COLORADO GEOLOGICAL SURVEY

Open-File Report OF-24-08
Technical Memorandum
Baseline Radiological Study Year 3: Uravan Belt

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ABOUT THIS REPORT

The Colorado Geological Survey (CGS), a department of the Colorado School of Mines, has been funded through a grant from the Colorado Department of Public Health & Environment (CDPHE) to conduct a 5-year study of baseline naturally occurring radionuclides and metals in groundwater obtained from privately owned residential water wells throughout Colorado. This report presents the methodology and results of Year 3 conducted in 2024 in the Uravan Belt region of western Colorado, including parts of Mesa, Montrose, and San Miguel counties.

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RE: Baseline Groundwater Study Year 3 Report, Uravan Belt, Contract 2024*4140

The Colorado Geological Survey (CGS), a department of the Colorado School of Mines, has been funded through a grant from the Colorado Department of Public Health & Environment (CDPHE) to conduct a 5-year study of baseline naturally occurring radionuclides and metals in groundwater obtained from privately owned residential water wells throughout Colorado. This report presents the methodology and results of Year 3 conducted in 2024 in the Uravan Belt region of western Colorado, including parts of Mesa, Montrose, and San Miguel counties.

Purpose: Per CDPHE, the primary purpose is as follows: "Ambient monitoring of groundwater will give scientists and the people of Colorado an idea of background conditions of radionuclides and metals in groundwater in Colorado. This information will help decision makers make informed decisions regarding the care and use of groundwater in these regions of the state. This project will help the state build a baseline water quality dataset for groundwater." CDPHE also stated that the study was to be education focused for homeowners on wells.

Background: The Uravan Belt consists of a narrow, elongated 70 by 30 miles geological area in western Colorado and eastern Utah which contains uranium, vanadium, and radium ore deposits. These deposits were mined historically from the Jurassic aged Salt Wash Member of the Morrison Formation. In the eastern portion of San Miguel County, uranium was mined as a by-product with vanadium in the mineral roscoelite in the Jurassic Entrada Sandstone near the town of Placerville. In Colorado, the Uravan Belt includes the currently inactive Gateway, Uravan, Bull Canyon, Gypsum Valley, and Slick Rock mining districts containing about 1,200 small mines[1]. The Uravan mineral belt mines produced almost fourteen million tons of ore averaging 0.24 percent triuranium octoxide (U_3O_8) and over 356 million pounds of vanadium oxide[2]. The population in this region is mostly concentrated within small former mining towns extending from Gateway through Uravan (a former town) to Slick Rock. Even though the population is generally restricted to small towns, this region was selected for Year 3 of this study based on the widespread deposits of uranium (**Figure 1**).

Geology: The sandstones of the Salt Wash Member were deposited in meandering streams and are porous, permeable, and locally contain abundant fossil plant material, including tree trucks and branches. These deposits were subsequently covered over by shales, siltstones, and volcanic ash beds of the Jurassic aged Brushy Basin Member of the Morrison Formation. Sometime after the deposition of the sandstones, uranium- and vanadium-

[1] Nelson-Moore, J.L., Collins, D.B., and Hornbaker, A.L., 1978, Radioactive mineral occurrences of Colorado and bibliography: Colorado Geological Survey Bulletin 40, 1054 p., 12 plates.

[2] https://coloradogeologicalsurvey.org/energy/e-uranium/

bearing waters, flowed through the sandstones. The source is presumed to have been the overlying volcanic ash beds. The uranium- and vanadium-bearing water met changing physicochemical conditions, such as a reducing zone occupied by organic material or changes in the acidity of the water. This resulted in the uranium precipitating as the minerals uraninite or coffinite, or co-precipitating with vanadium as carnotite. In addition, vanadium precipitated with mica as the mineral Roscoelite. Uranium and vanadium minerals formed irregularly shaped ore deposits often in patches, commonly referred to as uranium rolls or roll fronts. The dominant orientation of the logs and rolls were perpendicular to the main trend of the Uravan Belt[3].

Historic groundwater uranium data in wells and springs was sparse as shown in **Figure 2**. Exceedances of the uranium 0.030 milligram per liter (mg/L) drinking water guideline are shown in red. These data are sourced from the National Water Quality Monitoring Council Water Quality Portal (WQP) which also includes the National Uranium Resource Evaluation (NURE) dataset. No uranium groundwater quality data existed for the Uravan Belt area within the databases for the Colorado Energy & Carbon Management Commission (ECMC) (formerly known as the Colorado Oil and Gas Conservation Commission (COGCC)) and the Colorado Department of Agriculture (CDA).

2024 Methodology

The Year 3 contract included a total of 46 budgeted samples. To obtain representative coverage, a sampling grid was created using existing 1:24,000 scale geologic map boundaries. Grids spaces were placed in areas of radioactive mines and mining districts from the 1978 CGS Bulletin 40. Grid creation was then refined using the Colorado Division of Water Resources (DWR) completed residential wells downloaded on August 14, 2024. Specifically, if only a few residential wells were present in a grid area which would result in a low likelihood of obtaining volunteers, then multiple geologic map quadrangle areas were combined to create a larger numbered grid space. A total of 14 grid spaces were created containing 2, 3, or 4 samples per grid space (**Figure 3**).

The overall sampling approach was for the CGS to solicit volunteers whose water supply was from privately owned residential use wells, send them sampling kits to fill and ship (pre-paid) back to the CGS. Received groundwater samples were assigned anonymizing samples numbers and kept until there were enough to ship to the analytical laboratory in batches of typically six samples per cooler. Sample numbers were generated as follows: the year was listed first (2024) followed by the Federal Information Processing System (FIPS) code for the county (077 for Mesa County, 085 for Montrose County, and 113 for San Miguel County), then the FIPS Colorado code (08) and finally a sequential sample number within the county.

The CGS created sampling kits, which included 9x9x9 inch cardboard boxes lined with a plastic bag, a laboratory supplied sample container pre-preserved with a small amount of nitric acid, and a large Ziploc bag containing a pair of nitrile sampling gloves, sampling instructions, a sample form to be completed by the homeowner, tape for repackaging the box, and a prepaid FedEx Ground return shipping label. Homeowners had only to collect the sample, fill out the sample form and seal it inside the Ziplock bag, repackage the box, and drop it off at the local FedEx shipping office (or drop box) or arrange with FedEx to have it picked up.

The sample form included their contact information, sample date and time, and on a voluntary basis the well information (if known) such as well depth, DWR permit number, and whether the well was completed in overburden or bedrock.

[3] Fischer, R.P., and Hilpert, L.S., 1952, "Geology of the Uravan Mineral Belt": U.S. Geological Survey, Bulletin 998-A, 13 p.

If the homeowner had a filtration system, they were asked to bypass it to obtain "raw" water. All homeowners were also asked to run their water long enough to obtain fresh water from the well rather than water that may have been sitting in the piping or water tanks. Only one volunteer had a cistern, and they were asked to take the sample from before the cistern, rather than water that had been sitting in the cistern, if possible. Possible pre-cistern sample collection locations included near the well head (from an outdoor yard hydrant) or from the pipe that flowed into the cistern. This information was documented by the homeowner on the sample form.

Volunteer Solicitation: The CGS contacted county commissioners within the study area to ask that they place information about the sampling program on their websites or social media pages, using information provided by the CGS. The CGS created and placed an ad soliciting volunteers in the local newspaper, the San Miguel Basin Forum, for four weeks. In addition, a front page article ran in this paper on September 18, 2024. The ad and article explained the grant funded study and included a grid map showing the allotted number of well samples per numbered grid. Volunteers were requested to email Lesley Sebol at the CGS with their physical address, phone number (needed for FedEx shipping) and what grid number they thought they might be located within. The plan was to update the grid map as volunteers were obtained, to reflect the remaining grid samples available for next week's ad. Completed grids were to be progressively removed from the updated map. If too many volunteers were obtained from a grid space, they would be notified that they had been placed on reserve. However, the response to the ad was extremely low and the grid map did not need updating.

Additional efforts were made by the CGS to increase Year 3 homeowner participation within the study area. About 600 residential water-well records in the downloaded DWR database were reviewed against the county Assessor's information to identify owners who lived at or near their property. Those with contact addresses out of state were excluded for sampling logistic reasons. Initially, owners with viable email addresses were contacted, which was later expanded to include phoning for a total of 67 direct contacts.

Three volunteers never shipped back their water sample. One did not reply to reminders. For the other two, one had their well pump fail and the other did not get out to their cabin to sample within the necessary time frames. Thus, we received 23 samples out of 26 samples. Sampled well locations are shown in **Figure 4**.

A spreadsheet was used to track incoming volunteer requests, the status of sample kit shipments, address location coordinates, and well-specific information. Volunteers were also tracked using their addresses in ArcGIS Pro in which the grid had been created, as it provided necessary information confirming which grid an address was located within, and relative proximity to other volunteers.

On the well sampling form, most volunteers were able to fill out their well information at least partially, with well depth being the most common well item completed. For wells without DWR permit numbers, the DWR database was queried for the well details. If found, then the provided well depth on the sample form was verified, and where different from the DWR records was adjusted in the project data table. Also, the geologic formation from the driller's well log was obtained or verified, where available.

Sample Shipping to Eurofins St. Louis: The CDPHE contracted Eurofins St. Louis of Earth City, MO for this project in 2024. The CGS stockpiled received water samples until there were enough to fill a cooler (typically six per cooler). When one or more coolers were filled, the CGS dropped them off at the local Eurofins Denver laboratory using standard chain of custody procedures. Eurofins Denver then shipped it overnight to their St. Louis laboratory. The St. Louis lab logged in received water samples and assigned a unique lab ID number to each sample.

The 2024 list of metal and radionuclide analytes included:

- Metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium, thorium, tin, uranium, vanadium, and zinc),
- Gross alpha and gross beta,
- Isotopic radium-226 and radium-228, and
- Isotopic thorium-228, thorium-230, and thorium-232.

Homeowners were emailed their individual lab reports along with the CDPHE provided 2023 Fact Sheet entitled "Private well water and your health, potential health impacts from select metals and radionuclides". This Fact Sheet contained guidance criteria and potential health impacts for the above analyte list, along with water treatment related information.

2024 Lab Results

Table 1 summarizes all Uravan sampled wells, including their assigned sample numbers, location coordinates, well depth information (where available), and water quality data. It also includes the laboratory-assigned ID number for each sample. Results in Table 1 with concentrations greater than the applicable drinking water guidelines are bolded.

The spatial distribution of the groundwater quality data for specific metals and radionuclides that exhibited exceedances of their applicable drinking water guidelines is provided in **Figures 5 through 17**. Also included are radionuclides that either have no drinking water guideline (thorium) or exhibited no guideline exceedances but are contributors to the gross radionuclide measurements. Figures generated include uranium (Figure 5), thorium (Figure 6), gross alpha (Figure 7), gross beta (Figure 8), radium-226 plus radium-228 (Figure 9), thorium-230 plus thorium-232 (Figure 10), antimony (Figure 11), arsenic (Figure 12), boron (Figure 13), cobalt (Figure 14), iron (Figure 15), lead (Figure 16), and manganese (Figure 17). Sample locations in these figures with no detections of the analyte of interest are depicted by small, gray filled circles. Concentrations at or below the drinking water guideline (including detected estimated values below the reporting limit) were shown in blue, with guideline exceedances being shown in red. Figures were not generated for non-radioactive metals having no exceedances of their respective water quality guidelines.

Data Evaluation:

Analytes exhibiting exceedances of the applicable drinking water guidelines are listed with the number of exceedances from most to least: arsenic (6), lead (5), radium 226+228 (4), gross alpha (3), manganese (3), iron (2), uranium (1), gross beta (1), antimony (1), boron (1), and cobalt (1). The following bulleted list presents observations for the various analytes:

- Uranium was detected at 19 of the 23 sampled locations and at two additional locations with estimated values below the reporting limit. Only one exceedance was reported, located in grid #4 (Figure 5). This well was 150 feet deep and was described by the well driller as having a "mudstone" geology.
- Thorium was detected at one location above the reporting limit in the mg/L range (in grid #6 within a 293 ft deep well reported as sandstone). It was also detected with estimated concentrations (below the reporting limit) at six additional locations (Figure 6).
- Gross alpha (Figure 7) and gross beta (Figure 8) were detected above their calculated reporting limits at 11 and 20 locations, respectively. However, gross alpha only exhibited three exceedance and gross beta had one. The gross alpha exceedances occurred in sandstone & shale, sandstone, or conglomerate as reported by the well drillers. The gross beta exceedance occurred in the same conglomerate well.

