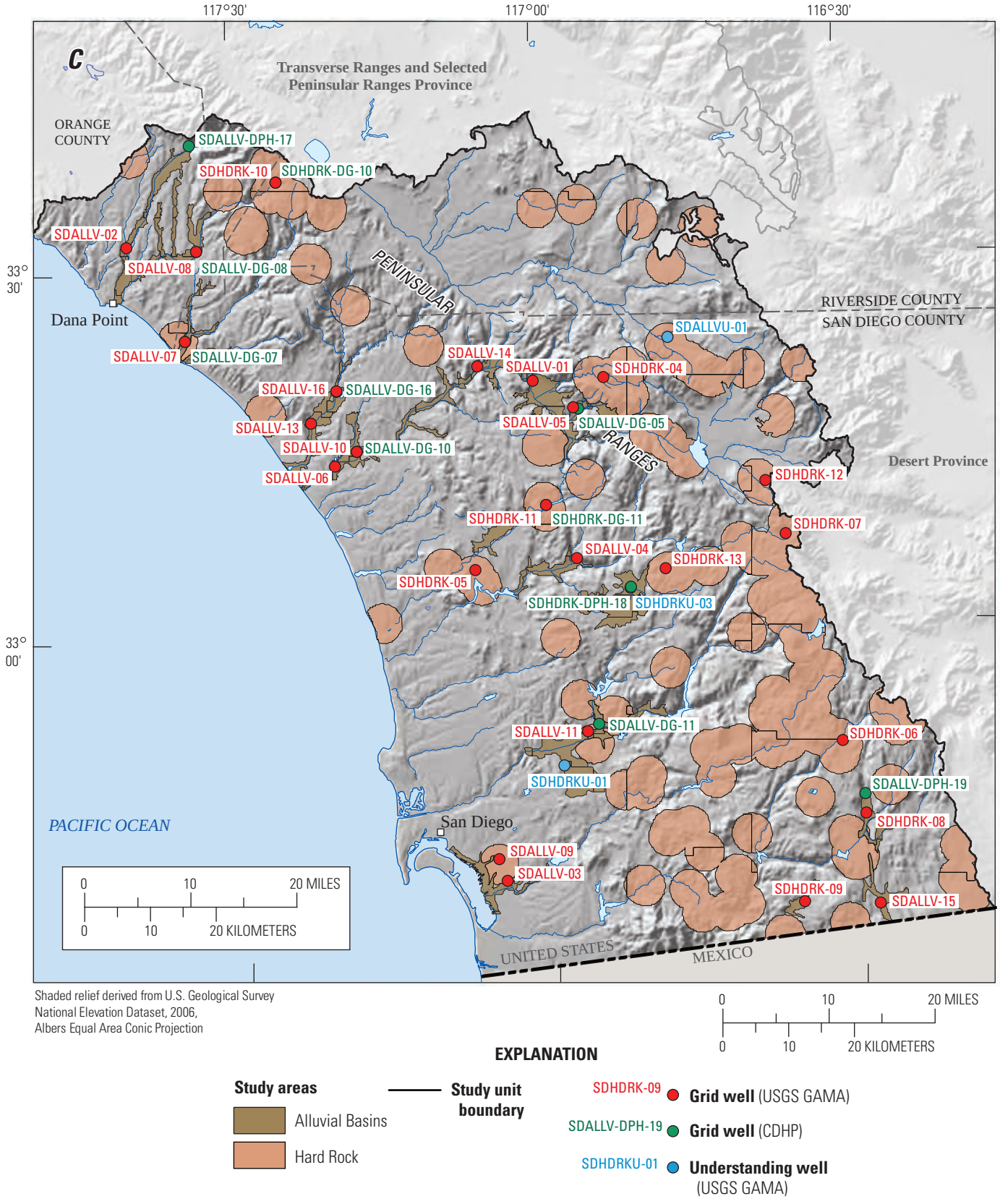


Figure *A1A–A1C.*—Continued

Appendix B. Aquifer Proportion

Three approaches—grid-based, raw detection frequency, and spatially weighted—were selected to evaluate the proportion of the primary supply aquifer in the San Diego study unit with concentrations of constituents greater than water-quality benchmarks (high relative-concentrations).

1. Grid-based: One well in each grid cell was randomly selected to represent the primary aquifers. The relative-concentration for each constituent (concentration relative to its benchmark), or class of constituents, was then evaluated for each grid well. The proportion of the primary aquifers with high relative-concentrations was calculated by taking the number of cells with concentrations greater than the benchmark (relative-concentration > 1), and dividing that number by the total number of grid wells in each of the study areas (Belitz and others, 2010). The proportion for each study area is calculated individually because grid-cell sizes are not uniform across study areas. The proportion for the study unit then is determined by calculating the area-weighted sum using the following equation:

$$AQP_{su} = \sum AQP_{SA}F_{SA,} \quad \text{(A1)}$$

where

AQP_{su} is the aquifer proportion for the study unit,
AQP_{SA} is the aquifer proportion for a study area, and
F_{SA} is the fraction of the total study unit area occupied by the study area.

The F_{SA} Alluvial Fill study areas are: Temecula Valley 0.41, Warner Valley 0.11, and Alluvial Basins 0.48. The proportions of moderate and low relative-concentrations were calculated similarly. Aquifer-scale proportions for individual constituents for each study area (including Hard Rock) are shown in tables B1A-D and for classes of constituents in tables B2A-D. Confidence intervals for grid-based proportions shown in tables B1A-D were computed using the Jeffreys interval for the binomial distribution (Brown and others, 2001). The grid-based estimate is spatially unbiased. However, the grid-based approach may not detect constituents that are present at high relative-concentrations in small proportions of the primary aquifers.

2. Raw detection frequency: Within selected time criteria (July 30 2001–July 29 2004), all available data from the following sources were used to calculate the percentage (frequency) of wells with high relative-concentrations: USGS-grid, CDPH data (most recent analysis per well), and USGS-understanding wells with open intervals representative of the primary aquifers. However, this approach is not spatially unbiased because the CDPH and USGS-understanding wells are not uniformly distributed. Consequently, high relative-concentrations in wells clustering in a particular area represent a small part of the primary aquifers and could be given a disproportionately high weight compared to spatially unbiased methods. Raw detection frequencies of high relative-concentrations are provided for reference in this report but were not used to assess aquifer-scale proportions.

3. Spatially weighted: Similar to the detection frequency approach, the USGS-grid, CDPH data (one analysis per well), and USGS-understanding well data are considered for the spatially weighted approach (Belitz and others, 2010). However for the spatially weighted approach, proportions are computed on a cell-by-cell basis (Isaaks and Srivistava, 1989) rather than as an average of all the wells. Using the spatially weighted approach, the proportion of high values for each study area was computed by (step 1) computing the proportion of high wells in each grid cell and (step 2) averaging the grid-cell values computed in step The spatially weighted high proportions for the study unit was calculated by summing the area-weight values for each study area in the same manner as was used in the grid-based approach. Calculations for individual constituents for each study area are shown in tables B1A-D and for classes of constituents in tables B2A-D. The resulting proportions are spatially unbiased (Isaaks and Srivistava, 1989). Confidence intervals for spatially weighted detection frequencies of high relative-concentrations are not described in this report. Results are based on the most recent analyses for each CDPH well during July 30, 2001–July 29, 2004 (3-year period of study).

The grid-based and spatially weighted estimation of aquifer-scale proportions, based on a spatially distributed grid-cell network across the study unit, are intended to characterize the water-quality of the aquifer at depths that are typically used for public supply. These approaches assign weights to wells based upon a single well per cell (grid-based) or the number of wells per cells (spatially weighted). Another possible approach is to assign weights to wells based on water use (withdrawal rate). However, water use data for public-supply and other wells are not readily available. Moreover, this approach, even if withdrawal data were available for all wells, would characterize the volume of groundwater currently used for public supply, which likely would be weighted towards fewer wells and smaller areas than the approaches used, which were based on spatially distributed grid cells across the study unit.

