# Wayne County Oil and Gas Task Force

"*Understanding Methane Migration Issues in Pennsylvania*"

October 18, 2011 - Public Meeting Summary - *by Chris Barrett*

On October 18, 2011, the Wayne County Oil and Gas Task Force hosted a public presentation, which was titled "Understanding Methane Migration Issues in Pennsylvania". The event, which took place at the Wayne County Park Street Complex, had approximately 50 people in attendance.

The program began with a welcome introduction from Edward Coar, the Wayne County Dept. of Planning Director and Chairman of the Task Force. Mr. Coar recognized and introduced Dave Messersmith of the Penn State Cooperative Extension and Chairman of the Wayne County Oil and Gas Task Force Outreach sub-committee, and also Michele Stahl, Craig Olver and Jamie Knecht as members of the Outreach sub-committee that were in attendance for their work to produce the program. Mr. Coar also recognized members of the main task force who were in attendance at the public meeting. The Wayne County Oil and Gas Task Force website, which is available at www.wcpaoilandgastaskforce.info was displayed by Mr. Coar. A specific item noted from the website was the recent proposal by Governor Tom Corbett in regard to impact fees. The updated website includes information on recent news and events, natural gas exploration activity in Wayne County and links to numerous websites.

Dave Messersmith introduced the first speaker, Mr. Burt Waite, who is a Senior Geologist and Program Director at Moody & Associates, Inc. Mr. Waite started his presentation with a discussion of the physical properties of natural gas and specifically methane, which is the major component in natural gas. He discussed the difference between "dry gas" and "wet gas". He stated that "dry gas" is the type of natural gas that does not have any of the longer chain hydrocarbons in it, such as propane, ethane and butane. Other than that type of gas, he stated that almost all of natural gas is indeed methane. He stated that in this part of Pennsylvania, the gas has a tendency to be mostly "dry", so 97-98% of the gas is methane. When he is talking about methane he is talking about natural gas. Methane is nearly 75% carbon and 25% hydrogen. Ethane and Propane are important byproducts found in the gas in the southwestern part of Pennsylvania. He stated that American natural gas is approximately 85% pure methane. Methane is colorless and odorless, which he stated can be a problem because its presence may not be known. He also stated that the density of methane is 0.554 in air. This means that it is lighter than air and will rise. Methane is soluble in

water at normal temperature and pressure at a concentration of about 21-35 mg/l. The solubility of methane in water increases with pressure (depth). This is important, as noted by Mr. Waite, if it is present in a water well. In the atmosphere, methane is explosive in concentrations between 5 – 15%. Mr. Waite next showed a slide that illustrated how the solubility of water increases in a hypothetical water well as the depth increases. For example, the slide illustrated that at 50' (water's surface), the methane solubility is 28 mg/l. However, at 250' or 200' below the water surface, the solubility of methane is 192 mg/l. He stated the significance of this is that if you have a pump at the bottom of the well and there is methane in the well at the maximum solubility, when the water is pumped into a house the solubility decreases rapidly and the methane comes out of solution into the air. If you see or hear about water that effervesces that means that the methane is coming out of solution at the surface.

Mr. Waite pointed out that there are no drinking water standards for methane. This includes both the PA DEP and US EPA. Methane is not recognized as a toxic substance. However, it is recognized as a safety issue as it will burn or explode. He mentioned that there have been instances where explosions have occurred in Pennsylvania due to fugitive gas that has accumulated, although he indicated this does not happen very often.

One issue that Mr. Waite currently considers bothersome is that there is not a universally accepted method for laboratory testing of methane in water. There are about 5 or 6 different tests that can be done with regard to methane in water. He would like to see State and Federal protocols developed. Without a standardized testing method it is not possible to compare concentrations of methane in water between labs that utilize different methods.

Mr. Waite also discussed some different sources of methane. He indicated that methane is extremely common in our environment from various sources and not just oil and gas exploration sources. Some of the sources include:

- Landfills
- Manure Digestion
- Coal mines and coal
- Natural Gas

In terms of identifying sources of stray gas Mr. Waite indicated that there is a technique available by utilizing geochemical and isotopic fingerprinting to help determine the origin of the gas source. However, he stressed that although it is a valuable tool it is not definitive. He stated that at this point it is not possible from this testing to determine a specific source gas well for methane found in well water. He did indicate that it is possible to determine between microbial origin gas (landfill and marsh gas) and thermogenic gas that is formed in deep seated formations through time from heat and pressure.

