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GROUNDWATER AMBIENT MONITORING AND ASSESSMENT (GAMA)

DOMESTIC WELL PROJECT
GROUNDWATER QUALITY DATA REPORT
SAN DIEGO COUNTY FOCUS AREA

California State Water Resources Control Board
Groundwater Protection Section
GAMA Program
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ABBREVIATIONS AND ACRONYMS

CDPH	California Department of Public Health
CHR	Colorado Hydrologic Region
DWR	California Department of Water Resources
EC	Electrical Conductivity
GAMA	Groundwater Ambient Monitoring and Assessment
LLNL	Lawrence Livermore National Laboratory
MCL	Maximum Contaminant Level
NL	Notification Level
SMCL	Secondary Maximum Contaminant Level
SDHR	San Diego Hydrologic Region
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
VOCs	Volatile Organic Compounds
µg/L	Micrograms per Liter
mg/L	Milligrams per Liter

ABSTRACT

The State Water Resources Control Board (State Water Board) established the Groundwater Ambient Monitoring and Assessment (GAMA) Program in 2000. Private domestic wells in San Diego County were sampled in 2008 and 2009 as part of the GAMA Domestic Well Project. San Diego County was selected for sampling due to the large number of domestic wells located within the county and the availability of well-owner data. A total of 137 domestic wells were sampled by Water Board staff. A subset of 54 wells was analyzed for radionuclides, and a subset of 38 wells was analyzed for triazine pesticides and pesticide degradates.

Groundwater samples were analyzed by an accredited environmental laboratory for chemical constituents commonly found in groundwater such as bacteria (total and fecal coliform), inorganic constituents (metals, major anions and general minerals), and volatile organic compounds (VOCs). Test results were compared against three public drinking water standards established by the California Department of Public Health (CDPH): primary maximum contaminant levels (MCLs), secondary maximum contaminant levels (SMCLs), and notification levels (NLs). These water quality standards are used for comparison purposes only, since private domestic well water quality is not regulated by the State of California. A total of 22 constituents were detected at concentrations above public drinking water standards, with one of these chemicals detected above multiple drinking water standards. Eleven constituents were detected above a primary MCL, eight constituents were detected above a SMCL, and four constituents were detected above NLs.

The eleven constituents detected at concentrations above a primary MCL included total coliform bacteria, arsenic, cadmium, nitrate, barium, fluoride, perchlorate, trichlorofluoromethane, gross alpha activity, radium 226+228 activity, and uranium activity. Total coliform bacteria were the most frequently detected constituent above an MCL (36 wells). Nitrate was detected above the MCL in 25 wells. Gross alpha activity and uranium were detected above the MCL in 19 and 16 of 54 wells, respectively.

The eight constituents detected at concentrations above SMCLs included aluminum, iron, manganese, zinc, total dissolved solids, electrical conductivity, chloride, and sulfate. Manganese was the most frequently detected constituent above an SMCL (45 wells). Iron, electrical conductivity, and total dissolved solids were also observed at concentrations greater than their respective SMCLs in more than 10% of the sampled wells. Lead, vanadium, boron, and manganese were detected at concentrations above NLs. None of these constituents exceeded the NL in more than three percent of the sampled wells.

INTRODUCTION

More than 95 percent of Californians get their drinking water from a public or municipal source - these supplies are typically treated to ensure that the water is safe to drink. However, private domestic wells supply drinking water to approximately 1.6 million Californians. Those served by public or municipal supplies should be concerned about groundwater quality too, as groundwater supplies part or all of the water delivered to approximately 15 million municipal public water supply users. Contaminated groundwater results in treatment costs, well closures, and new well construction which increases costs for consumers.

Groundwater is also an important source of irrigation and industrial supply water. Reliance upon this resource is expected to increase in the future, in part due to increased agricultural and industrial demand, drought, climate change, and population/land-use changes. Consequently, there are growing concerns regarding groundwater quality in California, and whether decreases in quality will affect the availability of this resource. Since the 1980s, over 12,000 public groundwater drinking water sources have been shut down – some due to the detection of chemicals such as nitrate, arsenic, or methyl tert-butyl ether (MTBE).

The State Water Board created the Groundwater Ambient Monitoring and Assessment (GAMA) Program to address public concerns over groundwater quality. The primary objectives of the GAMA Program are to improve comprehensive statewide groundwater monitoring and to increase the public availability of groundwater quality information. The data gathered by GAMA highlight regional and local groundwater quality concerns, and may be used to evaluate whether there are specific chemicals of concern in specific areas throughout the state. The GAMA Program consists of four current projects:

- **Domestic Well Project**: Samples domestic wells for commonly detected chemicals, at no cost to well owners who volunteer. To date, Domestic Well Project staff have sampled over 1,000 private domestic wells in five county focus areas: Yuba (2002), El Dorado (2003-2004), Tehama (2005), Tulare (2006), and San Diego (2008-2009).

- **Priority Basin Project**: A comprehensive, statewide groundwater monitoring program that primarily uses public groundwater supply wells in high-use, or “priority,” groundwater basins. These high-use basins contain more than 95% of all public groundwater supply wells. As of April 2009, the Priority Basin Project has sampled over 1,700 wells in over 90 different groundwater basins. The United States Geological Survey (USGS) is the project technical lead, with support from LLNL.

- **Special Studies Project**: Focuses on identification of contaminant sources and assessing the effects of remediation in private domestic and public supply wells. The Special Studies Project also studies

aquifer storage and recovery projects. LLNL is the project technical lead.

- **GeoTracker GAMA**: A publicly-accessible, map-based on-line query tool that helps users find useful groundwater quality data and information.

This Data Summary Report summarizes Domestic Well Project results from 137 domestic wells sampled in the San Diego County Focus Area during 2008 and 2009. Sampled well locations are shown in Figure 1.

Domestic Well Project Overview

Domestic wells differ from public drinking water supply wells in several respects; domestic wells are generally shallower, are privately owned, supply a single household, and tend to be located in more rural settings where public water supply systems are not available. 2000 census data indicate that there are over 600,000 private domestic wells in California, supplying water to approximately 1.6 million Californians. Due to low pumping rates, the volume of groundwater use by domestic well owners is estimated at 2 percent of the total groundwater volume used in California. The State of California does not regulate water quality in private domestic wells. As a result, many well owners do not have an accurate assessment of their own well water quality.

Domestic well owners are responsible for testing the water quality of their well to know if the water is safe for consumption. Domestic wells typically produce very high quality drinking water. However, poor well construction or placement close to a potential source of contamination can result in poor water quality. Chemicals from surface-related activities such as industrial spills, leaking underground fuel tanks, and agricultural applications can impact groundwater. Biological pathogens from sewers, septic systems, and animal facilities can infiltrate into groundwater. Naturally-occurring chemicals can also contaminate groundwater supplies.

Water quality testing results from the Domestic Well Project are compared to existing groundwater information and public supply well data to help assess California groundwater quality and to better identify issues that may impact private domestic well water.

San Diego County Background

San Diego County, at approximately 2.6 million acres in area and with a population of more than three million, is one of the fastest growing counties in California. Desirable weather, proximity to marinas, and proximity to Mexico contribute to the county's economy and population growth.

The coastal valleys, mountain ranges, high-altitude deserts, and desert basins result in a variety of microclimates within the county. However, San Diego County is primarily a desert and as a result must import much of its water. Approximately 90 percent of the county's municipal water supply comes from the Colorado River and the State Water Project (Northern California). San Diego County's water supply may be vulnerable during droughts when deliveries from northern California are reduced. Reliance upon groundwater during droughts or when other supplies are limited makes groundwater within the county susceptible to overdraft.

More than 500,000 people live in unincorporated areas of San Diego County. Due in part to the high population in unincorporated areas and the local climate, San Diego County ranks second in California in terms of domestic well water use (Figure 1), accounting for approximately 12 percent of California's total domestic well water withdrawls (32.92 million gallons per day).

