2024 Aquifer Risk Map Methodology

State Water Resources Control Board - Division of Water Quality

January 2024

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Introduction

The 2024 Aquifer Risk Map represents the fourth version of the Aquifer Risk Map[1]. This map fulfills requirements of Senate Bill 200[2] (SB 200, Monning, 2019) and is updated yearly to support California's Safe and Affordable Fund for Equity and Resilience (SAFER) program. The map is intended to help prioritize areas where domestic wells (less than five service connections) and state small water systems (between five and fourteen service connections) may be accessing groundwater that does not meet safe drinking water standards (maximum contaminant level or MCL).

Intended use of this analysis

The potential water quality risk presented here is not intended to depict actual groundwater quality conditions at any given domestic supply well or state small water system location. The State Water Board has limited water quality and location data for state small water systems and domestic wells, as these systems are not regulated by the state nor are MCL's applicable to domestic wells[3]. Therefore, a different approach for conducting a risk assessment for these systems was developed in comparison with the risk assessment for public water systems. The risk assessment for state small water systems and domestic wells uses modeled and estimated data based on nearby wells of similar depth to assess potential risk, because data directly from these systems is unavailable in most cases.

The purpose of this risk analysis is to identify areas that may not meet safe drinking water standards and prioritize them for additional outreach and sampling efforts. The current lack of available domestic well and state small system water quality data makes it difficult to characterize the water quality for individual domestic wells and state small water systems. The analysis described herein represents a best effort at using available data to estimate potential water quality risk for domestic wells and state small water systems.

Methodology (summary)

The 2024 Aquifer Risk Map uses a similar methodology to calculate potential water quality risk as the 2023 Aquifer Risk Map. Updates to the 2024 map include the addition of four per-and polyfluoroalkyl substances (PFAS) as potential risk contaminants, including new water quality data, and changing the methodology calculation so sections with between zero and one recent exceedances are medium risk instead of high risk. An in-depth methodology description is available at the end of this document including details about updates to the 2024 map.

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[1] Aquifer Risk Map (including old archived maps from 2021, 2022, and 2023)
[2] California Health and Safety Code § 116772
[3] State small water systems are typically required to conduct minimal monitoring. If water quality exceeds an MCL, corrective action is required only if specified by the Local Health Officer. State small water systems provide an annual notification to customers indicating the water is not monitored to the same extent as public water systems.

The Aquifer Risk Map methodology involves summarizing publicly available water quality data from previously sampled wells of a similar depth to domestic wells or state small water system wells, since these systems are largely unregulated by the state and there is no comprehensive database of water quality data available directly from these systems. Water quality data is summarized for each square mile section where data is available. Sections that do not contain a water quality data well but are adjacent to a section with a water quality data well are assessed using the summarized results for all neighboring sections with source data. Sections are assessed on two metrics: average water quality over the last twenty years, and the highest recent sample from the last five years. Sections are assigned a potential risk status using the following criteria:

Table 1. Details on potential water quality risk criteria.

Potential Water Quality Risk	Criteria
High	Twenty-year average OR highest recent sample are above the comparison concentration for one or more contaminants
Medium	Twenty-year average OR highest recent sample are within 80% - 100% of comparison concentration for one or more contaminants
Low	Twenty-year average AND highest recent sample are below 80% of the comparison concentration for all sampled contaminants
Unknown	No water quality results meeting time or depth filters was available in this area

Domestic well locations are identified by Well Completion Reports (WCR) submitted to the Department of Water Resources (DWR)[4]. Although DWR's Online System for Well Completion Reports (OSWCR) database is an incomplete record of domestic wells, it is the best available data source for identifying the count and location of potential domestic wells. At the time of data download (October 2023) there are approximately 296,283 domestic well records in OSWCR when the filtering criteria is applied.

State small water system locations are identified by the Division of Drinking Water (DDW). DDW has identified approximately 1,282 state small water systems in California[5].

The total number of domestic wells and state small water systems in potential high-risk areas is determined by overlaying the domestic and state small water system location data with the section water quality data. Domestic wells and state small water systems

[4] Online System for Well Completion Reports Feature Service (https://services.arcgis.com/aa38u6OgfNoCkTJ6/ArcGIS/rest/services/i07_WellCompletionReports_Exported_v2_gdb/FeatureServer)

[5] This count of state small water systems is a temporary estimate. DDW is currently working with counties to verify the number and location of state small water systems in California. This number is a current best available estimate.

within the boundary of the square mile section are assigned the water quality status of the section.

Results

Due to uncertainty in the available domestic well location data, and the lack of water quality results directly from domestic well and state small water systems, the numbers below should not be taken as absolute assessments of the number of domestic wells and state small water systems potentially serving contaminated water. A long-term average or highest recent result of a square mile section above the comparison concentration does not necessarily indicate that all wells within the sections are accessing contaminated water. Additionally, domestic well record counts for a section may not be an accurate representation of the number of domestic wells in the area and is likely to be represent a significant undercount of the actual number.

Table 2 shows the summarized count of domestic well records, state small water systems, and total square mile sections in each potential risk area. Approximately one-third of domestic well records and half of state small water systems are in potential high-risk areas, where water quality may be above the comparison concentration.

A map of the estimated water quality risk by square mile section is shown in Figure 1. The interactive webtool version of the map allows users to see section data in more detail and includes other geospatial information overlays.

Table 2. Water Quality Risk Results from 2024 Aquifer Risk Map

Potential Water Quality Risk	Domestic Well Records	State Small Water Systems	Square Mile Sections
High	88,351 (30%)	636 (50%)	18,536 (12%)
Medium	22,581 (8%)	95 (7%)	4,106 (3%)
Low	133,238 (45%)	400 (31%)	25,162 (16%)
Unknown	52,113 (18%)	151 (12%)	110,874 (70%)

Counties with the highest number of domestic well records in potential high-risk areas include Fresno County, Sonoma County, and San Joaquin County (Table 8). Counties with the highest number of state small water systems in potential high-risk areas include Monterey County, Riverside County, and Kern County (Table 9).

Nitrate accounts for 20% of domestic well records in potential high-risk areas (Figure 2).

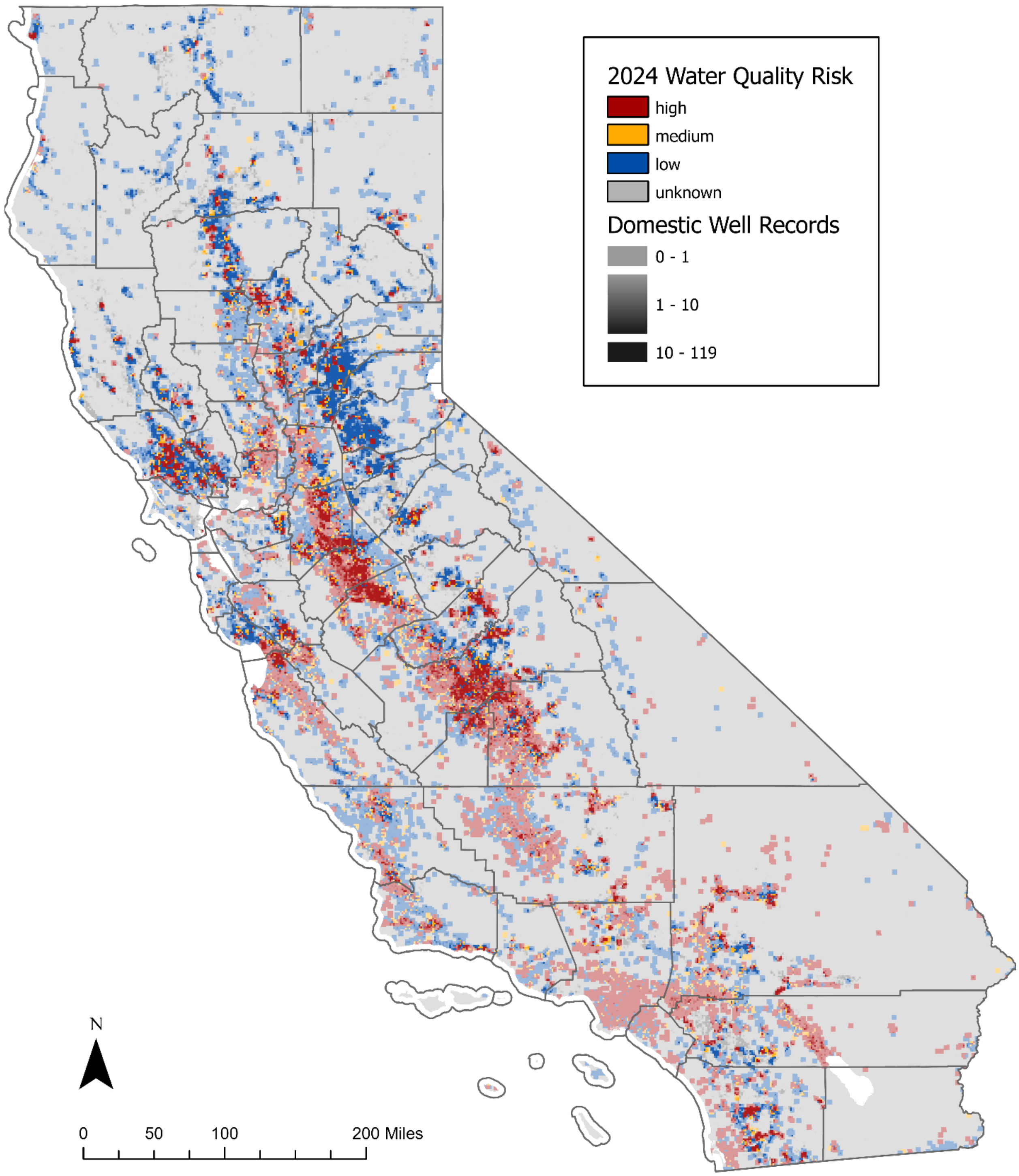

Figure 1. 2024 Aquifer Risk Map showing potential water quality risk and location of domestic well records.

