Shale Gas Monitoring

Katie Tomsho & Julie Vastine

Alliance for Aquatic Resource Monitoring

NWQMC 2012

ALLARM Background

- Empower communities with scientific tools to monitor, protect, and restore PA streams.
- Provide Dickinson students with the opportunity to convert classroom skills into practice.

Educate. Engage. Empower.

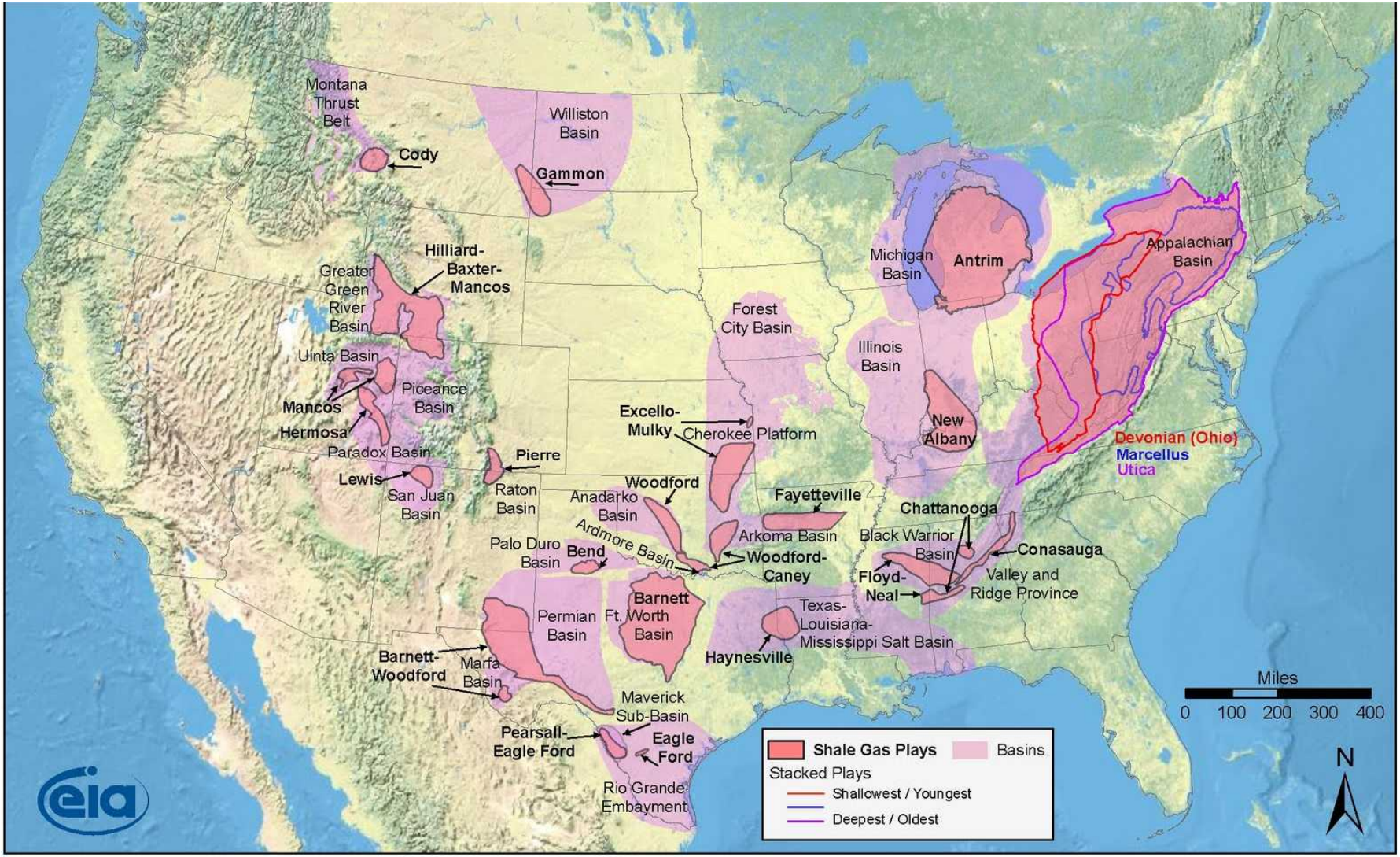
Who we are.

- Project of the environmental studies department (1986)
- 3 full time directors
- 1 science director/Dickinson faculty
- 10 – 14 students

Workshop Outline

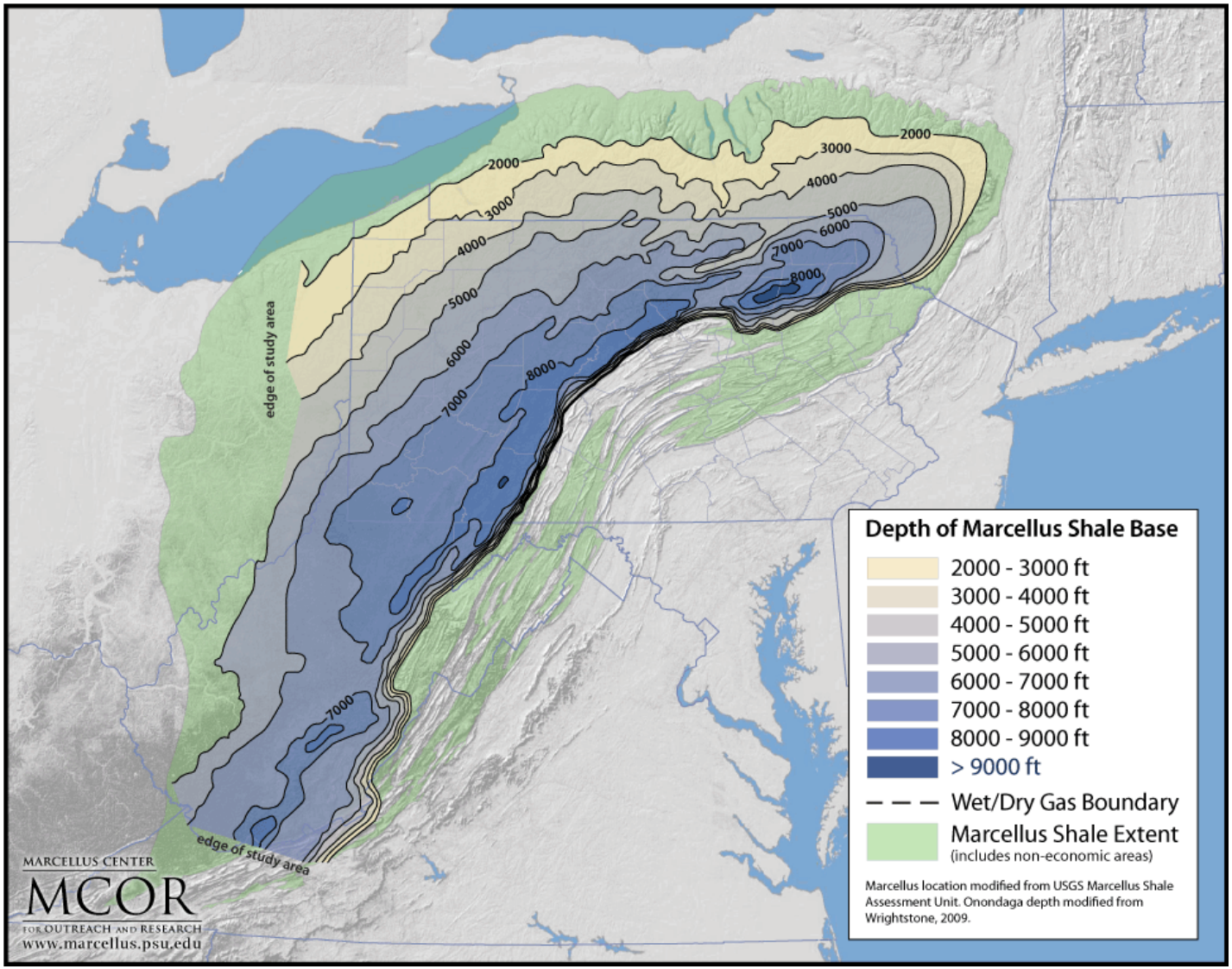
- Science of the Marcellus
- Marcellus Monitoring
- Model collaboration
- Q&A

