reach 1), 12 (San Antonio Reach 3), 14 (Fox Canyon Reach 1), and 15 (Stewart Canyon Reach 1). Figure 9, Scatter Plot of Temperature Results for the Ojai Streams, shows the temperature pattern of all samples taken at all stations over several dates in the creeks of Ojai. Note: samples that fall at "0ºC" are readings from creeks that were dry.

Figure 9. Scatter Plot of Temperature Results for the Ojai Streams



Dissolved Oxygen and Carbon Dioxide

Aquatic organisms rely on the presence of oxygen in streams. If oxygen is insufficient for those organisms, they will move, weaken, or die. In air, oxygen is 20% of the atmosphere; in water, oxygen is a dissolved gas with a maximum concentration of only approximately 16 parts per million (0.0016%). Water temperature, altitude, time of day, and season can all affect the amount of oxygen in water. Water holds less oxygen at warmer temperatures and high altitudes. Dissolved oxygen was primarily measured either in milligrams per liter (mg/L) or "percent saturation". Percent saturation is the amount of oxygen in a liter of water relative to the total amount of oxygen that water can naturally hold at that temperature.

Oxygen is both produced and consumed in a stream. Due to constant churning, running water dissolves more oxygen than still water found in pools. As flows drop, streams become more sluggish, and there is both less opportunity for water to pick up more oxygen through re-aeration and more time for wildlife and other biochemical processes to extract oxygen. Oxygen also has a greater solubility in cold water. As temperature increases, dissolved oxygen should decrease, and visa versa.

Ironically, very high dissolved oxygen concentrations can indicate trouble as well. In daylight, algae and aquatic vegetation photosynthesize, removing carbon dioxide from air and water and replacing it with oxygen. Unfortunately, this process is reversed at night: oxygen is removed and carbon dioxide added. Thus, very high daytime oxygen concentrations can indicate an overabundance of algae. Under these conditions, oxygen reaches a minimum just before sunrise. Therefore, it is the concentrations found during this critical period that determine the actual threat to fish, a threat usually not evaluated, but that probably should be.

THRESHOLDS

As dissolved oxygen levels in water drop below 5 mg/L, aquatic life is put under stress. Steelhead require oxygen levels above 6 mg/L. **Important dissolved oxygen thresholds for Steelhead** include the following:

- Below 4 mg/L results in severe damage and death;
- At 6 mg/L hypoxia begins and fish start to feel stress (significant decrease in swimming performance and activity between 6.5 to 7.0 mg/L [Reiser and Bjorn 1979]); and
- **Above 8 mg/L represents near ideal conditions** and may be required for spawning (and 80% saturation is essential to meet the needs of spawning fish [Reiser and Bjorn 1979]).

Warm-water fish can probably tolerate levels as low as 4 mg/L. The lower the concentration of oxygen, the greater the stress on Steelhead. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills.

RESULTS

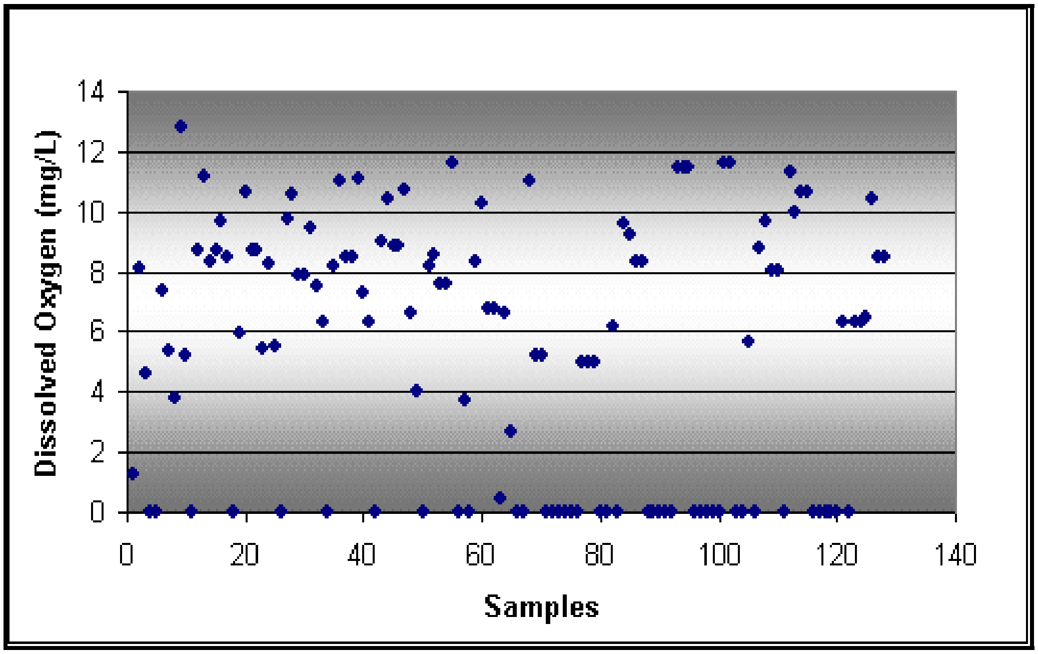
The range in dissolved oxygen for the 19 stations sampled (excluding zero values from dry creeks) is between 0.43 mg/L at Station 9 (Arbolada Reach 3) and 12.78 mg/L at Station 2 (Villanova Reach 1) (Tables 17A & 17B, Appendix B).

The following Stations represent the creek reaches that have favorable average dissolved oxygen measurements (above 8 mg/L):

- Station 2 (Villanova Reach 1)
- Stations 3, 4 (~7.9 mg/L), 5, 12 (San Antonio Reach 1, 2, and 3)
- Station 14 (Fox Canyon Reach 1)
- Station 11 (Ayers Reach 1)
- Station 13 (Thacher Reach 1)
- Stations 6 and 15 (Stewart Canyon Reach 1)
- Station 18 (Del Norte Reach 2)

Figure 10, Scatter Plot of Dissolved Oxygen Results for the Ojai Streams, illustrates the dissolved oxygen pattern of all samples taken at all stations over several dates in the creeks of Ojai. Note: samples with a "0 mg/L" value are readings from dry creeks.

Figure 10. Scatter Plot of Dissolved Oxygen Results for the Ojai Streams



Turbidity

Turbidity is a measure of the amount of sediment in the water column, and sediment has both long- and short-term effects on steelhead and other fish. Over the long term, sediment settles on the bottom and fills the interstices (spaces and cracks) between streambed gravels and rocks decreasing the amount of desirable habitat required for spawning as well as habitat required by smaller organisms (insects) which are a vital source of food for fish. Over the short term, turbidity reduces the ability of fish to see and feed.

Photograph 13. *Thacher Creek at Boardman Road during winter storm creating elevated levels of turbidity (9 January 2005).*

THRESHOLDS

Water quality begins to degrade by suspended sediment between turbidities of 3 and 5 NTU, and impacts on Steelhead begin to be noticeable above 25 NTU. These limits apply to the dry-season and periods between storms. During storms, these limits become meaningless as suspended sediment concentrations rise to tens of thousands of milligrams per liter, which would equal turbidity readings in the hundreds of thousands. During storms, fish hide until turbidities return to background levels within three days of a rainfall event. Normally, readings are below 5 NTU; however, if sampling is conducted during or soon after a storm, they reach levels above the ability of turbidity meters to record a value. **The EPA has suggested a turbidity limit of 1.9 NTU for streams in this region.**

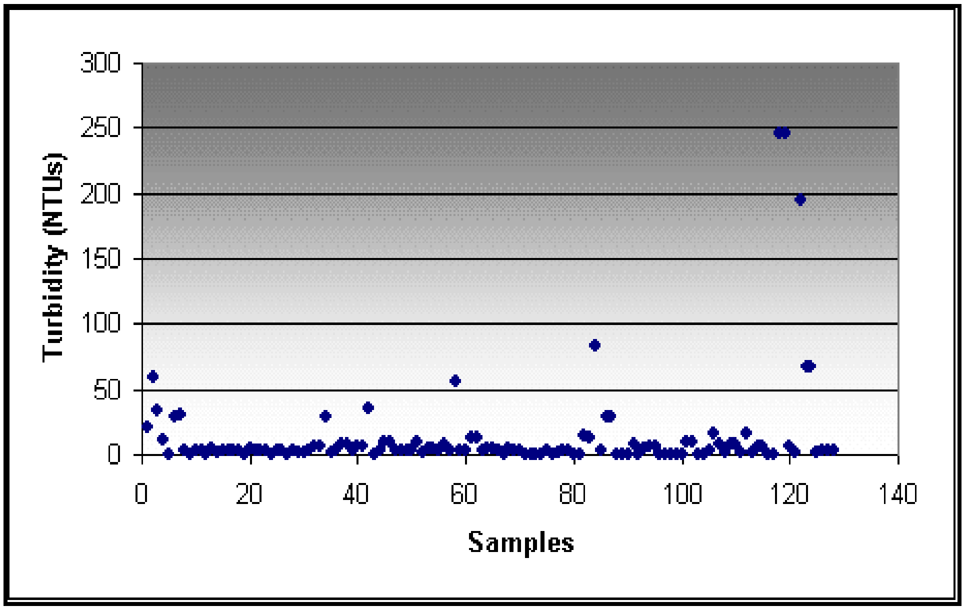
RESULTS

The range in turbidity for all measurements from all 19 stations (excluding zero values from dry creeks) over several dates is recorded between 0.1 NTU at Station 3 and 4 (San Antonio Reach 1) and 246 NTU at Station 16 (Arbolada Creek Reach 3). None of the 19 stations have an average turbidity level that is 1.9 NTU or below. The lowest average turbidity measurement is 2.13 NTU at Station 4 (San Antonio Reach 1) (Tables 17A & 17B). However, the results from individual dates for each station (according to the results table in Appendix B) show that of the dates sampled, December 8th and 9th 2004 yield the lowest turbidity levels. Favorable turbidity levels (below 1.9 NTU) were observed only at the following stations on the following dates:

- Station 2 (Villanova Reach 1) = 0.2 NTU (on 8 Dec 04)
- Station 3 (San Antonio Reach 1) = 0.1 NTU (on 8 Dec 04)
- Station 4 (San Antonio Reach 1) = 0.3 NTU (on 23 Feb 05) and 0.1 NTU (on 9 Dec 04)
- Station 5 (San Antonio Reach 2) = 1.2 NTU (on 9 Dec 04)
- Station 6 (Stewart Canyon Reach 1) = 0.6 (on 20 Oct 04 and 9 Dec 04)
- Station 17 (Del Norte Reach 2) = 1.9 NTU (on 8 Dec 04)

Figure 11, Scatter Plot of Turbidity Results for the Ojai Streams, shows the turbidity level pattern of all samples taken at all stations over several dates in the creeks of Ojai. Note: samples that fall to "0 NTU" are readings from dry creeks. The significantly high readings are a result of sampling conducted during the storms of the 2004/2005 winter season.

Figure 11. Scatter Plot of Turbidity Results for the Ojai Streams



*p*H

*p*H is a relative measure of alkalinity and acidity, or an expression of the number of free hydrogen atoms present. It is measured on a scale of 1 to 14, with 7 indicating neutral (neither acid nor base). The lower numbers (<7) indicate increasing acidity, whereas the higher numbers (>7) indicate increasing alkalinity. Blood (*p*H of 7.5), seawater (*p*H of 9.3), and household ammonia (*p*H of 11.4) are all alkaline or basic. Urine (*p*H of 6.0), oranges (*p*H of 4.5), Coca Cola Classic (*p*H of 2.5), and the contents of your stomach (*p*H of 2.0) are acidic. *p*H numbers represent a logarithmic scale, therefore, small differences in numbers can be significant: a *p*H of 4 is one thousand times more acidic than a *p*H of 6. All plants and animals live within a specific *p*H range, where altering *p*H beyond this range causes injury or death. Pollutants can push *p*H toward extremes, and low *p*H allows toxic elements and compounds to "mobilize" (go into solution) and be taken in by aquatic plants and animals. A change of more than two points on the scale can kill many species of fish. The EPA and Los Angeles Regional Water Quality Control Board (LARWQCB) regard a change of more than 0.5 as harmful.

THRESHOLDS

Several different standards exist for determining thresholds of *p*H. Fish can tolerate a range of 5 to 9; however, the best fishing waters are between 6.5 to 8.2. The Central Coast Regional Board uses a standard of 7.0 to 8.5 for surface water and 6.5 to 8.3 for potable water and swimming; the Los Angeles Board uses 6.5 to 8.5; and the EPA recommends 6.5 to 8.0 as being the best for aquatic animals. **We will use a *p*H of 6.5 as a lower limit** since this seems to be the consensus, and **8.5 will be used as an upper limit** since the LARWQCB establishes the legal standard for the Ventura.

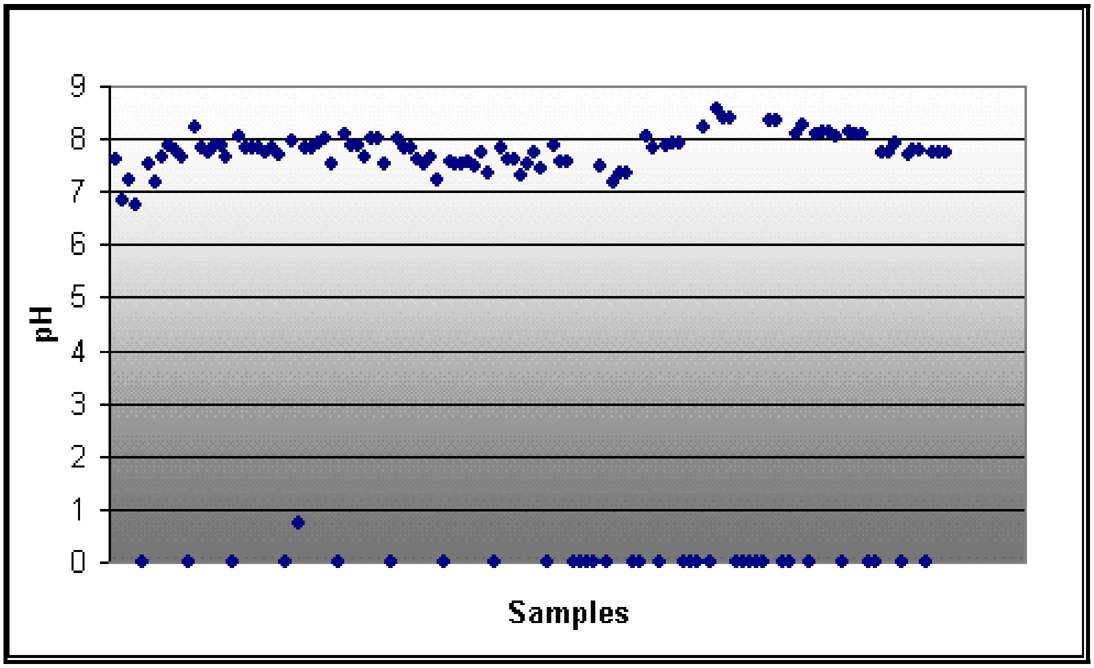
RESULTS

Lower reaches of the Ventura River are reported to have lower *p*H values occurring with the start of winter rains, while the highest occur in spring or early summer. Rain has a lower *p*H (usually slightly acidic) than baseflow in the Ventura River and its tributaries, and the first few storms usually lower river values. The spring/summer increase is caused by the same algal and plant growth responsible for increasing daylight dissolved oxygen. Photosynthesis withdraws carbon dioxide from the water at the same time as it releases oxygen. Removing carbon dioxide is the same as removing acidity, thus it increases in *p*H. Normally, little change in *p*H occurs, as the dissolved minerals that give us high conductivity usually are the same dissolved minerals that "buffer" the river against large variations; however, changes in dissolved carbon dioxide is a major exception.

The photosynthetic effect is responsible for almost all high *p*H values of the Ventura River. If sampling were conducted around the clock, similar variations in both *p*H and dissolved oxygen would occur over a 24-hour period. The variation would be appreciable at stations with algal problems, relatively muted in locations with normal conditions. This kind of testing would be one of the better ways of estimating the extent of over-fertilization and algal growth on the river.

The range of *p*H for all measurements from all 19 stations (excluding zero values from dry creeks) over several dates is recorded between 6.77 at Station 1 (Happy Valley Reach 1) and 8.57 at Station 12 (San Antonio Reach 3). This Station 12 is the only station (and has only one date) that has a *p*H over the recommended 8.5. However, all stations have an average *p*H that is within the 6.5 to 8.5 threshold (Tables 17A & 17B; Appendix B). Figure 12, Scatter Plot of *p*H Results for the Ojai Streams, shows the *p*H level pattern of all samples taken at all stations over several dates in the creeks of Ojai. Note: samples that fall to "0" are readings from dry creeks.

Figure 12. Scatter Plot of *p*H Results for the Ojai Streams



Salinity

Salinity is a measure of the amount of ocean-derived salts dissolved in water. Since this study focuses on freshwater river and stream systems, the level of salinity is expected to be very low. Although Steelhead are Southern Steelhead, and are adapted to both fresh and saline waters, salinity was measured as an additional environmental parameter to be discussed along with the more vital Steelhead parameters in this section. This parameter is measured primarily to determine the freshwater organism environment in terms of salinity rather than the requirements or limitations of salinity for Steelhead. Freshwater organisms can tolerate only small amounts of salinity, and measurements are expected to be low for freshwater environments.

THRESHOLDS

The freshwater streams sampled for this study are classified within the Riverine system according to the *Classification of Wetlands and Deepwater habitats of the United States* (Cowardin et al. 1979), which has been adopted by the U.S. Fish and Wildlife Service. The Riverine system includes all wetlands and deepwater habitats contained within a channel (or a conduit periodically or continuously containing moving water, or forming a connecting link between two bodies of water), with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens; and (2) habitats with water containing ocean-derived salts in excess of 0.5‰. Water is usually, but not always, flowing in this system.

Therefore, the Riverine system includes all water habitats with ocean-derived salt concentrations of less than 0.5‰ (‰ = parts per thousand = ppt). Since the U.S. Fish and Wildlife Service has adopted the Cowardin (1979) classification of wetlands, salinity values of **less than 0.5 ppt will be used as the threshold for salinity** for measurements taken in the streams of Ojai.

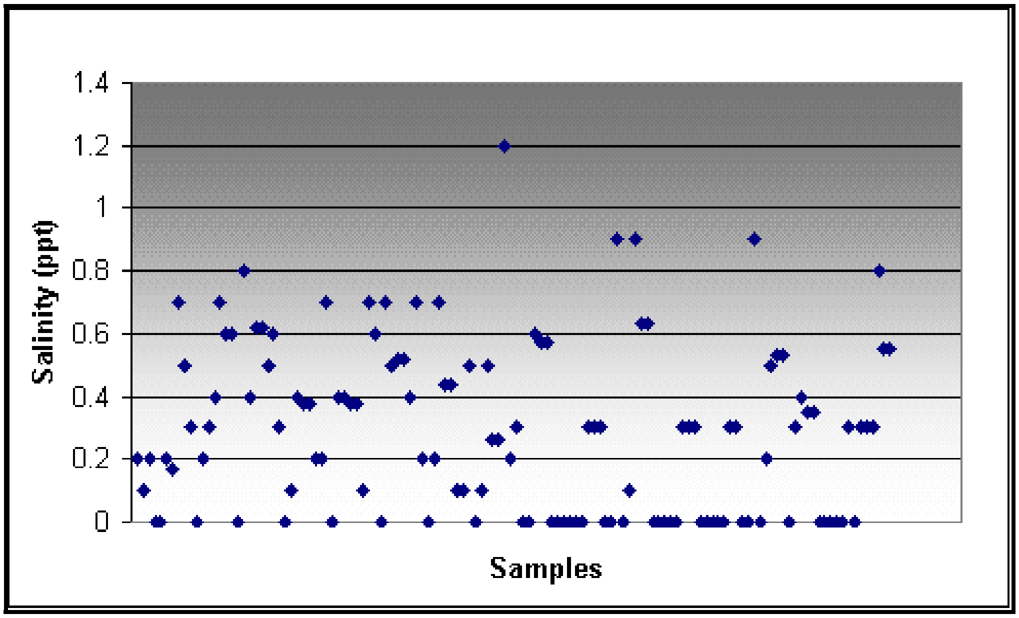
RESULTS

The range in salinity for all 19 stations sampled (excluding zero values from dry creeks) over several dates was between *0.1 ppt* - at Stations 4 (San Antonio Reach 1), 6 (Stewart Canyon Reach 1), 8 (Fox Canyon Reach 1), and 11 (Ayers Reach 1) - and *1.2 ppt* at Station 9 (Arbolada Reach 3). The stations with average salinity measurements (Tables 17A & 17B, Appendix B) that are less than 0.5 ppt (favorable for freshwater aquatic wildlife) include the following:

- Station 1 (Happy Valley Reach 1)
- Station 2 (Villanova Reach 1)
- Stations 4, 5, and 12 (San Antonio Reach 1, 2, 3)
- Station 7 (Ojai Reach 1)
- Station 8 (Fox Canyon Reach 1 [~0.5ppt])
- Station 9 (Arbolada Reach 3)
- Stations 10A and 15 (Stewart Canyon Reach 1 and 5)
- Station 13 (Thacher Reach 1)
- Station 18 (Del Norte Reach 1)

Figure 13, Scatter Plot of Salinity Results for the Ojai Streams, shows the salinity level pattern of all samples taken at all stations over several dates in the creeks of Ojai. Note: samples that fall to "0 ppt" are readings from creeks that were dry.

Figure 13. Scatter Plot of Salinity Results for the Ojai Streams



Total Coliform Bacteria

Members of three bacteria groups: coliforms, enterococci, and fecal streptococci, are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are not necessarily harmful themselves, they indicate the presence of pathogenic (disease causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Therefore, their presence in streams, lakes, and rivers suggests that pathogenic microorganisms might also be present and that swimming, drinking, or eating shellfish from those waters might be a health risk[10].

Due to the great expense and time required for testing every pathogen, scientists instead measure one of the indicator groups of bacteria to assess the sanitary quality of a water body. The most commonly tested fecal bacteria indicators are total coliforms, fecal coliforms, *Escherichia* coliforms (*E. coli*), fecal streptococci, and enterococci. All but *E. coli* are composed of a number of species of bacteria that share common traits such as shape, habitat, or behavior. *E. coli* is a single species in the fecal coliform group[11]. Total coliforms are a large and widespread group of bacteria. Coliforms can occur in human feces, but are also found in animal manure, soil, vegetation, submerged wood, and in other places outside the human body. Thus, the usefulness of total coliforms, as an indicator of fecal contamination, depends on the extent the bacteria found are fecal and human in origin.

For recreational waters, total coliforms are no longer recommended by the EPA as an indicator, but they are still the standard test for drinking water because their presence indicates contamination of a water supply by some outside source. California still requires a total coliform test for recreational waters because the *ratio* of fecal to total coliforms (number of fecal coliforms divided by the total number of coliforms) remains a good indicator of swimming related illness. (Leydecker and Grabowsky 2004.)

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[10] Obtained from: http://kingfish.coastal.edu/marine/risingtide/waterquality/background.html
[11] Ibid.

Photograph 14. *"Don't Litter" sign on fence of Fox Canyon Barranca at Ojai Avenue.*

Members of two bacteria groups, the coliforms and fecal streptococci, are typically used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoa that live in human and animal digestive systems. Their presence in streams suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for coliforms and fecal streptococci instead.

Photograph 15. *Showing close proximity of horse corral to the active creek channel creating a significant input of horse manure and urine (8 January 2005).*

WATER QUALITY STANDARDS AND THRESHOLDS

The South Carolina Department of Health and Environmental Control (SC DHEC) has issued water classification and standards for all bodies of water in South Carolina. In South Carolina's coastal region, the majority of drinking water comes from surface waters including regional rivers and lakes. Each water body has been given a classification, which establishes which activities - such as boating, swimming, or drinking - must be protected. A set of water quality criteria were established for each classification. The classifications and water quality criteria are described in "Water Classifications and Standards" (R.61-68). For example, the Waccamaw River has been assigned to the classification Freshwaters (FW), which is defined as "freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department (DHEC)." These waters are suitable for fishing, swimming, and the survival and propagation of a balanced indigenous flora and fauna. The water quality criteria, which assure that these uses are protected, are listed below in Table 18, Classes of Fresh Water Quality Standards (http://kingfish.coastal.edu/marine/risingtide/waterquality/ background.html). Table 18 provides a useful list of pollutants and water quality criteria for this study.

Table 18. Classes of Fresh Water Quality Standards

Pollutant	Water Quality Criteria
a. Garbage, cinders, ashes, oils, sludge, or other refuse	None allowed
b. Treated wastes, toxic wastes, deleterious substances, colored or other wastes except those given in "a" above.	None alone or in combination with other substances or wastes in sufficient to make the waters unsafe or unsuitable for primary contact recreation or to impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
c. Toxic Pollutants	As prescribed in a separate regulation. (Section E of this regulation which uses US EPA's criteria for human and aquatic health)
d. Color	Not to exceed a rise above background of 30 color units measured as true color.
e. Dissolved Oxygen	Daily average not less that 5.0 mg/L with a low of 4.0 mg/L.
f. Fecal Coliform	Not to exceed a geometric mean of 200 CFU per 100 mL, based on five consecutive samples during any 30-day period; nor shall more than 10% of the total samples during any 30-day period exceed 400 CFU per 100 mL.
g. *p*H	Between 6.0 and 8.5
h. Temperature	For free-flowing water, the temperature may not be increased more than 5°F above natural temperature conditions and shall not exceed a maximum of 90°F as a result of discharge.
i. Turbidity (Lakes only: Not to exceed 25 NTUs provided existing uses are maintained.)	Not to exceed 50 NTUs providing existing uses are maintained.

Table 19, Federal Standards for Indicator Bacteria, provides federal water quality standards promulgated by the U.S. Environmental Protection Agency (US EPA) for indicator bacteria. These standards can be found in the US EPA's publication "Ambient Water Quality Criteria for Bacteria" (1986). (http://kingfish.coastal.edu/marine/risingtide/waterquality/background.html.)

Table 19. Federal Standards for Indicator Bacteria

Indicator Bacteria	Acceptable Swimming Associated Gastroenteritis Rate Per 1000 Swimmers	Steady State Geometric Mean Indicator Density	Single Sample Maximum Allowable Density			
			Designated Beach Area	Moderate Full Body Contact Recreation	Lightly Used Full Body Contact Recreation	Infrequently Used Full Body Contact Recreation
Freshwater						
Enterococci	8	33	61	89	108	151
E. coli	8	126	235	298	406	576
Marine Water						
Enterococci	19	35	104	124	276	500

At this time, *E. coli* is recommended by the US EPA for freshwater testing and *Enteroccocus* for marine waters because these bacteria provide a better correlation with body-contact related illnesses than fecal or total coliforms. For historical reasons, many state standards (see above for South Carolina) still employ fecal coliform levels. Although the US EPA has not set standards for total coliforms, some states have promulgated their own. For example, the state of California has a set for its marine waters as shown below. South Carolina does not have standards for total coliforms. (http://kingfish.coastal.edu/marine/risingtide/waterquality/background.html.)

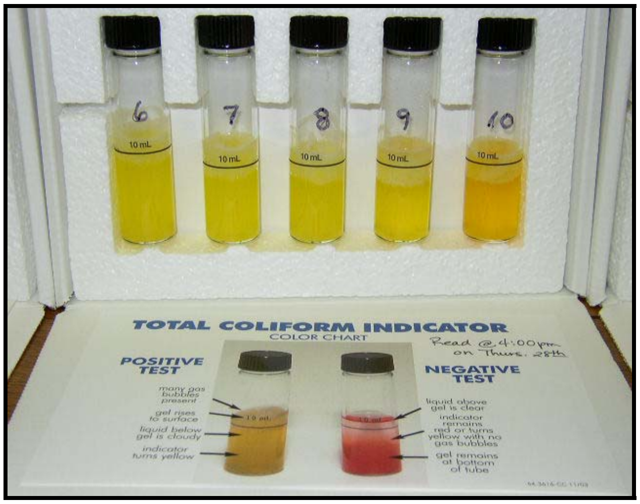
The total coliforms as per California Code for Ocean Water Quality include the following:

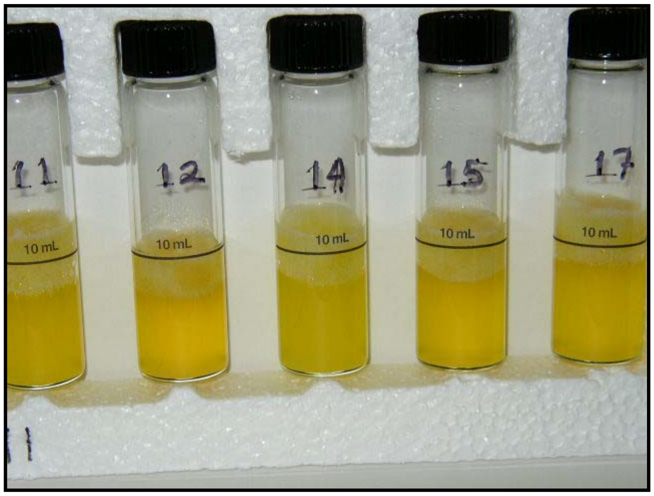
- Single Sample Maximum Allowable Density:
  - 1,000 total coliforms bacteria per 100 mL, if ratio of fecal/total coliforms exceeds 0.1; or
  - 10,0000 total coliform bacteria per 100 mL; or
  - 400 fecal coliform bacteria per 100 mL; or
  - 104 enteroccocus coliform bacteria per 100 mL.
- Geometric mean of at least five weekly samples during any 30-day period:
  - 1,000 total coliform bacteria per 100 mL;
  - 200 fecal coliform bacteria per 100 mL;
  - 35 enteroccocus coliform bacteria per 100 mL.

RESULTS

The LaMotte Model TC-5 Coliform Indicator Test Kit was used for determining the presence of coliform bacteria. This coliform test kit provides a test tube method to indicate the presence of Total Coliform Bacteria in a drinking water supply via a coliform-indicating test tablet, a gelling substance, and a *p*H indicator. The tablet neutralizes water samples containing chlorine that tends to suppress coliform bacteria growth, and provides growth-supporting nutrients for coliform bacteria. If coliform organisms are present in the sample, the bacteria metabolizing the nutrients in the tablet will generate gases. The gases will be trapped in the gelling substance causing the gel to rise in the tube. The *p*H indicator may change color from red to yellow, also indicating coliform bacteria activity. For this study, a sample was collected from each water quality sampling station, brought back to the lab, and analyzed for the **presence (a positive test result) or absence (a negative test result)** of total coliform bacteria.

Every sample of creek water that was tested produced a positive result for the presence of coliform. Therefore, all of the water quality sampling stations that had water present were positive for coliform bacteria at least once (see Appendix B for the dates on which the stations were sampled for coliform). It should be noted that the test used does not analyze the amount of bacteria present in each sample tested; therefore, the actual amount of coliform was not determined in this study, which would detect dangerous levels within specific creek reaches. The tests show that, after the high flows produced by the January 2005 storms, all water quality stations that were sampled produced positive coliform results. It can be assumed that in higher water flows, such as after a significant flood event, the presence of coliform will be higher, due to significant surface runoff into the streams, than during periods of low flows.





***Photograph 16** (top left). Positive coliform indicator results for Water Quality Sampling Stations 1 through 5. **Photograph 17** (top right). Positive coliform indicator results for Water Quality Sampling Stations 6 through 10, and showing the color chart for reading positive and negative results. **Photograph 18** (lower left). Positive coliform indicator results for Water Quality Sampling Stations 11, 12, 14, 15, and 17 (no water was present at Station 13 and 16; therefore, no sample was collected). Photos taken 28 October 2004.*

BIOLOGICAL ENVIRONMENT OF OJAI BASIN STREAMS

This subsection presents the predominant plant species observed during field surveys, and presents the habitats observed during water quality sampling and stream characterization studies. The habitat classifications into floristic plant communities are provided, along with a description of each habitat type and plant community. Habitat classifications and descriptions are based on the U.S. Fish and Wildlife Service classification system, *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), and the California Native Plant Society classification system, *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995). The predominant plant and wildlife species observed in the field are also provided below.

Predominant Plant Species

The predominant plant species observed during the field studies are listed below in Table 20, Predominant Plant Species of the Ojai Basin Streams. Although a thorough floristic assessment was not performed, the predominant plants observed were noted, and the majority of those predominant plants observed are introduced/ornamental plant species.

Photograph 19 *(left). Fox Canyon Barranca, Mugwort (*Artemisia douglasiana*) in foreground (27 May 2004).* ***Photograph 20*** *(middle). Ojai Creek, California Wild Grape (*Vitis californica*) climbing up old-growth sycamores and oaks (27 November 2004).* ***Photograph 21*** *(right). Post Office Creek, Pacific Blackberry (*Rubus ursinus*) creating the groundcover (11 January 2005).*

Habitat Descriptions

Habitats of the Ojai Basin streams project area have evolved to the specific conditions of the coastal climate of Southern California, and the plants of these communities show traits adapted to fit their niche. Elevation, aspect (shade or sun), rainfall and water availability are the primary determinants of where each community exists. Plants play a crucial role in the ecology of the watershed. They provide the habitat, food, and shelter for the dozens of animal species that inhabit the region. Plants help to prevent soil erosion by literally holding the soil together with their root systems. The leaf and branch canopies also reduce the impact of rain, and by absorbing rainfall from the soil, they help to reduce runoff too.

One problem for the native vegetation in these watersheds is the invasion of non-native species of plants – foreign plant species that have been introduced, intentionally or unintentionally, and then thrive in the local environment, often because of the absence of natural predators. In the process of replacing native species, they often harm local animals un-adapted to living with and on these invaders. Invasive, non-native species damage the biodiversity of both plants and animals in our local area. (Leydecker and Grabowsky 2004.)

Table 20. Predominant Plant Species of the Ojai Basin Streams

Scientific Name[12]	Common Name[13]	Habit[14]	WIS[15]	Family
Acacia sp.+	Acacia/Wattle	T	.	Fabaceae
Ailanthus altissima +	Tree-of-heaven	T	FACU	Simaroubaceae
Alnus rhombifolia	White Alder	T	FACW	Betulaceae
*Amaranthus albus**	Tumbleweed	AH	FACU	Chenopodiaceae
Ambrosia psilostachya var. *californica*	Western Ragweed	BH	FAC	Asteraceae
*Apium graveolens**	Celery	PH	FACW*	Apiaceae
Artemisia californica	California Sagebrush	S	.	Asteraceae
Artemisia douglasiana	Mugwort	PH	FACW	Asteraceae
*Arundo donax **	Giant Reed	PG	FACW	Poaceae
*Avena barbata**	Slender Wild Oat	AG	.	Poaceae
Azolla filiculoides	Mosquito Fern	AF	OBL	Azollaceae
Baccharis pilularis	Coyote Brush	S	.	Asteraceae
Baccharis salicifolia	Mulefat	S	FACW	Asteraceae
*Brassica nigra**	Black Mustard	AH	.	Brassicaceae
Brickellia californica	California Brickellbush	S	FACU	Asteraceae
*Bromus diandrus **	Ripgut Grass	AG	(FACU)	Poaceae
*Bromus hordeaceus **	Soft Chess	AG	FACU-	Poaceae
Bromus madritensis ssp. *Rubens **	Red Brome	AG	NI	Poaceae
*Carduus pycnocephalus **	Italian Thistle	AH	.	Asteraceae
Ceanothus spinosus	Greenbark Ceanothus	S	.	Rhamnaceae
*Centaurea melitensis **	Tocalote	AH	.	Asteraceae
*Chenopodium album**	Lambsquarters	AH	FAC	Chenopodiaceae
Conyza canadensis	Common Horseweed	AH	FAC	Asteraceae
*Cynodon dactylon **	Bermuda Grass	PG	FAC	Poaceae
Cyperus eragrostis	Umbrella Sedge	PH	FACW	Cyperaceae
Epilobium ciliatum ssp. *Ciliatum*	Northern Willow-herb	AH	FACW	Onagraceae
Eremocarpus setigerus	Dove Weed	AH	.	Euphorbiaceae
Eucalyptus globulus +	Tasmanian Blue Gum	T	.	Myrtaceae
Ficus carica+	Fig	T	.	Moraceae
*Foeniculum vulgare **	Sweet Fennel	PH	FACU	Apiaceae
Fraxinus sp.+	Ash	T	.	Oleaceae
Gnaphalium californicum	Green Everlasting	AH	.	Asteraceae

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[12] Scientific nomenclature follows Hickman (1993).
"*" indicates nonnative species which have become naturalized or persist without cultivation.
"+" indicates planted or escaped introduced ornamental species.

[13] Common names follow Abrams and Ferris (1960), DeGarmo (1980), Hickman (1993), and Niehaus and Ripper (1976).

[14] Habit definitions: PG = perennial grass; AG = annual grass; PH = perennial herb; AH = annual herb; PV = perennial vine; BH = biennial herb; S = shrub; T = tree.

[15] WIS = Wetland indicator status (Reed 1988):
OBL = obligate wetland species, occurs almost always in wetlands (>99% probability)
FACW = facultative wetland species, usually found in wetlands (67-99% probability).
FAC = facultative species, equally likely to occur in wetlands or nonwetlands (34-67% probability).
FACU = facultative upland species, usually occur in nonwetlands (67-99% probability).
\+ or - symbols are modifiers that indicate greater or lesser affinity for wetland habitats.
NI = no indicator has been assigned due to a lack of information to determine indicator status.
* = a tentative assignment to that indicator status by Reed (1988).
A period "." indicates that no wetland indicator status has been given in Reed (1988).
Parentheses around an indicator status indicates the wetland status as suggested by David L. Magney.

Table 20. Predominant Plant Species of the Ojai Basin Streams (continued)

Scientific Name	Common Name	Habit	WIS	Family
*Gnaphalium luteo-album**	Cudweed Everlasting	AH	FACW-	Asteraceae
Hedera helix+	English Ivy	PV	.	Araliaceae
Heteromeles arbutifolia	Toyon	S	.	Rosaceae
Heterotheca grandiflora	Telegraph Weed	PH	.	Asteraceae
*Hirschfeldia incana **	Summer Mustard	PH	.	Brassicaceae
Hordeum murinum ssp. *glaucum **	Summer Barley	AG	.	Poaceae
Ipomoea sp.+	Morning-glory	PV	.	Convolvulaceae
Juglans californica var. *californica*	Southern California Black Walnut	T	FAC	Juglandaceae
Juglans regia+	English Walnut	T	.	Juglandaceae
*Lactuca serriola **	Prickly Wild Lettuce	AH	FAC	Asteraceae
Lemna cf. *minuscula*	Duckweed	AH	OBL	Lemnaceae
Lepidospartum squamatum	Scalebroom	S	(FACW)	Asteraceae
Lessingia filaginifolia var. *filaginifolia*	Cudweed Aster	PH	.	Asteraceae
Leymus condensatus	Giant Wildrye	PG	FACU	Poaceae
*Lolium multiflorum **	Italian Ryegrass	AG	FAC*	Poaceae
Lotus scoparius var. *scoparius*	Deerweed	S	.	Fabaceae
Malosma laurina	Laurelleaf Sumac	S	.	Anacardiaceae
*Malva parviflora**	Cheeseweed	AH	.	Malvaceae
Marah macrocarpus	Man-root	PV	.	Cucurbitaceae
*Marrubium vulgare **	White Horehound	S	FAC	Lamiaceae
*Medicago polymorpha **	Bur-clover	AH	(FACU-)	Fabaceae
*Melilotus alba **	White Sweetclover	A/BH	FACU+	Fabaceae
*Melilotus indica **	Sourclover	AH	FAC	Fabaceae
Mentha spicata var. *spicata +*	Spearmint	PH	OBL	Lamiaceae
Mentha sp.	Chocolate Mint	PH	OBL/FACW	Lamiaceae
Nerium oleander+	Oleander	S	.	Apocynaceae
*Nicotiana glauca **	Tree Tobacco	S	FAC	Solanaceae
Olea europea+	Olive	T	.	Oleaceae
Phoenix canariensis+	Canary Island Date Palm	T	.	Arecaceae
Phoradendron macrophyllum	Bigleaf Mistletoe	PH	.	Viscaceae
*Picris echioides **	Bristly Ox-tongue	AH	FAC*	Asteraceae
*Piptatherum miliaceum **	Smilo Grass	PG	(FACU)	Poaceae
*Plantago lanceolata **	English Plantain	PH	FAC-	Plantaginaceae
Platanus racemosa var. *racemosa*	California Sycamore	T	FACW	Platanaceae
Plumbago ariculata+	Cape Plumbago	S	.	Plumbaginaceae
*Polypogon monspeliensis**	Rabbitsfoot Grass	AG	FACW*	Poaceae
Populus fremontii ssp. *fremontii*	Fremont Cottonwood	T	FACW	Salicaceae
Prunus ilicifolia	Hollyleaf Cherry	S	.	Rosaceae
Quercus agrifolia var. *agrifolia*	Coast Live Oak	T	(FACU)	Fagaceae
Quercus lobata	Valley Oak	T	FACU	Fagaceae
*Raphanus sativa**	Wild Radish	AH	.	Brassicaceae
Rhamnus tomentella	Hoary Coffeeberry	S	.	Rhamnaceae
*Ricinus communis **	Castor Bean	S	FACU	Euphorbiaceae
Rorippa nasturtium-aquaticum	Water Cress	PH	OBL	Brassicaceae
Rosa californica	California Wild Rose	S	FAC+	Rosaceae
Rubus ursinus	Pacific Blackberry	PV	FACW*	Rosaceae

Table 20. Predominant Plant Species of the Ojai Basin Streams (continued)

Scientific Name	Common Name	Habit	WIS	Family
Rumex crispus *	Curly Dock	PH	FACW-	Polygonaceae
Salix exigua	Narrow-leaved Willow	S	OBL	Salicaceae
Salix laevigata	Red Willow	T	FACW	Salicaceae
Salix lasiolepis	Arroyo Willow	T	FACW	Salicaceae
Salix lucida ssp. *lasiandra*	Shining Willow	T	OBL	Salicaceae
Salvia apiana	White Sage	S	.	Lamiaceae
Salvia leucophylla	Purple Sage	S	.	Lamiaceae
Salvia mellifera	Black Sage	S		Lamiaceae
Sambucus mexicana	Blue Elderberry	S/T	FAC	Caprifoliaceae
Schoenoplectus [*Scirpus*] *californicus*	California Bulrush	PH	OBL	Cyperaceae
Schinus molle+	Peruvian Pepper Tree	T	.	Anacardiaceae
Solanum americanum *	White Nightshade	A/PH	FAC	Solanaceae
*Sonchus oleraceus**	Common Sow-thistle	AH	UPL+	Asteraceae
*Spartium junceum**+	Spanish Broom	S	.	Fabaceae
Toxicodendron diversilobum	Western Poison Oak	S/V	.	Anacardiaceae
Typha domingensis	Southern Cattail	PH	OBL	Typhaceae
Typha latifolia	Broad-leaved Cattail	PH	OBL	Typhaceae
Verbena lasiostachys	Western Verbena	AH	.	Verbenaceae
Veronica anagallis-aquatica *	Common Speedwell	PH	OBL	Scrophulariaceae
Vinca major+	Periwinkle	PV	.	Apocynaceae
Vitis californica	California Wild Grape	PV	FACW	Vitaceae
Washingtonia robusta *+	Mexican Fan Palm	T	(FAC)	Arecaceae
Xanthium strumarium	Cocklebur	AH	FAC	Asteraceae
Yucca elephantipes+	Giant Yucca	T	.	Agavaceae

Two primary wetland systems were observed according to Cowardin et al. (1979): the Palustrine System (riparian habitats) and the Riverine System (aquatic habitats). Within each of the two systems, the class and subclass are provided and described. Along with each class/subclass, the respective plant series/alliance name and description are given as a cross reference, since these two classifications provide somewhat different information regarding the observed habitats throughout Ojai. The species associated with each plant community are also listed within each description (common names are provided once only).