Table B1A. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Temecula Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 12 grid wells in the Temecula Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Trace elements														
Vanadium	NL-CA	50	µg/L	11	18.2	54.5	27.3	46	11	23.9	13	19.5	5.4	41.9
Arsenic	MCL-US	10	µg/L	10	10.0	0.0	90.0	45	4	8.9	12	9.3	1.8	33.1
Boron	NL-CA	1,000	µg/L	10	10.0	0.0	90.0	42	2	4.8	12	3.1	1.8	33.1
Fluoride	MCL-CA	2	mg/L	10	0.0	0.0	100.0	45	1	2.2	12	1.7	0.0	17.1
Antimony	MCL-US	6	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Selenium	MCL-US	50	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Thallium	MCL-US	2	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Chromium	MCL-CA	50	µg/L	10	0.0	0.0	100.0	46	0	0.0	12	0.0	0.0	17.1
Lead	AL-US	15	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Nickel	MCL-CA	100	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Aluminum	MCL-CA	1,000	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Cadmium	MCL-US	5	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Mercury	MCL-US	2	µg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Radioactive constituents														
Gross-alpha	MCL-US	15	pCi/L	10	0.0	10.0	90.0	46	0	0.0	12	0.0	0.0	17.1
Radon-222	Proposed AMCL-US	4,000	pCi/L	6	0.0	0.0	100.0	11	0	0.0	8	0.0	0.0	26.4
Uranium	MCL-US	30	µg/L	8	0.0	0.0	100.0	18	0	0.0	9	0.0	0.0	20.8
Radium-228	MCL-US	5	pCi/L	6	0.0	0.0	100.0	11	0	0.0	8	0.0	0.0	26.4
Gross-beta radioactivity	MCL-CA	50	pCi/L	6	0.0	0.0	100.0	12	0	0.0	8	0.0	0.0	26.4
Nutrients														
Nitrate, as nitrogen	MCL-US	10	mg/L	12	0.0	8.3	91.7	53	0	0.0	15	0.0	0.0	14.5
Nitrite, as nitrogen	MCL-US	1	mg/L	9	0.0	0.0	100.0	46	0	0.0	12	0.0	0.0	18.7

Table B1A. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Temecula Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 12 grid wells in the Temecula Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Major and minor elements (SMCLs)														
Total dissolved solids	SMCL-CA	1,000	mg/L	11	0.0	9.1	90.9	47	0	0.0	13	0.0	0.0	15.7
Manganese	SMCL-CA	50	µg/L	10	0.0	0.0	100.0	47	6	12.8	12	7.6	0.0	17.1
Iron	SMCL-CA	300	µg/L	10	0.0	0.0	100.0	47	1	2.1	12	3.0	0.0	17.1
Chloride	SMCL-CA	500	mg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Sulfate	SMCL-CA	500	mg/L	10	0.0	0.0	100.0	45	0	0.0	12	0.0	0.0	17.1
Zinc	SMCL-CA	5,000	µg/L	10	0.0	0.0	100.0	44	0	0.0	12	0.0	0.0	17.1
Gasoline components														
Benzene	MCL-CA	1	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
MTBE	MCL-CA	13	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
Trihalomethanes														
Chloroform	MCL-US	[3]80	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
Solvents														
Tetrachloroethylene	MCL-US	5	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
Carbon tetrachloride	MCL-CA	0.5	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
Trichloroethylene	MCL-US	5	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
1,2-Dichloropropane	MCL-US	5	µg/L	12	0.0	0.0	100.0	42	0	0.0	13	0.0	0.0	14.5
Herbicides														
Prometon	HAL-US	100	µg/L	12	0.0	0.0	100.0	12	0	0.0	12	0.0	0.0	14.5
Simazine	MCL-US	4	µg/L	12	0.0	0.0	100.0	39	0	0.0	12	0.0	0.0	14.5
Atrazine	MCL-CA	1	µg/L	12	0.0	0.0	100.0	39	0	0.0	12	0.0	0.0	14.5

Table B1A. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Temecula Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 12 grid wells in the Temecula Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Constituent of special interest														
Perchlorate	MCL-CA	6	µg/L	7	0.0	66.7	33.3	26	0	0.0	12	0.0	0.0	23.2

[1]Based on most recent analysis for each CDPH well during July 30, 2001–July 29, 2004, combined with GAMA grid-based data.

[2]Based on the Jeffrey's interval for the binomial distribution (Brown and others, 2001).

[3]The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

Table B1B. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Warner Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from nine grid wells in the Warner Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Trace elements														
Vanadium	NL-CA	50	µg/L	4	0.0	25.0	75.0	5	0	0.0	4	0.0	0.0	36.2
Arsenic	MCL-US	10	µg/L	4	0.0	25.0	75.0	5	0	0.0	4	0.0	0.0	36.2
Fluoride	MCL-CA	2	mg/L	4	0.0	25.0	75.0	5	0	0.0	4	0.0	0.0	36.2
Boron	NL-CA	1,000	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Antimony	MCL-US	6	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Selenium	MCL-US	50	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Thallium	MCL-US	2	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Chromium	MCL-CA	50	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Lead	AL-US	15	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Nickel	MCL-CA	100	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Aluminum	MCL-CA	1,000	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Cadmium	MCL-US	5	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Mercury	MCL-US	2	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Radioactive constituents														
Radon-222	Proposed AMCL-US	4,000	pCi/L	3	0.0	0.0	100.0	3	0	0.0	3	0.0	0.0	44.4
Gross-alpha	MCL-US	15	pCi/L	4	0.0	0.0	100.0	3	0	0.0	4	0.0	0.0	36.2
Uranium	MCL-US	30	µg/L	3	0.0	0.0	100.0	3	0	0.0	3	0.0	0.0	44.4
Radium-228	MCL-US	5	pCi/L	3	0.0	0.0	100.0	3	0	0.0	3	0.0	0.0	44.4
Gross-beta radioactivity	MCL-CA	50	pCi/L	3	0.0	0.0	100.0	3	0	0.0	3	0.0	0.0	44.4
Nutrients														
Nitrate, as nitrogen	MCL-US	10	mg/L	5	0.0	0.0	100.0	6	0	0.0	5	0.0	0.0	30.6
Nitrite, as nitrogen	MCL-US	1	mg/L	5	0.0	0.0	100.0	6	0	0.0	5	0.0	0.0	30.6

Table B1B. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Warner Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from nine grid wells in the Warner Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Major and minor elements (SMCLs)														
Manganese	SMCL-CA	50	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Total dissolved solids	SMCL-CA	1,000	mg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Iron	SMCL-CA	300	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Chloride	SMCL-CA	500	mg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Sulfate	SMCL-CA	500	mg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Zinc	SMCL-CA	5,000	µg/L	4	0.0	0.0	100.0	5	0	0.0	4	0.0	0.0	36.2
Gasoline components														
Benzene	MCL-CA	1	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
MTBE	MCL-CA	13	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
Trihalomethanes														
Chloroform	MCL-US	[3]80	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
Solvents														
Tetrachloroethylene	MCL-US	5	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
Carbon tetrachloride	MCL-CA	0.5	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
Trichloroethylene	MCL-US	5	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
1,2-Dichloropropane	MCL-US	5	µg/L	9	0.0	0.0	100.0	10	0	0.0	9	0.0	0.0	17.1
Herbicides														
Prometon	HAL-US	100	µg/L	9	0.0	0.0	100.0	9	0	0.0	9	0.0	0.0	18.7
Simazine	MCL-US	4	µg/L	9	0.0	0.0	100.0	9	0	0.0	9	0.0	0.0	18.7
Atrazine	MCL-CA	1	µg/L	9	0.0	0.0	100.0	9	0	0.0	9	0.0	0.0	18.7

Table B1B. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Warner Valley study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from nine grid wells in the Warner Valley study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[High, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Constituent of special interest														
Perchlorate	MCL-CA	6	µg/L	9	0.0	0.0	100.0	9	0	0.0	9	0.0	0.0	18.7

[1]Based on most recent analysis for each CDPH well during July 30, 2001–July 29, 2004, combined with GAMA grid-based data.

[2]Based on the Jeffrey's interval for the binomial distribution (Brown and others, 2001).

