



# Understanding the Birds Nest Aquifer in Uintah County, Utah: A Potential Source for Large-Scale Saline Water Disposal

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Project website: [geology.utah.gov/emp/UBwater\\_study](http://geology.utah.gov/emp/UBwater_study)

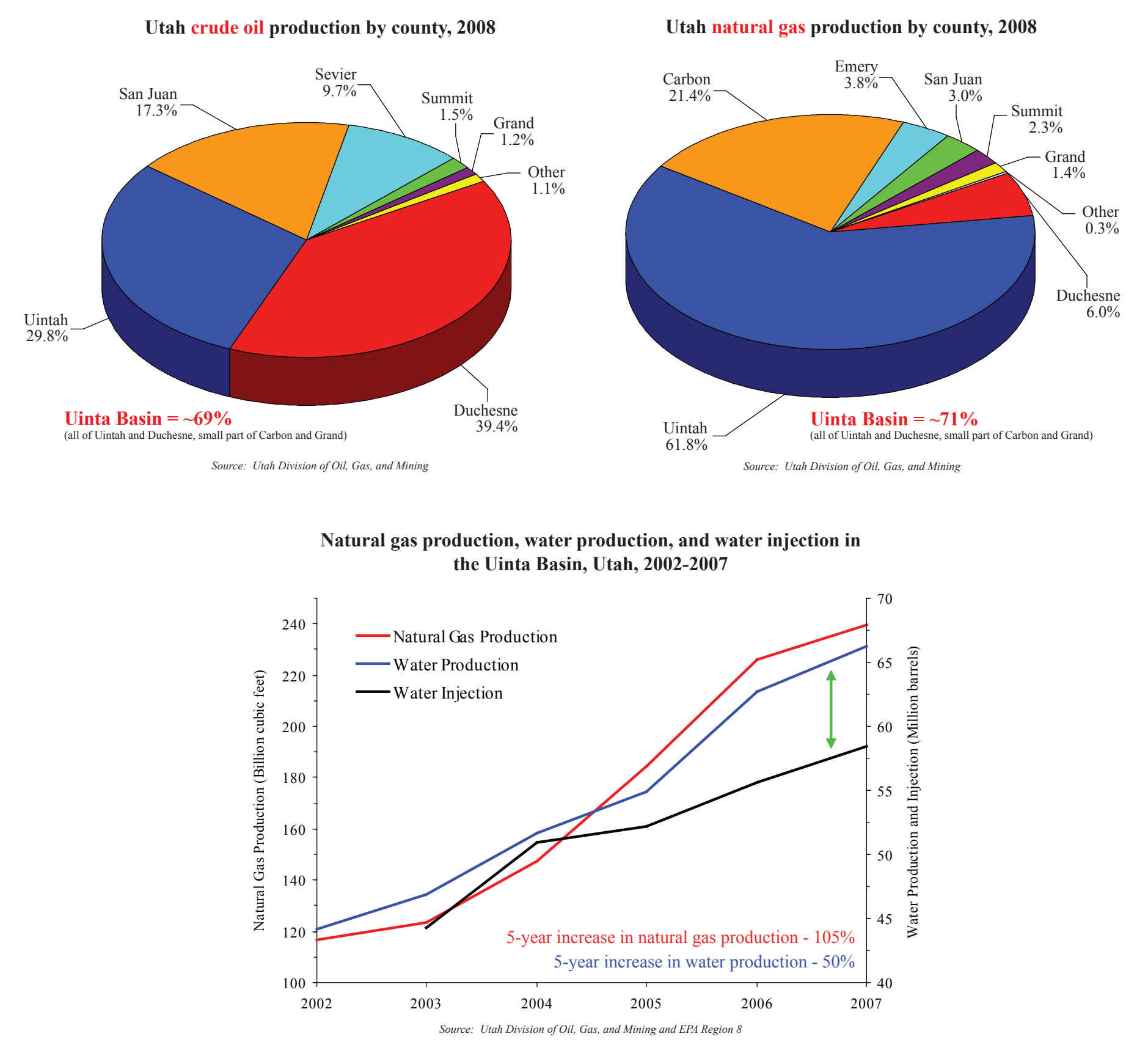


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## ABSTRACT

Saline water disposal is the single most pressing issue with regard to increasing petroleum production in the Uinta Basin of Utah, primarily from Uintah and Duchesne Counties. Conventional oil and gas fields in the basin provide 67% of Utah's total crude oil production and 71% of Utah's total natural gas, the latter of which has increased 175% in the past 10 years (see graphs below). As petroleum production increased, so has saline water production, creating an increasing need for economic and environmentally responsible disposal plans. Current water-disposal wells are near capacity and permitting for new wells is being delayed because of a lack of technical data regarding potential disposal aquifers and questions concerning contamination of freshwater sources. Many Uinta Basin operators claim that crude oil and natural gas production cannot reach its full potential until a suitable, long-term saline water disposal solution is developed.

