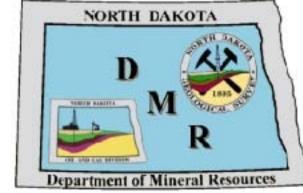
North Dakota Geological Survey Geologic Investigations No. 71 Edward C. Murphy, State Geologist Lynn D. Helms, Director Dept. of Mineral Reources

ABSTRACT

The investigation of shallow natural gas occurrences within existing



Field Screening for Shallow Gas in North Dakota

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2008



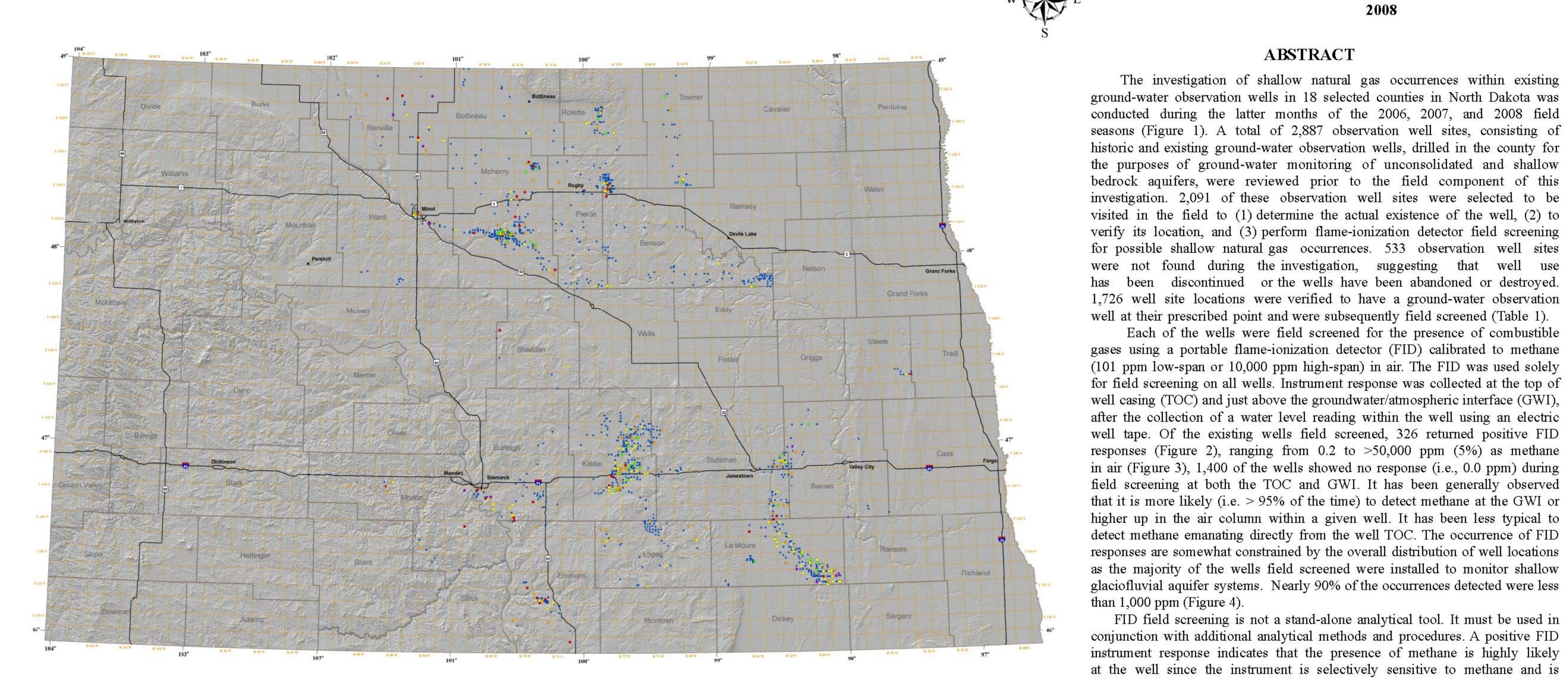
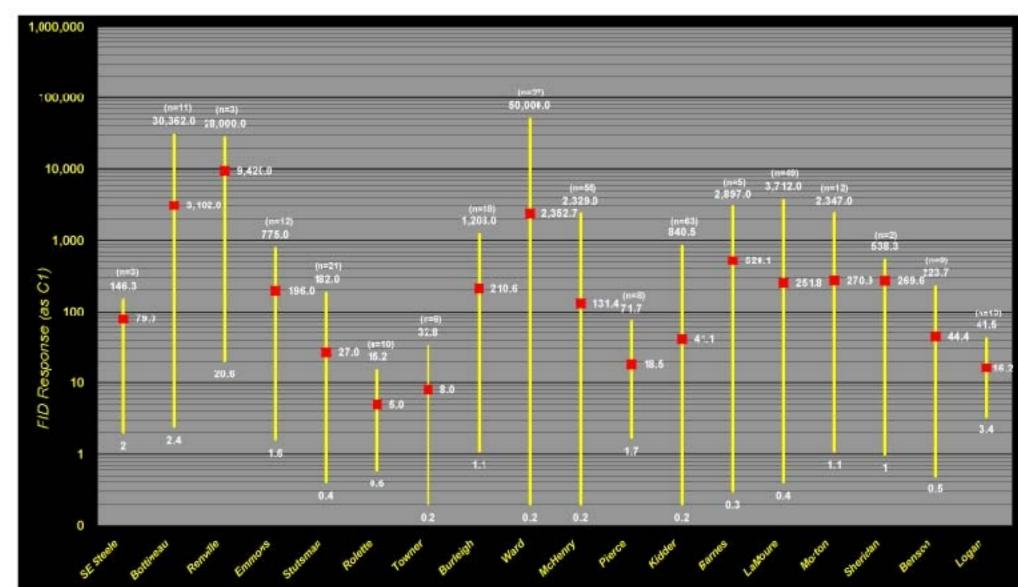