[3]The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

Table B1C. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Alluvial Basins study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 16 grid wells in the Alluvial Basins study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Trace elements														
Antimony	MCL-US	6	µg/L	14	7.1	0.0	92.9	56	1	1.8	15	6.7	1.3	24.8
Vanadium	NL-CA	50	µg/L	13	0.0	7.1	92.9	66	1	1.5	15	3.3	0.0	13.5
Selenium	MCL-US	50	µg/L	15	0.0	6.7	93.3	67	0	0.0	16	0.0	0.0	11.8
Arsenic	MCL-US	10	µg/L	15	0.0	0.0	100.0	67	0	0.0	16	0.0	0.0	11.8
Boron	NL-CA	1,000	µg/L	14	0.0	0.0	100.0	70	0	0.0	16	0.0	0.0	12.6
Fluoride	MCL-CA	2	mg/L	14	0.0	0.0	100.0	65	0	0.0	15	0.0	0.0	12.6
Thallium	MCL-US	2	µg/L	14	0.0	0.0	100.0	56	0	0.0	16	0.0	0.0	12.6
Chromium	MCL-CA	50	µg/L	14	0.0	0.0	100.0	58	0	0.0	16	0.0	0.0	12.6
Lead	AL-US	15	µg/L	14	0.0	0.0	100.0	64	0	0.0	15	0.0	0.0	12.6
Nickel	MCL-CA	100	µg/L	14	0.0	0.0	100.0	56	0	0.0	16	0.0	0.0	12.6
Aluminum	MCL-CA	1,000	µg/L	15	0.0	0.0	100.0	67	0	0.0	16	0.0	0.0	11.8
Cadmium	MCL-US	5	µg/L	15	0.0	0.0	100.0	67	0	0.0	16	0.0	0.0	11.8
Mercury	MCL-US	2	µg/L	15	0.0	0.0	100.0	67	0	0.0	16	0.0	0.0	11.8
Radioactive constituents														
Gross-alpha	MCL-US	15	pCi/L	15	6.7	13.3	80.0	64	4	6.3	15	7.1	1.2	23.3
Uranium	MCL-US	30	µg/L	11	0.0	27.3	72.7	32	1	3.1	14	1.8	0.0	15.7
Radon-222	Proposed AMCL-US	4,000	pCi/L	6	0.0	0.0	100.0	7	0	0.0	7	0.0	0.0	26.4
Radium-228	MCL-US	5	pCi/L	7	0.0	0.0	100.0	20	0	0.0	9	0.0	0.0	23.2
Gross-beta radioactivity	MCL-CA	50	pCi/L	10	0.0	0.0	100.0	32	0	0.0	11	0.0	0.0	17.1
Nutrients														
Nitrate, as nitrogen	MCL-US	10	mg/L	14	7.1	7.1	85.8	89	7	7.9	16	7.1	1.3	24.8
Nitrite, as nitrogen	MCL-US	1	mg/L	14	0.0	0.0	0.0	69	0	0.0	16	0.0	0.0	12.6

Table B1C. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Alluvial Basins study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 16 grid wells in the Alluvial Basins study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH ata collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; % , percent; mg/L, milligrams per liter; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Major and minor elements (SMCLs)														
Manganese	SMCL-CA	50	µg/L	14	28.6	7.1	64.3	68	26	38.2	16	37.7	12.8	50.3
Total dissolved solids	SMCL-CA	1,000	µg/L	14	28.6	57.1	14.3	67	15	22.4	16	27.1	12.8	50.3
Iron	SMCL-CA	300	µg/L	14	14.3	0.0	85.7	68	9	13.2	16	11.0	4.2	34.2
Chloride	SMCL-CA	500	µg/L	14	7.1	21.4	71.5	67	5	7.5	16	5.7	1.3	24.8
Sulfate	SMCL-CA	500	µg/L	14	7.1	14.3	78.6	67	2	3.0	16	7.8	1.3	24.8
Zinc	SMCL-CA	5,000	µg/L	15	0.0	0.0	100.0	65	0	0.0	16	0.0	0.0	11.8
Gasoline components														
MTBE	MCL-CA	13	µg/L	16	6.3	0.0	93.7	61	2	3.3	17	2.9	1.1	22.0
Benzene	MCL-CA	1	µg/L	16	0.0	0.0	100.0	61	0	0.0	17	0.0	0.0	11.1
Trihalomethanes														
Chloroform	MCL-US	[3]80	µg/L	16	0.0	0.0	100.0	60	0	0.0	16	0.0	0.0	11.1
Solvents														
1,2-Dichloropropane	MCL-US	5	µg/L	16	0.0	6.3	93.7	61	0	0.0	17	0.0	0.0	11.1
Tetrachloroethylene	MCL-US	5	µg/L	16	0.0	0.0	100.0	61	0	0.0	17	0.0	0.0	11.1
Carbon tetrachloride	MCL-CA	0.5	µg/L	16	0.0	0.0	100.0	61	0	0.0	17	0.0	0.0	11.1
Trichloroethylene	MCL-US	5	µg/L	16	0.0	0.0	100.0	61	0	0.0	17	0.0	0.0	11.1
Herbicides														
Prometon	HAL-US	100	µg/L	16	0.0	0.0	100.0	17	0	0.0	16	0.0	0.0	11.1
Simazine	MCL-US	4	µg/L	16	0.0	0.0	100.0	53	0	0.0	16	0.0	0.0	11.1
Atrazine	MCL-CA	1	µg/L	16	0.0	0.0	100.0	53	0	0.0	16	0.0	0.0	11.1

Table B1C. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Alluvial Basins study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 16 grid wells in the Alluvial Basins study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US; U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; % , percent; mg/L, milligrams per liter; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Constituent of special interest														
Perchlorate	MCL-CA	6	µg/L	16	0.0	18.8	81.2	68	1	1.5	17	0.4	0.0	11.1

[1]Based on most recent analysis for each CDPH well during July 30, 2001–July 29, 2004, combined with GAMA grid-based data.

[2]Based on the Jeffrey's interval for the binomial distribution (Brown and others, 2001).

[3]The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

Table B1D. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Hard Rock study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 10 grid wells in the Hard Rock study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Trace elements														
Arsenic	MCL-US	10	µg/L	5	0.0	20.0	80.0	45	0	0.0	9	0.0	0.0	30.6
Fluoride	MCL-CA	2	mg/L	5	0.0	0.0	100.0	50	2	4.0	9	2.2	0.0	30.6
Aluminum	MCL-CA	1,000	µg/L	5	0.0	0.0	100.0	47	1	2.1	9	1.2	0.0	30.6
Vanadium	NL-CA	50	µg/L	5	0.0	0.0	100.0	34	0	0.0	9	0.0	0.0	30.6
Boron	NL-CA	1,000	µg/L	5	0.0	0.0	100.0	30	0	0.0	9	0.0	0.0	30.6
Antimony	MCL-US	6	µg/L	5	0.0	0.0	100.0	41	0	0.0	9	0.0	0.0	30.6
Selenium	MCL-US	50	µg/L	5	0.0	0.0	100.0	46	0	0.0	9	0.0	0.0	30.6
Thallium	MCL-US	2	µg/L	5	0.0	0.0	100.0	39	0	0.0	9	0.0	0.0	30.6
Chromium	MCL-CA	50	µg/L	5	0.0	0.0	100.0	42	0	0.0	9	0.0	0.0	30.6
Lead	AL-US	15	µg/L	5	0.0	0.0	100.0	45	0	0.0	9	0.0	0.0	30.6
Nickel	MCL-CA	100	µg/L	5	0.0	0.0	100.0	39	0	0.0	9	0.0	0.0	30.6
Cadmium	MCL-US	5	µg/L	5	0.0	0.0	100.0	46	0	0.0	9	0.0	0.0	30.6
Mercury	MCL-US	2	µg/L	5	0.0	0.0	100.0	46	0	0.0	9	0.0	0.0	30.6
Radioactive constituents														
Radon-222	Proposed AMCL-US	4,000	pCi/L	4	25.0	0.0	75.0	4	1	25.0	4	25.0	4.6	65.1
Gross-alpha	MCL-US	15	pCi/L	6	0.0	50.0	50.0	42	7	16.7	9	18.5	0.0	26.4
Uranium	MCL-US	30	µg/L	5	0.0	20.0	80.0	23	3	13.0	7	7.3	0.0	30.6
Radium-228	MCL-US	5	pCi/L	5	0.0	0.0	100.0	19	2	10.5	7	9.5	0.0	30.6
Gross-beta radioactivity	MCL-CA	50	pCi/L	4	0.0	0.0	100.0	17	0	0.0	8	0.0	0.0	36.2
Nutrients														
Nitrate, as nitrogen	MCL-US	10	mg/L	6	0.0	0.0	100.0	99	1	1.0	10	1.2	0.0	26.4
Nitrite, as nitrogen	MCL-US	1	mg/L	6	0.0	0.0	100.0	69	0	0.0	10	0.0	0.0	26.4