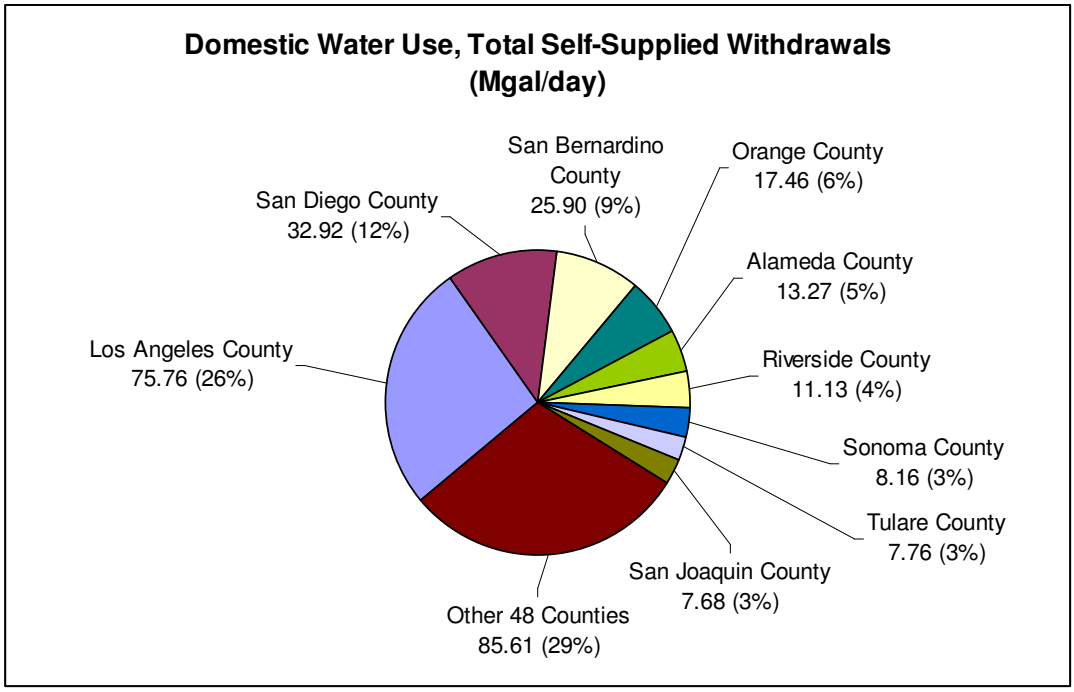


Figure 1: Top Ten California Counties for Domestic Water Use

Source: USGS, 2000

HYDROGEOLOGIC SETTING

The Peninsular Range divides San Diego County in two hydrologic regions: the San Diego Hydrologic Region (SDHR) and the Colorado Hydrologic Region (CHR). There are eleven major watersheds in the SDHR, and five major watersheds in the CHR. Watersheds in the SDHR generally drain westwards towards the Pacific, while watersheds in the CHR generally drain towards the Salton Sea or Gulf of California.

There are more than 35 Department of Water Resources (DWR)-defined groundwater basins in San Diego County. Groundwater basins in San Diego County are generally made up of unconfined alluvial deposits typically found in river valleys or as basin-fill deposits between mountain ranges. Thickness of the aquifers ranges from tens of feet in the smallest basins to thousands of feet in the larger basins. Some aquifers can yield thousands of gallons per minute to municipal wells (DWR, 2003).

However, of the 137 sampled domestic wells, only twenty wells were located within a defined DWR basin: twelve within the Santa Maria Valley basin (SDHR), four within the Borrego Valley basin (CHR), two within the El Cajon Valley basin (SDHR), and a single well in the San Luis Rey Valley and San Diego River Valley groundwater basins. The Santa Maria Valley groundwater basin is described below.

- Santa María Valley Groundwater Basin: Santa Maria Valley Groundwater basin is located in central San Diego County in the vicinity of the city of Ramona. The basin is bounded by impermeable crystalline rocks, with water-bearing deposits comprised of alluvium. These deposits are generally thin and unsaturated.

Wells located in the foothills or mountains of San Diego County, outside of defined groundwater basins, generally tap fractured bedrock. Bedrock in San Diego County is varied, with marine sediments along the coast and weathered granitic batholiths throughout much of the interior of the county. Eastern San Diego County is characterized by thick sedimentary deposits of marine, alluvial, and lacustrine origin.

METHODS

Well Selection

San Diego County was selected by GAMA due to the large number of domestic wells within the county (approximately 16,000) and the availability of electronic well owner data. The San Diego County Department of Environmental provided GAMA staff with an electronic database containing the names, mailing addresses, parcel map book numbers, and hydrologic unit numbers of approximately 2,100 domestic well owners. Flyers announcing free domestic well testing were mailed to several hundred of the well owners. A total of 137 domestic well owners volunteered to participate in the study.

Sample and Data Collection

The San Diego County Focus Area study was conducted in two phases. Phase 1 occurred from May-June 2008. Ninety-two wells were sampled during Phase 1. Phase 2 occurred from December 2008 through January 2009. Forty-five wells were sampled during Phase 2.

Well construction information was obtained from either well owners or well completion reports (well logs). Information collected at each well included the presence and location of nearby septic systems, agricultural activities, or t livestock that could result in contamination of the well. Well locations were recorded using a Geographic Positioning Satellite (GPS) unit. Water temperature, pH, and specific electrical conductance were measured and documented in the field.

Groundwater samples were collected as close to the well head as possible. Most often the sample was collected from a faucet or spigot just before or after the pressure tank. New nitrile gloves were worn by field staff during sample collection to minimize contamination during sampling. Samples were collected in laboratory supplied pre-cleaned bottles, and were stored in an iced cooler until delivery to the lab within 24 hours.

Trip blank and duplicate samples were collected at approximately 10 percent of the well locations. These samples are collected and analyzed to help determine if cross contamination was introduced during sample collection, processing, storage, and/or transportation. All trip blank and duplicate data results were within acceptable range criteria.

Test Results

Groundwater samples were analyzed by Truesdail Laboratories, Inc. of Tustin, California. Samples were identified as routine and non-routine. All 137 wells were analyzed for routine constituents, including:

- Bacteria (total and fecal coliform)
- Inorganic parameters (metals, major anions, and general minerals)
- Volatile organic compounds (VOCs)
- Perchlorate

A sub-set of the 137 wells were analyzed for non-routine constituents, including:

- Pesticides (38 wells)
- Radionuclides (54 wells)

In addition, LLNL analyzed water samples for several isotopic parameters including hydrogen and oxygen isotopes in water, oxygen and nitrogen isotopes in nitrate, and boron isotopes. Isotopic composition data can provide useful information in determining the source of some types of groundwater contamination. Isotopic results from the San Diego County focus area will be published in a separate report, available at www.waterboards.ca.gov/gama.

Test results were mailed to domestic well owners in a letter from the State Water Board. A summary list of test results was also shared with State and Local health officials to assist in well owner inquiries and concerns.

RESULTS

Well Locations

Well locations are shown in Figure 2. Twenty wells were located within a defined DWR basin: twelve within the Santa Maria Valley basin (SDHR), four within the Borrego Valley basin (CHR), two within the El Cajon Valley basin (SDHR), and a single well in the San Luis Rey Valley and San Diego River Valley groundwater basins. The majority of the wells sampled in the San Diego County focus area were located outside of a DWR-defined basin. Few wells are located in the western coastal areas of the county, in part because these areas are generally supplied by municipal water services.