- Radium-226 and radium-228 (Figure 9) were detected at 15 and 8 locations, respectively. Both were detected together at seven locations, of which four exhibited exceedances of the combined radium-226+228 guideline of 5 pCi/L. These exceedances were reported within sandstones or the conglomerate (Table 1).
- Thorium-228 and thorium-230 were detected in low concentrations at two and three locations, respectively. Thorium-232 was not detected at any of the sampled locations. No exceedances of the thorium-230+232 guideline of 60 pCi/L occurred (Figure 10).
- Antimony (Figure 11) exhibited one exceedance of the 0.006 mg/L guidance criteria and plus had one estimated value detection. The exceedance occurred at the same well as the gross alpha and radium-226+228 exceedances (grid #13).
- Arsenic was detected at concentrations above the reporting limit at six locations, of which five also exceeded the 0.01 mg/L guidance criteria (Figure 12). Six additional locations had estimated concentrations below the reporting limit.
- Boron was detected at concentrations above the reporting limit at eight locations, of which only one exceeded the 1.4 mg/L guidance criteria (Figure 13). This exceedance occurred in grid #11. Fifteen additional locations had estimated concentrations below the reporting limit.
- Cobalt was detected at estimated concentrations below the reporting limit at 3 locations. Cobalt was detected above the reporting limit at three other locations, of which one exceeded the 0.006 mg/L guidance criteria (Figure 14).
- Iron was detected at 17 locations above the reporting limit, but only two exhibited exceedances of the 14 mg/L guidance criteria (Figure 15). Iron was also detected at estimated concentrations below the reporting limit at two locations.
- Lead was detected at estimated concentrations below the reporting limit at five locations and was present above the reporting limit at five other locations which all exceeded the guidance criteria of being “present” above the reporting limit (Figure 16).
- Manganese was detected at estimated concentrations below the reporting limit at two locations and was detected above the reporting limit at 15 other locations. Three of these exceeded the 0.3 mg/L guidance criteria (Figure 17). These exceedances occurred in grid #13, #11, and #14 in sandstone, sandstone and shale, or sand and gravel deposits, respectively.

Best Regards,

Lesley Sebol, PhD
Senior Hydrogeologist

Orna Buch Leviatan
Geologist

Attachments:

Table 1. Water quality data near the Uravan Belt, Colorado

Figure 1. The Uravan Belt of western Colorado spans the south end of Mesa County southerly through Montrose and San Miguel counties.
Figure 2. Historic uranium water quality data from wells and springs in or near the Uravan Belt, Colorado
Figure 3. Sampling grid and residential water wells in the Uravan Belt, Colorado
Figure 4. Sampled residential water wells in The Uravan Belt, Colorado, in 2024
Figure 5. Uranium concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 6. Thorium concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 7. Gross Alpha concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado
Figure 8. Gross Beta concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado
Figure 9. Radium 226+228 concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, CO
Figure 10. Thorium 230+232 concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, CO
Figure 11. Antimony concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 12. Arsenic concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 13. Boron concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 14. Cobalt concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 15. Iron concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 16. Lead concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado
Figure 17. Manganese concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado

Table 1. Water quality data near the Uravan Belt, Colorado

Sample ID	Lab ID	Latitude	Longitude	Sample Date	Time	Well Depth	Geology[1]	Gross Alpha (pCi/L)	(±)[2]	Gross Beta (pCi/L)	(±)	Radium-226 (pCi/L)	(±)	Radium-228 (pCi/L)	(±)	Ra-226+228 (pCi/L)	Thorium-228 (pCi/L)	(±)	Thorium-230 (pCi/L)	(±)	Thorium-232 (pCi/L)	(±)	Th-230+232 (pCi/L)
							DWG[3]:	*15*		*50*		--->		--->		*5*	--->		--->		--->		*60*
20241130801	*160-55781-1*	37.93	-108.05	10/6/2024	13:45	103	*shale & sandstone*	2.56 UG	3.8	12.2	2.4	0.136	0.1	0.538 U	0.4	0.136	-0.0305 U	0.13	-0.0757 U	0.16	0.00807 U	0.05	ND
20241130802	*160-55781-2*	37.97	-107.93	10/6/2024	18:30	363	*Mancos Shale*	0.452 UG	1.9	1.87	0.8	0.16	0.1	-0.607 U	0.4	0.16	0.0962 U	0.20	0.491	0.31	-0.0208 U	0.03	0.491
20241130803	*160-55906-1*	37.99	-108.03	10/7/2024	7:15	25	*hand dug, unknown*	4.44	2.5	2.98	1.1	0.116	0.1	-0.0431 U	0.4	0.116	-0.0353 U	0.13	0.15 U	0.22	-0.014 U	0.03	ND
20240850804	*160-55906-2*	38.30	-108.62	10/7/2024	16:45	360	*sandstone*	11 UG	9.4	16.7	5.3	0.791	0.2	0.31 U	0.4	0.791	0.0487 U	0.19	0.251 U	0.24	0.00494 U	0.06	ND
20241130805	*160-55906-3*	37.93	-108.01	10/9/2024	11:00	180	*sandstone & shale*	**31.5**	10.9	32.3	6.4	7.35	1.0	9.38	1.8	**16.73**	1.11	0.52	0.0702 U	0.28	0.0284 U	0.09	ND
20240850806	*160-55978-1*	38.40	-108.99	10/15/2024	8:47	350	*sandstone*	0.768 U	1.5	2.07	0.8	0.102 U	0.1	0.0638 U	0.4	ND	-0.0809 U	0.13	0.164 U	0.24	0.0287 U	0.08	ND
20241130807	*160-55978-2*	38.06	-108.04	10/16/2024	15:50	265	*siltstone/unk*	9.04	4.6	10.7	2.4	0.221 U	0.2	1.03	0.5	1.03	0.179 U	0.50	0.0254 U	0.37	0.268 U	0.29	ND
20241130808	*160-55978-3*	38.07	-107.91	10/8/2024	17:00	88	*clay & boulders*	0.857 UG	2.1	0.274 U	0.7	0.00276 U	0.1	0.244 U	0.4	ND	0.0197 U	0.17	0.148 U	0.23	0.00713 U	0.08	ND
20240850809	*160-56067-1*	38.31	-108.89	10/21/2024	9:00	150	*mudstone*	30.2	10.2	24.6	4.6	0.0540 U	0.1	-0.00426 U	0.3	ND	0.160 U	0.21	0.488	0.30	-0.00554 U	0.03	0.488
20240850810	*160-56067-2*	38.25	-108.54	10/22/2024	17:00	293	*sandstone*	5.12 UG	5.5	10.5	3.2	0.517	0.2	2.70	0.6	3.22	-0.0285 U	0.17	0.459	0.32	-0.0169 U	0.03	0.459
20240770811	*160-56067-3*	38.78	-108.84	10/27/2024	11:17	10	*west creek alluvium*	5.19	2.0	2.37	0.9	0.138	0.1	0.313 U	0.3	0.138	-0.112 U	0.23	0.0250 U	0.25	0.0492 U	0.11	ND
20240770812	*160-56302-1*	38.68	-108.97	10/26/2024	15:57	50	*unkown, existing well*	7.48 G	3.3	3.24	1.1	0.228	0.1	0.145 U	0.3	0.228	-0.0172 U	0.13	-0.0762 U	0.16	-0.0101 U	0.02	ND
20240850813	*160-56302-2*	38.32	-108.91	11/4/2024	9:00	205	*sandy shale*	9.04 G	6.0	15.9	3.4	0.236	0.1	0.488 U	0.4	0.236	0.276 U	0.28	0.0119 U	0.19	-0.0235 U	0.03	ND
20241130814	*160-56302-3*	38.13	-107.97	11/11/2024	13:00	76	*sandstone*	0.0881 U	1.3	1.21	0.7	0.343	0.1	-0.279 U	0.3	0.343	0.0860 U	0.17	-0.0166 U	0.17	0.0336 U	0.07	ND
20240850815	*160-56433-1*	38.33	-108.93	11/1/2024	15:00	235	*sandstone & siltstone*	12.0 G	4.0	10.4	2.0	0.304	0.1	0.711	0.4	1.015	-0.0106 U	0.17	0.108 U	0.22	-0.0193 U	0.03	ND
20241130816	*160-56433-2*	38.02	-108.08	11/13/2024	18:00	45	*boulders & gravel*	0.259 UG	1.8	0.998 U	0.7	-0.0281 U	0.05	-0.00949 U	0.3	ND	-0.0264 U	0.16	-0.0703 U	0.17	-0.0281 U	0.03	ND
20241130817	*160-56433-6*	37.99	-108.02	11/21/2024	13:45	40	*sand & siltstone*	4.05 UG	2.9	2.53	1.0	-0.0249 U	0.1	0.103 U	0.3	ND	-0.00363 U	0.15	0.0590 U	0.19	-0.0136 U	0.02	ND
20241130818	*160-56433-3*	38.08	-108.04	11/17/2024	15:44	240	*sandstone & shale*	5.97 G	3.5	8.9	2.1	2.03	0.3	2.77	0.6	4.8	-0.0242 U	0.19	0.115 U	0.23	0.0983 U	0.11	ND
20241130819	*160-56433-4*	38.01	-108.04	11/21/2024	8:00	23	*sand & gravel*	2.07 UG	3.0	1.39 U	1.0	0.169 U	0.1	0.361 U	0.4	ND	0.216 U	0.40	0.0483 U	0.30	-0.0341 U	0.05	ND
20240850820	*160-56433-5*	38.28	-108.56	11/19/2024	15:30	290 (?)	*target-Dakota Ss*	12.9 UG	9.4	11.5 G	4.0	3.13	0.4	6.32	1.1	**9.45**	0.126 U	0.18	-0.0776 U	0.17	-0.00993 U	0.02	ND
20240850821	*160-56433-7*	38.21	-108.62	11/18/2024	13:38	250	*sand (sandstone)*	**18.7 G**	7.9	20.6	4.0	3.00	0.4	7.57	1.1	**10.57**	0.317	0.21	0.0744 U	0.19	0.0350 U	0.07	ND
20241130822	*160-56445-1*	37.99	-108.02	11/14/2024	12:30	25	*sand & boulders*	0.649 UG	1.8	1.24	0.7	0.0372 U	0.05	0.252 U	0.5	ND	0.00170 U	0.18	0.253 U	0.25	0.0652 U	0.09	ND
20241130823	*160-56548-1*	38.02	-108.07	11/26/2024	17:45	282	*conglomerate*	**66.8 G**	33.0	**66.2 G**	14.2	4.79	0.6	3.31	0.7	**8.1**	-0.0510 U	0.16	-0.0145 U	0.19	0.00542 U	0.07	ND

NOTES:

[1] Geology is based on well driller's log where available or homeowner self-reported information.

[2] Radionuclide total uncertainty value (2 sigma) shown as (±).

[3] DWG are drinking water guidelines. Results greater than these guidelines are bolded.

"U" = Result is less than the sample detection limit (i.e., not detected (ND)).

"J" = Value estimated between method detection limit (MDL) and practical quantitation limit (PQL).

"B" = Compound was found in the lab blank and sample.

"G" = The sample MDC is greater than the requested RL.

Radionuclide data values preceded by minus sign "-" are equivalent to ND.