The Birds Nest aquifer is one potential disposal zone for the large volumes of saline water produced by Uintah County natural gas companies. This poorly understood aquifer, ranging from slightly saline to briny, was formed from the dissolution of saline minerals within the upper Green River Formation's Parachute Creek Member, roughly 300 ft above the oil shale-rich Mahogany zone. Preliminary research indicates that water movement through the Birds Nest aquifer might be controlled by northwest-trending fractures and impermeable gilsonite veins, creating similarly trending aquifer compartments. The Utah Geological Survey is currently studying these compartmentalized zones of dissolution and water flow, as well as overall aquifer characteristics, in order to create an effective saline water disposal plan for the Birds Nest aquifer that ensures protection of fresh or nearly-fresh groundwater resources.



## PROJECT GOALS

- Comprehensive literature review and historic data collection
- Evaluate the Birds Nest aquifer in core, outcrop, and on geophysical logs
- Determine how disposal into the Birds Nest aquifer could affect future oil shale development
- Evaluate the oil shale resource within the Birds Nest interval
- Determine how gilsonite veins may influence water flow in the Birds Nest aquifer
- Create a GIS database and maps showing:
  - Outcrop
  - Thickness
  - Lateral extent
  - Water quality
  - Interburden between Birds Nest and "economic" oil shale zones