Figure 1. Shaded-relief map of North Dakota with the locations of shallow ground-water observation wells field screened for the occurrence of shallow gas. Symbols are color-coded indicating the range of flame-ionization detector (FID) instrument response recorded within the well at the groundwater/atmospheric interface (GWI). Well locations are color coded from cooler to warmer colors based on the order of magnitude of FID instrument response: green = 0 to 1 ppm, yellow = 1 to 10 ppm, orange = 10 to 100 ppm, red = 100 to 1,000 ppm, and purple = 1,000 to 1,000,000 ppm.

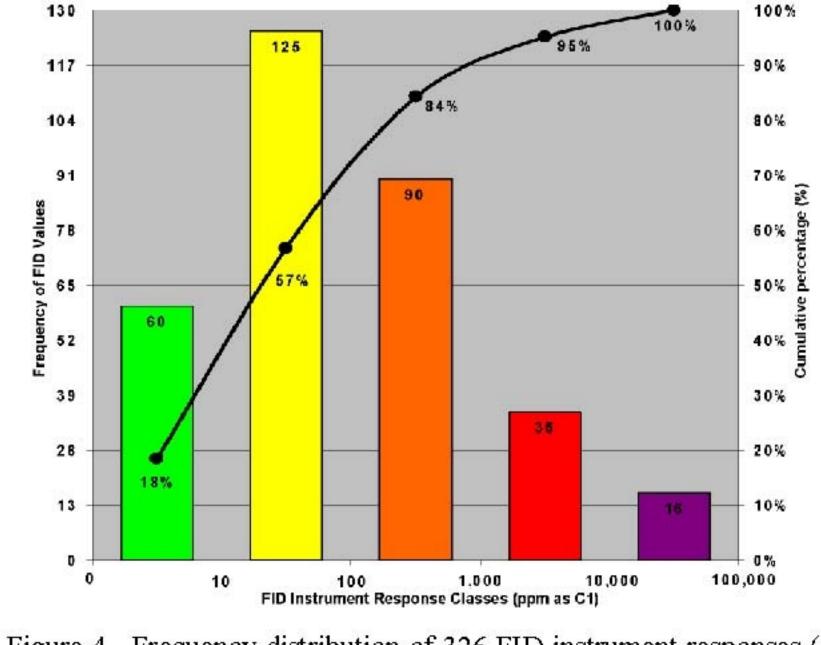
Explanation

FID Instrument Response	Misc. Features		Scale	1:1	,000,000	ĺ	
• 1,000 - 100,000	County Boundaries	0	20	40		60	
• 100 - 1,000	Township Boundaries	Miles					
• 10 - 100	Highways		0 20	40	60	80	
1 - 10	▲ Towns	Kilometers					
• 0-1		North American Datum 1983 Lambert Conformal Conic					
• 0.0							



(ppm as CH₄)

Figure 3. Comparison of the ranges and means of flame-ionization detector (FID) instrument responses (as methane in air in ppm) by county, in relative order of investigation. SE Steele, Bottineau, Renville, Emmons, Stutsman, Rolette, and Towner Counties were completed in 2006. Burleigh, Ward, McHenry, Pierce, Kidder, Barnes, LaMoure, and Morton Counties were completed in 2007, Sheridan, Logan, and Benson Counties were completed in 2008. Generally, wells were field screened on a county by county basis. Wells in counties where shallow gas occurrences were most likely (e.g. Renville and Bottineau Counties) based on historical data and occurrences, were field screened first. Counties in "frontier" areas were subsequently field screened. Counties in north-central North Dakota (e.g. Renville, Bottineau, Ward, McHenry), tend to show relatively higher mean values than other counties investigated. Mean values range across four orders of magnitude from 5 ppm (as methane in air) to 9,420 ppm (as methane in air) Concentration ranges per county are depicted by the vertical yellow bar with the minimum and maximum values reported at the top and bottom ends of the bar, respectively. Mean values are shown at at their respective position along the bar as red squares. The number of shallow gas occurrences per group (i.e. the n-value) is displayed at the top of each bar above the maximum value.



