



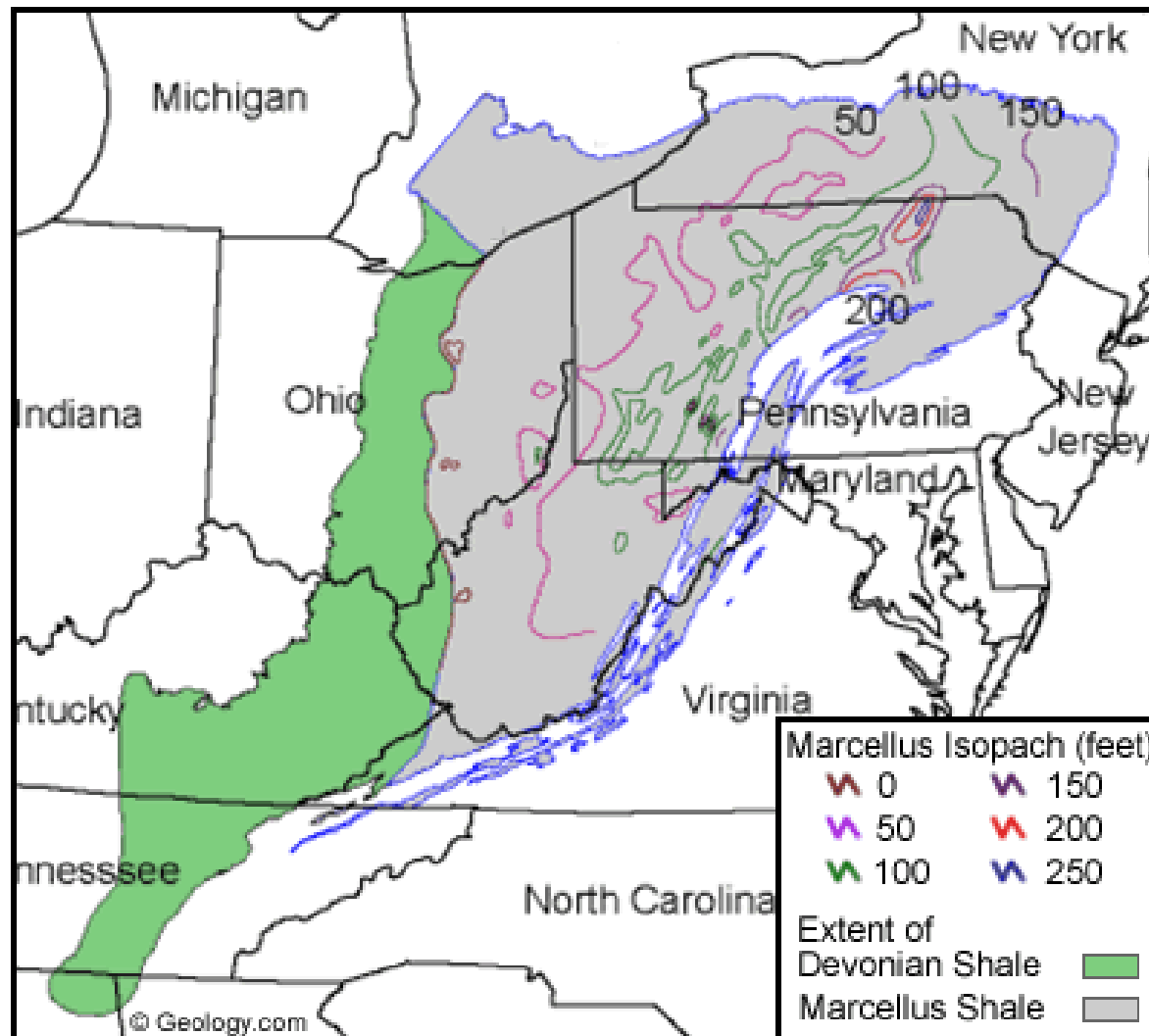
Estimating Annual Water Requirements for Marcellus Shale Development