Table 21, Plant Communities Observed within the Ojai Streams, is classification summary for predominant habitat types and their corresponding plant communities (series/alliances) observed in the field during the Ojai streams characterization and water quality sampling. The streams for which these plant communities were observed in are also indicated in Table 21. Please note that the Palustrine and Riverine systems generally refer to wetland habitats only. However, due to the highly disturbed nature of many stream reaches throughout Ojai (often successional habitats due to human impacts), and since all habitats observed were within the riparian zone of the Ojai streams, some plant communities typically considered upland habitats (i.e. California Annual Grassland Series and Coyote Brush Series) were encountered along the riparian zones throughout the City. Therefore, these more upland series are classified under the Cowardin (et al. 1979) classification that they were observed occupying.

Table 21. Plant Communities Observed within the Ojai Streams

Plant Series/Alliance or Aquatic Habitat Observed	Creek/Drainage Observed In													
	Arbo-lada	**Ayers**	**Del Norte**	**Fox Canyon**	**Grand-view**	**Happy Valley**	**Oak**	**Ojai**	**Nordhoff**	**Post Office**	**San Antonio**	**Stewart Canyon**	**Thacher**	**Villa-nova**
Palustrine System (Riparian Habitats)														
Palustrine Emergent Wetland														
Cattail Series		X	X						X		X			X
Bulrush Series			X					X	X		X	X		
California Annual Grassland Series	X		X						X		X	X		
Ruderal Grassland Series		X	X			X		X	X					
Palustrine Scrub/Shrub Wetland														
Arroyo Willow Series		X	X	X			X	X		X	X	X	X	X
Mulefat Series				X			X		X		X	X	X	X
Giant Reed Series			X	X							X	X		X
Scalebroom Series											X			
Western Poison Oak-Pacific Blackberry Series			X	X				X		X	X		X	X
Coyote Brush Series											X			X
Palustrine Forested Wetland														
California Sycamore Series		X		X				X		X	X	X	X	X
Coast Live Oak Series	X	X	X	X	X		X	X		X	X	X	X	X
Eucalyptus Series		X	X			X			X	X		X		
Planted and Escaped Ornamentals	X	X	X	X			X	X		X	X	X	X	X
Riverine System (Aquatic Habitats)														
Riverine Lower Perennial Wetland														
Riverine Lower Perennial Unconsolidated Shore											X	X		
Riverine Lower Perennial Unconsolidated Bottom											X	X		
Riverine Lower Perennial Aquatic Bed (Duckweed Series)				X		X		X	X		X	X		
Riverine Intermittent Wetland														
Riverine Intermittent Streambed	X	X	X	X	X	X	X	X	X	X		X	X	X

Palustrine System (Riparian Habitats)

The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergent plants, emergent mosses or lichens, and all such wetlands that occur in tidal areas, where salinity due to ocean-derived salts is below 0.5‰. This system is bounded by upland habitats or by any other system. The Palustrine system was developed to group the vegetated wetlands traditionally called such names as marshes, swamps, bogs, prairies, and ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. The erosive forces of wind and water are of minor importance except during severe floods. (Cowardin et al. 1979.)

PALUSTRINE EMERGENT WETLAND

Palustrine Emergent Wetlands are characterized by a dominance of erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation usually consists of perennial plants that are present for most or all of the growing season. Palustrine Emergent Wetlands are primarily bars and banks adjacent to Unconsolidated Bottom and Streambed Wetlands with at least a 30% cover by herbaceous vegetation. (Cowardin et al.1979.) The plant series observed that are classified as Palustrine Emergent Wetland include: Cattail Series, Bulrush Series, California Annual Grassland Series, and Ruderal Grassland Series. Cattail Series and Bulrush Series are much more typical of Palustrine Emergent Wetland, while California Annual Grassland Series and Ruderal Grassland Series are generally more typical of upland habitats.

Cattail Series

Cattail Series is dominated by species of *Typha*, typically *T. latifolia* (Broad-leaved Cattail) and *T. domingensis* (Southern Cattail). The National List of Wetland Plants (Reed 1988) lists cattails as OBL (obligate wetland species), or almost always found growing in water or saturated soil. This plant community typically forms a thicket less than four meters tall, but also forms less dense patches scattered about. Cattail Series requires flooding and includes a variety of water chemistry - such as fresh, mixohaline, hyperhaline, mixosaline, and hypersaline - and it occurs from sea level to 2,000 meters in elevation. (Sawyer and Keeler-Wolf 1995.) Cattail Series was observed inhabiting predominantly the channels, creeks, and ditch-margins of the Ojai streams, and typically consisted only of small patches. Cattail Series was observed growing with associate species including *Cyperus eragrostis* (Umbrella Sedge), *Rorippa nasturtium-aquaticum* (Water Cress), *Schoenoplectus* [*Scirpus*] *californicus* (California Bulrush), and *Veronica anagallis-aquatica* (Common Speedwell).

Photograph 22. *Del Norte Creek Reach 1, view north showing Cattail Series in the foreground (19 August 2004).*

Bulrush Series

Bulrush Series is dominated by *Schoenoplectus californicus* (California Bulrush). The National List of Wetland Plants (Reed 1988) also lists California Bulrush as an OBL species. Bulrush Series site requirements are very similar to those required by Cattail Series (described above). Bulrush Series occurs at elevations below 2,100 meters; it forms a variable (continuous to open), scrubby herbaceous layer of less than four meters tall; and it occurs in peaty, saturated soils of variably flooded and often ponded habitats with water chemistry requirements like those listed above in Cattail Series. (Sawyer and Keeler-Wolf 1995.) Bulrush Series observed throughout the Ojai streams was often intermixed with Cattail Series. Similar associates were generally observed in Cattail Series and Bulrush Series.

California Annual Grassland Series

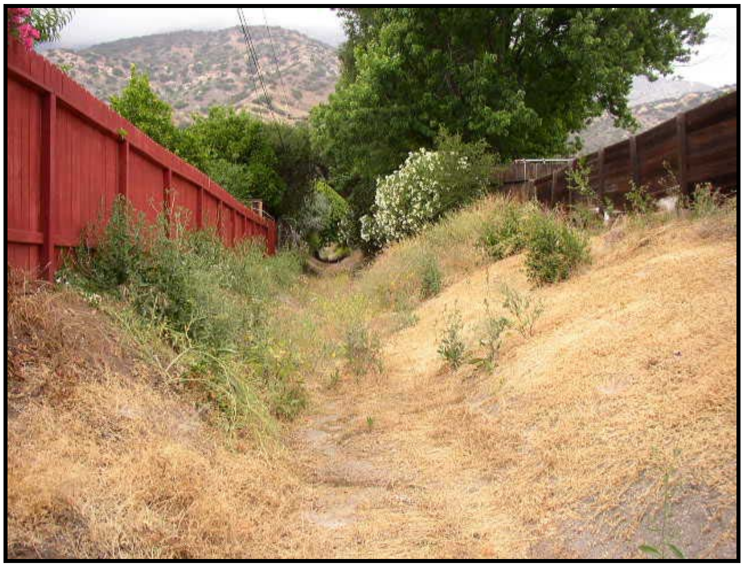
Although species composition varies among stands, alien and native annual grasses (genera including *Avena*, *Bromus*, *Hordeum*, *Lolium*, and *Vulpia*) typically dominate this plant community, while native wildflowers, naturalized annual forbs, and invasive exotics, are typically important contributors to the herbaceous cover of annual grassland. California Annual Grassland Series occurs on all topographic locations, especially gradual slopes, flats, coastal terraces, and in disturbed sandy sites; it typically grows in well-developed, deep, fine textured soils; and it occurs at elevations below 1,200 meters (Sawyer and Keeler-Wolf 1995). California Annual Grassland Series observed scattered throughout the Ojai streams exists as an understory growing below the riparian woodland habitats (or Palustrine Forested habitats [described below]), as well as in successional sites where riparian vegetation once predominated.

Photograph 23. *Nordhoff Drain showing California Annual Grassland (5 January 2005).*

The predominant nonnative annual grasses forming California Annual Grassland Series of the Ojai streams include *Avena barbata* (Slender Wild Oat), *Bromus diandrus*, *B. hordeaceus* (Soft Chess), *B. madritensis* ssp. *rubens* (Red Brome), *Hordeum murinum* ssp. *glaucum* (Summer Barley), and *Lolium multiflorum* (Italian Ryegrass). The nonnative perennial grasses observed onsite are *Cynodon dactylon* (Bermuda Grass) and *Piptatherum miliaceum* (Smilo Grass). The native herbaceous species recorded for California Annual Grassland Series include: *Ambrosia psilostachya* var. *californica* (Western Ragweed), *Conyza canadensis* (Common Horseweed), *Eremocarpus setigerus* (Dove Weed), *Heterotheca grandiflora* (Telegraph Weed), and *Verbena lasiostachys* (Western Verbena). Some of the naturalized, and often invasive, herbs scattered throughout California Annual Grassland Series include many of those listed below in Ruderal Grassland Series.

Ruderal Grassland Series

Ruderal Grassland Series is not described by Sawyer and Keeler-Wolf (1995); however, this plant series is classified based on their protocols for classifying vegetation. Ruderal Grassland Series is typically in early successional stages due to severe human disturbance and/or recurrent natural disturbances. This plant community is dominated by herbaceous, introduced, pioneering plant species that readily colonize open disturbed soil and thrive as a result of human impacts. Ruderal communities may provide a certain degree of erosion control for recently disturbed or graded areas, but such communities are also a threat to the natural biodiversity. They continually distribute invasive, highly competitive, nonnative propagules into otherwise native vegetation; however, if ruderal grassland stands are not disturbed for more than five years, they can undergo succession towards more stable, and less weedy, plant communities such as coastal or riparian scrub. (Zedler et al. 1997.)



Photograph 24. *Grandview-Park Drain showing Ruderal Grassland Series (27 May 2004).*

Ruderal Grassland Series observed in the disturbed portions of the Ojai streams are most commonly predominated by *Hirschfeldia incana*, *Centaurea melitensis* (Tocalote), and *Picris echioides* (Bristly Ox-tongue). Some of the introduced, and often invasive, associate herbs scattered throughout Ruderal Grassland Series include: *Amaranthus albus* (Tumbleweed), *Anagallis arvensis* (Scarlet Pimpernel), *Carduus pycnocephalus* (Italian Thistle), *Foeniculum vulgare* (Sweet Fennel), *Lactuca serriola* (Prickly Wild Lettuce), *Marrubium vulgare* (White Horehound), *Medicago polymorpha* (Bur-clover), and *Sonchus oleraceus* (Common Sow-thistle).

PALUSTRINE SCRUB/SHRUB WETLAND

Palustrine Scrub/Shrub Wetlands are one of the most widespread classes in the U.S. This habitat type includes areas dominated by woody, broad-leaved, deciduous plants less than six meters tall. The plant species of this wetland include true shrubs, young trees, and trees or shrubs that are small or stunted due to environmental conditions. Scrub/Shrub Wetlands may represent a successional stage leading to Forested Wetland, or may be relatively stable communities. All water regimes are included except subtidal. (Cowardin et al. 1979.)

Palustrine Scrub/Shrub Wetlands require at least seasonal flooding. These wetland types are predominated by shrubs located on bars and banks of river channels, and they form significant riparian habitat in floodplain areas as well. Although this habitat is typically characterized by the presence of broad-leaved winter-deciduous shrubs, such as *Salix* spp. (willows), the floodplain areas may consist of several evergreen shrubs, such as *Baccharis salicifolia* (Mulefat). Invasive species, such as *Arundo donax* (Giant Reed - a large, shrub-sized, invasive, perennial grass), *Nicotiana glauca* (Tree Tobacco - an invasive tree-like shrub), *Ricinus communis* (a robust, shrub-sized, noxious and invasive perennial herb), and *Spartium junceum* (invasive shrub) create highly competitive conditions for other native riparian plant species within the Scrub/Shrub layer of the Palustrine system. The Palustrine Scrub/Shrub plant series observed in the field include Arroyo Willow Series, Mulefat Series, Giant Reed Series, Scalebroom Series, Western Poison Oak Series, and Coyote Brush Series, and these plant communities are discussed in the following paragraphs.

Arroyo Willow Series

Arroyo Willow Series is a scrub community dominated by *Salix lasiolepis* (Arroyo Willow), which is a broad-leaved winter-deciduous large shrub to small tree. The National List of Wetland Plants (Reed 1988) lists *S. lasiolepis* as FACW, or a facultative wetland species that is usually found growing in water. Arroyo Willow has shinny dark green (upper surface) and white tomentose (lower surface) leaves. Arroyo Willow Series forms a continuous to intermittent tall shrub canopy with emergent trees. This plant community generally occurs in seasonally flooded and/or saturated, fresh water, wetland habitats, such as floodplains and low-gradient depositions along rivers and streams, at elevations between sea level and 1,800 meters (Sawyer and Keeler-Wolf 1995).

Photograph 25. *San Antonio Creek showing old-growth Arroyo Willow Series (8 February 2005).*

Predominant associate species observed contributing to the tall scrub canopy include the following: *Alnus rhombifolia* (White Alder), *Artemisia douglasiana* (Mugwort), *Baccharis salicifolia*, *Juglans californica* var. *californica* (Southern Californica Black Walnut), *Piptatherum miliaceum*, *Platanus racemosa* var. *racemosa* (California Sycamore), *Populus fremontii* ssp. *fremontii* (Fremont Cottonwood), *Prunus ilicifolia* (Holly-leaf Cherry), *Rosa californica* (California Wild Rose), *Rubus ursinus* (Pacific Blackberry), *Salix exigua* (Narrow-leaved Willow), and *Salix lucida* ssp. *lasiandra* (Shining Willow).

Mulefat Series

Mulefat Series is dominated by *Baccharis salicifolia*, which is a tall, deciduous shrub with glabrous, sticky, bright green leaves. *B. salicifolia* has a wetland indicator status of FACW (Reed 1988). Mulefat Series forms a continuous shrub canopy less than four meters tall; it requires freshwater habitats that are seasonally flooded and saturated, such as canyon bottoms, irrigation ditches, and stream channels; and it is found at elevations between sea level and 1,250 meters (Sawyer and Keeler-Wolf 1995).

Photograph 26. *Fox Canyon Barranca showing Mulefat Series (Baccharis salicifolia).*

The general Mulefat Series plant communities observed throughout the Ojai streams are mixed stands that include important associate species such as *Artemisia douglasiana*, *Arundo donax* (Giant Reed), *Baccharis pilularis* (Coyote Brush), *Epilobium ciliatum* ssp. *ciliatum* (Northern Willow-herb), *Nicotiana glauca*, *Plantago lanceolata* (Lanceleaf Plantain), *Salix exigua*, *Salix lasiolepis*, *Typha domingensis*, and *Xanthium strumarium* (Cocklebur).

Giant Reed Series

Giant Reed Series is dominated by the introduced, highly invasive *Arundo donax*. Giant Reed is a large, eight-meter-tall, perennial grass with thick rhizomes, and is native to Europe (Hickman 1993). The National Inventory of Wetland Plants (Reed 1988) lists this species as FACW. Giant Reed is an extremely invasive grass (introduced into California in the 1880's) that establishes and persists in riparian areas by reducing and replacing native species by establishing dense monocultures (Sawyer and Keeler-Wolf 1995). It is often described as forming an herbaceous layer based on its habit (perennial grass); however, it is categorized here as forming a scrub canopy due to the secondary vegetative stratum it creates.

Giant Reed Series consists of *A. donax* growing as the sole perennial grass forming a continuous scrubby canopy with few other species present. Giant Reed Series requires permanently saturated freshwater wetland habitats, with a shallow water table, at elevations below 500 meters. (Sawyer and Keeler-Wolf 1995.) Giant Reed Series was predominantly observed within the Ojai streams as large solitary thickets; however, *A. donax* also occurs as dense patches or individually scattered within other riparian communities. The scattered associate species observed growing with Giant Reed include *Baccharis pilularis*, *B. salicifolia*, *Foeniculum vulgare*, *Ricinus communis* (Castor Bean), *Salix lasiolepis*, *Schoenoplectus californicus*, *Piptatherum miliaceum*, and *Typha* spp. (cattails).

Scalebroom Series

Scalebroom Series is dominated by *Lepidospartum squamatum*, which is a round-topped, woolly, broom-like native shrub (less than three meters tall) with scale-like leaves and yellow flowers. This species occurs in sandy or gravely washes and stream terraces at elevations below 1,800 meters (Hickman 1993). Scalebroom is suggested to have a wetland indicator status of FACW (Magney 1992).

Scalebroom Series forms a continuous to intermittent canopy growing under emergent trees. The understory to Scalebroom Series is typically grassy or variable depending on hydrology. This series occurs in rarely flooded slopes and in low-gradient deposits along streams. Species composition differs greatly among Scalebroom stands, and disturbance may account for this high variation. (Sawyer and Keeler-Wolf 1995.) Magney (1992) further describes this series as Scalebroom Floodplain Scrub, which is a broad-leaved, phraetophytic, evergreen scrub type with *Artemisia californica* (California Sagebrush) and *Sambucus mexicana* (Blue Elderberry) as subdominant shrubs. This series is restricted to riverine cobbles, boulders, and sand of floodplain habitats (flooded every five to ten years), which is the driving force maintaining this phraetophytic vegetation type. Many upland species of Coastal Sage Scrub and chaparral communities become established in this streamside habitat.

Scalebroom Series was observed consisting of several associate species including *Ambrosia psilostachya* var. *californica*, *Artemisia californica*, *Baccharis pilularis*, *B. salicifolia*, *Bromus* spp. (brome grasses), *Hirschfeldia incana* (Summer Mustard), *Malosma laurina* (Laurelleaf Sumac), *Rosa californica*, *Solanum americanum* (White Nightshade), *Spartium junceum* (Spanish Broom), and *Toxicodendron diversilobum* (Western Poison Oak).

Western Poison Oak-Pacific Blackberry Series

Western Poison Oak-Pacific Blackberry Series is co-dominated by *Toxicodendron diversilobum* and *Rubus ursinus*. Western Poison Oak is a deciduous shrub or perennial vine with ternate, reddish-green leaves and cream-colored berries. This plant is one of the most hazardous plants in California because the resinous leaves, stems, and fruit cause severe contact dermatitis. Western Poison Oak occurs in canyons and on slopes, and is a typical species of chaparral and oak woodland. This species occurs at elevations below 1,650 meters. Pacific Blackberry is a prickly, deciduous perennial vine or shrub with toothed, dark green leaves, white petals, and black berries. This species occurs in moist places, such as streamsides, at elevations below 1,500 meters. (Hickman 1993.)

Although Western Poison Oak-Pacific Blackberry Series is not described by Sawyer and Keeler-Wolf (1995), biologists observed and classified this plant community based on its co-dominance by these two species. The canopy formed by Western Poison Oak and Pacific Blackberry at many of the Ojai streams is typically less than two meters tall, intermittent to continuous, and often occurs as dense understory ground cover to Coast Live Oak Series. Western Poison Oak-Pacific Blackberry Series is generally very shaded and includes associate species such as *Artemisia douglasiana*, *Heteromeles arbutifolia* (Toyon), *Piptatherum miliaceum*, *Prunus ilicifolia*, *Rosa californica*, and *Vitis californica* (California Wild Grape).

Coyote Brush Series

Coyote Brush Series is dominated by *Baccharis pilularis*, which is typically found in upland habitats, but was observed occupying much of the outer boundaries of the riparian zones throughout Ojai. Coyote Brush Series generally occurs in scrub and oak woodland communities on stabilized dunes of coastal bars, river mouths, coastline spits, coastal bluffs, open slopes with sometimes serpentine soils, and ecotonal areas with grasslands below 1,000 meters in elevation. This series forms a continuous or intermittent canopy (less than two meters tall), growing over a variable ground layer. (Sawyer and Keeler-Wolf 1998.)

The associate shrub and herbaceous plant species observed as contributors to Coyote Brush Series include *Artemisia californica*, *Baccharis salicifolia*, *Ceanothus spinosus* (Greenbark Ceanothus), *Heteromeles arbutifolia*, *Lepidospartum squamatum* (Scalebroom), *Malosma laurina*, *Rumex crispus* (Curly Dock), *Sambucus mexicana*, *Solanum americanum*, and *Toxicodendron diversilobum*. Emergent *Quercus agrifolia* (Coast Live Oak) were also quite common in this plant series.

PALUSTRINE FORESTED WETLAND

Palustrine Forested Wetlands are characterized by woody vegetation that is six meters tall or taller. Forested Wetlands only occur in the Palustrine and Estuarine systems and normally possess an overstory of trees, an understory of young trees and shrubs, and an herbaceous layer. Moisture must be relatively abundant, and wetlands in this subclass generally occur on mineral soils or highly decomposed organic soils. (Cowardin et al. 1979.)

Palustrine Forested Wetlands are important riparian plant communities as they provide suitable, structurally diverse, and often species-rich habitat for many species of wildlife that frequent and inhabit the streams of Ojai. Dominant trees that are typical of Palustrine Forested Wetland along the Ojai streams are predominantly broad-leaved winter-deciduous species. The plant communities classified under the Palustrine Forested Wetland class include California Sycamore Series and Coast Live Oak Series. These series are discussed in the following paragraphs.

It should be noted that the California Sycamore and Coast Live Oak woodland plant communities observed in the field are quite variable compared to how they are described by Sawyer and Keeler-Wolf (1995); however, these classifications fit most appropriately, and any differences are noted.

Also presented below is a description of Eucalyptus Series as observed during field surveys, as well as a discussion of other escaped ornamental and often highly invasive plant species that have become dominant in portions of the Ojai streams.

California Sycamore Series

California Sycamore Series is dominated by the monoecious, wind-pollinated, broad-leaved winter-deciduous *Platanus racemosa*. This native tree has smooth, pale bark and large, densely hairy, palmate leaves. It is a common tree occurring along streamsides and in canyons (Hickman 1993). California Sycamore is listed with a wetland indicator status of FACW, or a facultative wetland species. (Reed 1988.)

California Sycamore Series grows in wetland soils, permanently saturated at depth, of freshwater riparian corridors, braided depositional channels of intermittent streams, gullies, springs, seeps, riverbanks, and terraces adjacent to floodplains subject to high-intensity seasonal flooding. This series also occurs on upland rocky canyon slopes, in alluvial, open cobbly, and rocky soils, at elevations below 2,400 meters. A shrubby thicket of evergreen and deciduous shrubs may grow below the 35-meter, widely spaced, sycamore canopy, and the ground layer is variable.

Photograph 27. *Fox Canyon Barranca showing California Sycamore Series with oaks and willows, and showing influence of invasive exotic plant species (27 November 2004).*

The California Sycamore Series plant communities observed during the streams characterization studies varied from stream to stream, and the important often co-dominant tree species observed contributing to the sycamore canopy include *Quercus agrifolia*, *Q. lobata* (Valley Oak), *Salix lasiolepis*, or *Populus fremontii* ssp. *fremontii*. Other associate tree species include: *Alnus rhombifolia*, *Fraxinus* sp. (Ash), *Juglans californica* var. *californica*, and *S. lucida* ssp. *lasiandra*. The shrub layer observed growing below the tree canopy is generally predominated by *Arundo donax, Baccharis salicifolia, Rosa californica, Rubus ursinus, S. exigua,* and *Sambucus mexicana*. Many of the introduced ornamental plant species, listed below in Planted and Escaped Ornamentals, were observed throughout California Sycamore Series. Many of the ornamental species have become invasive and are creating severely competitive condition for the native riparian plant species that are crucial to the survival of Steelhead Trout as well as other wildlife.

Coast Live Oak Series

Coast Live Oak Series is dominated by *Quercus agrifolia* var. *agrifolia*, which is a broad-leaved, evergreen, broad-canopied tree with dark green leathery leaves. *Q. agrifolia* is the most widely distributed species of the evergreen oaks, and it is capable of achieving large size and old age. This oak typically occurs in valleys on predominantly north-facing slopes, along riparian woodland fringes, scattered in grassland or Coastal Sage Scrub communities, as an element of Mixed Evergreen Forest, or as a contributor to other oak woodlands (Zedler et al. 1997).

Coast Live Oak Series forms an intermittent, 30-meter-tall tree canopy growing over an understory of occasional shrubs and a grassy/herbaceous groundlayer. It also requires sandstone or shale-derived soils of elevations below 1,200 meters (Sawyer and Keeler-Wolf 1995). Coast Live Oak Series was observed in many riparian zones throughout the streams of Ojai. It is influenced by other adjacent plant series including California Sycamore Series, Arroyo Willow Series, and Coyote Brush Series.

***Photograph 28** (left). Upper end of Stewart Canyon Creek showing dense Coast Live Oak Series once continuous over the creek (28 January 2005). **Photograph 29** (right). Lower end of Stewart Canyon Creek showing an intermittent canopy (8 February 2005).*

The native trees and large shrubs observed contributing to the oak canopy include *Juglans californica* var. *californica, Quercus lobata, Platanus racemosa, Salix lasiolepis,* and *Sambucus mexicana.* The shrub stratum growing below the oak canopy includes *Baccharis pilularis*, *Ceanothus spinosus*, *Heteromeles arbutifolia*, *Malosma laurina*, *Prunus ilicifolia* (Hollyleaf Cherry), *Rosa californica*, and *Toxicodendron diversilobum*. Many of the introduced ornamental plant species, listed below in Planted and Escaped Ornamentals, were observed throughout Coast Live Oak Series. The ornamental species are invasive and are creating severely competitive condition for the native riparian plant species that are crucial to the survival of Steelhead Trout as well as other wildlife.

Eucalyptus Series

Eucalyptus Grove is dominated by *Eucalyptus globulus* var. *globules* (Tasmanian Blue Gum Eucalyptus) and/or *E. camaldulensis* (River Red Gum). These introduced, aromatic trees have a smooth straight trunk and are native to southeastern Australia. *E. globulus* is the most commonly cultivated and naturalized species of Eucalyptus in California (Hickman 1993), with *E. camaldulensis* also commonly planted. Eucalyptus Series (Sawyer and Keeler-Wolf 1995) forms a continuous canopy less than 50 meters tall with few other species present except infrequent shrubs growing over a sparse grassy ground layer. This series occurs on all slopes, and generally in disturbed areas, at elevations below 300 meters. The infrequent understory associate species of Eucalyptus Series observed within the watershed are *Arundo donax*, *Baccharis salicifolia*, *Platanus racemosa*, and *Washingtonia robusta* (Mexican Fan Palm). Although *E. globulus* is considered an escaped ornamental (further discussed below), this series is classified separately since it forms an almost pure stand with few associate species contributing to the canopy.

Planted and Escaped Ornamentals

Planted and Escaped Ornamentals is classified here as a plant community since it includes those areas of the Ojai streams riparian zones that are highly disturbed due to human activities or influences, and include those areas dominated by, or that have been completely invaded by, introduced and often invasive plant species. This plant community often forms a nonnative woodland type habitat that exists as a result of planting introduced ornamental tree and shrub species for landscaping purposes. Since many residences have been constructed immediately adjacent to many portions of the Ojai streams riparian zones, the exotic species planted for landscaping readily escape and invade the native riparian plant communities. The ornamental species are much hardier than the native species and create significantly competitive conditions for those native riparian species. This type of plant community typically includes very few natives, but rather includes an array of ornamental species that have replaced the riparian plant communities.

Photograph 30 *(left). Nordhoff Drain and Happy Valley Drain confluence showing dense Eucalyptus Series in the background (15 January 2005).* ***Photograph 31*** *(right). Arbolada Creek showing how very little grows beneath Eucalyptus Series (30 September 2004).*

Photograph 32 *(left). Arbolada Creek, view south showing planted ornamentals prohibiting the establishment of native riparian propagules (30 September 2004).* ***Photograph 33*** *(right). Fox Canyon Barranca along S. Montgomery Street showing dominance by escaped ornamentals such as Mexican Fan Palm (9 January 2005).*

The predominant introduced trees and shrubs observed contributing to the plant communities dominated by ornamental species include: *Acacia* sp. (Acacia/Wattle), *Ailanthus altissima* (Tree-of-heaven), *Eucalyptus globulus*, *Ficus carica* (Fig), *Fraxinus* spp., *Hedera helix* (English Ivy), *Hirschfeldia incana*, *Mentha* spp. (Spearmint), *Nerium oleander* (Oleander), *Olea europea* (Olive), *Phoenix canariensis* (Canary Island Date Palm), *Plumbago ariculata* (Cape Plumbago), *Ipomoea* sp. (Morning-glory), *Schinus molle* (Peruvian Pepper Tree), *Vinca major* (Periwinkle), *Washingtonia robusta*, and *Yucca elephantipes* (Giant Yucca). The naturalized and invasive species observed frequently in these plant communities include *Arundo donax*, *Foeniculum vulgare*, *Nicotiana glauca*, *Piptatherum miliaceum*, and *Ricinus communis*. Native trees, including *Quercus agrifolia*, *Q. lobata*, and *Platanus racemosa* are also typically scattered throughout these areas of the Ojai streams.

Riverine System (Aquatic Habitats)

The Riverine system includes all wetlands and deepwater habitats contained within a channel (or a conduit periodically or continuously containing moving water, or forming a connecting link between two bodies of water), with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens; and (2) habitats with water containing ocean-derived salts in excess of 0.5‰. The Riverine system is bounded on the landward side by the channel bank, or by wetland dominated by trees, shrubs, and persistent emergents. Water is usually, but not always, flowing in this system. (Cowardin et al. 1979.) The Riverine system is classified into two subsystems for the streams of Ojai: Lower Perennial and Intermittent.

RIVERINE LOWER PERENNIAL WETLAND

The Riverine Lower Perennial subsystem includes habitats where the gradient is low and water velocity is slow. No tidal influence exists, and some water flows throughout the year. The substrate consists of mainly sand and mud. Oxygen deficits may occur, the fauna is composed of species that reach their maximum abundance in still water, and true planktonic organisms are common. The gradient is lower than that of the Upper Perennial system, and the floodplain is well developed. (Cowardin et al. 1979.) The three general classes observed during the Ojai streams field surveys include Unconsolidated Shore, Unconsolidated Bottom, and Aquatic Bed, which are discussed below.

Riverine Lower Perennial Unconsolidated Shore Wetland

Riverine Lower Perennial Unconsolidated Shore includes all wetland habitats having three characteristics: unconsolidated substrates with less than 75% aerial cover of stones, boulders, or bedrock; having less than 30% aerial cover of vegetation other than pioneering plants; and having almost any particular flooding water regime. This habitat is characterized by substrates lacking vegetation except the pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents in this system produce landforms such as beaches, bars, and flats. Unconsolidated Shore is typically found adjacent to Unconsolidated Bottom in all systems, and particle size of the substrate and the water regime are the important factors determining types of plant/animal communities present. (Cowardin et al. 1979.)

Boulders, stones, and gravel were observed as predominant substrate types within the Riverine Lower Perennial Unconsolidated Bottom Wetland habitats of the Ojai streams. The scattered pioneering plants observed in this habitat include *Epilobium ciliatum* ssp. *ciliatum*, *Hirschfeldia incana, Melilotus alba* (White Sweetclover), *Plantago lanceolata*, *Polypogon monspeliensis* (Rabbitsfoot Grass), and *Xanthium strumarium*.

Riverine Lower Perennial Unconsolidated Bottom Wetland

Riverine Lower Perennial Unconsolidated Bottom includes habitats with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30%. Water regimes are restricted to subtidal (not present at the project site), permanently flooded, intermittently exposed, and semipermanently flooded. This class is characterized by the lack of large stable surfaces for plant and animal attachment. Exposure to wave and current action, temperature, salinity, and light penetration determine the composition and distribution of organisms. Most animals in unconsolidated sediments live within the substrate, while some maintain permanent burrows, and others may live on the surface. Unconsolidated Bottom is usually found in areas with lower energy than Rock Bottoms, and may be very unstable. In the Riverine System, the substrate type of this class is largely determined by current velocity, and plants and animals exhibit a high degree of morphologic and behavioral adaptation to flowing water. (Cowardin et al. 1979.)

Cobble, gravel, and sand were observed as predominant substrate types within the Riverine Lower Perennial Unconsolidated Bottom of portions of the Ojai streams. Scattered plants species include most of those mentions above in Unconsolidated Shore.

Riverine Lower Perennial Aquatic Bed Wetland (Duckweed Series)

Riverine Lower Perennial Aquatic Bed Wetland includes habitat dominated by plants that grow on or below the water surface for most of the growing season. Aquatic Beds represent a diverse group of plant communities that require surface water for optimum growth and reproduction (Cowardin et al. 1979). This habitat class is characterized by seasonally or permanently flooded freshwater channel/bed that is dominated by floating or attached vascular aquatic plants.

The Aquatic Bed plant series classified here based on field surveys is Duckweed Series, which is dominated by species of *Lemna* spp. (Duckweed). Duckweed species are free-floating, aquatic herbs with flat, oblong, bright green, small plant bodies (often joined or paired) with a single root. The common associate (or co-dominant) to Duckweed observed inhabiting ponded water in the Ojai streams is *Azolla filiculoides* (Mosquito Fern). Mosquito Fern is also free-floating, but is a fan-shaped, greenish-red, scaly, aquatic fern. These annual plants are typically present in quiet water during the warm summer months. (Hickman 1993.)

RIVERINE INTERMITTENT WETLAND

The Riverine Intermittent subsystem exists where the channel contains nontidal flowing water for only part of the year. When active flows are not present, surface water may be absent or water may remain in isolated pools. (Cowardin et al. 1979.) The areas of the Ojai streams, where water was not present during the time of the surveys and where the substrate was not dominated by vegetation, are classified as Riverine Intermittent Wetland.

Riverine Intermittent Streambed Wetland

The Streambed class includes all wetlands contained within the Intermittent Subsystem of the Riverine system. Riverine Intermittent Streambed varies greatly in substrate and form depending on the gradient of the channel, velocity of the water, and sediment load. The substrate material frequently changes abruptly between riffles and pools, and complex patterns of bars may form on the convex side of single channels or be included as islands within the bed of braided streams. In most cases, streambeds are not vegetated because of the scouring effect when moving water is present, but like Unconsolidated Shore, they may be colonized by pioneering annuals and perennials during periods of low flows, or they may be too scattered to qualify as an Emergent or Scrub/Shrub Wetland. (Cowardin et al. 1979.)

All non-active, unvegetated, primary channels and secondary drainages with no flows at the time of the surveys, are classified as Riverine Intermittent Streambed. The substrate varied from boulders, stones, and cobbles to stones, cobbles, and gravel with patches of sand. Scattered pioneering annual and perennial herbs include: *Conyza canadensis*, *Hirschfeldia incana Melilotus alba*, *Sonchus oleraceus*, and *Xanthium strumarium*.

Wildlife

Biologists conducted cursory wildlife surveys at each Water Quality Sampling Station; performed a nighttime cursory wildlife survey in Fox Canyon, Ojai, and Stewart Canyon Creeks; and reported all observed wildlife during the Ojai streams characterization study. The following subsections present the findings of those surveys.

Fauna

Numerous wildlife species are known to occur within the Ventura River system, as well as the streams (the tributaries of the Ventura River) that run directly through the City of Ojai. Wildlife frequent the Palustrine System and Riverine System habitats on a seasonal basis and/or regularly use resources provided by the streams of the Ventura River system. Table 22, Wildlife Species of the City of Ojai and Ojai Basin Streams, contains a list of animal species that are known and expected to be associated with creeks and drainages of Ojai. This table is a compilation of (1) the cursory daytime wildlife surveys conducted at each Water Quality Sampling Station, (2) the cursory nighttime wildlife survey (discussed in the following paragraph), (3) all observed wildlife during the Ojai Basin streams characterization study, and (4) any reported wildlife for the area.

Wildlife Survey Results

Biologists conducted cursory wildlife surveys at each Water Quality Sampling Station and performed a nighttime cursory wildlife survey in Fox Canyon, Ojai, and Stewart Canyon Creeks. These survey results are presented below as Table 23, Summary of Wildlife Surveys Conducted in the Ojai Streams, which indicates the date and time that each creek was surveyed, the general habitat type surveyed and dominant plant species observed, the wildlife observed, whether or not flows were present in each creek surveyed, and any creek modifications.

Wildlife observed during the Fox Canyon Barranca night survey. ***Photograph 34*** *(top left) Matilija Shoulderband Snail* (Helminthoglypa willetti). ***Photograph 35*** *(top right) Black-bellied Slender Salamander.* ***Photograph 36*** *(lower left) Spiders, including female Black Widow.* ***Photograph 37*** *(lower right) Beetle larvae. Photos taken 6 December 2004.*

Table 22. Wildlife Species of the City of Ojai and Ojai Basin Streams

Scientific Name[16]	Common Name	Habitat	Evidence[17]
Fish			
Cottus asper	Prickly Sculpin	Riverine Aquatic Bed	Observed
Gasterosteus aculeatus microcephalus	Partially Armored Threespine Stickleback	Riverine Aquatic Bed	Observed
*Pimephales promelas**	Fathead Minnow	Riverine Aquatic Bed	Observed
Gila orcutti	Arroyo Chub	Riverine Aquatic Bed	Observed
*Lepomis cyanellus**	Green Sunfish	Riverine Aquatic Bed	Observed
*Gambusia affinis**	Mosquitofish	Riverine Aquatic Bed	Observed
*Ictalurus punctatus**	Channel Catfish	Riverine Aquatic Bed	Reported
*Cyprinus carpio**	Carp	Riverine Aquatic Bed	Reported
*Carassius auratus**	Goldfish	Riverine Aquatic Bed	Observed
Lampetra tridentata	Pacific Lamprey	Riverine Aquatic Bed	Reported
Oncorhynchus mykiss	Southern Steelhead (Southern California ESU - Federally Listed as Endangered)	Riverine Aquatic Bed	Observed
Oncorhynchus mykiss[18]	Rainbow Trout	Riverine Aquatic Bed	Observed
Amphibians			
Batrachoseps nigriventris	Black-bellied Slender Salamander	Riverine Aquatic Bed, Palustrine	Observed
Bufo boreas halophilus	California Toad	Riverine Aquatic Bed, Palustrine	Expected
Hyla regilla	Pacific Treefrog	Riverine Aquatic Bed, Palustrine	Observed
*Rana catesbiana**	Bullfrog	Riverine Aquatic Bed, Palustrine	Observed
Reptiles			
Clemmys marmorata pallida	Southwestern Pond Turtle (CDFG Species of Special Concern)	Riverine Aquatic Bed, Palustrine	Expected
Elgaria multicarinatus	San Diego Alligator Lizard	Palustrine	Observed
Sceloporous occidentalis	Western Fence Lizard	Palustrine	Observed
Uta stansburiana elegans	Side-blotched Lizard	Palustrine	Observed
Pituophis melanoleucus annectens	San Diego Gopher Snake	Palustrine	Expected
Pituophis melanoleucus	Gopher Snake	Riverine Aquatic Bed, Palustrine	Expected
Thamnophis couchi	Western Aquatic Garter Snake	Riverine Aquatic Bed, Palustrine	Expected
Lampropeltis getulus californiae	California Kingsnake	Palustrine	Reported
Crotalus viridis	Western Rattlesnake	Palustrine	Expected
Avifauna			
Ardea herodias	Great Blue Heron	Riverine Aquatic Bed, Palustrine	Observed
Ardea alba	Great Egret	Riverine Aquatic Bed, Palustrine	Observed
Egretta thula	Snowy Egret	Palustrine	Observed
Butorides virescens	Green Heron	Palustrine	Reported
Nycticorax nycticorax	Black-crowned Night Heron	Riverine Aquatic Bed, Palustrine	Observed

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[16] An asterisk "*" after the scientific name indicated non-native species.

[17] Reported fish species are based on findings by Hunt (1991). Reported bird species are reported as being observed in October 2004 at the Ojai Meadows Preserve by Jon Diegas, while nomenclature follows National Geographic (2002).

[18] Rainbow Trout are treated separately to indicate those fish that lack access to the ocean, and not considered Southern Steelhead.

