Unconventional Oil and Gas—Health-Related Actions by the Federal Government

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January 8, 2013

Remarks at the

Progress Review of STAR Grant Research on Carbon Geosequestration

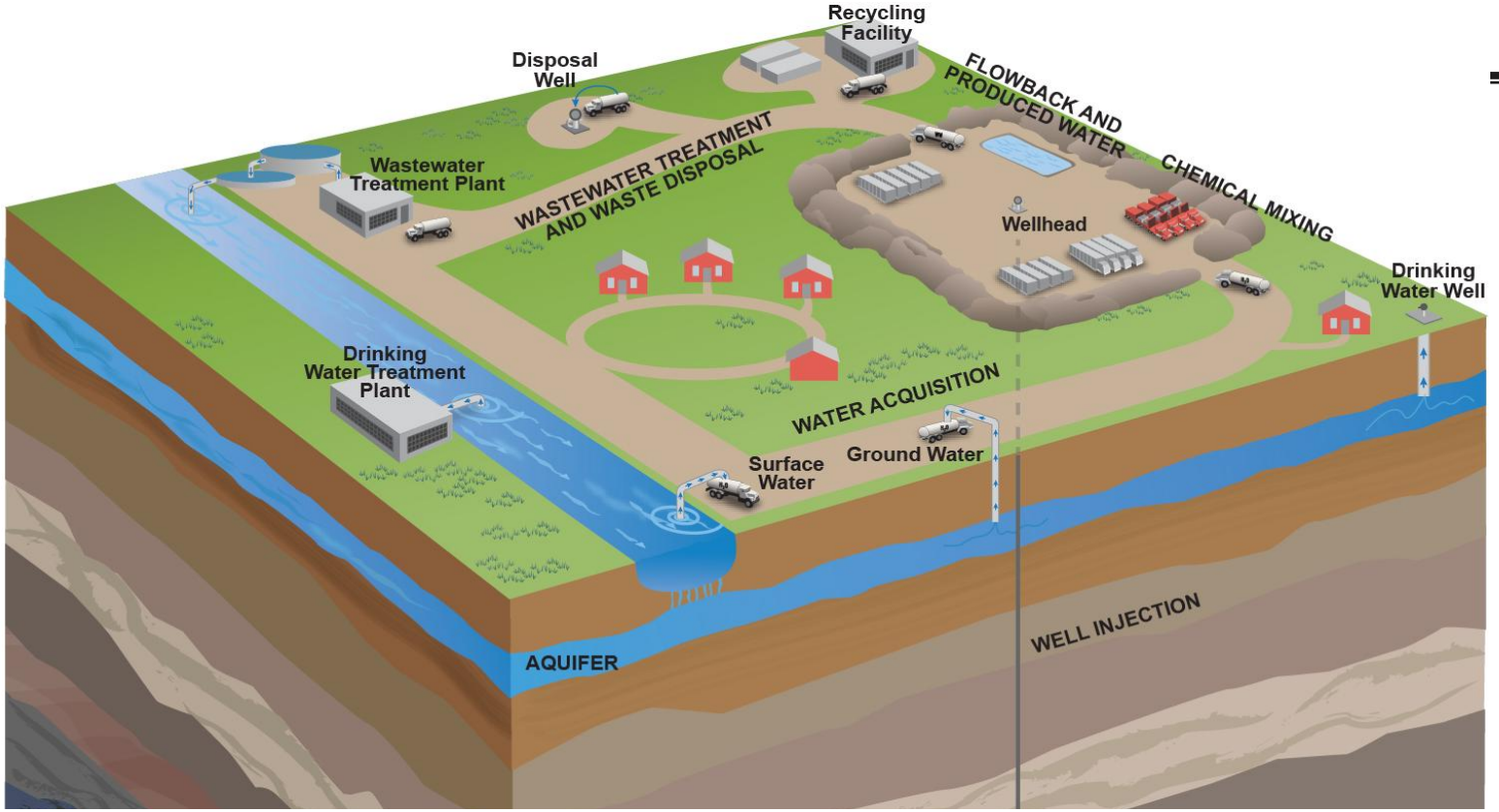
Overview of Presentation

- Overview of hydraulic fracturing
- Health issues possibly related to hydraulic fracturing
- HHS (NIEHS, ATSDR and NIOSH)
- DOL (OSHA)
- DOE
- EPA
- Federal Government Action (Executive Order)
- Proposed research by tri-agency steering committee

