USGS
science for a changing world

USGS-SWRCB GAMA Program Domestic Well Studies

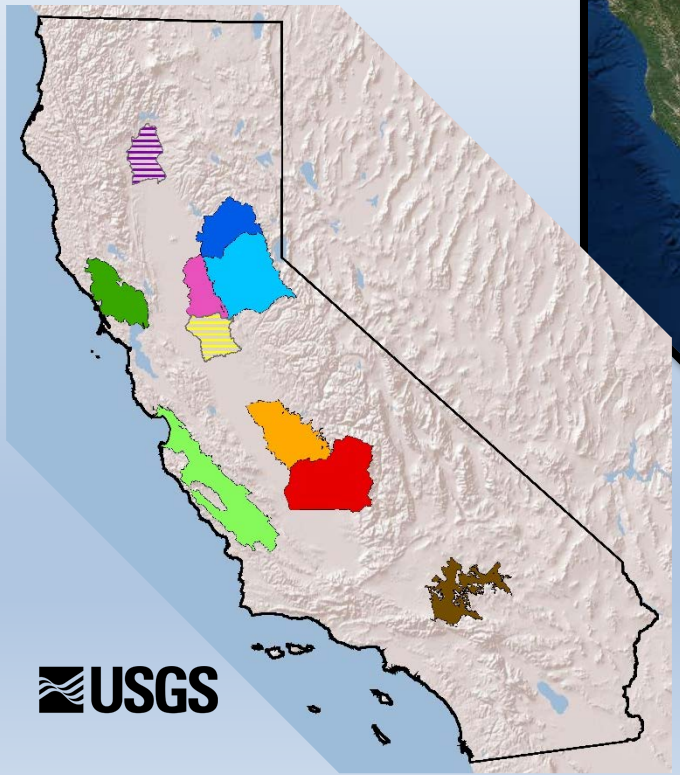
Miranda S. Fram, Ph.D.

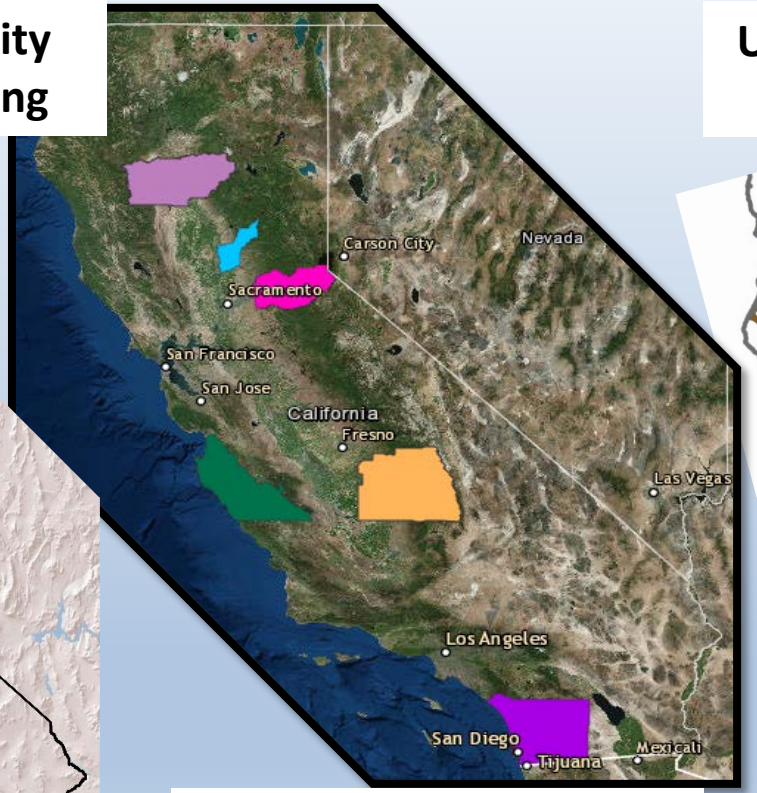
USGS California Water Science Center

U.S. Department of the Interior
U.S. Geological Survey

Overview – USGS-SWRCB Domestic Wells Studies

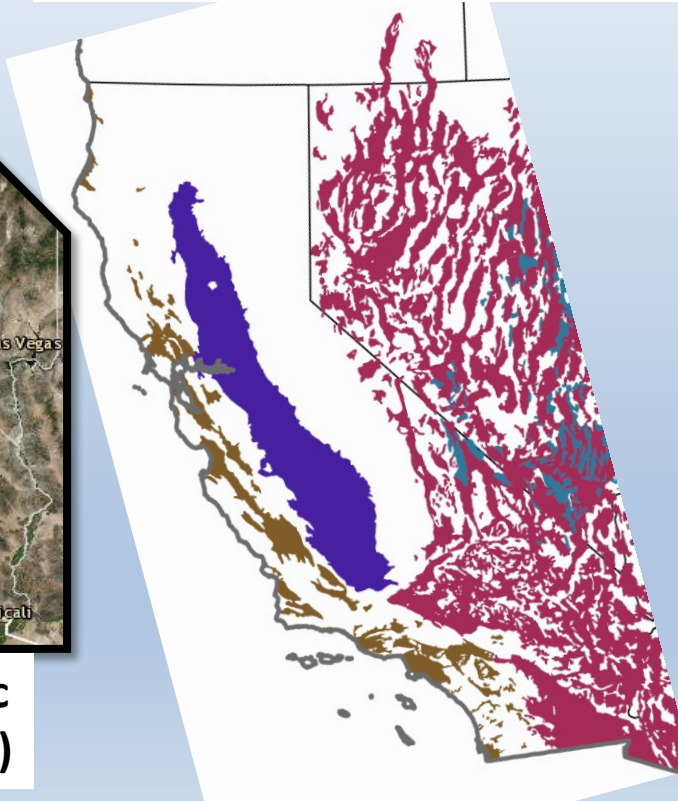
USGS-SWRCB GAMA Priority Basin Project 2012 - ongoing





SWRCB GAMA Domestic Well Project (2002-2011)

USGS National Water Quality Program 1990-ongoing



USGS-SWRCB GAMA Priority Basin Project
Domestic Well Studies 2012 - present

1) Where are people using domestic wells?

2) What part of the aquifer system is used by domestic wells?

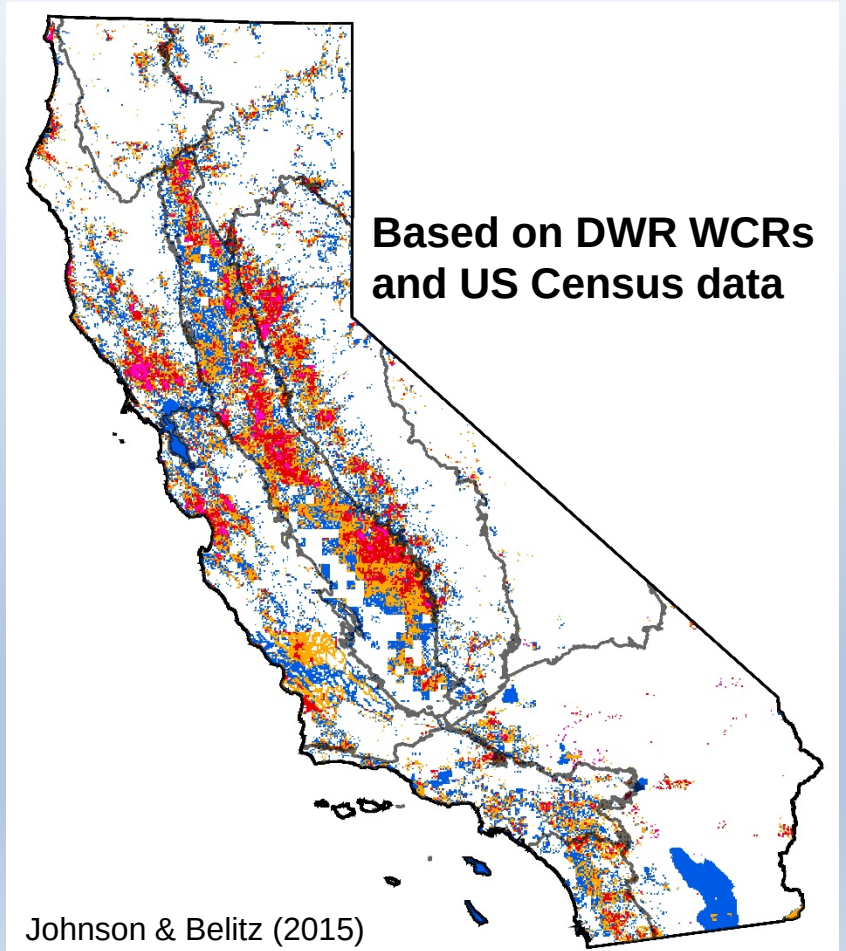
3) What are the current water-quality conditions in domestic well aquifers?

4) What are the processes and inputs affecting those water-quality conditions?

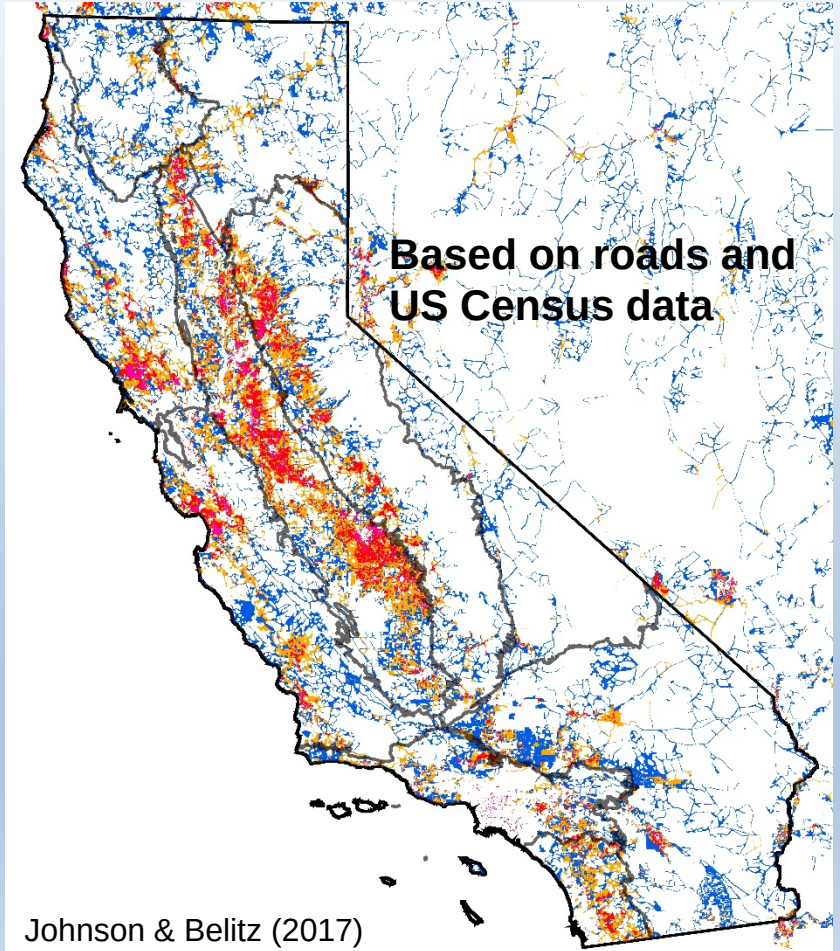
5) How will those water-quality conditions change over time?

