New York City Department of Environmental Protection
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Briefing to the NYC Water Board on the Natural Gas Impact Assessment Project

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HAZEN AND SAWYER
Environmental Engineers & Scientists

LBG

Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed

Presentation Overview

- Project Overview
- Risk to the NYC watershed
  - Risk to Water Quality
  - Projected well density/rate of development
  - Cumulative risks
  - Risk to NYC Infrastructure
  - Implications for City's Unfiltered Water Supply
- DEP Recommendations

Natural Gas Impact Assessment Project

- In January 2009, Water Board hired Hazen and Sawyer/Leggette, Brashears and Graham (Joint Venture) to conduct an assessment of potential impacts to the NYC watershed from natural gas drilling (DEP is managing the project).
- The assessment focuses on potential impacts to water quality, water quantity and water supply infrastructure.
- Original project is complete. Received a one-year extension to provide additional technical support and analyses.

Project Scope

- Evaluation of natural gas development activities and their impacts
- Analysis of regional hydrogeology and potential water quality signatures
- Review of available data on drilling and fracturing chemicals
- Review of natural gas issues and regulations in other states
- Risk evaluation for DEP major infrastructure
- Cumulative risk evaluation for NYC watershed

Overall Risks to the NYC Watershed

- The development of natural gas in the NYC watershed has significant risks:
  - "Industrialization" of the watershed
  - Infrastructure Risks and Subsurface Migration
  - Water Quality
  - Surface Spills
  - Water Withdrawals
  - Wastewater Treatment and Disposal
- All of these potential impacts could jeopardize our unfiltered status
- The risks are magnified by the rate and density of well development

Key Risks to Watershed and Water Supply

- Pennsylvania experience
  - Rapid natural gas development of the Marcellus shale over the past couple of years
  - Many documented problems including spills, subsurface migration, stream impairments and wastewater disposal issues
- Key risks to NYC watershed/water supply:
  - Water Quality
  - Infrastructure

