

Natural Gas – A Game Changer



Water Resources



Environment



Industry



Citizens



Old Issues



New Issues

A Balance is Needed - Lithuania

Presented by:



This is my Normal Attire.
(photo by: Samantha Oram)

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B.F. Environmental Consultants Inc.
<http://www.bfenvironmental.com>

Water Research Center
<http://www.water-research.net>

B.F. Environmental Consultants Inc.

Environmental Scientists, Hydrogeologists, & Environmental Education Specialists
Located in Northeastern Pennsylvania

water reuse

hydrogeology

soil testing



B.F. Environmental Consultants Inc.



- Professional Consulting Services in the areas of water quality, soils, stormwater, geology, aquifer analysis, and land-development.
- Baseline – Chain-of-Custody- Expert Testimony
- Continuing Education Courses for Engineers, Surveyors, and Water Treatment Professionals
- Water Treatment Process/ Product Development

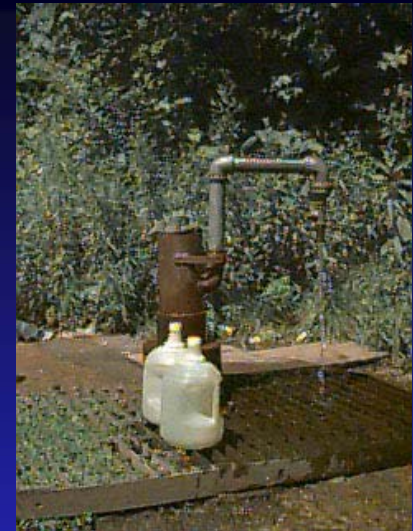


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Water-Research Center

Education and Outreach Program funded by
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Outreach Programs

- Environmental and Professional Education and Training for Citizens and Local Municipalities
- Water Quality Help Guides – Information Library
- Community and Business Outreach Programs
- Low Cost – Informational Water Testing Program with National Laboratory
- Citizen Monitoring Programs

Website: <http://www.water-research.net>

The Silurian- Ordovician Shale Play- What is it?

~416 to 480 million years old

~ 7,000 to 12,000 feet deep

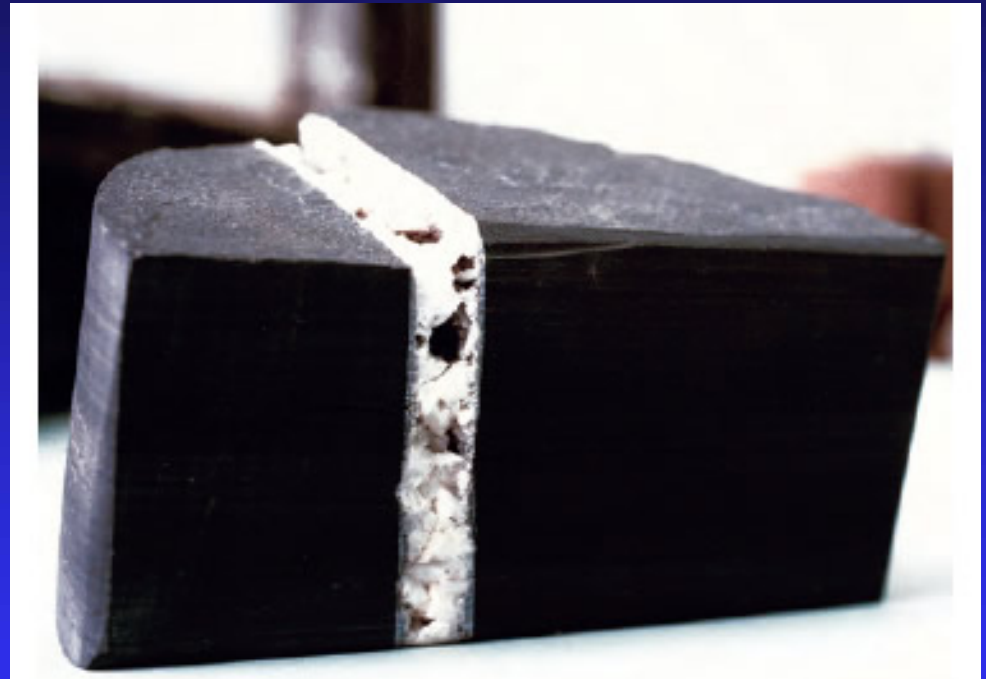
~ 500 to 2,500 feet thick

Formed from organic-rich mud

Natural gas

Radioactive (NORM)

