State Baseline Water Quality Programs for Oil & Gas Operations

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What is a Baseline Water Quality Sampling Program?

- Most commonly it is knowing the pre drill quality of drinking water supplies near proposed new oil and gas operations
  - What about older operations in the same area?
  - What about isolated production wells versus high density accumulations of wells?
  - How many wells should be sampled?
  - How 'reliable' are domestic wells as sampling points?
  - What do we know about risk pathways?
  - What do we know about local and regional hydrogeology?
  - Is it just about water quality?
- Are we proceeding appropriately in these 'Programs'?

Private Wells as Drinking Water Sources in U.S. (USGS, 2009)

- 43 million people use private wells as their drinking water source
- 23 % have at least one contaminant at a level of potential health concern
- Strontium, arsenic, nitrate, manganese, nitrate, uranium most common

Private Wells as Drinking Water Sources in U.S.

- Most states now require some type of permitting
- Most drillers have some type of licensing/certification
- Most states provide guidance on private well permitting, construction, maintenance
- Not unusual to have a well that receives water from more than one distinct aquifer
- ***No state requires water quality monitoring of private wells***

Why Collect Baseline Water Samples?

- Oil and Gas Industry
  - Insurance; protection against claims, fines
  - Helps identify pre-existing poor water quality
  - Encourages responsible drilling practices
  - Opportunity to improve relations with landowners and community, overcome misconceptions/misunderstandings (gain social license to operate)

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Why Collect Baseline Water Samples?

- Private well owners
  - In the absence of any pre-drilling characterization of the drinking water, it is difficult, if not impossible, to prove that oil & gas operations have impacted water quality
  - It is important to know the quality of the water you are drinking; many private well owners have never tested their water
  - Water quality in private wells is not regulated by federal or most state governments

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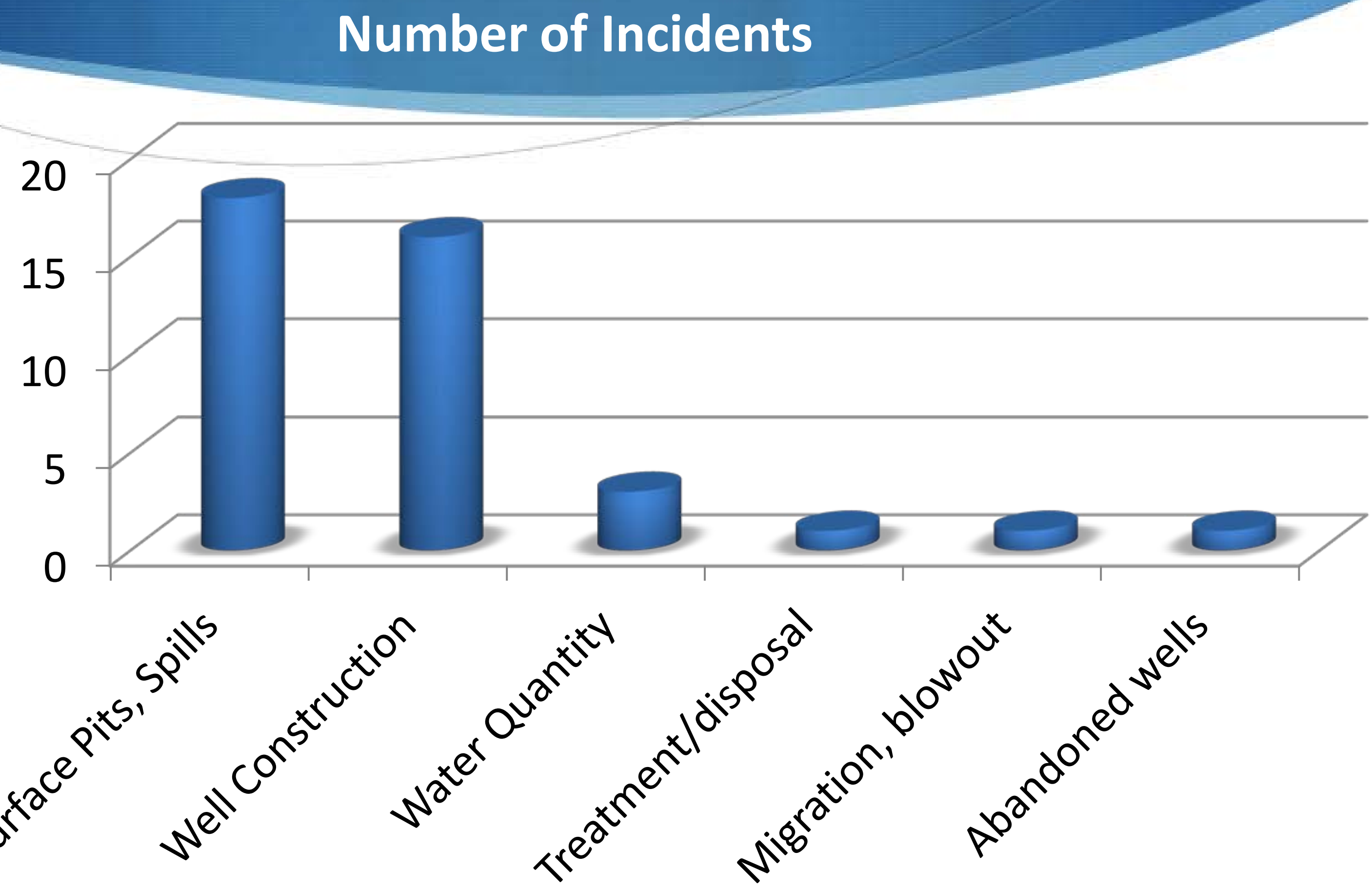
WHAT ARE THE RISKS?
Summary of Preliminary Findings for 40 sites of "reported suspected incidents" for EPA Study



