

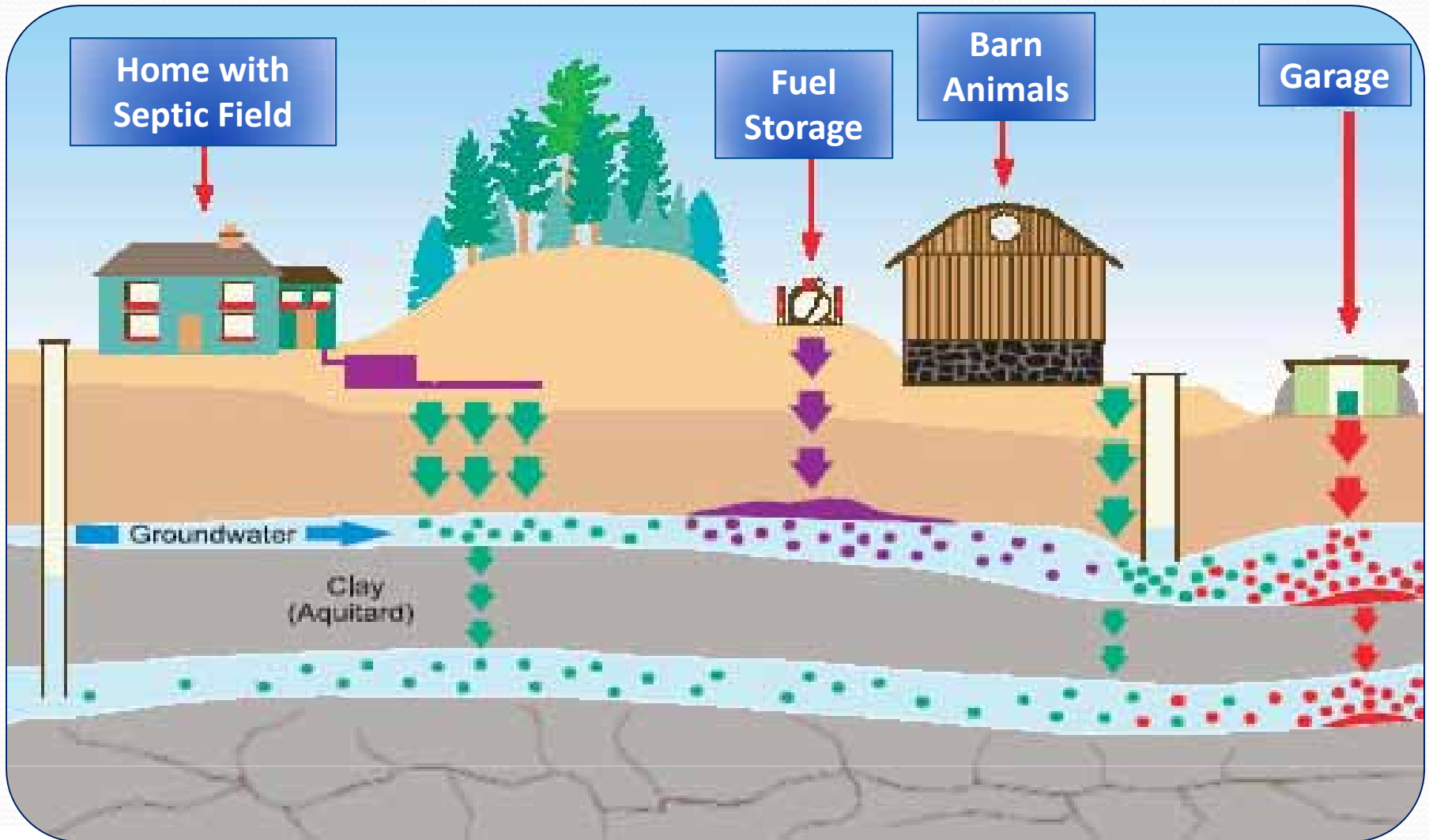
How Common is Methane in Ground Water?

- Is Methane Present in the Well?
- Not Regulated by EPA, So There is No Specific Method Detection Limit Requirements
 - “Reportable Quantities” Vary by Lab
 - Varies by several orders of magnitude (.1ug/L – 1mg/L)
- Laboratory Methods Vary
 - FID-GC vs. TCD-GC Analysis
 - RSKSOP-175 (Rev. No. 2, 2004)
(Robert S. Kerr Lab Std. Op. Procedure #175)
 - USEPA Region 1 (Rev. 1, 2002): Technical Guidance for the Natural Attenuation Indicators: Methane, Ethane, and Ethene
- Proper Collection Method is **IMPORTANT**

