Shale Gas Waste Disposal

What Do We Know

What Don't We Know

Updating Regulations

By

Bill Hughes
Wetzel County, WV

My Personal Assumptions on Regulations

In general, shale gas companies and their contractors are willing to comply with existing regulations **WHEN**:

1. Regulations are clear as to intent and specific action required
2. Regulations are uniformly applied to all operators and producers

3. Regulations are occasionally accompanied with ruthless enforcement, with **TEETH** and **BIG $-$-$**

TOP SECRET

SHALE GAS INDUSTRY

INSIDER INFORMATION

EXPOSED HERE

CONFIDENTIALITY REQUIRED

Marcellus Shale

Is

Radioactive

DON'T TELL ANYONE ELSE

How do we know that Marcellus is Radioactive

- Geologists reported it over **35 years ago**
- Leachate from landfills show radioactivity
- Marshall University report confirms it 7-01-2015
- Drillers use **gamma** logs to find it
- Drill Waste loads trip alarms at landfills

How do we know that Marcellus is Radioactive

1. **Below Taken from: CLIFF MINERALS**, Inc. Eastern Gas Shales Project. Year--1981
West Virginia, Number 7 well, Wetzel County. *Pages 6-10*

Marcellus Shale:

6. The **Marcellus Shale** occurs from 6,568 to 6,625 feet and is composed of black shaly mudstones, with several zones of silty mudstone and calcareous mudstone present in the lower 20 feet.

Easily distinguishable on the **gamma radiation** and formation density logs, the **Marcellus Shale** is represented by a **high gamma curve varying from 230 to 320** API units, and by a low density curve varying from 2.20 to 2.30 *glee*.

The contact between the Marcellus and the underlying Onondaga Limestone is sharp in the core and is marked by a **sudden decrease in gamma radiation** and a corresponding increase in rock density.

How do we know that Marcellus is Radioactive

2. Radium Content of Oil- and Gas-Field Produced Waters in the Northern Appalachian Basin (USA): Summary and Discussion of Data ---yr. 2011