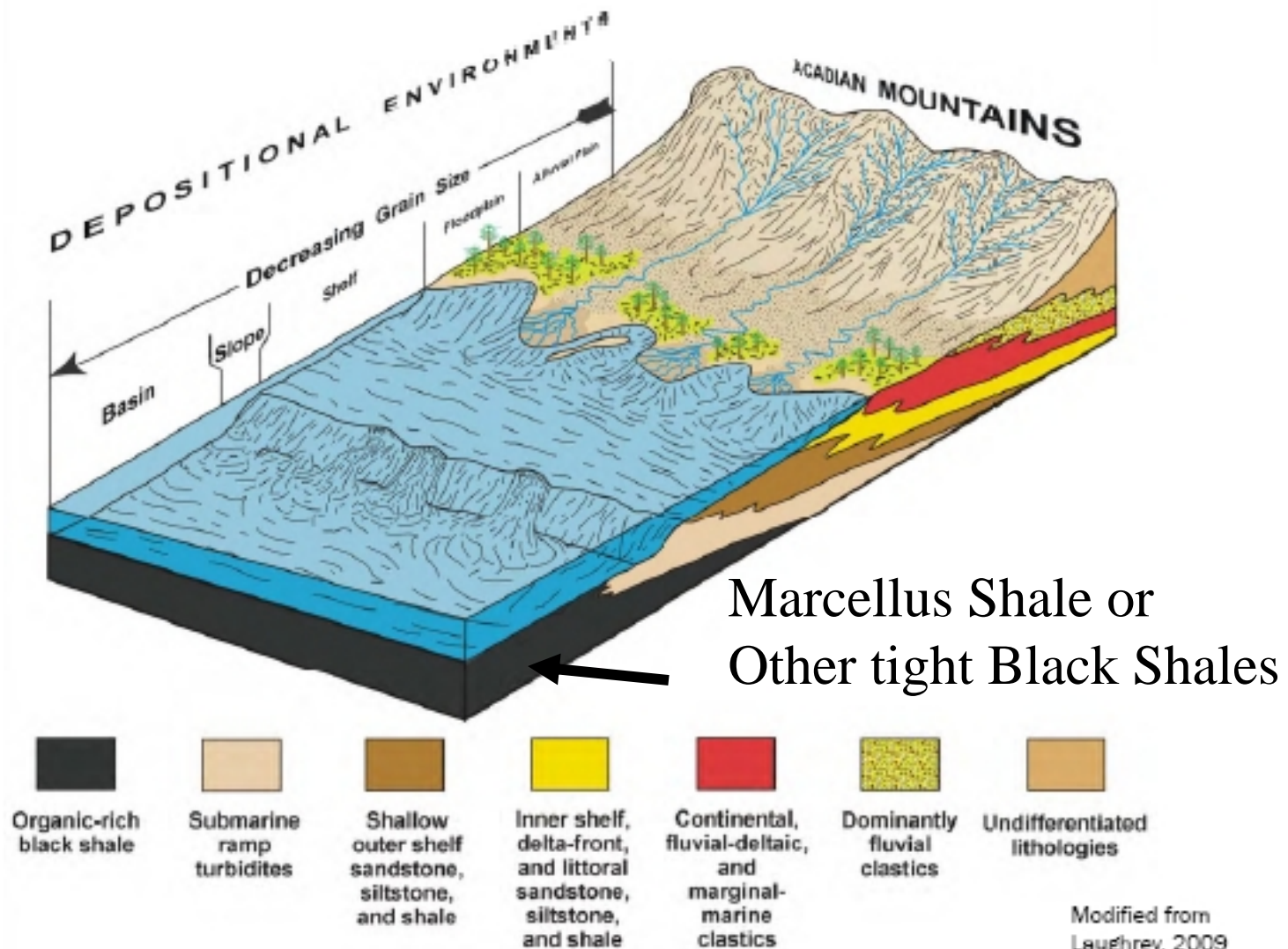
Low permeability



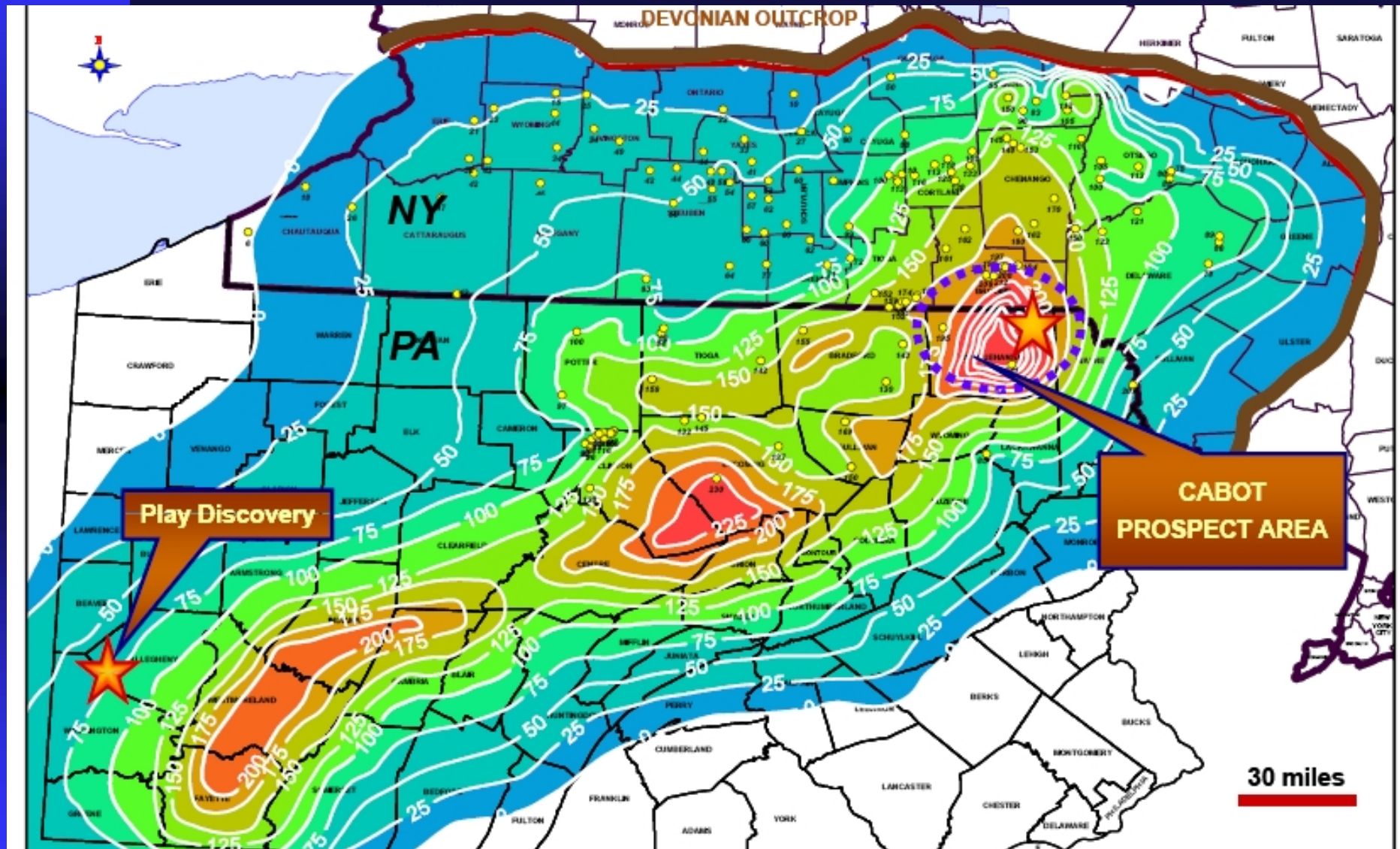
NORM – Naturally Occurring Radioactive Material

Sources: <http://world-nuclear.org/info/inf30.html>
<http://www.kpmginstitutes.com>

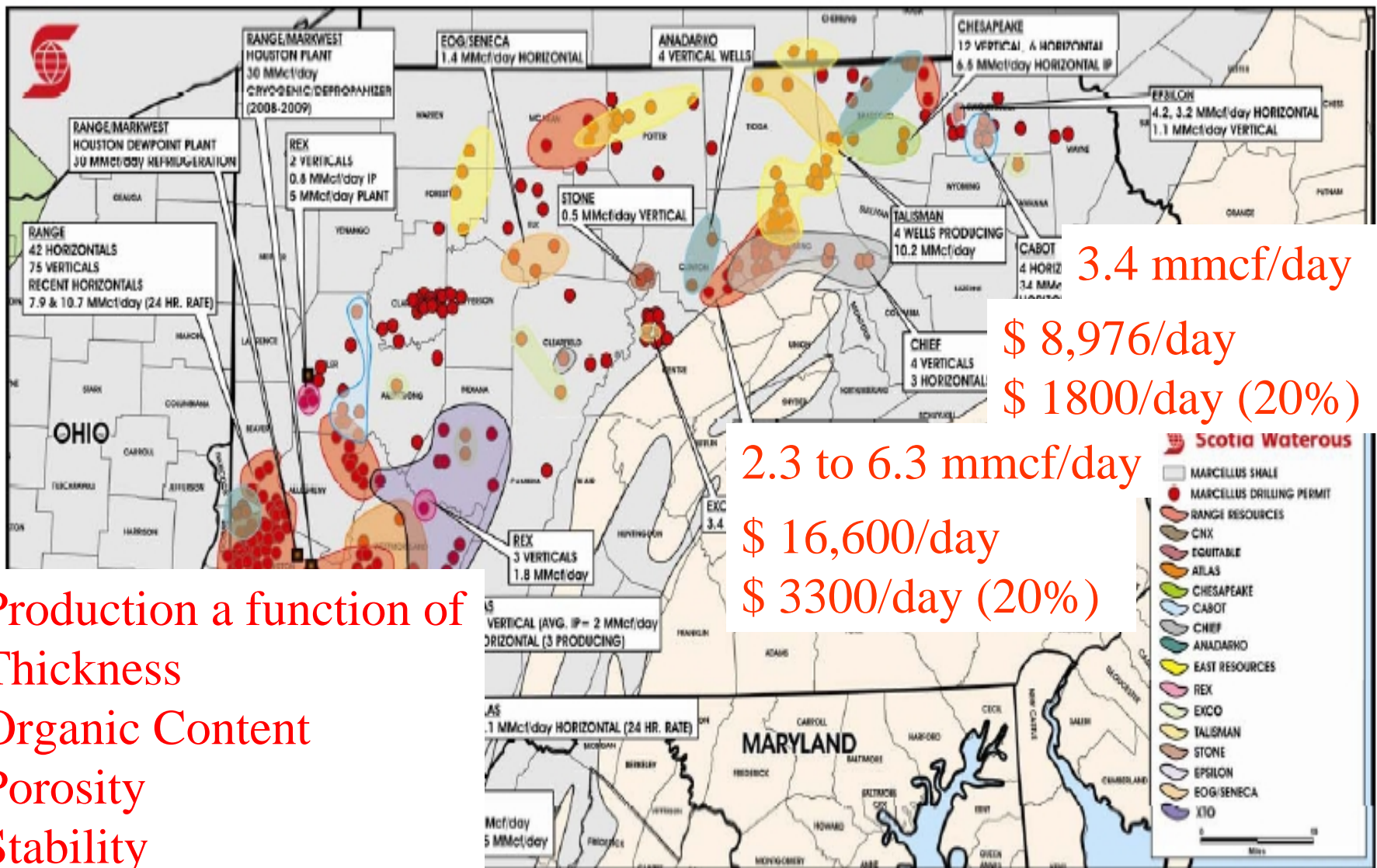
DEVONIAN DEPOSITIONAL ENVIRONMENTS



This is why the term – Fairway is being used to describe the play.