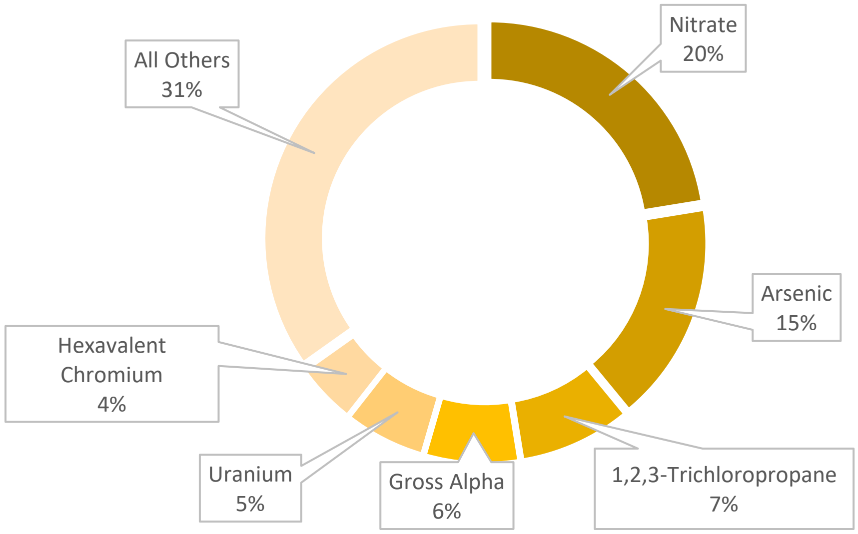

Figure 2. The number of domestic well records in potential high-risk areas, separated by the contaminant accounting for results above the comparison concentration.

Missing data

It is important to note that for most domestic wells in California, there is no direct water quality data available and the true water quality risk of each individual domestic well is unknown (Figure 3). The potential water quality risk presented here for domestic wells and state small water systems is determined by averaging data from nearby wells. As stated above, the estimated water quality results in an area may not represent the quality of water being accessed by nearby wells. Groundwater gradient, well screen intervals, and local geologic and hydrologic conditions are all factors that are not considered with this methodology.

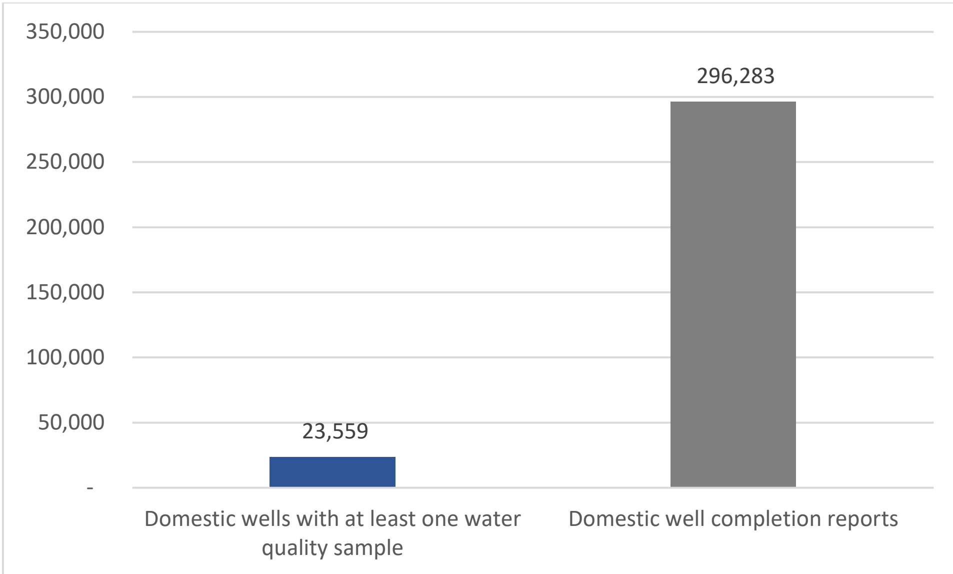

Figure 3. Count of domestic wells with water quality data compared to the count of domestic well completion records. Most domestic wells do not have water quality data available.

In addition to this lack of direct data, there are also areas of the state where there are no available nearby water quality results to even estimate water quality risk. Approximately 70% of square mile sections (110,874) do not have nearby available water quality data. Approximately 18% of domestic well records (52,113) are in areas without nearby available water quality data. These domestic well records in areas of unknown risk are mainly located in fractured rock and upland areas of the state, although some are in alluvial basins (Figure 12). Expanded water quality sampling in recent years has decreased the percentage of domestic well records in areas of unknown risk since the first iteration of the Aquifer Risk Map, which listed 26% of domestic well records in areas of unknown risk.

Comparison with previous assessments

Changes in the total summary statistics from previous Aquifer Risk Maps to the 2024 Aquifer Risk Map are due to the addition of new available water quality data, updates to the risk methodology, and correction of errors in previous maps. The changes do not necessarily indicate that water quality is actively degrading or improving.

Overall, the number of domestic well records and state small water systems in potential high-, medium-, and low-risk areas is generally consistent with the risk distribution of previous years (Figure 4, Table 3, Figure 5, and Table 4).[6] There are more state small

[6] The decrease in percentage of systems in potential high-risk areas from 2023 to 2024 is likely due in part to a nitrate conversion data error that was corrected in Groundwater Ambient Monitoring and Assessment Groundwater Information System (GAMA GIS) in January of 2023 (data for the 2023 map was downloaded from GAMA GIS in September of 2022). Nitrite and Nitrate results that were reported as “mg/L as NO3” or “mg/L as NO2” were erroneously being displayed as “mg/L as N” on GAMA GIS without

water systems in unknown risk areas in the 2024 assessment than in 2023, because the locations of some state small water systems were found to be inaccurate during a review. DDW is currently working with counties to improve and verify the count and location of known state small water systems.

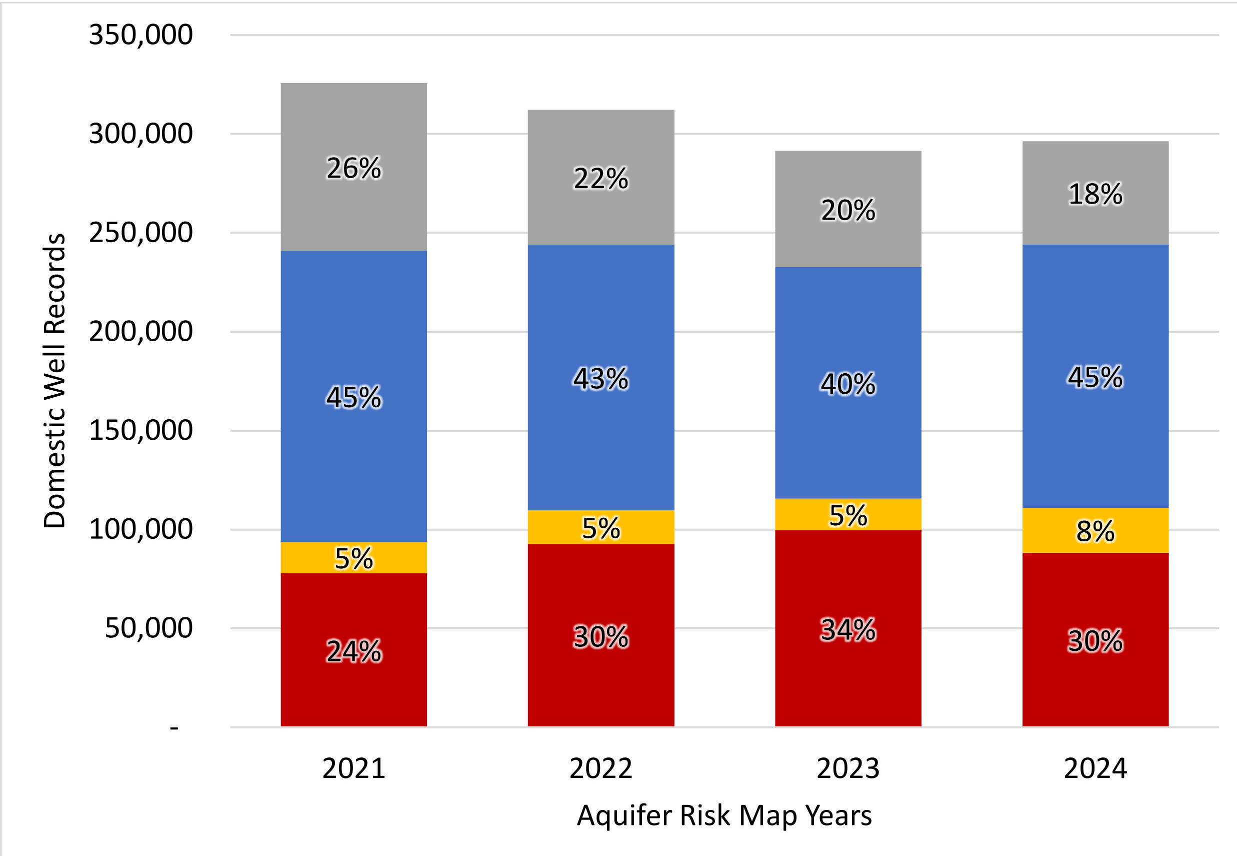

Figure 4. Domestic well water quality risk in the 2021, 2022, 2023 and 2024 Aquifer Risk Maps.

Table 3. Risk distribution of domestic well records for the 2021, 2022, 2023, and 2024 Aquifer Risk Maps.