Table B1D. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Hard Rock study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 10 grid wells in the Hard Rock study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; % , percent; mg/L, milligrams per liter; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Major and minor elements (SMCLs)														
Manganese	SMCL-CA	50	µg/L	6	33.3	16.7	50.0	48	15	31.3	9	27.5	10.4	65.9
Total dissolved solids	SMCL-CA	1,000	mg/L	6	16.7	0.0	83.3	45	2	4.4	10	10.0	3.0	49.5
Iron	SMCL-CA	300	µg/L	6	0.0	33.0	67.0	50	14	28.0	9	29.9	0.0	26.4
Sulfate	SMCL-CA	500	mg/L	5	0.0	20.0	80.0	45	1	2.2	9	1.6	0.0	30.6
Chloride	SMCL-CA	500	mg/L	5	0.0	0.0	100.0	46	1	2.2	10	5.0	0.0	30.6
Zinc	SMCL-CA	5,000	µg/L	5	0.0	0.0	100.0	44	1	2.3	10	1.4	0.0	30.6
Gasoline components														
Benzene	MCL-CA	1	µg/L	10	0.0	0.0	100.0	40	1	2.5	10	1.1	0.0	17.1
MTBE	MCL-CA	13	µg/L	10	0.0	0.0	100.0	46	0	0.0	10	0.0	0.0	17.1
Trihalomethanes														
Chloroform	MCL-US	[3]80	µg/L	8	0.0	0.0	100.0	38	0	0.0	9	0.0	0.0	20.8
Solvents														
Tetrachloroethylene	MCL-US	5	µg/L	10	0.0	0.0	100.0	40	0	0.0	10	0.0	0.0	17.1
Carbon tetrachloride	MCL-CA	0.5	µg/L	10	0.0	0.0	100.0	40	0	0.0	10	0.0	0.0	17.1
Trichloroethylene	MCL-US	5	µg/L	10	0.0	0.0	100.0	40	0	0.0	10	0.0	0.0	17.1
1,2-Dichloropropane	MCL-US	5	µg/L	10	0.0	0.0	100.0	40	0	0.0	10	0.0	0.0	17.1
Herbicides														
Prometon	HAL-US	100	µg/L	10	0.0	0.0	100.0	11	0	0.0	10	0.0	0.0	17.1
Simazine	MCL-US	4	µg/L	10	0.0	0.0	100.0	36	0	0.0	10	0.0	0.0	17.1
Atrazine	MCL-CA	1	µg/L	10	0.0	0.0	100.0	36	0	0.0	10	0.0	0.0	17.1

Table B1D. Current aquifer-scale proportions using grid-based and spatially weighted methods for constituents detected in Hard Rock study area (1) with concentrations greater than water-quality benchmarks during the period from July 30, 2001 to July 29, 2004 in the California Department of Public Health (CDPH) database, or (2) with high or moderate concentrations in samples collected from grid wells, or (3) with organic constituents detected in more than 10 percent of the grid wells sampled. Grid-based aquifer-scale proportions for organic constituents are based on samples collected by the U.S. Geological Survey from 10 grid wells in the Hard Rock study area during May–July 2004, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California. Spatially weighted aquifer-scale proportions are based on 3 years of CDPH data collected from July 30, 2001–July 29, 2004 in combination with grid and understanding well data.—Continued

[high, concentrations greater than water-quality benchmark; moderate, concentrations greater than or equal to 0.1 of benchmark but less than or equal to benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); low, concentrations less than or equal to 0.1 of benchmark for organic constituents (threshold for inorganic constituents is 0.5 of benchmark); MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, CDPH maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level; % , percent; mg/L, milligrams per liter; AMCL-US, U.S. Environmental Protection Agency alternate maximum contaminant level; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Constituent	Threshold type	Threshold value	Threshold units	Grid-based[1]				Raw detection frequency[1]			Spatially weighted[1]		90 percent confidence interval for grid-based high proportion[2]	
				Number of wells	High aquifer proportion (percent)	Moderate aquifer proportion (percent)	Low aquifer proportion (percent)	Number of wells	Number of wells with high values	Raw detection frequency (percent)	Number of cells	High aquifer proportion (percent)	Lower limit (percent)	Upper limit (percent)
Constituent of special interest														
Perchlorate	MCL-CA	6	µg/L	10	0.0	0.0	100.0	21	0	0.0	10	0.0	0.0	17.1

[2]Based on most recent analysis for each CDPH well during July 30, 2001–July 29, 2004, combined with GAMA grid-based data.

[1]Based on the Jeffreys interval for the binomial distribution (Brown and others, 2001).

[3]The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

Table B2A. Grid-based aquifer-scale proportions for constituent classes, Temecula Valley study area, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) Program study unit, California.

[SMCL, secondary maximum contaminant level; values are grid based unless otherwise noted]

Constituent class	Aquifer proportion values (percent)		
	High	Moderate	Low
Inorganics with health-based benchmarks			
Trace elements	27.3	45.5	27.3
Radioactive	0.0	10.0	90.0
Nutrients	0.0	8.3	91.7
Any inorganic with health-based benchmarks	27.3	50.0	22.7
Inorganics with aesthetic benchmarks			
Total dissolved solids and (or) chloride and (or) sulfate	0.0	10.0	90.0
Manganese and (or) iron	[1]7.6	0.0	100.0
Organics with health-based benchmarks			
Trihalomethanes	0.0	0.0	100.0
Solvents	0.0	0.0	100.0
Gasoline components	0.0	0.0	100.0
Pesticides	0.0	0.0	100.0
Any organic with health-based benchmarks	0.0	0.0	100.0
Constituent of special interest			
Perchlorate	0.0	66.7	33.3

[1]Spatially weighted value. Aquifer-scale proportions will not sum to 100 if a spatially weighted value is used.

Table B2B. Grid-based aquifer-scale proportions for constituent classes, Warner Valley study area, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) Program study unit, California.

[SMCL, secondary maximum contaminant level; values are grid based unless otherwise noted]

Constituent class	Aquifer proportion values (percent)		
	High	Moderate	Low
Inorganics with health-based benchmarks			
Trace elements	0.0	20.0	80.0
Radioactive	0.0	0.0	100.0
Nutrients	0.0	0.0	100.0
Any inorganic with health-based benchmarks	0.0	20.0	80.0
Inorganics with aesthetic benchmarks			
Total dissolved solids and (or) chloride and (or) sulfate	0.0	0.0	100.0
Manganese and (or) iron	0.0	0.0	100.0
Organics with health-based benchmarks			
Trihalomethanes	0.0	0.0	100.0
Solvents	0.0	0.0	100.0
Gasoline components	0.0	0.0	100.0
Pesticides	0.0	0.0	100.0
Any organic with health-based benchmarks	0.0	0.0	100.0
Constituent of special interest			
Perchlorate	0.0	0.0	100.0

Table B2C. Grid-based aquifer-scale proportions for constituent classes, Alluvial Basins study area, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) Program study unit, California.

[SMCL, secondary maximum contaminant level; values are grid based unless otherwise noted]

Constituent class	Aquifer proportion values (percent)		
	High	Moderate	Low
Inorganics with health-based benchmarks			
Trace elements	6.7	13.3	80.0
Radioactive	6.7	13.3	80.0
Nutrients	7.1	7.1	85.8
Any inorganic with health-based benchmarks	13.3	20.0	66.7
Inorganics with aesthetic benchmarks			
Total dissolved solids and (or) chloride and (or) sulfate	28.6	57.1	14.3
Manganese and (or) iron	28.6	7.1	64.3
Organics with health-based benchmarks			
Trihalomethanes	0.0	0.0	100.0
Solvents	0.0	6.3	93.7
Gasoline components	6.3	0.0	93.7
Pesticides	0.0	0.0	100.0
Any organic with health-based benchmarks	6.3	6.3	87.4
Constituents of special interest			
Perchlorate	[1]0.4	18.8	81.2

[1]Spatially weighted value. Aquifer-scale proportions will not sum to 100 if a spatially weighted value is used.