Table 1. Water quality data near the Uravan Belt, Colorado

Sample ID	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Thorium (mg/L)	Tin (mg/L)	Uranium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
	7	*0.006*	*0.01*	*2*	*0.004*	*1.4*	*0.005*	*0.01*	*0.006*	*1.3*	*14*	*present*	*0.3*	*0.035*	*0.1*	*0.05*	*0.035*	*0.002*	*n/a*	*2.1*	*0.03*	*0.07*	*2*
20241130801	0.070 J	ND	ND	0.066	ND	0.052 J	ND	ND	ND	0.087	0.43	0.0014 J	0.01	0.00061 J	0.0010 J	ND	ND	ND	0.00078 J	ND	0.00016 J	ND	0.064
20241130802	ND	ND	ND	0.021	ND	0.079 J	ND	ND	ND	0.036	ND	0.0025 J	ND	0.0029 J	ND	ND	ND	ND	ND	ND	ND	ND	0.011 J
20241130803	ND	ND	ND	0.075	ND	0.028 J	0.00039 J	ND	ND	0.025	ND	ND	ND	0.0015 J	ND	0.0011 J	ND	ND	0.0011 J	0.00086 JB	0.0035	ND	0.012 J
20240850804	0.35	ND	**0.11**	0.0091	ND	0.42	0.00042 J	ND	0.00033 J	1.2	2.8	**0.05**	0.034	0.0040 J	0.0016 J	ND	0.00027 J	ND	0.0016 J	0.0045 B	0.0016	ND	0.19
20241130805	ND	**0.057**	**13**	0.079	0.0015	0.042 J	0.0017	ND	**0.013**	0.11	**250**	**0.027**	**0.60**	ND	0.039	ND	ND	ND	0.00067 J	0.00082 JB	0.0034	ND	0.42
20240850806	ND	ND	0.0024 J	0.066	ND	0.078 J	ND	0.0015 J	ND	0.014	ND	0.0028 J	ND	0.0024 J	ND	ND	ND	ND	ND	ND	0.0028	0.0080 J	0.03
20241130807	0.36	ND	**0.072**	0.028	ND	0.066 J	ND	ND	0.00027 J	0.046	**15 B**	**0.0059**	0.095	0.0015 J	ND	ND	ND	ND	0.00059 J	ND	0.00061 J	ND	0.019 J
20241130808	0.29	0.0015 J	ND	0.0037	ND	0.015 J	ND	0.0013 J	ND	0.085	0.23 B	**0.0063**	0.0038 J	0.0014 J	0.0059	0.0012 J	ND	ND	ND	0.0019 J	0.001	ND	0.029
20240850809	ND	ND	0.0038 J	0.0096	ND	0.71	ND	ND	ND	0.0056	0.036 J	ND	ND	0.0081	ND	0.014	ND	ND	0.00092 J	ND	**0.038**	0.0087 J	0.024
20240850810	ND	ND	**0.011**	0.011	ND	0.62	0.00098	ND	0.00055 J	0.0014 J	0.093	0.0016 J	0.024	0.0022 J	ND	ND	ND	ND	0.0020	0.0011 J	0.0014	ND	0.88
20240770811	ND	ND	ND	0.14	ND	0.034 J	ND	ND	ND	0.0086	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0034	ND	0.0092 J
20240770812	ND	ND	ND	0.34	ND	0.043 J	ND	ND	ND	0.014	0.035 J	ND	ND	0.0014 J	ND	ND	ND	ND	ND	ND	0.0075	ND	0.039
20240850813	ND	ND	ND	0.008	ND	0.47	ND	ND	ND	0.0033	0.30	ND	0.0097	0.0057	ND	0.0065	ND	ND	ND	0.00095 J	0.016	ND	0.033
20241130814	ND	ND	ND	0.034	ND	0.016 J	ND	ND	ND	0.0028 J	5.6	ND	0.15	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0089 J
20240850815	0.13	ND	0.0074 J	0.03	ND	0.33	0.00020 J	0.0026 J	ND	0.0035	0.1	ND	0.0051	0.0097	0.0014 J	0.02	ND	ND	ND	0.004	0.017	0.0072	0.017
20241130816	ND	ND	ND	0.068	ND	0.030 J	ND	ND	ND	0.0036	0.097	ND	0.0092	0.0031 J	ND	0.0014 J	ND	ND	ND	0.00089	0.0015	ND	0.014
20241130817	ND	ND	ND	0.064	ND	0.020 J	ND	ND	ND	0.0062	0.77	ND	0.006	0.0033 J	ND	0.0012 J	ND	ND	ND	ND	0.0036	ND	0.0096
20241130818	ND	ND	0.0049 J	0.012	ND	0.048 J	0.00020 J	ND	0.0029	ND	8.6	ND	**0.51**	ND	0.0055	ND	ND	ND	ND	0.0014	0.00022	ND	ND
20241130819	0.17	ND	**0.018**	0.16	ND	0.028 J	ND	0.0034 J	0.0021	0.012	26	0.0020 JB	**1.7**	0.0047 J	0.011	0.00077 J	ND	ND	ND	0.0016	0.002	0.0047	0.031
20240850820	ND	ND	0.0035 J	0.0078	ND	0.1	ND	ND	ND	0.0058	2.4	ND	0.29	ND	0.0016 J	0.0010 J	ND	ND	ND	0.0025	0.0014	ND	0.0095
20240850821	ND	ND	0.0042 J	0.013	ND	0.21	ND	ND	ND	0.05	9.1	**0.0056 B**	0.097	0.0015 J	ND	ND	ND	ND	ND	0.0013	0.0021	ND	0.087
20241130822	ND	ND	ND	0.057	ND	0.018 J	ND	ND	ND	0.026	0.11	ND	0.0041 J	0.0030 J	0.0013 J	0.00094 J	ND	ND	ND	0.00091 J	0.0022	ND	0.0089 J
20241130823	ND	ND	**0.026**	0.009	0.0013	**2.5**	ND	ND	ND	ND	1.3	ND	0.13	ND	ND	ND	ND	ND	ND	ND	0.0044	ND	ND

NOTES:

[1] Geology is based on well driller's log where available or homeowner self-reported information.

[2] Radionuclide total uncertainty value (2 sigma) shown as (±).

[3] DWG are drinking water guidelines. Results greater than these guidelines are bolded.

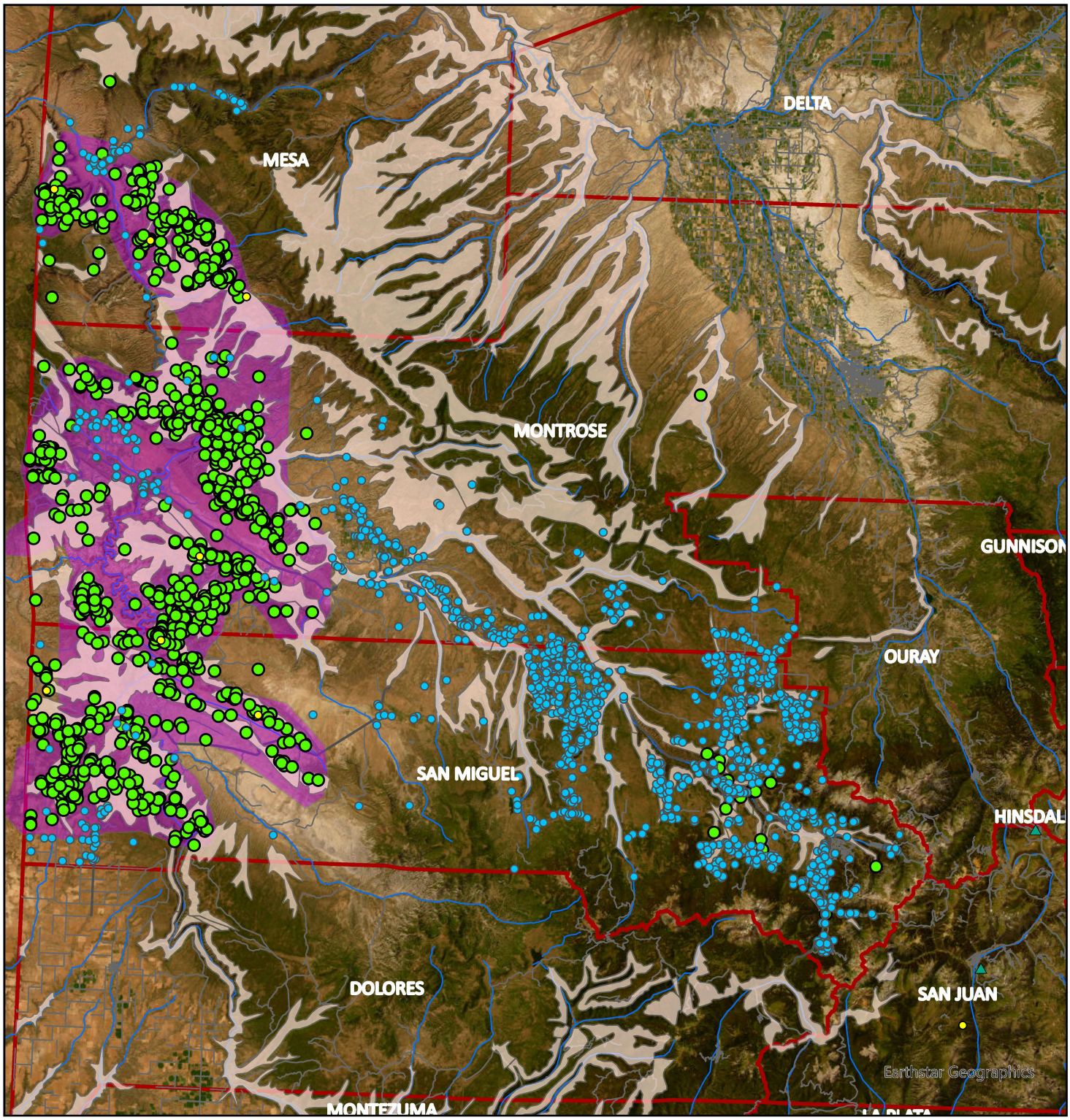
"U" = Result is less than the sample detection limit (i.e., not detected (ND)).

"J" = Value estimated between method detection limit (MDL) and practical quantitation limit (PQL).

"B" = Compound was found in the lab blank and sample.

"G" = The sample MDC is greater than the requested RL.

Radionuclide data values preceded by minus sign "-" are equivalent to ND.



LEGEND

- Permitted Residential Wells
- Rivers & Streams
- County border
- Morrison Formation
- U & Th Mining Districts Colorado

CGS Bulletin 40 Radioactive Rock Type

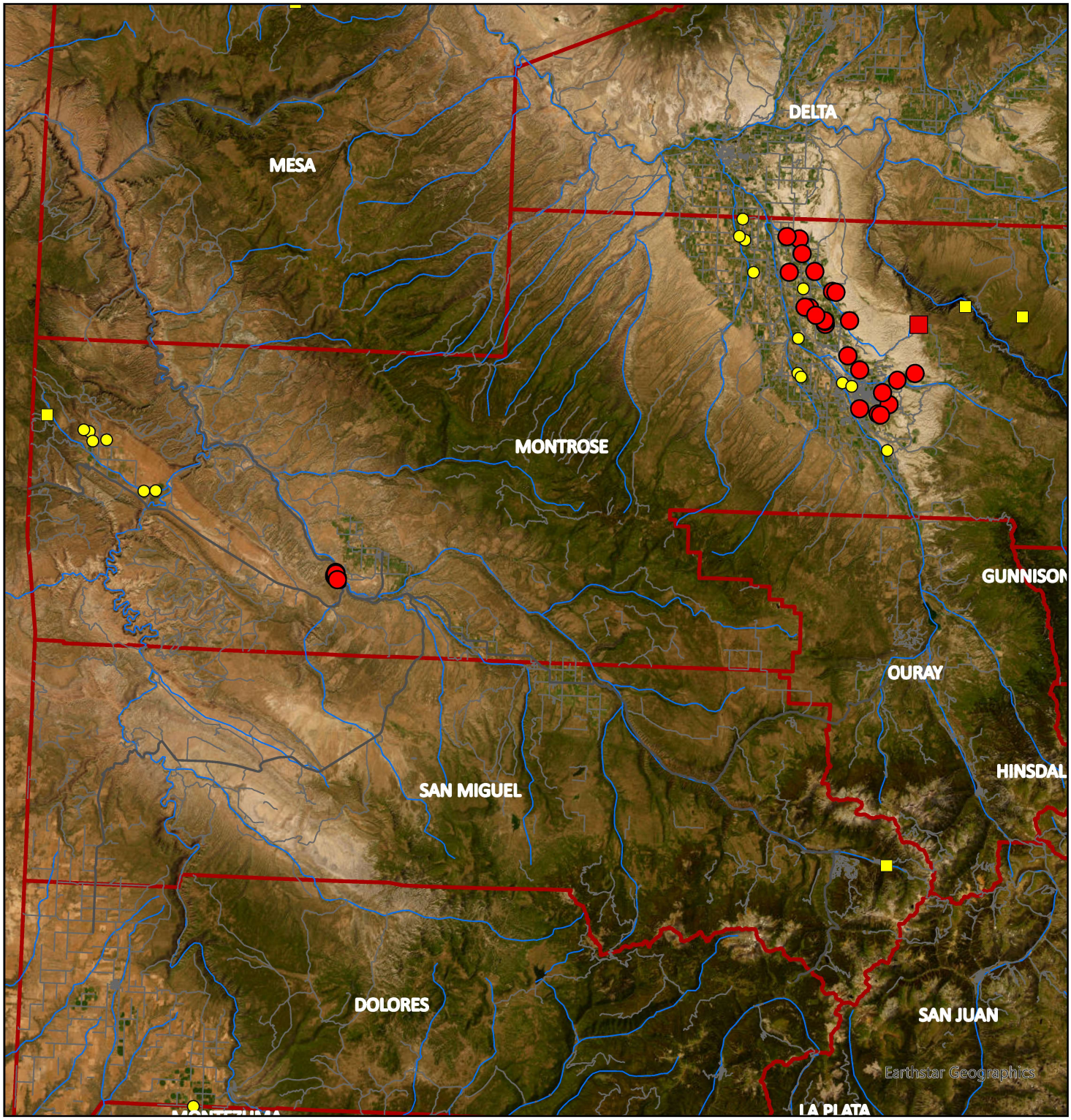
- Sandstone, Arkose, Siltstone, Conglomerate, Lake Sediments
- Igneous and Metamorphic
- Undetermined

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 1. The Uravan Belt of western Colorado spans the south end of Mesa County southerly through Montrose and San Miguel counties. Here, uranium, vanadium, and radium ore deposits were historically mined from the Jurassic aged Salt Wash Member of the Morrison Formation. Also shown are current residential water wells.