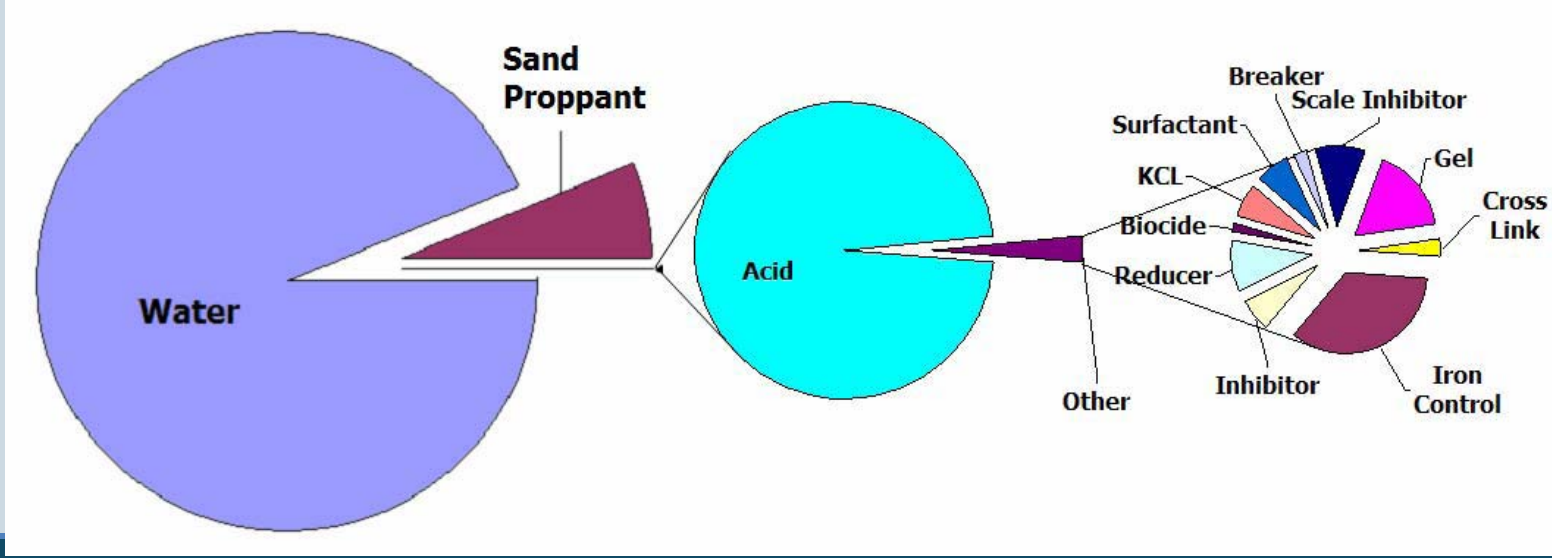
Risk to Water Quality

- Significant potential to adversely impact water quality: on-site spills, vehicle-related spills and subsurface migration of contaminants.
  - These concerns involve the undiluted chemicals, mixed fracking fluids and wastewater

- Cumulatively, the introduction of <u>hundreds of tons per day</u> of fracturing chemicals into the watershed over a period of several decades is significant.

Importation and use of high volumes of chemicals

- Because of the vast volumes of water utilized in hydraulic fracturing, 1 percent concentration of chemical additives to the fracking fluids results in 160 tons of "chemistry"; some of it benign, some of it hazardous, and much of it unknown and undisclosed.



Spill Assessment (High Concentrations)

- JV evaluated the impact of spills using the scenarios described in the dSGEIS but correcting flawed assumptions; analysis uses representative fracture fluid mixes and simple dilution calculations
- For a spill of fracturing chemicals released directly into an individual reservoir:
  - MCLs could be exceeded in all of the WOH reservoirs for most of the contaminants
  - The number of wells required to result in MCL violations ranged from one to eight, with smaller reservoirs being more susceptible

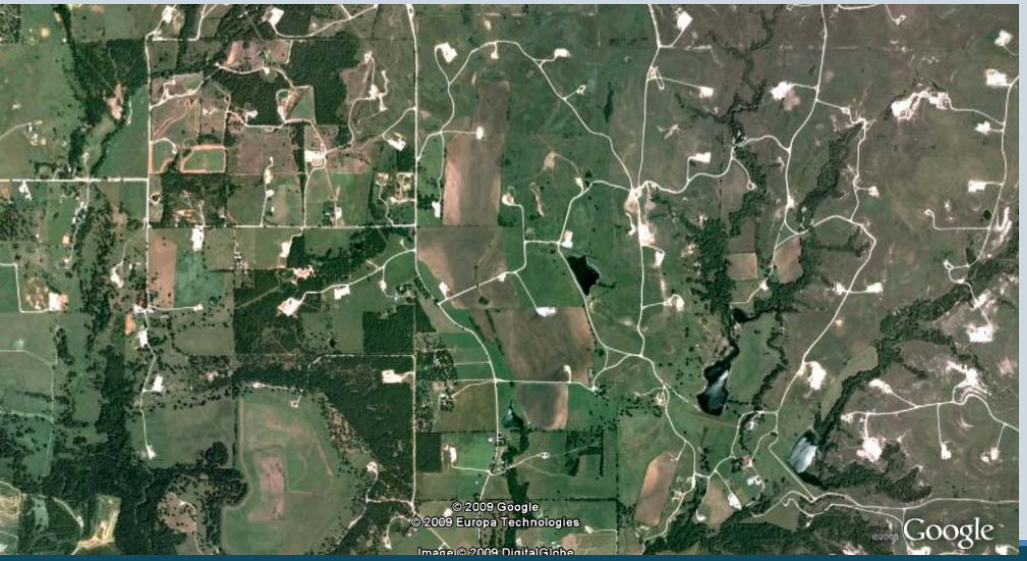
Chronic impacts (Low Concentrations)

- Introducing large amounts of chemicals into the water supply will result in gradual dispersion of low levels of toxic chemicals into the environment and potentially the water supply

- Future health impacts of chronic low doses of these chemicals and future possible regulatory limits and treatment requirements is unclear

