

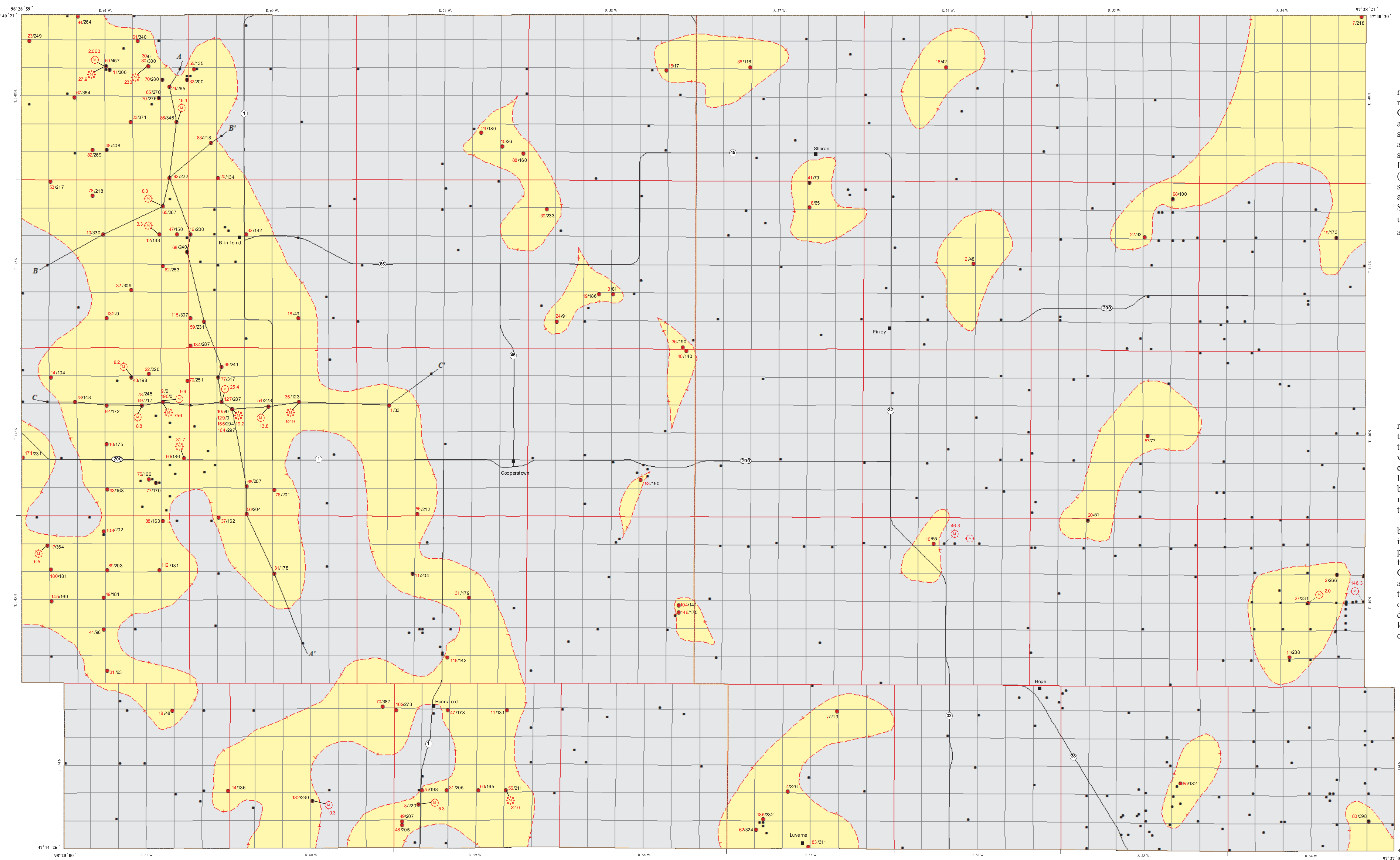


# POTENTIAL SHALLOW GAS SANDS & GRAVELS - GRIGGS AND STEELE COUNTIES, NORTH DAKOTA



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## DISCUSSION

Areas containing sands and gravels with a potential to host accumulated shallow natural gas are displayed on this map at a scale of 1:100,000. Potential areas were mapped from lithologic logs and well information maintained by the North Dakota Geological Survey and North Dakota State Water Commission. Over 600 well records and lithologic logs were reviewed during the creation of this map. A favorable stratigraphic relationship, for the accumulation of shallow natural gas, exists in Griggs and Steele Counties. Unconsolidated glacial sediments are underlain by gently dipping