

Natural Gas Development Impacts to Shallow Aquifers (Is there a monitoring silver bullet?)

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Discussion Topics

- Review of Current Practices and Conditions
- Potential for new analytical methods to be used for monitoring and impact investigation



Review of Current Conditions


- Review of Rules
 - Review of Current Monitoring and Investigation Practices
 - Review of Potential Sources
 - Review of Potential Groundwater Contaminants or Pollutants
 - Current Popular Analytes
 - GWPC May 2009 Report
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Past Rule Changes Initiated to Protect Groundwater

- Texas – 1950s drought brought changes to protect groundwater
- New Mexico – Pit study brought about changes to pit requirements
- Colorado – New rules to protect Source Water Protection Areas



Potential Sources of Groundwater Contamination in a Gas Field

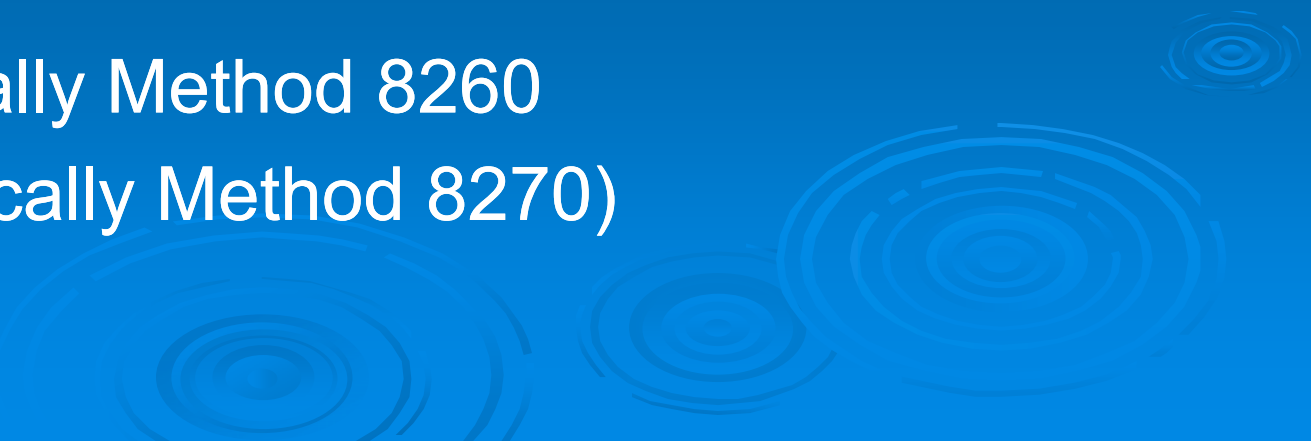
- Leaking pits
 - Inadequate surface casing and cement
 - Inadequate production casing and cement
 - Improperly P&Ad wells
 - Loss of well control during drilling
 - Spills
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Potential Groundwater Contaminants or Pollutants

- Production fluids
 - Crude oil
 - Water
 - Condensate
- Production gases
 - Methane
 - Ethane
 - Propane
 - Butane
- Drilling fluids
 - Muds
 - Additives
- Hydraulic Fracturing Fluids
- Pit fluids (fluids returned to the surface)
- Pit solids



Current Popular Analytes

- Hydrocarbons
 - Purgeable
 - Extractable
 - DRO/GRO
 - Light gases
 - Methane
 - BETX
 - VOC (Typically Method 8260)
 - SVOC (Typically Method 8270)
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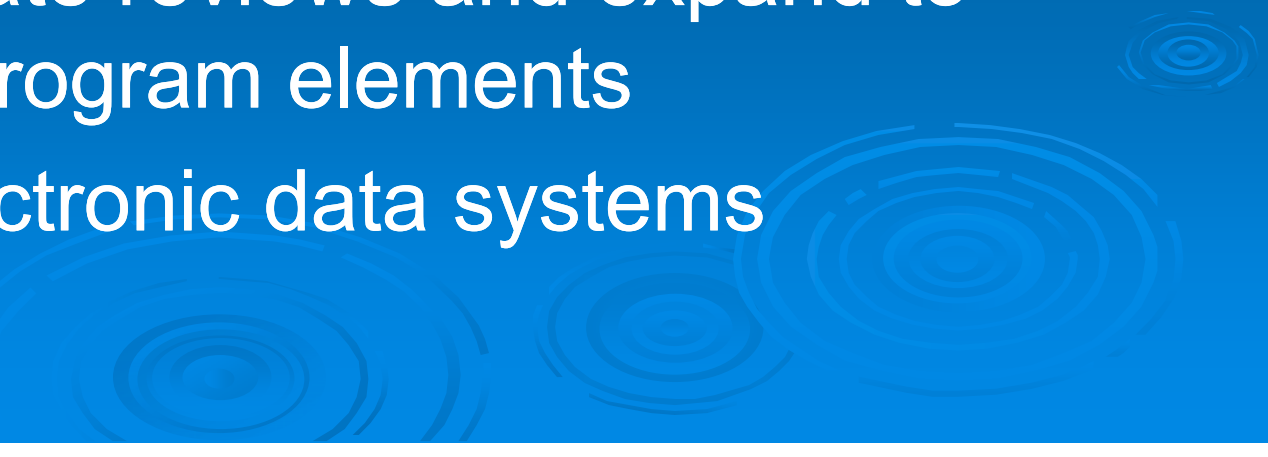
O&G Rules Protecting Groundwater