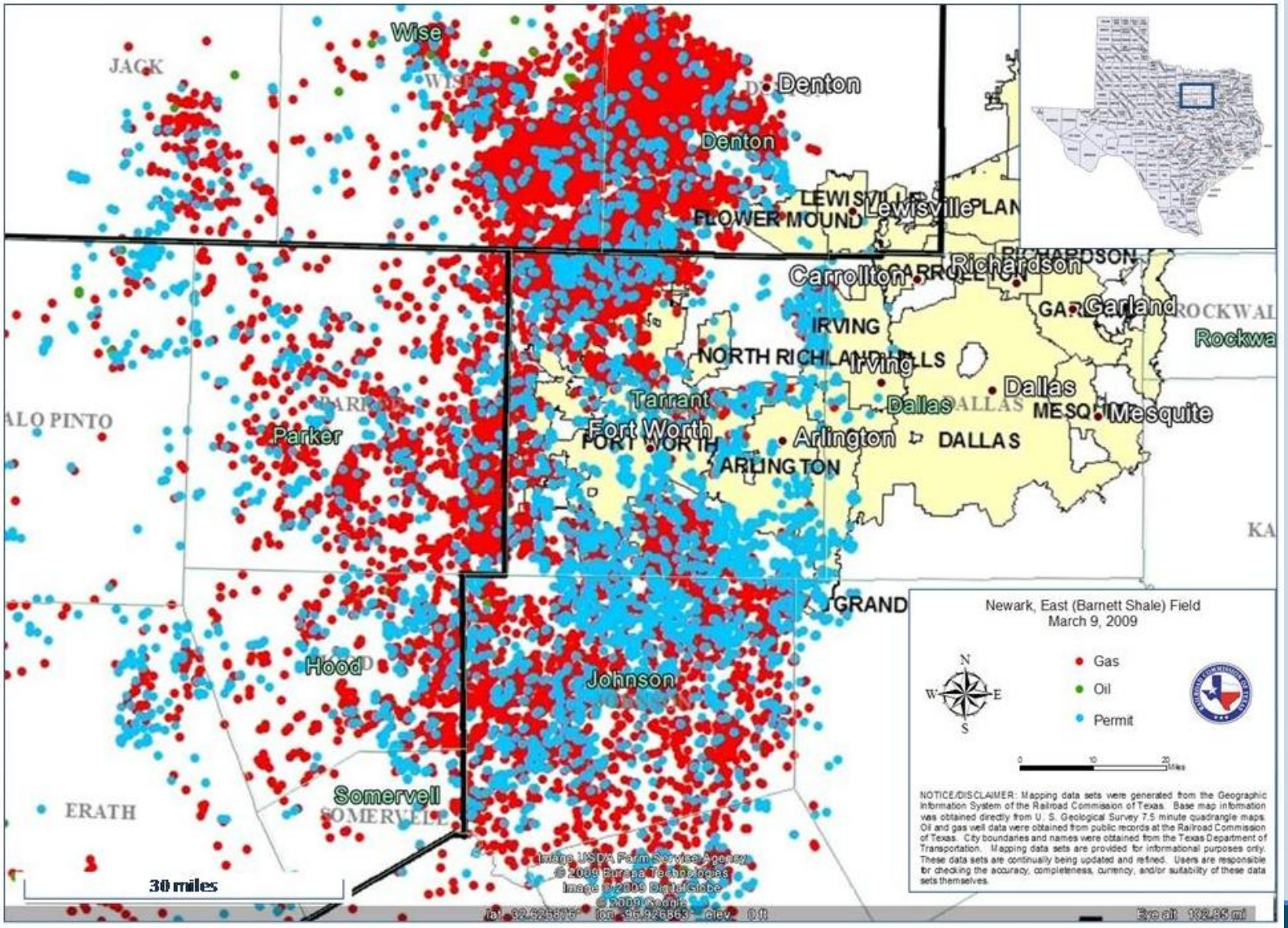
Well Development in the NYC Watershed

- Based on comparable formations:
  - initial rates of 5 to 20 wells per year to an average of 100 to 300 wells per year, potentially peaking at 500 wells per year.

