

High Groundwater Uranium in the Española Basin, New Mexico



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Aqueous Uranium

- Uranium has a high affinity for oxygen, and forms the uranyl ion UO_2^{2+} (stable at $\text{pH} < 5$)
- Uranyl carbonates are the most common species in natural water
 - $\text{UO}_2(\text{CO}_3)^0$ (pH 5-6.5)
 - $\text{UO}_2(\text{CO}_3)_2^{2-}$ (neutral pH)
 - $\text{UO}_2(\text{CO}_3)_3^{4-}$ (alkaline pH)



Uranium in Española Basin Groundwater

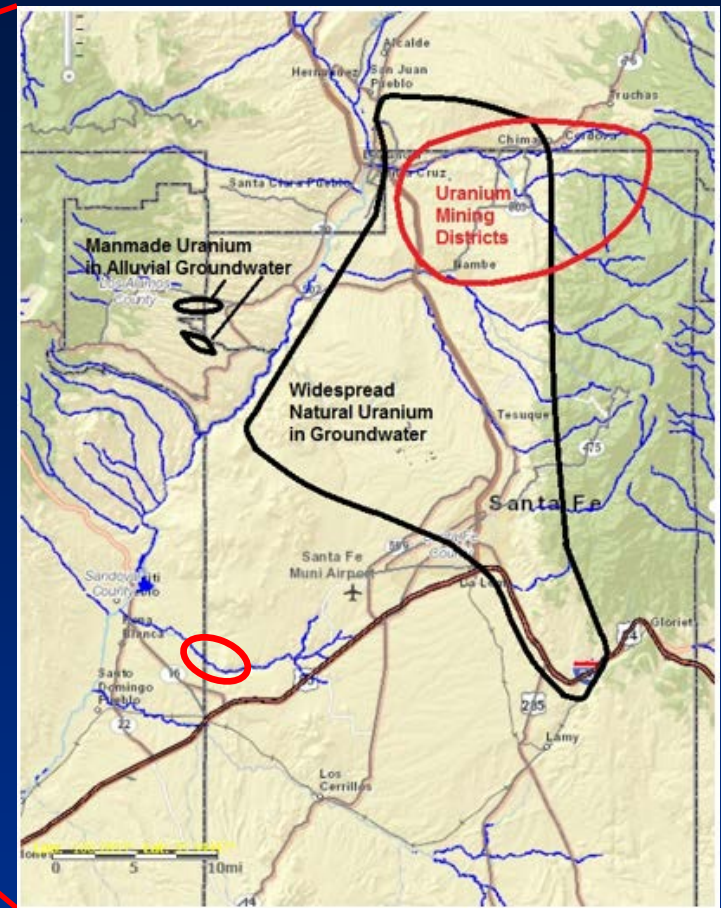
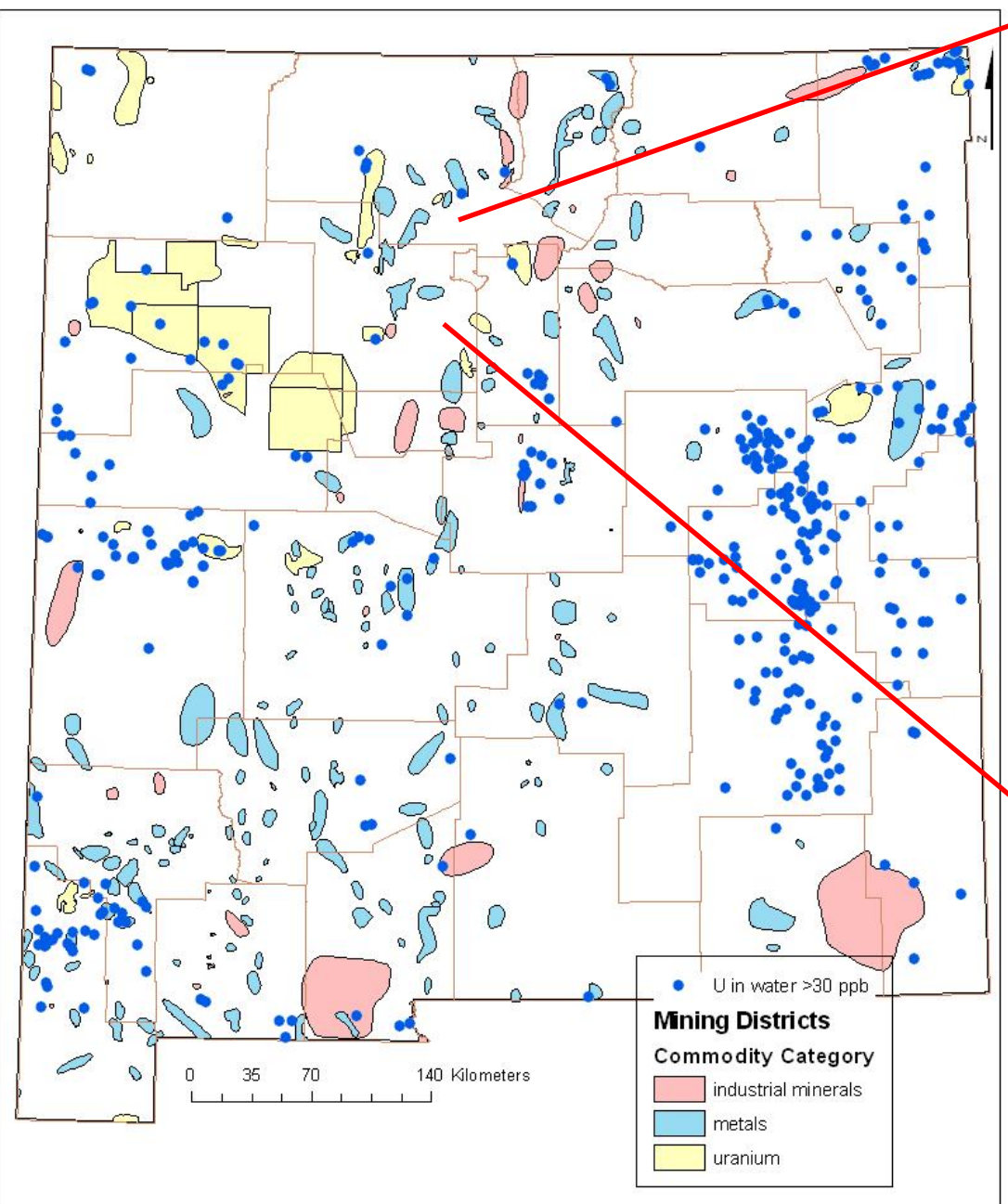
East of Rio Grande:

- Widespread contamination from geologic sources
- ~270 wells with uranium $>30 \mu\text{g/L}$
- Concentrations up to $1,820 \mu\text{g/L}$ in domestic well water

West of Rio Grande:

- Lower levels, less widespread, localized manmade sources





Mining Districts and NURE Uranium Detections >30 µg/L

Geologic Sources of Groundwater Uranium East of the Rio Grande

- Proterozoic granites and amphibolites
- Alteration of Tertiary volcanic ash
- Secondary deposits in Tertiary sediments
- Mineralization that is not of economic grade can be of great concern for contaminating water supply wells



Proterozoic Granites and Amphibolites

Correlation of uranium and sulfate concentrations in mountain front GW suggests that oxidation of sulfide minerals may release uranium.



Shear Zone Mineralization



Tertiary Volcanic Ash in Española Basin

An ash layer in the Skull Ridge member was dated at 15.45 ± 0.06 Ma by laser-fusion $^{40}\text{Ar}/^{39}\text{Ar}$.

Alteration of ash into smectite and zeolite clay minerals can release uranium in to GW.



Tertiary Sandstones



Secondary uranium mineralization in Española Basin can be associated with clay galls, oxyhydroxides and fossilized bone.

Uranium Isotope Testing

East of Rio Grande:

- ratios of U-234/U-238 and U-235/U-238 consistent with natural uranium;
- no detectable manmade U-236.

West of Rio Grande industrial area:

- ratios U-235/U-238 consistent with enriched uranium;
- detectable manmade U-236.



Ingested Uranium

- Most uranium ingested in drinking water is excreted within several days.
- Some uranium is stored in bone, liver and kidneys.
- Primary human health concern is nephrotoxicity.
- Uranium in urine $> 0.2 \mu\text{g/L}$ is a “notifiable condition” that must be reported to N.M. Dept. of Health.