sedimentary strata of Cretaceous age and include (from east to west) the Greenhorn Formation, the Carlile Formation, the Niobrara Formation and the Pierre Formation (Figure 1). An erosional unconformity exists between the underlying Cretaceous marine shales and overlying glacial sediments, consisting of subglacial clay-matrix diamictons and glaciofluvial sands and gravels associated with glacial, buried-channel aquifers. Sands and gravels, often with detrital lignites present, are commonly found at the unconformity and range in thickness from one to 190 feet (Cross-sections A-A', B-B', and C-C').

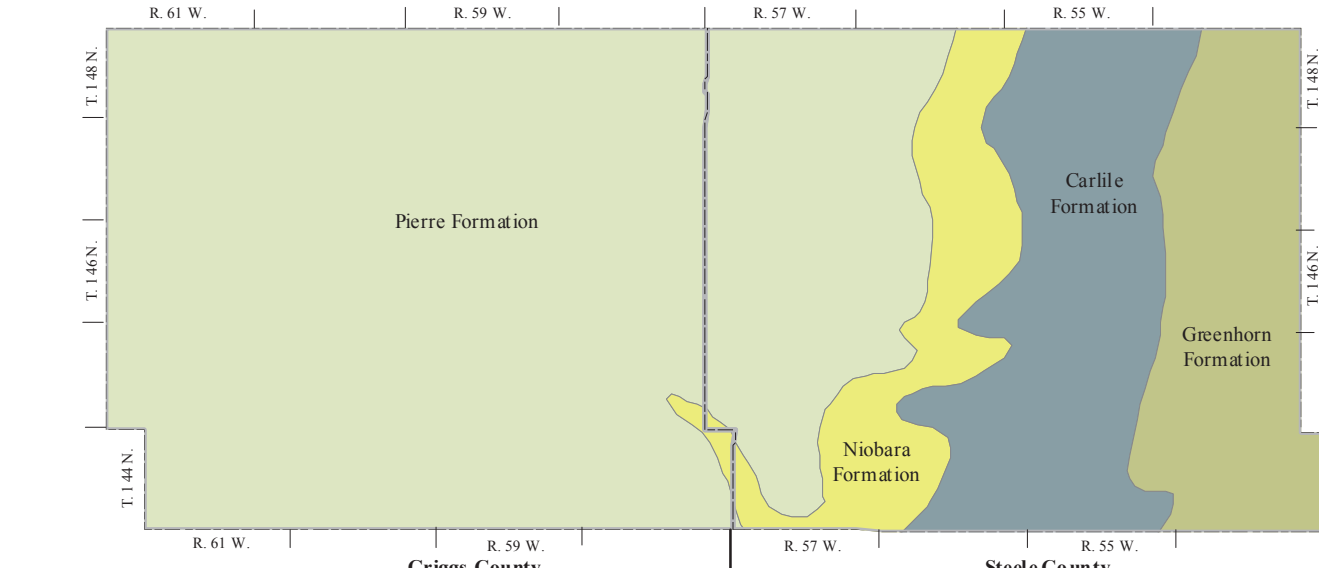


Figure 1. Cretaceous age bedrock geologic units found beneath surficial Pleistocene glacial sediments in Griggs and Steele Counties.