Table 22. Wildlife Species of the City of Ojai and Ojai Basin Streams (continued)

Scientific Name	Common Name	Habitat	Evidence
Avifauna (continued)			
Anas platyrhynchos	Mallard	Riverine Aquatic Bed, Palustrine	Observed
Fulica americana	American Coot	Riverine Aquatic Bed, Palustrine	Expected
Cathartes aura	Turkey Vulture	Palustrine	Observed
Callipepla californica	California Quail	Palustrine	Observed
Mergus merganser	Common Merganser	Palustrine	Reported
Accipiter cooperii	Cooper's Hawk	Palustrine	Observed
Buteo lineatus	Red-shouldered Hawk	Palustrine	Observed
Buteo jamaicensis	Red-tailed Hawk	Palustrine	Observed
Falco sparverius	American Kestrel	Palustrine	Observed
Falco columbarius	Merlin	Palustrine	Reported
Charadrius vociferus	Killdeer	Riverine Intermittent Streambed	Observed
Zenaida macroura	Mourning Dove	Palustrine	Observed
Calypte anna	Anna's Hummingbird	Palustrine	Observed
Ceryle alcyon	Belted Kingfisher	Riverine Aquatic Bed, Palustrine	Reported
Melanerpes formicivorus	Acorn Woodpecker	Palustrine	Observed
Picioides pubescens	Downy Woodpecker	Palustrine	Expected
Picioides villosus	Hairy Woodpecker	Palustrine	Expected
Picoides nuttallii	Nuttall's Woodpecker	Palustrine	Reported
Colaptes auratus	Northern Flicker	Palustrine	Observed
Empidonax difficilis	Pacific-slope [Western] Flycatcher	Palustrine	Expected
Sayornis nigricans	Black Phoebe	Palustrine	Observed
Sayornis saya	Say's Phoebe	Palustrine	Reported
Tyrannus vociferans	Cassin's Kingbird	Palustrine	Reported
Aphelocoma californica	Western Scrub-jay	Palustrine	Observed
Corvus caurinus	American Crow	Palustrine	Observed
Corvus corax	Common Raven	Palustrine	Observed
Eremophila alpestris	Horned Lark	Palustrine	Reported
Petrochelidon pyrrhonota	Cliff Swallow	Riverine Aquatic Bed, Palustrine	Observed
Hirundo rustica	Barn Swallow	Palustrine	Observed
Baeolophus inornatus	Oak Titmouse	Palustrine	Observed
Psaltriparus minimus	Common Bushtit	Palustrine	Observed
Thryomanes bewickii	Bewick's Wren	Palustrine	Reported
Troglodytes aedon	House Wren	Palustrine	Reported
Sialia mexicana	Western Bluebird	Palustrine	Observed
Mimus polyglottos	Northern Mockingbird	Palustrine	Observed
*Sturnus vulgaris**	European Starling	Palustrine	Observed
Vermivora celata	Orange-crowned Warbler	Palustrine	Reported
Dendroica petechia	Yellow Warbler	Palustrine	Reported
Geothlypis trichas	Common Yellowthroat	Palustrine	Reported
Pipilo crissalis	California Towhee	Palustrine	Observed
Chondestes grammacus	Lark Sparrow	Palustrine	Reported
Passerculus sandwichensis	Savannah Sparrow	Palustrine	Reported
Melospiza melodia	Song Sparrow	Palustrine	Reported
Melospiza lincolnii	Lincoln's Sparrow	Palustrine	Reported
Zonotrichia leucophrys	White-crowned Sparrow	Palustrine	Observed

Table 22. Wildlife Species of the City of Ojai and Ojai Basin Streams (continued)

Scientific Name	Common Name	Habitat	Evidence
Avifauna (continued)			
Agelaius phoeniceus	Red-winged Blackbird	Palustrine	Observed
Agelaius tricolor	Tricolored Blackbird (State Listed as Threatened)	Palustrine	Reported
Sturnella neglecta	Western Meadowlark	Palustrine	Reported
Euphagus cyanocephalus	Brewer's Blackbird	Palustrine	Observed
Molothrus ater	Brown-headed Cowbird	Palustrine	Reported
Carpodacus cassinii	House Finch	Palustrine	Observed
Carduelis psaltria	Lesser Goldfinch	Palustrine	Reported
Carduelis tristis	American Goldfinch	Palustrine	Observed
Carduelis lawrencei	Lawrence's Gold finch	Palustrine	Reported
Mammals			
Didelphis virginiana	Virginia Opossum	Palustrine	Observed
Scapanus townsendii	Townsend's Mole	Palustrine	Expected
Mustela frenata	Long-tailed Weasel	Palustrine	Expected
Spermophilus beecheyi	California Ground Squirrel	Palustrine	Observed
*Sciurus niger**	Eastern Fox Squirrel	Palustrine	Observed
Thomomys bottae	Botta's Pocket Gopher	Palustrine	Observed
Peromyscus maniculatus	Deer Mouse	Palustrine	Observed
Neotoma fuscipes	Dusky-footed Woodrat	Palustrine	Expected
Microtus californicus	California Vole	Palustrine	Expected
*Rattus rattus**	Black Rat	Palustrine	Observed
Canis latrans	Coyote	Palustrine	Observed
Urocyon cinereoargenteus	Gray Fox	Palustrine	Observed scat & tracks
Ursus americanus	Black Bear	Palustrine	Expected
Procyon lotor	Raccoon	Riverine Aquatic Bed, Palustrine	Observed
Spilogale gracilis	Western Spotted Skunk	Palustrine	Expected
Mephitis mephitis	Striped Skunk	Palustrine	Observed
Felis concolor	Mountain Lion	Palustrine	Expected
Lynx rufus	Bobcat	Palustrine	Observed scat & tracks
Odocoileus hemionus	Mule Deer	Palustrine	Observed scat & tracks
Invertebrates			
Helmintoglypta phlyctaena	Zaca Shoulderband Snail	Palustrine	Expected
Helmintoglypta willetti	Matilija Shoulderband Snail	Palustrine	Expected/Observed
*Deroceras reticulatum**	Reticulated Slug	Palustrine, landscaping	Expected
Haplotrema caelatum	Slotted Lancetooth Snail	Palustrine	Expected
*Helix aspersa**	European Garden Snail	Palustrine, ruderal	Observed
*Lehmannia valentiana**	Threeband Gardenslug Snail	Ruderal/landscaping	Expected
*Limax flavus**	Yellow Gardenslug Snail	Ruderal/landscaping	Expected
*Milax gagates**	Black-keeled Slug	Ruderal/landscaping	Expected
Lumbricus terrestris	Earth Worm	Palustrine	Observed
Astacidae*	Crayfish	Riverine	Observed
Arneida	Black Widow Spider	Palustrine	Observed
Hydrobius fuscipes	Water Scavenger Beetle	Riverine	Observed
Gerris remigis	Water Strider	Riverine	Observed
Notonecta undulata	Backswimmer	Riverine	Observed
Culicidae	Mosquito	Riverine	Observed
Danus plexippus	Monarch Butterfly	Palustrine	Observed
*Apis mellifera**	European Honey Bee	Palustrine	Observed

Table 23. Summary of Wildlife Surveys Conducted in the Ojai Streams

Reach No.	Date	Time	Stream Name	Habitat Type	Predominant Plant Species	Wildlife Observed	Inundated	Modifications
1	3-Dec-04	10:30 AM	Happy Valley Drain	Riverine Intermittent Streambed	Eucalyptus	House Finch American Goldfinch Warblers in Eucalyptus trees	No	Unnatural drainage, Eucalyptus grove
2	3-Dec-04	11:30 AM	Villanova Creek	Palustrine Forested	Arroyo Willow Mulefat California Sycamore	House Finch in Arroyo Willow canopy	Yes	Rock banks holding road shoulder
3	3-Dec-04	12:20 PM	Del Norte Creek	Palustrine Forested	Coast Live Oak California Sycamore	None	Yes	Rock/cement banks
4	9-Dec-04	10:30 AM	San Antonio Creek	Palustrine Scrub/Shrub	Arroyo Willow Giant Reed	None	Yes	Bridge and unnatural rock/cement spillway
5	9-Dec-04	12:25 AM	San Antonio Creek	Palustrine Scrub/Shrub	Giant Reed Pacific Blackberry	Western Scrub-jay in Fremont Cottonwood canopy	Yes	Giant Reed infestation
	5-Dec-04	11:05 PM	San Antonio Creek	Riverine Lower Perennial	Coast Live Oak, California Sycamore, Giant Reed	Mosquito Fish Crawfish	Yes	Narrow bridge with concrete spillway upstream
6	9-Dec-04	1:00 PM	Stewart Canyon Creek	Palustrine Forested	Coast Live Oak California Bay Arroyo Willow	Southern Steelhead (~12”)	Yes	Metal retaining wall holding road shoulder
7	9-Dec-04	1:35 PM	Ojai Creek	Palustrine Forested	Coast Live Oak Southern California Black Walnut California Bay California Sycamore	Pacific Treefrogs Common Bushtit in Coast Live Oak	Yes	Libbey Park adjacent to riparian zone
	5-Dec-04	10:10 PM	Ojai Creek	Riverine Intermittent Streambed	Coast Live Oak Morning-glory Mexican Fan Palm English Ivy	Matilija Shoulderband Snail Mosquito Fish Watercress 2 Pacific Treefrogs Crawfish	Yes	Libbey Park Adjacent to drainage
8	9-Dec-04	2:10 PM	Fox Canyon Barranca	Palustrine Forested	Mature Coast Live Oak overstory	Western Scrub-jays; Warblers in Coast Live Oak trees	Yes	Bridge, wooden fences fragmenting wildlife
	5-Dec-04	8:50 PM	Fox Canyon Barranca	Palustrine Forested	Coast Live Oak English Ivy	2 Slender Salamanders Land Snail in rocks above culvert	No	Culvert directing water under road through residential area
9	7-Dec-04	11:00 AM	Arbolada Creek	Palustrine Forested, Unnatural	Coast Live Oak Toyon Mexican Fan Palm	None	No	River rock spillway used to direct water under roadways
10	7-Dec-04	12:00 PM	Stewart Canyon Creek	Palustrine Forested	California Sycamore Greenbark Ceanothus Laurel Sumac	Western Scrub-jays	No	Residential exotics carried by water transport (palms, eucalyptus)
	5-Dec-04	9:40 PM	Stewart Canyon Creek	Palustrine Scrub/Shrub	Mulefat Arroyo Willow Laurel Sumac	None	No	Debris basin below site
11	7-Dec-04	2:00 PM	Ayers Creek	Palustrine Scrub/Shrub	Inundated with Mexican Fan Palm	None	Yes	Soule Park Golf Course to west

Table 23. Summary of Wildlife Surveys Conducted in the Ojai Streams (continued)

Reach No.	Date	Time	Stream Name	Habitat Type	Predominant Plant Species	Wildlife Observed	Inundated	Modifications
12	8-Dec-04	11:00 AM	San Antonio Creek	Palustrine Scrub/Shrub	Mulefat Arroyo Willow Laurel Sumac	Small songbirds Warblers under Mulefat	No	Trash accumulated under bridge
13	8-Dec-04	11:45 AM	Thatcher Creek	Palustrine Forested	Coast Live Oak Arroyo Willow Fremont Cottonwood	Juvenile Red-tail Hawk Adult Red-tail Hawk Acorn Woodpecker Pacific Treefrogs	No	Concrete banks, concrete tunnel under bridge with 3-ft. drop in spillway
14	8-Dec-04	1:30 PM	Fox Canyon Creek	Palustrine Forested	Coast Live Oak Mexican Fan Palm Morning-glory Pacific Blackberry	None	Yes	Concrete spillway, trash from athletics club, tennis balls
15	8-Dec-04	2:45 PM	Stewart Canyon Creek	Palustrine Scrub/Shrub	Spanish Broom Eucalyptus Yellow Star-thistle	2 Mallard Ducks Pacific Treefrogs	Yes	Mostly cement and rock banks
16	8-Dec-04	3:30 PM	Arbolada Creek	Palustrine Forested	Coast Live Oak	Small songbirds in residential trees	No	Residential area
17	8-Dec-04	4:10 PM	Del Norte Creek	Palustrine Forested, Unnatural	Eucalyptus Mexican Fan Palm Oleander (residential)	Acorn Woodpecker in California Sycamore	Yes	Rock/cement bank holding road shoulder
18	9-Dec-04	2:45 PM	Del Norte Creek	Palustrine Forested	Eucalyptus Coast Live Oak	Pacific Treefrog Acorn Woodpecker California Quail	Yes	Ojai Valley Inn Golf Course surrounds the drainage

Wildlife Habitats

Palustrine (riparian) and Riverine (aquatic) habitats contain numerous attributes and resources that are important for wildlife. The structure diversity of the riparian community, in addition to the high plant species richness, provides necessary foraging, nesting, and cover resources and opportunities for numerous species. Aquatic habitats are important sources of water for many wildlife species occupying upland habitats that frequent the streams specifically for water. The following subsections discusses some of the common species of fish, amphibians, reptiles, birds, and mammals that inhabit and/or frequent the riparian and aquatic habitats of the Ojai Basin streams and the San Antonio Creek Watershed.

RIPARIAN

The riparian zone is the vegetative corridor at the boundary of a body of water. It is often unique from the surrounding vegetation due to its proximity to water, and it acts as the interface between the terrestrial and aquatic zones. Riparian zones are frequently habitat for endangered and threatened species, including the Least Bell's Vireo and the Tiger Salamander. During the dry season, the riparian areas around a stream will be the only areas with green plant growth. Riparian areas are often the only home for deciduous trees, like sycamores and willows, which need year-round water to survive. Overhanging trees help to preserve threatened species like Steelhead Trout by providing shade and cool water. Riparian areas provide protected habitat and migration/travel corridors for much of the area's wildlife. These migration corridors can act as connections between habitat patches, and they allow for physical and genetic exchange between animal populations. Wildlife can use riparian zones for cover while traveling across otherwise open landscapes. Some studies have shown that as much as 85% of a region's wildlife inhabit riparian zones at some point in their life.

By preventing erosion, riparian plants keep water silt-free for trout eggs to hatch, and by providing shade, the stream temperatures stay cool enough for the spawn to survive. Riparian areas also serve as a buffer between land-use and the stream; they filter out pollutants before they reach the water and act as a bacteriological and chemical factory to cleanse stream water as it moves to and from the channel and stream bank. (Leydecker and Grabowsky 2004.)

The general riparian wildlife habitats discussed below are those of the Palustrine System, including Emergent Wetland (herbaceous), Scrub/Shrub Wetland (dominated by shrubs), and Forested Wetland (created by a tree canopy) (Cowardin et al. 1979). These habitat types are floristically described in detail in the Palustrine System subsection of this report.

Palustrine Emergent Wetland, or Freshwater Marsh, habitats provide escape, nesting, and thermal cover for a variety of mammals, birds, amphibians, and invertebrates. Species of wildlife that are expected to frequent Freshwater Marsh habitat for foraging purposes include the following: aquatic snails (family *Gastropoda*), Pacific Treefrog (*Hyla regilla*), Black-bellied Slender Salamander (*Batrachoseps nigriventris*), Gopher Snake (*Pituophis melanoleucus*), Western Aquatic Garter Snake (*Thamnophis couchi)*, Common Raven (*Corvus corax)*, Great Blue Heron and Great Egret (*Ardea* spp.), Green Heron (*Butorides virescens*), Black-crowned Night Heron (*Nycticorax nycticorax*), Snowy Egret (*Egretta thula*), Mallard (*Anas platyrhynchos*), Coyote (*Canis latrans*), Raccoon (*Procyon lotor)*, and Mule Deer (*Odocoileus hemionus)*.

Freshwater Marsh communities can also provide suitable foraging and cover habitat for the Southwestern Pond Turtle (*Clemmys marmorata pallida)*, a State- and Federally-designated Species of Special Concern; however, none have been observed during this study. This species prefers quiet waters of ponds, small lakes, streams, and marshes. It is found to inhabit the largest and deepest pools along streams with large amounts of basking sites, including fallen trees and boulders. Pond turtles also congregate in areas of streams with abundant underwater cover or places of escape beneath the water surface such as undercut banks, tangles of roots, and submerged logs (Hunt 1994).

Many reptiles use **Palustrine Scrub/Shrub** habitats for foraging purposes and for cover. Various reptiles that are known in the streams of Ojai, or that are expected to occur based on the presence of suitable habitats, include: San Diego Alligator Lizard (*Elgaria multicarinatus*), Western Fence Lizard (*Sceloporous occidentalis*), Side-blotched Lizard (*Uta stansburiana elegans*), California Kingsnake (*Lampropeltis getulus californiae*), and San Diego Gopher Snake (*Pituophis melanoleucus annectens*).

Birds that commonly frequent and inhabit scrub/shrub riparian habitats of the San Antonio Creek Watershed and its tributaries include: California Quail (*Callipepla californica*), Mourning Dove (*Zenaida macroura*), Anna's Hummingbird (*Calypte anna*), Pacific-slope [Western] Flycatcher (*Empidonax difficilis*), Black Phoebe (*Sayornis nigricans*), Say's Phoebe (*Sayornis saya*), Western Scrub-jay (*Aphelocoma californica*), American Crow (*Corvus caurinus*), Oak Titmouse (*Baeolophus inornatus*), Common Bushtit (*Psaltriparus minimus*), Common Yellowthroat (*Geothlypis trichas*), California Towhee (*Pipilo crissalis*), White-crowned Sparrow (*Zonotrichia leucophrys*), Red-winged Blackbird (*Agelaius phoeniceus*), Brewer's Blackbird (*Euphagus cyanocephalus*), House Finch (*Carpodacus cassinii*), and American Goldfinch (*Carduelis tristis*).

Many mammals are also closely associated with scrub/shrub riparian habitats of the San Antonio Creek Watershed and Ojai Basin streams. Several species will establish dens or burrows in areas of the riparian community, where understory growth is dense and food is readily available. Mammals that frequent and inhabit the riparian scrub habitats of the Ojai streams include: Virginia Opossum (*Didelphis virginiana*), Townsend's Mole (*Scapanus townsendii*), California Ground Squirrel

(*Spermophilus beecheyi*), Botta's Pocket Gopher (*Thomomys bottae*), Deer Mouse (*Peromyscus maniculatus*), Dusky-footed Woodrat (*Neotoma fuscipes*), Black Rat (*Rattus rattus*), Coyote, Gray Fox (*Urocyon cinereoargenteus*), Raccoon, and Striped Skunk (*Mephitis mephitis*).

Vegetation associated with **Palustrine Forested Wetland** may provide roosting and foraging habitat for various migratory bird species. In addition, many migratory bird species are dependent upon riparian communities such as Riparian Forest for overwintering habitat. Larger trees within the riparian zone often provide important roosting and nesting areas for numerous large birds, including Turkey Vulture (*Cathartes aura*), Western Scrub-jay, Cooper's Hawk (*Accipiter cooperi*), Red-shouldered Hawk (*Buteo lineatus*), and Red-tailed Hawk (*Buteo jamaicensis*). Dead trees and snags of California Sycamore, willows, cottonwoods, oaks, and White Alder provide essential habitat for a large number of cavity nesters including American Kestrel, Northern Flicker (*Colaptes cafer*), Downy and Hairy Woodpeckers (*Picioides* spp.), and Acorn Woodpecker (*Melanerpes formicivorus*). Additional bird species observed and expected to frequent or inhabit the Palustrine Forested Wetlands of the Ojai streams include: Western Meadowlark (*Sturnella neglecta*), Black Phoebe, Mourning Dove (*Zenaida macroura*), Pacific-slope Flycatcher, Cassin's Kingbird (*Tyrannus vociferans*), Common Raven, Western Bluebird (*Sialia mexicana*), and Northern Mockingbird (*Mimus polyglottos*).

Other vertebrate species that are expected to use Riparian Forest habitat for cover or foraging purposes include Pacific Treefrog, California Toad (*Bufo boreas halophilus*), Dusky-footed Woodrat, Virginia Opossum, Striped Skunk, Raccoon, Coyote, Mountain Lion (*Felis concolor*), Bobcat (*Lynx rufus*), and Mule Deer.

AQUATIC

Riverine systems provide habitat for aquatic wildlife species as well as water resources for terrestrial wildlife species. The general aquatic wildlife habitats of the Ojai streams include the Riverine Lower Perennial Wetland (water always present) and Riverine Intermittent Streambed Wetland (water present some of the time), which are described above in more detail in the Riverine System subsection (Cowardin et al. 1979).

Cobble-Gravel is the subclass to the Riverine classes – Lower Perennial Unconsolidated Shore, Lower Perennial Unconsolidated Bottom, and Intermittent Streambed (described above in the Riverine System subsection) – that generally represents most of the Ojai streams. Cobble-Gravel is characterized by the unconsolidated particles that are smaller than stones and have been transported by waves and currents. Shell fragments, sand, and silt fill the spaces between the larger particles, while stones and boulders may be also scattered about this subclass. The predominant invertebrates of the Cobble-Gravel subclass include the following: midges (*Diamesa* spp. and *Chironomus* spp.), stonefly-midges (*Nemoura-eukiefferiella* spp.), freshwater mollusks (*Anodonta* spp., *Elliptio* spp., and *Lampsilis* spp.), freshwater sponges (*Eunapius* spp.), mayflies (*Baetis* spp. and *Caenis* spp.), mosquitoes (*Anopheles* spp.), aquatic snails (*Lymnaea* spp. and *Physa* spp.), Oligochaete Worm (*Limnodrilus* sp.), Toad Bug (*Gelastocoris* sp.), Leech (*Erpodella* sp.), Scud (*Gammarus* sp.), and Spring-tail (*Agrenia* sp.). (Cowardin et al. 1979.)

The most important physical parameters for fish are stream depth, current velocity, substrate composition, cover, and temperature (Faber et al. 1989). However, the composition and structure of the associated riparian community can have a significant effect on the overall quality of the instream environment for fish. A well-established riparian corridor is important for fish in that shade provided by vegetation maintains cooler stream temperatures during the summer months. In addition, the presence of a well-developed riparian community provides an ongoing source input of woody debris within the stream channel, which consequently provides cover and refuge for fish and other wildlife.

Various resident fish species that are known to occur within the Riverine habitats of the San Antonio Creek system include: Prickly Sculpin (*Cottus asper*), Partially Armored Threespine Stickleback (*Gasterosteus aculeatus microcephalus*), Fathead Minnow (*Pimephales promelas*), Rainbow Trout (*Oncorhynchus mykiss*), and Arroyo Chub (*Gila american*) (Hunt 1991). Nonnative, warm-water species known to occur within portions of the study area include Green Sunfish (*Lepomis cyanellus*), Channel Catfish (*Ictalurus punctatus*), and Carp (*Carassius auratus*).

Two species of Southern Steelhead are present within the Ventura River and San Antonio Creek systems, including its tributaries, Pacific Lamprey (*Lampetra tridentata*) and Southern Steelhead (*Oncorhynchus mykiss irideus*, the migratory form of Rainbow Trout). The Pacific Lamprey spends one to two years in ocean waters as an adult before returning to its native stream to spawn. Upstream migration of this species to spawning areas usually occurs between April and late July (Moyle 1976). The life history of Southern Steelhead is discussed above in the Introduction section.

Amphibians and reptiles are well represented within riverine habitats of the Ojai Basin streams. Amphibians and reptiles known or expected to occur in the riparian habitats of the Ventura River and associated tributaries, as well as adjacent upland habitats, include California Toad, Pacific Treefrog, Black-bellied Slender Salamander, and Western Aquatic Garter Snake. The Bullfrog (*Rana catesbiana*) is an introduced species native to the East Coast of North America, and is expected in the creeks of Ojai. The introduction and presence of the Bullfrog in many California streams is most likely contributing to the decline of several native amphibian and reptile species (Faber et al. 1989).

Numerous bird species will frequent Riverine habitats for hunting resources to prey upon fish and amphibians, and they include Great Blue Heron, Great Egret, Black-crowned Night Heron, and Belted Kingfisher (*Ceryle alcyon*). Other foraging bird species of Riverine habitats include Mallard, American Coot (*Fulica Americana*), Killdeer (*Charadrius vociferous*), and Cliff Swallow (*Petrochelidon pyrrhonota*). Upland mammals will frequent the creeks and tributaries of the San Antonio Creek Watershed, and associated riparian zones, for the variety of food resources available and water. Upland mammals that frequent riverine habitats of the Ojai streams include Mule Deer, Coyote, Bobcat, Mountain Lion, and Gray Fox.

***Photograph 38** (left). Grandview-Park Drain showing Raccoon and bird tracks in the Riverine habitat (27 May 2004). **Photograph 39** (middle). Stewart Canyon Creek Reach 1 showing the root wads under which a Steelhead was observed (6 December 2004). **Photograph 40** (right). Stewart Canyon Creek showing a Mallard foraging in the stream channel.*

ADJACENT LAND USES

River systems are inextricably linked to the processes that shape and maintain their watersheds. Salmonid habitats within river systems are products of the geology, soils topography, vegetation, climate, and hydrology of a watershed (Meehan 1991). Natural events and land-use activities within a watershed can dramatically affect a river system and its biota. Though not as impressive in scale as major flooding events or other natural processes, land-use activities that result in incremental degradation of river system environments are much more prevalent. Land-use activities have the potential for greater cumulative impacts to fish habitat function and quality by changing streambank and channel morphology, altering streamflow and hydrologic function, altering water temperature, degrading water quality, blocking access to spawning areas, decreasing watershed water retention, and the introduction of competitive nonnative fish species. (CDFG 1996.)

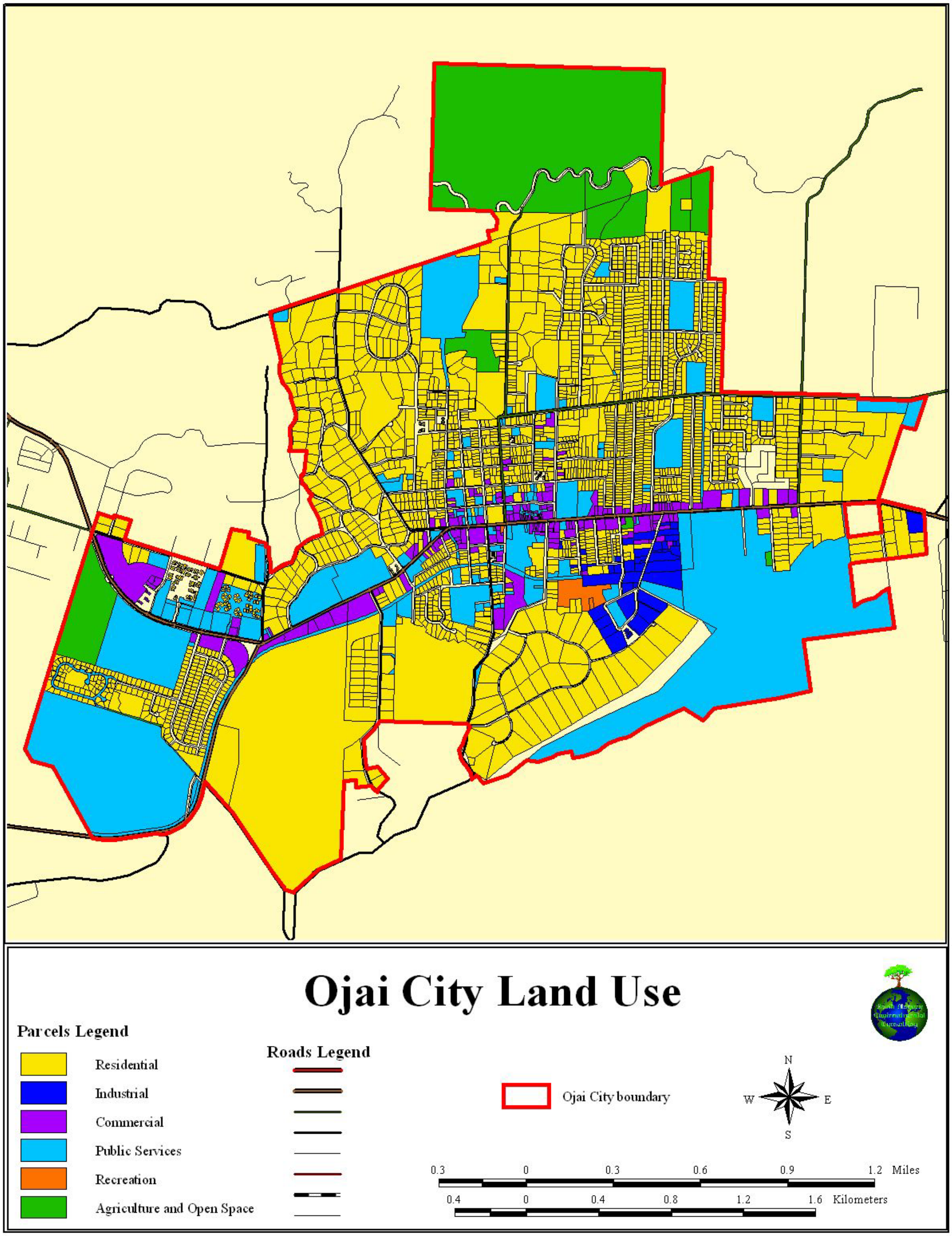
The City of Ojai, occupying an area of 4.5 square miles, is the smallest and slowest growing City in Ventura County. Current land use in the city is predominately residential, but a significant amount of land is reserved for parks and open space. Numerous urban, rural, and private roads cross the streams and creeks at various points. A small commercial area straddles the main road through town, and a 30-acre section of town is occupied by light industry. A zoning map of the City is included, representing current and ultimate planned land use (Figure 14, Map of Current and Planned Land Use).

All of the stream corridors subject to this study are within the jurisdiction of the Ventura County Watershed Protection District (VCWPD), formerly known as the Ventura County Flood Control District. The VCWPD maintains sections of Stewart and Fox Canyons that are concrete lined, but is committed to preserving the natural state of the reaches downstream of these structures. Though the flood carrying capacity of San Antonio Creek is preserved by VCWPD, all maintenance activities are performed in accordance with CDFG regulations.

Land use in the region is primarily open space, agriculture, and urban. Nearly half the coastal watershed (mainly upper elevation areas) is within the boundaries of the Los Padres National Forest. This land is off limits to timber harvesting, but open for recreational use and fuel hazard management. The Forest Service conducts regular monitoring and maintenance of its trail and road system in these watersheds, and is currently reestablishing an old fuel break on Nordhoff Ridge. Higher elevations are usually inhabited by native chaparral with areas of oak woodland, exotic grasses, and riparian woodland corridors. In the foothills many areas have been converted to exotic grass rangeland and avocado and citrus orchards.

Land use activities have decreased aquatic habitat quality throughout the City of Ojai. Most of the stream courses that pass through the City have been slightly to significantly altered, including undergrounding in long pipes and culverts. Many of the drainages flow through small urban residential properties with landowners causing (many unknowingly) direct and indirect adverse impacts to stream habitat and water quality. Many land uses immediately adjacent to “natural” drainages adversely impact stream habitats and water quality, such as placing horse corrals immediately adjacent to a stream. *Escherichia coli* (*E. coli*) bacteria contaminate surface waters and downstream aquatic habitats from surface runoff from such small corrals where buffers and filtering mechanisms are lacking. Numerous such conditions occur throughout the City’s drainages.

Figure 14. Map of Current and Planned Land Uses



***Photograph 41** (left). View of horse corral next to creek channel.*
***Photograph 42** (right). View of horse urine and manure within 25 feet of creek.*

***Photograph 43** (left). Lower open portion of Stewart Canyon Creek flood channel.*
***Photograph 44** (middle). Fire-fighting activities that damaged aquatic habitats on San Antonio Creek.*
***Photograph 45** (right). Example of undersized culvert for driveway entrance.*

Recognizing that such land use activities are a national concern, the EPA administers the National Pollutant Discharge Elimination System (NPDES) permit program to control water pollution by regulating point sources that discharge pollutants into waters of the United States. The City of Ojai participates in the local application of this effort through the Ventura Countywide Stormwater Quality Management Program, a countywide effort to identify, monitor, and mitigate land use practices that are potentially harmful to water quality. As part of this program, a number of specific activities and enterprises have been identified as particular concerns for water quality. The activities monitored in this program and deemed to have the most significant impact on water quality in Ojai are:

- Construction Sites – potential source for sediment and construction material waste;
- Corporate Yards – potential source for many pollutants related to the vehicle fleet and storage and handling of chemicals, waste, construction, and other materials;
- Roadways – potential source for automobile related pollutants and miscellaneous solid waste;
- Food Services – potential source of pollutants from solid waste and clean-up wastewater;
- Horse Boarding – potential source of pollution from manure and bedding materials; and
- Industrial Facilities – potential source for manufacturing process waste.

Illicit discharges from a variety of sources are also a concern of the program.

Location, Quantification, and Assessment of Specific Land-Use Activities of Concern

Specific land uses have a higher probability of producing polluted runoff unless specific containment measures are implemented onsite. The land uses that are of particular concern include: construction sites, corporate storage yards, roadways, automobile service businesses, food service businesses, livestock boarding, particularly horses in Ojai, and industrial businesses. Each of these land uses are discussed briefly below.

Construction Sites. New construction is a relatively insignificant activity in the City of Ojai, though the number of vacant lots would indicate that new construction would continue for some time. Figure 15, Map of Vacant Lots in Ojai, shows the location of the 145 vacant lots totaling approximately 161 acres as of September 2004. These parcels represent areas of potential construction activities. More common than new construction is remodeling and landscape alterations. These activities are all temporary in nature but need to be carefully managed to be certain that they do not contribute to water quality degradation.

Corporate Yards. There are a number of locations operated by public entities in and around the City of Ojai that are used for the purpose of parking and servicing a fleet of vehicles. Several are also used for storage and handling of chemicals and other materials that are potential pollutants. Their location is shown on Figure 16, Map of Restaurants, Automotive Facilities, and Corparate Yards. Because of the potential for pollution from a fairly wide variety of sources, corporate yards are one of the focal areas of the countywide stormwater program. Appropriate Best Management Practices (BMPs) have been designed for these yards to prevent pollutants from escaping the premises. Most of the yards implement these BMPs, though compliance is voluntary for certain government entities.

Auto Services. There are 18 auto service facilities, which include service stations, repair shops, new and used car dealers, and car wash facilities. Potential pollutants cover a wide range of automotive related chemicals and materials, including fuel, oil, solvents, cleaning solutions, and solids such as brake dust. The location of most of these facilities is shown on Figure 16.

Food Services. In general, the most troublesome food service facilities are outdoor seating operations because of the tendency for trash and leftover food to be blown or washed into the drainage system if precautions are not taken to minimize this occurrence. Another potential problem is the risk of pollution from wastewater from cleaning operations (such as mopping and outdoor spray cleaning of patios and mats). Greater Ojai has over 40 restaurants and other food service facilities. Those that have been visited as part of the stormwater management program are shown on Figure 16.

Industrial Facilities. Ojai does not have a large number of industrial or manufacturing facilities. Sites that are zoned for manufacturing are indicated on Figure 16.

Horse Boarding. The Ojai Valley has long been a popular place to enjoy horseback riding and other equestrian activities. Many horse owners keep their horses on their own property, while others have their horses boarded at commercial facilities. While horse manure is much less toxic than other pet wastes such as feces from dogs and cats, it is nevertheless a source of coliform bacteria, one of the pollutants found in our stream sampling tests. The presence of coliforms is widely recognized as an indicator of water quality in natural streams.

Figure 15. Map of Vacant Lots in Ojai

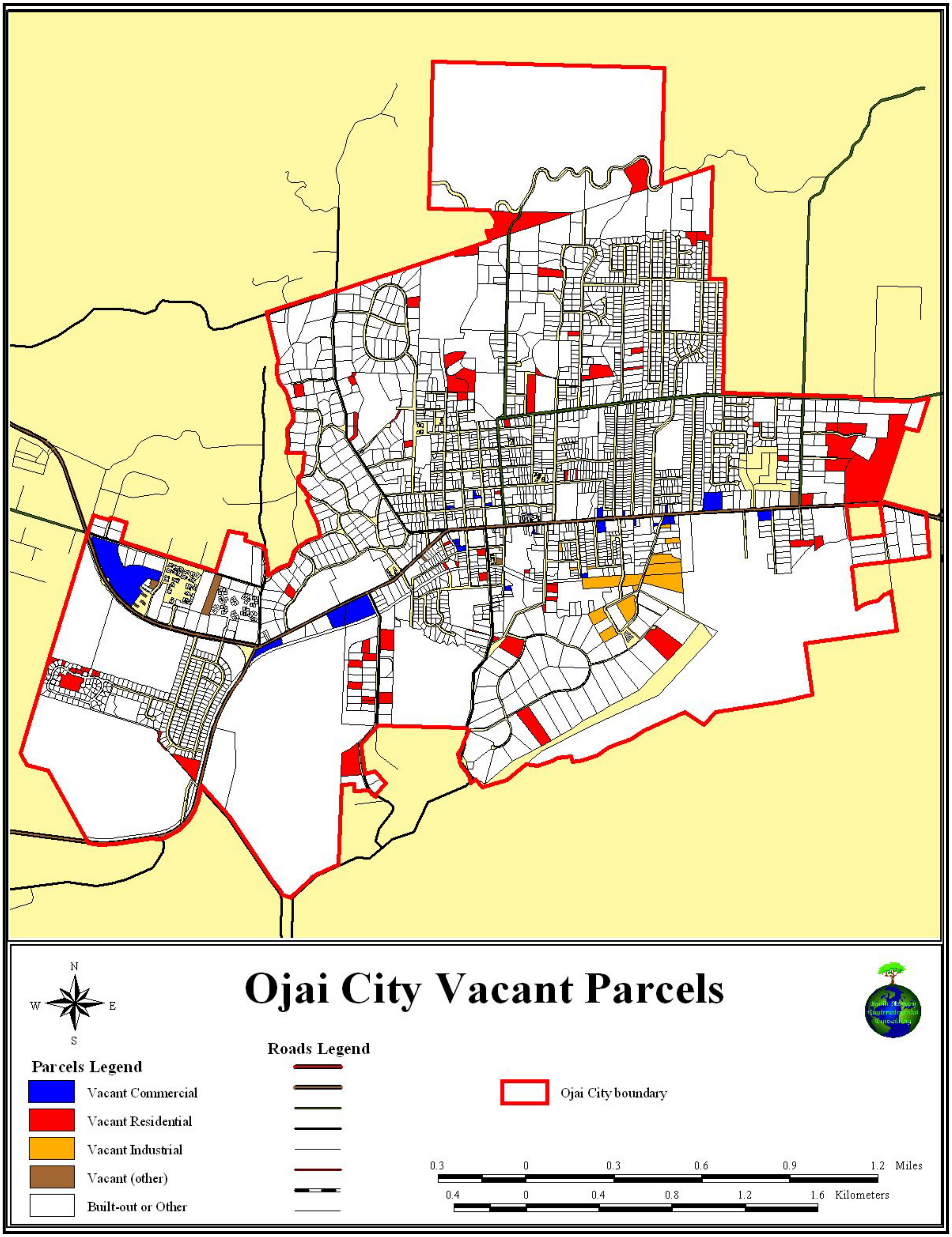
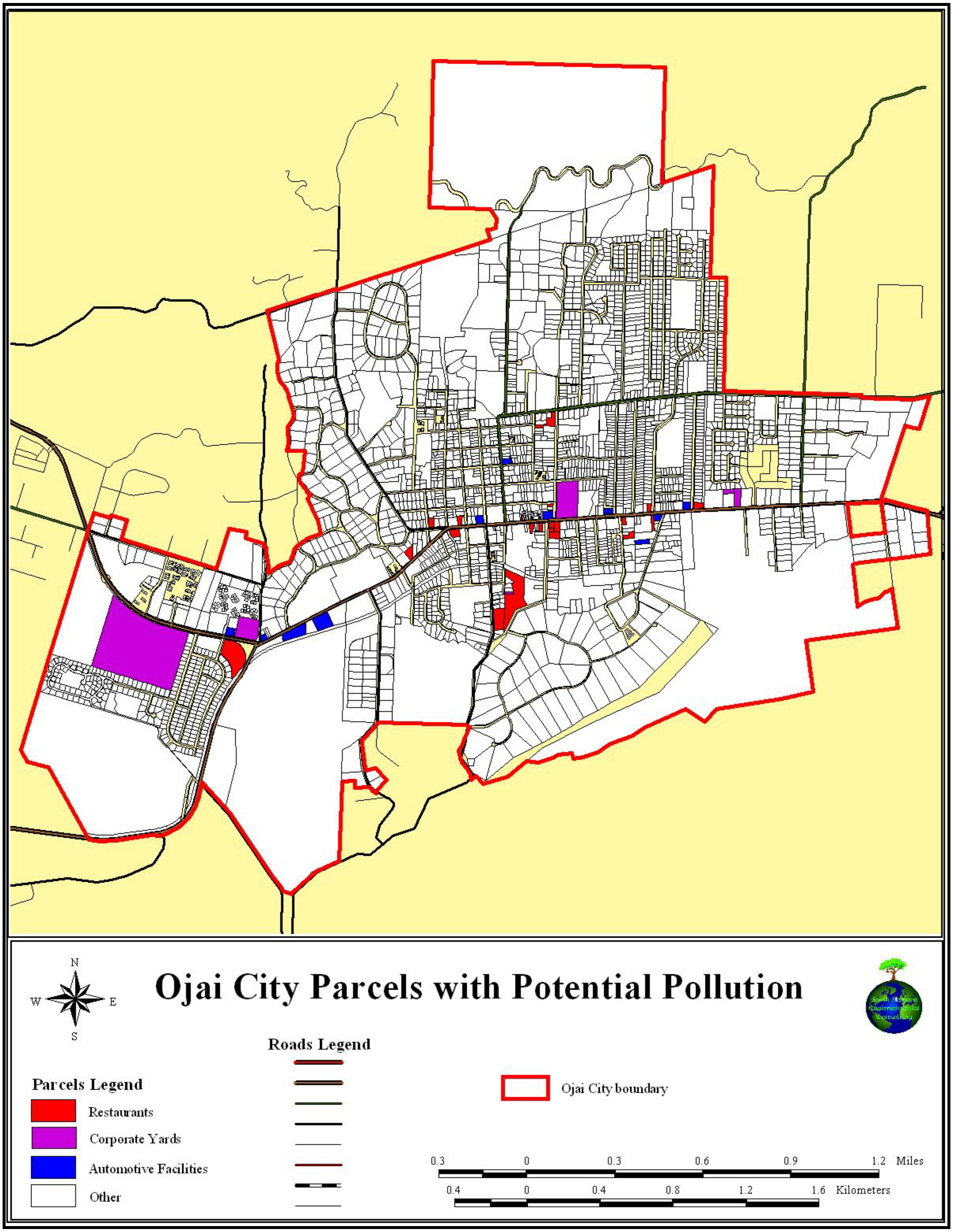


Figure 16. Map of Restaurants, Automotive Facilities, and Corporate Yards



Because individual horse boarding on private land does not require a permit, it was not possible to easily or efficiently locate these parcels on a map or to quantify the number of horses boarded in and around Ojai. However, neighborhoods in Ojai with larger parcels are where horse corals are located within the City, and are generally lacking on parcels less than 1 acre in size. Those neighborhoods in Ojai that are known to contain corals for one or more horses include: Arbolada, Del Oro, north Foothill Road, N. Montgomery, Persimmon Hill, and Gridley Road.