Table B2D. Grid-based aquifer-scale proportions for constituent classes, Hard Rock study area, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) Program study unit, California.

[SMCL, secondary maximum contaminant level; values are grid based unless otherwise noted]

Constituent class	Aquifer proportion values (percent)		
	High	Moderate	Low
Inorganics with health-based benchmarks			
Trace elements	[1]1.2	20.0	80.0
Radioactive	25.0	25.0	50.0
Nutrients	[1]1.2	0.0	100.0
Any inorganic with health-based benchmarks	25.0	25.0	50.0
Inorganics with aesthetic benchmarks			
Total dissolved solids and (or) chloride and (or) sulfate	16.7	0.0	83.3
Manganese and (or) iron	33.3	16.7	50.0
Organics with health-based benchmarks			
Trihalomethanes	0.0	0.0	100.0
Solvents	0.0	0.0	100.0
Gasoline components	[1]1.1	0.0	100.0
Pesticides	0.0	0.0	100.0
Any organic with health-based benchmarks	0.0	0.0	100.0
Constituents of special interest			
Perchlorate	0.0	0.0	100.0

[1]Spatially weighted value. Aquifer-scale proportions will not sum to 100 if a spatially weighted value is used.

Appendix C. Ancillary Datasets

Land-use classifications and percentages, well construction information, groundwater age data and classifications, and redox classifications are listed in tables A1, C1, and C2.

Land-Use Classification

Land use was classified using an "enhanced" version of the satellite derived (30 m pixel resolution), nationwide USGS National Land Cover Dataset (Volgeman and others, 2001; Price and others, 2003). This dataset has been used in previous national and regional studies relating land use to water quality (Gilliom and others, 2006; Zogorski and others, 2006). The data represent land use during approximately the early 1990s. The imagery is classified into 25 land-cover classifications (Nakagaki and Wolock, 2005). These 25 land-cover classifications were condensed into 3 principal land-use categories: urban, agricultural, and natural. Land-use statistics for the study unit, study areas, and for circles with a radius of 500-m around each study well were calculated for classified datasets using ArcGIS (Johnson and Belitz, 2009).

Well Construction Information

Well construction data primarily were determined from driller's logs. On occasion, well construction data was obtained from ancillary records of well owners or from the USGS National Water Information System database. Well identification verification procedures are described by Wright and others (2005).

Groundwater Age Classification

Groundwater dating techniques provide a measure of the time since the groundwater was last in contact with the atmosphere. Techniques aimed at estimating groundwater residence times or 'age' include those based on tritium (for example,Tolstikhin and Kamensskiy, 1969; Torgersen and others, 1979) and tritium in combination with its decay product helium-3 (Schlosser and others, 1988, 1989; Solomon and others, 1992), carbon-14 activities (for example, Vogel and Ehhalt, 1963; Plummer and others, 1993; Kalin, 2000), and dissolved noble gases, particularly helium-4 accumulation (for example, Andrews and Lee, 1979; Davis and DeWiest, 1966; Kulongoski and others, 2008).

Tritium (^3H) is a short-lived radioactive isotope of hydrogen with a half-life of 12.32 years (Lucas and Unterweger, 2000). ^3H is produced naturally in the atmosphere by the interaction of cosmogenic radiation with nitrogen, by above-ground nuclear explosions, and by the operation of nuclear reactors. Tritium enters the hydrological cycle following oxidation to tritiated water. Consequently, the presence of ^3H in groundwater may be used to identify water that has exchanged with the atmosphere in the past 50 years. By determining the ratio of ^3H to ^3He, resulting from the radioactive decay of ^3H, the time that the water has resided in the aquifer can be calculated more precisely than using tritium alone for water (Solomon and others, 1992)).

The widely used carbon-14 chronometer relies on evaluating the radiocarbon content of dissolved inorganic carbonate species in groundwater. ^{14}C is formed in the atmosphere by the interaction of cosmic-ray neutrons with nitrogen, and to a lesser degree with oxygen and carbon. ^{14}C is incorporated into carbon dioxide and mixed throughout the atmosphere, dissolving in precipitation and entering the hydrologic cycle. ^{14}C activity in groundwater, expressed as percent modern carbon (pmc), indicates exposure to the atmospheric ^{14}C source, and is governed by the decay constant of ^{14}C (with a half-life of 5,730 yrs). ^{14}C can be used to estimate groundwater ages ranging from 1,000 to less than 30,000 years before present because of its half-life. Calculated ^{14}C ages in this study are referred to as "uncorrected" because they have not been adjusted to consider exchanges with sedimentary sources of carbon (Fontes and Garnier, 1979;). The ^{14}C age (residence time) is calculated based on the decrease in ^{14}C activity as a result of radioactive decay with time since groundwater recharge, relative to an assumed initial ^{14}C concentration (Clarke and Fritz, 1997). A mean initial ^{14}C activity of 99 pmc is assumed for this study, with estimated errors on calculated groundwater ages up to 20 percent.

Helium (He) is a naturally occurring inert gas initially included during the accretion of the planet, and later produced by the radioactive decay of lithium, thorium, and uranium in the Earth. Measured groundwater He concentrations represent the sum of several He components including air-equilibrated He (He_{eq}), dissolved-air bubbles (He_a), terrigenic He (He_{ter}), and tritiogenic He-3 (^3He_t). Helium (^3He and ^4He) concentrations in groundwater often exceed the expected solubility equilibrium values, a function of the temperature of the water, as a result of subsurface production of both isotopes and their subsequent release into the groundwater (for example, Morrison and Pine, 1955; Andrews and Lee, 1979; Torgersen, 1980; Andrews, 1985; Torgersen and Clarke, 1985). The presence of terrigenic He in groundwater, from its production in aquifer material or deeper in the crust, is indicative of long groundwater residence times. The amount of terrigenic helium is defined as the concentration of the total measured helium minus the fraction resulting from air-equilibration [He_{eq}] and dissolved air-bubbles [He_a]. For the purposes of this study, percent terrigenic He is used to identify groundwater with residence times greater than 100 yr. Percent terrigenic He is defined as the concentration of terrigenic He (as defined previously) divided by the total measured He in the sample (corrected for air-bubble

entrainment). Samples with greater than, or equal to, 5 percent terrigenic He represent groundwater with a residence time of more than 100 yrs.

Recharge temperatures were calculated from dissolved neon, argon, krypton, and xenon using methods described in Aeschbach-Hertig and others (1999). Only modeled recharge temperatures having a probability greater than 1 percent were accepted (Aeschbach-Hertig and others, 2000), and the sample with the highest probability was used in this report.

^3H /^3He apparent ages were computed as described in Solomon and Cook (2000). The uncertainty for computed $^3H/^3He$ apparent ages is greater in samples with terrigenic He greater than 5 percent because of sensitivity to the $^3He/^4He$ ratio of the terrigenic He (Plummer and others, 2000). The $^3He/^4He$ ratio of samples was determined by linear regression of the percent of terrigenic He against the δ^3He ($[\delta^3He = R_{meas}/R_{atm} - 1] \times 100$) of samples with less than 1 tritium unit (TU).

