3.5 Water Resource Infrastructure

The four water resource areas are:

1. Flood Management
2. Water Quality
3. Water Supply
4. Habitat

Each of these areas is discussed in the following sections.

3.5.1 Flood Management

The following quote from the 2002 California Floodplain Management Task Force report summarizes recent state laws that address flood management:

"Flood management is an overarching term that encompasses both floodwater management and floodplain management. AB 1147, which authorized the creation of the California Floodplain Management Task Force, provides significant financial incentives for multi-purpose flood management projects that also address ecosystem and recreational needs. The Safe Drinking Water, Watershed Protection, and Flood Protection Act of 2000 (Proposition 13) funded projects that combine flood protection with agricultural conservation and ecosystem protection. The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50) contains additional incentives for watershed-based management approaches." (2002. California Floodplain Management Task Force).

The Orange County Flood Control District (OCFCD), established May 23rd,1927, under authorization of the Orange County Flood Control Act, Chapter 723 of the State of California Statutes of 1927, was created to provide for control of flood and stormwaters of the district (delineated by the Orange County boundary) and of streams flowing into the district (e.g., the Santa Ana River or San Juan Creek); to mitigate the effects of tides and waves; and to protect the harbors, waterways, public highways and property in the district from such waters.

The authority of OCFCD was expanded in a series of amendments to the California Water Code. Appendix 36 of the Water Code states that the purposes of the Orange County Flood Control Act "are to provide for the control of the flood and stormwaters of the district, …and to conserve those waters for beneficial and useful purposes by spreading, storing, retaining, and causing them to percolate into the soil within the district, … or to save or conserve in any manner all or any of those waters and protect from damage from those flow or store waters, the harbors, waterways, public highways and property in the district."

Chapter 36 also states that "the Orange County Flood Control District is hereby declared to be a body corporate and politic and has all the following powers:

- "(5) To acquire, or contract to acquire, lands, rights-of way, easements, privileges and property of every kind, and to construct, maintain and operate any and all works or improvements within or outside the district necessary or proper to carry out any of the objects or purposes of the act, and to complete, extend, add to, repair, or otherwise improve any works or improvements acquired by it as authorized on this act."
- "(14) To monitor, test, or inspect drainage, flood, storm, or other waters within the district for the purpose of recording, determining, and report the quality of the waters to appropriate regional water quality control boards."
- "(16) To carry on technical and other investigations, examinations, or tests of all kinds, make measurements, collect data, and make analyses, studies, and inspections pertaining to water supply, control of floods, use of water, water quality, nuisance, pollution, waste, and contamination of water, both within and outside the district."

The Orange County Flood Control District, administered by Orange County Public Works (OC Public Works), is governed by the Orange County Board of Supervisors. OCFCD is a political entity that has no employees, but owns land and assesses an annual benefit on all taxable real property in Orange County (not to exceed $0.20 on each $100 of assessed value or 0.2 percent of collected real property tax). Because OCFCD has no specific employees, the District and its property are administered, maintained, and operated by OC Public Works staff. Jurisdiction over flood control infrastructure in the Region is based on who built the infrastructure. In most cases, these projects were implemented by the Orange County Flood Control District (OCFCD). However, in some cases, the Army Corps of Engineers or a local municipal jurisdiction has implemented a project, and now has operations and maintenance responsibility.

The Region's flood control and surface water conveyance infrastructure defines how and where water moves through this hydrologic region. It defines the physical relationship between land and water, which supports all other ecological processes. In natural conditions, when it rains, a large percentage of that water soaks into the ground, reducing the amount of water that runs downhill into the nearest stream channel. As land becomes paved over with impermeable surfaces such as roads, roofs and parking lots, it can no longer absorb its share of the water, so greater amounts of water flow into the stream channels. In addition, drainage requirements for real estate development require grading practices that drain this water into nearby channels as fast as possible. This means that, not only is more water flowing directly into stream channels without getting absorbed into the ground, it's flowing into those channels at one time. This concentrated surge of water causes streams to flood and banks to erode, thus increasing the need to reinforce the banks and replace riparian habitat with concrete drainage channels. However, within the aforementioned forces at play within the hydrologic system, this response has been dealing with the symptoms and not the cause. Canyon erosion, sediment accumulation, loss of habitat, and water quality problems are all symptoms that the components of our watershed's basic hydrology are out of balance with each other.

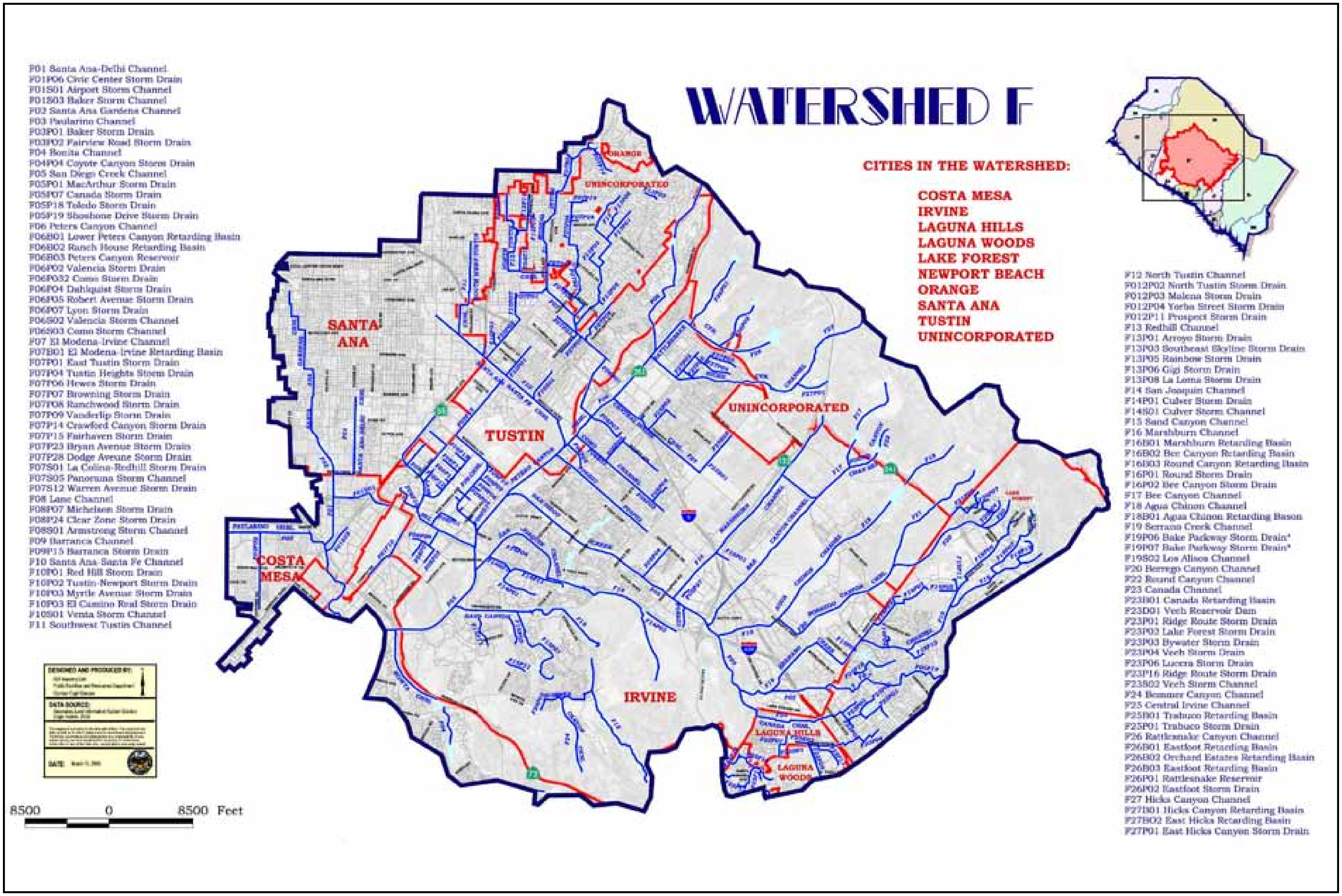

Figure 3.17 San Diego Creek Subwatershed. Flood Control Facilities – Major County Structures. (Orange County Flood Control District)

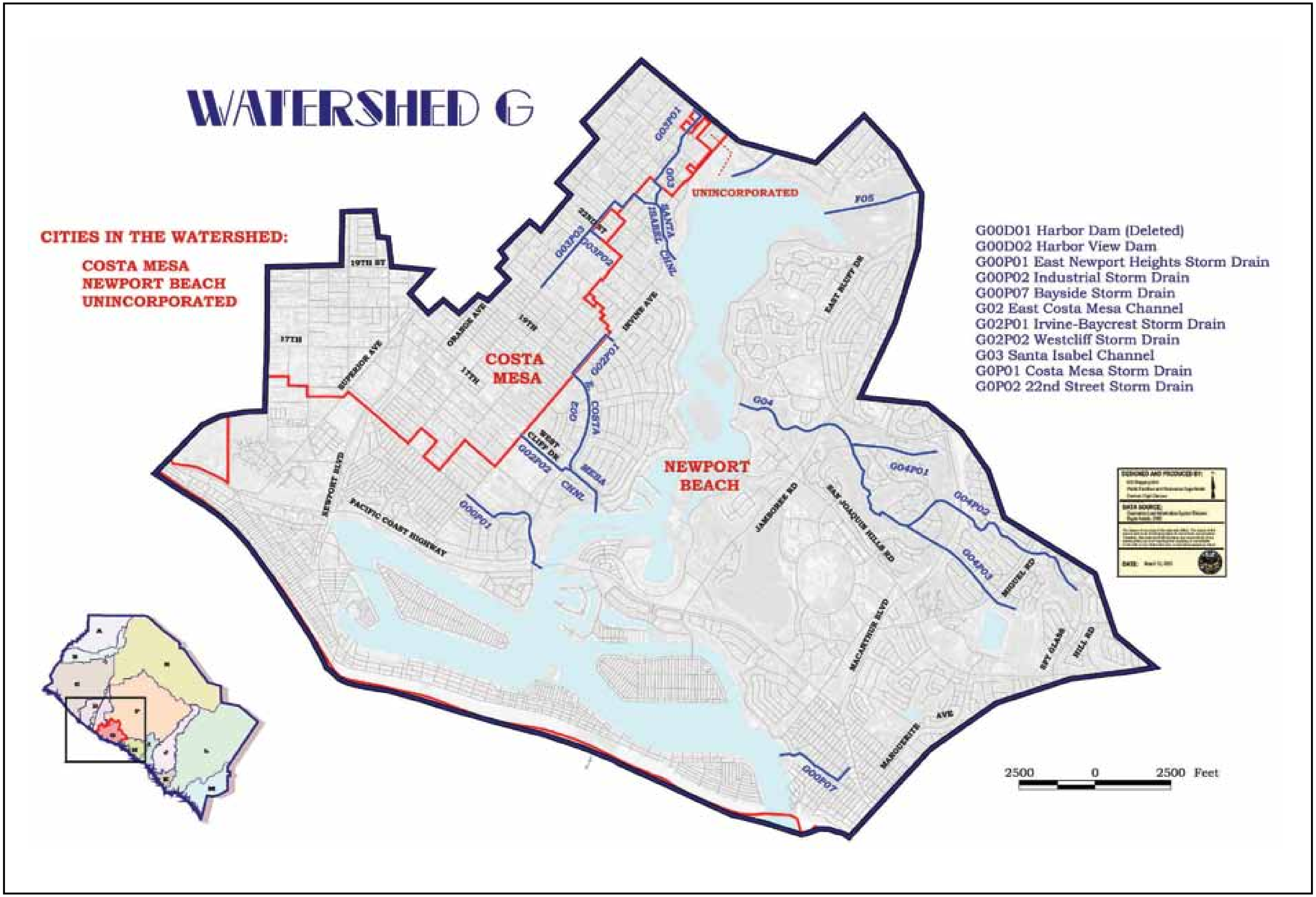

Figure 3.18 Newport Bay Subwatershed. Flood Control Facilities - Major County Structures. (Orange County Flood Control District)

To achieve a healthy equilibrium, a more multipurpose approach is needed for effectively dealing with the way water moves over land and through natural and man-made drainage systems.

In order to create a physically balanced and stable hydrologic system, the design objective for storm channels changes from increasing channel flow to establishing a stable sediment transport within a naturalized, multipurpose channel. Protecting surrounding land from flooding becomes a process of reducing flows into the channel that would destabilize its sediment transport or cause flooding elsewhere along that channel. This can be achieved with stormwater retention and reuse facilities, and to some extent, by establishing stormwater capture and management requirements and design strategies for private land.

This is consistent with the new Municipal Separate Storm Sewer System (MS4) requirements that are a part of the Regional Water Quality Control Board's National Pollutant Discharge Elimination System (NPDES) program requirements. The MS4 requirements include the implementation of low impact development strategies (LID), which are site-level and neighborhood-level design strategies that reduce the runoff coming from each parcel of land. Just as land owners currently have to demonstrate that water is being drained off their land before they can get permission from local land use jurisdictions to develop, land owners will instead be required to effectively manage a percentage of runoff on-site or within the neighborhood before they can get the green light to begin the construction process.

If climate change forecasts are realized, more extreme weather patterns will have a dramatic impact on stormwater infrastructure. In Southern California it is anticipated that storms may become more intense, less frequent and that there will be longer periods of dry weather and drought. Adapting to this will require increasing the capacity to handle larger storm flows. There are many ways to do this, such as increasing the size of the conveyance channels, increasing on-site stormwater retention capacities, and improving bank stabilization to withstand the larger flows. With hotter and drier conditions, fires will become more likely, which could result in greater erosion and sediment transport. This makes designing stream and flood channels with slope and flow velocities for balanced sediment transport rates even that much more critical.

3.5.1.1 Newport Bay / San Diego Creek Watershed Surface Water

Upper Newport Bay receives flows from San Diego Creek, Santa Ana-Delhi Channel, Santa Isabel Channel, Bonita Creek, and Big Canyon Wash (EPA 1998). The Lower Newport Bay receives flows from the Costa Mesa Channel and smaller surrounding storm drain channels. The two largest tributaries to Newport Bay are San Diego Creek (including Peters Canyon Channel) and the Santa Ana-Delhi Channel.

San Diego Creek accounts for approximately 80 percent of freshwater entering the bay and Santa Ana-Delhi Channel accounts for approximately 15 percent (ACOE, 2000). Most of the remaining 5 percent comes from minor tributaries such as Big Canyon Creek, Costa Mesa Channel and large storm drains such as the Arches Channel.

San Diego Creek's largest tributary is Peters Canyon Wash. Its other tributaries include Serrano Creek, Borrego Creek, Agua Chinon Wash, Bee Canyon Wash, Hicks Canyon Wash, Rattlesnake Canyon Wash, Round Canyon Wash, Trabuco Channel, Sand Canyon Wash and Bonita Canyon Creek. San Diego Creek is approximately 14 miles long, stretching from Newport Bay to its headwaters. It is divided into upstream and downstream reaches based on differences in beneficial uses and corresponding water quality objectives along the creek. Downstream, Reach 1 extends from the mouth of San Diego Creek at Upper Newport Bay to Jeffrey Road. Upstream, Reach 2 extends from Jeffrey Road to the headwaters of San Diego Creek.

The County of Orange has located San Diego Creek stream flow gauges at Campus Drive and further upstream at Culver Drive. Other flow gauges are located at: Peters Canyon Wash (at Barranca), El Modena Channel (at Michelle Drive), and Santa Ana-Delhi Channel (at Irvine Boulevard). In addition, two USGS gauges are located at Bonita Canyon Creek (at MacArthur Boulevard) and Agua Chinon Channel (at Irvine Boulevard). Flow rates in San Diego Creek Channel Reach 1 are monitored at the Campus Drive monitoring station. Table 3.7 presents stream flows for the 2004-2005 season. Mean daily flow rates varied from a low of 6.13 cubic feet per second (cfs) in August 2004 to a high of 427 cfs in February 2005 (County of Orange RDMD, 2005).

3.5.1.2 Newport Coast Surface Water

The other watershed within this Region is the Newport Coast Watershed. This 11-square mile watershed covers a much smaller area and has significantly smaller lower stream flow volumes. Five groups of coastal canyon drainage areas, defined by their canyon creeks, are included in the Newport Coast Watershed for this IRCWM Plan, including:

1) Buck Gully: Reaches 1, 2, and 3
2) Morning Canyon: Reaches 1 and 2
3) Pelican Point, Pelican Point Middle Creek, Pelican Point Waterfall Creek
4) Los Trancos Creek (and Crystal Cove Creek)
5) Muddy Creek.

Most of the canyon creeks in the upper portions of the drainage areas are steep natural channels. Several are developed in both the upper and lower portions and contain concrete storm drain outlets. Unpaved access roadways and hiking trails exist in several canyons but are generally not maintained. The lower portions of the steep canyon creek channels have been subject to erosion from increased and longer sustained peak flows. These flows are a result of increased

Table 3.7 Down-Stream Flow for San Diego Creek Reach 1: Mouth of San Diego Creek at Upper Newport Bay to Jeffrey Road (measured at Campus Drive)

MFR (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2004–2005	7.10	6.13	7.31	230	35.2	104	339	427	38.3	45.7	24.7	13.9

Source: County of Orange RDMD Hydrologic Data Report 2004–2005 Season, Section 2

MFR = Mean Flow Rate • cfs = cubic feet per second

Table 3.8 Up-Stream Flow for San Diego Creek Reach 2: Jeffrey Road to Headwaters (measured at Lane Road)

MFR (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2004–2005	.98	.87	1.17	80.5	8.40	37.9	128	176	10.5	14.6	7.85	2.66

Source: County of Orange RDMD Hydrologic Data Report 2004–2005 Season, Section 2

MFR = Mean Flow Rate • cfs = cubic feet per second

Table 3.9 Stream Flow for Peters Canyon Wash (measured at Barranca Parkway)

MFR (cfs)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
2004–2005	3.64	5.13	4.78	79.1	6.17	38.7	141	127	15.5	14.0	10.6	7.07

Source: County of Orange RDMD Hydrologic Data Report 2004–2005 Season, Section 2

MFR = Mean Flow Rate • cfs = cubic feet per second impervious surfaces, irrigation runoff, introduction of invasive/exotic species of vegetation, and greater number of channelized/piped flows into the canyons. Flow data from the Newport Coast Flow and Water Quality Assessment study completed in 2006 are shown in Table 3.10, Wet Weather Flow Data, and Table 3.11, Dry Weather Flows per Unit Area (Weston, 2006).