Hydraulic Fracturing

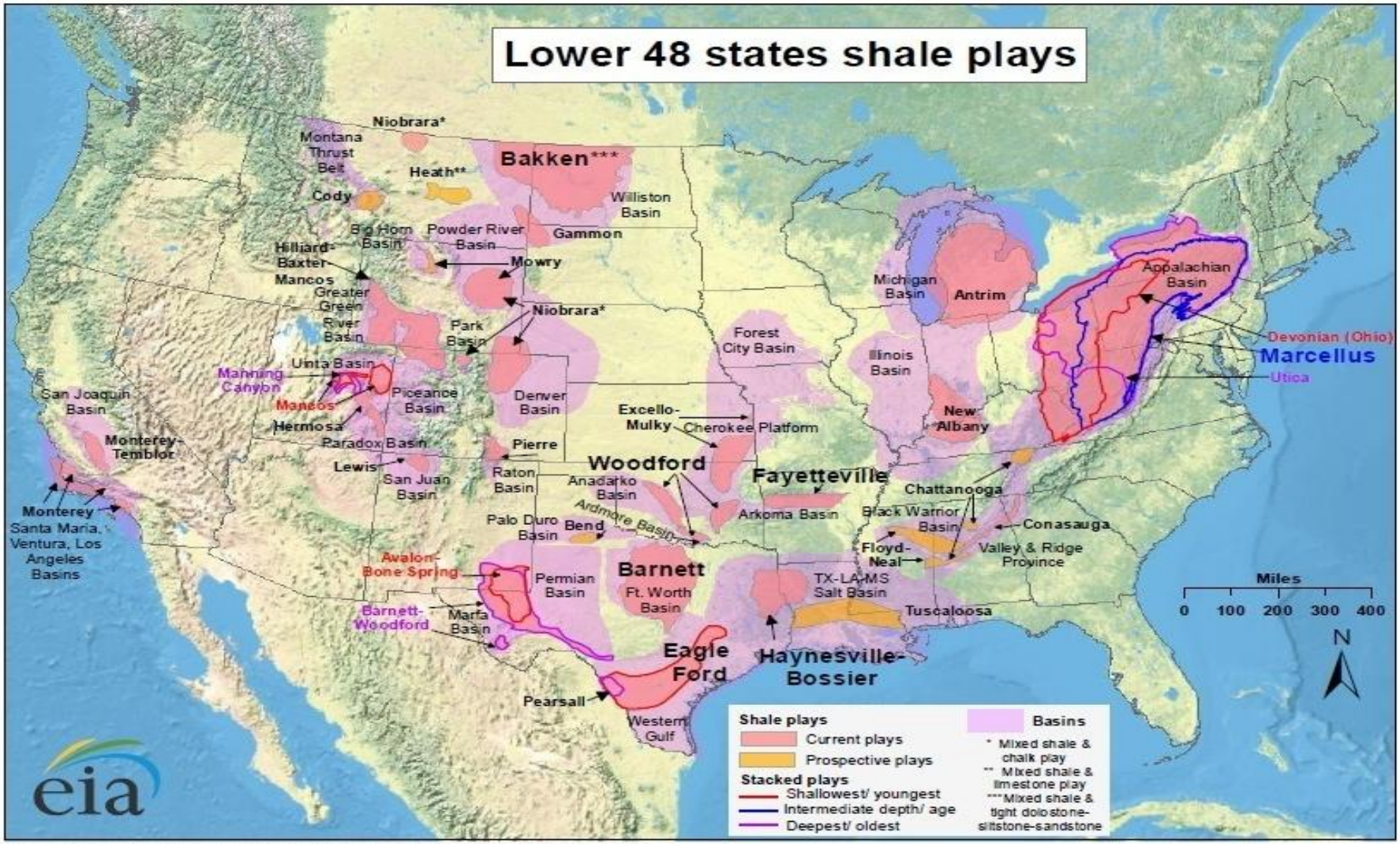
Hydraulic fracturing is a well stimulation process used to maximize the extraction of underground resources, including oil, natural gas, geothermal energy, and even water.

Hydraulic Fracturing Process



WATER CYCLE STAGES

Water Acquisition → Chemical Mixing → Well Injection → Flowback and Produced Water → Wastewater Treatment and Waste Disposal