USGS

Locations of Households Using Domestic Wells



Johnson & Belitz (2015)



Johnson & Belitz (2017)

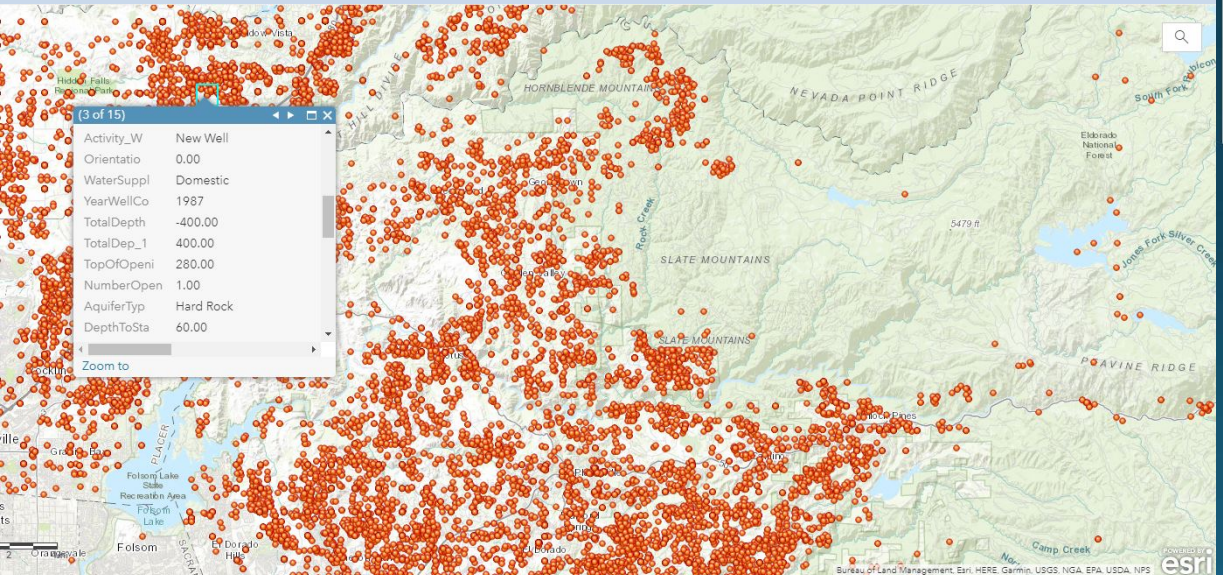
Locations of Domestic Wells

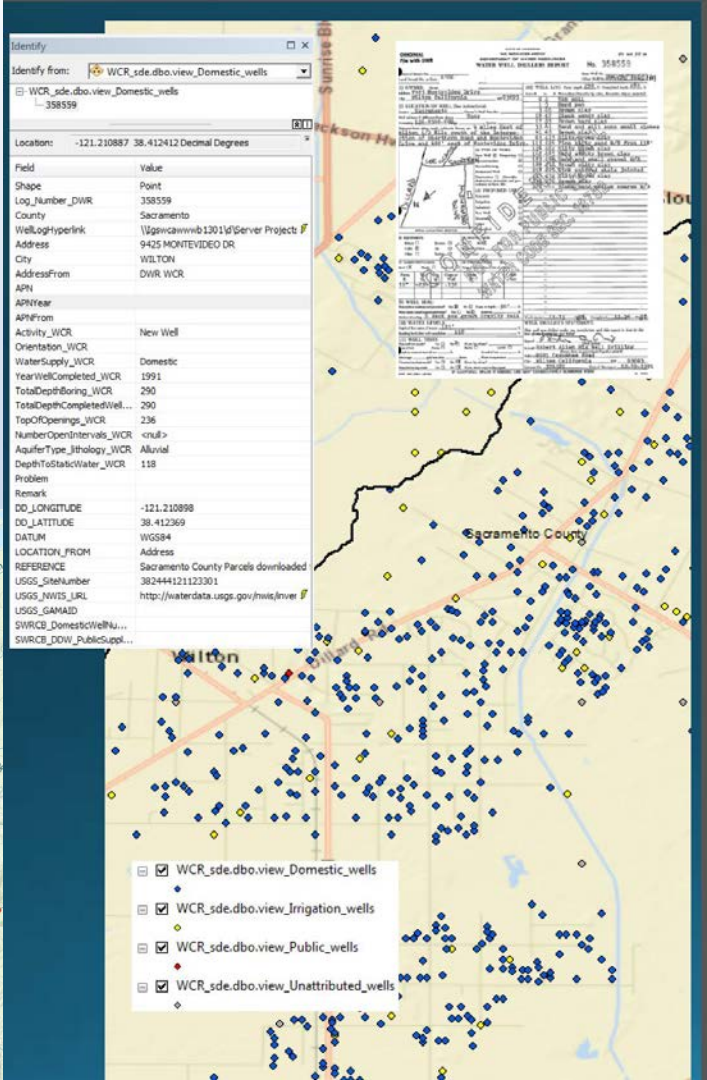
Compile data from WCRs (including point location)

Augment and QC check DWR OSWCR

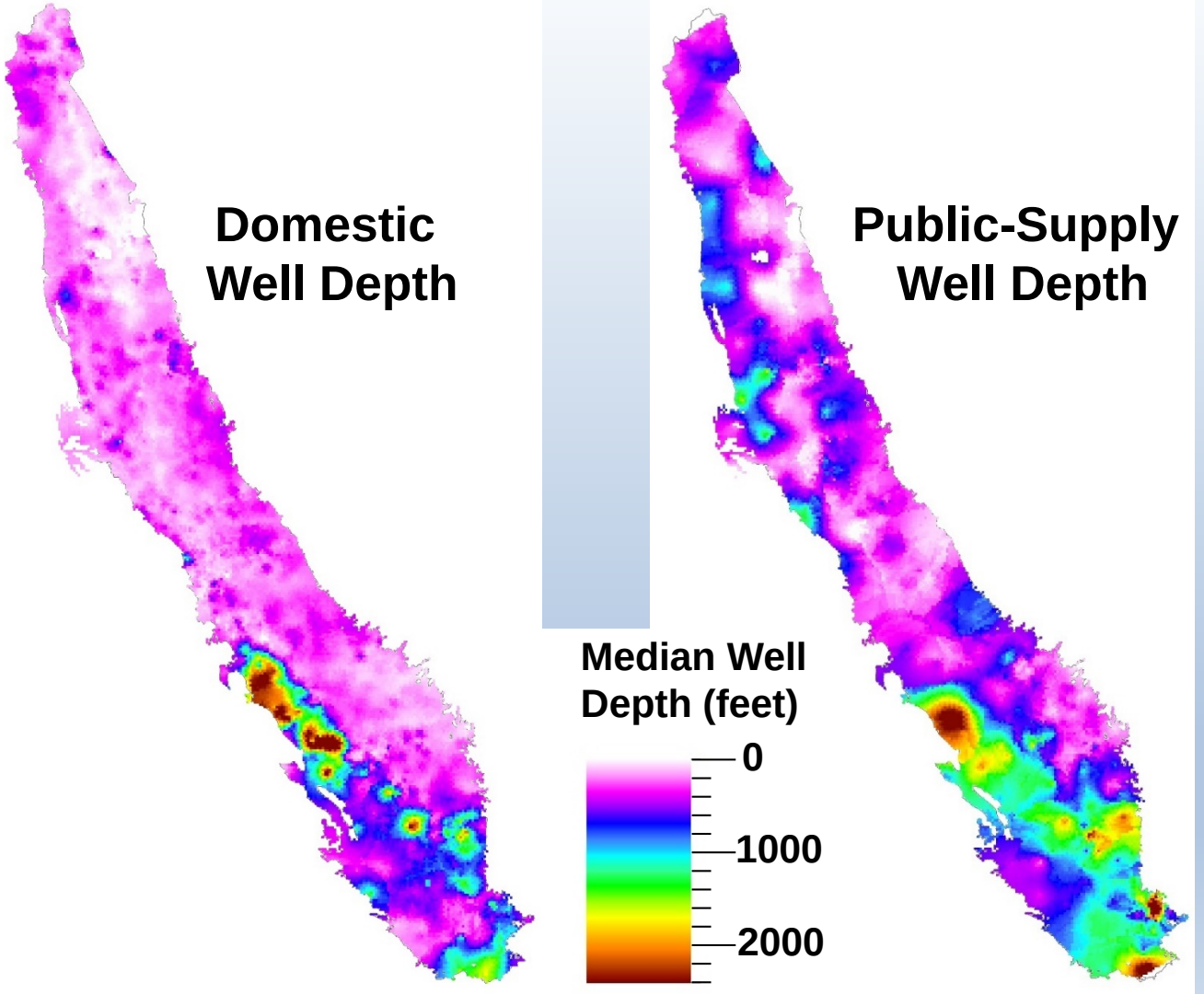
Coordinate data with local entities

Data from State Smalls





Aquifers Used by Domestic Wells



Voss & Jurgens (2018)

USGS

Water Quality – Current Conditions

What are the most widespread water-quality issues in domestic wells?