LEGEND

Uranium in Springs (mg/L)

- 0.0301 - 0.1138
- 0.00002 - 0.0300

Uranium in Wells (mg/L)

- 0.031 - 2.5
- 0.000033 - 0.030

- Rivers & Streams
- Highways
- Local Roads
- County border

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 2. Historic uranium water quality data from wells and springs in or near the Uravan Belt, Colorado. Also shown are current residential water wells near the study area.

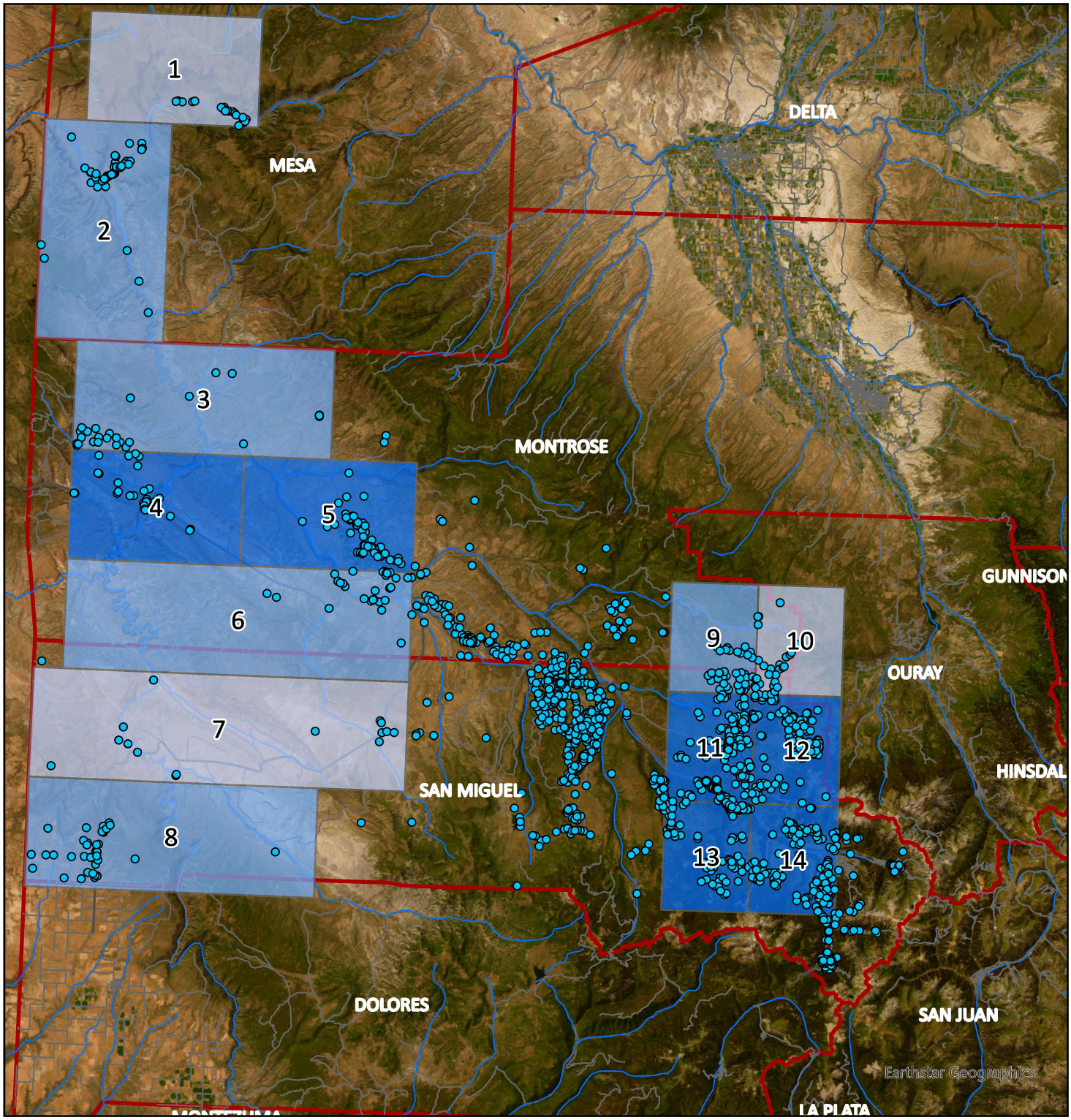
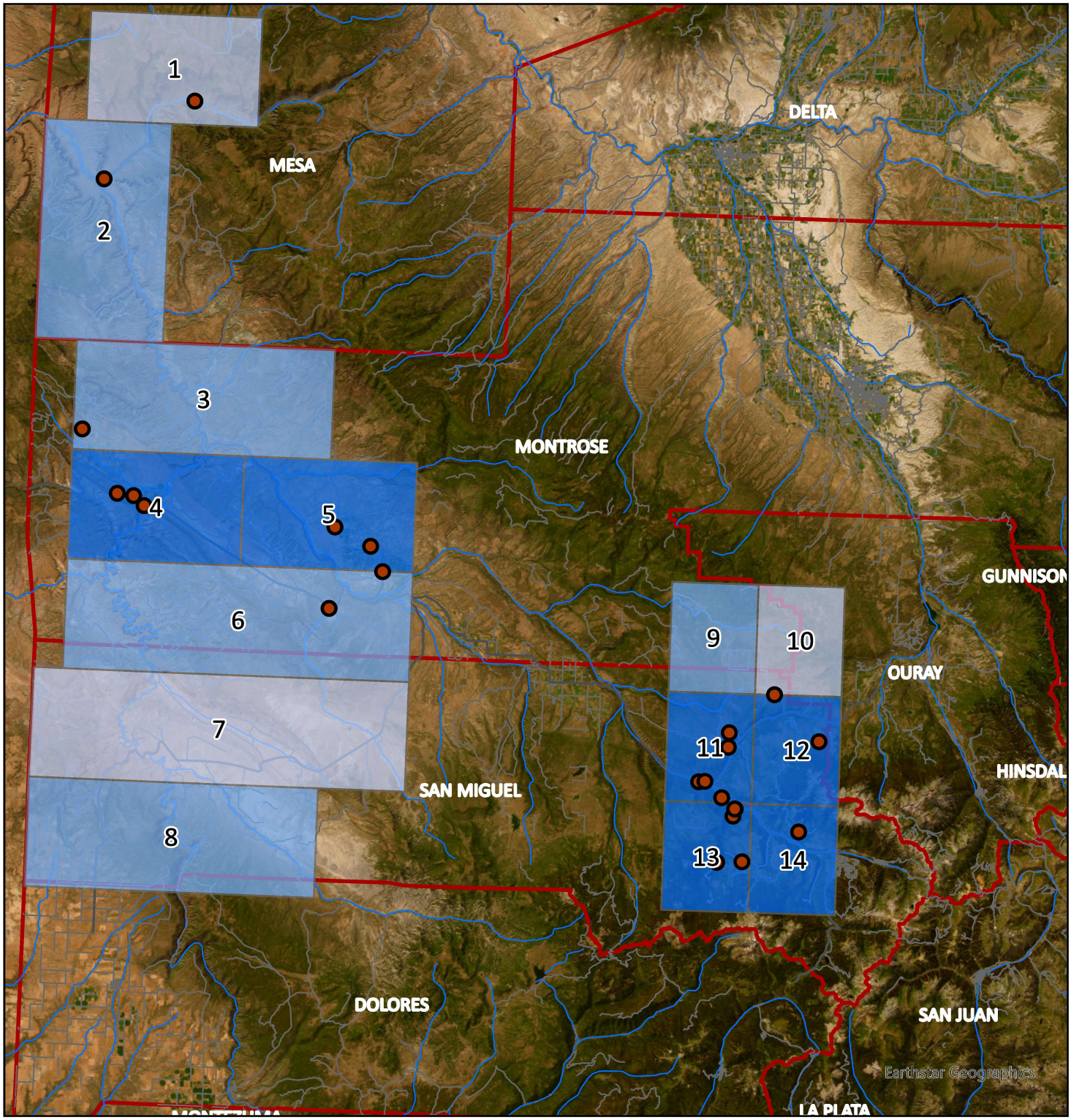


Figure 3. Sampling grid and residential water wells in the Uravan Belt, Colorado. The grid was designed using historic mining districts. The original assigned number of samples per grid space are shown.



LEGEND

Assigned samples per grid

- 2
- 3
- 4

- Uravan Belt Sampled Wells
- Rivers & Streams
- Highways
- Local Roads
- County border

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 4. Sampled residential water wells in the Uravan Belt, Colorado, in 2024. Volunteers were selected from available grids. Not all grids were able to be filled.