In this study, the age distributions of samples are classified as pre-modern, modern, and mixed. Groundwater with tritium activity less than 1 TU, percent terrigenic He greater than, or equal to, 5 percent, and ^{14}C less than 90 pmc is designated as pre-modern—defined as having recharged prior to 1950. Groundwater with tritium activities greater than 1 TU, percent terrigenic He less than 5 percent, and ^{14}C greater than 90 pmc is designated as modern—defined as having recharged during the last 50 years. Samples with both pre-modern and modern components are designated as mixed groundwater, which includes substantial fractions of both old and young waters. In reality, pre-modern groundwater could contain very small fractions of modern water and modern groundwater could contain small fractions of pre-modern water. Previous investigations have used a range of tritium values from 0.3 to 1.0 TU as thresholds for distinguishing pre-1950 from post-1950 water (Michel, 1989; Plummer and others, 1993; Michel and Schroeder, 1994; Clark and Fritz, 1997; Manning and others, 2005). By using a tritium value of 1.0 TU, at the upper end of the range used in the literature, for the threshold in this study, the age classification scheme allows a slightly larger fraction of modern water to be present in a classified pre-modern age distribution than if a lower threshold were used. A lower threshold for tritium would result in fewer wells classified as having a pre-modern rather than a mixed age distribution, when other tracers, carbon-14 and terrigenic helium, suggested that they were primarily pre-modern water. This higher threshold was considered more appropriate for this study because many of the wells are long-screened production wells and some mixing of at least some waters of different ages is likely to occur.

Tritium, pmc, and percent terrigenic helium, along with sample age classifications are reported in appendix table C1. Because of uncertainties in age distributions, in particular caused by mixing of waters of different ages in wells with long open interval intervals and high withdrawal rates, these more precise age estimates were not specifically used for quantifying the relation between age and water quality in this report. Although more sophisticated lumped parameter models for analyzing age distributions that incorporate mixing are available (Cook and Bohlke, 2000), use of these alternative models to understand age mixtures was beyond the scope of this report. Rather, classification into modern, mixed, and pre-modern categories was considered to provide an appropriate and useful characterization for the purposes of examining groundwater quality.

Geochemical Conditions

Geochemical conditions investigated as potential explanatory variables in this report include oxidation-reduction (redox) characteristics. Microorganisms affect the redox conditions of groundwater by utilizing terminal electron acceptors during the degradation of organic carbon. The order of terminal electron acceptor utilization is: $O_2 > NO_3^- > Mn$ (IV) > Fe (III) > $SO_4^{2-} > CO_2$ (McMahon and Chapelle, 2008). With the successive utilization and subsequent depletion of terminal electron acceptors, the redox condition of groundwater progresses from oxidizing (positive Eh values) to reducing (negative Eh values). Oxidation-reduction (redox) conditions affect the mobility of many organic and inorganic constituents (McMahon and Chapelle, 2008), and thus constituent concentrations were compared to redox conditions of the system.

Classification of redox conditions was done using a modification of the framework of McMahon and Chapelle (2008), and is shown in table C2. Redox conditions were classified as either oxic or anoxic. This study utilizes both filtered (USGS data) and unfiltered (CDPH data) samples to infer redox conditions of groundwater. For filtered samples, concentration thresholds as outlined by McMahon and Chapelle (2008) were used. However, because unfiltered samples may overestimate the concentration of dissolved constituents (see discussion in appendix D), a second set of raised concentration thresholds were used for CDPH data. The difference in concentration between unfiltered CDPH samples and filtered USGS samples collected at wells sampled by both methods were used to create a raised threshold for unfiltered samples. The amount that the thresholds were raised by was calculated by taking the median value of the range of concentration differences between filtered and unfiltered samples and adding that value to the concentration threshold used for filtered samples. For example, if the differences in concentration between unfiltered and filtered Mn samples collected at the same wells within one year of each other yielded a range in differences of 0.05 to 0.17 mg/L with a median value of 0.07 mg/L, then the raised threshold for unfiltered Mn would be: filtered threshold (0.05 mg/L) + median difference (0.07 mg/L) = raised threshold (0.12 mg/L). Available data did not allow for classifications to be made based on SO_4^2 and CO_2 reducing conditions.

Table C1. Summary of groundwater age data and classification of samples into modern, mixed, and pre-modern age distributions, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.

[°C, Degrees Celsius; TU, tritium units; –, no data]

GAMA_ID	Recharge temperature		Tritium		Terrigenic helium, percent of total helium	Modern carbon		Age classification
	(°C)	Error (°C)	(TU)	Error (TU)		(percent)	Counting error (percent)	
Grid Wells								
SDALLV-01	16.2	0.0	3.20	0.09	5.0	99	0.4	Mixed
SDALLV-02	15.9	0.0	4.08	0.18	0.5	99	0.4	Modern
SDALLV-03	17.0	0.0	0.00	0.07	90.2	59	0.3	Pre-Modern
SDALLV-04	19.2	0.1	2.28	0.11	7.6	–	–	Mixed
SDALLV-06	18.9	0.5	5.83	0.41	46.2	101	0.4	Mixed
SDALLV-07	16.0	0.0	4.31	0.18	7.4	–	–	Mixed
SDALLV-08	23.7	0.0	3.80	0.17	39.0	–	–	Mixed
SDALLV-09	20.4	0.2	0.01	0.03	81.6	22	0.2	Pre-Modern
SDALLV-10	15.7	0.0	5.81	0.22	18.8	–	–	Mixed
SDALLV-11	17.3	0.1	6.93	0.41	54.8	–	–	Mixed
SDALLV-12	18.3	0.0	2.65	0.12	83.6	–	–	Mixed
SDALLV-13	17.4	0.0	3.53	0.25	53.8	95	0.4	Mixed
SDALLV-14	15.9	0.0	2.16	0.10	28.2	–	–	Mixed
SDALLV-15	17.5	0.1	1.91	0.10	69.6	–	–	Mixed
SDALLV-16	21.0	0.8	4.92	0.41	0.0	–	–	Modern
SDHDRK-04	9.2	0.2	1.88	0.19	3.1	97	0.4	Modern
SDHDRK-05	18.3	0.0	3.32	0.31	63.7	102	0.4	Mixed
SDHDRK-06	12.7	1.3	0.41	0.05	96.4	76	0.4	Pre-Modern
SDHDRK-07	16.8	2.7	0.38	0.05	39.2	64	0.3	Pre-Modern
SDHDRK-08	14.0	0.3	1.92	0.11	72.3	–	–	Mixed
SDHDRK-09	14.7	0.6	1.93	0.10	30.2	–	–	Mixed
SDHDRK-10	15.1	0.7	2.82	0.13	10.4	–	–	Mixed
SDHDRK-11	17.4	0.0	1.00	0.19	84.4	–	–	Mixed
SDHDRK-12	14.1	15.1	0.50	0.19	1.2	–	–	Mixed
SDHDRK-13	15.5	1.5	2.82	0.31	21.4	–	–	Mixed
SDTEM-01	19.0	0.0	0.09	0.21	95.2	51	0.3	Pre-Modern
SDTEM-03	17.8	0.5	0.09	0.31	90.5	–	–	Pre-Modern
SDTEM-04	17.4	0.0	3.32	0.31	15.1	–	–	Mixed
SDTEM-05	20.9	0.0	0.00	0.15	58.3	84	0.4	Pre-Modern
SDTEM-06	16.3	0.0	1.50	0.09	22.0	96	0.4	Mixed
SDTEM-07	15.7	0.0	3.11	0.14	0.0	–	–	Modern
SDTEM-08	19.3	0.0	1.00	0.19	88.1	–	–	Mixed
SDTEM-09	13.8	0.2	0.03	0.04	99.1	–	–	Pre-Modern
SDTEM-10	17.1	0.1	6.43	0.41	0.0	91	0.4	Modern
SDTEM-11	17.6	0.0	0.04	0.04	82.6	–	–	Pre-Modern
SDTEM-12	16.9	0.0	0.91	0.07	94.0	98	0.4	Mixed
SDTEM-13	18.4	0.0	0.28	0.05	99.3	58	0.3	Pre-Modern
SDWARN-01	13.9	0.8	0.09	0.31	79.1	–	–	Pre-Modern
SDWARN-02	13.0	0.1	1.91	0.31	0.0	–	–	Modern
SDWARN-03	13.0	0.0	1.69	0.19	0.0	–	–	Modern

Table C1. Summary of groundwater age data and classification of samples into modern, mixed, and pre-modern age distributions, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.—Continued

[°C, Degrees Celsius; TU, tritium units; –, no data]