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

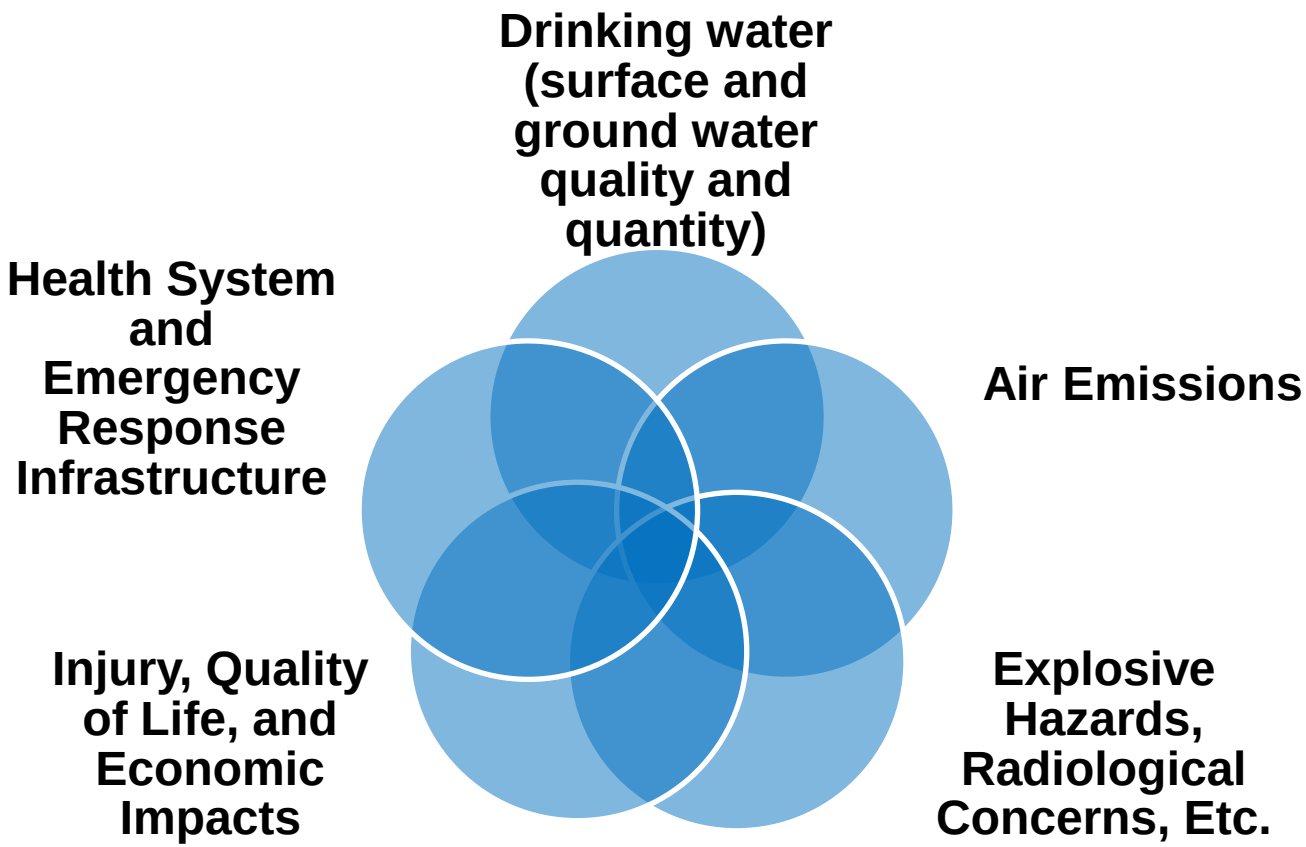
Some Outstanding Issues

- Are there potential hazards involved in unconventional gas activities?
- If so, what are they?
- Are there ways to reduce them?

- *"Many questions remain unanswered as scientists scramble to catch up with the boom in drilling for natural gas. All energy sources bring environmental impacts, and whether fracking's risks outweigh benefits isn't clear. Ultimately, that's as much a question of economics, politics, and philosophy as it is of science. But it's crucial that science has a place in that discussion".*

--Eva Emerson, Acting Editor in Chief, Science News (Sept. 8, 2012)

Potential Public Health Concerns of Natural Gas Activities



Activities of the Department of Health and Human Services

- NCEH/ATSDR: Addressing community concerns about potential health impacts from unconventional gas activities
- NIOSH: Worker safety
- NIEHS: Supports internal and external research on health issues related to unconventional gas activities

HHS: General Activities Related to Hydraulic Fracturing

- Participation in meetings & conferences to understand issues & activities at the federal, state, and local levels.
- Promotion of scientific discussions related to health effects, e.g.,

  April 30-May 1, 2012 Institute of Medicine (IOM) Roundtable
- Exploring health impacts and the use of Health Impact Assessments (HIA's) to examine and identify ways to mitigate potential health impacts. Issues include:
  - Worker health and exposures
  - Consequences of development
  - Community health and economic impacts
  - Environmental air and water impacts

http://www.iom.edu/Activities/Environment/EnvironmentalHealthRT/2012-APR-30.aspx

HHS: Examples of Identified Areas for Human Health Research

- Baseline measures of exposure & health status and assessment of spatial/temporal trends (biomonitoring; health surveillance)
- Representative epidemiology studies
- Toxicology studies on hydraulic fracturing fluids and complex mixtures
- Risk assessments
- Health Impact Assessments at selected affected communities
- Disproportionate impacts on communities
- Robust exposure assessment
  - Levels of hazardous compounds in water & air
  - Mobilization of naturally occurring hazardous compounds
  - Other chemicals to be monitored, needed levels of sensitivity of measurements

NCEH/ATSDR Activities Related to Unconventional Gas Activities

- Co-hosted the IOM meeting designed to better define environmental public health research needs and response
- Coordinate with EPA and other Federal, State and Local Partners
  - Provide toxicological and health expertise to national research planning work
  - Support local and state health and environmental agencies through public health tracking, exposure assessment, and targeted investigations

NCEH/ATSDR Activities Related to Unconventional Gas Activities, continued

- Provide health evaluations assessing exposures and hazards in areas with new or ongoing natural gas activities
  - *Evaluations of Water Quality Issues*:
    - LeRoy, PA; Pavilion, WY; Dimock, PA; Posey County, IN
  - *Evaluations of Air Quality Issues:*
    - Garfield County, CO and Washington County, PA
  - *Evaluation of Explosive Hazards:*
    - Medina, OH; Posey County, IN; Dimock, PA

NIOSH Activities Related to Hydraulic Fracturing (HF)

- Oil & Gas Extraction Program (http://www.cdc.gov/niosh/programs/oilgas/default.html)
  - High Quality Research, Practical Solutions, Partnerships, Research to Practice
- Field Efforts to Assess Chemical Exposure Risks
  - Worker exposures to respirable crystalline silica may be a significant health hazard, at times exceeding the OSHA Permissible Exposure Level (PEL) and NIOSH Recommended Exposure Level (REL)
  - OSHA/NIOSH joint Hazard Alert on Silica Exposures during Hydraulic Fracturing. (NIOSH pub #2010-130 at http://www.cdc.gov/niosh/docs/2010-130/)

NIOSH Activities Related to Hydraulic Fracturing (HF)

- Proposed studies to assess effects of combined inhalation of respirable silica and diesel particulate matter
  - Animal studies on pulmonary and other organ health effects
- Exposure assessment in oil and gas workers
  - Proposal: thoroughly evaluate and characterize exposures and identify potential health risks that may arise from a variety of activities
- NIOSH program opportunities for further workforce evaluation
  - Health Hazard Evaluation (HHE) Program

NIEHS: Extramural Funding Related to Hydraulic Fracturing

- Time Sensitive Funding Opportunity Announcements
  - Program Announcements (PAR): 10-083 (R03) and 10-084 (R21)
- Unsolicited proposals
- Research to Action: PA-12-153 (R01)
  - Hydraulic fracturing is a topic of current interest
  - Requires community participation
- EHS Core Center Opportunity Fund Announcement
  - Award to University of Rochester COEC for project titled “Health and Hydrofracking”
  - Focus on information needs in NC, NY, and OH
  - Key informant interviews in three states with selected community groups, health care professionals, and local government officials
  - Promote sustainable community-scientist dialogue on research development that respond to community needs

