Shale Gas Operations

Regulation of Water and Air Impacts
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November 15, 2011

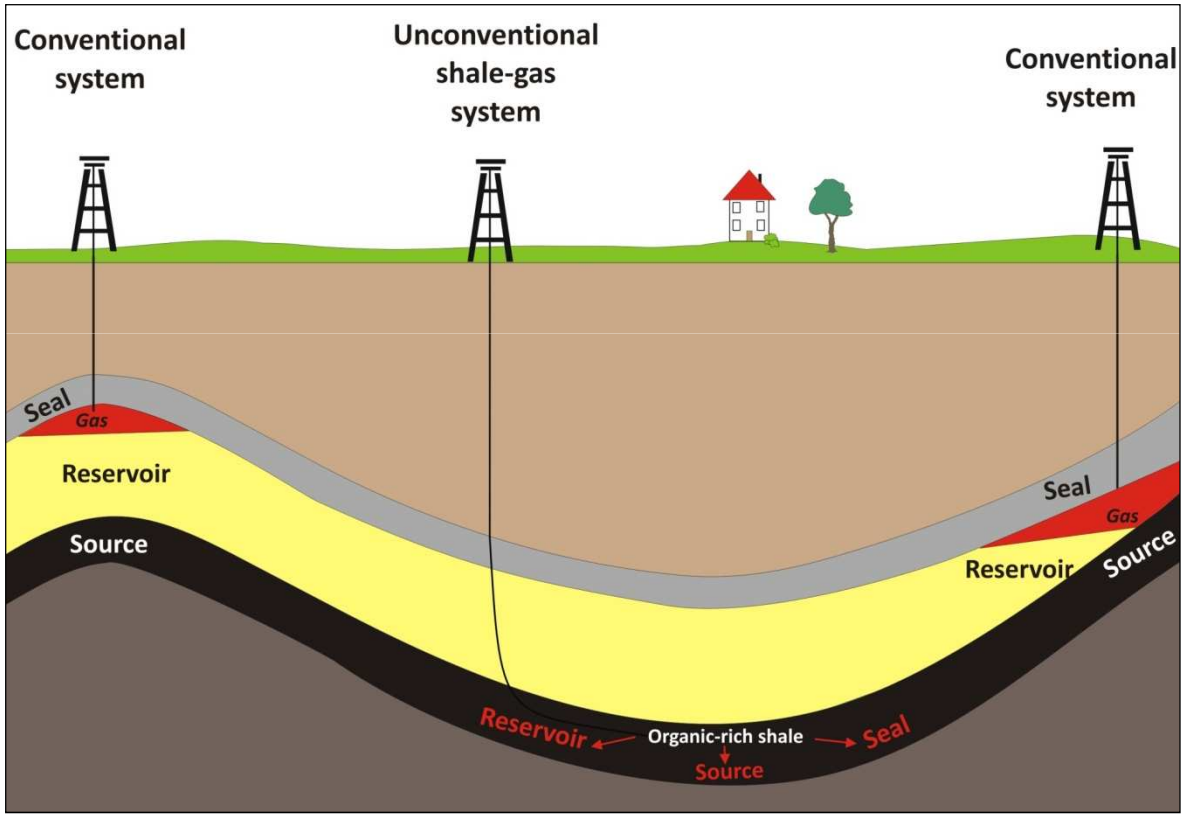
Dinsmore

We will be covering:

- Well drilling, fracking and steps to market
- Regulation of water impacts
  - Current & proposed federal law
  - EPA study, DOE Subcommittee report
  - Regulations & proposals in key states
- Regulation of air impacts
  - EPA NSPS/MACT proposal
  - Stationary engines
  - Ozone
  - Aggregation
  - GHG Reporting
  - State activity

Drilling the Shale Resources

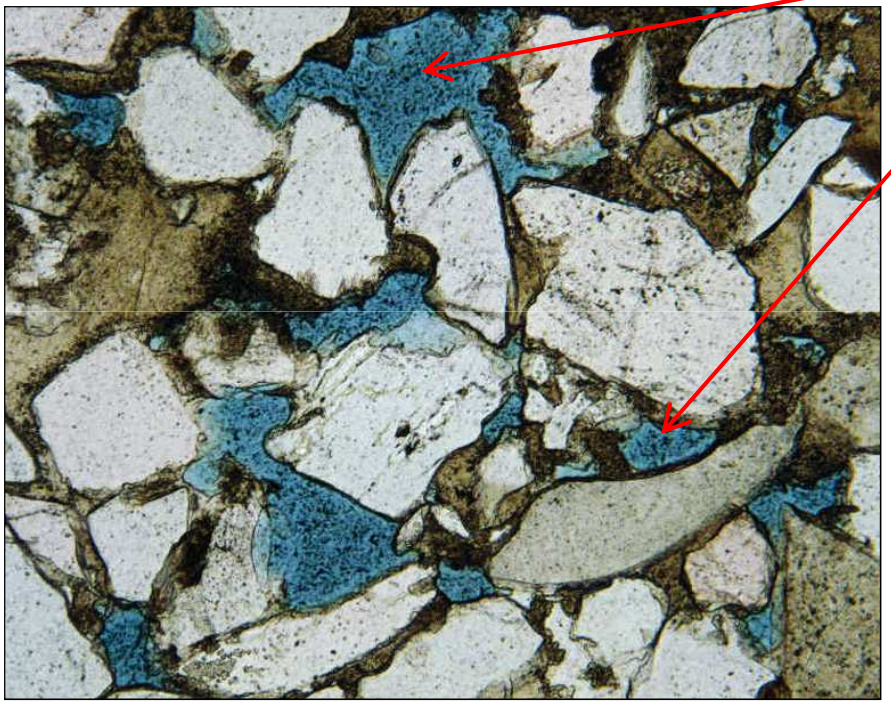
- First, what is shale?



From Kostelnick (2010), modified from Schmoker and Oscarson (1995).