Potential Water Quality Risk	2021	2022	2023	2024
unknown	84,800	68,192	58,690	52,113
low	147,185	134,282	117,134	133,238
medium	15,791	17,078	15,889	22,581
high	77,973	92,635	99,688	88,351

any mathematical conversion. This means that the nitrate results were shown as ~4.4 times higher and nitrite results were shown as ~3.3 times higher. This issue meant that multiple source wells were listed as high risk for nitrate in 2023 but are listed as low risk for nitrate in 2024 after this data correction.

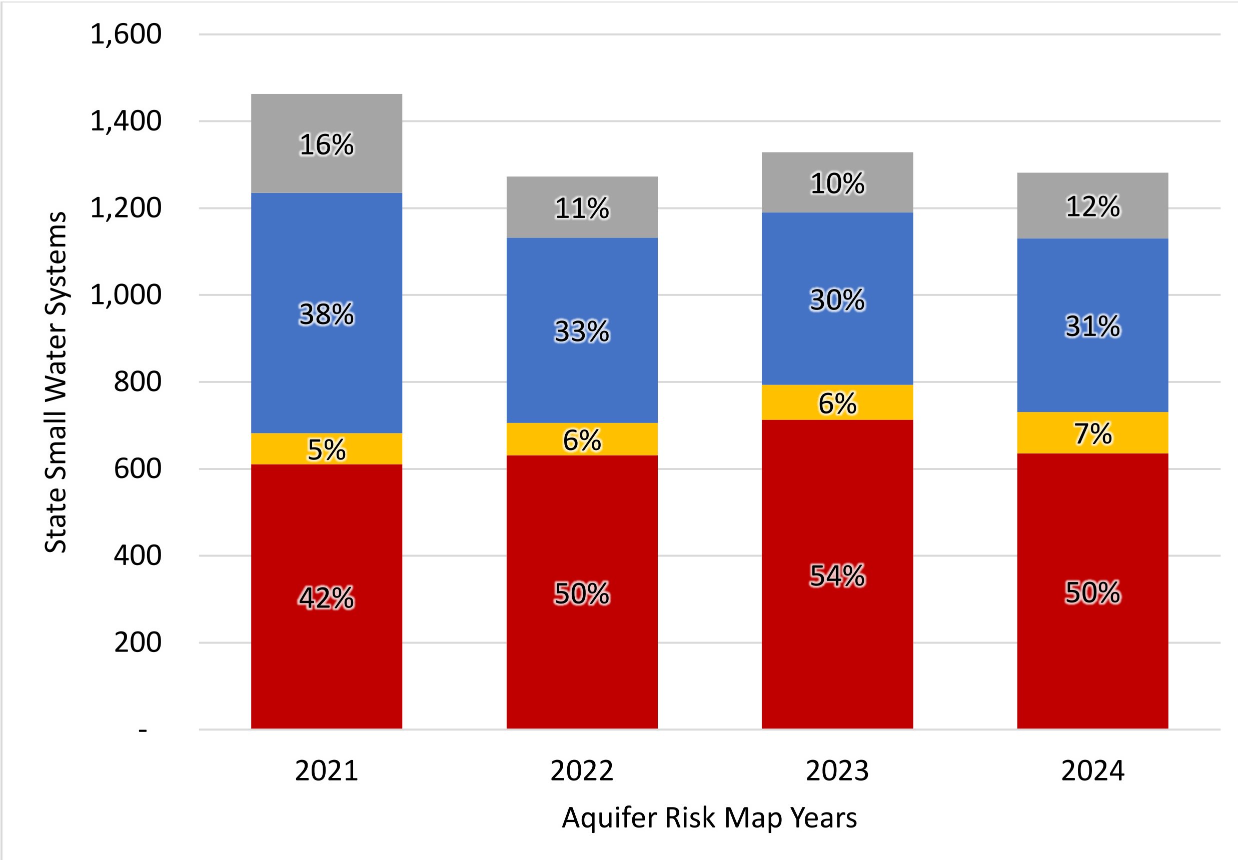

Figure 5. State small water system water quality risk in the 2021, 2022, 2023 and 2024 Aquifer Risk Maps

Table 4. Risk distribution of state small water system counts for the 2021, 2022, 2023, and 2024 Aquifer Risk Maps.

Potential Water Quality Risk	2021	2022	2023	2024
unknown	228	141	139	151
low	553	426	397	400
medium	71	75	80	95
high	611	631	713	636

Updates to 2024 map

A summary of the differences in map methodology between 2021 and 2024 is included in Table 6.

Additional water quality datasets

Data from the Department of Pesticide Regulation (DPR), Groundwater Ambient Monitoring and Assessment Local Groundwater Projects (GAMA_LOCALGW), GAMA

Special Studies Project (GAMA_SP-STUDY), UC Davis Nitrate dataset (UCD_NO3), and Water Replenishment District (WRD) was included in the map as source data.

Radium-226/Radium-228 combined MCL

Radium-226 and Radium-228 results were summed and compared to the combined MCL of 5 pCi/L (instead of being compared to the 5 pCi/L standard separately). Only results that were collected on the same day from the same well were summed. If one result was missing, the other represented the summed total. If one result was a non-detect, the other represented the summed total. This update had a minimal impact on the percentage of systems in potential high-risk areas.

New contaminants (Per- and polyfluoroalkyl substances)

Four new contaminants were included in the map – perfluorooctanoic acid (PFOA), Perfluorooctane sulfonic acid (PFOS), Perfluorobutane sulfonic acid (PFBS), and Perfluorohexane sulfonic acid (PFHxS). The notification level was used as the comparison concentration for these four compounds. The addition of these PFAS compounds slightly increases the number of domestic well records (+1.2%) and state small water systems (+1.6%) in potential high-risk areas.

Table 5. PFAS notification levels.

Abbreviation	**Chemical name**	**Notification Level ng/L (ppt)**
PFOA	Perfluorooctanoic acid	5.1
PFOS	Perfluorooctane sulfonic acid	6.5
PFBS	Perfluorobutane sulfonic acid	500
PFHxS	Perfluorohexane sulfonic acid	3

Non-detect results are considered low risk, even when the reporting limit is above the comparison concentration. When using the notification level as the comparison concentration, 2% of all PFOA, PFOS, PFHxS, or PFBS results are non-detects with a reporting limit above the comparison concentration.

Identification of non-detects

Non-detects were identified using the source modifier that describes non-quantified results that are less than the reporting limit according to the source dataset dictionary.

New guidelines are currently being established for the Groundwater Ambient Monitoring and Assessment Groundwater Information System (GAMA GIS) regarding the identification of non-detect samples. GAMA GIS receives data from a variety of federal, state, and local agencies, all of which have modifiers to explain the result per sample. Modifiers among the differing datasets are repetitive and sometimes contradictory, such as using "N" to indicate non-detects in the DPR dataset and detects in the DDW dataset. In previous years, samples with a “<” or “ND” source modifier were identified as non-detects, samples with a “NULL” result were identified as non-detects, and samples with a result less than the reporting limit were identified as non-detects.

Methodology for recent results above comparison concentration

The methodology calculation was adjusted so that sections with between zero and one recent results above the comparison concentration are classified as medium risk instead of high risk. Fractional recent results above the comparison concentration (ex. “0.5”) are possible in neighboring sections that receive averages from adjacent source sections. For example, if a neighbor section was adjacent to two source sections, one of which had one recent result above the comparison concentration and the other had zero recent results above the comparison concentration, the neighbor section would receive “0.5” recent results above the comparison concentration.

This update reduces the number of domestic well records (-3.2%) and state small water systems (-1.6%) in potential high-risk areas, as approximately 1,600 sections have a fractional recent result above the comparison concentration and were previously classified as potentially high risk but are now classified as potentially medium risk. This update does not affect sections that also have a 20-year average above the comparison concentration, as these sections will still be at potentially high risk no matter what the recent results are.

Table 6. Summarized updates to Aquifer Risk Map over time.

	2021	2022	2023	2024
Identification of domestic wells (DW)	OSWCR – "domestic" WCRs excluding those drilled before 1970	OSWCR – "domestic" WCRs excluding those drilled before 1970, excluding "destruction" record types	OSWCR – B118WellUse is "Domestic", date work ended is greater than 12/31/1969, RecordType is "WellCompletion /New /Production/ or Monitoring/NA". Wells attributed to county based on WCR designation.	OSWCR – B118WellUse is "Domestic", date work ended is greater than 12/31/1969, RecordType is "WellCompletion /New /Production/ or Monitoring/NA". Wells attributed to county based on WCR designation.
Identification of state small water systems (SSWS)	Rural Community Assistance Corporation	DDW		
Water quality datasets used[7]	DDW DWR GAMA_DOM GAMA_USGS[8] USGS_NWIS WB_ILRP	DDW DWR GAMA_DOM GAMA_USGS USGS_NWIS[9] WB_ILRP WB_CLEANUP	DDW DWR GAMA_DOM USGS_NWIS[10] WB_ILRP WB_LOCALGW WB_CLEANUP	DDW DPR DWR GAMA_DOM GAMA_LOCALGW GAMA_SP-STUDY GAMA_USGS UCD_NO3

[7] For more information about source datasets available in GAMA GIS, please refer to the GAMA GIS Dataset Descriptions (https://gamagroundwater.waterboards.ca.gov/gama/GAMA_Data_Descriptions.pdf). New dataset acronyms are defined here: GAMA_DOM (GAMA Domestic Wells), GAMA_USGS (GAMA US Geological Survey), USGS_NWIS (US Geological Survey National Water Information System), WB_ILRP (Water Boards Irrigated Lands Regulatory Program), WB_CLEANUP (GeoTracker – Water Board Cleanup and Permitted Sites).

[8] GAMA_USGS results are also reported in USGS_NWIS dataset. In all years where GAMA_USGS and USGS_NWIS results are both included, duplicate results were removed during data processing. In 2023, GAMA_USGS results were not downloaded because it was understood that USGS_NWIS data would cover the GAMA_USGS results. However, in 2024 staff reverted to including GAMA_USGS results since this dataset sometimes includes more well depth data alongside the water quality results.