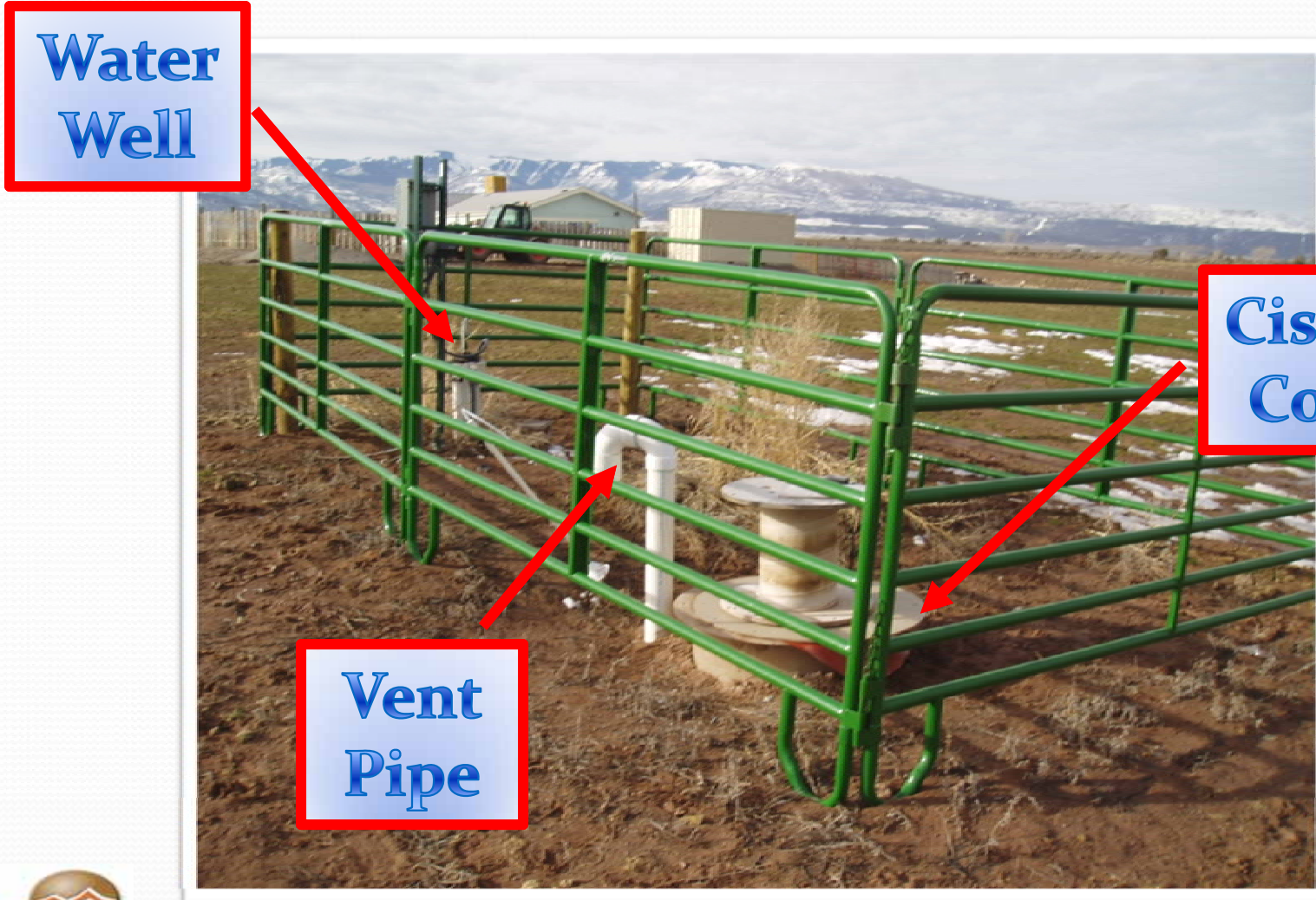


RSK METHOD: “This standard operating procedure has been prepared for the use of the Ground Water and Ecosystems Restoration Division of the U.S. Environmental Protection Agency and may not be specifically applicable to the activities of other organizations. **THIS IS NOT AN OFFICIAL EPA APPROVED METHOD.** This document has not been through the Agency’s peer review process or ORD clearance process.”

Potential Impacts to Water Wells



Livestock Pen, Water Well & Cistern



Water Well

Cistern Cover

Vent Pipe

Cistern or Septic Tank?



Preparing for Complaints

- **Establish a Baseline Program**
 - Conduct Sampling
- **Educate Water Well Owners on Your Efforts and Water Well Testing & Maintenance**
 - Promote it as a Valuable Community Service
 - *“How Well Do You Know Your Water Well”*

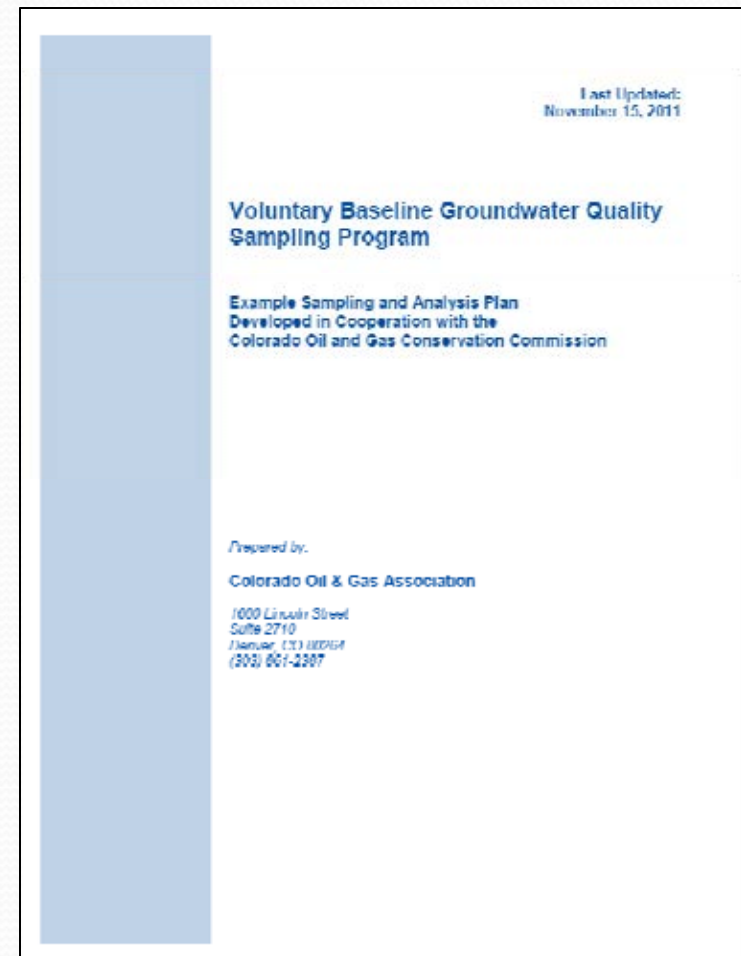
<http://cogcc.state.co.us/Library/WaterWellBooklet.pdf>

- **Use as Opportunity for Stakeholder Engagement**



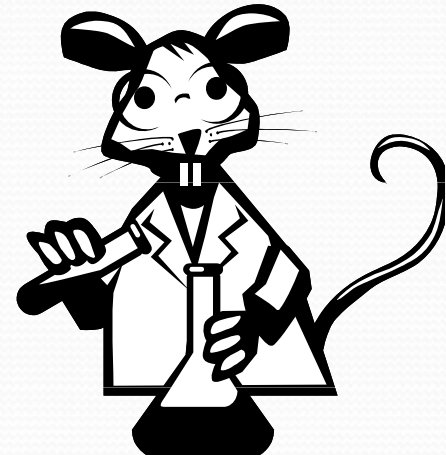
Establish Baseline Water Quality

- Voluntary Programs
- Regulated Programs
- Sampling & Analysis Plan (SAP)
 - Establish Data Quality Objectives
 - Quality Assurance & Quality Control
 - Field Protocol
 - Analytical Protocol
- Expertise & Experience



Baseline Water Quality & Dissolved Gas Parameters

- Fingerprint of Water and Gas Chemistry
- Major Anions and Cations - Balance
- Trace Metals (EPA Toxic Lists)
- pH, eH, Conductivity, Temp, DO
- Dissolved Hydrocarbons
 - Methane, Ethane, Propane
 - *C₁-C₆ recommended*
 - BTEX or VOCs (EPA - SW846 8260 GC-MS) + TPH
- Stable Isotopes
 - Methane - $\delta^{13}\text{C}$ and δD
 - C₂+, CO₂ and Water Isotopes (O & H)
 - Other Stable Isotopes