Drilling the Shale Resources

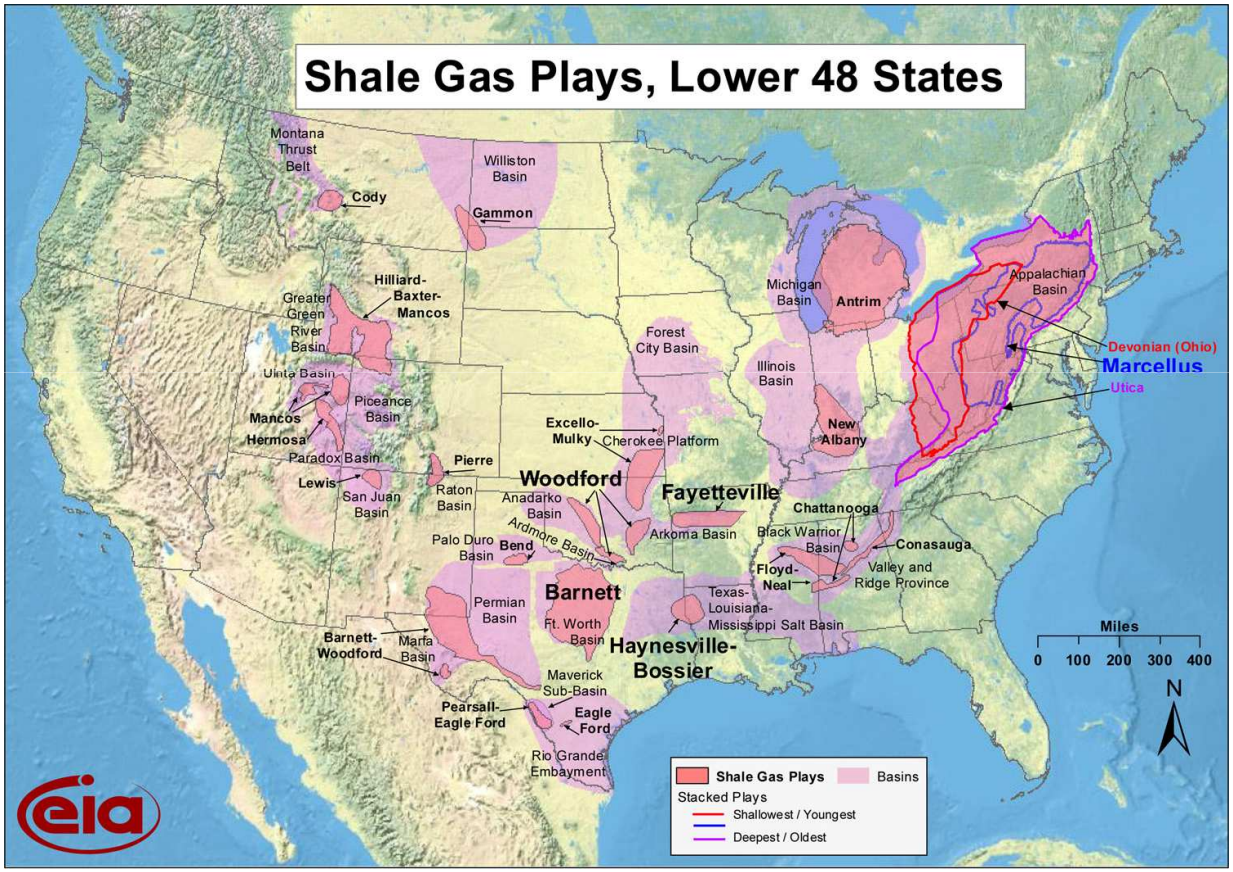
- Shale source, up close



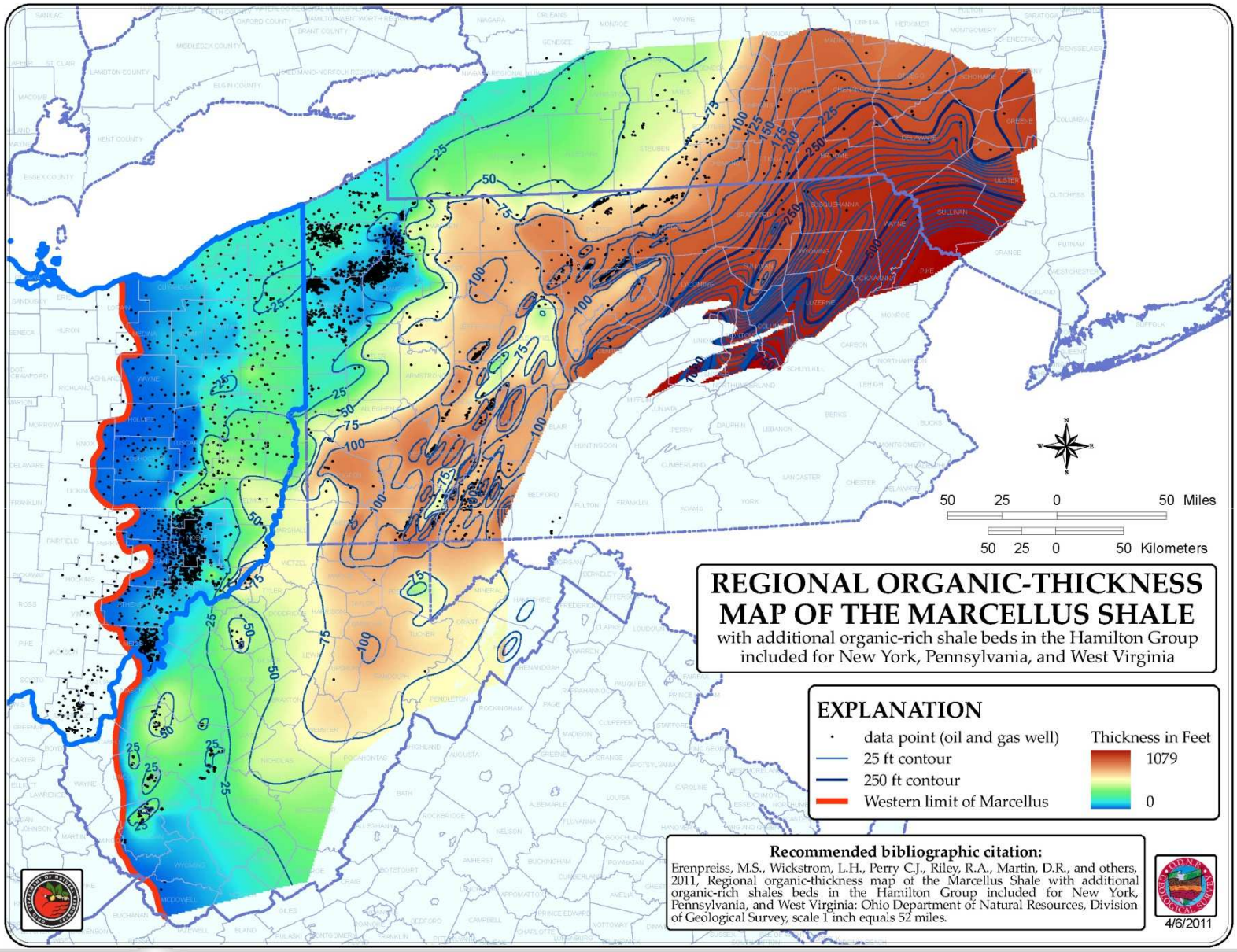
From Kostelnick (2010), modified by ODNR Geological Survey