[9] USGS_NWIS data in GAMA GIS was not updated from 2019-2021, so the 2021 and 2022 maps were missing some USGS_NWIS data from those years.

[10] A data processing error in the GAMA GIS meant that some USGS_NWIS nitrate results were incorrectly listed as "Nitrate as N" when they represented "Nitrate" concentrations. This caused the concentration to be ~4.4 times higher than it actually should be in the 2023 map. This error was corrected in March 2023 on GAMA GIS.

	2021	2022	2023	2024
				USGS_NWIS WB_ILRP WB_LOCALGW WB_CLEANUP WRD
Contaminants	All contaminants with an MCL excluding asbestos, coliform and fecal coliform bacteria, and radon 222, and including hexavalent chromium, copper, lead, and N-Nitrosodimethylamine.			Same as previous with addition of PFOA, PFOS, PFHxS, and PFBS.
Recent water quality results	Results sampled within the last 2 years	Results sampled within the last 5 years		
Determination of risk	If long term concentration or any recent result is above comparison concentration, section is high risk. If long term concentration or any recent result is within 80% of comparison concentration, section is medium risk. If long term concentration and all recent results are below 80% of comparison concentration, section is low risk. Section risk is assigned to all DWs and SSWS in section.			Same as previous but threshold for recent results is changed to "one or more recent results above/ within 80% of comparison concentration" instead of "more than zero recent results above/ within 80% of comparison concentration".
Summary by census area	Census areas ranked by percentile based on number of contaminants above comparison concentration, magnitude of exceedance, percent area with contaminants above comparison concentration.	Count of high risk and total DW and SSWS summarized by census area.		

Table 6 (cont.)

Methodology (detailed)

Data processing

Water quality results from the Division of Drinking Water (DDW), the US Geological Survey -Groundwater Ambient Monitoring and Assessment programs' Priority Basin and Domestic Well Projects (GAMA_USGS, GAMA_DOM), the US Geological Survey-National Water Information System dataset (USGS_NWIS), the Department of Water Resources (DWR), the Department of Pesticide Regulation (DPR), local groundwater monitoring projects (GAMA_LOCALGW and WB_LOCALGW), the Irrigated Lands Regulatory Program (WB_ILRP), cleanup monitoring sites (WB_CLEANUP), UC Davis Nitrate dataset (UCD_NO3) and Water Replenishment District (WRD) are included in this analysis.

The water quality results were downloaded from Groundwater Ambient Monitoring and Assessment Groundwater Information System[11] (GAMA GIS) on October 25th, 2023. Results are only included in the estimate calculation if the well met the depth-filtering criteria described below. Duplicate data (that is available in other datasets) in the USGS_NWIS and UCD_NO3 datasets were removed. Data for most[12] chemical constituents with a MCL are assessed, and several additional chemical constituents including hexavalent chromium, copper, lead, N-Nitrosodimethylamine (NDMA), Perfluorooctanoic acid (PFOA), Perfluorooctane sulfonic acid (PFOS), Perfluorobutane sulfonic acid (PFBS), and Perfluorohexane sulfonic acid (PFHxS) are included in the analysis as well[13]. Water quality results are converted to a Comparison Concentration Index[14] to allow comparison between chemical constituents (see Table 10 for chemical names and comparison concentration values). The R script used to download, process, and filter the water quality data is available on GitHub[15].

Depth filter

Most available groundwater quality data is sourced from public (municipal) supply wells. This is a result of California's requirement for monitoring and reporting of groundwater from wells that are part of a water system that supplies water to fifteen or more service connections (public water systems). In contrast, domestic wells (any system that serves

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[11] Groundwater Ambient Monitoring and Assessment Groundwater Information System (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)

[12] Asbestos, fecal coliform, and total coliform are not assessed for the aquifer risk map although these constituents have an MCL.

[13] The comparison concentration values for chemicals without an MCL are as follows: Hexavalent Chromium – 10 micrograms per liter (µG/L); Copper – 1.3 milligrams per liter (MG/L); Lead – 15 µG/L; N-Nitrosodimethylamine (NDMA) – 0.1 µG/L; PFOA – 5.1 ng/L; PFOS – 6.5 ng/L; PFBS – 500 ng/L; PFHxS – 3 ng/L.

[14] The Comparison Concentration Index consists of the finding divided by the comparison concentration (typically, the MCL), with a special consideration for non-detect results with a reporting limit above the MCL or comparison concentration which are automatically assigned a Comparison Concentration Index of 0.5.

[15] Aquifer Risk Map Github page (https://github.com/EmilyHoulihan/Aquifer_Risk_Map)

less than five connections) and state small water systems (five to fourteen connections) are not regulated by the state and therefore lack comprehensive data.

For many regions, public supply wells access a deeper portion of the groundwater resource when compared with domestic wells. This deeper groundwater is typically less affected by contaminants introduced at the ground surface than shallower groundwater. As a result, use of data from municipal wells would likely result in a systematic low bias for an estimate of the shallower groundwater typically accessed by domestic wells.

Staff developed a depth filter to focus on data that best represents shallower groundwater accessed by domestic wells. Since well depth varies throughout the state, a domestic well depth zone is defined numerically for each Groundwater Unit[16] based on Total Completed Depth statistics from the OSWCR database (Figure 6). Staff use OSWCR data to determine a "Domestic Bottom" and "Domestic Top" depth for each Groundwater Unit. The domestic well depth zone is defined as the range between "Domestic Bottom" depth[17] and "Domestic Top" depth[18]. Water quality wells with numeric depth data are filtered using the domestic well depth zone of the Groundwater Unit.

OSCWR well depth data is also used to determine the average public well depth per Groundwater Unit, and the public well and domestic well depth statistics are compared for each Groundwater Unit to assess whether domestic and public well depth intervals overlap, indicating both well types access the same groundwater source (Figure 7). For each Groundwater Unit, "Domestic Bottom" depth (defined above) is compared to "Public Bottom" depth[19] (defined below). If the "Public Bottom" depth for a given Groundwater Unit was shallower than the "Domestic Bottom" depth, or within 10% of "Domestic Bottom" depth, then water quality data from public wells in that Groundwater Unit is included in the analysis. If the "Public Bottom" depth for a given Groundwater Unit is more than 10% deeper than the "Domestic Bottom" depth, water quality data from public wells in that Groundwater Unit is excluded from the analysis. Water quality wells without numeric data are filtered using this well type depth filter.

[16] This project uses Groundwater Units as areas of analysis. Groundwater Units consist of groundwater basins as defined by DWR Bulletin 118 (https://www.arcgis.com/home/webmap/viewer.html?url=https://gis.water.ca.gov/arcgis/rest/services/Geoscientific/i08_B118_CA_GroundwaterBasins/FeatureServer), and the connecting upland areas associated with each of these basins as delineated by the USGS (https://pubs.usgs.gov/publication/ds796). Use of Groundwater Units results in coverage of the entire state. Averaging of well depths and groundwater quality within a Groundwater Unit is considered reasonable based on the assumed relative consistency of hydrogeologic conditions within each Unit.

[17] Domestic Bottom = average of section maximum domestic well depths (from OSWCR) plus 3 standard deviations of section maximum well depths for each Groundwater Unit.

[18] Domestic Top = average of section minimum domestic well depths (from OSWCR) minus 3 standard deviations of section minimum well depths for Groundwater Unit.

[19] Public Bottom = average of section maximum public well depths (from OSWCR) plus 3 standard deviations of section maximum well depths for Groundwater Units.

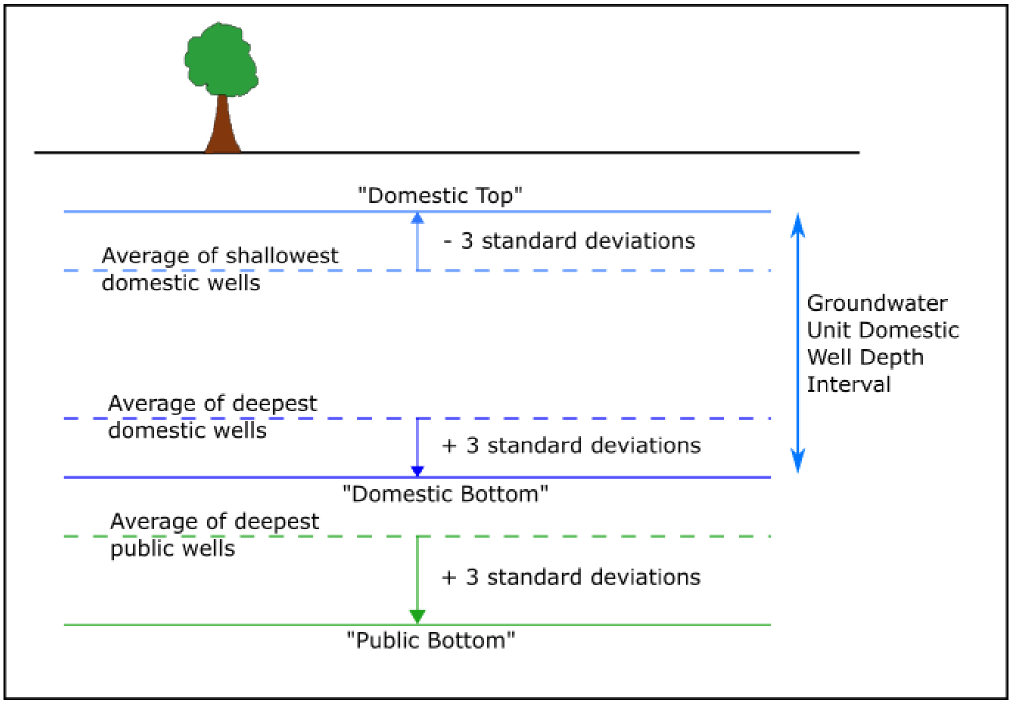

Figure 6. Numeric depth filter – based on average of section maximum/minimum well depths per Groundwater Unit. Wells with a known depth that fall within the "domestic well depth interval" are included in the analysis. Wells with a known depth that fall outside the "domestic well depth interval" are screened out of the analysis. For wells without a known depth – if the "public bottom" depth of a Groundwater Unit is shallower or within 10% of the "domestic bottom" depth, then wells classified as public are included in the analysis. If the "public bottom" depth of a Groundwater Unit is more than 10% deeper than the "domestic bottom" depth, then wells classified as public are screened out of the analysis.