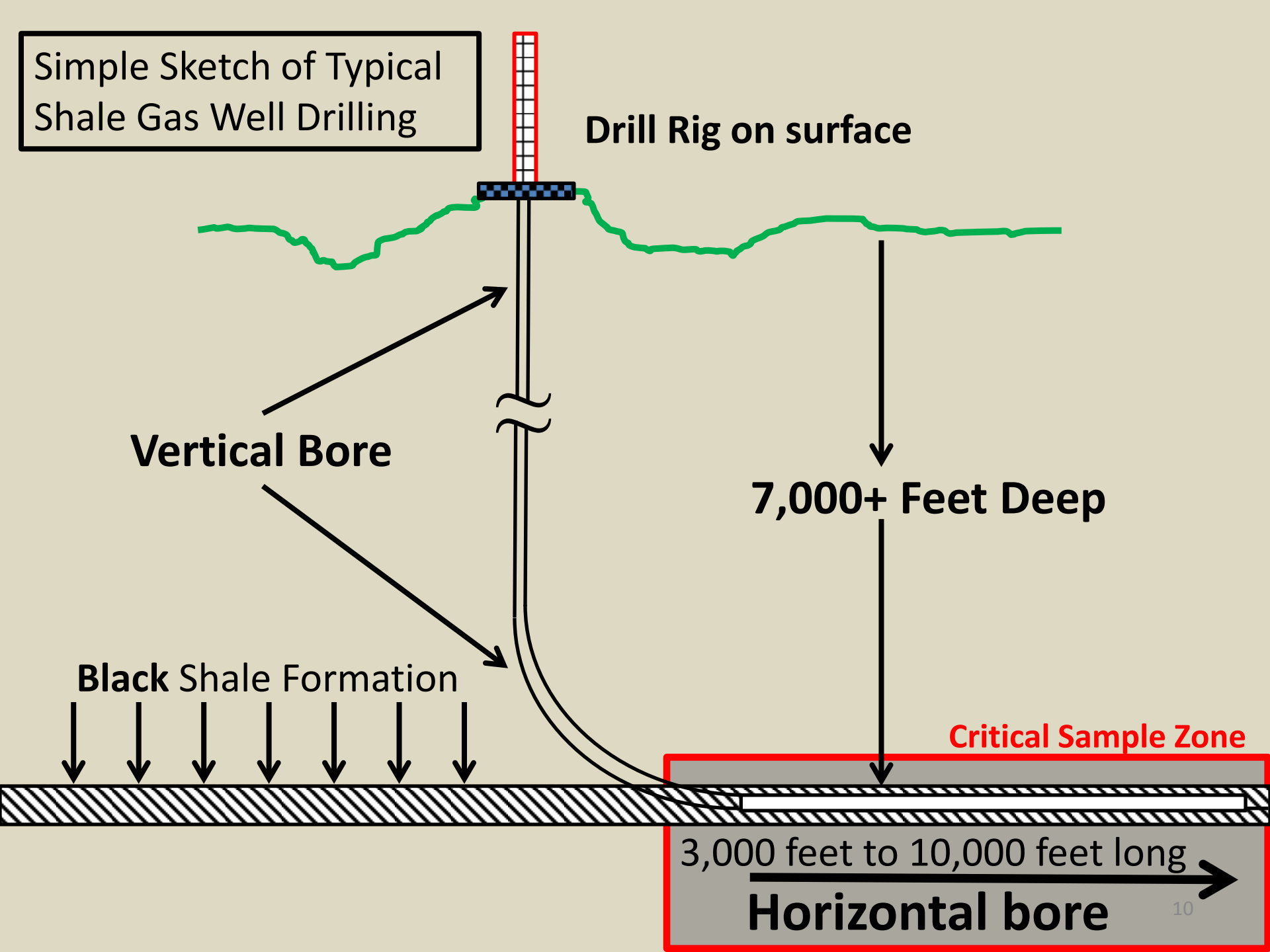
Page 12--In a study of NORM (naturally occurring radioactive material) in oil- and gas-producing regions, Fisher (**1998**) compiled radium activity data for nine sedimentary basins in the United States and Europe….. **Ra-226** activities ranges exceeded 4,500 pCi/L in the Ukraine and 5,000 pCi/L in the Texas Panhandle…. but the **Marcellus Shale** data range higher, with several activities **exceeding 10,000 pCi/L** (table 2; fig. 7).

3. FRACTURED SHALE GAS POTENTIAL IN NEW YORK—page 8; year 2004

The basal unit of the Hamilton is the Marcellus Shale. The **Marcellus formation is highly radioactive and regionally extensive**, covering most of the Allegheny Plateau and extending southward through the Appalachian Basin.

Quick review of Shale Gas Drilling And Drill Cuttings

Drill Rig at Work on a Shale Gas Site


Simple Sketch of Typical Shale Gas Well Drilling
Drill Rig on surface
Vertical Bore
7,000+ Feet Deep
Black Shale Formation
Critical Sample Zone
3,000 feet to 10,000 feet long
Horizontal bore

Less Toxic and Less Hazardous Drill Cuttings from the **Vertical** bore on a **Horizontal** Well Pad

Radioactive and Toxic Drill Cuttings
From the **Horizontal** bore on a **Horizontal** Well Pad