NIEHS: National Toxicology Program (NTP) Activities Related to HF

- Aware of community concerns about chemicals in extraction fluids and groundwater contaminants
- Conducting preliminary scoping activities
- Held seminar November, 2011
- Reviewing available monitoring data & lists of publicly disclosed information concerning hydraulic fracturing fluids
- Developing research on long term effects of acute & chronic broader scale coordination and collaboration with the UOG research efforts being performed by other agencies will allow for a more comprehensive understanding of the potential human and environmental impacts associated with UOG production activities.
- Exposure

OSHA Initiatives – Public Activities

- Released an OSHA/NIOSH joint Hazard Alert on Silica Exposures during Hydraulic Fracturing http://www.osha.gov/dts/hazardalerts/hydraulic_frac_hazard_alert.pdf
- Participating in public meetings on hydraulic fracturing (e.g., Institute of Medicine, ATSDR, NACOSH, AIHce, Shale Gas Oil Conference, etc)
- Collaborating with alliance and industry groups to mitigate risks posed by silica
- Conducting routine enforcement activities, including local emphasis programs in four regions that target the oil and gas industry

OSHA Initiatives – Public Activities

- "OSHA InfoSheet: Silica Exposure during Hydraulic Fracturing" released December, 2012: http://www.osha.gov/Publications/OSHA3622.pdf
- Updating OSHA's website to include information on risks associated with hydraulic fracturing
- Working with industry to design a training course on the oil and gas industry for OSHA Educational Resource Centers, which will include information on hydraulic fracturing
- Coordinating with other federal agencies on unconventional oil and gas initiatives (research, etc.)

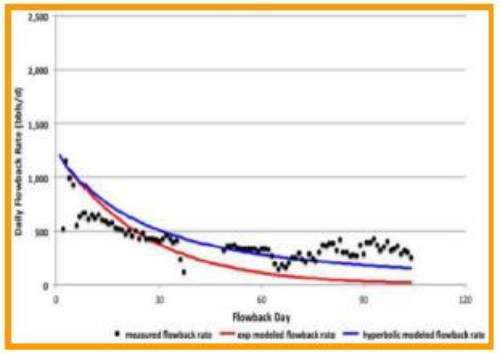
OSHA Initiatives – Internal Activities

OSHA is conducting additional technical training and providing technical resources for field staff on the process and hazards:

- Oil and Gas Training Class
- Technical Webinars
- Technical Documents
- Internal Wiki

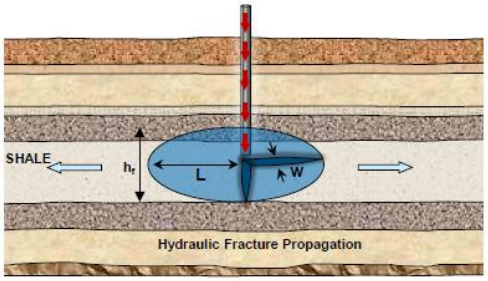
DOE NETL Office of Research and Development

- Fugitive Air Emissions and GHG - Air quality monitoring, leak detection, point-source measurements, and Life Cycle Assessment



- Water Management - Predict volume and composition of flowback water as a function of reservoir, stimulation, and fluid properties

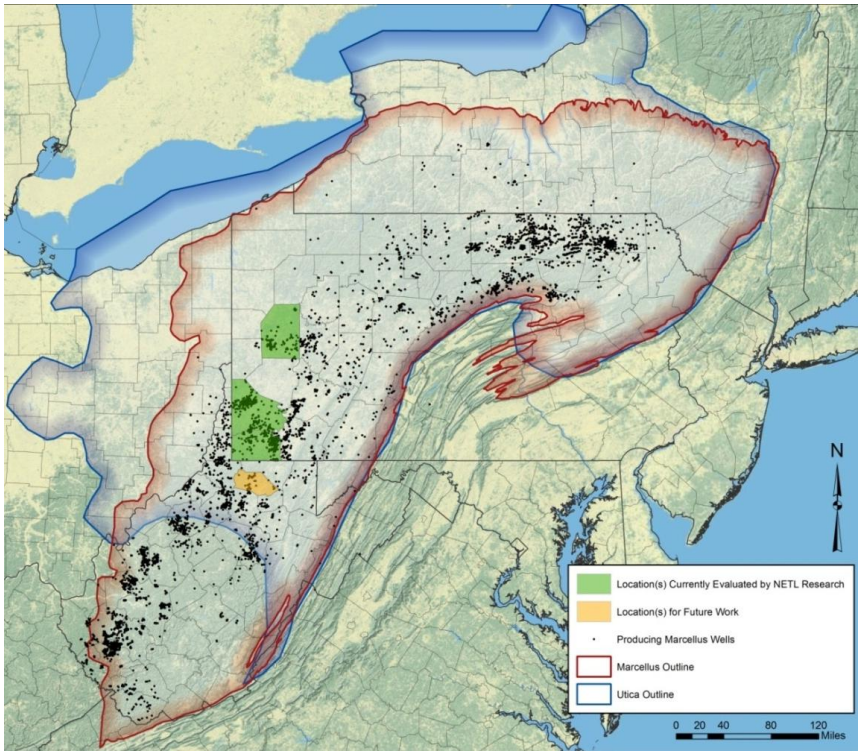
- Subsurface Migration of Gas and Fluids - Assess potential for gas and fluids to migrate along existing pathways to shallow systems