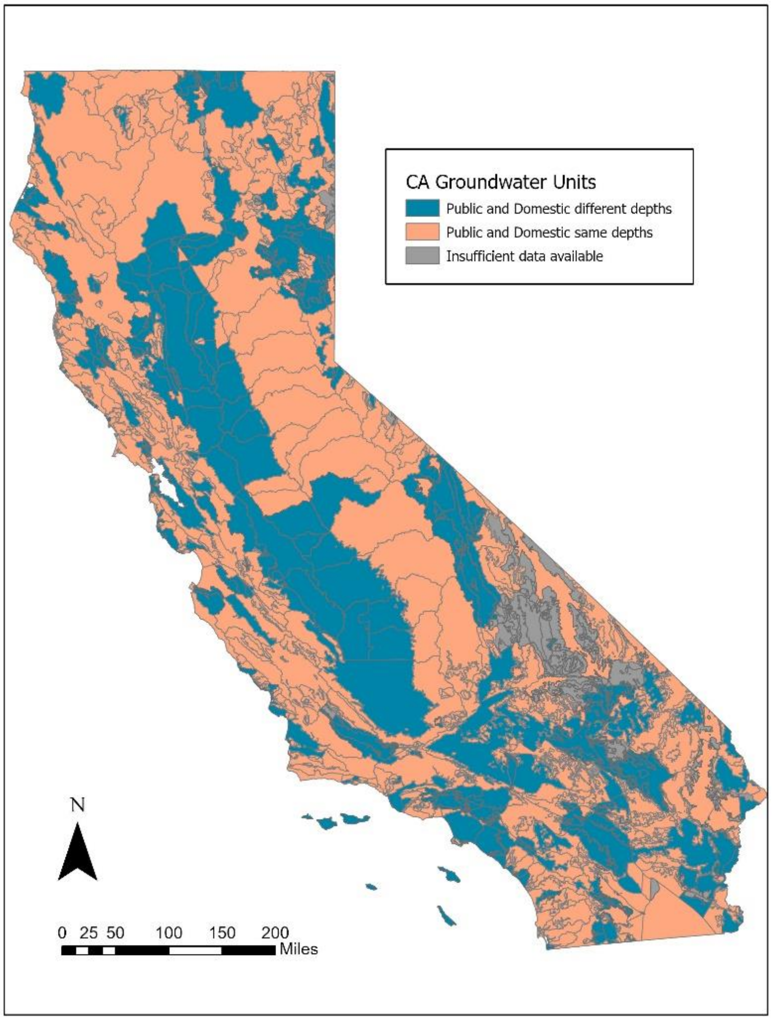

Figure 7. Depth filter by well type (for wells with unknown depth). This map shows basins where domestic wells and public wells may be accessing similar groundwater depths (pink) and basins where domestic wells and public wells are accessing different groundwater depths (blue).

De-clustering

Available water quality results are spatially and temporally de-clustered to square mile sections to account for differences in data sampling density within each section over space and time. This is to prevent certain areas with a high density of wells and frequent sampling to achieve a disproportionate weighting to the overall risk characterization of an area. To expand the coverage of the water quality risk map, averaged, de-clustered data from sections that contain a well(s) that provide water quality data ("source sections") are projected onto neighboring sections that do not include a well providing water quality data.

Water quality data is assessed using two metrics – the long-term (20 year[20]) average and all recent results (within 5 years[21]). The temporal and spatial de-clustering methodology for each metric is outlined below.

Long-term average

1. Water quality results from each well for each chemical constituent are averaged per year (for the past 20 years).
2. The results from step one is averaged per well.
3. The results from step two are averaged for all the wells that lie within a section.
4. For sections that do not contain a well with water quality data, the de-clustered data from step three is projected onto adjacent sections.

Recent results

1. All recent (within the past 5 years) results in a section are categorized as "under" (less than 80 percent of comparison concentration), "close" (80 percent – 100 percent of comparison concentration), or "over" (greater than comparison concentration).
2. The count of recent results in each category are summarized per square mile section for each constituent.
3. For square mile sections that do not contain a well with recent water quality data, the results from step two are averaged for all adjacent sections.

Water quality risk

Water quality data is summarized by square mile section using the methodology outlined above. For each square mile section, several metrics are reported (Table 7) and the sections are then grouped into high risk, medium risk, low risk, or unknown risk (Table 1). This potential water quality risk is then combined with the density of domestic well records and the location of state small water system to identify the number and location of wells and systems potentially at risk.

[20] To calculate the 20-year average, water quality results with sample collection dates after January 1, 2003 are used.
[21] To calculate results within the last five years, water quality results with sample collection dates after January 1, 2018 are used.

Table 7. Description of data available per square mile section.

GIS Attribute Name	GIS Alias	Description
MTRS	MTRS	Unique section identifier (square mile section)
SRF1	Count of contaminants above comparison concentration	Count of contaminants with long-term average or recent results above comparison concentration
SRF2	Count of contaminants close to comparison concentration	Count of contaminants long-term average or recent results between 80-100% of comparison concentration
SRF3	Magnitude of contamination	Average magnitude of long-term average or recent results for contaminants above comparison concentration (reported as Comparison Concentration Index)
SL1	List of contaminants above comparison concentration	List of contaminants above comparison concentration
SL2	List of contaminants close to comparison concentration	List of contaminants between 80-100% of comparison concentration
WQ_2024	2024 Water Quality Risk	Water quality risk based on comparison of long-term average and recent results to comparison concentration (see Table 1)
DWR_dm_	Domestic Well Record Count	Total number of domestic well records in section (from OSWCR)
ssws_cn	State Small Water System Count (DDW)	Total number of state small water systems in section (from DDW)
WQ_method	Water Quality Estimate Method	Indicates if risk is from source data (well located in section) or neighbor data (well in adjacent section). Method is for contaminant with the highest risk in that section.

Areas with no available water quality data

Areas without nearby available water quality data for any contaminant are listed as “unknown” risk.

Individual chemical constituents

Single-chemical constituent layers are available as square mile section data for nitrate, arsenic, 1,2,3-trichloropropane, hexavalent chromium, and uranium. These layers display the long-term average and the count of recent results over, close to, and under the comparison concentration per square mile section for a single chemical constituent.

Location of domestic wells and state small water systems

The location of potential domestic wells is determined by using well completion records from the OSWCR database. The count of potential domestic wells per square mile section is created by filtering the OSWCR database (https://services.arcgis.com/aa38u6OgfNoCkTJ6/arcgis/rest/services/i07_WellCompletionReports_Exported_v2_gdb/FeatureServer) for the following parameters:

- B118 Well Use is “Domestic”
- Date Work Ended is greater than “12/31/1969”
- Record Type is “WellCompletion/New/Production or Monitoring/NA”

The OSWCR database includes four types of well completion reports (new drilling, modification, destruction, or other). This year only reports of “new drilling” were included to count domestic wells, whereas last year both new drilling, modification, and other records were included to count domestic wells.

The location of state small water systems comes from records at the Division of Drinking Water (https://wbappsrv.waterboards.ca.gov/safer/login?returnUrl=%2Fsafer-systems).