Water Resources in the Next Decade

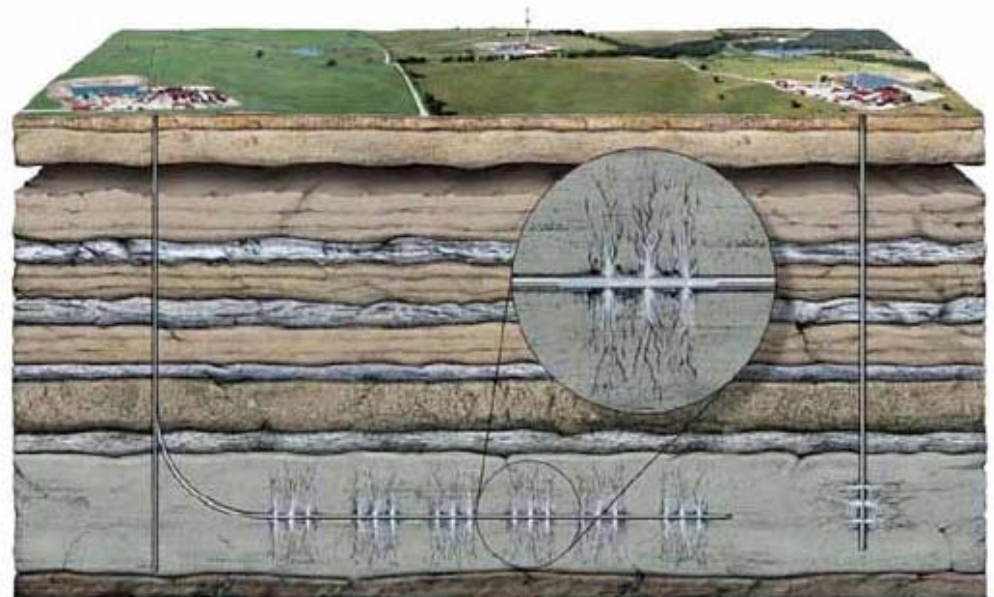
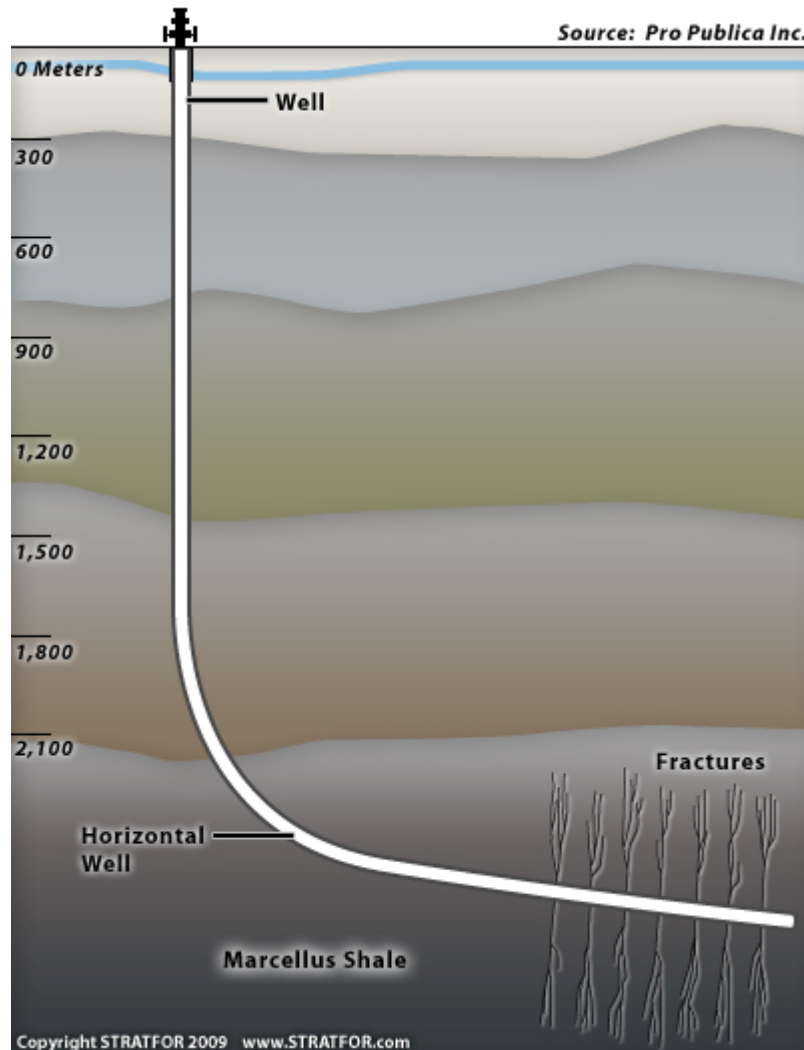
Edward M. Buchak
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Environmental Resources Management

Part 1: The Marcellus Shale Gas Reserve



Horizontal Drilling and Hydraulic Fracturing



What do I know...listen to this guy instead.