Well Construction Data

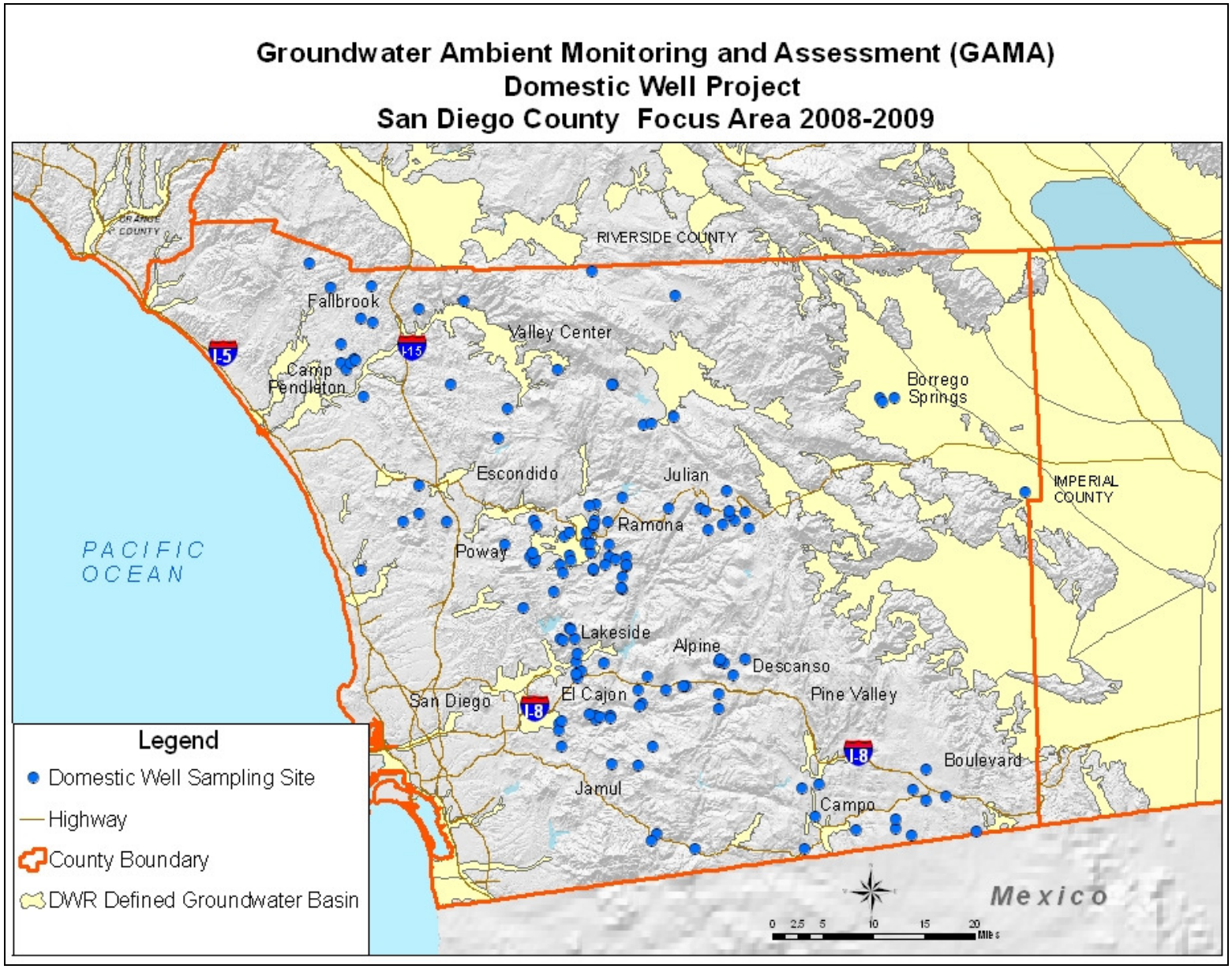
Well completion depth data were available for 128 of the 137 sampled wells. The data comes from driller's reports provided by the well owners, interviews with well owners, and information provided by the San Diego County Department of Environmental Health. Well completion depths are shown in Table 1.

Table 1: Domestic Well Depths
GAMA Domestic Well Project, San Diego Focus Area

Total Well Depth (feet)	Number of Wells
0-49	1
50-99	3
100-149	7
150-199	10
200-249	14
250-299	7
300-349	6
350-399	6
400-449	10
450-499	5
500-549	12
550-599	4
600-649	10
650-699	1
700-749	9
750-799	3
800-849	6
850-899	4
>900	9

Note: Well depth data not available for all wells

Figure 2: Well Locations



Detections Above a Drinking Water Standard

The Domestic Well Project compares analytical results to Federal and State water quality standards established to protect public (municipal) drinking water quality: CDPH primary maximum contaminant levels (MCLs), secondary MCLs (SMCLs), and notification levels (NLs). The MCL is the highest concentration of a contaminant allowed in public drinking water. Primary MCLs address health concerns, while secondary MCLs (SMCLs) address aesthetics, such as taste and odor. NLs are health-based advisory levels for chemicals in public drinking water that do not have an MCL or SMCL. These water quality standards are used for comparison purposes only, since private domestic well water quality is not regulated by the State of California.

Analytes that were detected in one or more domestic wells above a drinking water standard are:

- Total Coliform Bacteria
- Aluminum
- Arsenic
- Barium
- Boron
- Cadmium
- Chloride
- Electrical Conductivity (EC)
- Fluoride
- Gross Alpha Activity
- Iron
- Lead
- Manganese
- Nitrate
- Perchlorate
- Radium 226+228
- Sulfate
- Total Dissolved Solids (TDS)
- Trichlorofluoromethane (Freon)
- Uranium
- Vanadium
- Zinc

A summary of all analytes detected above a drinking water standard is outlined in Table 2. Detailed results of the domestic well sampling are summarized below.

Table 2: Summary of Detections Above a Drinking Water Standard

GAMA Domestic Well Project – San Diego County Focus Area (2008-2009)

Total Number of Wells Sampled: 137

Compound	Wells Above Public Drinking Water Standard		Range of Detections Above Public Drinking Water Standards	Public Drinking Water Standards[1,2,3]		
	Number	Percent		MCL	SMCL	NL
Bacteria Indicators						
Total Coliform	36	26%	NA[4]	Present		
Metals						
Aluminum	1	<1%	510 µg/L	1,000 µg/L	200 µg/L	
Arsenic	3	2%	10.1 – 15.7	10 µg/L		
Barium	1	<1%	1,350 µg/L	1,000 µg/L		
Cadmium	2	1%	5.94 – 9.4 µg/L	5 µg/L		
Iron	21	15%	302 – 12,500 µg/L		300 µg/L	
Lead	2	1%	41.5 – 74.8 µg/L			15 µg/L
Manganese	45	33%	52.3 – 679 µg/L		50 µg/L	500 µg/L
Vanadium	2	1%	58.5 – 65.8			50 µg/L
Zinc	2	1%	9,400 – 13,900 µg/L		5,000 µg/L	
Major Ions & General Chemistry						
Electrical Conductivity (EC)	19	14%	1,630 – 2,600 µmhos/cm		1,600 µmhos/cm	
Total Dissolved Solids (TDS)	21	15%	1,020 – 1,830 mg/L		1,000 mg/L	
Nitrate as NO_3	25	18%	47.3 – 249 mg/L	45 mg/L		
Chloride	3	2%	520 – 692 mg/L		500 mg/L	
Sulfate	1	<1%	613 mg/L		500 mg/L	
Boron	4	3%	1,110 – 2,300 µg/L			1,000 µg/L
Fluoride	1	<1%	3,340 µg/L	2,000 µg/L		
Perchlorate	5	4%	6.1 – 14 µg/L	6 µg/L		

Table 2: Summary of Detections Above a Drinking Water Standard, Continued

Compound	Number of Wells Above Public Drinking Water Standards	Percentage	Range of Detections Above Public Drinking Water Standards	Public Drinking Water Standards[1,2,3]		
				MCL	SMCL	NL
Radionuclides[3] (54 Selected Wells Sampled)						
Gross Alpha	19 of 54 wells	35%	15.8 – 170 pCi/L	15 pCi/L		
Radium 226+228	2 of 54 wells	4%	5.06 – 23.7 pCi/L	5 pCi/L		
Uranium	16 of 54 wells	30%	24.3 – 168 pCi/L	20 pCi/L		
VOCs						
Trichlorofluoromethane (Freon)[5]	1	<1%	2,230 µg/L	150 µg/L		

Notes:

1. MCL = California Department of Public Health (CDPH) Primary Maximum Contaminant Level; SMCL = CDPH Secondary Maximum Contaminant Level; NL = CDPH Notification Level
2. µg/L = micrograms per liter, or parts per billion (ppb); mg/L = milligrams per liter, or parts per million (ppm). A microgram is 1/1000th of a milligram.
3. Radionuclide units in picocuries per liter, or pCi/L. A picocurie is a measure of particle activity
4. Coliform are evaluated on a presence/absence criteria. No range can be determined.
5. Possible laboratory or field contamination

Coliform Bacteria

Total coliform bacteria were detected in 36 wells (26% of 137 wells). Fecal coliform were not detected in any of the 36 wells where coliform bacteria were present. Figure 3 shows the distribution of total coliform bacteria detected in sampled domestic wells.