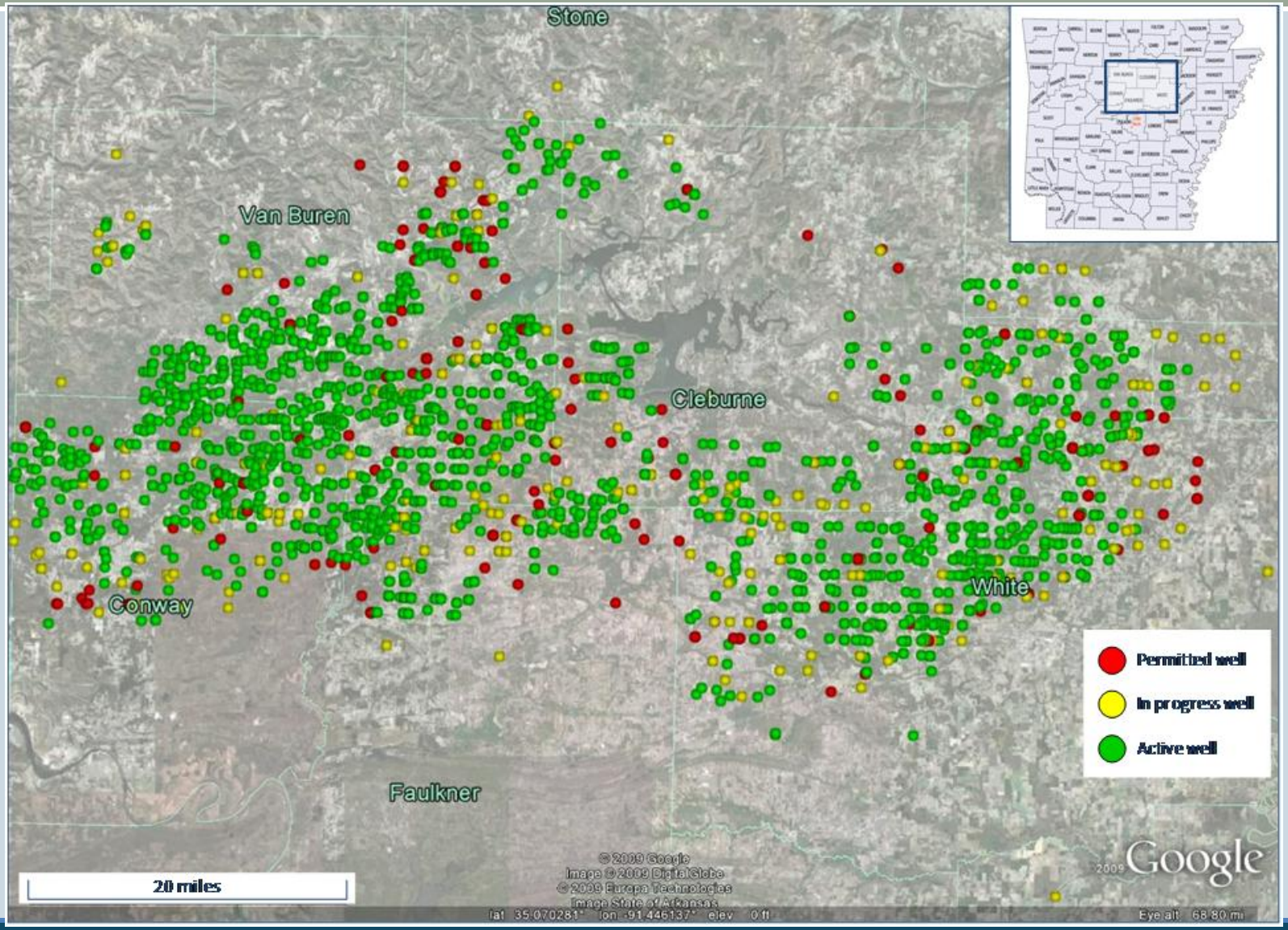


  - Full buildout on the order of 3,000 to 6,000 wells

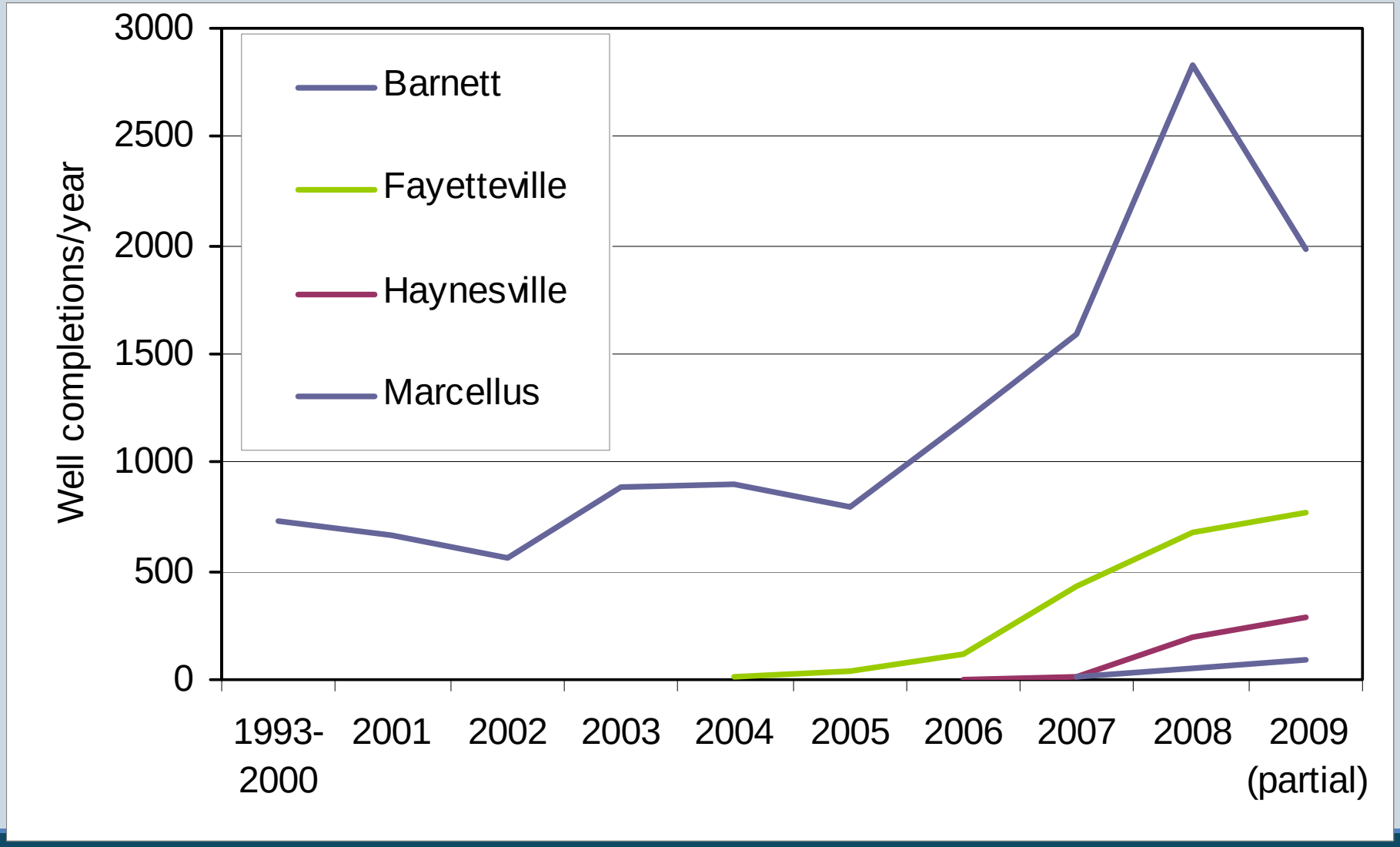
Well density in the Barnett Shale



Well density in the Fayetteville Shale



Well Development Rates in Other Shales



"Industrialization" of the Watershed

- High levels of site disturbance, truck traffic and intensive industrial activity, on a relatively constant basis, over a period of decades, and attendant impacts on overall watershed health

- Trucking activity will be accompanied by provision of equipment and material supply systems gas gathering and pipeline systems, compressor stations, and waste disposal systems.

Wastewater Treatment and Disposal

- The flowback and produced waters resulting from hydrofracturing and gas well operations will produce an industrial-strength waste stream with the potential for adverse health and water quality effects which can be expected to exceed existing treatment and assimilative capacities.

- Disposal options are further complicated by elevated levels of radioactivity in the wastewater and potentially in the wastewater treatment residuals.

