AIR QUALITY IMPACTS OCCURRING FROM HORIZONTAL WELL DRILLING AND RELATED ACTIVITIES

By the West Virginia Department of Environmental Protection
Office of Oil and Gas
Pursuant to W.Va. Code § 22-6A-22
June 28, 2013

INTRODUCTION

As directed by the Natural Gas Horizontal Well Control Act (the Act) passed by the West Virginia Legislature on December 14, 2011, the following is in fulfillment of the mandate pursuant to W. Va. Code §22-6A-22 that the West Virginia Department of Environmental Protection's (DEP) Office of Oil and Gas (OOG) report to the Legislature on the need, if any, for further regulation of air pollution occurring from well sites, including the possible health impacts, the need for air quality inspections during drilling, the need for inspections of compressors, pits and impoundments, and any other potential air quality impacts that could be generated from this type of drilling activity that could harm human health or the environment. This report relies in part upon sampling and data analyses performed by the faculty and students of West Virginia University's (WVU) School of Public Health via contract under the administration of WVU's West Virginia Water Research Institute (WRI).

BACKGROUND

Enhancements to drilling techniques applied over the past several years have accelerated the extraction of oil and gas from previously undeveloped/underdeveloped unconventional geologic formations such as shales. The techniques employed are on a larger scale than conventional drilling, and therefore have the potential for increased environmental impacts. Unconventional oil and gas drilling and related activities have already occurred in other states, for example, Wyoming and Colorado (Hilliard-Baxter-Mancos Shale gas) and Texas (Barnett Shale gas). Marcellus Shale is present in the subsurface beneath much of Ohio, West Virginia, Pennsylvania, and New York. Small areas of Maryland, Kentucky, Tennessee, and Virginia also contain Marcellus Shale. A number of state and federal government agencies have responded by developing or expanding environmental emissions standards and work practices related to oil and gas activities. These include the West Virginia Department of Transportation's Division of Highways (DOH) and DEP, as well as the Federal Energy Regulatory Commission (FERC), the

Occupational Safety and Health Administration (OSHA), the United States Army Corps of Engineers, and the United States Environmental Protection Agency (US EPA). There is no single federal agency whose primary responsibility it is to address environmental impacts from oil and gas activities. Within DEP, environmental impacts from oil and gas activities are regulated by OOG, the Division of Air Quality (DAQ), and the Division of Water and Waste Management (DWWM).[1] Additionally, there are a number of ambient air studies that have been conducted or are underway by the federal government and state agencies that continue to provide additional data on emissions from the oil and gas sector.

Office of Oil and Gas

OOG is responsible for regulating all activities related to the exploration, drilling, storage and production of oil and natural gas, and the reclamation of abandoned oil and gas well sites. These responsibilities include:

- Reviewing and processing of oil and gas well work permit applications.
- Conducting inspections and investigations of regulated sources.
- Addressing citizen complaints.
- Plugging and reclamation of abandoned wells and well sites.
- Administration of the Class II and Class III underground injection control program.
- Performing emergency response duties associated with oil and gas incidents.

A permit is required before well work, including site preparation, can begin. A well work permit must be obtained for activities associated with oil, gas, coalbed methane, secondary recovery, underground storage, solution salt mining, and brine disposal wells. OOG reviews all well work permit applications for compliance with the West Virginia Code, as well as state regulations and guidelines, to ensure that environmental impacts will be mitigated. The Act enhanced the regulatory requirements for horizontal wells, including adding well location restrictions in W. Va. Code §22-6A-12. West Virginia's administrative rule, 35 C.S.R. 8, "Rules Governing Horizontal Well Development," becomes effective July 1, 2013 and incorporates requirements of the Act. Appendix A provides a summary of OOG's location restrictions with respect to horizontal wells under W. Va. Code §22-6A-12 and §22-6-21.

An OOG well work permit application requires the applicant to develop and implement an erosion and sediment control plan meeting best management practices, and a site construction plan, both certified by and constructed in accordance with plans certified by a West Virginia registered professional engineer; a water management plan; and a well site safety plan. The OOG well work permit incorporates casing and cementing standards requiring the operator to prudently drill through fresh groundwater zones so as to minimize any disturbance of them, requiring the operator to construct the well and conduct casing and cementing activities of all

[1] Except for statutorily established requirements, and those duties and obligations conferred upon the shallow gas well review board, the coalbed methane review board, and the oil and gas conservation commissions, W. Va. Code §22-6A-6(b) provides the secretary with sole and exclusive authority to regulate the permitting, location, spacing, drilling, fracturing, stimulation, well completion activities, operation, and any and all other drilling and production processes, plugging and reclamation of oil and gas wells and production operations within the state.

horizontal wells in accordance with statutory requirements and administrative rules and in a manner that will provide for control of the well at all times, prevent the migration of gas and other fluids into the fresh groundwater and coal seams, and prevent pollution of or diminution of fresh groundwater. Upon determining that a permit application meets applicable state requirements, and after public notice and comment, OOG issues a permit requiring implementation of the approved application and plans, along with any site specific permit terms and conditions.