Why is this Waste a Problem

Drill Cuttings

And Produced Water & Flowback

Are all Radioactive--Toxic--Hazardous

And

There is Lot of this Waste

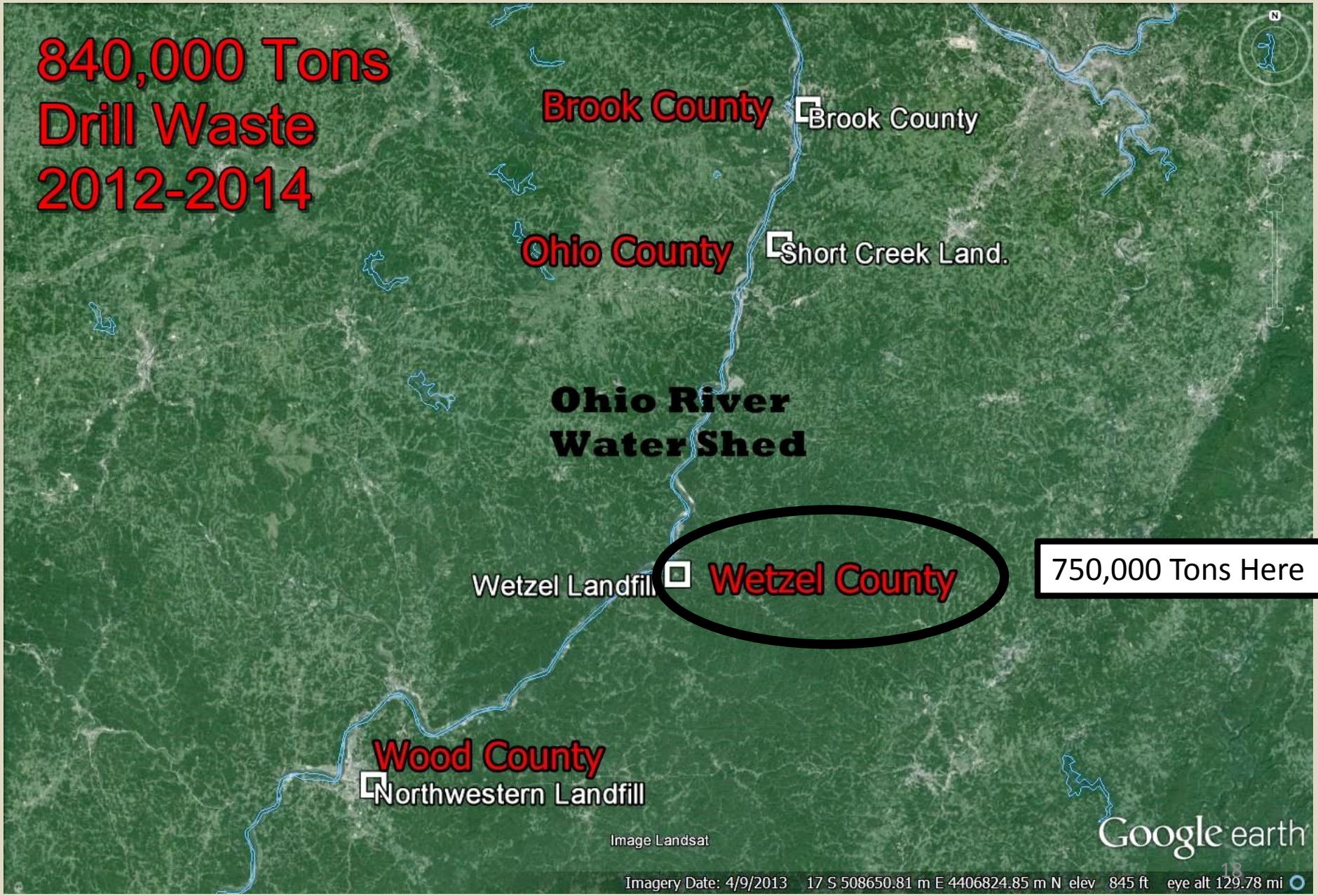
Rich, black, radioactive **Marcellus** shale drill cuttings From the actual **Horizontal Bore**

Drill Cuttings being dumped at the Wetzel County Landfill

Roll-Off Boxes with Drill Cuttings

Trucks Delivering Shale Gas Drill Cuttings to a Landfill

Total Tonnage of Drill Waste in West Virginia now over **1.5 million tons**



Rainfall or
Drilling Fluids or
Fracturing Fluids or
Formation fluid

Fresh
Water

Marcellus Shale
Drill Cuttings
Buried in Landfills

Coffee
Grounds

Leachate

Fresh Coffee

OUR LANDFILLS

Municipal
Solid Waste

Your KITCHEN

This Is What Marshall University was tasked to Examine

Marcellus Shale Operations Potential Water Contamination

1. Well pad drill rig → Drill cuttings → Landfills
2. → Moisture drains out becomes → Leachate
3. Leachate shows radioactive levels of concern
4. **Radioactivity** cannot be filtered out →
5. **Leachate** goes to Water treatment plant →
6. Effluent from water treatment plant goes into **Surface Streams and Rivers**
7. Surface waters→water intake→**Drinking water**

?