Source- Cabot – Marcellus Shale Thickness Map



Production a function of
Thickness
Organic Content
Porosity
Stability

Source: DUG Conference Presentation

1 *MMcf* = 1000 *MMBtu*

\$2.64 per *MMBtu*
(2/2012)

Baseline Groundwater and Surfacewater Monitoring Related to Natural Gas Development



Site Development
(Switching to Closed
Loop Drilling)



Frac Job – Hydraulic Fracturing



Production



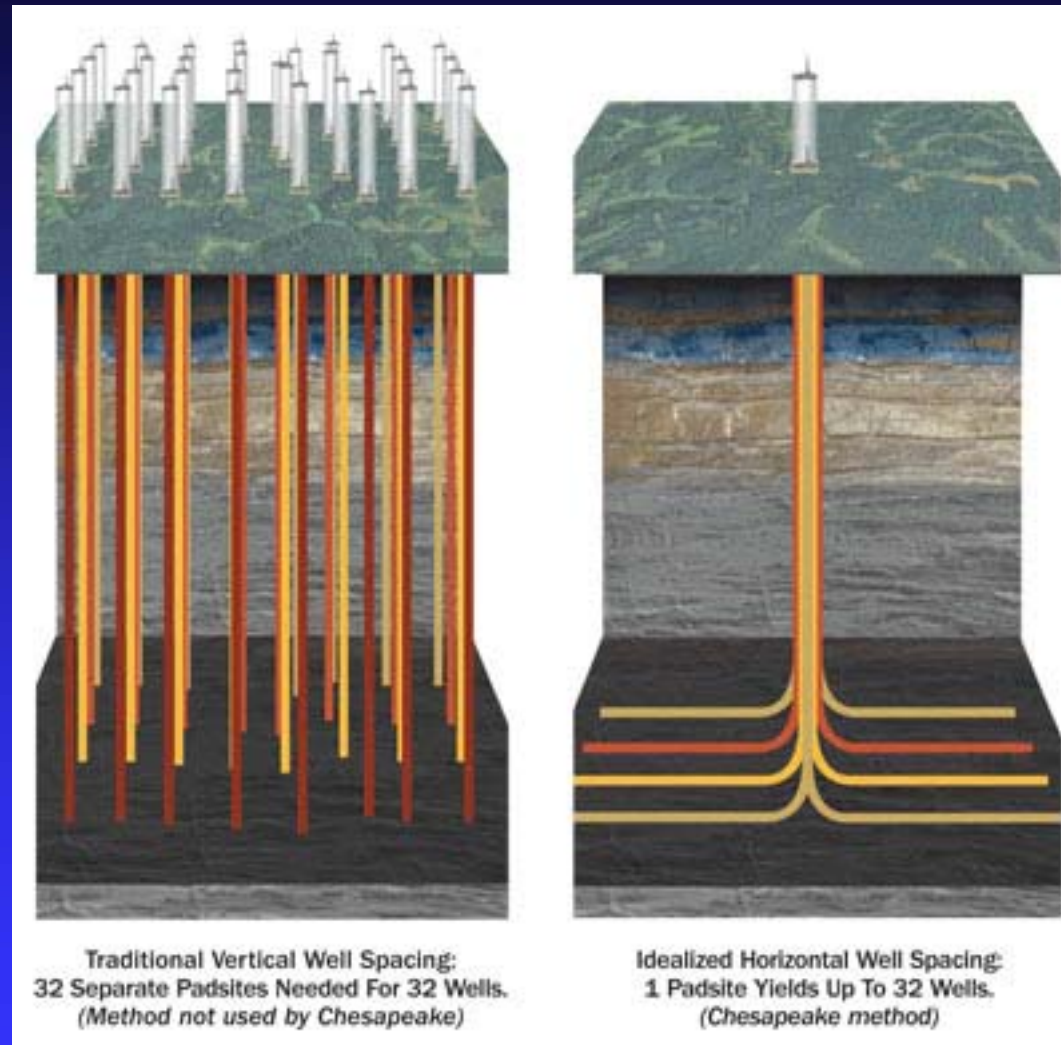
Processing

Marcellus Shale Drilling Site



Pads can be 5+ acres – but one pad may support drilling multiple horizontal wells. The large pad needed to fit “Hydraulic Fracturing Process”.