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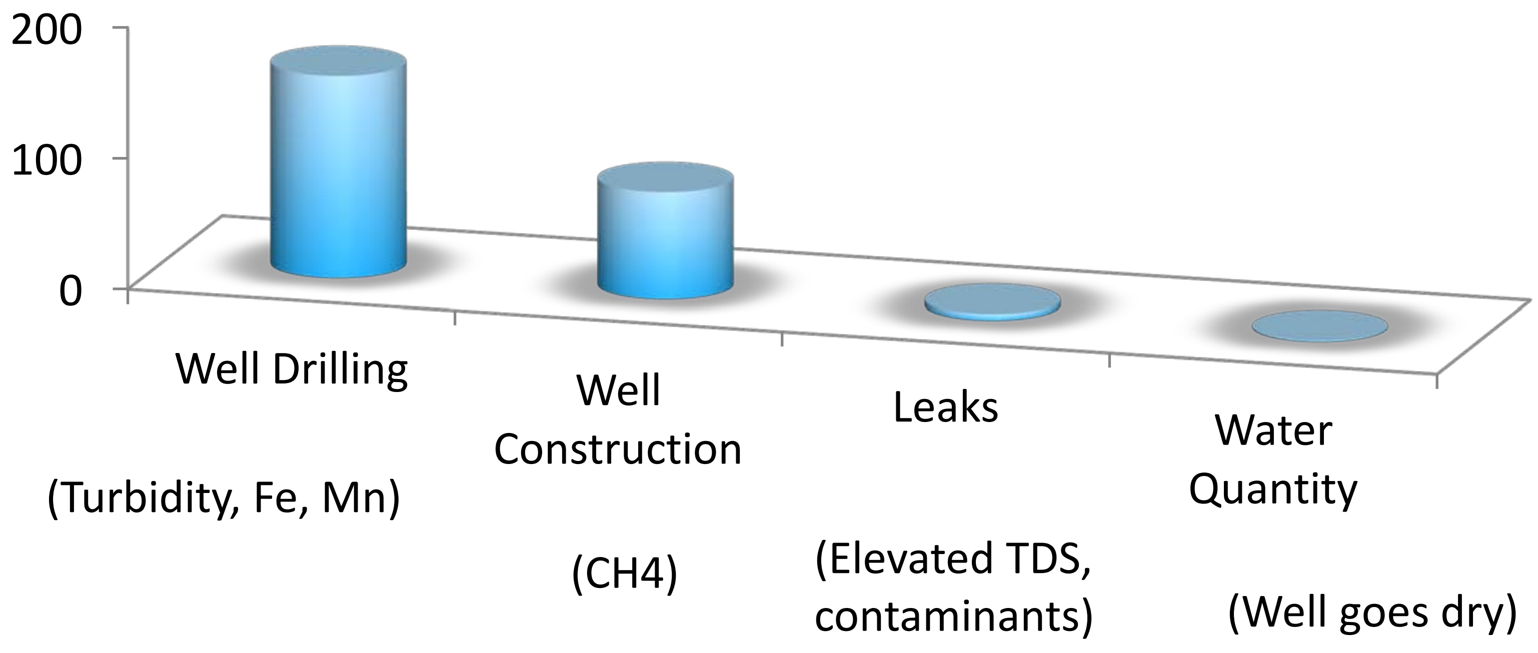
Pennsylvania Data