Once the OOG well work permit is issued, the operator is required to keep records and report on various operational criteria, including recordkeeping and reporting of all water used for hydraulic fracturing of horizontal wells and for flowback water from hydraulic fracturing activities and produced water from production activities from horizontal wells; for production activities, the quantity of flowback water from hydraulic fracturing of the well, the quantity of produced water from the well, and the method of management or disposal of the flowback and produced water must be recorded; and for transportation activities the quantity of water transported, the collection and delivery or disposal location(s) of the water, and the name of the water hauling company must be recorded. The operator must file with OOG a completion report within 90 days after completing the permitted well work. As part of the Well Completion Report, an operator or its service provider must list all the additives used in the hydraulic fracturing or stimulation process, including each additive's specific trade name, supplier, and purpose. The operator or its service provider must also list each chemical of each additive intentionally added to a base fluid for the purpose of preparing a fracturing fluid, along with each chemical's Chemical Abstract Services registry number if applicable, its maximum concentration in the additive, its maximum concentration as added to the base fluid, and the volume of the base fluid used. The operator must also file annually reports of natural gas, oil, and natural gas liquids production for each well. Upon request of a surface owner or water purveyor, the company must sample and analyze any existing water wells or developed springs actually used for consumption by humans or domestic animals if they are within 1,500 feet of the proposed well. The plans and specifications for construction of centralized pits and impoundments with a capacity of greater than 5,000 barrels must meet certain criteria to be eligible for a certificate of approval. W. Va. Code §22-6A-9(h) broadly authorizes OOG to condition the issuance of a certificate of approval for large pits and impoundments with any terms and conditions the secretary prescribes. Spill and pollution prevention and control measures are required for drilling, completion, work-over, and production operations. Site equipment must be positioned and techniques used on well sites so as to prevent spills of any pollutants to surface waters and ground waters of the State.

Division of Air Quality

DAQ operates a statewide program to protect and improve air quality. DAQ's regulatory structure includes implementation of state and federal rules, as well as permitting and enforcement authority to prevent and minimize air pollution from a wide range of stationary sources, including oil and gas production and transmission activities.

DAQ regulates approximately 2,000 facilities across West Virginia including large coal-fired power plants, chemical processing and metals production facilities, surface coating operations, compressor stations, natural gas processing facilities, operations of natural gas

production facilities located at well sites, stationary reciprocating internal combustion engines, wood manufacturing, dry cleaners, gas stations, and boilers and process heaters.

Some of the major operations DAQ undertakes are:

- Monitors ambient air, collects and analyzes samples, and summarizes air quality data from a comprehensive statewide network.
- Submits ambient air quality data to the national US EPA database.
- Performs continuous emission monitoring audits of the federal Title IV acid rain program at coal-fired power plants.
- Conducts inspections and investigations of air pollution sources, addresses citizen complaints, and inspects asbestos demolition and renovation projects.
- Reviews and processes initial and renewal operating permit applications for major air emission facilities in accordance with Title V of the federal Clean Air Act.
- Reviews and processes major and minor source preconstruction permit applications.
- Develops and revises State Implementation Plans to attain the Clean Air Act's National Ambient Air Quality Standards, enabling West Virginia to maintain federal funding and remain free of US EPA sanctions.
- Provides free confidential assistance to the State's eligible small businesses on air quality issues and regulatory compliance through the Small Business Assistance Program.
- Compiles calendar year inventories of air pollutant emissions from West Virginia's large industrial sources.
- Develops and coordinates public awareness of air quality issues and education outreach programs.

With respect to the oil and gas sector, DAQ requires permits for and inspects a wide variety of operations including extraction facilities, compressor stations, dehydrators, and operations of natural gas production facilities located at well sites. Appendix B provides a summary of state and federal regulations implemented by DAQ that apply to potential air emissions and air quality impacts associated with the completion (hydraulic fracturing and flowback) and production phases (processing, transmission and storage) of the oil and gas sector. Upon determining that a permit application meets applicable state and federal requirements, and after public notice and comment, DAQ issues a permit containing emission limits for each air pollutant, as well as monitoring, recordkeeping, and reporting to ensure on-going compliance. DAQ has a general permit under development for operations of natural gas production facilities located at well sites. Once completed, this general permit will afford all the protections of an individual permit, including public notice, while streamlining the review process. Once a well has been developed under an OOG well work permit and is producing oil and/or natural gas, the well is said to be in its production phase. An air quality permit includes all operations involved in an oil and gas well site during the production phase of the well, including natural gas and diesel engines, fixed roof storage tanks, completion combustion devices, and ancillary equipment.

A new federal regulation affecting air emissions from wellhead operations went into effect in October 2012. DAQ implements this new rule – 40 C.F.R. 60, Subpart OOOO - as part of its statewide program. While focusing on production activities, the rule requires that well completion operations at hydraulically fractured wells drilled on or after January 1, 2015 safely

maximize resource recovery and minimize releases to the atmosphere during flowback and subsequent recovery. During flowback, recovered liquids must be routed into one or more storage vessels or re-injected into either the same well or another well. The recovered gas must be routed into a gas flow line or collection system, re-injected into the same well or another well, or used as an on-site fuel source, or used for another useful purpose that a purchased fuel or raw material would serve, with no direct release to the atmosphere. If this is not feasible, flowback emissions must be captured and directed to a completion combustion device except where high heat emissions from a completion combustion device may negatively impact tundra, permafrost or waterway, or may result in a fire hazard or explosion. Completion combustion devices must be equipped with a reliable continuous ignition source over the duration of flowback. All salable quality gas must be routed to the gas flow line as soon as practicable.