These permeable zones have a potential for hosting shallow gas as they form the reservoir portion of a three-component ultra-shallow gas system consisting of: the source; the underlying organic laden marine shales and organic detritus within the reservoir sands themselves, the reservoir; the fluid-filled glaciofluvial sands and gravels, and the trap; which is made up of low-permeability, clay dominated glacial sediments, overlying and effectively "capping" the system. This stratigraphic relationship can be found on lithologic logs from well records where sands and gravels are described as overlying and being in depositional contact with the shallow shale bedrock. Recent shallow gas investigations have revealed several shallow gas occurrences (Table 1) within similar types of sediments throughout the central and eastern portions of the state.

This map displays the total sand and gravel interval thickness, found above the shale bedrock that is "capped" by a low-permeability lithology. These areas tend to be found in the deeper portions of the buried-channel aquifer systems present in the counties, primarily within the Spiritwood Aquifer system in western Griggs County. They are also found within the shallower McVillie Aquifer straddling eastern Griggs and western Steele County, and in several localized areas of the Page Aquifer in southeastern Steele County and the Elk Valley Aquifer in northeastern Steele County (Figure 2). The thickness of these zones are generally greater towards the area centers, most likely the result of original glaciofluvial channel morphology. The areas with the thickest interval of deposits-up to 190 feet-are found at the base of the Spiritwood Aquifer. Several smaller localized areas are also found, primarily in the central portion of the map area, where overall depth to bedrock is shallower.

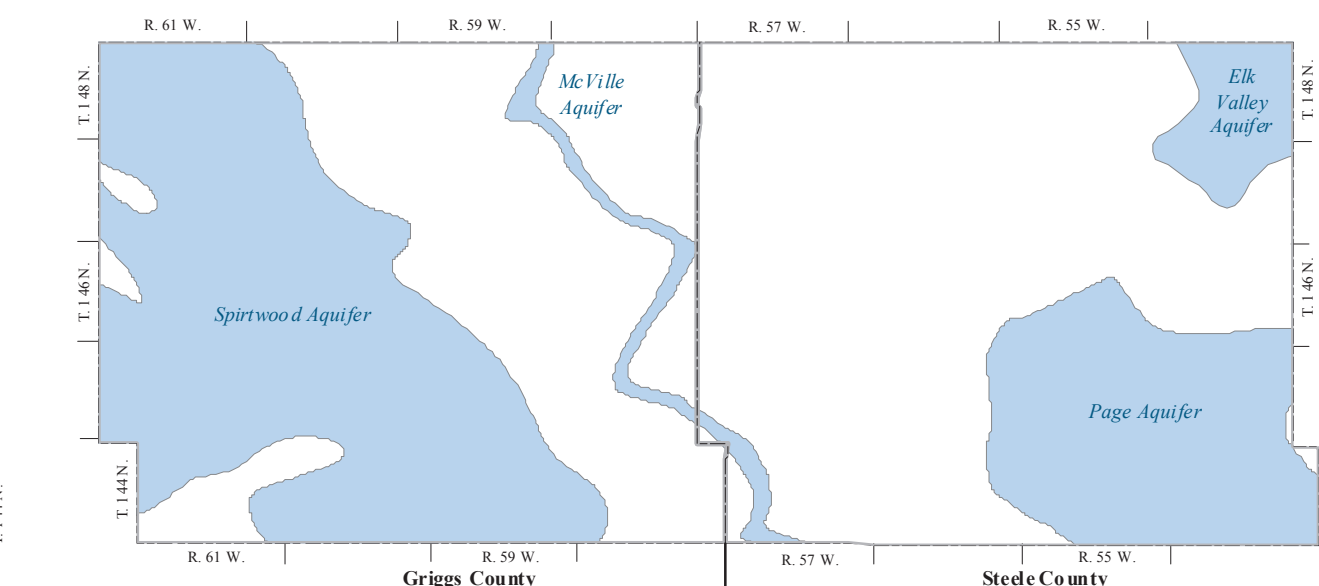


Figure 2. Location of shallow glacial buried channel aquifers in Griggs and Steele Counties.

The intent of this map is to present areas of interest for continued shallow gas exploration and investigation, that have a potential to host ultra-shallow gas accumulations.