Additional figures and tables

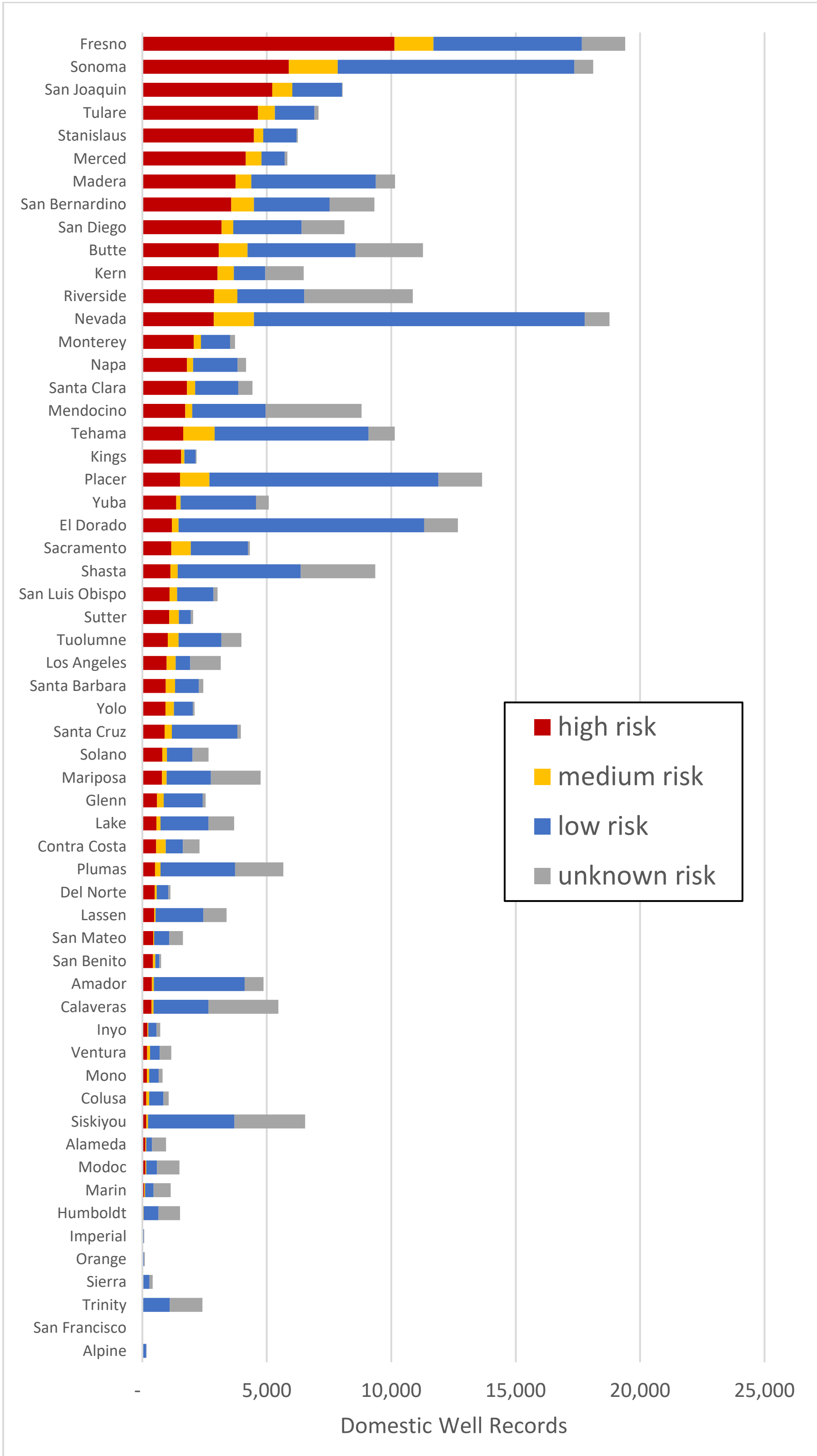

Figure 8. Domestic well risk by county (chart).

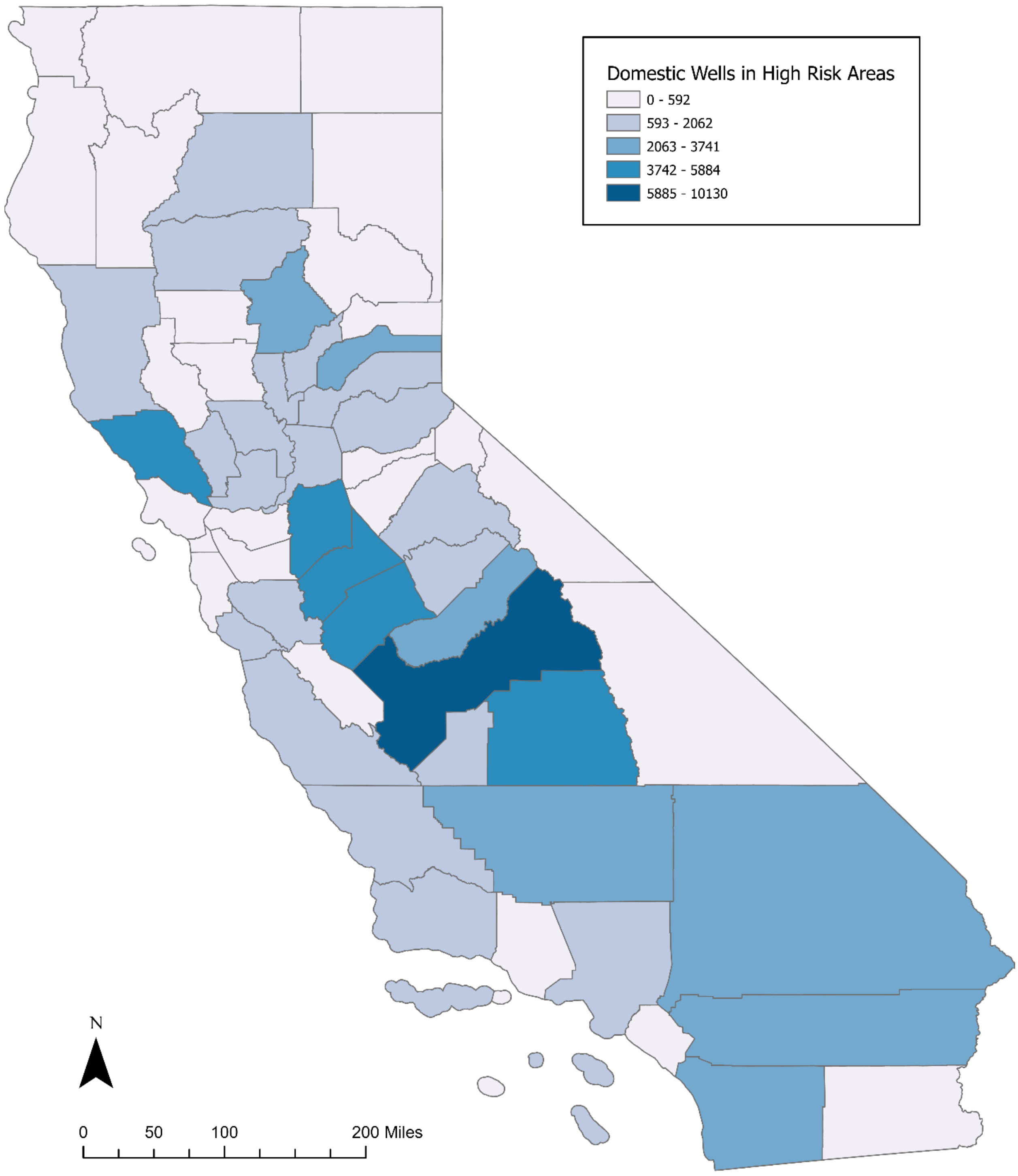

Figure 9. Number of domestic wells in high-risk areas by county (map).

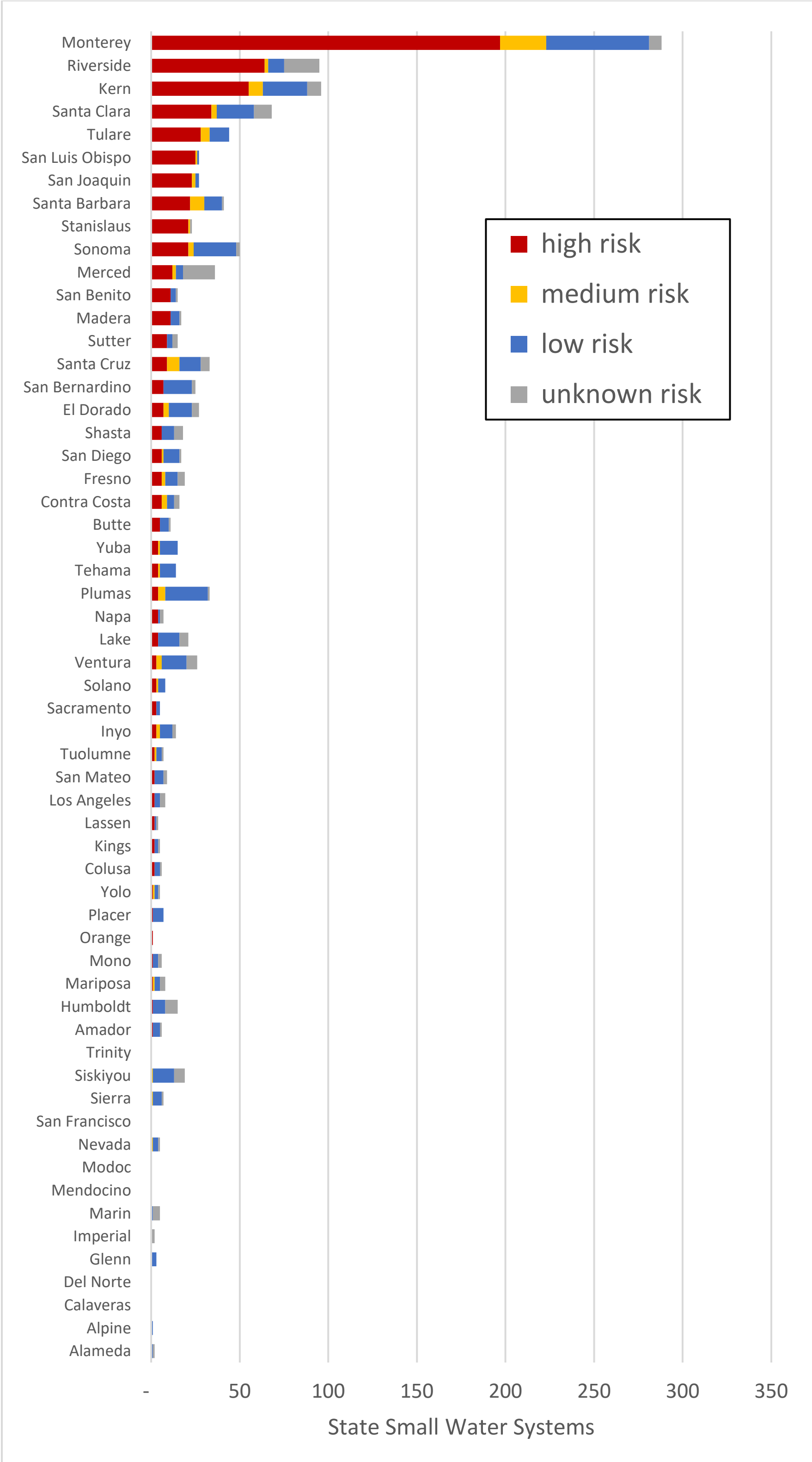

Figure 10. State small water systems risk by county (chart).