Drilling the Shale Resources

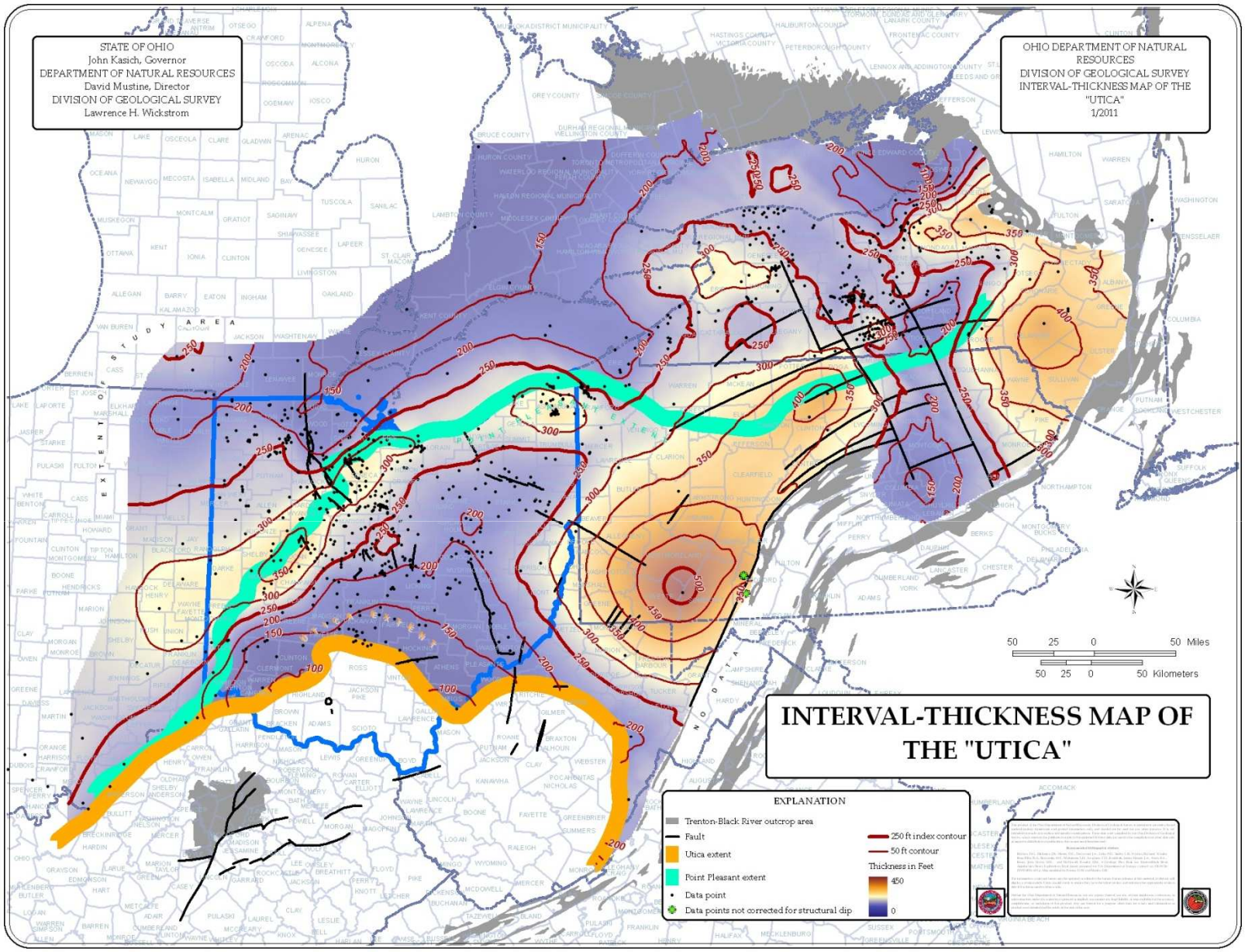
- Where is it, geographically?



From U.S. EIA (2010).



