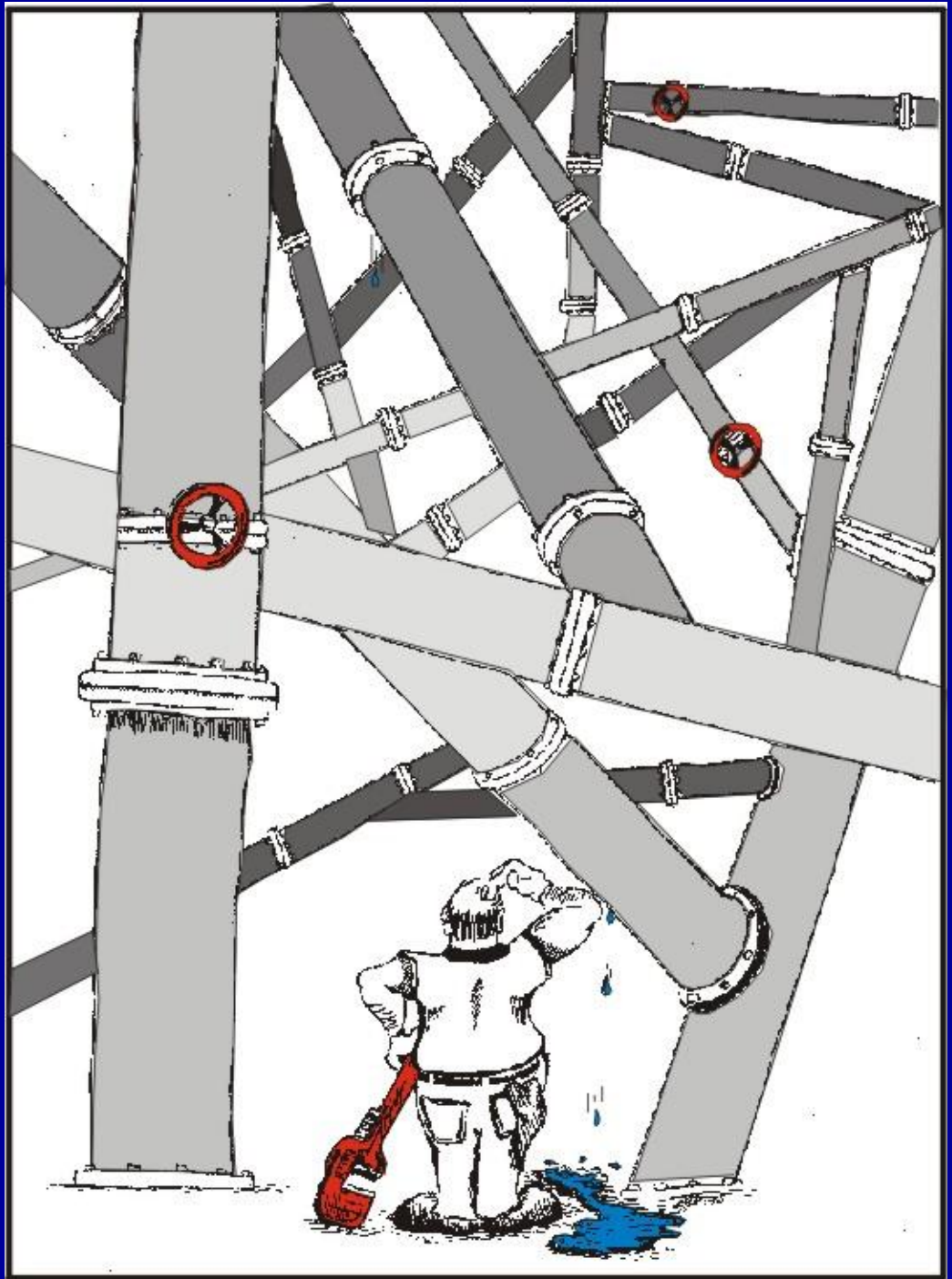


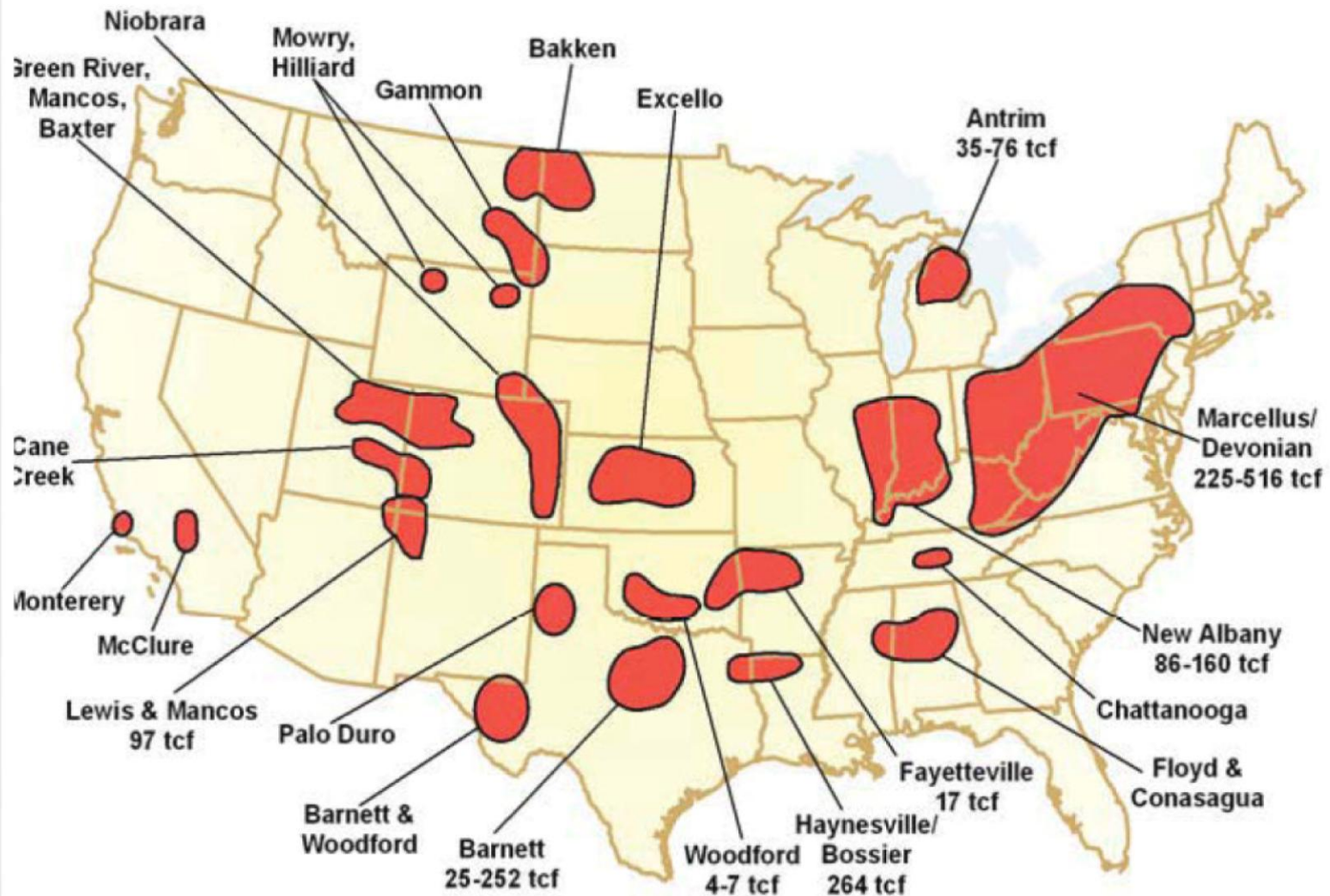
Where in New York  
are the Marcellus and  
Utica Shales??

How do they get to the gas  
resource and how do they get  
the gas out of the ground?

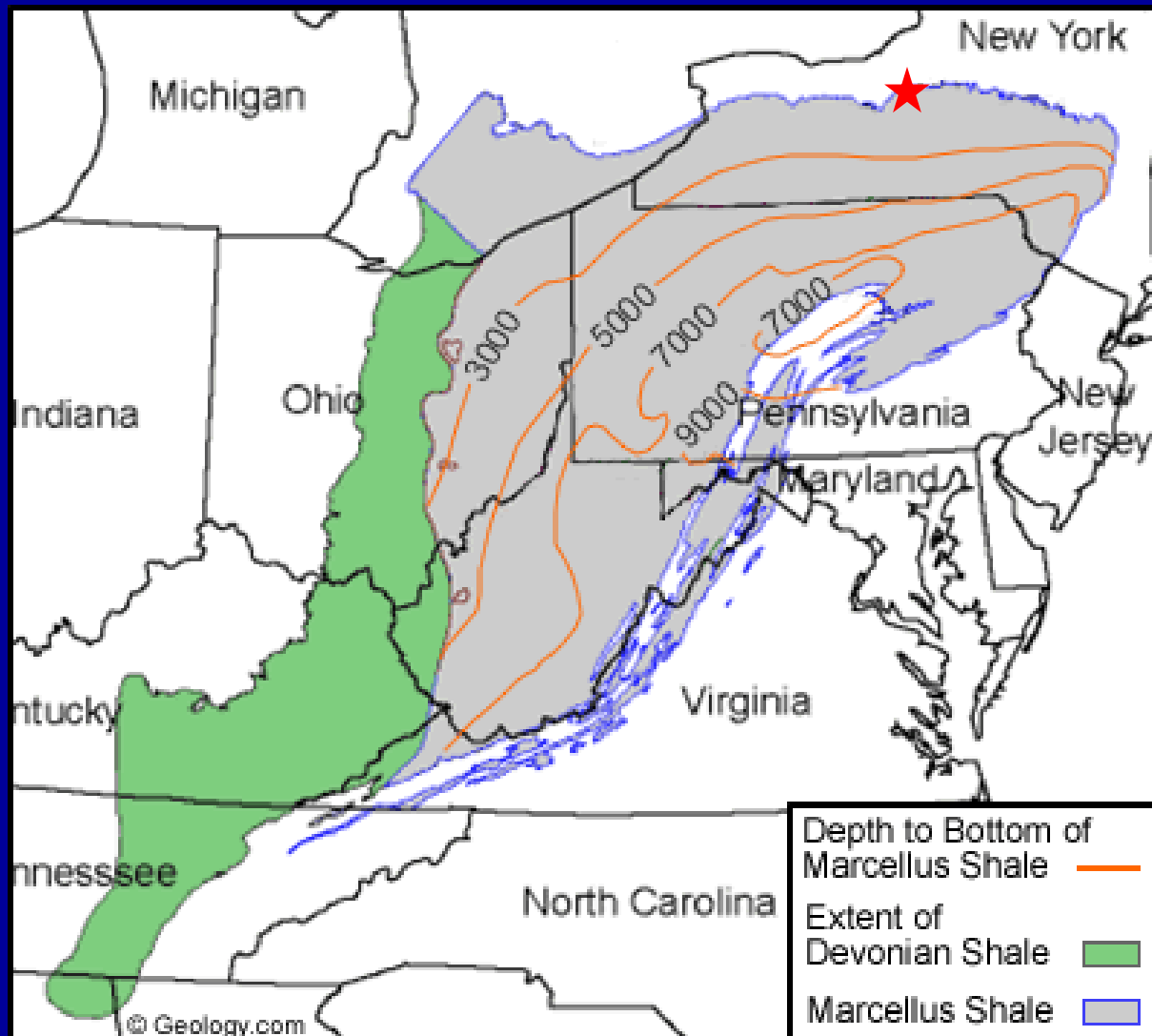
What are the concerns about  
this entire process and what  
can/should we do about it?



