Marcellus Shale Factor
Getting the Waters Tested !

EWQA Fall Conference and Trade Show!
November 16, 17-18, 2010
Eden Resort, Lancaster, PA

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Center for Environmental Quality

Non-profit/ equal opportunity employer, is operated and managed within the Department of Environmental Engineering and Earth Sciences at Wilkes University

Outreach Programs

- Environmental and Professional Education and Training
- Applied Research
- Community and Business Outreach Programs

Website: http://www.wilkes.edu/water

Before Marcellus Shale Development
What was the Quality of Private Well Water?

A USGS survey found that 70% of private wells were contaminated. This contamination could result in acute or chronic health concerns (1996).

Testing Conducted by Wilkes University in through out the United States indicates that 30 to over 50% may be contaminated – Mostly by Total Coliform Bacteria (1989 – 2010).

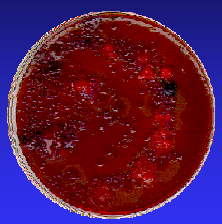
PSU – Master Well Owner Network suggests that 33 to 50 % of Private Well Owners in PA may have some Form of contamination.

Most Contamination appears to be associated with Total Coliform Bacteria

- Insects, Larvae and Nests / Egg Masses
- Mouse Colonies
- Snakes
- Beehives
- Mud - when casing to close to ground

Therefore – In some cases are the Private Wells are Facilitating Groundwater Contamination.

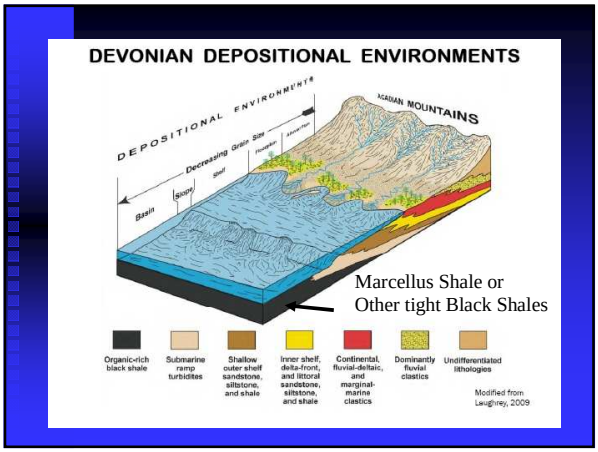
Based on the geology of the NEPA, the common water quality problems are as follows:



Corrosive Water
Low pH
Soft Water (low hardness) to Moderate Hardness
Iron and Manganese
Discolored Water – Reddish to Brown Tints
Total Coliform Bacteria
Sulfur Odors and Methane- Biogenic Gas

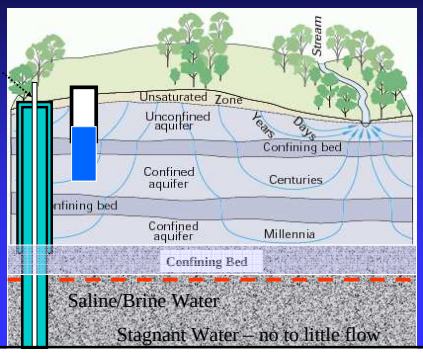
Contamination by VOCs, SOCs, Glycols, and Radionuclides are NOT COMMON!

Marcellus Shale



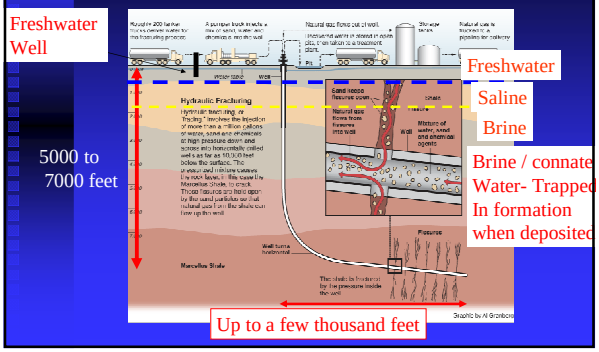
Barkley, 2009

Properly Constructed Wells and Ideal Natural Gas Wells

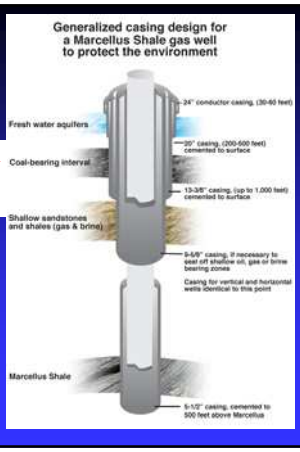


Sea Level

Getting to The Natural Gas

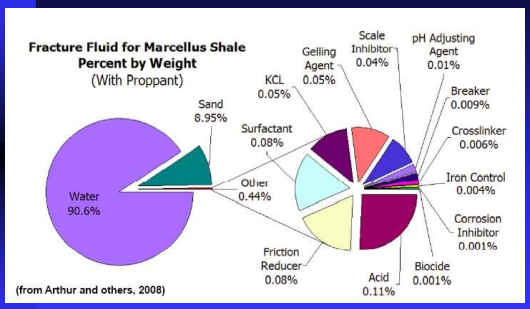


Multiple Grouted Casing Used in Drilling Process



Types of Fluids - Associated with Marcellus Shale

- Top hole fluids – typically the water from the freshwater aquifer. This water from the first 600 to 1200 feet.
- Bottom hole fluids – brine or connate water.
- Stimulation Fluids – fluid used to improve recovery (frac process)- includes biocides and other chemicals.
- Production Fluids – water produced along the natural gas release – similar to bottom hole fluid.



