Geologic, Hydrologic, and Water-Quality Data From Multiple-Well Monitoring Sites in the Central and West Coast Basins, Los Angeles County, California, 1995–2000

By Michael Land, Rhett R. Everett, *and* Steven M. Crawford

U.S. GEOLOGICAL SURVEY

Open-File Report 01-277

Prepared in cooperation with the

WATER REPLENISHMENT DISTRICT OF
SOUTHERN CALIFORNIA

5025-30

Sacramento, California
2002

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey
Placer Hall, Suite 2012
6000 J Street
Sacramento, CA 95819-6129

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Federal Center
Denver, CO 80225

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS, VERTICAL DATUM, ABBREVIATIONS, AND WELL-NUMBERING SYSTEM

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
Area		
acre	0.004047	square kilometer
square mile (mi^2)	2.590	square kilometer
Volume		
gallon (gal)	3.785	liter
cubic foot (ft^3)	0.02832	cubic meter
cubic foot (ft^3)	28.32	cubic decimeter/liter

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows: °F = (1.8 × °C) + 32

Vertical Datum:

Sea level**:** In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Abbreviations

cm^3	cubic centimeter
g/cm^3	gram per cubic centimeter
L	liter
mL	milliliter
mg/L	milligrams per liter
mm^2/s	square millimeter per second
µg/L	micrograms per liter
µm	micrometer
µS/cm	microsiemens per centimeter at 25 ^oC
per mil	parts per thousand, as used with delta (δ) notation
pmc	percent modern carbon
TU	tritium unit
J	joule
W	watts
^oC	degrees Celsius
mm	millimeter
cm	centimeter
NBS	National Bureau of Standards
NWIS	National Water Information System
NWQL	U.S. Geological Survey National Water Quality Laboratory
PES	polyethersulfone
PVC	polyvinyl chloride
USGS	U.S. Geological Survey
WRDSC	Water Replenishment District of Southern California

Water-Quality Information

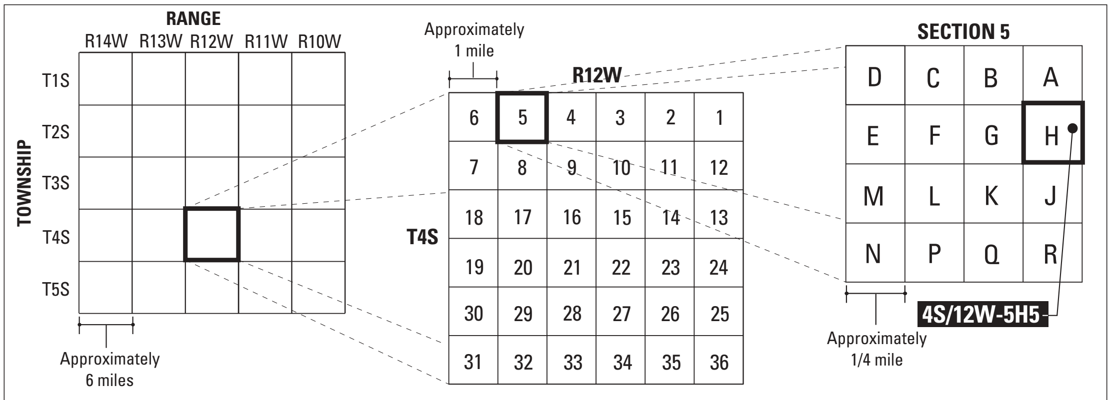
Chemical concentration is given in milligrams per liter (mg/L) or in micrograms per liter (μg/L). One thousand micrograms per liter is equal to 1 milligram per liter. Milligrams and micrograms per liter are units expressing the mass of a solute per unit volume (liter) of solution. Milligrams per liter is equivalent to “parts per million” and micrograms per liter is equivalent to “parts per billion” for the concentrations normally found in most ground water. At the high dissolved-solids concentration found in seawater and in some brines, the mass of a liter of solution is greater than 1 kilogram, and “milligrams per liter” and “parts per million,” a mass-to-mass ratio, are not equivalent.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (μS/cm at 25 ˚C).

Well-Numbering System

Wells are identified and numbered by the State of California according to their location in the system for the subdivision of public lands. Identification consists of the township number, north or south; the range number, east or west; and the section number. Each section measures one square mile and is divided into 40-acre tracts lettered consecutively (except I and O), beginning with “A” in the northeast corner of the section and progressing in a sinusoidal manner to “R” in the southeast corner. Within the 40-acre tract, wells are sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. In California, there are three base lines and meridians; Humboldt (H), Mount Diablo (M), and San Bernardino (S). All wells in the study area are referenced to the San Bernardino base line and meridian (S). Well numbers consist of 15 characters and follow the format 004S012W05H005S.

In this report, well numbers in text and figures are abbreviated and written 4S/12W-5H5. Wells in the same township and range may also be conveniently referred to by their section designation, 5H5. The following diagram shows how the number for well 4S/12W-5H5 (Lakewood-1 #1) is derived.



Well-numbering diagram (Note: maps in this report use abbreviated well numbers such as **"5H5"**)

Geologic, Hydrologic, and Water-Quality Data From Multiple-Well Monitoring Sites in the Central and West Coast Basins, Los Angeles County, California, 1995–2000

By Michael Land, Rhett R. Everett, *and* Steven M. Crawford

ABSTRACT

In 1995, the U.S. Geological Survey (USGS), in cooperation with the Water Replenishment District of Southern California (WRDSC), began a study to examine ground-water resources in the Central and West Coast Basins in Los Angeles County, California. The study characterizes the geohydrology and geochemistry of the regional ground-water flow system and provides extensive data for evaluating ground-water management issues. This report is a compilation of geologic, hydrologic, and water-quality data collected from 24 recently constructed multiple-well monitoring sites for the period 1995–2000.

Descriptions of the collected drill cuttings were compiled into lithologic logs, which are summarized along with geophysical logs—including gamma-ray, spontaneous potential, resistivity, electromagnetic induction, and temperature tool logs—for each monitoring site. At selected sites, cores were analyzed for magnetic orientation, physical and thermal properties, and mineralogy. Field and laboratory estimates of hydraulic conductivity are presented for most multiple-well monitoring sites. Periodic water-level measurements are also reported. Water-quality information for major ions, nutrients, trace elements, deuterium and oxygen-18, and tritium is presented for the multiple-well monitoring locations, and for selected existing production and observation wells. In addition, boron-11, carbon-13, carbon-14, sulfur-34, and strontium-87/86 data are presented for selected wells.

INTRODUCTION

The Los Angeles coastal plain is one of the Nation's largest urban centers (fig. 1). Ground water constitutes about one-third of the total water supply to approximately 4 million people within the Central and West Coast Basins. Water managers are faced with numerous water-supply and water-quality issues, including conjunctive use of ground water and surface water, long-term sustainability of ground-water resources, seawater intrusion, quantity and quality of natural and artificial recharge, anthropogenic and naturally occurring constituents with concentrations exceeding drinking-water standards, and potential for aquifer contamination from adjacent basins.

Purpose and Scope

In 1995, the U.S. Geological Survey (USGS), in cooperation with the Water Replenishment District of Southern California (WRDSC), began a long-term study to examine ground-water resources in the Central and West Coast Basins in Los Angeles County, California. The purpose of this study is to evaluate the geohydrology and geochemistry of the basins to better characterize the regional ground-water flow system. New data, interpretations, and analytical tools developed from this study will be used to evaluate and address water-management issues.

An essential component of this study was the construction of multiple-well monitoring sites to collect an array of depth-dependent information within the Central and West Coast Basins aquifer systems. Boreholes were drilled and partially cored at 24 sites for collection of lithologic and geophysical data. Multiple wells were subsequently installed at isolated depths within each borehole for collection of hydraulic, water-quality, and additional geophysical data.

The purpose of this report is to present a compilation of site location, well construction, geologic, hydrologic, and water-quality information collected from these monitoring sites and from selected existing ground-water wells for the period 1995–2000. These data are the basis for a comprehensive hydrologic analysis that will be presented in a subsequent report.