**Figure 1: Gas Shale Basins of the United States**

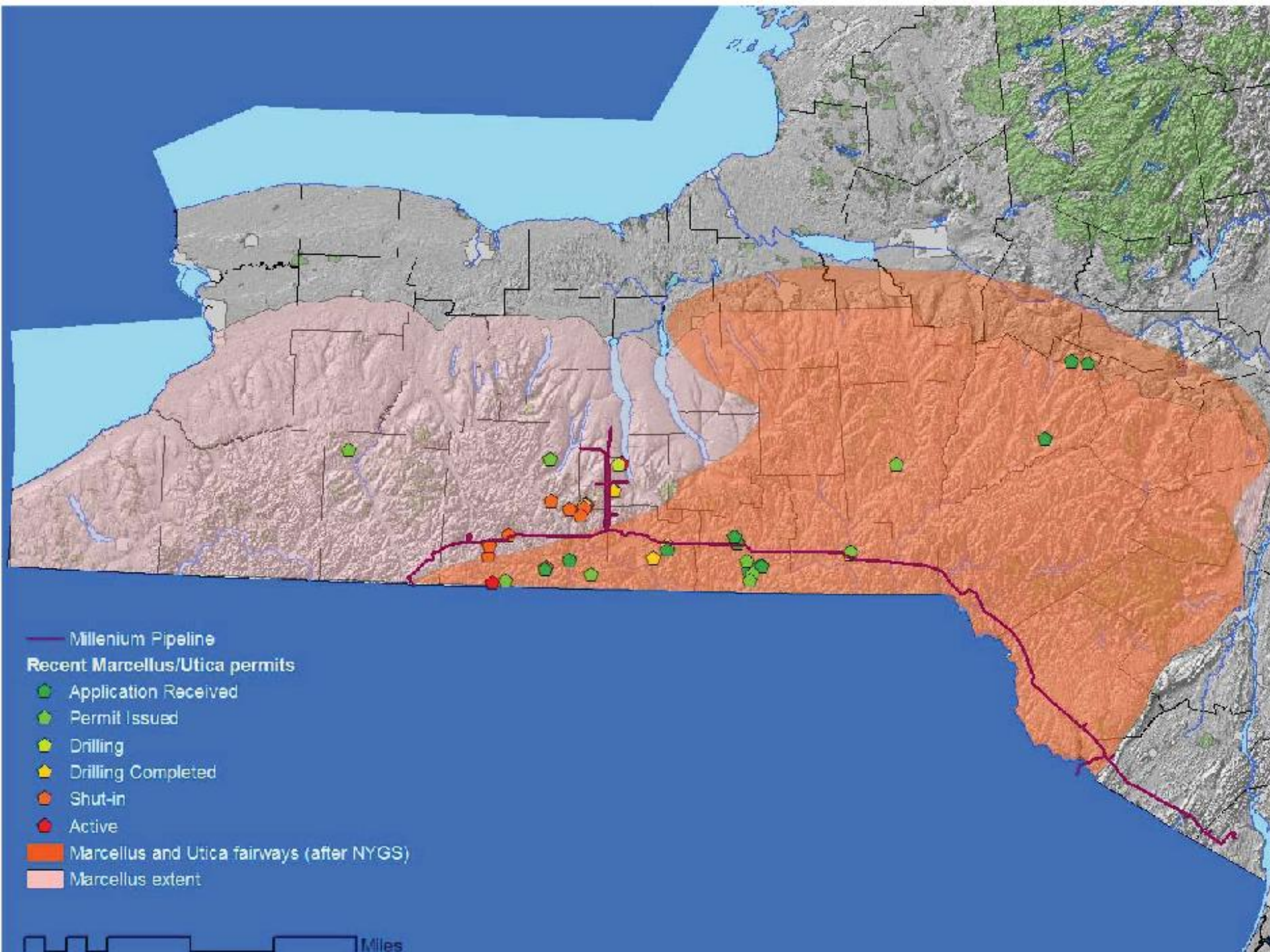


# Depth and extent of the Marcellus Shale



★ Marcellus, NY type section







## Legend

- Thickness Organic-Rich Marcellus Shale (in feet)
- ▨ Marcellus Shale and Hamilton Group Outcrop
- Extent of the Marcellus Shale in New York

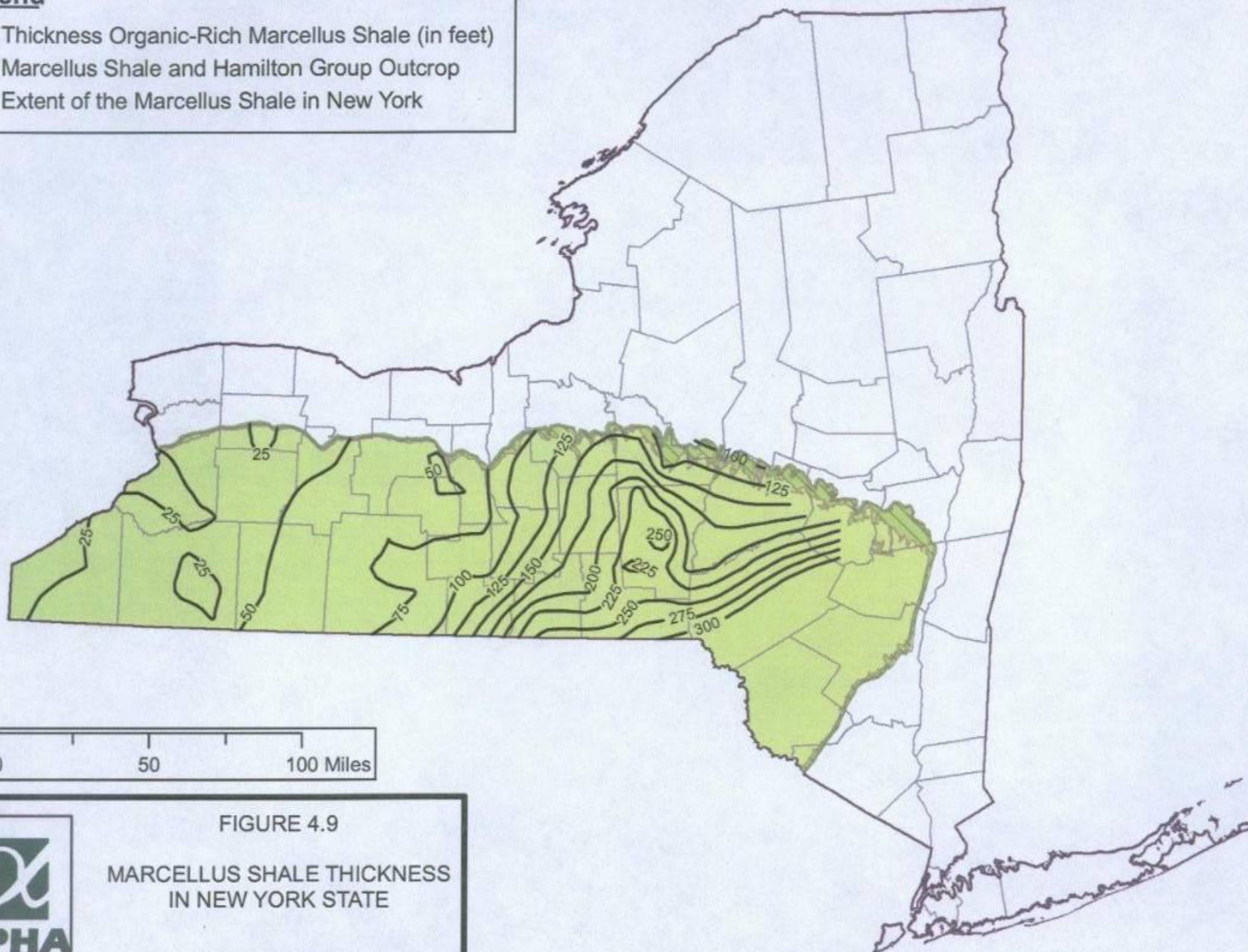


FIGURE 4.9

### MARCELLUS SHALE THICKNESS IN NEW YORK STATE

Technical Support Document to the  
Draft Supplemental Generic  
Environmental Impact Statement

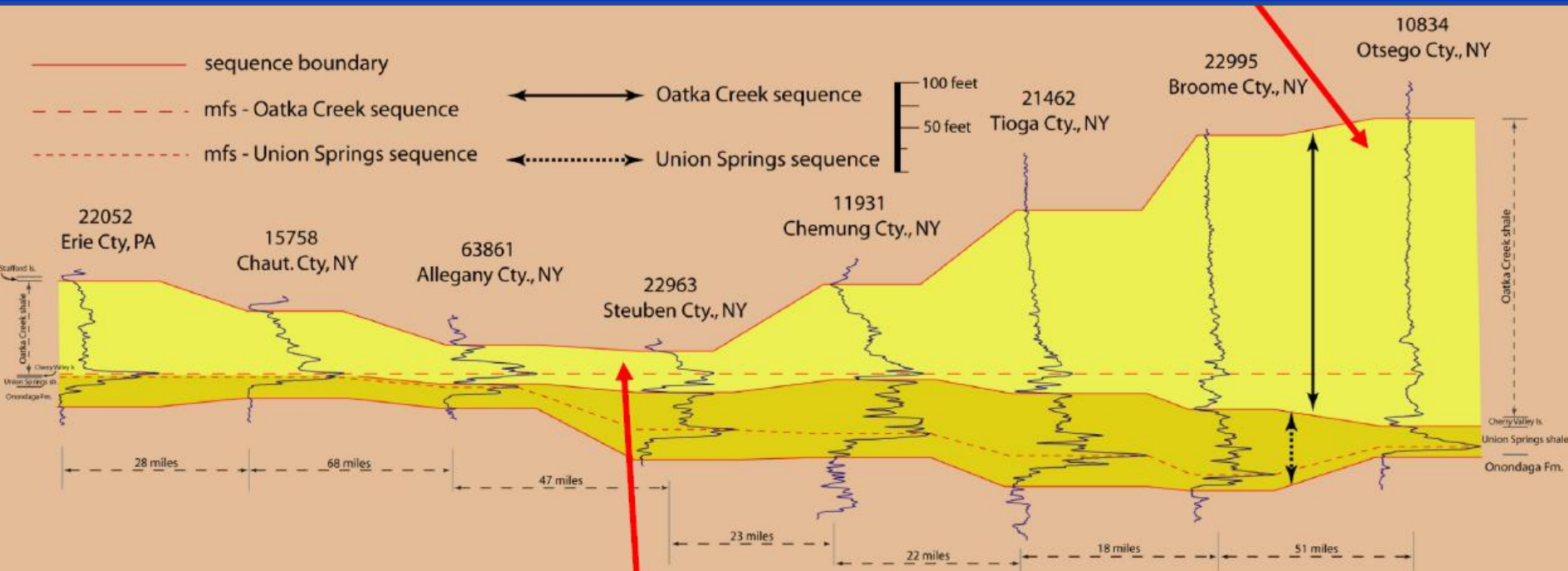
#### Notes:

- Source: New York State Museum - Reservoir Characterization Group (Leone, 2009)
- Organic-rich Marcellus includes Union Springs and Oatka Creek Members and lateral equivalents.

Source – dSGEIS, 2009

# East-West Geologic Section of the Marcellus Shale Across Southern New York

Thickening of Oatka Creek

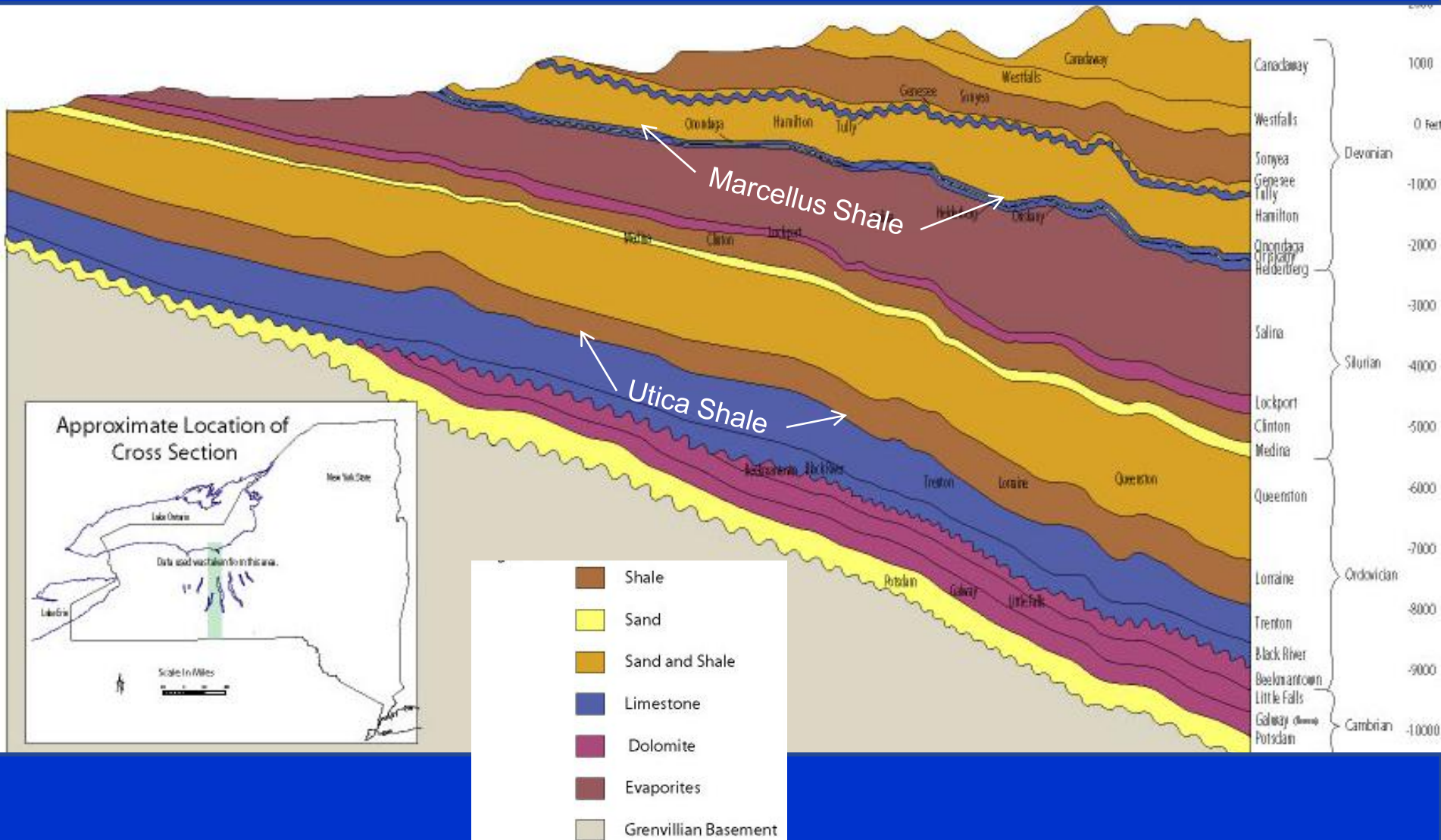


Thinning of Oatka Creek  
and Union Springs members

Lash and Engelder, 2009



# North-South Geologic Section Across New York State



## Legend

- Depth to the Top of the Marcellus Shale
- ▨ Marcellus Shale and Hamilton Group Outcrop
- Extent of the Marcellus Shale in New York