Table 3.10 Wet Weather Flow Data

Station ID	Unit Modeled Flow (cfs)
BUCK GULLY	
BG1	1.18
BG2	1.08
BG3	1.03
BG4	0.89
BG5	0.69
BG6	0.46
BG7	0.29
MORNING CANYON	
MCD	0.36
Pelican Point	
PP1	0.02
PPM	0.22
PPW	0.13
LOS TRANCOS CANYON	
LTD*	1.10
Muddy Canyon	
MCC	0.93
EL MORRO CANYON	
EMD*	2.00

**Dry weather flows are diverted at these sites*

3.5.2 Water Quality

Water quality is regulated for health purposes and for the purposes of preserving its 'Beneficial Uses', as defined by the Clean Water Act. The Santa Ana Regional Water Quality Control Board (RWQCB) has designated beneficial uses for surface waters within the Region.

Table 3.11 Dry Weather Flows Per Unit Area

Station ID	Unit Modeled Flow (cfs)
BUCK GULLY	
BG1	0.43
BG2	0.39
BG3	0.37
BG4	0.32
BG5	0.25
BG6	0.17
BG7	0.10
MORNING CANYON	
MCD	0.13
PELICAN POINT	
PP1	0.01
PPM	0.08
PPW	DRY
LOS TRANCOS CANYON	
LTD*	
MUDDY CANYON	
MCC*	
EL MORRO CANYON	
EMD	0.72

**Dry weather flows are diverted at these sites*

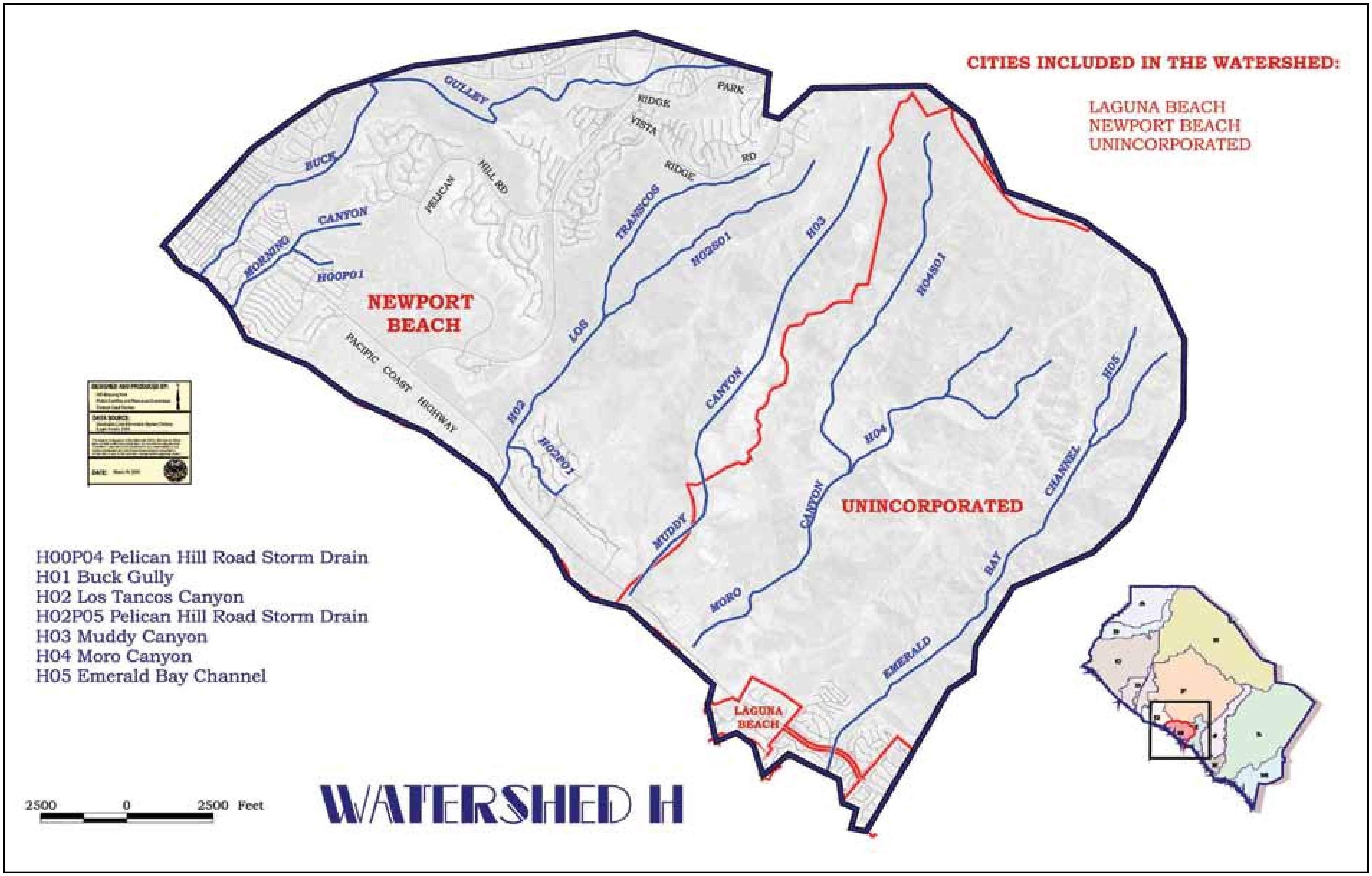

Figure 3.19 Newport Coast Subwatershed. Flood Control Facilities – Major County Structures. (Orange County Flood Control District)

At this time, surface waters in this Region are not used as a potable water supply. When impaired water quality does not allow for one of the designated beneficial uses, agencies imposes regulations on the contaminants. Water quality related agencies in this Region include:

1) **SANTA ANA REGIONAL WATER QUALITY CONTROL BOARD**
   The Central Orange County IRCWMP Region is entirely within the jurisdiction of the Santa Ana Regional Water Quality Control Board. Both above-ground and below-ground water quality has been degraded by polluted runoff from urban and natural areas. Eight water segments in central Orange County are listed as Section 303(d) impaired water bodies and there are five Total Maximum Daily Load (TMDL) limits established for nutrients, fecal coliform, sediment, toxics and organophosphate pesticides, with more TMDLs pending. For more details regarding Total Maximum Daily Loads (TMDLs), see Appendix H, Water Quality Regulatory Issues - Total Maximum Daily Loads and Related Strategies and http://www.ocwatersheds.com/watersheds/tmdls.

2) **COSTA MESA SANITARY DISTRICT** provides wastewater collection service.

3) **THE COSTA MESA SANITARY DISTRICT** provides sanitary sewer service to a 16-square-mile area which includes most of the City of Costa Mesa, a portion of the City of Newport Beach, and some unincorporated areas.

4) **ORANGE COUNTY SANITATION DISTRICT** collects and treats wastewater, and engages in recycled water resource planning.
   The Orange County Sanitation District (OCSD) manages wastewater collection and treatment for approximately 471 square miles in central and northwest Orange County, which includes 21 cities, 3 special districts, and 2.5 million residents. OCSD's system consists of 581 miles of sewer lines and 16 off-site pumping stations. It utilizes Reclamation Plant No. 1 in Fountain Valley and Treatment Plant No. 2 in Huntington Beach to treat a combined daily average of 238 million gallons of wastewater. OCSD partners with the Orange County Water District for the Groundwater Replenishment System that provides purified wastewater for recharge use. Within the Central Orange County IRCWM Region, OCSD provides service for Santa Ana and Costa Mesa and portions of Tustin and Newport Beach. During the winter, it takes IRWD sanitation overflows that are not recycled.

5) **ORANGE COUNTY HEALTH CARE AGENCY**
   The Orange County Health Care Agency is highly involved with water quality in the region and is responsible for monitoring water quality at over 150 locations along the Orange County coastline.

In compliance with RWQCB requirements, the map in Figure 3.20 shows the water quality monitoring stations throughout the Region.

3.5.2.1 Beneficial Uses of Water within the Region

The Water Quality Control Plan for the Santa Ana River Basin lists both Upper and Lower Newport Bay as tributaries to the

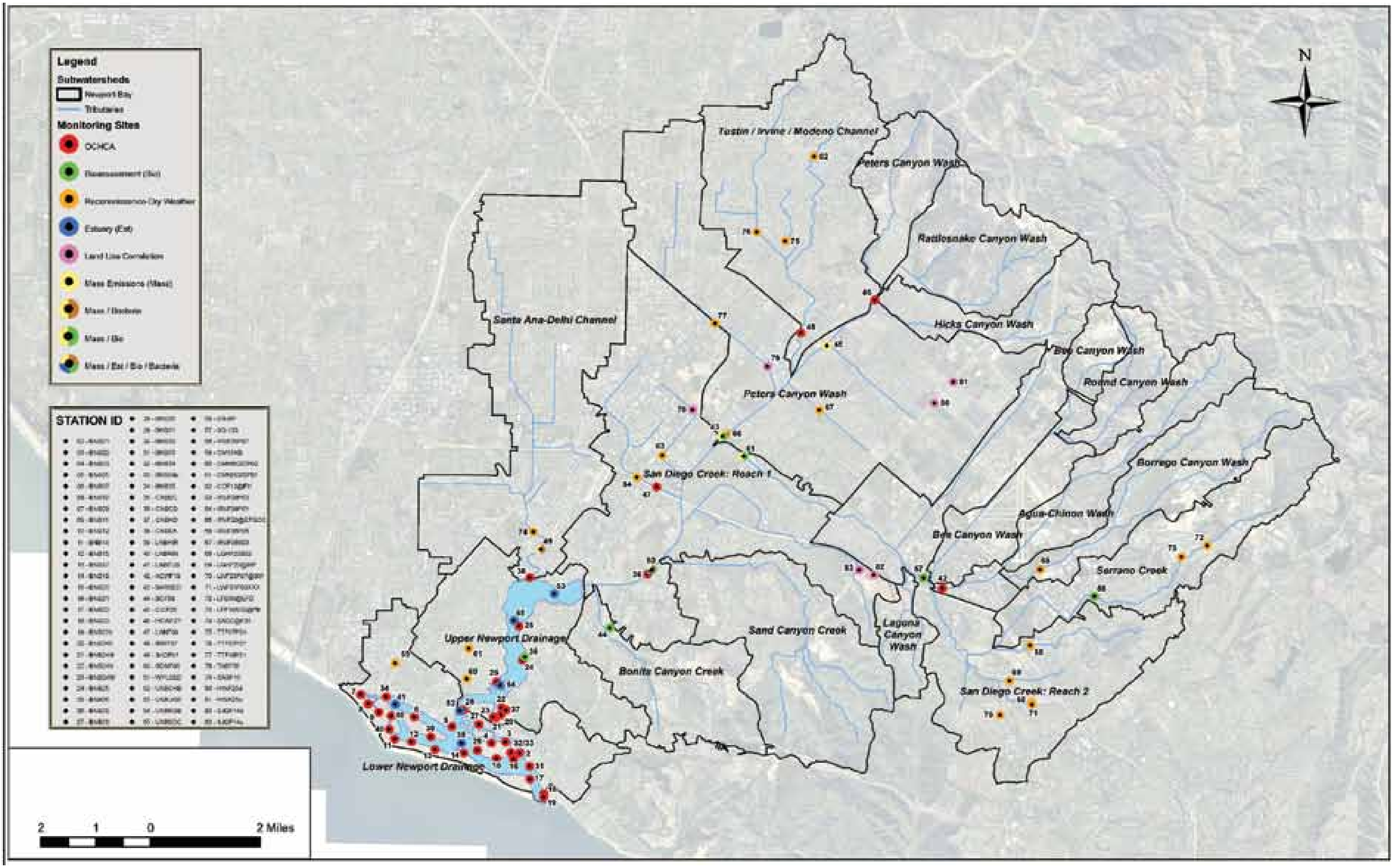

Figure 3.20 Monitoring locations

Table 3.12 Beneficial Uses of Water in Central Orange County IRCWM Region

	MUN	AGR	IND	PROC	GWR	NAV	POW	REC-1	REC-2	COMM	WARM	LWRM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST	Hydro-logic unit
LAKES																					
Laguna, Lambert, Peters Canyon, Rattlesnake, Sand Canyon, and Siphon Reservoirs	+	X						X1	X		X				X						801.11
BAYS, ESTUARIES, AND TIDAL PRISMS																					
Lower Newport Bay	+					X		X	X	X					X	X	X	X	X		801.11
Upper Newport Bay	+							X	X	X				X	X	X	X	X	X	X	801.11
Tidal Prisms of Flood Control Channels Discharging to Coastal or Bay Waters	+							X	X	X					X			X			801.11
OCEAN WATERS																					
SWQPA (former ASBS)						X		X	X					X				X			
Newport Bay						X		X	X	X									X		
INLAND SURFACE STREAMS																					
Buck Gully		X			X						X	X									
Morning Canyon		X			X						X	X									
Pelican Point		X			X						X	X									
Pelican Point Middle Creek		X			X						X	X									
Los Trancos		X			X						X	X									
Muddy Canyon		X			X						X	X									
SAN DIEGO CREEK																					
Reach 1 – below Jeffrey Road	+							X2	X		X				X						801.11
Reach 2 – above Jeffrey Road to headwaters	+				•			•	•		•				•						801.11

Table 3.12 Beneficial Uses of Water in Central Orange County IRCWM Region																					
	MUN	AGR	IND	PROC	GWR	NAV	POW	REC-1	REC-2	COMM	WARM	LWRM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST	Hydro-logic unit
Other Tributaries: Bonita Creek, Serrano Creek, Peters Canyon Wash, Hicks Canyon Wash, Bee Canyon Wash, Borrego Canyon Wash, Agua Chinon Wash, Laguna Canyon Wash, Rattlesnake Canyon Wash, and other Tributaries to these Creeks	+				•			•	•		•				•						801.11
Sand Canyon Wash	+				•			•	•		•				•						801.11
Wetlands																					
San Joaquin Freshwater Marsh	+							X	X		X			X	X	X					801.11

X Present or Potential Beneficial Use
• Intermittent Beneficial Use
+ Excepted from MUN
1 Access prohibited by Irvine Ranch Company
2 Access prohibited in all or part by Orange County Environmental Agency (OCEMA)

DEFINITIONS OF BENEFICIAL USE ARE AS FOLLOWS

MUN Municipal and Domestic Supply (MUN) waters are used for community, military, municipal, or individual water supply systems. These uses may include, but are not limited to, drinking waters supply.

AGR Agricultural Supply (AGR) waters are used for farming, horticulture, or ranching. These uses may include, but are not limited to, irrigation, stock watering, and support of vegetation for range grazing.

IND Industrial Service Supply (IND) waters are used for industrial activities that do not depend primarily on water quality. These uses may include, but are not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

PROC Industrial Process Supply (PROC) waters are used for industrial activities that depend primarily on water quality. These uses may include, but are not limited to, process water supply and all uses of water related to product manufacture or food preparation.

GWR Groundwater Recharge (GWR) waters are used for natural or artificial recharge of groundwater for purposes that may include, but are not limited to, future extraction, maintaining water quality, or halting saltwater intrusion into freshwater aquifers.

NAV	Navigation (NAV) waters are used for shipping, travel, or other transportation by private, commercial, or military vessels.
POW	Hydropower Generation (POW) waters are used for hydroelectric power generation.
REC-1	Water Contact Recreation (REC-1) waters are used for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses may include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, whitewater activities, fishing, and use of natural hot springs.
REC-2	Non-contact Water Recreation (REC-2) waters are used for recreational activities involving proximity to water but not normally involving body contact with water where ingestion of water would be reasonably possible. These uses may include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities.
COMM	Commercial and Sportfishing (COMM) waters are used for commercial or recreational collection of fish or other organisms, including those collected for bait. These uses may include, but are not limited to, uses involving organisms intended for human consumption.
WARM	Warm Freshwater Habitat (WARM) waters support warm-water ecosystems that may include, but are not limited to, preservation and enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates.
LWRM	Limited Warm Freshwater Habitat (LWRM) waters support warm-water ecosystems that are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows that result in extreme temperature, pH, and/or dissolved oxygen conditions. Naturally reproducing finfish populations are not expected to occur in LWRM waters.
COLD	Cold Freshwater Habitat (COLD) waters support cold-water ecosystems that may include, but are not limited to, preservation and enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates.
BIOL	Preservation of Biological Habitats of Special Significance (BIOL) waters support designated areas or habitats, including, but not limited to, established refuges, parks, sanctuaries, ecological reserves or preserves, and ASBSs, where the preservation and enhancement of natural resources require special protection.
WILD	Wildlife Habitat (WILD) waters support wildlife habitats that may include, but are not limited to, the preservation and enhancement of vegetation and prey species used by waterfowl and other wildlife.
RARE	Rare, Threatened, or Endangered Species (RARE) waters support habitats necessary for the survival and successful maintenance of plant or animal species designated under state or federal law as rare, threatened, or endangered.
SPWN	Spawning, Reproduction, and Development (SPWN) waters support high-quality aquatic habitats necessary for reproduction and early development of fish and wildlife.
MAR	Marine Habitat (MAR) waters support marine ecosystems that include, but are not limited to, preservation and enhancement of marine habitats, vegetation (e.g., kelp), fish and shellfish, and wildlife (e.g., marine mammals and shorebirds).
SHEL	Shellfish Harvesting (SHEL) waters support habitats necessary for shellfish (e.g., clams, oysters, limpets, abalone, shrimp, crab, lobster, sea urchins, and mussels) collected for human consumption, commercial, or sports purposes.
EST	Estuarine Habitat (EST) waters support estuarine ecosystems, which may include, but are not limited to, preservation and enhancement of estuarine habitats, vegetation, fish and shellfish, and wildlife, such as waterfowl, shorebirds, and marine mammals.

Pacific Ocean and also as receiving waters for San Diego Creek. Existing beneficial uses are designated in the Basin Plan for the reservoirs, bays, estuaries and tidal prisms, watershed streams and wetlands within the Newport Bay Watershed. For the Newport Coast Watershed, only the near-shore zone of the ocean waters has designated beneficial uses. Table 3.12 summarizes the designated beneficial uses within the Region.

3.5.2.2 Newport Bay Watershed

A major source of water quality contamination is urban runoff. San Diego Creek, Peters Canyon Channel, Upper and Lower Newport Bay and the Rhine Channel are listed on the 303(d) list as impaired with fecal coliform, organochlorine pesticides, PCBs, metals, and sediment toxicity. The EPA and the Santa Ana RWQCB have implemented TMDLs for the San Diego Creek and Newport Bay for toxics (including pesticides and metals), sediment, and nutrients. Additionally, a TMDL for fecal coliform has been established for Newport Bay.

Urbanization of our watershed has led to the creation of significant amounts of non-native landscaping that requires fertilization and irrigation during dry weather conditions. However, this landscaping is often over-irrigated and studies indicate that, when property owners reduce watering, plants' health often improves (IRWD, MWD, et al.). If irrigation were reduced, not only would polluted dry weather runoff decrease, but the amount of water leaching contaminants into the streams and groundwater would substantially decrease as well. The groundwater and soils in the central part of the watershed contain high levels of selenium, a serious hazard to wildlife. When over-irrigation elevates the water table, more selenium-rich groundwater flows into the surface streams to contaminate the aquatic habitat.