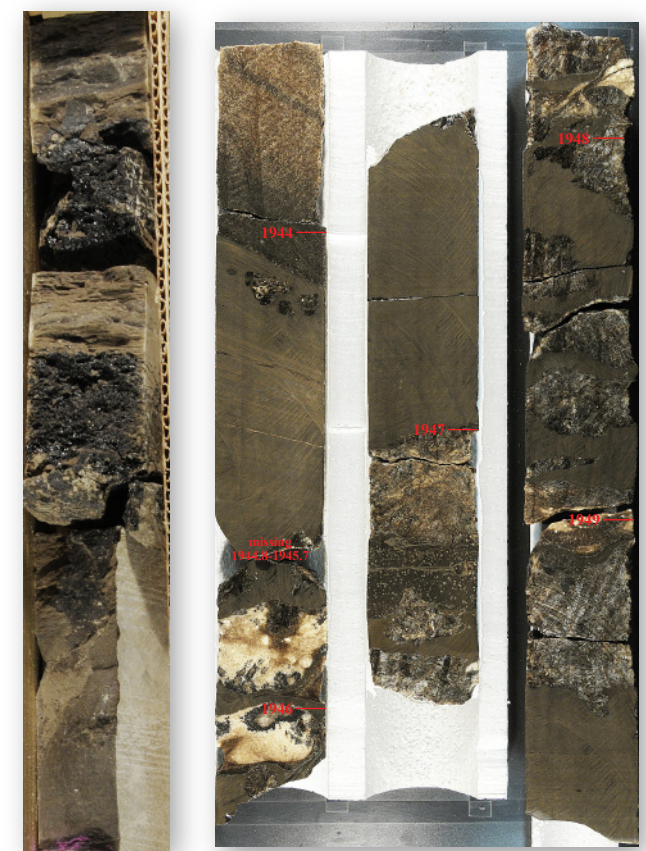
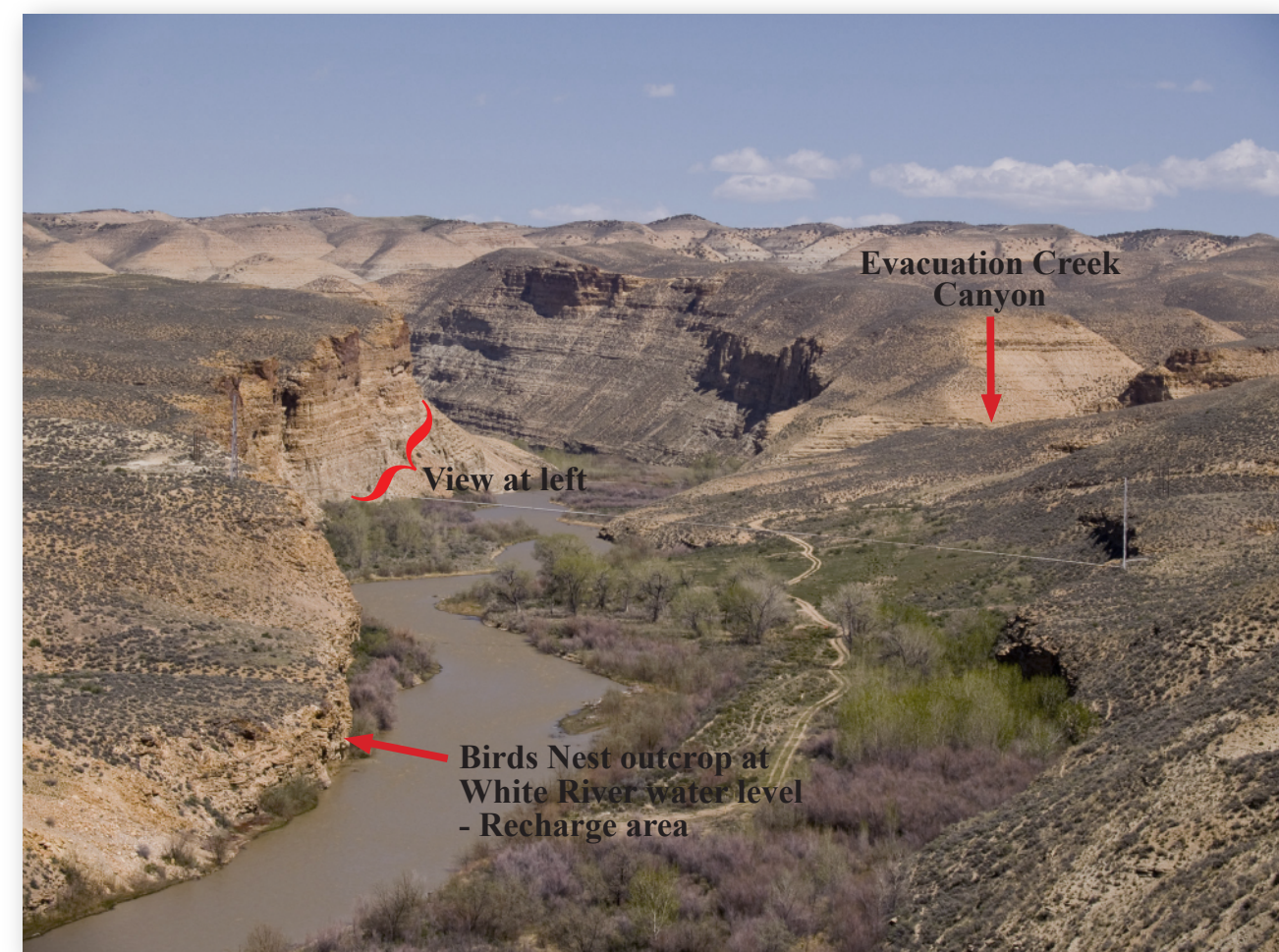
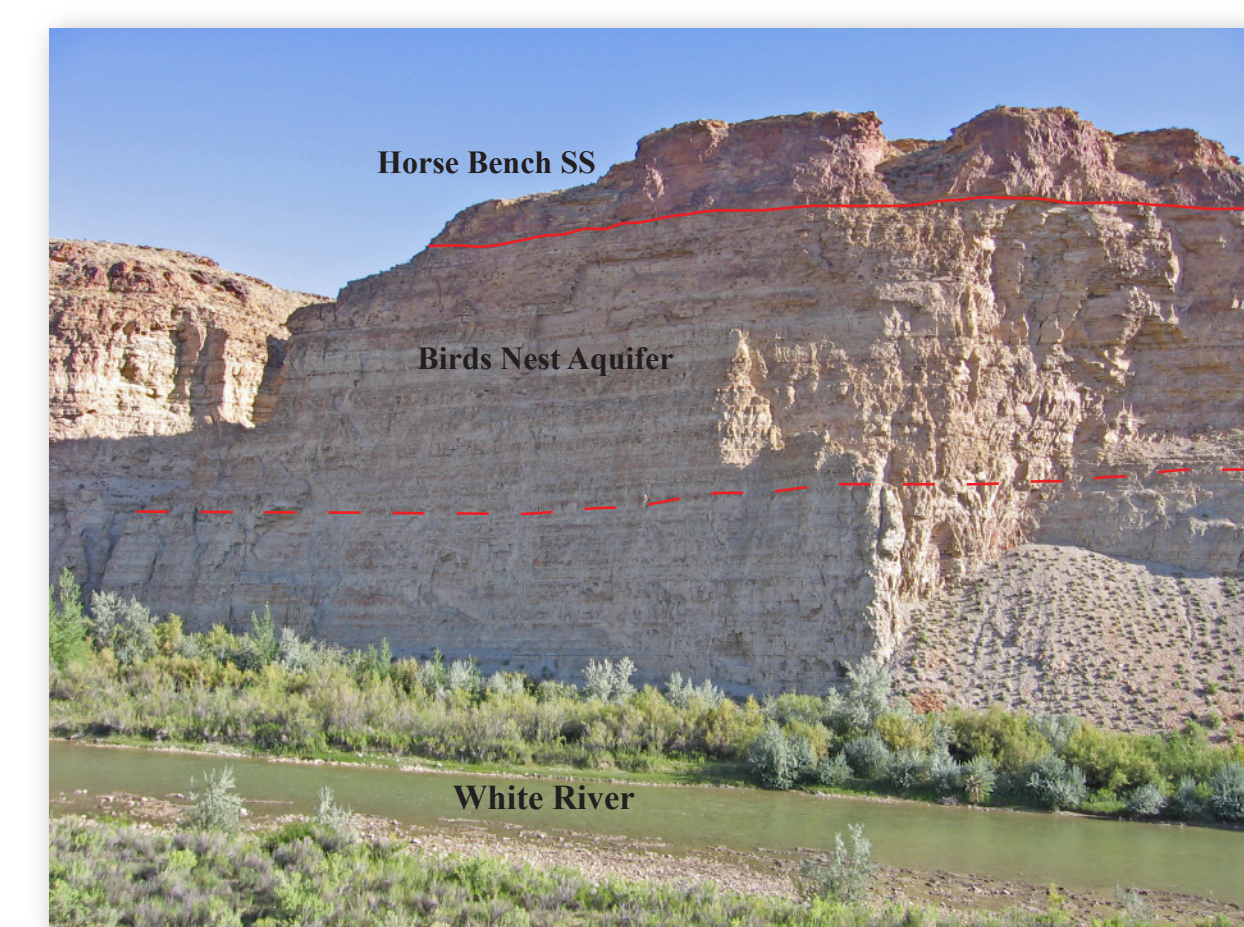
Birds Nest aquifer in outcrop along Evacuation Creek, eastern Uinta Basin. The large cavities resulted from the dissolution of nahcolite nodules, creating the aquifer's porosity and permeability.