Mr. Waite spoke on the hydrostatic pressure of water. He stated that 1 pound per square inch (psi) is equal to 2.3 feet of head (height of a column of water). Similarly, 1 foot of head is equal to 0.433 psi. The importance of this is related to PA DEP regulations that were recently modified and went into effect on February 5$^{th}$ of this year. These facts are the basis of the "80 % Rule". The "80 % Rule" indicates that 0.80 is multiplied by 0.433 (psi pressure for 1 foot of head) which is then multiplied by the length or depth of surface casing (in feet). The numerical result of this formula is the maximum allowable pressure on a surface casing. Mr. Waite indicated that the importance of this is that, historically speaking, most of the stray gas problems encountered in the State over the last two decades originated from over pressured surface casing. He indicated that this rule does not allow this to happen unless there is cheating. He stated that there should not be gas migration into fresh water aquifers and individual water wells from the drilled gas wells if the maximum allowable pressure is not exceeded.

Mr. Waite indicated that natural gas does occur naturally in water wells. He displayed a geologic cross section of Pennsylvania that illustrated how the same rock and sandstone units that historically produced oil and gas are the same units that are used for water wells in Wayne County. It is in fact the dominant bedrock formation that is used for water wells in Wayne County.

He mentioned that PA DEP does recognize stray gas migration as a major issue. Mr. Waite predicts that to date the DEP has investigated close to 130 stray gas incidents in the State since 1987. He stated that more cases are being investigated now than they were before. He did indicate that the occurrence of methane in fresh water aquifers is not a new phenomenon. He stated that the old geologic literature going back to 1939 recognizes methane in water wells across the northern tier of Pennsylvania. He indicated that does not mean that an existing problem may not be exasperated by gas drilling and it also does not mean that every time methane is encountered in a water well it is because of gas well drilling.

Next Mr. Waite gave a brief overview on the types of casing utilized in gas well drilling. He described the conductor casing, which is the first string of casing that is used in the gas drilling process. This type of casing is often about 20 inches in diameter and it is installed to a depth of 20 feet or more. The next string of casing is the surface casing and this is drilled inside of the conductor casing. This string of casing is installed to a depth of about 300 feet. This string is often called the water casing and it is suspended from the bottom. This string is then cemented in place using what is called the positive displacement cementing method. This method is required by regulation and all operators follow this regulation. During this process, the cement is pumped down the center of the pipe until it circulates back toward the surface on the outside of the casing until it reaches the surface. This method ensures that there is a good cement sheath completely around this surface casing. He indicated that this is done for every Marcellus well that is drilled in the State. Following this step, Mr. Waite stated that almost always there is another string of casing installed, which is called the intermediate casing. This next string of casing is normally set to a depth of about 1,000 feet. It is situated inside the surface casing, which is now cemented in place. Again, he stated, cement is pumped down this casing until it circulates back out to the surface in the same manner discussed previously. Mr. Waite mentioned that this series of casings with cement is designed to protect fresh water aquifers and it works very well. Inside of the casing they can now drill down to the desired depth and make a curve for horizontal drilling using what is called the production casing, which is typically about 5.5 inches in diameter. The horizontals run about 3,000 to 5,000 feet and, he stated that these horizontals are now stretching out even further than that. Next, he mentioned that cement is again pumped down the well bore until it circulates back to the surface. He noted that there is currently some debate in regard to whether or not the production casing cement should be extended to the surface or if it should only extend to the string of intermediate casing. The reason being that if last string of cement casing was stopped below the depth of the intermediate casing and there is gas leakage it would be contained and then could be liberated to the surface in a vent. He stated further that currently both methods are being used in Pennsylvania.

Mr. Waite stated that in almost all cases when gas does escape from a gas well and ends up where it is unwanted, such as a water well, which he further indicated is rare, the stray gas is coming from the shallower Venango group sands that he mentioned earlier and not the Marcellus formation. He indicated that it is important during gas well construction to not penetrate those gas sands, which could allow gas channeling in the surface casing. He displayed a slide that illustrated why deeper

surface casing may not always be better. He pointed out that the surface casing should be set above the depth of the gas sands where they are present. The gas wells need to be constructed according to the local conditions at the particular well pad, he stated. He noted that the operators are getting very good at doing this by basing the design of the surface casing on the local conditions.