MCL

Nitrate-N

Uranium

Arsenic

Fluoride

Fumigants

Perchlorate

Gross alpha/beta

Selenium

Chromium

SMCL

TDS

Manganese

Iron

Unregulated

Hexavalent chromium

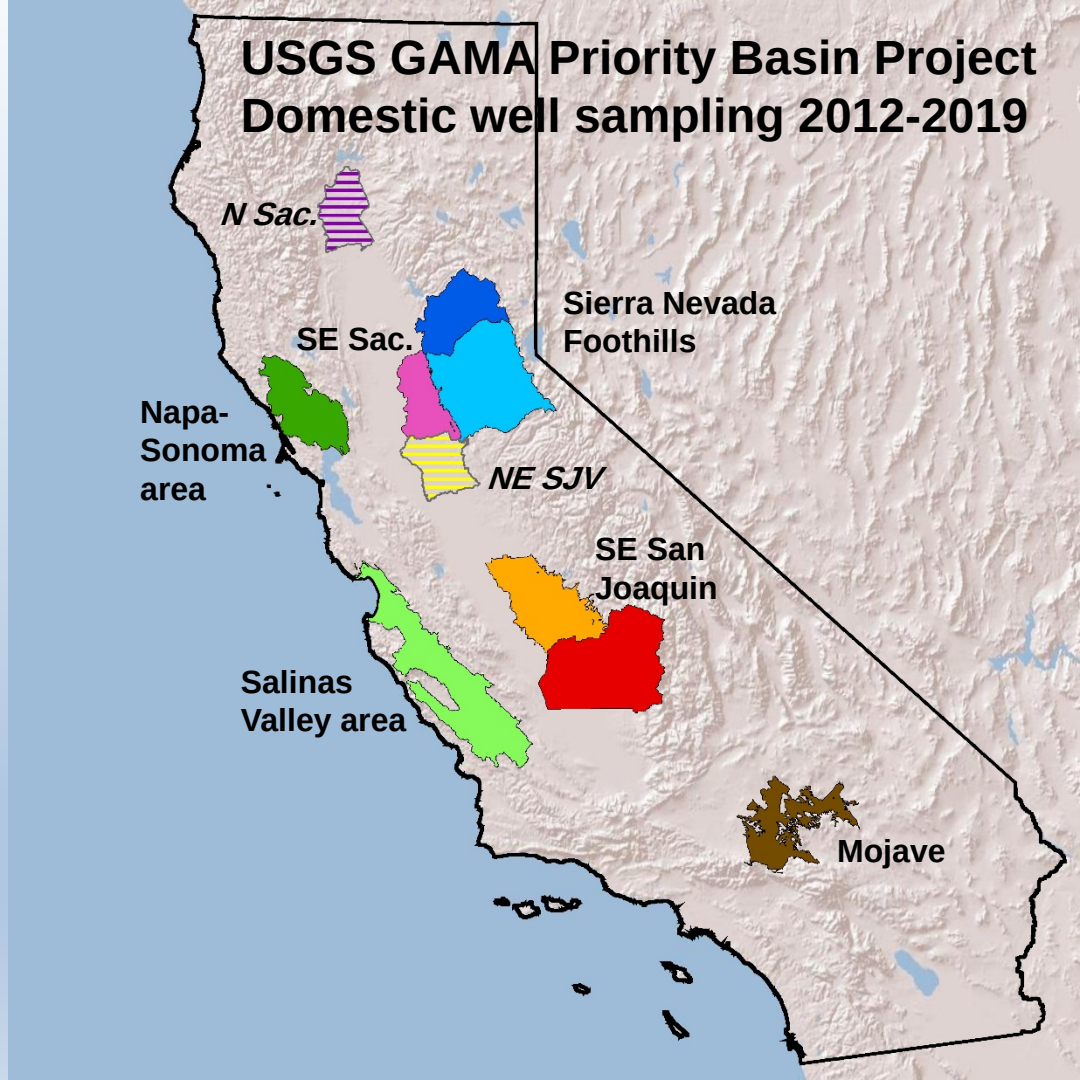
Molybdenum

Vanadium

Strontium

Boron

USGS



Six Stories about Domestic Wells

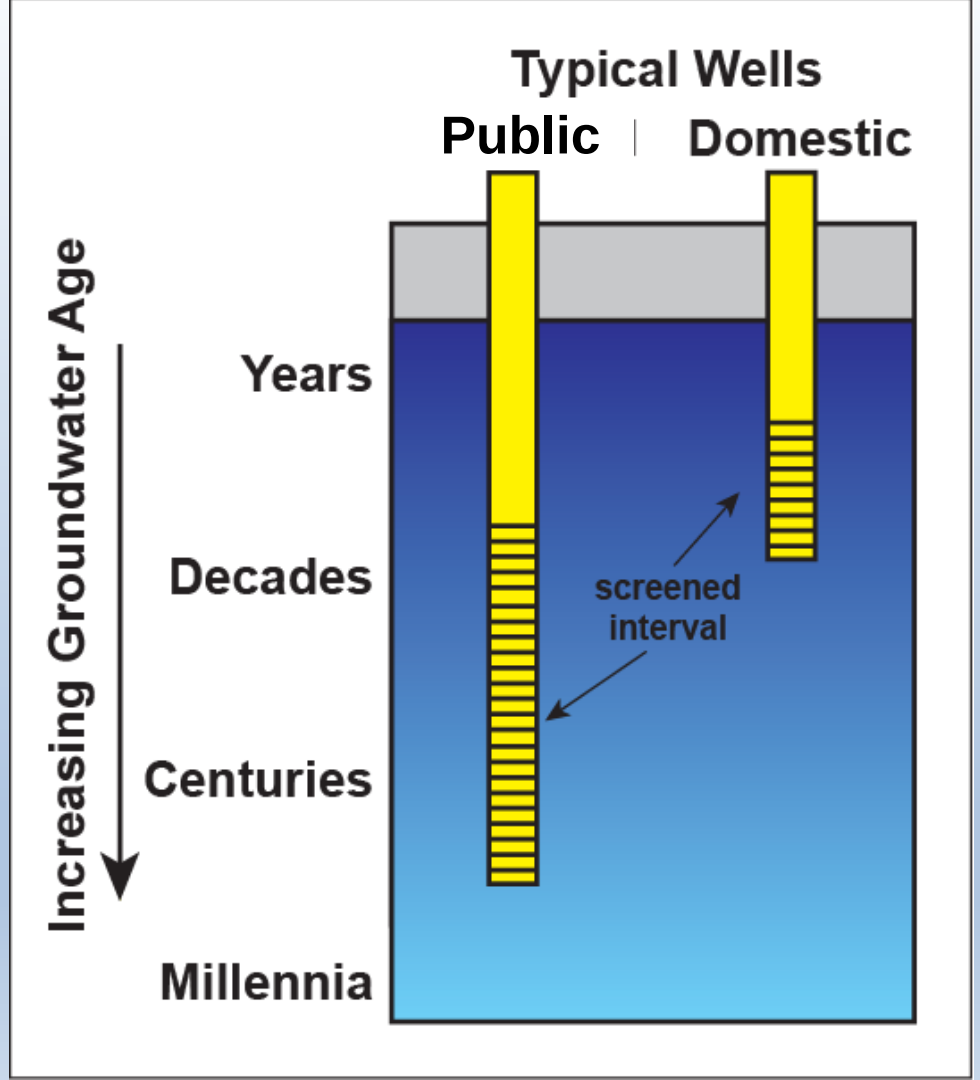
1) Nothing happens right away
2) Nothing is as simple as it seems
3) Everything is connected to everything else
4) Rules can change
5) Chemistry really does matter
6) Population grows

USGS

Nothing happens right away:

Groundwater age and prediction of nitrate concentrations

USGS



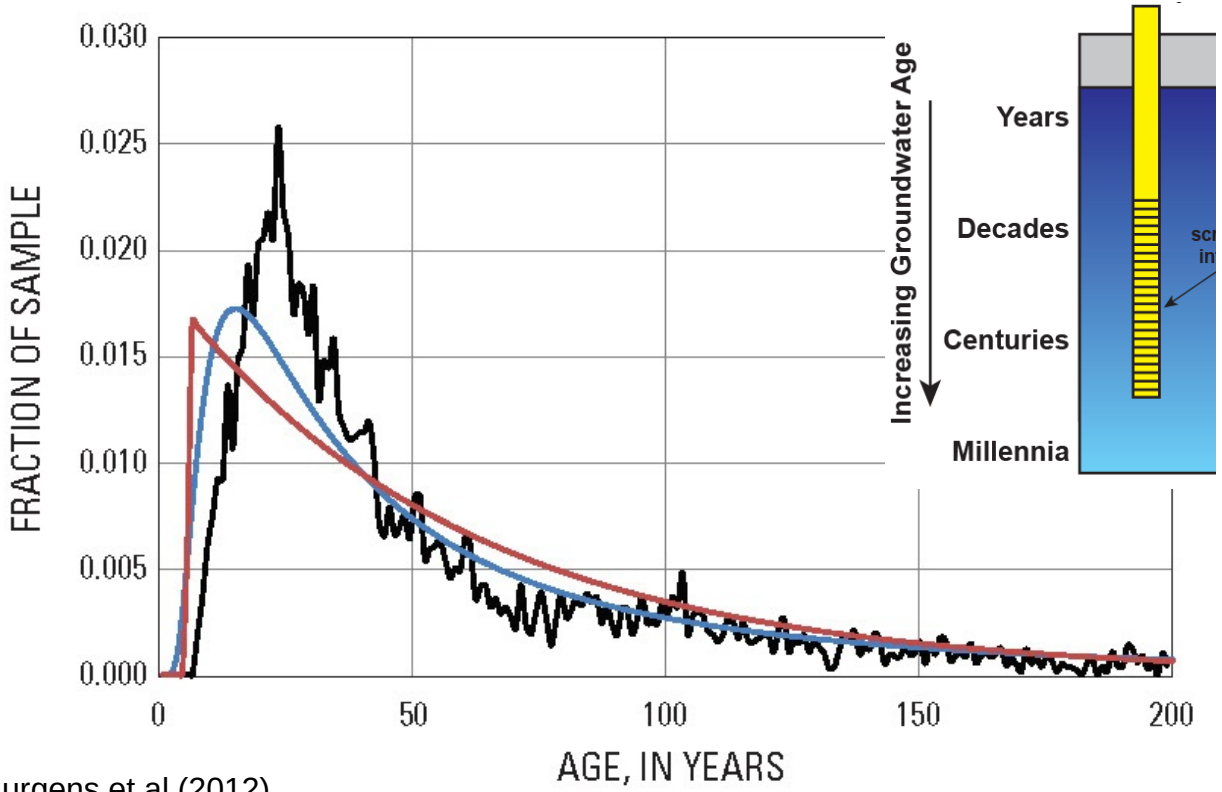
USGS

[Nothing happens right away]