GAMA_ID	Recharge temperature		Tritium		Terrigenic helium, percent of total helium	Modern carbon		Age classification
	(°C)	Error (°C)	(TU)	Error (TU)		(percent)	Counting error (percent)	
SDWARN-04	13.1	0.0	0.19	0.19	94.3	78	0.4	Pre-Modern
SDWARN-05	12.8	0.0	0.09	0.19	23.7	85	0.4	Pre-Modern
SDWARN-06	16.0	0.4	0.06	0.05	5.8	81	0.4	Pre-Modern
SDWARN-08	11.9	0.1	0.21	0.05	98.8	–	–	Pre-Modern
SDWARN-09	12.0	0.0	0.04	0.05	98.7	–	–	Pre-Modern
Understanding Wells								
SDALLVU-1	17.1	0.5	1.84	0.09	99.2	–	–	Mixed
SDHDRKU-01	20.4	0.0	2.60	0.31	86.5	–	–	Mixed
SDHDRKU-02	16.1	0.0	0.32	0.06	0.0	–	–	Mixed
SDHDRKU-03	19.0	0.0	3.00	0.14	62.5	–	–	Mixed
SDTEMFP-01	17.6	0.1	0.28	0.04	93.5	74	0.4	Pre-Modern
SDTEMFP-02	14.2	0.0	1.10	0.19	95.1	70	0.3	Mixed
SDTEMFP-03	15.2	0.0	0.89	0.06	90.9	75	0.4	Pre-Modern
SDTEMFP-04	13.6	0.0	6.83	0.41	0.0	92	0.4	Modern
SDTEMFP-05	17.0	0.0	2.92	0.31	8.6	–	–	Mixed
SDTEMFP-06	14.4	0.0	1.25	0.19	95.1	–	–	Mixed
SDTEMFP-07	15.9	0.1	0.62	0.06	96.6	60	0.3	Pre-Modern

Table C2. Concentration thresholds in milligrams per liter for dissolved redox indicator constituents used to infer redox conditions in groundwater, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.

[Modified from McMahon and Chapelle, 2008. Numbers in parenthesis are raised thresholds used for unfiltered samples. ≥, greater than or equal to; <, less than; –, data not available]

Redox condition	O_2	NO_3– as N	Mn	Fe
Oxic	≥ 0.5	≥ 0.5 (0.6)	< 0.05 (0.12)	< 0.1 (0.23)
Oxic	≥ 0.5	< 0.5 (0.6)	< 0.05 (0.12)	< 0.1 (0.23)
Anoxic	< 0.5	< 0.5 (0.6)	≥ 0.05 (0.12)	≥ 0.1 (0.23)
Anoxic	< 0.5	< 0.5 (0.6)	≥ 0.05 (0.12)	< 0.1 (0.23)
Anoxic	< 0.5	< 0.5 (0.6)	< 0.05 (0.12)	≥ 0.1 (0.23)
Anoxic	–	< 0.5 (0.6)	≥ 0.05 (0.12)	≥ 0.1 (0.23)
Anoxic	–	< 0.5 (0.6)	≥ 0.05 (0.12)	< 0.1 (0.23)
Anoxic	–	< 0.5 (0.6)	< 0.05 (0.12)	≥ 0.1 (0.23)

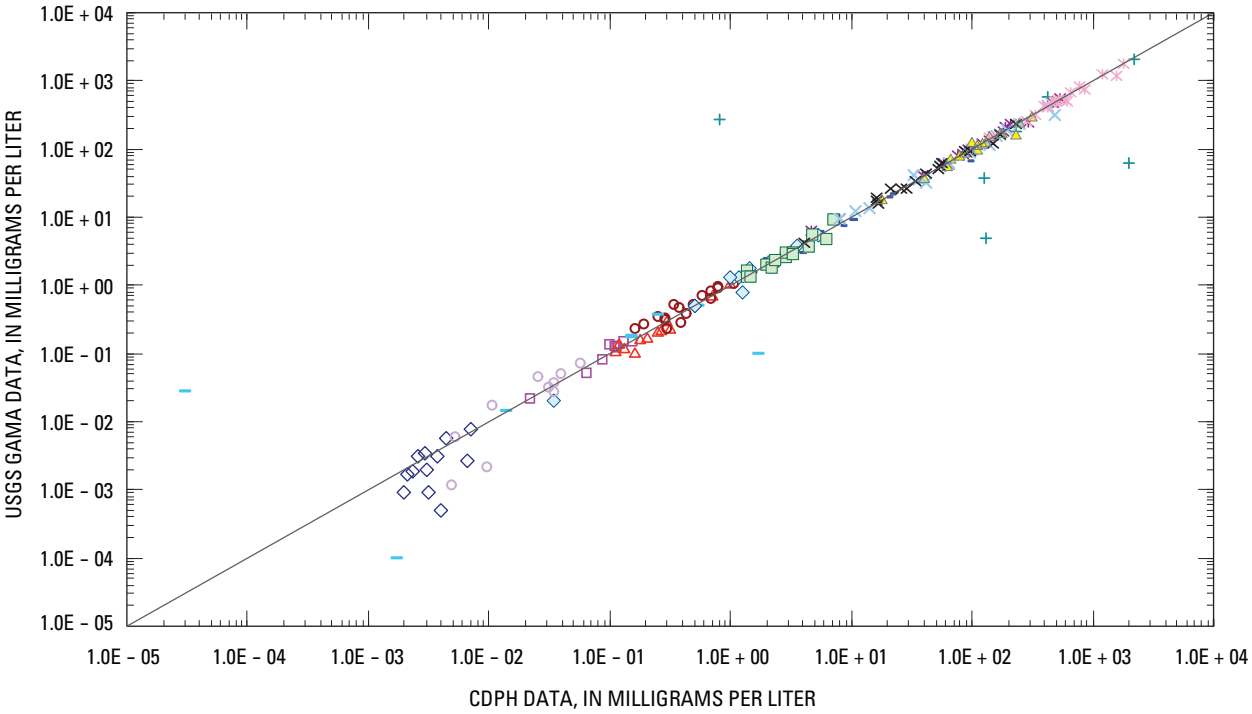
Appendix D. Comparison of CDPH and USGS-GAMA Data

Comparisons of CDPH and GAMA data were done to assess the validity integrating these datasets for the purpose of assessing water quality in the San Diego study unit. Because reporting levels for most organic constituents were substantially lower for data collected by the USGS than for data from the CDPH database (table 3), it generally was not possible to meaningfully compare concentrations of these constituent types in individual wells. However, because concentrations of inorganic constituents generally are detected at concentrations substantially above LRLs, a comparison of the two datasets was possible. Qualitative comparisons were done by plotting constituent concentrations on a one-to-one line graph and quantitative comparisons were done by calculating the relative percent difference (RPD) for each data pair (fig. D1). Only constituents with at least seven data pairs were examined.

Sample mass was sufficient for 15 inorganic constituents to allow comparisons to be made. Of these 15 constituents, the median RPD for 11 constituents was less than 15, for 3 constituents median RPD was either 23 or 24, and for 1 (iron) median RPD was 100 (fig. D1). Iron concentrations reported in the CDPH database were higher than the concentrations reported for samples collected by the USGS in five of seven replicate pairs. The differences in the sample collection procedures between the USGS and CDPH (filtered versus non-filtered) may be the reason for the higher concentrations observed in the CDPH samples than in the USGS samples. The results of this comparison show that inorganic data for most constituents from the CDPH database can be reasonably integrated with USGS data for the purposes of examining water quality in the San Diego study unit.

Major ion data for grid wells (USGS and CDPH data) were plotted on Piper diagrams (Piper, 1944) with CDPH major ion data to determine whether the grid wells represented the range of groundwater types that have historically been observed in the study unit. Piper diagrams show the relative abundance of major cations and anions (on a charge equivalent basis) as a percentage of the total ion content of the water. Piper diagrams are often used to define groundwater type (Hem, 1985).

The similarity of water types represented by CPDH data to water types represented by GAMA data indicate that the GAMA sampling design indeed did collect a representative sample of groundwater that is used for public supply in the San Diego study unit (fig. D2).