Side View



Vertical Approach

Horizontal Drilling

Go To You Tube to See Some Videos -<http://youtu.be/lnPqKvE60uI>

Getting to The Natural Gas

Freshwater
Well

Rate of Water Movement

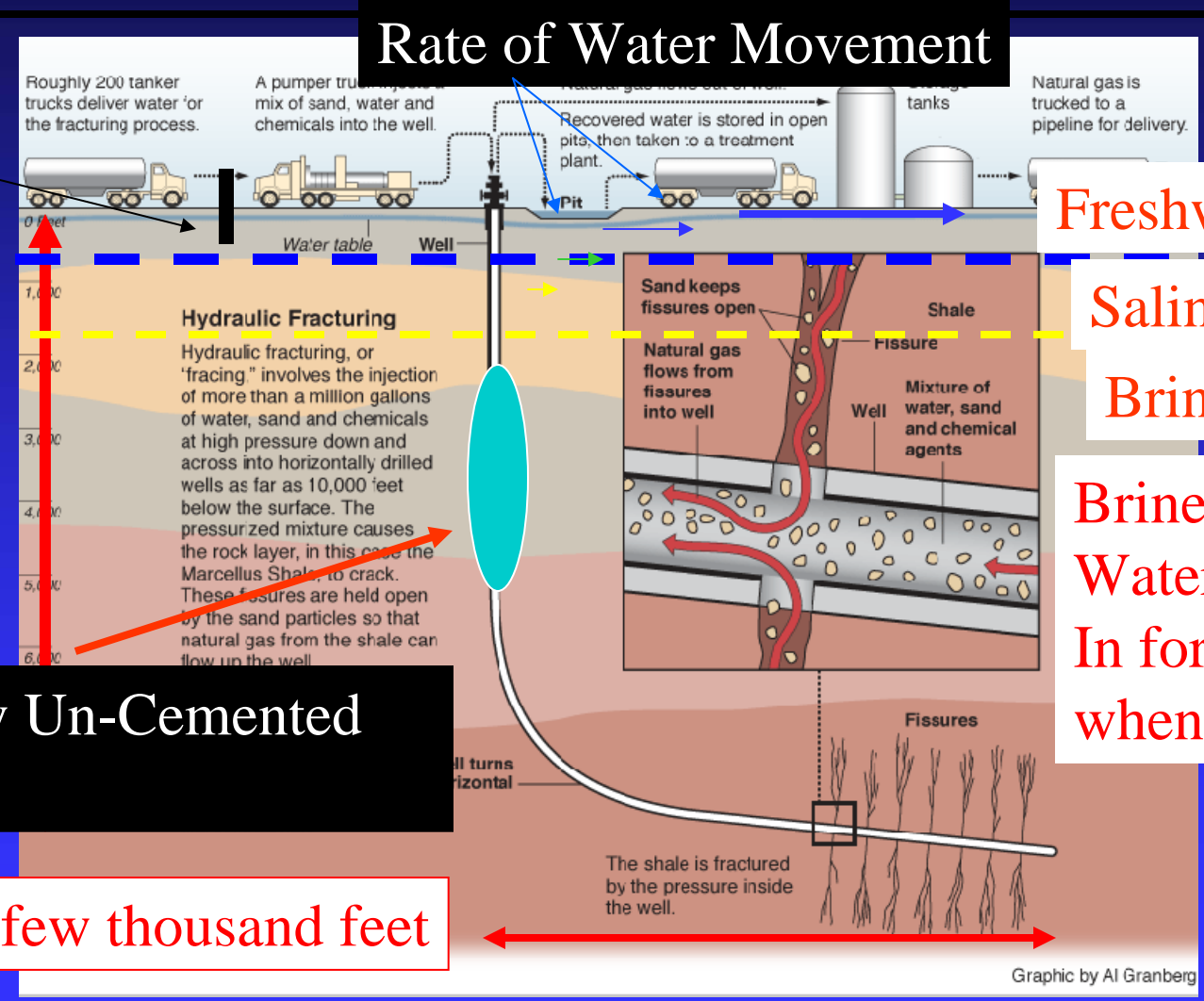
Freshwater

Saline
Brine

5000 to
7000 feet

Potentially Un-Cemented
Zone

Up to a few thousand feet



Brine / connate
Water- Trapped
In formation
when deposited

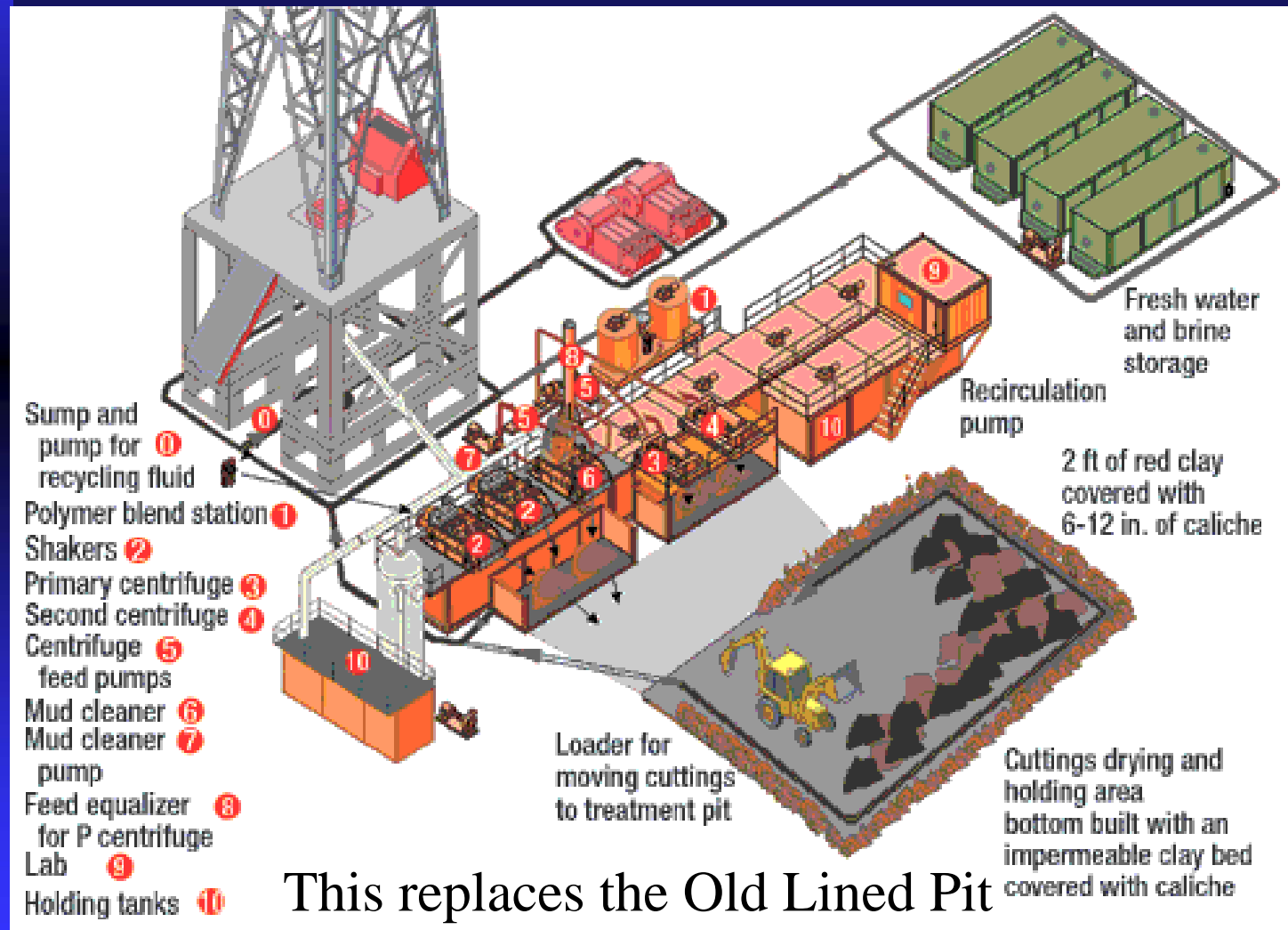
Open Loop Replaced by Closed Loop Drilling