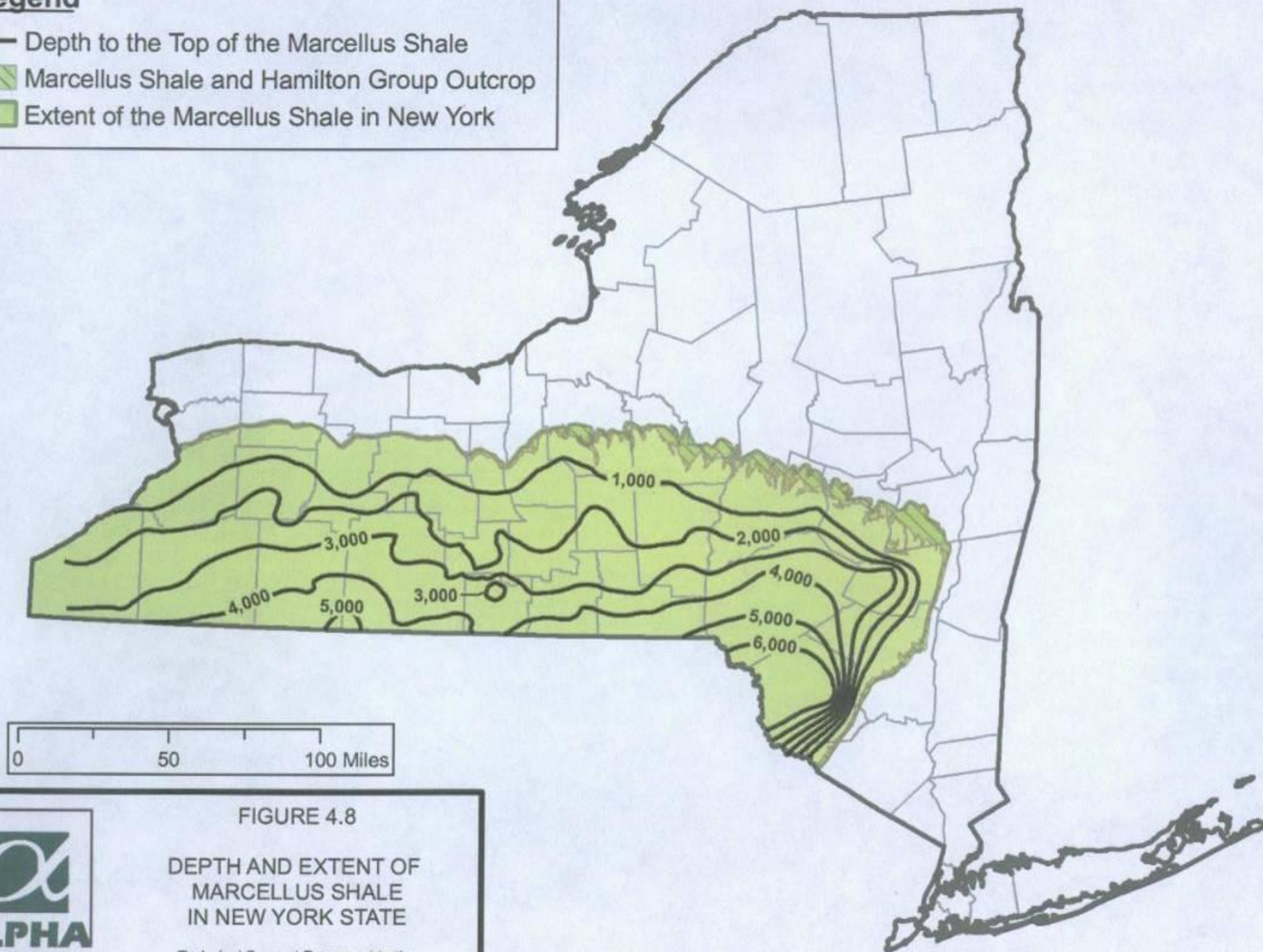


FIGURE 4.8

### DEPTH AND EXTENT OF MARCELLUS SHALE IN NEW YORK STATE

Technical Support Document to the  
Draft Supplemental Generic  
Environmental Impact Statement




Source:

- New York State Museum - Reservoir Characterization Group (Leone, 2009).

Source – dSGEIS, 2009



### Legend

-  Marcellus Shale and Hamilton Group Outcrop  
 Marcellus Shale Fairway  
 Extent of the Marcellus Shale in New York

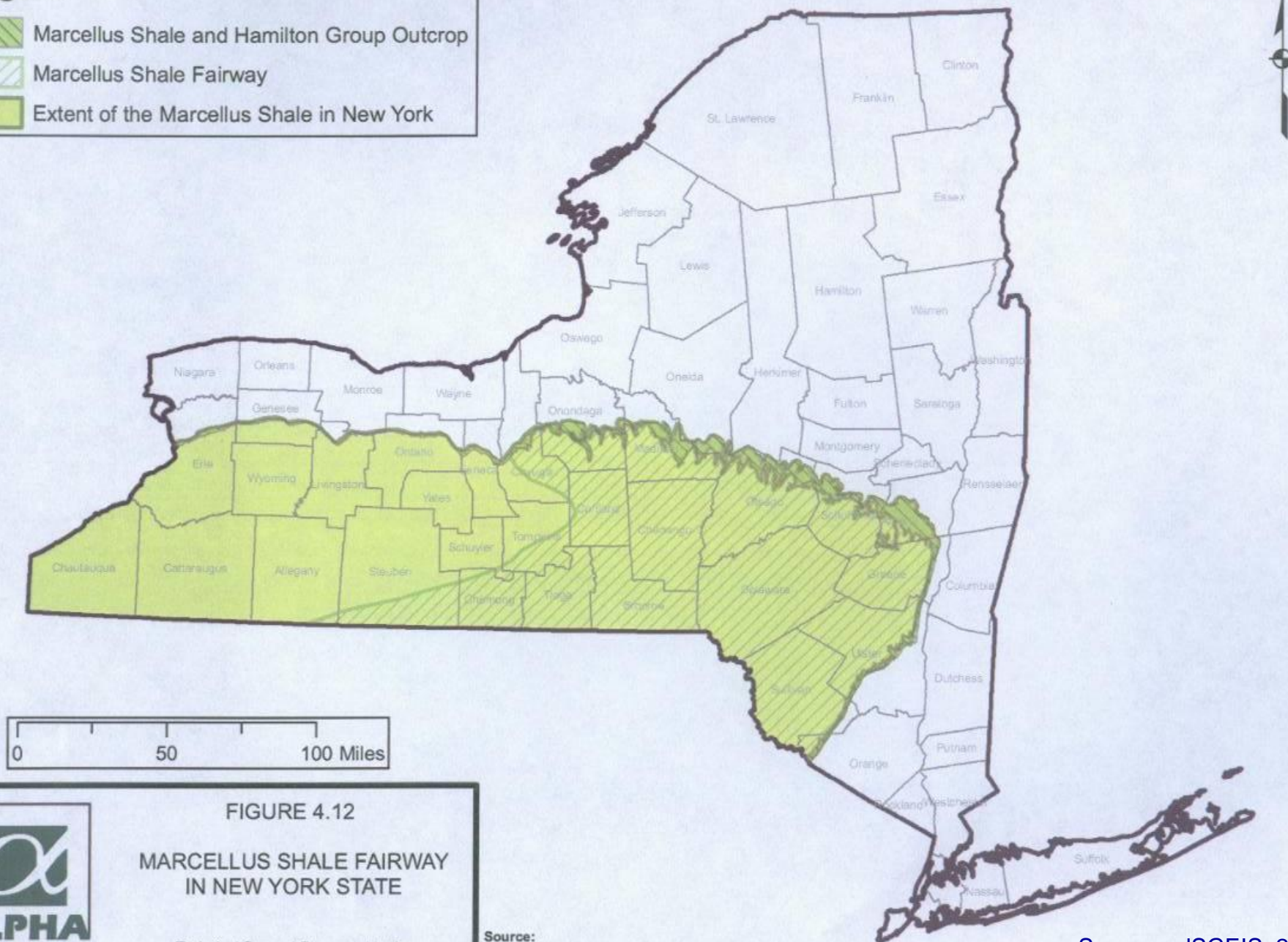


FIGURE 4.12  
MARCELLUS SHALE FAIRWAY  
IN NEW YORK STATE

Technical Support Document to the  
Draft Supplemental Generic  
Environmental Impact Statement

Source:

- US Geological Survey, Central Energy Resources Team (2002)
- New York State Museum - Reservoir Characterization Group
- Nyahay et al. (2007)

Source – dSGEIS, 2009

## Legend

- Utica Shale Outcrop
- Utica Shale Fairway
- Extent of the Utica Shale in New York

Source:  
- modified from Nyahay et al. (2007)

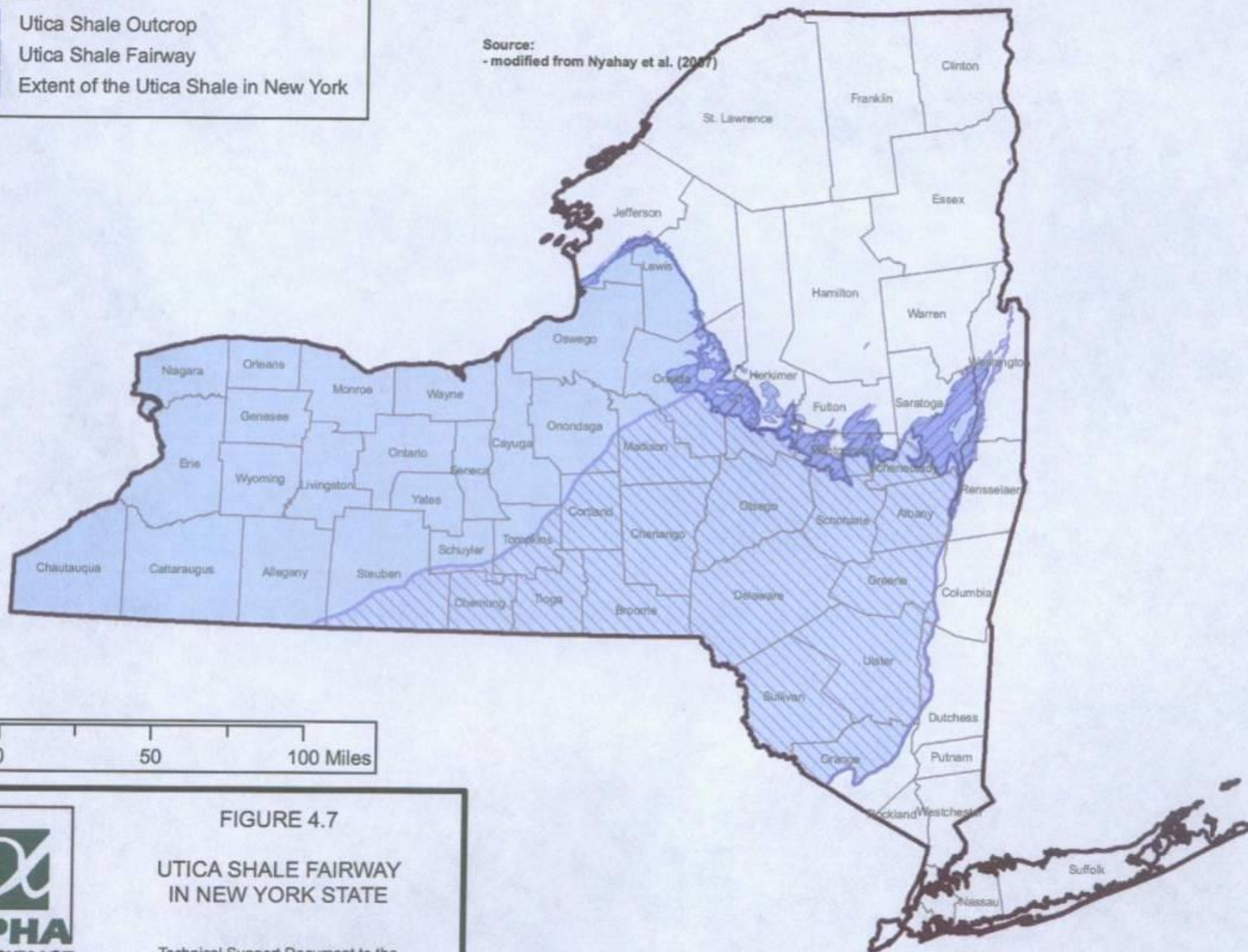


FIGURE 4.7

### UTICA SHALE FAIRWAY IN NEW YORK STATE

Technical Support Document to the  
Draft Supplemental Generic  
Environmental Impact Statement