Close-up of cavity; notice how the nodule growth warped and fractured the surrounding sediments.



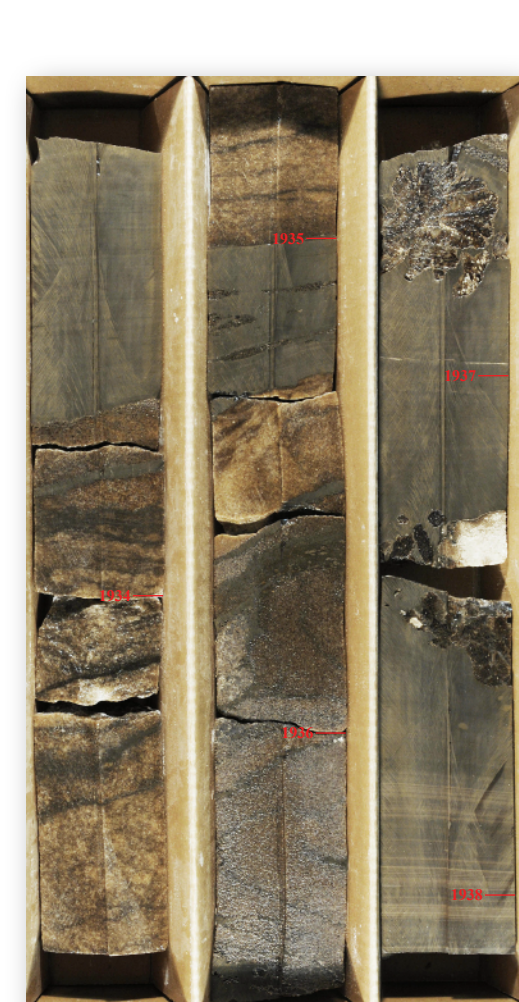
Cliff face along Evacuation Creek showing cavities of the Birds Nest aquifer.



Well EX-1 (left) 1830-1831 ft, right: 1943.5-1949.7 ft) - Limited dissolution of saline minerals; left, dissolved nahcolite nodules filled with brine; right, no saline mineral dissolution.