The development of a well typically involves increased vehicle activity to and from the well site. Local community planning organizations working in conjunction with the DOH can assist in mitigating traffic flow and restoring road integrity. Communities in Marshall County and Wetzel County have convened standing taskforces to address community safety and community relations issues. These community taskforces typically include community planners and members of emergency services, law enforcement, DOH, OOG, oil and gas companies and service providers, schools, hospitals, and citizens. The Act requires the applicant for an OOG well work permit to provide either a letter of certification from DOH that the company has entered into an agreement regarding any state or local service roads pursuant to the DOH Oil and Gas Road Policy, or to certify that the policy does not apply. *See* W. Va. Code §22-6A-20. As discussed in OOG's May 28, 2013 report to the Legislature, "Noise, Light, Dust, and Volatile Organic Compounds Generated by the Drilling of Horizontal Wells Related to the Well Location Restriction Regarding Occupied Dwelling Structures," there are a number of mitigation strategies available to reduce nuisance issues associated with vehicle traffic and vehicle engine idling. For example, vehicle idling may be minimized pursuant to the Diesel-Powered Motor Vehicle Idling Act. Additionally, the use of DEP-approved dust suppressants and lower traffic speeds would aid in minimizing dust emissions.

National standards for mobile sources ensure consistency as vehicles move across state borders. US EPA's federal mobile source program requires emission standards for all gasoline and diesel motor vehicles and mobile engines, as well as for fuels. The vehicle or engine manufacturer is responsible for compliance with the emission standard. Removal or disabling of vehicle or engine emission controls is prohibited. Newer vehicles and engines must meet progressively more stringent emissions standards. However, diesel engines are very reliable and can last over 30 years. To address emissions from this legacy fleet, US EPA had developed programs and provided grant funding to encourage replacements, repowers, and the use of verified retrofit technology ahead of the normal attrition cycle. During the well pad development process, combustion engines are used to power construction equipment, as well as used to pressurize materials during hydraulic fracturing. The activities, emissions, and exposures that exist during well pad development will not be present continuously over a long period of time. The combustion engines used in the construction and development of the well site are nonroad engines and therefore not regulated as stationary sources at a federal level. DAQ regulates stationary sources and does not have oversight of federal mobile source air emissions standard implementation.

Division of Water and Waste Management

While the focus of this report is on air quality issues, a brief overview of DWWM's regulation of unconventional drilling is provided in this section to afford a more complete synopsis of the resources DEP has committed to protecting the environment across all of its programs. DWWM's mission is to preserve, protect, and enhance the State's watersheds for the benefit and safety of all its citizens through implementation of programs controlling hazardous waste, solid waste and surface and groundwater pollution from any source. OOG regulates water issues associated with erosion and sediment controls on the well pad and access roads that are permitted by the OOG well work permit. As discussed in the OOG section, the Act added requirements for water management plans in order to address water withdrawals used in in oil and gas development. The water management plans are reviewed and approved by the Water Use Section of DWWM for OOG. The Act also requires all drill cuttings and associated drilling muds generated by the drilling of a horizontal gas well to be disposed of in an approved solid waste facility. DWWM has required any landfill taking drill cuttings from horizontal gas well drilling to monitor for additional contaminants in the leachate. While it is prohibited to discharge from an oil and gas operation (well pad) to the waters of the State, it is allowable to transport to a centralized treatment plant and discharge. Any publically owned treatment works considering accepting such fluids must industrial discharge treatment requirements. DWWM recently issued a General Water Pollution Control Permit for Stormwater Associated with Oil and Gas Related Construction Activities on May 13, 2013; this permit became effective on June 12, 2013. This general permit covers construction activities associated with oil and gas development that are not already regulated by OOG. This general permit applies to water runoff from the construction of laydown areas, compressor stations, pipelines, etc. that disturb more than one acre of earth.

Unconventional Oil and Gas Drilling Air Quality Studies

Along with the significant growth in domestic gas production in recent years, there has been an increased need for better air emissions data from the oil and gas sector. US EPA's Office of Inspector General formally recognized in a February 2013 report that the federal agency needs to develop and implement a comprehensive strategy for collecting and improving air emissions data for the oil and gas production sector. More comprehensive data will in turn allow for a more consistent basis for air quality planning and rulemaking. There are a number of studies underway by state agencies and the federal government that will provide additional data on emissions from unconventional techniques used in the oil and gas sector in the Marcellus region once finalized. Of the studies that have been completed, many have not been in the Marcellus region. Air studies in non-Marcellus regions provide useful information on trends; however, specific gas constituents and therefore air emissions may vary due to the geological formation, topography, and meteorological conditions of any given area, as well as density of development activities. For example, unusual winter-time ozone in Wyoming has been widely recognized as being due to air emissions from unconventional oil and gas drilling activities and adverse meteorology. As a result, enhanced air emission controls are required in certain areas of Wyoming due to the increased concentration of development and production equipment and the resulting air quality impact. Appendix C contains a compendium of air quality studies related to unconventional oil and gas drilling.