**ALPHA  
GEOSCIENCE**

Alpha Project No. 09104



# New York State Stratigraphy

PERIOD		GROUP	UNIT	LITH.	THICKNESS	PRODUCTION	
DEVONIAN	UPPER	Conewango	Riceville	Sh, ss, cgl	700'		
		Conneuat	Chadakoin	Sh, ss	700'		
		Canadaway	Undiff	Sh, ss	1100 – 1400	Oil, Gas	
			Perrysburg - Dunkirk	Sh, ss		Oil, Gas	
			sh	Gas			
		West Falls	Java	Sh, ss	365 – 1250'		
			Nunda	Sh, ss		Oil, Gas	
			Rhinestreet	Sh			
		Sonyea	Middlesex	Sh	0 – 400'	Gas	
		Genesee	Geneseo	Sh	0 – 450'		
	?		Tully	Ls	0 – 50'	Gas	
	MIDDLE	Hamilton	Moscow	Sh	200 – 600'		
			Ludlowville	Sh			
			Skaneateles	Sh			
			Marcellus	Sh		Gas	
			Onondaga	Ls	30 – 235'	Gas, Oil	
	LOWER	Tristates	Oriskany	Ss	0 – 40'	Gas	
		Helderberg	Manlius	Ls	0 – 10'		
Rondout			Dol				
			Akron	Dol		0 – 15'	Gas
SILURIAN	UPPER	Salina	Camillus	Sh, gyp	450 – 1850'		
			Syracuse	Dol, sh, silt			
			Vernon	Sh			
			Lockport	Lockport		Dol	150 – 250'
		Clinton	Rochester	Sh	125'	Gas	
			Irondequoit	Ls			
	LOWER		Clinton	Sodus	Sh	75'	Gas
		Reynales		Ls			
		Thorold		Ss			
		Medina	Grimsby	Sh, ss	75 – 150'	Gas	
			Whirlpool	Ss	0 – 25'	Gas	
	UPPER		Queenston	Sh		Gas	
			Oswego	Ss	1100 – 1500'		
			Lorraine	Sh			
			Utica	Sh		900 – 1000'	
			MIDDLE	Trenton-Black River	Trenton	Ls	425 – 625'
		Black River			Ls	225 – 550'	
	LOWER		Tribes Hill-				

## Primary Black/Gray Shales

Dunkirk

Rhinestreet

Genesee

Marcellus

Rochester

Sodus

Medina Ss  
Central/  
Western NY

Lorraine

Utica (estimated  
4,500 ft. deep in  
vicinity of Dayton)

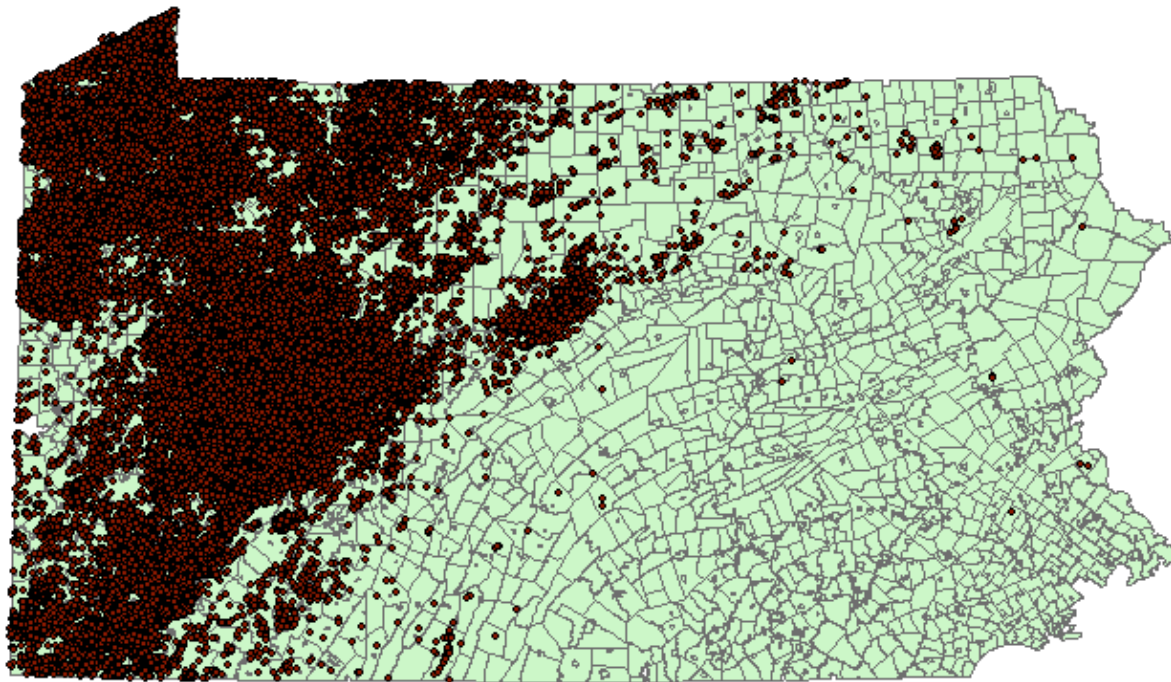
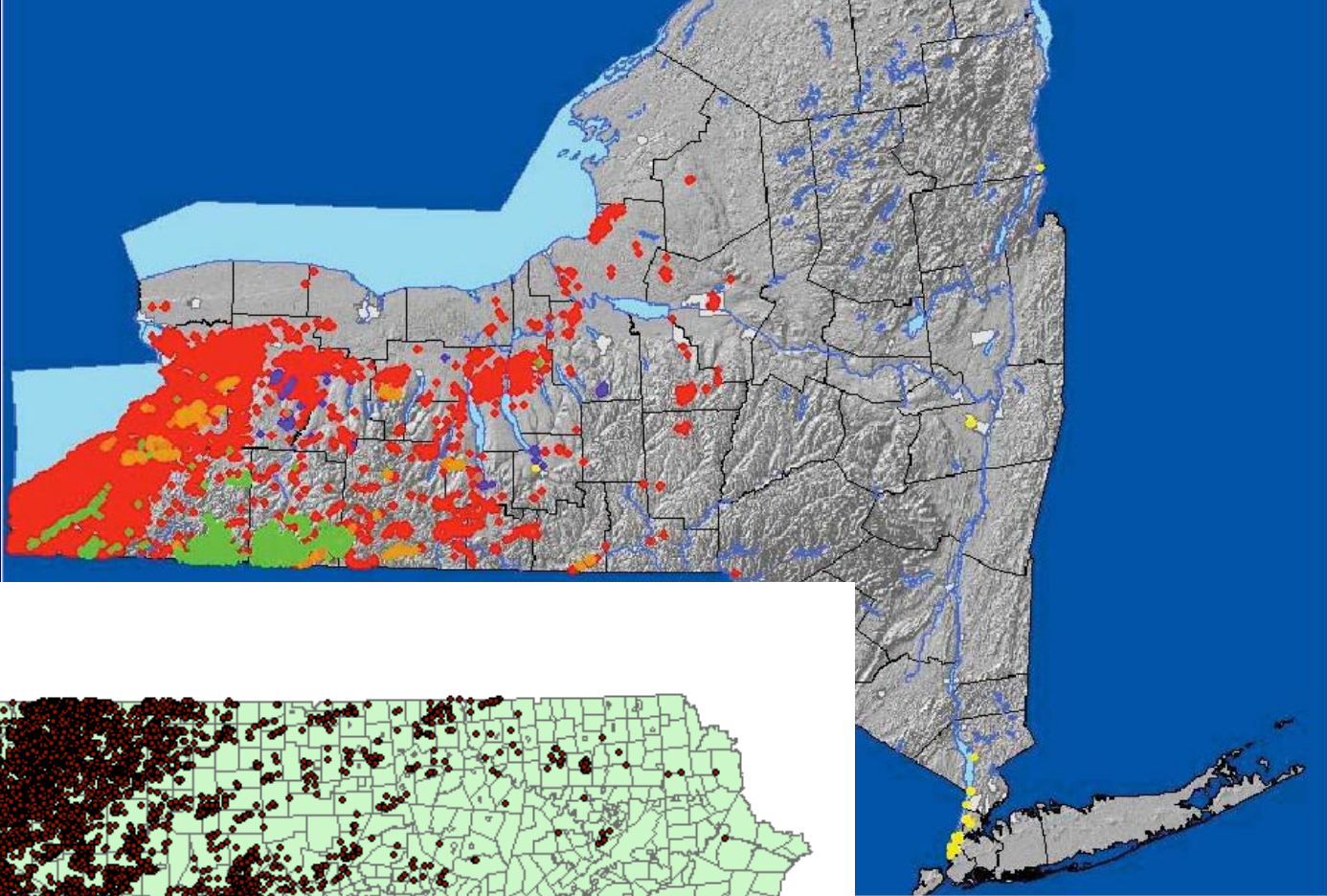


# Marcellus Stratigraphy





Oil and Gas wells  
are not new in  
Pennsylvania and  
New York.....



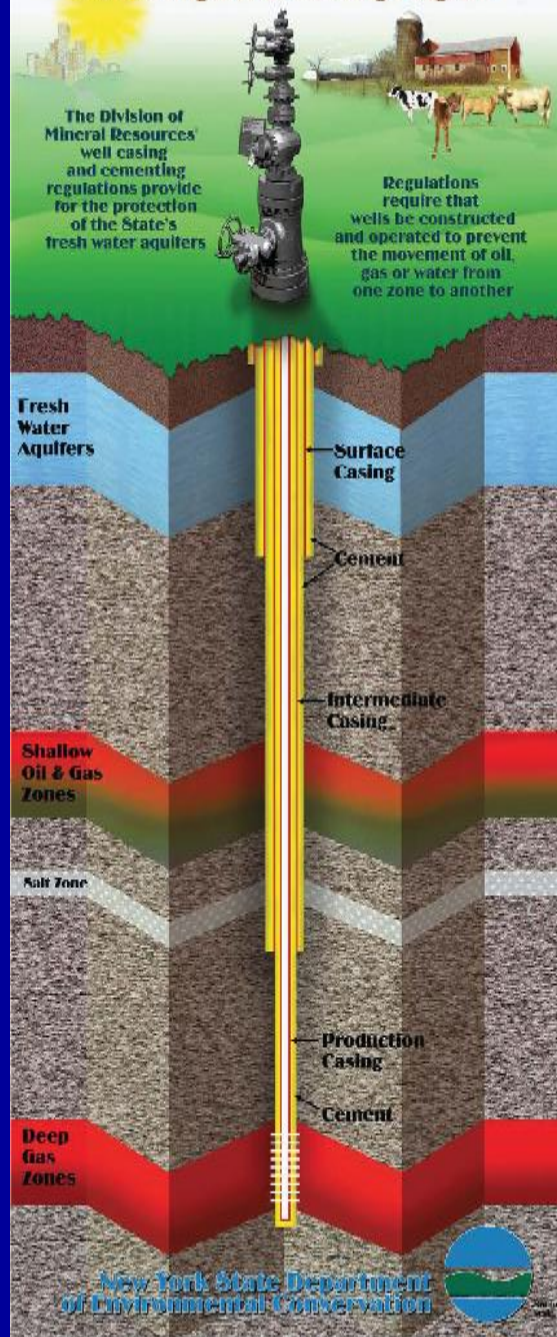
...and there are  
different  
regulations  
in **and within** each  
state.