General Minerals

General minerals detected in domestic well samples are summarized in Table 3. General minerals include measures of alkalinity, hardness, and total dissolved solids (TDS). All of the general minerals listed in Table 3, with the exception of foaming agents (MBAS), naturally occur in groundwater. However, leachate from septic systems, disposal of partially treated wastewater, and some agricultural activities can sometimes change the concentrations of these minerals in groundwater.

There are no established regulatory levels for many general mineral analytes; only foaming agents (MBAS), EC, and TDS have SMCLs. MBAS, which are associated with the presence of detergents, were not detected in any sample at a concentration above the SMCL. TDS, which is an estimate of the concentration of all dissolved components in water, was above the SMCL (1,000 mg/L) in 21 wells. EC was above the SMCL (1,600 µmhos/cm) in 19 wells.

Table 3: General Minerals

GAMA Domestic Well Project, San Diego County Focus Area

Analyte	Range of Detected Values (mg/L)	Public Drinking Water Standard (mg/L)	Number of Wells Above Standard
Total Alkalinity (as $CaCO_3$)	44 – 347	NA	–
Bicarbonate	53.7 – 423	NA	–
Carbonate	1.2	NA	–
Calcium	1.63 – 204	NA	–
Magnesium	0.087 – 119	NA	–
Potassium	0.906 – 46.1	NA	–
Sodium	14.8 – 272	NA	–
Foaming Agents (MBAS)	0.0612 – 0.083	0.5 SMCL	0
Hardness (Total) as $CaCO_3$	24 – 1,000	NA	–
pH, Laboratory	6.14 – 9.17	NA	–
Total Dissolved Solids (TDS)	119 – 1,830	1000 SMCL	21
Electrical Conductivity (EC)	142 – 2,600 µmhos/cm	1,600 µmhos/cm SMCL	19

Notes:
1. SMCL = Secondary Maximum Contaminant Level
2. mg/L = milligrams per liter
3. NA = Health or aesthetic standards are not available for this constituent

Figure 3: Total Coliform Results

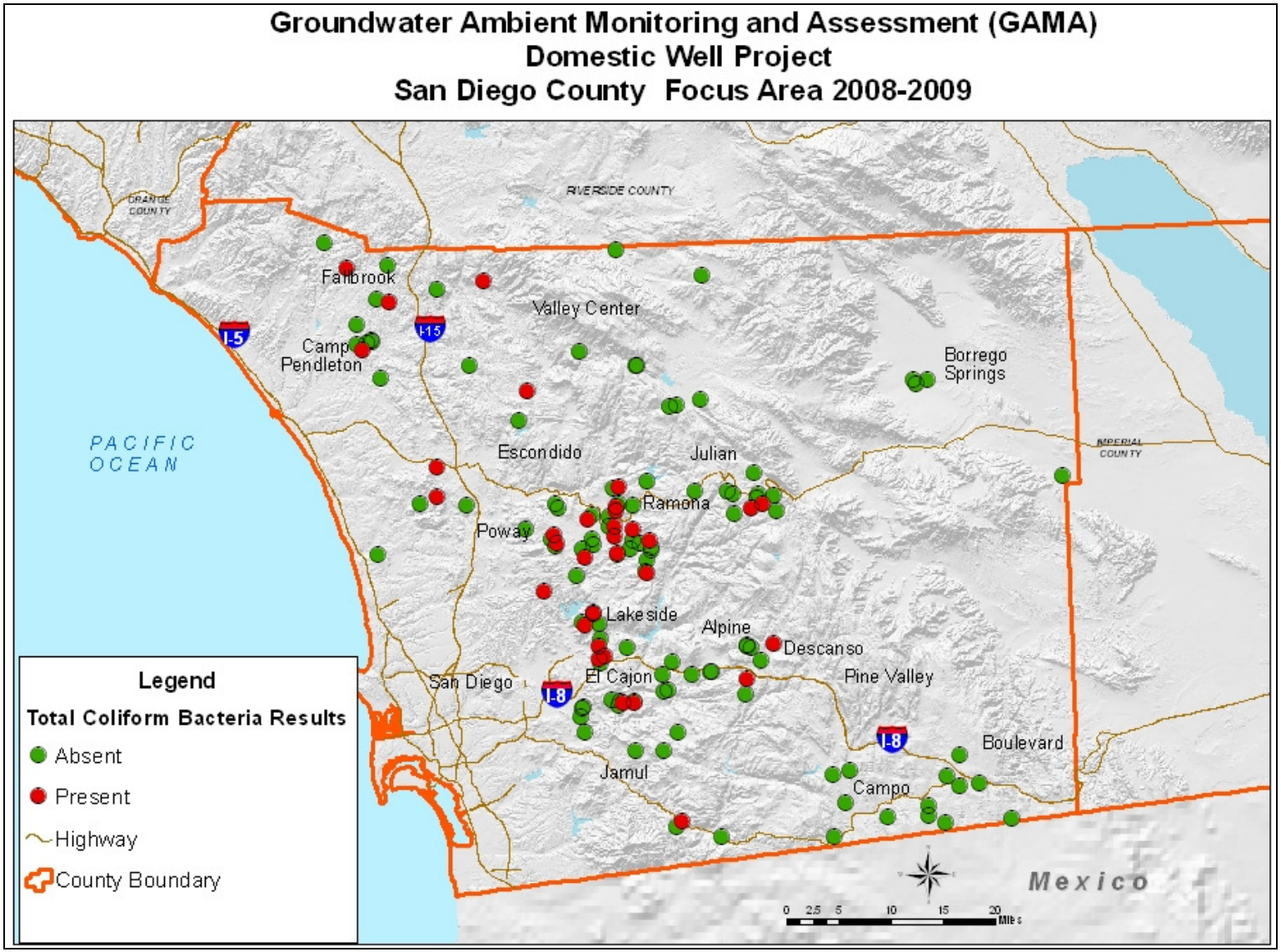
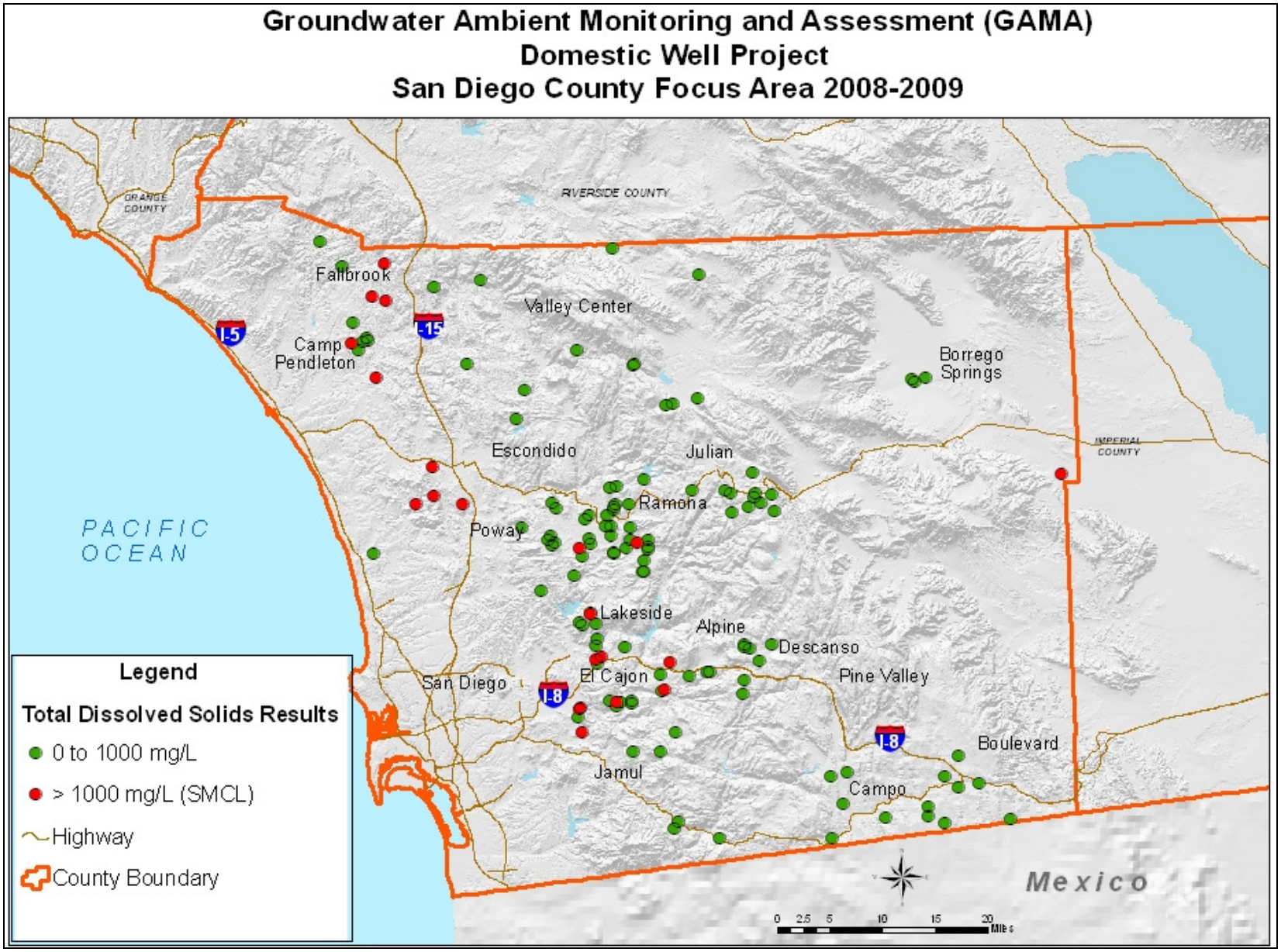


