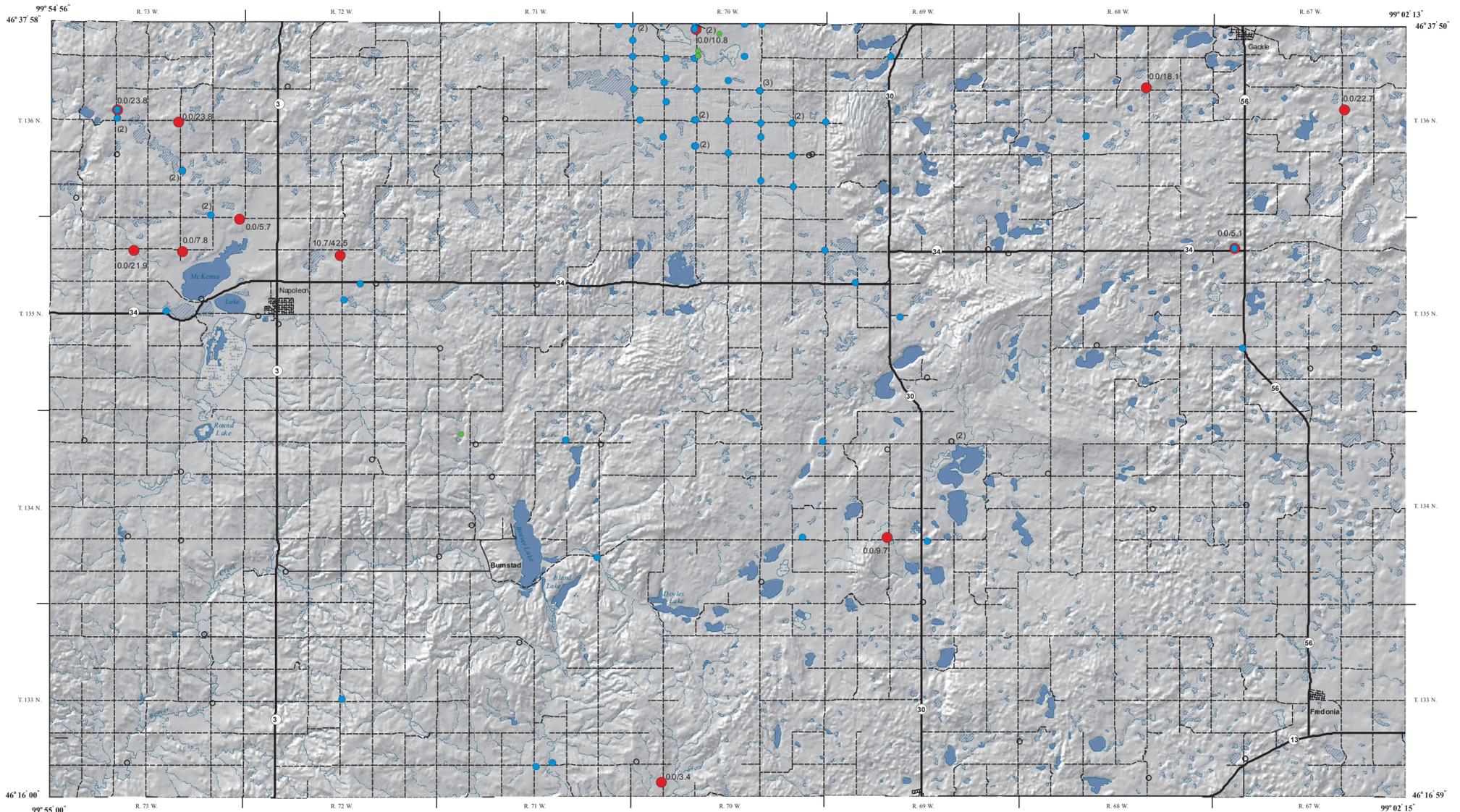


Field Screening for Shallow Gas in Logan County, North Dakota



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The investigation of shallow natural gas occurrences within existing ground-water observation wells in Logan County, North Dakota was conducted over a two-day period on August 7 & 8, 2007. A total of 127 observation well sites, consisting of historic and existing ground-water observation wells, drilled in the county for the purposes of ground-water monitoring of unconsolidated and shallow bedrock aquifers, were reviewed prior to the field component of this investigation. 120 of these observation well sites were selected to be visited in the field to (1) determine the actual existence of the well, (2) to verify its location, and (3) perform flame-ionization detector field screening for possible shallow natural gas occurrences. 45 observation well sites were not found during the investigation, suggesting that these wells have either been abandoned or destroyed. 75 observation well site locations were verified to have a ground-water observation well at their prescribed point and were subsequently field screened.