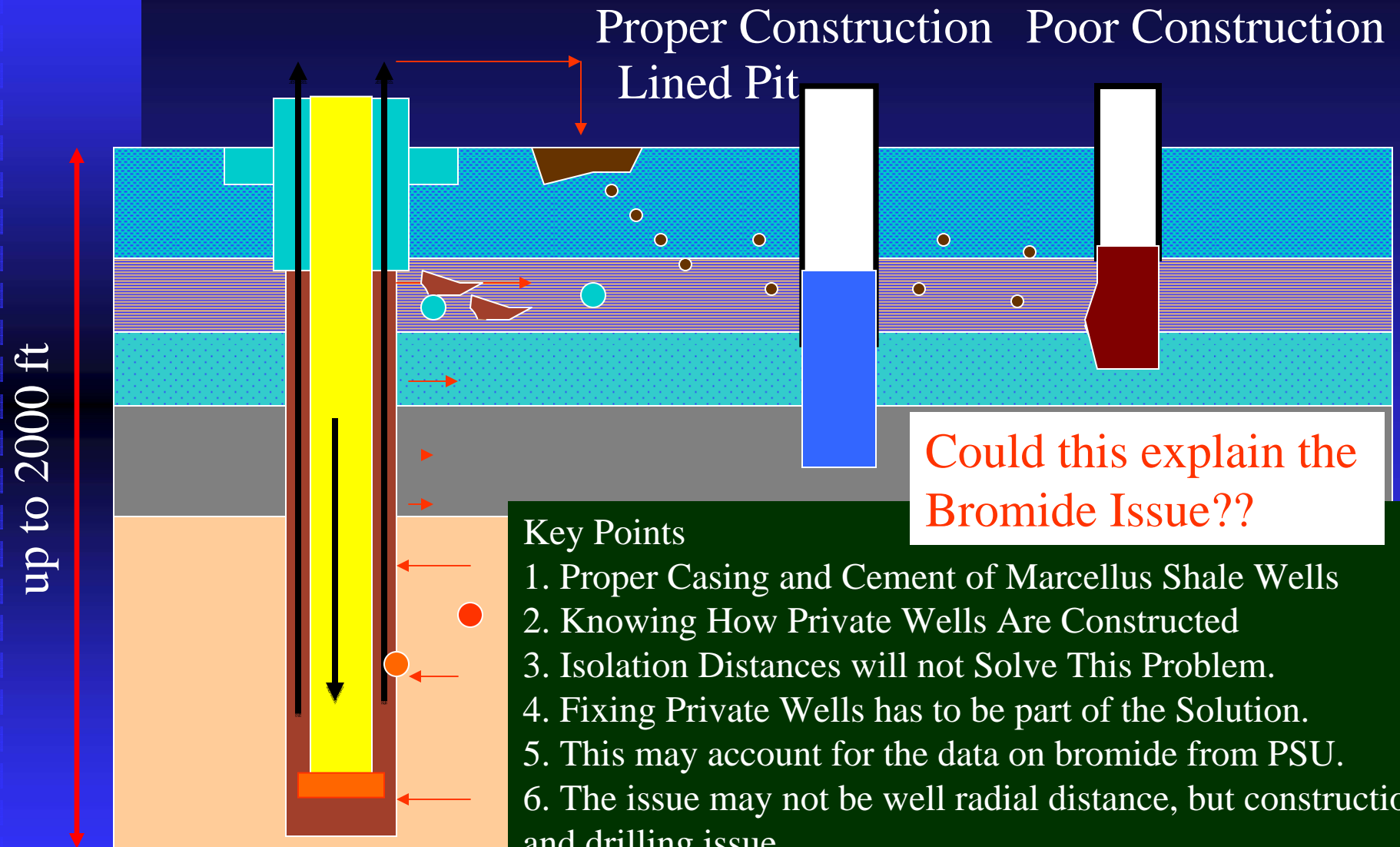
Other Legacy Issues Abandon Wells

No open pits – no leaky liners – a better approach – testing
Depends on the types of practices that are used. Remember
Pits may not be located on a Deed only a Permit. (Legacy Issues)

Closed Loop Drilling



PSU Study -Migration and Disturbance During Drilling-losing circulation



Key Points

1. Proper Casing and Cement of Marcellus Shale Wells
2. Knowing How Private Wells Are Constructed
3. Isolation Distances will not Solve This Problem.
4. Fixing Private Wells has to be part of the Solution.
5. This may account for the data on bromide from PSU.
6. The issue may not be well radial distance, but construction and drilling issue.
7. Recommend closed loop drilling with water within freshwater aquifer (no muds) or water-based muds.

Catskill Formation

Notice these pathways
decrease with depth



“Bluestone Quarry – West of Dimock”

Note – Preferential Flow Pathways Along Joints and Bedding Planes

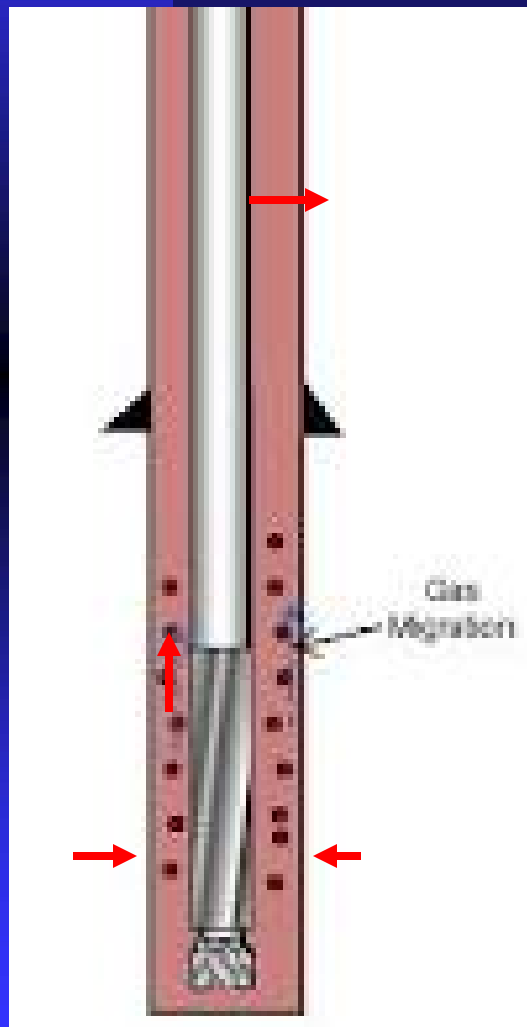
Drilling Changes/ Practices

- Using Water Only for Drilling Through the Freshwater Aquifer, Water/Air or Water Based Muds
- Using – Food Grade Mineral Oil for Drilling the remainder of the borehole.
- Flowback Water Reuse – 100% Treated and Re-used, by blending 80/20 with freshwater.
- More Strings, i.e., cemented casements.

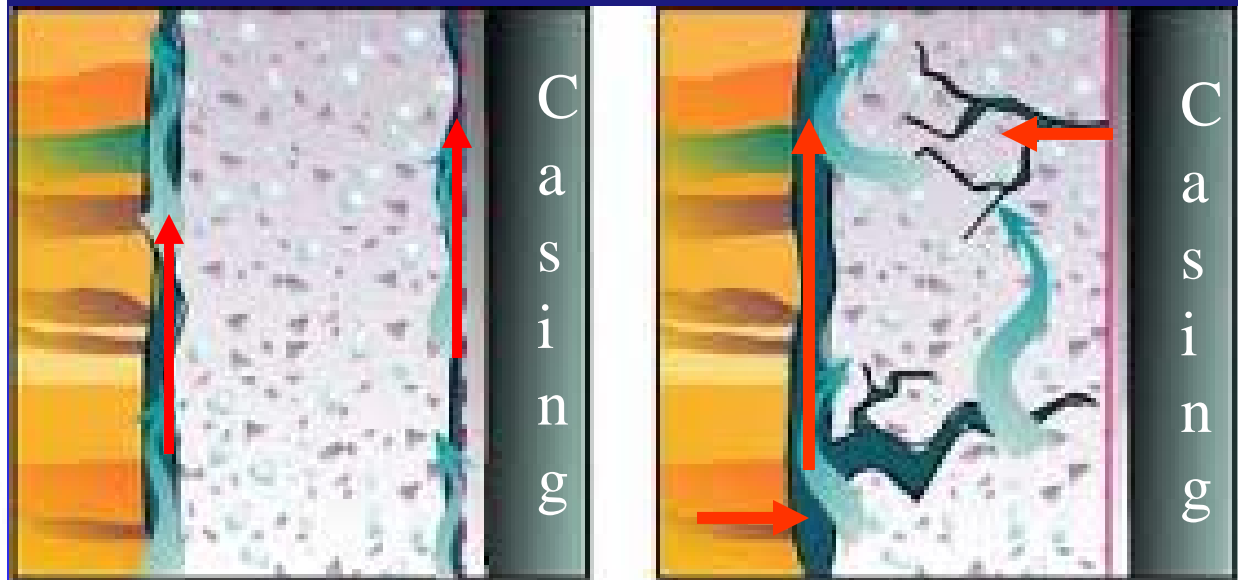
Protective Casing – Do it Right !