- [Hydraulic Fracturing Video](#)

Single Well Development



Single Well and Well Pad Water Balances

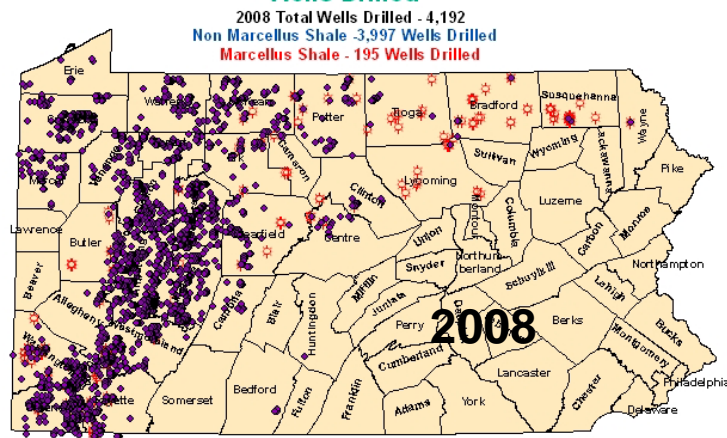
- **Single Well**
 - ◆ 2 to 7 million gallons for initial stimulation
 - ◆ 10% to 40% frac flow back of which 20% to 100% is recycled
- **A well pad can consist of 10 to 12 wells**
- **Potential sources**
 - ◆ Municipal water supplies
 - ◆ Surface water withdrawals
 - ◆ Direct groundwater withdrawals becoming more common

Part 2: Susquehanna River Basin

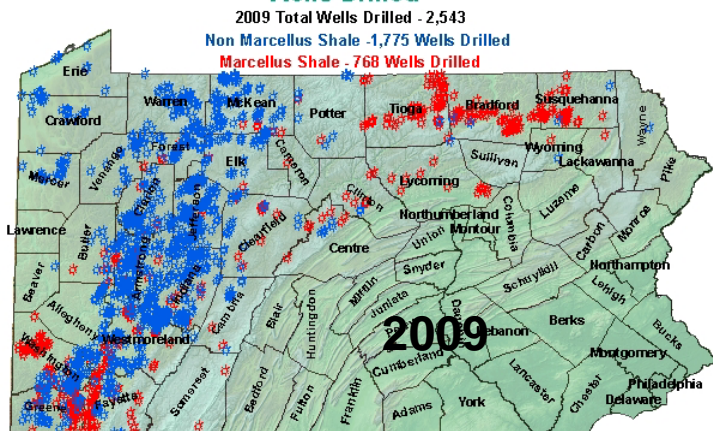


Rate of Well Development

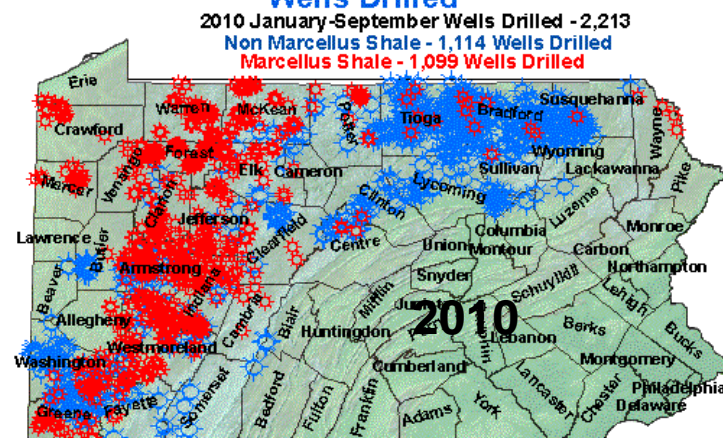
Department of Environmental Protection Bureau of Oil and Gas Management Wells Drilled