Roadways. There are approximately 35 miles of paved roads in the city, covering 253 acres or 9% of the surface area of the city. The city conducts regular street cleaning activities and has an active catch basin labeling program. A map of Ojai city streets is included as Figure 17, Map of Ojai Roads, illustrating the intensity with which the City is crisscrossed by roads, which are impervious surfaces that serve as vectors for pollutants from vehicles (petroleum hydrocarbons, etc.) and adjacent land uses that then enter the City's drainage system.

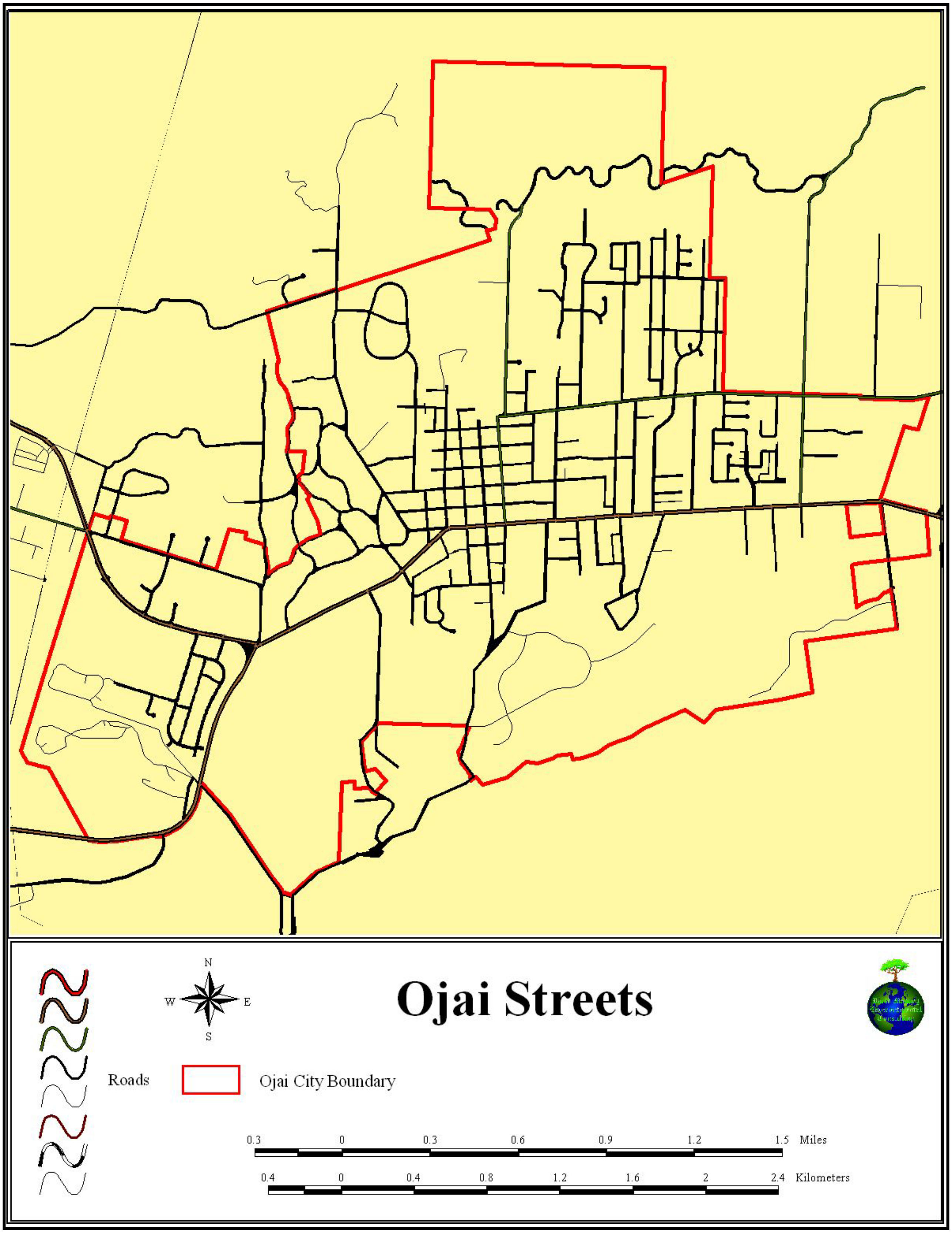
IMPERVIOUS COVER

The conversion of farmland, forests, wetlands, and meadows to rooftops, roads, and parking lots creates a layer of impervious surface in the urban landscape. Impervious cover is a very useful indicator with which to measure the impacts of land development on aquatic systems. The process of urbanization has a profound influence on the hydrology, morphology, water quality, and ecology of surface waters.

Recent research has shown that streams in urban watersheds possess a fundamentally different character than streams in forested, rural, or even agricultural watersheds. The amount of impervious cover in the watershed can be used as an indicator to predict how severe these differences can be. In many regions of the country, as little as 10% watershed impervious cover has been linked to stream degradation, with the degradation becoming more severe as impervious cover increases. (Schueler 1994.)

Impervious cover directly influences urban streams by dramatically increasing surface runoff during storm events. Depending on the degree of impervious cover, the annual volume of stormwater runoff can increase many times its predevelopment rate, with proportional reductions in groundwater recharge. In natural settings, very little annual rainfall is converted to runoff and about half is infiltrated into the underlying soils and the water table. This water is filtered by the soils, supplies deepwater aquifers, and helps support adjacent surface waters with clean water during dry periods. In urbanized areas, less and less annual rainfall is infiltrated, and more and more volume is converted to runoff. Not only is this runoff volume greater, it also occurs more frequently and at higher magnitudes. As a result, less water is available to streams and waterways during dry periods, and more surface flow occurs during storms.

Figure 17. Map of Ojai Roads



Other key changes in urban streams due to increases in impervious cover levels include:

- **Channel enlargement.** The customary response by an urban stream is to increase its cross-sectional area to accommodate the higher flows. Channel enlargement is done by streambed down-cutting, stream bank widening, or a combination of both. Urban stream channels often enlarge their cross-sectional area by a factor of two to five, depending on the degree of impervious cover and the age of development in the upland watershed.
- **Stream channels are highly modified by human activity.** Urban stream channels are extensively modified in an effort to protect adjacent property from streambank erosion or flooding. Headwater streams are frequently enclosed within storm drains, while others are channelized, lined, and or "armored" by heavy stone (riprap).
- **Upstream channel erosion contributes greater sediment load to the stream.** The high rate of channel erosion in urban streams, coupled with sediment erosion from active construction sites, increases sediment discharge to urban streams. Urban streams also tend to have a higher sediment discharge than non-urban streams during the active channel enlargement stage.
- **Dry weather flow in the stream declines.** Since impervious cover prevents rainfall from infiltrating into the soil, less flow is available to recharge groundwater. Consequently, during extended periods without rainfall, baseflow levels are often reduced in urban streams.
- **Instream habitat structure degrades.** Urban streams are routinely scored as having poor instream habitat quality, regardless of the specific method employed. Habitat degradation is often exemplified by a loss of pool and riffle structure, embedding of streambed sediments, shallow depths of flow, eroding and unstable banks, and frequent streambed turnover.
- **Large woody debris is reduced (LWD).** Large woody debris is an important structural component of many streams systems, creating complex habitat structure and generally making the stream less susceptible to erosion. In urban streams, the quantity of LWD found in stream channel declines sharply, due to the loss of riparian forest cover, storm washout, and channel maintenance practices.
- **Stream crossings and potential fish barriers increase.** Many forms of urban development are linear in nature (e.g. roads, sewers, and pipelines) and cross-stream channels. The number of stream crossings increases directly in proportion to impervious cover, and many crossings can become partial or total barriers to upstream fish migration, particularly if the streambed erodes below the fixed elevation of a culvert or a pipeline.
- **Riparian forests become fragmented, narrower, and less diverse.** The important role that riparian forests play in stream ecology is often diminished in urban watersheds, as tree cover is often partially or totally removed along the stream as a consequence of development. Even when stream buffers are reserved, encroachment often reduces their effective width, and native species are supplanted by exotic trees, vines, and ground covers.
- **Water quality declines.** The water quality of urban streams during storm events is consistently poor. Urban stormwater runoff often contains moderate to high concentrations of sediment, carbon, nutrients, trace metals, hydrocarbons, chlorides, and bacteria. While considerable debate exists as to whether stormwater pollutant concentrations are actually toxic to aquatic organisms, researchers agree that pollutants deposited in the streambed exert an undesirable impact on the stream community.

- **Summer stream temperatures increase.** The impervious surfaces, ponds, and poor riparian cover found in urban watersheds can increase mean summer stream temperatures. Since temperature plays a central role in the rate and timing of biotic and abiotic reactions in streams, even moderate increases can have an adverse impact on streams. In some regions, summer stream warming can irreversibly shift a cold-water stream to a cool-water or even warm-water stream, with harmful effects on salmonids and other temperature sensitive organisms.
- **Reduced aquatic diversity.** Urban streams are typified by fair to poor fish and macro invertebrate diversity, even at relatively low levels of watershed impervious cover or population density. The ability to restore pre-development fish assemblages or aquatic diversity is constrained by a host of factors: irreversible changes in carbon supply, temperature, hydrology, lack of instream habitat structure, and barriers that limit natural recolonization. As the level of impervious cover in the watershed increases, the amount of sensitive species declines. (Note: This subsection adapted from "Basic Concepts in Watershed Planning" *in The Practice of Watershed Protection* 2000.)

Quantifying Impervious Cover

An estimation of the percent impervious cover for the watersheds draining to the streams covered in this report is based on a number of sources, including aerial photography, site-use information from the County Assessor's office, and zoning classification from the City's planning office. In addition, to approximate the relationship between land use and impervious cover, reference is made to a recent study conducted in the suburban areas of the Chesapeake Bay (Cappiella and Brown 2001). That study developed the relationship between land use and percent impervious cover as described below in Table 24, Land Use/Impervious Cover Relationships for Suburban Areas of Chesapeake Bay, where IC = impervious cover.

Table 24. Land Use/Impervious Cover Relationships for Suburban Areas of Chesapeake Bay

Land Use Category	Mean IC	Land Use Category	Mean IC
Agriculture	1.9	Institutional	34.4
Open Urban Land	8.6	Light Industry	53.4
2 Acre Lot Residential	10.6	Commercial	72.2
1 Acre Lot Residential	14.3	Churches	39.9
1/2 Acre Lot Residential	21.2	Schools	30.3
1/4 Acre Lot Residential	27.8	Municipals	35.4
1/8 Acre Lot Residential	32.6	Golf Courses	5
Townhome Residential	40.9	Cemeteries	8.3
Multifamily Residential	44.4	Parks	12.5

It is important to note that this method of analysis is only approximate. There are many assumptions that prohibit impervious cover analysis from being a definitive assessment of land use impact on stream quality. For example, runoff from impervious areas that are directly connected to the city drainage system (i.e. roads) has a much greater impact than runoff from impervious areas that must pass over lawns (i.e. most rooftop drainage) or other non-impervious surfaces prior to entering the drainage system. That said, impervious cover analysis serves as a useful indicator of watershed conditions and provides a general frame of reference within which a more detailed analysis may be warranted.

Classifying Urban Stream Quality Potential

This subsection provides the results of the land impervious cover analysis and the instream impervious cover assessment for the Ojai Valley portion of the San Antonio Creek Watershed.

Land Impervious Cover

A general system of classifying stream quality, based on percent impervious cover of the watershed, has been proposed by the Center for Watershed Protection (Schueler, 1994). This stream quality classification divides urban streams into three management categories based on the general relationship between impervious cover and stream quality, and they include the following:

1. **Sensitive Streams (1% to 10% impervious cover).** The resource objective and management strategies in each stream category differ to reflect the potential stream quality that can be achieved. The most protective category is Sensitive Streams in which strict zoning, site impervious restrictions, stream buffers, and stormwater practices are applied to maintain predevelopment stream quality.
2. **Impacted Streams (11% to 25% impervious cover).** Impacted Streams are above the threshold and can be expected to experience some degradation after development (i.e. less stable channels and some loss of diversity). The key resource objective for these streams is to mitigate these impacts to the greatest extent possible, using effective stormwater management practices.
3. **Non-Supporting Streams (26% to 100% impervious cover).** The last category, Non-Supporting Streams, recognizes that predevelopment channel stability and biodiversity cannot be fully maintained, even when stormwater practices or retrofits are fully applied. The primary resource objective shifts to protect downstream water quality by removing urban pollutants. Efforts to protect or restore biological diversity in degraded streams are not abandoned; in some priority subwatersheds, intensive stream restoration techniques are employed to attempt to partially restore some aspects of stream quality. In other subwatersheds, however, new development (and impervious cover) is encouraged to protect other sensitive or impacted streams.

Based on the analysis and classification system described above, the results are presented in Table 25, Results of Impervious Cover Analysis for the Ojai Valley Watershed (below), and in Figure 18, Map of Impervious Cover Levels for the Ojai Valley Subwatersheds.

Table 25. Results of Land Impervious Cover Analysis for the Ojai Valley Watershed

Subwatershed Name	Area (acres)	Hectares	% Impervious Cover	Rating
Happy Valley Drain	725.1	293.5	21.8	Impacted
Villanova Creek	308.8	125.0	21.5	Impacted
Del Norte Creek	417.8	169.1	15.5	Impacted
Lower San Antonio Creek	121.5	31.2	6.7	Sensitive
Stewart Canyon Creek	1816.0	734.9	10.0	Sensitive
Fox Canyon Creek	1042.2	421.8	26.4	Impacted
Ayers Creek	1195.8	483.3	10.2	Impacted
Black Mountain West	238.3	96.4	2.8	Sensitive
Black Mountain	361.2	146.2	2.6	Sensitive
Lower Thacher Creek	1185.2	479.6	6.9	Sensitive
Ladera Ranch	1508.5	610.5	7.4	Sensitive
Gridley Canyon Creek	2848.3	1152.7	2.2	Sensitive

Instream Impervious Cover

Impervious cover has a direct and indirect affect on the earth and its drainage systems. Some natural surfaces are naturally impervious, such as bedrock. Other natural substrates may be relatively impervious to water percolation downwards. Unnatural surfaces are the primary source of impervious cover in the Ojai Valley and City of Ojai. The amount of impervious cover in a watershed is a strong indicator of a watershed's ability to maintain and support high quality aquatic habitats and water quality. Degradation of aquatic habitats and water quality, which are often closely related, directly and indirectly adversely affects aquatic life, such as Southern Steelhead Trout.

Watersheds with as little as 20% impervious cover cannot support high quality aquatic habitats. Or, stated another way, watersheds that have as little as 20% of their surface covered by impervious materials are so degraded and polluted that most aquatic life cannot survive. Only the hardiest species can tolerate such conditions (see Figure 18 above).

Figure 19, Map of Ojai City Streams Imperviousness, shows the impervious, compacted, and natural portions of all creeks within the Ojai City limits. Table 26, Impervious Cover Lengths Summary for Creeks within the City of Ojai, and Table 27, Percent Impervious Cover Summary for Creeks within the City of Ojai, present the results of the impervious cover assessment conducted within the sixteen (16) creeks of the City of Ojai during the streams characterization assessment. Table 26 includes the creek distances for natural, impervious, and compacted surfaces. Table 27 provides the creek percentages for natural, impervious, and compacted surfaces.

Figure 18. Map of Impervious Cover Levels for the Ojai Valley Subwatersheds

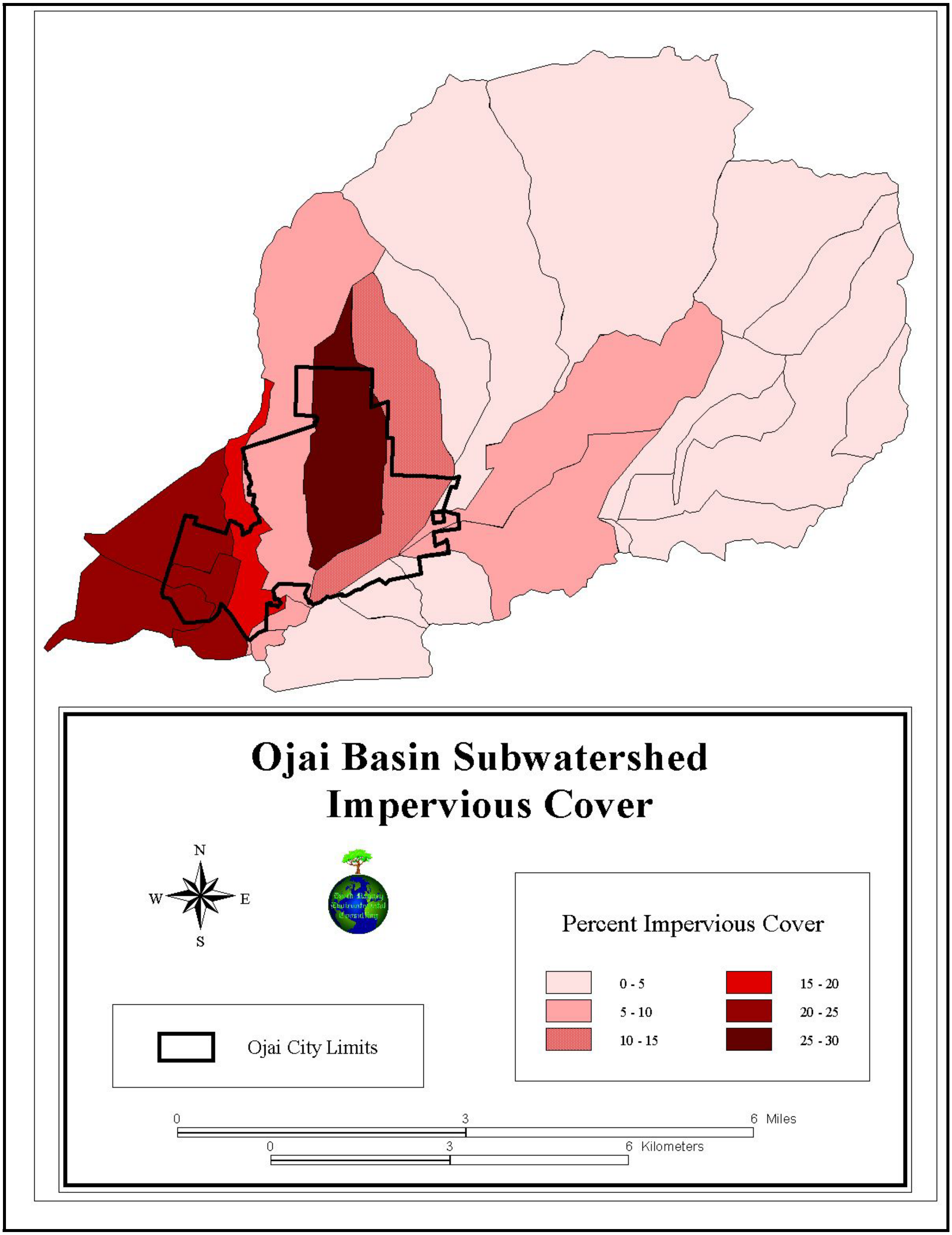


Table 26. Impervious Cover Lengths Summary for Creeks within the City of Ojai

Creek Name	**Creek Lengths (feet)**			
	Total Length	***Natural***	***Impervious***	***Compacted***
Arbolada Creek	5,759	5,533	225	0
Ayers Creek	10,197	1,022	5,511	3,664
Del Norte Creek	7,928	321	1,349	6,257
East End Creek	339	339	0	0
Fox Canyon Barranca	17,426	8,188	6,620	2,617
Grandview-Park Drain	4,160	0	4,161	0
Nordhoff Drainage	837	837	0	0
Oak Creek	1,720	1,720	0	0
Ojai Creek	8,018	2,681	4,227	1,110
Post Office Creek	1,036	1,036	0	0
San Antonio Creek	12,096	12,096	0	0
Soule Park Creek	1,561	1,561	0	0
West Soule Park Creek	1,305	1,305	0	0
Stewart Canyon Creek	9,003	4,062	4,941	0
Thacher Creek	2,445	2,445	0	0
Villanova Creek	3,078	1,701	50	1,327
Total Length	**86,905**	**44,847**	**27,083**	**14,975**

Table 27. Percent Impervious Cover Summary for Creeks within the City of Ojai

Creek Name	**Percent of Creek**		
	Natural	***Impervious***	***Compacted***
Arbolada Creek	96.1	3.9	0.0
Ayers Creek	10.0	54.0	35.9
Del Norte Creek	4.1	17.0	78.9
East End Creek	100.0	0.0	0.0
Fox Canyon Barranca	47.0	38.0	15.0
Grandview-Park Drain	0.0	100.0	0.0
Nordhoff Drainage	100.0	0.0	0.0
Oak Creek	100.0	0.0	0.0
Ojai Creek	33.4	52.7	13.8
Post Office Creek	100.0	0.0	0.0
San Antonio Creek	100.0	0.0	0.0
Soule Park Creek	100.0	0.0	0.0
West Soule Park Creek	100.0	0.0	0.0
Stewart Canyon Creek	45.1	54.9	0.0
Thacher Creek	100.0	0.0	0.0
Villanova Creek	55.3	1.6	43.1
Results:	**51.6** of the length of all Ojai Creeks consist of natural channel	**31.2** of the length of all Ojai Creeks consist of impervious channel	**17.2** of the length of all Ojai Creeks consist of compacted channel

Of the 16 creeks flowing through the City of Ojai, 51 distinct primary reaches were delineated. Table 28, Summary of Stream Reach Imperviousness for Creeks of the City of Ojai, indicates which creek reaches are above or below ground, and shows the general substrate, imperviousness, and length of each creek reach included in the Ojai city limits.

Table 28. Summary of Stream Reach Imperviousness for Creeks of the City of Ojai

Creek Name	Reach	Above or Below Ground	Most common Substrate	Imperviousness	Length (ft.)	Tributary Drains Into Reach
Arbolada Creek	1	Above	Natural	Natural	987.2	
	2	Below	Concrete pipe	Impervious	225.3	
	3	Above	Natural	Natural	4,546.0	
Ayers Creek	1	Above	Natural	Natural	228.8	
	2	Below	Culvert/pipe	Impervious	4,076.4	
	3	Above	Mixed compacted	Impervious	2,786.1	
	4	Above	Natural	Natural	511.3	
Tributary A	1	Above	Mixed compacted	Compacted	520.9	2
Tributary B	1	Above	Soil compacted	Compacted	2,073.0	3
Del Norte Creek	1	Above	Mixed compacted	Compacted	5,355.6	
	2	Above	Mixed compacted/natural	Compacted	1,034.8	
	3	Below	High-density polyethylene pipe	Impervious	898.9	
	4	Above	Natural	Natural	158.9	
Tributary A	1	Above	Lawn	Compacted	444.8	1
Tributary B	1	Above	Natural	Natural	34.8	1
East End Creek	1	Above	Natural	Natural	339.1	
Fox Canyon Barranca	1	Above	Natural	Natural	2,810.0	
	2	Above	Concrete channel	Impervious	3,407.4	
	3	Below	Concrete	Impervious	3,212.3	
	4	Above	Natural	Natural	4,540.6	
Tributary A	1	Above	Natural/mixed compacted	Compacted	2,470.7	3
Tributary B	1	Above	Natural	Natural	984.6	3
Grandview-Park Drain	1	Below	Reinforced concrete pipe	Impervious	1,180.1	
	2	Above	Concrete channel	Impervious	2,980.4	
Nordhoff Drain	1	Above	Natural	Natural	837.1	
Oak Creek	1	Above	Natural	Natural	1,719.7	
Ojai Creek	1	Above	Natural	Natural	1,955.2	
	2	Below	Reinforced concrete pipe	Impervious	813.0	
	3	Above	Mixed compacted	Compacted	786.4	
	4	Below	Pipe	Impervious	1,067.5	
	5	Above	Masonry channel	Impervious	1,668.4	
Tributary A	1	Above	Mixed compacted	Compacted	323.6	4
Tributary B	1	Below	Corrugated metal pipe	Impervious	204.4	4
	2	Above	Gutter	Impervious	474.0	4
	3	Above	Natural soil	Natural	562.3	4
Tributary A of Tributary B	1	Above	Natural soil	Natural	163.1	4

Table 28. Summary of Stream Reach Imperviousness for Creeks of City of Ojai (continued)

Creek Name	Reach	Above or Below Ground	Most common Substrate	Imperviousness	Length (ft.)	Tributary Drains Into Reach
Post Office Creek	1	Above	Natural	Natural	1,035.8	
San Antonio Creek	1	Above	Natural	Natural	1,226.7	
	2	Above	Natural	Natural	5,554.3	
	3	Above	Natural	Natural	5,314.5	
Soule Park Creek	1	Above	Natural	Natural	1,560.7	
West Soule Park Creek	1	Above	Natural	Natural	1,304.6	
Stewart Canyon Creek	1	Above	Natural	Natural	3,091.8	
	2	Above	Concrete channel	Impervious	718.7	
	3	Below	RCB	Impervious	2,554.4	
	4	Above	Cement channel	Impervious	1,468.1	
	5	Above	Natural	Natural	970.0	
Thacher Creek	1	Above	Natural	Natural	2,445.1	
Villanova Creek[19]	2	Above	Natural	Natural	816.1	
	3	Above	Compacted soil	Compacted	1,410.0	
Tributary B	1	Above	Natural	Natural	851.8	2

***Photograph 46** (left). Stewart Canyon Creek showing example of natural surface (5 January 2005).*
***Photograph 47** (right). Watershed drainage to Villanova Creek showing example of compacted surface (8 January 2005).*

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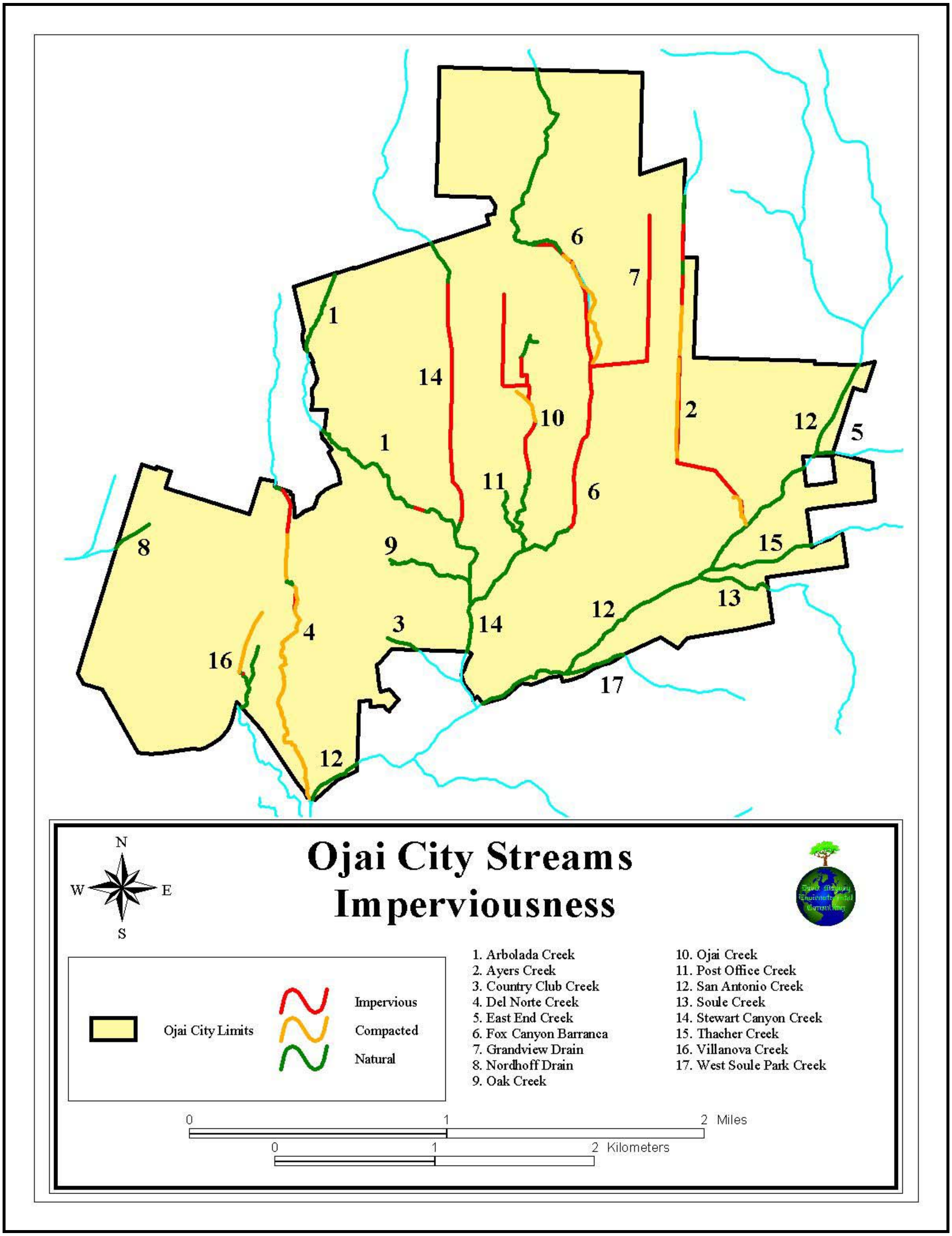
[19] Villanova Creek Reach 1 and Tributary A are not listed here, since they are both outside of the City limits.

Figure 19. Map of Ojai City Streams Imperviousness



Photograph 48. *Stewart Canyon Creek showing example of impervious surface (28 January 2005).*

BARRIERS/FACTORS CAUSING HABITAT DEGRADATION

Fish barriers are stream modifications and factors causing impact on fisheries resources and habitat degradation by:

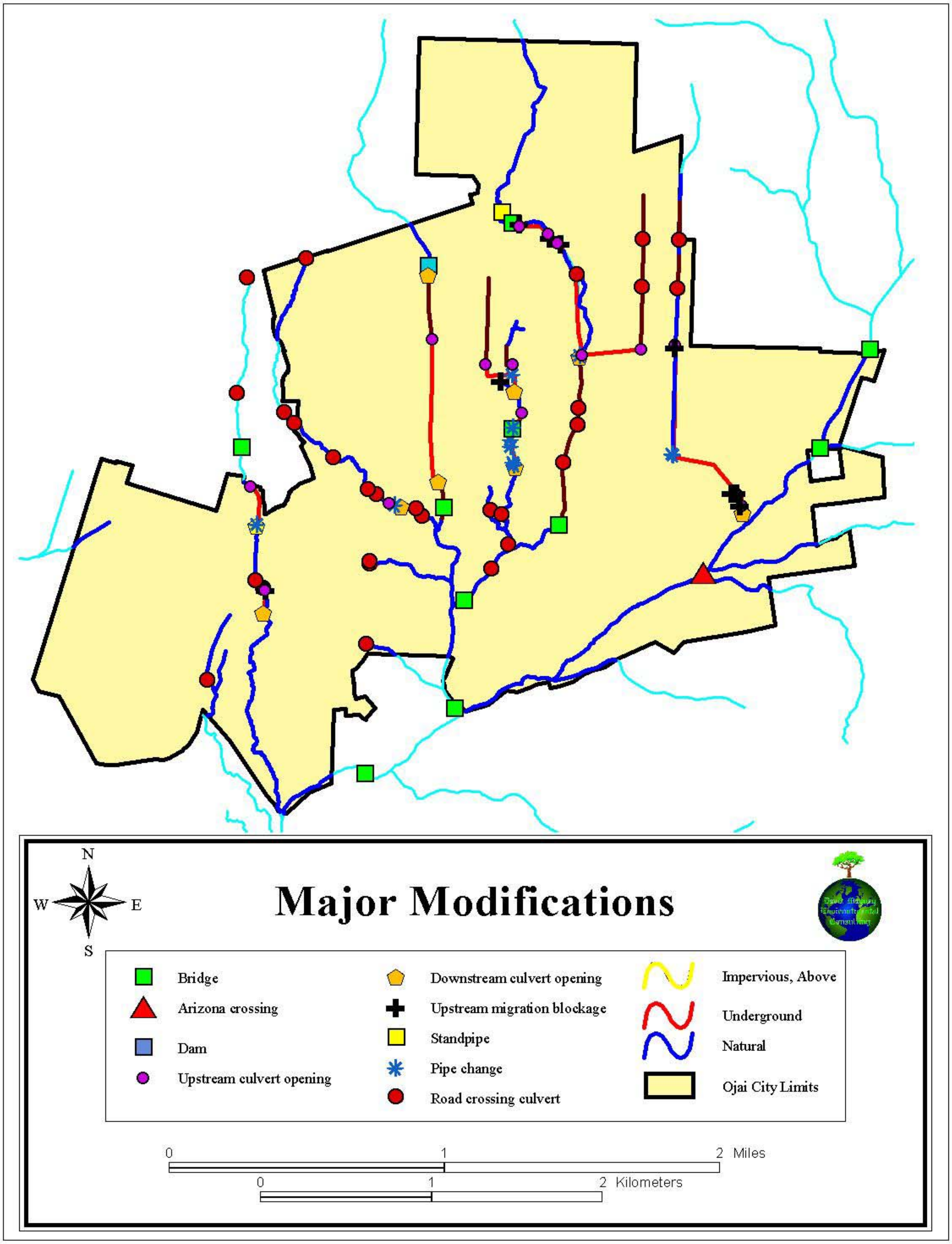
- Reducing the magnitude and duration of peak discharges;
- Reducing the duration and magnitude of between-storm-flows;
- Increasing the extent and duration of desiccation of stream sections; and
- Blocking or inhibiting the passage of adult Steelhead to historically important spawning and rearing habitat in the river's major tributaries. (Moore 1980b.)

Adult Steelhead can maintain a speed of 6.0 feet per second (ft/sec.) for 30 minutes and a burst speed of 10.0 ft/sec. for 5 seconds until they reach exhaustion. The maximum jump speed is stated as 12 ft/sec. and the depth of a pool below an obstruction that requires a jump should be 1.25 times greater than the jump height of the structure from the surface of the water (McEwan 2001, Abramson and Grimmer 2005). Modifications that create conditions that exceed these thresholds are considered barriers or limiting factors to Steelhead that cause habitat degradation.

San Antonio Creek Watershed Modifications

Significant barriers to Steelhead exist on all streams (except San Antonio Creek and Thacher Creek) flowing through Ojai. The major San Antonio Creek Watershed modifications include the barriers to fish passage and factors that cause habitat degradation and inhibit Steelhead spawning and rearing activities. Significant barriers to Steelhead exist on most streams flowing through Ojai, including stream channelization and impervious surfaces, undergrounded streams for significant lengths, road crossings (bridges and culverts), and other steep drops into streams associated with these crossings/channelizations. Figure 20, Major Modifications to the Streams of Ojai, maps out all public service infrastructure modifications, including channelizations, bridges, road-crossing and non-road culverts, pipe diameter changes, upstream migration blockages, and dams.

Figure 20. Major Modifications to the Streams of Ojai



***Photograph 49** (left)**.** Stewart Canyon Debris Basin empty during spring and summer months (27 May 2004).*
***Photograph 50** (right). Stewart Canyon Debris Basin filled after winter storm event (9 January 2005).*

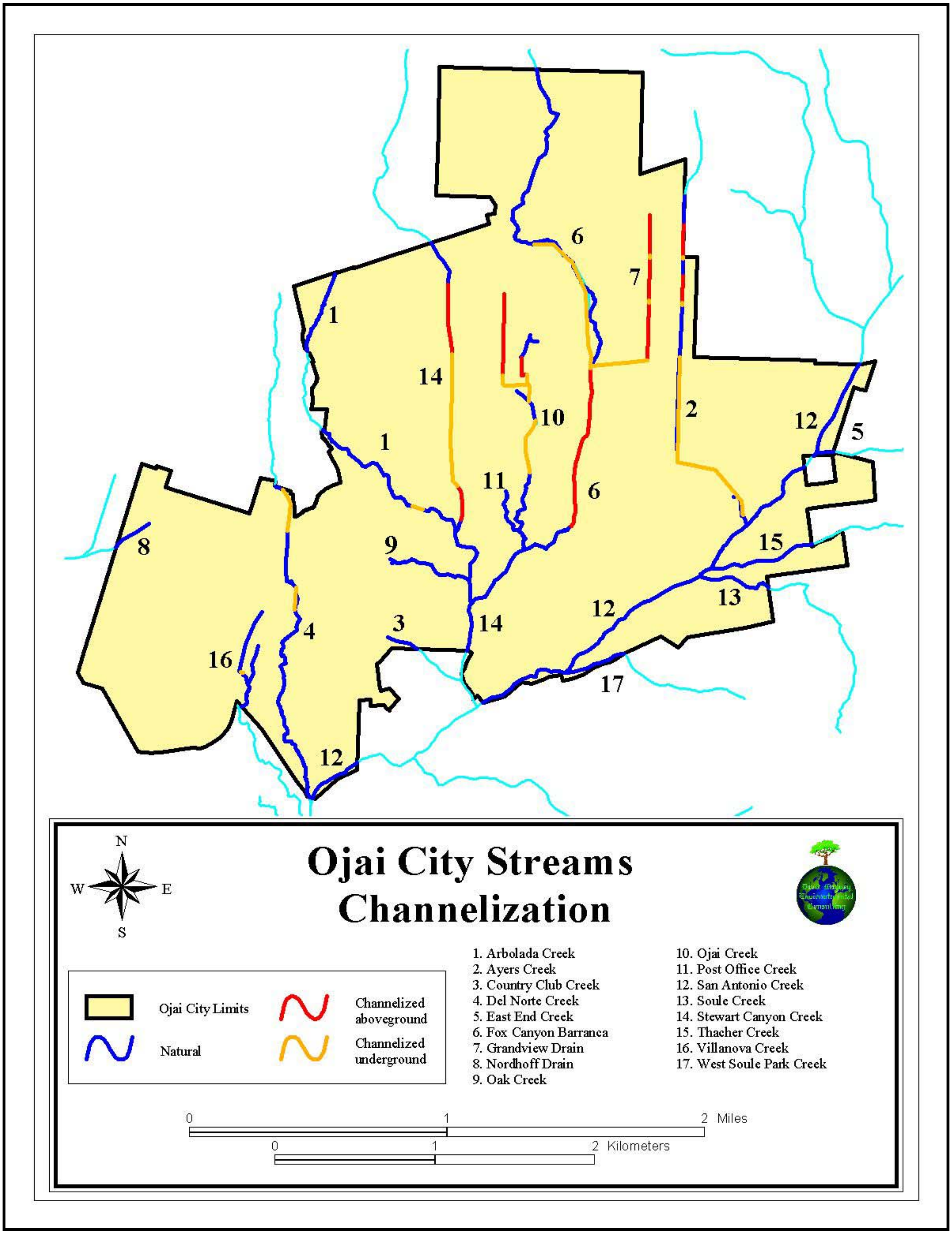
***Photograph 51** (left). San Antonio Creek Arizona Crossing at Soule Park Golf Course creating a major barrier to Steelhead (16 July 2004). **Photograph 52** (right). San Antonio Creek Arizona Crossing at Soule Park Golf Course was washed out and buried by sediment during significant winter storm (8 February 2005).*

Channelized Streams

Several creeks that flow through the City of Ojai are significantly channelized. Channelized creeks are defined here as modified channels that are now impervious, but are still above ground. Typically, these types of channels are modified into cement box channels that are designed to convey floodwaters. For example, Fox Canyon Barranca is channelized for most of its length through the City. This extensive channelized reach is approximately 3,407 feet long, consisting of vertical and flat concrete walls and bottom. Such a long stretch of channelization creates an effective barrier to fish passage and migration when a low-flow channel and channel roughness are lacking. The channelized portions of Fox Canyon Barranca and Stewart Canyon Creek both have smooth concrete bottoms. The following are creeks with significant channelization within the City (Figure 21, Ojai City Streams Aboveground and Underground Channelization):

Creek Name	Channelized (feet)
Fox Canyon Barranca	3,407
Grandview-Park Drain	2,892
Ojai Creek	2,142
Ayers Creek	1,350
Stewart Canyon Creek	719
Total:	**10,510**

Figure 21. Ojai City Streams Aboveground and Underground Channelization



***Photograph 53** (left). Stewart Canyon Creek showing aboveground flood control concrete channel (27 May 2004).*
***Photograph 54** (right). Fox Canyon Barranca showing meander pattern in concrete channel (9 January 2005).*

Undergrounded Streams

Several major Ojai creek runs have been directed underground as flood control channels due to development and urbanization. Examples of significant undergrounding include the following (Figure 21 above, and Figure 22, Map of Ojai City Non-road Culverts, below):

- Ayers Creek includes two primary undergrounded continuous runs (1,960 feet and 2,140 feet) from the pumping plant to Grandview;
- Del Norte Creek includes an 800-foot undergrounded run at the cemetery;
- Fox Canyon Barranca is undergrounded for 3,210 feet from Grandview up stream;
- Ojai Creek is undergrounded for 1,240 feet from Libbey Park to Aliso Drive, and for 1,070 feet from the Eucalyptus/Lyon intersection to the Grand/Signal intersection; and
- Stewart Canyon Creek includes an underground run for 2,750 feet from Highway 150 upstream.

Fish are not likely to migrate up Ayers, Del Norte, Fox Canyon, and Ojai Creeks since these creeks do not lead to a permanent source of water upstream; however, Stewart Canyon Creek leads to a permanent water source upstream where fish would potentially be able to live year round. Table 29, Undergrounded Streams Summary for Creeks within the City of Ojai, provides the lengths and percentages of above and below ground portions of all Ojai creeks.