Arthur et. al., 2008 – All Consulting – " Natural Gas Wells of the Marcellus Shale", Presented at Groundwater Protection Council 2008 Annual Forum.

Available Frac Water (Includes Recycled) Chemistry

Parameter	Units	Concentration	PWS	MultipleAbove PWS Standard
Aluminum	mg/L	1.2	0.2	6
Arsenic	mg/L	0.014	0.01	1.4
Barium	**mg/L**	**410**	**2**	**205**
Iron	mg/L	17	0.3	56
Manganese	mg/L	0.89	0.05	17.8
Hardness	mg/L	1750	500	3.5
T. Dissolved Solids	**mg/L**	**31324**	**500**	**62**
Nirate @ N	mg/L	90.1	44	2
pH	su	6.73	6.5 - 8.5	oK
Bromide	**mg/L**	**61.8**	**0.01**	**6180**
Chloride	**mg/L**	**27000**	**250**	**108**
Gross Alpha	pCi/L	223.3	15	15
Gross Beta	mrem/yr (Sr)	38.65	4	10
Radium 228	pCi/L	18.55	5	4
Radium 226	pCi/L	69.63	5	14

http://www.prochemtech.com/

Flowback Water Chemistry

Flowback water is generated from drilling and it is what gets produced from the first 5% of water returned after a well is started

Parameter	Frac 1	Frac 2	Frac 3	Frac 4
barium mg/l	3,310	2,300	7.75	4,300
calcium mg/l	14,100	5,140	683	31,300
iron mg/l	52.5	11.2	211	134.1
magnesium mg/l	938	438	31.2	1,630
manganese mg/l	5.17	1.9	16.2	7.0
strontium mg/l	6,830	1,390	4.96	2,000
dissolved solids mg/l	175,268	69,640	6,220	248,428
suspended solids mg/l	416	48	490	330
chemical oxygen demand mg/l	600	567	1,814	2,272

May contain elevated levels of trace metals, nitrogen, bromide, uranium, and hydrocarbons. Most of the dissolved solids includes chloride and sodium.

Source: http://www.prochemtech.com/

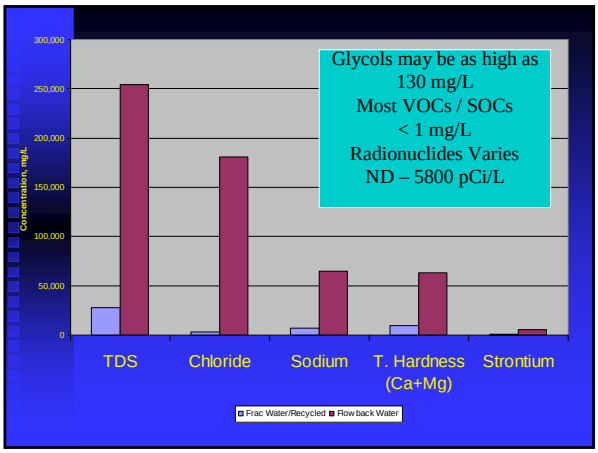
Production Water

Produced water is wasted water that accompanies oil extraction and is high in saline. Typically, separated stored on site and then hauled to treatment/disposal facility.

Parameter	Result	Parameter	Result
pH	4.79	conductivity mmhos	366,600
total oil/grease mg/l	9	chemical oxygen demand mg/l	2,332
surfactants mg/l	105.7	barium mg/l	690
calcium mg/l	23,200	iron mg/l	160
magnesium mg/l	2,240	manganese mg/l	10.1
strontium mg/l	732	dissolved solids mg/l	224,300
suspended solids mg/l	33		

May contain elevated levels of trace metals, nitrogen, bromide, uranium, and hydrocarbons. Most of the dissolved solids includes chloride and sodium.

Source: http://www.prochemtech.com/



Active Marcellus Production Site – Frac Fluid Chemistry

Typically Frac Water is comprised of clean water with a low probably for scale formation, but treated effluents and other sources being evaluated.
The components include:

Friction Reducer – anionic polymer high molecular weight
(hold frac sand and other particles)

Wetting Agent- nonionic surfactant – reduce surface tension and improve frac water flowback.

Biocides- control growth or regrowth of microorganisms.

Scale Inhibitor – phosphate based chemicals to inhibit precipitate formation and scale formation.

The Marcellus Shale Factor

- In 1996 – we knew 50% of Private Wells in PA where contaminated – But What Did We DO?
- The Marcellus Shale Factor or the Development of this resource is NOW bringing this problem to the surface.
- Baseline Testing is being conducted and more problems with groundwater quality are being identified.
- What to do now?