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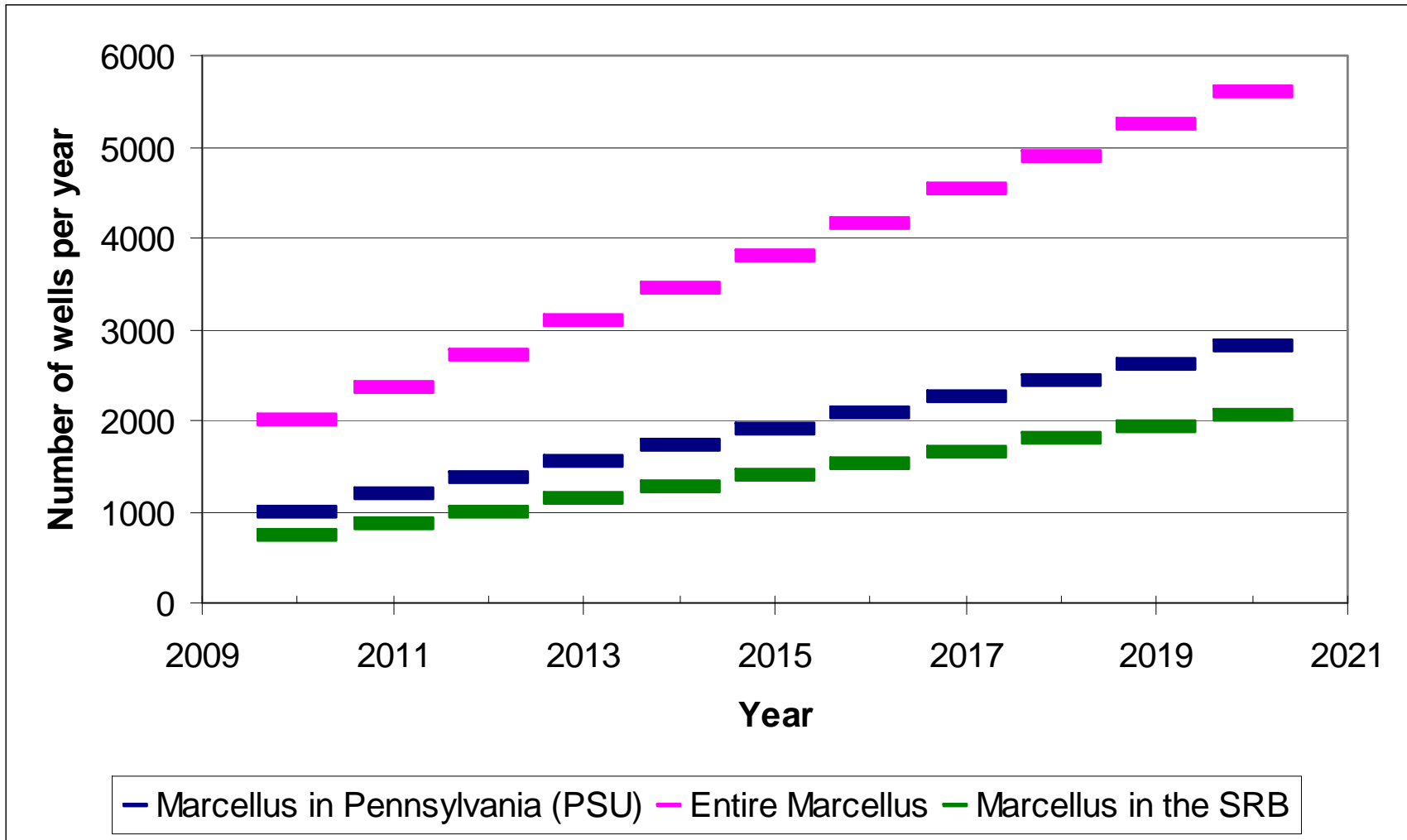
Department of Environmental Protection Bureau of Oil and Gas Management Wells Drilled