Shale Gas Plays

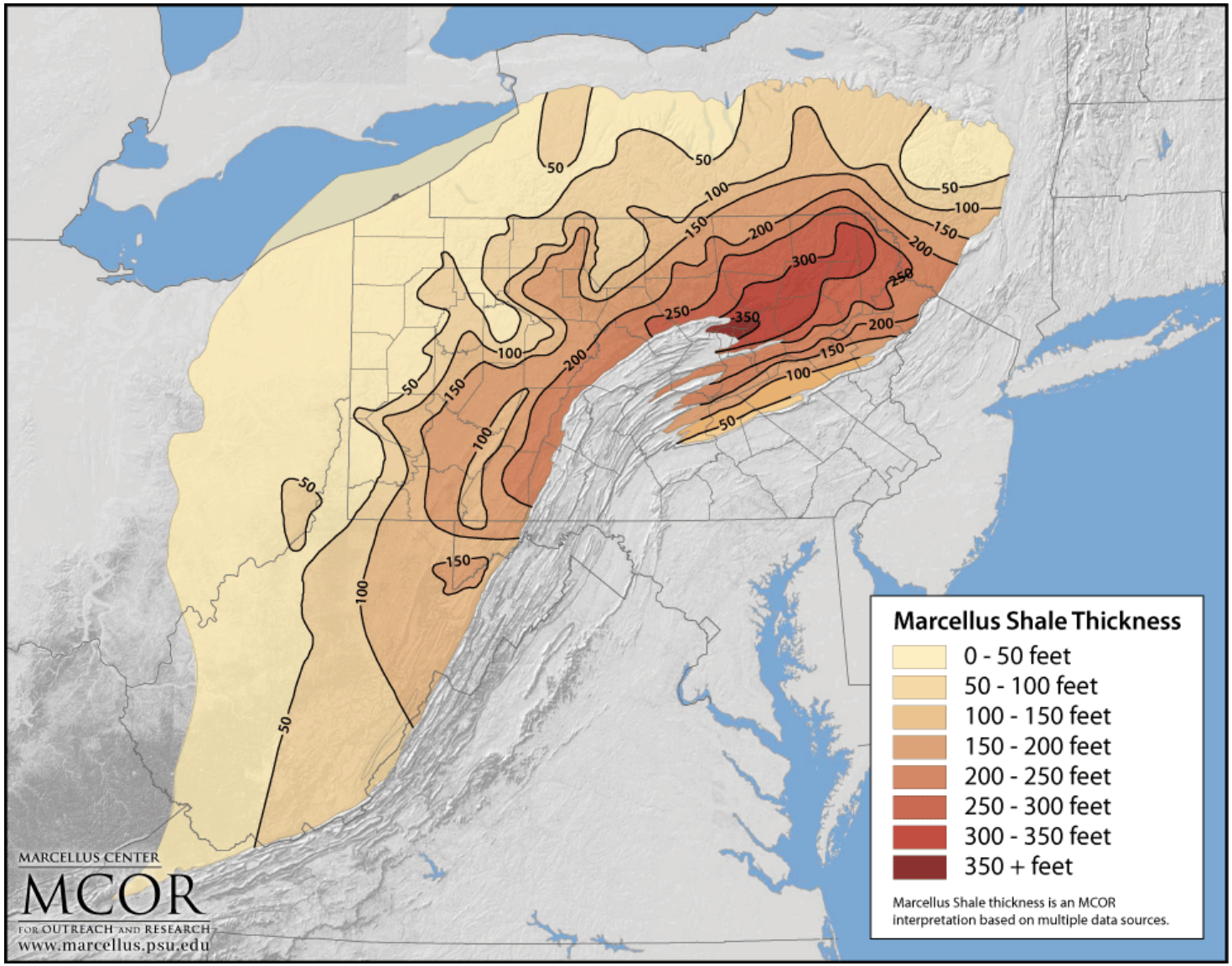


Source: Energy Information Administration based on data from various published studies
Updated: May 28, 2009

