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Hydraulic Fracturing and Horizontal Gas Well Drilling Reference List
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This list is in no way exhaustive. Rather, it attempts to provide a set of primary references that offer key pieces of information in building a clear understanding of the gas drilling issue. Thus, it is subjective in its completeness. Annotations attempt to identify unique or defining characteristics of each entry. References to popular press and advocacy groups, both of which are numerous and described in detail elsewhere, are for the most part excluded here.

Comprehensive Reports & Analyses

Revised Draft Supplemental Generic Environmental Impact Statement (2011) NYSDEC
http://www.dec.ny.gov/energy/75370.html

- The most comprehensive review of shale gas drilling in New York State, as well as the most comprehensive collection of data and consultant-supplied analyses

Addressing the Environmental Risks from Shale Gas Development (2010) Worldwatch Institute
http://www.worldwatch.org/node/6421

- An intelligent analysis of environmental risks along with general suggestions for ways to address these risks

Frac Attack: Risks, Hype, and Financial Reality of Hydraulic Fracturing in the Shale Plays (2010). Tudor Pickering Holt & Co with Reservoir Research Partners
http://geology.com/news/2010/frac-attack.shtml

- An impartial and well written analysis of the state of the gas drilling issue, including evidence both for and against the practice, a list of incidents that have received media attention, the state of regulatory discussions, and a breakdown of key financials associated with the industry

The Future of Natural Gas (2011) MIT
http://web.mit.edu/mitei/research/studies/natural-gas-2011.shtml

- An analysis of the role of natural gas in our energy future under a variety of possible economic and policy scenarios

How Energy Choices Affect Fresh Water Supplies: A Comparison of US Coal and Natural Gas (2010) Worldwatch Institute
http://www.worldwatch.org/system/files/NGSEI-BriefingPaper2.pdf

- A good lifecycle assessment of water resource impacts associated with coal and natural gas, with a thoughtful discussion

Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources (2011) USEPA
http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/FINAL-STUDY-PLAN-HF_Web_2.pdf

- Review and outline of the approach the EPA will take on their multi-year study of hydraulic fracturing and drinking water; note that environmental/ecological issues will not be covered, except as they pertain to drinking water

Modern Shale Gas Development in the United States: A Primer (2009). USDOE

http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf

- Good background report, which takes a slightly favorable view of the shale gas industry, providing basic information on each major play and a thorough review of federal laws that cover gas development

Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed (2009). NYCDEP
http://home2.nyc.gov/html/dep/html/news/natural_gas_drilling.shtml

- Review of water related impacts specific to the NYC watershed; presents a case for contamination of water supplies via fracture communication and present build-out scenarios as well as risk assessments of acute and chronic spills and infiltration events

Subsurface Water Quality

The Impact of Marcellus Gas Drilling on Rural Drinking Water Supplies (2011). Boyer, et al. The Center for Rural Pennsylvania
http://www.rural.palegislature.us/documents/reports/Marcellus_and_drinking_water_2011_rev.pdf

- A carefully presented study of water quality in drinking water wells in close proximity to shale gas wells in PA

Natural Gases in Ground Water near Tioga Junction, Tioga County, North-Central Pennsylvania – Occurrence and Use of Isotopes to Determine Origins, 2005 (2007). Breen, et. al. *USGS Scientific Investigations Report 2207-5085*
http://pubs.usgs.gov/sir/2007/5085/

- A monitoring study in response to complaints of methane in private water wells in PA; shows the uses of stable isotopes, biogeochemistry and hydrogeology in determining potential contamination sources; also demonstrates limitations and difficulties associated with monitoring

Evaluating system for ground-water contamination hazards due to gas-well drilling on the glaciated Appalachian plateau (1983). Harrison, S.S., *Ground Water*
http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.1983.tb01940.x/abstract

- Provides a nice, though somewhat outdated, assessment of gas well drilling related hazards to ground, surface, and well waters using specific knowledge of geology in northwest PA

Contamination of Aquifers by Overpressuring the Annulus of Oil and Gas Wells (1985). Harrison, S.S., *Ground Water*
http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.1985.tb00775.x/abstract

- Explains the danger that pressure build up within the well annulus can pose to ground water resources

Methane in West Virginia ground water (2006). USGS Fact Sheet 2006-3011
http://pubs.usgs.gov/fs/2006/3011/

- Shows extent and severity of historic methane contamination of wells in WV, with links to coal mining activities

Water & Wastewater Management

Evaluating the Acceptability of Gas Well Development and Production-Related Wastewater at New York Wastewater Treatment Plants (2011). New York Water Environment Association
http://nywea.org/gac/HFSCEvaluatingAcceptability.pdf

- Discusses challenges facing wastewater treatment plants in NY and provides recommendations for plant operators and policy makers

Water Management Technologies Used by Marcellus Shale Gas Producers (2010). Veil, J.A.
http://www.evs.anl.gov/pub/dsp_detail.cfm?PubID=2537

- Discusses water management in general and provides results on a survey of current practices by operators in PA, as well as information on the capacity of treatment facilities to handle wastewaters