- State
- BLM
- BIA
- EPA

GWPC has a good review of state program rules in the May 2009 GWPC Report



GWPC 5 Key Messages and Suggested Actions

- Review current regulations for gaps
 - Study hydraulic fracturing and develop BMPs
 - Better MOAs in States with jurisdictional splits among agencies
 - Continue state reviews and expand to include all program elements
 - Improve electronic data systems
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Key Action Item # 3 - Better MOAs in States with jurisdictional splits among agencies

- Development and incorporation of comprehensive “near surface” geology and hydrology studies into oil and gas field operation and design decisions
- Geologic and hydrologic studies can assist well design engineers with the information to protect fresh water zones on a field by field basis
 - Surface casing
 - Production casing
 - Pit design or areas where pits should not be used
 - Proper P&A requirements
 - Potential for hydraulic fracturing impacts

Key action item #4 -Continue state reviews and expand to include all program elements

Monitoring analytes for groundwater background parameters prior to development and investigation of groundwater impacts




Monitoring and Investigation Analytes

- What are the current popular analytes?
- What fluid components do we need to be looking for as contaminants or pollutants?
- What analytes are missing from the current list?



Current Popular Analytes


- Total Petroleum Hydrocarbons
 - Purgeable
 - Extractable
 - Light gases
 - Methane
 - BETX
 - VOC
 - SVOC
- 

Fluids That Contain Groundwater Contaminants or Pollutants

- Production fluids
 - Crude oil
 - Produced water associated with oil (?)
 - Produced water associated with gas (?)
 - Condensate (?)
- Production gases
 - Methane
 - Ethane
 - Propane
 - Butane
 - Other VOCs (?)
- Drilling fluids
 - Muds (?)
 - Additives (?)
- Hydraulic Fracturing Fluids (?)
- Pit fluids (fluids returned to the surface) (?)
- Pit solids (?)



Constituents in Production Water

- Dispersed Oil
 - Hydrocarbons that occur naturally in produced water include
 - Organic acids
 - Polycyclic aromatic hydrocarbons (PAHs)
 - Phenols
 - Volatiles
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Constituents in Production Water (cont.)

- Treatment Chemicals
- Produced solids
- Scales (precipitates)
- Bacteria
- Metals
- pH
- Sulfates
- Naturally Occurring Radioactive Materials

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Assessment of the Usefulness of the Popular Analyte List

- Not all of the organic compounds potentially found in the groups listed above are included on the 8260 and 8270 list
- Additional analytical methods and instruments are available to identify and quantify TICs
- Instrument capabilities are being improved or expanded.
- Therefore, the analyte list can be expanded in some cases when necessary.

Pilot Investigation

Hydrocarbon Fingerprinting

Light Gases C1-C5

Polar Fractions

Chromatogram Finger Printing

Low concentration TPH/TEH



Pilot Investigation (cont.)

➤ Stable Isotope Analyses

- Deuterium/Hydrogen, $\delta^{18}\text{O}$ in groundwater
- Deuterium/Hydrogen $\delta^{12}\text{C}$, $\delta^{15}\text{N}$, $\delta^{34}\text{S}$ of petroleum crude, fuels
- $^{13}\text{C}/^{12}\text{C}$ Methane, + ethane, propane, butane
- Deuterium/Hydrogen of methane

Pilot Investigation (cont.)

➤ Specific Analyte Testing

- Alcohols, Ketones, 2-Butoxy Ethanol and Glycols by 8015 or 8300
- Low concentration SVOCs by GC/MS (SIM/Full Scan) (Large volume extraction/injection)
- Low concentration VOCs by GC/MS
- Time of Flight LC/MS
- GRO/DRO 8015

Pilot Investigation Results

Is there a monitoring and investigation silver bullet?

- Slow going (not done)
- Expensive
- Need additional sites to test methods
- Need better information on what has gone down the hole
- Working on better Data Quality Objectives for Oil and Gas Impact sites

Thank You

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- Mark McDaniel, UOS
- Mark Murphy, Region 8 Lab
- Vince Marty, Region 8 Lab
- Mark Burkhardt, Region 8 Lab

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