Of particular note in West Virginia are studies conducted at a Monongalia County elementary school by US EPA in the summer of 2011, and OOG's report regarding noise, light, dust and volatile organic compounds generated by the drilling of horizontal wells related to the well location restriction regarding occupied dwelling structures. In the summer of 2011 DEP requested US EPA Region III to conduct air quality monitoring at Skyview Elementary School in Morgantown, West Virginia due to citizen concerns regarding a recently permitted Marcellus Shale well pad operation located approximately one mile away. Ambient and indoor air monitoring at the school was conducted before and after hydraulic fracturing at the well pad. Extremely low concentrations of carbonyls, volatile organic compounds, and hydrogen sulfide were detected, and no indications of public health impacts related to hydraulic fracturing were found. Submitted to the Legislature in May 2013, OOG's noise, light, dust and volatile organic compounds report found that while there were no indications of a public health emergency or threat based on the air data obtained, potential impacts from various well pad geometries existed.

The Pennsylvania Department of Environmental Protection's Bureau of Air Quality (PADEP) has completed three short-term air quality studies related to Marcellus Shale drilling activities, and has a long-term one-year study underway. The short-term studies in northcentral, northeastern, and southwestern Pennsylvania included ambient air monitoring near compressor stations, a condensate tank farm, a wastewater impoundment, a producing well, during hydraulic fracturing and during flaring/completion. The short-term studies did not identify any concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities. Data collection for Pennsylvania's long-term one year of air monitoring data near permanent facilities in Washington County associated with oil and gas activities (a large-scale compressor station and a gas processing station) should be completed towards the end of 2013. Once available, the long-term monitoring data will allow estimates of community exposure to air pollutants. Pennsylvania began collecting annual emissions inventory data from companies involved in unconventional natural gas development for calendar year 2011 in order to assess statewide air quality impacts, and PADEP issued a general permit for natural gas compression and/or processing facilities, including well head operations.

US EPA Region III has a Natural Gas Ambient Air Monitoring Initiative (NGAAMI) underway in collaboration with the Agency for Toxic Substances and Disease Registry (ATSDR) in Region III. Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia are included in Region III. The NGAAMI air monitoring site is in the same area as Pennsylvania's ongoing long-term air study, but was for a shorter duration. This data was collected from August 2012 until November 2012, and is currently being compiled and analyzed.

The Ohio Environmental Protection Agency (OhioEPA) began collecting ambient air data in April 2012 in The Wilds in Muskingum County near an unconventional gas drilling site. While data collection is on-going, during a four-month period in which particulate matter, various hydrocarbons, and methane were monitored, there was one exceedance of the federal 150 microgram per cubic meter PM_{10} concentration attributed to construction of a nearby road. OhioEPA plans to continue monitoring air quality near well sites for at least two years. OhioEPA has also issued a general permit for oil and gas well-site production operations.

A Multi-Agency Collaboration on Unconventional Oil and Gas Research effort at the federal level is still in its early stages. It is an outgrowth of a March 30, 2011 White House

"Blueprint for a Secure Energy Future" which supports the responsible development of the nation's oil and natural gas while promoting safe practices and reducing energy imports. On April 13, 2012 a Memorandum of Agreement was signed among the US Department of Energy, the US Department of the Interior, and US EPA to develop a multi-agency research plan to gather data to support timely, policy-relevant science.

The US Department of Energy's National Energy Technology Laboratory (NETL) and the National Institute for Occupational Safety and Health (NIOSH) signed a Memorandum of Understanding in April 2013 to perform collaborative research related to air quality at natural gas drilling sites. Via the Multi-Agency Collaboration on Unconventional Oil and Gas Research, scientists from the US Department of the Interior and US EPA will also be involved in this multi-agency team. The research will allow the development of modeling tools to predict and quantify potential risks associated with shale gas reserves that require hydraulic fracturing and assist researchers in analyzing greenhouse gas lifecycle emissions. It will also provide a basis for local, regional, state, and federal decision-makers to take positive actions to improve air quality and identify opportunities to reduce emissions from shale gas development and operations.

CONCLUSIONS

Submitted to the Legislature in May 2013, OOG's noise, light, dust and volatile organic compounds report found that, while there were no indications of a public health emergency or threat based on the air data obtained in the study, potential impacts from various well pad geometries existed. West Virginia Code §22-6A-12 established a number of siting criteria for horizontal wells, including a 625-feet distance from the well pad center to an occupied dwelling. The agency stated:

> While the statutorily-specified location restriction is defined to be from the center of the well pad, there are a wide variety of pad sizes and configurations that may allow an occupied dwelling to be close to a well pad.[2] Because of the potential for different well pad geometries, DEP recommends that the Legislature reconsider the reference point (i.e., from the center of the well pad) for the location restriction to occupied dwellings to reduce potential exposures. One option to consider would be to establish a location restriction from the Limit of Disturbance (LOD) of the well pad to provide for a more consistent and protective safeguard for residents in affected areas. The outermost sediment control barrier establishes the LOD around the well pad.