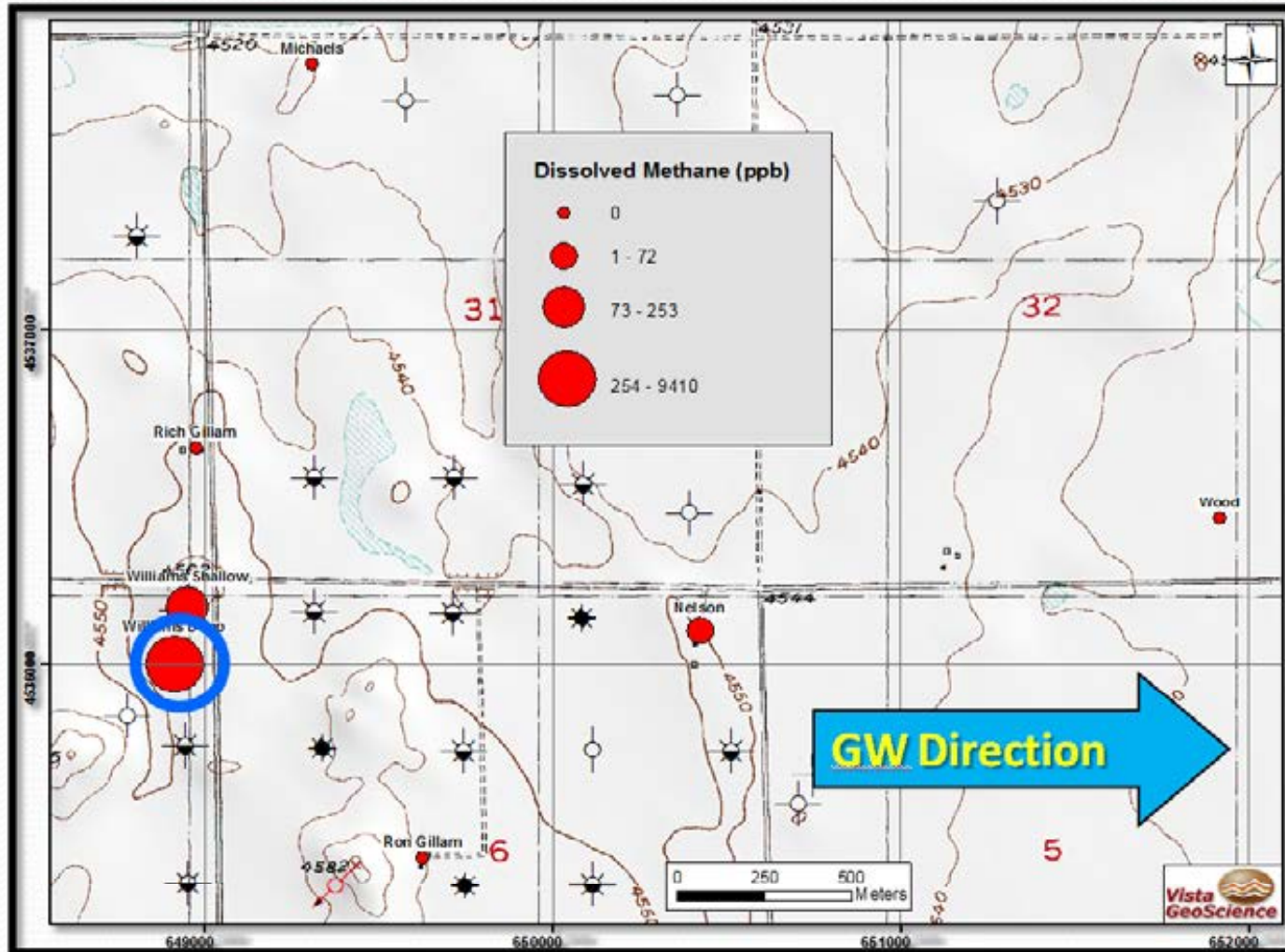
Establish Baseline Water Quality Parameters (continued)

- Uranium/Radon, other NORMs
- Arsenic
- Nitrates
- Coliform Bacteria
- Bacteria Activity Reaction Test (BART)
 - Iron Related (IRB)
 - Sulfate Related (SRB)
 - Slime Forming (SLYM)
- Design for Local Geochemistry Issues
- How Many Pre-Drill Events?
 - Natural Variability can be Significant
 - Seasonal Changes
 - Mixed Aquifers
 - Water Demand/Usage



Methane in Fox Hills Aquifer

Denver Basin, Colorado, USA



Denver Basin Baseline Survey, Colorado, USA

ERA	Period	GEOLOGIC EPOCH/AGE	FORMATION NAME	TYPE WELL M. Segelke # 1 NENE Sec. 27 T11N R53W API 05-075-09050	
Recent		Holocene	Alluvial & Dune Sand	0 - 50 ft	
		Pleistocene			
TERTIARY		Pliocene	Ogallala	0 - 180 ft	
		Miocene	Arikaree	0 - 80 ft (Not present in area)	
		Lower Oligocene	White River	25 - 100 ft	
MESOZOIC	CRETACEOUS	Late Maestrichtian	Laramie Fox Hills	400 - 550 ft	
		Maestrichtian Campanian	Pierre	3150 ft	
		Campanian Coniacian	Niobrara & Fort Hays	350 ft	
		Turonian	Carlile	195 ft	
			Greenhorn	250 ft (Storage Caprock)	
		Cenomanian	Graneros Shale		
		Albian	Dakota "D"	50 ft (Storage Zone)	
			Huntsman	65 ft	
			Aptian	Dakota "J"	104 ft (Storage Zone)
				Skull Creek	115 ft
Lytle	104 ft				
Jurassic	Morrison	420 ft			

Ogallala Aquifer (80 m)

Fox Hills Aquifer (300 m)
Anomalous dissolved CH₄

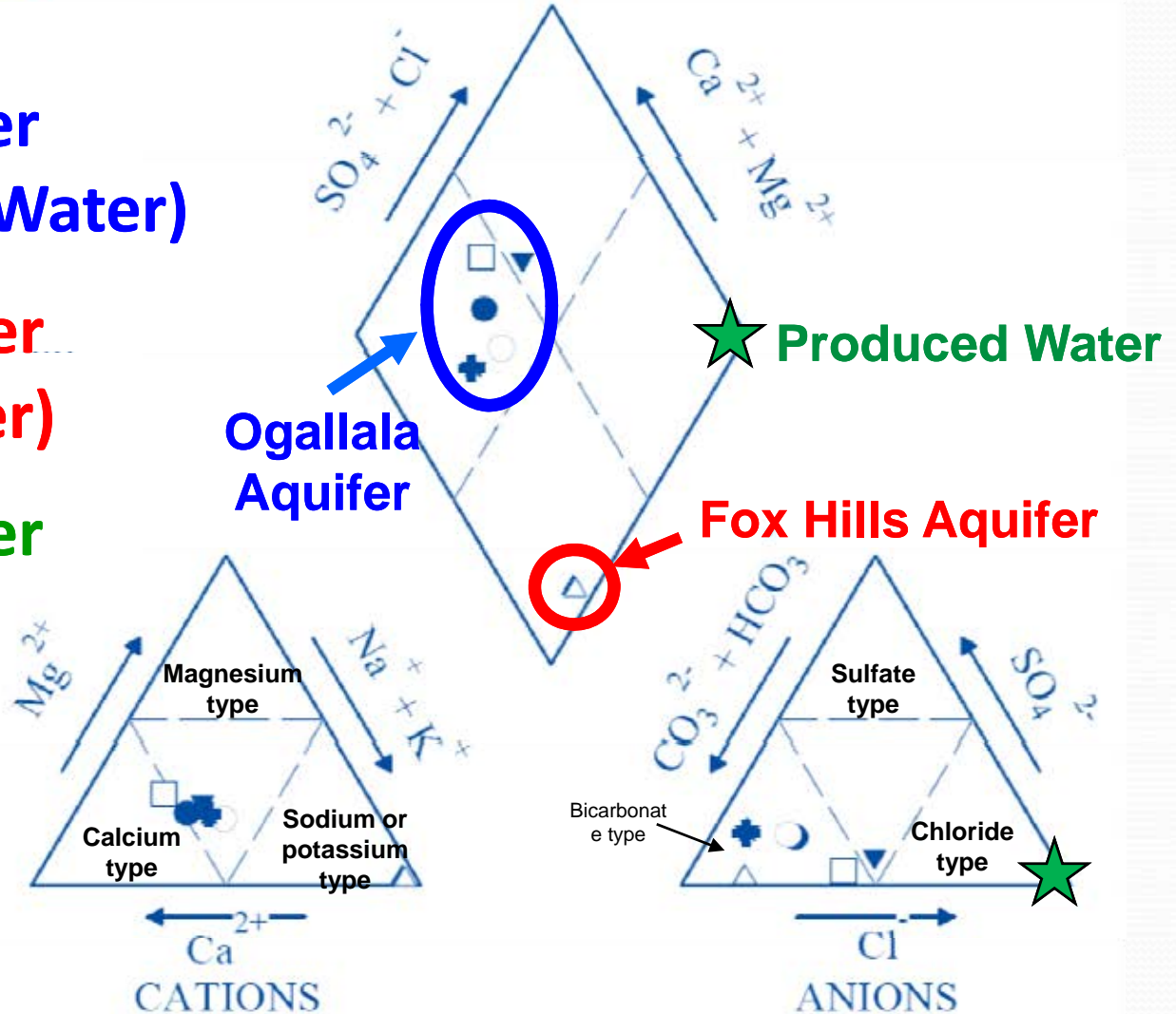
O&G Reservoir (2,100 m)