***Photograph 55** (left). Undergrounding of Ojai Creek (27 May 2004). **Photograph 56** (right).*
Undergrounding of Stewart Canyon Creek by a flood control channel and box culvert (8 January 2005).

Figure 22. Map of Ojai City Non-road Culverts

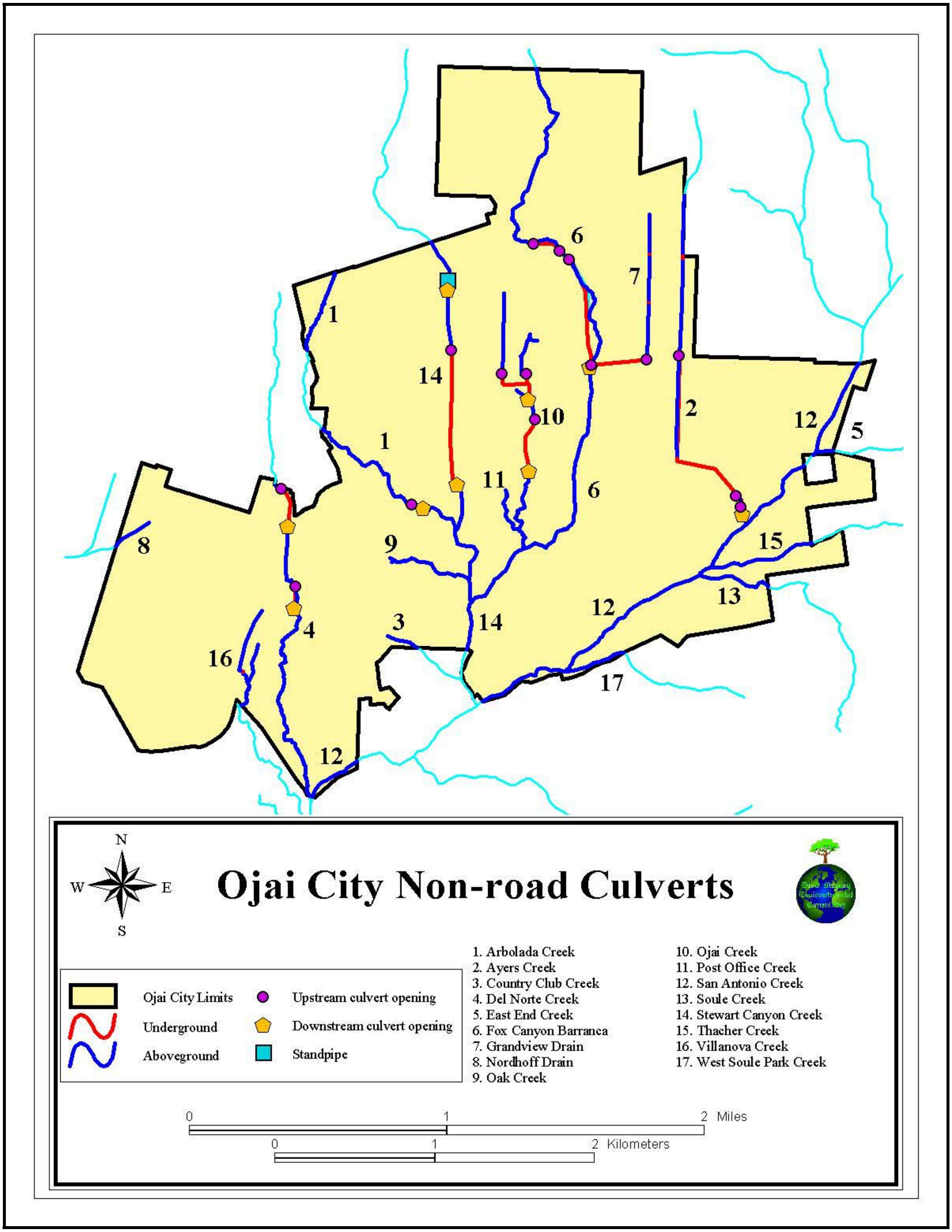
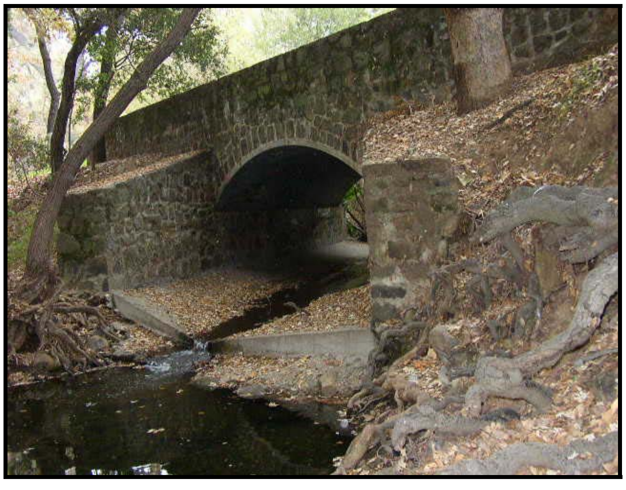


Table 29. Undergrounded Streams Summary for Creeks within the City of Ojai

Creek Name	*Total Length (in feet)*	*Above Ground*		*Below Ground*	
		Length (feet)	*Percent*	*Length (feet)*	*Percent*
Arbolada Creek	5,759	5,533	96.1	225	3.9
Ayers Creek	10,197	6,036	59.2	4,160	40.8
Del Norte Creek	7,928	6,579	83.0	1,349	17.0
East End Creek	339	340	100.0	0	0.0
Fox Canyon Barranca	17,426	14,213	81.6	3,212	18.4
Grandview-Park Drain	4,160	2,892	69.5	1,269	30.5
Nordhoff Drainage	837	837	100.0	0	0.0
Oak Creek	1,720	1,720	100.0	0	0.0
Ojai Creek	8,018	5,933	74.0	2,085	26.0
Post Office Creek	1,036	1,036	100.0	0	0.0
San Antonio Creek	12,096	12,096	100.0	0	0.0
Soule Park Creek	1,561	1,561	100.0	0	0.0
West Soule Park Creek	1,305	1,305	100.0	0	0.0
Stewart Canyon Creek	9,003	6,248	69.4	2,755	30.6
Thacher Creek	2,445	2,445	100.0	0	0.0
Villanova Creek	3,078	3,028	98.4	50	1.6
Results	**86,905**	**71,800**	**82.6** of the length of all Ojai Creeks	**15,105**	**17.4** of the length of all Ojai Creeks

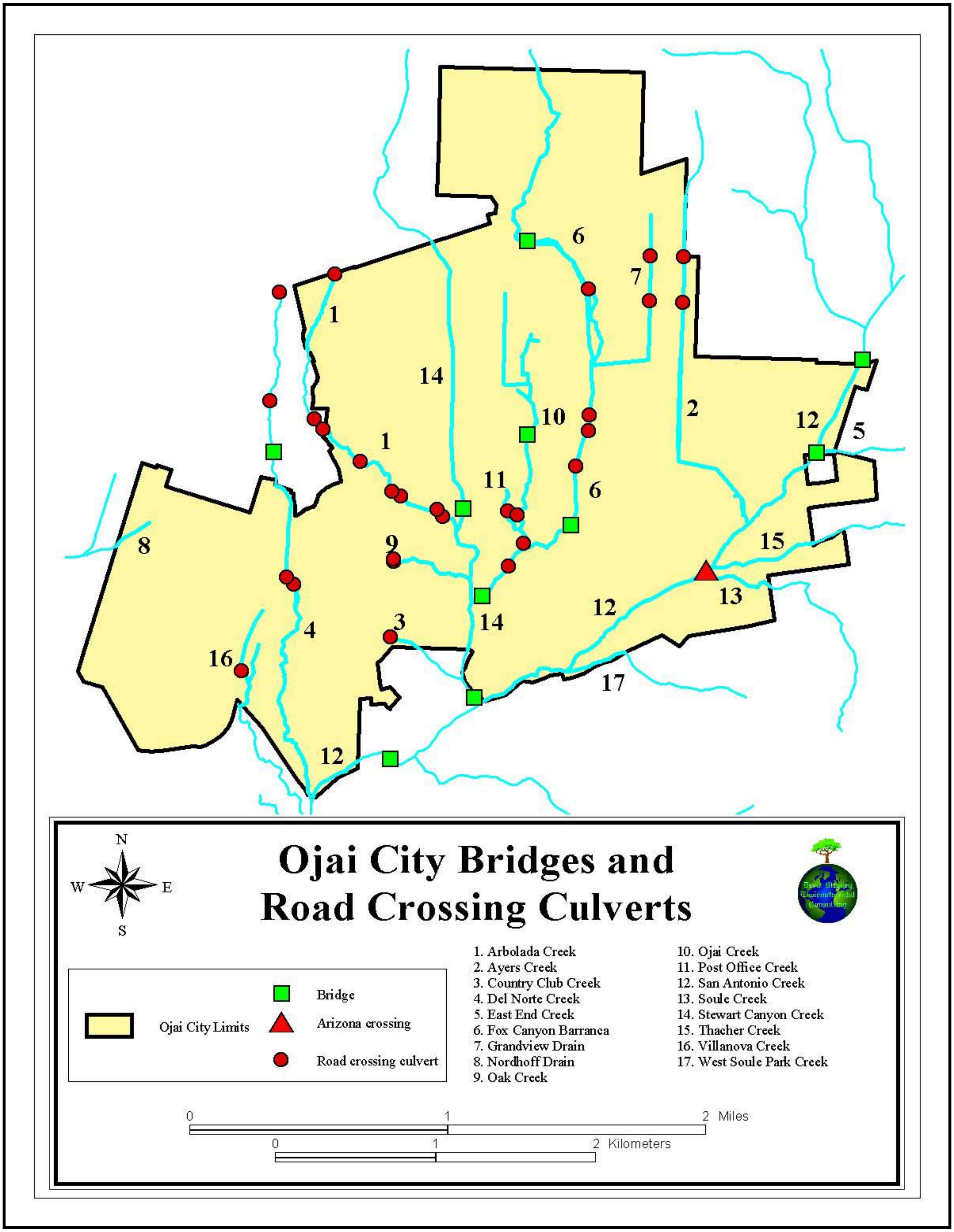
Bridges, Culverts, and Other Barriers

Based on the 1996 Existing Storm Drain System Drawing for the City of Ojai, the creeks within the City limits include six major bridge crossings with a mean length of approximately 93.33 feet and a total of approximately 560 feet of bridge crossings. Figure 23, Map of Ojai City Bridges and Road Crossing Culverts, shows the bridge locations in the City.



***Photograph 57** (left). Fox Canyon Barranca bridge with box culvert above N. Montgomery St. (27 May 2004).*
***Photograph 58** (right). Fox Canyon Barranca bridge with cement floor at North Ventura St. (27 November 2004).*

Figure 23. Map of Ojai City Bridges and Road Crossing Culverts



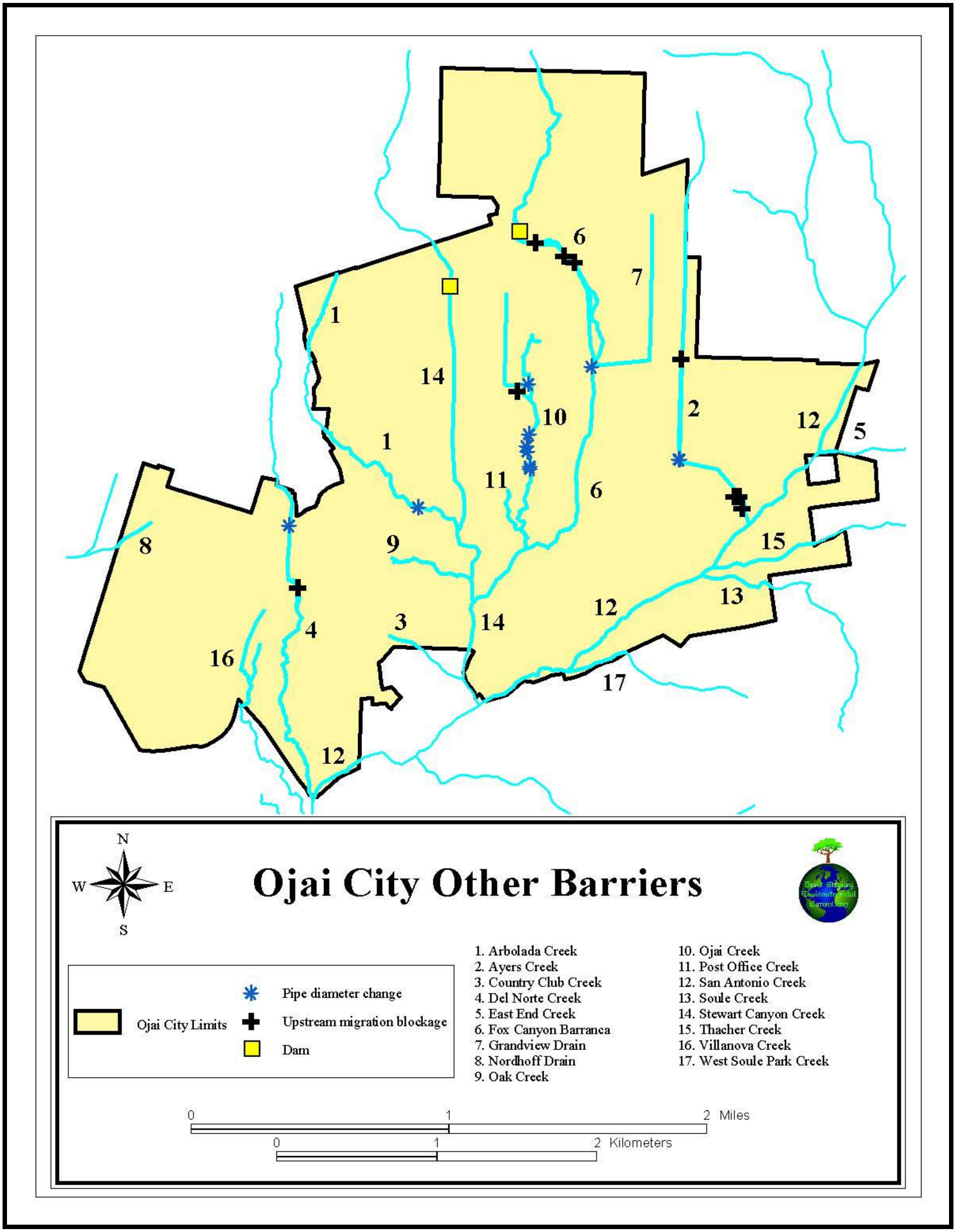
Based on the 1996 Existing Storm Drain System Drawing for the City of Ojai, the creeks within the City limits include 41 culvert crossings. Twenty-seven (27) of those culverts are road crossings with a mean length of 77.4 feet and totaling 14,440 feet of road crossing culverts (see Appendix C, Summary Table of Creek Obstructions). The remaining 14 culverts are underground runs with a mean length of 1,031.4 feet and a total of approximately 14,440 feet. Figure 22, Map of Ojai City Non-road Culverts, and Figure 23, Map of Ojai City Bridges and Road Crossing Culverts, show all culverts within the City.

Photograph 59 *(left). Fox Canyon Barranca underground intake (non-road) culvert, view downstream (27 May 2004).*
Photograph 60 *(right). Grandview-Park Drain road culvert (27 May 04).*

Some other barriers found throughout the City of Ojai include pipe diameter changes, upstream mitigation blockages, the Fox Canyon Barranca Debris Dam (Photograph 61), and Stewart Canyon Creek Debris Basin Standpipe (Photograph 62). These barriers are shown below in Figure 24, Map of Other Barriers in the City of Ojai.

Photograph 61 *(left). Fox Canyon Barranca Debris Dam (27 May 2004).*
Photograph 62 *(right). Stewart Canyon Creek Debris Basin Standpipe (27 May 2004).*

Figure 24. Map of Other Barriers in the City of Ojai



SUMMARY OF OJAI CREEK CONDITIONS

This subsection summarizes all creeks that low through the City of Ojai. All water quality and stream characterization results are pulled together here to provide conclusive determinations on the status and condition of the Ojai Basin streams. Table 30, Summary of Favorable Conditions for Determining Spawning and Rearing Potential in the Ojai Creeks, is presented below as a quick reference to the findings of this study. This subsection also provides a brief summary and description for each creek in the Ojai City limits.

Arbolada Creek

Arbolada Creek is in the northwestern portion of the City limits and is a tributary to Stewart Canyon Creek. Its confluence with Stewart Canyon Creek is located south of SR 150 and immediately south of the Ojai Bike Path, between South Blanche and San Antonio Streets. Arbolada Creek crosses SR 150 (moving upstream) and flows parallel to Bristol Street and then Palomar Street. Arbolada Creek includes three primary reaches. Reach 1 is above ground with natural substrate and includes a total length of 987 feet within the City limits. Reach 2 is below ground by an impervious concrete pipe for a distance of 225 feet. Reach 3 is above ground with mostly natural substrate for a total length of 4,546 feet.

Arbolada Creek Reach 3 includes two water quality sampling stations (Stations 9 and 16): Station 9 is located at the lower end of Arbolada Creek, near the intersection of Ojai Avenue and Bristol Street. Water quality at Station 9 is moderately low in that the average measurements for temperature, dissolved oxygen, turbidity, and presence of coliform were not favorable to fish or other aquatic organisms. However, Station 9 shows favorable average conductivity, *p*H, and salinity measurements. Station 16, in Arbolada Creek Reach 3, is located just north of 509 Palomar Road and is just outside the city limits of Ojai, but still provides valuable information (see Figure 5). Station 16 tests shows favorable water conditions for average temperature and *p*H measurements; however, it does not show favorable conditions for the remaining vital parameters including conductivity, dissolved oxygen, turbidity, salinity, and coliform bacteria.

Arbolada Creek includes a moderate level of instream cover (1 to 4 types reported throughout the creek). It is no longer inhabited by functional riparian plant communities, but the vegetation does provide moderate shading (predominantly introduced and ornamental plant species). When flows are present in this intermittent and partially ephemeral stream during the winter and spring months, water velocity is favorable and appropriate spawning and rearing substrates are present in Reach 1 and 3.

Due to poor water quality results and the lack of riparian vegetation, the creek generally does not support suitable Steelhead habitat.

Table 30. Summary of Favorable Conditions for Determining Spawning and Rearing Potential in the Ojai Creeks

Creek Name	Reach No.	Morphology: Reach is 95-100% Natural?	No. of Instream Cover Types in Natural Portions of Creek	Satisfactory Riparian Habitat?	Riparian Canopy Shading in Natural Portions of Creek 76% to 90%?	Months Flows Present	Favorable Water Velocity when Flows are Present?	Spawning/ Rearing Substrate Present?	Potential Spawning/ Rearing Habitat Present?
Arbolada	**1**	Yes	1-2	No	Yes	Jan, Feb, Mar, Oct, Nov, Dec	No	Yes	No
	2	No	2-3	No	No	Jan, Feb, Mar, Oct, Nov, Dec	No	No	No
	3	Yes	3-4	No	No	Jan, Feb, Mar, Oct, Nov, Dec	No	Yes	No
Ayers	**1**	No	5-6	No	No	Jan, Feb, Mar, Apr, Oct, Nov, Dec	No	No	No
	2	No	0	No	No	Jan, Oct, Dec	No	No	No
	3	No	1-2	No	No	Jan, Feb, Mar, Oct, Dec	No	No	No
	4	No	1-2	No	No	Jan, Feb, Mar, Oct, Dec	No	No	No
	A-1	No	0	No	No	Jan, Apr, Oct, Dec	No	No	No
	B-1	No	0	No	No	Jan, Oct, Dec	No	No	No
Del Norte	**1**	No	5-6	Yes	No	Jan, Feb, Apr, Sep, Oct, Nov, Dec	Yes	No	No
	2	No	3-4	Yes	No	Jan, Feb, Oct, Dec	Yes	No	No
	3	No	0	Yes	No	Jan, Feb, Oct, Dec	No	No	No
	4	No	3-4	Yes	Yes	Jan, Feb, Oct, Dec	No	Yes	No
	A-1	No	0	Yes	No	Jan, Feb, Oct, Dec	No	Yes	No
	B-1	No	1-2	Yes	No	Jan, Feb, Sep, Oct, Dec	No	Yes	No
East End	**1**	Yes	1-2	No	No	Jan, Oct, Dec	No	Yes	No
Fox Canyon	**1**	No	5-6	Yes	Yes	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	Yes	Yes	Yes
	2	No	0	Yes	No	Jan, Feb, Jun, Oct, Nov, Dec	Yes	No	No
	3	No	0	No	No	Jan, Feb, Oct, Dec	Yes	No	No
	4	No	1-2	Yes	No	Jan, Feb, Oct, Dec	No	Yes	No
	A-1	No	1-2	No	No	Jan, Oct, Nov, Dec	No	Yes	No
	B-1	No	1-2	No	Yes	Jan, Oct, Dec	No	Yes	No
Grandview-Park	**1**	No	1-2	No	No	Jan, Mar, Oct, Dec	No	No	No
	2	No	1-2	Yes	No	Jan, Mar, Oct, Dec	No	No	No
Nordhoff	**1**	Yes	1-2	No	No	Jan, Feb, Mar, Oct, Nov, Dec	No	No	No
Oak	**1**	Yes	1-2	No	Yes	Jan, Feb, Oct, Nov, Dec	No	Yes	No

Table 30. Summary of Favorable Conditions for Determining Spawning and Rearing Potential in the Ojai Creeks (continued)

Creek Name	Reach No.	Morphology: Reach is 95-100% Natural?	No. of Instream Cover Types in Natural Portions of Creek	Satisfactory Riparian Habitat?	Riparian Canopy Shading in Natural Portions of Creek 76% to 90%?	Months Flows Present	Favorable Water Velocity when Flows are Present?	Spawning/ Rearing Substrate Present?	Potential Spawning/ Rearing Habitat Present?
Ojai	**1**	No	5-6	Yes	Yes	Jan, Feb, Sep, Oct, Nov, Dec	No	Yes	Yes
	2	No	0	No	No	Jan, Feb, Oct, Nov, Dec	No	No	No
	3	No	1-2	No	Yes	Jan, Feb, Oct, Dec	No	No	No
	4	No	0	No	No	Jan, Feb, Oct, Dec	No	No	No
	5	No	0	No	No	Jan, Feb, Mar, Oct, Dec	No	No	No
	A-1	No	1-2	No	No	Jan, Oct, Dec	No	No	No
	B-1	No	0	No	No	Jan, Oct, Dec	No	No	No
	B-2	No	0	No	No	Jan, Oct, Dec	No	No	No
	B-3	No	0	No	No	Jan, Oct, Dec	No	No	No
	A of B-1	No	0	No	No	Jan, Oct, Dec	No	No	No
Post Office	**1**	Yes	3-4	No	Yes	Jan, Feb, Oct, Nov, Dec	No	Yes (lower portion)	Yes (lower portion only)
San Antonio	**1**	Yes	5-6	Yes	Yes	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	Yes	Yes	Yes
	2	Yes	5-6	Yes	Yes	Jan, Feb, Mar, Apr, May, Jun, Oct, Nov, Dec	Yes	Yes	Yes
	3	Yes	3-4	Yes	Yes	Jan, Feb, Oct, Nov, Dec	Yes	Yes	Yes
Soule Park	**1**	Yes	.	.	.	.	.	.	No
West Soule Park	**1**	Yes	.	.	.	.	.	.	No
Stewart Canyon	**1**	Yes	5-6	Yes	Yes	Year Round	Yes	Yes	Yes
	2	No	1-2	No	No	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	Yes	No	No
	3	No	0	No	No	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	Yes	No	No
	4	No	0	No	No	Jan, Feb, Mar, Dec	Yes	No	No
	5	Yes	5-6	Yes	Yes	Jan, Feb, Mar, Apr, May, Oct, Nov, Dec	Yes	Yes	Yes
Thacher	**1**	Yes	3-4	Yes	No	Jan, Feb	No	Yes	No
Villanova Note: Reach 1 is outside the City limits	**2**	No	1-2	Yes	Yes	Jan	No	Yes	No
	3	No	1-2	No	No	Jan	No	No	No
	B-1	No	1-2	No	No	Jan	No	No	No

***Photograph 63** (left). Arbolada Creek Reach 1 (7 December 2004).*
***Photograph 64** (right). Arbolada Creek Reach 2, view north (30 September 2004).*

Ayers Creek

Ayers Creek is in the northeastern portion of the City limits and is a tributary to San Antonio Creek. Its confluence with San Antonio Creek is located just upstream from the Thacher Creek confluence at the northeastern end of the Soule Park Golf Course. Ayers Creek moves northwest from San Antonio Creek (moving upstream) and crosses SR 150 at Shady Lane, and then runs parallel to Ayers Street.

Ayers Creek includes four primary reaches and two tributary reaches. Reach 1 is above ground with natural substrate for a distance of 229 feet within the City limits. Reach 2 is below ground by an impervious culvert/pipe for 4,076 feet. Reach 3 is above ground with a compacted impervious creek bottom for 2,786 feet. Reach 4 is also above ground, but has natural substrate for 511 feet. Ayers Creek Tributary A includes only one reach, which is above ground with a compacted channel bottom for 521 feet, and this tributary drains into Ayers Creek Reach 2. Ayers Creek Tributary B has one above ground reach with compacted soil for 2,073 feet, and this tributary drains into Ayers Creek Reach 3.

Ayers Creek Reach 1 includes one water quality sampling station (Station 11), which is located at the end of Fairway Lane and drains south to San Antonio Creek (Figure 5). Station 11 water sampling tests indicate that this portion of the creek is favorable for parameters such as temperature, dissolved oxygen, and *p*H; however, this creek's water tests do not show favorable conditions for parameters including turbidity, salinity, and coliform bacteria.

In general, the reaches of Ayers Creek are predominantly impervious and/or compacted. This creek includes minimal instream cover for aquatic vertebrates, it does not provide suitable riparian habitat, and consequently, it generally has insufficient shading (percent canopy shading less than 76%). Flows are present in Reach 1 for at least seven months out of year making this an intermittent reach; however, the remaining ephemeral reaches only have rain event surface flows three to five months out of the year.

Although flows may be present during the appropriate time of the year for Steelhead, and although water quality is satisfactory for Steelhead, water velocity, spawning and rearing substrate, instream cover, riparian vegetation, and shading are all lacking from the reaches of this creek. Therefore, no reaches of Ayers Creek were determined to have suitable spawning or rearing habitat for Steelhead.

Photograph 65 *(left). Ayers Creek (27 May 2004).*

Photograph 66 *(right). Ayers Creek (3 January 2005).*

Del Norte Creek

Del Norte Creek is in the western half of the City limits and is a tributary to San Antonio Creek. Its confluence with San Antonio Creek is located just a short distance upstream of the San Antonio Creek crossing at the Hermosa Road bridge. Del Norte Creek's path moves directly north (moving upstream) on the east side of Hermosa Road and crosses SR 150 at the 33/150 "Y-intersection". Del Norte Creek then continues north along Del Norte Road.

Del Norte Creek consists of four reaches and two tributary reaches. Reach 1 is above ground with a mixed compacted substrate for 5,355 feet within the City limits. Reach 2 is also above ground with mixed compacted and natural substrate for 1,034 feet. Reach 3 is below ground by an impervious plastic pipe (High-density polyethylene pipe [HDPE]) for 899 feet. Reach 4 is above ground with a natural channel bottom for a distance of 159 feet. Del Norte Creek Tributary A is one above-ground reach consisting of compacted lawn for 445 feet, and this tributary drains into Del Norte Creek Reach 1. Tributary B is also one above-ground reach consisting of natural substrate for a distance of 35 feet, and this tributary drains into Del Norte Creek Reach 1.

Del Norte Creek has two water quality sampling stations. Reach 1 includes Station 18, and Reach 2 includes Station 17. Station 18 is located at the lower end of Del Norte Creek near Hermosa Road, just upstream of San Antonio Creek (see Figure 5). Station 18 water testing results show favorable water conditions for parameters including temperature, *p*H, and salinity; however, this reach of creek does not test favorably for conductivity, dissolved oxygen, turbidity, and coliform bacteria. Station 17 of Del Norte Creek Reach 2, is located north of the intersection of Ojai Avenue and Del Norte Street (Figure 5). Station 17 water testing shows favorable conditions for temperature, dissolved oxygen, turbidity, and *p*H, and indicates unfavorable conditions for conductivity, and coliform bacteria.

Most Del Norte Creek reaches have compacted surfaces (approximately 75% compacted), while only a small percentage (4%) is natural. Instream cover varies from several cover types in Reach 1 to three or four in Reaches 2 and 4, to less than two in Reaches 3, A-1, and B-1. All reaches of Del Norte Creek are occupied by satisfactory riparian habitat (predominantly native functional plant communities); however, only Reach 4 provides sufficient shading (percent canopy shading in the natural portions of the creek reach is at least 76%). Flows are present in Del Norte Creek Reach 1 for at least seven months out of the year making this an intermittent reach. The remaining ephemeral reaches only have rain event surface flows for approximately four months out of the year. Water velocities are generally unfavorable for Steelhead in most reaches, and suitable spawning and rearing substrate exist in Reaches 4, A-1, and B-1. In general, no reaches of Del Norte Creek were determined to have potentially suitable Steelhead habitat

Photograph 67 *(left). Del Norte Creek view north.* ***Photograph 68*** *(right). Del Norte Creek view south.*
Photos taken 19 August 2004.

East End Creek

East End Creek is a tributary to San Antonio Creek. East End Creek enters the City from the east on the north side of SR 150, where SR 150 and Boardman Road intersect. East End Creek flows west until its confluence with San Antonio Creek.

East End Creek consists of one above ground, natural reach for a distance of 339 feet within the City limits. Although this creek has all natural channel morphology, this creek flows through orchards and is occupied by segmented patches of riparian vegetation, including Arroyo Willow and Mulefat. No water quality sampling was conducted in this creek. East End Creek has minimal instream cover and minimal shading. Flows are only present in this ephemeral channel during the winter months, and velocity is unfavorable when flows are present. East End Creek does contain some suitable spawning and rearing substrate; however, due to generally unfavorable conditions, East End Creek is not determined to be suitable Steelhead habitat.

Fox Canyon Barranca

Fox Canyon Barranca is located more or less in the middle of the City limits, and its path moves downstream in south/southwesterly direction. Fox Canyon Barranca has one main tributary, which is Ojai Creek. Fox Canyon Barranca is a tributary to Stewart Canyon Creek, and its confluence with Stewart Canyon Creek is located south of the intersection of South Ventura Street and South Montgomery Street. Moving upstream, Fox Canyon Barranca goes north from Stewart Canyon Creek, running northeast and along Fox Street. Fox Canyon Barranca crosses SR 150 between Fox Street and Bald Street, and heads straight north to Grand Avenue. North of Grand Avenue, it flows generally from the north-northwest.

Fox Canyon Barranca includes four reaches and two tributaries. Reach 1 is above ground with natural pervious substrate for a distance of 2,810 feet within the City limits. Reach 2 is also above ground, but consists of an impervious concrete channel for 3,407 feet. Reach 3 is undergrounded by an impervious, concrete channel for a length of 3,212 feet. Reach 4 is a natural, above ground channel for 4,541 feet. Fox Canyon Barranca Tributary A is one above ground reach with a mixed natural and compacted channel for a distance of 2,471. Tributary A drains into Fox Canyon Barranca Reach 3. Fox Canyon Barranca Tributary B is also one above ground reach with a natural channel bottom for 985 feet, and this tributary drains into Fox Canyon Barranca Reach 3. Fox Canyon Barranca Reach 1 includes three water quality stations (Stations 8 and 14) (see Figure 5):

- Station 8 is located upstream of the creek confluence near the intersection of Ventura Street and South Montgomery-Buckboard Lane bridge at Montgomery. Station 8 water testing indicates favorable water quality conditions for parameters including temperature, *p*H, and salinity, but does not indicate favorable conditions for conductivity, dissolved oxygen, turbidity, and coliform bacteria.
- Station 14 is located at the south end of Fox Street under a walking bridge on the Athletics Club facility premises. Station 14 shows favorable average measurements for parameters including conductivity, temperature, dissolved oxygen, and *p*H. Station 14 does not show favorable measurements for turbidity, salinity, and coliform bacteria.

Fox Canyon Barranca has only approximately 45% natural morphology. Reach 1 is a perennial channel that includes several instream cover types, Reach 2 is an intermittent channel with no instream cover, and the remaining ephemeral reaches contain minimal instream cover. Only Reaches 1, 2, and 4 are still inhabited by satisfactory riparian plant communities, and shading is only adequate in Reach 1 and B-1. Water flows for nine out of 12 months in Reach 1 of Fox Canyon Barranca, and flows less than half a year in the rest of the reaches. Water velocity is only favorable in Reach 1, 2, and 3, while required substrate materials are present only in Reach 4, A-1, and B-1.

Reach 1 and 4 of Fox Canyon Barranca are determined to contain potential spawning and rearing habitat for Steelhead, based predominantly on good water quality and favorable riparian habitat, shading, and substrate; however, spawning and rearing are precluded by significant migration barriers (debris dam, long flat-bottomed concrete channel, and significant reaches mostly underground).

Photograph 69 *(left). Fox Canyon Barranca Reach 1 above S. Ventura St. bridge (27 November 2004).*
Photograph 70 *(right). Fox Canyon Barranca Reach 4 above N. Montgomery St. (27 May 2004).*

Grandview-Park Drain

Grandview-Park Drain a tributary to Fox Canyon Barranca. Grandview-Park Drain starts just northeast of the end of Park Road. It continues south, crossing Pleasant Avenue and Mountain View Avenue. Grandview-Park Drain is undergrounded at Grand Avenue, and then heads west until it empties into the underground Reach 3 of Fox Canyon Barranca.

Grandview-Park Drain consists of two reaches. Reach 1 is below ground by an impervious reinforced concrete pipe (RCP) for a distance of 1,180 feet within the City limits. Reach 2 is an aboveground, impervious, concrete channel for a length of 2,980 feet. No water quality sampling was conducted in this creek. Grandview-Park Drain is an ephemeral drainage that is completely channelized with no natural surfaces. Instream cover, riparian habitat, and shading are all minimal. During the four months that water was present (January, March, October, and December), water velocity was slow and spawning and rearing substrate material is absent. Grandview-Park Drain does not contain potential spawning or rearing habitat for Steelhead.

***Photograph** 71 (left). Grandview-Park Drain above housing tract.*
***Photograph** 72 (right). Grandview-Park Drain near Topa Topa Elementary School. Photos taken 27 May 2004.*

Nordhoff Drain

Nordhoff Drain is in the westernmost portion of the City limits, and is a tributary to Happy Valley Drain. Nordhoff Drain's confluence with Happy Valley Drain is located just south of Basant Road in the southwest corner of the Ojai Meadows Preserve. Moving upstream, Nordhoff Drain moves northeast across the Meadow and crosses State Route 33 midway between Church and Cuyama Roads, and then dissipates.

Nordhoff Drain consists of only one above ground reach with an all-natural substrate channel bottom for a length of approximately 837 feet within the City limits. No water quality sampling was conducted in this creek. Although this creek is an intermittent natural channel, it contains minimal instream cover and unsatisfactory riparian habitat and shading. Water flows six of the twelve months; however, when water is present, flow velocity is low and spawning and rearing substrate is absent. Since Nordhoff Drain does not contain satisfactory conditions for any of the vital parameters studied, this creek does not contain potential spawning and rearing habitat for Steelhead.

Photograph 73. *Confluence of Happy Valley Drain (veering to the left) and Nordhoff Drain (veering to the right), view northeast (15 January 2005).*

Oak Creek

Oak Creek is a tributary to Stewart Canyon Creek. Oak Creek starts as Freshwater Marsh habitat southwest of the junction of the Ojai Bike Path and Country Club Drive. It flows east under Country Club Drive, crossing San Antonio Street, and continues southeast to its confluence with Stewart Canyon Creek.

Oak Creek consists of one reach for a distance of 1,720 feet within the City limits. Oak Creek is all above ground and is an all-natural channel. No water quality sampling was conducted in this creek. This ephemeral creek has minimal instream cover and unsatisfactory riparian habitat, but has favorable shading due to only the predominantly introduced ornamental plant species. Water flows in this creek during the first fall rains and into the winter. Oak Creek has insufficient water velocity, but does contain spawning and rearing substrate required by Steelhead. Since instream cover, riparian habitat, and velocity are not adequate, and since water does not flow for a long enough period of time to support Steelhead activities, Oak Creek does not contain Steelhead spawning and rearing habitat.

Photograph 74 *(left). Oak Creek view upstream, at the end of San Antonio Street.* ***Photograph 75*** *(right). Oak Creek view downstream, at the end of San Antonio Street. Photos taken 11 January 2005.*

Ojai Creek

Ojai Creek is in the middle of downtown Ojai, and is a tributary to Fox Canyon Barranca. Ojai Creek runs on the west side of, and parallel to, the Montgomery Street, and it drains into Fox Canyon Barranca just south of South Montgomery Street.

Ojai Creek includes five primary reaches and five tributary reaches. Reach 1 is an above-ground natural reach for a distance of 1,955 feet within the City limits. Reach 2 is below ground by impervious RCP for 813 feet. Reach 3 is above ground with a mixed compacted channel for 786 feet. Reach 4 is undergrounded again by impervious pipe for a distance of 1,067 feet. Reach 5 is above ground with an impervious masonry channel for 1,668 feet. Ojai Creek Tributary A consists of one aboveground reach with mixed compacted channel for 324 feet that drains into Ojai Creek Reach 4. Tributary B of Ojai Creek includes three reaches that all drain into Ojai Creek Reach 4. Reach 1 of Tributary B is undergrounded by impervious corrugated metal pipe (CMP) for 204 feet; Reach 2 of Tributary B is an aboveground impervious gutter for 474 feet; and Reach 3 of Tributary B is above ground with a natural soil bottom for 562 feet. Tributary A of Tributary B is one aboveground channel with natural soil for 163 feet.

Ojai Creek includes one water quality sampling station (Station 7), which is located in Reach 1, upstream of the confluence with Fox Canyon Barranca, north of South Montgomery Street, near the lower Libbey Park Tennis Courts (see Figure 5). Station 7 shows favorable average test measurements for parameters including temperature, *p*H, and salinity; however, it shows unfavorable measurements for conductivity, dissolved oxygen, turbidity, and coliform bacteria.

Reaches 1 through 5 of Ojai Creek are all intermittent, while Reach A-1; B-1, -2, and -3; and A of B-1 are all ephemeral channels. Only approximately 35% of Ojai Creek is natural with approximately 65% impervious/compacted surfaces. Reach 1 includes several instream cover types and is inhabited by functional riparian habitat; however, the remaining reaches all have minimal instream cover and unsatisfactory riparian habitat. Ojai Creek Reaches 1 through 5 all have water flowing from four to six months out of the year, and they all have generally favorable water velocity when water is present. Reaches 1 and 3 include adequate shading. Only Reach 1 was determined to contain potentially suitable spawning and rearing habitat for Steelhead based on satisfactory measurements for parameters including riparian habitat, shading, and substrate.

Photograph 76 *(left). Ojai Creek Reach 1 at lower end next to lower Libbey Park tennis courts (5 January 2005).*
Photograph *77 (right). Ojai Creek Reach 3 at Lion Street, high flows during winter storm event (5 January 2005).*

Post Office Creek

Post Office Creek is parallel to, and is a tributary to, Ojai Creek in downtown Ojai. Post Office Creek begins at the Ojai Post Office, and flows south along the east side of Signal Street to Ojai Creek. Post Office Creek has one aboveground reach consisting of an all-natural channel bottom for a distance of 1,036 feet within the City limits.

No water quality sampling was conducted in this creek. The results of the Streams characterization study show that instream cover and shading is adequate throughout this creek; however, most shading is a result of predominantly invasive exotic plant species. Water flows during the months of fall and winter. When flows are present in the upper portions of this creek, water velocity is slow and no Steelhead-required spawning and rearing substrates are present. The most potential for fish habitat exists at the lower end of this creek, which consists of adequate measurements of most vital parameters, including instream cover, satisfactory riparian habitat and shading, and favorable water velocity and spawning/rearing substrate. Therefore, the lower portion of Post Office Creek is determined to potentially support suitable spawning and rearing habitat for Steelhead.

***Photograph 78** (left). Post Office Creek just above confluence with Ojai Creek. **Photograph 79.** (right) Confluence of Ojai and Post Office Creeks with Ojai Creek prominent in photograph. Photos taken 11 January 2005.*

San Antonio Creek

The stretch of San Antonio Creek that occurs within the City limits is located in the southeastern portion of the City. San Antonio Creek is the primary stream making up the Ojai Valley Watershed in which all other Ojai streams empty, except Nordhoff/Happy Valley Drains. San Antonio Creek, within the City of Ojai, flows in a southwesterly direction from Ojai Avenue (SR 150) to Hermosa Road.

The portion of San Antonio Creek that exists within the City limits consists of three aboveground, natural channel reaches (Reach 1 = 1,227 feet, Reach 2 = 5,554 feet, and Reach 3 = 5,314 feet). San Antonio Creek includes four separate water quality sampling stations (Stations 3, 4, 5, and 12):

- Station 3 is located in Reach 1 just upstream from its confluence with Del Norte Creek (see Figure 5). Station 3 sampling indicates favorable average measurements for water quality parameters including temperature, dissolved oxygen, turbidity, and *p*H. Station 3 indicates unfavorable average measurements for conductivity, salinity, and coliform bacteria.

- Station 4 is also located in Reach 1 and is just below the confluence of Villanova Creek under the Creek Road bridge at Hermosa Road (see Figure 5). Station 4 shows more favorable conditions than Station 3, including temperature, dissolved oxygen, turbidity, *p*H, and salinity, while showing unfavorable conditions for only conductivity and coliform bacteria.
- Station 5 is located in Reach 2 below the confluence of Fox Canyon Barranca and below the Creek Road bridge (see Figure 5). Station 5 indicates favorable average measurements for the same parameters as Station 4 including temperature, dissolved oxygen, turbidity, *p*H, and salinity.
- Station 12 is located within Reach 3 under the bridge on Ojai Avenue between Gridley and Boardman Roads (see Figure 5). Station 12 shows favorable conditions for temperature, dissolved oxygen, *p*H, and salinity; however, it shows unfavorable conditions for conductivity, turbidity, and coliform bacteria.