Constantly saturated soils also compromise the integrity of street subgrades leading to pavement failure. The repair of these failures is expensive and problematic when heavy equipment is brought in to work in saturated mud. Excessive irrigation in hillside areas is especially dangerous in a region prone to mud slides. In 2005, Bluebird Canyon in Laguna Beach failed because clay layers 100 feet deep became saturated resulting in a massive failure along this clay slip layer

Sediment

Sediment control has been a key water quality issue for decades. Increased surface water flow due to urbanization and channelization has increased the quantity of sediment transported through the watershed to Upper Newport Bay. For example, an estimated 400,000 cubic yards of sediment were deposited in Upper Newport Bay during the 1969 storm season (ACOE 1998). Issues related to increased surface water flow and sedimentation are: increased stream erosion, which has threatened homes, utilities, and other structures; impacts to estuarine species and habitats in Upper Newport Bay; and loss of navigation channels in Newport Bay (ACOE 1998). Stream erosion has been most notable in Serrano Creek, upstream of Serrano Creek Community Park, and in Borrego Wash. In Serrano

Table 3.13 Sediment Discharge from San Diego Creek to Newport Bay

Year	Annual Flow in Acre-Feet in the San Diego Creek at Campus Drive	Annual Sediment Discharge in Tons in the San Diego Creek at Campus Drive
1983	58,952	534,035
1984	29,425	64,455
1985	26,987	32,236
1986	29,746	37,760
1987	21,423	20,060
1988	22,089	34,186
1989	17,359	19,810
1990	19,154	24,855
1991	28,935	83,924
1992	37,186	173,212
1993	62,510	355,208
1994	20,000	33,027
1995	61,182	347,579
1996	23,501	49,438
1997	33,946	92,181
1998	92,345	618,006
1999	17,334	16,439
2000	17,780	28,864
2001	27,320	75,686
2002	10,610	5,640
2003	30,090	64,740

Source: URS 2003.

Creek, stream erosion threatens to undercut homes, has damaged and threatened a Los Alisos Water District sewer line and a Southern California Edison utility pole. It has cut hundreds of thousands of cubic yards of channel bank in a single storm season, which has resulted in the loss of riparian habitat (ACOE 1998).

Sedimentation in the Upper Newport Bay has altered the depth of the bay, which in turn has altered tidal exchange and the type and availability of aquatic and wildlife habitat (ACOE 1998). These conditions are of concern to natural resource groups and regulatory agencies, as Upper Newport Bay is one of only a few remaining estuaries in Southern California. It is one of the few remaining coastal Mediterranean habitats, is used as a stopover point on the Pacific flyway and is the home to numerous species of mammals, fish, invertebrates and native plants, including several endangered species (Newport Bay Naturalists and Friends 2007).

Upper Newport Bay has been dredged several times to keep it from filling in with sediment and is presently undergoing a multimillion dollar, multi-phased dredging and restoration operation by the Army Corps of Engineers, County of Orange, California Department of Fish & Game and the California Coastal Conservancy. This project addresses chemical and biological problems that have been created by a physically altered hydrologic system. The dredging project is only a remedial solution. Optimally, other solutions to control the sediment problem will be implemented in the upper watershed, such as erosion control and sediment capture and stabilization. The Sediment Control Monitoring and In-Channel Maintenance

Program is one strategy addressing this issue. In addition, the Orange County Stormwater Program mandates BMPs to improve overall runoff water quality. The IRWD Natural Treatment System, a network of constructed wetlands, also contributes to slowing and infiltrating runoff while trapping sediment.

The implementation of BMPs and the Sediment TMDL have improved these conditions of concern. However, tens of thousands of tons of sediment are still being deposited in the bay each year, as shown in Table 3.13, Sediment Discharge from San Diego Creek to Newport Bay (URS 2003). Appendix H, Water Quality Regulatory Issues, contains the 1999-2007 annual sediment discharge summary excerpted from the 2006-2007 Sediment TMDL Annual Report. The Sediment TMDL monitoring program includes a monitoring element for Newport Bay. The Newport Bay monitoring element includes bathymetric surveys, vegetation surveys, and sediment removal. All of the TMDL annual monitoring reports are posted at: http://www.ocwatersheds.com/watersheds/tmdls.

Nutrients

Over the past century, changes in land use from grazing to farmland have resulted in the discharge of nutrients into San Diego Creek and Upper Newport Bay. Nutrients are also discharged from landscaped areas of residential and commercial developments. The increased nutrient loading to the San Diego Creek and Upper Newport Bay has resulted in algal growth. Algal blooms in Newport Bay have been responsible for aesthetic nuisances and have interfered with recreational activities; furthermore, decomposing algae has resulted in fish kills due to the creation of anoxic conditions (EPA 1998). The nutrient impairment has resulted in non-compliance with the narrative water quality objectives of the Santa Ana River Basin Plan regarding algae and dissolved oxygen (EPA 1998).

Nutrient loading from San Diego Creek to Upper Newport Bay peaked in the mid-1980s at 7 million pounds of nitrate during the 1985-1986 season (EPA 1998). Nutrient loading decreased in the 1990s due to increased controls and BMPs; however, total inorganic nitrogen (TIN) data continued to be greater than the water quality goals in the 1990s, and algal blooms continued as a problem in Upper Newport Bay (EPA 1998). According to the 2005 Regional Monitoring Program Report for the Nutrient TMDL, "Algal biomass measurement over the past 10 years show that the overall trend in the bay is a decrease in macroalgal density… but the bay is still susceptible to large blooms when a flux of nutrients enter the bay… Such blooms occurred in 1999 (dredging of the bay resulting in a likely release of nutrients from sediment), in 2004 (unknown cause of localized increase at site 24) and in 2005 (record rainfall resulting in increased groundwater inputs)." (County of Orange, 2005)

San Diego Creek and Newport Bay have been placed on the EPA Section 303(d) list of impaired waters. Based on that listing, TMDLs of nutrients entering waters of the creek and bay were established. In accordance with the Nutrient TMDL, a Regional Monitoring Program was initiated in 2000. Data from the November 2003 Regional Monitoring Program Report for San

Diego Creek at Campus Drive (Reach 1) are presented in Table 3.14, Summary of 2003 Concentrations in San Diego Creek at Campus Drive (Reach 1). TIN data for San Diego Creek Reach 1 are presented in Table 3.15, Summary of Total Inorganic Nitrogen, 1990-1997.

The Basin Plan and Resolution R8-2004-0001 designate water quality objectives to meet or exceed the beneficial uses, as defined in Table 3.12. The water quality objectives designated for San Diego Creek are shown in Table 3.16, Santa Ana Basin Water Quality Objectives. There are no water quality objectives designated for Newport Bay; however, the water quality objectives include San Diego Creek – Reach 1, which empties into Upper Newport Bay.

Toxic Pollutants

Changes in land use from grazing to farming, as well as residential, industrial and military development, have resulted in the discharge of metals (cadmium, copper, lead, selenium, and zinc) and toxic organic compounds into San Diego Creek, Upper Newport Bay, and Lower Newport Bay. Furthermore, land use activities that cause erosion have increased the delivery of toxic substances to the waterways.

The U.S. EPA has established TMDLs for toxic pollutants, including organic chemicals and metals. The Toxics TMDLs focus on the RARE and WILD beneficial uses of San Diego Creek and Upper and Lower Newport Bay. These beneficial uses are "two of the most sensitive designated aquatic life and wildlife beneficial uses of concern in the watershed" and are designed to protect the special habitat of the Upper Newport Bay (EPA 2002). The TMDL includes the metals, cadmium, copper, lead, selenium and zinc and the organic compounds chlorpyrifos, diazinon, chlordane, dieldrin, DDT, PCBs and toxaphene.

Selenium, a primary metal of concern in the watershed, has been discharged to the San Diego Creek and eventually Newport Bay, through erosion, runoff, and discharges of shallow groundwater from dewatering activities and pump-and-treat groundwater remediation activities (EPA 2002).

Selenium is a naturally occurring substance that is a part of the Toxics TMDL, and it has become a chemical and biological problem due to physical alterations of the hydrologic system. Historically, selenium from soils in the Santa Ana Mountains flowed down through the San Diego Creek drainage basin and into the historic Swamp of the Frogs near the present confluence of San Diego Creek and Peters Canyon Channel. There, it accumulated in the sediments over thousands of years. The selenium remained insoluble while bound up in the anoxic marsh sediments but, when the Irvine Ranch dug channels to drain the swamp, oxidation processes turned the insoluble forms into soluble forms, which then leached into the groundwater. Because of the shallow water table and further channel deepening, it is seeping into the channels and is being carried into Upper Newport Bay, where it is toxic to wildlife, especially birds.

Table 3.14 Summary of 2003 Concentrations in San Diego Creek at Campus Drive (Reach 1)

	Total Nitrogen (mg/l)			Total Phosphorus as PO4 (mg/l)			Total Suspended Solids (mg/l)		
	YEAR	DRY WEATHER	WET WEATHER	YEAR	DRY WEATHER	WET WEATHER	YEAR	DRY WEATHER	WET WEATHER
Number of Samples	44	38	6	44	38	6	44	38	6
Mean	6.51	6.4	7	0.79	0.6	2.2	89	65.2	237
Maximum	12.14	12.1	10	3.98	1.8	4	670	200	670
Minimum	2.79	2.8	4.7	0.25	0.2	0.3	10	10	34

Source: Report of the Regional Monitoring Program for the Newport/San Diego Creek Watershed Nutrient TMDL, November 2003.

Table 3.15 Summary of Total Inorganic Nitrogen, 1990-1997 (San Diego Creek at Campus)

	October-March	April-September
Average	14.1 mg/L TIN	14.8 mg/L TIN
Standard Deviation	6.1	3.8
Median	16.0 mg/L TIN	14.0 mg/L TIN
Number of Samples	105	71

Source: EPA 1998.

Table 3.16 Santa Ana Basin Water Quality Objectives

	Water Quality Objectives, mg/L							
Surface Water Body	TDS	Hard.	Na	Cl	TIN	NO3-N	SO4	COD
San Diego Creek – Reach 1	1,500	-	-	-	13	-	-	90
San Diego Creek – Reach 2	720	-	-	-	5	-	-	-
Tributaries to San Diego Creek	-	-	-	-	-	-	-	-

LEGEND

Na = sodium
Cl = chloride
TIN = total inorganic nitrogen
NO_3-N = nitrate-nitrogen
SO_4 = sulfate
COD = chemical oxygen demand
TDS = total dissolved solids
Hard. = hardness

A recent set of studies by Dr. Barry Hibbs of California State University, Los Angeles (2004-2007) suggests that nitrates from synthetic fertilizers remaining in the soil and groundwater from surrounding historic orchards also play a role in oxidizing the selenium to more soluble forms. In addition, the presence of certain types of selenium-laden clays may be a factor. More testing of soils and groundwater needs to be done to determine the precise mechanisms for much of this. The Nitrogen and Selenium Management Program is addressing this problem through testing and experimental BMPs, including the Cienega selenium removal project (Selenium update workshop, March 10, 2008).

In November 2006, the Santa Ana RWQCB presented a staff report for TMDLs for organochlorine pesticides and PCBs. The RWQCB TMDLs report summarizes the information presented in the EPA TMDL and presents some new information and modifications to reflect the 2006 proposed 303(d) list and revised loading information.

The Lower Newport Bay has additional water quality issues associated with metals used in boat paints. Rhine Channel, located in the western end of Lower Newport Bay, has been surrounded by industrial uses, such as canneries, metal plating companies, and shipyards, since the 1920s (Anchor Environmental 2006). It is a dead-end channel where toxic pollutants have accumulated in the sediment.

Table 3.17, Toxic Pollutant TMDLs and Newport Bay/San Diego Creek Concentrations, shows the TMDLs and the concentrations of pesticides and metals contained in samples collected from San Diego Creek, Upper and Lower Newport Bay, and the Rhine Channel.

Groundwater

The Orange County Groundwater Basin is currently recharged by streambed percolation, recycling programs, and imported water purchases. OCWD monitors the quality of the groundwater basin extensively, testing for over 190 constituents, including nitrate, salts, selenium, trichloroethylene, volatile organic compounds, and radon to ensure potable quality. OCWD and OCSD are also implementing the new Groundwater Replenishment System, online in 2007, which takes highly treated wastewater from the OCSD Water Reclamation Plant and purifies it using micro-filtration, reverse osmosis, ultraviolet light and hydrogen peroxide before percolating it into the basin. Water produced by this system exceeds all state and federal drinking water standards and is so pure it is expected that it will actually help to reduce the growing mineral content in the basin.(OCWD 2005).

OCWD’s Green Acres Project (GAP) is a water recycling effort that provides reclaimed water for landscape irrigation at parks, schools and golf courses as well as for industrial uses, such as carpet dying. The GAP has the capacity to purify 7.5 million gallons per day of reclaimed water from the Orange County Sanitation District. The use of reclaimed water allows an equivalent amount of groundwater to be saved for household uses (www.ocwd.com).

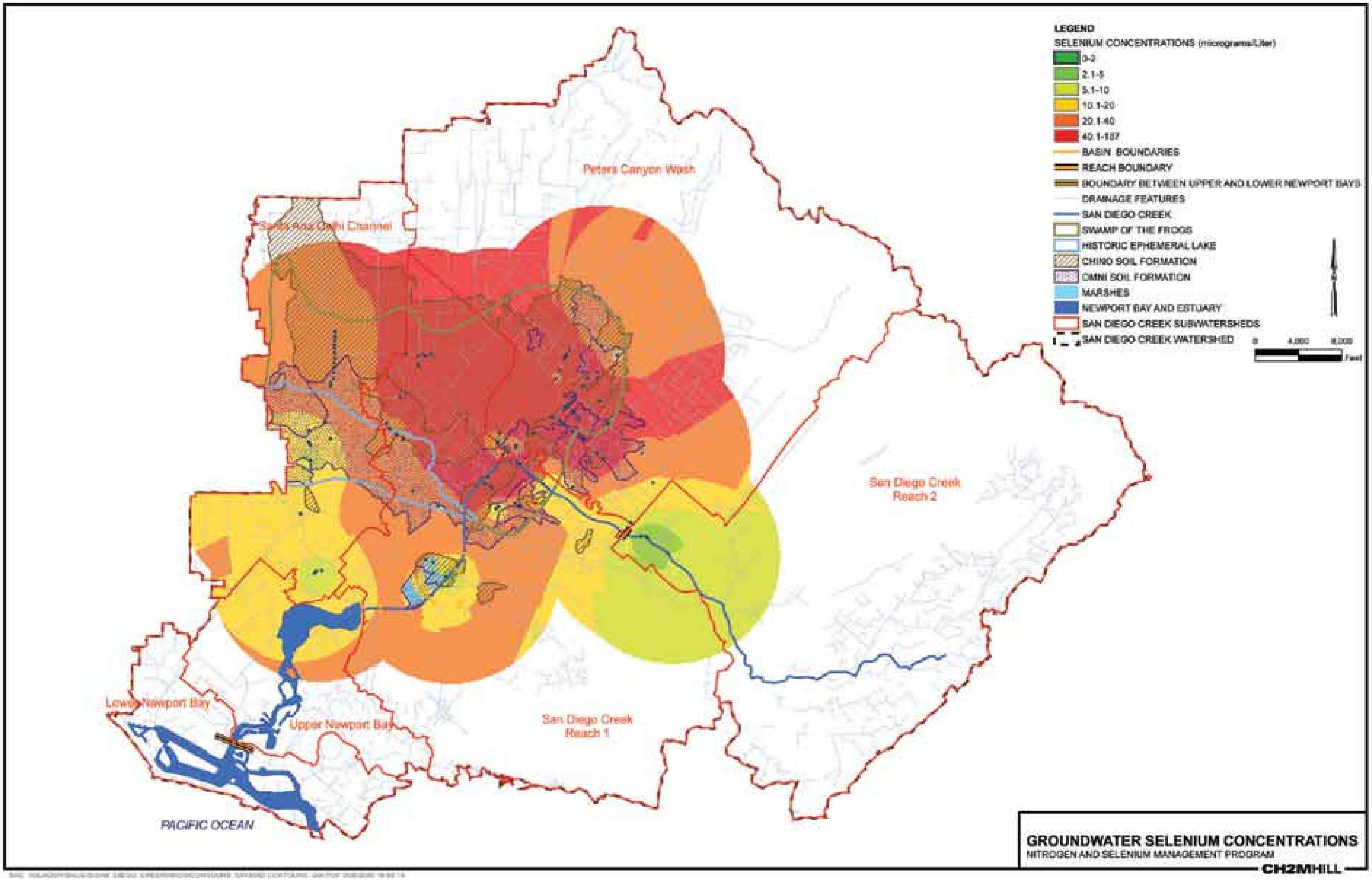

Figure 3.21 Selenium Concentrations in Groundwater (OC Nitrogen and Selenium Management Program).

Table 3.17 Toxic Pollutant TMDL Concentrations

Pollutant	Type Of Compound	Location	Criterion	Criteria Freshwater (ug/l)	Criteria Saltwater (ug/l)	2002 Concentrations San Diego Creek (ug/l)	2002 Concentrations Upper Newport Bay (ug/l)	2002 Concentrations Lower Newport Bay (ug/l)	2002 Concentrations Rhine Channel (ug/l)
Diazinon	Organophosphate Pesticide	San Diego Creek	Chronic Acute	0.05 0.08		0.2	0.202		
Chlorphyrifos	Organophosphate Pesticide	San Diego Creek	Chronic Acute	0.014 0.02	0.009 0.02	0.111	0.0433		
Selenium	Metal	San Diego Creek	Chronic Acute	5 20	 71 (dissolved)	22.1			
Cadmium	Metal	San Diego Creek	Acute Chronic	8.9 to 19.1 for large flows to baseflows 4.2 to 6.2 for medium flows to baseflows	42 9.3	0.13-0.27	0.095-0.22	-	-
Copper	Metal	San Diego Creek	Acute Chronic	25.5 to 50 for large flows to baseflows 18.7 to 29.3 for medium flows to baseflows	4.8 3.1	2.4-5.5	3.4-29.0	8.2-26.3	-
Lead	Metal	San Diego Creek	Acute Chronic	134 to 281 for large flows to baseflows 6.3 to 10.9 for medium flows to baseflows	210 8.1	0.05-0.35	0.023-0.96	0.03-0.89	-
Zinc	Metal	San Diego Creek	Acute	208 to 379 for large flows to baseflows	90	2.6-23.1	10-100	2.5-11.5	-
			Chronic	244 to 382 for medium flows to baseflows	81				
PCBs	Organochlorine Pesticides	San Diego Creek	Chronic	0.014		ND			ND

Table 3.17 Toxic Pollutant TMDL Concentrations

				Criteria		2002 Concetrations			
Pollutant	Type Of Compound	Location	Criterion	Freshwater (ug/l)	Saltwater (ug/l)	San Diego Creek (ug/l)	Upper Newport Bay (ug/l)	Lower Newport Bay (ug/l)	Rhine Channel (ug/l)
DDT	Organochlorine Pesticides	San Diego Creek	Acute Chronic	1.1 0.001		ND		ND	
Chlordane	Organochlorine Pesticides	San Diego Creek	Acute Chronic	2.4 0.0043		ND			ND
Dieldrin	Organochlorine Pesticides	San Diego Creek	Acute Chronic	0.24 0.056		ND			ND
Toxaphene	Organochlorine Pesticide	San Diego Creek	Acute Chronic	0.73 0.0002		ND			ND

Source: EPA 2002;metal data from Newport Bay Toxics TMDL Part E.
LEGEND
NA – not analyzed   ND – not detected   DNQ – detected but not quantified

Individual water districts, such as IRWD, also test their domestic groundwater sources. IRWD, which serves the majority of the planning area, obtains domestic groundwater from three sources: the Irvine Subbasin, which is located within the Orange County Groundwater Basin, the Main Basin underlying northern Orange County and Lake Forest, which does not overlie the Orange County Groundwater Basin. The Irvine Subbasin is mainly used for non-potable water, as the groundwater is high in TDS, nitrates, and has color. Additionally, the groundwater obtained from the six Lake Forest wells within the former Los Alisos Water District service area has poor quality and is used as non-potable water to supplement IRWD's recycled water production. Water quality for groundwater from these two areas is presented in Table 3.18, Select Groundwater Concentrations in 2005.