No Mixing of Groundwater & Produced Water

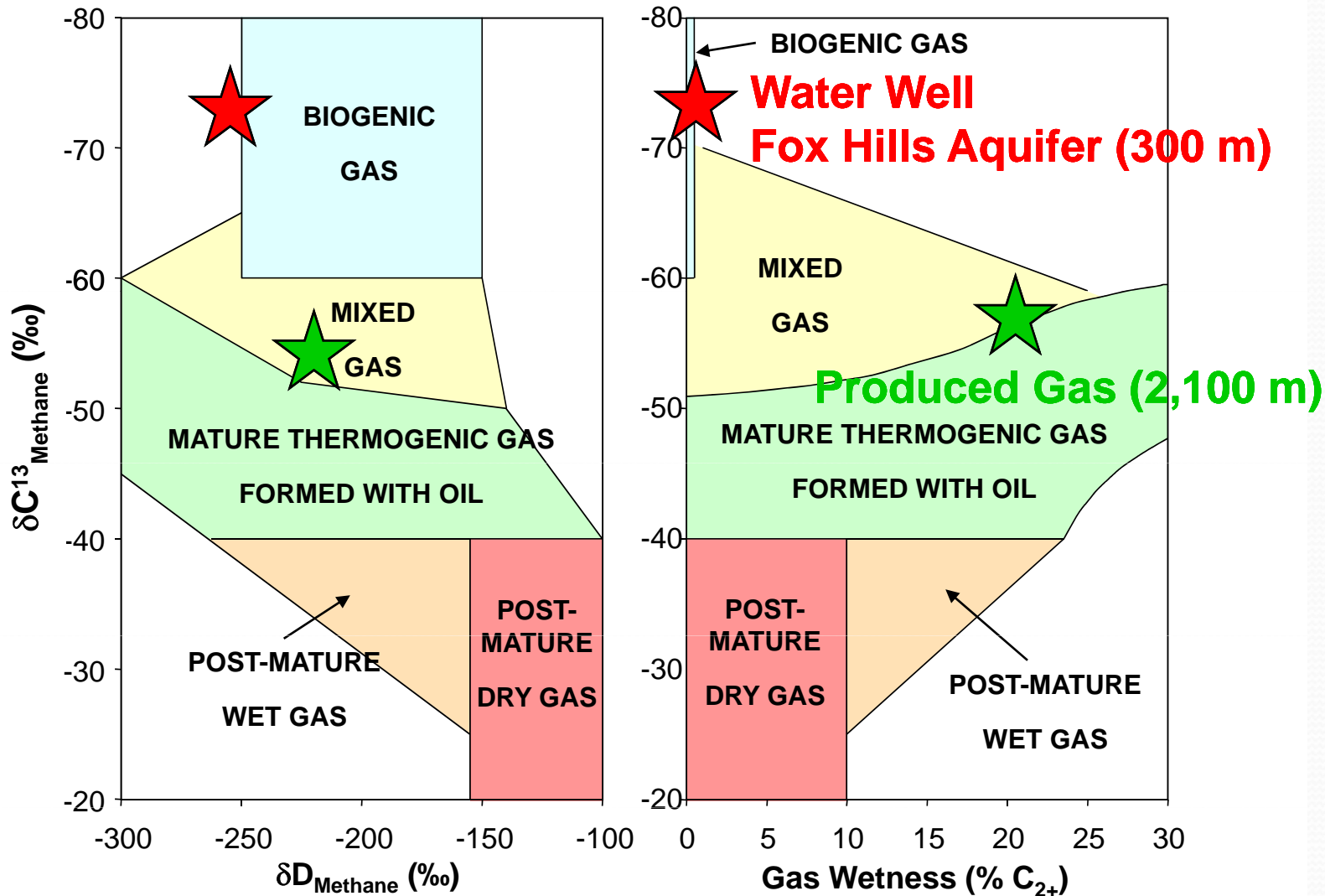
Ogallala Aquifer
(Ca/Mg HCO₃ Water)

Fox Hills Aquifer
(NaHCO₃ Water)