Water Supplies (243) Impacted by Oil & Gas Activities 2008-2014



Darrah et al, August 2014, Procceedings National Academy Sciences

- 8 clusters of domestic wells in Marcellus, Barnett
- Gas geochemistry data implicate leaks through annulus cement and production casings as cause of elevated hydrocarbon concentrations in domestic wells for 7 of 8 clustes
- One case involved underground well failure
- No case where gas migration induced by hydraulic fracturing

Current pre-drill water quality state programs: some examples

- Pennsylvania
  - Act 13 - Presumption of liability for wells within 2500 ft; no requirement for pre-drill sampling but onus is on oil and gas industry
- West Virginia
  - HB 401, 22-6A-18.b Well owner may request operator within 1000 ft to sample well
- Ohio
  - SB 315 requires oil and gas industry to collect pre-drill samples within 300 ft of conventional well and 1500 ft for horizontal well

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Current pre-drill water quality state programs: some examples

- North Dakota
  - ND Rules requires ‘mineral developer’ to collect pre-drill sampling within 5280 ft of oil and gas well, data collected less than 1 yr prior to drilling activities
- California
  - Within 1500 ft or wellhead, 500 ft of lateral extension
- New York
  - Proposed rules require oil and gas industry to sample all wells within 1000 ft or 2000 ft if none available within 1000 ft

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Current pre-drill water quality state programs: more recent examples

- Colorado
  - New rule 609 requires oil and gas industry to collect pre-drill samples within 2640 ft
- Illinois (draft)
  - HB2615 - rules require oil and gas industry to sample all water sources (3 times) within 1500 ft and post completion sampling at 6, 18, and 30 months later
- Wyoming
  - Up to 4 available water sources within ½ mile with post completion sampling as well at 12 to 24 months and 36 to 48 months
- Michigan (draft)
  - Up to 10 water sources within 1320 ft, less than 6 mos prior to drilling

State Baseline Monitoring Programs

State	Sampling radius (ft)	Number of Wells	Timing* (*presumed liability)	Post-Drill Sampling
PA *	2500	All	1 year after*	No
WV*	1000	Owner request	Prior to drilling	TBD
CO	2640	All to 4 max	1 year prior	Yes, 3 (1, 3, 6 yrs)
OH	1500	All	Prior to drilling	No
ND	2640	All	1 year prior	No
NY	1000	All	Prior to site disturbance	Yes, TBD
CA	1500	All	Prior to drilling	Yes
IL (draft)	1500	All (3 samples)	Prior to drilling	Yes, 3 (6, 18, 30 mos)
WY	2640	All to 4 max	Prior to drilling	Yes, 2 (2, 4 yrs)
MI (draft)	1320	Up to 10	< 6 mos prior	No
NC (draft)	2640	All	Prior to drilling	Yes

Specific constituents to test

- Bromide – common in brackish water, brines
- Chloride – common in brackish water and large volumes used in hydraulic fracturing
- Barium – indicator of radioactive elements in oil brines, production waters
- Total dissolved solids (TDS) – indicates increase in salt content (produced waters)
- Methane – naturally occurring gas, common in areas with oil and gas development, may be present in shallow zones
- Iron, manganese, arsenic – may be released into water from disturbance by drilling

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Methane

- Naturally occurring, especially in oil and gas production areas
- If methane present, it can alter the oxidation-reduction potential of the water:
  - Produce sulfide in the water
  - Promote dissolution of iron oxide solids which may release iron, manganese, arsenic into the water
  - Solids dissolution will increase turbidity
- If there is elevated turbidity it may indicate other problems

Methane

- No health standards set for methane in water
- Main concern is explosion hazard
- States vary as to what concentration in water may trigger a concern and further investigation
  - PA – 7 mg/L
  - WY – 5 mg/L
  - CO - 2 mg/L
  - MI – 1 mg/L

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Where are Samples Collected?

- Almost all states provide some guidance either from the state regulator, agricultural extension office (e.g. PA, OK), or state environmental agency (e.g. LA)
- If at all possible, water samples should be collected directly from the well column. This is often not possible as the well is sealed. Use of the permanently installed pump is then used but sampled upstream of any ancillary equipment (e.g. holding tank, pressure tank, water softener etc.)


Figure 10. Location 2 wellhead.