Each of the wells were field screened for the presence of combustible gases using a portable FID calibrated to methane (101 ppm low-span or 10,000 ppm high-span) in air. The FID was used solely for field screening on all wells. Instrument response was collected at the top of well casing (TOC) and just above the groundwater/air interface (GWI). After the collection of field screening readings, a depth to water level reading within the well was taken using an electric well tape. Of the existing wells field screened, 12 returned positive FID responses, ranging from 3.4 to 42.5 ppm as methane (Figure 1); 63 of the wells showed no response (i.e., a 0.0 ppm as methane instrument reading) during field screening at both the TOC and GWI. One well was found to have a detectable concentration of methane at the TOC. Well 135-72-9-AAD recorded a concentration of 42.5 ppm at the TOC (Table 1). It has been observed that it is more likely to detect methane at the GWI or higher up in the air column within a given well. It has been less typical to actually detect methane emanating from the TOC.

The occurrence of FID responses are variably distributed throughout the monitoring network in the northwestern and east-northeastern portion of the county following the general trend of the aquifer(s) being monitored and the relatively shallow Cretaceous subcrop in these areas. Stock wells and individual private, irrigation, or municipal water supply wells were not considered as a part of this investigation. FID field screening is not a stand-alone analytical tool. It must be used in conjunction with additional analytical methods and procedures. A positive FID instrument response indicates that the presence of methane is highly likely at the well since the instrument is selectively sensitive to methane and is calibrated specifically to a predetermined concentration of methane in air. However, excessive moisture and low oxygen levels or high values of carbon dioxide can influence FID response. A confirmatory gas analysis is required to determine and quantify the absolute presence and concentration of methane and other hydrocarbons that may be present in conjunction with FID field screening results. The reconnaissance level field screening results presented here are intended to aid in the selection of future candidate observation well locations and or areas to conduct additional sampling and analysis and potentially focus future field investigative and exploration efforts.

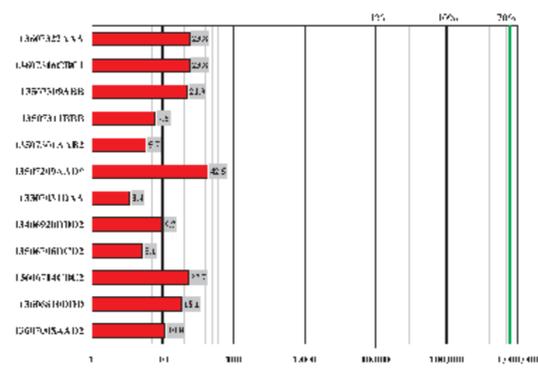


Figure 1. Graph depicting the relative relationship and absolute maximum values of flame-ionization detector (FID) instrument responses from selected wells in Logan County. FID results for each well are presented in order of field screening occurrence from top to bottom. Values shown are those reported from the air/ground-water interface (GWI) (as CH₄ in ppm). The typical concentration of methane in commercial natural gas is highlighted by the vertical green line at 70%.

Location	Shallow Gas Field Screening Results				Atmospheric Conditions		
	Date	Time	FID @ TOC (ppm)	FID @ GWI (ppm)	Depth to Water (ft)	Temp. (°F)	Pressure (mb)
13607322AAA	8/6/08	12:10	0.0	23.8	89.05	83.8	1014
13607316CBC1	8/6/08	12:50	0.0	23.8	30.64	94.8	1016
13507309ABB	8/6/08	13:24	0.0	21.9	7.50	85.5	1016
13507311BBB	8/6/08	13:36	0.0	7.8	17.45	89.1	1015
13507301AAB2	8/6/08	14:13	0.0	5.7	53.41	91.7	1014
13507209AAD	8/6/08	15:07	10.7	42.5	29.84	88.1	1013
13307031DAA	8/6/08	20:47	0.0	3.4	25.15	75.0	1009
13406920DDD2	8/7/08	08:50	0.0	9.7	17.52	68.7	1017
13506706DCD2	8/7/08	12:09	0.0	5.1	41.73	90.0	1017
13606714CBC2	8/7/08	12:55	0.0	22.7	15.70	88.1	1017
13606810DDD	8/7/08	13:23	0.0	18.1	69.02	87.6	1017
13607005AAD2	8/7/08	15:17	0.0	10.8	--	84.3	1018

TOC = Top of Casing
GWI = Groundwater-Atmospheric Interface
(ppm) = FID instrument reading as calibrated to C1 in air.
-- = No water level measured in well (Dry).
1 Measured from top of well casing.
2 Atmospheric conditions (temperature & pressure) measured outside the well at the well site.

Table 1. Field screening information collected from ground-water observation wells in Logan County, North Dakota where shallow gas was detected using a portable Flame-Ionization Detector.

Explanation

Geologic Symbols

- Existing observation well with a positive numerical FID instrument response in parts per million (ppm) as methane, at the top of casing (TOC) and/or the ground-water/air interface (GWI).
- Existing observation well, no FID response at TOC and/or the GWI.
- Well sites not visited during this investigation.
- Historical observation well location. No existing well at well site location visited. Well presumed abandoned or destroyed.
- Nested wells; locations not separable at this scale.
- (3) Indicates number of wells drilled at same coordinates.

Other Features

- Water
- Water - Intermittent
- Marsh
- River/Stream - Perennial
- Stream - Intermittent
- State Highway
- Paved Road
- Unpaved Road