# Groundwater Protection

## Well Casing and Cementing Program

The Division of Mineral Resources' well casing and cementing regulations provide for the protection of the State's fresh water aquifers

Regulations require that wells be constructed and operated to prevent the movement of oil, gas or water from one zone to another

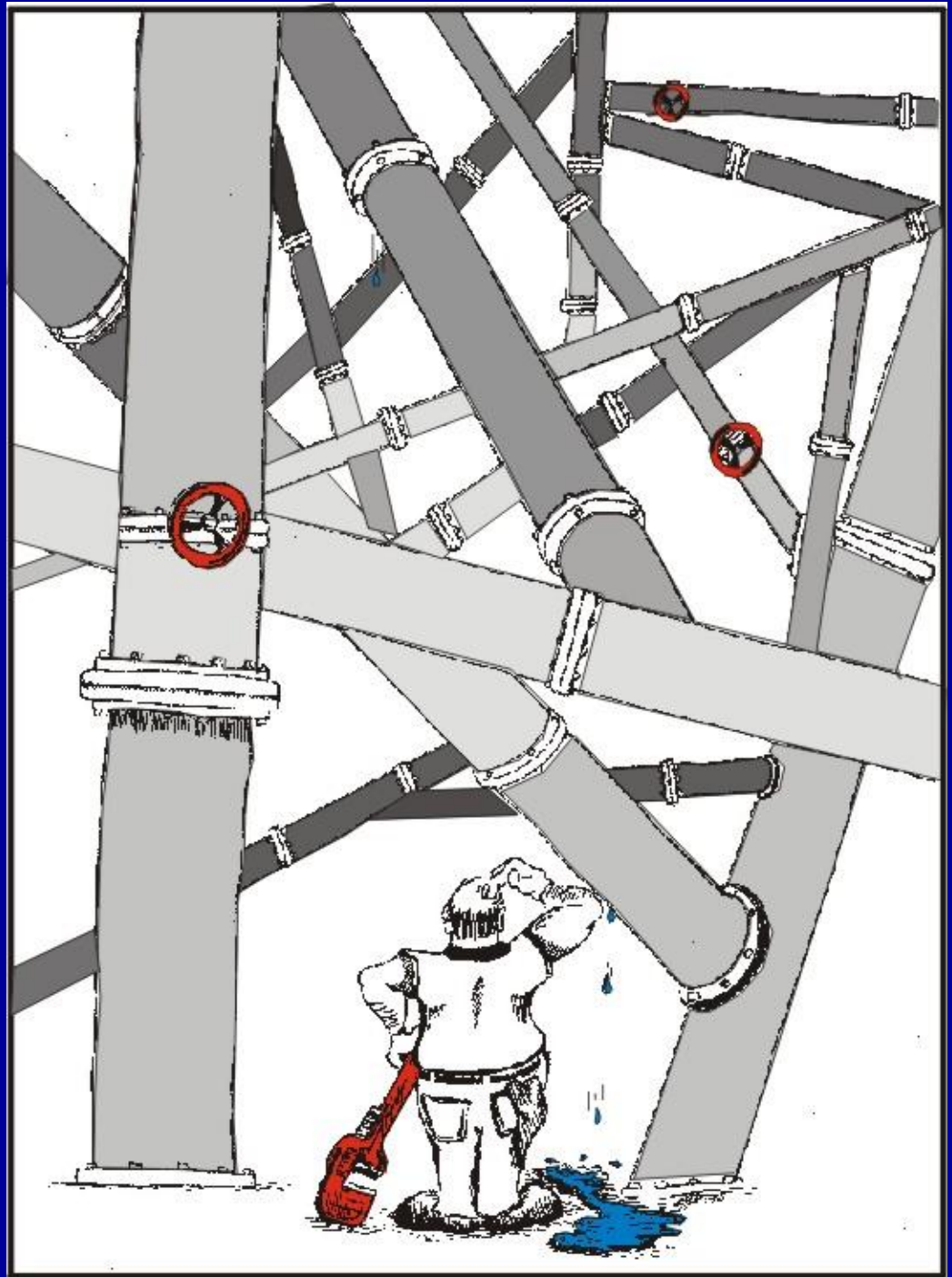


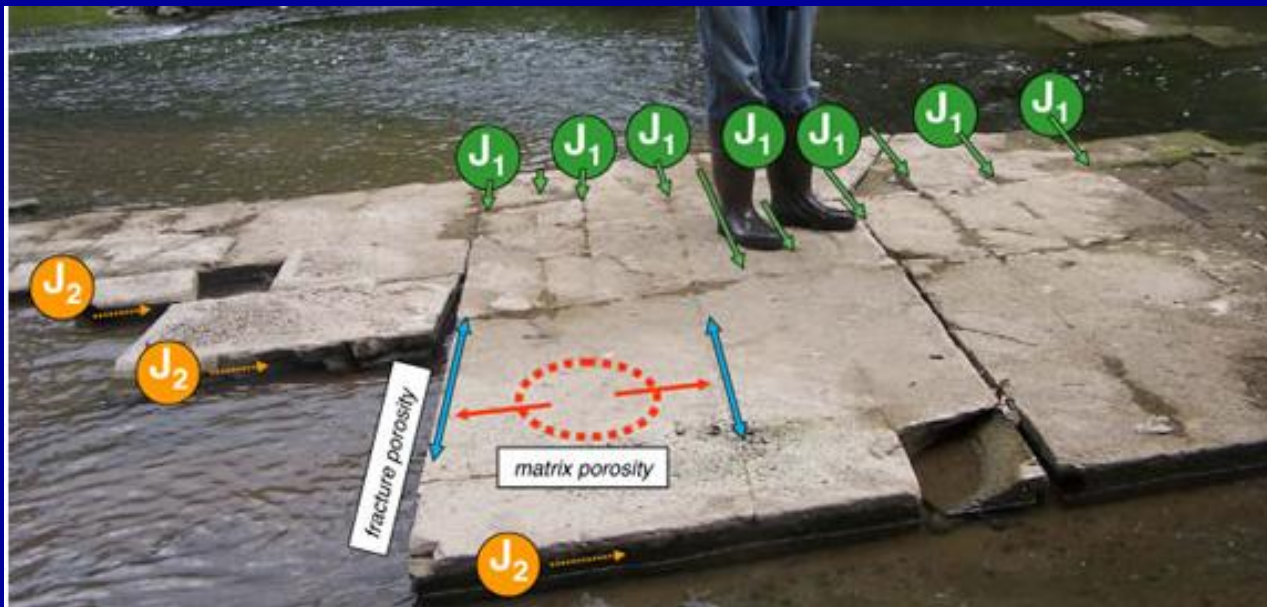
Multiple steel casings with high-strength cement to isolate well from surrounding aquifers and bedrock units.





What is different about Marcellus/Utica shale gas development?



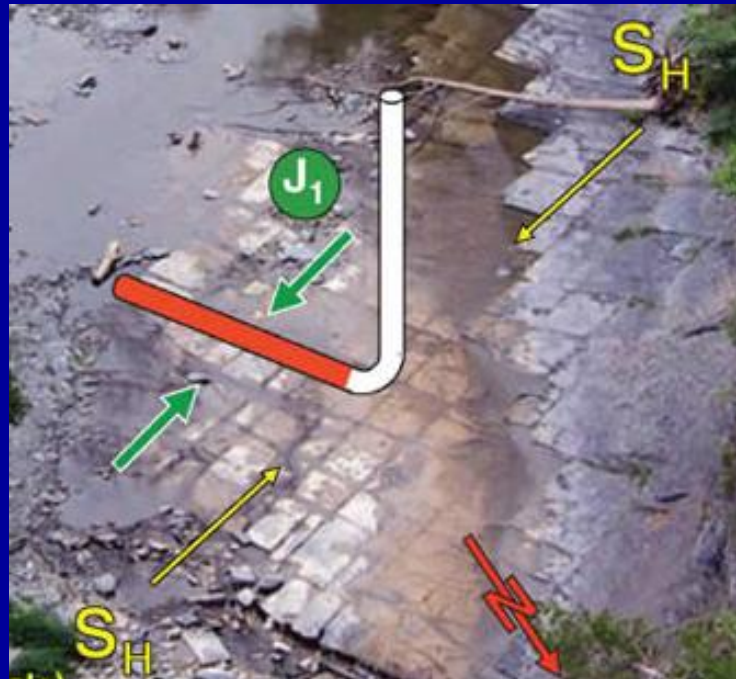


East-northeast trending  $J_1$  fractures more closely spaced and cross-cut by less well-developed, northwest-trending  $J_2$  fractures

Dual porosity gas reservoir where fractures drain rapidly and matrix drain slowly

Free gas and adsorbed gas in matrix

Connect matrix porosity to the wellbore by intersecting multiple  $J_1$  fractures

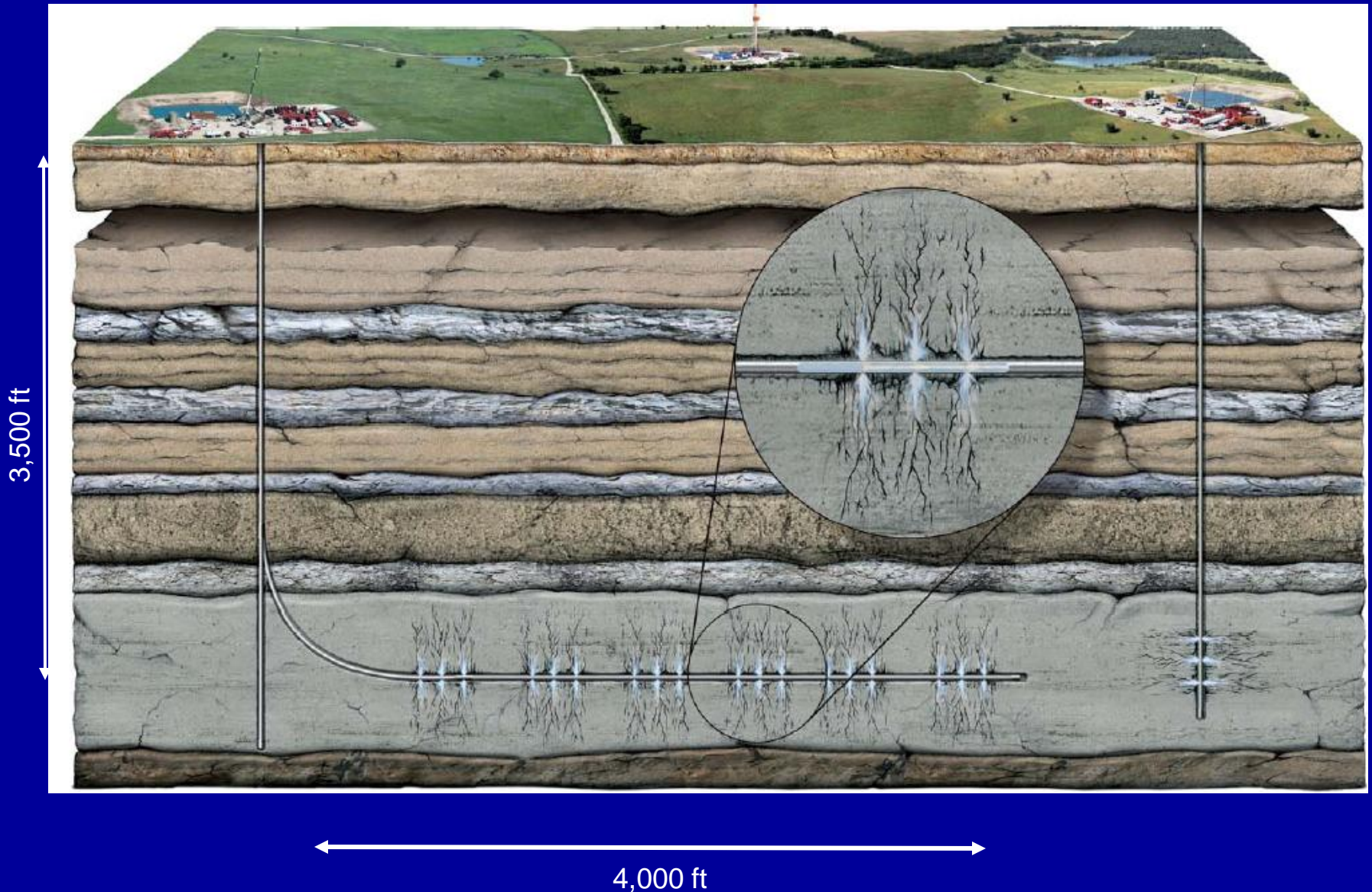


Drill horizontal wells to the north-northwest, or south-southeast that cross and drain densely developed  $J_1$  fractures