As shown in Table 3.18 and Table 3.25, color is a water quality issue faced in portions of the Groundwater Basin, including Costa Mesa. Colored water is generally a problem in the deeper aquifer.

High total dissolved salts (TDS) in portions of the Irvine Subbasin are a water quality issue. High TDS in other areas of the groundwater basin are due to seawater intrusion.

Selenium is an issue in shallow groundwater in parts of the study area. High selenium concentrations are mainly found in the Peters Canyon Wash subwatershed and in the vicinity of the former MCAS–Tustin. Selenium concentrations in the main subbasins of the San Diego Creek Watershed from 1999-2005 are presented in Table 3.19, Selenium Concentrations in Groundwater Sources.

Table 3.18 Select Groundwater Concentrations in 2005

	Dyer Road Well Field (Irvine Subbasin)		Lake Forest Wells		
Analyte	Concentration Range	Average Concentration	Concentration Range	Average Concentration	Concentration Limit (MCL)
Nitrate and Nitrite as Nitrogen	ND-1.9 mg/l	<0.4 mg/l	ND-1.3 mg/l	0.6 mg/l	10 mg/l
Nitrate as Nitrate	ND-8.2 mg/l	<2 mg/l	ND-5.7 mg/l	2.6 mg/l	45 mg/l
Arsenic	ND-9.0 ug/l	<2 ug/l	3.3-5.7 ug/l	4.3 ug/l	0.004 ug/l
PCE	ND-0.9 ug/l	<0.5 ug/l	ND	<5 ug/l	5 ug/l
Color	ND-500	41	5-10	8	15
Iron	ND-172 ug/l	<100 ug/l	170-490 ug/l	300 ug/l	300 mg/l
Manganese	ND-22 ug/l	<20 ug/l	ND-75 ug/l	44 ug/l	50 ug/l
TDS	208-394 mg/l	263 mg/l	450-850 mg/l	670 mg/l	1,000 mg/l
Perchlorate	ND-6.1 ug/l	<4 ug/l	ND	<4 mg/l	N/A

Source: IRWD 2006 Water Quality Annual Report, Dyer Road Wellfield Data.

OCWD and local water districts have implemented water quality projects to treat the groundwater. These projects include the Irvine Desalter Project to remove nitrates, TDS, and volatile organic compounds (VOCs); the Tustin Desalter and Nitrate Projects to remove TDS, perchlorates and nitrates; the IRWD Deep Aquifer Treatment to remove color and organics; and the Mesa Consolidated Water District (MCWD) colored water program.

The Irvine Desalter Project focuses on groundwater in central Irvine, specifically in the vicinity of the former MCAS–El Toro facility. In addition to high TDS and nitrate concentrations, groundwater in this area was found to contain VOCs due to former use and disposal of solvents related to aerospace use. A one by three mile plume of VOC contamination extends southwestward from the former MCAS–El Toro. The contamination is about 150 feet deep beneath the base and 300-1,000 feet deep in the community area and is slowly moving toward the main Orange County underground water basin. The Irvine Desalter Project is a joint groundwater quality restoration project by IRWD and OCWD, with financial participation by the U.S. Navy, the Metropolitan Water District of Southern California (MWD) and the State of California. The

Table 3.19 Selenium Concentrations in Groundwater Sources

Sub-watershed	Range of Selenium Concentrations (ug/l)	Concentration Limits (ug/l)
San Diego Creek, Reach 1	3.15-187	2-5
San Diego Creek, Reach 2	1.87-12.8	2-5
Peters Canyon Wash	2.6-270	2-5
Santa Ana-Delhi Channel	7.69-106	2-5

Source: Sources and Loads and Identification of Data Gaps for Selenium – Nitrogen and Selenium Management Program.

cleaned water from the VOC plume is used for irrigation and the desalted water from outside the plume is used for drinking water. The Tustin 17th Street Desalter Project is now removing perchlorates in addition to nitrates and high concentrations of TDS. The Tustin Main Street water treatment plant removes nitrate contaminants from groundwater.

3.5.2.3 Newport Coast Watershed

In recent years, the Newport Coast Watershed, like much of Orange County, has faced watershed problems involving streambed instability, as exhibited by head-cutting and slope failures, the arrival of invasive plant species, and the loss of native wetland and riparian habitat. Seven of the seasonal canyon streams now flow year around due to over-irrigation in the upstream developments. The dry weather flows carry bacteria, fertilizer, and pesticides through the canyon reaches and into the ocean. These problems have become progressively worse and pose a threat to residents, the two ASBSs, Crystal Cove State Park, and the ecological function of the riparian corridors within the watershed. A piecemeal approach to dealing with these problems has been relatively ineffective due to the technical, jurisdictional, and financial hurdles that are best handled simultaneously.

Over the past 40 years, the Orange County Health Care Agency has been testing the coastal waters in Orange County for bacteria. As of 1999, new requirements for frequent testing of surf zone waters and stringent criteria for beach water closures went into effect as part of Assembly Bill 411. Samples from the watershed are collected weekly by the Health Care Agency from ten ocean, bay, and drainage locations (County of Orange 2003). The Irvine Company, IRWD, Surfrider Foundation, and Orange County Coastkeeper have performed limited water quality sampling as well. The results of these sampling programs are currently being reviewed. Monitoring programs are specifically geared toward providing information that can be used to develop programs to protect the two ASBSs (Newport Coast Watershed Program 2004).

In accordance with the Clean Water Act, the Santa Ana Regional Board in 2006 placed Buck Gully Creek and Los Trancos Creek on the draft 303(d) list for total coliform and fecal coliform. The Orange County coastline, which runs along over 5 miles of the Newport Coast Watershed, is also listed on the draft 303(d) list for trash.

A confluence of separate investigations and projects is being carried out in the Newport Coast Watershed by the City of Newport Beach, the Irvine Company, the County of Orange, IRWD, Orange County Coastkeeper, and the Surfrider Foundation. In order to address the destabilization and degradation of the watershed's coastal canyons in a systematic and effective manner, the City of Newport Beach is developing a watershed program for the Newport Coast community as an organizing tool for future activities in the watershed. As part of this program, a monitoring program will specify biological indicators and metrics to assess and monitor ecosystem health relative to watershed function. Examples of applicable indicators include biomass of native riparian wetland vegetation, habitat use by declining or sensitive species, attached fresh-water algae, aquatic macro-invertebrate diversity and distribution, and the health and diversity of intertidal and subtidal communities in the marine life refuges. Additional indicators will be selected in consultation with the Santa Ana RWQCB and the County of Orange. In addition, the watershed program will include a program for mapping the areas of invasive giant reed, *Arundo donax*, and instituting a removal program.

Six objectives have been put forth by the Newport Coast Watershed Program (Newport Coast Watershed Program 2004), several of which are already being implemented:

1) Complete the technical studies and prepare the watershed assessment report for the watershed management area (completed);
2) Implement a monitoring program for baseline data and ongoing monitoring to track changes in the watershed (in process);
3) Prepare a Watershed Management Plan that provides specific restoration recommendations for each of the coastal streams, with attendant ecological benefits for the intertidal and subtidal communities in the ASBSs (completed).
4) Implement specific stabilization and restoration projects in Buck Gully and Morning Canyon within the framework of the Watershed Management Plan;
5) Provide educational opportunities for city staff, community members, and stakeholders in watershed science and management skills and enlist community support in monitoring and restoring the health of the watersheds and marine life refuges (in process); and
6) Expand the scope of the watershed management program, including researching funding opportunities for subsequent restoration projects as outlined by the Watershed Management Plan.

Major efforts being conducted within the watershed to reduce non-point source releases and improve water quality as identified in the June 2006 State of the CCAs Report for Upper Newport Bay include:

1) **WORKING AT THE WATERSHED LEVEL SCIENCE & STEWARDSHIP PROGRAM & EARTH RESOURCES FOUNDATION HIGH SCHOOL CLUBS**: These include teaching modules on understanding the importance of a healthy watershed, urban refuse collection, data collection, source identification, and bioassessment. The program enhances teachers' opportunities to involve students in science (www.earthresource.org).
2) **NEWPORT COAST WATERSHED PROGRAM, ASSESSMENT, MANAGEMENT AND RESTORATION:** Objectives are to complete watershed assessments (survey, hydrologic/hydraulic, biological/ecological, water quality, and sedimentation), prepare restoration recommendations, and

implement stabilization and restoration projects (www.city.newportbeach.ca.us/Pubworks/pwmain.htm).

3) **ORANGE COUNTY COASTKEEPER**

Their mission is to protect and preserve Orange County's marine habitats and watersheds through education, advocacy, restoration, and enforcement (www.coastkeeper.org).

Streamflow and surface water quality data are lacking due to limited dry weather flows in the past. A program has been developed by the City of Newport Beach to monitor dry weather flows and water quality in Buck Gully (City of Newport Beach 2007). Additionally, a program is being developed by the City of Newport Beach to evaluate pollutant loads in the drainages in the Newport Coast Watershed.

Groundwater

While a groundwater basin has not been identified in the Santa Ana RWQCB Basin Plan for the Newport Coast Watershed, groundwater is present in the watershed (City of Newport Beach 2007). According to the City of Newport Beach, groundwater seepage occurs in Buck Gully and Crystal Cove State Park, located at the exit of Los Trancos Creek at the Pacific Ocean. A pumping experiment in Buck Gully in 1999 indicated that groundwater exfiltration adds a significant amount of water to dry-weather flows in the canyon. A groundwater seepage study is now underway to identify sources, quantities, and quality.

3.5.2.4 Regional Water Quality Projects

Major efforts being conducted within the Region to reduce non-point source releases and improve water quality, as identified in the June 2006 State of the CCAs Report for Upper Newport Bay, are listed in Table 3.20, Water Quality Projects Defined in the State of the CCAs Report.

Natural Treatment Systems

The Irvine Ranch Water District has plans to treat dry-weather surface flow throughout the Region using a Natural Treatment System. This is a constructed wetland technology that uses natural processes to filter dry weather runoff. Because plants and soil are used to metabolize and sequester contaminants in these systems, they may not be well suited as habitat for wildlife populations. However, they do improve water quality for downstream habitats and are a strategic tool for enabling healthy natural habitat elsewhere in the system.

Table 3.20 Water Quality Projects Defined in the State of the CCAs Report

1	Serrano Creek Stabilization and Restoration Project	Restore about 1.2 miles of Serrano Creek in the City of Lake Forest through installation of several creek stabilization features coupled with riparian restoration; designed to balance flood management, habitat, and recreation objectives. **www.willdan.com/Services_Flood.asp?ProjectID=41**
2	Newport Bay/San Diego Creek Watershed Management Plan	Framework for how to achieve effective watershed management, leading to a sustainable urban environment; includes wetland protection, education, water conservation, regulation, ad stormwater management, economics. **www.ocwatersheds.com/watersheds/pdfs/Newport_Bay_Watershed_Plan_04-12-15.pdf**
3	Special Area Management Plan for San Diego Creek Watershed	Plan will describe an approach and set of actions to preserve, enhance, and restore aquatic resources, while allowing reasonable economic development and construction and maintenance of public infrastructure facilities. **www.spl.usace.army.mil/samp/sandiegocreeksamp.htm**
4	Selenium Removal Pilot Project	Tested an anoxic biofiltration process using laboratory cylinders and "mesocosms" to remove selenium from surface water in San Diego Creek; now constructing a full-scale in situ version to treat water from Peters Canyon Wash. **www.irwd.com**
5	Upper Newport Bay Ecosystem Restoration Project	The project will deepen two sediment basins in the upper bay; includes an ongoing maintenance-dredging program and enhancements to several existing wetlands and tidal channels and the creation of a least tern nesting island. **www.spl.usace.army.mil/newportbay/uppernewportbay.htm**
6	Newport Bay Naturalists and Friends	Mission is to restore and preserve the native habitat of the bay and surroundings; educate the public about the ecological value of the bay; achieve good water quality, healthy native flora and fauna, and compatible public use. **www.newportbay.org**
7	Orange County CoastKeepers	Mission is to protect and preserve Orange County's marine habitats and watersheds through education, advocacy, restoration, and enforcement. **www.coastkeeper.org**
8	Dry Weather Diversions, Storm Drain Inlet Modifications, and Circulation Study	Clean Beaches Initiative grant study at Newport Bay to divert or treat urban runoff. **www.city.newport-beach.ca.us/Pubworks/pwmain.htm**
9	Divert Urban Runoff at Newport Bay Beaches and Newport Beach and Ocean Beach	Grant for storm drain to sewer diversions. **www.city.newport-beach.ca.us/Pubworks/pwmain.htm**
10	Working At the Watershed Level Science & Stewardship Program & ERF High School Clubs	Modules on understanding importance of a healthy watershed, urban refuse collection, data collection, source identification, and bioassessment. Program enhances the teachers' opportunity to involve students in science. **earthresource.org**
11	Big Canyon Creek Restoration Project	Improving the water quality of Big Canyon Creek as it enters Upper Newport Bay; remove exotic species and replace with native, non-invasive species; create effective riparian, wetlands, coastal sage scrub, and other habitat. **www.city.newport-beach.ca.us/Pubworks/pwmain.htm**
12	Newport Bay Fecal Coliform Source Identification and Management Plan	Activities to determine extent that urban and natural sources of fecal coliform contribute to bacterial quality problems throughout the bay; and development of a source management plan to address source inputs. **www.ocwatersheds.com**

Table 3.20 Water Quality Projects Defined in the State of the CCAs Report

13	Newport Bay Nutrient Total Maximum Daily Load (TMDL) Dissolved Oxygen and Algae Distribution Study	Two investigations of the Newport Bay Nutrient TMDL Regional Monitoring Program: (1) monitor dissolved oxygen levels continuously; and (2) collect remote sensing data of bay to document extent of algae growth. **www.ocwatersheds.com**
14	Assessment of Food Web Transfer of Organochlorine Compounds and Metals in Fishes Newport Bay, California	Identify fish species that could be used as surrogates for assessing ambient water quality relative to wildlife protection and human health concerns; examine food-web interactions of DDTs, PCBs, and trace metals in fish. **www.sccwrp.org**
15	Storm Drain Inlet Modifications and Implement Circulation Measures	Source abatement at Newport Bay. **www.city.newport-beach.ca.us/Pubworks/pwmain.htm**

3.5.3 Water Supply

Central Orange County's water supplies include groundwater, desalted groundwater, surface water, recycled water, and imported water. This water is used for both ecological and urban purposes. The water supply agencies in the Region obtain roughly two-thirds of their supplies from local groundwater and one-third from imported water (Orange County Phase 1, 2007). Imported sources come from the Metropolitan Water District (MWD), which imports water into Southern California from the Colorado River via the Los Angeles Aqueduct, and from Northern California via the State Water Project. Imported water is purchased wholesale from MWD by the Municipal Water District of Orange County (MWDOC) and separately by the City of Santa Ana, who is not a member of MWDOC. MWDOC then sells the water to its member water retail agencies, who then sell it to the individual water users (See Figure 3.24, Orange County Water Supply Agencies).

The water agencies in Central Orange County that manage and use this infrastructure include:

1) **MUNICIPAL WATER DISTRICT OF ORANGE COUNTY**

IRCWM Implementation Authority: water resource planning; water conservation. The Municipal Water District of Orange County (MWDOC) is a member agency of MWD and purchases imported water from the State Water Project and the Colorado River Aqueduct for the benefit of MWDOC member agencies. MWDOC's current services include: representation at MWD, water use efficiency programs, emergency preparedness, reliability studies, project development, water awareness/public information school programs, and legislative advocacy.