Figure 4: TDS Results



Major Anions

Major anions detected in domestic well samples are summarized in Table 4. Boron, chloride, fluoride, nitrate (NO_3^-), perchlorate, and sulfate were detected above a drinking water standard. Summaries of the major anions detected above a drinking water standard are included below:

- Boron was detected in 122 wells, at concentrations ranging from 0.025 to 2.3 mg/L. Boron was detected above the NL (1 mg/L) in four wells.

- Chloride was detected in all 137 wells, at concentrations ranging from 10.1 to 692 mg/L. Chloride was detected above the SMCL (500 mg/L) in three wells

- Fluoride was detected in 135 wells, at concentrations ranging from 0.104 to 3.34 mg/L. Fluoride was detected above the MCL (2 mg/L) in one well.

- Nitrate was detected in 96 wells, at concentrations ranging from 0.895 to 249 mg/L. Nitrate was detected above the MCL (45 mg/L as NO_3) in 25 wells.

- Perchlorate was detected in five wells, at concentrations ranging from 6.0 to 14 µg/L. Perchlorate was detected above the MCL (6 µg/L) in four wells.

- Sulfate was detected in all 137 wells, at concentrations ranging from 5.67 to 692 mg/L. Sulfate was detected above the SMCL (500 mg/L) in one well.

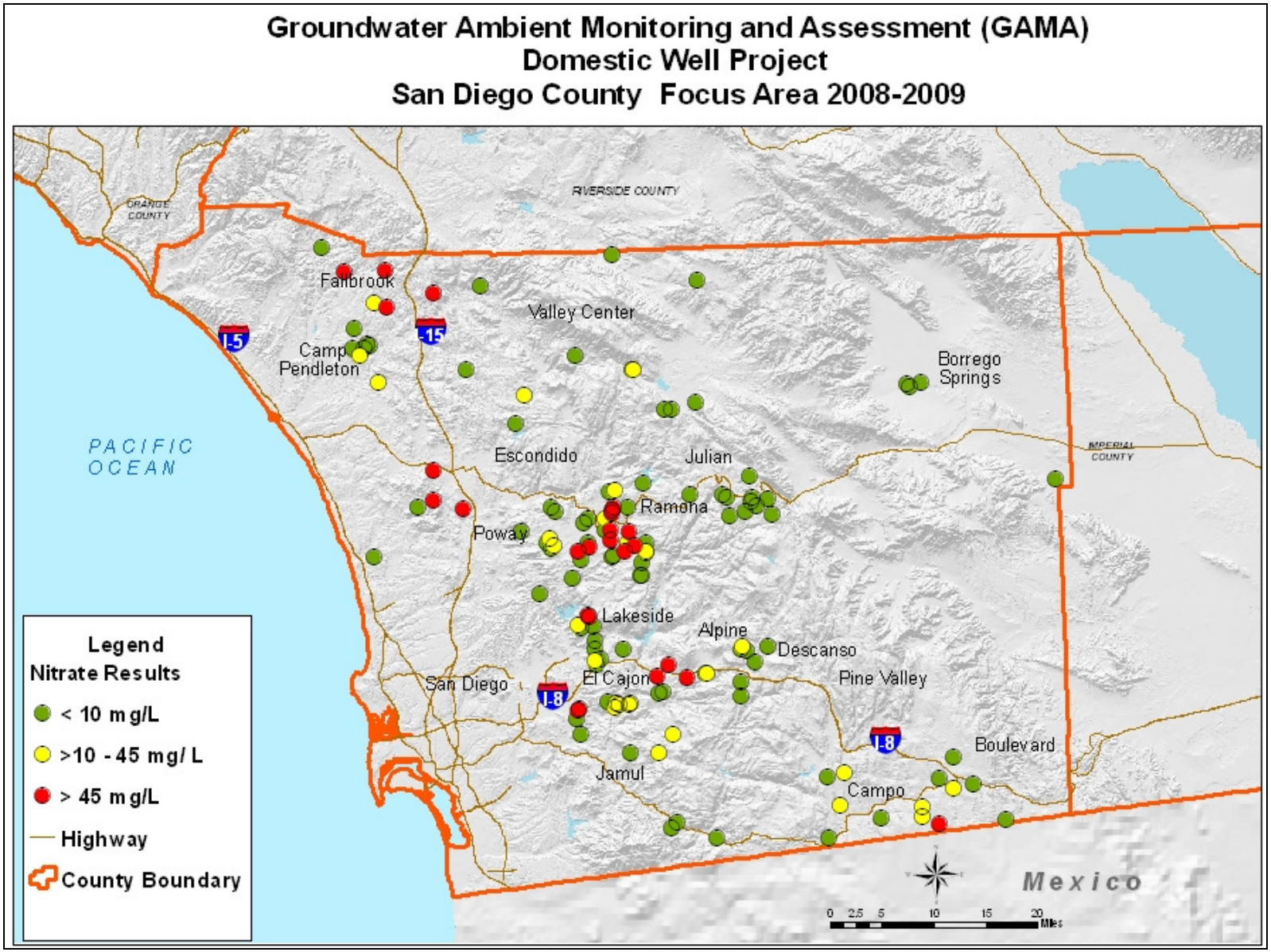
Table 4: Major Anions

GAMA Domestic Well Project, San Diego County Focus Area

Analyte	Range of Detected Values (mg/L)	Public Drinking Water Standard (mg/L)	Number of Wells Above Standard
Boron	0.025 – 2.3	1 NL	4
Chloride	10.1 – 692	500 SMCL	3
Fluoride	0.104 – 3.34	2 MCL	1
Nitrate (as NO_3^-)	0.895 – 249	45 MCL	25
Nitrite (as N)	0.005 – 0.0708	1 MCL	0
Perchlorate	0.006 – 0.014	0.006 MCL	4
Sulfate	5.67 – 613	500 SMCL	1

Notes:
1. MCL = Maximum Contaminant Level, SMCL = Secondary Maximum Contaminant Level
2. mg/L = milligrams per liter

Figure 5: Nitrate Results



Metals

Metals detected in domestic well samples are summarized in Table 5. Nine metals (aluminum, arsenic, barium, cadmium, iron, lead, manganese, vanadium, and zinc) were detected at concentrations above a public drinking water standard. Summaries of the metals detected above a drinking water standard are provided below.