- Predicting Subsurface Phenomena – Estimate the extent of fracture development, fluid migration, and induced seismicity due to fracturing and waste injection

DOE Field Monitoring Efforts

- Ongoing field efforts in PA and WV
- Ambient and point source air quality monitoring
- Detection of abandoned wellbores using remote sensing techniques
- Effect of shallow gas on well cementing
- Microseismic monitoring during hydraulic fracturing
- Fluid and gas monitoring (for leakage detection) using tracers
  - Natural (e.g., Sr, U, C, H isotopes)
  - Synthetic (Perfluorocarbon tracers)



DOE NETL Office of Research and Development

http://www.netl.doe.gov/about/index.html

EPA's Drinking Water Study

- To assess whether hydraulic fracturing can impact drinking water resources
- To identify driving factors that affect the severity and frequency of any impacts

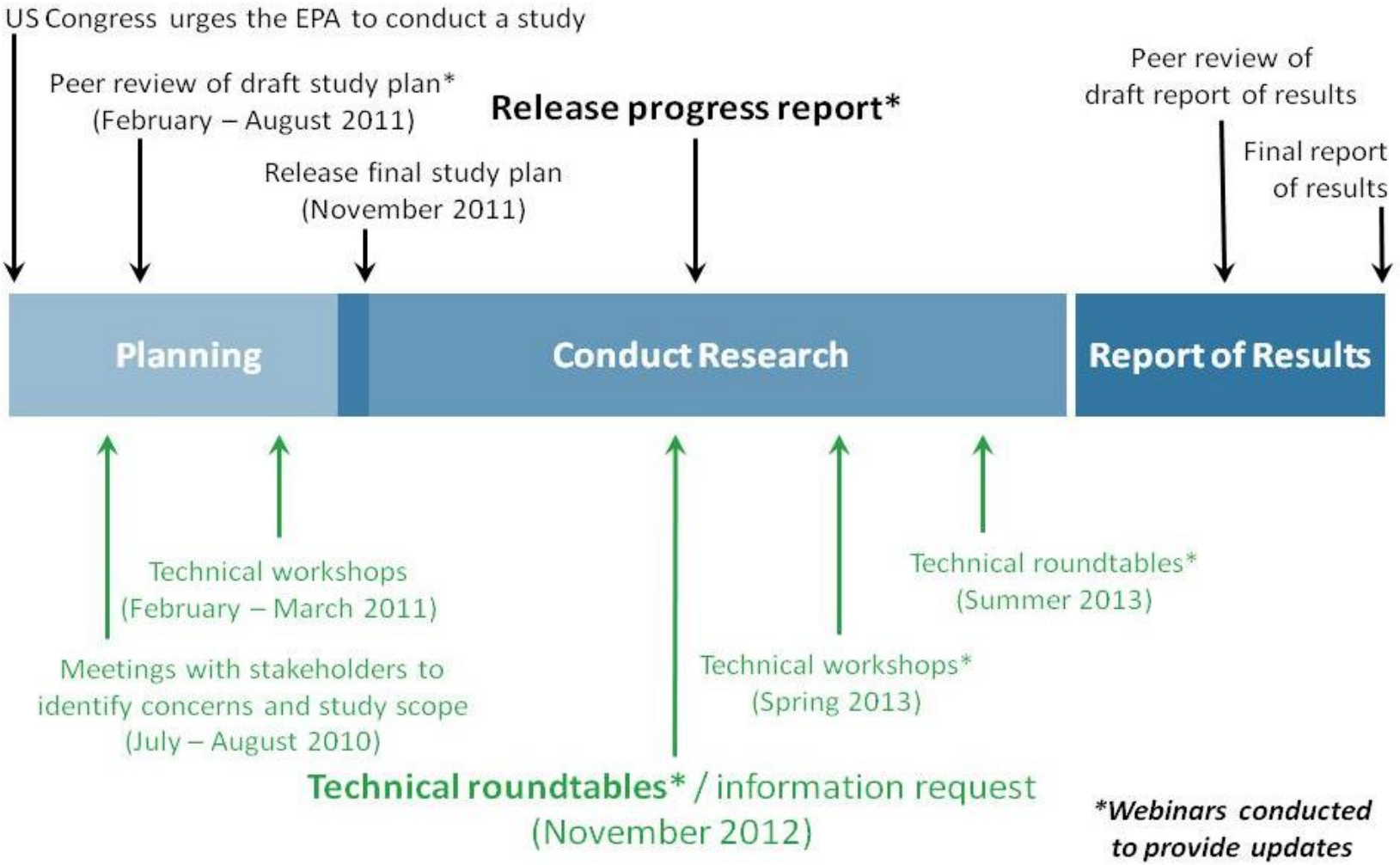
EPA's study plan focuses on the water cycle in hydraulic fracturing.

http://www.epa.gov/hfstudy/

EPA is committed to using:

- Best available science
- Independent sources of information
- Transparent, peer-reviewed process
- Consultation with others

Study Timeline



Links to updated information

http://www.epa.gov/hfstudy/

November 2012 Technical Roundtables:

http://www.epa.gov/hfstudy/techwork13.html

December 2012 Progress Report:

http://www.epa.gov/hfstudy/pdfs/hf-report20121214.pdf

January 2013 Webinars:

http://www.epa.gov/hfstudy/getinvolved.html

Purpose of the Progress Report

Demonstrate progress made on the EPA's *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*

- Project-specific updates that include research approach, status and next steps

Progress report is available at www.epa.gov/hfstudy

Research Overview

What are the potential impacts on drinking water resources of:

Water Acquisition	Large volume water withdrawals from ground and surface water?
Chemical Mixing	Surface spills on or near well pads of hydraulic fracturing fluids?
Well Injection	The injection and fracturing process?
Flowback and Produced Water	Surface spills on or near well pads of flowback and produced water?
Water Treatment and Waste Disposal	Inadequate treatment of hydraulic fracturing wastewaters?