Description of Study Area

The study area, shown in figure 1, is in the coastal plain of Los Angeles County and is bounded by the Santa Monica Mountains to the north, the Elysian,

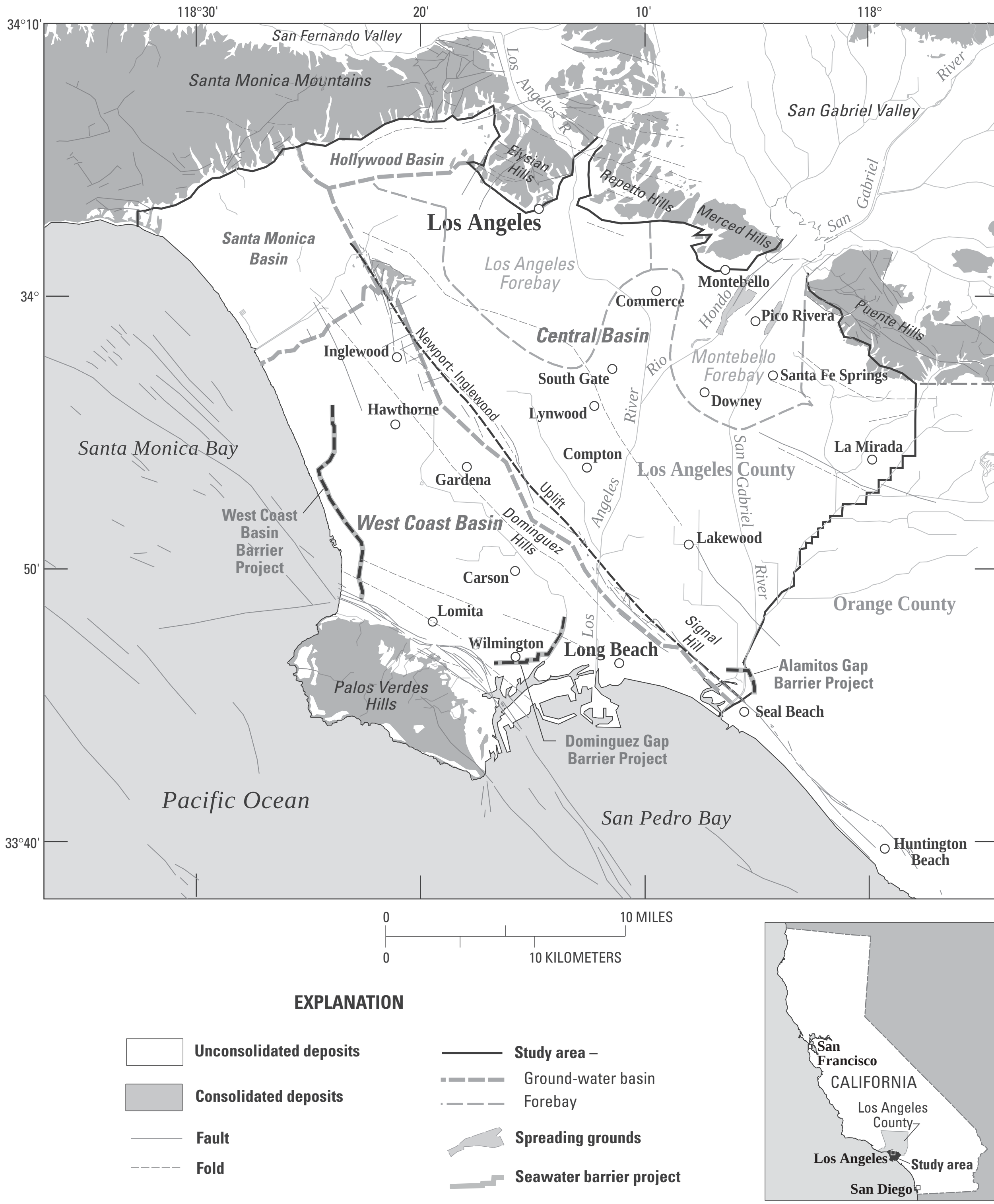


Figure 1. Location of study area and geologic and other features, Los Angeles County, California.

Repetto, Merced, and Puente Hills to the northeast, Orange County to the east, and the Pacific Ocean (Santa Monica Bay and San Pedro Bay) and the Palos Verdes Hills to the west and southwest. The area has a Mediterranean-type climate characterized by warm summers and cool, wet winters. Precipitation across the coastal plain averages 14 inches per year (Los Angeles County Department of Public Works, 1996). The coastal region includes four ground-water basins in Los Angeles County (fig. 1): the Central Basin, the Hollywood Basin, the West Coast Basin, and the Santa Monica Basin (California Department of Water Resources, 1961). The focus area for this report—the Central and West Coast Basins—totals 420 square miles.

The study area is drained by two main rivers—the Los Angeles and the San Gabriel—that discharge to the Pacific Ocean. These rivers enter the study area through the Los Angeles and Montebello Forebays, which historically have been areas of ground-water recharge. Prior to significant development of the basin, artesian conditions existed and ground water flowed south and westward, eventually discharging to wetlands or offshore in the Santa Monica and San Pedro Bays (Mendenhall, 1905a, 1905b). Under current conditions, most recharge in the study area occurs in the Montebello Forebay (fig. 1). Winter storm water, imported water, and treated waste water are artificially recharged through spreading grounds adjacent to the Rio Hondo and San Gabriel River. In the West Coast Basin, a mixture of imported and treated waste water is injected into the ground-water system at the West Coast Basin, Dominguez Gap, and Alamitos Gap Barrier Projects.

The water-bearing deposits underlying the Central and West Coast Basins are unconsolidated to partly consolidated deposits, and include marine and nonmarine alluvial sediments of Holocene, Pleistocene, and Pliocene age (Poland and others, 1959; California Department of Water Resources, 1961). These water-bearing deposits compose a complex series of aquifers that are more than 1,800 feet thick in some parts of the study area (California Department of Water Resources, 1961; Yerkes and others, 1965). For the purposes of this study, the water-bearing deposits are subdivided into four aquifer systems: Recent, Lakewood, Upper San Pedro, and Lower San Pedro. Active ground-water pumping in the basin does not occur in the underlying Pico stratigraphic unit.

Acknowledgments

The collection of the data that are presented in this report was made possible with the cooperation and support of numerous local water purveyors, municipalities, and entities/organizations. Access and accommodation to, and permission to drill on, property was granted or provided by the city of Carson, Downey Unified School District, city of Inglewood, city of Lakewood, city of Lomita, city of Long Beach, city of Los Angeles, Pico Water District, city of Pico Rivera, city of South Gate, Southern California Water Company, Suburban Water Systems, Los Angeles County Department of Parks and Recreation, Los Angeles County Department of Probation, Los Angeles County Department of Public Works, and the Los Angeles County Sanitation Districts. The WRDSC provided cooperative funding for this study, and provided logistical support through the Hydrogeology Group of Theodore Johnson, Anthony Kirk, Bennett Chong, Nancy Matsumoto, and Tracy Parr.

GROUND-WATER MONITORING NETWORK

Most information presented in this report focuses on 24 multiple-well monitoring sites installed between August 1995 and June 2000 within the study area (fig. 2). Existing wells (38 production and 20 observation) were incorporated into the monitoring network to help meet additional water-quality data-collection needs.

Multiple-well monitoring sites in the Central Basin include locations within the Montebello Forebay, within the Los Angeles Forebay, and areas across the Central Basin downgradient from these forebay areas. Monitoring sites in the West Coast Basin include locations near the Newport–Inglewood Uplift (fig. 1) and seawater-barrier projects. Data collected from these wells provide information on vertical differences in hydraulic properties, water levels, and water quality at the same areal location; and help characterize the three-dimensional ground-water system. Well-identification and well-construction information for ground-water wells in the monitoring network are presented in table 1.

Multiple-well monitoring sites–also referred to as a well cluster–consist of four to six small-diameter (generally 2-inch) wells installed at different depths in the same borehole. Each well is screened over a specific interval (generally 20 feet) and is isolated from other wells by a low-permeability bentonite grout. The construction of these wells enables the collection of depth-specific chemical, water-quality, water-level, and aquifer-property data.