As described in this report, with respect to the oil and gas sector, DAQ permits and inspects extraction facilities, compressor stations, dehydrators, and operations of natural gas production facilities located at unconventional well sites. Reciprocating internal combustion engines at stationary sources have been the subject of new federal standards in recent years,

[2] Under W. Va. Code §22-6-21, no well shall be drilled nearer than two hundred feet from a dwelling without first obtaining the written consent of the owner of such dwelling.

which have increasingly required the installation of air pollution control devices. OOG maintains oversight of the drilling process, as well as the design, construction, operation and maintenance of pits and impoundments through its regulatory program, which includes permitting and inspections. As a result of field sampling and analyses conducted by WVU's Department of Civil and Environmental Engineering commissioned pursuant to W. Va. Code §22-6A-23, OOG provided additional training specific to the proper design, construction, and maintenance of large capacity pits and impoundments to agency personnel and the regulated community. In addition, OOG developed a standard inspection checklist to ensure that the inspection of pits and impoundments is consistent across the Office. The March 7, 2013 report from OOG, "Safety of Centralized Large Pits and Impoundments Used in the Drilling of Horizontal Natural Gas Wells," is based on the sampling results from 15 pits and impoundments across the State, including three (3) centralized pits. There was overlap between two (2) of the pit and impoundment sites and the seven (7) sites where ambient air quality was monitored in the noise, light, dust and volatile organic compounds study.

As noted in the noise, light, dust and volatile organic compounds report to the Legislature, vehicle traffic and engine exhaust present during well pad development are likely sources of intermittently elevated emissions of dust and volatile organic compounds. Vehicle traffic associated with well pad development activities may pose a nuisance. Training on mitigation measures for noise, dust and volatile organic compounds has been provided to agency personnel and the regulated community. Continuous improvement through training has been, and will continue to be, ongoing at workshops in order to keep both internal personnel and external interested parties apprised of the new and constantly changing industrial activities associated with horizontal well drilling.

OOG addresses a wide variety of environmental impacts associated with activities authorized by the well work permit. On a case-by-case basis, OOG continues to work with individual operators and companies to resolve citizen complaints. Permitting authority includes the ability to establish site specific permit conditions as recognized in W. Va. Code §22-6A-2(a)(5). As an example, community concerns regarding oil and gas development near a public water supply intake in Monongalia County resulted in site specific permit conditions as part of a well work permit.

Based on a review of completed air studies to date, including the results from the well pad development monitoring conducted in West Virginia's Brooke, Marion, and Wetzel Counties, no additional legislative rules establishing special requirements need to be promulgated at this time. As evident by the many air studies underway, these initiatives will result in more complete information over time. Once available, this data will help advance and guide future rule development. In the meantime, the existing regulatory framework provides a basis for implementation of requirements to minimize and mitigate human health and environmental impacts

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Appendix A: Summary of Office of Oil and Gas location restrictions for horizontal wells under W. Va. Code §22-6A-12 [1] and §22-6-21			
Reference Point	**Minimum Distance (feet)**	**End point**	**Citation**
Well pad [2]	100	Perennial stream [3]	W. Va. Code §22-6A-12(b)
	100	Natural lake [3]	W. Va. Code §22-6A-12(b)
	100	Artificial lake [3]	W. Va. Code §22-6A-12(b)
	100	Pond [3]	W. Va. Code §22-6A-12(b)
	100	Reservoir [3]	W. Va. Code §22-6A-12(b)
	100	Wetland [3]	W. Va. Code §22-6A-12(b)
	300	Naturally reproducing trout stream [3]	W. Va. Code §22-6A-12(b)
	1,000	Surface or ground water public water supply intake [3, 4]	W. Va. Code §22-6A-12(b)
Well pad center	625	Occupied dwelling structure [5]	W. Va. Code §22-6A-12(a)
	625	≥2,500 ft^2 used to house or shelter dairy cattle or poultry husbandry [5]	W. Va. Code §22-6A-12(a)
Well	200	Dwelling [6]	W. Va. Code §22-6-21
	250	Water well used for human or domestic animal consumption [5]	W. Va. Code §22-6A-12(a)
	250	Developed spring used for human or domestic animal consumption [5]	W. Va. Code §22-6A-12(a)
[1] These restrictions do not prevent activities permitted or authorized by the US Army Corps of Engineers.			
[2] Established by the Limit of Disturbance (LOD) of the well pad. The outermost sediment control barrier establishes the LOD around the well pad.			
[3] May be waived by the department.			
[4] Distance to end point measured pursuant to W. Va. Code §22-6A-12(b)(1)-(3).			
[5] May be waived by the surface owner. A variance may also be granted by the secretary.			
[6] May be nearer upon consent by the dwelling owner.			