Calculated Mixture of Ages in Groundwater from a Well

From water-quality data from one well

From particle tracking in full groundwater flow model for entire basin

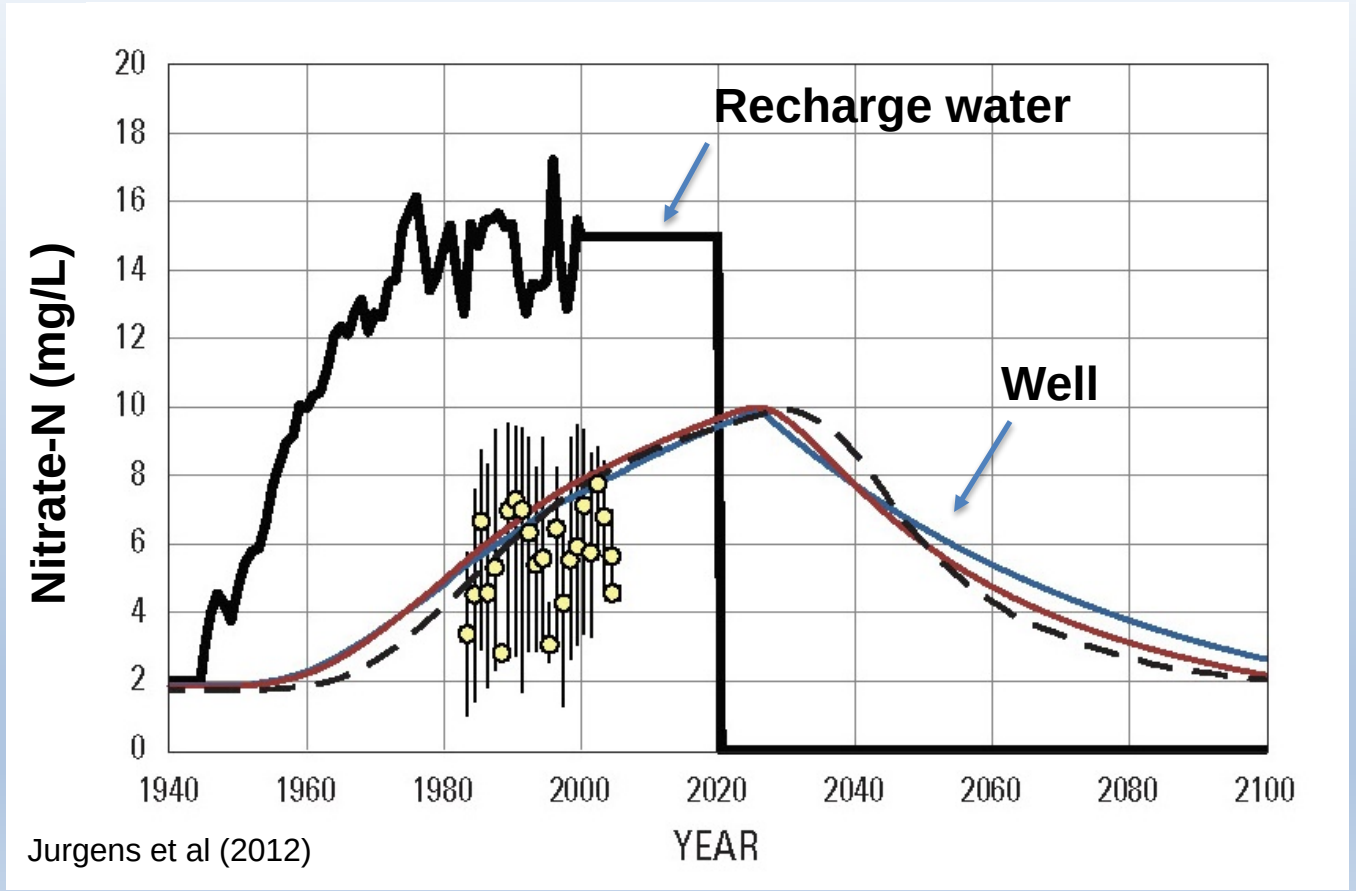


Jurgens et al (2012)

USGS

[Nothing happens right away]

Predicted Change in Nitrate Concentration



Jurgens et al (2012)

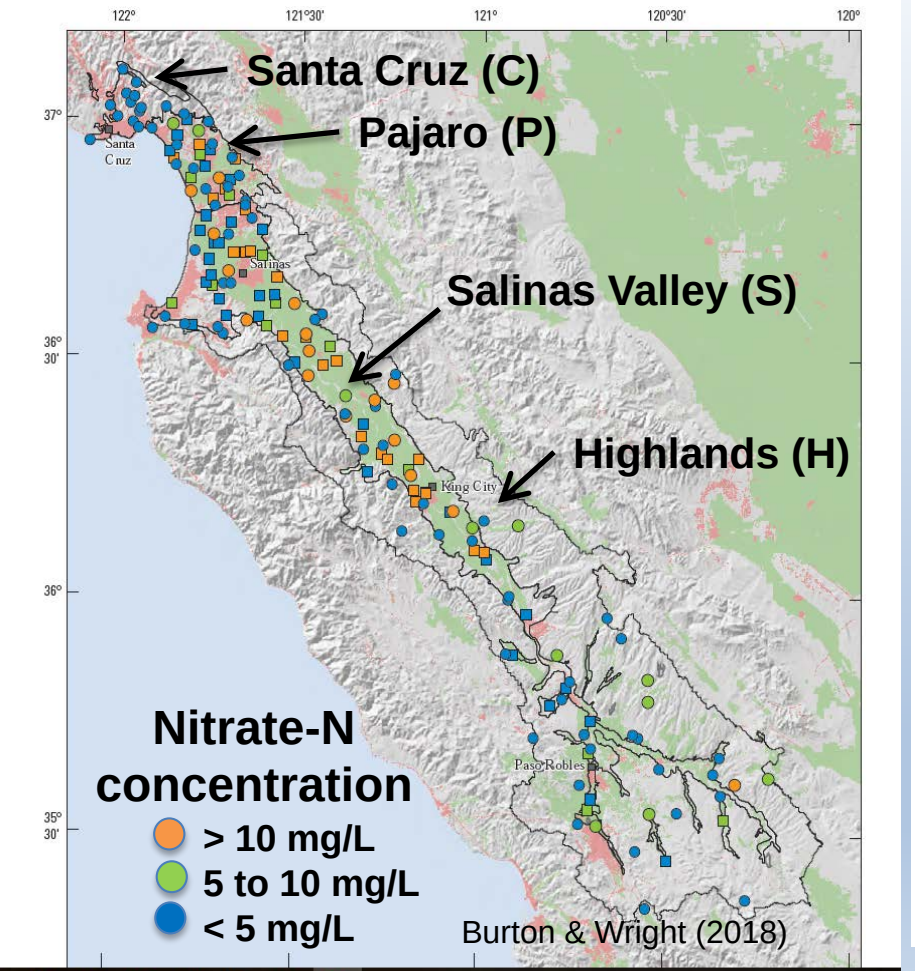
USGS

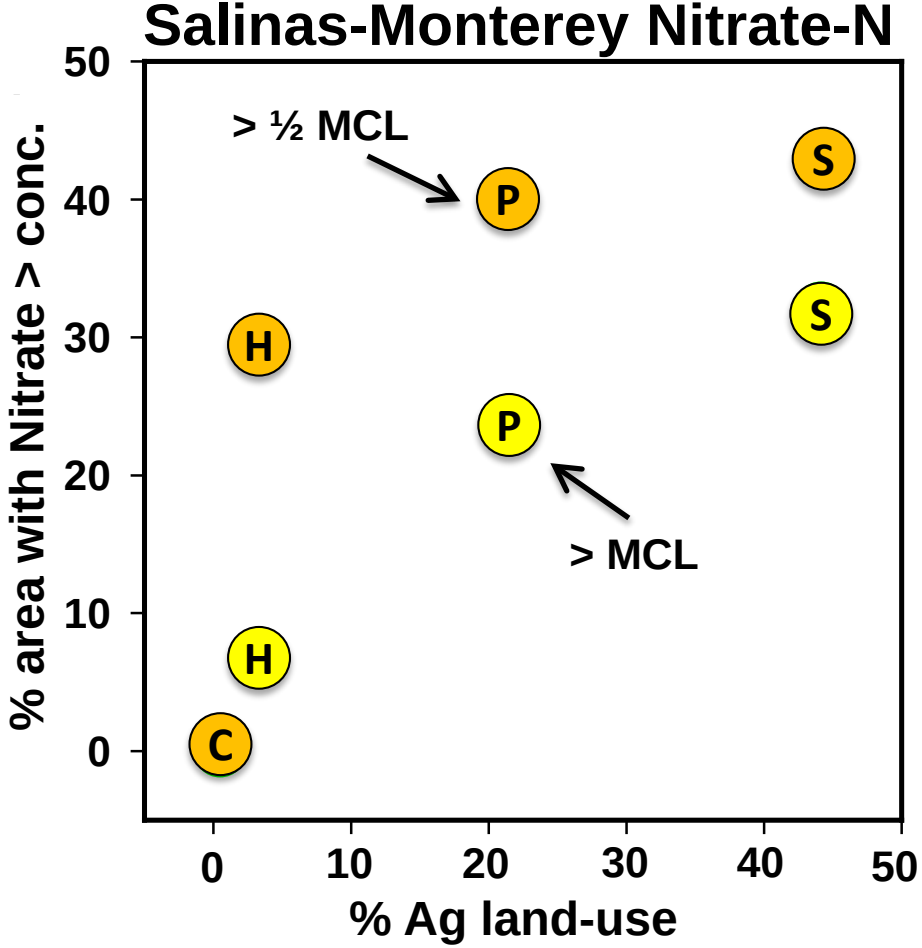
[Nothing happens right away]

Nothing is as simple as it seems:

Nitrate and agricultural land use

USGS





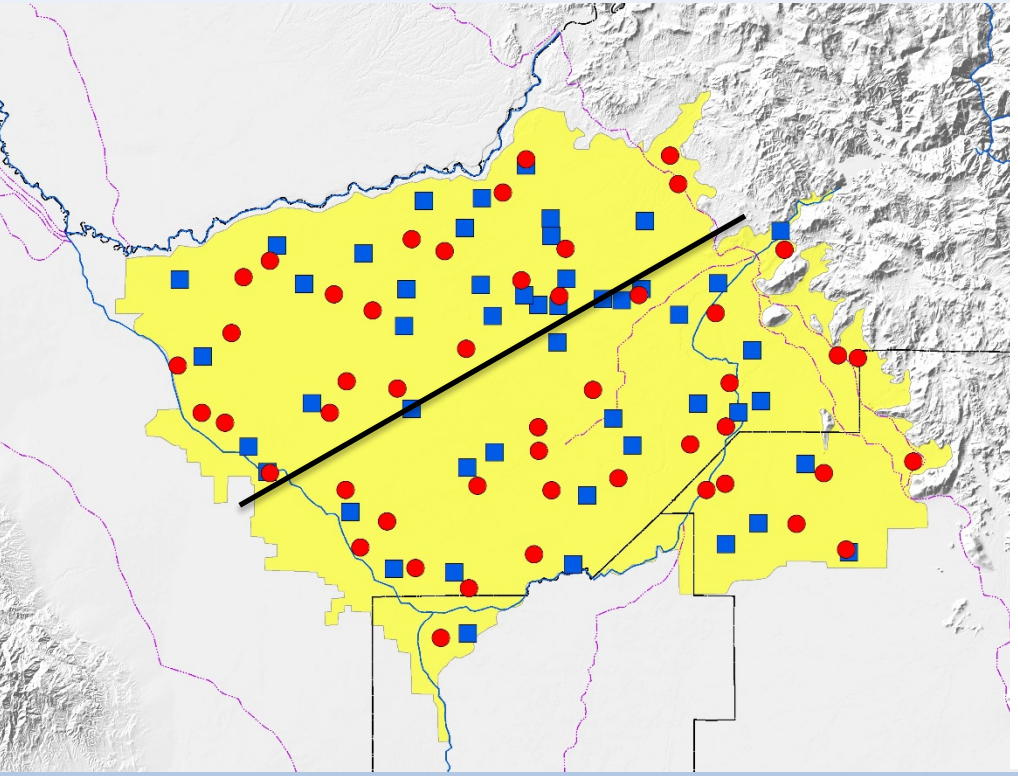
[Nothing is as simple as it seems]