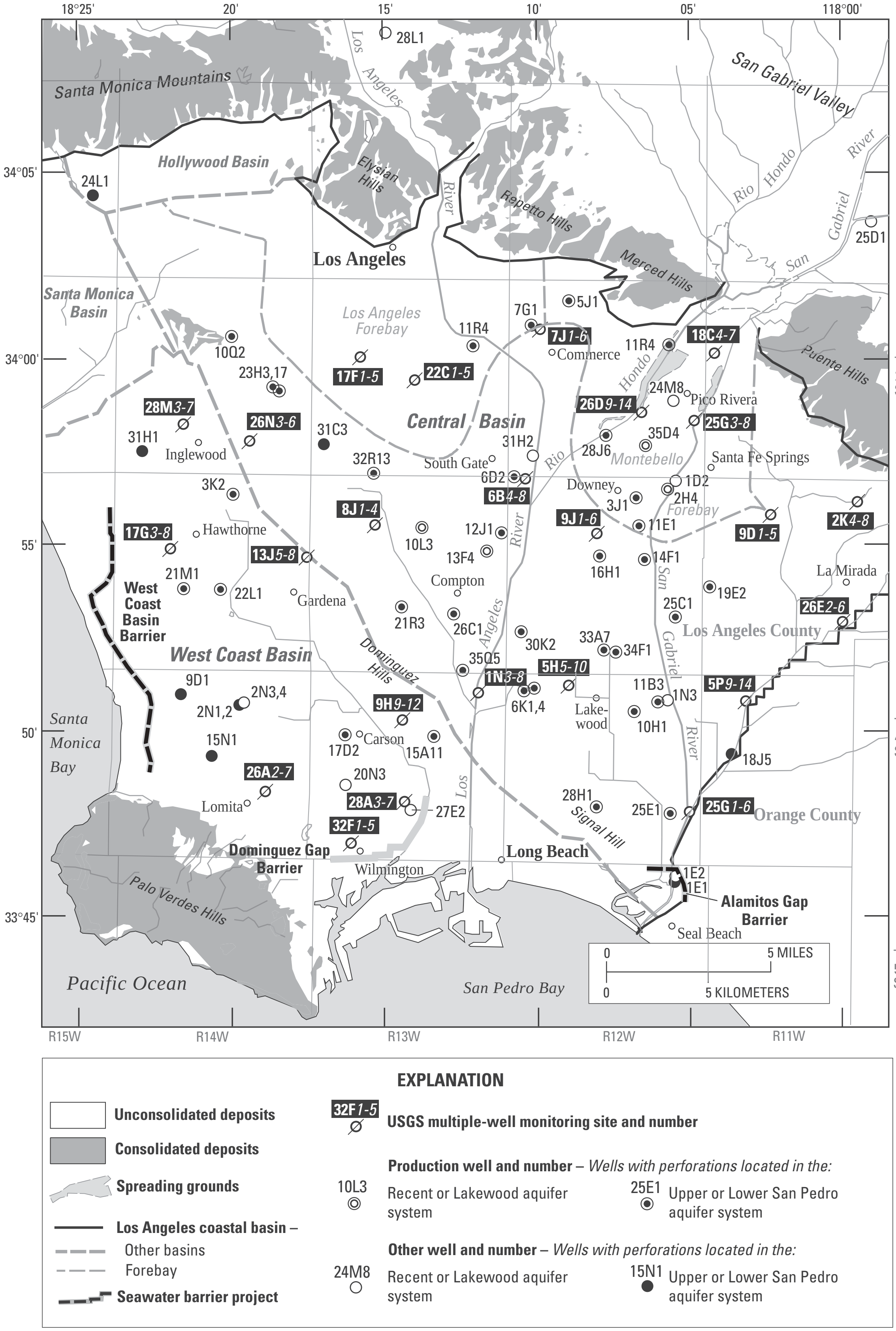


Figure 2. Ground-water sampling sites, Los Angeles County, California.

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California

[Location of sites is shown in figure 2. State well numbers: See well-numbering diagram in text. Well type: MULTI, multiple-well monitoring site; PROD, production well; OBS, observation well. Altitude is in feet above sea level reported to the National Geodetic Vertical Datum of 1929; depths are in feet below land surface; diameter of casing is in inches; —, no data]

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
001N013W28L001S	340830118150901	LACDPW 3945C	OBS	520	342	2	317	337	Lakewood
001S011W25D001S	340339117593301	LACDPW 3003A	OBS	297	150	2	140	150	Recent
001S015W24L001S	340405118243001	Linden B-1	OBS	270	780	4	700	760	Lower San Pedro
002S011W18C004S	340005118043301	Pico Rivera-1 #1	MULTI	181	900	3	860	900	Pico
002S011W18C005S	340005118043302	Pico Rivera-1 #2	MULTI	181	480	2	460	480	Lower San Pedro
002S011W18C006S	340005118043303	Pico Rivera-1 #3	MULTI	181	400	2	380	400	Upper San Pedro
002S011W18C007S	340005118043304	Pico Rivera-1 #4	MULTI	181	190	2	170	190	Upper San Pedro
002S012W05J001S	340125118091701	Cal-Water 51-01	PROD	205	455	16	347	436	Upper San Pedro
002S012W07G001S	340047118102601	Cal-Water 39-01	PROD	170	510	14	340	465	Upper San Pedro
002S012W07J001S	340040118100901	Commerce-1 #1	MULTI	162	1,390	2	1,330	1,390	Pico
002S012W07J002S	340040118100902	Commerce-1 #2	MULTI	162	960	2	940	960	Lower San Pedro
002S012W07J003S	340040118100903	Commerce-1 #3	MULTI	162	780	2	760	780	Lower San Pedro
002S012W07J004S	340040118100904	Commerce-1 #4	MULTI	162	590	2	570	590	Upper San Pedro
002S012W07J005S	340040118100905	Commerce-1 #5	MULTI	162	345	2	325	345	Upper San Pedro
002S012W07J006S	340040118100906	Commerce-1 #6	MULTI	162	225	2	205	225	Lakewood
002S012W11R004S	340020118060101	Montebello #11a	PROD	170	380	16	240	360	Upper San Pedro
002S012W24M008S	335850118055301	LACDPW 1601T	OBS	159	185	4	155	175	Lakewood
002S012W25G003S	335818118051201	Pico Rivera-2 #1	MULTI	150	1,200	2	1,180	1,200	Lower San Pedro
002S012W25G004S	335818118051202	Pico Rivera-2 #2	MULTI	150	850	2	830	850	Upper San Pedro
002S012W25G005S	335818118051203	Pico Rivera-2 #3	MULTI	150	580	2	560	580	Upper San Pedro
002S012W25G006S	335818118051204	Pico Rivera-2 #4	MULTI	150	340	2	320	340	Upper San Pedro
002S012W25G007S	335818118051205	Pico Rivera-2 #5	MULTI	150	255	2	235	255	Lakewood
002S012W25G008S	335818118051206	Pico Rivera-2 #6	MULTI	150	120	2	100	120	Recent
002S012W26D009S	335829118065201	Rio Hondo-1 #1	MULTI	145	1,150	2	1,110	1,130	Lower San Pedro
002S012W26D010S	335829118065202	Rio Hondo-1 #2	MULTI	145	930	2	910	930	Upper San Pedro

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
002S012W26D011S	335829118065203	Rio Hondo-1 #3	MULTI	145	730	2	710	730	Upper San Pedro
002S012W26D012S	335829118065204	Rio Hondo-1 #4	MULTI	145	450	2	430	450	Upper San Pedro
002S012W26D013S	335829118065205	Rio Hondo-1 #5	MULTI	145	300	2	280	300	Lakewood
002S012W26D014S	335829118065206	Rio Hondo-1 #6	MULTI	145	160	2	140	160	Recent
002S012W28J006S	335752118080201	Downey #7	PROD	133	686	14	616	656	Upper San Pedro
002S012W31H002S	335719118101501	LACDPW 1524E	OBS	108	205	2	195	205	Lakewood
002S012W35D004S	335736118064501	Downey #5	PROD	137	324	12	285	310	Lakewood
002S013W11R004S	340015118121901	Vernon #12	PROD	183	1,580	18	996	1,580	Lower San Pedro
002S013W17F001S	335952118155601	Los Angeles-1 #1	MULTI	174	1,370	2	1,350	1,370	Lower San Pedro
002S013W17F002S	335952118155602	Los Angeles-1 #2	MULTI	174	1,100	2	1,080	1,100	Upper San Pedro
002S013W17F003S	335952118155603	Los Angeles-1 #3	MULTI	174	940	3	920	940	Upper San Pedro
002S013W17F004S	335952118155604	Los Angeles-1 #4	MULTI	174	660	2	640	660	Upper San Pedro
002S013W17F005S	335952118155605	Los Angeles-1 #5	MULTI	174	370	2	350	370	Upper San Pedro
002S013W22C001S	335917118141001	Huntington Park-1 #1	MULTI	177	910	2	890	910	Upper San Pedro
002S013W22C002S	335917118141002	Huntington Park-1 #2	MULTI	177	710	2	690	710	Upper San Pedro
002S013W22C003S	335917118141003	Huntington Park-1 #3	MULTI	177	440	2	420	440	Upper San Pedro
002S013W22C004S	335917118141004	Huntington Park-1 #4	MULTI	177	295	2	275	295	Lakewood
002S013W22C005S	335917118141005	Huntington Park-1 #5	MULTI	177	134	2	114	134	Recent
002S013W31C003S	335734118165601	LACDPW 1414C	OBS	132	472	2	441	462	Upper San Pedro
002S013W32R013S	335647118152501	99th Street #11	PROD	133	1,500	30	500	1,452	Upper San Pedro
002S014W10Q002S	340023118200201	Crenshaw	PROD	126	456	14	200	456	Upper San Pedro
002S014W23H003S	335858118183301	Manhatten #1a	PROD	136	599	20	301	556	Upper San Pedro
002S014W23H017S	335858118183101	Manhatten #6	PROD	134	1,390	12	424	1370	Upper San Pedro
002S014W26N003S	335737118192501	Inglewood-2 #1	MULTI	215	860	2	800	840	Pico
002S014W26N004S	335737118192502	Inglewood-2 #2	MULTI	215	470	2	450	470	Pico