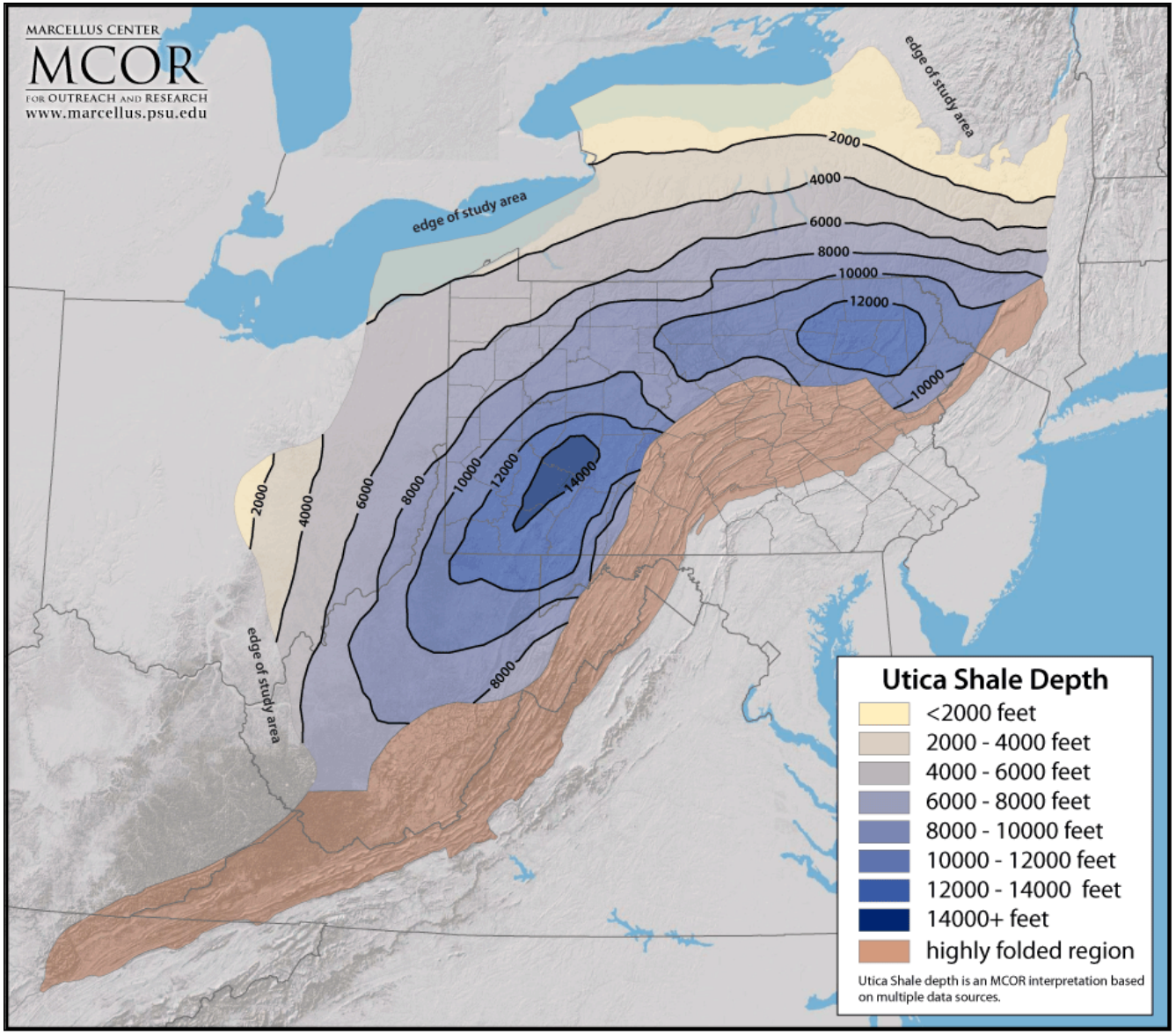
Depth to Marcellus Shale



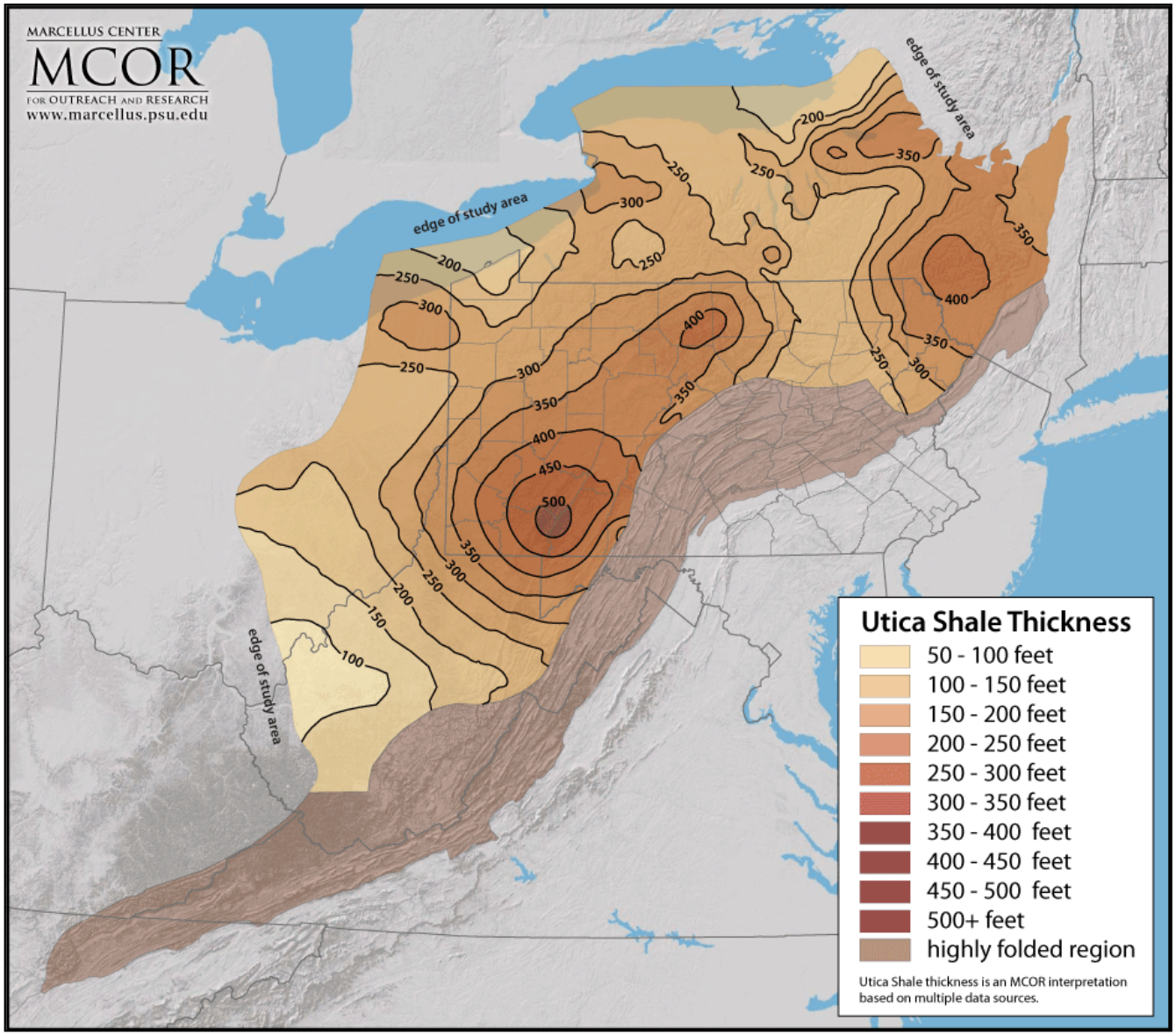
Thickness of Marcellus Shale



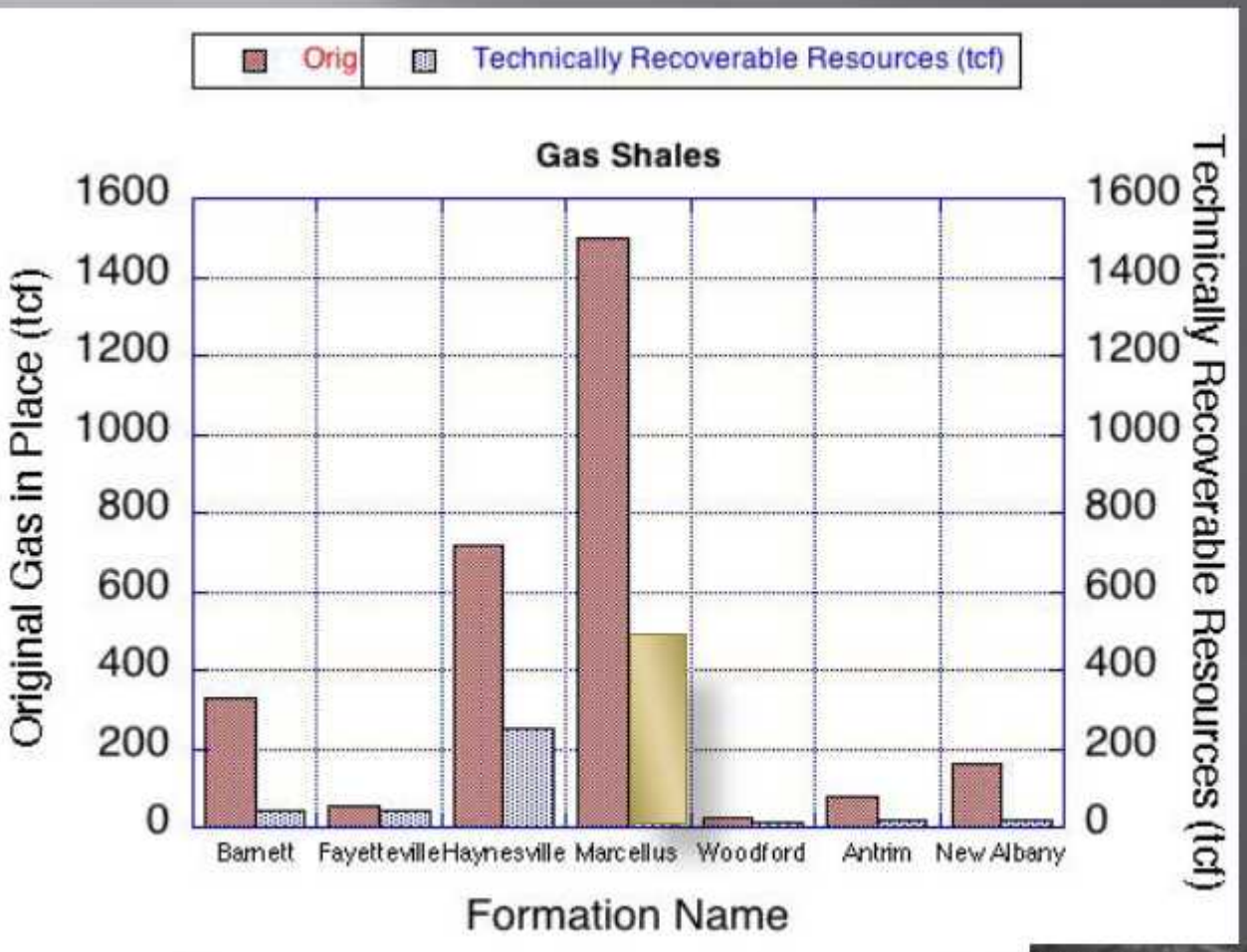
Depth to Utica Shale



Thickness of Utica Shale



Natural Gas Shale Plays



Estimates of Technical Recoverable Resources Vary but…

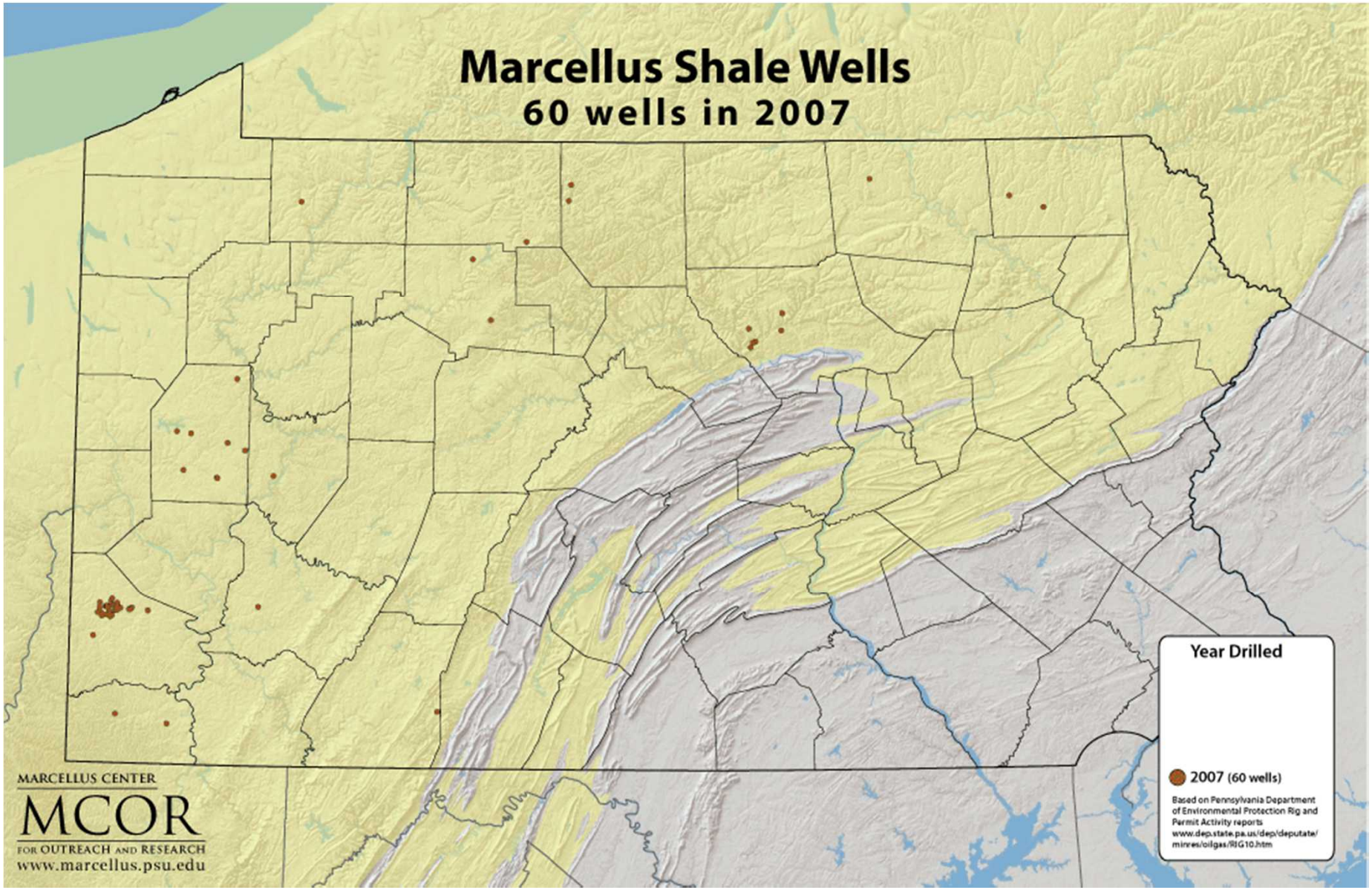
The Marcellus Shale is a "gas giant"!

Enough gas recoverable for >20 years US demand

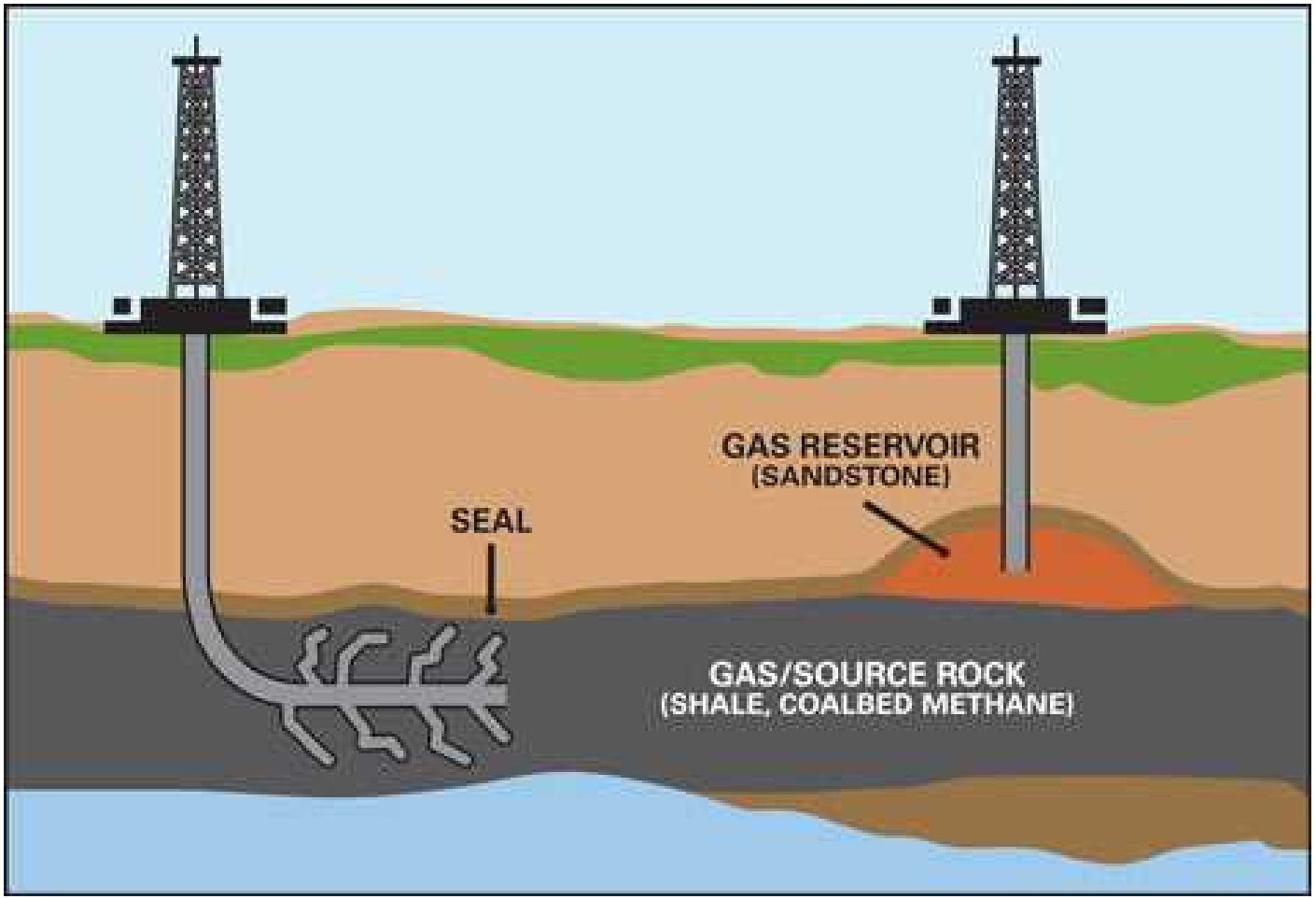
MARCELLUS CENTER for OUTREACH & RESEARCH (MCOR)