Bio-Monitoring

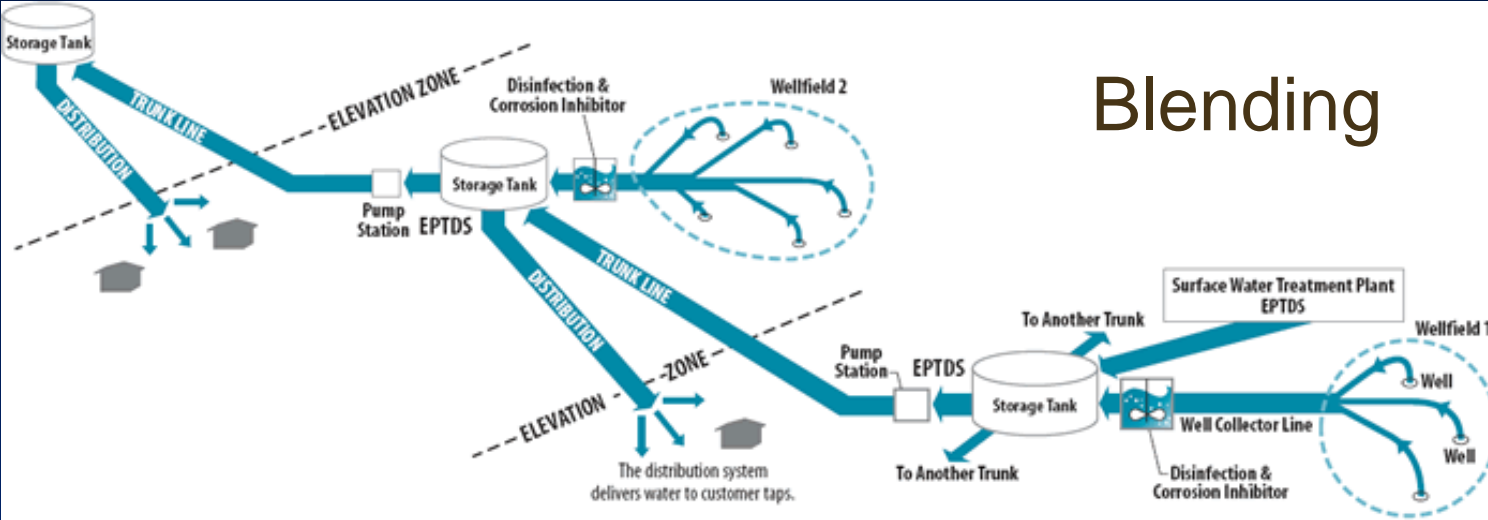
NM Dept. of Health

Uranium in urine (averages):

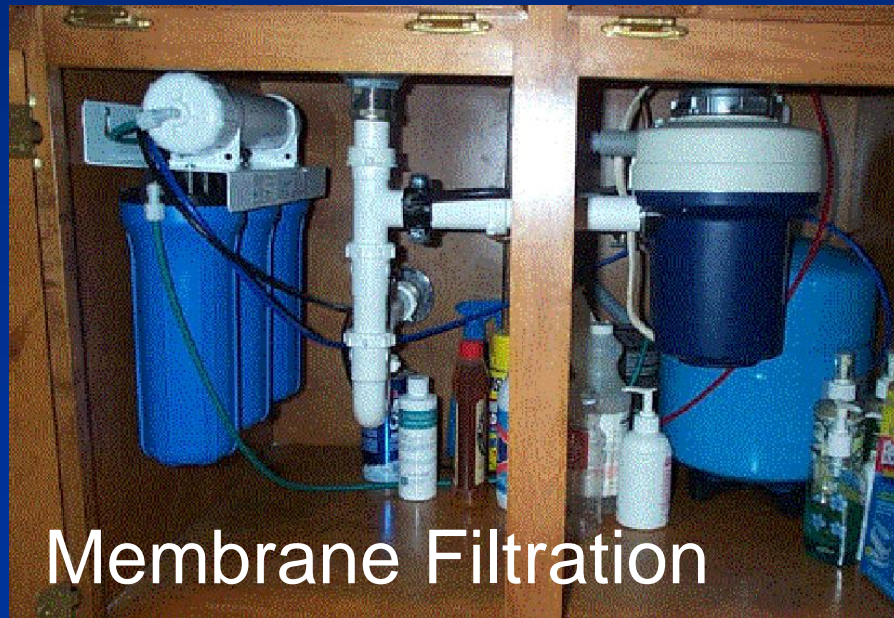
- 0.005 $\mu\text{g/L}$ – U.S. Population
- 0.03 $\mu\text{g/L}$ – N.M. multiple populations
- 0.045 $\mu\text{g/L}$ – N.M. Grants Mineral Belt
(0.004 to 0.25 $\mu\text{g/L}$ range in 99 people)