Water Withdrawals

- Withdrawals for hydrofracturing could significantly impact commitments for water supply and habitat protection, particularly during periods of low flow.
  - Delaware Basin withdrawals downstream of the NYC reservoirs
  - Withdrawals from the Upper Esopus Creek

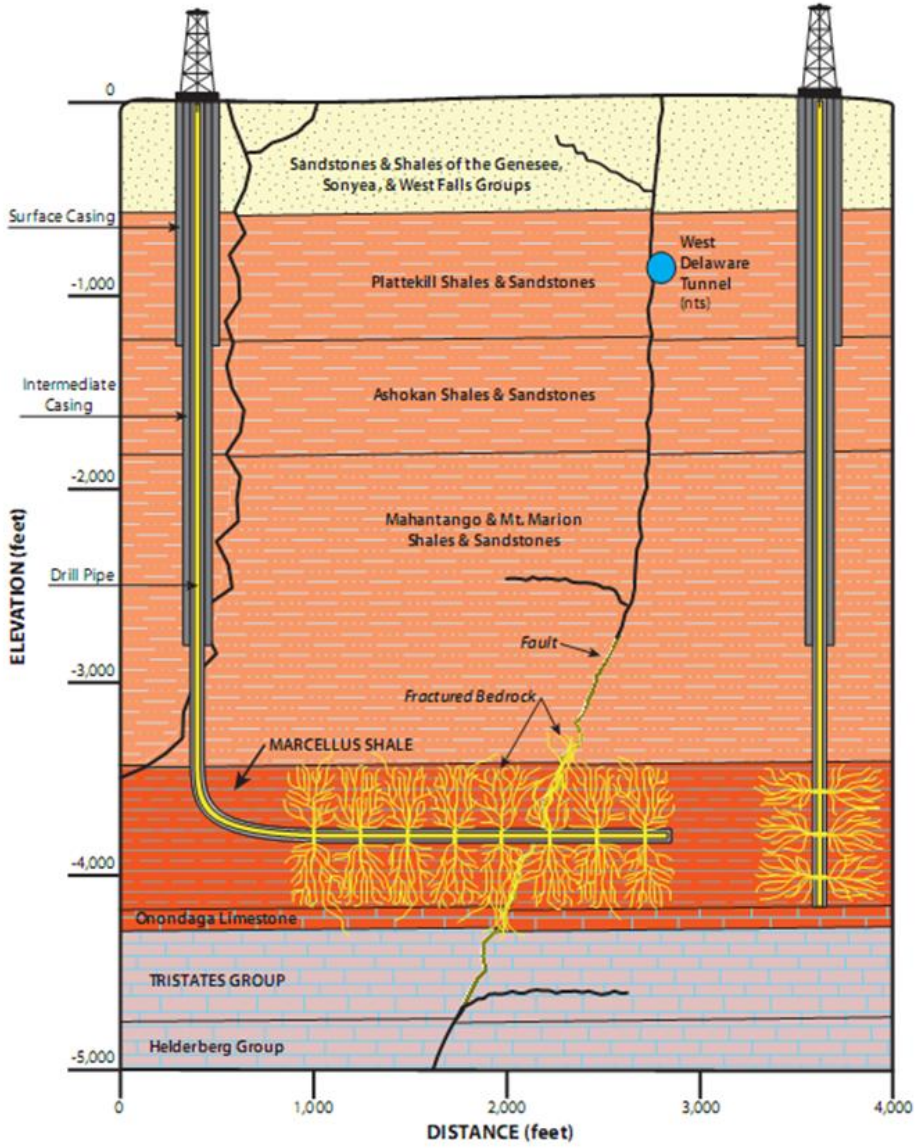
- Excessive water withdrawals may also locally impact aquatic habitat and biota.