Michael Arthur, http://marcellus.psu.edu/resources/presentations.php

Marcellus Wells in PA



Conventional vs. Unconventional

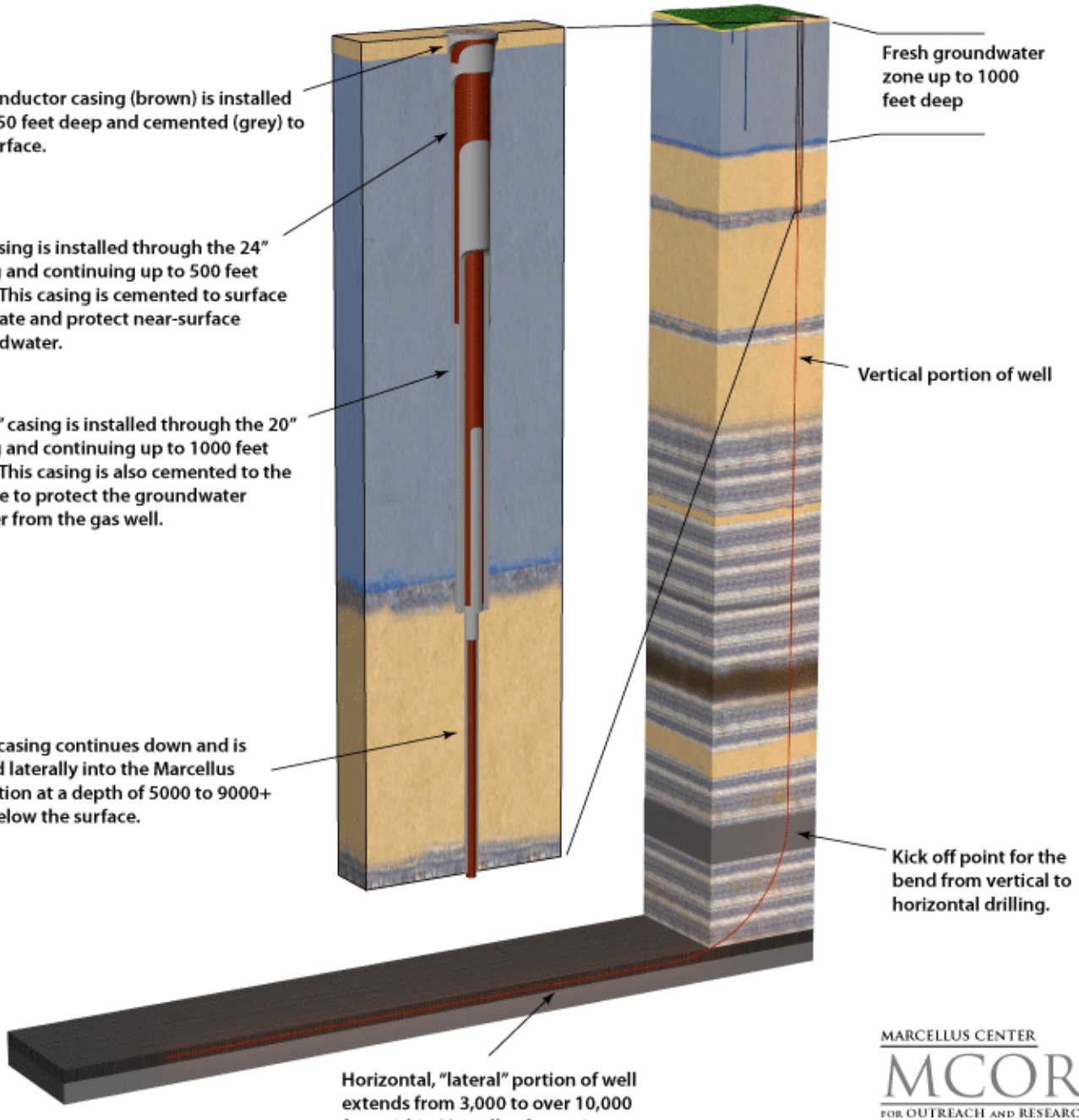


http://seekingalpha.com/article/131641-unconventional-natural-gas-just-a-frac-away

Differences in Drilling

Traditional Hydrofracking	High Volume Hydrofracking (HVHF)
• In traditional hydrofracking, typically 20,000 to 80,000 gallons of fluid were used each time a well was hydrofractured.	• HVHF uses between 2 and 10 million gallons of fluid (on average 5.6 million), the exact amount depends upon the length of the well bore and the number of fractures created along the lateral extent.
• Traditional hydrofracking used 700 to 2,800 lbs. of chemical additives	• HVHF uses between 205,000 and 935,000 lbs. of chemical additives, per well many of which are toxic to humans and wildlife.
• 1940s	• Late 1990s

Cross-Section of Typical Horizontal Marcellus Well



MARCELLUS CENTER
MCOR
FOR OUTREACH AND RESEARCH
www.marcellus.psu.edu

Water Trucks

Drill Pipe


FONTAINE
Y74-873
THINK SAFETY
SUPERIOR TRAILER
SUNNYVALE, TX
800-637-0324
SUPERIOR TRAILER
SUNNYVALE, TX
800-637-0324


XFX-9954

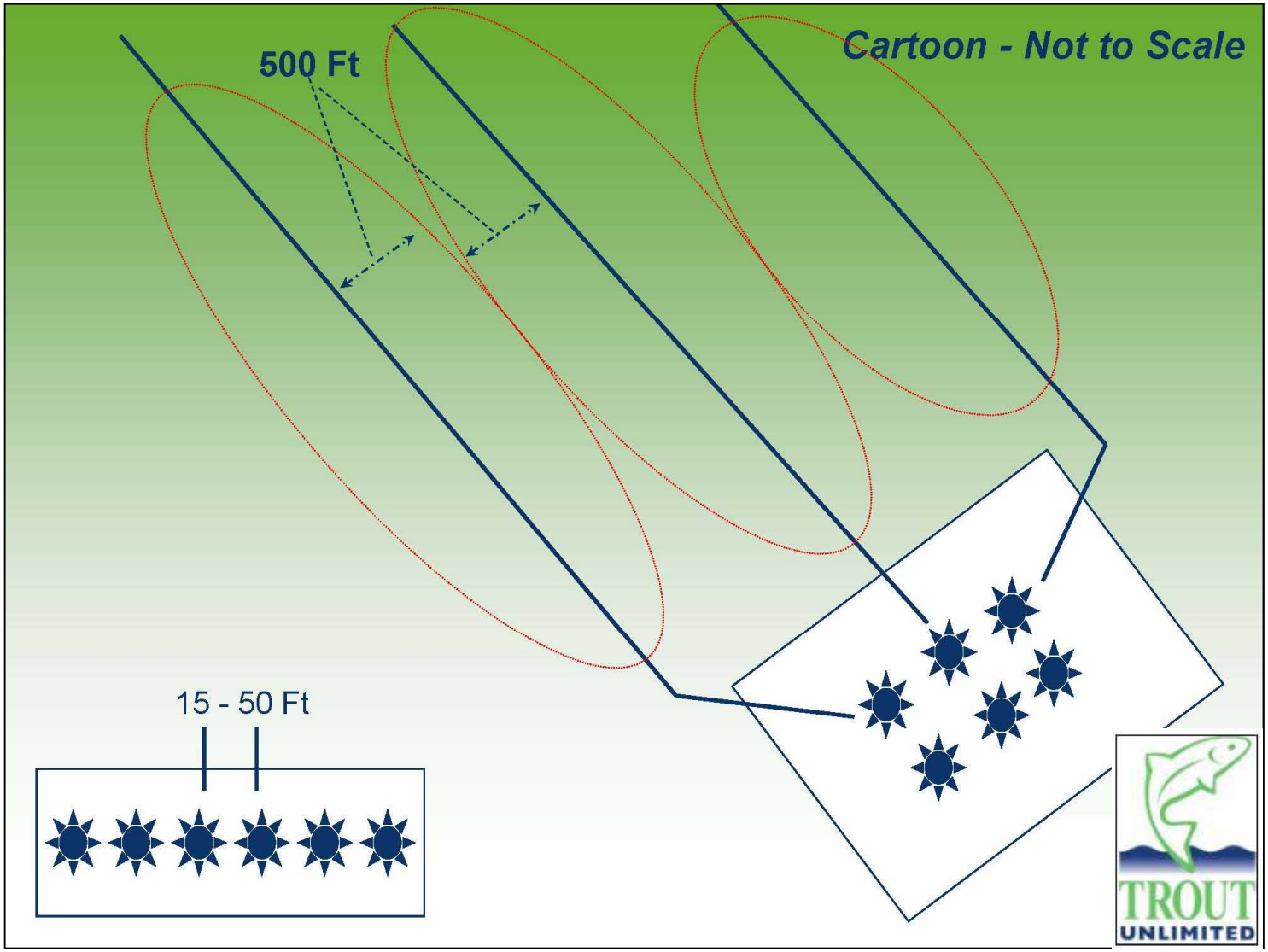
Trucks, Trucks, Trucks

Drilling Sites

http://savethewatertable.org/wp-content/uploads/2010/08/marcellus-shale-us_brush-run-600x401.jpg

- Drilling pads are typically 3-5 acres, each pad containing 5-6 horizontal wells
- 2-9 million gallons of water used per well
- 200-1400 truck trips to supply water per well
- Drilling pads must be >500 feet from structures with potable water supplies; >300 feet from streams and wetlands
- Drinking water presumptive responsibility 2500 feet.