Blending



Drinking-Water Treatment



Membrane Filtration

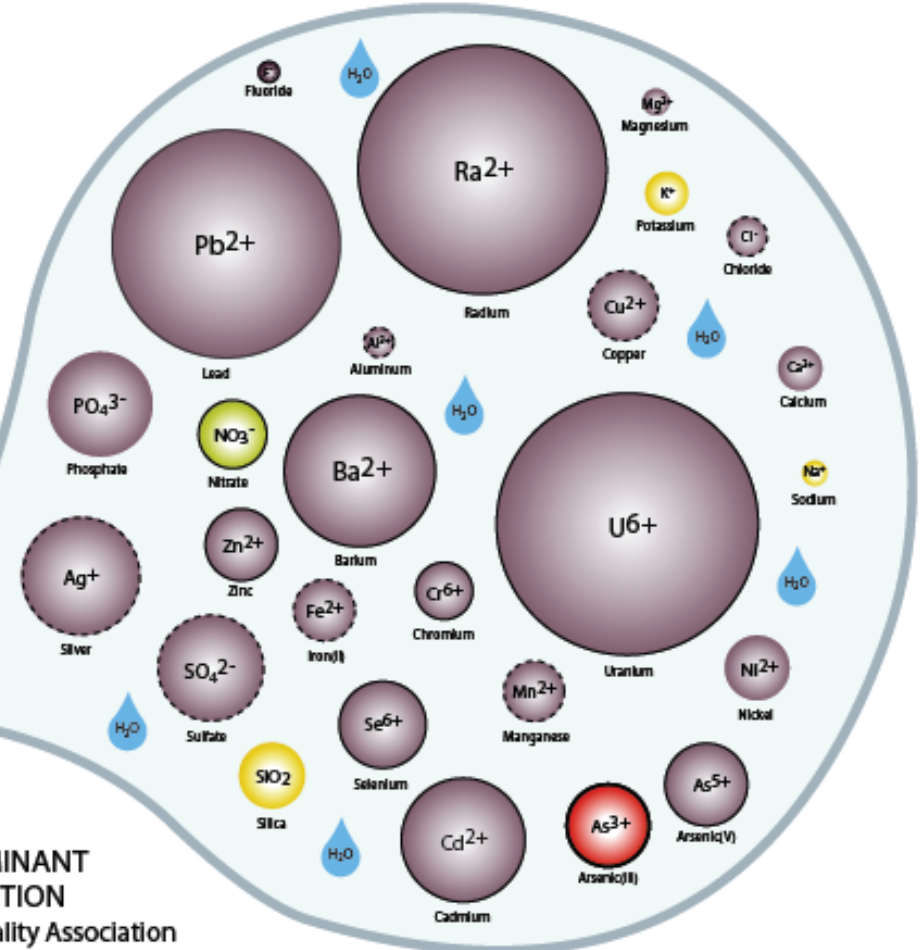
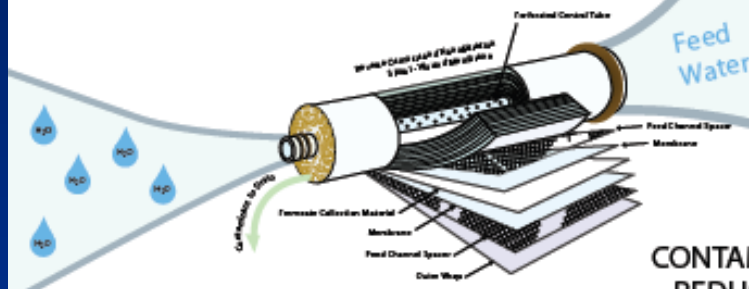


Anion Exchange

Pojoaque Mobile Home Park Ion Exchange System

- 9,000 to 14,000 gpd from two wells
- ~100 $\mu\text{g/L}$ uranium in raw water reduced to $< 5 \mu\text{g/L}$
- \$15,000 total capital cost (2 units)
- \$200/year operation and maintenance

CONTAMINANT REDUCTION by MEMBRANE FILTRATION (REVERSE OSMOSIS and NANOFILTRATION)



CONTAMINANT REDUCTION

Source: Water Quality Association

EPA DRINKING WATER STANDARDS

-  Primary (MCLs)
-  Secondary

-  93-99%
-  90-98%
-  85-95%
-  70-80%

MEMBRANE PORE SIZE

- Reverse Osmosis 0.0001μ
- Nanofiltration 0.001μ
- Buckman Direct Diversion 0.1μ

1μ (micron or micrometer)
= 1,000,000th meter (1x10⁻⁶ m)
= 0.0000394 inches

RELATIVE SIZE COMPARISON of COMMON LOCAL CONTAMINANTS by MOLECULAR WEIGHT

Treatment Wastes

- Currently discharged to on-site septic systems in this area.
- Pojoaque mobile home park ion exchange generates 500 gal, four times/year, of 200,000 $\mu\text{g/L}$ U waste, ~3.3 lbs uranium per year.

How to Reduce Uranium Exposure

- Get your private well water tested and, if uranium $>30 \mu\text{g/L}$, provide treatment before cooking, drinking or irrigating food crops.
- Wash hands after hiking, biking, working in soil.
- Wash fruits and veggies, peel if they are roots.

These recommendations are more important in areas with high uranium.