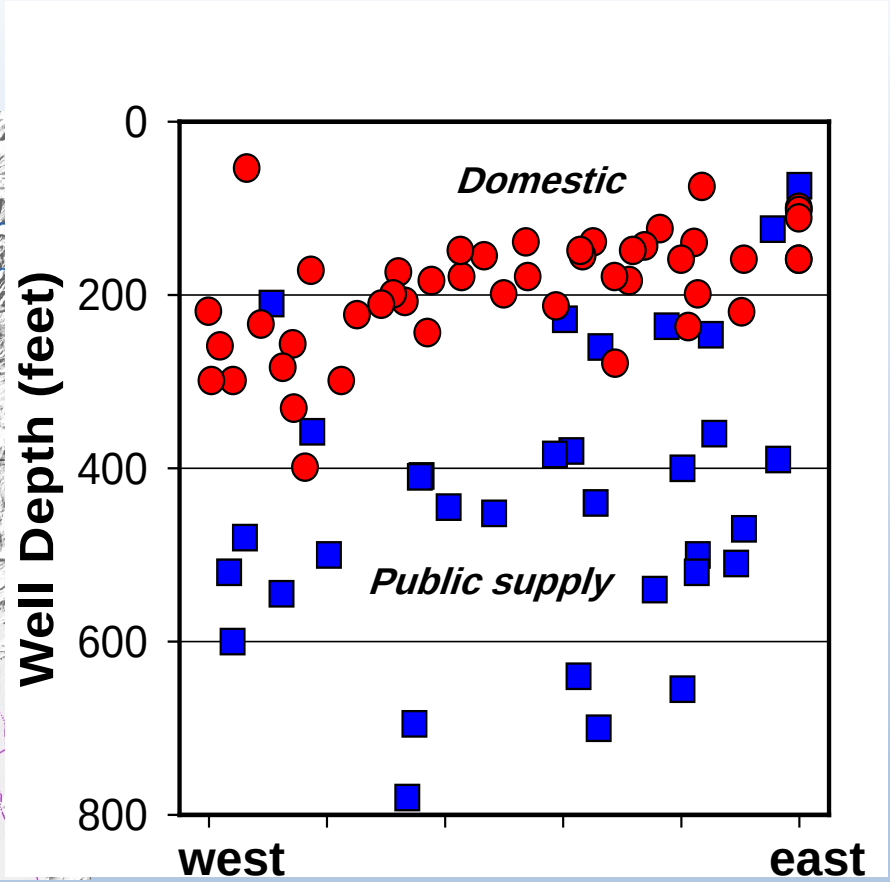
Everything is connected to everything else:

Uranium in the San Joaquin Valley

USGS

SJV Kings Basin



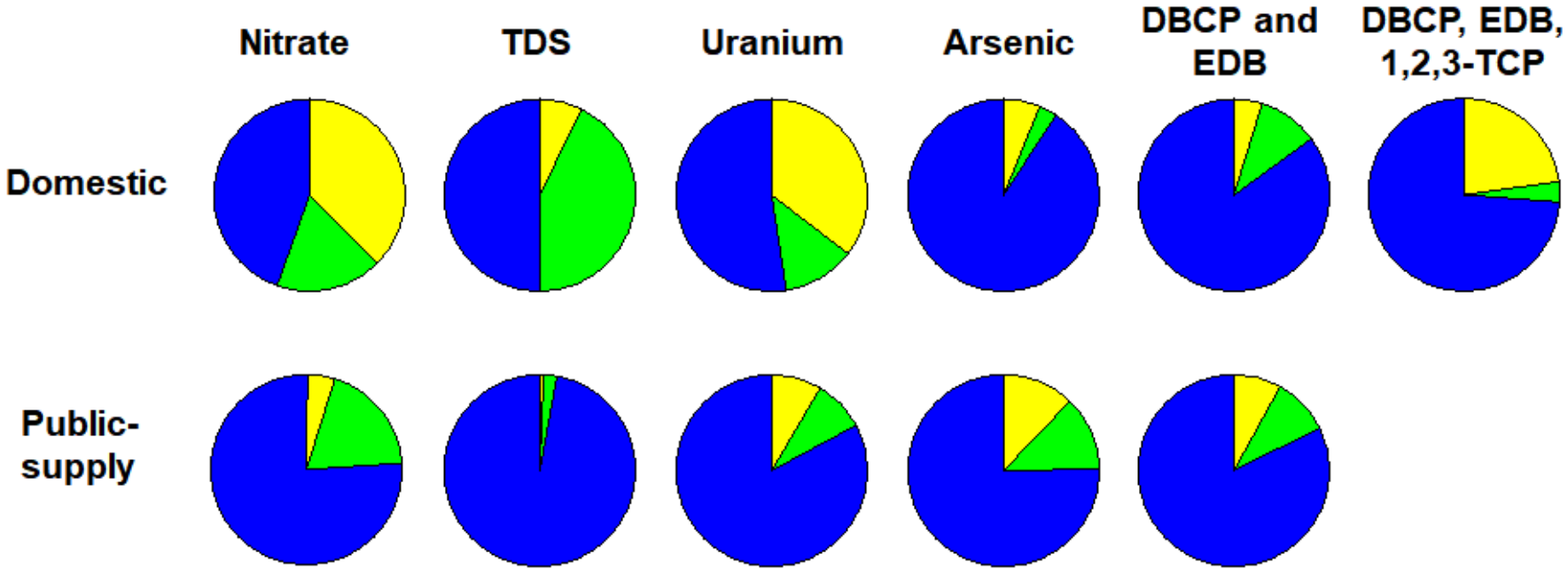


USGS

Modified from:
Burton et al (2012)
Shelton & Fram (2017)

[Everything is connected to everything else]

SJV Kings Basin– Current Conditions



% of Basin with Concentration:

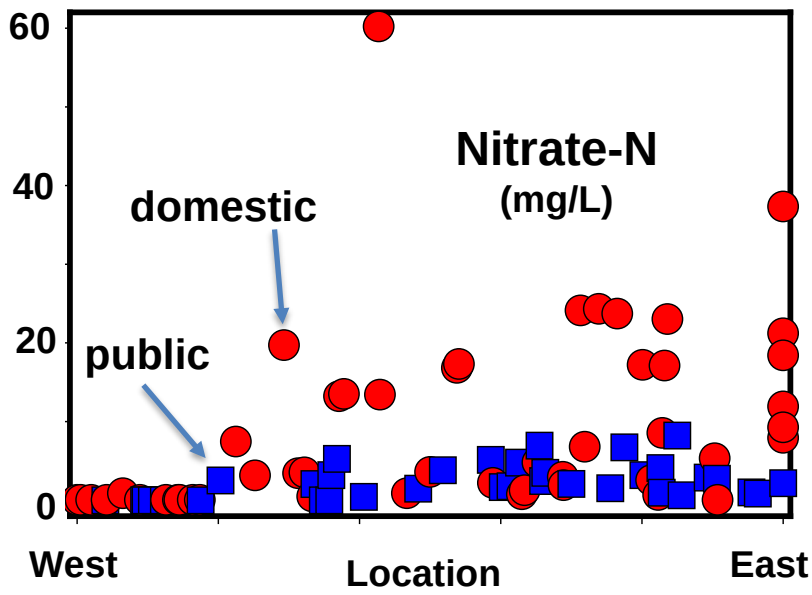
- **Above MCL (upper SMCL for TDS)**
- **Above 0.5 x MCL (0.1 x MCL for fumigants)**
- **Below 0.5 x MCL or not detected**

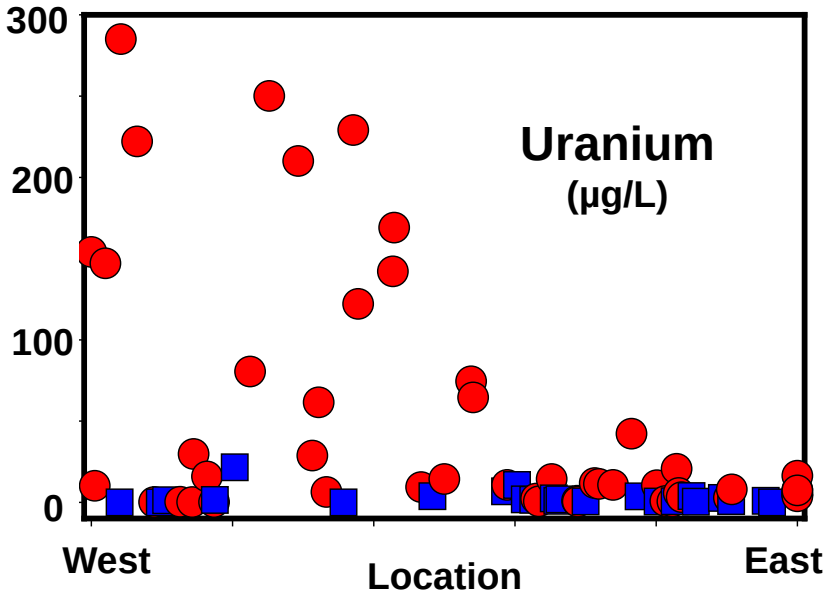
Modified from:
Burton et al (2012)
Fram & Shelton (2018)

USGS

[Everything is connected to everything else]

SJV Kings Basin – Current Conditions



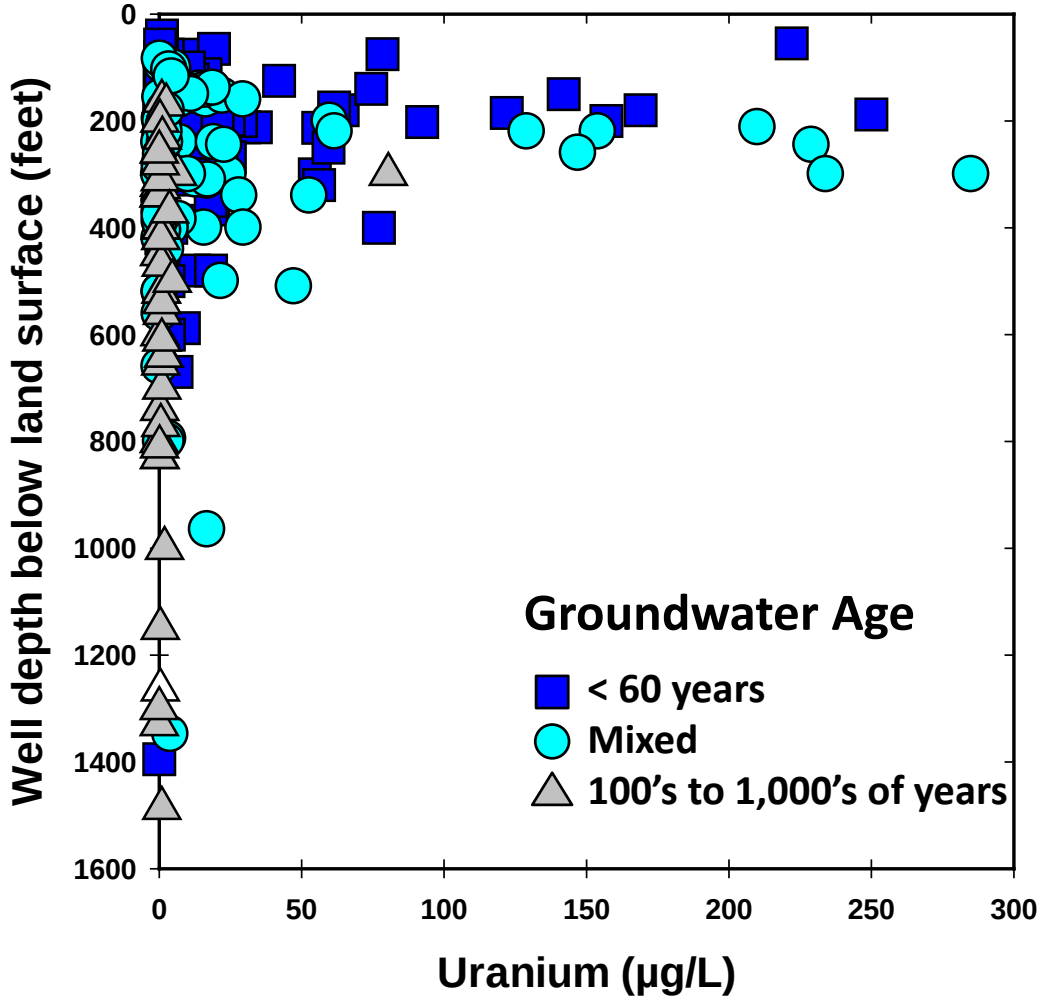


USGS

Modified from:
Burton et al (2012)
Shelton & Fram (2017)