Appendix B: Summary of state and federal air quality rules implemented by DAQ that affect the oil and gas sector			
Rule	**Sources**	**Pollutants**	**Requirement**
45CSR2	Hot Oil Heater, Reboiler	PM	Visible emission readings, particulate matter emission limits.
45CSR4	Facility Wide	VOC	Objectionable odors are prohibited.
45CSR6	Flare	PM	Particulate matter emission limits. Temporary flares meeting specific requirements are exempt from this rule.
45CSR13	Criteria pollutants emitted above 6 pph and 10 tpy. HAPs emitted above 2 pph or 5 tpy.	Criteria Pollutants (Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Volatile Organic Compounds (VOC), Sulfur Dioxide (SO_2), Particulate Matter (PM)), Hazardous Air Pollutants (HAPs)	Required to obtain air quality permit.
40CFR60.18	Flare	VOC	98% destruction efficiency of VOC emissions.
40CFR60 Subparts K, Ka, Kb	Storage Tanks	VOC	Prescribed control devices on storage tanks to reduce VOC emissions.
40CFR60 Subpart GG	Gas Turbines	NO_x, SO_2	Must meet the emission control limits for NO_x and SO_2. Must conduct performance testing.
40CFR60 Subpart KKK	Natural Gas Processing Plants	VOC	Must conduct Leak Detection and Repair (LDAR) on all processing equipment to reduce VOC emissions.
40CFR60 Subpart LLL	Natural Gas Sweetening Plants	SO_2	Must conduct appropriate testing and monitoring to show compliance of SO_2 limit for the gas sweetening facility.
40CFR60 Subpart IIII	Diesel Fired Engines	VOC, NO_x, CO, PM	Emission limits that may require the use of air pollution control devices. Must conduct performance testing.
40CFR60 Subpart JJJJ	Natural Gas Fired Engines	VOC, NO_x, CO	Emission limits that may require the use of air pollution control devices. Must conduct performance testing.
40CFR60 Subpart KKKK	Gas Turbines	NO_x, SO_2	Must meet the emission control limits for NO_x and SO_2. Must conduct performance testing. ***(Appendix B Continued Next Page)***

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Rule	**Sources**	**Pollutants**	**Requirement**
40CFR60 Subpart OOOO	Gas Wells, Compressors, Pneumatic Controllers, Storage Vessels, Sweetening Units	VOC, SO_2	Must meet the emission control limits for VOC and SO_2. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR63 Subpart H	Equipment Leaks	HAPs	Varies depending upon source category.
40CFR63 Subpart HH	Tanks, Equipment Leaks, Glycol Dehydration Units at Production Facilities	HAPs	Must control HAP emissions from tanks, equipment leaks, and glycol dehydration units. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR63 Subpart VV	Oil-Water Separators	HAPs	Varies depending upon source category. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR63 Subpart HHH	Glycol Dehydration Unit	HAPs	Must control HAP emissions from glycol dehydration units. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR63 Subpart YYYY	Gas Turbines	HAPs	Must control HAP emissions from stationary gas turbines. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR63 Subpart ZZZZ	Reciprocating Internal Combustion Engines	HAPs	Emission limits that may require the use of air pollution control devices. Must conduct appropriate testing, monitoring and recordkeeping.
40CFR98 Subpart W	Facility Wide	Greenhouse Gases	Greenhouse gas reporting requirements for applicable sources.

Appendix C: Compendium of unconventional oil and gas drilling air studies

Colorado Department of Public Health and Environment, Air Pollution Control Division
Air Emissions Requirements for Oil and Gas Industry website:
http://www.colorado.gov/cs/Satellite/CDPHE-AP/CBON/1251597643322
This website provides information on air emission control requirements, permitting, and record-keeping and reporting.

Colorado School of Public Health & University of Colorado, Anschutz Medical Campus
McKenzie LM, et al, "Human health risk assessment of air emissions from development of unconventional natural gas resources," Sci Total Environ (2012)
http://cogcc.state.co.us/library/setbackstakeholdergroup/Presentations/Health%20Risk%20Assessment%20of%20Air%20Emissions%20From%20Unconventional%20Natural%20Gas%20-%20HMcKenzie2012.pdf
This article discusses air monitoring results, raises questions about the health impacts of unconventional drilling.

Multi-Agency Collaboration on Unconventional Oil and Gas Research
http://unconventional.energy.gov/
This effort is still in its early stages. It is an outgrowth of a March 30, 2011 White House "Blueprint for a Secure Energy Future" which supports the responsible development of the nation's oil and natural gas while promoting safe practices and reducing energy imports. On April 13, 2012 a Memorandum of Agreement was signed among the Department of Energy, the Department of the Interior, and the Environmental Protection Agency to develop a multi-agency research plan to gather data to support timely, policy-relevant science.

National Conference of State Legislatures (NCSL)
"Natural Gas Development and Hydraulic Fracturing – A Policymaker's Guide," June 2012
http://www.ncsl.org/documents/energy/frackingguide_060512.pdf
This report provides an overview of domestic natural gas issues and summarizes state legislation to ensure safe natural gas extraction.