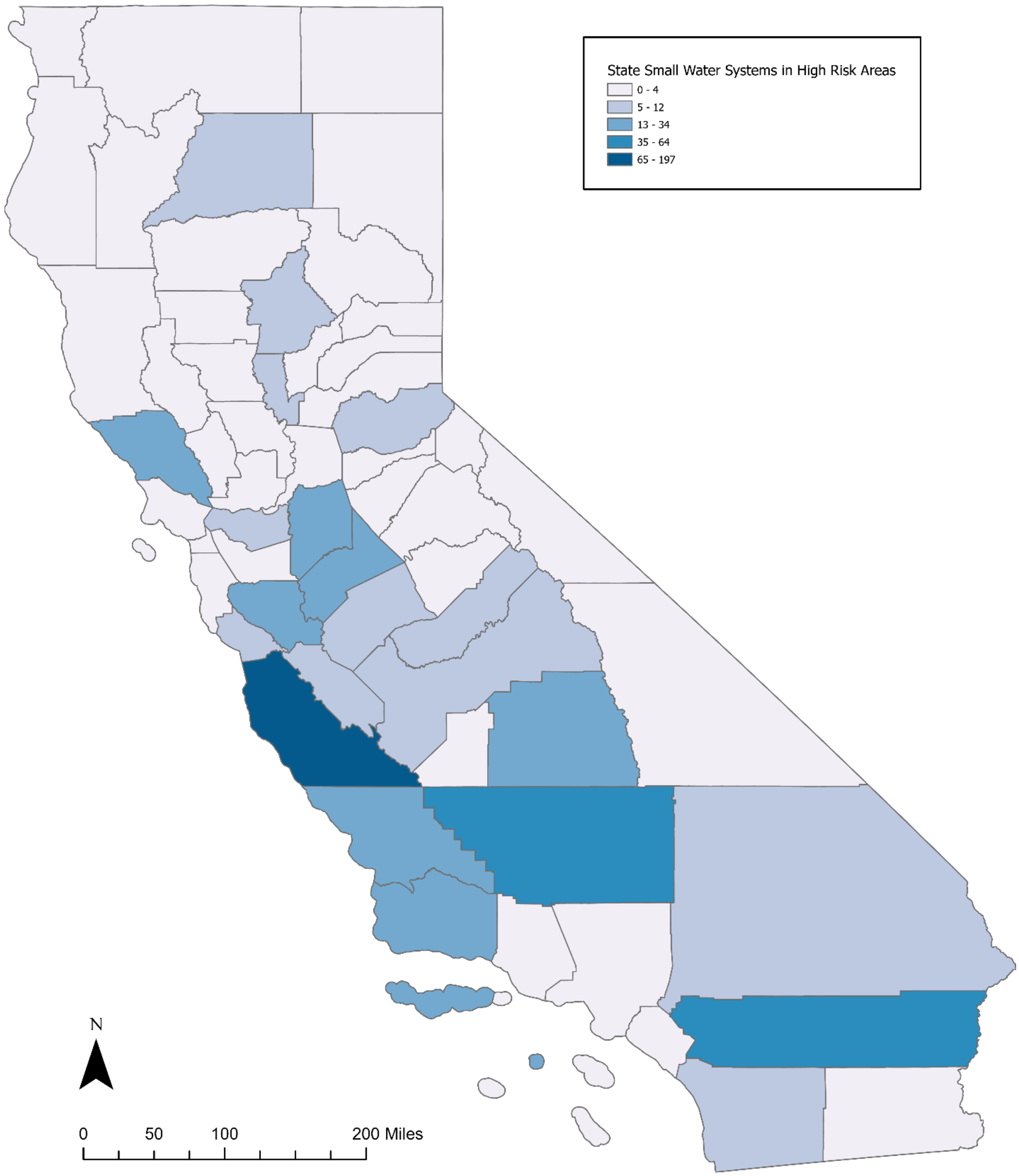

Figure 11. State small water systems in high-risk areas by county (map).

Table 8. Domestic well risk by county (table).

County	High Risk Domestic Wells	Medium Risk Domestic Wells	Low Risk Domestic Wells	Unknown Risk Domestic Wells
Fresno	10,130	1,563	5,968	1,737
Sonoma	5,884	1,960	9,512	760
San Joaquin	5,213	808	2,007	22
Tulare	4,649	679	1,583	167
Stanislaus	4,476	378	1,343	50
Merced	4,157	632	936	99
Madera	3,741	640	4,997	776
San Bernardino	3,572	911	3,033	1,801
San Diego	3,189	467	2,740	1,717
Butte	3,071	1,150	4,342	2,717
Kern	3,018	654	1,271	1,538
Riverside	2,884	928	2,692	4,363
Nevada	2,868	1,618	13,290	988
Monterey	2,062	290	1,166	208
Napa	1,797	240	1,792	342
Santa Clara	1,787	331	1,736	571
Mendocino	1,721	279	2,953	3,853
Tehama	1,640	1,267	6,181	1,056
Kings	1,555	134	458	36
Placer	1,509	1,178	9,203	1,756
Yuba	1,356	175	3,033	515
El Dorado	1,182	275	9,863	1,362
Sacramento	1,162	786	2,294	73
Shasta	1,125	290	4,950	2,993
San Luis Obispo	1,087	304	1,464	170
Sutter	1,079	383	485	94
Tuolumne	1,022	436	1,713	803
Los Angeles	972	368	583	1,230
Santa Barbara	942	372	961	175
Yolo	929	342	761	66
Santa Cruz	895	295	2,629	132
Solano	800	189	1,030	634
Mariposa	782	194	1,779	2,001
Glenn	592	270	1,558	124
Lake	569	162	1,928	1,032

County	High Risk Domestic Wells	Medium Risk Domestic Wells	Low Risk Domestic Wells	Unknown Risk Domestic Wells
Contra Costa	551	391	689	665
Plumas	511	223	2,989	1,943
Del Norte	492	83	470	83
Lassen	473	60	1,909	944
San Mateo	440	28	614	548
San Benito	422	91	166	69
Amador	372	87	3,644	760
Calaveras	371	73	2,216	2,805
Inyo	197	38	324	162
Ventura	191	115	391	463
Mono	179	91	390	156
Colusa	158	115	576	204
Siskiyou	151	73	3,480	2,839
Alameda	124	35	234	553
Modoc	123	31	432	908
Marin	77	33	340	683
Humboldt	40	9	593	874
Imperial	25	1	24	25
Orange	21	9	36	28
Sierra	16	28	243	121
Alpine	-	19	140	14
San Francisco	-	-	-	2
Trinity	-	-	1,104	1,303

Table 9. State small water system risk by county (table).

County	High Risk State Small Water Systems	Medium Risk State Small Water Systems	Low Risk State Small Water Systems	Unknown Risk State Small Water Systems
Monterey	197	26	58	7
Riverside	64	2	9	20
Kern	55	8	25	8
Santa Clara	34	3	21	10
Tulare	28	5	11	-
San Luis Obispo	25	1	1	-
San Joaquin	23	2	2	-
Santa Barbara	22	8	10	1
Sonoma	21	3	24	2
Stanislaus	21	1	-	1
Merced	12	2	4	18
Madera	11	-	5	1
San Benito	11	-	3	1
Santa Cruz	9	7	12	5
Sutter	9	-	3	3
El Dorado	7	3	13	4
San Bernardino	7	-	16	2
Contra Costa	6	3	4	3
Fresno	6	2	7	4
San Diego	6	1	9	1
Shasta	6	-	7	5
Butte	5	-	5	1
Lake	4	-	12	5
Napa	4	-	1	2
Plumas	4	4	24	1
Tehama	4	1	9	-
Yuba	4	1	10	-
Inyo	3	2	7	2
Sacramento	3	-	2	-
Solano	3	1	4	-
Ventura	3	3	14	6
Colusa	2	-	3	1
Kings	2	-	2	1
Lassen	2	-	1	1

County	High Risk State Small Water Systems	Medium Risk State Small Water Systems	Low Risk State Small Water Systems	Unknown Risk State Small Water Systems
Los Angeles	2	-	3	3
San Mateo	2	-	5	2
Tuolumne	2	1	3	1
Amador	1	-	4	1
Humboldt	1	-	7	7
Mariposa	1	1	3	3
Mono	1	-	3	2
Orange	1	-	-	-
Placer	1	-	6	-
Yolo	1	1	2	1
Alameda	-	-	1	1
Alpine	-	-	1	-
Calaveras	-	-	-	-
Del Norte	-	-	-	-
Glenn	-	-	3	-
Imperial	-	-	-	2
Marin	-	-	1	4
Mendocino	-	-	-	-
Modoc	-	-	-	-
Nevada	-	1	3	1
San Francisco	-	-	-	-
Sierra	-	1	5	1
Siskiyou	-	1	12	6
Trinity	-	-	-	-