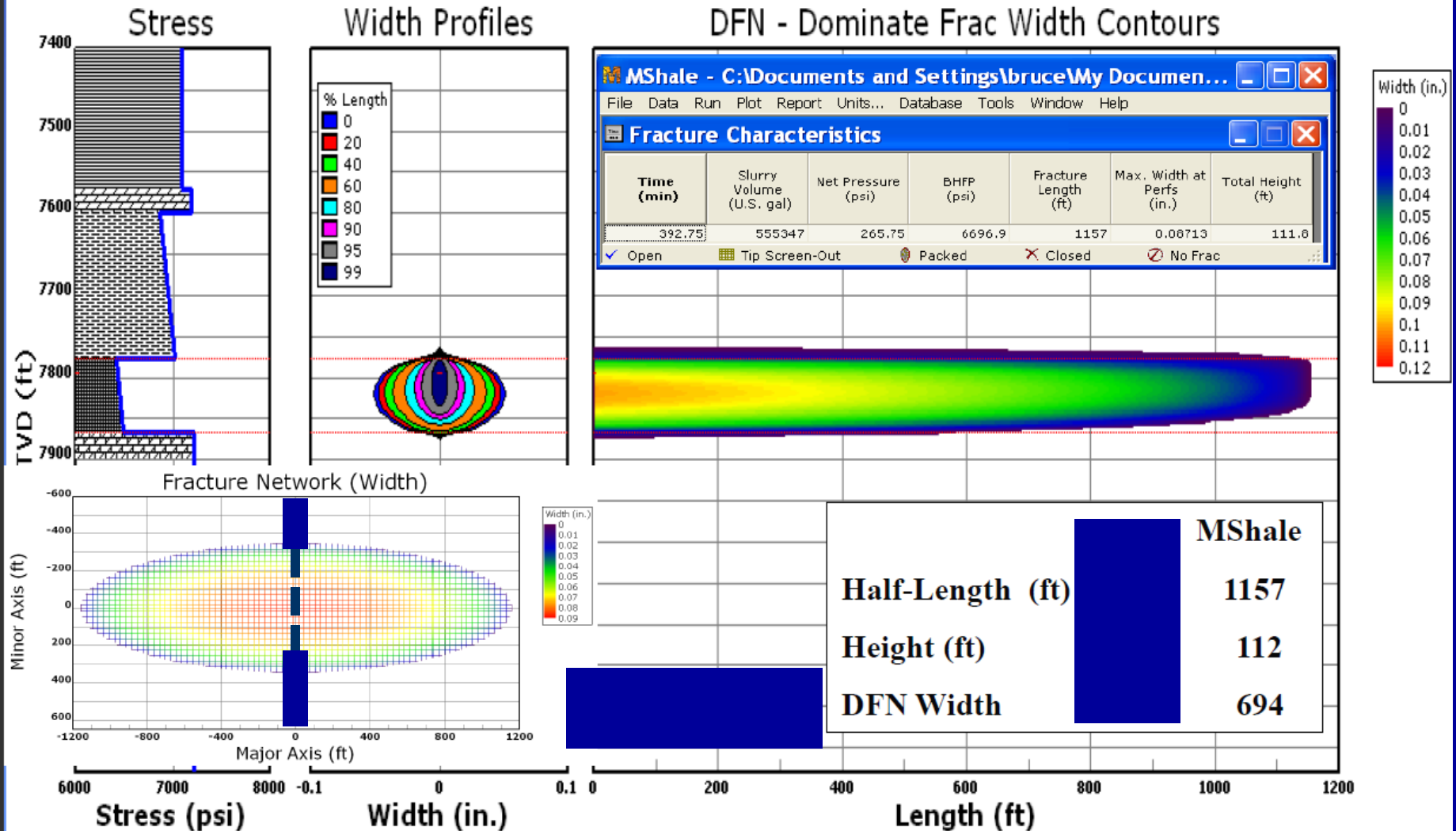


# Marcellus Shale Gas Development

## Horizontal Drilling in Black Shale with High-Volume Hydraulic Fracturing



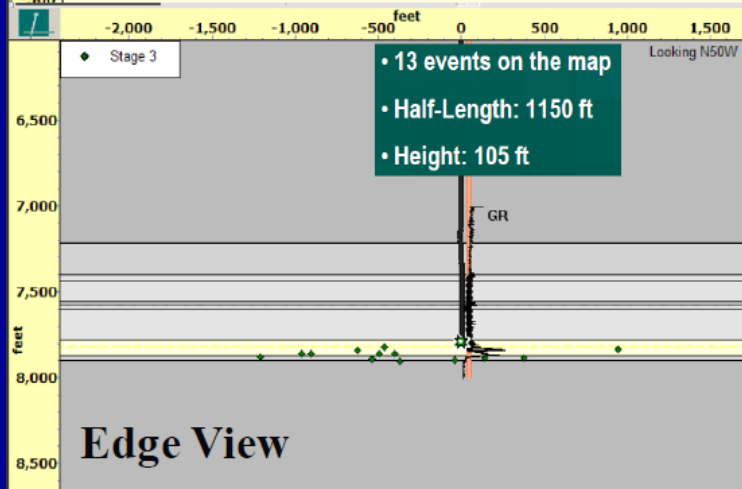
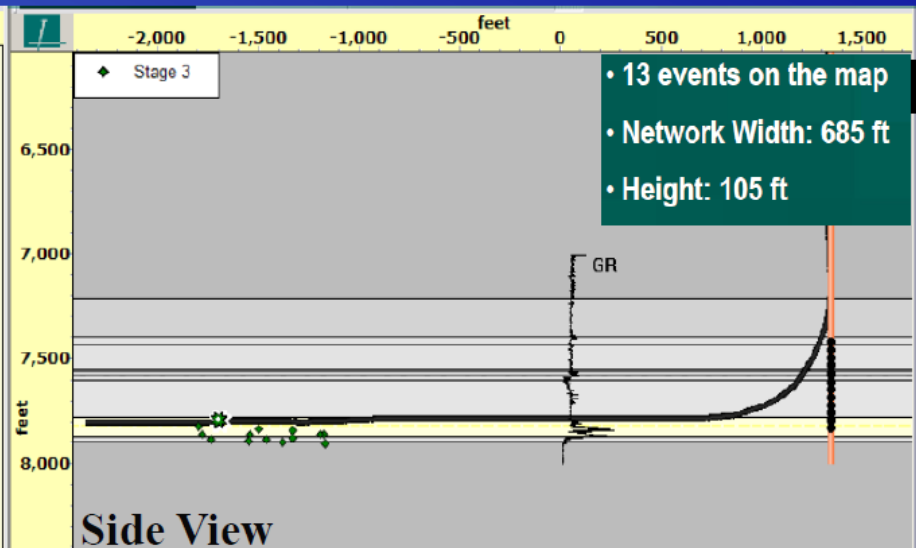
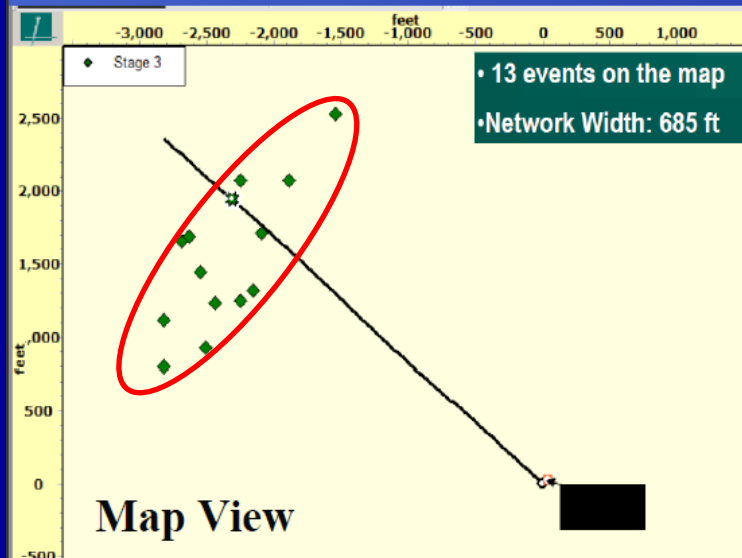
# Marcellus Shale – Ex. 1 (Single Cluster)



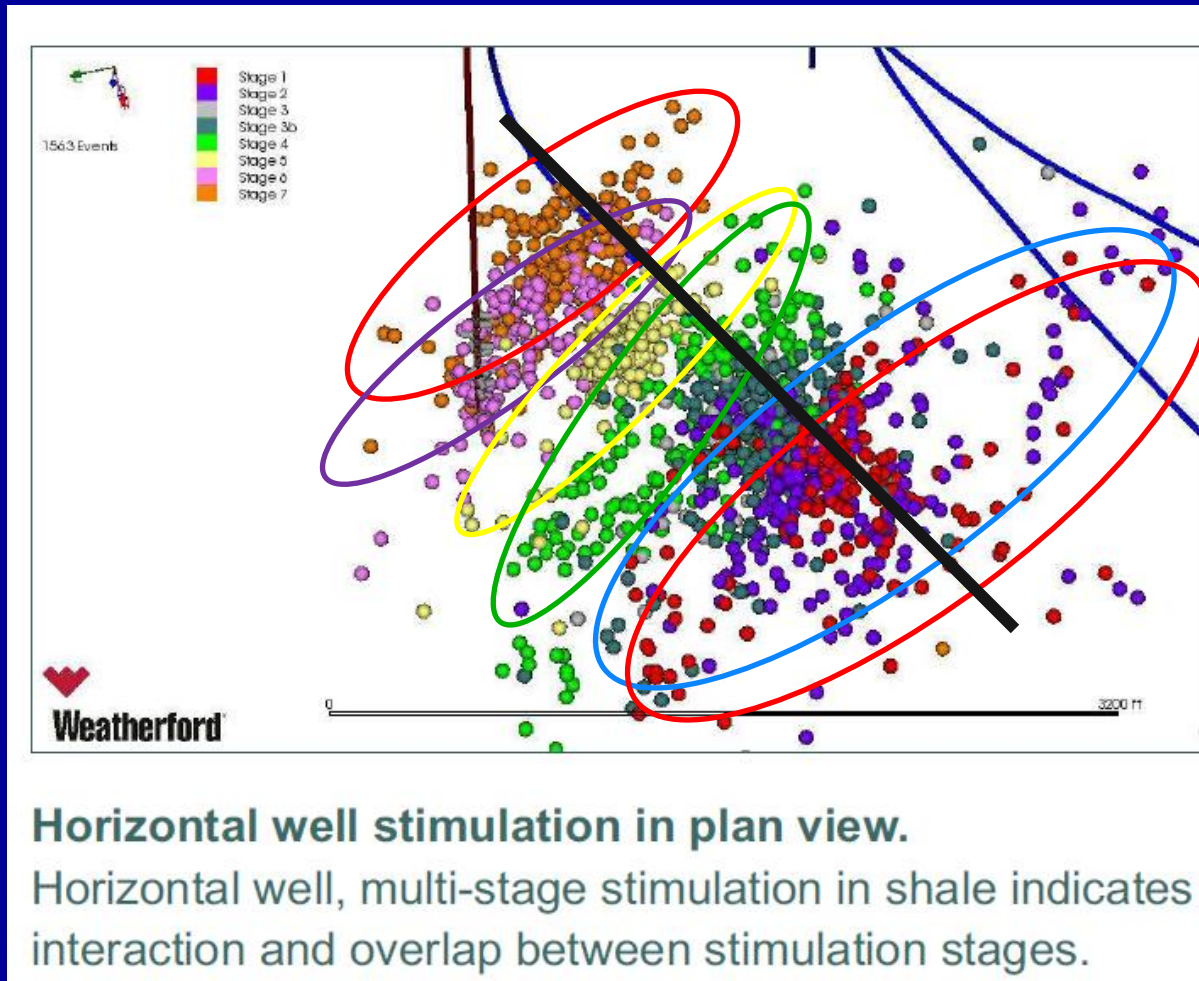
Meyer (2009)



# Marcellus Shale (Ex. 1) – Microseismic



# Microseismic Monitoring of Hydraulic Fracturing



**Horizontal well stimulation in plan view.**

Horizontal well, multi-stage stimulation in shale indicates interaction and overlap between stimulation stages.



# “Typical” Drillpad Design





# Drilling Phase – drillrig, pumps, supplies, frack tanks

(a month or two)







## Hydro-fracking Phase – (a week or two)

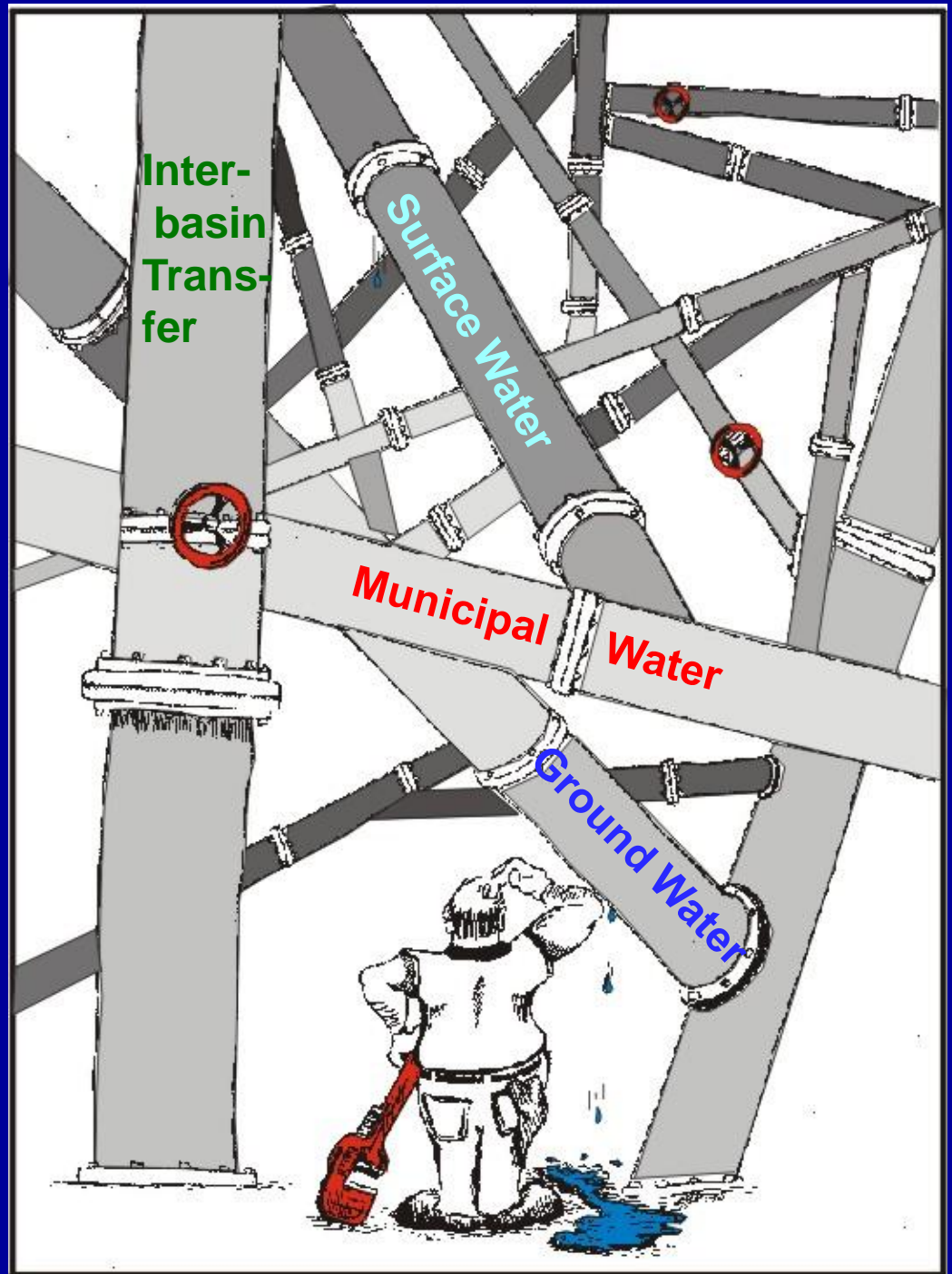
Injection pumps, supplies,  
and many frack tanks for  
fresh and flowback waters