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
002S014W26N005S	335737118192503	Inglewood-2 #3	MULTI	215	350	2	330	350	Lower San Pedro
002S014W26N006S	335737118192504	Inglewood-2 #4	MULTI	215	245	2	225	245	Upper San Pedro
002S014W28M003S	335801118213101	Inglewood-1 #1	MULTI	115	1,400	2	1,380	1,400	Pico
002S014W28M004S	335801118213102	Inglewood-1 #2	MULTI	115	885	2	865	885	Lower San Pedro
002S014W28M005S	335801118213103	Inglewood-1 #3	MULTI	115	450	2	430	450	Lower San Pedro
002S014W28M006S	335801118213104	Inglewood-1 #4	MULTI	115	300	2	280	300	Upper San Pedro
002S014W28M007S	335801118213105	Inglewood-1 #5	MULTI	115	170	2	150	170	Lakewood
002S014W31H001S	335710118225001	LACDPW 1314	OBS	99	450	4	270	440	Upper San Pedro
003S011W02K004S	335609118000101	Whittier-1 #1	MULTI	210	1,280	2	1,180	1,200	Upper San Pedro
003S011W02K005S	335609118000102	Whittier-1 #2	MULTI	210	940	3	920	940	Upper San Pedro
003S011W02K006S	335609118000104	Whittier-1 #4	MULTI	210	470	2	450	470	Upper San Pedro
003S011W02K007S	335609118000105	Whittier-1 #5	MULTI	210	220	2	200	220	Lakewood
003S011W02K008S	335609118000201	Whittier-1 #3	MULTI	210	620	2	600	620	Upper San Pedro
003S011W09D001S	335546118024301	Santa Fe Springs-1 #1	MULTI	165	1,410	2	1,290	1,310	Pico
003S011W09D002S	335546118024302	Santa Fe Spring-1 #2	MULTI	165	845	2	825	845	Lower San Pedro
003S011W09D003S	335546118024303	Santa Fe Springs-1 #3	MULTI	165	560	2	540	560	Upper San Pedro
003S011W09D004S	335546118024304	Santa Fe Springs-1 #4	MULTI	165	285	2	265	285	Upper San Pedro
003S011W09D005S	335546118024305	Santa Fe Springs-1 #5	MULTI	165	190	2	170	190	Lakewood
003S011W19E002S	335352118044001	Park Water #29K	PROD	86	736	16	684	718	Upper San Pedro
003S011W26E002S	335258118002401	La Mirada-1 #1	MULTI	78	1,150	2	1,130	1,150	Lower San Pedro
003S011W26E003S	335258118002402	La Mirada-1 #2	MULTI	78	985	2	965	985	Upper San Pedro
003S011W26E004S	335258118002403	La Mirada-1 #3	MULTI	78	710	2	690	710	Upper San Pedro
003S011W26E005S	335258118002404	La Mirada-1 #4	MULTI	78	490	2	470	490	Upper San Pedro
003S011W26E006S	335258118002405	La Mirada-1 #5	MULTI	78	245	2	225	245	Lakewood
003S012W01D002S	335639118055301	LACDPW 1605M	OBS	129	126	2	116	126	Recent

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
003S012W02H004S	335810118070201	Downey #12	PROD	118	444	16	301	352	Lakewood
003S012W03J001S	335612118070101	Downey #16	PROD	116	866	16	405	488	Upper San Pedro
003S012W06B004S	335642118103701	South Gate-1 #1	MULTI	102	1,460	2	1,140	1,460	Lower San Pedro
003S012W06B005S	335642118103702	South Gate-1 #2	MULTI	102	1,340	2	1,320	1,340	Upper San Pedro
003S012W06B006S	335642118103703	South Gate-1 #3	MULTI	102	930	2	910	930	Upper San Pedro
003S012W06B007S	335642118103704	South Gate-1 #4	MULTI	102	585	2	565	585	Upper San Pedro
003S012W06B008S	335642118103705	South Gate-1 #5	MULTI	102	240	2	220	240	Lakewood
003S012W06D002S	335645118105601	South Gate #14	PROD	—	813	18	615	775	Upper San Pedro
003S012W09J001S	335517118081301	Downey-1 #1	MULTI	98	1,190	2	1,170	1,190	Upper San Pedro
003S012W09J002S	335517118081302	Downey-1 #2	MULTI	98	960	2	940	960	Upper San Pedro
003S012W09J003S	335517118081303	Downey-1 #3	MULTI	98	600	2	580	600	Upper San Pedro
003S012W09J004S	335517118081304	Downey-1 #4	MULTI	98	390	2	370	390	Lakewood
003S012W09J005S	335517118081305	Downey-1 #5	MULTI	98	270	2	250	270	Lakewood
003S012W09J006S	335517118081306	Downey-1 #6	MULTI	98	110	2	90	110	Recent
003S012W11E001S	335529118065501	Downey #24	PROD	107	510	16	465	510	Upper San Pedro
003S012W14F001S	335435118064401	Park Water #28B	PROD	92	644	16	568	612	Upper San Pedro
003S012W16H001S	335440118081101	Park Water #40D	PROD	—	606	16	546	572	Upper San Pedro
003S012W25C001S	335303118053801	Cerritos JC #2	PROD	71	914	14	760	914	Upper San Pedro
003S012W30K002S	335215118102001	Edison #922-E	PROD	59	660	12	640	660	Upper San Pedro
003S012W33A007S	335209118080101	Lakewood #2a	PROD	58	658	20	612	637	Upper San Pedro
003S012W34F001S	335208118073801	Lakewood #18	PROD	60	1,108	16	1,041	1,069	Lower San Pedro
003S013W08J001S	335524118152001	Willowbrook-1 #1	MULTI	97	905	2	885	905	Lower San Pedro
003S013W08J002S	335524118152002	Willowbrook-1 #2	MULTI	97	520	2	500	520	Upper San Pedro
003S013W08J003S	335524118152003	Willowbrook-1 #3	MULTI	97	380	2	360	380	Upper San Pedro
003S013W08J004S	335524118152004	Willowbrook-1 #4	MULTI	97	220	2	200	220	Lakewood

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
003S013W10L003S	335513118140002	Willowbrook #3	PROD	83	352	16	220	300	Lakewood
003S013W12J001S	335515118112101	Lynwood #5	PROD	85	751	13	650	720	Upper San Pedro
003S013W13F004S	335435118115201	Park Water #4B	PROD	75	389	16	363	389	Lakewood
003S013W21R003S	335314118142901	Park Water #31A	PROD	90	470	16	300	427	Upper San Pedro
003S013W26C001S	335305118125001	Compton #13	PROD	63	738	16	554	670	Upper San Pedro
003S013W35Q005S	335133118123201	Dominguez #23b	PROD	48	626	16	430	564	Upper San Pedro
003S014W03K002S	335608118195801	Yukon #2	PROD	76	756	18	367	405	Upper San Pedro
003S014W13J005S	335431118173101	Gardena-1 #1	MULTI	84	990	3	970	990	Lower San Pedro
003S014W13J006S	335431118173102	Gardena-1 #2	MULTI	84	465	2	445	465	Upper San Pedro
003S014W13J007S	335431118173103	Gardena-1 #3	MULTI	84	365	2	345	365	Upper San Pedro
003S014W13J008S	335431118173104	Gardena-1 #4	MULTI	84	140	2	120	140	Lakewood
003S014W17G003S	335443118215501	Hawthorne-1 #1	MULTI	84	990	2	910	950	Pico
003S014W17G004S	335443118215502	Hawthorne-1 #2	MULTI	84	730	2	710	730	Lower San Pedro
003S014W17G005S	335443118215503	Hawthorne-1 #3	MULTI	84	540	2	520	540	Upper San Pedro
003S014W17G006S	335443118215504	Hawthorne-1 #4	MULTI	84	420	2	400	420	Upper San Pedro
003S014W17G007S	335443118215505	Hawthorne-1 #5	MULTI	84	260	2	240	260	Upper San Pedro
003S014W17G008S	335443118215506	Hawthorne-1 #6	MULTI	84	130	2	110	130	Lakewood
003S014W21M001S	335340118212601	Chicago #1	PROD	60	399	16	378	399	Upper San Pedro
003S014W22L001S	335340118201801	Compton+Doty	PROD	—	502	2	352	458	Upper San Pedro
004S011W05P009S	335049118032901	Cerritos-1 #1	MULTI	38	1,215	2	1,155	1,175	Lower San Pedro
004S011W05P010S	335049118032902	Cerritos-1 #2	MULTI	38	1,020	2	1,000	1,020	Lower San Pedro
004S011W05P011S	335049118032903	Cerritos-1 #3	MULTI	38	630	2	610	630	Upper San Pedro
004S011W05P012S	335049118032904	Cerritos-1 #4	MULTI	38	290	2	270	290	Upper San Pedro
004S011W05P013S	335049118032905	Cerritos-1 #5	MULTI	38	200	2	180	200	Lakewood