EXPLANATION

- **Arsenic** (median RPD = 23; n = 12)
- **Barium** (median RPD = 11; n = 8)
- **Boron** (median RPD = 13; n = 12)
- **Calcium** (median RPD = 4; n = 18)
- **Chloride** (median RPD = 5; n = 18)
- **Fluoride** (median RPD = 14; n = 17)
- **Iron** (median RPD = 100; n = 7)
- **Magnesium** (median RPD = 7; n = 17)
- **Manganese** (median RPD = 23; n = 23)
- **Nitrate** (median RPD = 10; n = 10)
- **Potassium** (median RPD = 13; n = 17)
- **Sodium** (median RPD = 5; n = 17)
- **Sulfate** (median RPD = 5; n = 18)
- **Total dissolved solids** (median RPD = 5; n = 18)
- **Vanadium** (median RPD = 24; n = 10)

One-to-one line

Figure D1. Paired inorganic concentrations from wells sampled by the Groundwater Ambient Monitoring and Assessment (GAMA) Program and the California Department of Public Health, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.

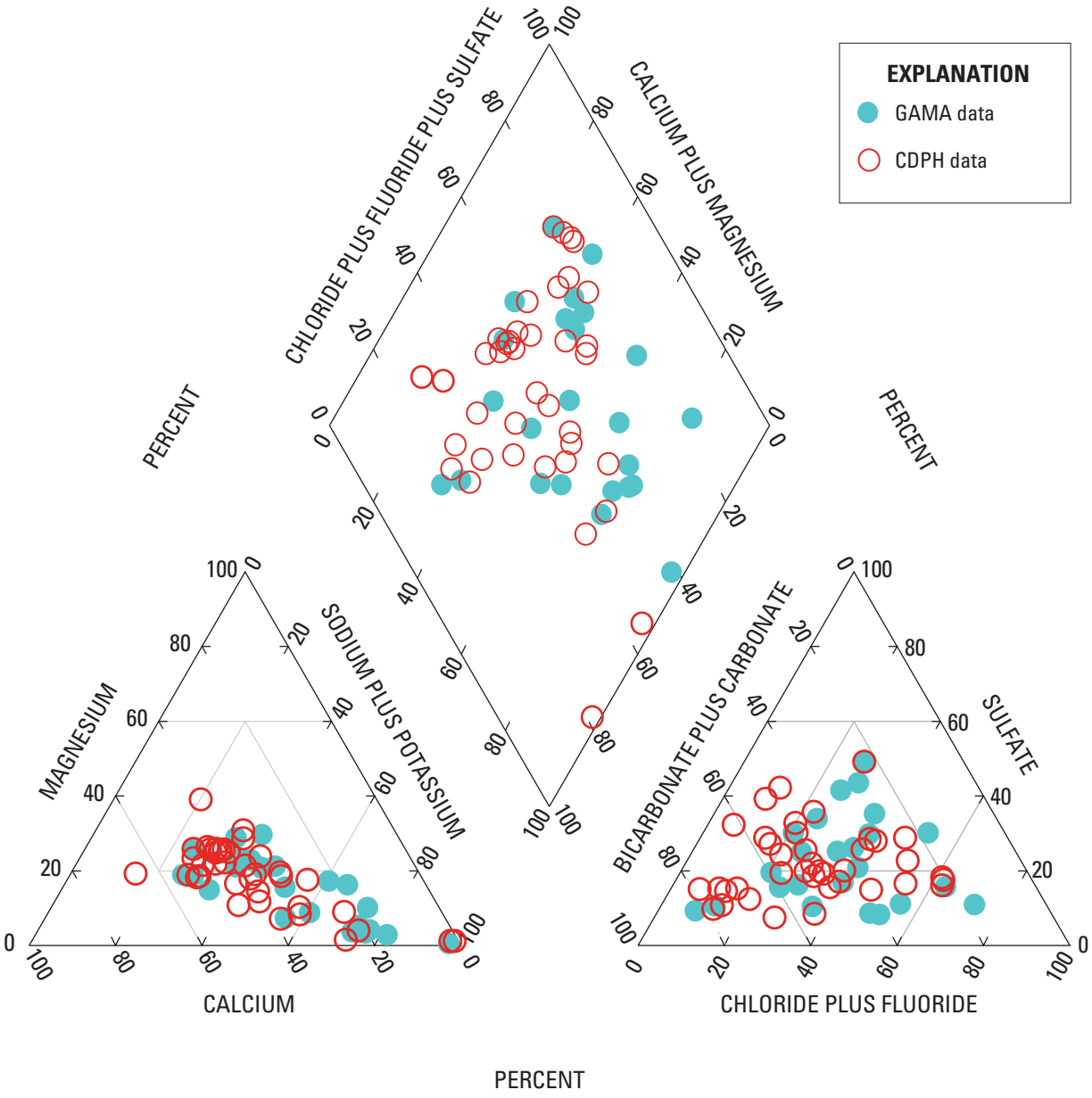


Figure D2. Piper diagram for grid wells and all wells in the California Department of Public Health database with a charge imbalance of less than 10 percent, San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.

Appendix E. Calculating Total Dissolved Solids

Specific conductance, an electrical measure of TDS, was available in all 58 grid and understanding wells sampled by the USGS, whereas measured TDS data only were available for 24 of these wells. TDS values for the other 34 wells were calculated from specific conductance (SC) values using a linear regression equation (TDS = 0.628*SC –15.34) so that all grid wells would have TDS values. The predicted TDS values using the regression equation closely matched measured TDS values (r^2 = 0.98). TDS values from CDPH were combined with USGS measured and calculated TDS values.

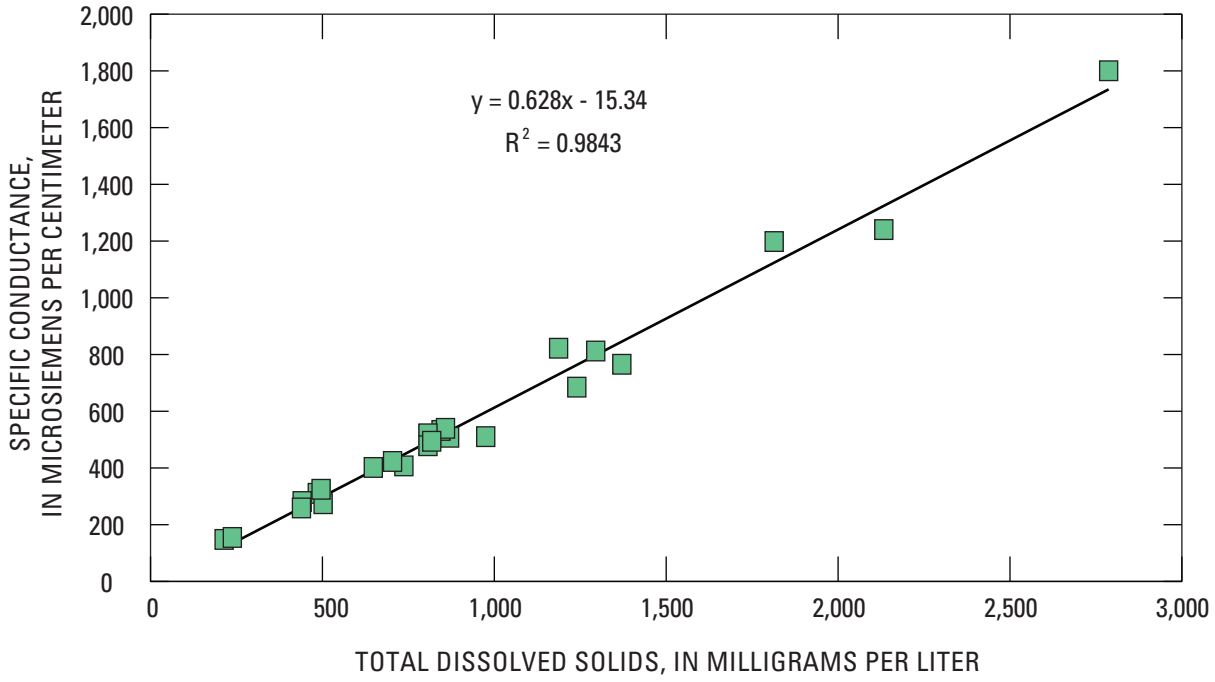


Figure E1. Regression of total dissolved solids versus specific conductance for samples collected by the U.S. Geological Survey. San Diego Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, May–July 2004.

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