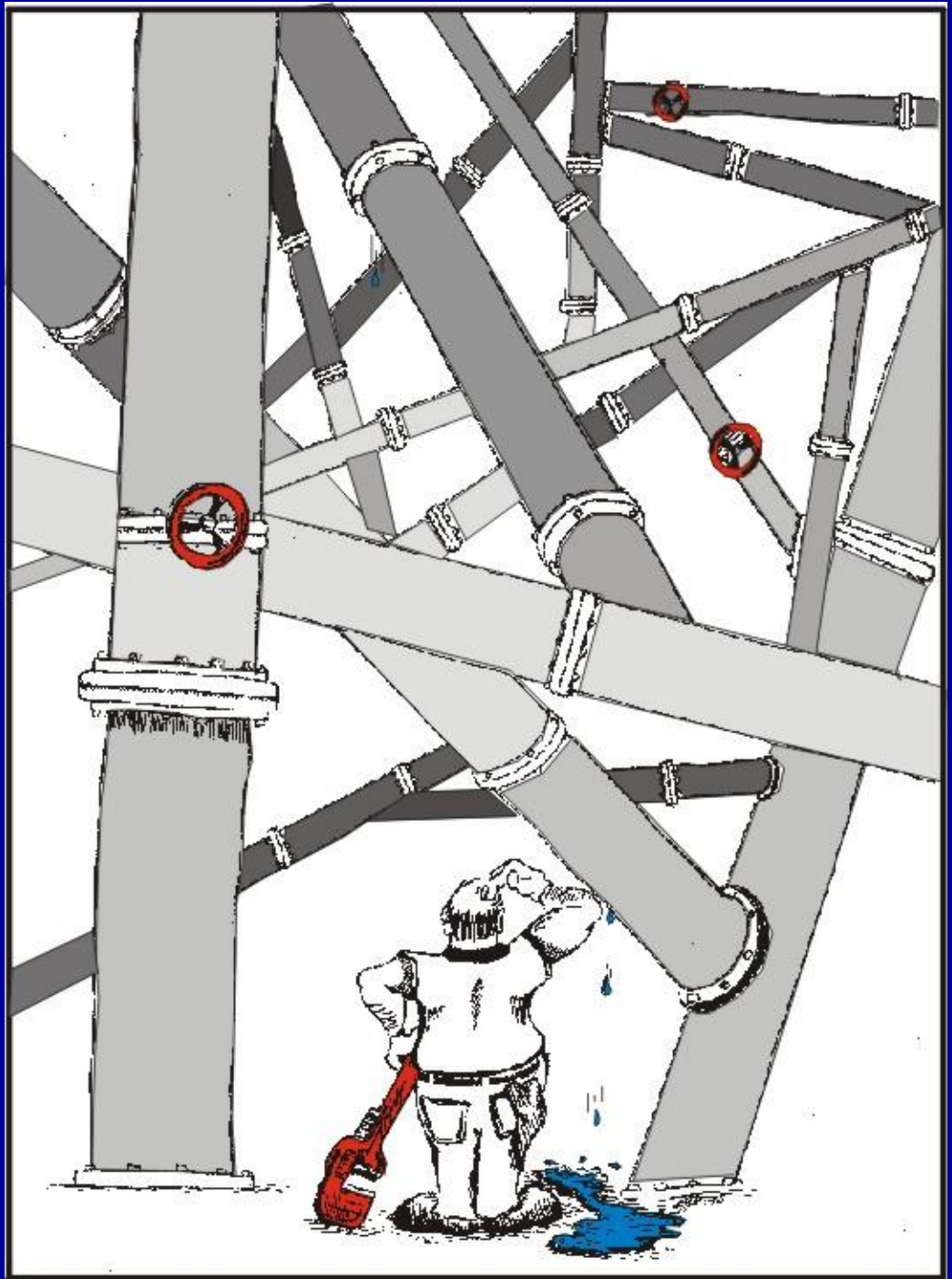
Where do you get the water for fracking?

Each source has its own set of concerns.....



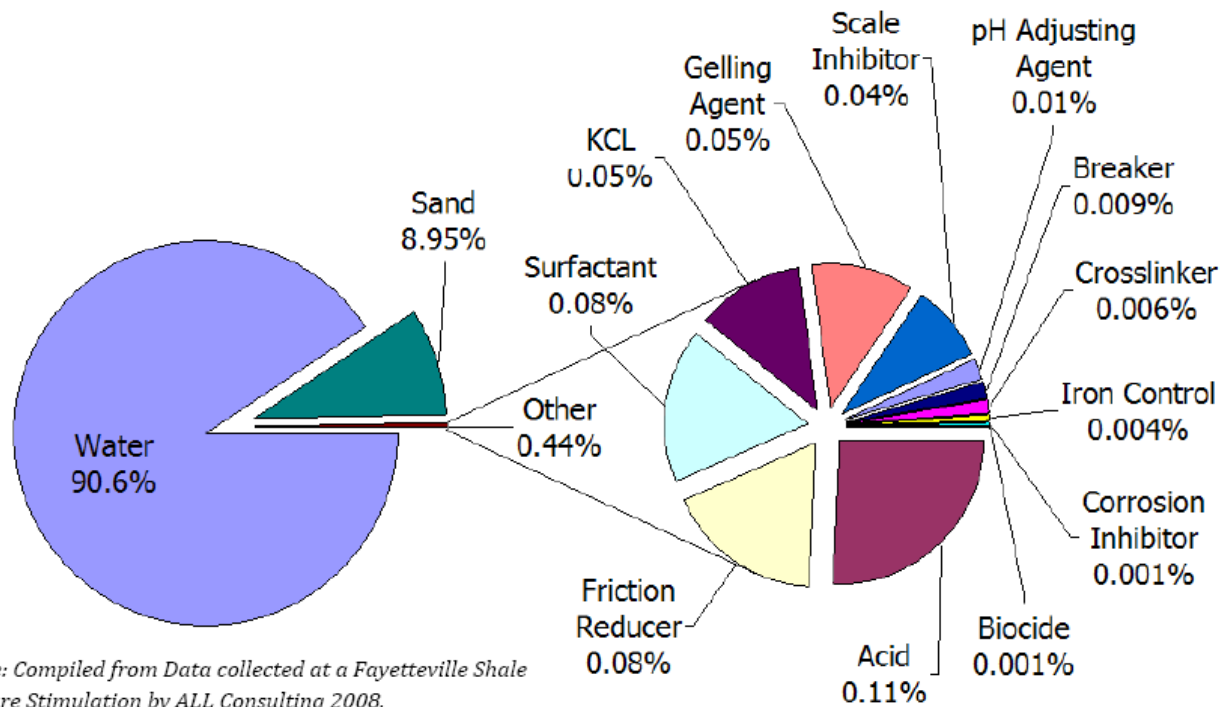


What is the quality  
of the frack and  
flowback water?



# Typical Components of Frack Fluid

For a 1.5 million frack job, the 0.5 percent is equivalent to 7,500 gallons of “chemistry”.



Source: Compiled from Data collected at a Fayetteville Shale Fracture Stimulation by ALL Consulting 2008.

(Arthur, Bohn, Layne, 2008, ALL Consulting)

<http://www.all-llc.com/shale/GWPCMarcellusFinal.pdf>



What do we do with the **flow-back water** after the hydrofrac process is complete, and the **formation water** as gas is produced from the well?



## Frack Water Return – (Flowback Water)

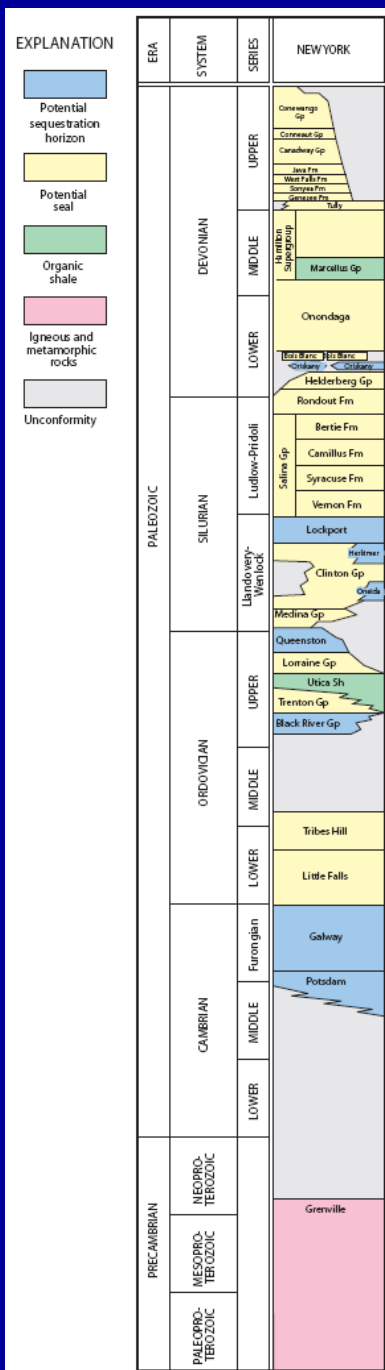
Total volume injected (1.5 million gal), returned over a 2-week period of time.

(From a well in SW Pennsylvania.)

Constituent	1st Third	2nd Third	Final Third	Units
Bromide	124	479	753	MG/L
Chloride	18,600	80,500	109,000	MG/L
Sulfide	<0.50	29.5	<2.5	MG/L
T. Dissolved Solids	34,578	133,620	192,000	MG/L
Temperature	29.3	29.4	25.3	Degrees C
Barium	668	6,100	8,730	MG/L
Iron, Total	23	31.3	71.9	MG/L
Magnesium	69.3	572	890	MG/L
Gross Alpha	1,159	22.41	18,950	pCi/L
Gross Beta	6,500	9.68	7,445	pCi/L
Radium 226	33	2.58	4.67	pCi/L
Radium 228	4.66	1.15	18.41	pCi/L
Manganese, Total	0.73	1.8	2.79	MG/L
Mercury, Total	<0.0002	<0.0002	<0.0002	MG/L
Molybdenum, Total	0.16	0.72	1.08	MG/L
Nickel, Total	0.03	0.07	<0.01	MG/L
Selenium, Total	<0.02	<0.02	<0.02	MG/L
Silver, Total	<0.01	<0.01	<0.01	MG/L
Thallium, Total	<0.02	<0.02	0.1	MG/L
Titanium, Total	0.06	<0.01	<0.01	MG/L
Zinc, Total	0.036	0.028	0.035	MG/L