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
004S011W05P014S	335049118032906	Cerritos-1 #6	MULTI	38	135	2	125	135	Lakewood
004S011W18J005S	334924118035301	LACDPW 1037G	OBS	28	763	2	754	763	Upper San Pedro
004S012W01N003S	335046118055501	LACDPW 1005E	OBS	51	300	2	250	270	Lakewood
004S012W05H005S	335112118090401	Lakewood-1 #1	MULTI	48	1,009	3	989	1,009	Lower San Pedro
004S012W05H006S	335112118090402	Lakewood-1 #2	MULTI	48	660	2	640	660	Upper San Pedro
004S012W05H007S	335112118090403	Lakewood-1 #3	MULTI	48	470	2	450	470	Upper San Pedro
004S012W05H008S	335112118090404	Lakewood-1 #4	MULTI	48	300	2	280	300	Lakewood
004S012W05H009S	335112118090405	Lakewood-1 #5	MULTI	48	160	2	140	160	Lakewood
004S012W05H010S	335112118090406	Lakewood-1 #6	MULTI	48	90	2	70	90	Lakewood
004S012W06K001S	335105118102802	North Long Beach-4	PROD	47	1,160	16	972	1,142	Lower San Pedro
004S012W06K004S	335106118101901	North Long Beach-5	PROD	—	810	16	572	636	Upper San Pedro
004S012W10H001S	335030118070001	Lakewood #10	PROD	46	1,130	14	448	471	Upper San Pedro
004S012W11B003S	335047118061601	Lakewood #16	PROD	43	1,166	16	926	1,082	Lower San Pedro
004S012W25E001S	334747118055001	Annex #204	PROD	16	1,186	2	999	1,146	Lower San Pedro
004S012W25G001S	334753118051901	Long Beach-1 #1	MULTI	31	1,470	2	1,430	1,450	Lower San Pedro
004S012W25G002S	334753118051902	Long Beach-1 #2	MULTI	31	1,250	2	1,230	1,250	Lower San Pedro
004S012W25G003S	334753118051903	Long Beach-1 #3	MULTI	31	990	2	970	990	Upper San Pedro
004S012W25G004S	334753118051904	Long Beach-1 #4	MULTI	31	619	2	599	619	Upper San Pedro
004S012W25G005S	334753118051905	Long Beach-1 #5	MULTI	31	420	2	400	420	Upper San Pedro
004S012W25G006S	334753118051906	Long Beach-1 #6	MULTI	31	175	2	155	175	Lakewood
004S012W28H001S	334757118081201	Alamitos #9	PROD	—	1,184	16	768	1,148	Lower San Pedro
004S013W01N003S	335100118120401	Long Beach-2 #1	MULTI	42	1,090	3	970	990	Pico
004S013W01N004S	335100118120402	Long Beach-2 #2	MULTI	42	740	2	720	740	Lower San Pedro
004S013W01N005S	335100118120403	Long Beach-2 #3	MULTI	42	470	2	450	470	Upper San Pedro
004S013W01N006S	335100118120404	Long Beach-2 #4	MULTI	42	300	2	280	300	Upper San Pedro

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
004S013W01N007S	335100118120405	Long Beach-2 #5	MULTI	42	180	2	160	180	Lakewood
004S013W01N008S	335100118120406	Long Beach-2 #6	MULTI	42	115	2	95	115	Lakewood
004S013W09H009S	335013118142501	Carson-1 #1	MULTI	24	1,010	2	990	1,010	Upper San Pedro
004S013W09H010S	335013118142502	Carson-1 #2	MULTI	24	760	2	740	760	Upper San Pedro
004S013W09H011S	335013118142503	Carson-1 #3	MULTI	24	480	2	460	480	Upper San Pedro
004S013W09H012S	335013118142504	Carson-1 #4	MULTI	24	270	2	250	270	Lakewood
004S013W15A011S	334950118132501	Dominguez #15	PROD	27	1,049	16	802	1,000	Upper San Pedro
004S013W17D002S	334953118160701	Dominguez #19	PROD	23	685	16	510	665	Upper San Pedro
004S013W20N003S	334826118161003	LACDPW 829N	OBS	38	177	4	117	167	Lakewood
004S013W27E002S	334748118141901	LACDPW 360H	OBS	35	189[1]	2	181	191	Lakewood
004S013W28A003S	334802118141801	Wilmington-1 #1	MULTI	30	1,035	3	915	935	Lower San Pedro
004S013W28A004S	334802118141802	Wilmington-1 #2	MULTI	30	800	2	780	800	Lower San Pedro
004S013W28A005S	334802118141803	Wilmington-1 #3	MULTI	30	570	2	550	570	Upper San Pedro
004S013W28A006S	334802118141804	Wilmington-1 #4	MULTI	30	245	2	225	245	Upper San Pedro
004S013W28A007S	334802118141805	Wilmington-1 #5	MULTI	30	140	2	120	140	Lakewood
004S013W32F001S	334657118160001	Wilmington-2 #1	MULTI	29	1,030	3	950	970	Lower San Pedro
004S013W32F002S	334657118160002	Wilmington-2 #2	MULTI	29	775	2	755	775	Upper San Pedro
004S013W32F003S	334657118160003	Wilmington-2 #3	MULTI	29	560	2	540	560	Upper San Pedro
004S013W32F004S	334657118160004	Wilmington-2 #4	MULTI	29	410	2	390	410	Upper San Pedro
004S013W32F005S	334657118160005	Wilmington-2 #5	MULTI	29	140	2	120	140	Lakewood
004S014W02N001S	335033118193101	PM-3 Madrid #1	OBS	65	685	4	640	680	Lower San Pedro
004S014W02N002S	335033118193102	PM-3 Madrid #2	OBS	65	525	4	480	520	Upper San Pedro
004S014W02N003S	335033118193103	PM-3 Madrid #3	OBS	65	285	4	240	280	Upper San Pedro
004S014W02N004S	335033118193104	PM-3 Madrid #4	OBS	65	190	4	145	185	Lakewood
004S014W09D001S	335048118212901	LACDPW 745A	OBS	113	647	4	547	627	Lower San Pedro

See footnote at end of table.

Table 1. Well-identification and construction information for ground-water sampling sites, Los Angeles County, California—Continued

State well No.	USGS site identification No.	Common name	Well type	Altitude of land surface	Depth to bottom of casing	Diameter of casing	Depth to top perforation	Depth to bottom perforation	Aquifer system or unit
004S014W15N001S	334904118202401	LACDPW 758A	OBS	78	380	2	360	370	Upper San Pedro
004S014W26A002S	334815118184701	Lomita-1 #1	MULTI	75	1,340	2	1,240	1,260	Lower San Pedro
004S014W26A003S	334815118184702	Lomita-1 #2	MULTI	75	720	2	700	720	Upper San Pedro
004S014W26A004S	334815118184703	Lomita-1 #3	MULTI	75	570	2	550	570	Upper San Pedro
004S014W26A005S	334815118184704	Lomita-1 #4	MULTI	75	420	2	400	420	Upper San Pedro
004S014W26A006S	334815118184705	Lomita-1 #5	MULTI	75	240	2	220	240	Lakewood
004S014W26A007S	334815118184706	Lomita-1 #6	MULTI	75	120	2	100	120	Lakewood
005S012W01E001S	334607118053801	LACDPW 503M	OBS	10	635	2	610	620	Lower San Pedro
005S012W01E002S	334607118053901	LACDPW 503N	OBS	10	187	2	157	182	Lakewood

[1]Depth to bottom of casing sounded on August 31, 1995.

Boreholes at each site were drilled by the USGS Western Region Research Drilling Unit using a mud-rotary rig. Borehole diameter decreased with depth, using tri-cone roller drill bits, ranging in diameter from 12-3/4 to 7-1/2 inches. After total hole depth was attained, geophysical log surveys were completed, and the monitoring wells were installed. The monitoring wells were constructed using flush-threaded, 2-inch-diameter, schedule 80 polyvinyl chloride (PVC) casing. The screened interval for each monitoring well typically consisted of a 20-foot section of slotted PVC (slot size is 0.020 inch) at the bottom. Once the well was set to the desired depth, a filter pack was tremied around the screened interval using Monterey No. 3 sand. A low-permeability bentonite grout was then tremied in place to seal the borehole and effectively isolate the monitoring well. The process was repeated for each successive well. Some multiple-well monitoring sites have 3-inch-diameter casing in one of the deeper wells to more easily accommodate future geophysical logging. Well-construction diagrams for each multiple-well monitoring site are presented in figures 3–26 (at back of report).

After completion, drilling fluid was evacuated from each monitoring well using compressed air. Extensive airlifting and a surging technique with compressed air were employed to further develop the filter pack surrounding the well. Specific conductance, pH, temperature, apparent color, and turbidity, along with the discharge rate and total volume, were recorded during this process. Development was continuous until no discernible drilling mud was present and field measurements had stabilized.

GEOLOGIC DATA COLLECTION

Geologic information was collected to characterize and correlate stratigraphic units and boundaries associated with the regional aquifer systems. Geologic information collected at each multiple-well monitoring site includes lithologic cutting descriptions and a suite of geophysical logs. At a few locations, selected core or cutting samples were analyzed for magnetic orientation, physical properties, thermal properties, and mineralogy.

Lithologic Descriptions

Detailed lithologic logs were compiled from descriptions of drill cuttings collected at each borehole site and from observations recorded during drilling. Cutting samples, denoted as “sieve,” were composited along 20-foot drill intervals at the borehole surface using a No. 120 sieve. At most sites, additional cutting samples, denoted as “shaker,” were collected at 10-foot intervals and at distinguishable changes in lithology from a No. 60-mesh screen mounted on the drill rig’s shaker tank.