As Reported by Operators

Updated 10/05/2010

Estimated Rate of Well Development

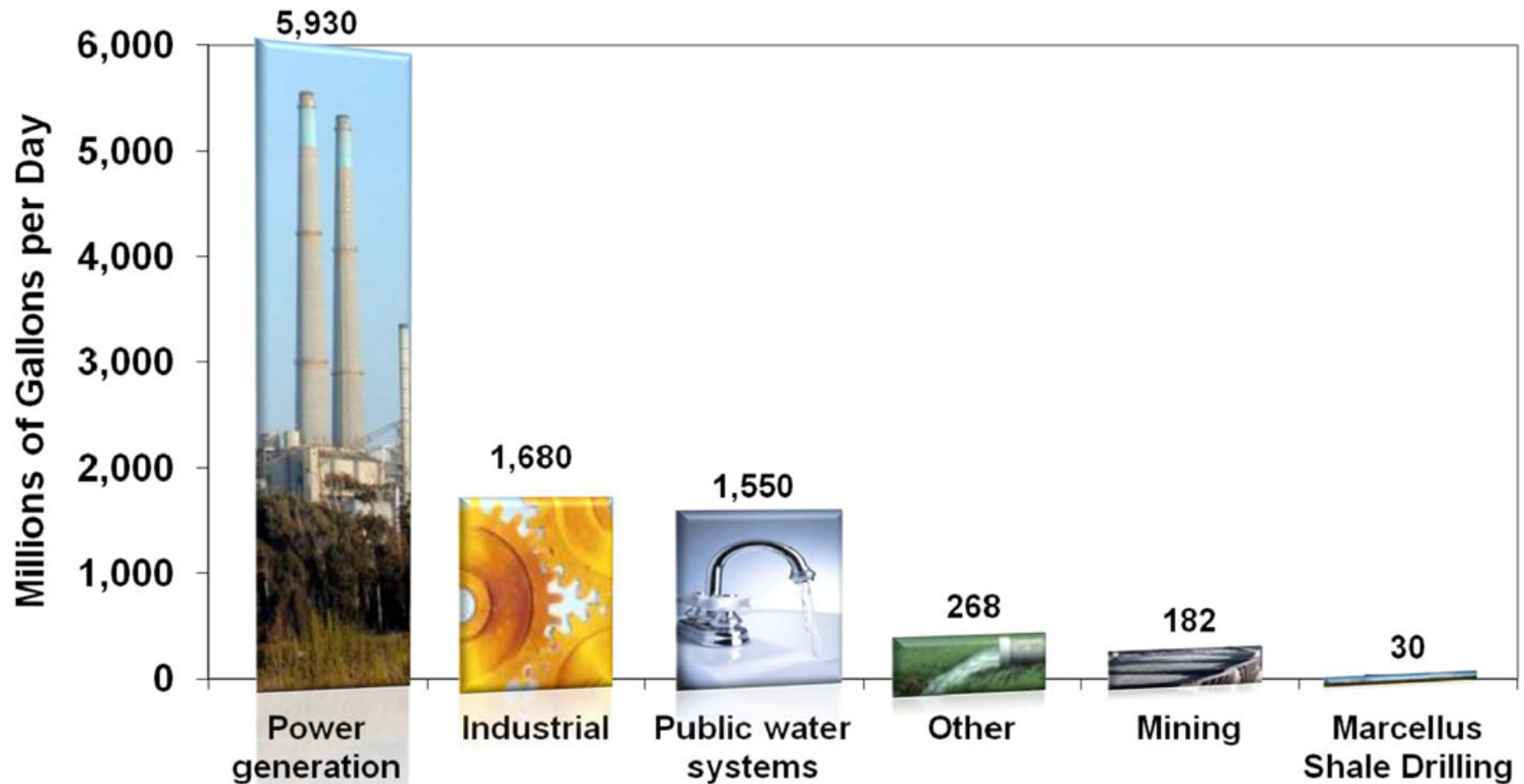


Estimated *Rate* of Water Use

<i>Per well</i>	
Initial stimulation requirement, MG	Stimulation consumption, MG
7.0	6.3