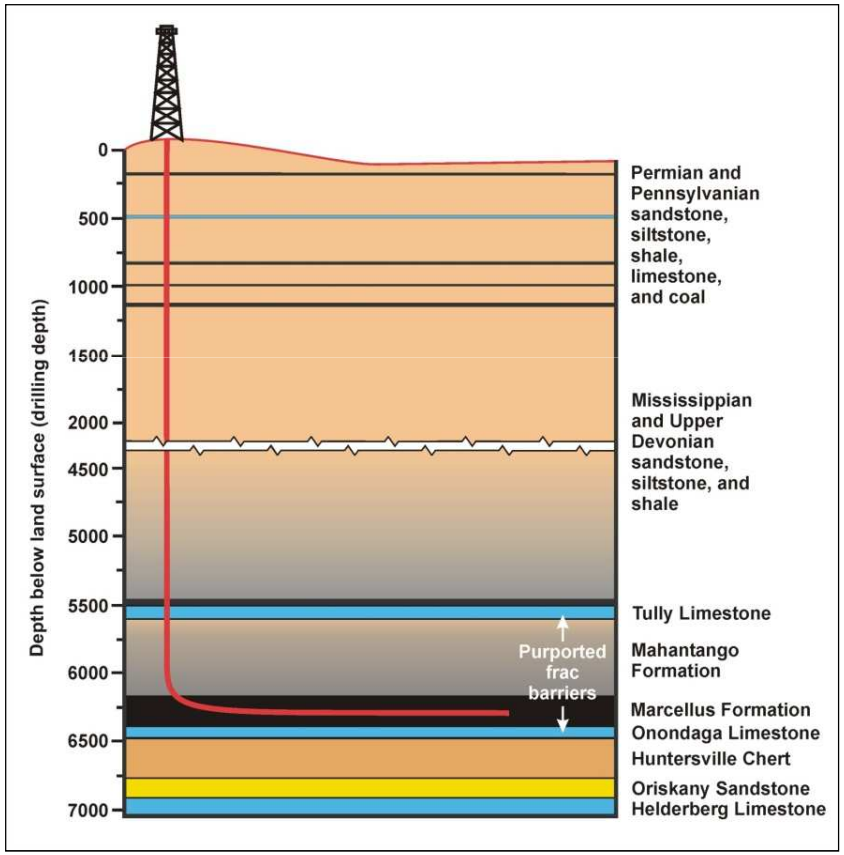
Source: www.dnr.oh.state.us



Source: www.dnr.oh.state.us

Drilling the Shale Resources

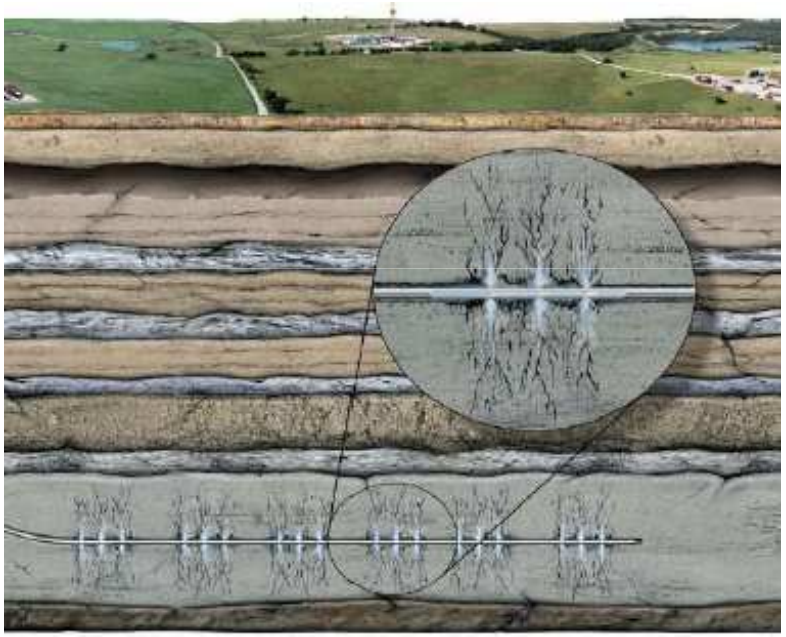
- Where is it, in terms of depth?



Graphic from Kostelnick (2010).

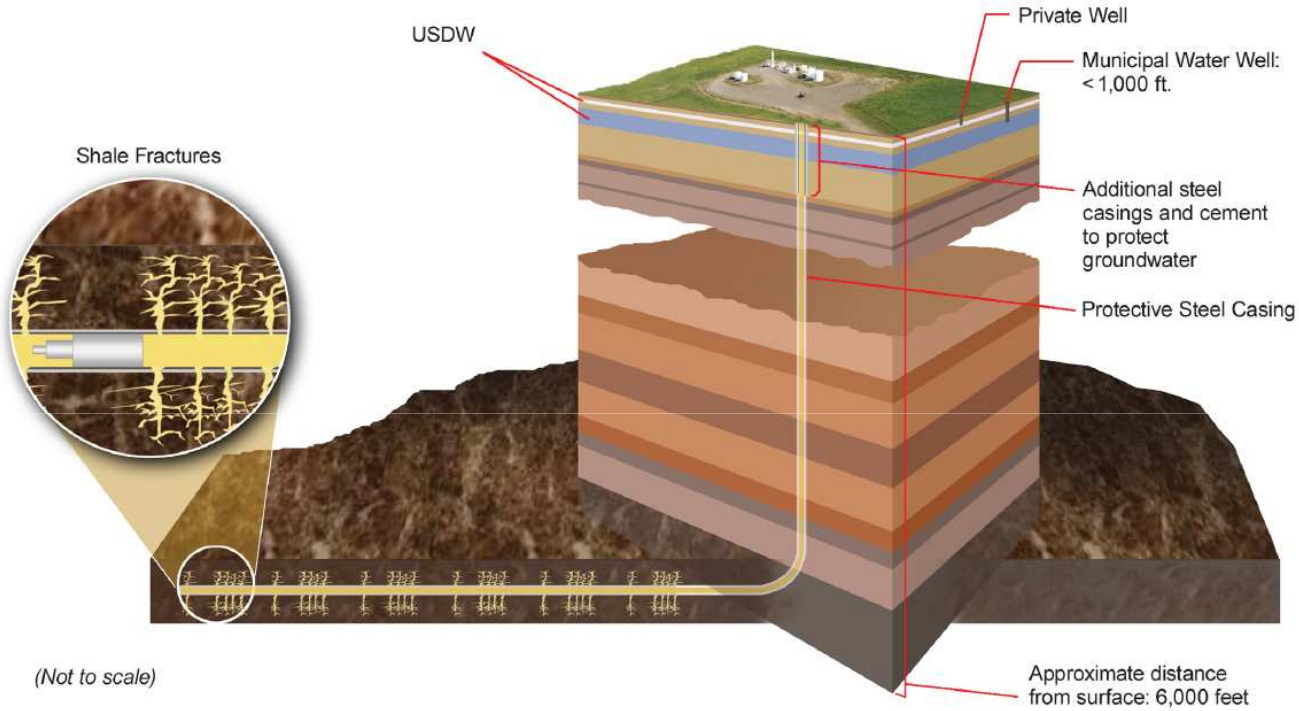
Drilling the Shale Resources

- Basic Process



Source: PIOGA.

Drilling the Shale Resources



Steel casing lines the well and is cemented in place to prevent any communication up the wellbore as the fracturing job is pumped or the well is produced. Shallow formations holding fresh water that may be useful for farming or public consumption are separated from the fractured shale by thousands of feet of rock.

Source: Shale Gas: Applying Technology to Solve America's Energy Challenges," NETL, 2011 (as posted on www.fossil.energy.gov).

Drilling the Shale Resources

- Estimating the Resources:
  - Marcellus wells drilled in West Virginia:
    - 2008: 299
    - 2009: 430
    - 2010: 58
    - 2020 (estimate): 900
  - Estimated economic impact in W.Va. (2008):
    - $371 million – gross economic impact
    - $189 million – value added
    - $ 68 million – taxes
    - 2,200 jobs
  - Estimated cumulative value added (2020): $2.8 billion*