Reaches 1, 2, and 3 of San Antonio Creek are intermittent. Instream cover, riparian habitat, shading, water flows, water velocity, and required spawning and rearing substrate are all satisfactory to high-quality in all three reaches. Therefore, Reaches 1, 2, and 3 are all determined to have potentially suitable habitat for Steelhead.

***Photograph 80** (left). San Antonio Creek showing high-quality riparian/aquatic habitat with summer flows (16 July 2004). **Photograph 81** (right). San Antonio Creek with peak flows during winter storm (9 January 2005).*

Soule Park Creek & West Soule Park Creek

Soule Park and West Soule Park Creeks are in the southeastern portion of the City limits, and are tributaries to San Antonio Creek. Soule Park and West Soule Park Creeks are more or less parallel to each other, and flow from the southeast to northwest. West Soule Park Creek is west of Soule Park Creek, and both creeks enter San Antonio Creek from the south. Only a small portion of each creek (the northern extent) is within the limits of the City.

Soule Park Creek and West Soule Park Creek are both completely aboveground ephemeral channels, and they consist of predominantly natural channel morphology. Soule Park Creek consists of one reach for a distance of 1,561 feet within the City limits, and West Soule Park Creek consists of one reach for a distance of 1,305 feet within the City limits; however, the lower end of this creek was obliterated decades ago by agricultural development, and no streambed has existed below Black Mountain since. No water quality sampling was conducted in these creeks. Suitable habitat is lacking in both creeks for Southern Steelhead.

Stewart Canyon Creek

Stewart Canyon Creek more or less bisects the City, and is a tributary to San Antonio Creek. Stewart Canyon Creek flows from north to south and is generally parallel to, and west of, Fox Canyon Barranca. If moving upstream, Stewart Canyon Creek moves north along the west side of South Ventura Street, crosses SR 150 at Cañada Street, and then follows Cañada Street north through the City.

Stewart Canyon Creek consists of five stream reaches. Reach 1 is above ground with a natural channel bottom for a distance of 3,092 feet within the City limits. Reach 2 is also above ground, but consists of an impervious concrete channel for 719 feet. Reach 3 is undergrounded by impervious RCB for 2,554 feet. Reach 4 is above ground again, but is an impervious cement channel for a distance of 1,468 feet. Reach 5 is above ground with a natural channel bottom for 970 feet, and north of and beyond the City.

Stewart Canyon Creek includes four water quality sampling stations (Stations 6 and 15 are in Reach 1, while Stations 10 and 10A are in Reach 5):

- Station 6 is located upstream from a narrow bridge on Creek Road (at the 10 mph curve). This station is not within the city limits of Ojai, but provides valuable information. Station 6 water sampling results show favorable conditions for parameters including temperature, dissolved oxygen, turbidity, and *p*H. Station 6 tests do not show favorable conditions for conductivity, salinity, and coliform.
- Station 10 is the inflow into the Stewart Debris Basin at the top of the logical extension of Cañada Street at the Pratt Trailhead (see Figure 5). Station 10 indicates favorable average sampling measurements for parameters for only temperature and *p*H, while showing unfavorable conditions for conductivity, dissolved oxygen, turbidity, salinity, and coliform bacteria.
- Station 10A is located where the Foothill Road bridge crosses Stewart Canyon Creek, upstream from Station 10 (see Figure 5). This station indicates favorable average measurements for only *p*H and salinity, but shows unfavorable conditions for all other vital parameters measured including conductivity, temperature, dissolved oxygen, turbidity, and coliform bacteria.
- Station 15 is located just upstream from Stewart Canyon Creek's confluence with Fox Canyon Barranca (west of South Ventura Street) (see Figure 5). Station 15 has favorable conditions for water quality parameters including conductivity, temperature, dissolved oxygen, *p*H, and salinity. Station 15 shows unfavorable conditions for turbidity, and coliform bacteria.

Stewart Canyon Creek Reach 1 is a perennial channel, and is one of the most favorable locations for potentially suitable Steelhead habitat. Reach 1 is the only reach of this creek that flows through Ojai that has natural morphology. In addition to natural morphology, Reach 1 has satisfactory to high-quality measurements for all parameters studied for this project, including favorable instream cover, riparian habitat, shading, water flows, water velocity, and substrate materials.

Reach 5 is also determined to consist of potentially suitable habitat for Steelhead spawning and rearing. Reach 5 has natural channel morphology, consists of an intermittent channel, has flows present eight months out of the year, and has favorable conditions in almost all other parameters studied. Reaches 2, 3, and 4 (with perennial and intermittent flows) are not determined to have potentially suitable Steelhead habitat. These middle reaches are lacking in all parameters studied except that they have favorable water velocity when flows are present.

***Photograph 82** (left). Stewart Canyon Creek Reach 5 with functional riparian habitat (24 January 2005).*
***Photograph 83** (right). Stewart Canyon Creek channelized Reach 4 showing peak flows during winter storm, view north (9 January 2005).*

Thacher Creek

A small portion of Thacher Creek exists within the City of Ojai. It is a tributary to San Antonio Creek and its confluence is at the northeastern end of the Soule Park Golf Course. Thacher Creek runs through a portion of the Soule Park and its golf course. Thacher Creek enters San Antonio Creek from the east. Thacher flows into the City from the east, while San Antonio flows in from the northeast.

Thacher Creek includes just one aboveground, natural reach for a distance of 2,445 feet within the City limits. Thacher Creek Reach 1 includes one water quality sampling station (Station 13). Water Quality Station 13 is located under the bridge on Boardman Road south of the entrance to Soule Park (Figure 5). Station 13 indicates favorable conditions for water quality parameters including temperature, dissolved oxygen, *p*H, and salinity; however, this station shows unfavorable conditions for conductivity, turbidity, and coliform bacteria.

Thacher Creek is an intermittent creek channel with flows present only during the winter months. It contains natural channel morphology, adequate instream cover, satisfactory riparian plant communities, and suitable spawning and rearing substrate materials; however, due to the lack of flows thoughout most of the year, Thacher Creek is not determined to contain potentially suitable habitat forSteelhead.

***Photograph 84** (left). Thacher Creek below Boardman Road (9 January 2005).*
***Photograph 85** (right). Thacher Creek at Siete Robles Tract (12 January 2005).*

Villanova Creek

Villanova Creek is in the southwestern portion of the City limits, and is a tributary to San Antonio Creek. Villanova Creeks confluence with San Antonio Creek is located just south of the intersection of Hermosa Road and Creek Road. Villanova Creek generally flows in a southeasterly direction. If moving upstream, it runs along the southwest side of Hermosa Road and crosses it just before SR33. Villanova Creek then crosses SR33 north of Hermosa Street.

Villanova Creek consists of three primary reaches within the City limits, one of which is a tributary to Villanova Creek. Tributary B-1 is an aboveground, natural channel for a distance of 852 feet that drains into Villanova Creek Reach 2. Reach 2 is also an aboveground, natural channel for 816 feet. Reach 3 is above ground with a channel consisting of primarily compacted soil for 1,410 feet.

Villanova Creek Reach 1 includes Water Quality Station 2, which is located at the lower end of Villanova Creek at Hermosa Road, just upstream from San Antonio Creek (see Figure 5). Station 2 indicates favorable average measurements for most parameters tested, including temperature, dissolved oxygen, turbidity, *p*H, and salinity. This station only shows unfavorable measurements for conductivity and coliform bacteria.

Flows were only present in this ephemeral creek during the month of January. Villanova Reach 2 has satisfactory riparian habitat and shading and includes suitable spawning and rearing substrate material; however, water velocity and instream cover are not favorable. Reach 3 and Tributary B-1 do not have any favorable conditions based on the parameters studied. Based on these findings, no reaches within Villanova Creek were determined to have potentially suitable spawning and rearing habitat for Steelhead.

***Photograph 86** (left). Drainage to Villanova Creek at Hermosa Rd along Ojai Bike Path.*
***Photograph 87** (right). Drainage to Villanova Creek (upper end) along Ojai Bike Path. Photos taken 8 January 2005.*

RESTORATION PLAN

This section identifies restoration opportunities, makes estimates of potential benefits, and classifies the restoration efforts into feasibility categories. Restoration opportunities include improving and enhancing the stream corridors themselves; land use practices and other activities outside of the stream corridor that would benefit the watersheds are suggested as well. All actions necessary to restore habitat for Southern Steelhead to Ojai Basin streams are identified and considered, even though the likelihood of implementation is considered infeasible.

Since restoring and improving instream and adjacent habitats for Southern Steelhead in the City of Ojai will vary considerably from site to site, the Limiting Factor Analysis was used to identify restoration projects for implementation as part of this restoration plan. This plan identifies the necessary restoration elements for each stream in the City; however, some elements of the suggested restoration approach may be infeasible and/or not cost-effective. Therefore, a phased project approach is presented here, which focuses first on the restoration projects that are both feasible and that have a high level of potential benefit. Regardless, a matrix of the range of actions available to the City that would directly and indirectly benefit Southern Steelhead is provided. A qualitative assessment of the level of benefit to City streams and stream habitats is provided for each identified project or recommendation.

The reaches that are identified as consisting of one or more habitat limiting factors are assigned specific recommendations for restoration and a feasibility assessment. Since the main objective is simply to restore a means for Steelhead to pass through Ojai to reach otherwise suitable spawning and rearing habitat upstream, this restoration plan focuses on removing barriers to Steelhead migration upstream and downstream.

CDFG'S FOCUS ON RESTORATION

Many streams and rivers exist in California where water has been over-appropriated, which is a major cause for the current decline of Steelhead in California. Adverse watershed effects from human activities - such as logging, grazing, road building, improper construction practices, and hydraulic mining - have historically contributed greatly to instream habitat degradation and continue to do so. In addition, impacts to instream habitat, from gravel mining, dredging, flood control, and bank stabilization/protection projects, are a major cause of current habitat loss and degradation. Natural events, such as floods, droughts, and forest fires, can also contribute to habitat degradation, though not as severe in scope as human-induced activities. Finally, most streams throughout California include artificial barriers that eliminate access to historic spawning and rearing areas. (CDFG 1996).

According to the *Steelhead Restoration and Management Plan for California* (CDFG 1996), the CDFG's focal point for efforts to restore Steelhead populations throughout California is watershed restoration, watershed protection, and maintaining sufficient flows. Watershed restoration and protection are basic prerequisites for restoring and maintaining naturally produced Steelhead and other Southern Steelhead. Establishment of conditions, constraints, and practices that maintain watershed integrity, and restoration of problem areas that continue to degrade aquatic habitats, are of the utmost importance to restoring Steelhead populations. Restoration to correct past and ongoing localized environmental perturbations is a necessary and valuable component of fishery restoration if incorporated into overall management and restoration objectives. However, restoration does not substitute for habitat protection.

Since protection for Steelhead habitat can be partially achieved by maintaining and protecting adequate stream flows, the best solutions to the problem of declining populations of Steelhead in California are (1) an aggressive enforcement of Fish and Game codes and other laws designed to protect instream flows and spawning habitat (the responsibility of CDFG), and (2) augmentation of instream flows through acquisition of riparian lands with water rights. Maintaining streambank stability, keeping sedimentation at normal levels, and protecting riparian vegetation are also necessary. Restoration priority, either throughout all of California or in more localized areas, should also be given to identifying and correcting the habitat problems that are most limiting to the target population. Finally, habitat improvement should be focused in streams that historically had significant Steelhead populations and areas where Steelhead habitat is severely degraded and restoration work is greatly required. For example, habitat restoration that attempts to correct problems created by watershed damage, or that restore access to historic habitats through barrier modification/removal, should have the highest priority. (CDFG 1996.)

OJAI BASIN STREAMS RESTORATION OPPORTUNITIES

As described in previous sections of this report, the wetlands and floodplains in the tributaries of the San Antonio Creek watershed are significantly degraded, particularly in the lowland areas, due to urbanization of those lowland areas. Degradation of watershed wetland functions generally increases downstream as a result of upstream impacts of urbanization. Regardless of the level of wetlands and riparian habitat degradation, restoration potential exists for several portions of the watershed, including within the City of Ojai.

The streams and drainages in the City of Ojai can be grouped into two basic categories: (1) natural but impacted, and (2) highly modified and impacted. The streams that are in a natural condition can be improved relatively easily. The condition of the highly modified and impacted streams can also be improved; however, the cost and level of effort to do so is much higher.

It is not likely that the grand scheme of restoration and protection suggestions, discussed above in the CDFG’s Focus on Restoration subsection, can be implemented within the scope of this project. It may not even be feasible to completely restore optimal Steelhead habitat or to provide adequate migratory paths for Southern Steelhead in most streams flowing through the limits of the City of Ojai. However, many actions can be taken to improve habitat condition and water quality within the Ojai Basin streams, especially in the Stewart Canyon Creek, Fox Canyon Barranca, San Antonio Creek, and Thacher Creek watersheds. Habitat improvements would also benefit the flora and fauna of the area and would positively influence downstream aquatic habitats as well. It is with these facts in mind that a set of restoration goals and projects are identified and describe below. Implementation of any of these projects would result in improvements in:

- Water quality;
- Aquatic habitats;
- Aesthetics;
- Nonpoint source pollution control; and
- Fisheries habitat.

Restoration Goals and Projects

Examples of actions that can be taken to restore and enhance Steelhead habitat conditions include the following:

- Remove barriers to fish migration where feasible, especially on streams that provide spawning and rearing habitat upstream of the City;
- Establish minimum-width buffers between urban land uses and streams;
- Restore riparian vegetation along streams that pass through the City;
- Eradicate invasive exotic plants from City streams and drainages;
- Develop minimum stream crossing requirements[20] to ensure fish passage and habitat quality are not adversely affected;
- Minimize impervious surfaces on all parcels; and
- Establish regular water quality monitoring stations at key locations on streams that flow through the City, and monitor them at least annually.

The primary objective in this report, and that of CDFG and the City, is to maintain and/or restore City stream habitat conditions and migratory paths for Southern Steelhead within the City. To accomplish this objective, a number of goals need to be identified that if achieved, will accommodate that objective. Specific goals need to be identified and established as a means to evaluate which projects or actions the City or other interested parties may wish to consider for implementation. Restoration goals occur at various levels, with one or more components necessary to achieve a specific goal. That is, if the primary goal is to provide Southern Steelhead access to spawning and rearing habitats upstream from the City, a number of elements (specific projects) may need to be implemented. Implementation of any of the restoration projects presented in this report is designed to have a direct or indirect benefit to Southern Steelhead or habitat for Southern Steelhead, which will benefit other species as well. The restoration goals are presented below in a hierarchical fashion, with the goals that offer the most direct positive impact on Southern Steelhead listed first.

- Goa1 A – Remove fish migration barriers within the City of Ojai:
  - Replace road crossing barriers (A-1)
  - Remove debris dams/construct fish ladders (A-2)
  - Construct site-specific fish passage devices (A-3)
- Goal B – Improve aquatic habitat conditions with City of Ojai streams:
  - Remove invasive exotic plants (B-1)
  - Remove trash and debris (B-2)
  - Prevent fecal material and other pollutants from entering streams (B-3)
  - Establish vegetated buffers between streams and urban land uses (B-4)
- Goal C – Preserve existing riparian and instream habitats within City of Ojai:
  - Restrict incompatible activities within streams and drainages (C-1)
  - Acquire parcels with stream habitats (C-2)
  - Preserve parcels upstream of Ojai that contain Steelhead habitat (C-3)

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[20] Procedures and guidelines have already been developed by NOAA Fisheries and CDFG for fish passage, and should be incorporated into City stream crossing requirements.

- Goal D – Prevent aquatic habitat and water quality degradation within and downstream of Ojai:
  - Conduct water quality monitoring in City streams and drainages (D-1)
  - Educate landowners to prevent nonpoint source pollution entering drainages (D-2)
  - Provide technical assistance to landowners (and residents) to control nonpoint source pollution (D-3)
  - Modify zoning codes to minimize impervious cover for each parcel (D-4)
  - Modify building/land use codes to prevent nonpoint source pollutants from leaving parcels (D-5)
  - Modify building/land use codes to require stream/drainage crossings to be sized to prevent adverse changes to fish or aquatic habitats (D-6)
  - Preserve undeveloped upland portions of watershed (D-7).

Each of these goals and projects are described further below, with specific actions that the City can consider for implementation, grouped according to general types of actions, such as: land use changes, instream restoration actions, habitat enhancements, and preservation of upland portions of the watershed. Table 31, Matrix of Potential Stream Habitat Restoration Actions by the City of Ojai, provides a matrix illustration of the types of actions the City can take or consider that will accomplish one or more of the restoration plan goals. Each of these projects can be grouped into four basic categories: instream restoration; habitat enhancement; land use changes; and habitat preservation.

Goal A - Remove Fish Migration Barriers

The greatest benefits towards improving conditions for Southern Steelhead in the City of Ojai and the Ojai Valley is to remove existing fish migration barriers, and to protect and enhace existing aquatic and riparian habitats. Three basic types of actions would need to be taken to remove existing fish barriers: replace road-crossing barriers; remove debris dams/construct fish ladders; and construct site-specific fish passage devices. These types of actions are difficult technically and financially. They require significant modifications or replacements of existing man-made structures that serve specific functions that did not consider their effects on fish migration when they were built.

ROAD CROSSINGS

Road crossings often create barriers to fish migration due to poor design (as related to stream flow) by creating significant drop-offs from the upstream portion to the downstream portion of the stream. The resulting wall can be too high for fish and other aquatic wildlife to overcome. Often these drop-offs are created intentionally to provide a barrier to upstream channel erosion, but cause excessive water velocities and a lack of sufficient water depth for Steelhead. (Projects A-1, A-2)

Soule Golf Course Creek Crossing (A-1)

One road-crossing barrier to fish passage occurs on San Antonio Creek at Soule Golf Course. This is the only significant road-crossing barrier within the City. However, the golf course is owned by the County of Ventura Parks Department, operated by a private concession. Several Southern Steelhead were trapped below this barrier in the spring of 1997-8, and failed to reach spawning habitat upstream. Soule Golf Course Arizona Road Crossing (Photographs 51 and 52 shown above in the San Antonio Creek Watershed Modifications subsection) is a barrier created on San Antonio Creek that effectively prevents Southern Steelhead from migrating to historic spawning grounds in the Ojai Valley and on Nordhoff Ridge.

Table 31. Matrix of Potential Stream Habitat Restoration Actions by the City of Ojai

Category	Restoration Goal Item No.	Description	Feasibility	Benefit to Steelhead	Cost Estimate[21]
Instream Restoration	A-1	Soule Golf Course Creek Crossing	High	Direct/High	$0 to $30K
Instream Restoration	A-2a	Stewart Canyon Debris Basin Fish Ladder	Low	Direct/High	$2M
Instream Restoration	A-2b	Fox Canyon Barranca Debris Basin Removal	Moderate to High	Direct/Moderate to Low	$500K
Instream Restoration	A-3a	Modify Fox Canyon Barranca Channel	Low	Direct & indirect/ Mod. to Low	$2M
Instream Restoration	A-3b	Modify Stewart Canyon Creek Underground Culvert	Moderate	Direct	$5M
Habitat Enhancement	B-1	Eradicate Invasive Exotic Plants	High	Indirect	$175K initially; $25K/yr
Habitat Enhancement	B-2	Remove Trash	High	Indirect	$30K initially; $10K/yr
Land Use	B-3	Prevent Fecal Material and Other Pollutants from Entering Streams	Moderate	Indirect	$100K
Habitat Enhancement	B-4	Establish Vegetated Buffers Between Streams and Urban Land Uses	Moderate	Direct & indirect	$300K
Land Use	C-1	Restrict Incompatible Activities Within Streams and Drainages	High	Direct & indirect	$15K
Preservation	C-2	Acquire Parcels With Stream Habitats	Moderate	Direct & indirect	$20M
Preservation	C-3	Preserve Parcels Upstream of Ojai That Contain Steelhead Habitat	Moderate	Direct & indirect	$20M
Instream Restoration	D-1	Conduct Water Quality Monitoring in City Streams	High	Indirect	$25K to $50K/year
Land Use	D-2	Educate Landowners to Prevent Nonpoint Source Pollution Entering Drainages	High	Indirect	<$25K
Habitat Enhancement	D-3a	Provide Technical Assistance to Landowners to Control Nonpoint Source Pollution	High	Direct & indirect	$50K
Land Use	D-3b	Provide Technical Assistance to Horse Owners	High	Direct & indirect	$10K to $50K
Land Use	D-4	Modify Zoning Codes to Minimize Impervious Cover for Each Parcel	High	Indirect	$30K
Land Use	D-5	Modify Building/Land Use Codes to Prevent Nonpoint Source Pollutants from Leaving Parcels	High	Indirect	$30K
Land Use	D-6	Modify Building/Land Use Codes to Require Stream/Drainage Crossings to be Sized to Prevent Adverse Changes to Fish or Aquatic Habitats	High	Indirect	$30K
Preservation	D-7	Preserve upland portions of watershed	Low	Direct & indirect	$20 M

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[21] Cost estimates are best guestimates and have only been broadly calculated.

Replacing this road crossing with a bridge or culvert to allow fish-passage would allow access to historic fisheries habitat that has been isolated since the construction of this structure. Bridge replacements are expensive, costing from $250,000 to over $1,000,000 each, depending on the width and length of the crossing.

The City would need to find outside funding sources to pay for these projects. The benefits achieved for fish passage by each creek crossing replacement should be evaluated before project initiation or work spent on seeking funding. Fortunately, the Ventura County Parks Department has scheduled a project to fix this problem, scheduled for Summer 2005, after creek-flows have ceased. Fortunately for the Parks Department, the storm of early January 2005 washed much of this structure away, removing the barrier to fish passage, even though portions of the crossing (concrete slabs) remain in the creek bed.

DAMS (A-2)

Two dams across two creeks occur within the City of Ojai: Stewart Canyon Debris Basin Dam on Stewart Canyon Creek and a small debris dam on upper Fox Canyon Barranca. Both dams represent significant and impassable barriers to fish migration. Removing one or both of these debris dams or constructing fish ladders over them would greatly improve access of migrating fish past existing barriers to historic upstream habitats.

Stewart Canyon Debris Basin Fish Ladder (A-2a)

As described previously in this report, the reaches of Stewart Canyon Creek upstream of the debris basin is the largest stream and drainage system that flows through the City besides San Antonio Creek, and provides the second longest length of Steelhead habitat of all the streams flowing through the City. Stewart Canyon Creek enters the City just above the Stewart Canyon Debris Basin, from a natural stream channel with 29,116 linear feet of streambed upstream, with a watershed area of 1,160 acres. The creek is channelized below the debris basin with concrete walls and bottom for 1,468 feet, and then covered by Cañada Street ada Street for 2,554 feet until it daylights just south of Carrows Restaurant (south of Ojai Avenue and between Santa Ana and Blanch Streets), channelized for another 719 feet, for a total length 4,741 feet. The creek does not have a natural channel until south of the Ojai Bicycle Trail.

Since Stewart Canyon Creek provides the greatest amount of historic and suitable fish spawning and rearing habitat north of the City, fixing this barrier would provide the greatest benefit to Southern Steelhead. Constructing a fish ladder over the debris basin dam would be necessary to remove this barrier. Photograph 88, Stewart Canyon Debris Dam Spillway, illustrates the height and length of the spillway of the dam of this large debris basin. Southern Steelhead are not capable of swimming up this spillway into the debris basin when flows are sufficient for migration as the ramp is smooth concrete and too high to leap over. No plunge pool exists at the base of this spillway either.

Removing the debris dam is not considered an option since it provides important sediment control functions during large flood events, such as occurred in late December 2004 and January 2005, as shown on Photograph 50, Stewart Canyon Debris Basin filled by winter storm event (shown above in the San Antonio Creek Watershed Modifications subsection).

The cost to construct an adequate fish ladder here would range from $500,000 to $9,000,000[22]. However, the construction of any fish ladder over this debris basin dam would be ineffective unless

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[22] The fish ladder at the Robles Diversion on the Ventura River, which was completed in 2004, cost approximately $9,000,000; however, it is a much larger and likely a more sophisticated structure than would be needed for the Stewart Canyon Debris Dam.

the channelized portion of the creek downstream of the basin were not also modified to allow fish passage, which is discussed later in this report.

***Photograph 88**. Stewart Canyon Debris Dam Spillway (28 January 2005).*

Fox Canyon Barranca Debris Basin Removal (A-2b)

The small debris dam on Fox Canyon Barranca, Photograph 61, Fox Canyon Barranca Debris Dam (shown above in the San Antonio Creek Watershed Modifications subsection), was built in late 1985 or early 1986 to retain sediment material that washed down from Nordhoff Ridge after the Wheeler Fire of 1985 and has completely filled in. This structure prevents any fish from migrating upstream to any suitable habitats on the south slope of Nordhoff Ridge. Since this stream is ephemeral in nature for most of its length north of the City, the benefit achieved by removing this debris dam or constructing a fish ladder over it would have only minimal benefit to Southern Steelhead.

MODIFY CONCRETE FLOOD CONTROL CHANNELS (A-3)

The concrete channelized portions of both Stewart Canyon Creek and Fox Canyon Barranca through the City has created an effective barrier to fish passage. Both channels were constructed to provide flood conveyance through the City, but perform no other wetland functions. Solutions to removing the barriers consist of three options: removing the concrete channels and replacing them with natural substrates; modifying the channel bottoms to create artificial pools at regular intervals; and constructing fish passage devices, such as water flow baffles. When water is flowing in these concrete channels, because of their length and slope, fish cannot swim these long lengths to reach natural stream habitat north of the City. The fish need to rest periodically to swim against strong currents, and the currents down these channels are likely too strong[23] when enough water is present.

These floodways are operated and maintained by the Ventura County Watershed Protection District (VCWPD), specifically to convey floodflows to protect life and property in Ojai. The VCWPD has stated that it is willing to allow these culverts to be modified to accommodate fish ladders as long as flood flow capacities are not changed (Jeff Pratt pers. comm.).

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[23] CDFG staff have observed Steelhead migrating long distances up concrete channels successfully, such as in the San Gabriel River, and to a lesser extent in Ballona Creek and the Santa Ana River.

Modify Fox Canyon Barranca Channel (A-3a)

Replace Fox Canyon Barranca culvert with natural substrate and riparian vegetation, or install features to create pools or areas with still water to allow migrating fish to rest. Removing the concrete bottom would be more practical, or necessary to best achieve the channel morphology to create resting pools, but would still be very expensive. Since no Steelhead Trout habitat occurs upstream, the benefit to fish is minimal except for water quality and general habitat condition improvements. (Refer to Photograph 54, Meander Pattern in Fox Canyon Barranca Channel, shown above in the San Antonio Creek Watershed Modifications subsection.)

Originating on the south slope of Nordhoff Peak in the Los Padres National Forest, the Fox Canyon Barranca follows a natural course and bed until just upstream of North Montgomery Street, after which it is diverted into a large underground pipe to Grand Avenue. The abovementioned debris dam is located upstream of North Montgomery Street. Fox Canyon Barranca channel (concrete sides and bottom) extends from Grand Avenue southward to the south end of Fox Street, after which it returns to a natural stream channel.

Restoring either stream to natural channel conditions is not feasible since there is little undeveloped land available to provide adequate flood conveyance without removing both streets and houses, both unacceptable actions, not to mention very costly.

Modify Stewart Canyon Creek Channel (A-3b)

The Stewart Canyon Creek flood control channel represents a significant barrier to fish migration or movement between lower and upper reaches. At present, the flood control channel provides only one function, floodwater conveyance, which it does well. However, the flood control channel, as constructed, eliminates the 13 other functions Riverine wetland systems typically provide (See Introduction Section for discussion of Riverine wetland functions).

Replacing the Stewart Canyon Creek underground culvert with fish-friendly channel would be the most significant effort to restoring historic spawning and rearing habitat for Southern Steelhead in the City of Ojai. Removing the existing barrier to fish passage would restore 29,116 linear feet of stream upslope of Ojai that is currently inaccessible, as described earlier in the Restoration section of the report.

Approximately 2,000 linear feet of Stewart Canyon Creek is channelized into an open box culvert. Approximately 2,850 linear feet of the creek is in an underground box culvert, under Cañada Street. Photograph 56 (Stewart Canyon Creek flood control channel and box culvert shown above in the San Antonio Creek Watershed Modifications subsection) illustrates existing conditions of the channel and culvert. These three connected reaches, and the Stewart Canyon Debris Basin Dam, represent the largest barrier to Steelhead Trout migration through the City of Ojai to upstream spawning and rearing habitat.

Modifying the flood control channel to accommodate fish passage would be extremely expensive and challenging, but would provide the most significant migration barrier removal project in the City. Periodically, the City could evaluate technical advancements that could potentially make significant restoration efforts like these feasible in the future.

Goal B - Improve Aquatic Habitat Conditions

As part of the Ventura Countywide Stormwater Quality Management Program, the City of Ojai has implemented the following specific components/projects to reduce nonpoint source pollution generated from within the City:

- Labeled all stormdrains with "Don't Dump, Drains to Ocean" signs;
- Instituted a Junior High Service Club Stormwater Patrol program;
- Increased enforcement by City inspectors (but no citations are issued to violators);
- Increased hazardous waste collection disposal for small businesses; and
- Held education programs at Topa Topa Elementary School.

While these five projects are an important component to reducing nonpoint source pollution originating from within Ojai, additional tasks are required to significantly reduce this pollution and improve aquatic habitat and water quality conditions both within the City and downstream. Tasks to improve aquatic habitat conditions include a range of projects from eradicating invasive exotic plants, removing trash, preventing urban pollution from entering drainages, and establishing vegetated buffers from Ojai streams. Each task is described in the following paragraphs.

Remove Invasive Exotic Plants (B-1)

The City should lead a project to remove invasive exotic plants from all streams within Ojai. Figure 25, Map of Ojai Stream Reaches with Invasive Exotic Plants, illustrates the portions of streams that flow through the City that contain significant amounts of invasive exotic plants that should be eradicated. Approximately 47,370 linear feet of streams within Ojai with a natural bed contain invasive exotic nonnative plants. These stream reaches can be made "weed free" fairly quickly as some reaches are only sparsely vegetated, or the number of invasive exotic plants is relatively low.

A small start on this type of restoration was started in Libbey Park with a grant from the California Department of Water Resources Urban Streams Restoration Program (Libbey Park Creek project - DWR #Z60154), a summary of which can be viewed at the following website (http://endeavor.des.ucdavis.edu/cerpi/ProjectDescription.asp?ProjectPK=5376).

Ojai citizens can be organized by neighborhood to use hand tools only to eradicate stream reaches in their neighborhoods of the invasive exotic plants present. Invasive exotic trees that need to be removed may need to be eradicated by professional tree trimmers or City maintenance staff.

All City parks (Libbey Park) that contain streams should be maintained free of invasive exotic plants. Focus should be placed on removing the most aggressive and problematic non-native plants[24], such as: Mexican Fan Palm, Canary Island Date Palm, Tree-of-Heaven, River Red Gum, Spanish Broom, Giant Reed, Sweet Fennel, Periwinkle, Algerian Ivy, Morning-glory, and Smilo Grass (see Table 20 in the Existing Conditions section for a complete list of plants, including invasive exotics). The most regularly encountered invasive plant in the Ojai streams is the Mexican Fan Palm, some of which are 5 meters tall, but most are less than 1 meter high, as illustrated in Photograph 89, Mexican Fan Palm Invading Oak Creek, as well as Algerian Ivy.

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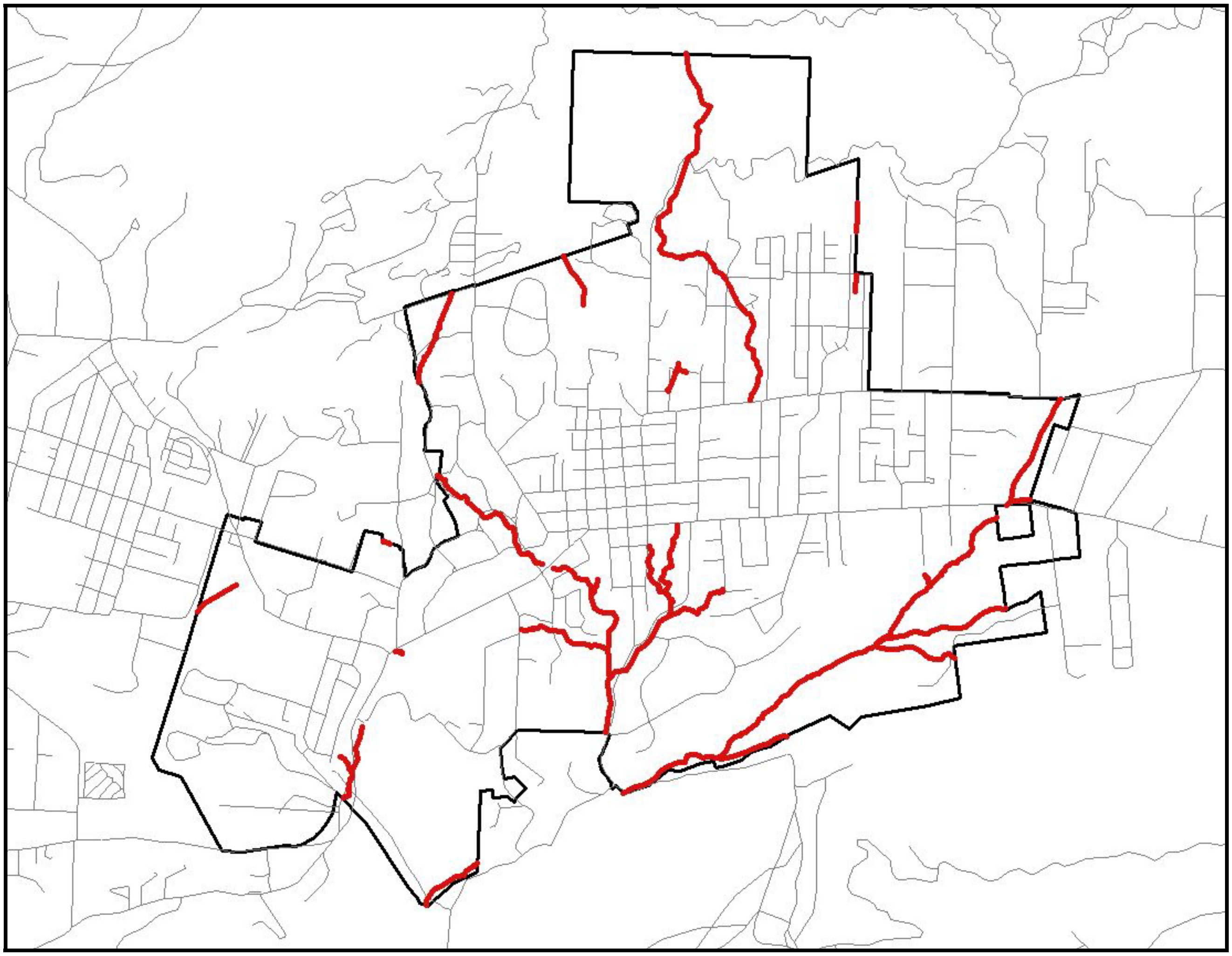
[24] See Subsection titled, "Biological Environment of Ojai Streams" and Table 20 (Predominant Plants of Ojai Streams) for a complete discussion and list of invasive exotic plants.

Figure 25. Map of Ojai Stream Reaches with Invasive Exotic Plants



The red lines on this map indicate stream reaches within the City of Ojai that contain invasive exotic nonnative plants that should be targeted for weed eradication.

This effort should have two components, an initial eradication phase, and a maintenance phase. Once the streams have been eradicated of the existing invasive exotic plants, keeping them free of such pests should be a relatively small task. Work groups such as C.R.E.W. and the California Conservatoin Corps are well suited for taking on this project, in conjunction with nonprofit groups such as the California Native Plant Society, Audubon Society, Friends of the Ventura River, and Matilija Coalition.

Photograph 89*. Mexican Fan Palm invading Oak Creek (11 January 2005).*

Remove Trash and Debris (B-2)

The City should lead a project to remove all trash and debris that has been dumped or washed into the streams within Ojai, such as illustrated in Photographs 90 and 91 below. This effort should have two components, an initial clean-up phase, and a maintenance phase. Once the streams have been cleaned of the existing trash and debris, keeping them free of such trash should be a relatively simple (but labor-intensive) task if performed on a quarterly or biannual basis, annually at a minimum. Work groups such as C.R.E.W. and volunteer organizations such as Trout Unlimited and the Sierra Club are well suited for taking on this project, in conjunction with nonprofit groups such as the Lions Club and public and private school students. An annual creek cleanup day can be used to maximize public participation.

Photograph 90 *(left). Trash in Grandview-Park Drain (27 May 2004).*
Photograph 91 *(right). Foreign material in Ayers Creek (8 February 2005).*

Prevent Fecal Material and Other Pollutants from Entering Streams (B-3)

All of the streams flowing through Ojai have been found to have relatively high levels of bacteria (*Escherichia coli* [*E. coli*]) associated with fecal material. Fecal coliforms are bacteria that are associated with human or animal wastes. They usually live in human or animal intestinal tracts, and their presence in drinking water is a strong indication of recent sewage or animal waste contamination. *E. coli* O157:H7 is a specific serotype of *E. coli* that causes watery diarrhea, hemorrhagic colitis, and hemolytic-uremia syndrome (HUS) in humans.

E. coli is used as a water quality indicator because large numbers of the bacteria are always present in the feces of humans and other warm-blooded animals, but are not naturally found in water. Since these bacteria don't live long in water once outside the intestine, their presence in water means there has been recent contamination through sewage discharges or other sources.

Water can be contaminated in a variety of ways. The primary sources of *E. coli* are municipal sewage discharges, runoff from failing septic systems, animal feed operations, farms, and feces deposited on the ground from warm-blooded animals. In urban areas, the *E. coli* from the excrement of warm-blooded animals (such as pets in a park or on the street) may be washed into creeks, rivers, streams, lakes, or groundwater during rainfalls. The contamination in water is often highest immediately following a storm, because of the runoff. In addition, swimmers and bathers can unknowingly contaminate water, or contamination can occur from boaters discharging wastes directly into the water. When these waters are used as sources of drinking water and the water is not treated or inadequately treated, *E. coli* may end up in drinking water.

There are hundreds of strains of *E. coli*. Most are harmless and live in the intestines of healthy humans and animals. Some, such as *E. coli* O157:H7, can cause severe illness. Infection often causes severe bloody diarrhea, abdominal cramps, and possibly fever (common symptoms for a variety of diseases). Young children, the elderly, and the chronically ill are at greater risk for severe symptoms. In some cases, infection can lead to kidney failure and possibly death.

There is limited information on the effects of *E. coli* (or any fecal pathogens) on the aquatic community. Fungus and virus strains are now being identified as a reason for declines in amphibian populations around the world, such as frogs in South America and tiger salamanders in Saskatchewan, Canada. Contamination from pathogens also leads to closing beaches for recreation, closing shellfish beds, and the contamination of irrigation waters for agriculture. (Data were obtained from the internet - http://www.ccme.ca/sourcetotap/ecoli.html.)

All stations sampled during 2004 and January 2005 were contaminated by *E. coli*. Sources of *E. coli* include fecal material from livestock, fowl, dogs, cats, and humans, as well as wild mammals. Domestic animals are the primary source in urban areas such as Ojai. This material enters Ojai streams from yards, street gutters, and corrals, unless the fecal material is properly disposed of into garbage bins or sewer lines. Photograph 92 (below) illustrates one example of a horse corral in close proximity to a creek within the City. Fecal material and urine from this small horse corral, and from similar situations elsewhere in the City, can easily enter the natural and man-made drainage systems within the City and introduce *E. coli* and other bacteria and viruses into the aquatic habitats downstream.

***Photograph 92**. Fecal material source contaminating a stream within the City of Ojai (8 January 2005).*

Establish Vegetated Buffers Between Streams and Urban Land Uses (B-4)

Many studies have shown that buffers between streams and urban land uses are most effective if they contain natural vegetation. The vegetation works hard to filter out pollutants, stabilize soil, and reduce erosion, as well as produce free atmospheric oxygen. A number of the drainages in Ojai lack vegetation, or any substantial amount of natural vegetation. The City could implement a program to plant native plants along existing drainages in public areas and easements, and provide guidance to property owners to do the same on private property.

The upper reach of Ojai Creek just downstream of the bridge on Lion Street is an example of an ephemeral stream that generally lacks natural vegetation but has room for such planting, as illustrated on Photograph 93. Native riparian plants should be planted along the creek to provide: erosion control and bank stability, natural cover, shade, nesting sites, and structural diversity along this, and similar creeks within the city.

***Photograph 93.** Unvegetated and compacted channel of Ojai Creek (8 January 2005).*

Restore Riparian Habitat to Del Norte Creek (B-4a)

Riparian habitat could be restored to Del Norte Creek on Ojai Valley Inn property. The riparian habitats that once occurred along this creek have been almost entirely removed over the years to accommodate the golf course at the Ojai Valley Inn and Country Club. The golf course fairways and greens often encroach to the very edge of the creek or even entirely over it.

Photograph 94. *Del Norte Creek through golf course; creek conditions lack buffer between the stream and golf course turfgrass. Using native Saltgrass here would be preferable rather than the existing high water-demanding grasses.*

Typical maintenance activities for facilities such as lawns for golf courses contribute high quantities of fertilizers and pesticides into downstream reaches. Furthermore, nearly all habitat functions have been eliminated. This can be rectified by removing or setting back lawns, fairways, and greens from the creek and replanting native riparian plants, such as Arroyo Willow, Mulefat, Pacific Blackberry, and California Sycamore.

Saltgrass (*Distichlis spicata*), a native perennial grass that is very tolerant of foot traffic, could be used as a substitute turfgrass in the vicinity of the creeks to provide a natural vegetation buffer between the golf course facilities while maintaining the general condition and playability of the course. Saltgrass also requires significantly less water than turfgrasses used in golf courses.