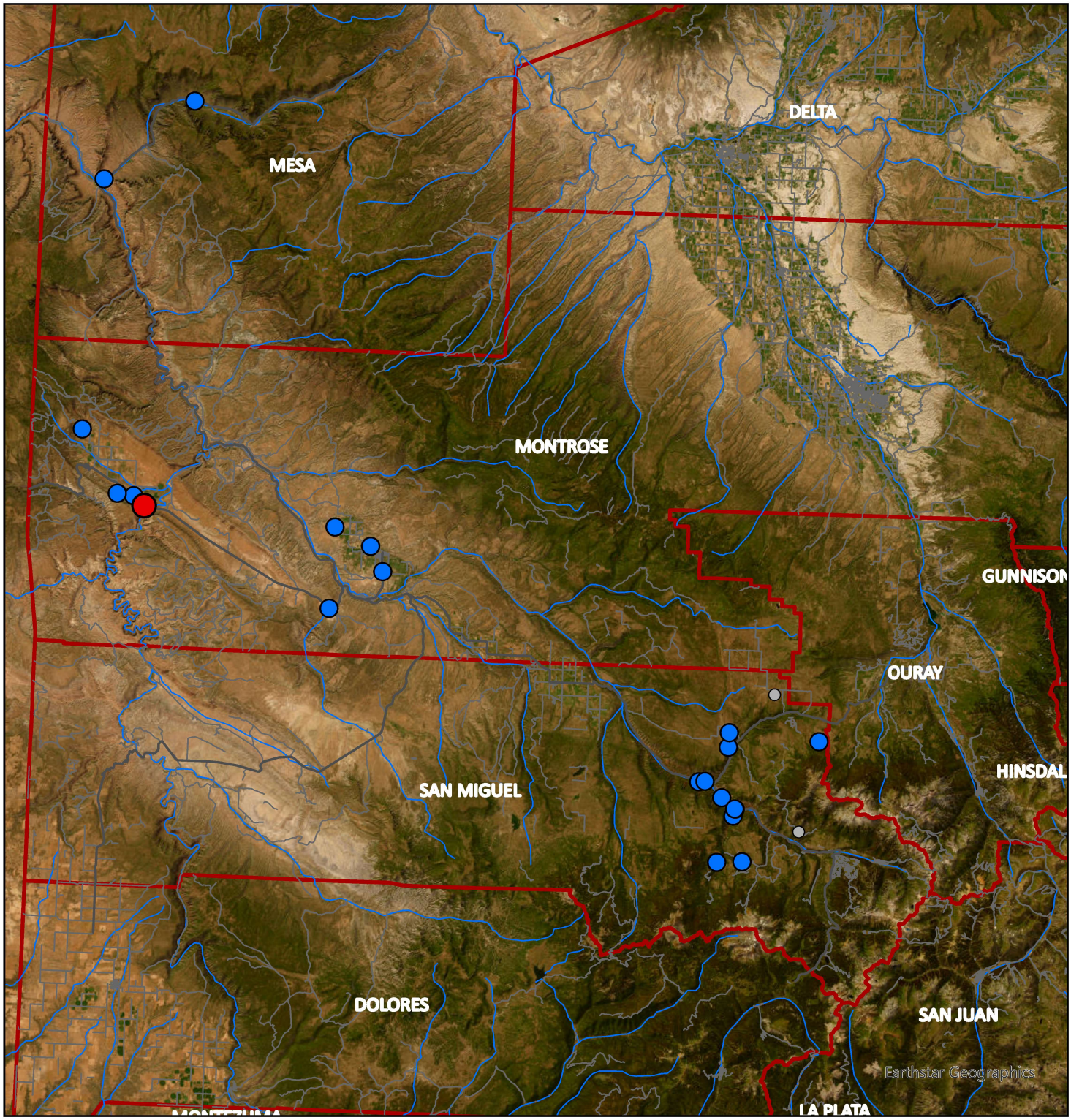
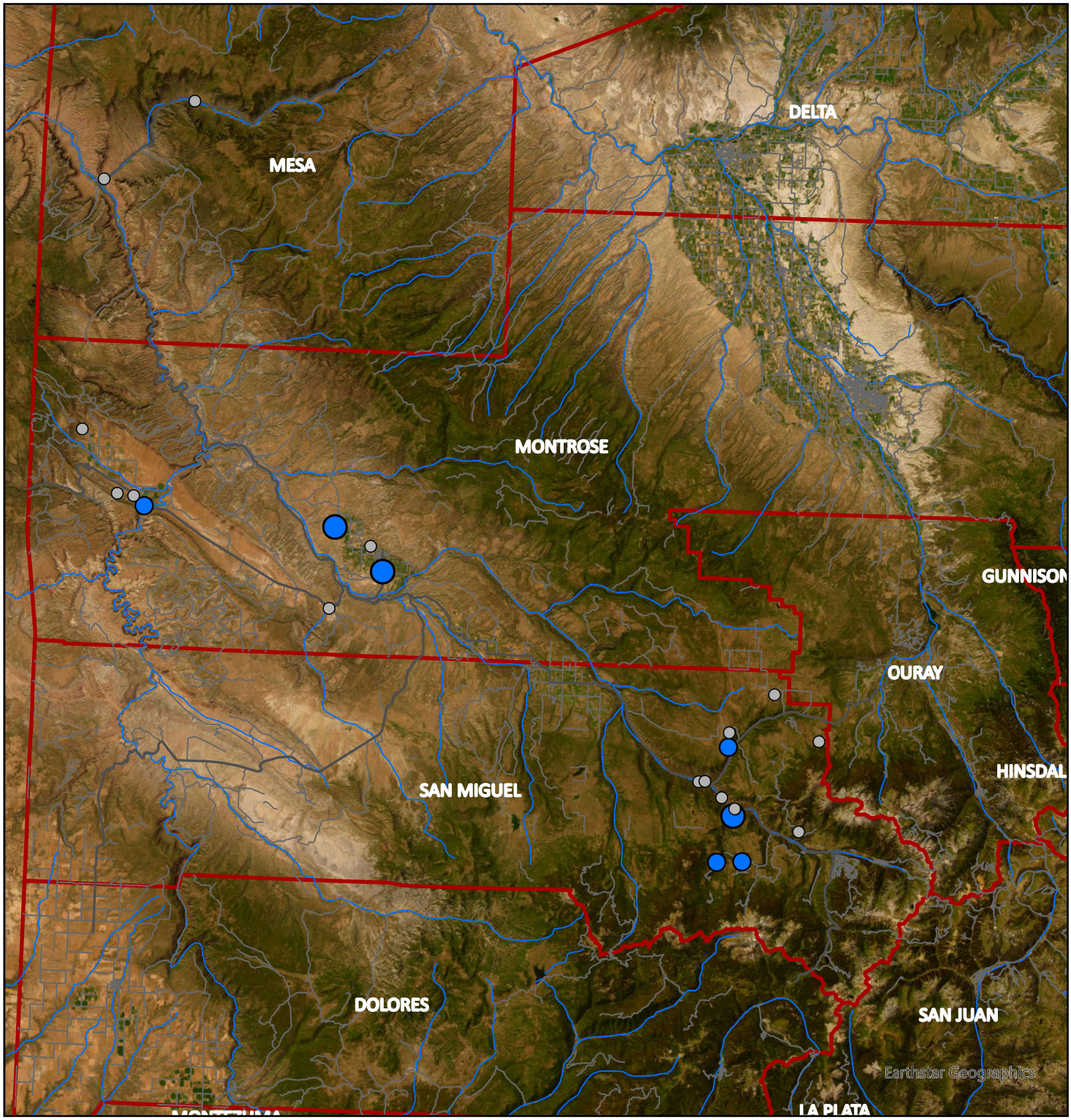


Figure 5. Uranium concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 0.03 mg/L are shown in red.



LEGEND

- Rivers & Streams
- Highways
- Local Roads
- County border

Thorium (mg/L)

- 0.001- 0.002
- 0.0006 - 0.001
- ND

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 6. Thorium concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Thorium does not have a drinking water guideline, but it does contribute to other gross radionuclide measurements.

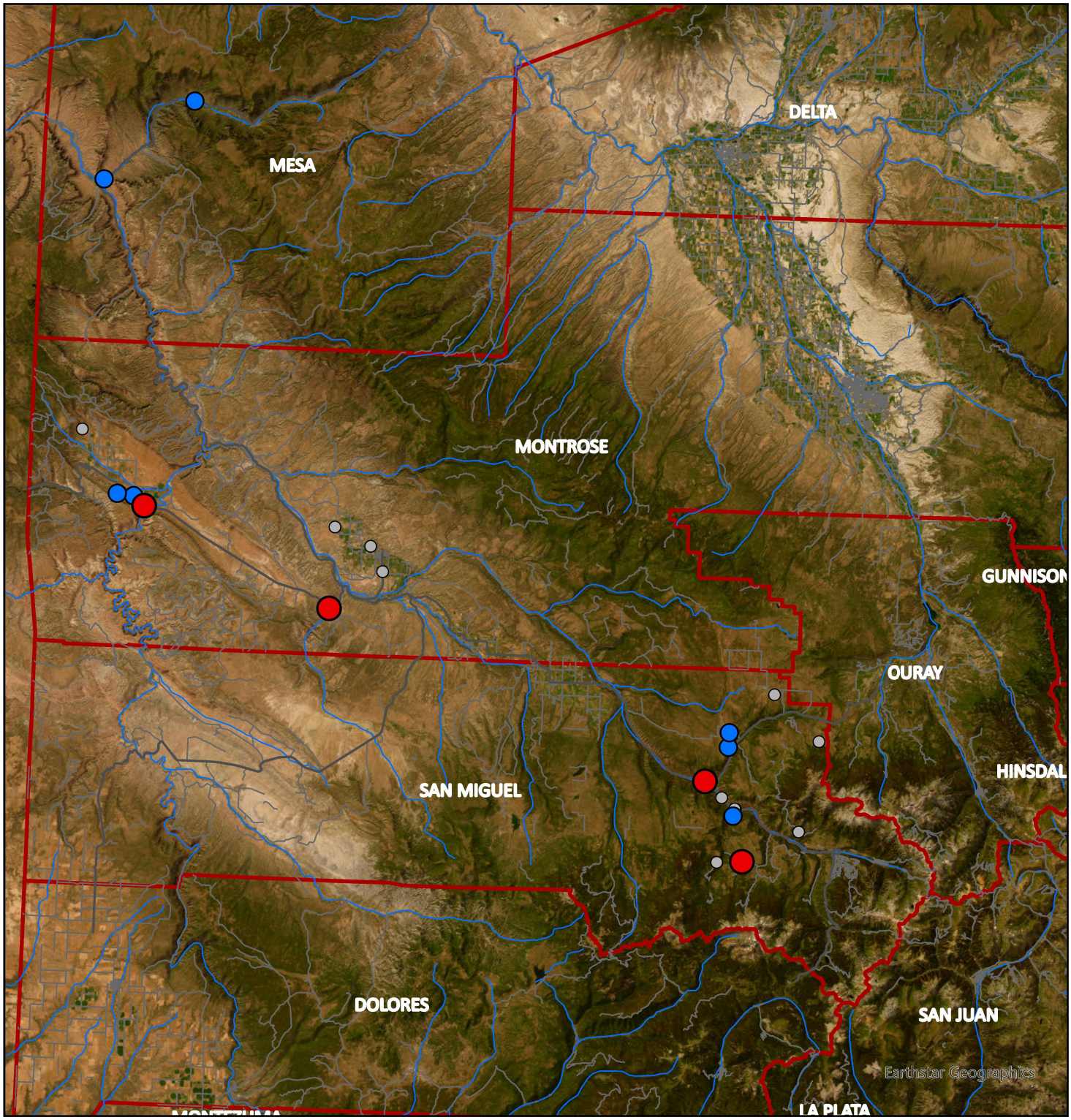
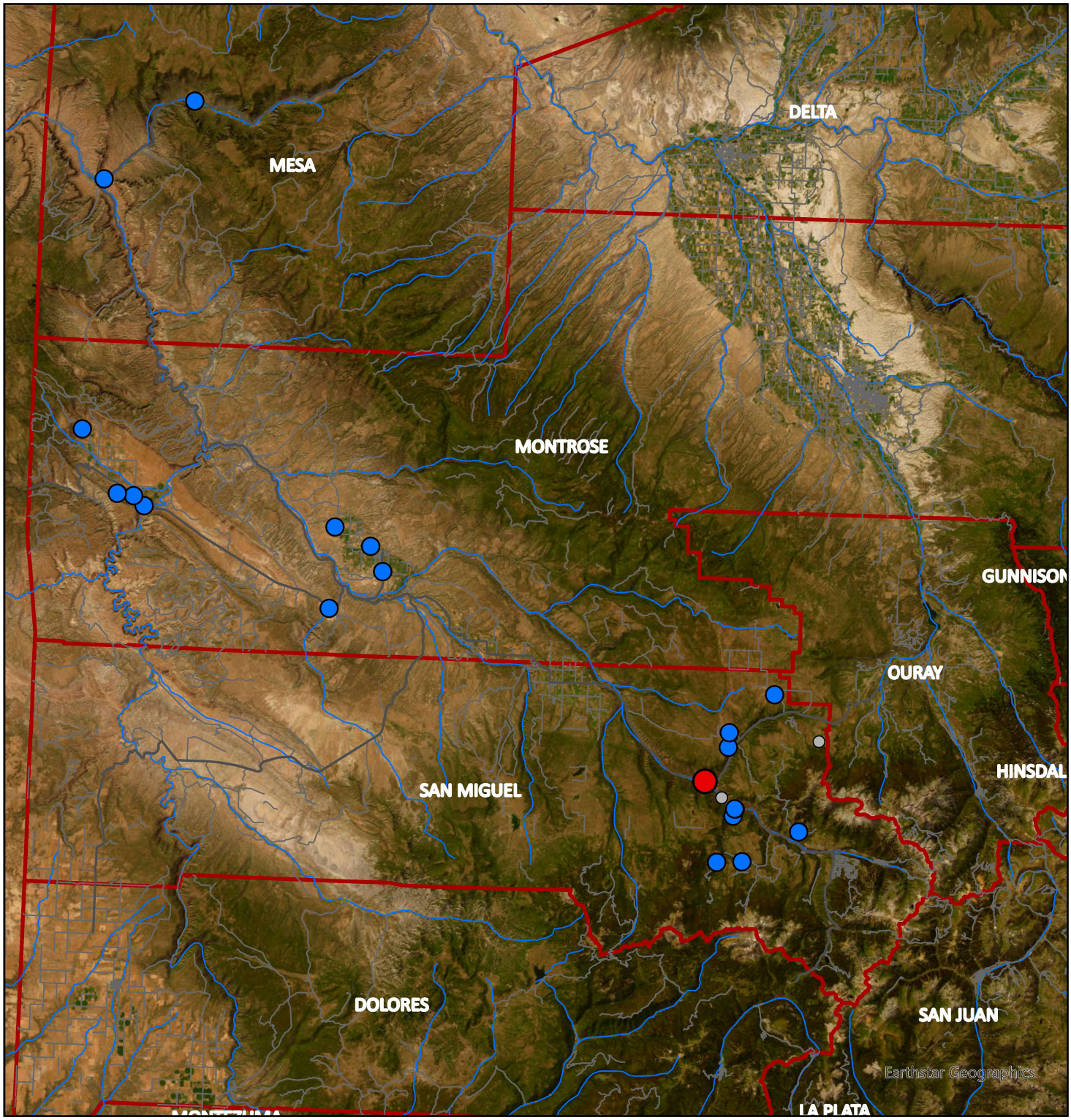


Figure 7. Gross Alpha concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 15 pCi/L are shown in red.