[Everything is connected to everything else]

SE SJV Uranium

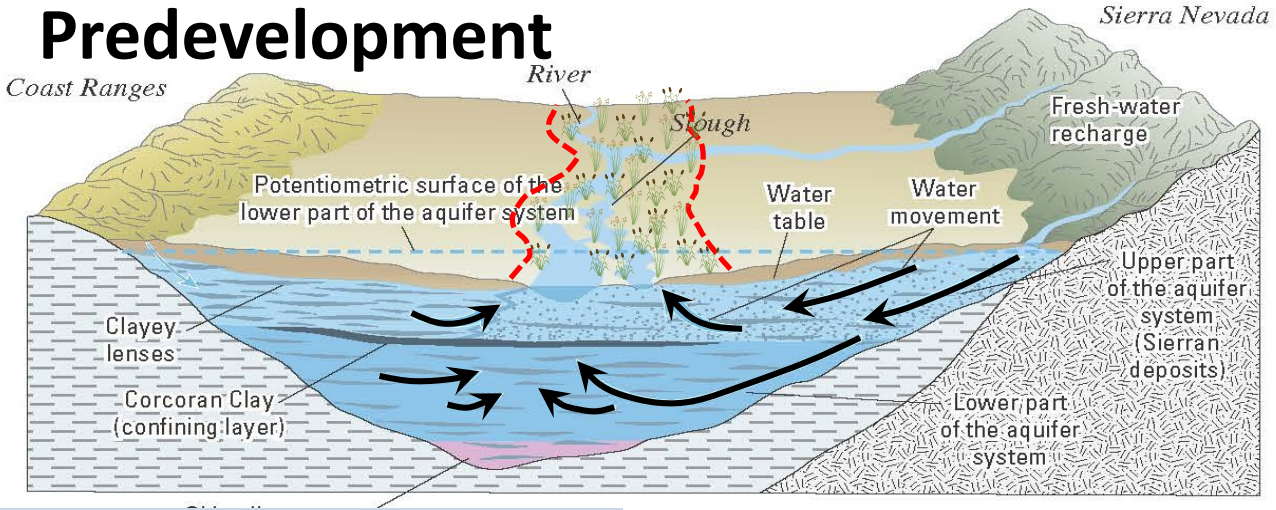


Modified from:
Jurgens et al (2010)
Burton et al (2012)
Shelton & Fram (2017)

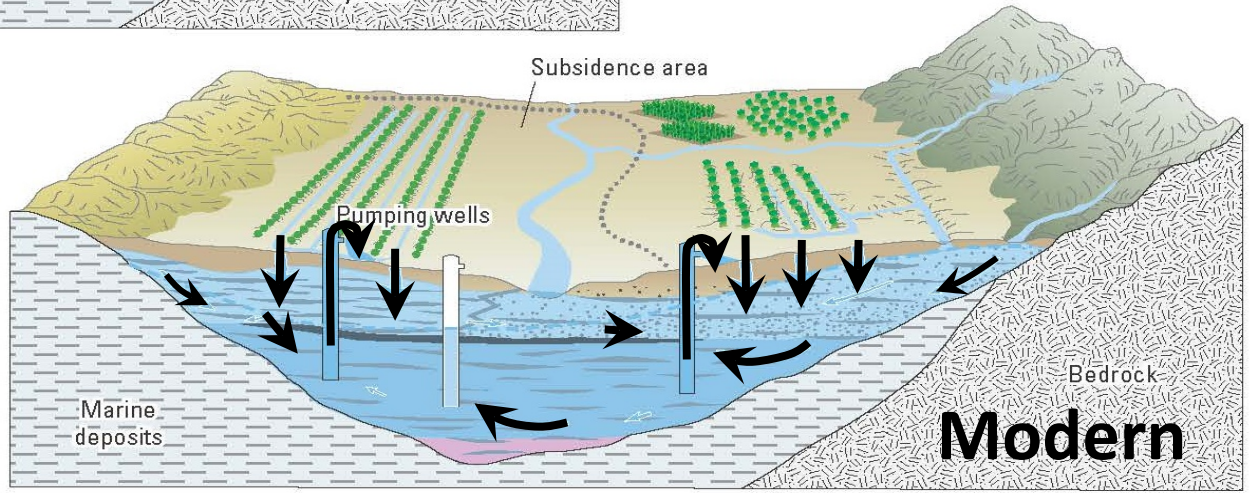
USGS

[Everything is connected to everything else]

Predevelopment



San Joaquin Valley



USGS

Faunt (2009)

[Everything is connected to everything else]

Rules can change:

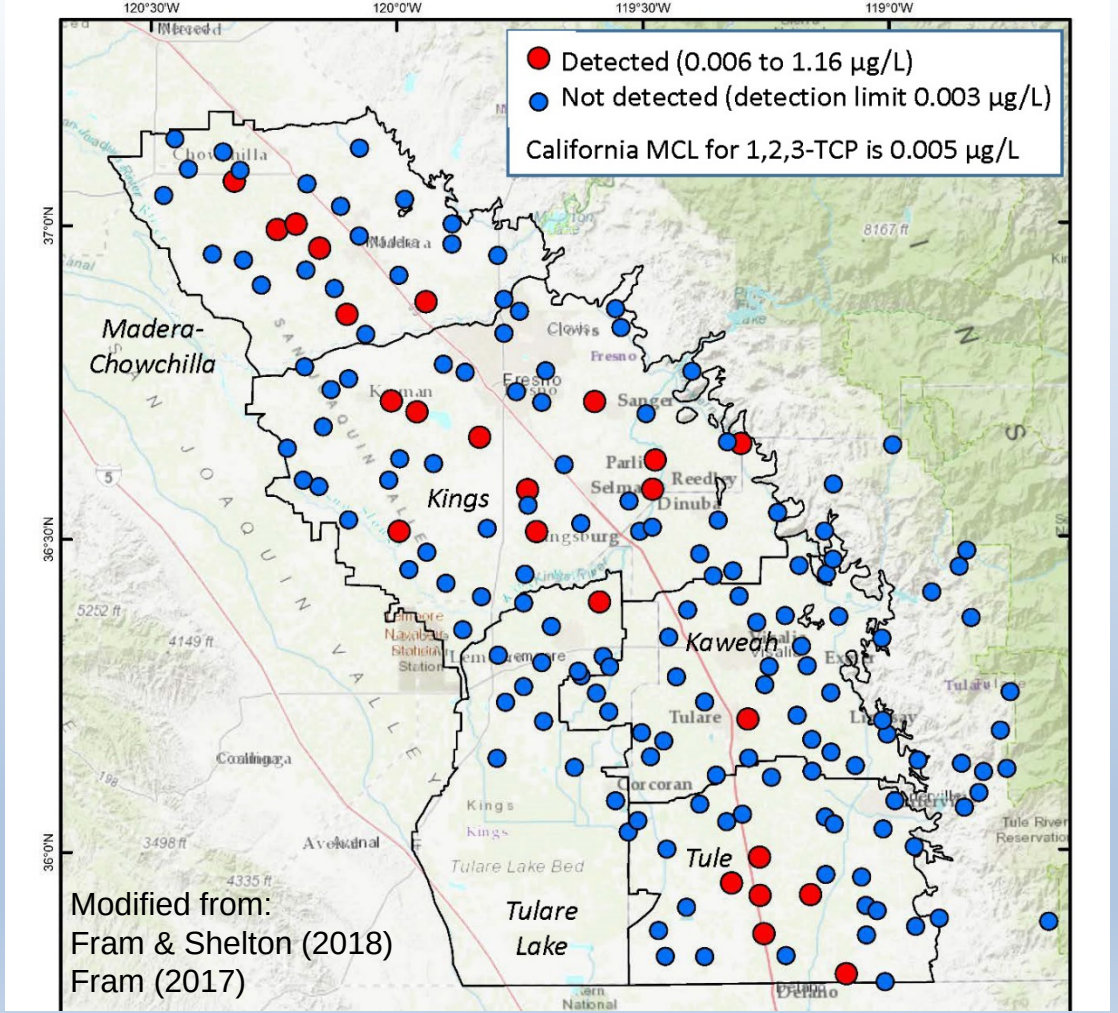
1,2,3-Trichloropropane

USGS

123-TCP in San Joaquin Valley Domestic Wells

- > 0.005 µg/L (MCL)
- < 0.005 µg/L or not detected

MCL as of 2014



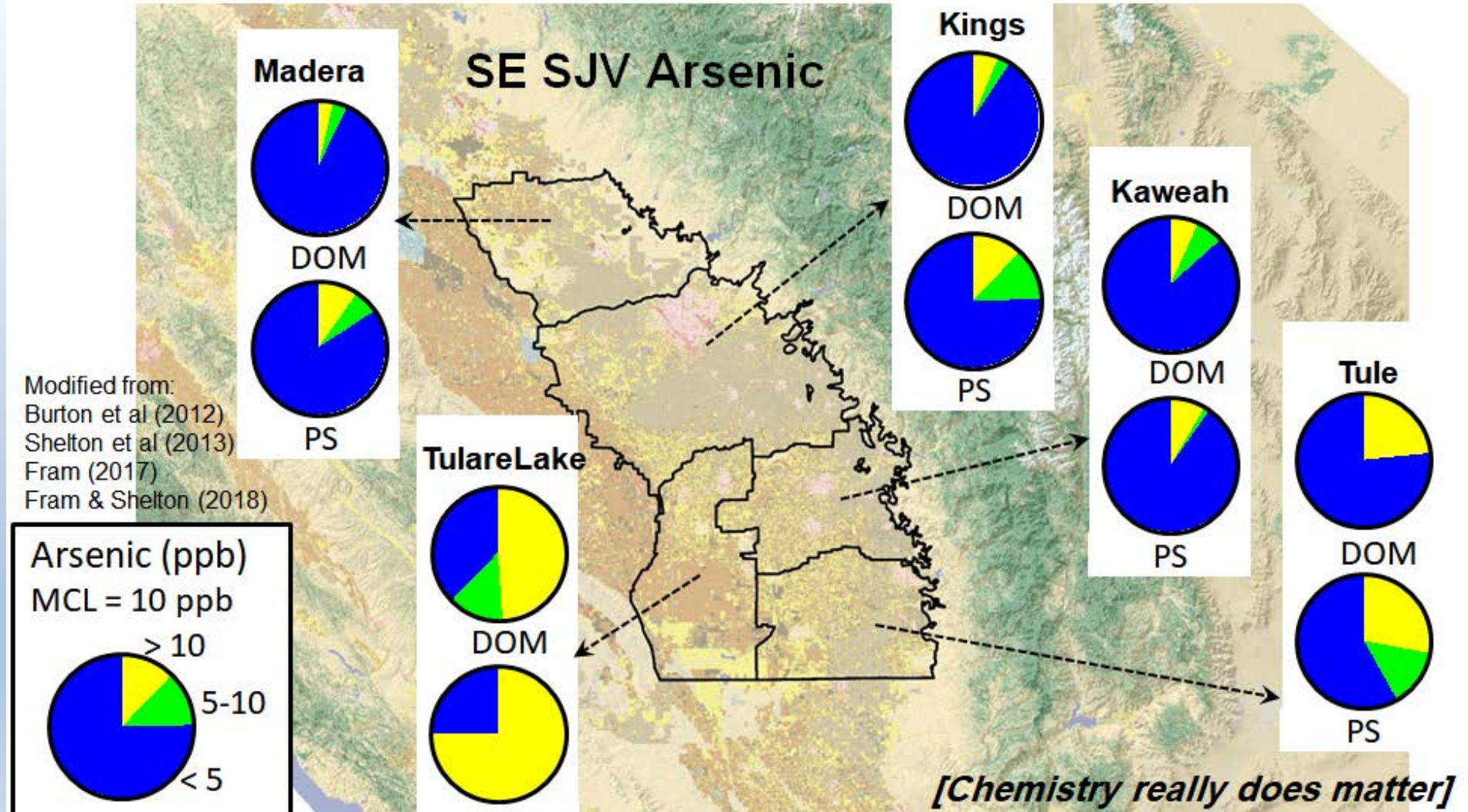
USGS

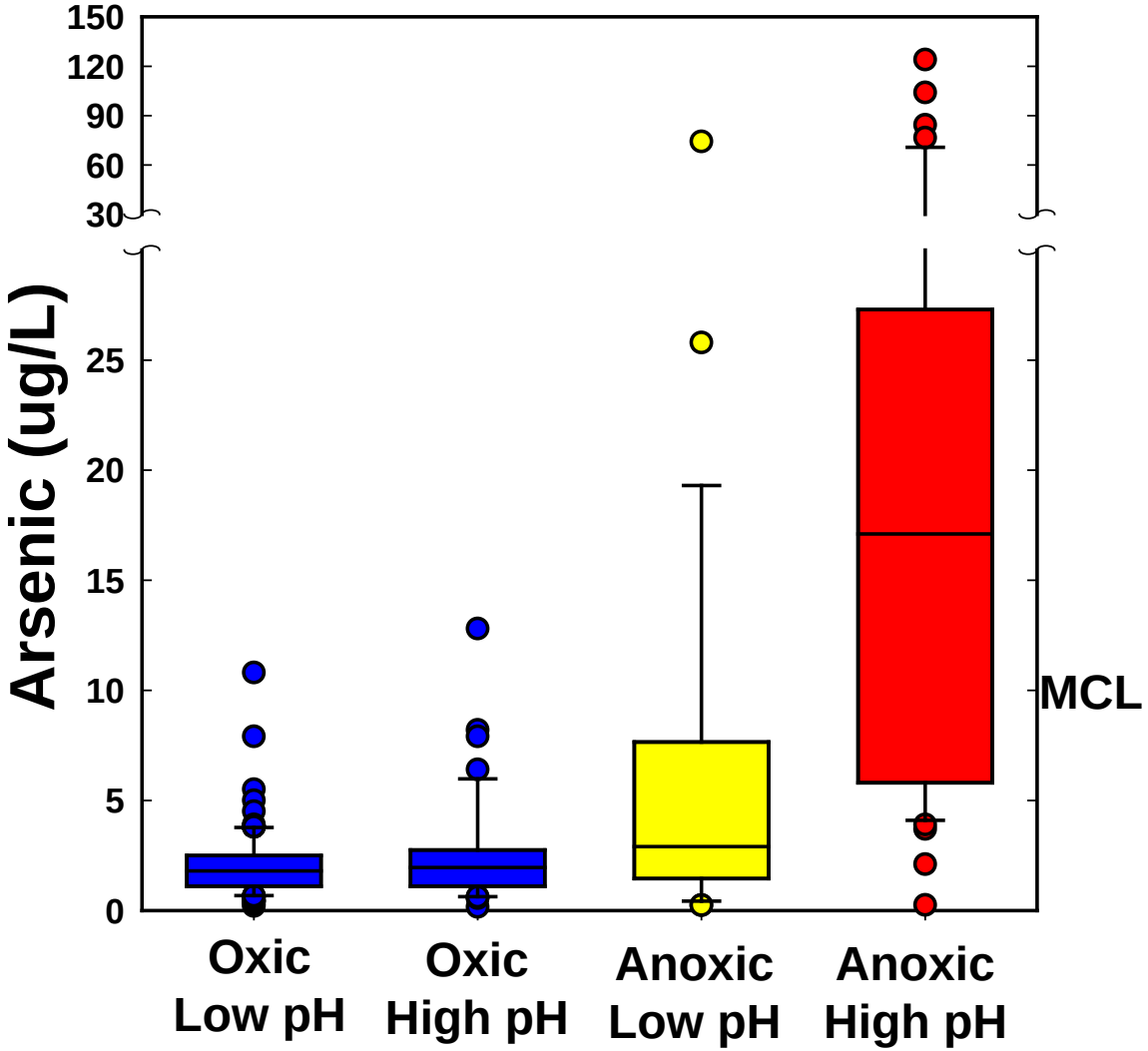
[Rules can change]

Chemistry really does matter:

Trace metals

USGS


SE SJV Arsenic
Madera
DOM
PS
Kings
DOM
PS
Kaweah
DOM
PS
Tule
DOM
PS
TulareLake
DOM
Modified from:
Burton et al (2012)
Shelton et al (2013)
Fram (2017)
Fram & Shelton (2018)
Arsenic (ppb)
MCL = 10 ppb
> 10
5-10
< 5
[Chemistry really does matter]



SE SJV Arsenic

Geochemical Conditions

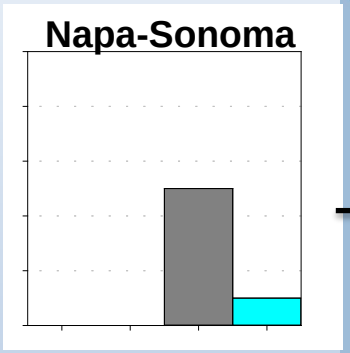
Modified from:
Belitz et al (2003)
Data from NWIS

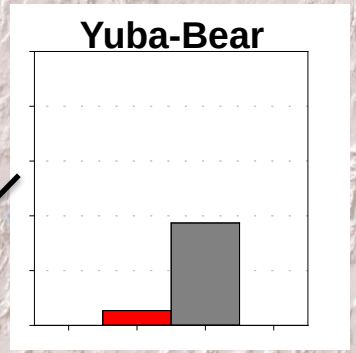
[Chemistry really does matter]

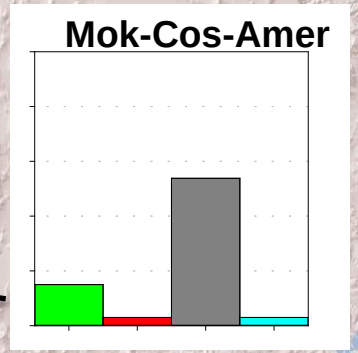
Fractured Bedrock Aquifers

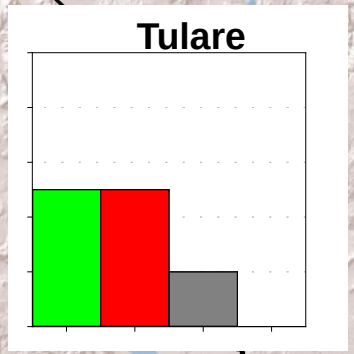
Modified from:
Fram & Shelton (2018)
Fram et al (2017)
Bennett (2018)
Burton & Wright (2018)

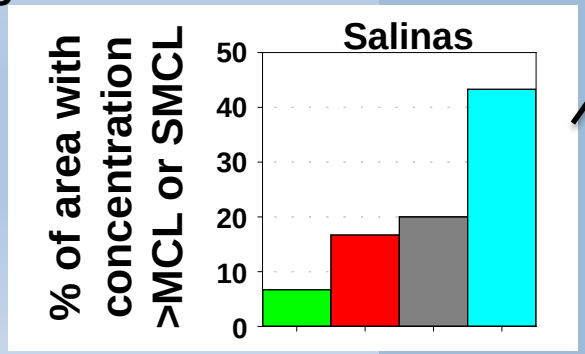
- Nitrate
- As, Ba, F, Se, U
- Manganese
- TDS