Marcellus Site



A well pad can contain 4-10 sites or more. -MCOR

Combining the power of science with the power of communities.

Volunteer Monitoring

- Citizens involved in data collection
- US: 1890 – 2012

Georgia Adopt-A-Stream
GEORGIA'S VOLUNTEER WATER QUALITY MONITORING PROGRAM

Friends of Casco Bay
Casco BAYKEEPER

Citizen Stewards Water Quality Monitoring Program

National Weather Service
WORKING TOGETHER TO SAVE LIVES

NJ Watershed Watch Network

TEXAS STREAM TEAM

PA Volunteer Stream Monitoring

Rich history – 1980s

Over 85,000 miles of streams and rivers in Pennsylvania.

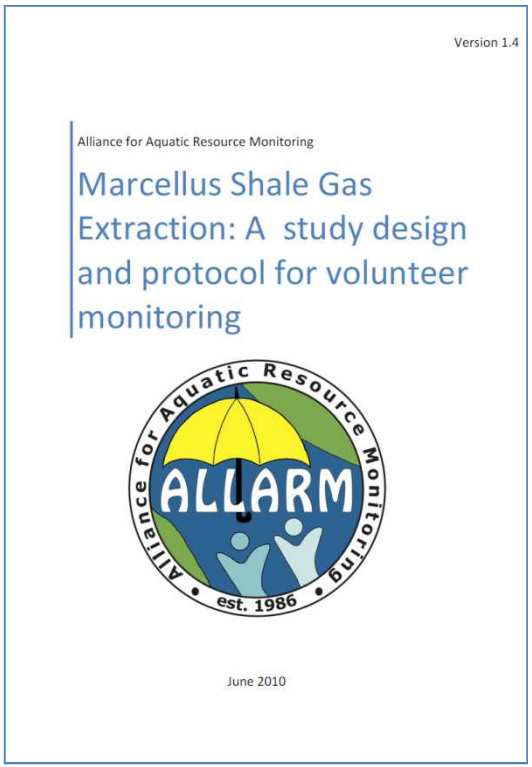
Marcellus Monitoring

A. Citizen surveillance
B. Baseline monitoring
C. Continuous monitoring

Great network of partners

Volunteer Monitoring

- Feasibility
- Affordability
- Scientifically robust



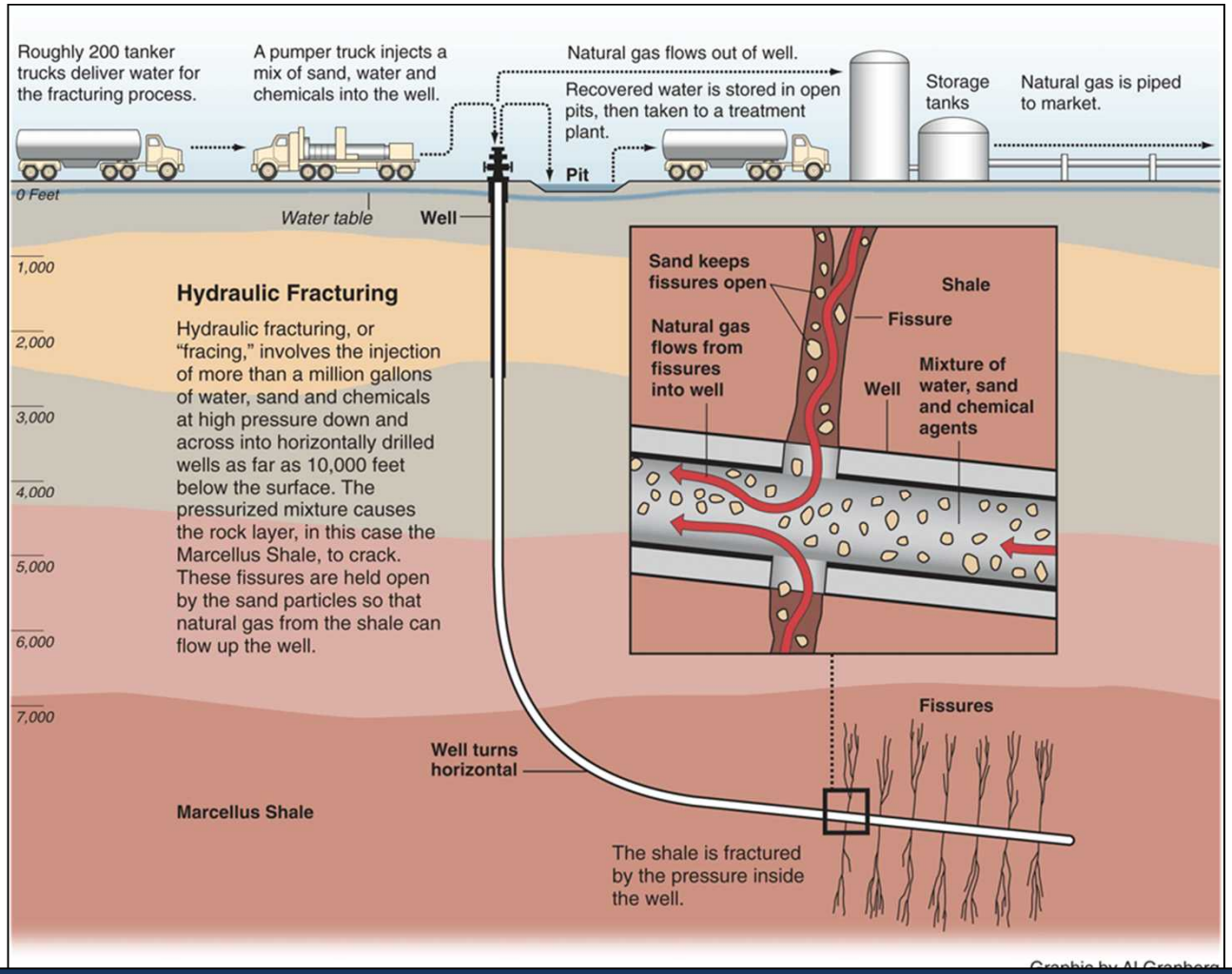
www.dickinson.edu/allarm

Why Are You Monitoring?

1. Early detection and prevention of contamination of flowback water in small streams
2. Document stream quality – long term impacts
3. Community education
4. Watchdog

The data collected using this monitoring protocol are not intended to be used for legal purposes.

Hydraulic Fracturing & Stream Monitoring



Flowback water – Fracking involves injecting several million gallons of water, sand, and chemical additives into the formation at high pressure. After the injection is completed, approximately 10-20 percent of the fluids (known as flowback) return to the surface.

What to Monitor?

1. Chemical Monitoring:

Indicator chemicals

- Conductivity -> TDS

Signature chemicals

- Barium
- Strontium
- Exploring others

2. Visual Assessment:

Land disturbances
Spills and discharges
Gas migration/leakages
Illegal dumping

3. Water Quantity Monitoring:

Relationship to conductivity

Conductivity and Total Dissolved Solids

- Conductivity measures the ability of water to pass an electrical current
- Total Dissolved Solids (TDS) measures the amount of ions dissolved in the water

(PA standard – 500 mg/L)

Voltage is applied between two probes to measure conductivity in microSiemens/centimeter (µS/cm)

TDS conversion ratio factor

TDS value (mg/L)

Why TDS & Conductivity?

- Frack water mixes with natural brine, found in the shale
- Flowback water contains high concentrations of salts and metals