LEGEND

- Rivers & Streams
- Highways
- Local Roads
- County border

Gross Beta (pCi/L)

- 50.1 - 66.2
- 0 - 50.0
- ND

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 8. Gross Beta concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado. There are no locations where values were above the drinking water guideline of 50 pCi/L, but Gross Beta does contribute to other gross radionuclide measurements.

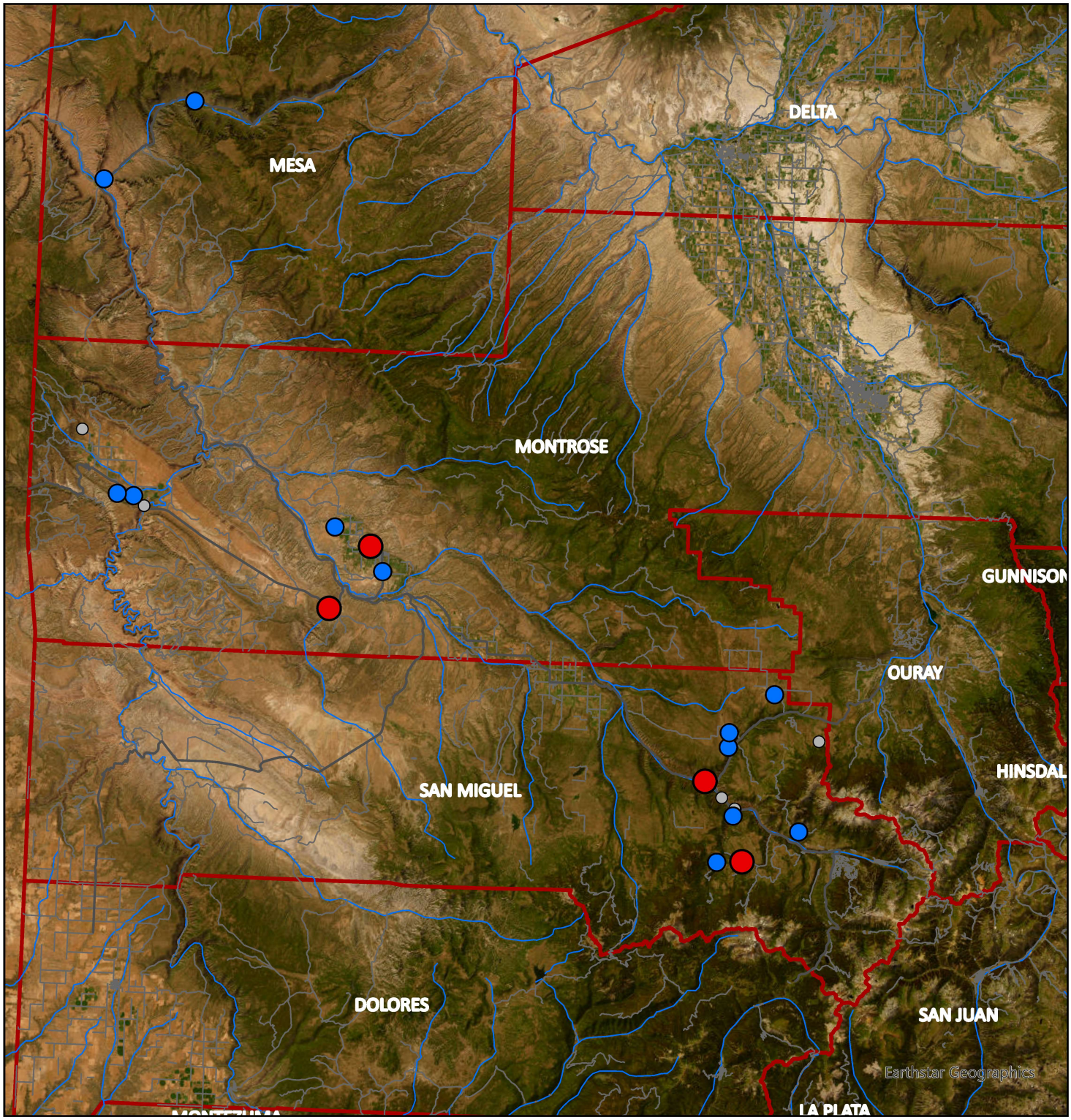


Figure 9. Radium-226+228 concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 5 pCi/L are shown in red.

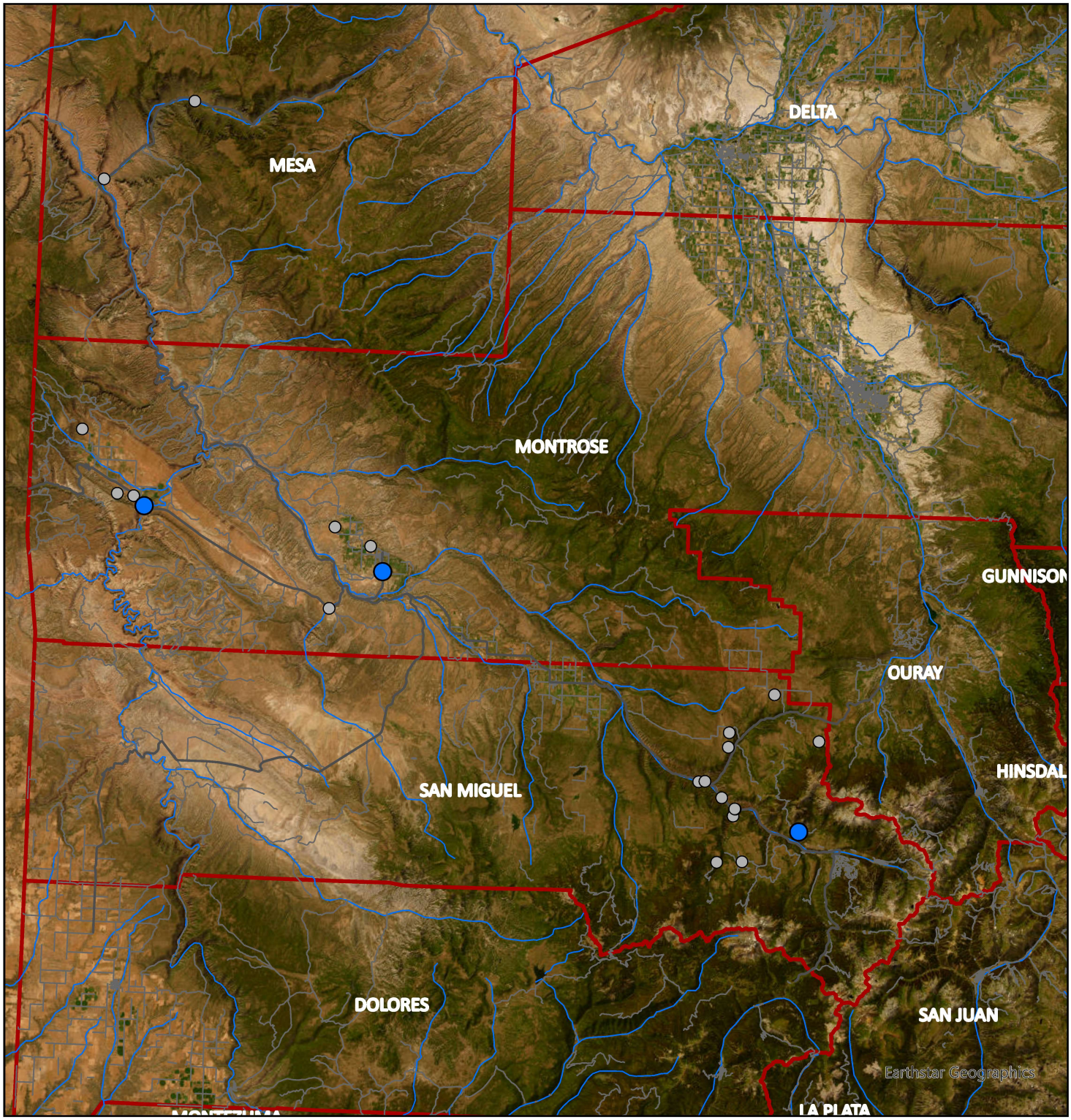


Figure 10. Thorium-230+232 concentrations in picocuries per liter (pCi/L) from water wells in the Uravan Belt, Colorado. There are no locations where values were above the drinking water guideline of 60 pCi/L, but Thorium-230+232 does contribute to other gross radionuclide measurements.

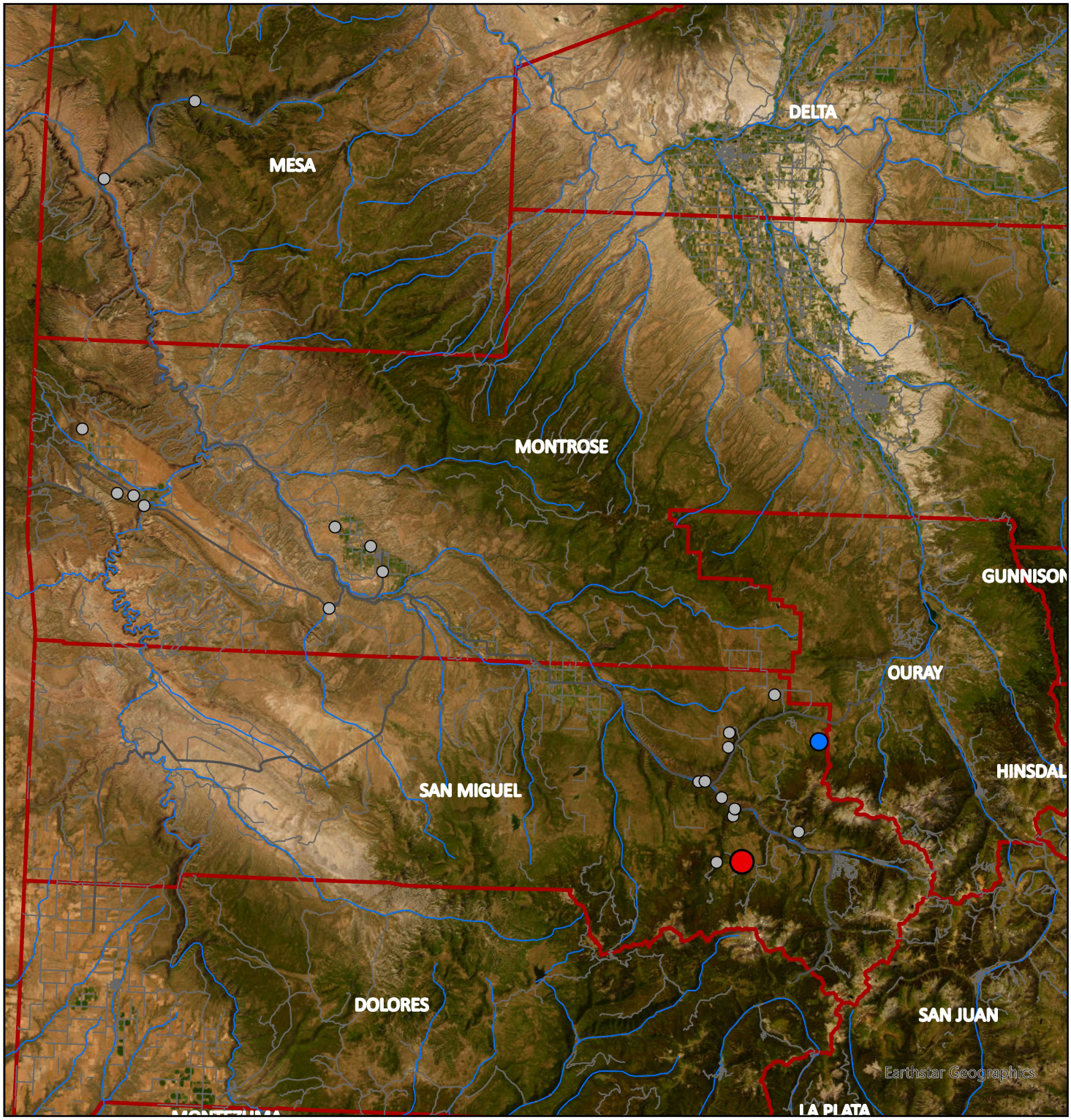


Figure 11. Antimony concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 0.006 mg/L are shown in red.