Mr. Waite spoke on the changes to the gas regulations in Pennsylvania that went into effect on February 5th of this year on the topic of gas migration. He stressed that DEP takes this issue very seriously and there were changes in the Chapter 78 regulations to address stray gas concerns. Mr. Waite used a slide that contained a portion of the regulations to stress that when the operator or owner of a gas well is notified or made aware of a potential gas migration incident the operator shall immediately conduct an investigation of the incident in order to determine if there is a hazardous condition and also to assess the level of the potential hazard. He illustrated that when a potential natural gas migration incident is discovered the owner/operator must:

- Conduct site visits and interviews
- Conduct a field survey of the presence of gas, concentrations and aerial extent
- Establish monitoring locations at potential sources, impacted structures and subsurface

He noted that the 1,000 foot rule, which involves the presumption of guilt within that distance, does not apply to this issue. If an operator is notified of a potential gas migration issue, they must conduct the investigation even if they are outside the 1,000 feet threshold.

In terms of the required gas migration response, Mr. Waite pointed out that "If combustible gas is detected inside a building or structure at concentrations equal to or greater than 10% of the lower explosive limit (L.E.L.), the operator shall:

1) Immediately notify the department, local emergency response agency, gas and electric utility companies, police and fire departments and, in conjunction with the department and local emergency response agencies, take measures necessary to ensure public health and safety;
2) Initiate mitigation measures necessary to control and prevent further migration;
3) Implement the additional investigation and mitigation measures as provided in subsection (E)(1)-(5)."

He also pointed out that if the concentration of gas is lower than 10% of the L.E.L. and other lesser criteria there is a lesser response required. Concentrations at or equal to the 10% L.E.L. must be reported to the department (DEP) within 24 hours. Also, the department can also require the operator to take additional actions by conducting field surveys to assess the presence of gas in soils, surface water, water wells and other potential migration pathways. Mr. Waite also noted that if an

operator is conducting an investigation they must collect water and/or gas samples for molecular and stable carbon and hydrogen isotope analysis from the impacted locations and from the potential sources of the migration. Next, he stated that during the response an immediate evaluation of the operator's adjacent oil / gas wells. The evaluation includes an initial search within 2,500 feet, but may expand beyond that distance. The evaluation needs to determine the well cement integrity, the casing integrity and the annular pressures for adjacent wells. Mr. Waite also noted that for all stray gas migration reports, a final written report is required and must be signed by a Pennsylvania licensed geologist (PG) or engineer (PE).

Mr. Waite discussed the topic of pre-drill water well surveys and pre-drill gas. A question came up with respect to pre-drill methane encountered in concentrations greater than the threshold limit of 7 mg/l and whether or not a methane migration investigation needed to be conducted. If water samples contained methane above this threshold limit, the DEP said that the operator / owner does not have to conduct an investigation, but it does need to be reported. DEP will determine if it is an issue or not, according to Mr. Waite. He further stated that actually the occurrence of methane in water wells above 7 mg/l is not that uncommon and it happens quite a bit.

Mr. Waite described a situation where a well is over pressured and begins to push stray gas out. The stray gas will find its way to the lowest pressure. The points of lowest pressure are valleys, water wells and basements etc. This is where the gas will show up first and it is the situation that is most worried about, but it does not happen often, according to Mr. Waite. He also described a situation where cloudy water may be encountered by the water well owner. He believes this is caused by the gas well operator drilling the top hole portion with air, which creates a pressure front that increases the turbidity in the aquifer. At the point when stray gas has been detected in a water well that was caused by over pressuring a gas well a number of remedies can fix the problem at the source (gas well), but he asked the question of what can be done to remedy the situation in the water well. He displayed a photograph of a system that was installed to vent stray gas from an affected water well. He also presented a conceptual illustration of a methane treatment system that is designed to liberate the methane in the well water and then vent it out of the well water treatment system chamber. He stated that this type of system works well. This concluded Mr. Waite's presentation.

At this point, Dave Messersmith introduced the second and final speaker of the evening, Mr. Brian Oram who is a licensed Professional Geologist (PG), licensed well driller (IGSHPA), soil scientist and owner of B.F. Environmental Consultants, Inc.

Mr. Oram highlighted some of the outreach programs that he conducts, which includes:

- Environmental and professional education and training for citizens and local municipalities
- Water quality help guides
- Community and business outreach programs
- Low cost informational water testing program with a national laboratory
- Citizen monitoring programs

Currently, he is working on a private well owner / watershed group survey that is being conducted in the Marcellus region. Through the survey, he is hoping to sample approximately 200 water wells for free to test for radon.

Mr. Oram spoke about the divisional mindset in regard to the region's drinking water and the exploration of the Marcellus Shale. This mindset results in people choosing sides and this is what is causing problems, he stated. He pointed out that we need to find a balance where we understand the risks and make good decisions with the science behind it. He stated further that if we have the science and technology to do it in the right way then do it.