Sieve and shaker cuttings were described in the office by grain size, texture, sorting, rounding, color, and any other noticeable features, such as wood or shell fragments. Texture descriptions follow the National Research Council (National Research Council, 1947) grain-size classification shown in figure 27. This classification allows for correlation of grain-size terms (such as “sand”) to size limits in millimeters or inches. For samples containing gravel, the terms “silt” and (or) “clay” are used in lieu of “mud.” Color, determined on moist samples, follows the numerical color designations in Munsell Soil Color Charts (Munsell Color, 1994). Sieve lithology descriptions are presented in tables 2–25 (at back of report).

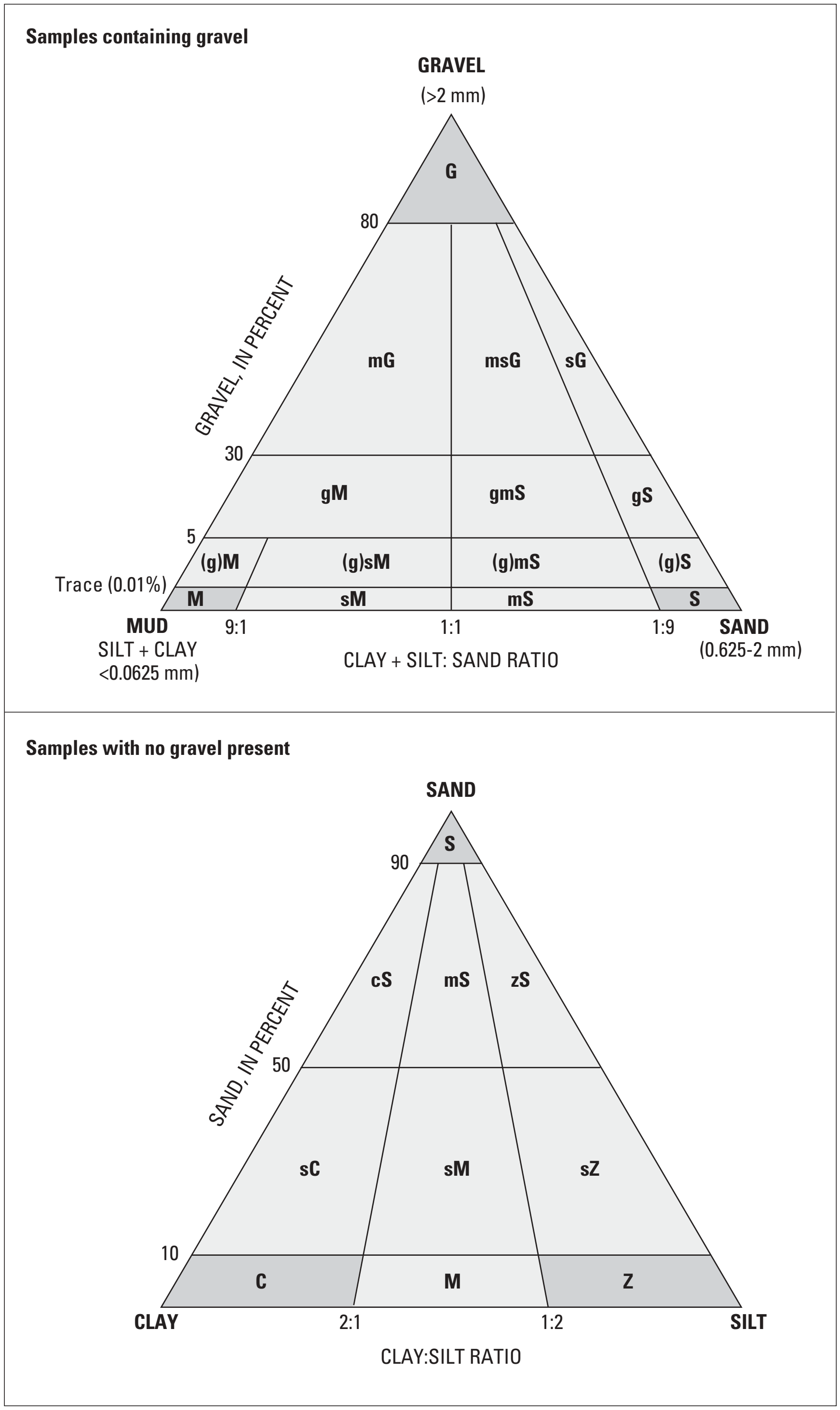
The generalized stratigraphic column next to each monitoring site diagram (see figs. 3–26, at back of report) was compiled by grouping similar lithologic units as determined from detailed lithologic sieve sample descriptions. The lithologic units were categorized into textural groups, such as gravels or sands (see fig. 27)—on the basis of estimated percentages of gravel and (or) sand and the ratios of sand, silt, and clay present–following the nomenclature of Folk (1954). Information collected from borehole geophysical logs was also used to help identify contact depths between major lithologic units.

Geophysical Logs

Borehole geophysical surveys conducted in this study provide information on the nature of the lithologic units and on the chemical character and flow of ground water. Geophysical logs were made shortly after attaining total hole depth in the uncased, fluid-filled borehole. These surveys generally include caliper, natural gamma, spontaneous potential, 16- and 64-inch normal resistivity, and electromagnetic induction. Temperature logs were made at a later date. Geophysical-log information for each multiple-well monitoring site is presented in figures 3–26 (at back of report).

Caliper devices measure the diameter of the borehole. The caliper log can be used to show the existence of cave-in in unconsolidated sand or the presence of swelling clay.

Natural gamma logs measure the intensities of gamma-ray emissions resulting from the natural decay of potassium-40 and of the daughter products of uranium and thorium (Schlumberger, 1972). The gamma logs are used primarily to define lithology



EXPLANATION

G Gravel	**Z** Silt	**S** Sand	**C** Clay	**M** Mud
g Gravelly	**z** Silty	**s** Sandy	**c** Clayey	**m** Muddy
(g) Slightly gravelly				

Figure 27. Rock-type nomenclature used for lithologic log descriptions and stratigraphic columns.(>, greater than value shown; mm, millimeter; <, less than value shown.)

indicators and for geologic correlation. Clay, feldspar-rich gravel, and granite generally emit higher intensity gamma rays.

Resistivity devices measure the apparent resistivity of a volume of rock under the direct application of an electric current (Keys and MacCary, 1983). These logs are used to determine formation and fluid resistivity and to estimate formation porosity. In general, low resistivity indicates water higher in dissolved solids and (or) fine-grained deposits such as silt, clay, and shale, whereas high resistivity indicates water lower in dissolved solids and (or) coarser material, such as sand or gravel.

Electromagnetic induction logs yield detailed information on the vertical electrical conductivity of the formation and pore water (McNeill, 1986). These logs can identify water-bearing units of different electrical conductivity through both PVC casing and screen. Because the electromagnetic induction tool responds to changes in the dissolved-solids concentration of ground water, it is possible to repeatedly track and map electrical anomalies associated with seawater intrusion over time (Williams and others, 1993).

Temperature logs measure the local geothermal gradient. Temperature logs provide information on geologic formation changes as well as horizontal and vertical ground-water flow patterns. Ground-water temperature is related to factors such as lithology (which affects thermal conductance), well depth, recharge source, and residence time within the aquifer. Measurements were made in the deepest well several months after the site had been constructed, developed, and sampled for water quality to ensure that the water temperature within the casing was not disturbed.

Core Measurements

At each multiple-well monitoring site, two to four core samples were collected at various depths in 3-inch-diameter thin-walled tubes. As much as 3 feet of sample was recovered. The location and depth of these core samples is given in table 26. Several whole cores were first analyzed for bulk density, porosity, and magnetic susceptibility using a multi-sensor core log scanner (Kayen and others, 1999). Results of these determinations are archived and available for viewing at the USGS office in San Diego, California. The core was then split lengthwise into a “working” section for further analysis, and an “archive” section.

Core material intended for the measurement of magnetic orientation was subsampled from the split core using a special device to notch the “up” direction. Samples were preferentially collected from finer grained subunits of the core, and analyzed by a super-conducting rock magnetometer by the USGS in Menlo Park, California. Results of the polarity measurement are given in table 27, and are expressed with respect to the present-day magnetic field. The most recent reversal of the earth’s magnetic orientation occurs at the Brunhes/Matuyama Boundary, about 780,000 years ago (Merril and others, 1998).

Whole-core sections (approximately 6 inches in length) were subsampled from a limited number of cores to measure the physical and thermal properties of the soil material. Physical properties, such as bulk density, porosity, particle density, and water content, were measured at the USGS Soil and Rock Laboratory in Sacramento, California, following procedures defined by Soeder (1996). Results of the physical-property determinations are presented in table 28. Thermal properties, such as thermal conductivity, thermal diffusivity, and specific heat, were measured at the USGS Soil and Rock Laboratory in Sacramento, California, using a standard thermal probe (ThermoLink Incorporated, 1997). Results of the thermal-property determinations are presented in table 29.

Selected drill-cutting samples were submitted to the USGS, Geologic Division, Branch of Geochemistry, in Denver, Colorado, for bulk mineralogy determination by x-ray diffraction (Klug and Alexander, 1974). Results of this analysis, shown in table 30, are presented in terms of relative mineral abundance.