C1 in ppm) described within five logarithmic intervals from zero to table. A total of 1,726 shallow ground-water observation wells 100,000. The 10 ppm to 100 ppm interval contained the majority were field screened for the occurrence of combustible gas (38%) of the responses. FID values in the 100 ppm to 1,000 ppm (i.e. methane) using a portable FID during the latter portions of (27%) were second, followed by FID values in the zero ppm to 10 ppm the 2006, 2007 and 2008 field seasons. Approximately 19% (326 range (18%). Only 16 values (5%) were reported that were greater wells) returned positive instrument responses for potential than 10,000 ppm. None of the values within the 10,000 ppm to shallow gas occurrence. The remaining 81% (1,400) showed no 100,000 ppm methane concentration interval were greater than 50,000 response for shallow gas. Of the wells initially planned for ppm. The cumulative percentage trend through the data is shown with the curved black line. Nearly 90% of the FID instrument responses as C1 were below 1,000 ppm (as C1)

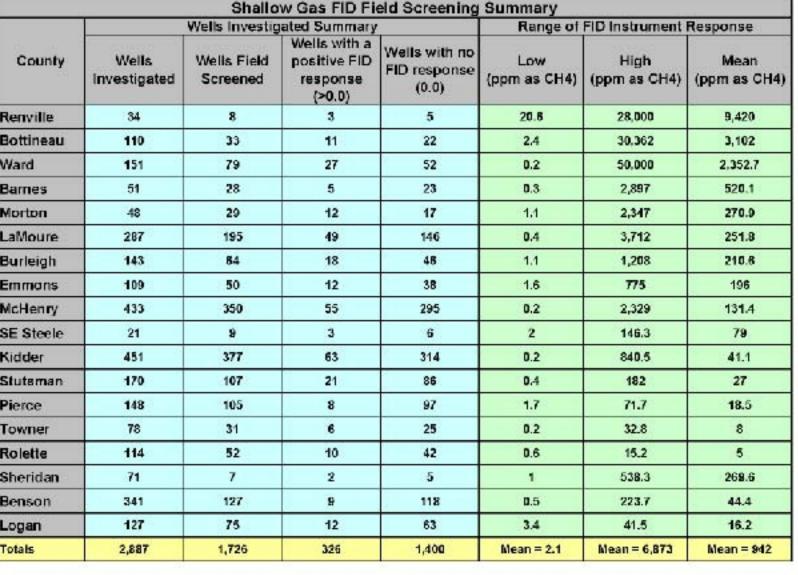


Figure 4. Frequency distribution of 326 FID instrument responses (as Table 1. Shallow gas well and FID field screening summary investigation and field screening, 40% were found to have been either destroyed or abandoned in the field. The mean value of shallow gas occurrences found within each county was 942 ppm (as methane in air). Investigated well information and values of FID instrument responses are provided in this table in relative order of investigation from top to bottom.

well at their prescribed point and were subsequently field screened (Table 1). Each of the wells were field screened for the presence of combustible gases using a portable flame-ionization detector (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/atmospheric interface (GWI), after the collection of a water level reading within the well using an electric well tape. Of the existing wells field screened, 326 returned positive FID responses (Figure 2), ranging from 0.2 to >50,000 ppm (5%) as methane in air (Figure 3), 1,400 of the wells showed no response (i.e., 0.0 ppm) during field screening at both the TOC and GWI. It has been generally observed that it is more likely (i.e. > 95% of the time) to detect methane at the GWI or higher up in the air column within a given well. It has been less typical to detect methane emanating directly from the well TOC. The occurrence of FID responses are somewhat constrained by the overall distribution of well locations as the majority of the wells field screened were installed to monitor shallow glaciofluvial aquifer systems. Nearly 90% of the occurrences detected were less than 1,000 ppm (Figure 4). 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 in the

individual county studies compiled 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 oil and gas

exploration and field investigation efforts.