* U.S. DOE, NETL, March 31, 2010

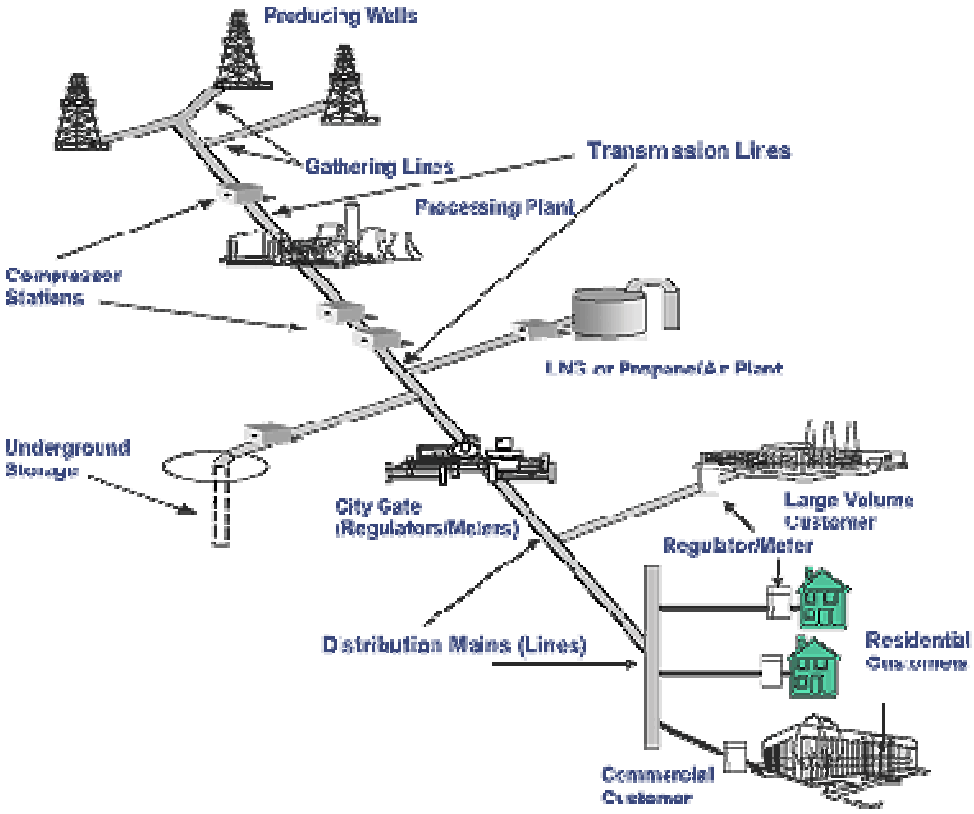
Drilling the Shale Resources

more Insight.

- Estimating the Resources, cont'd:
  - Chris Perry, ODNR Geological Survey:
    - Estimates Utica/Point Pleasant to have 3.75-15.7 Tcf natural gas & 1.31-5.5 billion barrels oil (recoverable from the interval)
  - Chesapeake:
    - Aug. 1, 2011: Estimated its then-acreage of 1.25 million acres in the Utica formation to be worth $15-20 billion
    - Sept. 21-22, 2011 Kasich Energy Summit: Overall shale play could be worth $500 billion. Aubrey McClendon: "I prefer to say half a trillion."

Drilling the Shale Resources

- Steps beyond production



Source: www.epa.gov

Regulation of Water Impacts

more Insight.

- Key Water Issues
  - 500,000 to 5,000,000+ gallons of water used per well
    - Per GWPC, averages = 80,000 gal for drilling & 3.8 mill gal for hydraulic fracturing of one Marcellus well
    - Per Chesapeake's estimates: 100,000 gal for drilling, 5.5 mill gal for fracturing
  - In relation to other water users (power plants, municipalities, relatively low percentage of total basin water use (estimates: 0.1% to 0.8% – GWPC)

Regulation of Water Impacts

more Insight.

- Key Water Issues, cont'd
  - Source of the water?
    - Surface waters
      - Registration, notification requirements
      - Limits on flows and total amounts (note: WVDEP on-line tool)
      - Impoundments to retain seasonal flow
    - Groundwater wells
    - Re-use of produced water
    - Use of treated acid mine drainage?

Regulation of Water Impacts

more Insight.

- Key Water Issues, cont'd
  - Water Uses
    - Drilling fluids: water and chemicals to promote circulation of cuttings, lubricate/cool drilling bit, stabilize wellbore & control downhole fluid pressure
    - Key concern: use in fracturing along horizontal well bore (a.k.a. "fracking")
      - Composition: water, proppant (such as sand) & chemicals (<2%)
      - Identity of chemicals and mix: "designing hydraulic fracture treatments"
        - Sequential stages of hydraulic fracturing
        - Sub-stages: series of different volumes of fracture fluids

Regulation of Water Impacts

- Water Uses, cont'd:
  - Chemicals / mix cont'd:
    - Types: friction-reducers; biocides; anti-corrosion stabilizers; acids to remove drilling mud damage close to wellbore area
    - Typical constituents: hydrochloric or muriatic acid; glutaraldehyde; ammonium persulfate; borate salts; polyacrylamide; mineral oil; guar gum; citric acid; potassium chloride; sodium or potassium carbonate; silica/quartz sand; ethylene glycol; isopropanol

Regulation of Water Impacts

- Terminology
  - Produced water (i.e., “produced” along with the gas)
    - Returned fracturing fluids (a.k.a. “flowback” water)
    - Natural formation water
  - Flowback water (includes “stranded fluids” that take longer to return)
  - Slickwater: water-based fracturing fluid mixed with friction-reducer
  - Drilling fluids: see above
  - “Waters of the United States” (Clean Water Act)
    - *a separate Webinar would be necessary!*

Regulation of Water Impacts

more Insight.

- Disposal Issues
  - Amounts: from 10%-70% of original fracture fluid volume
    - Varies by formation and geology
    - Most produced water generated within hours to 2 weeks; some months
    - EPA: up to 1 million gallons from a single well within 30 days
    - Other estimates: 25% after fracking complete; 20% more over life of well

Regulation of Water Impacts

more Insight.

- Disposal issues, cont'd
  - Direct discharge to surface waters prohibited under Clean Water Act
    - Pretreatment and discharge via Publicly Owned Treatment Works (POTWs) – substantially curtailed by State agencies
    - EPA – developing Effluent Limit Guidelines (2014) for shale gas wastewater treatment based on current and evolving technologies and options, affordability, etc.
      - Note: Stormwater rule already requires NPDES permit coverage for surface activities if runoff contributes to a water quality standard violation

Regulation of Water Impacts

more Insight.

- Disposal issues, cont'd
  - Underground injection
    - Underground Injection Control (UIC) program under Safe Drinking Water Act
    - May be either EPA-administered or delegated to State environ agency
    - Currently, "underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas or geothermal production activities" is excluded from the definition of "underground injection" subject to UIC permitting requirement

Regulation of Water Impacts

more Insight.

- Disposal issues, cont'd
  - Underground injection, cont'd
    - Based on 2004 EPA study regarding possible effects of hydraulic fracturing of coalbed methane wells (found no concerns, other than when diesel fuel used)
    - Pending litigation (D.C. Circuit) over EPA requirement (announced via 6/28/20 web posting) that UIC projects involving use of diesel fuel must obtain permits (challenge is based on alleged violation of Administrative Procedures Act's rulemaking requirements)
    - House Committee on Energy and Commerce study regarding scope of use of diesel fuel in hydraulic fracturing (see 10/25/11 letter from Democrats on committee to Lisa Jackson, EPA)

Regulation of Water Impacts

more Insight.