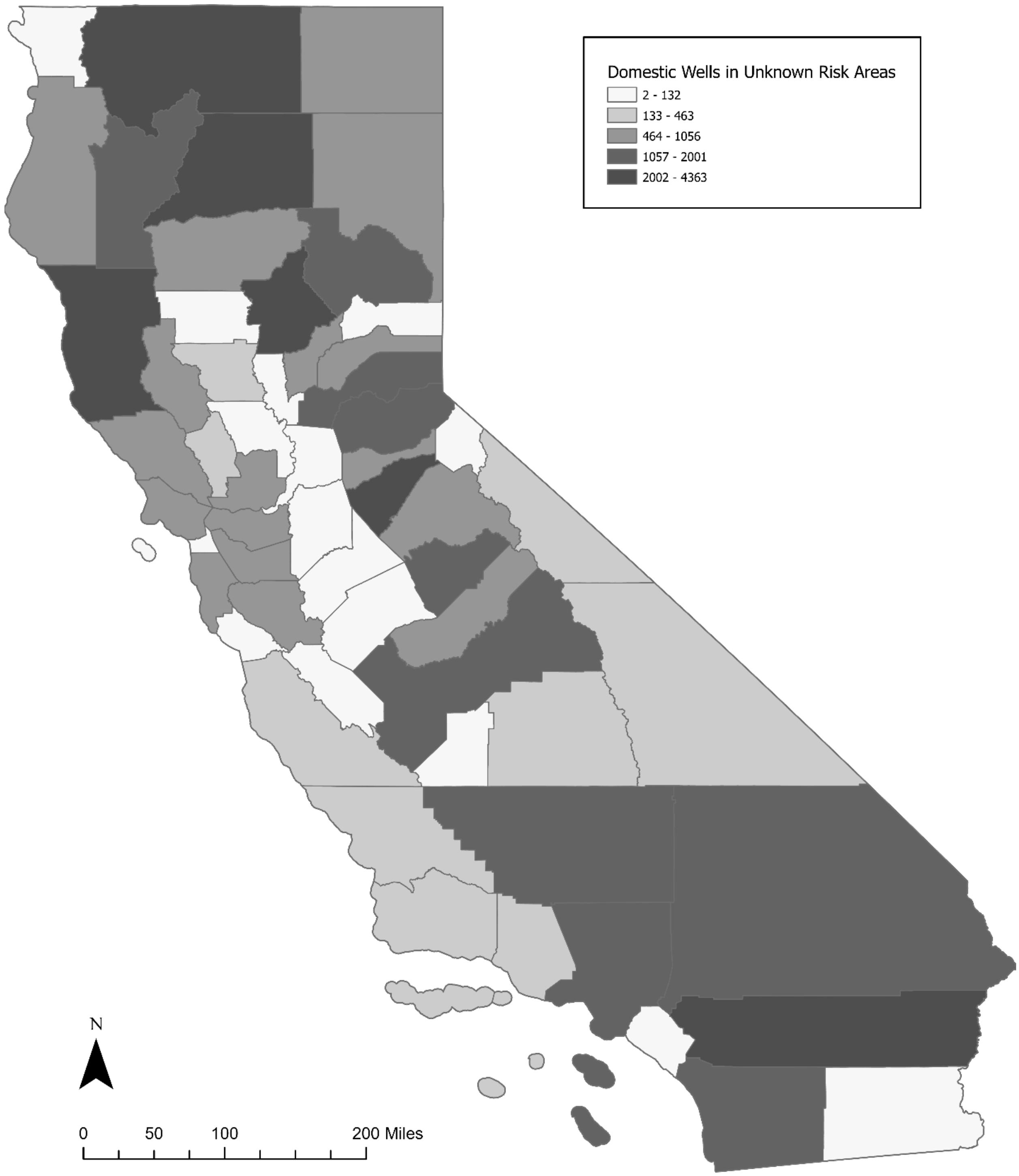

Figure 12. Map of California highlighting the location of domestic well records in areas of unknown water quality risk by county.

Table 10. Chemical Abbreviations Used in Aquifer Risk Map

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
24D	2,4-Dichlorophenoxyacetic acid (2,4 D)	UG/L	70	MCL
AL	Aluminum	UG/L	1000	MCL
ALACL	Alachlor	UG/L	2	MCL
ALPHA	Gross Alpha radioactivity	pCi/L	15	MCL
AS	Arsenic	UG/L	10	MCL
ATRAZINE	Atrazine	UG/L	1	MCL
BA	Barium	MG/L	1	MCL
BDCME	Bromodichloromethane (THM)	UG/L	80	MCL
BE	Beryllium	UG/L	4	MCL
BETA	Gross beta	pCi/L	50	MCL
BHCGAMMA	Lindane (Gamma-BHC)	UG/L	0.2	MCL
BIS2EHP	Di(2-ethylhexyl)phthalate (DEHP)	UG/L	4	MCL
BRO3	Bromate	UG/L	10	MCL
BTZ	Bentazon	UG/L	18	MCL
BZ	Benzene	UG/L	1	MCL
BZAP	Benzo(a)pyrene	UG/L	0.2	MCL
BZME	Toluene	UG/L	150	MCL
CD	Cadmium	UG/L	5	MCL
CHLORDANE	Chlordane	UG/L	0.1	MCL
CHLORITE	Chlorite	MG/L	1	MCL
CLBZ	Chlorobenzene	UG/L	70	MCL
CN	Cyanide (CN)	UG/L	150	MCL
CR	Chromium	UG/L	50	MCL
CR6	Chromium, Hexavalent (Cr6)	UG/L	10	Temporary comparison level for this analysis only[22]
CRBFN	Carbofuran	UG/L	18	MCL
CTCL	Carbon Tetrachloride	UG/L	0.5	MCL
CU	Copper	MG/L	1.3	Action Level
DALAPON	Dalapon	UG/L	200	MCL

[22] The HBSL for Hexavalent Chromium is 20 ug/l.

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
DBCME	Dibromochloromethane (THM)	UG/L	80	MCL
DBCP	1,2-Dibromo-3-chloropropane (DBCP)	UG/L	0.2	MCL
DCA11	1,1-Dichloroethane (1,1 DCA)	UG/L	5	MCL
DCA12	1,2 Dichloroethane (1,2 DCA)	UG/L	0.5	MCL
DCBZ12	1,2 Dichlorobenzene (1,2-DCB)	UG/L	600	MCL
DCBZ14	1,4-Dichlorobenzene (p-DCB)	UG/L	5	MCL
DCE11	1,1 Dichloroethylene (1,1 DCE)	UG/L	6	MCL
DCE12C	cis-1,2 Dichloroethylene	UG/L	6	MCL
DCE12T	trans-1,2, Dichloroethylene	UG/L	10	MCL
DCMA	Dichloromethane (Methylene Chloride)	UG/L	5	MCL
DCP13	1,3 Dichloropropene	UG/L	0.5	MCL
DCPA12	1,2 Dichloropropane (1,2 DCP)	UG/L	5	MCL
DINOSEB	Dinoseb	UG/L	7	MCL
DIQUAT	Diquat	UG/L	20	MCL
DOA	Di(2-ethylhexyl)adipate	MG/L	0.4	MCL
EBZ	Ethylbenzene	UG/L	300	MCL
EDB	1,2 Dibromoethane (EDB)	UG/L	0.05	MCL
ENDOTHAL	Endothall	UG/L	100	MCL
ENDRIN	Endrin	UG/L	2	MCL
F	Fluoride	MG/L	2	MCL
FC11	Trichlorofluoromethane (Freon 11)	UG/L	150	MCL
FC113	1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	MG/L	1.2	MCL
GLYP	Glyphosate (Round-up)	UG/L	700	MCL
H-3	Tritium	pCi/L	20000	MCL
HCCP	Hexachlorocyclopentadiene	UG/L	50	MCL
HCLBZ	Hexachlorobenzene (HCB)	UG/L	1	MCL
HEPTACHLOR	Heptachlor	UG/L	0.01	MCL
HEPT-EPOX	Heptachlor Epoxide	UG/L	0.01	MCL
HG	Mercury	UG/L	2	MCL
MOLINATE	Molinate	UG/L	20	MCL
MTBE	MTBE (Methyl-tert-butyl ether)	UG/L	13	MCL

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
MTXYCL	Methoxychlor	UG/L	30	MCL
NI	Nickel	UG/L	100	MCL
NNSM	N-Nitrosodimethylamine (NDMA)	UG/L	0.01	NL
NO2	Nitrite as N	MG/L	1	MCL
NO3N	Nitrate as N	MG/L	10	MCL
OXAMYL	Oxamyl	UG/L	50	MCL
PB	Lead	UG/L	15	Action Level
PCA	1,1,2,2 Tetrachloroethane (PCA)	UG/L	1	MCL
PCATE	Perchlorate	UG/L	6	MCL
PCB1016	Polychlorinated Biphenyls (PCBs)	UG/L	0.5	MCL
PCE	Tetrachloroethene (PCE)	UG/L	5	MCL
PCP	Pentachlorophenol (PCP)	UG/L	1	MCL
PFBSA	Perfluorobutane sulfonic acid (PFBS)	NG/L	500	Notification Level
PFHXSA	Perfluorohexanesulfonic acid (PFHxS)	NG/L	3	Notification Level
PFOA	Perfluorooctanoic acid (PFOA)	NG/L	5.1	Notification Level
PFOS	Perfluorooctane sulfonic acid (PFOS)	NG/L	6.5	Notification Level
PICLORAM	Picloram	MG/L	0.5	MCL
RA-226-228	Combined Radium 226 and Radium 228	pCi/L	5	MCL
SB	Antimony	UG/L	6	MCL
SE	Selenium	UG/L	50	MCL
SILVEX	2,4,5-TP (Silvex)	UG/L	50	MCL
SIMAZINE	Simazine	UG/L	4	MCL
SR-90	Strontium 90	pCi/L	8	MCL
STY	Styrene	UG/L	100	MCL
TBME	Bromoform (THM)	UG/L	80	MCL
TCA111	1,1,1-Trichloroethane	UG/L	200	MCL
TCA112	1,1,2-Trichloroethane	UG/L	5	MCL
TCB124	1,2,4- Trichlorobenzene (1,2,4 TCB)	UG/L	5	MCL
TCDD2378	2,3,7,8-Tetrachlorodibenzodioxin (Dioxin)	UG/L	3.00E-05	MCL
TCE	Trichloroethene (TCE)	UG/L	5	MCL
TCLME	Chloroform (THM)	UG/L	80	MCL

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
TCPR123	1,2,3-Trichloropropane (1,2,3 TCP)	UG/L	0.005	MCL
THIOBENCARB	Thiobencarb	UG/L	70	MCL
THM	Total Trihalomethanes	UG/L	80	MCL
TL	Thallium	UG/L	2	MCL
TOXAP	Toxaphene	UG/L	3	MCL
U	Uranium	pCi/L	20	MCL
VC	Vinyl Chloride	UG/L	0.5	MCL
XYLENES	Xylenes (total)	UG/L	1750	MCL