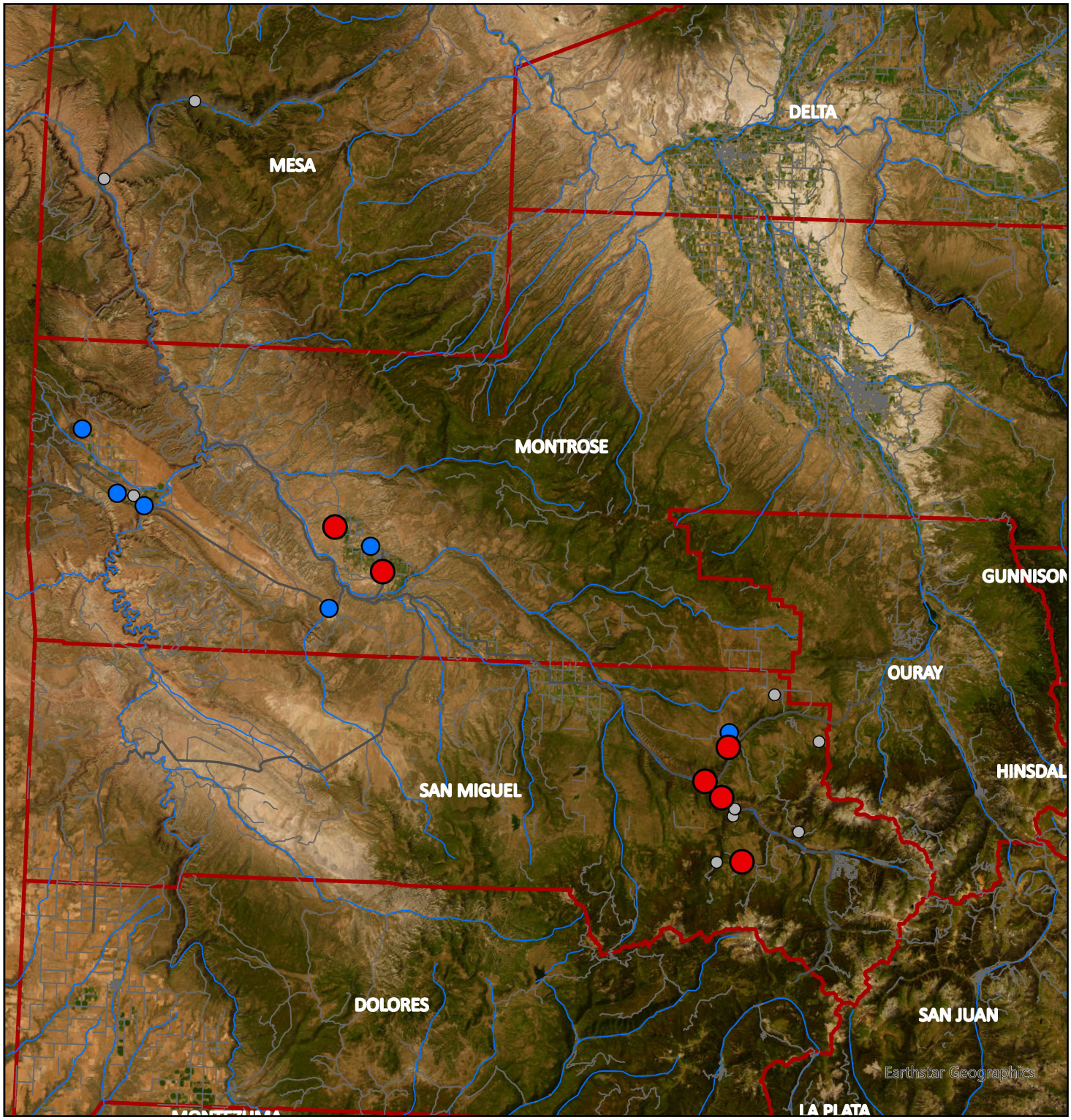


Figure 12. Arsenic concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 0.01 mg/L are shown in red.

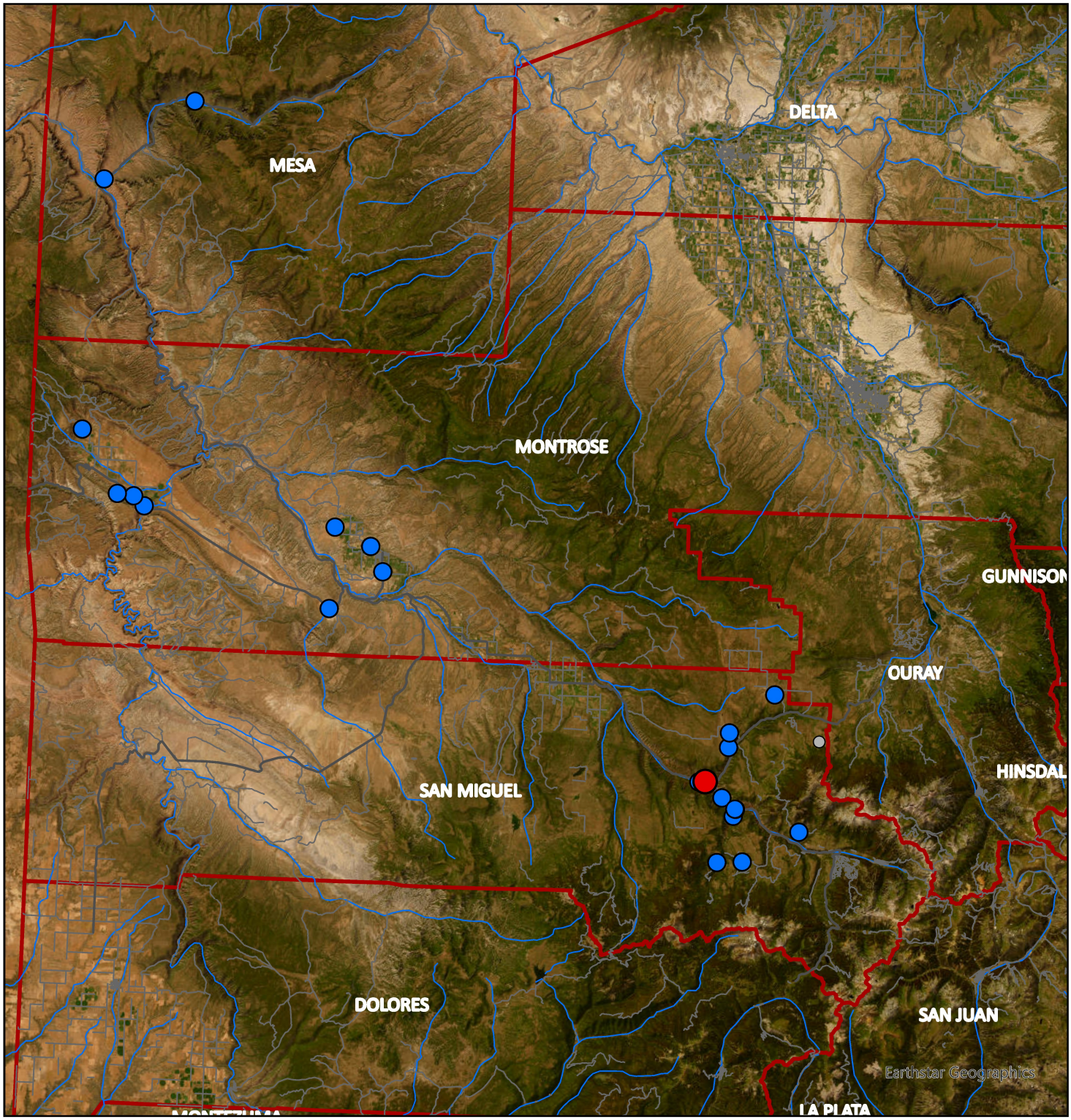


Figure 13. Boron concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 1.4 mg/L are shown in red.