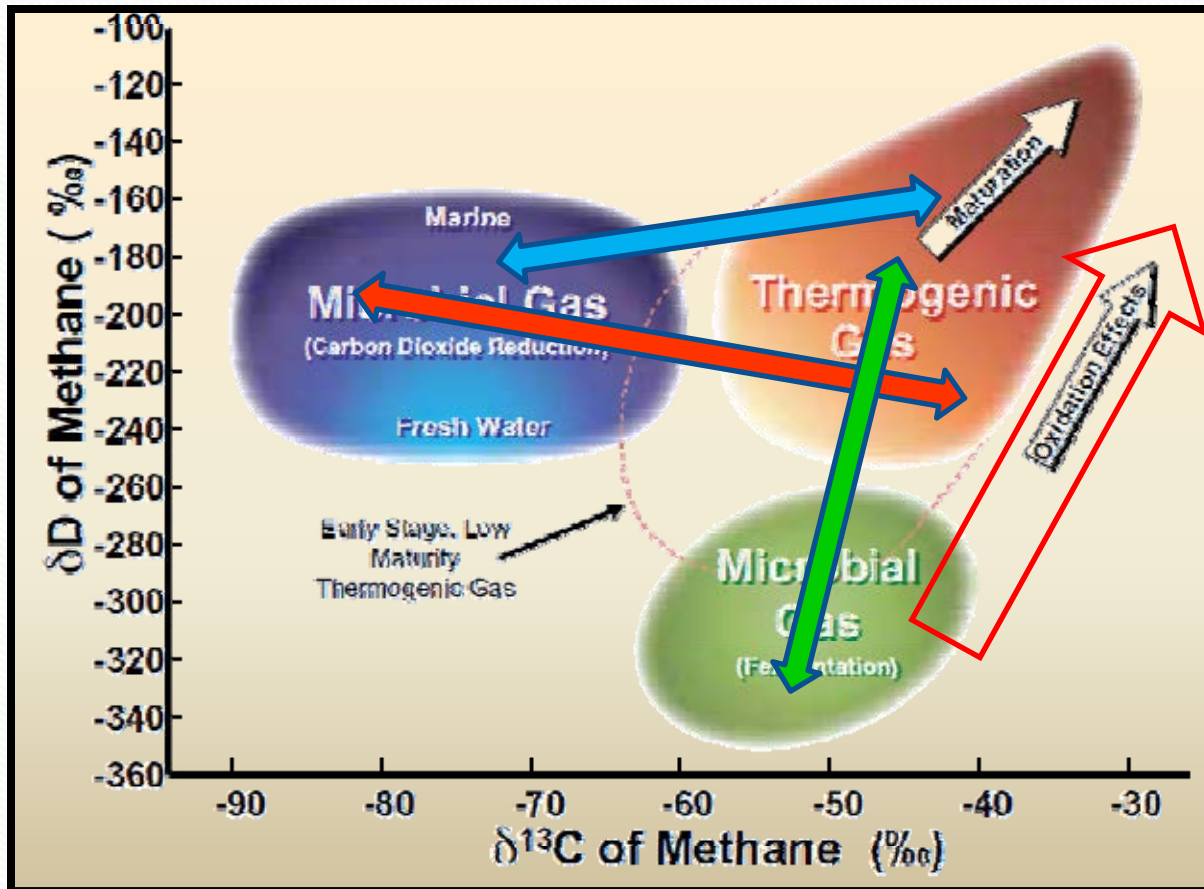
Produced Water
(NaCl Water)