2) **ORANGE COUNTY WATER DISTRICT**

IRCWM Implementation Authority: water resource planning; groundwater management. The OCWD is an independent special district formed by an act of the State Legislature to protect Orange County's water rights to the Santa Ana River and to manage the groundwater basin that underlies northern and central Orange County. OCWD holds rights to up to 362,000 acre-feet per year of all Santa Ana River flows that reach Prado Dam. The District recharges the Orange County

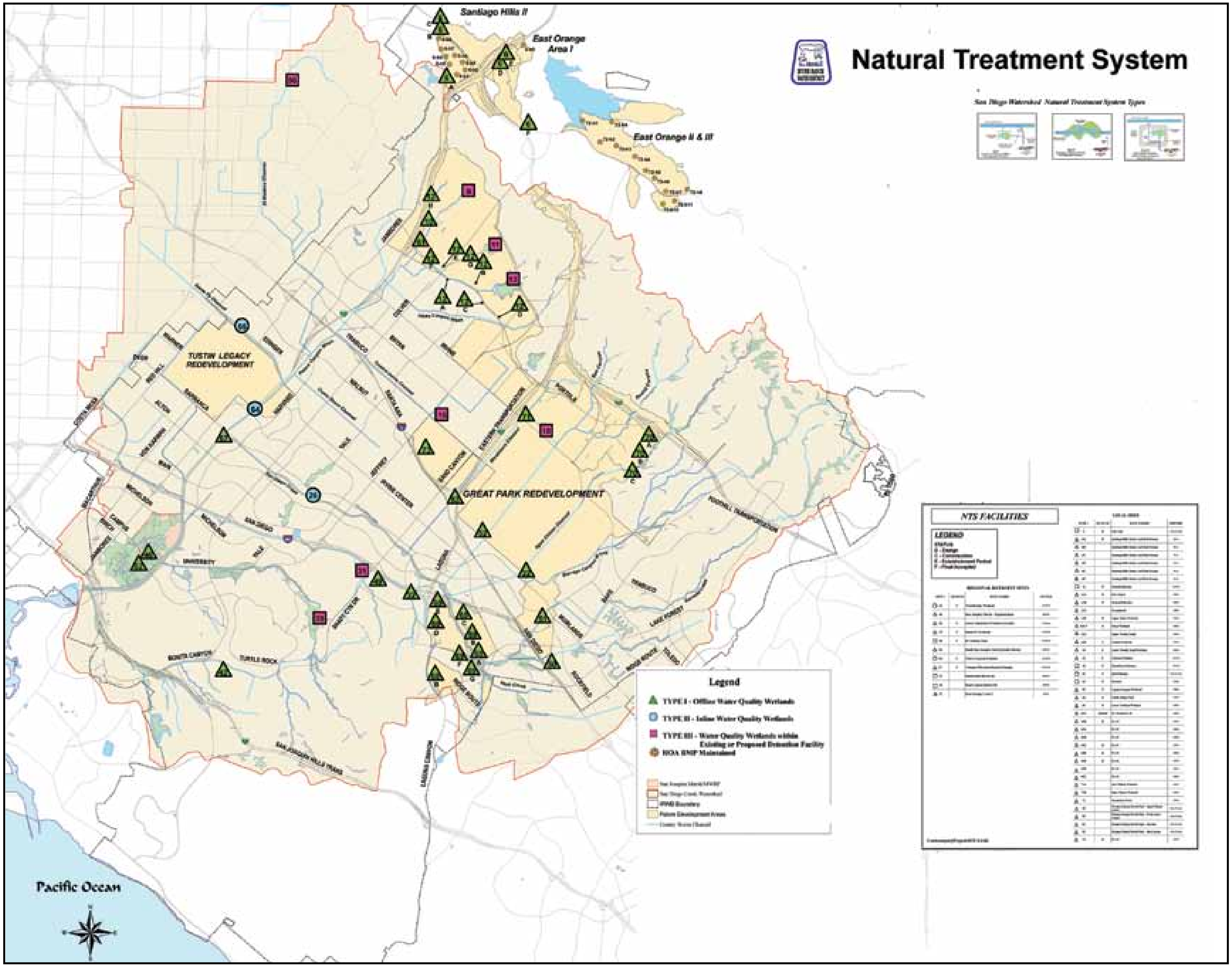

Figure 3.22 Proposed Natural Treatment System locations. Source: IRWD

NTS REGIONAL RETROFIT SITES

SITE #	STATUS	SITE NAMES	OWNER
● 26	C	Woodbridge Wetland	OCFCD
▲ 46		San Joaquin Marsh Augmentation	IRWD
▲ 53	C	Lower Marshburn Wetland (on hold)	Caltrans
▲ 55	C	Santa Fe Wetlands	OCFCD
■ 56	C	El Modena Park	OCFCD
■ 62		South San Joaquin Marsh (South Marsh)	IRWD
● 64	C	Peters Canyon Wetland	OCFCD
▲ 67	C	Cienega Filtration Project	OCFCD
■ 13		Rattlesnake Reservoir	IRWD
■ 39		Sand Canyon Reservoir	IRWD
▲ 72		East Orange 2 and 3	HOA

NTS LOCAL SITES

SITE #	STATUS	SITE NAMES	OWNER
■ 9	D	East Foot	City of Irvine
▲ 6A	D	Santiago Hills Basins & East Orange	HOA
▲ 6B		Santiago Hills Basins & East Orange	HOA
▲ 6C		Santiago Hills Basins & East Orange	HOA
▲ 6D		Santiago Hills Basins & East Orange	HOA
▲ 6E		Santiago Hills Basins & East Orange	HOA
▲ 6F		Santiago Hills Basins & East Orange	HOA
■ 11	D	Orchard Springs	OCFCD
▲ 12A	E	Port Culver	IRWD
▲ 12B	E	Orchard Meadow	IRWD
▲ 12C		No name yet	IRWD
▲ 12D	D	Upper Hicks Wetland	IRWD
▲ 12E/F	E	Forge Wetland	IRWD
▲ 12G		Upper Woody Knoll	IRWD

NTS LOCAL SITES

▲ 12H	C	Chelsie Wetlands	IRWD
▲ 10	C	Lower Woody Knoll Wetland	IRWD
▲ 16	C	Trabuco Wetland	OCFCD
■ 18	C	Marshburn Meadow	OCFCD
■ 31	F	Quail Springs	City of Irvine
■ 49	F	Meadow	IRWD
▲ 32	F	Laguna Canyon Wetland	IRWD
▲ 42	F	Turtle Ridge Pond	IRWD
▲ 61	E	Lower Eastfoot Wetland	IRWD
▲ 68A	deleted	PA 18 & PA 39	IRWD
▲ 68B	D	PA 18	IRWD
▲ 69A		PA 39	IRWD
▲ 69B		PA 39	IRWD
▲ 69C	D	PA 39	IRWD
▲ 69D	D	PA 18	IRWD
▲ 69E	D	PA 18	IRWD
▲ 69F		PA 18	IRWD
▲ 69G		PA 18	IRWD
▲ 70A		Alta Chinon Wetland	IRWD
▲ 70B		Baja Chinon Wetland	IRWD
▲ 71		Marshburn West	IRWD
▲ 22		Orange County Great Park — Agua Chinon Lower	City of Irvine
▲ 50		Orange County Great Park — Irvine Auto Center	City of Irvine
▲ 51		Orange County Great Park — Serrano	City of Irvine
▲ 52		Orange County Great Park — Bee Canyon	City of Irvine
▲ 73	D	PA 40	IRWD

LEGEND – STATUS

D—Design E—Establishment period C—Construction period F—Final groundwater basin primarily with water from the Santa Ana River, supplemented by untreated imported water purchased from MWD. The percolation ponds are located in northern Orange County, outside of this watershed. The groundwater basin is not adjudicated but is cooperatively managed by OCWD according to the Groundwater Management Plan developed in collaboration with the groundwater producers and adopted by the OCWD Board of Directors in 2004. OCWD, with the Orange County Sanitation District (OCSD), began operation of the Groundwater Replenishment System in 2008 and also operates the Green Acres Project to enhance the supply of recycled water for irrigation and industrial uses.

3) **EL TORO WATER DISTRICT**

IRCWM Implementation Authority: potable and recycled water service; water conservation; wastewater collection and treatment. The ETWD service area encompasses approximately 8.5 square miles, providing both potable and recycled water to Laguna Woods and parts of Lake Forest, Laguna Hills, Mission Viejo, and Aliso Viejo. ETWD provides water service to approximately 51,000 residents. Its six reservoirs have a combined capacity of 136 million gallons. Additionally, it provides sanitation services through its wastewater treatment plant, supplying recycled water to a portion of its service area.

4) **EAST ORANGE COUNTY WATER DISTRICT**

IRCWM Implementation Authority: water service; groundwater management; water conservation. The East Orange County Water District operates as a wholesale and retail water supplier. The District's wholesale pipeline distribution system delivers water to four sub-agencies within its boundaries, including the Golden State Water Company, City of Tustin, City of Orange and Irvine Ranch Water District. In addition, the District's Retail Zone is a financially and operationally distinct component of EOCWD. It serves portions of the North Tustin and County of Orange unincorporated areas with 1,192 service connections.

5) **GOLDEN STATE WATER COMPANY**

IRCWM Implementation Authority: water service; groundwater management; water conservation. The Golden State Water Company is a public utility company operating under the authority of the California Public Utilities Commission. It provides retail water service in Cowan Heights, an unincorporated area north of Tustin.

6) **IRVINE RANCH WATER DISTRICT**

IRCWM Implementation Authority: Land use; potable and recycled water service; groundwater management; water conservation; wastewater collection and treatment; habitat protection and restoration; water quality. The IRWD provides potable and non-potable water service; wastewater collection, treatment, and disposal; and wastewater reclamation. IRWD serves all of the City of Irvine and portions of the surrounding Cities of Tustin, Santa Ana, Orange, Costa Mesa, Lake Forest, Newport Beach, and unincorporated areas of the County of Orange. IRWD operates the Michelson Water Reclamation Plant (MWRP), a major regional facility providing recycled water throughout the District's service area. Currently, IRWD serves a

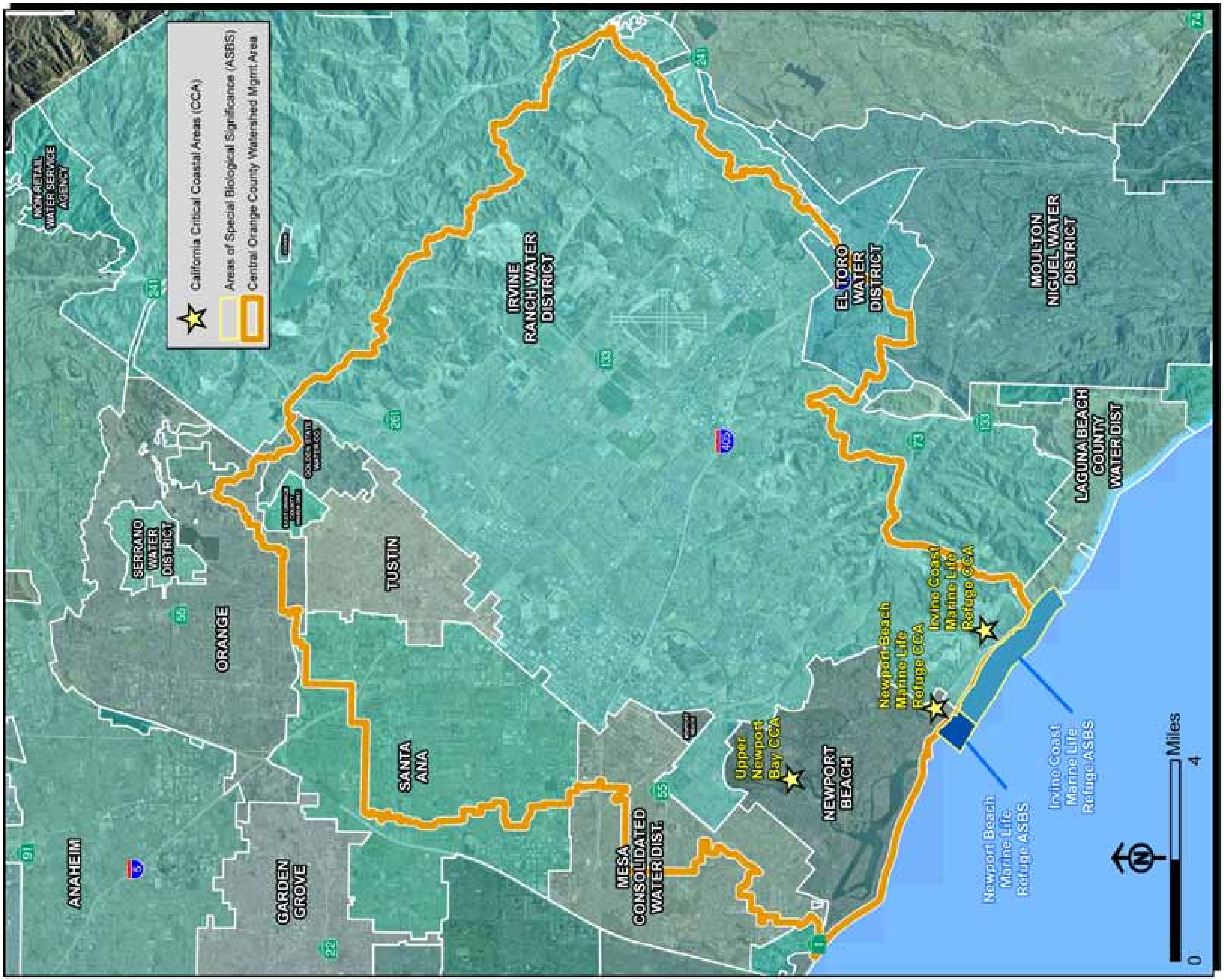

Figure 3.23 Water Agencies in IRCWMP Region.

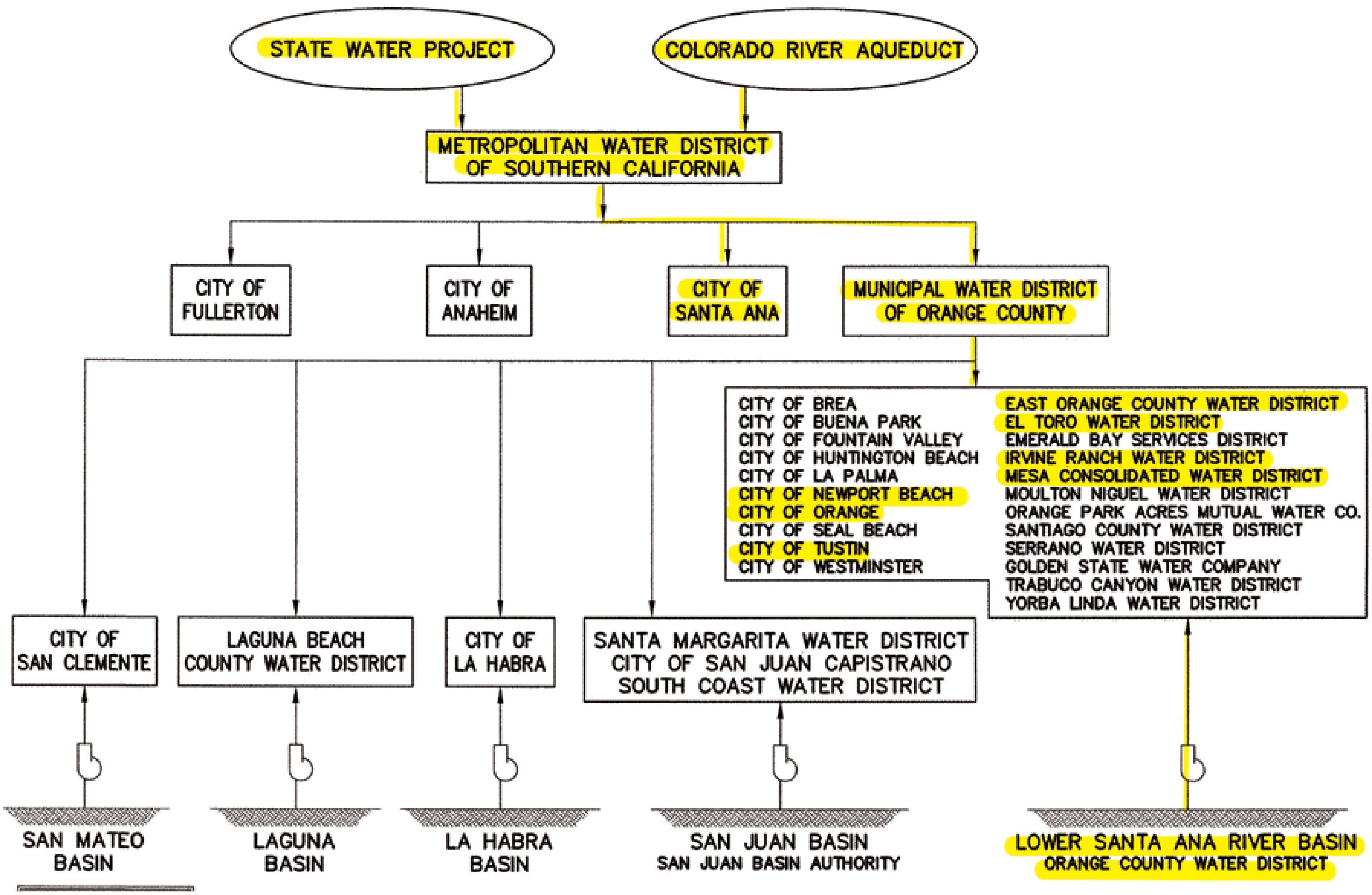

Figure 3.24 Orange County water supply agencies, not including recycled water, non-potable groundwater for irrigation or the Groundwater Replenishment System. Yellow highlights indicate Newport Bay / San Diego Creek watershed sources and agencies. Source: Orange County LAFCo

133-square-mile area with an estimated population of 316,000. In 2001, the California Legislature passed Assembly Bill 810, adding the diversion and treatment of urban runoff to the list of services that the District may provide. This gave the District authority to construct and operate a set of Natural Treatment Systems throughout its service area (See Figure 3.22).

7) **MESA CONSOLIDATED WATER DISTRICT**

IRCWM Implementation Authority: water service; groundwater management; water conservation. The MCWD services an 18-square-mile area with a population of approximately 112,000. The District's service area includes the City of Costa Mesa, portions of the City of Newport Beach, and a small portion of unincorporated Santa Ana Heights.

3.5.3.1 Balancing Water Supply and Demand

The 2005 MWDOC Urban Water Management Plan summarizes the total increases in demand expected by 2030 for the member agency service area. It states that demand is expected to increase from approximately 504,000 acre-feet in 2005 to approximately 614,000 acre-feet in 2030, an increase of 21.9 percent. Additionally, about 50 percent of the current direct water use in the MWDOC service area (including northern Orange County) is supplied with imported water. Over the next 25 years, increased demand will require significant investment in developing the local water resources and recycled water infrastructure, including comprehensive water use efficiency programs to reduce per capita demand.

Table 3.21, Retail Agency Water Sources, summarizes reported water sources by water providers within the Central Orange County Region for fiscal year 2005. Groundwater is the primary source of water supply for the Region. This is expected to continue, with the percentages shifting even more toward groundwater and recycled water as agencies seek to decrease their dependence on imported water supplies. Expanding the Groundwater Replenishment System will increase groundwater supplies with treated wastewater. Surface water is currently not used for water supply, but this will also change over time.

Table 3.21 Retail Agency Water Sources Fiscal Year 2005

Agency	Imported	Ground-water	Recycled Surface[1]	Non-potable
El Toro Water District	95%			5%
Mesa Consolidated WD	52%	44%		4%
East Orange County WD, Retail	37%	63%		
Golden State Water Company	36%	64%		
Newport Beach, City of	33%	67%		
Santa Ana, City of*	33%	67%		
Orange, City of	32%	66%	2%	
Irvine Ranch Water District	21%	41%	8%	30%
Tustin, City of	16%	84%		

Source: Orange County Water Agencies Water Rates Study (2005).
[1]Surface water supplies are obtained from Irvine Lake, which is outside the San Diego Creek watershed boundary.