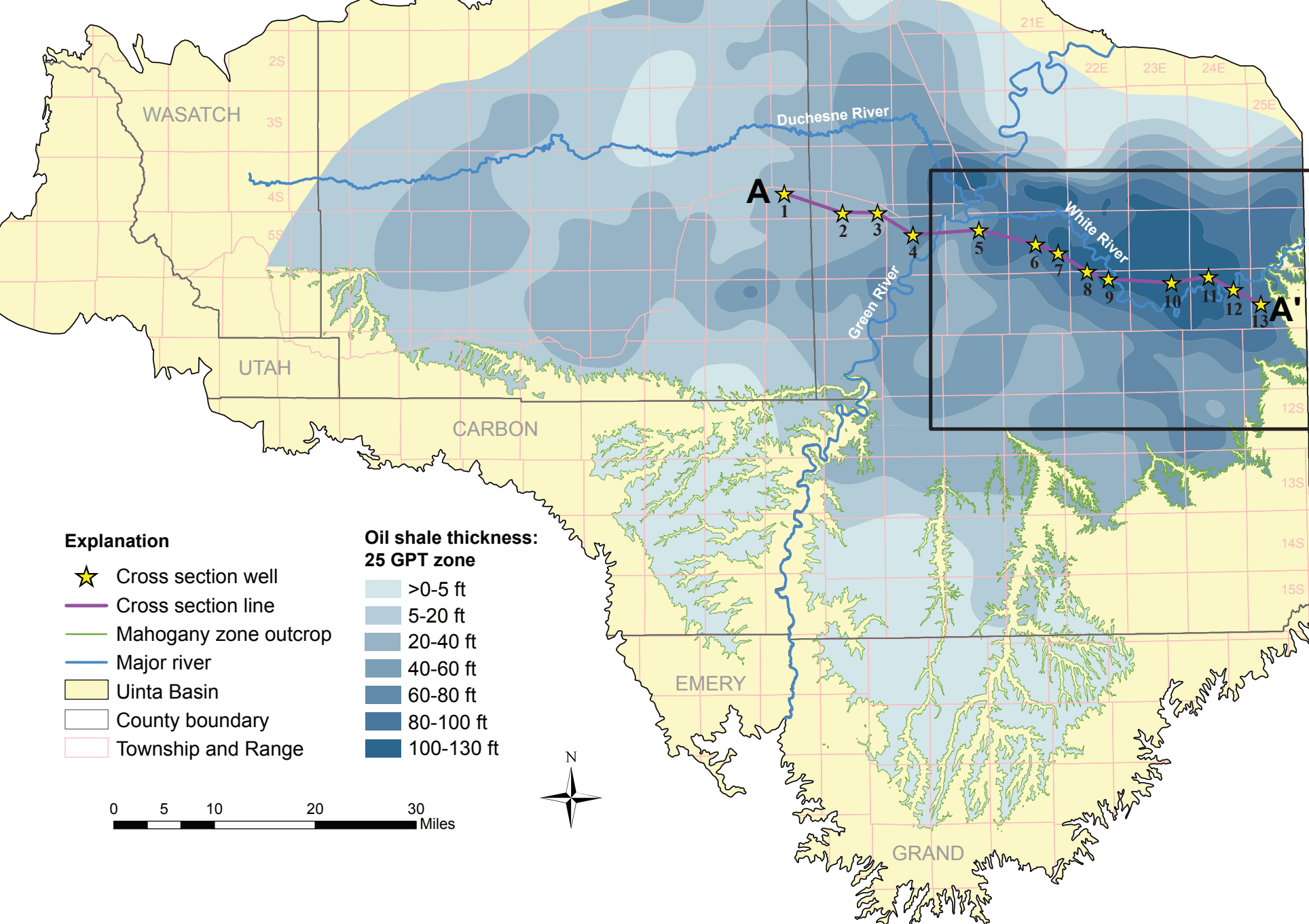


Well 42-33 (1648-1671 ft) - Dissolution of saline minerals; each white tag represents a 0.5 to 1.5 ft void left behind by a dissolved nahcolite nodule.