New York Department of Environmental Conservation
http://www.dec.ny.gov/energy/75370.html
The New York Department of Environmental Conservation released a revised draft Supplemental Generic Environmental Impact Statement (SGEIS) in September 2011 on the oil, gas and solution mining regulatory program regarding well permit issuance for horizontal drilling and high-volume hydraulic fracturing in the Marcellus Shale and other low-permeability gas reservoirs. The SGEIS contains a draft air dispersion modeling analyses, discussion of air impact mitigation measures, and air monitoring plans.

(New York Continued Next Page)

New York Legislature
New York has had a moratorium since July 2008 prohibiting any horizontal or vertical Marcellus or Utica well development that would use high-volume hydraulic fracturing. In March 2013 the New York State Assembly passed legislation continuing the moratorium until May 15, 2015. Some communities in New York have their own bans or moratoriums on high volume horizontal hydraulic fracturing.
http://assembly.state.ny.us/mem/John-T-McDonald-III/story/51278/
http://www.huffingtonpost.com/steve-horn/ny-assembly-fracking-moratorium_b_2831272.html

Ohio Environmental Protection Agency (OhioEPA) November 2, 2012 news release
http://www.epa.state.oh.us/news/onlinenewsroom/newsreleases/tabid/5967/vw/1/itemid/220/early-air-quality-data-near-gas-drilling-site-shows-clear-air.aspx
OhioEPA conducted a four-month air quality study during mid-2012 in The Wilds in Muskingum County near a gas drilling site. During that period particulate matter, various hydrocarbons, and methane were monitored; there was once exceedance of the federal 150 microgram per cubic meter PM_{10} concentration attributed to construction of a nearby road. OhioEPA plans to continue monitoring air quality near well sites for at least two years. A general permit for oil and gas well-site production operations has been issued.

Oil and Gas Well-Site Production Operations General Permit:
http://www.epa.ohio.gov/dapc/genpermit/Oil_Gas_GP12.aspx

Pennsylvania Department of Environmental Protection, Bureau of Air Quality
http://www.portal.state.pa.us/portal/server.pt/community/air/6000
This website is a portal to information regarding PA's three completed short-term Marcellus Shale air quality studies, and the long-term study underway. It also links to information on PA's emission inventory for companies involved in unconventional natural gas development, and their general permit for natural gas compression and/or processing facilities, including well head operations.

Texas Commission on Environmental Quality (TCEQ)
http://www.tceq.texas.gov/airquality/barnettshale
TCEQ conducts air sampling, including for volatile organic compounds and carbonyls, in the Dallas-Forth Worth area where Barnett shale is drilled in highly populated urban areas. Near real-time automated gas chromatograph data is available for some site. TCEQ has also conducted a special air emissions inventory.

Air compliance information for oil and gas facilities, including permits by rule, can be found at
http://www.tceq.texas.gov/assistance/industry/oilgas_air.html

(Texas Continued Next Page)

Texas Department of State Health Services, Final Report - DISH, Texas Exposure Investigation - DISH, DENTON COUNTY, TEXAS, May 12, 2010.
www.dshs.state.tx.us/epitox/consults/dish_ei_2010.pdf
http://www.dshs.state.tx.us/news/releases/20100512.shtm
The agency found that based on biological testing, residents' exposure to certain contaminants was not greater than that of the general US population. Blood levels of volatile organic compounds, particularly benzene, were tested in 28 residents based on community concerns about potential health effects of unconventional natural gas drilling.

Texas, Flower Mound Environmental Resources staff of Flower Mound, Texas increased its air monitoring to monthly in January 2011 in response to citizen concerns. They test for over 60 volatile organic compounds, reduced sulfur compounds, and carbonyls.
http://www.flower-mound.com/index.aspx?NID=930

Texas, Fort Worth "City of Fort Worth Natural Gas Air Quality Study," July 13, 2011
Eastern Research Group, Inc. and Sage Environmental Consulting conducted a study including an estimate of air emissions from natural gas exploration, reviewed air monitoring data, conducted limited air dispersion modeling, and reviewed the city's 600-foot setback distance.

United States Department of Energy, National Energy Technology Laboratory (NETL)
NETL Sept. 2012 factsheet on a Marcellus test well site in Washington County, PA
"DOE Leads Collaborative Effort to Quantify Environmental Changes that Coincide with Shale Gas Development" http://www.netl.doe.gov/publications/factsheets/rd/R%26D186.pdf

Nov. 17, 2011 presentation provides additional details.
http://groundwork.iogcc.org/sites/default/files/Pekney%20Air%20Sampling%20Initiatives%20Marcellus%20Shale%20Summit%20Nov%202011.pdf

NETL and WVU will publish on the data collected in Brooke, Marion, and Wetzel Counties in WV from July – October 2012 as part of the Noise, Light, Dust and Volatile Organic Compounds study. http://www.netl.doe.gov/publications/factsheets/rd/R%26D160.pdf

United States Environmental Protection Agency (US EPA) Region III Natural Gas Ambient Air Monitoring Initiative (NGAAMI)
A collaboration with the Agency for Toxic Substances and Disease Registry (ATSDR) in Region III. Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia are included in Region III. The NGAAMI air monitoring site is in the same area as Pennsylvania's ongoing long-term air study, but was for a shorter duration. This data was collected from August 2012 – November 2012, and is being compiled and analyzed.