Mr. Oram provided a snapshot of the drinking water in Pennsylvania. He pointed out that 50% of the drinking water in Pennsylvania meets the drinking water standards, but the other half of the private water well owners drink water that does not meet the drinking water standards. He pointed out problems with corrosion and specifically copper, lead, iron and manganese. There are issues with sediment and gases, including methane. He pointed out that he lit his first well in 1989. Also contributing to the poor water quality is bacteria.

Mr. Oram discussed his previous history of going to meetings and meeting with private citizens with respect to their drinking water. His response rates were in the area of 5%. He stated it took the gas industry to come to the area to get people to care about the quality of their drinking water. More importantly, he stated, that people are now getting their water tested for parameters well beyond bacteria. They are finding things such as arsenic and lead. He pointed out that we need to work together to protect our surface water, but this also entails fixing our problems. He stated that

the same principles that apply to surface water in terms of water flowing downhill or downgrade also apply to groundwater. If there are wells where the well water is not good and not drinkable, then that water is moving downgrade to someone else and that is a concern. The numbers of wells that are contaminated can affect the wells that are not contaminated. His slide pointed out identifying zones or areas that are vulnerable to contamination. This idea lead to the creation of the citizen groundwater / surfacewater database, which is a voluntary program established and managed by Brian Oram. The database, he stated, would only contain data submitted by the citizens.

He also pointed out some of the common problems with the water in Northeastern Pennsylvania. Some of the problems he highlighted included water with a low pH, which causes it to be corrosive. This corrosive water will leach metals from the piping it comes in contact with over time. He noted that copper, like lead, can cause health problems when it leaches into drinking water. He also pointed out problems with iron and manganese. He stated that problems with discolored water are possible. He mentioned that the gas companies need to keep landowners informed that discolored water is possible during drilling, but it does not necessarily mean that a contaminant moved to the water supply. He also pointed out problems with bacteria, sulfur odors and methane (biogenic and thermogenic). What we don't have in our water, he stated are volatile organic compounds (VOC's) such as benzene, toluene etc. These compounds are found near leaking gas tanks and this has been a very common problem. We also don't have problems with Synthetic Organic Chemicals (SOC's), glycols, saline water and radionuclides. One thing he pointed out is that the green movement is resulting in people moving towards ground force heating and cooling systems. These systems have pipes filled with ethylene and propylene glycol, according to Mr. Oram. There are no construction standards for these systems, he stated and they are at 100% solutions in the freshwater aquifer.

He noted that there are water wells in Wayne County that are between 900 and 1,200 feet deep. He stated that it is very important to know the depth of your water well as it relates to natural gas drilling. It is also important to participate in the baseline survey so the gas company has all of the information on your well to know how deep to set the surface casing.

Mr. Oram mentioned that most contamination appears to be associated with total coliform bacteria. Some possible sources of this that were pointed out in the slides included:

- Insects, larvae and nests / egg masses
- Mouse colonies
- Snakes

- Beehives
- Mud – when the casing is close to the ground

These contaminated wells are conduits for further contamination, he stated, and they need to be fixed. As the slide pointed out, the contaminated wells can facilitate groundwater contamination.

Mr. Oram noted that there are no construction standards for private water wells in the State. There are two states in the nation that do not have private water well standards - Pennsylvania and Alaska. He further pointed out that cement or bentonite is not required for private water wells to seal the annular spacing and it very rarely is done. The danger, he noted, is that water from the surface can move along the casing and get into the groundwater aquifer. Contamination of sanitary wells is then possible from a nearby source if contamination is present in the water that has infiltrated the groundwater supply.

Next, he pointed out some goals of the citizen's groundwater database, which included:

- Provide a central location to store baseline pre-drilling and/or post-drilling water quality data for the region
- Document quality by geological formation
- Identify existing regional issues or concerns
- Provide an un-biased community resource
- Provide a mechanism to track temporal, spatial and other geospatial variation in water quality

The database will only contain certified water testing data. The data must come from third party samplers with a full chain of custody to a certified laboratory. No home water quality testing kit data will be eligible.

Mr. Oram spoke about recent baseline testing that he conducted in Luzerne County. The study consisted of 320 private wells. According to Mr. Oram, 49% of the wells tested positive for fetal coliform bacteria. He also spoke about phthalates. Phtalates are used a plasticizers, which are substances added to a material to make it flexible. They can cause gastrointestinal problems and they are carcinogens. He believes the path of entry is black coil pipe that is used in water wells may be leaching the plasticizers. He also spoke about methane in groundwater and the various possible sources, which include wetlands, landfills, lakes and gas from non-marcellus shale formations. He noted that the methane levels change over time. Mr. Oram illustrated with a slide that highest levels are observed when:

- Barometric pressure is low and soils are saturated
- When snow cover is just beginning to melt
- The ground is frozen or ice covered
- Under long pumping conditions when the well is experiencing the lowest dynamic water level and greatest drawdown

He also noted that the observances of brown or discolored water may be due to the presence of iron and manganese. He stated that about 50% of the wells that have a total coliform problem have problems with iron and manganese. The discoloration that is being observed may be caused by bacteria.