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What Do We Know

Conclusions
From the Marshall University Report

- Drill Cuttings **toxic** to plants
- Leachate **toxic** to plants and invertebrates
- **Radioactive** compounds are in **LEACHATE**
- **Long term** studies have **not been done**

Now We Know

- **Marcellus** Shale is **radioactive**;
- Radium is **water soluble;**
- **Radioactivity** is in the landfill **leachate;**
- **We ARE testing leachate.**

However, **WV** DOES **NOT** require the drill cuttings to be tested for **ANY** radioactive isotopes, **EVER**, **ANYWHERE**.

The only testing required by State Code is:

5.6.c.1.C.1. Toxicity Characterization Leaching Procedure (TCLP) Metals, EPA Method 1311; TCLP Volatile Organic Compounds, EPA Method 8260B; TCLP Semivolatile Organic Compounds, EPA Method 8270C; and Total Petroleum Hydrocarbons (TPH), EPA Method 8015C. Sampling results for these parameters must not exceed the limits of 40 C.F.R. § 261.24;

NO RADIATION TEST IN THERE

However, Radiation Detectors are required at Landfills in WV

The Marshall University Report States:

1. The **Marcellus Shale** has higher concentrations of **radioactivity** than other shales
2. Drill cuttings contain **radioactive** compounds.
3. The **Radium** isotopes within the Marcellus shale are **soluble in water**
4. **Radioactive** compounds are present in landfill leachate
5. **Radium 226** has a half-life of **1600** years.
6. **Landfill liners will leak**

General Observations

Taken from the Marshall University Report

- No existing studies on landfills with drill cuttings
- Little or no empirical data on risks with drill cuttings
- Studies of long-term exposure to unconventional natural gas development have not been conducted
- **Landfill liners will leak**

What Don’t We Know

HINT------What is in all the trucks ?


Small
RESIDUAL WASTE
COYLE
Medium
RESIDUAL WASTE
COYLE
Large
RESIDUAL WASTE
COYLE
? ? Residual Waste ? ?

100 Dollars

To anyone can tell all of us

Exactly what is

RESIDUAL WASTE

Whatever **RESIDUAL** is, there is a lot of it in all these trucks

Fresh—Brine—Fresh—Brine—Fresh--Brine

Radiation Detectors at the Scales at Wetzel County Landfill

They Look Good, they are brand new —**but they will not detect Radium 226**

From the manufacturer

"**Portions** of Radium 226/228 may be detected but our gate monitor systems do not "quantify" isotopes"

"**Radium** contains Alpha and Beta particles; these cannot travel far or penetrate like Gamma waves. **Therefore they are nearly impossible to detect with a gate monitor** scintillator detector through a metal sided vehicle".

Is there other radioactivity to worry about ? Well, Yes ….

Radon Gas

- The greatest risk from Radium is **RADON GAS**
- There is no safe level of **RADON GAS**
- Testing for **RADON GAS** at landfills or well pads is NOT required.

Where do we go from here ?

Known Problems

- **Inaccurate test methods are being** used to measure the radioactivity in leachate with high **Total Dissolved Solids:**
- **Horizontal** drill cuttings are **NEVER REQUIRED** to be tested for any radioactive isotopes
- **Leachate is radioactive** and drill cuttings appear to be toxic to plants and aquatic life:
- **Goal-post** radiation monitors will **not likely detect Radium** or Radon
- The attempt to obtain samples of Marcellus drill cuttings from three horizontals well bores appears to have been **unsuccessful**.
- This is a **new problem** with **little historical guidance**

Our HIGH Priority TO-DO List

1. We can and must get this right
2. There is more work to be done
3. We must use proper test protocols
4. We must test the horizontal bore material for radiologicals
5. This will be a very long-lasting problem
6. We must accurately identify all risks to public waters of the **Tri-State Area**

We Just Do NOT Know Now

The End

Bill Hughes
Wetzel County, West Virginia
FracTracker Alliance and Ohio Valley Environmental Coalition