Biogenic Methane in Aquifer Easily Distinguished from Produced Gas

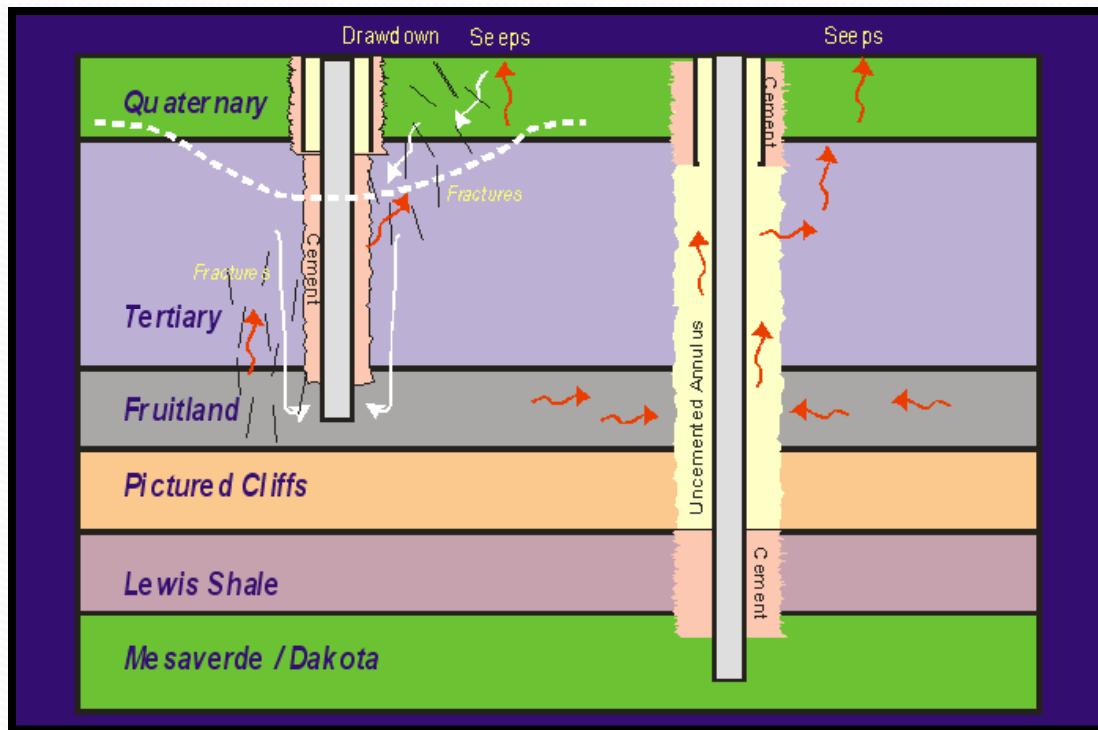


Caveat: Mixing & Alteration can Create a Complex Picture

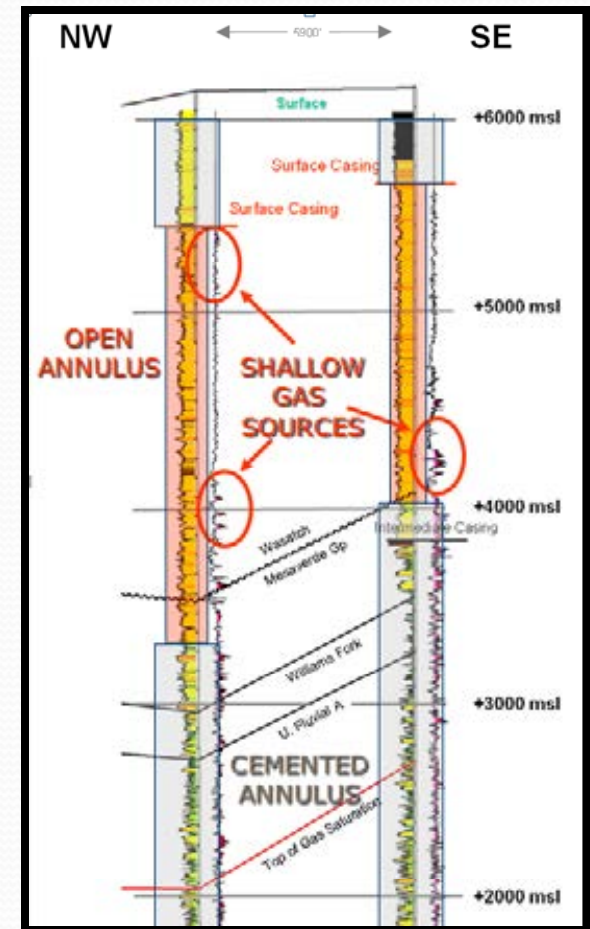


Assess Nearby Wells (and Mines) for Leakage

- Old Wells or Open Annulus Can Create Cross-Communication with Aquifers



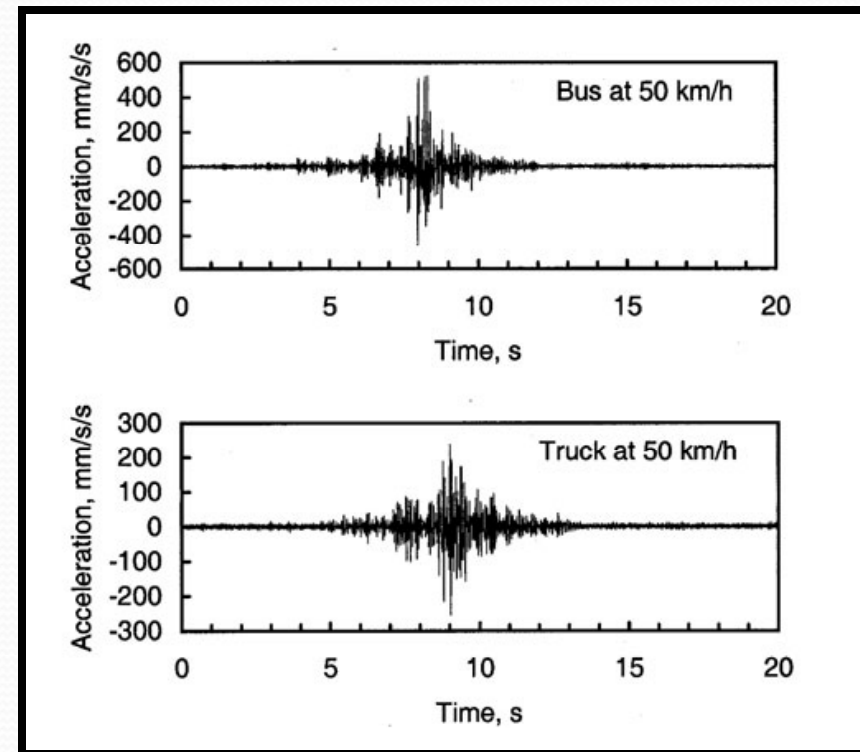
Courtesy Anthony Gorody



Some Symptoms May Be Related to Ancillary Activities

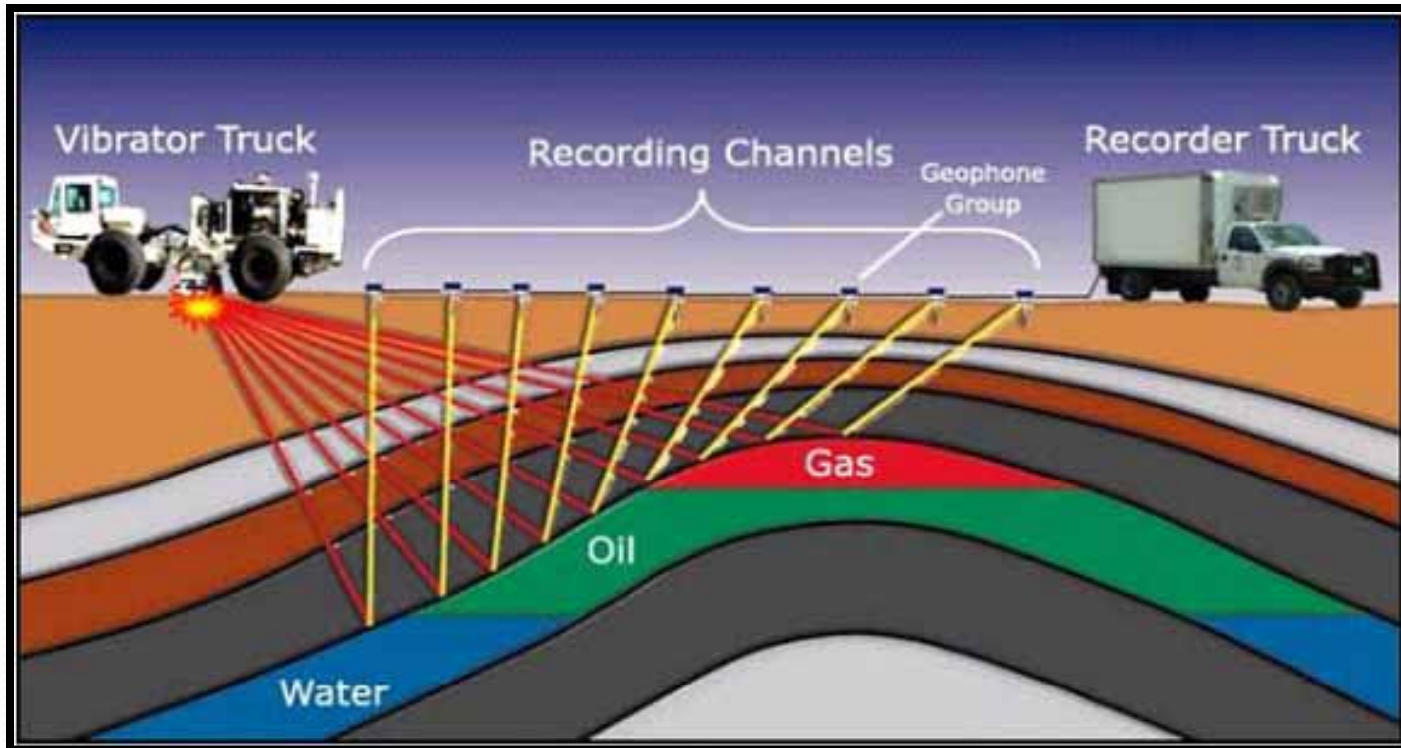
Vibrations from Construction & Hydraulic Fracturing Activities

- Ground motion impacts on water wells can
 - Disturb bottom sediment
 - Dislodge scale & bacterial slime
 - Temporarily increase suspended material
 - = *Immediate complaint*



Exploration Activity

- Seismic exploration may disturb the sediments in a water well temporarily



Regulated & Voluntary Baseline Program Are a Good Start....