Location	FID <sup>1</sup> (ppm CH <sub>4</sub> )	Screened Interval (ft)	Bedrock Depth (ft)	Total Depth (ft)	Aquifer
148-61-24DCC	16.1	318 - 321	346	380	Spiritwood
148-61-11DCC2	230	102 - 107	300	1,200	Spiritwood
148-61-10CCC3	27.9	281 - 284	>340	340	Spiritwood
148-61-10CCC2	2,063	398 - 407	457	470	Spiritwood
147-61-1CCC	8.3	237 - 240	267	340	Spiritwood
147-61-11DDD	3.3	128 - 133	133	140	Spiritwood
146-61-24DDC	31.7	138 - 144	186	200	Spiritwood
146-61-12CCC2	756	478 - 487	>550	550	Spiritwood
146-61-12CCC1	9.6	138 - 141	>430	430	Spiritwood
146-61-11CDD	8.8	198 - 204	>260	260	Spiritwood
146-61-10AAA2	8.2	65 - 68	>100	100	Spiritwood
146-60-8CCD	25.4	197 - 203	287	300	Spiritwood
146-60-17ABB	19.2	177 - 183	295	310	Spiritwood
146-60-16AAA	13.8	177 - 180	228	240	Spiritwood
146-60-10DDD	52.9	97 - 103	123	140	Spiritwood
145-61-7AAA	6.5	188 - 194	364	380	New Rockford
145-56-4DDD	46.3	50 - 60	36	60	Pierre Shale
145-54-22AAA2	2.0	74 - 79	>106	106	Page
145-54-13DDD3	146.3	75 - 80	>100	100	Page
144-60-27BCB1	0.3	198 - 204	230	240	Spiritwood
144-59-30ADD	5.3	195 - 98	200	220	Spiritwood
144-59-23CCC	22	197 - 200	211	260	Spiritwood

<sup>1</sup>Flame-Ionization Detector (FID) instrument response as methane (CH<sub>4</sub>) in air.

Table 1. Wells in Griggs and Steele counties where a measured shallow gas occurrence was found.

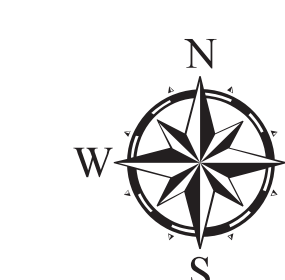
## REFERENCES

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## EXPLANATION

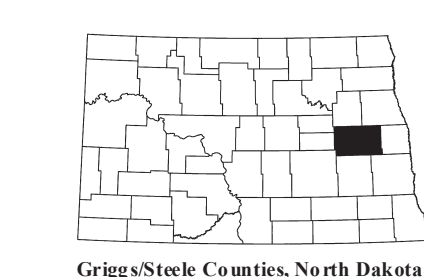
- Areas where no potential shallow gas sands and gravels are known.
- Areas of potential shallow gas sands and gravels.
- Approximate extent of area containing a mappable interval of potential shallow gas hosting sands and gravels.
- Cross-section
- Well Location - Potential Shallow Gas Interval Thickness (feet)/Bedrock Depth (feet)
- Well Location - test hole or well location with no potential shallow gas sand and gravel interval described.
- Location of Measured Shallow Gas Occurrence: Number indicates FID instrument reading as methane in air in parts per million (ppm).
- Location of Anecdotal Shallow Gas Occurrence: Obtained from historical accounts or well records.
- County Boundary
- Township Boundary
- Town
- State Highway
- Section Boundary

## Other Features



## UNITS DEPICTED IN CROSS-SECTION

- Glacial Sediment (Undifferentiated): Clays, Silty-Clays, and Sands.
- Glaciofluvial Sands and Gravels: Poorly sorted sands and gravels. Detrital organics common. Potentially gas hosting.
- Pierre Formation: Gray shale bedrock of Cretaceous age. Overlain unconformably by Pleistocene glacial sediments.



Scale 1:100,000  
 0 1 2 3 4  
 Miles  
 Mercator Projection  
 1983 North American Datum  
 Standard parallel 47° 15'  
 Central meridian 98° 00'