Picture by Amy Bergdale, US EPA

Flowback Water Concentrations

TDS: 70,000 mg/L

TDS: 211,000 mg/L

TDS: 132,000 mg/L

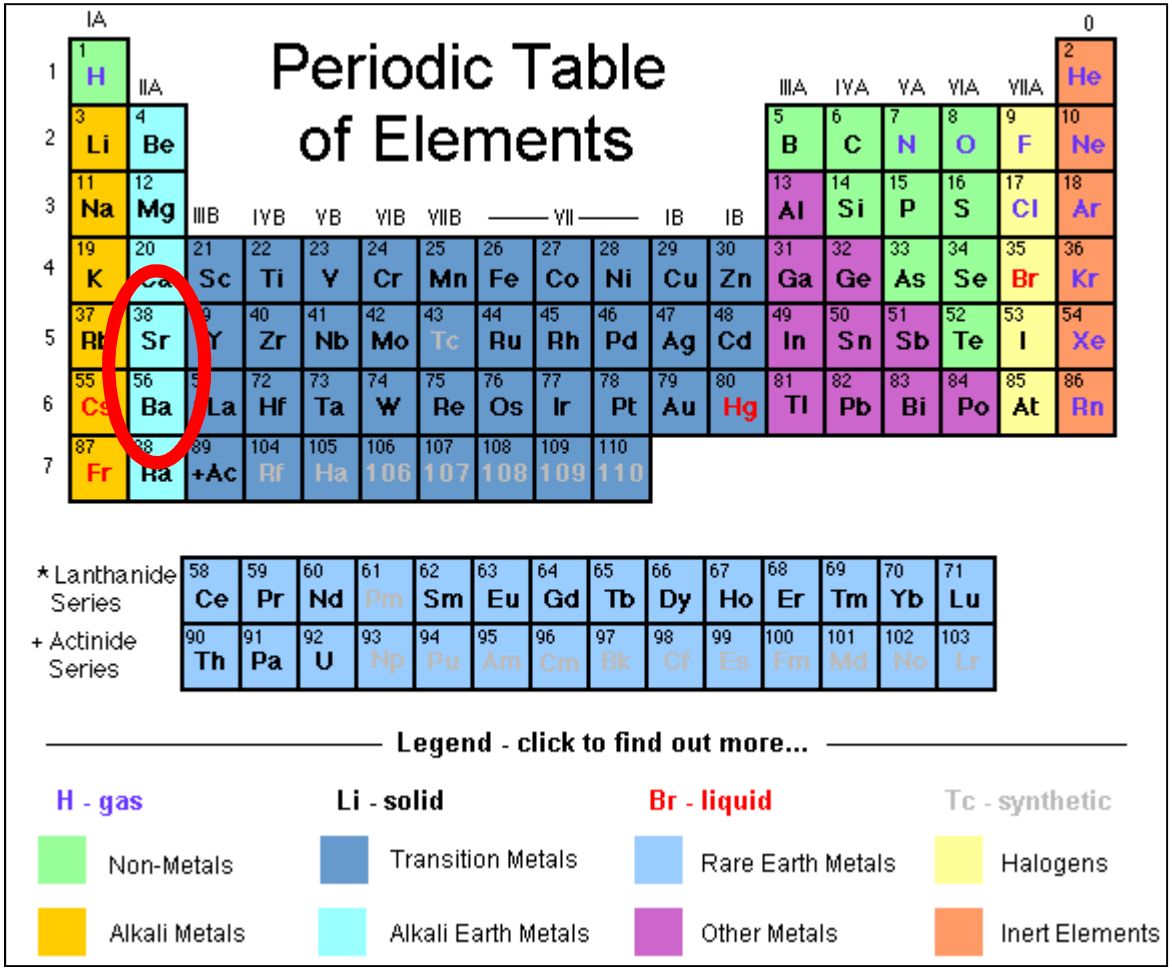
TDS: 217,000 mg/L

Source: Amy Bergdale, USEPA

Brine & Waste Trucks

Barium and Strontium

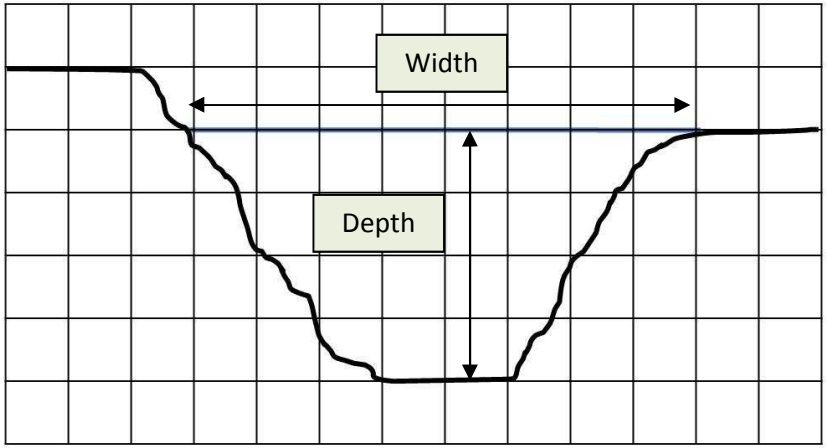
- Naturally-occurring metals found deep underground
- Indicate contamination from Marcellus Shale activities (signature chemicals)

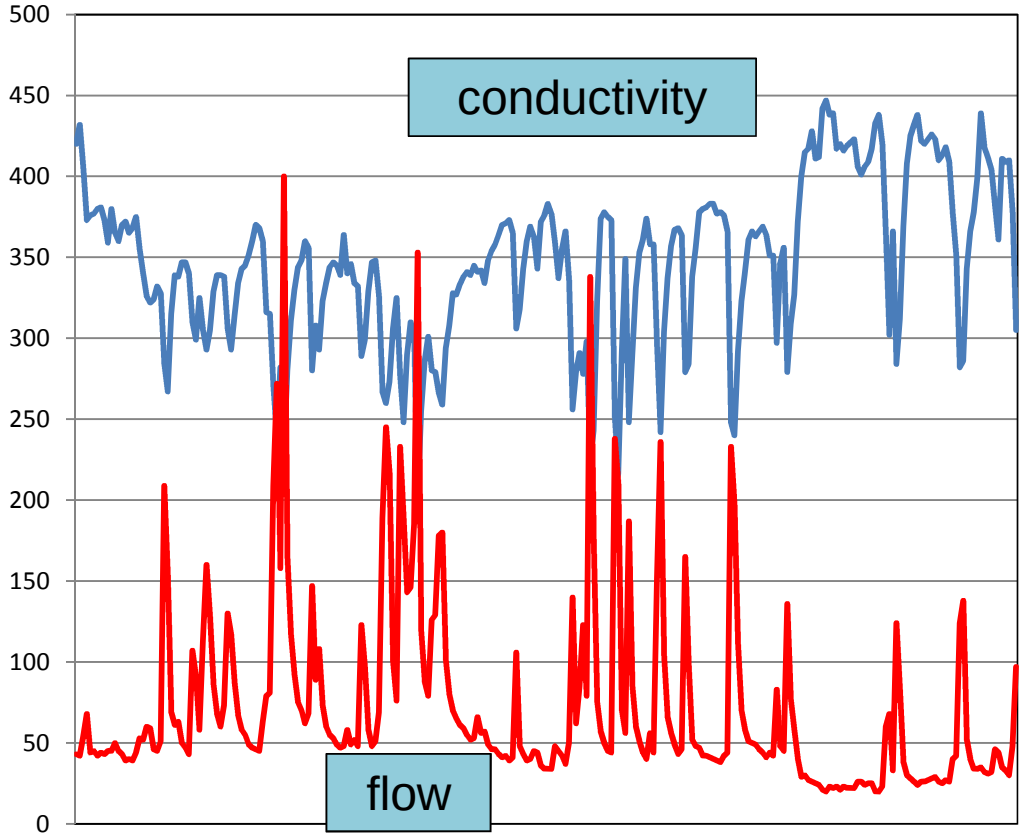


https://www.msu.edu/~zeluffjo/periodic_table.gif

Water Quantity Monitoring

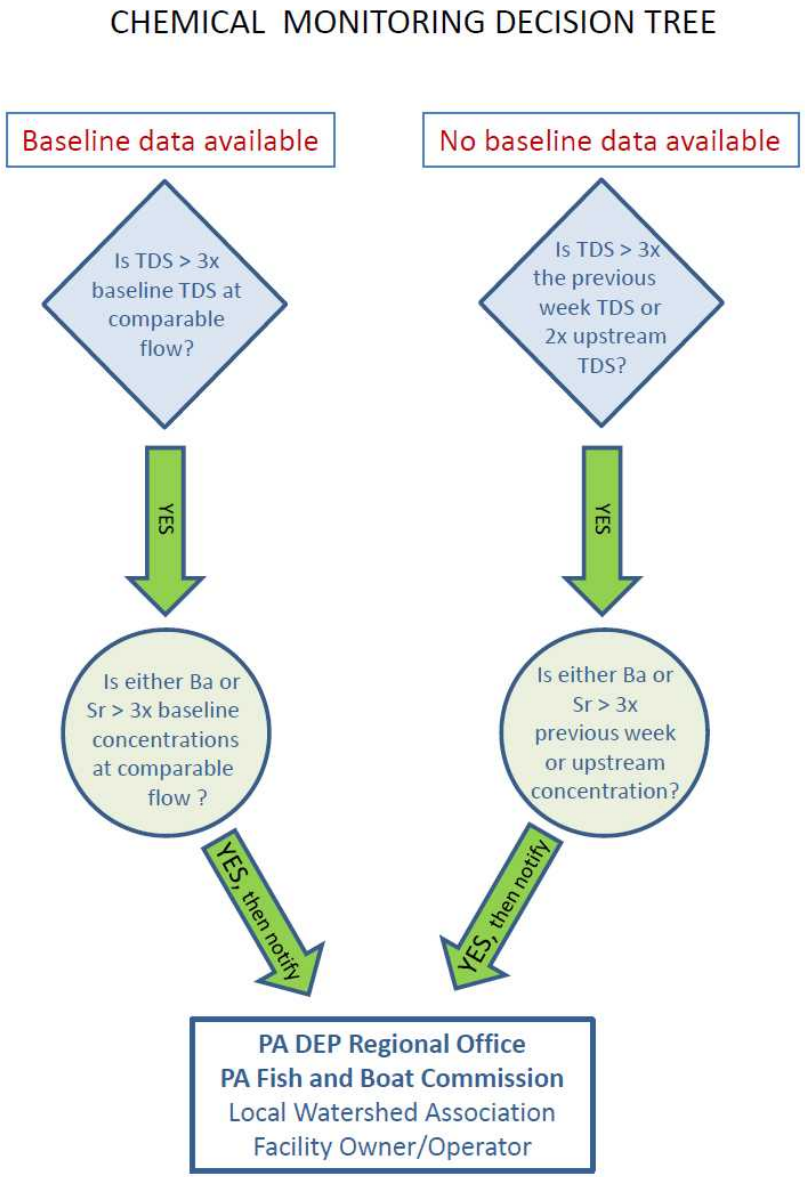
Cross-sectional area – understand relationship between amount of water in stream and conductivity





Data Use: Decision Trees

Chemical Monitoring
*
Visual Assessment
*
Surrogate Flow



Report monitoring information when values exceed criteria in decision trees

Reportable event

Sample Date	TDS (mg/L)	Conductivity (µS/cm)	Water Quantity(ft^2)
7/14/2010	120	178	1
7/21/2010	120	173	2
7/26/2010	130	182	3
8/4/2010	120	169	3
8/11/2010	100	165	6
8/16/2010	110	167	8
8/25/2010	110	168	9
8/30/2010	120	178	3
9/9/2010	110	174	5
9/14/2010	130	183	1
9/23/2010	100	156	8
10/2/2010	70	109	61
10/6/2010	70	113	33
10/11/2010	60	110	14
10/18/2010	140	200	5
10/26/2010	120	170	5
11/2/2010	510	680	1
11/9/2010	100	165	8