Water Resources and Use for Hydraulic Fracturing in the Marcellus Shale Region (2010). ALL Consulting
http://www.netl.doe.gov/technologies/oil-gas/publications/ENVreports/FE0000797_WaterResourceIssues.pdf
- Discusses water sourcing and explains the physical characteristics of relevant watersheds and the role of regulatory bodies in maintaining water resources

Marcellus Hydrofracture Flowback and Production Wastewater Treatment, Recycle, and Disposal Technologies (2010). Keister, T.
http://energy.wilkes.edu/PDFFiles/Library/The_Science_of_Marcellus_Shale_Wastewater.pdf
- Describes typical flowback chemistry, the challenges it presents to POTWs, and possible solutions for effective treatment

Water Resources and Natural Gas Production from the Marcellus Shale (2009). USGS Fact Sheet 2009-3032
http://md.water.usgs.gov/publications/online.html

Monitoring

Evaluation of Well Logs for Determining the Presence of Freshwater, Saltwater, and Gas above the Marcellus Shale in Chemung, Tioga, and Broome Counties, New York (2010). Williams, J., USGS Scientific Investigations Report 2010-5224
- Reviews water and gas well data from various sources, and discusses the need for a more comprehensive and well-managed database on well water quality

Marcellus Shale Gas Extraction: A Study Design and Protocol for Volunteer Monitoring (2010). ALLARM
www.dickinson.edu/ALLARM
- The Alliance for Aquatic Resource Monitoring (ALLARM) is a project of the Environmental Studies Department at Dickinson College. This protocol supplies technical and programmatic support to community organizations interested in watershed assessment and protection related to Marcellus drilling, specifically by providing instruction on TDS testing, stream flow and observational monitoring

Gas Well Drilling and Your Private Water Supply (2010). PSU Cooperative Extension Water Facts #28
http://extension.psu.edu/water/webinar-series/past-webinars
Provides information for landowners with respect to private water supply testing, including what parameters may be important to monitor

Legal Information, Government Regulations, and Industry Guidelines

HVHF Proposed Regulations (New York) (2011). NYSDEC
http://www.dec.ny.gov/regulations/77353.html

Citizens' Guide to Marcellus Shale in Pennsylvania (2010). National Sea Grant Center & Pennsylvania Sea Grant
http://seagrant.psu.edu/news/marcellus_citizens_guide.pdf
- Basic information on issues of concern with a focus on legal rights of various stakeholders

Hydraulic Fracturing and Safe Drinking Water Act Issues (2011). Tiemann & Vann, Congressional Research Service
http://www.arcticgas.gov/node/529
- Thoroughly discusses the evolution of policy and legal precedence regarding the coverage of hydraulic fracturing under major federal legislation

Marcellus groundwater claims: A case for scientifically informed decisions (2010). McKay & Salita. *World Oil*
http://www.worldoil.com/Marcellus-groundwater-claims-A-case-for-scientifically-informed-decisions.html

- Discusses from a legal perspective the kinds of information and expertise required for supporting/refuting claims of groundwater contamination

Short Scholarly Features

Natural Gas Plays in the Marcellus Shale: Challenges & Potential Opportunities (2010). Kargbo, D.M.; Wilhelm, R.G.; Campbell, D.J., *Environ. Sci. & Technol.*
http://pubs.acs.org/doi/abs/10.1021/es903811p
- A feature piece by EPA representatives that reviews some of the challenges and opportunities associated with Marcellus shale gas development

The Implications of Multi-Well Pads in the Marcellus Shale (2011). Ladlee & Jacquet, Community & Regional Development Institute Issue 43
http://devsoc.cals.cornell.edu/cals/devsoc/outreach/cardi/publications/research-and-policy-brief-series.cfm
- An analysis of current drilling patterns in PA and their implications

Marcellus 2008: Report card on the breakout year for gas production in the Appalachian Basin (2009). Engelder, T., *Basin Oil & Gas*
http://www.fwbog.com/index.php?page=Issue&archived=20
- Provides an update on gas production data as of mid 2009, as well as a revised estimate of total recoverable gas in the Marcellus

Marcellus Shale Play's Vast Resource Potential Creating Stir In Appalachia (2008). Engelder & Lash, *The American Oil & Gas Reporter*
http://www.geosc.psu.edu/~engelder/references/link150.pdf
- Information on the geological formation of the Marcellus, as well as an estimate of the gas-in-place widely referenced by others

Data & Information Sources

New York State Department of Environmental Conservation
http://www.dec.ny.gov/energy/205.html
- Well locations
- Active wells & operators
- Production statistics

Pennsylvania Department of Environmental Protection
http://www.dep.state.pa.us/dep/deputate/minres/oilgas/reports.htm
- Permit & rig activity reports
- Active wells & operators
- Production statistics
- Construction contracts, and more…

Susquehanna River Basin Commission
http://www.srbc.net/wrp/
- Hydrologic conditions
- Policies & regulations
- Project locations & approved water sources

Delaware River Basin Commission
http://www.state.nj.us/drbc/
- Hydrologic conditions

- Policies & regulations
- Natural gas related water withdrawal information

Intermountain Oil & Gas BMP Project
http://www.oilandgasbmps.org/resources/gis.php#gis
- GIS data resource for oil & gas drilling activity in western US

FracFocus
http://fracfocus.org/
- Chemical disclosure registry (industry sponsored)

Explore Shale
http://exploreshale.org/
- Check it out!

