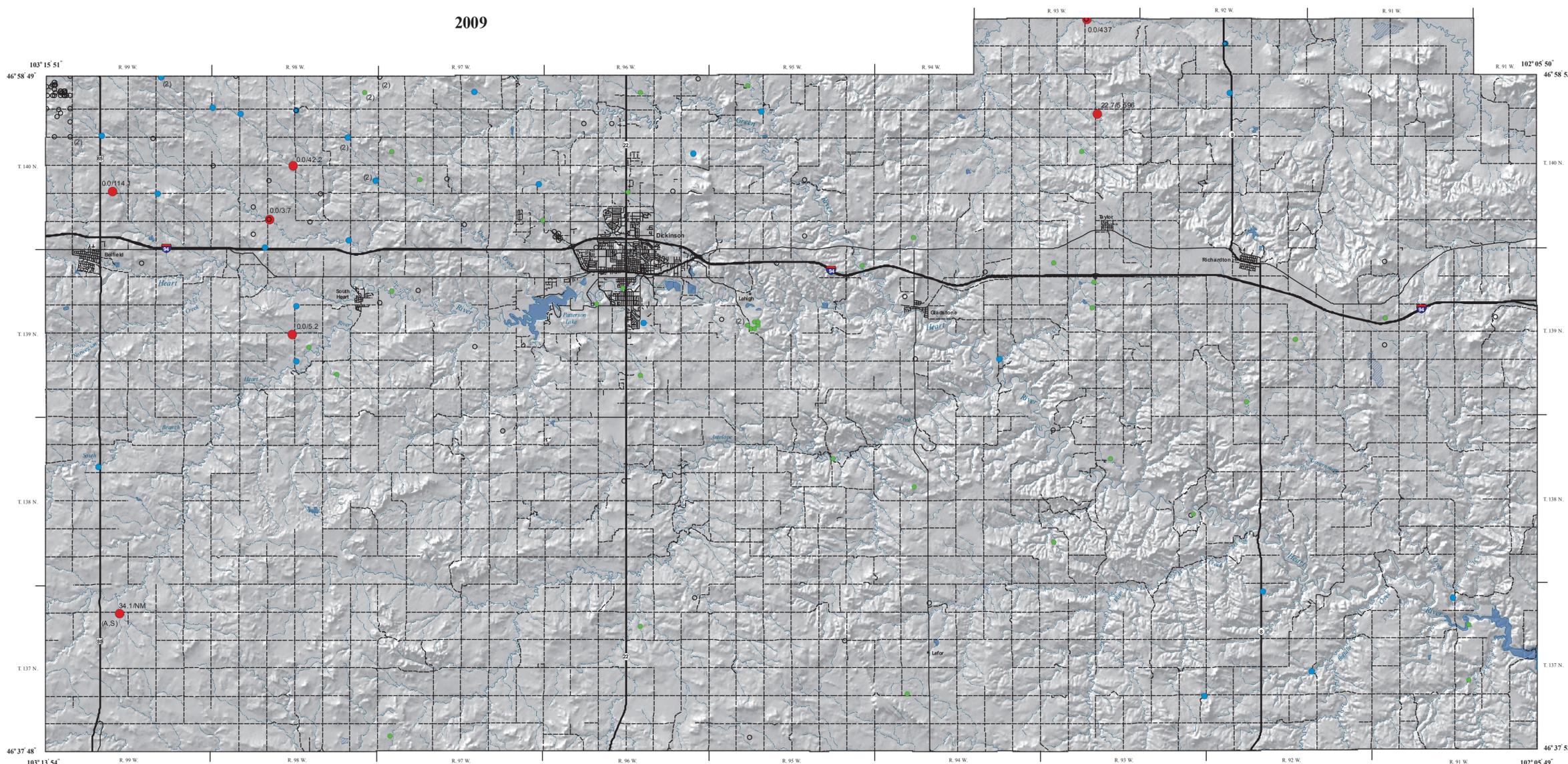


Field Screening for Shallow Gas in Stark County, North Dakota

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The investigation of shallow natural gas occurrences within existing ground-water wells in Stark County, North Dakota was conducted over a eight non-consecutive day period from June 24 to July 7, 2009. A total of 170 well sites, consisting of historic and existing ground-water wells, drilled in the county for the purposes of ground-water monitoring of unconsolidated and shallow bedrock aquifers and stock water supply, were reviewed prior to the field component of this investigation. Each of these 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. 94 well sites were not found during the investigation, suggesting that these wells have either been abandoned or destroyed. 35 ground-water well site locations (34 observation wells and 1 stock well) were verified to have a testable 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 (100 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, seven returned positive FID responses, ranging from 0.7 to 5,596 ppm as methane (Figure 1); 28 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. Two wells were found to have detectable concentrations of methane at the TOC. Well 140-93-9BBC recorded a concentration of 22.7 ppm at the TOC. Well 137-99-9ABA, an artesian stock well, recorded a concentration of 34.1 ppm at the TOC. 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 western and east-central portions of the county following the general trend of the aquifers(s) being monitored. Domestic, 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 screening results. The reconnaissance level 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 efforts.

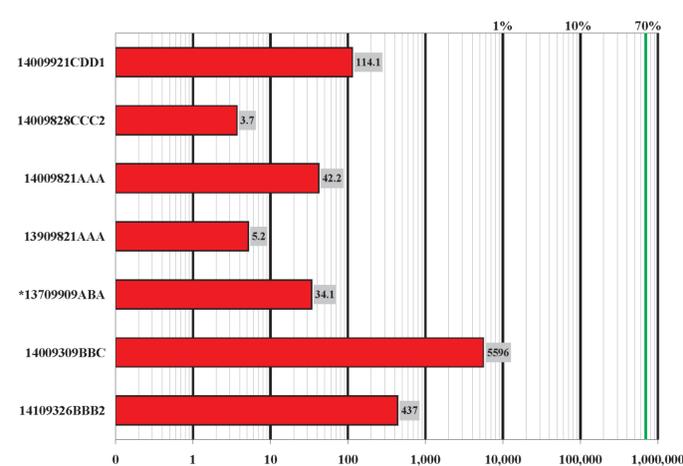


Figure 1. Graph depicting the relative relationship and absolute maximum values of flame-ionization detector (FID) instrument responses from selected wells in Stark County. FID results for each well are presented in order of field screening occurrence from top to bottom. Values shown are those reported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

* FID instrument response collected from the top of well casing (TOC).

Explanation

Geologic Symbols

- 0.0/14.1 (TOC/GWI) 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). (S) notation indicates stock well. (A) notation indicates artesian well. NM indicates not measured.
- Existing observation well, no FID response at TOC and/or the GWI.
- Historical observation well location. No existing well at well site location visited. Well presumed abandoned or destroyed.
- Wells sites not visited during this investigation.
- Nested wells; locations not separable at this scale.
- (2) Indicates number of wells drilled at same coordinates.

Other Features

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