Number of wells	Annual rate, MGD	Annual rate, cfs
2000	34.5	53.4

Competing Demands

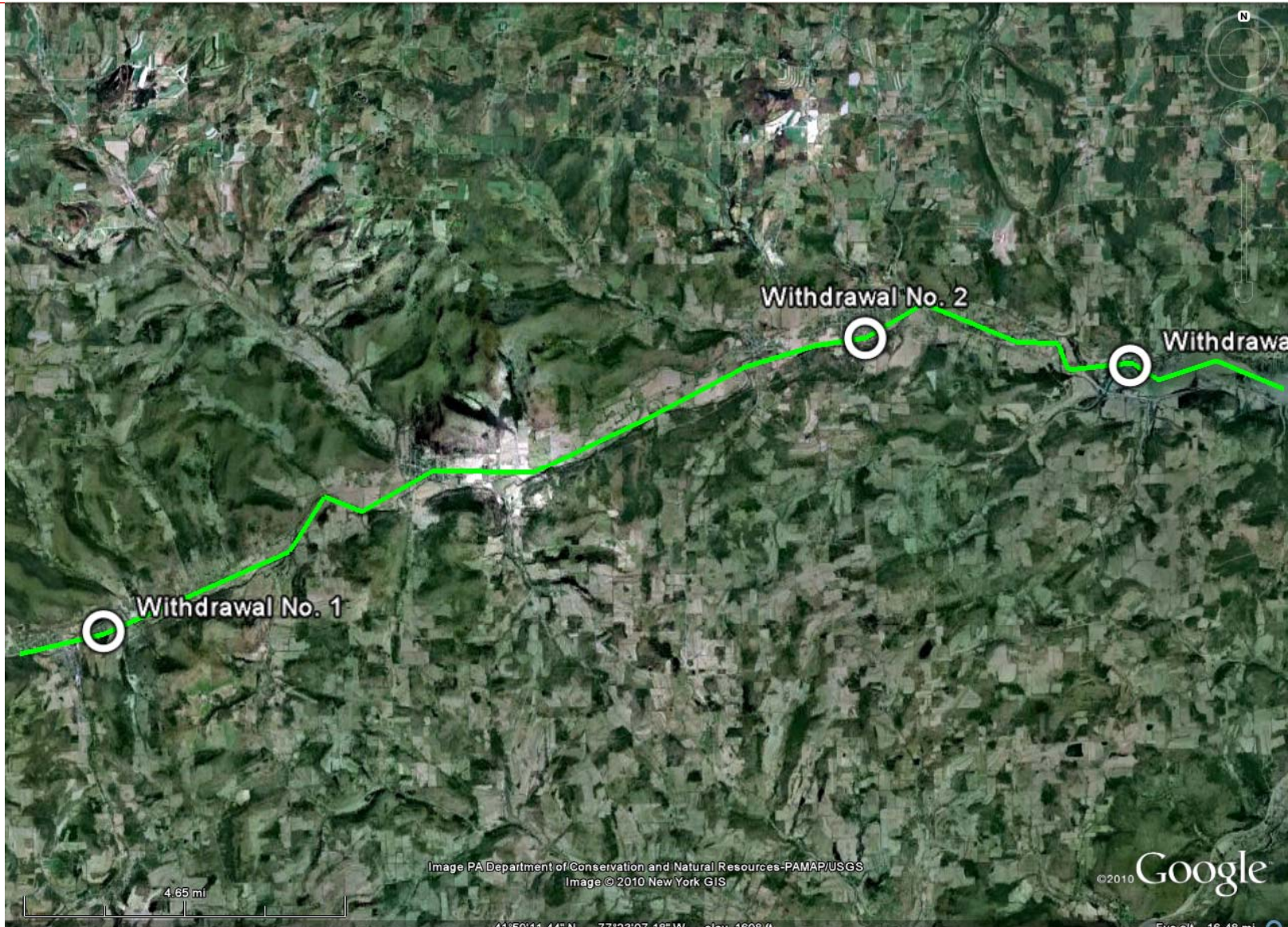


Source: USGS

Susquehanna Basin Gross Availability

	Discharge, cfs	
	$Q_{7,10}$, cfs	Annual mean
Susquehanna River at Wilkes-Barre, PA	821	12,970
Susquehanna River at Danville, PA	1,010	15,000
West Branch Susquehanna River at Williamsport, PA	481	8,760
Susquehanna River at Sunbury, PA	1,740	26,800

Part 3: Benfield Creek



A Local Comparison...

Oatka Creek, Garbutt, New York

ADF = ~95 CFS



Benfield Creek Water Balance, Mean Flow

	Annual mean, cfs	Remaining flow, cfs
USGS Gage	98.10	98.10
Withdrawal No. 1	0.580	97.52
Withdrawal No. 2	0.413	97.11
Withdrawal No. 3	0.772	96.33

20% ADF
19.62

Benfield Creek Water Balance, Low Flow

	$Q_{7,10}$, cfs	Remaining flow, cfs
USGS Gage	1.14	1.14
Withdrawal No. 1	0.580	0.56
Withdrawal No. 2	0.413	0.15
Withdrawal No. 3	0.772	-0.63

Passby Flow

- **Susquehanna River Basin Commission (SRBC) prescribes a quantity of flow that must be allowed to pass a prescribed point downstream of a withdrawal point**
- **Generally calculated based downstream use**
 - ◆ Fish and wildlife
 - ◆ Human consumption
- **Requested withdrawal can sometimes be calculated as percentage of Average Daily Flow (ADF)**
- **Passby Flow can never be less than the Q7,10 flow**

Conclusions

- **There is an abundance of water to support development of the Marcellus Shale in the Susquehanna River Basin**
- **But local flow balances may show periodic insufficient availability**
- **The regulatory process, including the concept of interruptible withdrawals, addresses these insufficiencies**



Questions?
Comments?

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