Table 3.22 Central Orange County Water Demand Projections

Water Agency	Water Demand Projections (acre-feet per year)					
	2005	2010	2015	2020	2025	2030
East Orange County Water District (Retail only)	1,026	1,110	1,130	1,140	1,150	1,170
El Toro WD	11,536	11,559	11,728	11,898	12,068	12,220
Irvine Ranch Water District	86,602	116,710	123,119	130,063	135,208	136,560
Mesa Consolidated Water District	21,849	21,982	22,083	22,193	22,303	22,401
City of Newport Beach	18,648	19,791	21,555	21,640	21,716	21,716
City of Orange	35,081	36,588	37,244	37,244	37,244	37,244
City of Santa Ana	44,944	52,700	55,840	58,770	62,240	62,520
Golden State Water Company	30,214	31,431	32,371	33,367	32,920	33,101
Total	249,900	291,871	305,070	316,315	324,849	326,932

Source: 2005 UWMPs for Agencies and MWDOC.
Note: Some service areas extend beyond the Central Orange County IRCWM region; estimates include water demand for the agency's entire service area.

Water demand and supply projections for the water agencies within the Central Orange County IRCWM Region are shown in Table 3.22, Central Orange County Water Demand Projections, and Table 3.23, Central Orange County Water Supply Projections.

3.5.3.2 Imported Sources

Approximately 50 percent of Central Orange County's current potable water needs are met by imported water from MWD, delivered through the State Water Project and Colorado River Aqueduct. The majority of this water is supplied through the MWD Diemer Filtration Plant. Typically, the Diemer Filtration Plant receives a blend of Colorado River water from Lake Matthews through the MWD lower feeder and State Water Project water through the Yorba Linda feeder. The two major transmission pipelines that deliver water to the service areas are the Allen-McColloch Pipeline (AMP) and East Orange County Feeder No. 2 (EOCF #2). In addition to the Diemer Plant, imported water is also sent through the Orange County Feeder to the Weymouth Filtration Plant. The agencies understand the critical condition of water supplies throughout the state and the western United States and are actively working to enhance local water supplies and decrease reliance on imported supply.

Untreated water is also supplied by MWD. Untreated imported water and local runoff are delivered via the Irvine Lake Pipeline. Within the Region, untreated imported water is used primarily to meet agricultural demands and supplement landscape irrigation

Table 3.23 Central Orange County Water Supply Projections

Water Agency	Water Supply Projections (AFY) 2005	2010	2015	2020	2025	2030
BY AGENCY						
East Orange County Water District	383.8	290	300	300	300	310
El Toro WD	11,446	11,559	11,728	11,898	12,068	12,220
Irvine Ranch Water District	86,602	116,710	123,119	130,063	135,208	136,560
Mesa Consolidated Water District	21,848	21,982	22,083	22,193	22,303	22,401
City of Newport Beach	18,648	19,792	21,556	21,640	21,716	21,716
City of Orange	77,354	91,421	91,421	91,420	91,420	91,421
City of Santa Ana	48,722	54,810	57,410	61,560	63,800	62,750
City of Tustin	11,450	12,870	12,850	12,890	12,850	12,810
Golden State Water Company	3,287	3,281	3,302	3,327	3,352	3,375
Total	279,740.8	332,715	343,769	355,291	363,017	363,563
BY SUPPLY TYPE						
Imported Water	95,953.8	100,066	107,402	114,079	115,764	115,519
Treated Groundwater Production	66,290	67,030	69,120	71,070	73,390	73,570
Clear Groundwater Production	9,598	31,208	33,286	35,526	37,679	37,973
Recycled Water	17,193	28,603	28,534	30,413	31,696	31,988
Orange County Groundwater Basin	42,097	56,238	56,238	56,238	56,238	56,238
Surface Diversions - SWD	1,000	1,000	1,000	1,000	1,000	1,000
Purchased MWD untreated	5,304	6,303	4,556	3,434	3,225	3,225
Native (surface water)	7,251	4,000	4,000	4,000	4,000	4,000
Non-potable Groundwater	2,285	3,898	3,898	3,898	3,898	3,898
Supplier produced (with CWTF)	19,281	19,298	19,312	19,328	19,585	19,617
OCWD (Lower Santa Ana Basin)	11,927	13,590	14,921	14,778	14,990	14,960
Water Supplies from EOCWD	1,561	1,481	1,502	1,527	1,552	1,575
Total	279,740.8	332,715	343,769	355,291	363,017	363,563

Source: 2005 UWMPs for Agencies and MWDOC

Note: Some service areas extend beyond the Central Orange County IRCWM region; estimates include water demand for the agency's entire service area demands. Agricultural demands within Irvine Ranch Water District are expected to decline in future years as development occurs. Landscape irrigation demands will be partially met with an increased supply of recycled water. The Irvine Lake Pipeline conveys untreated MWD water and local runoff from Irvine Lake to the Lambert Reservoir (owned by The Irvine Company). Connections along the Irvine Lake Pipeline serve The Irvine Company irrigation system and the Irvine Ranch Water District's recycled water distribution system. The Baker Aqueduct also delivers MWD untreated water to central and south Orange County. Utilization of the Baker Pipeline has declined due to the use of the Allen-McColloch Pipeline and decline of area agriculture.

As stated in MWD's Regional Urban Water Management Plan and Integrated Resources Plan, MWD's planning efforts have acknowledged the importance of water quality and have set specific targets for imported water. Each of MWD's sources has specific quality issues or concerns, and, to date, MWD has not identified any water quality risk that cannot be mitigated. The only potential effect of water quality on the level of imported water supplies available could be increases in the salinity of water sources. If diminished water quality caused a need for membrane treatment, MWD could experience water losses of up to 15 percent of the water processed. However, MWD would only process a small portion of the affected water and would reduce salinity by blending processed water with the remaining unprocessed water. Thus, MWD anticipates no significant reductions in water supply availability due to water quality concerns (Metropolitan Water District 2005).

3.5.3.3 Local Sources

MWD and MWDOC have developed complementary strategies to incentivize the development of local resources while ensuring the continued delivery of high-quality supplemental imported water. Water remains a valuable resource, and it is imperative that Southern California continues to develop and implement alternative strategies to meet the demands of a growing population. The IRCWM Plan is consistent with the strategies of these regional water agencies, and, like them, it emphasizes a diversification of supplies and a reduced reliance on imported sources where possible.

Agency water use efficiency practices focus on the California Urban Water Conservation Council's 14 Best Management Practices for urban water use efficiency in California (www.cuwcc.org). These include home water surveys, low-flow showerheads and toilet retrofits, metering with commodity rates, landscape irrigation budgets, education, public information, conservation-based rate structures, water waste prohibitions, and industrial process water improvements. These BMPs offer cost-effective opportunities to moderate the amount of imported and local water supplies required by municipal and industrial users. These programs are offered both regionally by MWDOC and locally by individual water agencies.

Groundwater is the primary local water source for potable demand. In some portions of the groundwater basin, maximizing the benefit of this water resource requires treatment for nitrates, selenium, TDS, toxic plumes, perchlorates and colored water. Water recycling already occurs at a significant level in Central Orange County, but efforts can be extended to satisfy additional needs, particularly non-domestic demands for irrigation uses. Local water recycling systems require upgrades and infrastructure expansions to maximize and increase supplies and delivery. Surface water capture and treatment for non-potable supply, groundwater basin recharge, and riparian habitats are also considered a critical aspect of local water needs. Irvine Lake stores and captures local runoff.

Recycled Water

The existing non-potable water system is supplied by three primary sources: recycled wastewater, untreated imported water, and non-potable groundwater. This water comes from different sources, but reaches consumers through the same purple pipes used for non-potable water. Recycled wastewater provides the primary supply to the non-potable distribution system. Most wastewater in the Region is collected and treated by Orange County Sanitation District and the Irvine Ranch Water District. IRWD treats approximately two thirds of its wastewater to Title 22 recycled water standards (IRCWMP, 2007). El Toro Water District and Santa Margarita Water District also treat a small percentage of their wastewater to Title 22 standard for reuse. Sand Canyon Reservoir and Rattlesnake Reservoir store reclaimed water.

OCSD serves a population of approximately 2.5 million people living in a 471 square-mile area encompassing the majority of metropolitan Orange County, with regional treatment plants in Fountain Valley and Huntington Beach. During 2008, an average daily sewage influent flow of 216 million gallons per day (mgd) was treated and an average of 699 wet tons per day of biosolids was produced. (OCSD Biosolids Management Compliance Report, 2008).

The Orange County Water District's Green Acres Project is a recycled water supply project that takes clarified, secondary wastewater effluent from the Sanitation District and further treats it for irrigation and industrial purposes. Most of the water is used for irrigation of golf courses, greenbelts, cemeteries, and nurseries. The project was initiated in 1991 and produces approximately 7,700 acre-feet per year.

IRWD operates the Michelson Water Reclamation Plant and Los Alisos Water Reclamation Plant with a combined treatment capacity of 25.5 mgd. Wastewater is conveyed to the Michelson Plant for treatment and redistribution via a separate "purple piping" system. The nominal, dry weather treatment capacity is 18.0 mgd. In 2001, average influent flow into Michelson Plant was 14 mgd. With expansion, MWRP could treat up to 33 mgd. (IRWD-UWMP). The efficiency of recycled water production has been estimated at 86 percent of the wastewater inflow to the plant. The recycled water is used for irrigation,, landscape lakes and other non-potable uses. The water quality is high enough to earn an "unrestricted use permit",

Table 3.24 IRWD Wastewater Recycled Water Production

	2000	2005	2010	2015	2020	2025	2030
Wastewater Collected by IRWD	16.71	18.64	22.33	23.63	24.91	26.11	26.37
Wastewater Treated to recycled standard by IRWD	14.81	13.97	16.75	17.73	18.68	19.58	19.78
WASTEWATER COLLECTED AND TREATED BY OTHERS							
OCSD	9.5	11.3	12.8	13.6	14.5	14.8	14.9
Santa Margarita WD or El Toro WD	.9	1.1	.5	.5	.5	.5	.5

Source: IRWD Urban Water Management Plan, 2005.

qualifying it for every use except drinking. In 1991, IRWD obtained health department permits for the use of recycled water within interior spaces. Recycled water is now used for toilet flushing in both IRWD offices and in two high-rise office buildings in Irvine, which are dual-piped. Los Alisos Water Reclamation Plant has permitted capacity of 7.5 mgd for secondary treatment and 5.5 mgd for recycled water production.

Approximately 35 percent of all wastewater collected within IRWD's service area does not go to the Michelson or the Los Alisos Reclamation Plants but is currently served by OCSD, Santa Margarita Water District or the El Toro Water District. There are future plans to divert some of these other area flows to IRWD's treatment facilities. Table 3.24 summarizes the current and projected wastewater amounts collected by IRWD and treated to recycled water standards.

Groundwater

The Orange County Water District (OCWD) manages groundwater resources in northern and central Orange County. The groundwater in the Central Orange County Region is a part of the Orange County Groundwater Basin (Main Basin), which encompasses approximately 350 square miles and lies primarily under the Lower Santa Ana River Watershed. It is bounded on the north by the Puente and Chino Hills, on the east by the Santa Ana Mountains, and on the south by the San Joaquin Hills. It is bounded on the southwest by the Pacific Ocean and on the northwest by a low topographic divide that runs approximately along the Orange County–Los Angeles County line.

The Main Basin has three aquifer layers. "The aquifers comprising the Basin extend over 2,000 feet deep and form a complex series of interconnected sand and gravel deposits" (DWR, 1967). In coastal and central portions of the Basin, these deposits are more separated by extensive lower-permeability clay and silt deposits, known as aquitards.

In the inland area, generally northeast of Interstate 5, the clay and silt deposits become thinner and more discontinuous, allowing larger quantities of groundwater to flow more easily between shallow and deeper aquifers." (GWMP, 2004)

"OCWD's extensive groundwater monitoring well network provides data on the Basin's aquifers to depths of 2,000 feet in many areas of the Basin. The monitoring wells provide detailed, depth-specific water level and water quality data from individual aquifer zones. Data from these wells were used to delineate the depth of the "principal" aquifer system, within which most of the groundwater production occurs. Shallower aquifers exist above the principal aquifer system, the most prolific being known as the Talbert aquifer. With the exception of a few large-system municipal wells in the cities of Garden Grove, Anaheim, and Tustin, wells producing from the shallow aquifer system predominantly have small-system industrial and agricultural uses. Production from the shallow aquifer system is typically about five percent of total Basin production.

The middle, or main, aquifer consists of lower Pleistocene Coyote Hills and San Pedro Formations. The average thickness of the middle aquifer is 1,600 feet and is composed of sand, gravel, and minor amounts of clay. The primary recharge of the middle aquifer occurs through a series of recharge basins receiving flows from the Santa Ana River in the northeast portion of the basin, in the Northern Orange County Watershed Management Area near Anaheim and Yorba Linda (DWR 2004).

"Deeper aquifers exist below the principal aquifer system, but these zones have been found to contain colored water or have been too deep to economically construct production wells. With the exception of four colored water production wells constructed by Mesa Consolidated Water District (MCWD) and IRWD, few wells penetrate the deep aquifer system." (GWMP, 2004) The lower aquifer system consists of the Upper Fernando Group of upper Pliocene age and is composed of sand and conglomerate 350 to 500 feet thick (DWR 2004).

3.5.3.4 Irvine Subbasin

Resolution No. R8-2004-0001 was adopted by the Santa Ana Regional Water Quality Control Board to amend the Water Quality Control Plan and combine the Irvine Forebay I, Irvine Forebay II, and Irvine Pressure groundwater basins into one groundwater management zone called the Irvine Management Zone. In the Orange County Water District Groundwater Management Plan (2004), this area is called the Irvine Subbasin.

The Irvine Subbasin and Main Basin are hydraulically continuous; however, they have separate recharge conditions. The percentage of clay and impermeable silt is much higher in the Irvine Subbasin than in the Main Basin (USGS 2002). The thickness and permeability of the water-bearing alluvium increases substantially from Irvine towards the central portion of the Main Basin. The Irvine Subbasin is bounded by the San Joaquin Hills to the south and the foothills of the Santa Ana Mountains to the northeast (Wildermuth 2000).

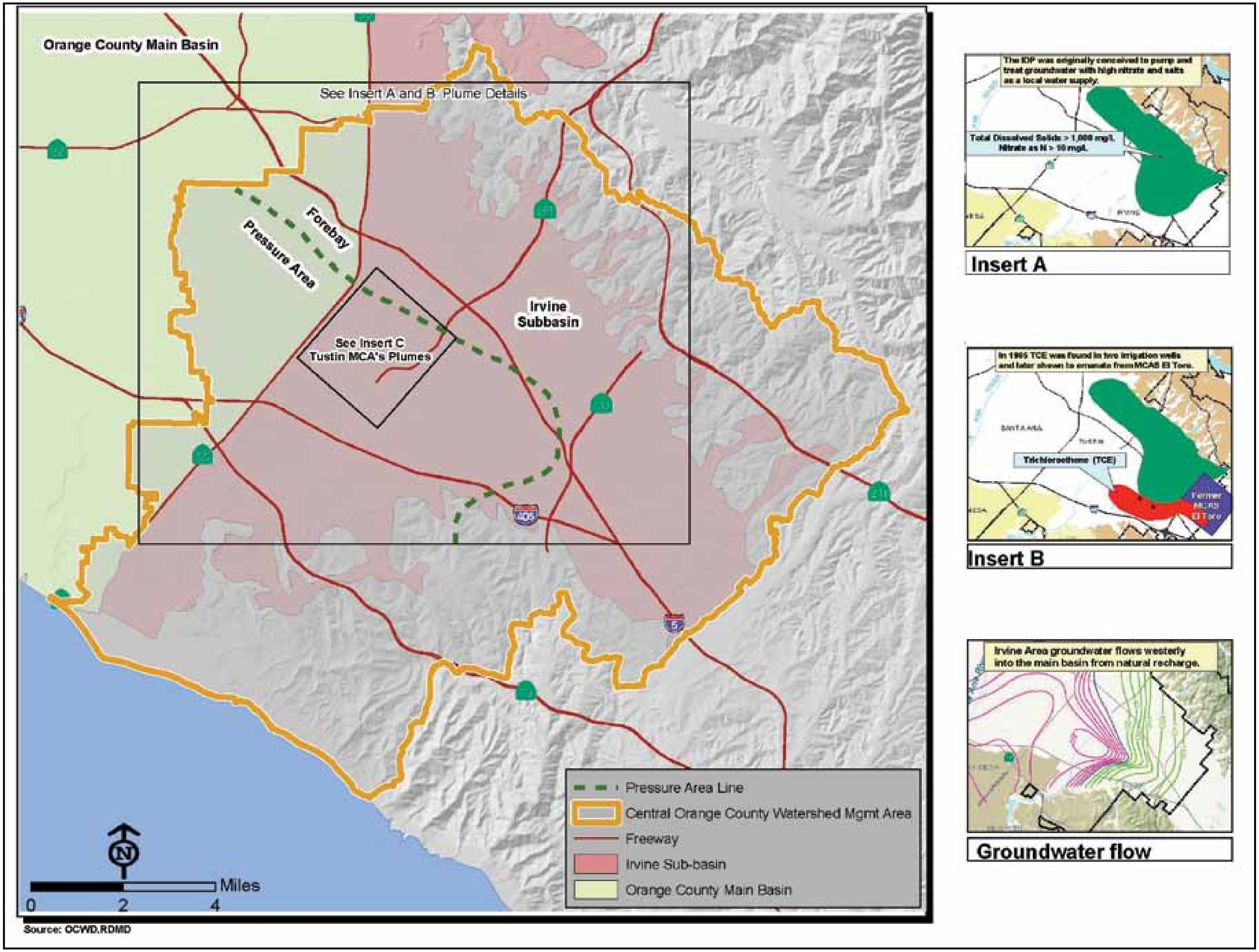

Figure 3.25 Irvine Subbasin Groundwater with pressure area, forebay and inserts for groundwater plumes. See also the associated map of Tustin MCAS plumes (Insert C). (Source: OCWD)

The boundary with the Main Basin is approximately along Interstate Highway 55 and Newport Boulevard.

Much of the central and coastal portions of the Irvine Subbasin are referred to as the "pressure area". This is an area where dense clay and silt layers at shallow depths (upper 50 feet) impede significant percolation. Traditional groundwater recharge is unlikely to succeed in this area because water cannot infiltrate well and would instead lead to surface flooding and increased discharges into surface waters. The Subbasin groundwater recharge that does happen occurs through streambed percolation, precipitation infiltration, flow from the Main Basin, irrigation infiltration, and recharge basins.

Groundwater in the Irvine Subbasin flows westward from the forebay area near the northern foothills into the pressure area. Groundwater flow direction can vary locally due to variations in climate and groundwater production patterns; however, the prevailing flow direction remains westward (Wildermuth 2000). The depth to groundwater in the basin also varies, based on the permeability characteristics of the subsurface soils, irrigation, groundwater pumping, and groundwater recharge.