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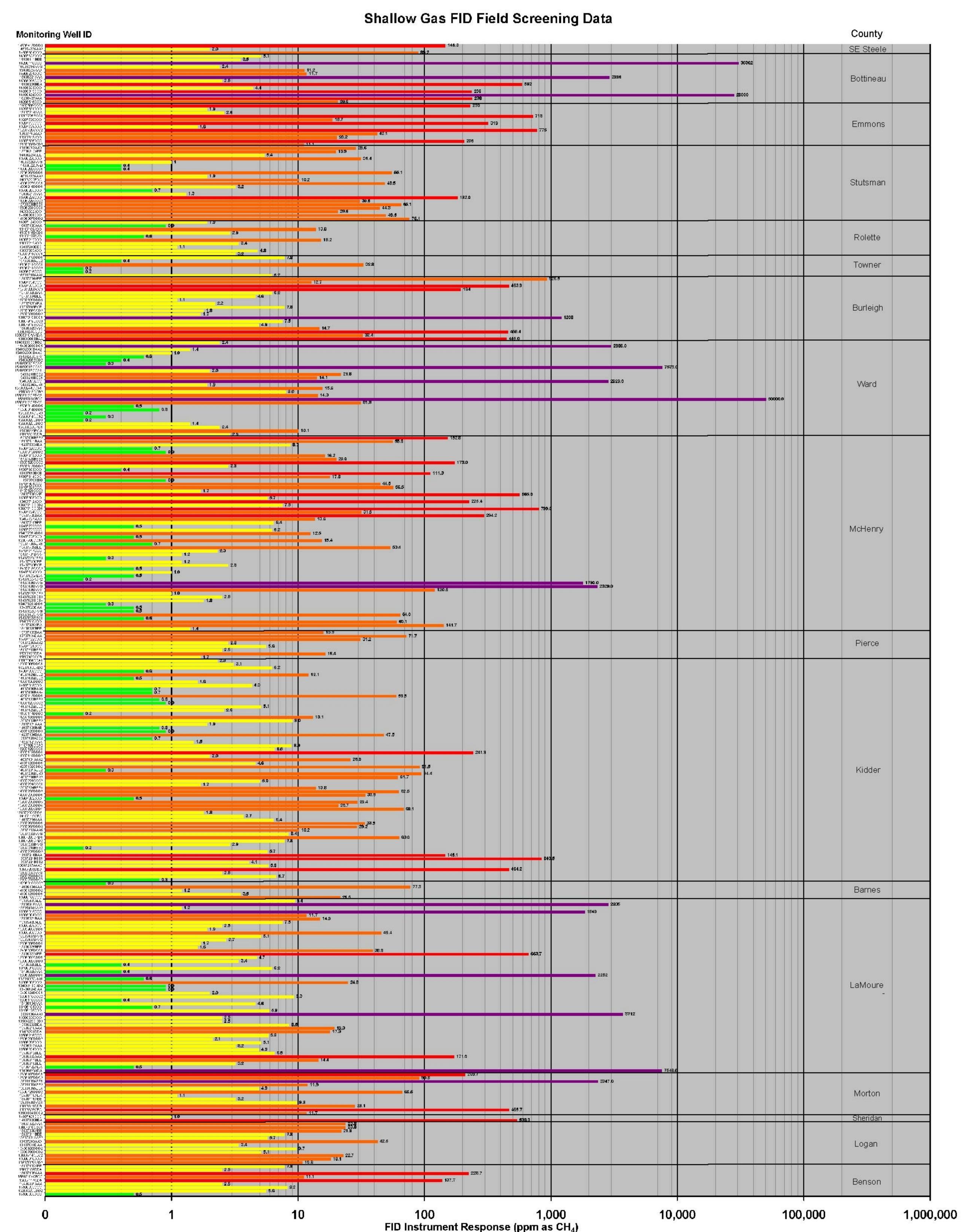


Figure 2. Comparison of positive FID instrument responses interpreted as shallow gas occurrences for all wells field screened in North Dakota in 2006, 2007, and 2008. Data grouped by county in relative order of investigation from bottom to top. Data within each county grouping is sorted by Township in descending order (i.e. north to south). Bars are color coded with increasing values changing from cooler to warmer colors based on the order of magnitude of FID instrument response: green = 0 to 1 ppm, yellow = 1 to 10 ppm, orange = 10 to 100 ppm, red = 100 to 1,000 ppm, and purple = 1,000 to 1,000,000 ppm. Monitoring well identification numbers are displayed at the left of each respective bar. Well identification format is in ND State Water Commission database format as Township, Range, Section, and 1/4, 1/4, 1/4 (e.g. 01ABC) sections. Nested wells are commonly listed with an appended 1, 2, 3 etc., attached to the well identification (e.g. 01ABC2).