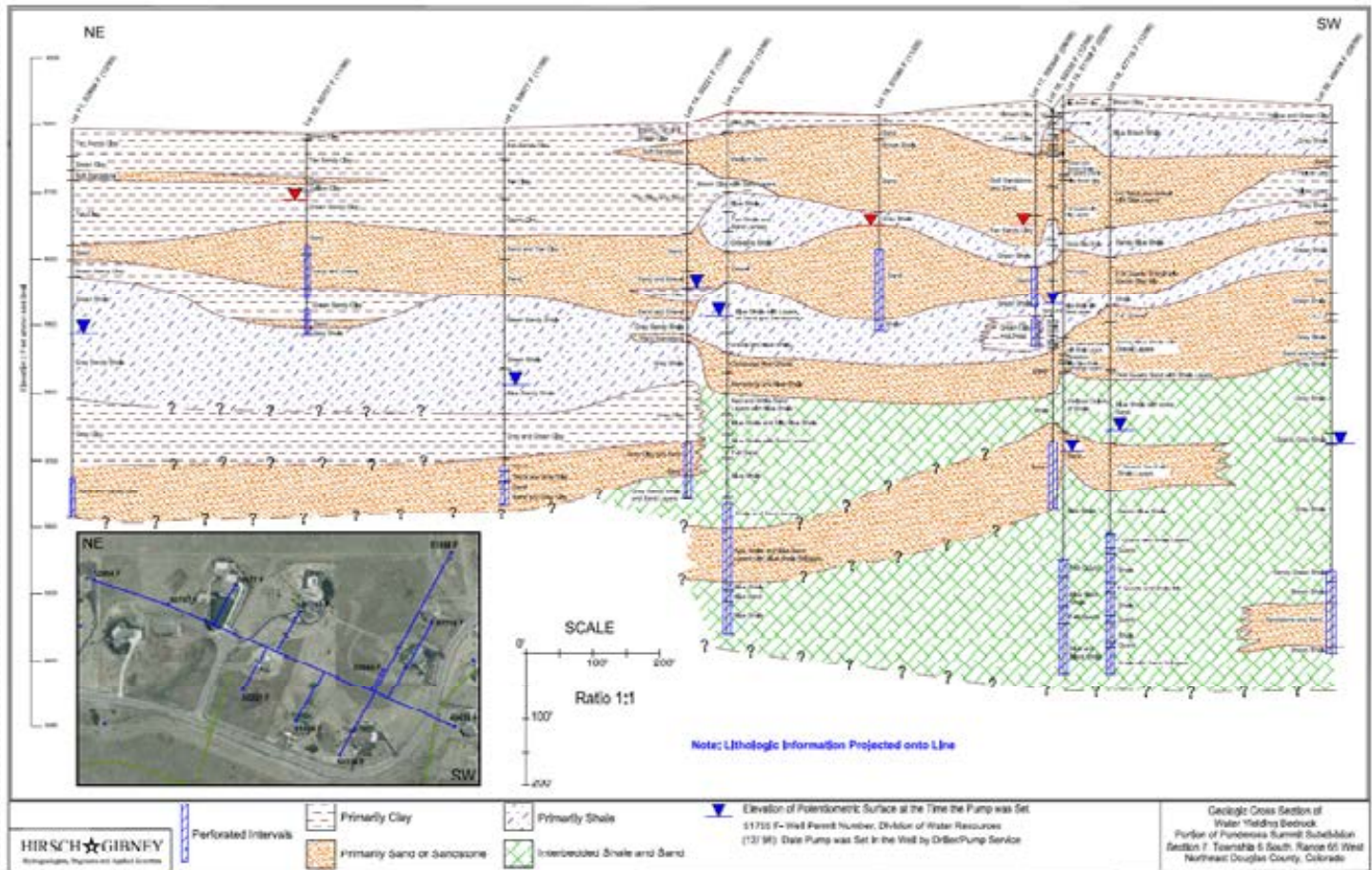
A Use Them as a Minimum Set of Standards



2012, Richard Hirsch, Section of Douglas County Rural Water Providers Map

.... But it May not be Enough

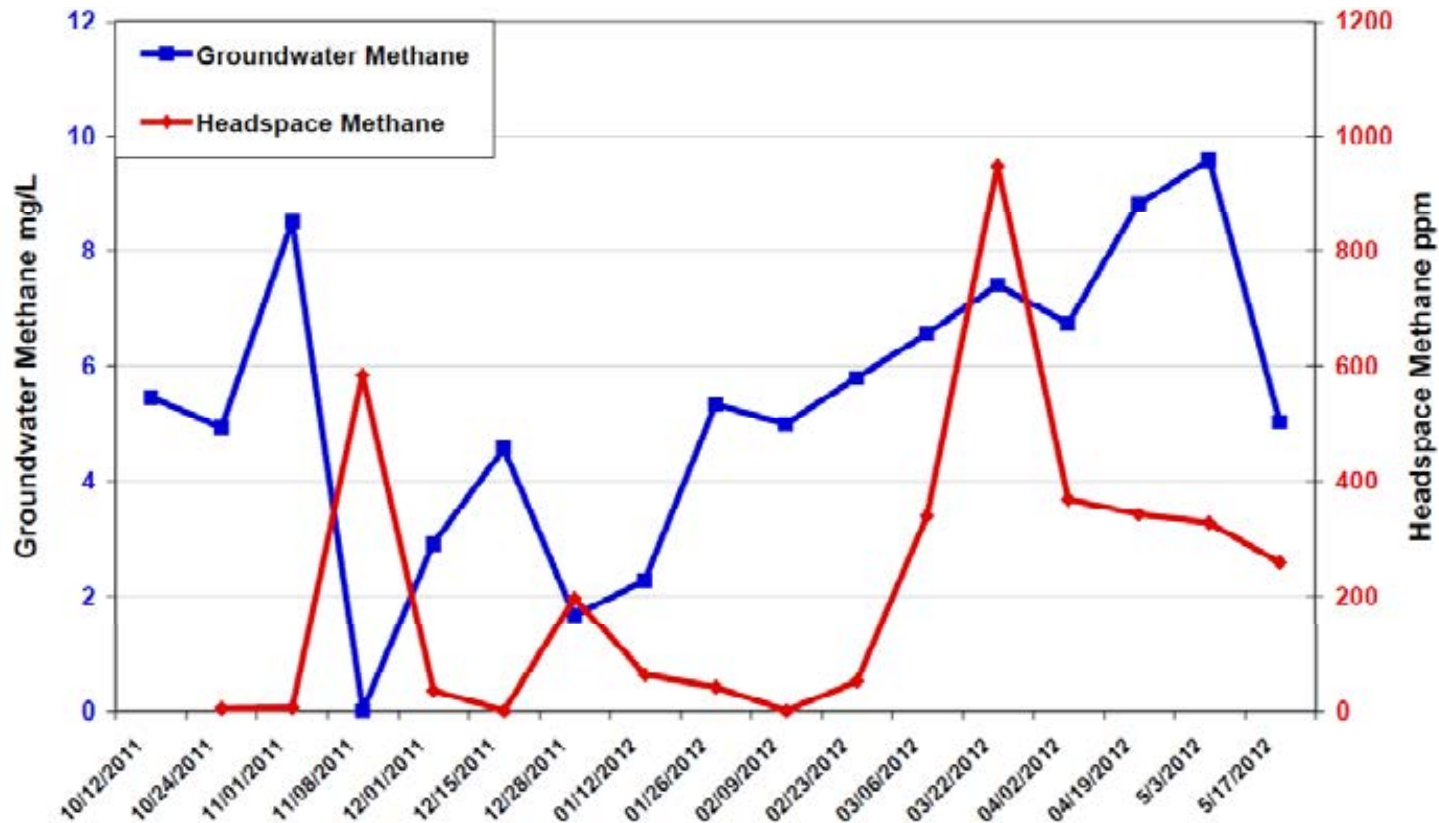
Multiple Confined Aquifers & High Density Water Wells Requires More Samples