Goal C - Preserve Existing Riparian and Instream Habitats

Land use is generally under the control of the City, as guided by the Ojai General Plan (GP) and its required elements. For the purposes of this restoration plan, land use is used in the broadest sense: how the city and its residents use the land. The GP provides the template for what types of land uses will occur where within the City. The GP includes numerous policies and guidelines that dictate or direct how new development will occur within the City. Changing existing land uses, as opposed to zoning, is generally not practical/politically extremely difficult, and expensive to accomplish.

Most citizens want to be good neighbors and live in harmony with their neighbors and habitats. However, due usually to ignorance of the consequences of their actions, many citizens' actions on their land result in degradation of the environment, both onsite and downstream. Educating the citizens about such adverse impacts can be extremely helpful in modifying a citizen's behavior to reduce or eliminate the adverse impact. Providing technical assistance will generally also be well received by landowners.

The City can also develop specific policies and ordinances to regulate certain activities and land uses to avoid problems existing or potentially existing in Ojai city streams and drainages.

Restrict Incompatible Activities Within Streams and Drainages (C-1)

The City should prohibit incompatible land uses within streams and drainages to ensure high habitat functionality. Existing zoning codes provide mechanisms to maintain a minimum setback; however, there are many instances of strict violation of this code. Depending on the wetland function, a 25-foot buffer (setback) is not adequate to maintain high functionality. On small lots in areas of the City zoned for high or medium density, establishing a larger setback would not be practical. However, larger undeveloped lots could be developed adequately while providing additional setback distance. Some wetland functions are best maintained with a 100-foot buffer zone.

Enforce Article 10 of the City Zoning Code. Article 10 of the Ojai City Zoning Code, Section 10-2.1003 *et seq*. (Creekside Development Standards) states that development "shall be set back a minimum of 25 feet from a blue line creek's top of bank. Additional setbacks may be necessary to protect sensitive environmental resources." Section 10-2.1004(c) goes on to state, "Grading or filling, planting of exotic/non-native or non-native riparian species, or removal of native vegetation shall not occur within a creek or creekside setback area". While this code section clearly identifies natural stream conditions within the City as the preference, enforcement is generally lacking, and a 25-foot setback is the recommended minimum needed to provide any sort of adequate buffer between typical urban and suburban land uses to maintain even a minimum level of habitat and water quality. Regardless, if this code section where properly enforced, habitat conditions in the streams flowing through the City would be higher than they are at present.

The City should distribute a pamphlet to each property owner and address with a creek crossing it that educates the landowner and resident of the requirements and need to protect creek habitats, even ephemeral creeks, within the City. The 25-foot setback should be enforced through inspections to ensure compliance. The pamphlet should also explain that any changes to natural drainages also require a permit from the CDFG and the U.S. Army Corps of Engineers[25]. The reasons why City streams need to be protected should be included in the pamphlet. A copy of this pamphlet should also be made available on the City website.

Acquire Parcels With Stream Habitats (C-2)

Since intact stream habitats are relatively rare within the City, those remaining parcels that have yet to be developed should be acquired for the purposes of habitat protection. The City could endeavor to identify candidate parcels where preservation of stream habitats are desirable and designate them for purchase from willing sellers. The City could establish a fund to be used solely for the purchase of such properties.

Preserve Parcels Upstream of Ojai That Contain Steelhead Habitat (C-3)

Since suitable Steelhead habitat upstream of the City is vital to maintaining a viable Steelhead population in the Ojai Valley, the City should facilitate or directly work to preserve key parcels that contain suitable Steelhead habitat upstream of the City. If the City is to expend effort and monies to maintain and protect aquatic habitats in a healthy condition within the City, it is important to the City

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[25] U.S. Army Corps of Engineer permits have already been written and "issued" for a variety of actions, called Nationwide or General Permits, which typically includes small projects such as might occur at a single-family residence.

to also protect the upstream habitats. Fortunately, much of the best habitat for Steelhead upstream of the City is located within the Los Padres National Forest, and generally protected. However, there are numerous parcels as in-holdings in the Forest and adjacent to the City that are in private ownership and future development could significantly degrade in-stream habitats. Key downstream parcels that contain high quality Steelhead habitat should also be protected.

Figure 26, Map of Potential Preserve Parcels, illustrates some of the parcels occurring within or adjacent to the City that are generally undeveloped and adjacent or including streams. None of these parcels are currently in public ownership and could be developed in the future. Preserving the natural vegetation on such parcels would benefit wetland functions and downstream water quality.

Goal D - Prevent Aquatic Habitat and Water Quality Degradation

Maintaining high water quality in the surface water flowing through and downstream of Ojai is very important to maintaining or restoring a viable Steelhead population. The City needs to take actions to prevent degradation of surface water quality within and downstream of the City. To prevent degradation, monitoring needs to be conducted systematically at key points to identify contamination sources and how surface water is polluted.

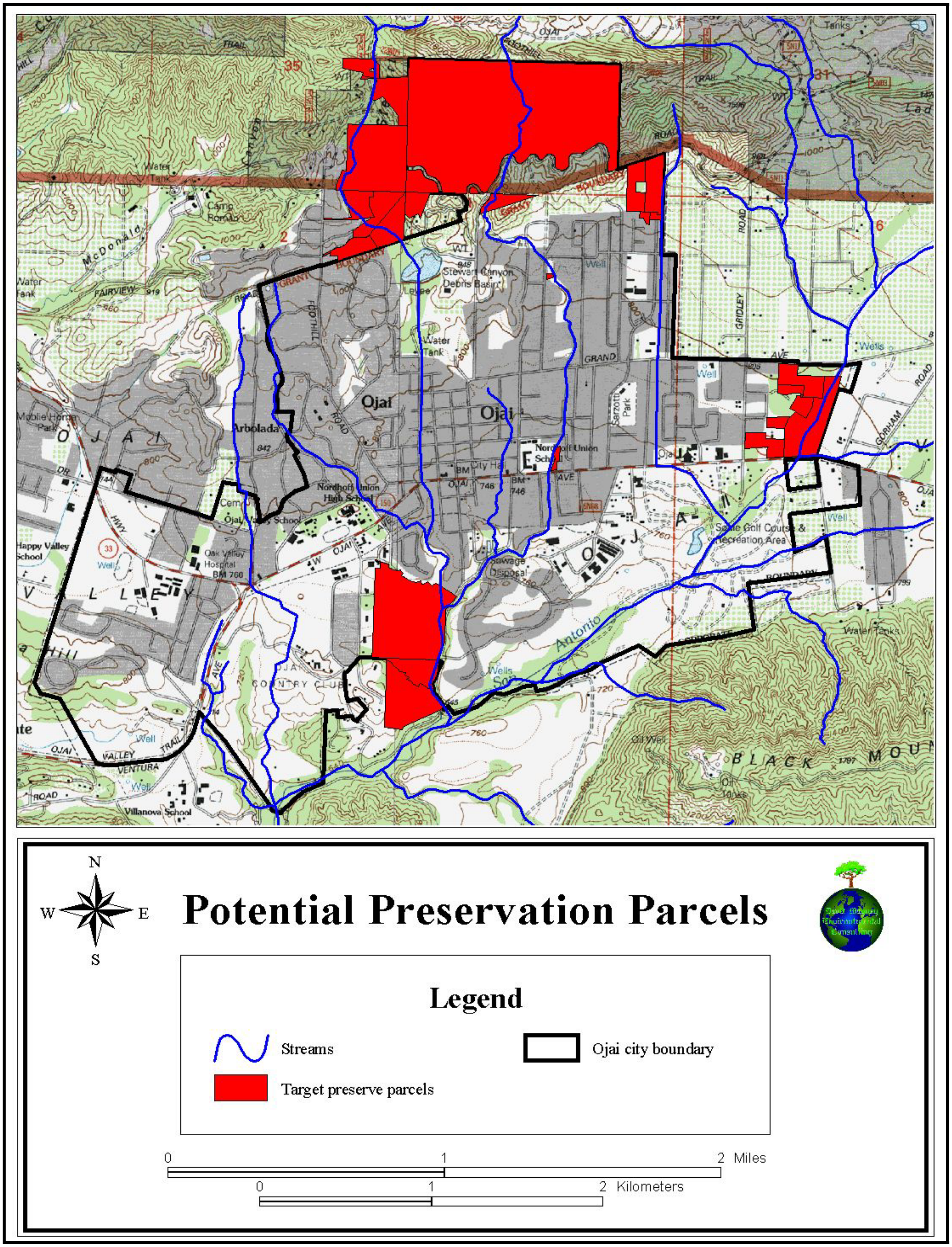
CONDUCT WATER QUALITY MONITORING IN CITY STREAMS (D-1)

Develop a water quality monitoring program, including regular water quality sampling at selected strategic sampling stations. Water quality parameters would focus on parameters important in measuring and determining minimum water quality conditions for aquatic life, such as: dissolved oxygen, *p*H, salinity, total dissolved solids, nitrogen, bacteria, temperature, surface flows, turbidity, pesticides, total organic carbon, heavy metals. This project would require the purchase of water quality sampling equipment and water flow meters. Aquatic invertebrates would also be sampled as they are valuable indicators of habitat quality.

Why monitor water quality? Human beings are constantly dependent on intake of water to maintain our health and well being. Human bodies are 60% water. Most Ojai drinking water is taken from local streams, reservoirs, and groundwater. The groundwater supply is recharged by local streams. As a result, it is very important to establish that surface waters have adequate purity. To determine this, environmental scientists monitor many physical, chemical, and biological characteristics such as the water's temperature, turbidity, dissolved oxygen content, and abundance of fecal coliform bacteria.

Fecal coliform bacteria are used to assess the quality of water because their presence is well correlated with the many waterborne disease-causing organisms or pathogens. These include bacteria, protozoans, and viruses and can cause diseases such as gastroenteritis, dysentery, typhoid fever, and cholera. Although fecal coliform bacteria are not necessarily pathogenic, they indicate the likely presence of pathogens and hence are referred to as indicator organisms. Their abundance is typically expressed as the number of colony forming units detected in 100 milliliters of a sample or CFU per 100 mL. Federal and state governments have set acceptable levels of fecal coliforms to provide guidelines for evaluating water safety.

Figure 26. Map of Potential Preserve Parcels



Fecal coliforms are naturally present in the intestines of warm-blooded animals and hence in their solid wastes. Solid wastes from pets, livestock, and wildlife can enter water bodies after rains run waste materials off the land. Other sources of fecal coliforms include sewage treatment plant effluent and leaking septic systems and sewer pipes. Most fecal coliforms die within days of release into the water bodies although some scientists have reported that fecal coliforms can survive in sediments of river bottoms and even reproduce. The presence of fecal coliforms in high quantities is interpreted as evidence of fecal contamination from warm-blooded animals and indicates the possible presence of pathogens. High levels are also associated with other water quality impairments including cloudy (or turbid) water, unpleasant odors, eutrophication (nutrient pollution), and an increased oxygen demand.

See Section "Total Coliform Bacteria" beginning on Page 62 for more a more detailed discussion of fecal coliform bacteria, and water quality standards for this parameter.

EDUCATE LANDOWNERS AND RESIDENTS

The City should educate landowners and residents about reducing animal waste entering City streams and drainages. The City should develop and distribute pamphlets describing what activities and substances degrade Ojai streams, and what actions each homeowner and resident can take to avoid or minimize the adverse effects of their actions. An educated public is much less likely to allow unhealthy conditions to exist or continue if they have the resources and knowledge on how to avoid or reduce such pollution on their own property.

Educate Landowners and Residents to Prevent Nonpoint Source Pollution Entering Drainages (D-2)

Nitrogen and phosphorus contaminate water and lead to impacts on aquatic habitats. These two natural elements are present in the environment naturally; however, abnormally high levels of these elements, found in manufactured fertilizers and laundry detergent, can result in adverse impacts on aquatic habitats and water quality.

Nitrogen is an essential nutrient for plant growth, and is one of the primary components of manure and commercial fertilizers. However, although nitrogen is very productive when applied to crops, excess nitrogen can have negative impacts in our lakes, rivers, and groundwater.[26]

- Because of its fertilizing properties, nitrogen is a key contributing factor to algae growth in streams and lakes.
- Excess nitrogen in rivers and streams can be toxic to aquatic animals at high levels. This toxicity is due to ammonium hydroxide (NH_4OH), which is produced at greater rates under conditions that are common where waste spills have occurred (such as low oxygen levels, high pH, and high temperature). Toxic levels of ammonium hydroxide are usually due to pollution from manure and sewage spills, and can result in fish kills and loss of other aquatic organisms.
- Nitrogen pollution also leads to human health concerns about groundwater contamination. Unlike phosphorus, which binds to the soil's surface, nitrogen filters down through the soil easily and can enter drinking wells. Infants less than six months are most susceptible to nitrate poisoning. High nitrate levels in groundwater can reduce the blood's capacity to carry oxygen, causing a fatal condition in infants called "blue baby syndrome". For this same reason, deaths can also occur in livestock that drink from a water supply high in nitrates. Pregnant or nursing women are advised to avoid water with high nitrate levels. Adults with heart or lung disease, certain inherited

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[26] Obtained from the Wisconsin Department of Natural Resources website (http://www.dnr.state.wi.us/org/water/wm/nps/ag/waterquality.htm.)

enzyme defects, or cancer may have increased sensitivity to the toxic effects, and adults with lifetime exposures to high nitrate levels may experience related health issues. The federal safety standard for Nitrate-N is 10 mg/L with a maximum contamination level (MCL) of 45 mg/L. Nitrate levels averaged 20.5 mg/L for Southern California Water Company groundwater in 1999 in Ojai (Southern California Water Company 2000).

How can nitrogen and phosphorus levels be reduced? For farmers, nutrient management is an integral part of business, and there are important steps that can be taken to reduce their nutrient loss to streams and lakes. The two main ways of reducing the nutrients that enter our waterways from agriculture are 1) decreasing the amount of nutrients applied to the landscape, and 2) preventing spills, runoff, and erosion from transporting those nutrients to our streams and drainages.[27]

- Decreasing excess nutrients applied to the landscape is the first step necessary for maintaining good water quality.
- Careful nutrient management planning can help farmers and landscapers determine how much nitrogen and phosphorus is in their manure and how much the crops on each field require to be productive. This planning can help fertilizer users apply only as much nitrogen and phosphorus as their plants will use, preventing excess runoff. In areas that already have phosphorus buildup in the soil or impacted waterways, applicators may need to manage specifically to reduce phosphorus levels.
- Use native plants to the maximum extent possible in landscaping. Plants indigenous to the Ojai Valley are already adapted to local soil and climate conditions, and generally do not need supplemental irrigation and fertilization. Reducing applications of both irrigation water and commercial fertilizers will result in lower levels of nitrogen and phosphorus from leaving the landscape and entering drainages and streams. Information about native plants can be obtained from nonprofit organizations such as the California Native Plant Society (CNPS – www.cnps.org, www.cnpsci.org), the Santa Barbara Botanic Garden, and from local water agencies (http://www.bewaterwise.com/). The Cluff Vista Park, at the intersection of Ojai Avenue, El Paseo, and Rincon Street, is an excellent example of how native plants can be attractively used as landscaping, many of which have low irrigation requirements.

Photograph 95. *Common Yarrow (*Achillea millefolium*) and other native plants are used exclusively at Cluff Vista Park in downtown Ojai.*

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[27] Obtained from Wisconsin Department of Natural Resources website: http://www.dnr.state.wi.us/org/water/wm/nps/ag/waterquality.htm.

Provide Technical Assistance to Landowners to Control Nonpoint Source Pollution (D-3a)

The City is a partner in the Ventura Countywide Stormwater Quality Management Program, which provides direction on how to control pollution from runoff. Education of the public is a large component of this Program, which includes providing pamphlets and brochures to new homeowners. Information is also included for the general public in City newsletters that are mailed to Ojai residents.

While brochures, newsletters, and pamphlets are very useful, they do not provide site-specific technical assistance that a property owner may need. For example, a property with a small horse corral that contains a drainage can be, and likely is, a direct source of fecal coliforms during rainstorms. The City could provide the property owner with technical assistance on how to properly buffer and/or filter out the pollutants from the surface runoff. Such technical assistance would be focused towards existing residences, not new construction. Such technical assistance for new construction is best provided, and should be provided, by the landscape architects and contractors, and building designers/engineers.

Provide Technical Assistance to Horse Owners (D-3b)

The City could provide technical assistance to horse owners with corrals to develop runoff treatment structures, such as: buffers needed; drainage filters; and educational materials to horse owners and feed stores. Instructions on where to safely discard horse manure should also be developed and dispensed. The City could help design site-specific structures or facilities to reduce animal waste from entering City streams. Another option would be to implement horse manure recycling center that would remove waste from the site and recycle it back into the local agricultural community as a natural fertilizer.

DEVELOP CITY POLICIES/ORDINANCES

The City should develop and/or modify City policies/ordinances to improve water quality within and downstream of Ojai. The City could implement a watershed-based approach to zoning and land-use planning. This approach would be based on the urban stream classification system presented earlier, with zoning modified to preserve or improve the classification of the various subwatersheds. The intent would be to preserve or reduce impervious cover percentages in subwatersheds where necessary.

Another ordinance to be considered would be one that regulates livestock/horse corrals to specifically protect water quality of adjacent streams. The City could consider minimum buffer setbacks from all streams, similar to that by Ventura County, but with more details and specific conditions used to guide decisionmakers on appropriate setback buffers.

Modify Zoning Codes to Minimize Impervious Cover for Each Parcel (D-4)

Impervious cover eliminates any ability of rainfall to infiltrate the soil. Infiltration of rainfall serves several important functions: groundwater recharge, filtration of pollutants, stormwater retention, a reduction of nonpoint source pollution from entering surface drainages, amelioration of peak flood flow levels, and a reduction of flood flow levels. The City could modify zoning codes to minimize impervious cover on all land uses. Impervious surfaces in high to medium density land uses could use less impervious materials, such as reticulated block matting, that allow some water infiltration while providing the desired stable walking/driving surface. This could easily be applied to driveways and walkways that are now constructed of asphalt or concrete.

Modify Building/Land Use Codes to Prevent Nonpoint Source Pollutants from Leaving Parcels (D-5)

Currently, nearly all rainfall that falls on homes, commercial buildings, and paved areas of residences and businesses runs off into the City drainage system, which then discharges directly into City streams. Runoff from roofs could be collected in underground cisterns onsite and allow natural leaching underground, similar to how septic system leach fields function, but with relatively clean water. This would both reduce surface runoff, which at times exceeds the capacity of the City flood runoff collection system, and allow the soil onsite to filter any contaminants locally rather than being discharged to the streams. A change in the Municipal Code would be onsite runoff collection and retention.

Modify Building/Land Use Codes to Require Stream/Drainage Crossings to be Sized to Prevent Adverse Changes to Fish or Aquatic Habitats (D-6)

Several of the culverts on streams flowing through Ojai are not large enough to accommodate natural fluvial processes, or habitat for fish. They are typically sized to accommodate expected flood flows according to specific runoff calculations (see Photographs 32, 59, and 64 as examples). This problem is endemic throughout southern California watersheds, such as the Calleguas Creek watershed (DMEC 2000).

The City should adhere to guidelines developed by CDFG and NOAA Fisheries that specify how stream crossing are to be constructed to provide salmonid passage rather than serving only one function: flood conveyance. Also, the City engineers should attend the annual Fish Passage Workshops held in southern California to become more familiar with fish passage requirements and needs.

Preserve Upland Portions of Watershed (D-7)

Development imposes a variety of changes on stream networks. These changes have profound physical and biological implications, many of which are obvious even to the casual observer. Unfortunately, most restoration attention is directed toward the channel and floodplain systems. It is rarely recognized that the stream network itself drains a watershed and, therefore, the specific characteristics of a stream reach are products of the cumulative impacts in the contributing area. Thus, the cumulative impacts to the upland portions of the contributing areas are commonly ignored in spite of the fact that the National Research Council (1992) has clearly articulated a position stating that changes in uplands are important in determining overall stream function.

Several areas of the upper watershed are currently undeveloped (see Figure 26). Access is difficult and slopes are steep, so these areas often are of low priority insofar as development is concerned. However, development of these areas is an important recent trend, in part due to the scarcity of undeveloped land in the lowlands. Unfortunately, these upland areas are characterized by rapid runoff and high erosion potential, even in their undisturbed states, and development of these areas exacerbates these problems. The preservation of large tracts of upper watershed is critical to the effective, long-term maintenance of the physical processes of the stream network.

CONCLUSIONS

The decline of California's Steelhead populations and habitat is illustrative of a trend of declining biodiversity due to habitat loss and degradation. Steelhead are unique in that they are dependent on essentially all habitats of a river system: the estuary for rearing and acclimation to ocean water; the main channel for migration between the ocean and upstream spawning and rearing areas; and the tributaries for spawning and rearing. This dependence on the entire river system explains, in part, why Steelhead was one of the first Southern Steelhead in California to experience dramatic declines in numbers and in distribution. (CDFG 1969.)

Restoration of Steelhead populations is intimately tied to the establishment of a new ethic for management of California's rivers and streams – an ethic that places a much higher priority on the continuance of essential physical, biological, and ecological processes in rivers that are regulated or proposed for development. In simpler terms, rivers need to flow and contain sufficient water to maintain their aquatic biota in good condition. Without this, aquatic habitat will continue to degrade, species will continue to decline, and there will be continued impasses on water usage and development. (CDFG 1969.)

The streams that flow through the City of Ojai are both in good condition and in poor condition, depending on the stream reach and past and present land uses in or adjacent to the streams. San Antonio Creek, which passes through the southeastern portion of the City is generally in good condition except where it passes through the Soule Golf Course, a Ventura County park facility. The best and largest Ojai stream for Steelhead (other than San Antonio Creek), Stewart Canyon Creek, has fairly good habitat in its downstream reach, but it is converted solely to flood water conveyance as it passes through the City. This has resulted in the truncation of suitable spawning and rearing habitat for Steelhead in Stewart Canyon north of the City.

Urban and rural runoff from parcels within the City have largely resulted in degraded water quality, and is a primary source for coliform bacteria contamination. The high percentage of impervious cover within the City contributes to poor water quality downstream.

All the reaches of streams that flow through the City are contaminated with invasive non-native plants, some intentionally planted. Natural vegetation has largely been eliminated along most reaches of Ojai streams. This has resulted in reduced habitat values for wildlife, both aquatic and terrestrial.

Wetland functions have been severely decreased within the City as a result of typical urban development.

Even with the general poor condition of Ojai's streams, there are many opportunities to protect what remains, and enhance and restore stream habitat conditions. Much can be done to improve water quality through minor changes in human practices and monitoring.

A few large-scale stream restoration projects could significantly restore favorable conditions for Steelhead; however, those projects would likely be very expensive. Some stream restoration projects simply may not be feasible due to high cost, limited benefit, and disruption to residents.

Preserving intact habitat should be accomplished. Remaining stream habitats within the City should be protected and enhanced. Implementation of recommended actions in this should improve conditions for Steelhead and other aquatic and riparian species, and water quality will be improved.

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PERSONAL COMMUNICATIONS

Pratt, Jeff, Director, VCWPD, email to David Magney (dmagney@aol.com) dated 14 February 2004 – "WPD would of course be open to modifications of its facilities to achieve fish passage with the caveat that you mentioned, i.e., full flood control function remained. You should coordinate any proposed activity with our advanced planning section (Sergio/Denny). Hope this helps. Jeff Pratt, P.E., Director, Watershed Protection Department, jeff.pratt@mail.co.ventura.ca.us"

ACKNOWLEDGEMENTS

This Ojai streams assessment and restoration report was written by Cher Batchelor and David Magney. Mr. Magney and Kenneth Niessen prepared the GIS database and graphics for this report. Mr. Magney managed all aspects of this project under the direction of Glenn Hawks of the City of Ojai Public Works Department.

Mr. Magney, Ms. Batchelor, Ken Niessen, and James Castle conducted the streams characterization field study, while Ms. Batchelor, Brian Holly, Zak Hansted (C.R.E.W.), and Erik Blundell (C.R.E.W.) conducted the streams water quality sampling field study. Ms. Batchelor and Mr. Holly performed in-lab tests for water quality parameters that could not be measured in the field. Water quality sampling equipment was loaned to DMEC and C.R.E.W. for this project by Nordhoff High School, of the Ojai Unified School District, for which the City is grateful.

Mr. Holly conducted cursory wildlife surveys at each Water Quality Sampling Station. Mr. Holly, Mr. Magney, and Elizabeth Chattin conducted a nighttime cursory wildlife survey in three creeks of Ojai. Ms. Batchelor, Mr. Magney, Mr. Niessen, and Mr. Castle reported all observed wildlife during the streams characterization studies throughout the streams of Ojai.

Barry Rands (Hawks & Associates) analyzed hydrology data of each of the streams to identify discharge rates for each subwatershed, and to determine how they affect the Ojai streams. These data were used to identify constraints and opportunities for any stream habitat restoration projects proposed under this study.

Glenn Hawks (Hawks & Associates) reviewed a draft of this report. John O'Brien, Associate Fisheries Biologist with CDFG, managed the grant for this project and provided comments on the final draft of this report.

This report was presented to the public at the Ojai City Hall on 27 April 2005. Comments were received and incorporated into this report as appropriate based on that presentation.

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APPENDIX A.

SAMPLE STREAM CHARACTERIZATION AND WATER QUALITY SAMPLING FIELD DATA SHEET

COMPLETED STREAM CHARACTERIZATION FIELD DATA SHEETS

COMPLETED WATER QUALITY SAMPLING FIELD DATA SHEETS

Stream Characterization and Water Quality Sampling Field Data Sheet

Date:	**Investigator(s):**			**Site ID #:**
Time:	**Lat.:**	**Long:**	**Waypoint #**	**Elev. ft.:**
Photo No:	**Photo Notes:**			

Drainage/Creek Name: ____________________

Site Location: ____________________

General Flow Conditions: ____________________

____

Channel Morphology (include stream banks): ____________________

Water Depth (3 cross sectional measurements in ft/in): _____ _____ _____ Avg. Depth (ft/in)__________

Water Width (ft/in)____________________

Stream Velocity ([10] feet / seconds)__________

Discharge (CFS)____________________

Stream Habitat Type: ____ Pool, ____ Riffle, ____ Run

Inundated? ____ Yes, ____ No

Cover Type: ____ Over-hanging Vegetation ____ Submerged Boulders ____ Logs ____ Root Wads
____ Submerged Vegetation ____ Undercut Banks ____ Other____________

Instream: ____________________

Riparian Habitat: ____________________

Shading: ____________________

Substrate Composition: ____________________

Particle Size Range: ____________________

Potential Spawning? ____ Yes, ____ No Potential Rearing? ____ Yes, ____ No

*p*H (0-14): ____________________

Dissolved Oxygen (mg/L & %): ____________________

Dissolved Oxygen (ppm): ____________________

Temperature (°C): ____________________

Conductivity (µS / mS): ____________________

Specific Conductance (µS / mS): ____________________

Salinity (ppt): ____________________

Carbon Dioxide: ____________________

Turbidity (NTUs): ____________________

Coliform Bacteria: ____________________

Hardness: ____________________

Other Observations: ____________________

____

____

____

____

____

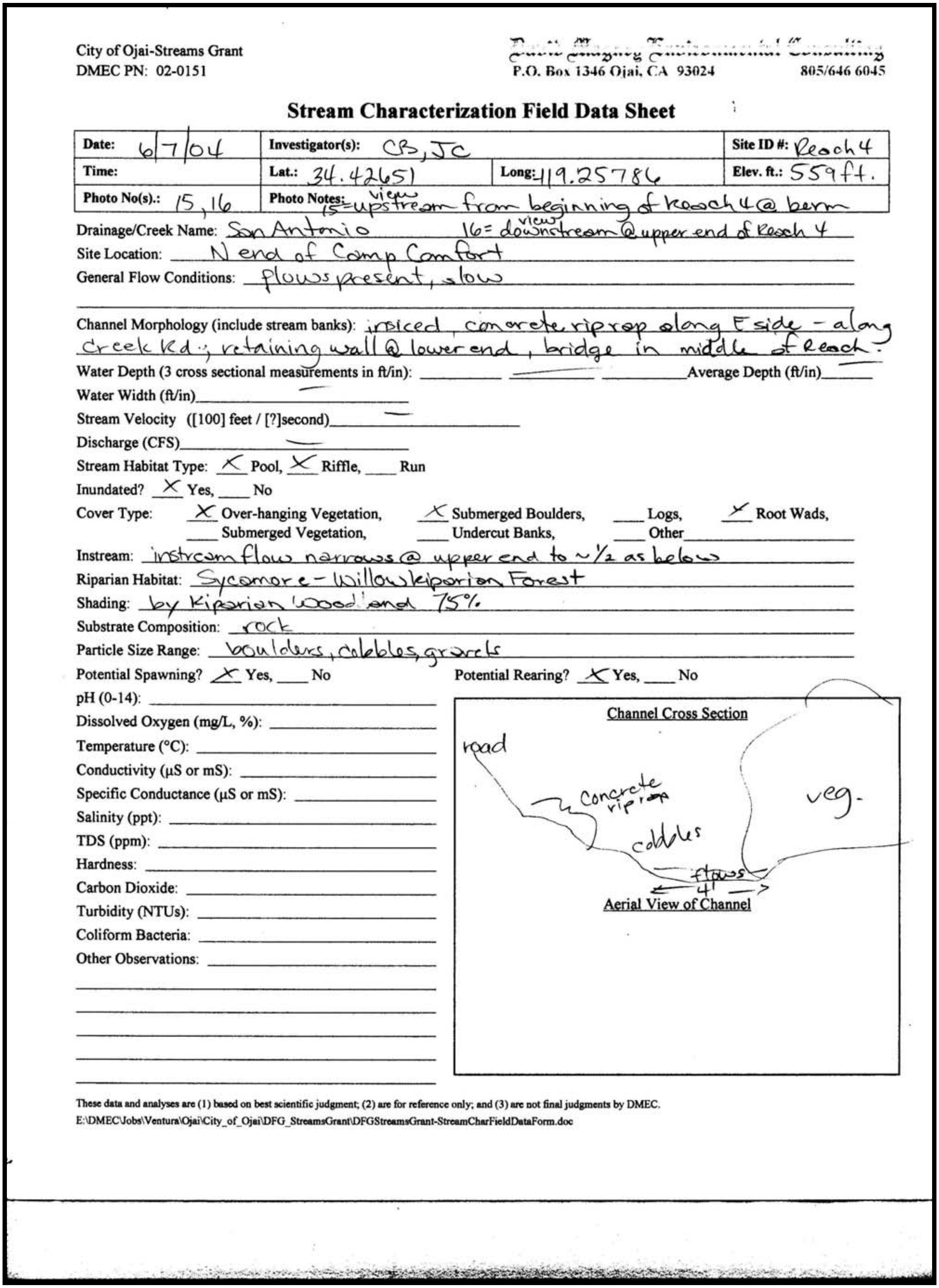
Channel Cross Section

Aerial View of Channel

APPENDIX A

(CONTINUED)

COMPLETED STREAM CHARACTERIZATION FIELD DATA SHEETS



City of Ojai-Streams Grant
DMEC PN: 02-0151

David Magney Environmental Consulting
P.O. Box 1346 Ojai, CA 93024 805/646 6045

Stream Characterization Field Data Sheet

Date: 6/7/04	**Investigator(s):** CB, JC		**Site ID #:** Reach 4
Time:	**Lat.:** 34.42651	**Long:** 119.25786	**Elev. ft.:** 559 ft.
Photo No(s).: 15, 16	**Photo Notes:** 15 = view upstream from beginning of Reach 4 @ berm		

Drainage/Creek Name: San Antonio 16 = view downstream @ upper end of Reach 4

Site Location: N end of Camp Comfort

General Flow Conditions: flows present, slow

Channel Morphology (include stream banks): insiced, concrete riprap along E side - along Creek Rd.; retaining wall @ lower end, bridge in middle of Reach.

Water Depth (3 cross sectional measurements in ft/in): ____ — ____ Average Depth (ft/in) —

Water Width (ft/in) —

Stream Velocity ([100] feet / [?]second) —

Discharge (CFS) —

Stream Habitat Type: X Pool, X Riffle, ____ Run

Inundated? X Yes, ____ No

Cover Type: X Over-hanging Vegetation, X Submerged Boulders, ____ Logs, ✓ Root Wads,
____ Submerged Vegetation, ____ Undercut Banks, ____ Other ____

Instream: instream flow narrows @ upper end to ~1/2 as below

Riparian Habitat: Sycamore - Willow Riparian Forest

Shading: by Riparian Woodland 75%

Substrate Composition: rock

Particle Size Range: boulders, cobbles, gravels

Potential Spawning? X Yes, ____ No

Potential Rearing? X Yes, ____ No

pH (0-14):
Dissolved Oxygen (mg/L, %):
Temperature (°C):
Conductivity (µS or mS):
Specific Conductance (µS or mS):
Salinity (ppt):
TDS (ppm):
Hardness:
Carbon Dioxide:
Turbidity (NTUs):
Coliform Bacteria:
Other Observations:

Channel Cross Section

Aerial View of Channel

These data and analyses are (1) based on best scientific judgment; (2) are for reference only; and (3) are not final judgments by DMEC.
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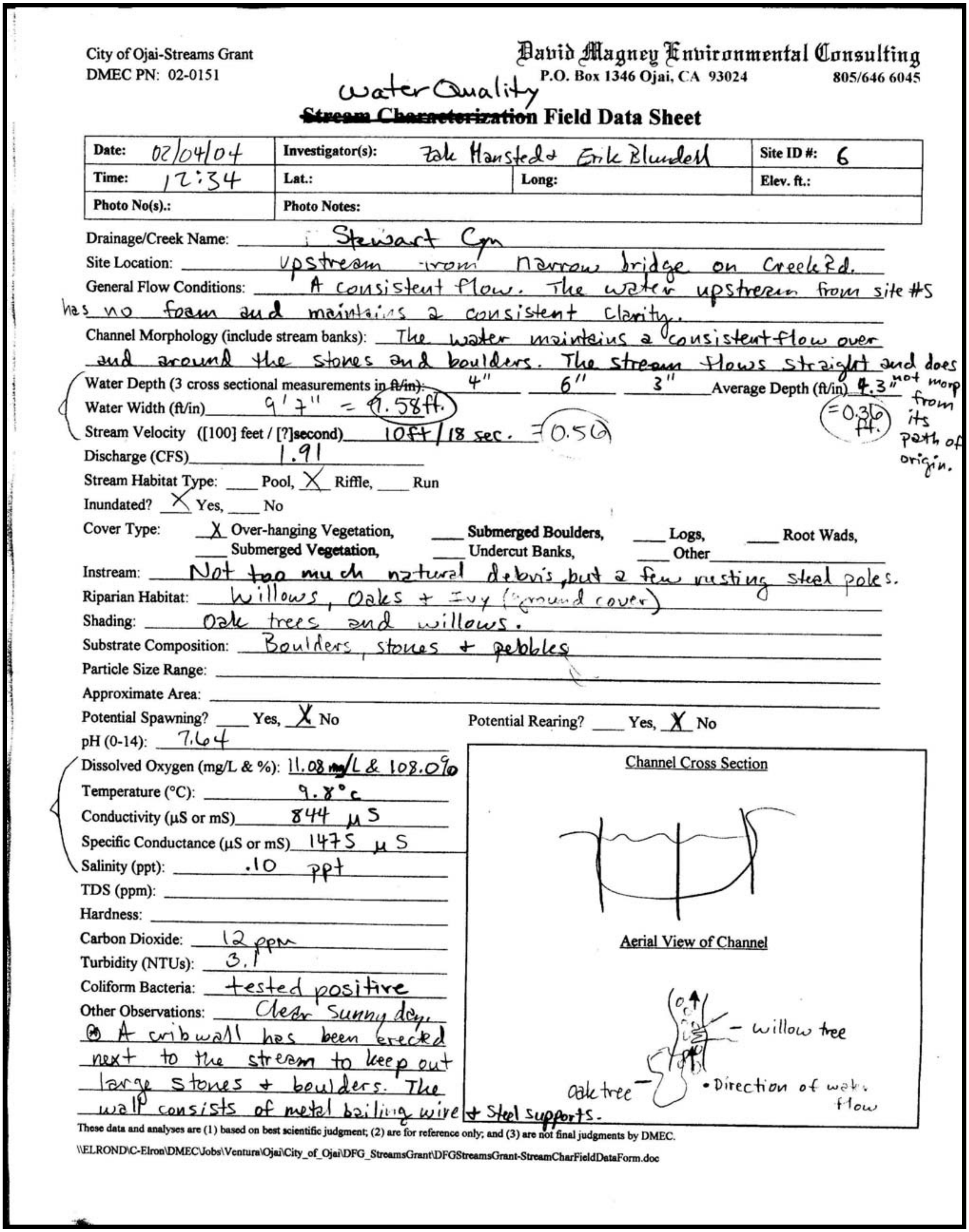
APPENDIX A
(CONTINUED)

COMPLETED WATER QUALITY SAMPLING FIELD DATA SHEETS



City of Ojai-Streams Grant
DMEC PN: 02-0151

David Magney Environmental Consulting
P.O. Box 1346 Ojai, CA 93024 805/646 6045

Water Quality ~~Stream Characterization~~ Field Data Sheet

Date: 02/04/04	**Investigator(s):** Zak Hansted & Erik Blundell		**Site ID #:** 6
Time: 12:34	**Lat.:**	**Long:**	**Elev. ft.:**
Photo No(s).:	**Photo Notes:**		

Drainage/Creek Name: Stewart Cyn
Site Location: upstream from narrow bridge on Creek Rd.
General Flow Conditions: A consistent flow. The water upstream from site #5 has no foam and maintains a consistent clarity.
Channel Morphology (include stream banks): The water maintains a consistent flow over and around the stones and boulders. The stream flows straight and does not morp from its path of origin.
Water Depth (3 cross sectional measurements in ~~ft/in~~): 4" 6" 3" Average Depth (ft/in) 4.3" (=0.36 ft.)
Water Width (ft/in) 9'7" = 9.58 ft.
Stream Velocity ([100] feet / [?]second) 10ft/18 sec. = 0.56
Discharge (CFS) 1.91
Stream Habitat Type: ___ Pool, X Riffle, ___ Run
Inundated? X Yes, ___ No
Cover Type: X Over-hanging Vegetation, ___ **Submerged Boulders,** ___ Logs, ___ Root Wads, ___ Submerged **Vegetation,** ___ Undercut Banks, ___ Other ___
Instream: Not too much natural debris, but a few rusting steel poles.
Riparian Habitat: Willows, Oaks + Ivy (ground cover)
Shading: Oak trees and willows.
Substrate Composition: Boulders, stones + pebbles
Particle Size Range:
Approximate Area:
Potential Spawning? ___ Yes, X No
Potential Rearing? ___ Yes, X No
pH (0-14): 7.64
Dissolved Oxygen (mg/L & %): 11.08 mg/L & 108.0%
Temperature (°C): 9.8°c
Conductivity (µS or mS) 844 µS
Specific Conductance (µS or mS) 1475 µS
Salinity (ppt): .10 ppt
TDS (ppm):
Hardness:
Carbon Dioxide: 12 ppm
Turbidity (NTUs): 3.1
Coliform Bacteria: tested positive
Other Observations: Clear sunny day.
* A cribwall has been erected next to the stream to keep out large stones + boulders. The wall consists of metal bailing wire + steel supports.

Channel Cross Section

Aerial View of Channel

- willow tree
oak tree
• Direction of water flow

These data and analyses are (1) based on best scientific judgment; (2) are for reference only; and (3) are not final judgments by DMEC.