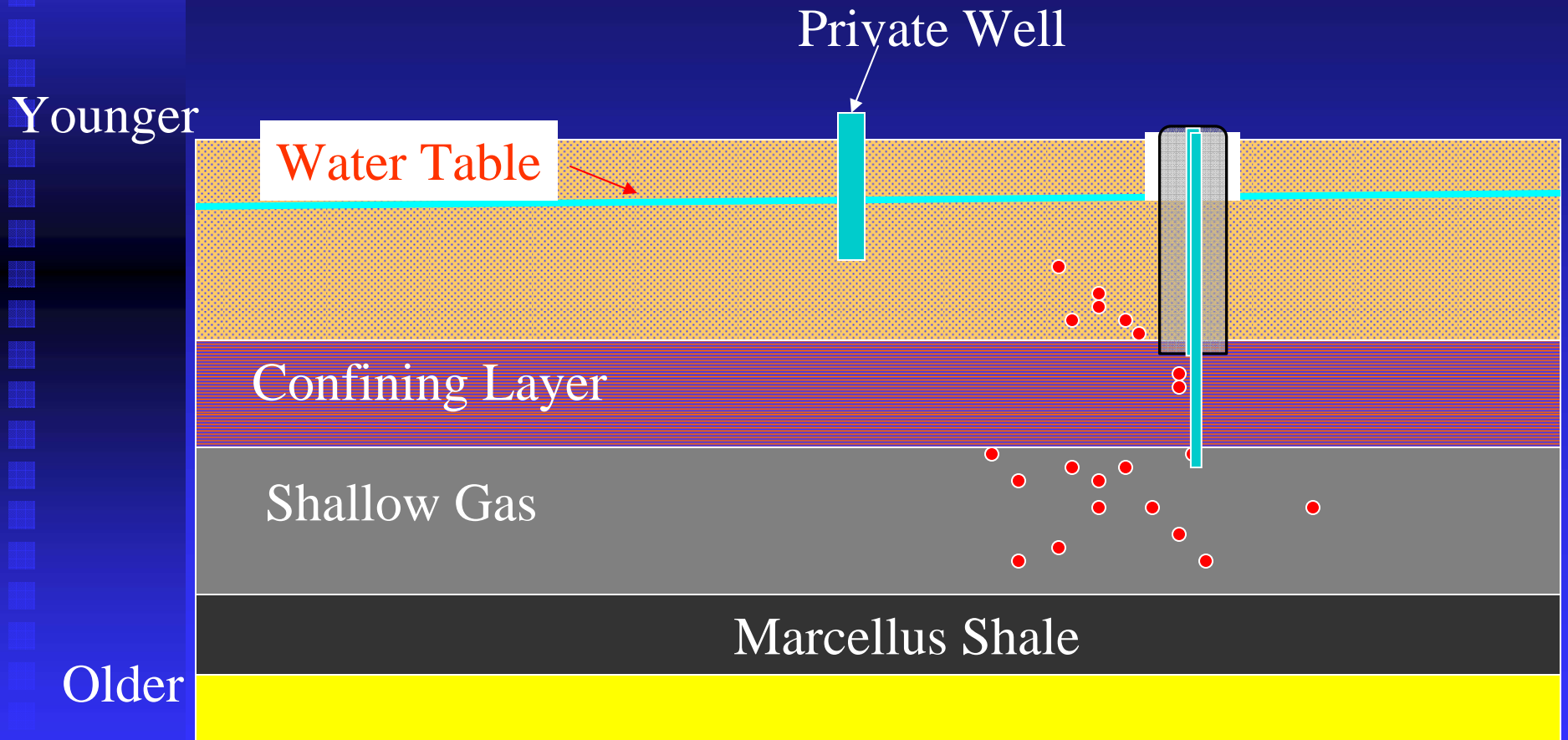
Problems with Gas Migration and Cement



Does not Bound



Migration Concepts- Non-Marcellus Shale - While Drilling- Proper Casement Placement

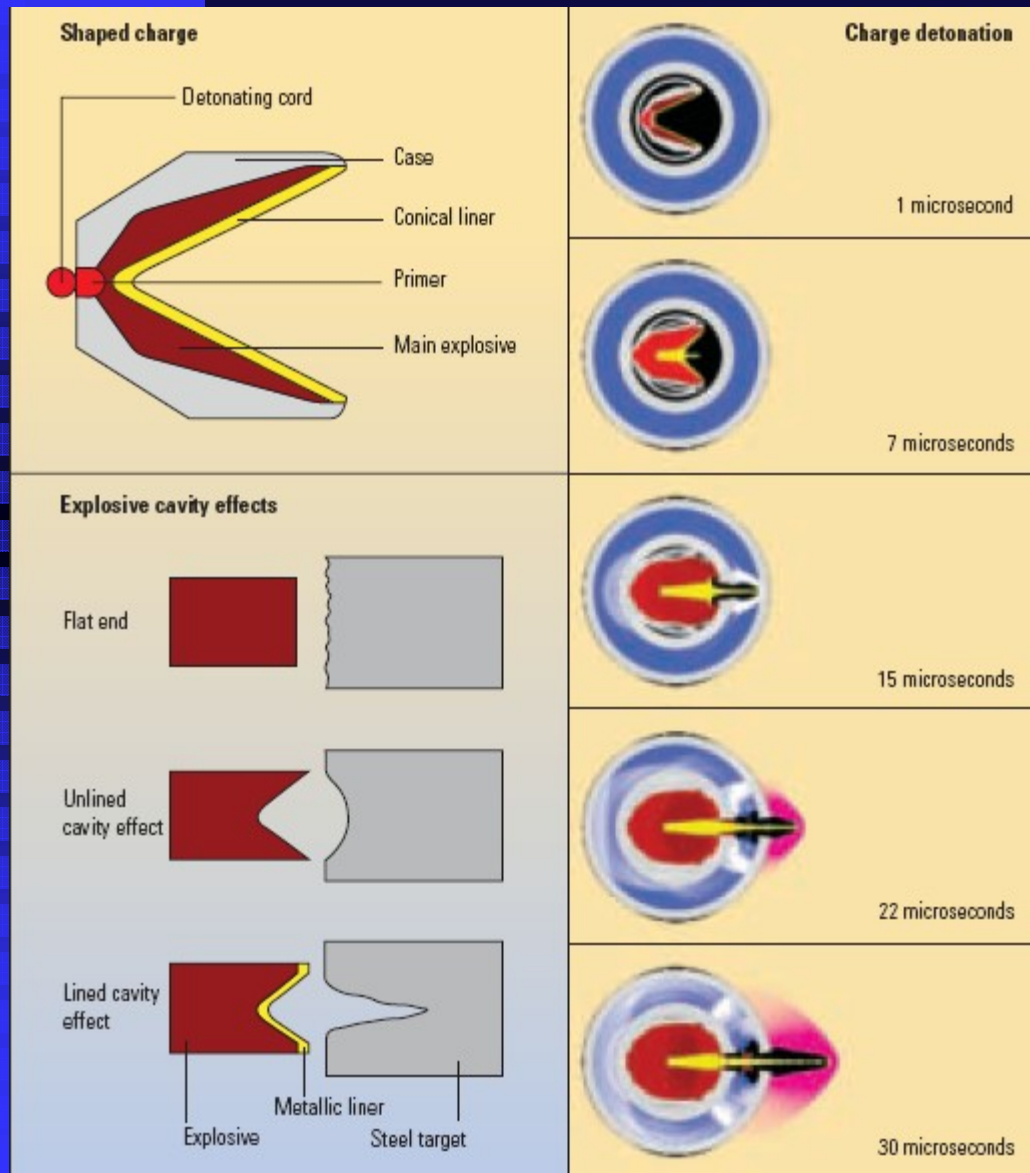




If this much is coming to the surface how much
may be being pushed into shallow bedrock units?
What happens when this pressure is shut in?