Marcellus Center for Outreach & Research (Penn State)
http://www.marcellus.psu.edu/
- A variety of shale gas development resources

Environmentally Friendly Drilling Systems
http://www.efdsystems.org/
- Research projects underway with collaboration from universities, industry, and government

Energy Information Administration
http://www.eia.doe.gov/
- Information on national energy usage and related trends

US Environmental Protection Agency
http://www.epa.gov/oem/tools.htm
- EPA site dedicated to emergency management, especially with respect to release of hazardous compounds, local emergency planning, and emergency response logistics

Fact Sheets & Miscellaneous

Primer on Natural Gas Development in Bradford County (2010). Bradford County Office of Planning & Grants
http://bradfordcountypa.org/Natural-Gas.asp
- A good series of maps for Bradford County, PA showing well locations, water withdrawal, etc

Challeges Facing Developers of the Marcellus Shale in the Appalachian Basin (2010). NETL Summer 2010
http://www.netl.doe.gov/technologies/oil-gas/ReferenceShelf/epfocus.html
- A newsletter containing a snapshot of development, as well as a list and description of research projects currently underway related to Marcellus and water resources issues

Economic Analyses

Economic Assessment Report for the SGEIS (2011). Ecology & Environment
http://www.dec.ny.gov/docs/materials_minerals_pdf/rdsgeisecon0811.pdf
- A socio-economic assessment of the effect of shale gas development on NY performed under contract to the NYSDEC

The Economic Consequences of Marcellus Shale Gas Extraction: Key Issues (2011) Christopherson, S.
http://www.greenchoices.cornell.edu/downloads/development/marcellus/Marcellus_CaRDI.pdf

- A compilation of studies, with a focus on the "boom & bust" aspects of extractive development that may be important for NY

Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009 (2011). Kelsey, T.W., et al.
http://www.msetc.org/docs/EconomicImpactFINALAugust28.pdf
- A detailed study examining economic impacts of shale gas in PA during 2009

The Economic Impact of Marcellus Shale Gas Drilling: What Have We Learned? What are the Limitations? (2011). Kay, D.
http://www.greenchoices.cornell.edu/downloads/development/marcellus/Marcellus_Kay.pdf
- A summary and critique of several economic analyses and how policy makers may best be able to use such studies

Shale Gas – Abundance or Mirage? Why the Marcellus Shale Will Disappoint Expectations (2010). Berman, A.
http://www.theoildrum.com/node/7075
- An analysis of whether the financial, physical, and technical data support the current enthusiastic predictions of shale gas potential

The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia (2010). Considine, T.J.
http://www.api.org/policy/exploration/hydraulicfracturing/index.cfm
- A strictly economic analysis, written in a pro-industry voice, that relies on IMPLAN data to show real and potential impacts on the Marcellus state economies

Climate Change & Air Quality

Life Cycle Greenhouse Gas Emissions of Marcellus Shale Gas (2011). Jiang, M., et al
http://iopscience.iop.org/1748-9326/6/3/034014/
- An LCA assessment of gas when used for electricity

Greenhouse Gas Emissions Reporting from the Petroleum and Natural Gas Industry (2010). USEPA
http://www.epa.gov/climatechange/emissions/downloads10/Subpart-W_TSD.pdf
- An EPA update of GHG emissions from oil & gas industries, showing dramatically increased estimates for several emission factors, particularly those for unconventional gas well completions and compressor stations

Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements (2009). Armendariz, A.
http://www.edf.org/documents/9235_Barnett_Shale_Report.pdf
- Details an emissions inventory of gas drilling activities in the Barnett Shale play, including GHGs, NOx, VOCs, and other toxic volatile chemicals

Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report (2011). PADEP
http://www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus_NE_01-12-11.pdf
- Brief, preliminary study of ambient air quality in the vicinity of shale gas operations; evidence for elevated levels of some VOC's, though no exceedance of health standards found

Southwestern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report (2010). PADEP
http://www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus_SW_11-01-10.pdf
- Brief, preliminary study of ambient air quality in the vicinity of shale gas operations; evidence for elevated levels of some VOC's, though no exceedance of health standards found

News & Journalism

ProPublica
http://www.propublica.org/
- Quality reporting that keeps a national-scale view; includes graphs and figures

Geology.com
http://geology.com/articles/marcellus-shale.shtml
- Informative collection of background materials, news pieces, and educational resources, with a focus on the geology itself

West Virginia Surface Owners' Rights Organization
http://www.wvsoro.org/resources/how_a_well_is_drilled/index.html
- A slide show of vertical well drilling, and the potential water related hazards associated with drilling in general