As in the Main Basin, the Irvine Subbasin also has three layers of groundwater aquifers, the shallow, principal, and deep aquifers (OCWD 2004). The shallow aquifer is unconfined, is of poor quality, and is generally used for irrigation water. Plumes of pollution or selenium contamination may be present in the shallow aquifer. The principal aquifer provides 90-95 percent of the groundwater produced from the subbasin. The deep aquifer has colored water issues, so is not widely used, although Irvine Ranch Water District (IRWD) and Mesa Consolidated Water District (MCWD) are operating colored water treatment facilities.

Table 3.25 Irvine Groundwater Aquifers

Aquifer	Description	Thickness
Shallow	System of unconfined semi-perched aquifers in Pleistocene marine terrace deposits that is generally not used for domestic or agricultural supply. Consists mostly of fine sands, silts, and clays. In the vicinity of the Upper Newport Bay, the shallow aquifer discharges to Upper Newport Bay.	1 to 180 feet
Principal	The principal aquifer is where the majority of the water is produced. It includes an alluvial sequence of interbedded sands and gravels with silts and clays.	400 to 1,000 feet
Deep	The deep aquifer consists of fine- to coarse-grained sands. It is rarely used for supply due to economical constraints and slight brownish tint. IRWD began pumping and treating approximately 7,400 acre-feet per year in 2002. Water in the deep aquifer contains fewer minerals than in other areas of the basin.	1,000 to 3,000 feet

Source: USGS 2005.

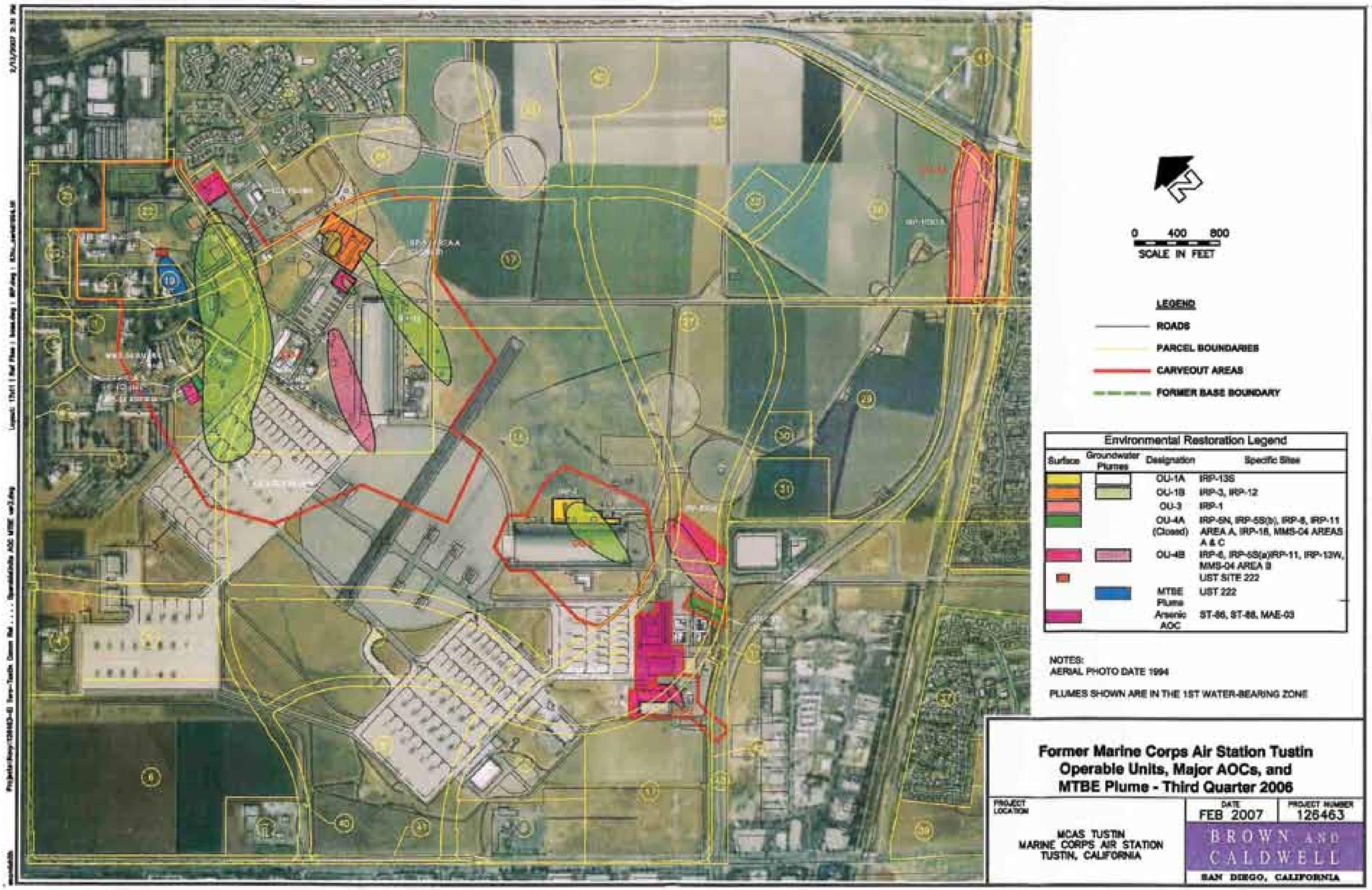

Figure 3.26 Insert C for Irvine Subbasin Groundwater map. Tustin groundwater plumes

Details regarding each of these aquifers are presented in the Table 3.25. This table is an overall generalization of a fairly complex aquifer system, and the depths of the three aquifer units described above vary based on location. For instance, the units thin and converge at the basin margins, and the principal aquifer is located at much shallower depths in these areas.

3.5.3.5 Groundwater Budget

Based on the studies and modeling conducted by OCWD, the Main Basin stores approximately 66 million acre-feet of water, although only a fraction can be removed without causing physical damage, such as seawater intrusion or land subsidence (OCWD 2004). OCWD annually sets an optimum level of pumping considering a sustainable level of pumping and maintaining a safe operating range. OCWD has developed a water budget (with balanced inflows and outflows) to evaluate Basin production capacity and recharge requirements. The budget factors in recharge, groundwater production, and groundwater flows along the coast and across the Los Angeles/Orange County line. The budget shown in Table 3.26, Representative Basin Water Budget, is based on the following assumptions: (1) average precipitation; (2) accumulated overdraft (400,000 acre-feet from full); (3) recharge at forebay facilities equal to current maximum capacity of 250,000 acre-feet per year; and (4) adjusted groundwater production to balance inflows and outflows (OCWD 2004).

Table 3.26 Representative Basin Water Budget

INFLOW	Acre Feet
MEASURE RECHARGE	
1. Forebay spreading facilities, current maximum, including imported water	250,000
2. Talbert Barrier injection, Orange County only	12,000
3. Alamitos Barrier injection, Orange County only	2,500
UNMEASURED RECHARGE (AVERAGE PRECIPITATION)	
1. Inflow from La Habra Basin	3,000
2. Santa Ana Mountain recharge into Irvine subbasin	13,500
3. San Joaquin Hills recharge into Irvine subbasin	50
4. Areal recharge from rainfall/irrigation (Forebay area)	13,000
5. Areal recharge from rainfall/irrigation (Pressure area)	4,500
6. Chino Hills recharge into Yorba Linda subbasin	6,000
7. Subsurface inflow at Imperial Highway beneath SAR	4,000
8. SAR recharge between Imperial Highway and Rubber Dam	4,000
9. Subsurface inflow beneath Santiago Creek	10,000
10. Peralta Hills recharge into Anaheim/Orange	4,000
11. Tustin Hills recharge into City of Tustin	6,000
12. Seawater inflow through coastal gaps	2,000
Subtotal:	70,500
TOTAL INFLOW	335,000
OUTFLOW	
1. Groundwater Production	327,000
2. Flow across Orange/Los Angeles County line, est. at 400,000 acre-feet accumulated overdraft	8,000
TOTAL OUTFLOW	335,000
CHANGE IN STORAGE	0

Note: The representative water budget has equal (balanced) total inflow and total outflow and does not represent data for any given year.
Source: OCWD 2004

Figure 6.7. Soils in San Diego Creek classified based on their infiltration capacities.

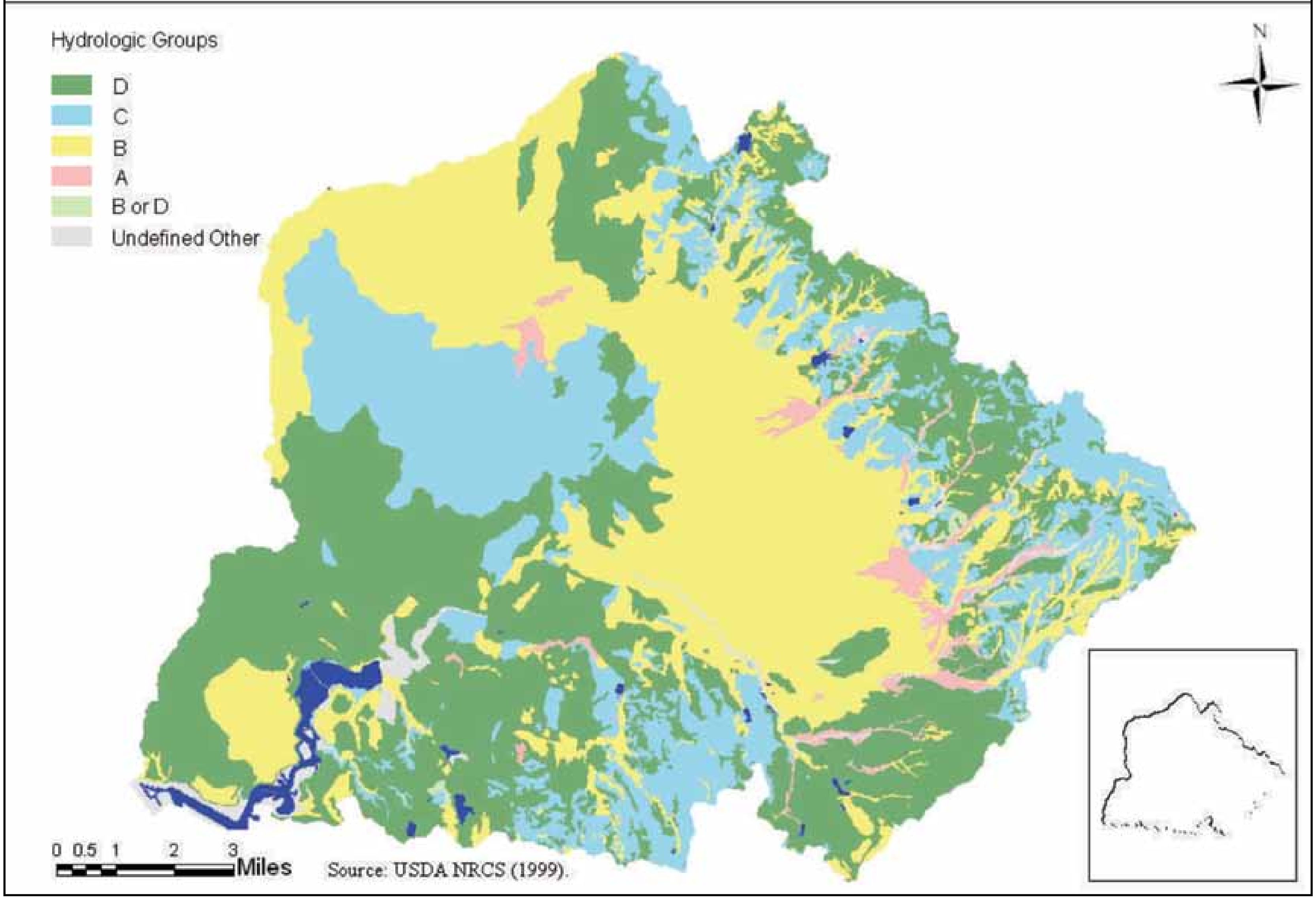

Figure 3.27 Soils by infiltration capacity. (with legend) This map is too general to be used to locate specific infiltration sites but shows generally where appropriate soils might occur. The groundwater pressure area, groundwater levels and groundwater pollution areas should also be considered, as well as slopes too steep to allow safe infiltration. On-site soil samples will also need to be tested. (Source ACOE, 2005)

Orange County Hydrological Soil Groups

GROUP	INFILTRATION RATE (IN/HR)	RUNOFF POTENTIAL	SOIL COMPONENTS & CHARACTERISTICS
A	High	Low	Deep, well-drained sands or gravels
B	Moderate	Moderately Low	Moderately deep & moderately well-drained sandy-loam with moderately fine to coarse texture.
C	Moderate Low	Moderate	Silty-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture.
D	Low	High	Clay soil with high-swelling potential, soils with permanent light water table, soils with clay pan or clay layer at or near the surface, or shallow soils over nearly impervious material

3.5.3.6 Production

There are approximately 500 active wells within OCWD's boundaries, with an estimated 300 wells producing less than 25 acre-feet per year (OCWD 2004). All large-capacity wells are metered, and individual well production is documented monthly. OCWD manages groundwater production from the groundwater basin by setting an annual basin pumping percentage based on net water available for pumping divided by net total water demands from the previous year. The basin pumping percentage is directly related to hydrologic conditions and recent groundwater production. Water available for future basin pumping is estimated at approximately 357,000 acre-feet in 2007-2008, increasing to 367,104 acre-feet in 2010-2011 (OCWD 2006). Producers pay a Replenishment Assessment for groundwater production up to the basin pumping percentage; production that exceeds the basin pumping percentage is assessed an additional higher-cost Basin Equity Assessment charge to cover the cost of replenishing that groundwater. Through these methods, OCWD is able to manage the basin resources and provide financial incentive for producers to work cooperatively to manage total pumping.

Groundwater production has doubled since 1954, and increasing use is anticipated as agencies seek to reduce dependence on imported water. OCWD has developed a draft Long-Term Facilities Plan that identifies and evaluates projects that could increase the sustainable yield of the basin to the highest possible amount. The Plan also identifies projects to protect and enhance groundwater quality and protect the coastal portion of the basin.

3.5.3.7 Recharge

Recharge to the Main Basin originates from Santa Ana River flow infiltration, infiltration of precipitation, and injection into wells. The Santa Ana River flow contains natural flow, water from wastewater treatment plants upstream of El Prado Dam, and imported water that is spread in the basin forebay (DWR 2004). The water is released from Prado Dam and delivered into recharge basins in the northern portion of the County (Main Basin), outside of this Region.

Recharge to the Irvine Subbasin occurs through infiltration of flow within the unlined stream channels, underflow from the saturated alluvium and fractures within the bordering bedrock, and from precipitation and irrigation (Wildermuth 2000). As groundwater production increases in the Irvine Subbasin to where it exceeds recharge, groundwater will flow from the Main Basin into the Subbasin. Unmeasured recharge to the Irvine Subbasin, based on average precipitation, is approximately 20,000 acre-feet per year.

In 2008, OCWD's new Groundwater Replenishment System began treating secondarily-treated water from OCSD's reclamation plant for groundwater recharge and as a seawater barrier. The first phase of this project provides an estimated 72,000 acre-feet of highly treated recycled water per year to the Talbert Seawater Intrusion Barrier and the Anaheim recharge operation. The Anaheim recharge system uses surface spreading basins to recharge the Main Basin northwest of Highway 55. The Groundwater Replenishment System will operate at a maximum of 120,000 acre-feet per year, to be realized in subsequent phases. One of the key components of future phases is the availability of secondarily treated wastewater flows from OCSD.

OCWD replenishes the Main Basin through recharge basins located outside of the IRCWMP Region because soil permeability is limited in the Irvine Subbasin. Although the Groundwater Replenishment facility is located just outside of the IRCWMP Region near the mouth of the Santa Ana River, it benefits this Region's supply because water retail agencies in the Central Orange County area pump groundwater from the Northern Orange County area for use in the Central Orange County area.

Desalted Water

As previously mentioned, local water agencies operate three groundwater desalter programs in Irvine and Tustin to remove total dissolved solids (TDS), nitrates from historical agricultural practices, perchlorates and a volatile organic compound (VOC) plume from the former EL Toro Marine Corps Air Station. The Irvine Desalter Project is a joint groundwater quality restoration project by IRWD and OCWD, with financial participation by the U.S. Navy, Metropolitan Water District and the State of California. In 1985, portions of the basin beneath the former El Toro Marine Corps Air Station in the central area of Irvine were found to contain VOCs from compounds used on the base. A plume of contamination now extends off the base and is currently moving toward the main basin. The Irvine Desalter Project consists of two water purification plants with separate wells and pipeline systems. One treatment plant removes TDS and VOCs from contaminated groundwater. The treated water is used for irrigation and other recycled water purposes. A second purification plant treats water from outside the VOC plume to remove total dissolved solids and nitrates. This treated water is used for potable water supply (OCWD 2004). The Irvine Desalter Project will yield approximately 7,700 acre-feet per year of potable drinking water and 3,900 acre-feet per year of non-potable water, which will supplement IRWD's non-potable system (IRWD 2005).

The second project is the Tustin Seventeenth Street Desalter, which has been in operation since 1996. It reduces nitrate, perchlorate and TDS contaminants from the groundwater produced by Tustin's Seventeenth Street Wells Nos. 2 and 4 and Tustin's Newport well. During fiscal year 2001-2002, 354,000 pounds of nitrate per year were removed at this treatment facility (OCWD 2004). The facility yields approximately 2,100 acre-feet per year. The third project is Tustin's Main Street Plant which removes nitrates from groundwater.

A number of sites in Southern California are currently being considered for ocean water desalination facilities. The Central Orange County Region could someday receive potable water produced by one or more of these facilities. Just north of this Region in Huntington Beach, an ocean water desalination facility is being proposed. The project consists of the construction and operation of a 50 million gallon-per-day desalination facility. However, as proposed, the water agencies within the Central Orange County Region would not be receiving supplies from this plant. The Metropolitan Water District addresses seawater desalination on a regional basis in its 2005 Regional Urban Water Management Plan, and it is included in its Integrated Resources Plan Update targets under local water production.

3.5.3.8 Climate Change and Water Supply

Water supply in Central Orange County is complex, as it is dependent upon an imported water network as well as on groundwater recharge sourced from local surface water and treated wastewater. Climate change will affect all of these water sources. Imported water and surface water supplies are dependent on annual precipitation, not only in this Region, but also in all the areas across California and the Colorado River watershed from which we import water. The local groundwater basins are also heavily dependent on imported water because a large component of recharge comes from water that has been imported, used, treated and released into the upstream reaches of the Santa Ana River, other stream channels and groundwater recharge facilities.