US EPA, Natural Gas Extraction - Hydraulic Fracturing
http://www2.epa.gov/hydraulicfracturing
This website provides background on US EPA's approach to regulating unconventional drilling activities and addressing data gaps. There is a section on "Addressing air quality impacts associated with hydraulic fracturing activities."

US EPA, Office of Inspector General, "EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector", Report No. 13-P-0161, February 20, 2013, http://www.epa.gov/oig/reports/2013/20130220-13-P-0161.pdf
Determines that US EPA needs to develop and implement a comprehensive strategy for collecting and improving air emissions data for the oil and gas production sector.

US EPA Region III, Morgantown, West Virginia "Skyview Elementary School Site, Morgantown, Monongalia County, West Virginia," Trip Report - Air Sampling Event, Raj Sharma (by TechLaw) January 17, 2012

In summer 2011 DEP requested US EPA Region III conduct air quality monitoring at Skyview Elementary School in Morgantown, West Virginia due to citizen concerns regarding recently permitted Marcellus Shale well pad operation. Ambient and indoor air monitoring was conducted before and after hydraulic fracturing at the well pad located approximately one mile from the school. Extremely low concentrations of carbonyls, volatile organic compounds, and hydrogen sulfide were detected, and no indications of public health impacts related to hydraulic fracturing were found.

US EPA Region III, The Mid-Atlantic States, Key Documents About Mid-Atlantic Oil and Gas Extraction http://www.epa.gov/region3/marcellus_shale/
This website contains background on Marcellus Shale impacts with an emphasis on potential impacts to water resources.

United States Government Accountability Office (GAO), "Report to Congressional Requesters, Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks," GAO-12-732, September 5, 2012 http://www.gao.gov/assets/650/647791.pdf

GAO was asked to determine what is known about the (1) size of shale oil and gas resources and the amount produced from 2007 through 2011 and (2) environmental and public health risks associated with the development of shale oil and gas. GAO reviewed estimates and data from federal and nongovernmental organizations on the size and production of shale oil and gas resources. GAO also interviewed federal and state regulatory officials, representatives from industry and environmental organizations, oil and gas operators, and researchers from academic institutions. GAO did not make any recommendations in this report.

West Virginia Department of Environmental Protection, Office of Oil and Gas, "Noise, Light, Dust, and Volatile Organic Compounds Generated by the Drilling of Horizontal Wells Related to the Well Location Restriction Regarding Occupied Dwelling Structures," May 28, 2013.http://www.dep.wv.gov/oil-and-gas/Horizontal-Permits/legislativestudies/Pages/NoiseLightDustVolatileOrganicCompounds.aspx
This report found that while there were no indications of a public health emergency or threat based on the air data obtained in the study, potential impacts from various well pad geometries existed.

(West Virginia Continued Next Page)

West Virginia Department of Environmental Protection, Office of Oil and Gas, "Safety of Centralized Large Pits and Impoundments Used in the Drilling of Horizontal Natural Gas Wells," March 7, 2013. http://www.dep.wv.gov/oil-and-gas/Horizontal-Permits/legislativestudies/Pages/ImpoundmentandPitSafety.aspx
This report found that based on the results of the field sampling and structural reviews performed by WVU's Department of Civil and Environmental Engineering, no additional rules were immediately necessary for the design and construction of large pits and impoundments.

West Virginia University, School of Public Health
McCawley, M. PhD, WVU, "Air, Noise, and Light Monitoring Results for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project)," May 3, 2013.http://www.dep.wv.gov/oil-and-gas/Horizontal-Permits/legislativestudies/Documents/WVU%20Final%20Air%20Noise%20Light%20Report.pdf This report was commissioned by DEP to measure noise, light, dust and volatile organic compounds during well pad development. DOE's NETL mobile monitoring trailer was also used to collect data in Brooke, Marion and Wetzel Counties from July – October 2012.

Wyoming Department of Environmental Quality, Division of Air Quality
Sept 6, 2012 WY DEQ, Air Quality Division – Pavillion Station Data Summary re air quality complaints http://deq.state.wy.us/out/downloads/Memo_090612_initialed.pdf

News Release, DEQ to increase compliance checks of engines at oil and gas production sites, April 11, 2013 http://deq.state.wy.us/out/downloads/AQD_Tests_APR_2013.pdf

Air Permit Application Forms and Guidance for Oil and Gas http://deq.state.wy.us/aqd/oilgas.asp

Enhanced air emission controls are required in some areas due to the increased concentration of production equipment and the resulting air quality impact
http://deq.state.wy.us/aqd/Oil%20and%20Gas/JONAH%20INFILL%20GUIDANCE%20FINAL%207-28-04.pdf

Winter Ozone Update, March 22, 2011, Public Meeting, Pinedale, WY
http://deq.state.wy.us/out/downloads/March22PublicMtg_2011Ozone_WDEQ.pdf