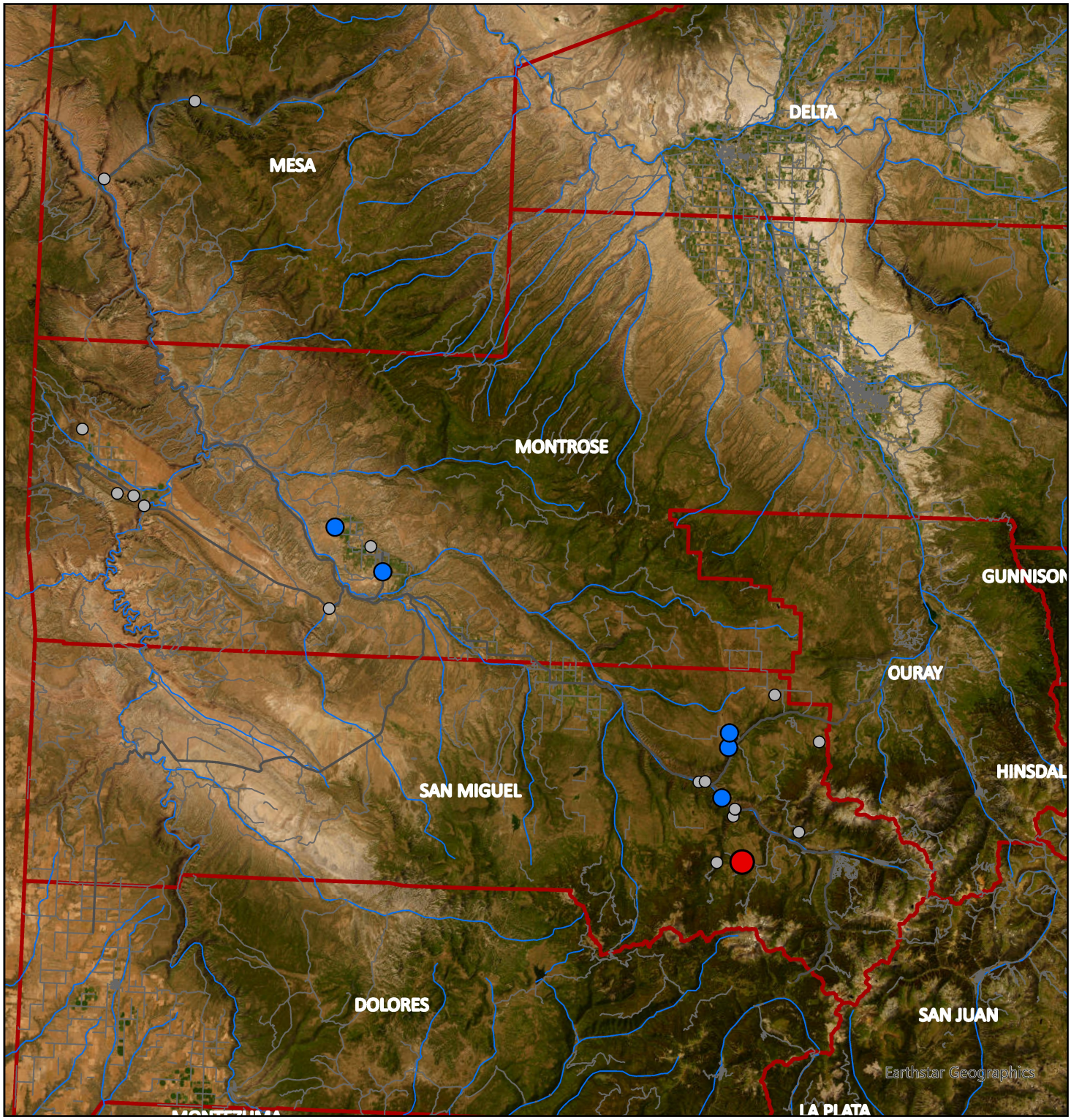
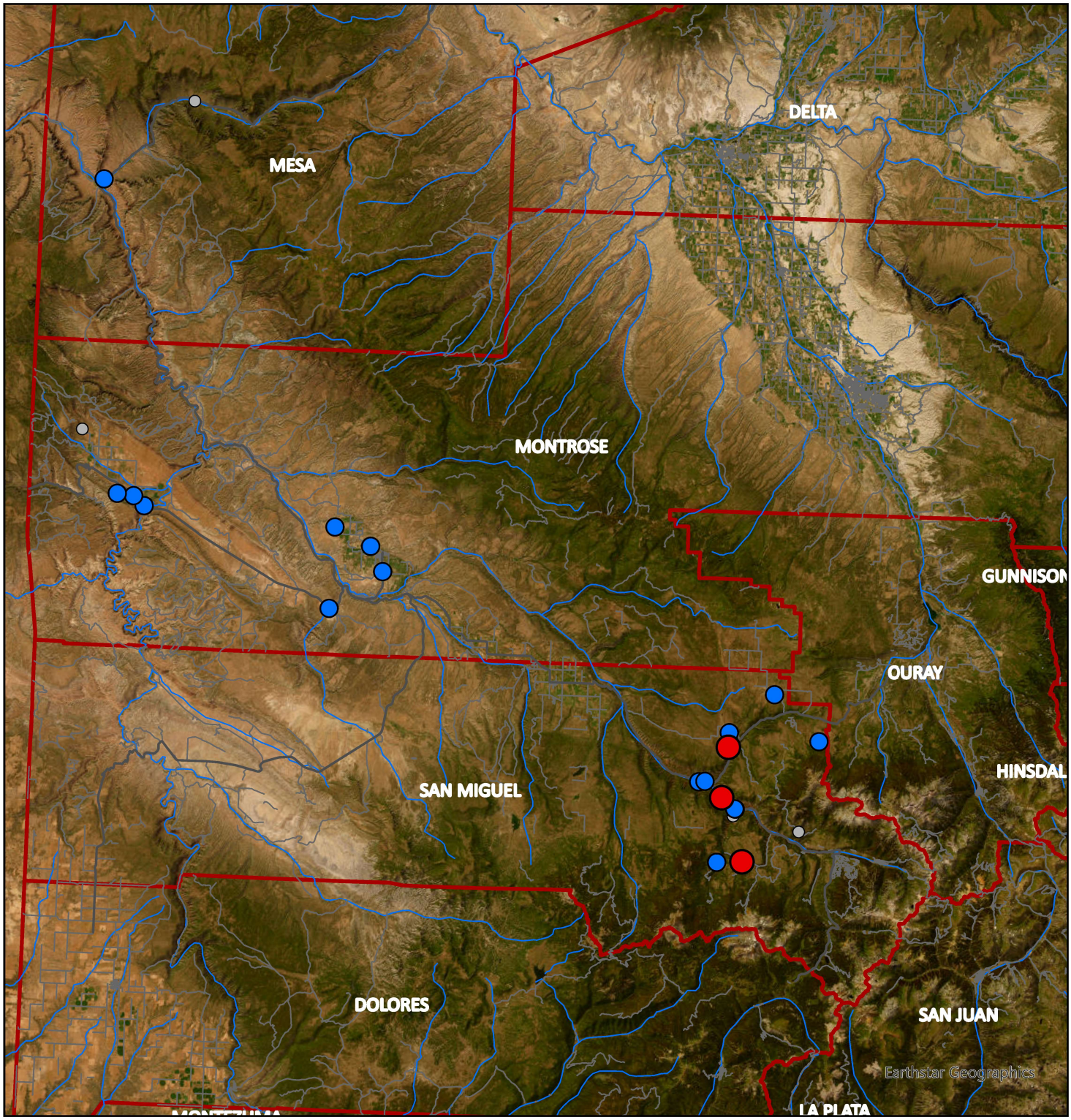


Figure 14. Cobalt concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 0.006 mg/L are shown in red.



LEGEND

- Rivers & Streams
- Highways
- Local Roads
- County border

Iron (mg/L)

- 14 - 250
- 0 - 14
- ND

N W E S

0 5 10 Miles

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES

Figure 15. Iron concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 14 mg/L are shown in red.

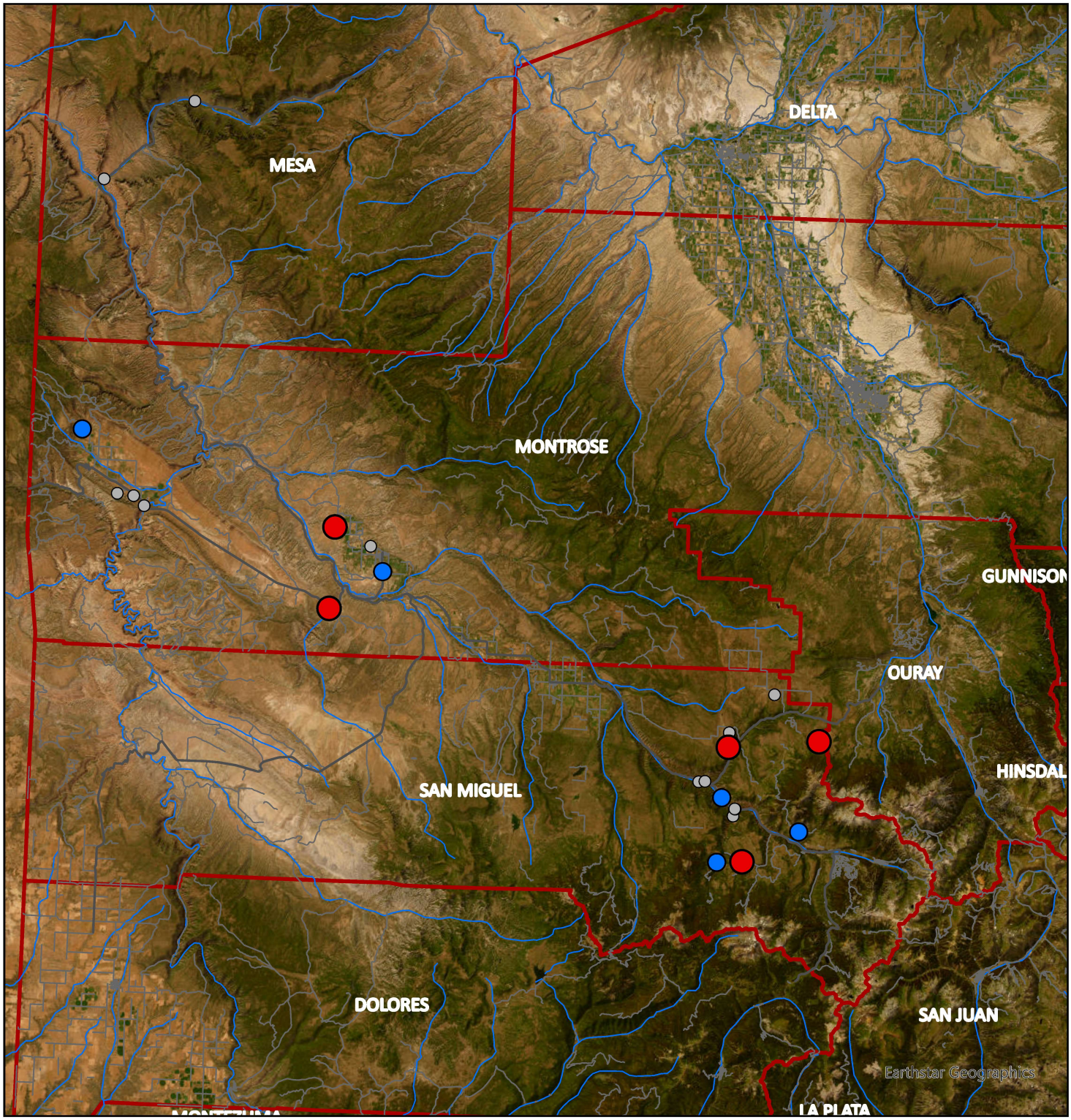


Figure 16. Lead concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of being "Present" above the analytical reporting limit are shown in red. Blue are estimated detections under the reporting limit.

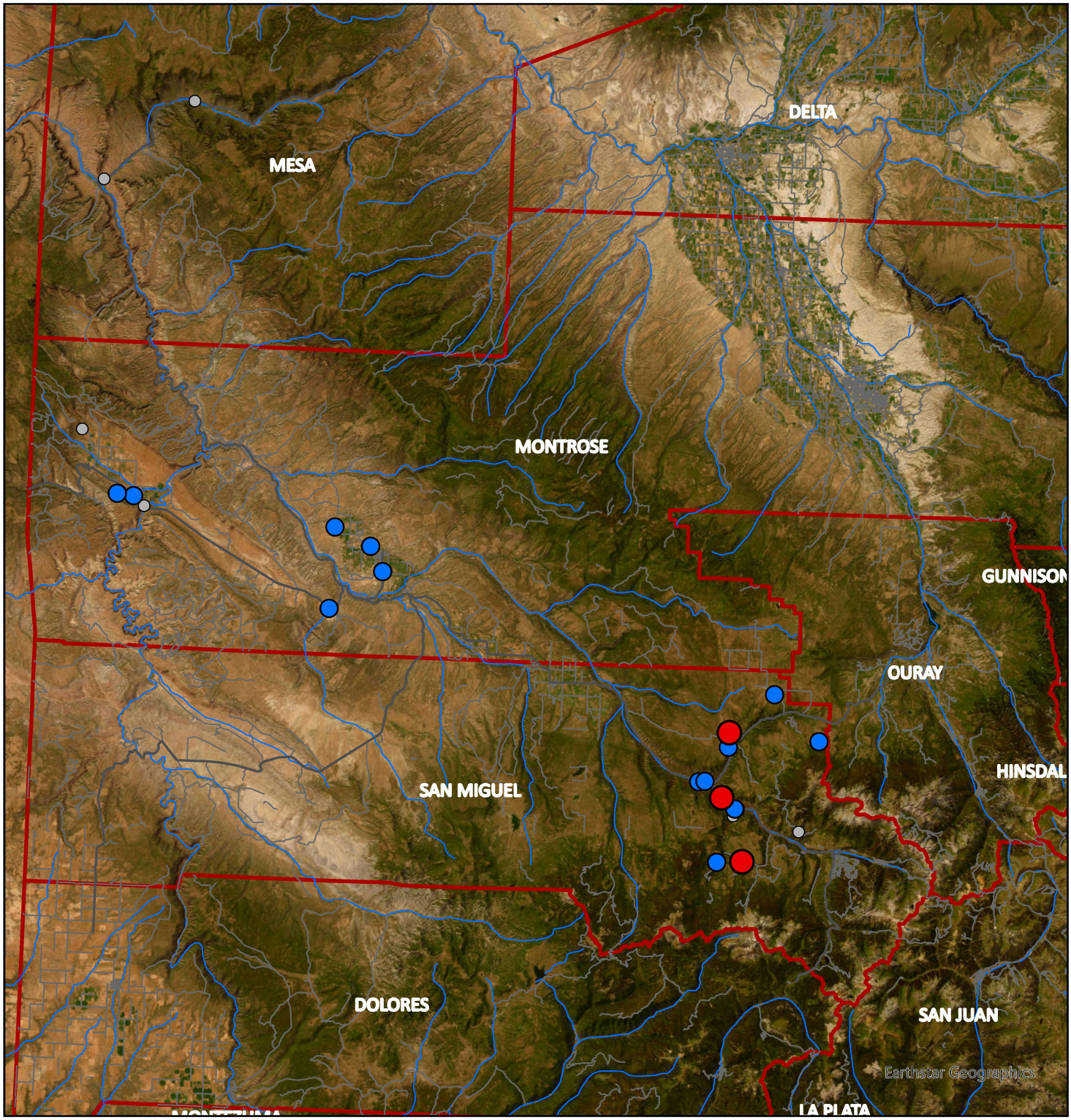


Figure 17. Manganese concentrations in milligrams per liter (mg/L) from water wells in the Uravan Belt, Colorado. Locations where values were above the drinking water guideline of 0.3 mg/L are shown in red.