Climate change (see also Chapter 2.1) is expected to have the following impacts:

- **SMALLER SNOW PACK:** By 2050, scientists project a loss of at least 25 percent of the Sierra snowpack, an important source of water for urban, agricultural, and environmental functions.
- **CONCENTRATED FLOWS:** Weather patterns are becoming more variable, causing more severe winter and spring flooding and longer, drier droughts.
- **POTENTIAL INFRASTRUCTURE DAMAGE:** Since the 1950's, flood flows on many California rivers have been the largest on record. Levees, dams and flood bypasses are forced to manage flows for which they weren't designed.
- **RISING SEA LEVEL:** In the past century, sea level has risen over one-half foot at the Golden Gate. Projected continued sea level rise will threaten many coastal communities as well as

the sustainability of the Sacramento-San Joaquin Delta which supplies 25 million Californians with drinking water.

- **CHANGING TEMPERATURES AND HYDROLOGY:** Rising water temperatures and changes in runoff patterns are adversely impacting salmon and other aquatic species (DWR, June 2007).

The above impacts would have direct impacts upon Central Orange County. Smaller Sierra Nevada snow pack volumes means less water available for export to Southern California. Loss of levees, dams and flood bypass infrastructure would also result in a direct loss of the ability to capture and convey water to Southern California. Concentrated flood events in this Region would increase the amount of stormwater capture facilities needed to reduce in-stream flooding and to develop stormwater as a local source of supply. Furthermore, sea level rise may eventually threaten the Orange County groundwater basins by increasing the threat of seawater intrusion.

Rising sea levels will affect surface water habitat in Newport Bay and lower San Diego Creek by bringing in more sea water, possibly flooding the estuary, parts of Balboa Island and increasing salinity levels. If flood levels in lower San Diego Creek rise, increased flood protection for IRWD's Michelson Water Reclamation Plant will become increasingly imperative.

We've already seen a reduction in the amount of water Northern California will export in order to maintain the amount of water it takes to support viable populations of Delta Smelt. The years 2007 and 2008 have seen record low runs of salmon in California. This may result in additional reductions in flow from the Delta to protect those populations.

An IRWMP must consider how to reduce climate change impacts, as well as how to respond to those that do occur. Adapting to climate change scenarios will require more storage in groundwater basins, more surface water capture and reuse and innovative, integrated water projects to help ensure a reliable water supply for Central Orange County's future. The biggest tool the Central Orange County IRCWMP has available to it for reducing this Region's impact on climate change is to work toward severely reducing the use of imported water. This requires further policy discussions among affected Orange County water agencies to determine future policy direction. According to the Metropolitan Water District, pumping and conveying water from one end of the state to another is the single largest user of energy in the state.

3.5.4 Habitat

Water usage in Southern California increased significantly in 1913 when the first aqueduct was built, bringing water from the Owens Valley to Los Angeles. Since then, the State of California and the Metropolitan Water District have developed one of the most advanced water conveyance systems in the world, bringing water from seven states into Southern California. This movement of water has a heavy impact on ecosystems. Water is the basis of life and the more water that gets taken from other places, the less primary production is left to support the local food chain in those places. For aquatic species, smaller water flows also means less viable living conditions.

In Southern California the ecological impact of an increased water supply has been the freedom to disregard and pave over local rivers, wetlands and groundwater recharge areas to make way for increased development. This separates local water flow from its normal interaction with the ground, which degrades local habitat functions and water quality. While the growth in this Region over the last century has been good for many social and economic reasons, the overall environmental outcome is that we have degraded and polluted our own water resources to make way for an environmentally unfriendly kind of land development, while at the same time, degrading and depriving the ecosystems that are the source of the imported water.

The equation that justifies this approach has relied on the ability to access more and more sources of water from elsewhere, while externalizing many of the costs of doing so. However, as the resources become stretched to their limits in these places, the equation is beginning to change. Courts are ruling that water export-related threats to habitats and endangered species must be considered. Furthermore, the cost of imported water increases with competition from urbanization in those regions. And, in our own region, we find that complex hydrological problems and the costs of fixing them can negatively influence ecological, social and economic conditions.

A combination of such factors are pushing stakeholders to find ways to refocus on the health of the local aquatic ecosystem so as to make the best use of this Region's human, natural and monetary capital. This requires place-based urban design that works with the needs of the local habitat and hydrologic system, rather than against it. Having a clear understanding of the local ecosystem and how it works is the first step.

Habitat Types

Orange County's native plant communities are part of the California Floristic Province, designated by Conservation International as a world biodiversity "hotspot" due to an unusually large number of species that occur only here. Diegan coastal sage scrub is the most common native plant community in this Region. Others are oak and sycamore woodlands, chaparral, willow riparian, coastal strand, fresh water marsh and saltwater marsh. Much of the terrestrial and riparian habitat is naturally dry during parts of the year.

The following maps of the NCCP/HCP Central and Coastal Subregions provide an illustration of the general distribution of the habitat types described below.

Most of the following information in this section is based on the U.S. Army Corps of Engineers 2005 Newport Bay/San Diego Creek Watershed Study Feasibility Report. The descriptions of the nine natural habitat types identified in the Region are taken from Holland (1986) and the County of Orange (1991).

Figure 3.28 Central and Coastal Subregion NCCP/HCP.(Nature Reserve of Orange County).

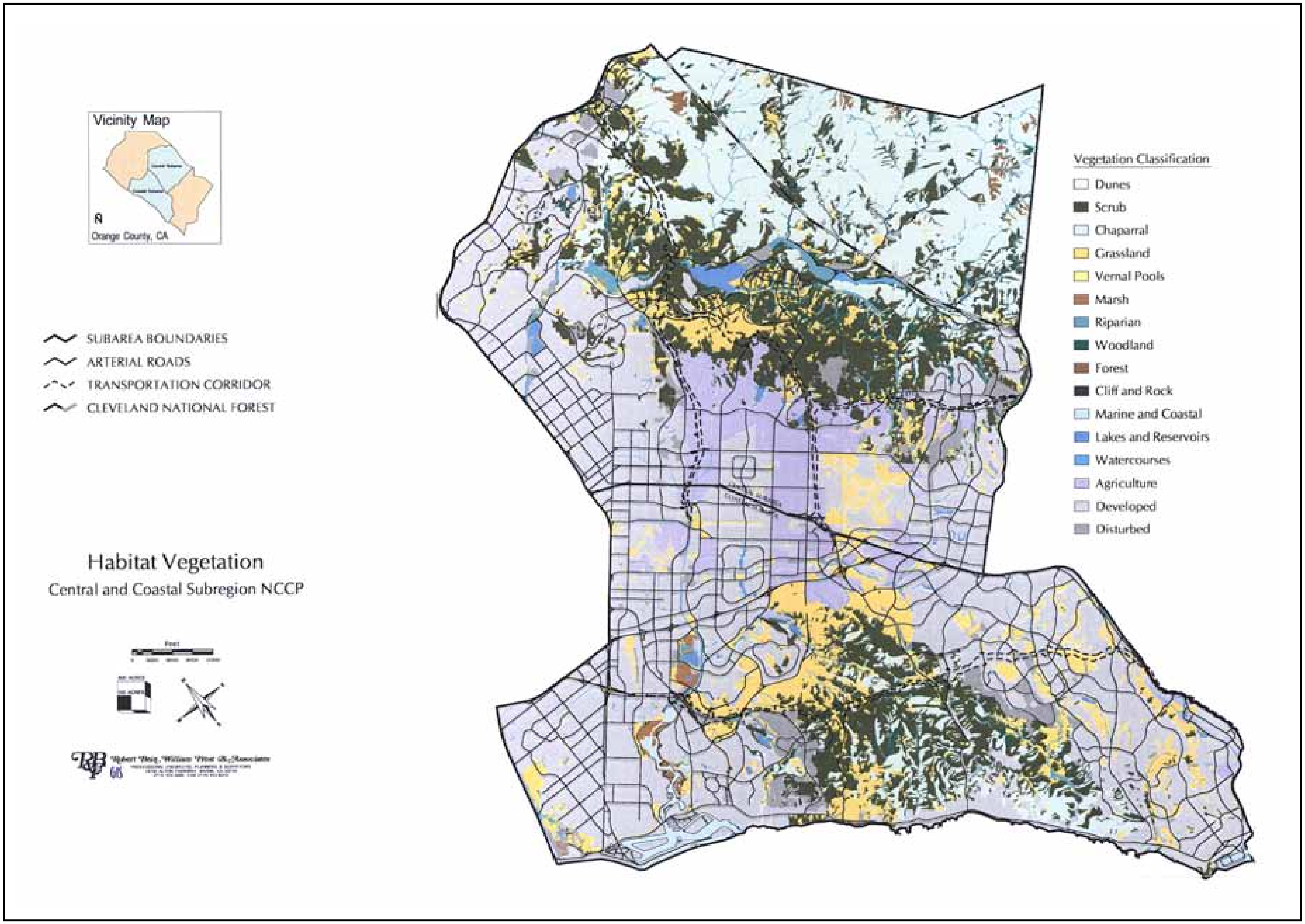

Figure 3.29 Habitat vegetation in the Central and Coastal Subregion NCCP/HCP

WOODLAND HABITATS: Woodland habitats are multi-layered vegetation communities dominated by trees that characteristically have an open canopy. The extent of woodland habitat is limited primarily to one sub-community, coast live oak woodland. Coast live oak woodland is typically found on north-facing slopes and shaded ravines usually below 1,200 meters (4,000 feet). It is described as evergreen woodland dominated by *Quercus agrifolia* and reaching a height of 10 to 25 meters (30 to 80 feet) in height. The shrub layer is poorly developed but may include *Heteromeles arbutifolia*, *Ribes spp*., *Rhus laurina*, or *Sambucus mexicana*. The herb layer is continuous and dominated by *Bromus diandrus* and several other introduced taxa.

CLIFF AND ROCK HABITATS: Cliff and rock habitats are characterized by vascular plants and lichens that grow on steep rocky faces. Some cliff faces have been identified in the San Joaquin Hills, the foothills of the Santa Ana Mountains, and around Upper Newport Bay.

SCRUB HABITAT: Scrub communities are generally dominated by small shrubs with drought deciduous leaves. Most of the plant species found within these communities regenerate following fire events. These communities often occur on dry xeric sites, such as south facing slopes, and provide structures for shelter and nesting. The Orange County Habitat Classification System identifies eight scrub communities occurring within the county: southern coastal bluff scrub, maritime succulent scrub, Venturan-Diegan transitional coastal sage scrub, southern cactus scrub, Riversidian coastal sage scrub, floodplain sage scrub, chenopod scrub, and sage-scrub grassland ecotone. The most prominent of these are the Venturan-Diegan transitional coastal sage scrub (found in the Central/Coastal NCCP), southern cactus scrub, and floodplain sage scrub.

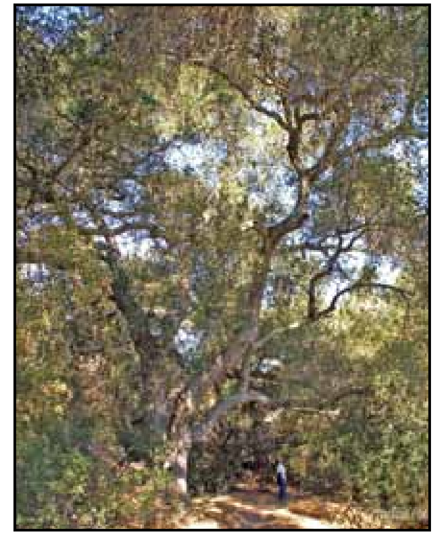

Figure 3.30 Coastal live oak woodland

CHAPARRAL HABITAT: Chaparral communities are dominated by large arborescent shrubs that generally have large evergreen leaves. Most chaparral plant species regenerate from underground root structures following fire events. These communities generally occur on moderately moist mesic sites, such as north facing slopes.

GRASSLAND HABITAT: Grasslands consist of low-growing herbaceous species dominated by annual and perennial grasses and forbs. The native grassland communities that once blanketed the southern California landscape have largely been out competed by non-native annual grasslands. Existing native grasslands are presently restricted to designated open space areas contained within the NCCP reserve system.

VERNAL POOLS, SEEPS, AND WET MEADOWS: Three types of vernal pools, seeps, or wet meadows are found in the Region. The southern hardpan vernal pool is typically found on level grassland or scrub areas with a deep underlying clay hardpan layer. Alkali meadows are seeps and wet areas that occur in low-lying alkaline or saline soils. Freshwater seeps are isolated, small perennial water sources often associated with outcrops. Southern hardpan vernal pools have been observed in Whiting Ranch Regional Park while alkali meadows and freshwater seeps are known to occur in and around Upper Newport Bay.

MARSH HABITATS: All four of the marsh habitats identified in the County of Orange inventory are represented here. Two of these, southern coastal salt marsh and coastal brackish marsh, are linked to Upper Newport Bay in the lower part of the watershed. Coastal freshwater marsh and cismontane alkali marsh are found in the vicinity of the Bay as well as in other areas of the Region.

MARINE AND COASTAL HABITATS: Habitats falling under this category include tidal mud flats and marine open water subtidal areas.

RIPARIAN HABITATS: Riparian areas are defined as narrow ecotones that typically exist between the bankfull channel of alluvial streams and adjacent uplands. These systems are characterized by two distinct zones although either may be absent under certain conditions. The first zone is the portion of the riparian corridor that is flooded by a river or stream at least every five or ten years. The second zone consists of abandoned floodplains or terraces

Figure 3.31 Coastal sage scrub

Figure 3.32 Non-native grassland

that are now flooded only episodically during larger precipitation events.

- **Southern Coastal Salt Marsh:** Salt marsh consists of halophytic perennial herbs and low shrubs that occur on regularly (or historically) flooded or saturated clay and silt solids that are high in salts, such as Upper Newport Bay. Salt marsh is dominated by California cord grass (*Spartina foliosa*) in low intertidal areas, pickleweed (*Salicornia virginica*), coastal salt grass (*Distichlis spicata*), shoregrass (*Monanthochloe littoralis*), fleshy jaumea (*Jaumea carnosa*), American saltwort (*Batis maritime*), alkali heath (*Frankenia salina*), California marsh rosemary (*Limonium californicum*), saltbush (*Atriplex sp.*), and sea-blite (*Suaeda spp.*).
- **Coastal Freshwater Marsh:** Freshwater marsh consists of seasonally or permanently flooded low-lying areas (such as San Joaquin Marsh) dominated by cattails (*Typha spp.*) and bulrushes (*Scirpus spp.*), along with species such as marsh fleabane (*Pluchea odorata*), swamp water weed (*Polygonum lapathifolium*), mayweed (*Cotula coronopifolia*), willow herb (*Epilobioum spp.*), Spanish sunflower (*Pulicaria paludosa*), seep monkeyflower (*Mimulus guttatus*), and speedwell (*Veronica spp.*).
- **Riparian Herb:** Herbaceous riparian vegetation is an early successional stage of riparian scrub and forest. Flooding (or other disturbance factors) often scours woody riparian vegetation away and the site is rapidly colonized by pioneer wetland herbaceous plants and various non-native weedy species. Examples are mugwort (*Artemesia douglasiana*), cattails, sedges, willow seedlings and saplings, millet ricegrass (*Piptatherum meliacea*), rabbit-foot grass (*Polypogon monspeliensis*), cocklebur (*Xanthium strumarium*), western ragweed (*Ambrosia psilostachya*), and black mustard (*Brassica nigra*). Various grasses may also be found within this habitat type.
- **Floodplain Sage Scrub:** The vegetation types occurs in alluvial washes and floodplains where flooding is infrequent. Dominant species include *Lepidospartum squamatum*, California sage (*Artemisia californica*), buckwheat (*Eriogonum fasciculatum*), and various introduced grasses.
- **Mule Fat Scrub:** Mule fat (*Baccharis salifcilfolia*) scrub consists of dense stands of mule fat with lower concentrations of willow. This vegetation type is commonly found within intermittent streambeds, washes, and seeps. Other species associated with this vegetation type often include mugwort, western ragweed, castor bean (*Ricinus communis*), cocklebur, rabbit-foot grass, Bermuda grass (*Cynodon dactylon*), and *Bromus spp*.
- **Southern Willow Scrub:** Willow species and riparian forest saplings dominate willow riparian scrub. This vegetation type is characterized by arroyo willow (*Salix laseolepis*) and red willow (*Salix laevigata*) with lower concentrations of mule fat and/or black willow.
- **Sandbar Willow Scrub:** This vegetation type is dominated by *Salix exigua* in shrub and herb layers. This willow species is

adapted to areas with repeated natural disturbances, such as in flood scour zones.

- **Southern Arroyo Willow Forest:** This vegetation type is dominated by an arroyo willow canopy, with other components being other willow species such as black willow.
- **Black Willow Riparian Forest:** Black willow riparian forest is a multilayered forest with a canopy dominated by mature black willow (*Salix goodingii*) with some lower concentrations of arroyo willow and red willow, and coast live oak (*Quercus agrifolia*) and sycamore (*Platanus racemosa*) occasionally present on the outer margins. This vegetation type is found on floodplains along major streams and creeks.
- **Cottonwood-Willow Riparian Forest:** Cottonwood-willow riparian forest (southern cottonwood-willow riparian forest) is a multilayered forest community dominated by Fremont cottonwood (*Populus fremontii ssp.fremontii*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), black willow, and red willow. A second canopy layer consisting of arroyo willow, mule fat, poison oak (*Toxicodendron diversilobum*), wild grape (*Vitis girdiana*) is often present. Various herbs and vines may comprise the understory. Several invasive weedy species are found in this vegetation type, including giant reed (*Arundo donax*), castor bean, and tree tobacco (*Nicotiana glauca*).
- **Southern Sycamore Riparian Woodland:** Sycamore riparian woodland consists of open to dense woodlands dominated by western sycamore, with coast live oak and mule fat Scrub, or willow riparian scrub as an understory. Other species associated with this vegetation type include holly-leaf redberry (*Rhamnus ilicifolia*), California coffee-bean (*Rhamnus californica*), laurel sumac (*Malosma laurina*), Mexican elderberry (*Sambucus mexicana*), fuchsia-flowered gooseberry, toyon (*Heteromeles arbutifolia*), poison oak, and lemonadeberry (*Rhus integrifolia*). Large grassland areas dominated by *Bromus sp*. are often present under and between the canopies of the trees in this vegetation type. Sycamore riparian woodland is often found on large intermittent streams.
- **Southern Coast Live Oak Riparian Forest:** This vegetation type occurs around intermittent and ephemeral drainages. Dominated by coast live oak, the understory may contain various riparian and/or upland plant species. Often, this vegetation type is intergraded with sycamore riparian and coast live oak woodlands.
- **Coast Live Oak Woodland:** This community type is dominated by coast live oak with associated shrubs such as California coffee-berry, toyon, *Ribes spp.*, elderberry, and poison oak. The herb layer may contain various herbs and grasses. This vegetation type is generally located on north-facing slopes and shaded ravines, not necessarily associated with drainages.
- **Canyon Live Oak Ravine Forest:** This vegetation type is a montane riparian community of steep headwaters dominated by various *Quercus spp.*, and may include such tree species as

maple (*Acer macrophyllum*) and California bay (*Umbellularia californica*).

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