http://youtu.be/N4Ibbs7BN_E

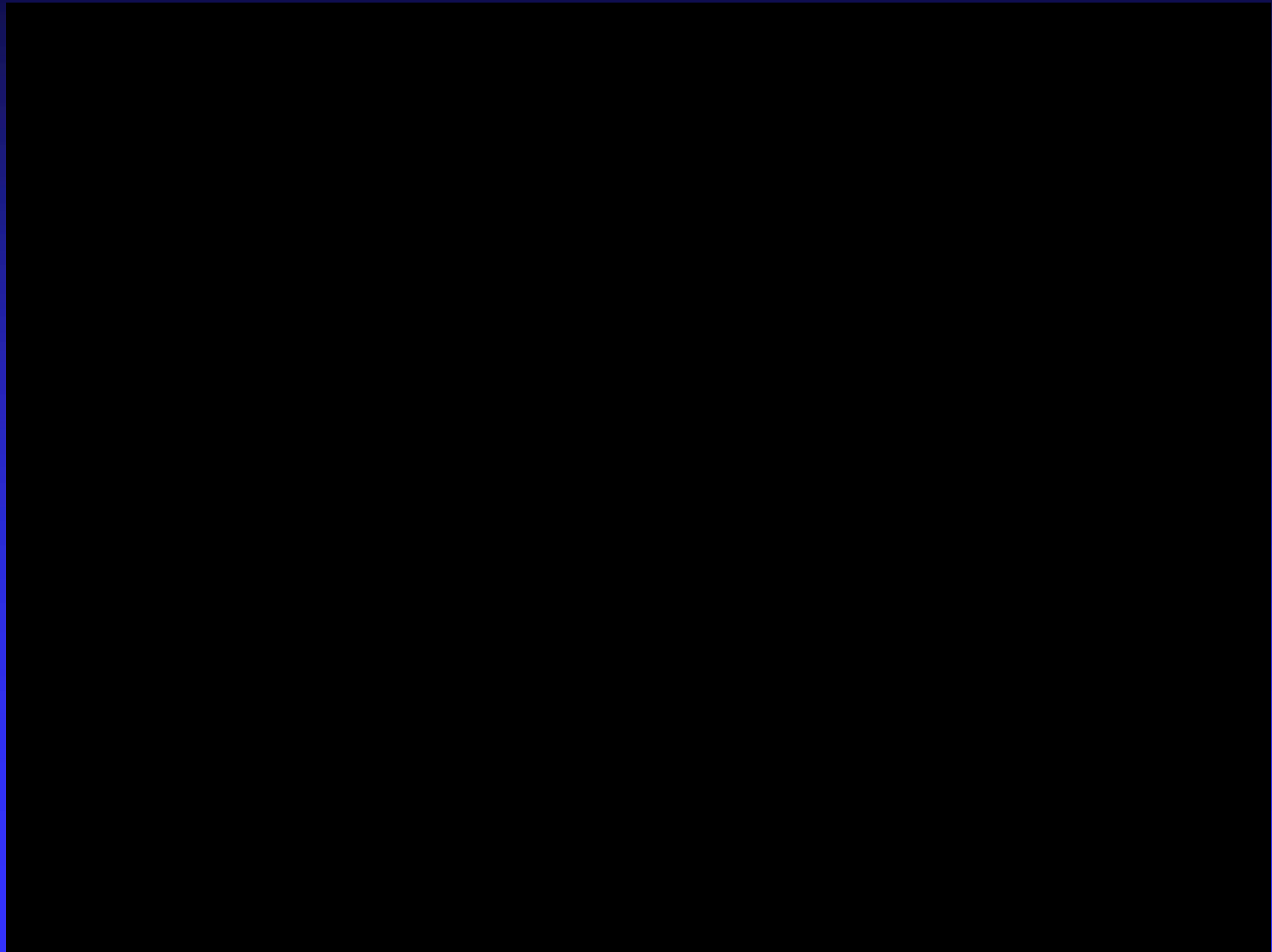
Perforating The Well Casing: Shaped Charges



The well liner needs to be perforated so fracturing fluid can flow out of the lined wellbore, and so gas can flow back into it. Perforation is done using shaped charges.

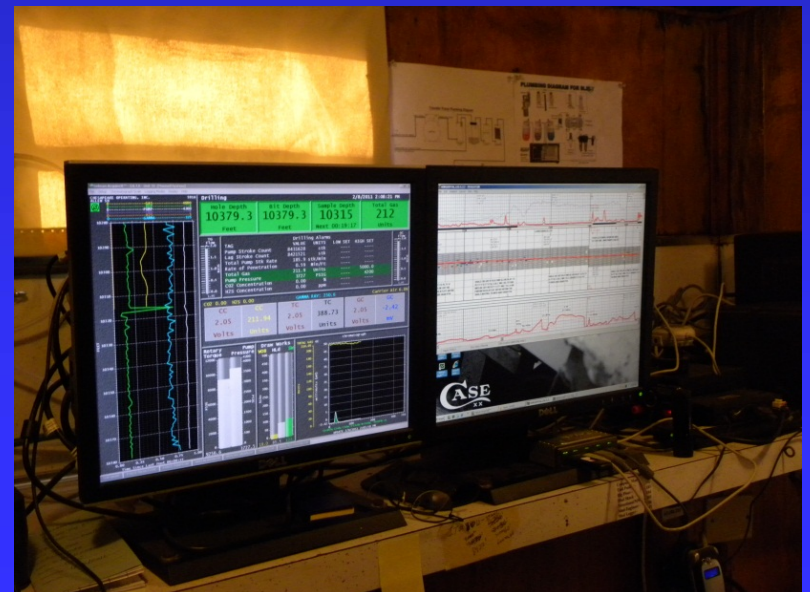
From *Oilfield Review*.
Schlumberger

Rarely Seen Video



Hydraulic Fracturing

Get On Site - See and Witness the Process



Hydrofracturing

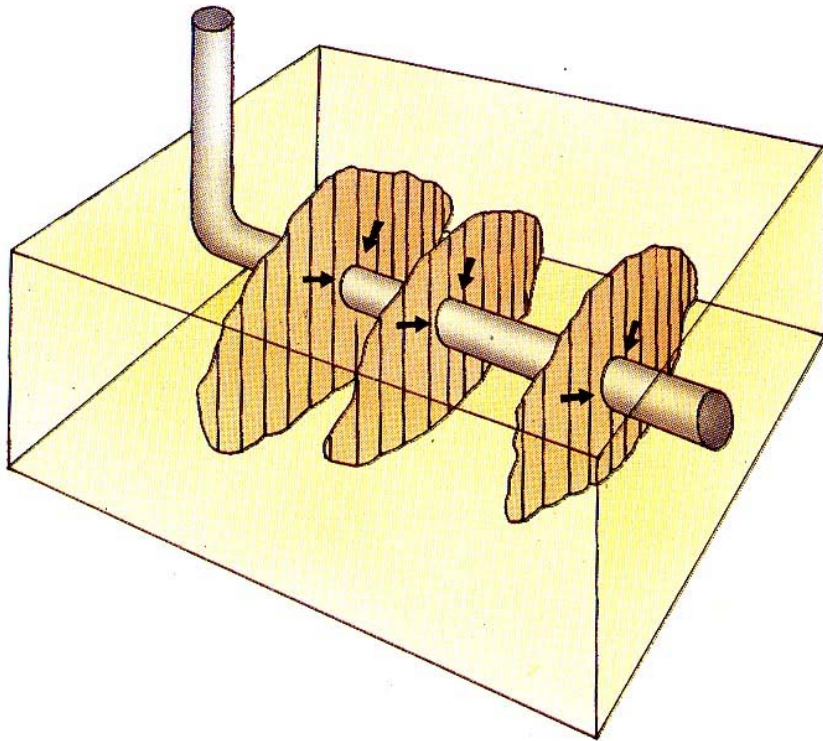


High Pressure Injection of Water, sand, and a mixture of chemicals in a series of stages to part formation. Note- Drilling Rig is not on the site – all drilling is done.



Fluid being pumped down at 3000 gpm – Total Hole Pressure 4000 psi – bottom hole pressure about 9000 psi.

Hydraulic Fracturing: An Oblique View



Each fracture is roughly elliptical in shape. Height should be thickness of Marcellus layer, length as long as possible.