EPA Research Approaches

- Analysis of existing data
- Scenario evaluations—including modeling
- Laboratory studies—water analyses
- Toxicity assessments
- Case studies

Progress report is available at www.epa.gov/hfstudy

Analysis of Existing Data

Data sources include:

- Peer-reviewed literature
- FracFocus Analysis: http://fracfocus.org/
- Spills Database Analysis
- Service Company Analysis
- Information from requests to industry

Analysis of Existing Data: Research Progress

- Data sources identified for review and analysis, including:
  - Over 12,000 well records entered into FracFocus
  - State spill databases from Colorado, New Mexico and Pennsylvania
  - National Response Center spill database
  - Information provided by 9 hydraulic fracturing service companies
  - 333 well files supplied by 9 oil and gas operators
- Literature review is ongoing

Scenario Evaluations

- Water availability modeling
- Subsurface migration modeling
- Surface water modeling

Scenario Evaluations: Research Progress

- Computer models identified, including TOUGH+, HSPF, SWAT
- Scenarios constructed:
  - Future water use scenarios, including business-as-usual, full development and “green” technologies
  - Fluid and gas migration due to faulty well construction, nearby wells, existing faults and fractures
  - General surface water discharge scenarios based on data from wastewater treatment facilities in Pennsylvania
- Models are being run

Laboratory and Other Technical Studies

- Analytical method development
- Source apportionment studies
- Wastewater treatability studies
- Brominated disinfection byproducts (Br-DBPs) precursor studies

Laboratory Studies: Research Progress

- Adapting and testing analytical methods for several classes of chemicals, including:
  - Glycols, acrylamide, ethoxylated alcohols, radionuclides, inorganic chemicals
- Samples of surface water, raw hydraulic fracturing wastewater and treated effluent collected and undergoing laboratory analyses
- Wastewater treatability experiments are being designed
- Studies assessing the ability of hydraulic fracturing wastewater to create Br-DBPs are underway

Toxicity Assessment

For hydraulic fracturing fluids and wastewater:

- Identify chemicals in injected fluid and wastewater
  - Sources include: service company data, well files, FracFocus, state and federal reports
  - Identify chemical name, CASRN, chemical structure
- Compile information on chemical, physical and toxicological properties
  - Chemical and physical properties from LeadScope, EPISuite, QikProp
  - Toxicological properties from federal and state databases (e.g., IRIS, State of California Toxicity Criteria Database)
- Estimate properties for chemicals with known structures, but unknown properties, using quantitative structure activity relationships

Toxicity Assessment: Research Progress

- Over 1,000 unique chemical substances identified
  - Chemicals are included in Appendix A of the progress report
- Chemical structures are available for roughly 750 chemicals
  - Some properties obtained for over 300 chemical structures

Retrospective Case Studies

- Las Animas and Huerfano Counties, CO: Coalbed methane extraction in the Raton Basin
- Dunn County, ND: A well blowout during hydraulic fracturing for oil in the Bakken Shale
- Bradford County, PA: Shale gas development in the Marcellus Shale
- Washington County, PA: Shale gas development in the Marcellus Shale
- Wise County, TX: Shale gas development in the Barnett Shale

Conducting High Quality Science

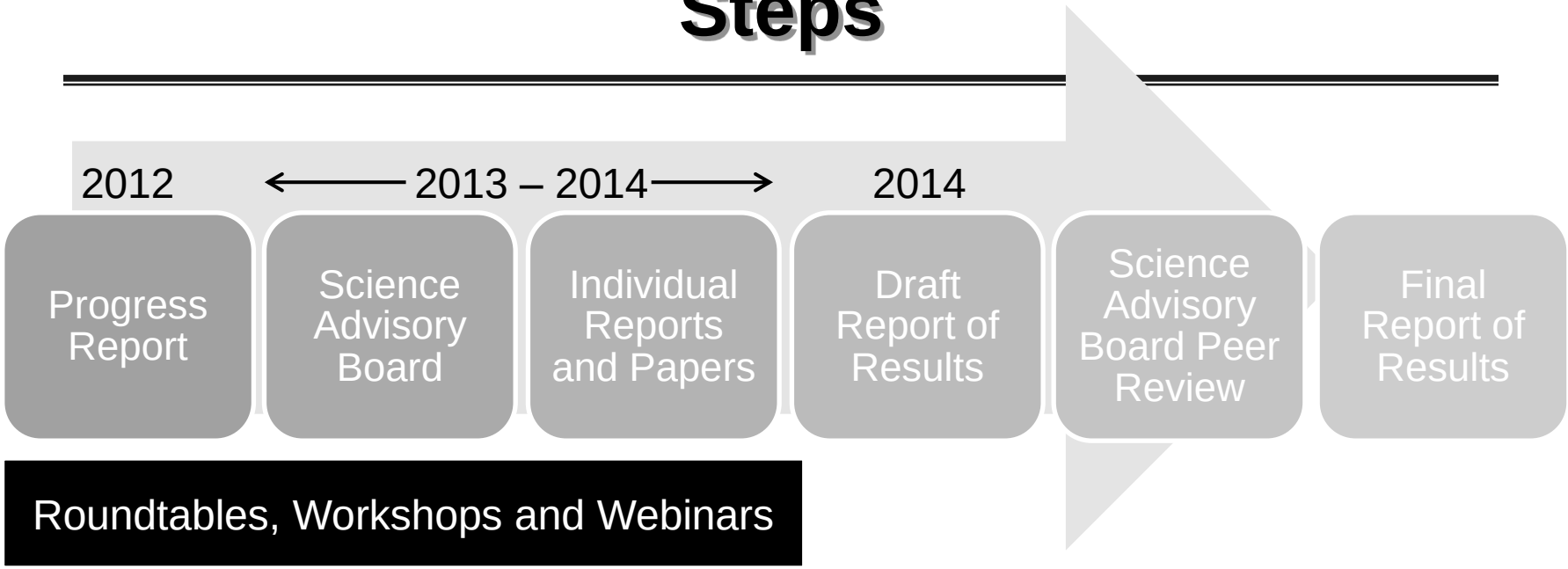
Quality Assurance:

- Quality Management Plan defines the QA-related policies, procedures, roles and responsibilities for the study
- Quality Assurance Project Plans document the planning, implementation and assessment procedures for individual research projects

Peer Review:

- Products for individual research projects will undergo external peer review through scientific journals, letter reviews or *ad hoc* panels
- Report of results classified as a Highly Influential Scientific Assessment
  - Peer review will be conducted by the EPA's Science Advisory Board

Research Progress Summary and Next Steps



Report of results will include a synthesis of available results from the research projects described in the progress report

EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

- Study updates are available at website
- Sign up for email updates

http://www.epa.gov/hfstudy/

Government Accountability Office (GAO)

Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health (12-732), October, 2012.

http://www.gao.gov/assets/650/647791.pdf

Unconventional Oil and Gas Development: Key Environmental and Public Health Requirements (12-874), October, 2012

http://www.gao.gov/assets/650/647782.pdf

Multi-Agency Collaboration on Unconventional Oil and Gas Research

Department of Energy
Department of the Interior
Environmental Protection Agency

http://unconventional.energy.gov

Executive Order - Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources

". . . it is vital that we take full advantage of our natural gas resources, while giving American families and communities confidence that natural and cultural resources, air and water quality, and public health and safety will not be compromised."

-- President Obama

Executive Order - Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources

Interagency working group, chaired by the Director of the Domestic Policy Council, with Deputy-level representatives from:

- Department of Defense
- Department of Interior
- Department of Agriculture
- Department of Commerce
- Department of Health and Human Services
- Department of Transportation
- Department of Energy
- Department of Homeland Security
- Environmental Protection Agency
- Council on Environmental Quality
- Office of Science and Technology Policy
- Office of Management and Budget
- National Economic Council

Interagency Working Group Functions

- Coordinate agency policy activities
- Coordinate among agencies the sharing of scientific, environmental, and related technical and economic information
- Engage in long-term planning with respect to such issues as research, natural resource assessment, and the development of infrastructure
- Promote interagency communication stakeholders
- Consult with other Federal agencies and offices, as appropriate

April 13, 2012, Multi-Agency Agreement

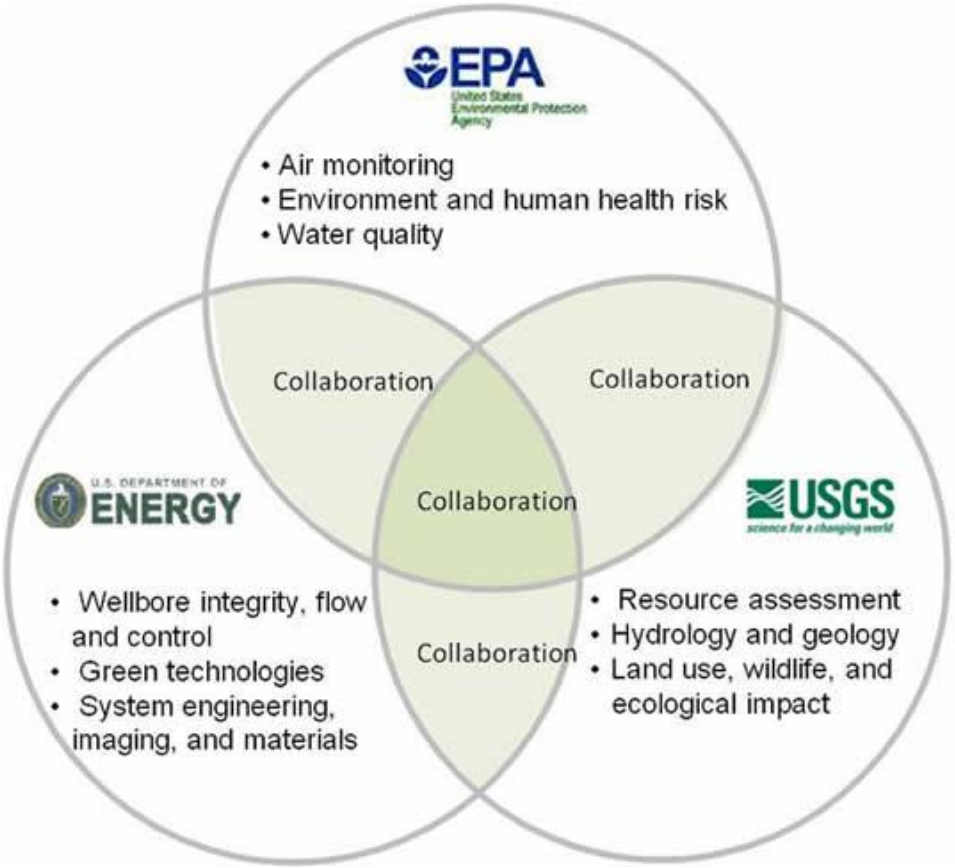
- DOE, DOI, and EPA will develop a multi-agency research plan to address the highest priority research questions associated with safely and prudently developing unconventional shale gas and tight oil resources (UOG)
- This program will focus on:
  - timely, policy-relevant science directed to research topics where collaboration among the three agencies can be most effectively and efficiently conducted
  - providing results and identifying technologies that support sound policy decisions to ensure the prudent development of energy sources while protecting human health and the environment