Potential Problems in Obtaining Representative Samples

- Low yield wells with long recovery times
- Wells with long screens or long perforation zones
  - May have mixing of different aquifers and related water quality
- Poor condition of the well (usually indicated by high turbidity)
- Improperly trained investigators, samplers

Baseline Water Quality Programs Next Steps

- Characterization of regional subsurface system
  - Hydrology, Geology, Soils, Aquifer chemistries
- In many locations there is already available information to enable this additional characterization/understanding (state, USGS, EPA data),

BUT, NOT ALWAYS

- Where insufficient data exists, data gaps need to be filled

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Baseline Water Quality Programs vs. Subsurface Characterization

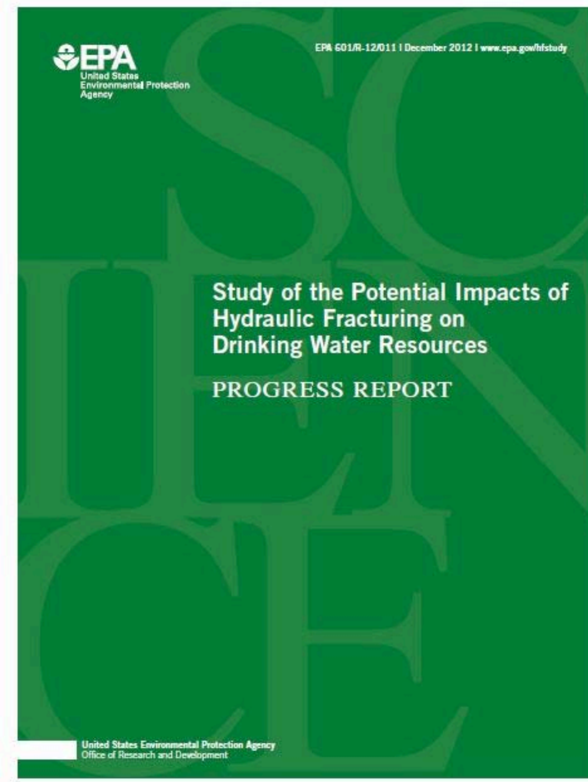
- State baseline water quality programs objective:
  - Determine if impact occurs to nearby drinking water sources following oil and gas activities
  - Relies heavily on sampling of domestic wells
    - Domestic wells susceptible to variety of contamination sources
  - Limited science-based reasoning for determining number of wells, location or distance from production well
  - Most do not address regional ground water flow characterization

Baseline Water Quality Programs vs. Subsurface Characterization

- Subsurface Characterization
  - Objective is to understand migration/risk pathways
  - Identify receptors
  - Develop conceptual site model for transport rate, direction, and potential impacts from oil & gas operations
  - Adaptive monitoring programs which test conceptual site model are best
  - Groundwater generally moves very slowly

EPA National Study on Hydraulic Fracturing "Prospective Study Sites"

- These case studies have not materialized for a number of reasons
- Unfortunately they would have addressed the issue of subsurface characterization and provided a template for how to address well site and subsurface characterization
- At a minimum, they would have provided more confidence to the public that oil and gas operations can be conducted that protect water resources



Prospective Case Study Approach

- Evaluate existing data and information
- Get stakeholder input and participation
- Conduct baseline environmental sampling, testing ***using monitoring wells, soil sampling, soil gas analysis***
- Develop site conceptual models for potential exposure
- Conduct environmental sampling before, during/following pad and well construction, including well integrity testing
- Conduct environmental sampling before, during/following hydraulic fracturing operations
- Collect additional samples over time during resource production

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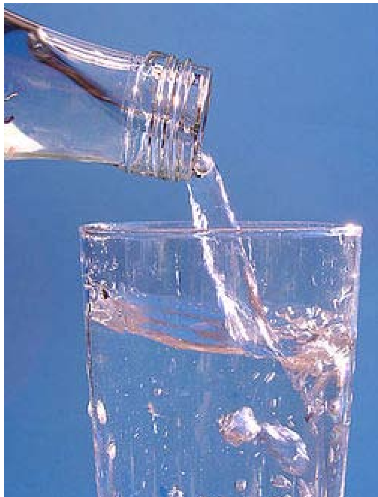
SUMMARY

- Baseline water quality data is important for adequate assessment of potential impacts to local domestic water supplies
- Understanding local and regional hydrogeology enables a more sound scientific knowledge base for assessment of risk to all potential receptors over longer time frames
- Site-specific research projects should be established with all stakeholders similar to proposed EPA prospective studies



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