The length can be 100's to 1000's of feet, but probably 500 ft vertical and 1000 horizontal.

Takes a lot of injection fluid to create many such fractures from a single well.

■ *Multiple transverse fractures—probably the best way to tap a reservoir. A drawback is the flow constriction that occurs at the intersection between each fracture plane and the well.*



Barriers / Liners – Separate - Containment – Tracking Waste/ Reuse
Barriers that Work !



Water Reuse – In Action

Migration Concepts- Multiple Casements and Recreate Confining Layers – No Uncemented Zones.

Most Private Wells

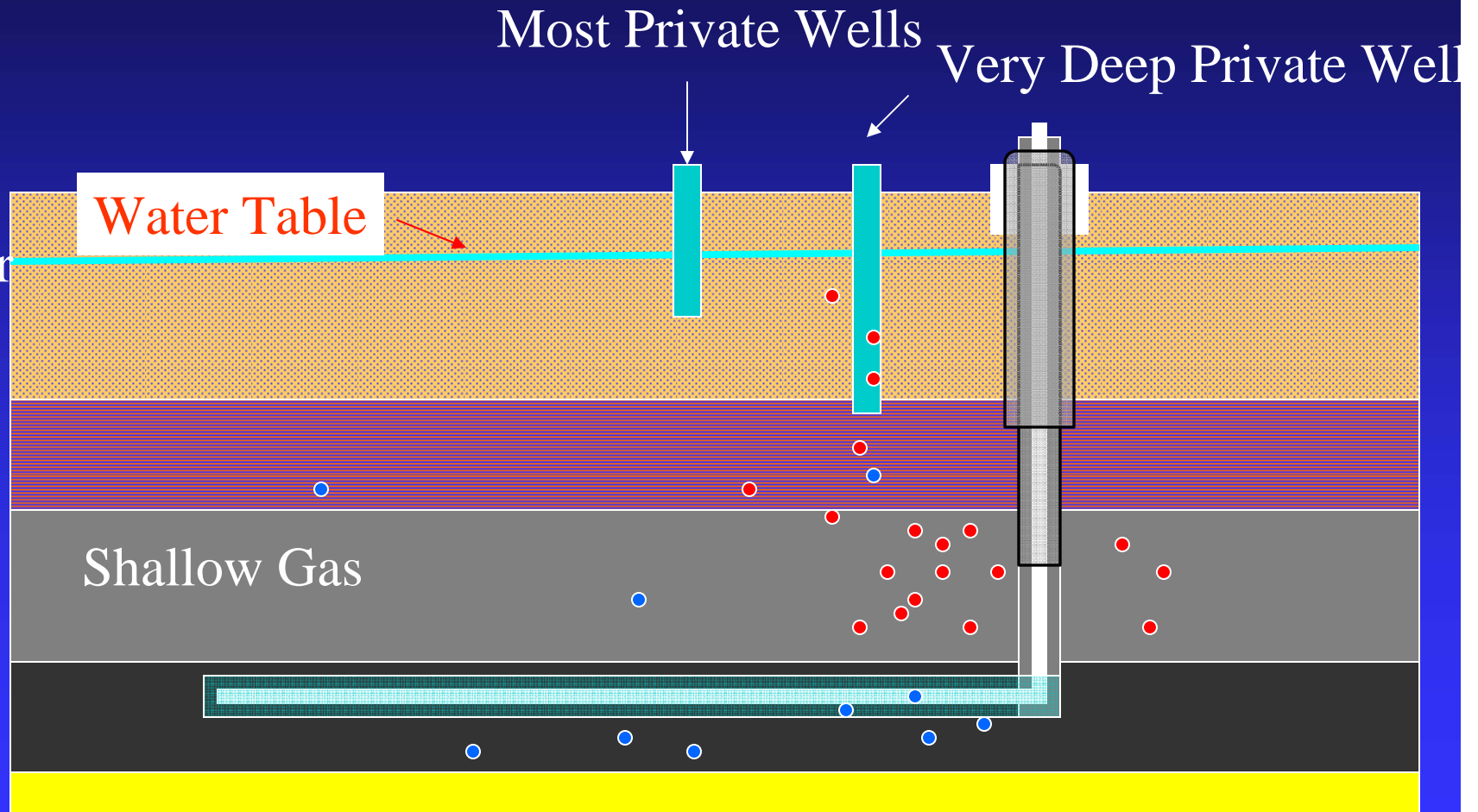
Very Deep Private Well

Water Table

Younger

Shallow Gas

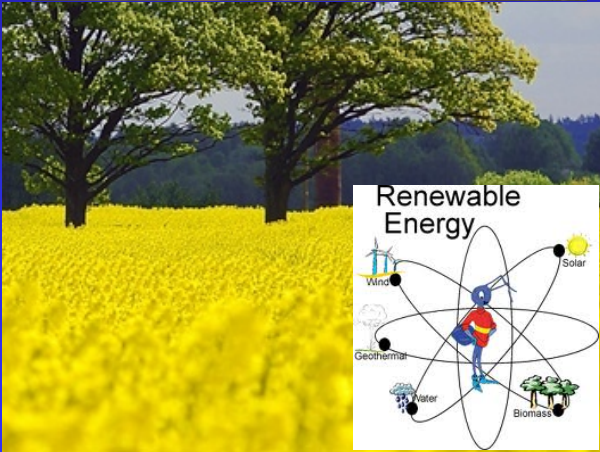
Older



The other Problem – Private Water Wells that are Too Deep or Old
Vertical Gas Wells- Storage

We Want This

Not This



Moving Forward
Without Planning

This Takes a Balance – Planning – Strategic Thinking –
It Takes a Community !

Announcements

- New Methane Gas Migration and Methane Gas Mitigation Website

<http://www.water-research.net/methanegas.htm>

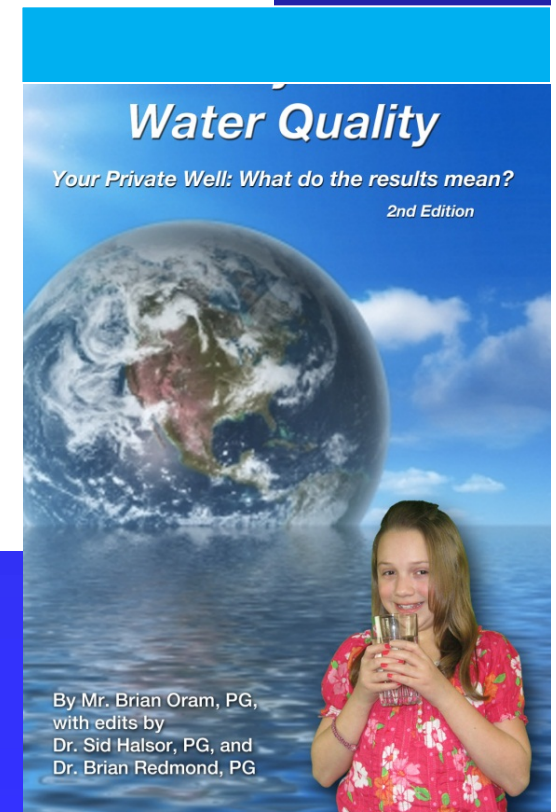
- New Information Guide for Private Well Owners will be available in August 2012. <http://www.water-research.net>

- New Online Training Courses for Professionals

◆ <http://www.bfenvironmental.com>

- Fact Based Review of Dimock, PA

<http://www.water-research.net/dimockwellwater.htm>



Thanks



QUESTIONS



Stop Using the Word – “Frac”



“Frak”



“Frak – was the “four” letter word for the 12 Colonies in Battlestar Galactica.



War
Battle



The process is called Hydraulic Fracturing.

This will make our Jobs a lot easier !

Hydrofracturing