Visual Assessment

- Earth Disturbances
- Spills and Discharges
- Gas Migration/Leakages

Marcellus Shale Well Sites in Dimock, PA; 2010

Earth Disturbances: Drill Pad, Storage Pond, & Staging Areas

Outlets of sediment control structures are NOT stabilized

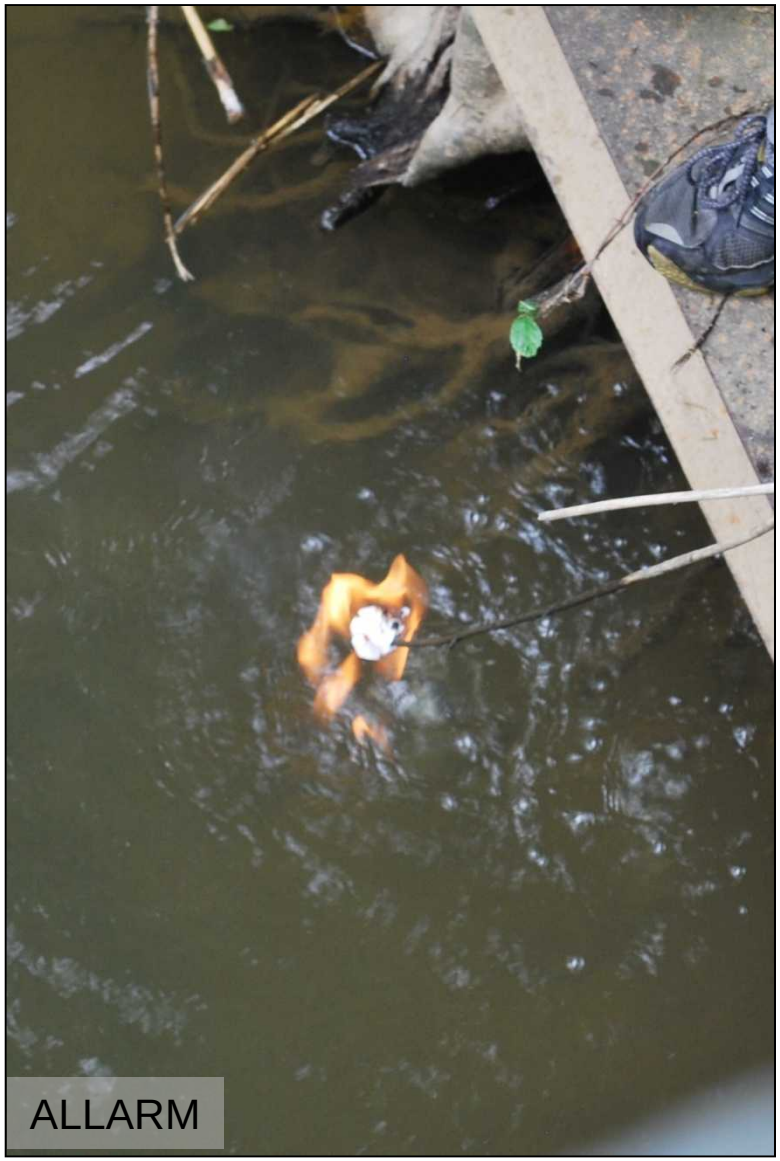
Outlets of sediment control structures are stabilized

Spills & Discharges

Photos courtesy of Delaware Riverkeeper Network

Drilling fluid spill at Cabot site
Dimock, PA
September 2009

Gas Migration or Leakages



Illegal Dumping


Wetzel County Action Group


Wetzel County Action Group

Mountain Watershed Association

Determining Monitoring Locations

Step 1:

Find where drilling permits have been issued (lat/long)

- eNOTICE/eFacts/eMap PA
- DEP reports

Step 2:

Find issued drilling permit locations on map

- Google Maps
- Topographic map

Step 3:

Choose monitoring site based on important features

- Well locations
- Stream access

Quality Assurance/Quality Control

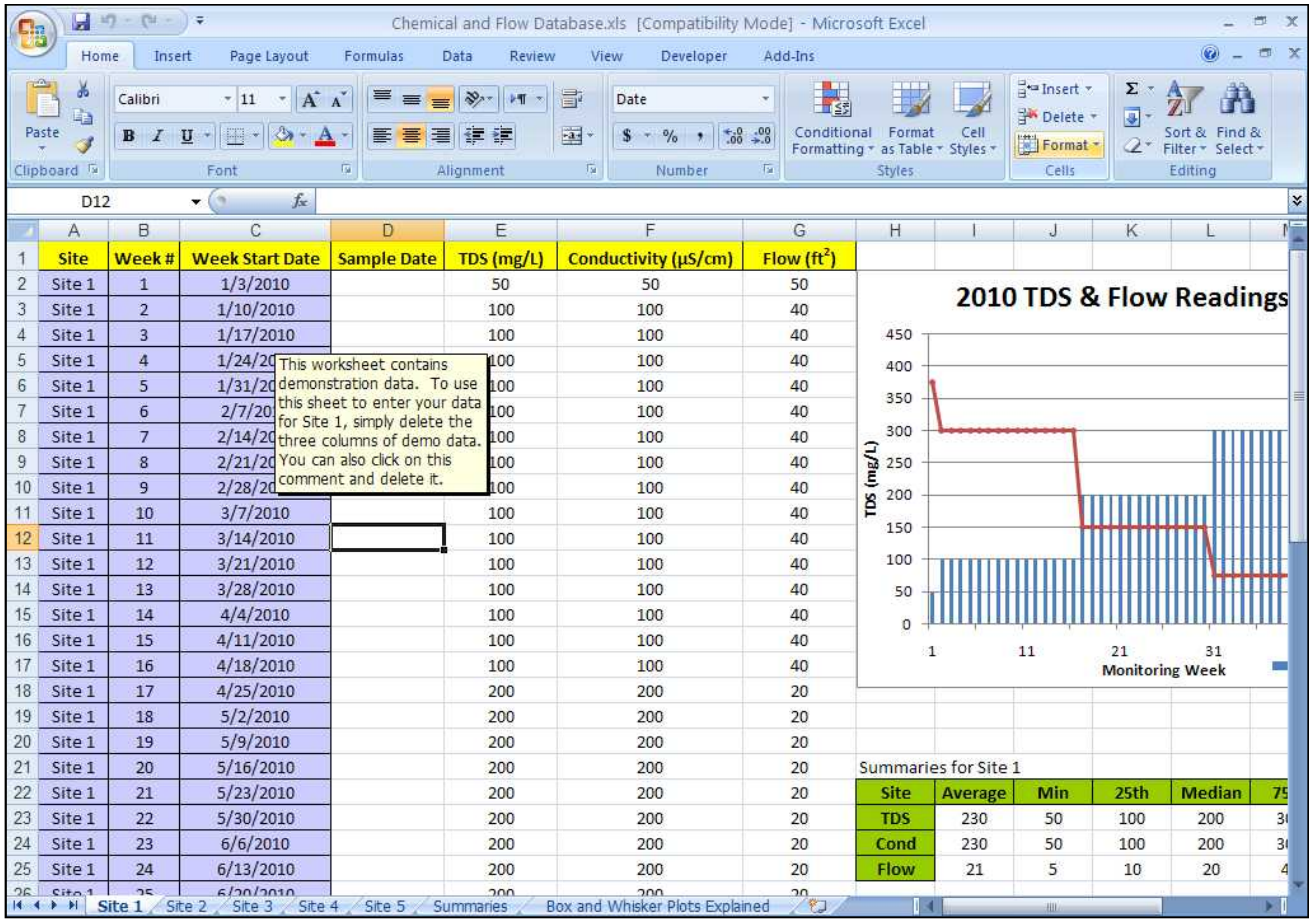
Considerations: What is feasible for volunteers?

Standard QA/QC Practices:

- Training requirements
- Care/calibration of equipment
- Replicates
- Documentation of procedures
- Split sample analysis

Data Management

Considerations: What tools and methods are available to volunteers?



Site	Week #	Week Start Date	Sample Date	TDS (mg/L)	Conductivity (µS/cm)	Flow (ft³)
Site 1	1	1/3/2010		50	50	50
Site 1	2	1/10/2010		100	100	40
Site 1	3	1/17/2010		100	100	40
Site 1	4	1/24/20		100	100	40
Site 1	5	1/31/20		100	100	40
Site 1	6	2/7/20		100	100	40
Site 1	7	2/14/20		100	100	40
Site 1	8	2/21/20		100	100	40
Site 1	9	2/28/20		100	100	40
Site 1	10	3/7/2010		100	100	40
Site 1	11	3/14/2010		100	100	40
Site 1	12	3/21/2010		100	100	40
Site 1	13	3/28/2010		100	100	40
Site 1	14	4/4/2010		100	100	40
Site 1	15	4/11/2010		100	100	40
Site 1	16	4/18/2010		100	100	40
Site 1	17	4/25/2010		200	200	20
Site 1	18	5/2/2010		200	200	20
Site 1	19	5/9/2010		200	200	20
Site 1	20	5/16/2010		200	200	20
Site 1	21	5/23/2010		200	200	20
Site 1	22	5/30/2010		200	200	20
Site 1	23	6/6/2010		200	200	20
Site 1	24	6/13/2010		200	200	20

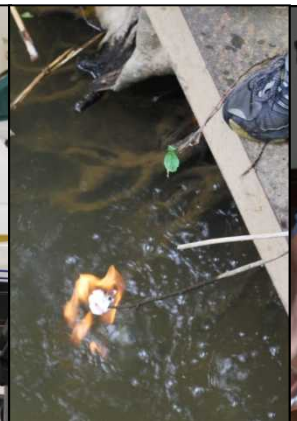
Site	Average	Min	25th	Median	75
TDS	230	50	100	200	3(
Cond	230	50	100	200	3(
Flow	21	5	10	20	4

ALLARM created easy to use templates for volunteers to store their chemical, water quantity, and visual assessment data.