Individual and Cumulative Impact Estimates

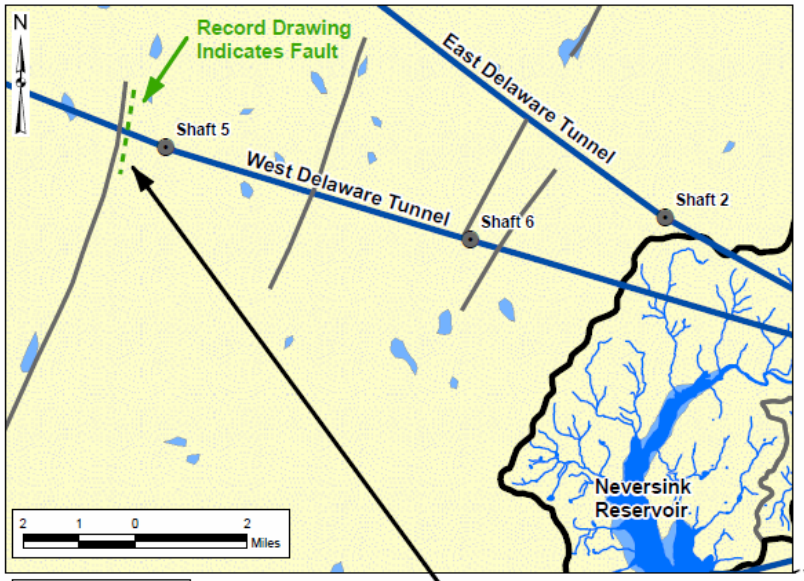
Parameter (units) Estimate (source)	Quantity for One Well (range)	Annual Well Development (Quantity/year)		Full Build-out (Total Quantity)	
		Low	High	Low	High
Number of Wells Assume 6 wells/square mile	1	20	500	3,000	6,000
Site Disturbance (acres) 4 – 6 wells/pad (dSGEIS)	7	28	700	4,200	8,400
Water Consumption (MG) Industry and dSGEIS	4 (3 – 8)	80	2,000	12,000	24,000
Chemical Usage (tons) 0.5 to 2% of fracture fluid; assume 1% (dSGEIS)	167 (83 to 334)	3340	83,500	500,000	1,000,000
Flowback (MG) 10 to ~70% of fracture fluid; assume 50%	2 (0.4 to 2.8)	8	1,400	6,000	12,000
Produced Water (MG /yr) Industry and dSGEIS	0.075 (0.015 to 0.15)	1.5	37.5	225	450
Truck trips 800 – 2000 per well (RIA) 890 – 1340 per well (dSGEIS)	1,200 (800 – 2000)	24,000	600,000	3,600,000	7,200,000

Risk to Infrastructure

- Risk of structural compromise or contamination due to pre-existing fractures and faults that may be influenced by fracking
- Tunnels were designed to keep water in, not to withstand external pressures

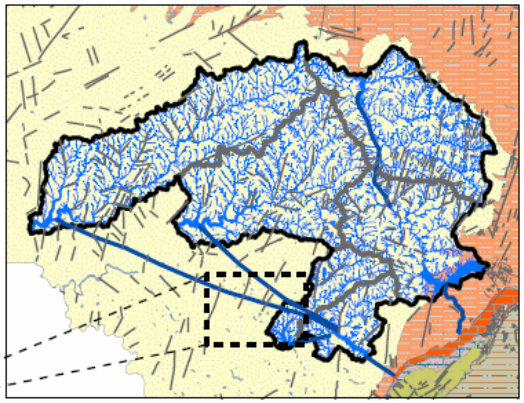


Geologic/Hydrogeologic Data
West Delaware Tunnel



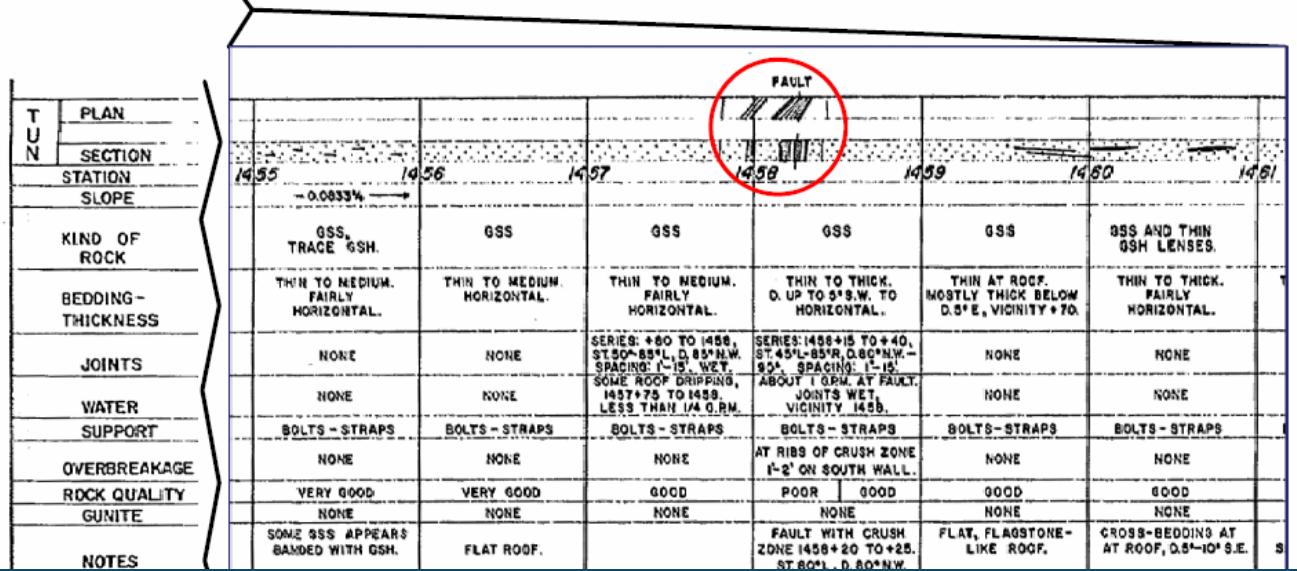
Tunnel at this location is approximately 800' below grade