- Current Federal Studies and Initiatives
  - EPA Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Sources (finalized Nov. 3, 2011)
    - Criticized by many as being unjustified, given the dearth of documented instances of adverse effects on drinking water (EPA: no documented cases of fracking process causing contamination of water supplies – Feb. 2009, Steve Heare – Director, EPA Drinking Water Protection Division)
    - Criticized by some States as overly intrusive on traditional State areas and beyond scope of UIC program (i.e., “Full lifecycle of water in hydraulic fracturing,” including water withdrawal, well design and construction, etc.)

Regulation of Water Impacts

- Current Federal Studies and Initiatives
  - EPA Plan, cont'd
    - Concern that EPA plans to ignore effect of existing state regulation, best industry practices and existing federal laws to manage any risk associated with hydraulic fracturing
    - Concern that EPA will duplicate prior studies addressing potential impact of spills, treatment and disposal of produced water, that have already been reflected in current programs under SDWA, CWA, and RCRA – and suggest entire new regulatory program following that new review ("Unfortunately, objectivity is not EPA's strong suit…." Chairman Ralph M. Hall (R-TX), House Committee on Science, Space and Technology)

Regulation of Water Impacts

more Insight.

- Current Federal Studies and Initiatives, cont'd
  - DOE, Advisory Board, Shale Gas Production Subcommittee, Second 90-Day Report (Nov. 18, 2011)
    - No demonstrated need for additional federal regulation via SDWA; recommend that federal funding be granted to STRONGER and Ground Water Protection Council, and improved communication between federal and state regulators
    - recommends development of a national data portal, to improve public information about shale gas operations
    - Supports DOI announced plan to require disclosure of fracturing fluid composition for all wells drilled on federal lands; recognizes that industry appears willing to do this across-the-board
    - Measure and publicly report composition of water stocks and flow throughout the fracturing and reclamation process; manifest all transfers of water among different locations
    - Adopt best practices in well development and construction (especially casing, cementing and pressure management)
    - Adopt requirements for background water quality surveys

Regulation of Water Impacts

more Insight.

- Current Federal Studies and Initiatives, cont'd
  - EPA, Pavillion, Wyoming Water Well Study (Latest Data Release – Nov. 9, 2011)
    - Follows earlier testing from April, 2010
    - Methane found in 10 of 28 drinking water wells of thermogenic origin
    - Low levels of petroleum compounds in 17 of 19 drinking water wells sampled (same results found in nearby shallow groundwater)
    - Monitoring wells showed significantly elevated potassium and chloride
    - Only gas operator in area: Encana
    - No published conclusions; residents provided with alternative water by Encana

Regulation of Water Impacts

more Insight.

- State Studies and Legislative Initiatives
  - Penn State, Center for Rural Pennsylvania, October, 2011 Study
    - Pre- and post-drilling assessment of 233 drinking water wells
    - Pre- and post-hydraulic fracturing assessments
    - Conclusion: no statistically significant correlation between water quality and gas well drilling or fracturing
    - Approximately 40% of wells fell below SDWA standards before drilling
    - A few wells showed higher bromide levels after drilling

Regulation of Water Impacts

more Insight.

- State Studies and Legislative Initiatives, cont'd
  - West Virginia Emergency Rules, Draft Legislation
    - July 12, 2011 – W.Va. Governor Tomblin's Executive Order 4-11
    - August 29, 2011 – WVDEP Emergency Rule, W.Va. CSR 35-8-1, et seq.
      - "Rules Governing Horizontal Well Development"
      - Expires November 29, 2012
    - Draft Legislation
      - withdrawing 210,000 gallons of water or more in one month – Water Management Plan
      - includes complete identification of water supply, use and disposal; disclosure of expected composition of fracking fluid and post-reporting of actual constituents; signage at water withdrawal locations, etc.

Regulation of Water Impacts

more Insight.

- State Studies and Legislative Initiatives, cont'd
  - West Virginia Draft Legislation, cont'd
    - impoundment capable of holding 210,000 gallons or more: requires Certificate of Approval (RPE)
    - detailed casing "Guidance" to be issued by WVDEP
    - mandatory pre-drilling surveys; rebuttable presumption of water well contamination if damage occurs and gas well was within 2500' of water well

Regulation of Air Impacts

- Potential Air Emission Sources and Issues
  - Engine emissions from drill rigs, fracking equipment and on-site power generation
  - Fugitive emissions from hydrocarbons in flowback
  - Emissions from venting and flaring of gas during flowback (prior to routing of gas to gathering or capture)
  - Separators (to heat multi-phase production)
  - Storage vessels
  - Pneumatic controls
  - Glycol dehydrators
  - Compressors
  - Desulfurization units

Regulation of Air Impacts

- EPA Proposed NSPS and MACT for oil and gas:
  - New Source Performance Standards (NSPS)
    - Under Section 111 of the Clean Air Act (CAA)
    - For new, modified or reconstructed sources in categories of stationary sources that EPA has determined cause or contribute significantly to air pollution
    - Based on best system of emission reduction
    - NSPS at issue:
      - 40 CFR part 60, subpart KKK -- leak detection of VOCs & repairs at gas processing plants
      - 40 CFR part 60, subpart LLL -- SO2 controls at gas processing plants
      - Set in 1985
    - Compliance stems from *promulgation* of revised NSPS*

Regulation of Air Impacts

- EPA Proposed NSPS and MACT for oil and gas, cont'd:
  - National Emissions Standards for Hazardous Air Pollutants (NESHAP)
    - Under Section 112 of the CAA
    - For major sources:
      - those with PTE 10 tpy of a hazardous air pollutant (HAP), or
      - those with PTE 25 tpy of any combination of HAPs
    - Based on the maximum degree of emission reductions of HAP achievable ("maximum achievable control technology" or MACT)
    - NESHAPs at issue:
      - Benzene, toluene, ethylbenzene, xylene and n-hexane
      - 40 CFR part 63, subpart HH -- oil and natural gas production operations (tanks, leaks, certain glycol dehydrators)
      - 40 CFR part 63, subpart HHH -- glycol dehydrators at natural gas transmission and storage operations that are considered major

Regulation of Air Impacts

more Insight.

- EPA Proposal, cont'd:
  - Background behind current proposal:
    - NSPS: 8-year review, revised as appropriate
    - NESHAPs: 8-year technology review & one-time "residual risk" review
    - "Deadline suit" brought by WildEarth Guardians & San Juan Citizens Alliance in January 2009, U.S. District Court in D.C.; resulted in consent decree
      - July 28, 2011: signature date for proposal (published August 23, 2011*)
        - October 31, 2011: comment deadline
      - April 3, 2012: signature date for final
  - Significant claims by EPA:
    - Methane emissions significantly reduced (not directly controlled) – 3.4 mill tons
    - Industry will actually *save* money! ($30 mill annually)

Regulation of Air Impacts

more Insight.