HYDROLOGIC DATA COLLECTION

Hydrologic information collected includes depth-to-water measurements at each of the multiple-well monitoring sites. Slug tests were performed at the multiple-well monitoring sites, and various hydraulic properties of selected core samples were measured in the laboratory.

Water-Level Measurement

Water levels were measured periodically at the multiple-well monitoring sites, and also prior to water-quality sample collection. Water levels were measured and recorded to within 0.01 foot using a calibrated steel tape. A calibrated electric tape was used when a measurement with the steel tape was not possible. Water-level data for the multiple-well monitoring sites are presented in table 31, along with location, depth, perforated interval, and altitude.

Hydraulic Properties

Slug tests were performed at the multiple-well monitoring sites to estimate hydraulic conductivity. Slug test analyses are archived and available for viewing at the USGS office in Sacramento, California. Pressure transducers were set at a depth ranging from 10 to 20 feet below the water level for measuring water-level changes during these tests. A slug was lowered to approximately 5 feet above the water surface. After sufficient time—30 minutes for most wells—was allowed for the water level to stabilize, the slug was dropped into the water. Change in the water level was recorded every second using a data logger. Recovery time for most wells ranged from 3 to 10 minutes. The slug was then quickly removed, and the change in water level was recorded until recovery to static levels was attained. This process was then repeated 3 to 20 times per well.

Computations were performed using three methods: the Cooper-Bredehoeft-Papadopulus method (Cooper and others, 1967) for overdamped responses, and the Kipp (1985) or Van der Kamp (1976) method for underdamped responses. These methods compute values for transmissivity based on specific storage. Two values, 10^{-4} and 10^{-6}, were used to estimate the range of specific storage for aquifers in the study area. Transmissivity was then used to calculate hydraulic conductivity, with the assumption that the response in the well is influenced equally across the length of the screened interval. Mean estimates of hydraulic conductivity are presented—along with the selected computational test, number of observations, and 97 percent confidence level—in table 32.

Whole-core sections (approximately 6 inch) were subsampled from a limited number of cores to measure hydraulic conductivity of the soil material. Testing was performed by either the USGS Soil and Rock Laboratory in Sacramento, California, following a standard method for saturated porous material (American Society for Testing and Materials, 1997), or by Daniel B. Stephens & Associates, Inc., in Albuquerque, New Mexico, following a similar standard method (American Society for Testing and Materials, 1986; Klute, 1986). Results of these determinations are presented in table 33.

WATER-QUALITY DATA COLLECTION

Two hundred and nineteen ground-water samples were collected from 170 ground-water wells at 78 sites. This ground-water quality network (fig. 2) includes 125 monitoring wells (at the 24 USGS multiple-well monitoring sites), 38 existing production wells, and 20 existing observation wells. Reference and selected construction information for all wells sampled is provided in table 1.

Sample Collection

Sampling was conducted by USGS personnel, and all samples were collected, handled, and preserved following written USGS field procedures (Sylvester and others, 1990). Purge logs, field measurements, and other information related to sample collection are on file at the USGS office in San Diego, California.

Prior to sampling, water-level measurements were made, and at least three well-casing volumes were purged from the well using a portable submersible pump. Specific conductance, pH, and temperature were monitored during the purging process. Samples were collected only after these parameters had stabilized. Stability was attained when three successive measurements taken at intervals of 5 minutes or more differed by less than 5 percent for specific conductance, 0.1 units for pH, and 0.2 degrees Celsius for temperature.

The 20 existing observation wells sampled as part of this study were screened over short intervals, typically 10 to 40 feet. These wells are owned by local water purveyors, by the WRDSC, or by the Los Angeles County Department of Public Works, and are constructed of 2- or 4-inch-diameter PVC or galvanized steel. The same purging procedures, described above, were used to sample water from these wells.

Existing production wells sampled as part of this study were designed for municipal water supply. Unlike observation wells, production wells have a screened interval that may be open to several water-bearing units; consequently, water from such wells is a mixture of water from those units. Therefore, the 38 production wells chosen were selected for sampling on the basis of the limited screen length (commonly less than 100 feet). Most of the existing production wells were designated as “active,” and had permanently installed pumps that operated on a daily or 24-hour basis. When possible, sample collection was arranged to coincide with the normal pumping schedule of the well. For “inactive” production wells, at least three casing volumes of water were removed prior to sampling.

Field Measurements

Portable meters were used for field measurements of specific conductance, pH, and alkalinity using methods outlined by Wilde and Radtke (1998). All instruments were calibrated in the field prior to sample collection (during the purging process).

Dissolved-oxygen measurements were performed by a Winkler titration (Fishman and Friedman, 1989). Water temperature was measured using a hand-held alcohol-filled thermometer having a full-scale accuracy of 0.5 degrees Celsius or using the built-in thermistor on the conductivity probe (plus or minus 0.1 degrees Celsius). Both measuring devices were frequently checked against an American Standard Laboratory and Materials standard mercury thermometer, and conformed to within 0.5 degrees Celsius. Instrument log and calibration data are on file at the USGS office in San Diego, California.

Sample Handling, Preservation, and Analysis

During collection, purge water from the pump was diverted into a special sample-collection chamber designed to minimize contamination. Most water samples intended for routine analyses (major ions, nutrients, and trace elements) were pressure filtered in the field through a membrane polyethersulfone (PES) filter capsule having a pore size of 0.45 μm. Laboratory samples intended for the analysis of pH, specific conductance, and acid-neutralizing capacity were not filtered. Polyethylene bottles were used to contain most samples, and rinsed three times with sample prior to filling. Samples for nutrient determinations were contained in dark, opaque polyethylene bottles, and preserved on ice to inhibit bacterial growth. Samples for cation and selected trace element determinations were collected in acid-rinsed polyethylene bottles and preserved by acidifying the sample to a pH less than 2 with a small volume of concentrated nitric acid. Samples were shipped to the USGS National Water Quality Laboratory (NWQL) in Arvada, Colorado, for analysis following standard methods outlined by Fishman (1993), Garbarino (1999), Faires (1993), and Struzeski and others (1996). Results of these determinations are presented in table 34.

Water samples for analysis of stable isotopes deuterium and oxygen-18 were collected in 60-mL glass bottles. The samples were not filtered. The bottles were not rinsed, but were sealed with a special polyseal (conical) cap to minimize exchange with the atmosphere. These samples were shipped to the USGS Stable Isotope Laboratory in Reston, Virginia, for analysis according to methods outlined by Coplen and others (1991). The results of these determinations are expressed in terms of per mil relative to Vienna Standard Mean Ocean Water (Gonfiantini, 1984) in table 35. The estimate of precision (two-sigma) for deuterium and oxygen-18 is 2 and 0.2 per mil, respectively.

Water samples intended for the analysis of tritium were collected in 1-L polyethylene bottles. The sample was not filtered. Bottles were not rinsed, and care was taken not to aerate the sample during collection. Samples were sealed with a polyseal (conical) cap to minimize exchange with the atmosphere. These samples were analyzed at the USGS Isotope Tracers Laboratory in Menlo Park, California, or at the University of Miami (through arrangements with the NWQL) by gas counting (or liquid scintillation) after electrolytic enrichment as described by Ostlund and Dorsey (1977) and Ostlund and others (1987). The activity of tritium is reported in terms of tritium units (TU) with a two-sigma estimate of precision in table 35. Each tritium unit equals one atom of ^{3}H in 10^{18} atoms of hydrogen.

Water samples for analysis of carbon-13 and carbon-14 isotopes were collected in 1-L amber glass bottles. Samples were filtered in the field through a membrane (PES) filter capsule having a pore size of 0.45 μm. The bottle was bottom-filled and allowed to overflow to several times the bottle volume, then sealed with a special Teflon-septa cap and held on ice. Carbon-13 and carbon-14 of the dissolved inorganic carbon were analyzed by the University of Waterloo and IsoTrace Laboratory (Ontario, Canada) by accelerator mass spectrometry (through arrangements with the NWQL). Results of the carbon-13 determination are reported in per mil relative to the Vienna PeeDee belemnite standard (Coplen, 1994). The activity of carbon-14—expressed as percent modern carbon (pmc)—is reported with a one-sigma estimate of precision relative to the 1950 National Bureau of Standards (NBS) oxalic acid standard (Stuiver and Polach, 1977; Wigley and Muller, 1981) in table 35.

Water samples for analysis of sulfur-34 in dissolved sulfate were typically collected in 1-L borosilicate glass bottles. For wells yielding water with low concentrations of dissolved sulfate, a large volume of water (20 to 75 L) was passed through an exchange column to concentrate sufficient sample for analysis. In both instances, the sample was not filtered. If the odor of dissolved sulfide was noted or positively measured by a field titration technique (Fishman and Friedman, 1989) during well purging, the sulfide was first removed from solution by acidification and rapid degassing following procedures outlined by Carmody and others (1998) prior to sample collection. Sample bottles and columns were shipped to the USGS Stable Isotope Laboratory in Reston, Virginia, for analysis by mass spectrometry. Results are reported in per mil relative to the Vienna Canyon Diablo Troilite (Carmody and others, 1998) in table 36. The estimate of precision (two-sigma) for the sulfur-34 determination is 0.2 per mil.