Marcellus Formation occurs approximately 4,500' below tunnel



Legend

- Tunnel Shaft
- Linear Feature
- Tunnel



TUN						
PLAN				FAULT		
SECTION						
STATION	1455 1456	1457	1458	1459	1460	1461
SLOPE	→ 0.0833% →					
KIND OF ROCK	GSS, TRACE GSH.	GSS	GSS	GSS	GSS	GSS AND THIN GSH LENSES.
BEDDING-THICKNESS	THIN TO MEDIUM. FAIRLY HORIZONTAL.	THIN TO MEDIUM. HORIZONTAL.	THIN TO MEDIUM. FAIRLY HORIZONTAL.	THIN TO THICK. D. UP TO 5° S.W. TO HORIZONTAL.	THIN AT ROOF. MOSTLY THICK BELOW D. 5° E, VICINITY + 70.	THIN TO THICK. FAIRLY HORIZONTAL.
JOINTS	NONE	NONE	SERIES: +60 TO 1456, ST. 50°-85° L, D. 85° N.W. SPACING: 1'-15', WET.	SERIES: 1456+15 TO +40, ST. 45° L-85° R, D. 80° N.W.-90°. SPACING: 1'-15'.	NONE	NONE
WATER	NONE	NONE	SOME ROOF DRIPPING, 1457+75 TO 1459. LESS THAN 1/4 G.P.M.	ABOUT 1 G.P.M. AT FAULT. JOINTS WET, VICINITY 1458.	NONE	NONE
SUPPORT	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS
OVERBREAKAGE	NONE	NONE	NONE	AT RIBS OF CRUSH ZONE 1'-2' ON SOUTH WALL.	NONE	NONE
ROCK QUALITY	VERY GOOD	VERY GOOD	GOOD	POOR / GOOD	GOOD	GOOD
GUNITE	NONE	NONE	NONE	NONE	NONE	NONE
NOTES	SOME GSS APPEARS BANDED WITH GSH.	FLAT ROOF.		FAULT WITH CRUSH ZONE 1456+20 TO +25. ST. 60° L, D. 80° N.W.	FLAT, FLAGSTONE-LIKE ROOF.	CROSS-BEDDING AT AT ROOF, D. 5°-10° S.E.

LEGEND

GSS	GRAY	SANDSTONE
RSS	RED	SANDSTONE
GSH	GRAY	SHALE
RSH	RED	SHALE
CGL	CONGLOMERATE	
ST	STRIKE	
D	DIP	

Implications for City's Unfiltered Supply

- Compromise both public confidence in the City's ability to adequately protect the water supply and technical compliance with water quality regulations.
- "Unfunded mandate" to build a filtration facility currently estimated at $10 billion to build and $100 million per year to operate.
- Current design would be inadequate to remove the chemicals that could be introduced into the watershed potentially raising costs by 50% - 100% and increase the size of the facility.
- Long lead time to design and construct plant.

Major Concerns with SGEIS

- Significant NYC impacts are not adequately analyzed or mitigated (e.g., unfiltered supply, water quality, water quantity, infrastructure, waste disposal)
- SEQRA requirements and SAPA
  - Permit conditions are actually "rules" that need to go through the State Administrative Procedures Act process
- Lack of a Cumulative Impact Assessment

DEP Conclusions

- Major risks result from industrialization, chemical contamination and infrastructure damage
- Given these defects, the City is requesting that DEC withdraw the dSGEIS
- DEP concludes that natural gas exploration, using current industry practices, is incompatible with the unfiltered drinking water system

Questions?