2012, Richard Hirsch, Ponderosa Summit Subdivision

Assess Variability

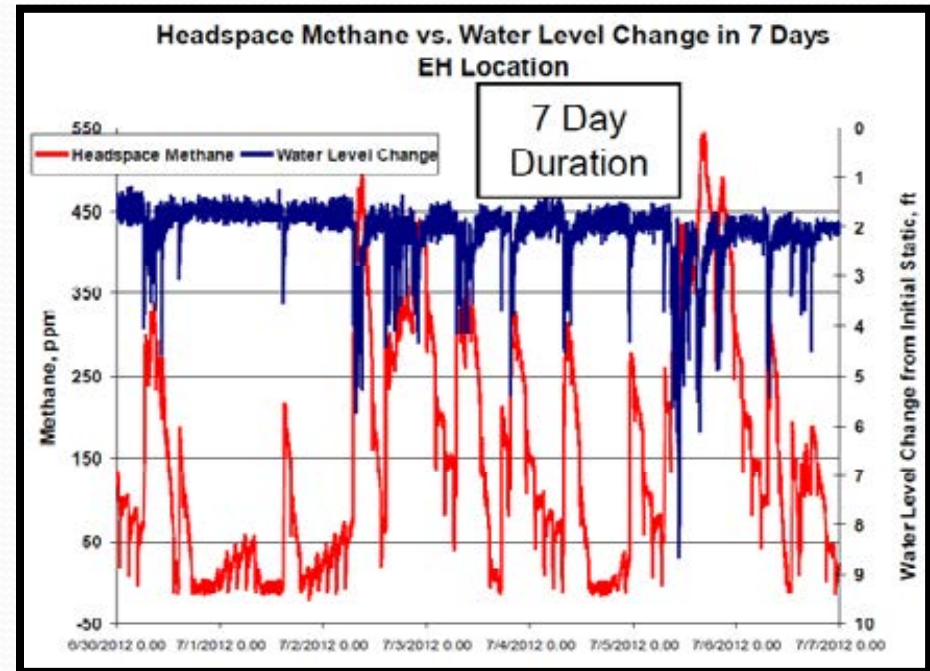
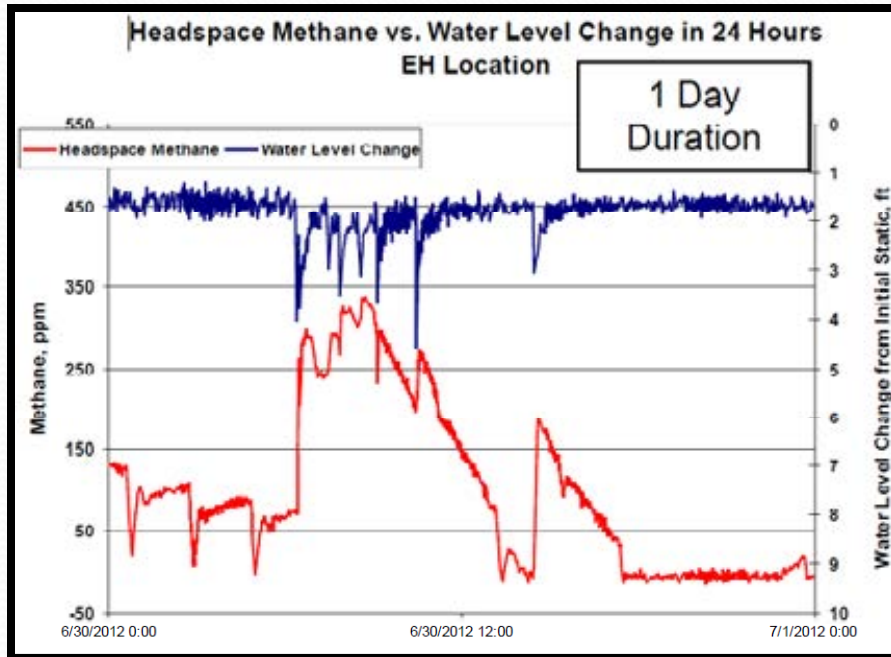
Ground Water & Well Headspace Methane: 17 Sampling Events in 8 Month Period



Courtesy: Chuck Whisman (GES), Debby McElreath (Chesapeake); 2012 Stray Gas Incident & Response Forum

Assess Variability

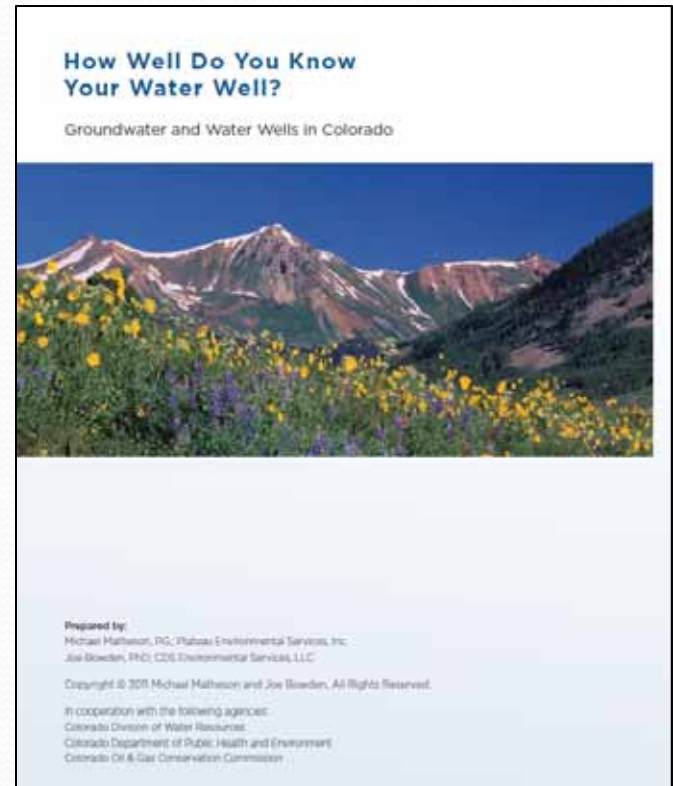
Well Headspace Methane vs. Water Level (Drawdown)



Courtesy: Chuck Whisman (GES), Debby McElreath (Chesapeake); 2012 Stray Gas Incident & Response Forum

Fight Misinformation with Good Information & Education

- **Many Water Well Organizations Provide Good Public Service Information**
 - **NGWA**
 - **AGWT**
 - **GWPC**
 - **State Water Well Organizations**
- **Industry Information Websites**



Summary

- ***Complaints Happen!***
- **Water Well Problems or Contaminants are a Result of:**
 - Lack of Maintenance & Testing (**most common**)
 - Poor Construction, Poor Aquifer or Lifespan of a Well
 - Historic Drilling or Mining Activities
 - Natural In Place Gas, Migration or Seepage
 - Naturally Occurring Bacteria, Minerals, Etc.
 - New Releases, Casing Leaks, Spills (**least common**)
- **A Proper Designed Baseline & Monitoring Program can:**
 - Educate Stakeholders
 - Establishes Pre-Drill Baseline Conditions
 - Monitor Variability
 - Prepare you with *Answers to the Complaints!*
 - Mitigate Risk



Thanks

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**AAPG International
Conference & Exhibition
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