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APPENDIX B.
OJAI STREAMS WATER QUALITY SAMPLING RESULTS

Appendix B. Ojai Streams Water Quality Sampling Results (Stations 1 & 2)

Site ID Number	**1**							**2**						
Drainage/Creek Name	**Happy Valley Drain**							**Villanova Creek**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	3-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	0.63	0.39	0.35	0.31	dry	0.42	**0.42**	0.33	0.61	0.53	1.75	0.42	0.5	**0.69**
Water Width (ft)	2.75	2.5	2.5	2.5	dry	2	**2.45**	6.42	9.92	14.5	17	4	12	**10.64**
Stream Velocity (ft/sec)	0.17	0.4	1.25	1.67	dry	0.38	**0.77**	0.42	1	0.71	2	1.67	1.67	**1.24**
Discharge (cfs)	0.29	0.39	1.09	1.29	dry	0.32	**0.68**	0.89	6.05	5.46	59.5	2.8	10.02	**14.12**
pH (0-14)	7.63	6.82	7.21	6.77	dry	7.55	**7.2**	7.67	7.88	7.81	7.65	.	8.24	**7.85**
Dissolved Oxygen (mg/L)	1.26	8.08	4.65	.	dry	7.36	**5.34**	3.81	12.78	5.21	.	8.73	11.18	**8.34**
Dissolved Oxygen (%)	10.2	74	45.3	.	dry	52.2	**45.42**	36.9	123.6	48.5	.	.	1.8	**52.7**
Dissolved Oxygen (ppm)	.	.	.	8.2	dry	.	**8.2**	.	.	.	9.6	.	.	**9.6**
Temperature (°C)	7.9	11.3	14.4	15.5	dry	6.9	**11.2**	11.1	13.1	13.1	15.7	12.5	10.6	**12.68**
Conductivity (µS)	363.3	82.9	out of range	240	dry	495	**295.3**	965	830	925	499	1492	543	**875.67**
Specific Conductance (µS)	543	311.9	250	.	dry	487.1	**398**	1360	1080	1200	.	.	756	**1099**
Salinity (ppt)	0.2	0.1	0.2	.	dry	0.2	**0.17**	0.7	0.5	0.3	.	0.2	0.3	**0.4**
Carbon Dioxide (ppm)	14	17	16	21	dry	5	**14.6**	13	9	10	8	15	6	**10.17**
Turbidity (NTUs)	20.9	59.8	33.9	11.1	dry	28	**30.74**	2.6	0.37	3.1	3.1	0.2	5	**2.39**
Coliform Bacteria	.	.	.	positive	dry	positive	**.**	.	.	.	positive	positive	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 3 & 4)

Site ID Number	**3**							**4**						
Drainage/Creek Name	**San Antonio Creek**							**San Antonio Creek**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	9-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	0.36	0.57	0.31	1.72	0.89	2	**0.97**	0.5	0.47	0.33	0.31	0.5	0.67	**0.46**
Water Width (ft)	8	12	14	16	5	9	**10.67**	10.67	17.33	16.33	30	6.5	11	**15.3**
Stream Velocity (ft/sec)	0.5	1.25	1.43	2.5	.33	2	**1.34**	0.33	1.25	1.11	1.67	0.71	2	**1.18**
Discharge (cfs)	1.44	8.55	6.21	68.8	1.47	36	**20.41**	1.78	10.18	5.99	15.5	2.31	14.74	**8.41**
pH (0-14)	7.74	7.87	7.86	7.65	.	8.03	**7.83**	7.83	7.76	7.84	7.71	.	7.97	**7.82**
Dissolved Oxygen (mg/L)	8.68	9.69	8.46	.	5.94	10.68	**8.69**	5.44	8.3	5.5	.	9.77	10.57	**7.9**
Dissolved Oxygen (%)	79.4	93.1	81.5	.	.	95.6	**87.4**	53.7	79.7	53.4	.	.	95.3	**70.52**
Dissolved Oxygen (ppm)	.	.	.	6	.	.	**6**	.	.	.	5.6	.	.	**5.6**
Temperature (°C)	12.1	13.6	13	15.9	12.8	10.5	**12.98**	12.5	14	13.1	15.9	13.1	10.6	**13.2**
Conductivity (µS)	99.8	863	936	535	1505	551	**748.3**	1010	884	938	557	1487	553	**904.83**
Specific Conductance (µS)	1327	1103	1216	.	.	762	**734.67**	1070	1120	1214	.	.	767	**1042.75**
Salinity (ppt)	0.7	0.6	0.6	.	0.8	0.4	**0.62**	0.5	0.6	0.3	.	0.1	0.4	**0.38**
Carbon Dioxide (ppm)	14	9	12	8	12.5	8	**10.58**	7	10	11	10	10.5	6	**9.08**
Turbidity (NTUs)	2.4	3.2	3.4	3.5	0.1	4	**2.52**	2.8	0.31	3.3	3.3	0.1	3	**2.13**
Coliform Bacteria	.	.	.	positive	positive	positive	**.**	positive	.	.	positive	positive	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 5 & 6)

Site ID Number	**5**							**6**						
Drainage/Creek Name	**San Antonio Creek**							**Stewart Canyon Creek**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	9-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	9-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	0.22	0.31	0.33	0.5	0.32	0.42	**0.35**	0.42	0.75	0.69	0.64	0.64	2.67	**0.92**
Water Width (ft)	10.83	14.25	15	15	6	9	**11.68**	8	10.92	12	11	11	9	**10.08**
Stream Velocity (ft/sec)	0.83	1.11	1.43	1.67	1.11	1.67	**1.3**	0.67	0.63	1.11	0.63	0.63	0.67	**0.71**
Discharge (cfs)	1.98	4.91	7.07	12.5	2.13	6.31	**5.82**	2.24	5.12	9.2	4.43	4.43	16.1	**6.5**
pH (0-14)	7.83	7.93	8.01	7.53	.	8.11	**7.88**	8	7.99	7.55	.	.	8.02	**7.84**
Dissolved Oxygen (mg/L)	9.47	7.52	6.35	.	8.22	11.02	**0.8**	7.27	6.3	.	9.03	9.03	10.46	**8.83**
Dissolved Oxygen (%)	93.7	71.1	60	.	.	101.4	**81.55**	69.9	57.5	.	.	.	94.7	**82.52**
Dissolved Oxygen (ppm)	.	.	.	9.6	.	.	**9.6**	.	.	8.88	.	.	.	**8.88**
Temperature (°C)	9.7	13.1	12.6	14.4	11.3	11.3	**12.07**	13.3	12.6	15.3	11.6	11.6	11.5	**12.35**
Conductivity (µS)	1034	972	1112	638	1426	668	**975**	1025	1118	680	1447	1447	675	**964.83**
Specific Conductance (µS)	1464	632	1460	.	.	905	**1115.25**	1349	1465	.	.	.	910	**1299.75**
Salinity (ppt)	0.2	0.2	0.7	.	0.4	0.4	**0.38**	0.7	0.6	.	0.7	0.7	0.5	**0.52**
Carbon Dioxide (ppm)	6	11	9	12	11	7	**9.33**	7	10	13	10	10	9	**10.17**
Turbidity (NTUs)	3.1	6.4	6	28.8	1.2	3	**8.08**	6.1	5.7	35.5	0.6	0.6	3	**9**
Coliform Bacteria	.	.	.	positive	positive	positive	**.**	.	.	positive	positive	positive	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 7 & 8)

Site ID Number	7							8						
Drainage/Creek Name	**Ojai Creek**							**Fox Canyon Barranca**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	9-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	9-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	0.33	0.25	0.5	0.5	0.14	0.19	**0.32**	0.28	0.31	0.19	0.28	0.14	0.33	**0.25**
Water Width (ft)	3	5	5.17	5	2	4	**4.03**	3.42	5.17	8	5	2.5	5	**4.85**
Stream Velocity (ft/sec)	0.55	0.07	0.5	1.25	0.5	1.11	**0.66**	0.77	1.11	1	1.25	0.91	1.43	**1.08**
Discharge (cfs)	0.54	0.09	0.04	3.13	0.14	0.84	**0.8**	0.74	1.78	1.52	1.75	0.32	2.36	**1.41**
pH (0-14)	7.6	7.54	7.67	7.24	.	7.56	**7.52**	7.57	7.5	7.75	7.35	.	7.83	**7.6**
Dissolved Oxygen (mg/L)	10.7	6.62	4.03	.	8.19	8.55	**7.62**	11.65	0	3.7	.	8.35	10.24	**6.79**
Dissolved Oxygen (%)	101	62.1	38.9	.	.	82.1	**71.02**	110.6	67.6	34.3	.	.	94.4	**76.72**
Dissolved Oxygen (ppm)	.	.	.	10	.	.	**10**	.	.	.	7.6	.	.	**7.6**
Temperature (°C)	13	15	14.2	16.1	14	13.4	**14.28**	12.3	14.4	13.3	15.8	12.9	11.6	**13.38**
Conductivity (µS)	407	.	1087	1062	1525	1145	**871**	190.5	.	1185	671	1319	904	**853.9**
Specific Conductance (µS)	585	1331	1371	.	.	1474	**1190.25**	1320	.	1529	.	.	1117	**1322**
Salinity (ppt)	0.4	0.7	0.2	.	0.2	0.7	**0.44**	0.1	0.1	0.5	.	0.1	0.5	**0.26**
Carbon Dioxide (ppm)	11	9	21	21	11.5	17	**15.08**	11	20	16	13	12	11	**13.83**
Turbidity (NTUs)	3.8	2.8	3	3.85	10.3	2	**4.29**	3.4	7.8	3.5	56.4	3.4	3	**12.92**
Coliform Bacteria	.	.	.	positive	positive	positive	**.**	.	.	.	positive	positive	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 9 & 10)

Site ID Number	**9**							**10**				**10A**			
Creek Name	**Arbolada Creek**							**Stewart Canyon Creek**				**Stewart Canyon Creek**			
Date	4-Feb-04	23-Feb-04	3-Mar-04	20-Oct-04	7-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	**Average**	20-Oct-04	7-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	0.42	0.28	0.25	0.25	dry	0.19	**0.28**	dry	dry	dry	**0**	0.39	dry	0.11	**0.25**
Water Width (ft)	3.75	1.5	2	2	dry	3	**2.45**	dry	dry	dry	**0**	8	dry	2	**5**
Stream Velocity (ft/sec)	0.1	0.25	0.23	0.48	dry	1.11	**0.43**	dry	dry	dry	**0**	2	dry	1.33	**1.66**
Discharge (cfs)	0.16	0.11	0.11	0.24	dry	0.63	**0.25**	dry	dry	dry	**0**	6.24	dry	0.29	**3.26**
pH (0-14)	7.33	7.52	7.75	7.44	dry	7.89	**7.59**	dry	dry	dry	**0**	7.5	dry	7.2	**7.35**
Dissolved Oxygen (mg/L)	0.43	6.66	2.67	.	dry	11.01	**5.2**	dry	dry	dry	**0**	.	dry	4.99	**4.99**
Dissolved Oxygen (%)	3.8	62.2	25	.	dry	99.3	**47.57**	dry	dry	dry	**0**	.	dry	50.4	**50.4**
Dissolved Oxygen (ppm)	.	.	.	4.4	dry	.	**4.4**	dry	dry	dry	**0**	12.1	dry	.	**12.1**
Temperature (°C)	9.1	13	12.6	16.1	dry	10.7	**12.3**	dry	dry	dry	**0**	18.5	dry	14.4	**16.45**
Conductivity (µS)	1615	.	1633	1320	dry	915	**1370.75**	dry	dry	dry	**0**	975	dry	578	**776.5**
Specific Conductance (µS)	2319	.	2138	.	dry	1261	**1906**	dry	dry	dry	**0**	.	dry	705	**705**
Salinity (ppt)	1.2	0.2	0.3	.	dry	0.6	**0.57**	dry	dry	dry	**0**	.	dry	0.3	**0.3**
Carbon Dioxide (ppm)	9	21	12	20	dry	9	**14.2**	dry	dry	dry	**0**	136	dry	14	**75**
Turbidity (NTUs)	2.5	5.4	4.3	2.4	dry	5	**3.92**	dry	dry	dry	**0**	3.35	dry	2	**2.67**
Coliform Bacteria	positive	.	.	positive	dry	positive	**.**	dry	dry	dry	**.**	positive	dry	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 11 & 12)

Site ID Number	**11**							**12**						
Drainage/Creek Name	**Ayers Creek**							**San Antonio Creek**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	5-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	5-Jan-05	**Average**
Average Depth (ft)	dry	dry	0.39	0.42	0.36	0.19	**0.34**	dry	dry	dry	0.33	dry	0.19	**0.26**
Water Width (ft)	dry	dry	5	5	4	3	**4.25**	dry	dry	dry	23	dry	13	**18**
Stream Velocity (ft/sec)	dry	dry	0.25	0.25	0.2	0.16	**0.21**	dry	dry	dry	1.43	dry	1.25	**1.34**
Discharge (cfs)	dry	dry	0.49	0.53	0.29	0.09	**0.35**	dry	dry	dry	10.84	dry	3.09	**6.96**
pH (0-14)	dry	dry	8.03	7.82	.	7.89	**7.91**	dry	dry	dry	8.23	dry	8.57	**8.4**
Dissolved Oxygen (mg/L)	dry	dry	6.16	.	9.61	9.24	**8.34**	dry	dry	dry	.	dry	11.48	**11.48**
Dissolved Oxygen (%)	dry	dry	62.5	.	.	91.6	**77.05**	dry	dry	dry	.	dry	101.8	**101.8**
Dissolved Oxygen (ppm)	dry	dry	.	10	.	.	**10**	dry	dry	dry	9.1	dry	.	**9.1**
Temperature (°C)	dry	dry	14.3	16.8	13.5	13.7	**14.57**	dry	dry	dry	18.5	dry	10.3	**14.4**
Conductivity (µS)	dry	dry	1335	661	560	1130	**921.5**	dry	dry	dry	1054	dry	478	**766**
Specific Conductance (µS)	dry	dry	1693	.	.	1932	**1812.5**	dry	dry	dry	.	dry	664	**664**
Salinity (ppt)	dry	dry	0.9	.	0.1	0.9	**0.63**	dry	dry	dry	.	dry	0.3	**0.3**
Carbon Dioxide (ppm)	dry	dry	6	11	6.5	17	**10.12**	dry	dry	dry	6	dry	7	**6.5**
Turbidity (NTUs)	dry	dry	14.7	12.6	83.6	3	**28.47**	dry	dry	dry	7.64	dry	5	**6.32**
Coliform Bacteria	dry	dry	.	positive	positive	positive	**.**	dry	dry	dry	positive	dry	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 13 & 14)

Site ID Number	**13**							**14**						
Drainage/Creek Name	**Thacher Creek**							**Fox Canyon Creek**						
Date	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	6-Jan-05	**Average**	4-Feb-04	23-Feb-04	2-Mar-04	20-Oct-04	8-Dec-04	6-Jan-05	**Average**
Average Depth (ft)	dry	dry	dry	dry	dry	0.39	**0.39**	dry	dry	4	4	0.94	2	**2.73**
Water Width (ft)	dry	dry	dry	dry	dry	6	**6**	dry	dry	19	19	6	13	**14.25**
Stream Velocity (ft/sec)	dry	dry	dry	dry	dry	0.5	**0.5**	dry	dry	.	.	.	0.1	**0.1**
Discharge (cfs)	dry	dry	dry	dry	dry	1.17	**1.17**	dry	dry	.	.	.	2.63	**2.63**
pH (0-14)	dry	dry	dry	dry	dry	8.34	**8.34**	dry	dry	8.08	8.26	.	8.11	**8.15**
Dissolved Oxygen (mg/L)	dry	dry	dry	dry	dry	11.62	**11.62**	dry	dry	5.66	.	8.79	9.68	**8.04**
Dissolved Oxygen (%)	dry	dry	dry	dry	dry	93.9	**93.9**	dry	dry	55.4	.	81	89.4	**75.27**
Dissolved Oxygen (ppm)	dry	dry	dry	dry	dry	.	**.**	dry	dry	.	5.5	.	.	**5.5**
Temperature (°C)	dry	dry	dry	dry	dry	7.7	**7.7**	dry	dry	15.2	18.5	11.3	13.3	**14.57**
Conductivity (µS)	dry	dry	dry	dry	dry	475	**475**	dry	dry	1433	942	1300	931	**1151.5**
Specific Conductance (µS)	dry	dry	dry	dry	dry	710	**710**	dry	dry	1763	.	.	1202	**1482.5**
Salinity (ppt)	dry	dry	dry	dry	dry	0.3	**0.3**	dry	dry	0.9	.	0.2	0.5	**0.53**
Carbon Dioxide (ppm)	dry	dry	dry	dry	dry	8	**8**	dry	dry	5	10	9.5	7	**7.87**
Turbidity (NTUs)	dry	dry	dry	dry	dry	9	**9**	dry	dry	3.6	15.2	8.1	2	**7.22**
Coliform Bacteria	dry	dry	dry	dry	dry	positive	**.**	dry	dry	.	positive	positive	positive	**.**

Appendix B (continued). Ojai Streams Water Quality Sampling Results (Stations 15, 16, 17, & 18)

Site ID Number	**15**				**16**				**17**				**18**		
Drainage/Creek Name	**Stewart Canyon Creek**				**Arbolada Creek**				**Del Norte Creek**				**Del Norte Creek**		
Date	20-Oct-04	8-Dec-04	6-Jan-05	**Average**	20-Oct-04	8-Dec-04	9-Jan-05	**Average**	20-Oct-04	8-Dec-04	9-Jan-05	**Average**	9-Dec-04	6-Jan-05	**Average**
Average Depth (ft)	0.36	0.19	0.67	**0.41**	dry	dry	4	**4**	0.42	0.33	5	**1.92**	0.33	3.67	**2**
Water Width (ft)	3	4	7	**4.67**	dry	dry	7	**7**	2.25	0.5	7	**3.25**	2.5	3	**2.75**
Stream Velocity (ft/sec)	0.56	0.33	0.71	**0.53**	dry	dry	3.33	**3.33**	0.67	0.4	3.33	**1.47**	0.67	1.11	**0.89**
Discharge (cfs)	0.6	0.25	3.33	**1.39**	dry	dry	93.33	**93.33**	0.63	0.07	116.55	**39.08**	0.55	12.23	**6.39**
pH (0-14)	8.05	.	8.15	**8.1**	dry	dry	7.73	**7.73**	7.9	.	7.7	**7.8**	.	7.76	**7.76**
Dissolved Oxygen (mg/L)	.	11.3	10.01	**10.65**	dry	dry	.	**.**	.	6.33	.	**6.33**	6.49	10.44	**8.46**
Dissolved Oxygen (%)	.	.	98.5	**98.5**	dry	dry	.	·	.	.	.	**.**	.	93.7	**93.7**
Dissolved Oxygen (ppm)	11.9	.	.	**11.9**	dry	dry	.	·	6.9	.	.	**6.9**	.	.	**.**
Temperature (°C)	17.3	12	14.4	**14.57**	dry	dry	14.5	**14.5**	16.1	10.7	14.5	**13.77**	10.1	9.8	**9.95**
Conductivity (µS)	1345	1738	613	**1232**	dry	dry	.	·	622	1285	0	**953.5**	314	1157	**735.5**
Specific Conductance (µS)	.	.	768	**768**	dry	dry	.	·	.	.	.	**.**	.	1630	**1630**
Salinity (ppt)	.	0.3	0.4	**0.35**	dry	dry	.	·	.	0.3	.	**0.3**	0.3	0.8	**0.55**
Carbon Dioxide (ppm)	13	.	6	**6.33**	dry	dry	6	**6**	18	18.5	5	**13.83**	14	16	**15**
Turbidity (NTUs)	2.21	16.7	2	**6.97**	dry	dry	246	**246**	5.65	1.9	194	**67.18**	2.1	3	**2.55**
Coliform Bacteria	positive	positive	positive	**.**	dry	dry	positive	**.**	positive	positive	positive	**.**	positive	positive	**.**

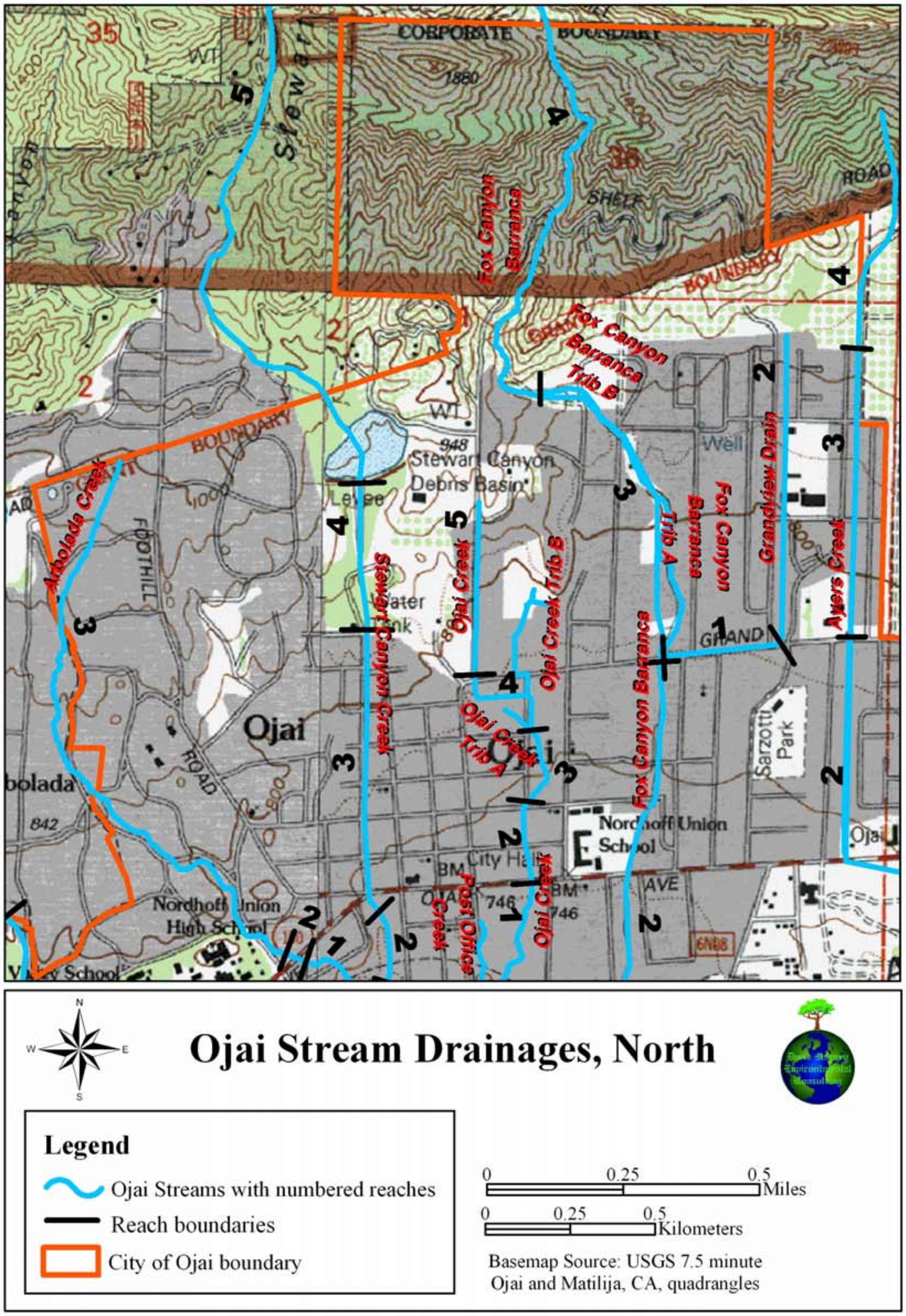
APPENDIX C.
SUMMARY TABLE OF CREEK OBSTRUCTIONS

Stream	**Type of Obstruction**	**Material of Obstruction**	**Road Crossing?**	**Cross-section of Obstruction**	**Width of Obstruction** (in.)	**Height of Obstruction** (in.)	**Length of Obstruction** (ft.)	**Within City Limits?**	**Source**
Villanova	Road crossing culvert	RCP	Yes	Circular	36	36	60	Yes	CAD
Del Norte	Road crossing culvert	Wood	Yes	Square	48	48	50	Yes	CAD
Del Norte	Road crossing culvert	RCP	Yes	Square	48	48	160	Yes	CAD
Del Norte	Underground (upstream)	RCB	Yes	Rectangular	60	66	100	Yes	CAD
Del Norte	Pipe change	HDPE	No	Circle	36	36	800	Yes	CAD
Del Norte	Bridge	-	Yes	Arch	72	42	50	No	CAD
Del Norte	Road crossing culvert	CMP	Yes	Circle	15	15	50	No	CAD
Del Norte	Road crossing culvert	CMP	Yes	Circle	36	36	160	No	CAD
Oak Creek	Road crossing culvert	RCP	Yes	Circle	30	30	50	Yes	CAD
Oak Creek	Road crossing culvert	CP	Yes	Circle	30	30	50	Yes	CAD
Arbolada	Road crossing culvert	CMP	Yes	Circular	48	48	50	Yes	CAD
Arbolada	Road crossing culvert	CMP	Yes	Circular	36	36	120	Yes	CAD
Arbolada	Underground (upstream)	CMP	Yes	Circular	36	36	120	Yes	CAD
Arbolada	Road crossing culvert	-	Yes	Arch top	48	48	120	Yes	CAD
Arbolada	Road crossing culvert	RCP	Yes	Circular	36	36	90	Yes	CAD
Arbolada	Road crossing culvert	RCB	Yes	Rectangle	48	30	80	Yes	CAD
Arbolada	Road crossing culvert	CMP	Yes	Circle	30	30	60	Yes	CAD
Arbolada	Road crossing culvert	Concrete box	Yes	Arch	48	30	100	Yes	CAD
Arbolada	Road crossing culvert	CMP	Yes	Circle	24	24	90	Yes	CAD
Arbolada	Pipe change	CP	No	Circular	48	48	100	Yes	CAD
Stewart Canyon Creek	Bridge	-	Yes	Rectangle	-	-	70	No	CAD
Stewart Canyon Creek	Bridge	-	Yes	Rectangle	-	-	70	Yes	CAD
Stewart Canyon Creek	Underground (upstream)	RCB	No	Rectangular	120	132	2750	Yes	CAD
Fox Canyon Barranca	Bridge	RC	Yes	Rectangular	120	60	90	Yes	CAD
Fox Canyon Barranca	Road crossing culvert	2x RCB	Yes	2x rectangular	144	72	80	Yes	CAD
Ojai Stream	Road crossing culvert	2x CMP	Yes	2x circular	66	66	60	Yes	CAD
Fox Canyon Barranca	Bridge	-	Yes	Rectangle	-	-	90	Yes	CAD
Fox Canyon Barranca	Road crossing culvert	Concrete box	Yes	Square	120	120	100	Yes	CAD
Fox Canyon Barranca	Road crossing culvert	Concrete box	Yes	Square	120	120	60	Yes	CAD

Stream	**Type of Obstruction**	**Material of Obstruction**	**Road Crossing?**	**Cross-section of Obstruction**	**Width of Obstruction** (in.)	**Height of Obstruction** (in.)	**Length of Obstruction** (ft.)	**Within City Limits?**	**Source**
Fox Canyon Barranca	Road crossing culvert	Concrete box	Yes	Square	120	120	50	Yes	CAD
Fox Canyon Barranca	Underground (upstream)	RCP	No	Circular	66	66	3210	Yes	CAD
Post Office Creek	Road crossing culvert	RCP	Yes	Circular	60	60	70	Yes	CAD
Ojai Creek	Road crossing culvert	Wooden box	Yes	Rectangle	90	48	70	Yes	CAD
Ojai Creek	Underground (upstream)	RCB	Yes	Rectangle	96	60	100	Yes	CAD
Ojai Creek	Pipe change	CMPA	No	Rectangle	58	36	60	Yes	CAD
Ojai Creek	Pipe change	RCP	No	Circle	54	54	310	Yes	CAD
Ojai Creek	Pipe change	RCP	No	Circle	60	60	140	Yes	CAD
Ojai Creek	Pipe change	RCP	No	Circle	63	63	170	Yes	CAD
Ojai Creek	Bridge	-	Yes	Rectangle	144	60	120	Yes	CAD
Ojai Creek	Underground (upstream)	RCP	No	Circle	36	36	1070	Yes	CAD
Ojai Creek Trib B	Pipe change	CMP	No	Circular	30	30	210	Yes	CAD
Grandview Drain	Pipe change	RCB	No	Rectangle	78	58	1180	Yes	CAD
Grandview Drain	Road crossing culvert	RCB	Yes	Rectangle	24	60	50	Yes	CAD
Grandview Drain	Road crossing culvert	RCP	Yes	Circular	36	36	50	Yes	CAD
Ayers Creek	Underground (upstream)	CIPP	No	Circle	48	48	1960	Yes	CAD
Ayers Creek	Road crossing culvert	RCB	Yes	Rectangle	36	72	50	Yes	CAD
Ayers Creek	Road crossing culvert	RCB	Yes	Rectangle	36	60	50	Yes	CAD
Ayers Creek	Pipe change	CIPP	No	Circle	36	36	2140	Yes	CAD
San Antonio Creek	Bridge	-	Yes	Rectangle	-	-	90	No	CAD
San Antonio Creek	Bridge	-	Yes	Rectangle	-	-	100	Yes	CAD
San Antonio Creek	Bridge	-	Yes	Rectangle	-	-	90	No	CAD
Ojai Creek	Pipe change	HDPE	No	Circle	18	18	340	Yes	CAD
San Antonio Creek	Arizona crossing	Concrete	Yes	-	-	-	-	Yes	Airphoto
Fox Canyon Barranca	Road crossing culvert	Concrete	Yes	Circle	-	-	-	Yes	Survey
Fox Canyon Barranca	Dam	Concrete	No	-	-	12	-	Yes	Survey
Ayers Creek Trib B	Pipe change	-	No	-	-	-	-	Yes	-
Del Norte Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ayers Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-

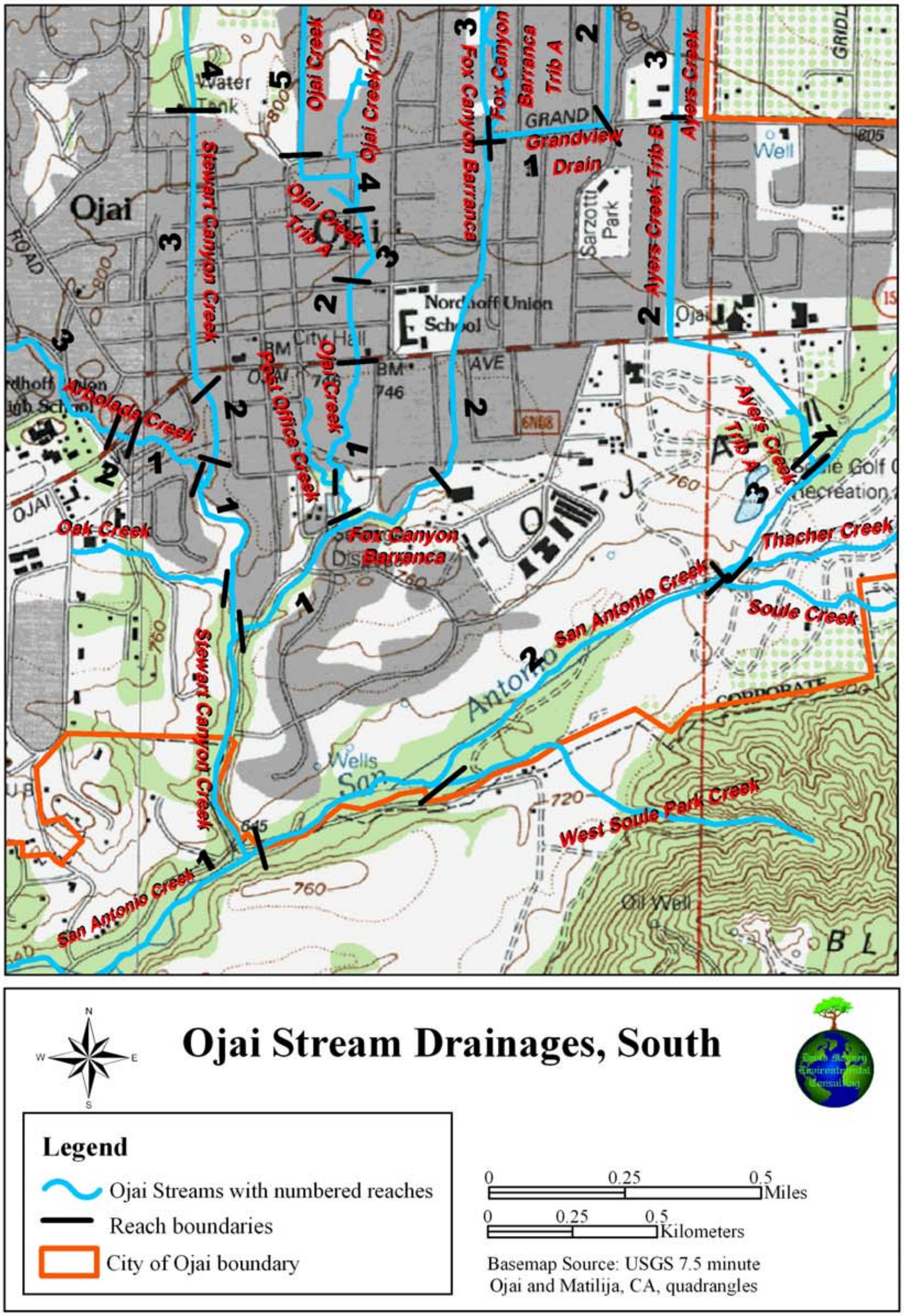
Stream	Type of Obstruction	Material of Obstruction	Road Crossing?	Cross-section of Obstruction	Width of Obstruction (in.)	Height of Obstruction (in.)	Length of Obstruction (ft.)	Within City Limits?	Source
Grandview Drain	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ojai Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ojai Creek Trib B	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ojai Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-
Stewart Canyon Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-
Stewart Canyon Creek	Standpipe	-	No	-	-	-	-	Yes	-
Stewart Canyon Creek	Underground (upstream)	-	No	-	-	-	-	Yes	-
Grandview Drain	Underground (downstream)	-	No	-	-	-	-	Yes	-
Fox Canyon Barranca	Bridge	-	Yes	-	-	-	-	Yes	-
Fox Canyon Barr A	Upstream blockage	-	No	-	-	-	-	Yes	-
Fox Canyon Barr B	Upstream blockage	-	No	-	-	-	-	Yes	-
Fox Canyon Barr C	Upstream blockage	-	No	-	-	-	-	Yes	-
Ayers Creek	Upstream blockage	-	No	-	-	-	-	Yes	-
Arbolada Creek	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ayers Creek Trib A 3	Upstream blockage	-	No	-	-	-	-	Yes	-
Ayers Creek Trib A 2	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ayers Creek Trib A 3	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ayers Creek Trib A	Upstream blockage	-	No	-	-	-	-	Yes	-
Ayers Creek Trib A 2	Upstream blockage	-	No	-	-	-	-	Yes	-
Del Norte Trib A	Upstream blockage	-	No	-	-	-	-	Yes	-
Del Norte	Underground (upstream)	-	No	-	-	-	-	Yes	-
Del Norte	Underground (downstream)	-	No	-	-	-	-	Yes	-
Ojai Creek Trib A	Upstream blockage	-	No	-	-	-	-	Yes	-
Country Club Creek	Road crossing culvert	-	Yes	-	-	-	-	Yes	-
Fox Canyon Barranca	Underground (downstream)	-	No	-	-	-	-	Yes	-
Fox Cyn Barranca Trib C	Underground (downstream)	-		-	-	-	-	Yes	-
Fox Cyn Barranca Trib B	Underground (downstream)	-	No	-	-	-	-	Yes	-
Stewart Canyon Creek	Dam	-	No	-	-	-	-	Yes	-

APPENDIX D.
SMALL SCALE TOPO MAPS OF OJAI STREAM DRAINAGES (NORTH, SOUTH, EAST, & WEST PORTIONS OF CITY LIMITS)

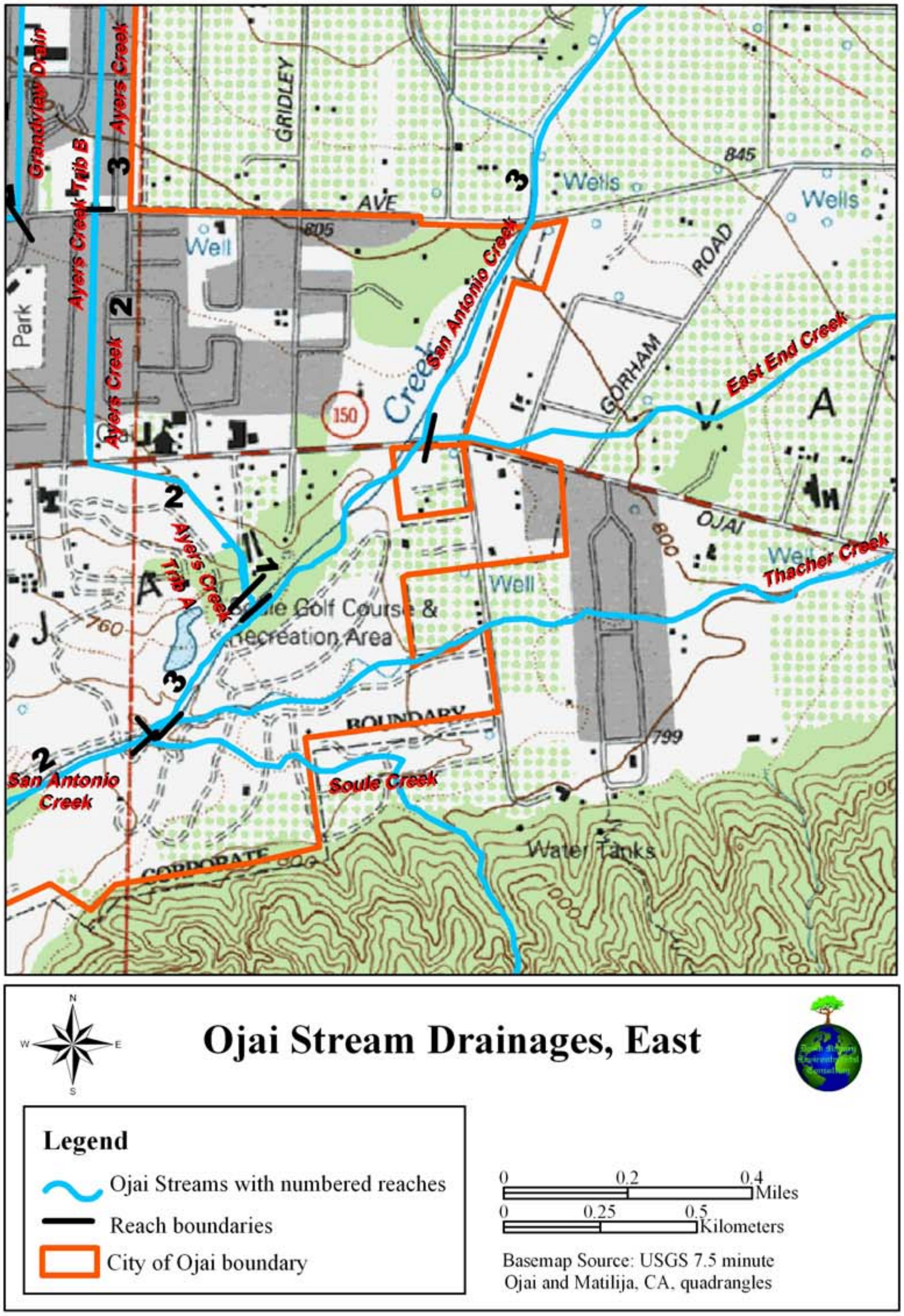


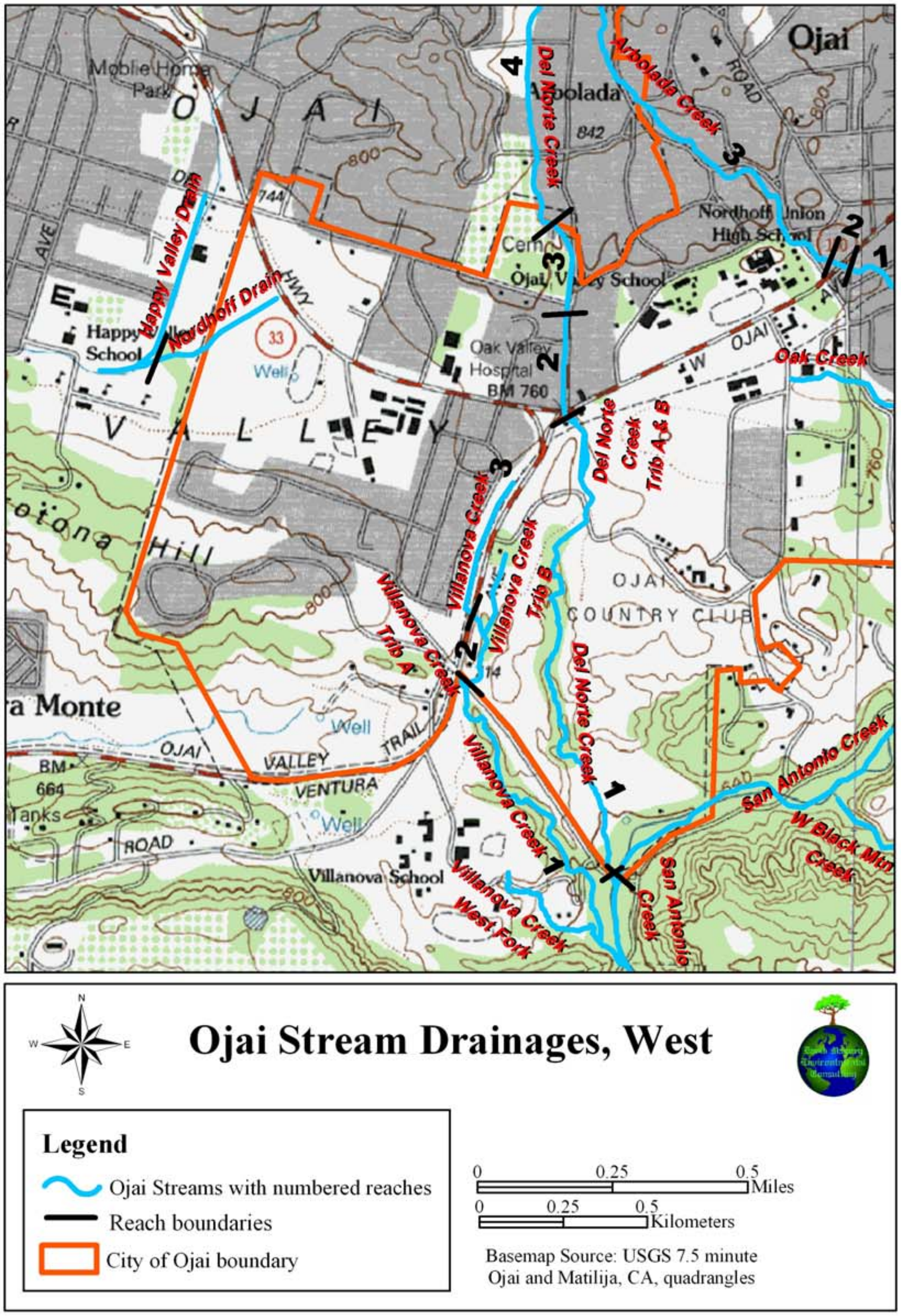
Ojai Stream Drainages, North

Basemap Source: USGS 7.5 minute Ojai and Matilija, CA, quadrangles



Ojai Stream Drainages, South


Grandview Drain
Ayers Creek
Ayers Creek Trib B
Ayers Creek
Ayers Creek
Ayers Creek Trib A
San Antonio Creek
San Antonio Creek
East End Creek
Thacher Creek
Soule Creek
Creek
GRIDLEY
AVE
ROAD
GORHAM
OJAI
BOUNDARY
CORPORATE
Wells
Wells
Well
Well
Well
Park
Soule Golf Course & Recreation Area
Water Tanks
845
805
800
760
799
150
A
A
1
1
2
2
2
2
3
3
3
3
N
S
E
W
Ojai Stream Drainages, East
Legend
Ojai Streams with numbered reaches
Reach boundaries
City of Ojai boundary
0
0.2
0.4
Miles
0
0.25
0.5
Kilometers
Basemap Source: USGS 7.5 minute
Ojai and Matilija, CA, quadrangles



Ojai Stream Drainages, West

Basemap Source: USGS 7.5 minute Ojai and Matilija, CA, quadrangles