# DISPOSAL OF FRACK WATER BY DEEP WELL INJECTION



Marcellus Shale

Utica Shale

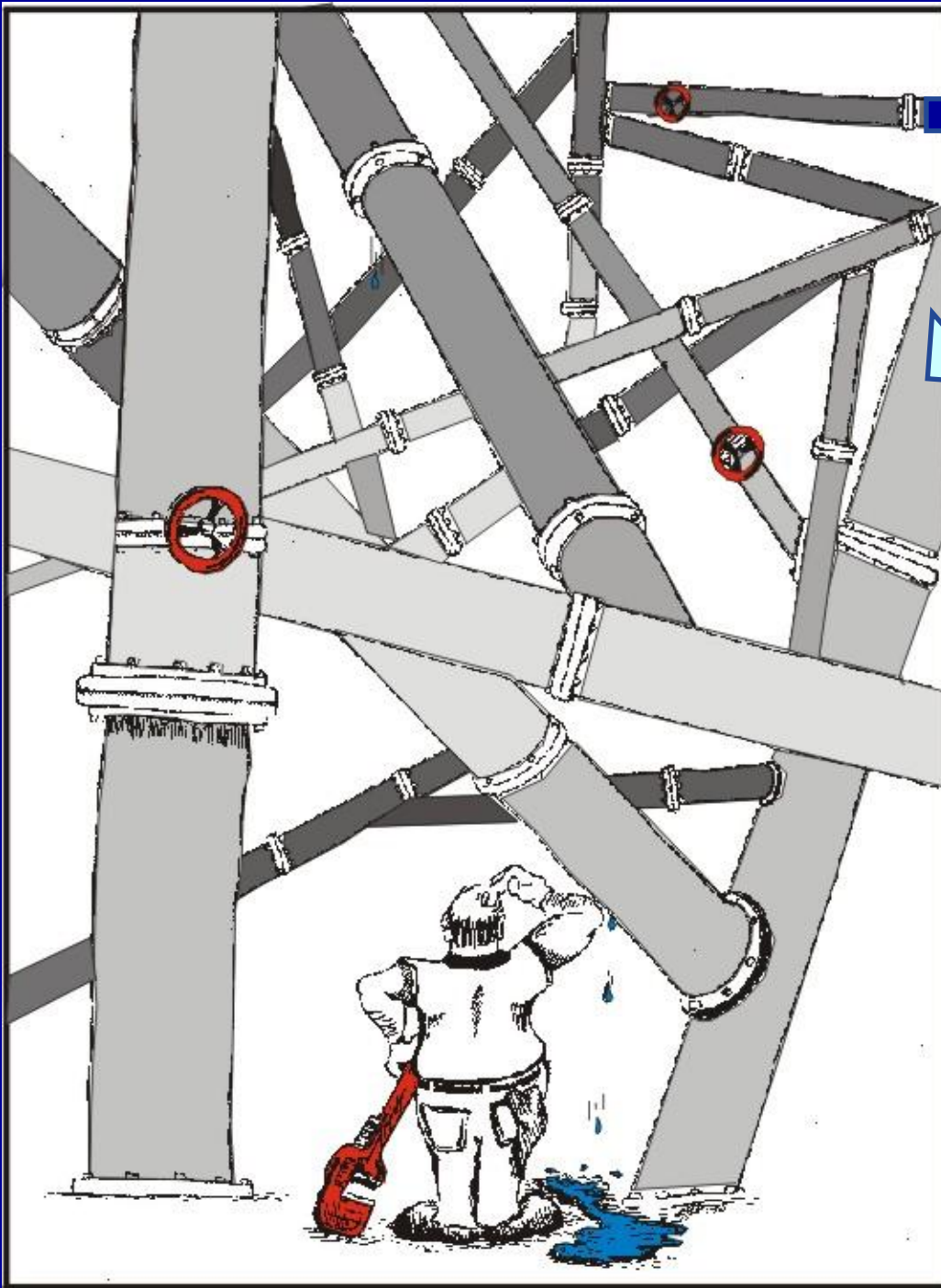
Trenton-Black River carbonates

Potsdam sandstone

**DISPOSAL OF FRAC WATER -  
BY MUNICIPAL WASTEWATER TREATMENT PLANTS  
AND DISCHARGE TO SURFACE WATER**







Black Box

Proposed “Black box(es)”  
pretreatment systems  
to remove ‘constituents  
of concern’ prior to  
other treatment, reuse, or  
discharge

# New Concepts to Reduce Flowback Volume

Reuse / Recycle the flowback

Reduce frack volumes

Use minimal frack volumes followed by a freshwater for application of frack pressures

Leave more frack fluid in the hole

Assumes down-hole gas will pass through the spent frack fluids

Use of liquefied propane instead of water

LP turns back to a gas and can be recovered for reuse.

**Bottom Line** – The gas industry wants to reduce the volume of water used.



# Local Water-Resource Concerns

- Protection of surface water and groundwater during entire process
- Drill pad construction, storm runoff, chemical storage, and handling
- Drilling & hydro-fracturing process – cuttings and fluid handling
- Transportation of water & waste fluids to and away from site
- Flowback disposal -- Variable mineral and water-quality characteristics
  - Brines, oil & grease, heavy metals, radiochemicals, organics
- Site remediation when done

**Bottom line** – we need water-quality data prior to, during, and following drilling to determine the impact, or lack thereof, on the resources of NYS

# Regional Water-Resource Concerns

- What are the regional characteristics of black shale bedrock formations throughout the Marcellus, Utica, and other potential gas-bearing units?
  - Geologic nature – thickness of units, fracture tendencies, faults, etc.?
  - Geochemical nature – how variable are the mineral and water-quality characteristics?
  - Radiochemical nature – what radioisotopes are present and are they mobile, or made-mobile during drilling and fracking?

**Proposed** – A regional Marcellus Play database wherein data from across the play is entered into a USGS-maintained database and is available to be accessed by all.

**Bottom line** – We need to understand/document existing conditions prior and during the gas development/production process to assess and monitor our water, air, environmental resources.

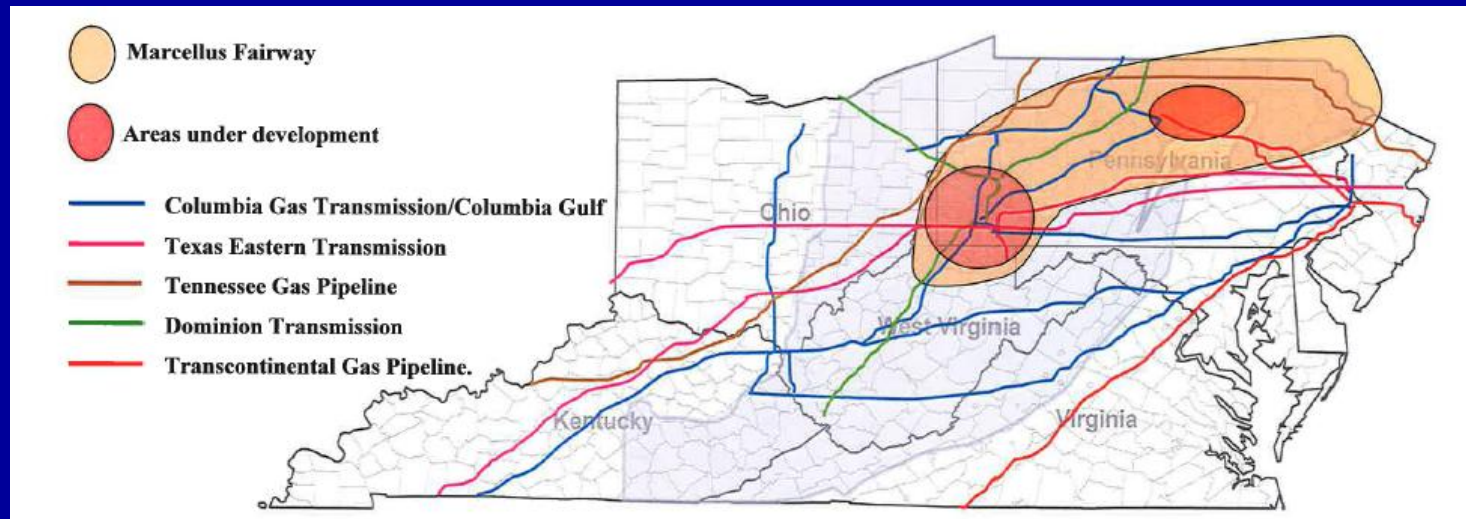


# Pipeline infrastructure and land disturbance



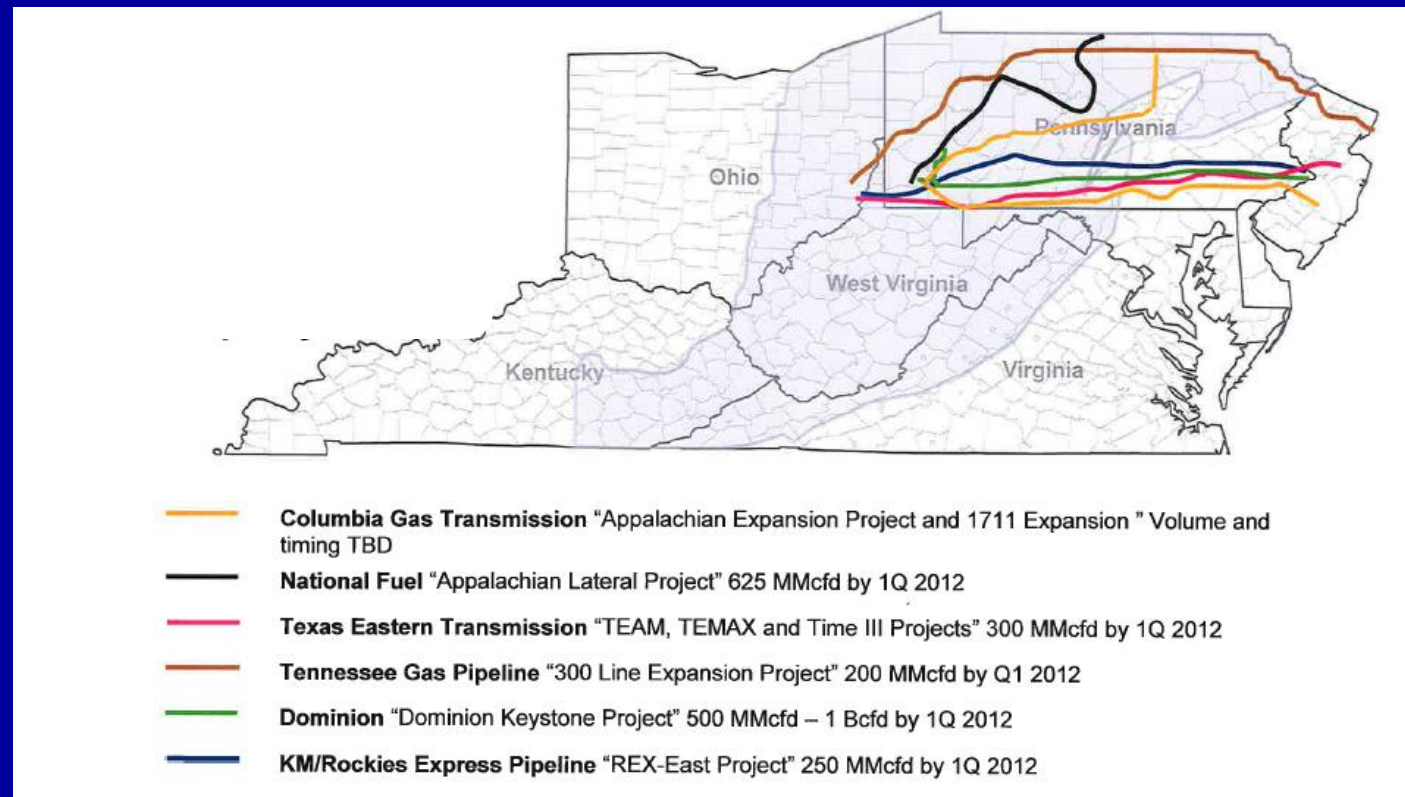


## Existing Major Pipelines



## Potential new pipelines in Pennsylvania

These are only the major transmission pipelines, not the gathering or intermediate pipelines





# Considerations in relation to what a Village, Town, or County can and can't do in relation to shale-gas development within their jurisdiction.

Regulation of Oil, Gas, and Solution Mining Drilling and Production  
Environmental Conservation Law (ECL), Article 23, Titles 1 to 13, Title 19  
Regulation 6 NYCRR Part 550-559

***New York's Oil, Gas and Solution Mining Law specifically supersedes all local laws or ordinances relating to the regulation of the oil, gas, solution mining, and brine disposal industries, but reserves to local governments jurisdiction over local roads and the rights of local governments under the Real Property Tax Law.***

## **Under the Oil Gas and Solution Mining Law the jurisdiction can:**

(this interpretation is by a hydrogeologist, not a lawyer – “Caveat emptor” )

Table 15.1 - Oil, Gas, Solution Mining and Brine disposal - Interagency Coordination

Regulate the use and bonding of local roads (with proper documentation)

Tax “value” of gas or oil from production wells — information provided by  
NYS Office of Real Property Services

Regulate, to a degree, the location of new wells (DEC) and gas pipelines (PSC)  
near agricultural districts, wetlands, & water supplies through SEQRA reviews.

Regulate the use (sale) of municipal water (from that jurisdiction)  
for the drilling and hydrofracking processes.

Regulate the disposal (road spreading) of brine on roadways and use of the  
jurisdictions’ wastewater treatment plant(s) to treat flowback/formation waters.

Follow-up on Oil and Gas complaints but only after County Health  
Department does their assessment – local jurisdiction has a secondary role.



# Questions?