- Aluminum was detected in 67 wells, at concentrations ranging from 1.06 to 510 µg/L. Aluminum was detected above the SMCL (200 µg/L) in one well.

- Arsenic was detected in 66 wells, at concentrations ranging from 1.06 to 15.7 µg/L. Arsenic was detected above the MCL (10 µg/L) in three wells.

- Barium was detected in 135 wells, at concentrations ranging from 1.07 to 1,350 µg/L. Barium was detected above the MCL (1,000 µg/L) in one well.

- Cadmium was detected in three wells, at concentrations ranging from 4.01 to 9.4 µg/L. Cadmium was detected above the MCL (5 µg/L) in two wells.

- Iron was detected in 55 wells, at concentrations ranging from 20 to 12,500 µg/L. Iron was detected above the SMCL (300 µg/L) in 21 wells.

- Lead was detected in 45 wells, at concentrations ranging from 1.04 to 74.8 µg/L. Lead was detected above the NL (15 µg/L) in two wells.

- Manganese was detected in 98 wells, at concentrations ranging from 1.05 to 679 µg/L. Manganese was detected above the SMCL (50 µg/L) in 45 wells, and was detected above the NL (500 µg/L) in four wells.

- Vanadium was detected in 87 wells, at concentrations ranging from 1.16 to 65.8 µg/L, and was detected above the NL (50 µg/L) in two wells.

- Zinc was detected in 129 wells, at concentrations ranging from 2.62 to 13,900 µg/L. Zinc was detected above the SMCL (5,000 µg/L) in two wells.

The locations of wells with detections above a drinking water standard for iron and manganese are shown in Figures 6 and Figure 7, respectively.

Table 5: Metals

GAMA Domestic Well Project, San Diego County Focus Area

Analyte	Range of Detected Values (µg/L)	Public Drinking Water Standard (µg/L)	Number of Wells Above Standard
Aluminum	1.06 – 510	200 SMCL 1,000 MCL	1 0
Arsenic	1.05 – 15.7	10 MCL	3
Antimony	1.42 – 2.56	6 MCL	0
Barium	1.07 – 1,350	1,000 MCL	1
Beryllium	ND	4 MCL	0
Cadmium	5.01 9.4	5 MCL	2
Chromium (Total)	1.09 – 6.8	50 MCL	0
Copper	1.1 60	1,000 SMCL	0
Iron	20 – 12,500	300 SMCL	21
Lead	1.04 – 74.8	15 NL	2
Manganese	1.05 – 679	50 SMCL 500 NL	45 4
Nickel	1.06 – 11.1	100 MCL	0
Selenium	1.05 – 24.2	50 MCL	0
Silver	1.06 – 9.79	100 SMCL	0
Thallium	ND	2 MCL	0
Vanadium	1.03 – 65.8	50 NL	2
Zinc	2.62 – 13,900	5,000 SMCL	2

Notes:
1. MCL = Maximum Contaminant Level, SMCL = Secondary Maximum Contaminant Level, NL = Notification level
2. µg/L = micrograms per liter
3. ND = Non-Detect

Figure 6: Iron Results

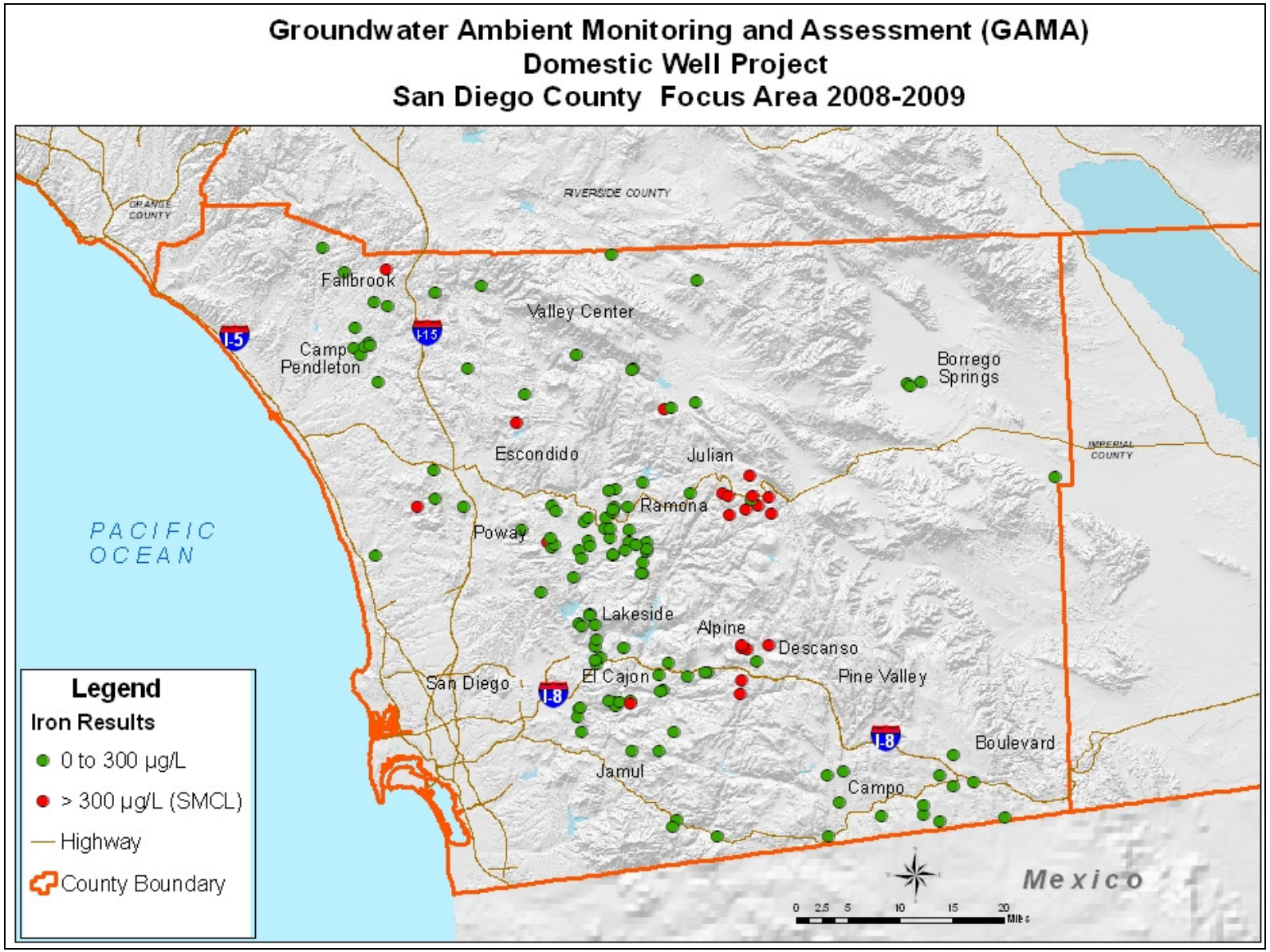
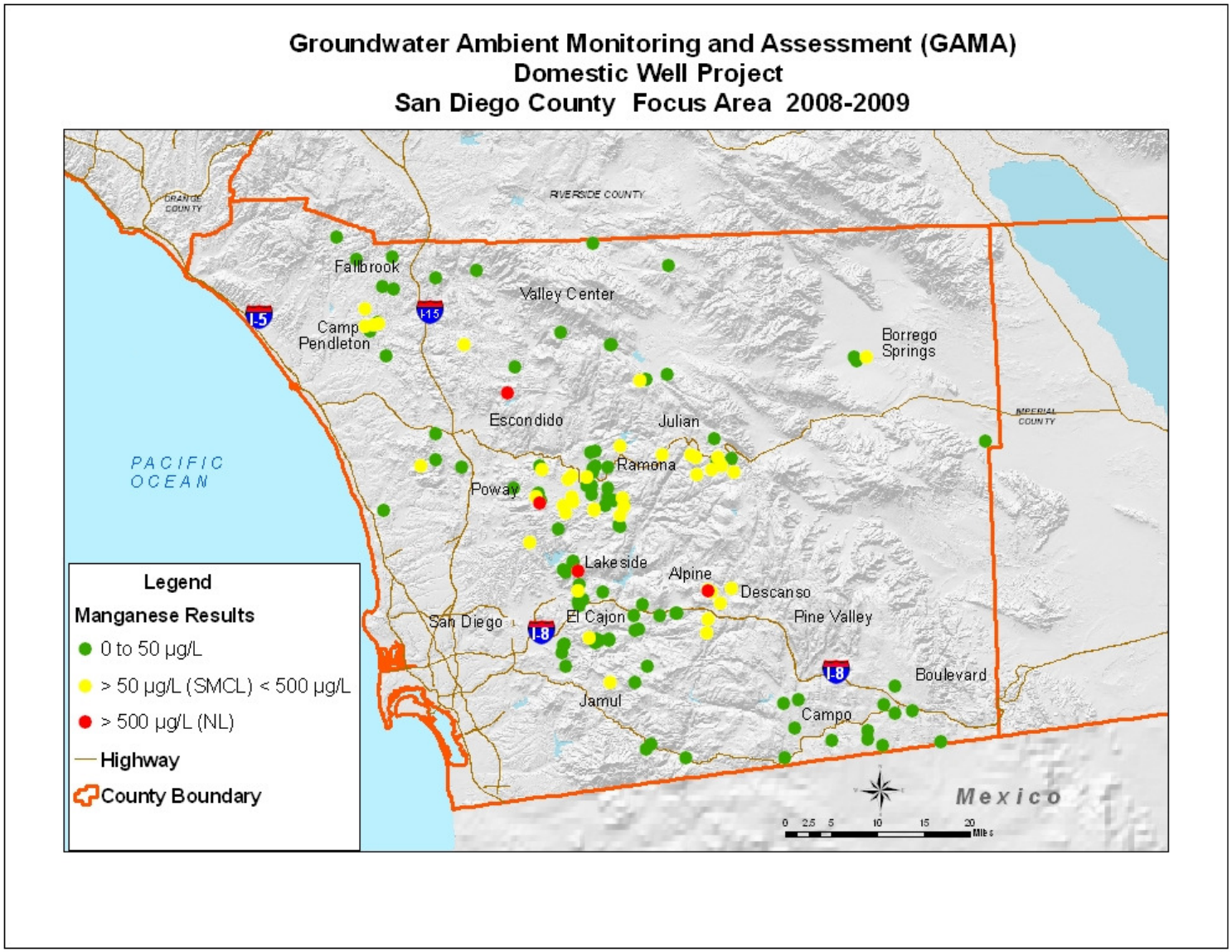