Multi-Agency Committee Members

Steering Committee: composed of a policy level appointee and a senior scientist from DOI, DOE, and EPA, plus a representative from the Office of Science and Technology Policy Office

In addition to the Steering Committee, there is a technical subcommittee comprised of over 20 scientists and engineers from the three agencies and HHS with expertise in a wide range of research areas.

Agency Core Research Competencies



Potential Research Topics

- Scale and Nature of UOG Resources
- Water Quality
- Water Availability
- Air Quality and Greenhouse Gas Emissions
- Ecological Effects
- Induced Seismicity
- Effects on Human Health and Communities

Scale and Nature of UOG Resources

- Develop improved reservoir characterization and reservoir-to-basin scale geologic/engineering/economic tools and science

- Such play-specific information/tools and science would enable an improved basis of understanding the geologic variability and scale of potential risks over a variety of time-scales, as well as an improved basis for resource-management approaches that minimize potential for environmental impacts

Water Quality

- Conduct research to understand the potential near-term and long-term water quality impacts of unconventional oil and gas production on surface and groundwater resources
- This research could address the implications of pollutants associated with hydrocarbon production and waste by-products interfacing with water resources, including research on pollutant measurement and modeling to understand fate, transport, and migration in surface water and groundwater, and related effects of hydrogeologic structures and geochemical processes
- This research could also study innovative technologies to ensure water quality

Water Availability

- Understand water availability and consumptive use of surface and groundwater resources for multiple uses as unconventional oil and gas production increases
- Research under this topic could address technical and data challenges with monitoring water withdrawals associated with increased oil and gas industrial activity and innovative technologies (e.g. reuse, use of alternative water sources including brackish water)

Air Quality and Greenhouse Gas Emissions

- Identify and monitor unconventional oil and gas production's potential impact on air quality and greenhouse gas emissions
- This topic would aim to improve scientific understanding of the rate of generation and fate of air pollutants that contribute to regional air quality hazards and climate change – including stakeholder partnerships that support improved monitoring, measurement protocols, data analysis, and control

Ecological Effects

- Identify and monitor potential ecological impacts associated with unconventional oil and gas production activities
- This research could address the impacts of cumulative changes in land use, hydrology, and water and air quality on ecological resources including ecosystem services, wildlife, aquatic ecology, and threatened and endangered species

Induced Seismicity

- Research to understand the potential induced seismicity risk associated with unconventional oil and gas production activities
- This research could address how hydraulic fracturing and related oil and gas production activities, such as wastewater disposal, may contribute to induced seismic hazards, the potential for predictive tools and hazard assessment methodologies, and best practice techniques or standards to reduce seismic risks

Effects on Human Health and Communities

- Understand the potential cumulative impacts on human health of increasing concentrations of and exposures to pollutants associated with unconventional oil and gas production and on communities in the regions where production is occurring
- This research topic builds upon air and water quality research (a) to assess potential human health effects and risks, and (b) combined with resource availability research, to understand and monitor potential environmental health risks that are realized at a regional scale
- Research on topics relating to socioeconomic impacts and benefits; public health outcomes; epidemiology; safety, visual, noise, and light pollution; infrastructure and cultural impacts; and risk perception and communication that could inform local decision-makers on the implications of unconventional oil and gas production in their communities

Additional Information on Multi-Agency Committee Activities

To provide additional input
to the Steering Committee,
please send your comments to:
unconventional@hq.energy.gov

In addition, a website has been set up
if you wish to follow this effort:
http://www.unconventional.energy.gov

NSF funded projects

Routes to Sustainability for Natural Gas Development and Water and Air Resources in the Rocky Mountain Region:
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1240584

RCN-SEES: The Marcellus Shale Research Network:
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1140159

Standard Research Grant: The Marcellus Shale Gas Rush: A Study of Public, Private, and Academic Water Quality Monitoring Policies:
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1126235

Collaborative Research: Modeling and Analysis of Fracture Network for Shale Gas Development and Its Environmental Impact:
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1209124

Summary

- Technology is now available that is capable of extracting energy resources that were not previously accessible.
- Federal agencies are working together with input from stakeholders to better assess the health and environmental impacts of the process.
- Participants are relying on high quality information to conduct health and environmental studies and assessments.
- Video and slides from a similar talk on the website: Health Effects of Shale Gas Extraction 2012, University of Pittsburgh, Graduate School of Public Health (November 2012)

Acknowledgements

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- Mike Focazio (USGS)
- Bill Leith (USGS)
- Margaret Kitt (HHS)
- Tina Forrester (HHS)
- Aubrey Miller (HHS)
- Sandra Howard (HHS)
- Tina Jones (OSHA)

Thank you

Questions?

Previous talk at University of Pittsburgh:

http://mediasite.cidde.pitt.edu/mediasite/Catalog/pages/catalog.aspx?catalogId=36f041af-37b4-42d7-b274-b5e258a08a14