- EPA Proposal – NSPS Component:
  - 40 CFR Part 60, Subpart OOOO
    - Subparts KKK & LLL will continue to exist, for sources already subject to standards
  - Proposed NSPS targets:
    - Well completions and recompletions
      - Process of preparing wells for completion
      - Includes hydraulically fractured (& refracked) wells
    - Compressors
    - Pneumatic controllers
    - Storage vessels

Regulation of Air Impacts

more Insight.

- EPA Proposal – NSPS Component, cont'd:
  - Well completions & recompletions:
    - **Green** completion, aka "reduced emissions completion"
      - flowback water, sand, hydrocarbon condensate and natural gas separated to reduce natural gas and VOCs vented to the atmosphere
      - VOC condensate & salable natural gas are recovered
      - Pit-flaring for gas not suitable for entering the gathering line + for exploratory or delineation wells
    - 30-day advance notice
    - EPA predicts:
      - 20,000 wells annually
      - VOCs reduced by 95%; 90% salable gas recovered

Regulation of Air Impacts

more Insight.

- EPA Proposal – NSPS Component, cont'd:
  - Centrifugal natural gas compressors
    - Use of dry seal systems
      - Comment sought on whether to allow alternative of wet seals + routing through closed vent system
  - Reciprocating compressors
    - Rod packing changed every 26,000 hours

Regulation of Air Impacts

- EPA Proposal – NSPS Component, cont'd:
  - Pneumatic controllers
    - Gas-driven at processing plants
      - 0 emissions limit (few exemptions)
      - Replacements included
    - Other locations (e.g., compressor stations)
      - Bleed limit of 6 scf/hr
      - Manufacturer's guarantee that < 6 scf/hr

Regulation of Air Impacts

- EPA Proposal – NSPS Component, cont'd :
  - Storage tanks
    - Vapor recovery units or routing
    - For tanks 1 barrel condensate/day or 20 barrels crude/day
    - EPA estimates VOCs reduced 95%
  - Existing NSPS for processing plants
    - Tighten requirements for leak detection and repair (LDAR) to reflect VOC equipment leak standards at 40 CFR 60, subpart VVa (rather than subpart VV); changes "leak" from 10,000 ppm to 500 ppm
    - Tighten SO_2 controls (up to 99.9% control) for facilities with highest sulfur feed rates and H_2S concentrations

Regulation of Air Impacts

more Insight.

- EPA Proposal – NSPS Component, cont'd :
  - Apply during startup, shutdown & malfunction (SSM)
    - Proposed affirmative defense to civil penalties
  - Annual certification of compliance (with annual report)
    - Plus other notice & recordkeeping requirements(e.g., 30-day notices for well completions)
    - Comment sought: 3rd-party service providers to do verification of sources' NSPS compliance?
  - * Compliance stems from proposal (Aug. 23rd)

Regulation of Air Impacts

more Insight.

- EPA Proposal – NESHAP Component:
  - Change to how "major" source determined
    - Previously: for sources upstream of processing plant, emissions from dehydrators + storage vessels with the potential for flash emissions → major determination
    - Proposal: include emissions from *all* storage vessels – even those that contain produced water.
    - Effect: increase the sources that qualify as "major" and thus are subject to the MACT rules

Regulation of Air Impacts

- EPA Proposal – NESHAP Component, cont'd:
  - Removal of "benzene 1 tpy compliance option" for glycol dehydrators at oil and gas production facilities and natural gas transmission and storage sources:
    - Previously: operator could escape major-source HAP regulation by reducing the source's benzene emissions to less than 1 ton per year
    - Proposal: reducing benzene emissions to avoid major-source regulation will no longer be an option
  - Storage vessels:
    - Previously: controls for storage vessels with the potential for flash emissions
    - Proposal: requirements – namely closed vent systems, 95% emission reduction – apply to all storage vessels, including those that store produced water (as well as crude oil and condensate)

Regulation of Air Impacts

more Insight.

- EPA Proposal – NESHAP Component, cont'd:
  - Change in "leak" definition for valves:
    - From 10,000 parts per million (ppm) to 500 ppm
  - Compliance changes
    - Non-flare combustion devices – manufacturer can demonstrate destruction efficiency instead of facilities being tested
    - More performance testing, recordkeeping
    - Revisions to parametric monitoring calibration provisions
  - Elimination of SSM exemption
    - Proposed affirmative defense to civil penalties

Regulation of Air Impacts

- EPA Proposal – NESHAP Component, cont'd:
  - When applicable:
    - Small glycol dehydrators, storage vessels other than those with the potential for flash emissions, and production field facilities that become newly subject to these MACT standards (those not considered "major" under the prior rules):
      - Compliance deadline = 3 years after final rule published
    - Large dehydrators that previously escaped "major" regulation with benzene < 1 tpy option:
      - Compliance deadline = 90 days after final rule published
    - Equipment leaks and certain SSM requirements:
      - Compliance deadline = presumably upon publication of final rule (no compliance date mentioned)

Regulation of Air Impacts

more Insight.

- EPA Proposal – Sampling of Comments:
  - National Wildlife Federation (mass email campaign):
    - "Requir[e] this rule to target direct methane reductions and controls"
    - "End[] the industry's common practice of 'flaring' or burning-off un-captured gas"
  - League of Women Voters of West Virginia:
    - "[W]e strongly support measures to eliminate fugitive methane releases."
  - Ken Zeserson, Planning Board Chairman, Ulysses, NY:
    - Cited to Cornell researcher as showing that "intolerable methane leakage is inevitably associated with hydrofracking."

Regulation of Air Impacts

more Insight.

- EPA Proposal – Sampling of Comments, cont'd:
  - North Central Texas Council of Governments:
    - VOC controls should not apply to storage tanks at 6 tpy threshold, but at 15 tpy ("most cost-effective level")
  - Interstate Natural Gas Association of America (INGAA):
    - "EPA's recently proposed oil and natural gas regulations are portrayed as regulating emissions of [VOCs]. These rules would have far-reaching impacts on our industry, yet, for natural gas transmission and storage companies, VOC emissions are relatively minimal. This leads us to believe that the actual aim of these proposed standards is to regulate greenhouse gases (GHGs) . . . . [INGAA] strongly objects to these proposed regulations because they do not address VOCs but instead clearly target GHG emissions."
    - "[T]he cost to comply would be very high. . . . [These] costs cannot be justified by the projected VOC reductions from interstate pipelines and storage facilities."