Figure 7: Manganese Results



Radionuclides

Fifty four wells were analyzed for radionuclides. The results of these analyses are shown on Table 6. Radionuclide analyses included gross alpha particle activity, gross beta activity, combined radium (activity of radium-226 and radium-228), tritium activity, and uranium activity.

Results are reported in picocuries per liter or milirems per year. A curie is the radioactivity associated with one gram or radium – a picocurie is one trillionth of a curie. Due to the analytical method, some samples with very low activities will be reported as negative values.

The gross beta activity drinking water standard is in terms of milirems per year. A 'rem' is a unit of measure describing how a specific type of radiation damages biologic tissue. A milirem is one thousandth of a rem. There is no simple conversion between a curie and a rem. Gross beta activity previously had an MCL of 50 pCi/L, which was replaced by the milirem standard. A gross beta activity of 50 pCi/L is still used as trigger for additional testing by CDPH. A summary of radionuclide test results is included below.

- Gross alpha activity was detected in all 54 wells at activities ranging from -0.58 to 170 pCi/L. Activities above the MCL (15 pCi/L) were observed in 19 wells.

- Gross beta activity was detected in all 54 wells at activities ranging from ranging from -3.57 to 35.4pCi/L. No activities were observed above the NL (50 pCi/L).

- Combined radium (radium 226+228) activity was detected in all 54 wells at activities ranging from -0.2 to 23.7 pCi/L. Activities above the MCL (5 pCi/L) were observed in two wells.

- Tritium activity was detected in all 54 wells at activities ranging from -348 to 787 pCi/L. No activities were observed above the MCL (20,000 pCi/L).

- Uranium activity was detected in all 54 wells at activities ranging from -0.08 to 174 pCi/L. Activities above the MCL (20 pCi/L) were observed in sixteen wells.