Regional Data Management

- Shale Network
- WRI – Mon River Quest
- FracTracker
- SkyTruth



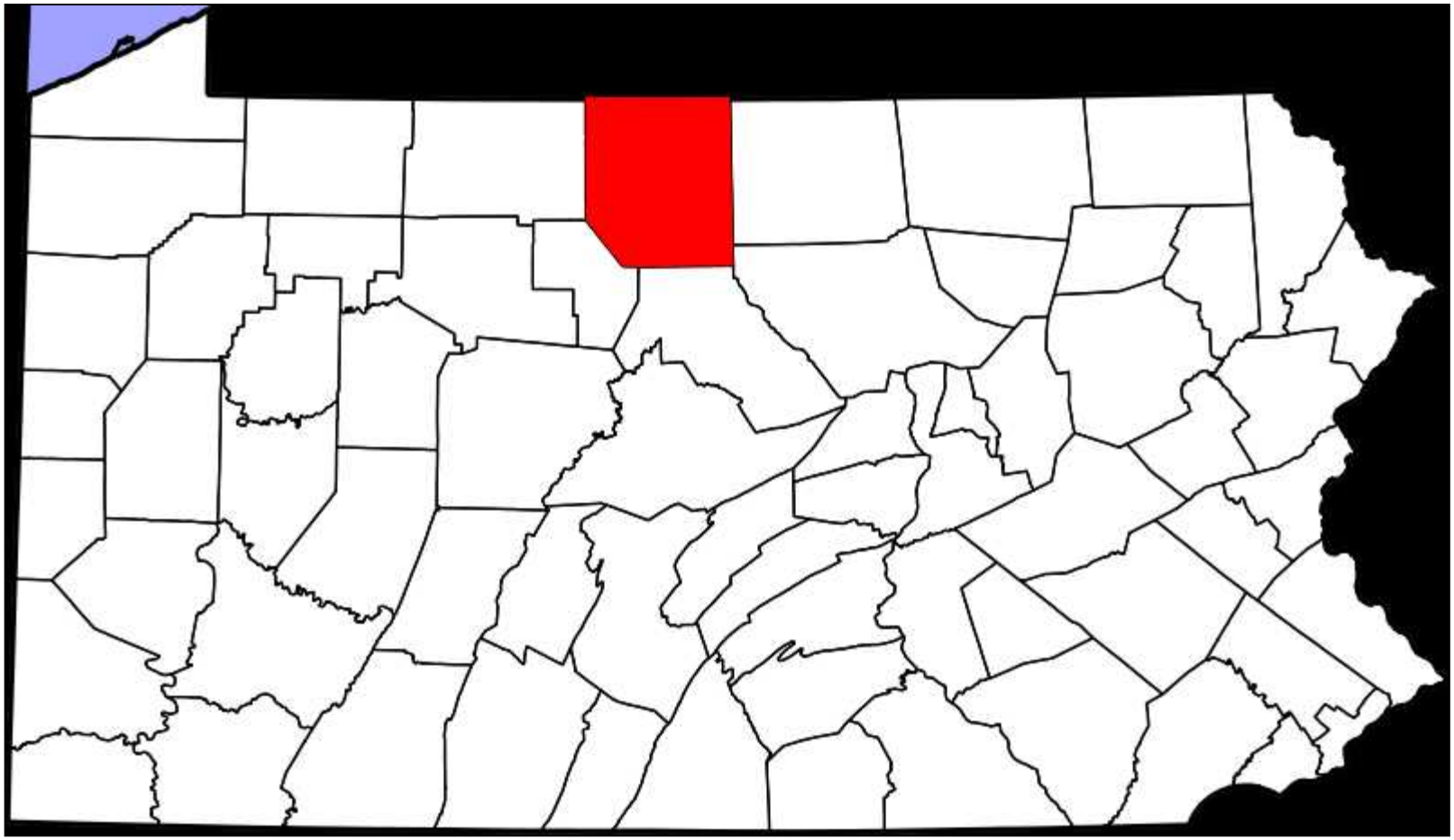



Building a Monitoring Constituency

- ALLARM – 700 volunteers
- Movement - 1500 volunteers trained since the start of 2010
- ALLARM, DRN, MWA, Mon River Quest, PACTU, PASA, Sierra Club & Waterdogs

Model Community Collaboration

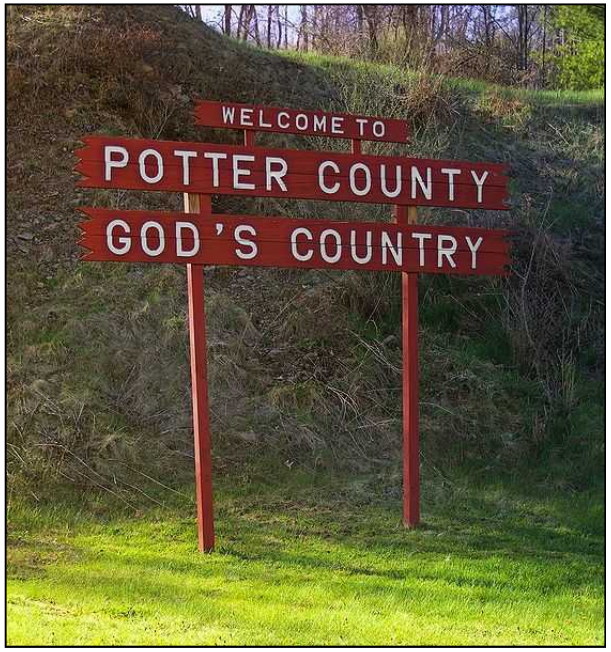
Potter County –aka “God’s Country”



http://en.wikipedia.org/wiki/File:Map_of_Pennsylvania_highlighting_Potter_County.svg

Potter Background

- Rural – 18,000 people
- Heavily forested
- Three rivers – Allegheny, Genessee, Susquehanna



http://en.wikipedia.org/wiki/File:Pike_Township_Enter.jpg

Drilling in Potter

- 2005-2009: 22
- 2010-2011: 50

Potter a Model County

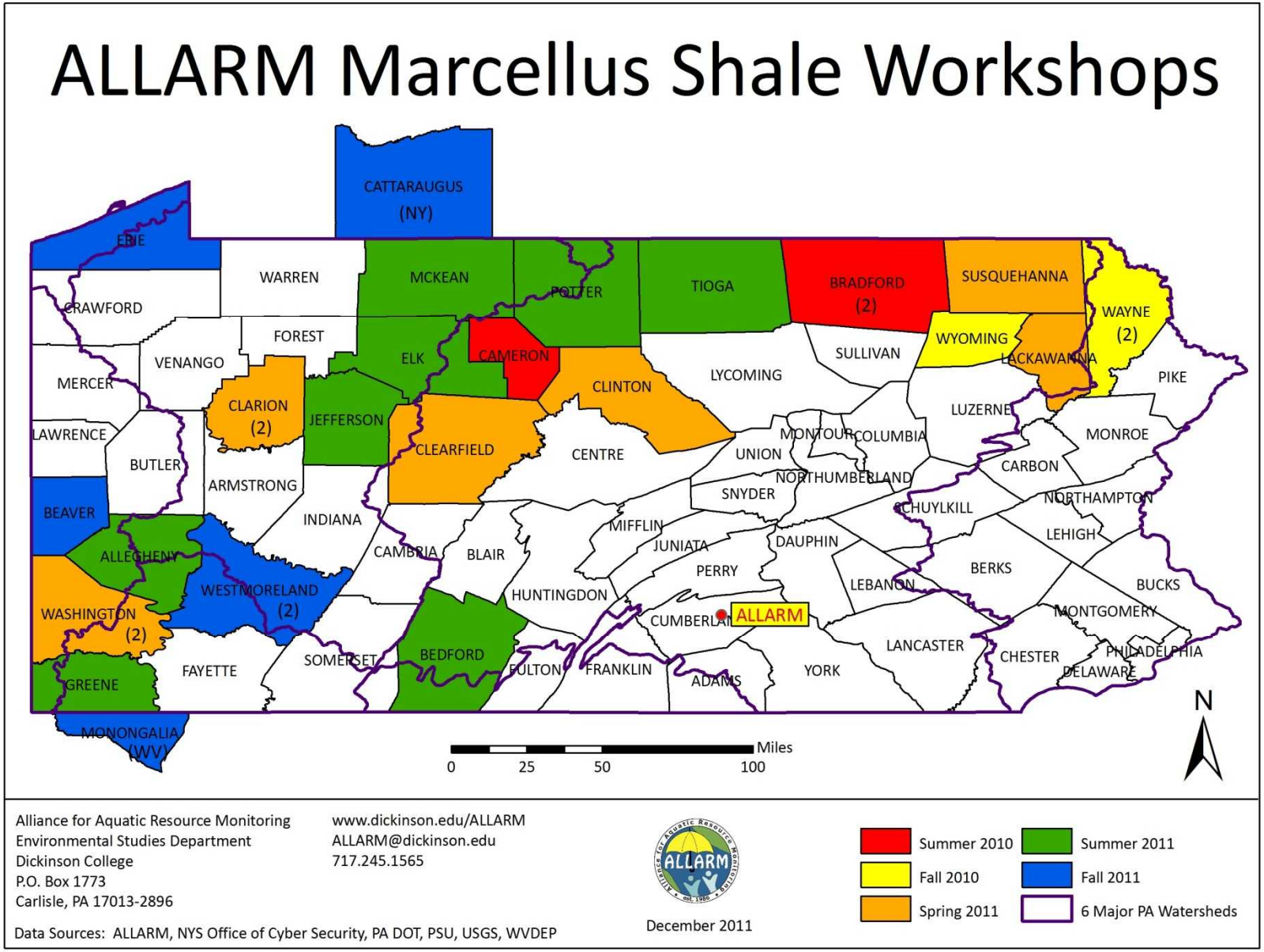
- County Commissioners
- Potter Marcellus Task Force
- Coordinated monitoring
  - Trout Unlimited
  - Waterdogs
  - PCCD

ALLARM was recognized in town as the “water monitoring creek people”

Workshop Site Location Activity

Chemical Hands-On Training

Training Locations



Questions?

Alliance for Aquatic Resource Monitoring (ALLARM)
Dickinson College
P.O. Box 1773
Carlisle, PA 17013
717.245.1565
allarm@dickinson.edu
www.dickinson.edu/allarm

http://blogs.dickinson.edu/marcellusmonitoring/