Mr. Oram had some recommendations for the local leadership:

- Educate and inform
- Promote discussion between the gas companies and the royalty owners
- Encourage citizens to participate in baseline water well testing
- Encourage private water well construction and siting standards
- Develop a way to fix poorly constructed wells
- Monitor private wells during the drilling process
- Develop a community support program
- Promote solutions that fix a problem not just treat the symptoms

At the conclusion of Mr. Oram's presentation the floor was opened for a question and answer session.

A member of the audience initiated a discussion about a recent school construction project and drilling that occurred there. Mr. Oram was familiar with this project and commented that he was the consultant that reviewed the design for the geothermal system. The plans were modified to change the standard by leaving a piece of steel in with the annular face being sealed with cement. Mr. Oram indicated that the original proposal to drill 70 wells 400 feet deep without the proper casing and grout could create a problem. The audience member stated that they had dirty water to come up in their water wells near the site. He also mentioned problems that were potentially created by the water company further south as they drilled wells into that aquifer. Mr. Oram stated that he should let the water company know of this situation. They are his client and it may warrant an investigation.

Another audience member raised questions about dirty water in his wells, which were also near the school. Mr. Oram discussed the water flow patterns around the school, which he believed would not cause the observed conditions. The audience member questioned why he never had problems before the school drilled the wells. Mr. Oram did not know, but stated he could look into it if the landowner wanted to pursue this.

Another audience member had a question about the variability of water samples tested for methane between different laboratories. Mr. Waite confirmed what the audience member suspected that there is a degree of variability between different laboratories and their individual testing methods. One thing Mr. Waite pointed out is that the detection limit variability that is used between different laboratories. He noted detection limits of .001 mg/l for one lab and 2.5 mg/l for another lab. Operators are reporting great variations in the concentrations of methane being detected and he believes this is largely due to the different testing methods being used. Mr. Waite believes that eventually there will be a standard or recommended testing method to be used.

Mr. Waite had a comment that was directed at Mr. Oram. He stated that he 100% supports and endorses Mr. Oram's recommendation for construction standards for domestic water wells. He feels it is absolutely critical.

An audience member questioned when the best time was to conduct a baseline test. Mr. Waite responded that ideally he would like to see baseline samples obtained at two different periods. One would be at the high water lever and the other would be at the low water level. Other than that he recommended that the audience member get baseline testing conducted. Mr. Oram suggested getting baseline testing done now. The audience member asked if there was a specific recommended time period between the testing and when the drilling would occur. Mr. Oram stated that the company will come in and conduct testing, but he again recommended getting baseline testing conducted now.

Another question from the audience asked for advice in regard to the recommended level of price of the baseline testing. Mr. Oram indicated that there is a recommended list that DEP put out that would cost about $400. Mr. Oram also suggested that anyone interested can contact him for guidance in regard to suggested parameters.

Wayne County Commissioner Brian Smith commented that everyone in the room is here because they care. We have common ground in that we have a great County and we care very much about it. He wanted the attendees to know that the Commissioners also care very much about this County. Mr. Smith commented on something that Mr. Oram stated during his presentation, which was that we need to understand the risks and make decisions based on what the risks really are. This can be accomplished by talking to the people that have the skill sets that can help to address those risks and that, in part, is the goal of these forums.

Wayne County Commissioner Wendell Kay stated that the Commissioners were very happy to make the Park Street Complex available for the Task Force's educational forum, which is similar to the way the Emergency Operations Center (EOC) is utilized for the training of emergency responders. Mr. Kay found it very appropriate that the prior use of the Park Street Complex was a school, since the goal of the Wayne County Oil and Gas Task Force is to educate people about all of the aspects of the oil and gas industry. Today, the topic was methane migration, he said, but the Commissioners and the Task Force are looking at all of the issues, both positive and negative that may materialize from this economic opportunity. Mr. Kay complemented those in attendance who came to acquire the knowledge that will be necessary to make decisions in the future in the same way that the Wayne County Commissioners educate themselves on this and other important topics. In closing, he also noted that the Commissioners and the County employees are always available to answer any of the public's questions.

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