Water samples intended for analysis of the stable isotopes of boron-11 and strontium-87/86 were collected in 250-mL polyethylene bottles. Samples were pressure filtered in the field through a membrane (PES) filter capsule having a pore size of 0.45 µm. Boron-11 isotopes were measured at the USGS Isotope Laboratory in Menlo Park, California, by negative-ion ratio mass spectrometry. Results of this determination are reported in per mil relative to the NBS-951 boric acid standard in table 36, and are precise (two-sigma) to within 0.5 per mil (Tom Bullen, U.S. Geological Survey, oral commun., 2001) Strontium-87/86 isotopes were measured at the USGS Isotope Laboratory in Menlo Park, California, by isotope-ratio mass spectrometry. The results of this determination are presented as the ratio of strontium-87/86 in table 36. The long-term precision (two-sigma) associated with the measurement of NBS-987 strontium standard is better than 0.005 percent (Tom Bullen, U.S.Geological Survey, oral commun., 2001).

ACCESSING DATA

Users of the data presented in this report are encouraged to access information through the USGS National Water Information System Web page (NWISWeb) located at http://water.usgs.gov/nwis/. NWISWeb serves as an interface to a database network of site information, real-time, ground-water, surface-water, and water-quality data collected from locations throughout the 50 states and elsewhere. Data are updated from the database network on a regularly scheduled basis.

Data are retrieved by category and geographic area; and can be selectively refined by specific location or parameter field. NWISWeb is able to output water-level and water-quality graphs, site maps, data tables (in HTML and ASCII tab format), and develop site-selection lists.

Updates after publication to data presented in this report are made to the U.S. Geological Survey's NWIS. Additional geophysical logs, sample collection notes, and other information not contained in NWIS are kept on file at the USGS office in San Diego, California. Formal requests for specific data should be directed to the U.S. Geological Survey, California District Office, Hydrologic Data Center in Sacramento, California.

SUMMARY

For the period 1995–2000, ground-water data were collected from 170 individual wells at 78 sites as part of a USGS study of the geohydrology and geochemistry of the Central and West Coast Basins in Los Angeles County, California. These data—and data collection methods—are presented, including description of drill cuttings, bore-hole construction, bore-hole geophysical logs, water levels, hydraulic parameters, and water quality. Other data collected as part of this study are available at the USGS offices in San Diego, Sacramento, and Menlo Park; or through national databases.

REFERENCES CITED

American Society for Testing and Materials, 1997, Standard test method for measurement of hydraulic conductivity of saturated porous materials using a flexible wall permeameter: West Conshohocken, Pa., D5084-90.

American Society for Testing and Materials, 1986, Standard test method for permeability of granular soils (constant head): West Conshohocken, Pa, D2434-68(1994).

California Department of Water Resources, 1961, Planned utilization of the ground water basins of the coastal plain of Los Angeles Country, Appendix A, Ground water geology: California Department of Water Resources Bulletin 104, 191 p.

Carmody, R.W., Plumier, L.N., Busenberg, E., and Coplen, T.B., 1998, Methods of collection of dissolved sulfate and sulfide and analysis of their sulfur isotope composition: U.S. Geological Survey Open-File Report 97-234, p. 92.

Cooper, H.H., Bredehoeft, J.D., and Papadopolous, I.S., 1967, Response of finite diameter well to an instantaneous charge of water: Water Resources Research, v. 3, no. 1, p. 263–269.

Coplen, T.B., 1994, Reporting of stable hydrogen, carbon, and oxygen isotopic abundances: Pure & Applied Chemistry, v. 66, p. 273–276.

Coplen, T.B., Wildman, J.D., and Chen, J., 1991, Improvements in the gaseous hydrogen-water equilibration technique for hydrogen isotope ratio analysis: Analytical Chemistry, v. 63, p. 910–912.

Faires, L.M., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of metals in water by inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 92-634, 28 p.

Fishman, M.J., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Folk, R.L., 1954, The distinction between grain size and mineral composition in sedimentary-rock nomenclature: Journal of Geology, v. 62, no. 4, p. 344–359.

Garbarino, J.R., 1999, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of dissolved arsenic, boron, lithium, selenium, strontium, thallium, and vanadium using inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 99-093, 31 p.

Gonfiantini, R., 1984, Advisory group meeting on stable isotope reference samples for geochemical and hydrological investigations, Vienna, September 19–21, 1983: International Atomic Energy Agency, Vienna, 77 p.

Kayen, R.E., Edwards, B.D., and Lee, H.J., 1999, Nondestructive laboratory measurement of geotechnical and geoacoustic properties through intact core-liner, *in* Nondestructive and Automated Testing for Soil and Rock Properties, 1999: West Conshohocken, Pa., American Society for Testing and Materials, STP 1350, p. 83–94.

Keys, W.S., and MacCary, L.M., 1983, Application of borehole geophysics to water-resources investigations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 2, chap. E1, 126 p.

Kipp, K.L., 1985, Type curve analysis of inertial effects in the response of a well to a slug test: Water Resources Research, v. 21, no. 9, p. 1397–1408.

Klug, H.P., and Alexander, L.E., 1974, X-ray diffraction procedures for polycrystalline and amorphous materials (2nd edition): New York, John Wiley and Sons, 966 p.

Klute, A., 1986, Methods of soil analysis, Part 1: American Society of Agronomy, Madison, Wis., 1,186 p

Los Angeles County Department of Public Works, 1996, Hydrologic Report 1994–1996: 7 p.

McNeill, J.D., 1986, Geonics EM39 borehole conductivity meter-theory of operation: Mississauga, Ontario, Geonics Ltd., Technical Note 20, 11 p.

Mendenhall, W.D., 1905a, Development of underground waters in the central coastal plain region of southern California: U.S. Geological Survey Water-Supply Paper 138, 162 p.

Mendenhall, W.D., 1905b, Development of underground waters in the western coastal plain region of southern California: U.S. Geological Survey Water-Supply Paper 139, 103 p.

Merril, R.T., McElhinny, M.W., and McFadden, P.L., 1998, Magnetic field of the Earth: Academic Press, San Diego, Calif., 531 p.

Munsell Color, 1994, Munsell soil color charts: Baltimore, Md., Munsell Color, Inc.

National Research Council, 1947, Report of the Subcommittee on Sediment Terminology: American Geophysical Union Transactions, v. 28, no. 6, p. 936–938.

Ostlund, H.G., Craig, H., Broecker, W.S., and Spencer, D., 1987, Geosecs Atlantic, Pacific, and Indian Ocean Expeditions, Shorebased Data and Graphics: v. 7, p. 7–19.

Ostlund, H.G. and Dorsey, H.G., 1977, Rapid electrolytic enrichment and hydrogen gas proportional counting of tritium, *in* Low-Radioactivity Measurements and Applications: Proceedings of the International Conference on Low-Radioactivity Measurements and Application, October 6–10, 1975, The High Tatras, Czechoslovakia, p. 55–60.

Poland, J.F., Garrett, A.A., and Sinnot, A., 1959, Geology, hydrology, and chemical character of ground waters in the Torrance-Santa Monica area, California: U.S. Geological Survey Water Supply Paper 1461, 425 p.

Schlumberger, 1972, Log interpretation, volume I—principles: New York, Schlumberger Limited, 113 p.

Soeder, D., 1996, U.S. Geological Survey, Yucca Mountain Project Technical Procedure HP–229, revision 3, module 3.

Stuiver, M., and Polach, H.A., 1977, Reporting of ^{14}C data: Radiocarbon, v. 19, p. 355–363.

Struzeski, T.M., DeGiacomo, W.J., and Zayhowski, E.J., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of dissolved aluminum and boron in water by inductively coupled plasma-atomic emission spectrometry: U.S. Geological Survey Open-File Report 96–149, 17 p.

Sylvester, M.A., Kister, L.R., and Garrett, W.B., 1990, Guidelines for the collection, treatment, and analysis of water samples: U.S. Geological Survey Western Region Field Manual, 143 p.

ThermoLink Incorporated, 1997, ThermoLink System Manual: Decagon, Pullman, Wash., ver. 2.5.

Van der Kamp, G., 1976, Determining aquifer transmissivity by means of well response tests—The underdamped case: Water Resources Research, v. 12, no. 1, p. 71–77.

Wigley, T.M.L., and Muller, A.B., 1981, Fractionation corrections in radiocarbon dating: Radiocarbon, v. 23, p. 173–190.

Wilde, F.D., and Radtke, D.B., 1998, Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, variously paged.

Williams, J.H., Lapham, W.W., and Barringer, T.H., 1993, Application of electromagnetic logging to contamination investigations in glacial sand-and-gravel aquifers: Ground Water Monitoring Review, v. 13, no. 3, p. 129–138.

Yerkes, R.F., McCulloh, T.H., Schoellhamer, J.E., and Vedder, J.G., 1965, Geology of the Los Angeles basin, California–An introduction: U.S. Geological Survey Professional Paper 420-A, 57 p.