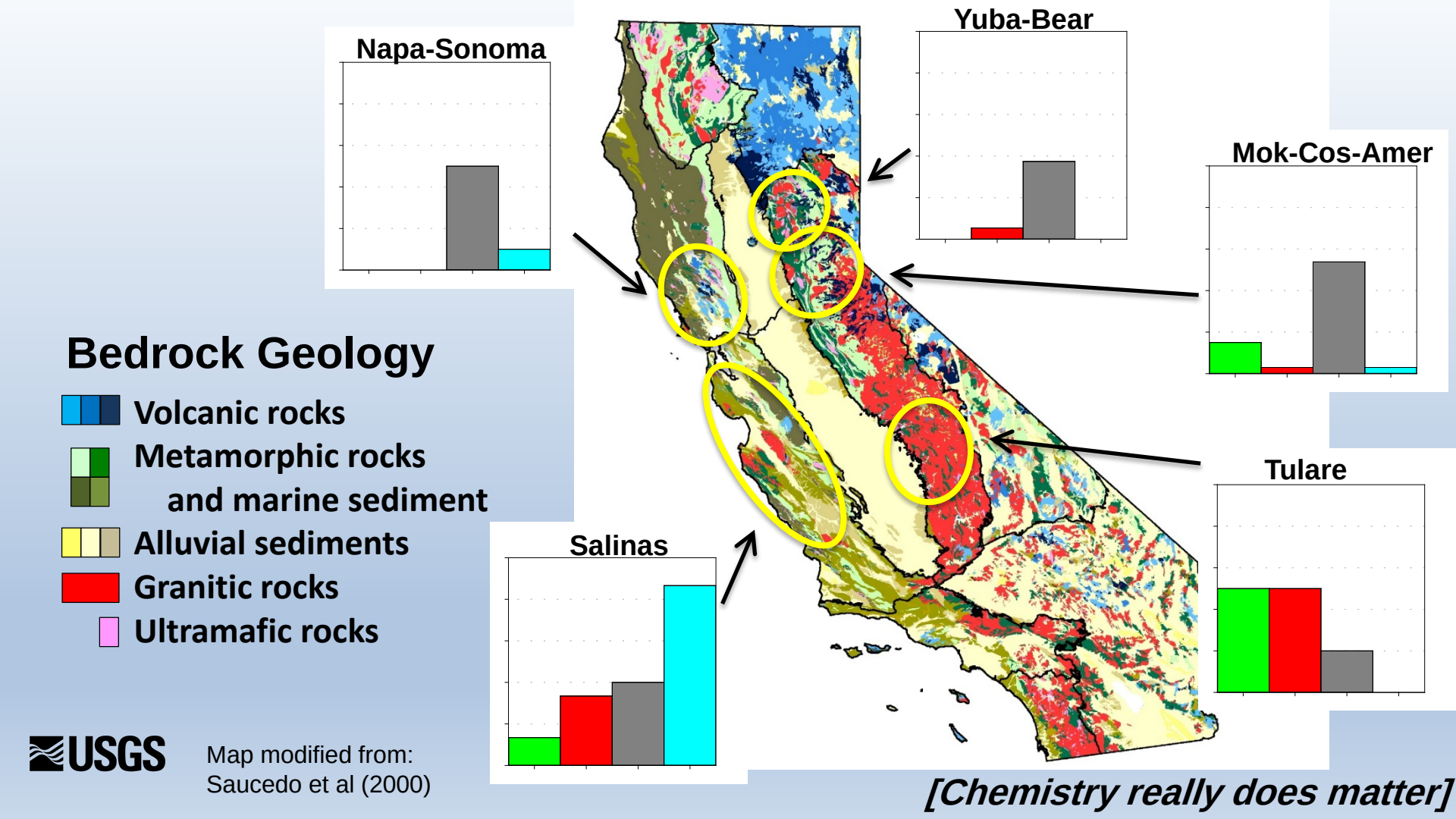






USGS

[Chemistry really does matter]



USGS

Map modified from:
Saucedo et al (2000)

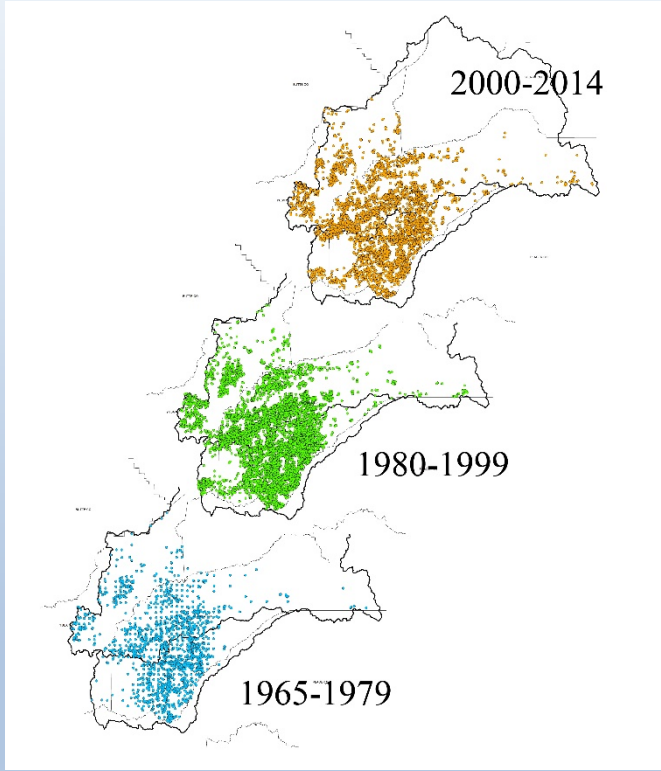
[Chemistry really does matter]

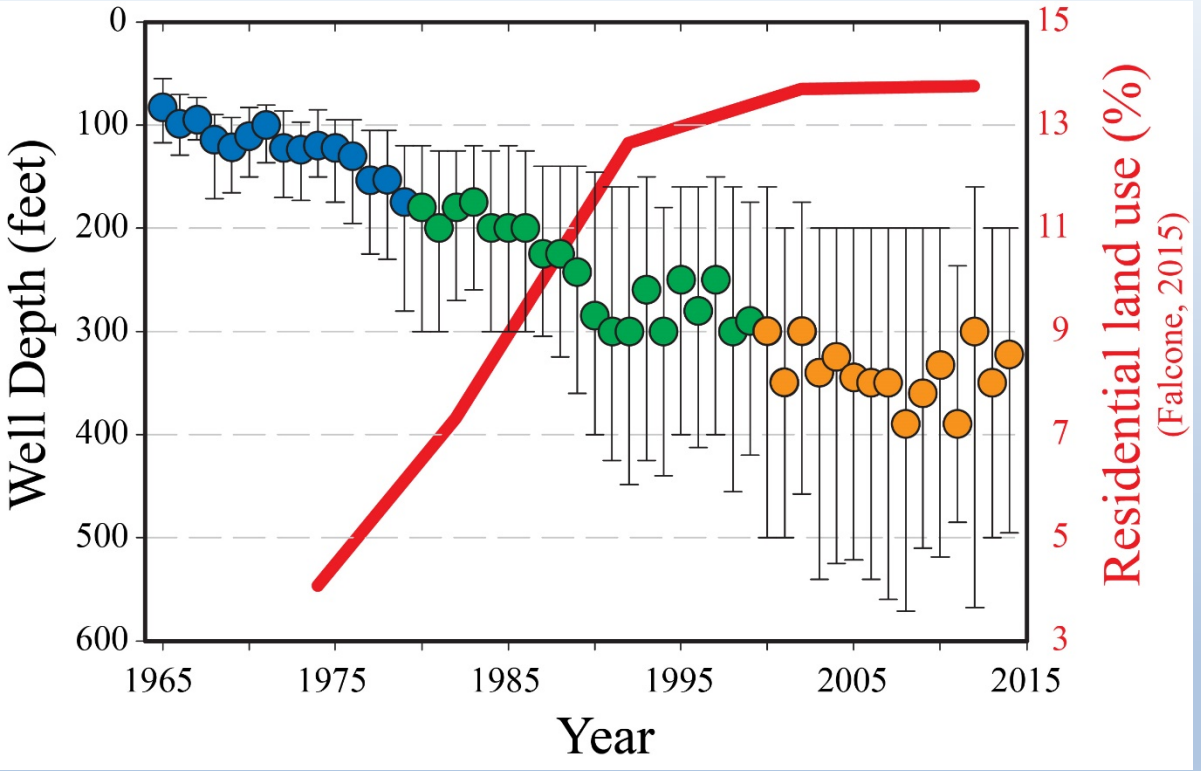
Population grows:

Land use change and groundwater in the Foothills

USGS

Land Use Change and Well Depth in Yuba-Bear Bedrock Aquifers





USGS

Fram & Taylor (2018)

[Population grows]

Considerations for Domestic Well Needs Assessment

1) Nothing happens right away
2) Nothing is as simple as it seems
3) Everything is connected to everything else
4) Rules can change
5) Chemistry really does matter
6) Population grows

USGS

Cited References

Belitz, K., Dubrovsky, N.M., Burow, K.R., Jurgens, B.C., and Johnson, T.D., 2003, Framework for a ground-water quality monitoring and assessment program for California: USGS WRIR 2003-4166, 78 p., https://doi.org/10.3133/wri034166

Bennett, G.L., V, 2018, Status and understanding of groundwater quality in the North San Francisco Bay Shallow Aquifer study unit, 2012; California GAMA Priority Basin Project: USGS SIR 2017–5051, 74 p., https://doi.org/10.3133/sir20175051

Burton, C.A., and Wright, M.T., 2018, Status and understanding of groundwater quality in the Monterey-Salinas Shallow Aquifer study unit, 2012–13: California GAMA Priority Basin Project: USGS SIR 2018–5057, 116 p., https://doi.org/10.3133/sir20185057

Burton, C.A., Shelton, J.L., and Belitz, K., 2012, Status and understanding of groundwater quality in the two southern San Joaquin Valley study units, 2005–2006—California GAMA Priority Basin Project: USGS SIR 2011–5218, 150 p. https://doi.org/10.3133/sir20115218

Faunt, C.C. (ed.), 2009, Groundwater availability of the Central Valley Aquifer, California: USGS Professional Paper1766, 227 p., https://doi.org/10.3133/pp1766

Fram, M.S. and Shelton, J.L., 2018, Groundwater Quality in the Shallow Aquifers of the Madera–Chowchilla and Kings Subbasins, San Joaquin Valley, California: USGS OFR 2017–1162, 4 p., https://doi.org/10.3133/ofr20171162

Fram, M.S., 2017, Groundwater quality in the shallow aquifers of the Tulare, Kaweah, and Tule Groundwater Basins and adjacent highlands areas, Southern San Joaquin Valley, California: USGS Fact Sheet 2017-3001, 4 p., https://doi.org/10.3133/fs20173001

Fram, M.S., and Shelton, J.L., 2018, Groundwater quality in the Mokelumne, Cosumnes, and American River Watersheds, Sierra Nevada, California: USGS OFR 2018-1047, 4 p., https://doi.org/10.3133/ofr20181047

Fram, M.S., and Taylor, K.A., 2018, Groundwater Recharge and Depletion in the Yuba River and Bear River Watersheds, Sierra Nevada, California (abstract and poster for Groundwater Resources Association Western Groundwater Congress, September 25-27, 2018, Sacramento, CA).

Fram, M.S., Jasper, M., and Taylor, K.A., 2017, Groundwater Quality in the Yuba River and Bear River watersheds, Sierra Nevada, California: USGS OFR 2017–1115, 4 p., https://doi.org/10.3133/ofr20171115

Johnson, T.D., and Belitz, K., 2015. Identifying the location and population served by domestic wells in California: J. Hydrol.: Regional Studies, v. 3, p. 31-86, http://dx.doi.org/10.1016/j.ejrh.2014.09.002

Johnson, T.D., and Belitz, K., 2017, Domestic well locations and populations served in the contiguous U.S.: 1990: Science of the Total Environment, v. 607-608, p. 658-668, https://doi.org/10.1016/j.scitotenv.2017.07.018

Jurgens, B.C., Böhlke, J.K., and Eberts, S.M., 2012, TracerLPM (Version 1): An Excel® workbook for interpreting groundwater age distributions from environmental tracer data: USGS Techniques and Methods Report 4-F3, 60 p. https://doi.org/10.3133/tm4F3

Jurgens, B.C., Fram, M.S., Belitz, K., Burow, K.R., and Landon, M.K., 2010, Effects of Groundwater Development on Uranium: Central Valley, California, USA: Groundwater, v. 48, p. 913-928, https://doi.org/10.1111/j.1745-6584.2009.00635.x

Shelton, J.L., and Fram, M.S., 2017, Groundwater-quality data for the Madera/Chowchilla–Kings shallow aquifer study unit, 2013–14: Results from the California GAMA Program: USGS Data Series 1019, 115 p., https://doi.org/10.3133/ds1019

Voss, S.A., and Jurgens, B.C., 2018, Spatial Point Data Sets and Interpolated Surfaces of Well Construction Characteristics for Domestic and Public Supply Wells in the Central Valley, California, USA: USGS data release, https://doi.org/10.5066/F76Q1V9G

USGS