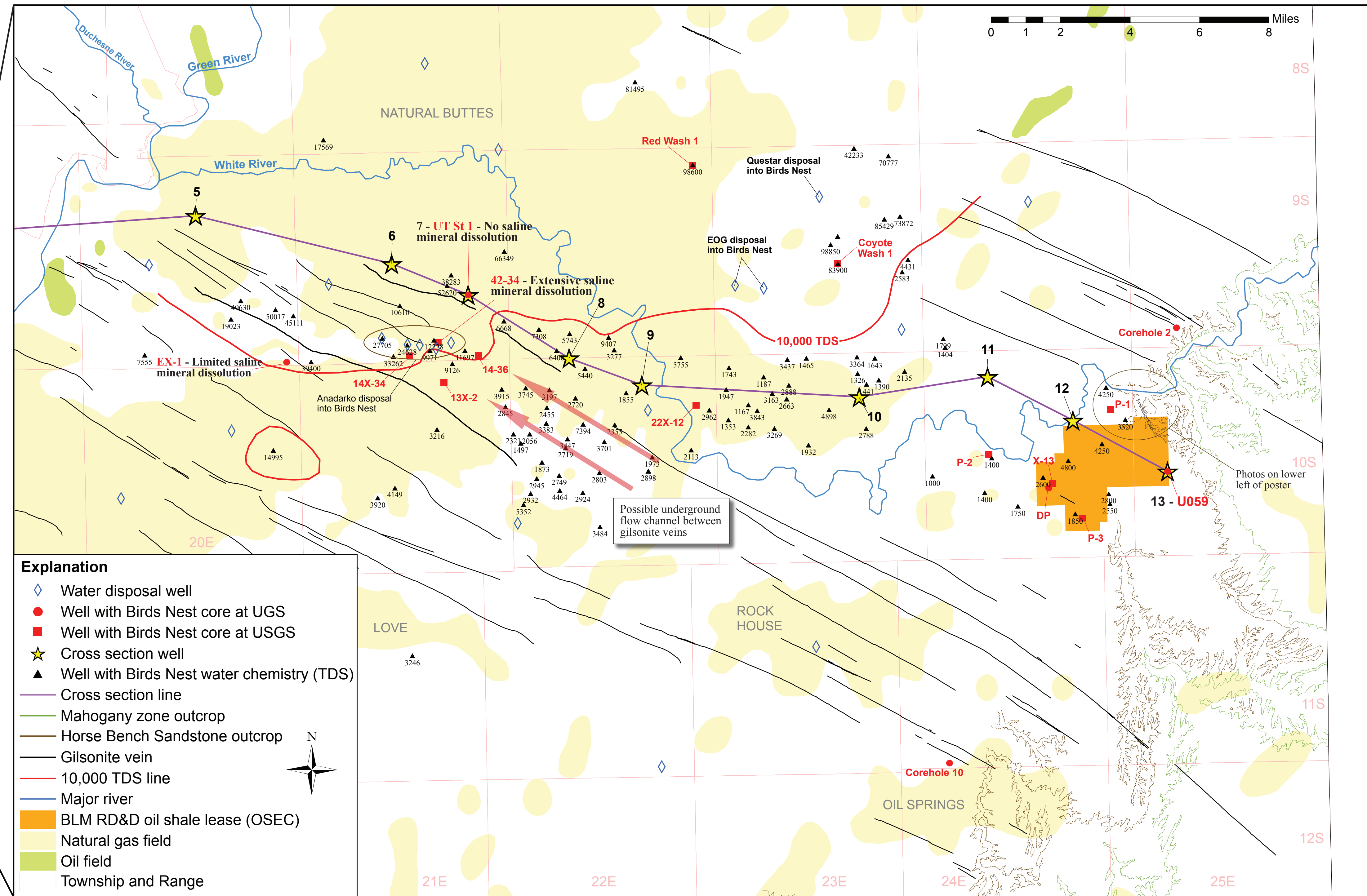


Well UT 8-1 (1933-1938 ft) - No dissolution of saline minerals.

