

PRODUCED WATER ISSUES WITH SHALE GAS PRODUCTION

J. Daniel Arthur, P.E., SPEC, ALL Consulting
SPE Tight Gas Completions Workshop
Denver, Colorado
April 28, 2010

*ALL*CONSULTING

SHALE GAS BASINS IN THE UNITED STATES



WATER MANAGEMENT LIFECYCLE

- Phases of water management for shale gas development:
 - Withdrawal
 - Transport
 - Storage
 - Drilling and fracturing
 - Treatment and reuse/recycle
 - Treatment and disposal
- Each stage is inter-related with produced water management



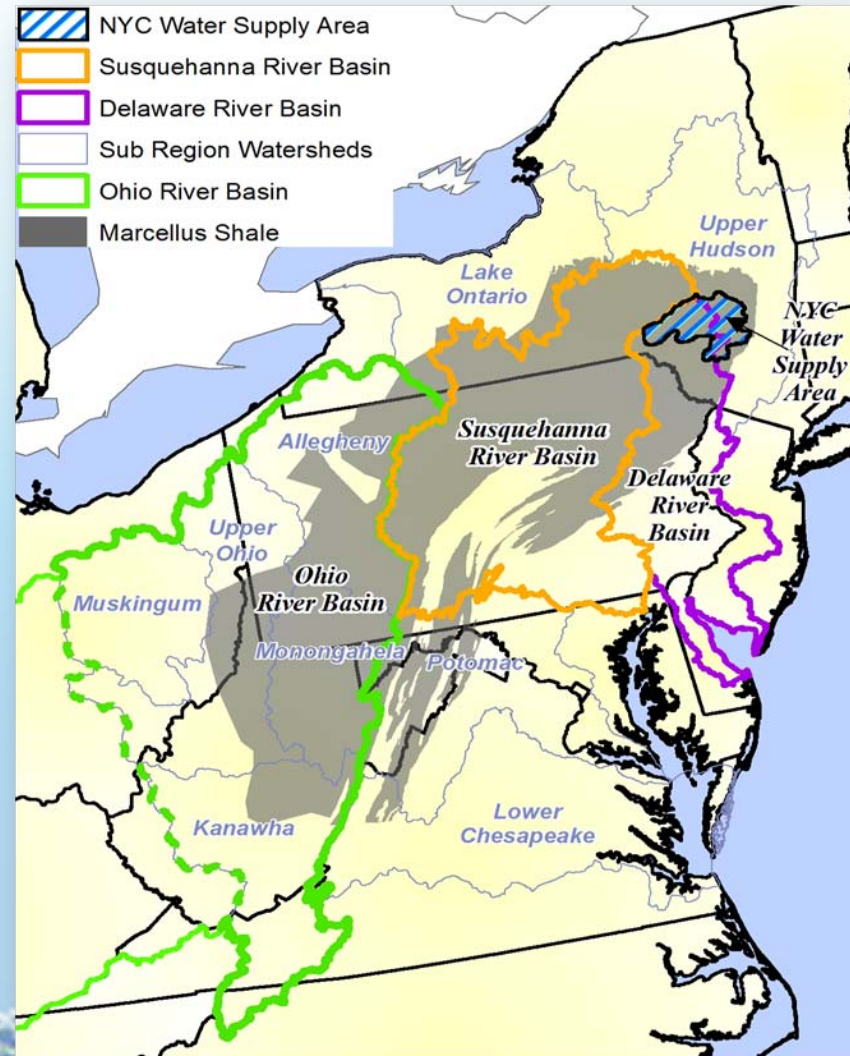
WATER SOURCING ISSUES

- Fresh water volumes
- Location of withdrawal
- Timing of withdrawal
- Re-use /recycling of produced water can reduce these concerns