Recent Baseline Testing in Luzerne County, PA
320 Private Wells

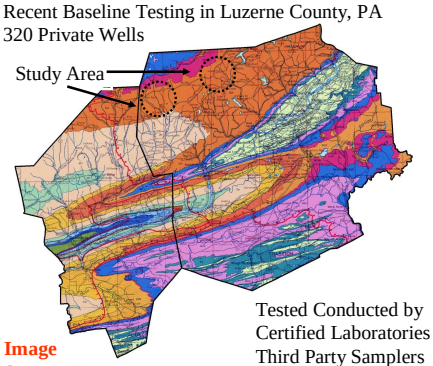
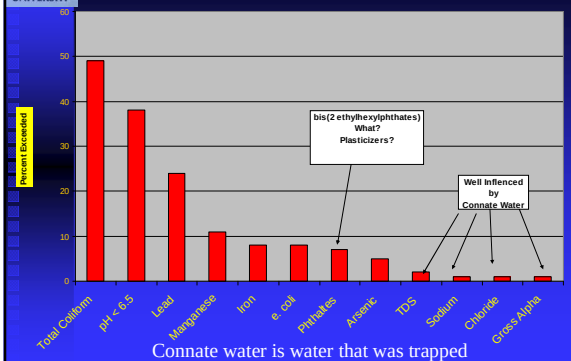


Image
Source: Luzernecounty.org

Tested Conducted by
Certified Laboratories
Third Party Samplers
Not Wilkes University

Source – Wilkes University Database



Connate water is water that was trapped in formation when material was deposited.

What are Phthalates?

- Used as Plasticizers- is a substance which when added to a material, usually a plastic, makes it flexible and easier to handle.
- Bis(2thylhexylphthalte) (DEHP) – DW Standard – 6 ppb – GI problems, possible endocrine disruptor and carcinogen.
- Recent Testing – Highest Value was 60 ppb.
- How did this get in the aquifer?

How ? Not Sure – Here are Some Ideas

- Private Wells Not Regulated and there are no plumbing codes.
- Sources – PVC plastic piping used in the home.
- Sources – Drop Pipe and Delivery Piping used in the well.

This is only a hypothesis.

Arsenic (5 % above Limit)

- The drinking water MCL is 0.010 mg/L.
- Arsenic can result in the formation of malignant tumors on skin and lungs and may cause nervous system disorders.
- For this particular parameter within Northeastern Pennsylvania (NEPA), it would be advisable to retest the water for dissolved and total arsenic.
- In many cases, the arsenic has been leached from a colloid or particle that could be more cost effectively removed by standard filtration. It is also typically bound to iron oxide complexes.

Suggested Baseline- For Citizens

- Testing Package # 1

  Total Coliform with e. coli confirmation, chloride, sodium, bromide, barium, pH, total dissolved solids, MBAS, iron, manganese, and methane/ethane.

- Testing Package # 2
  Package # 1- plus T. Hardness, Magnesium, Selenium, Strontium, Conductivity, Calcium, Zinc, Alkalinity, Arsenic, Nitrate, Total Suspended Solids, Sulfate, Oil & Grease, and 21-VOCs/MTBE.

- Testing Package # 3

  Package #1 and # 2 - plus Potassium, Sulfide, Ammonia, Acidity, Nickel, Gross, Alpha/Beta, Lead, and Uranium.

It may be advisable to add Glycols and other organics and inorganics Depending on surrounding land-use, use of geothermal wells, and past history.
http://www.wilkes.edu/water (Fact Sheet - Recommended Baseline)

Problems with Iron, Manganese, and Sulfur – May be Bacterially Related

In Northeastern PA- "Nuisance Bacteria may be associated with an Odor, Iron, Manganese, or Sulfur problem. Up to 50% of the time. Make sure to test for total coliform, standard plate count, and Nuisance Bacteria.

Citizen Database at Wilkes University- Guidelines for Submission

II. Guidelines for Data Submission

1. Third Party Samplers following chain-of-custody to certified laboratory.

2. Submit detailed reports from certified laboratory with a GPS position for the well.

3. The water sample must be collected ahead of any water treatment system.

4. other conditions – Learn More at the Wilkes University Website.

Learn More –
http://www.wilkes.edu/water

Suggested Action

- Baseline Testing should identify and document current water quality and quantity and be specific to the wellowner.
- Baseline testing information should be used to correct, improve, or abandon wells that can not be remediated. This may not just mean installing treatment – we may also need to improve the well.
- Establish Statewide Standards for Private Well Placement and Construction.
- Establish specific plumbing codes for drinking water piping for private wells.
- Establish more detailed standards and guidelines for geothermal well placement and construction.

WORK as a Community – Participate in the Citizen Database

New Community Resource

Download a Free Copy (pdf) or Link to a copy at http://www.wilkes.edu/water

Also:
1. We are Working on a Regional Citizen Water Quality Database.

2. We provide informational water testing- not Certified Test

Add Your Data to the Citizen Database

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