Regulation of Air Impacts

- Stationary engines
  - Recent (August 2010) new MACT for toxic air emissions from existing stationary reciprocating internal combustion engines (RICE)
    - Used in natural gas transmission, gathering, underground storage tanks and processing plants
    - Engines > 100 HP located at major sources and engines greater than 500 HP located at area (non-major) sources
      - Generally, must comply with numerical CO or formaldehyde emissions standards (as surrogates)
    - Engines at smaller sources subject to certain maintenance practices

Regulation of Air Impacts

more Insight.

- Ozone NAAQS
  - Oil and gas activities have been blamed for winter-time exceedances of existing ozone standards (most recently set in 2008)
  - EPA proposed even tougher standards in January 2010
    - If proposal had been finalized, most of country would have been considered “nonattainment”
      - Limitations to growth very likely would have made permitting for new ozone-producing activities quite difficult
  - September 2nd: President Obama announced would *not* be revising the ozone standard after all

Regulation of Air Impacts

- Aggregation / Source Determination
  - The grouping of two or more pollutant-emitting activities together as a single source of emissions
    - Smaller emitting units that ordinarily would not trigger regulations could, if aggregated, constitute a "major" source (NSR, Title V)
  - 2007: Bill Wehrum (EPA Acting AA for Office of Air & Radiation)
    - Proximity would be given particular emphasis in source determination
  - 2009: Gina McCarthy (EPA AA for OAR)
    - Withdrew Wehrum memo
    - Consider equally:
      - whether the activities are under common control;
      - whether they are located on one or more contiguous or adjacent properties;
      - whether belong to the same industrial grouping

more Insight.

Regulation of Air Impacts

- Aggregation / Source Determination, cont'd
  - Now a "dedicated interdependence" standard?
    - EPA Region 5, re Summit Petroleum's Mt. Pleasant, MI sour gas wells, sweetening plant and associated flares
      - Single source found
      - Analyzed "nature of the relationship between the facilities and the degree of interdependence between them in determining whether multiple non-contiguous emissions points should be considered a single source"
      - Appealed to 6th Circuit
    - EPA Region 8, re BP compressor facility in Durango, CO
      - *Not* a single source
      - Wells at issue did not have "dedicated interrelatedness"
      - EAB appeal stayed pending ADR process
    - CO re Kerr-McGee/Anadarko Title V renewal for Frederick Compressor Station
      - Long disagreement between CO & EPA
      - February 2011, EPA agreed *not* single source – "did not have a unique or dedicated interdependent relationship and were not proximate and therefore were not contiguous and adjacent"
      - Appealed to 10th Circuit
  - States attempting to take steps to clarify
  - Subject of many permit challenges

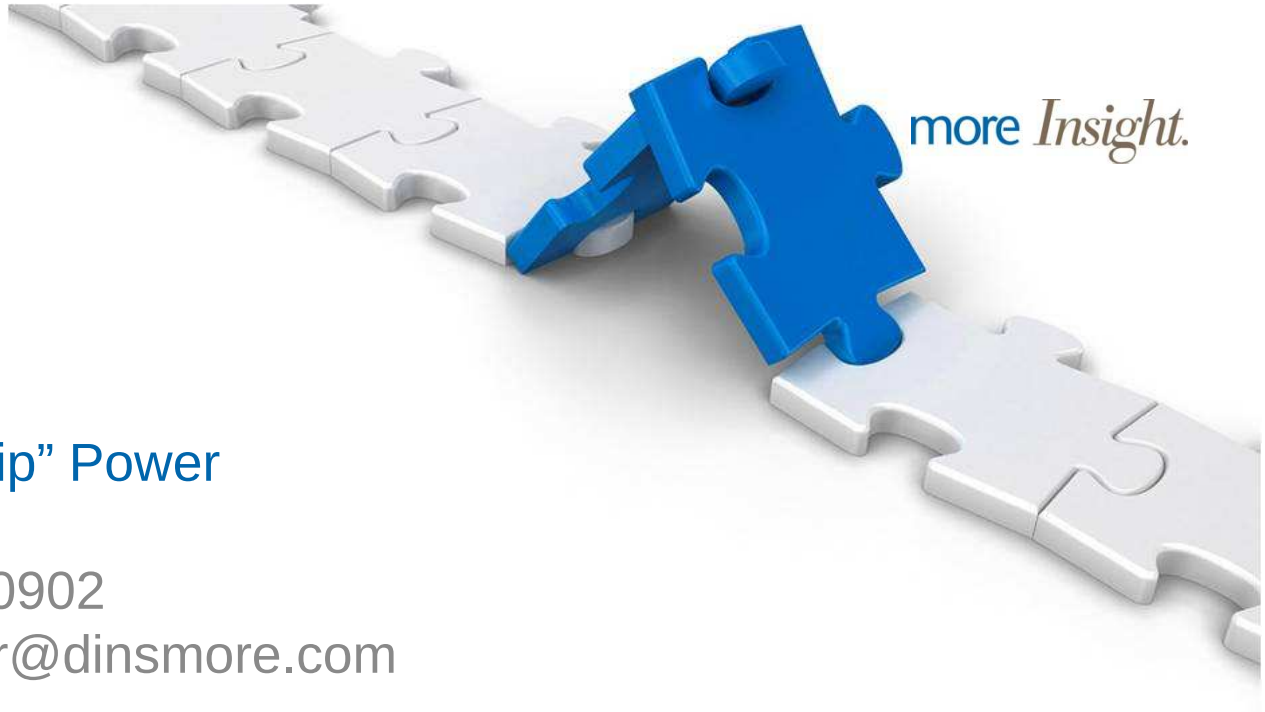
Regulation of Air Impacts

more Insight.

- GHG Mandatory Reporting
  - Petroleum and natural gas facilities that emit 25,000 tpy CO_2-e to report (for 2011):
    - annual CH_4 and CO_2 emissions from equipment leaks and venting
    - emissions of CO_2, CH_4, and N_2O from gas flaring, onshore combustion emissions & stationary equipment combustion emissions used in distribution
  - Recent proposed revisions to “Best Available Monitoring Methods” (BAMM); can be used for 2011 data, permission required for beyond
  - September 28, 2012 deadline for 2011 data

Regulation of Air Impacts

- State Activity – a sampling:
  - WY
    - Presumptive best available control technology for flashing & “breathing” losses from atmospheric storage tanks, pressurized vessels; dehydrator vents; pneumatic equipment; natural gas-fired pumping unit engines
    - If emissions known, then presumptive BACT addressed in permit application
  - TX
    - Recent revisions to permit-by-rule and standard permit provisions for oil and gas; additional controls on activities in Barnett Shale
  - CO
    - Tighter controls since 2004 related to attainment of ozone NAAQS
  - OH
    - Draft air pollution oil and gas well-site general permit
    - Would cover equipment during production phase of shale well
    - OEPA states drilling and completion activities are currently exempt
    - Comments due November 28, 2011



Questions?

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