MARCELLUS PRIMARY WATER JURISDICTIONS

- States
- River Basin Commissions
 - Susquehanna
 - Delaware



SHALE GAS WATER USE - 4 MAJOR SHALE PLAYS

- **Barnett Shale**

10,000 BBLs used for Drilling
70,000 BBLs used for Fracturing

80,000 Total BBLs Used

- **Fayetteville Shale**

1,500 BBLs used for Drilling
70,000 BBLs used for Fracturing

71,500 Total BBLs Used

- **Haynesville Shale**

25,000 BBLs used for Drilling
65,000 BBLs used for Fracturing

90,000 Total BBLs Used

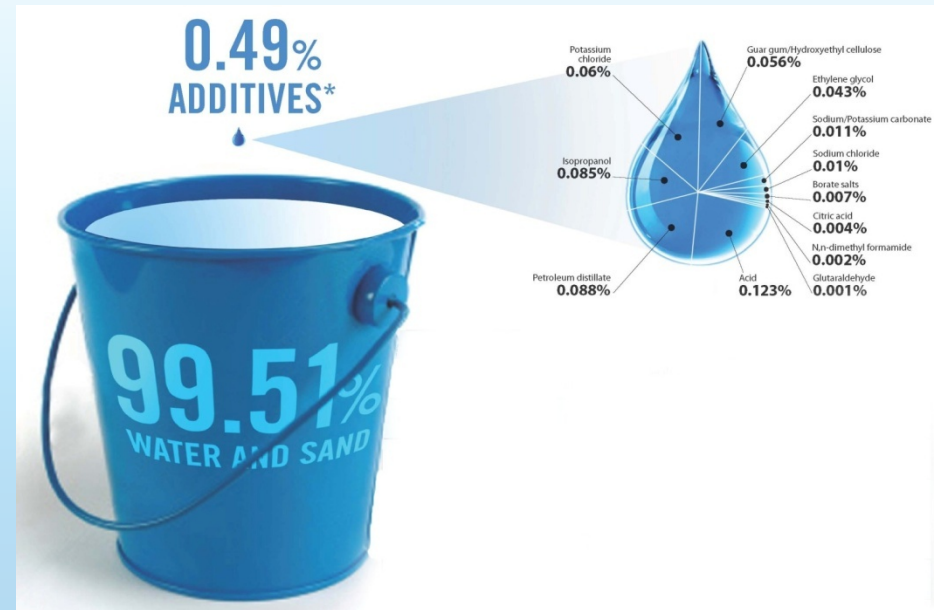
- **Marcellus Shale**

2,000 BBLs used for Drilling
90,000 BBLs used for Fracturing

92,000 Total BBLs Used

WELL DRILLING AND HYDRAULIC FRACTURING

- Hydraulic fracturing uses more water than drilling,
- Fracturing fluid is >99% water and sand.
- Analysis shows extremely low probability of fracture fluid migration from the shale up to fresh water zones.



*Image: EnergyinDepth.org 2009
Source: Compiled from Data
collected at a Fayetteville Shale
Fracture Stimulation by ALL
Consulting 2008.*

ALLCONSULTING

Total Water Use – 4 Major Shale Plays

Shale Play	Public Supply	Industrial and Mining	Power Generation	Irrigation	Livestock	Shale Gas Wells	Total Water Use (Billion Bbl/yr)
Barnett	82.70%	4.50%	3.70%	6.30%	2.30%	0.4%	11.15
Fayetteville	2.30%	1.10%	33.30%	62.90%	0.30%	0.1%	31.9
Haynesville	45.90%	27.20%	13.50%	8.50%	4.00%	0.8%	2.15
Marcellus	11.97%	16.13%	71.70%	0.12%	0.01%	0.8%	85

Water Disposal Options by Basin

Basin	Class II UIC	Water Treatment	Reuse/Recycle
Barnett	Local	No	Yes
Fayetteville	Distant	Evaluating	Evaluating
Haynesville	Local	No	No
Marcellus	Limited/Exploring	Yes	Evaluating

PRODUCED WATER- UIC DISPOSAL

- Class II UIC wells are the primary means for management of produced water from Shale Gas
- In areas new to O&G development, commercial UIC wells may not yet be available
- Some areas (e.g. the Marcellus Shale play) are geologically challenged with limited available injection zones



PRODUCED WATER TREATMENT OPTIONS

- Distillation/ Evaporation
 - To concentrated brine
 - To crystalline salts
- Reverse osmosis
- Treatment and recycling



Treatment Option Limitations

- All approaches have limitations, primarily:
 - Quality and quantity of water that can be treated
 - Waste volumes and management:
 - › Concentrated brine from Distillation/Evaporation and RO
 - › Salt crystal from Distillation/Evaporation
 - Economic viability
- Generally, as the TDS of the produced water increases, the volume of useable treated water decreases and waste increases

PRODUCED WATER TREATMENT AND REUSE

- Many operators and service companies now considering viability of partially treating flowback water sufficient for reuse in the next fracture job
- Controlling factors may include:
 - TDS
 - Scale producing sulfates
 - Chemical requirements of next fracture job



NATURALLY OCCURRING RADIOACTIVE MATERIALS (NORM)

- Shales naturally contain low levels of NORM – levels vary by play
- NORM generally remains in drill cuttings or scale – some of which may be suspended in produced water
- Radiation levels are low (these are not NRC levels)
- Implications for produced water management are likely to evolve as data are gathered



REGULATORY CONSIDERATIONS

- New York Draft Supplemental Generic Environmental Impact Statement
- Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act)
- EPA Study of Hydraulic Fracturing and Drinking Water

EPA HYDRAULIC FRACTURING STUDY

- Requested by Congress: “*carry out a study on the relationship between hydraulic fracturing and drinking water...*”
- Being conducted by EPA ORD
 - Research study
 - Not a policy study
- EPA’s draft scope is very broad
- \$4.4 million budgeted thus far
- Research plan scheduled for September 2010
- Initial research products by the end of 2012

CONTACT INFORMATION

Dan Arthur, P.E., SPEC

ALL Consulting
1718 S. Cheyenne Avenue
Tulsa, Oklahoma 74119
www.ALL-LLC.com

*ALL*CONSULTING