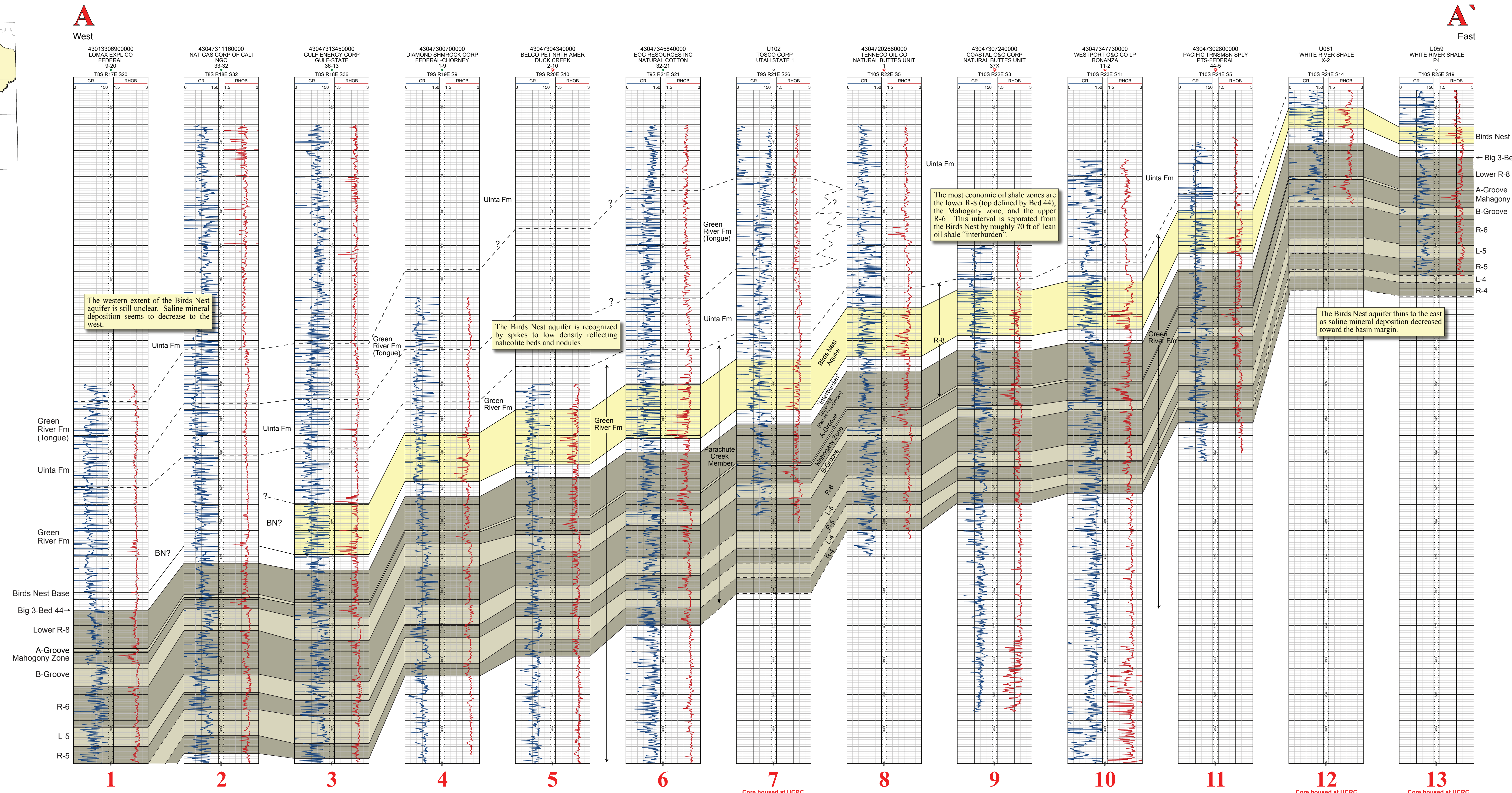
One of the questions related to disposal of saline water into the Birds Nest aquifer is how such practices might affect potential oil shale development. This map shows the thickness of the 25 gallon per ton (GPT) oil shale zone, which is considered to be the minimum economic grade. Our cross-section is drawn through the thickest and richest of the oil shale in central Uintah County.



- Explanation**
- ★ Cross section well
  - Cross section line
  - Mahogany zone outcrop
  - Major river
  - Uinta Basin
  - County boundary
  - Township and Range
- Oil shale thickness: 25 GPT zone**
- >0-5 ft
  - 5-20 ft
  - 20-40 ft
  - 40-60 ft
  - 60-80 ft
  - 80-100 ft
  - 100-130 ft



- Explanation**
- ◇ Water disposal well
  - Well with Birds Nest core at UGS
  - Well with Birds Nest core at USGS
  - ★ Cross section well
  - ▲ Well with Birds Nest water chemistry (TDS)
  - Cross section line
  - Mahogany zone outcrop
  - Horse Bench Sandstone outcrop
  - Gilsonite vein
  - 10,000 TDS line
  - Major river
  - BLM RD&D oil shale lease (OSEC)
  - Natural gas field
  - Oil field
  - Township and Range



The western extent of the Birds Nest aquifer is still unclear. Saline mineral deposition seems to decrease to the west.

The Birds Nest aquifer is recognized by spikes to low density reflecting nahcolite beds and nodules.

The most economic oil shale zones are the lower R-8 (top defined by Bed 44), the Mahogany zone, and the upper R-6. This interval is separated from the Birds Nest by roughly 70 ft of lean oil shale "interburden".

The Birds Nest aquifer thins to the east as saline mineral deposition decreased toward the basin margin.