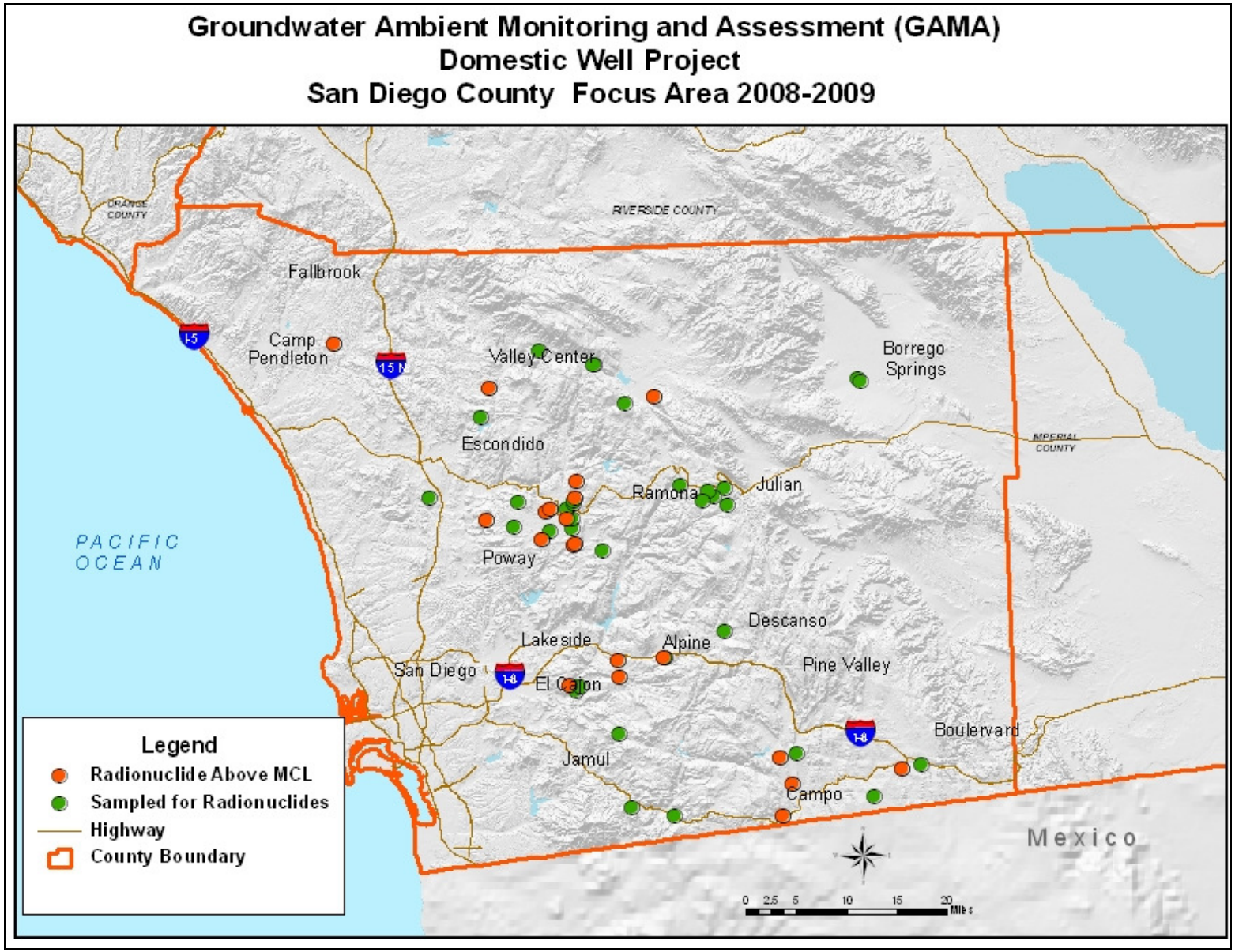
Table 6: Radionuclides

GAMA Domestic Well Project, San Diego County Focus Area

Analyte	Range of Detected Values (pCi/L)	Public Drinking Water Standard (pCi/L)	Number of Wells Above Standard
Gross alpha	-0.58 to170	15 MCL	19
Gross beta	-3.57 to 35.4	50 NL 4 milirem/yr MCL	0 0
Radium 226+228	-0.2 to 23.7	5 MCL	2
Tritium	-348 to 787	20,000 MCL	0
Uranium	-0.08 to 174	20 MCL	16

Notes:
1. MCL = Maximum Contaminant Level; NL = Notification Level
2. pCi/L = picocurie per liter. milirem/yr = milirems per year

Figure 8: Radionuclide Results



Pesticides and Pesticides Degradates

Important agricultural areas are located throughout San Diego County. A subset of 38 domestic wells were analyzed for sixteen triazine pesticides or pesticide degradates, including alachlor, atrazine, bromacil, cyanazine, diazinon, simazine, molinate, prometryn, and thiobencarb. No pesticides were detected in any of the 38 sampled wells.

Volatile Organic Compounds (VOC's)

Nine VOCs were detected in San Diego County domestic wells, with only one VOC at a concentration greater than the applicable drinking water standard. Chloroform was the most frequently detected VOC, and was observed in eleven wells at concentrations ranging from 0.5 to 9.72 µg/L. A chloroform concentration of 39.4 µg/L was observed in a well that had recently been disinfected – this result is not considered typical of normal groundwater conditions, and is not included in the VOC results. In addition, toluene was detected in a duplicate sample (but not the original sample); the duplicate toluene result is not included in the summary below. VOC results are summarized below:

- Trichlorofluoromethane (Freon) was detected in seven wells, at concentrations ranging from 0.75 to 2,230 µg/L. Freon was detected at concentrations greater than the MCL (150 µg/L) in one well. There is some evidence that the Freon concentrations observed in these domestic wells result from laboratory or field contamination. The relatively high number of wells with Freon (seven wells) is unusual; coupled with the high concentration observed in a single well and the detection of Freon in trip blanks, the Freon data indicates that contamination may have occurred in these samples.

- Tetrachloroethylene (PCE) was detected in a single well at a concentration of 1 µg/L, below the MCL (5 µg/L).

- 1,1-dichloroethene was detected in two wells, at concentrations ranging from 1.37 to 1.38 µg/L. There is no applicable drinking water standard for this constituent.

- Methylene chloride (dichloromethane) was detected in three wells, at concentrations ranging from 0.73 to 4.97 µg/L (a concentration of 6.03 µg/L was observed in the recently-disinfected well, but is not included in the summary table). There is no applicable drinking water standard for this constituent.

- Chloromethane was detected in a single well at a concentration of 0.72 µg/L. There is no applicable drinking water standard for this constituent.

- 1,1,1-trichloroethane was detected in a single well at a concentration of 1.66 µg/L, below the MCL (200 µg/L).

- Tert-butyl alcohol was detected in six wells at concentrations ranging from 2.54 to 5.14 µg/L. There is no applicable drinking water standard for this constituent.

- Xylenes were detected in one well at a concentration of 1.27 µg/L, below the MCL of 1,750 µg/L.

- Methyl ethyl ketone (MEK) was detected in a single well at a concentration of 3.7 µg/L. There is no applicable drinking water standard for this constituent.

Table 7: VOCs

GAMA Domestic Well Project, San Diego County Focus Area

Analyte	Range of Detected Values (µg/L)	Public Drinking Water Standard (µg/L)	Number of Wells Above Standard
1,1,1-Trichloroethane	1.66	200 MCL	0
1,1-Dichloroethene	1.37 – 1.38	NA	–
Chloroform	0.5 – 9.72	80 MCL	0
Chloromethane	0.72	NA	–
Methylene chloride	0.73 – 4.97	NA	–
Methyl ethyl ketone (MEK)	3.7	NA	–
Tetrachloroethene (PCE)	0.5 – 1	5 MCL	0
Trichlorofluoromethane (Freon)	0.75 – 2,230	150 MCL	1
Tert-butyl alcohol	2.54 – 5.14	NA	–
Xylene (total)	1.27	1,750 MCL	0

Notes:
1. MCL = Maximum Contaminant Level
2. µg/L = micrograms per liter
3. NA = Public drinking water standards are not available for this constituent

POSSIBLE SOURCES OF CONTAMINANTS

Twenty-two chemical constituents were detected above water quality standards in the San Diego County Focus Area. Five of these constituents were observed in more than five percent of the sampled wells. Potential sources for these constituents, summarized from groundwater collected across the country, are discussed below. The focus of this sampling was not to pinpoint a source of a constituent found in groundwater, and the source descriptions do not imply that a constituent observed in a domestic well comes from any single, specific source. The summaries are provided as information for well owners. Additional information for domestic well owners is available on the GAMA website at: http://www.waterboards.ca.gov/gama/wq_privatewells.shtml

Bacteria Indicators

Total coliform bacteria are naturally present in the environment, and in general are harmless to people. However, some coliforms may cause illness in humans, and the presence of coliforms is an indication that other micro-organisms may be present. Fecal coliforms are found in human and animal wastes and, when present, indicate contamination. Drinking water that contains coliform bacteria increases the risk of becoming ill, and should not be consumed.

Iron and Manganese

Iron and manganese have water quality standards associated with aesthetic properties of water such as color, odor, and taste (SMCLs). Both metals naturally occur in soil and rocks, and most frequently enter the environment through natural weathering. Concentrations above SMCLs may lead to discoloration, metallic or bitter tasting water, and staining. Manganese has a notification level of 500 µg/L. Ingestion of manganese at high concentrations can lead to neurological disorders, including memory loss and loss of balance.

Nitrate

Nitrate is commonly found in groundwater. Low levels of nitrate may be natural in origin; however, high concentrations of nitrate are generally related to fertilizer production and application, septic systems, agricultural and animal waste ponds, leaking sewer lines, sludge or manure application, and the production of explosives. The most significant health threat associated with nitrate is associated with methemoglobinaemia ("blue baby" syndrome). Toxic effects occur when bacteria in an infant's stomach convert nitrate to more toxic nitrite, interfering with the body's ability to carry oxygen. High nitrate levels are also a health risk for pregnant women. Some studies suggest an association between high nitrate in drinking water and certain types of cancers (Weyer et al., 2001).

Radionuclides

Radionuclides are a natural component of groundwater, and are naturally present, typically at very low levels. Most radionuclides detected in groundwater are the result of interactions with natural geologic materials that contain trace levels of radioactive elements. Different radionuclides will interact and damage biologic tissue differently – as a result, some constituents have greater or lower MCLs than others. Drinking water with concentrations of radionuclides above a public drinking water standard increases the risk of certain types of cancers.

ADDITIONAL INFORMATION AND REFERENCES

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