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***Evaluation of Risk to Brockway Borough Municipal
Authority Surface Water and Groundwater Sources
from
Flatirons Development, LLC Gas Drilling Operations
Jefferson and Elk County, Pennsylvania***

PREPARED BY:

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Respectfully Submitted:

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telecommunications | environmental | geotechnical

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1.0 INTRODUCTION

1.1 Project Summary

This document provides the findings of Advantage Engineers, LLC (Advantage) evaluation of the potential for adverse impact from gas drilling operations to the water resources of Brockway Borough Municipal Authority (BBMA). The evaluation involved review of Flatirons Development, LLC (Flatirons) Well Pad 6 operations and their potential effects to Rattlesnake Reservoir and Rattlesnake Run. In addition to Pad 6, Flatirons has begun development, and/or proposed additional facilities, in the Rattlesnake Creek watershed and the contiguous Whetstone Branch watershed. The risk evaluation considered all of BBMA's land holdings where they have developed reservoirs and supply wells for potable water production. The attached Figures 1 and 2 show the approximate extent of BBMA's land holdings, and Flatirons existing and proposed facilities on USGS topographic mapping and recent aerial photography.

1.2 Documents Reviewed

The following documents were reviewed as part of this evaluation:

- *Draft*, Brockway Borough Municipal Authority, Well #5 Protection Plan, Flatirons Development, LLC, March 8, 2011, Rev. March 21, 2011.
- Responses to Advantage Engineers Review of Plan, August 2, 2011.
- Field Preparedness, Prevention, & Contingency Plan (PPC), Flatirons Development, LLC, 10-6-2011 (Revision Date).
- Erosion and Sedimentation General Permit (ESCGP-1) Application for the Flatirons Development, LLC, Dannie ESCGP-1 #4 Project, Horton Township, Elk County and Snyder Township, Jefferson County, Pennsylvania, October 2010, W.J. Young & Associates.
- Erosion, Sediment and Stormwater Control Plan for Oil and Gas Operations, Dannie ESCGP-1 #3A, Snyder and Horton Townships, Jefferson and Elk Counties, for Flatirons Development, LLC, prepared by Botsford Surveying, Inc. Marion Center, PA.
- Post Construction Stormwater and Site Restoration Plan for: Dannie ESCGP-1 #3A, Snyder, Horton Township, Jefferson, Elk County, Pennsylvania, July 2010, prepared by Botsford Surveying, Marion Center, PA.
- Material Safety Data Sheets for: CI-100 Acid Corrosion Inhibitor, CS 500 SI (scale inhibitor), FE-100L Iron Chelator, Shale Surf 1000, NE 100, ICI-3240 (biocide), Dupont Oust® XP Herbicide, Monsanto Roundup Pro® Herbicide, Genesis Xtra Drench (antiparasitic for sheep), CI 150 (acid corrosion inhibitor), B317 (scale inhibitor), HO15 (hydrochloric acid 15%), HO36 (hydrochloric acid 36%), J609 (friction reducer), L058 (iron stabilizer), and Diesel Fuel – High Sulfur.

1.3 Project Area Hydrologic Setting and Description

BBMA owns over 2,000 acres of environmentally-sensitive and unique land area in Elk and Jefferson Counties. Dating to the 1930's, these lands have been relied on to produce and store all potable water for the BBMA water system. The water supply sources found on BBMA lands include the following:

- Rattlesnake Reservoir
- Groundwater supply Well 5 located in the Rattlesnake Creek watershed
- Whetstone Branch Reservoirs Nos. 1 and 2
- Groundwater supply Wells 1 and 2 located in the Whetstone Branch watershed.

Given the heavily forested, undeveloped, and "pristine" condition of BBMA's lands, the water quality from the reservoirs and wells is exceedingly high, and requires minimal treatment prior to potable use.

The water sourced from these lands includes surface water from the streams that is stored in the reservoirs, spring water that discharges to the reservoirs and streams, and groundwater supply wells. The water from the streams and springs is sufficient to meet BBMA's average day demand of nearly 1,000,000 gallons per day (gpd) for most of the year. During the drier summer periods the artesian flow from wells 1, 2, and 5 are needed to supplement the supply.

The baseflow to the streams within the BBMA property is supplied from groundwater and spring flow which originates as infiltrating precipitation to the nearby lands. Some of this precipitation water infiltrates to shallow depths through only the soil mantle and discharges to springs and streams within hours to days. Water that drains further downward and into the bedrock aquifer will have a longer residence time in the subsurface prior to discharging to springs and the streams. Because of this interconnection between the springs and streams, and the nearby lands, both the Whetstone Branch and Rattlesnake Creek are susceptible to even small releases of contaminants from nearby areas, including sediment releases from construction. Some of the baseflow to the streams is also anticipated to originate from precipitation water that recharges the more distant uplands to the east at Boone Mountain.

Regarding Rattlesnake Creek and Whetstone Branch, Pennsylvania Department of Environmental Protection (PADEP) has classified the designated use for both streams as Cold Water Fishery (CWF). This classification refers to protected uses, and is the basis for development of water quality criteria for purposes such as determining appropriate land use in the watershed, and determining acceptable stream impact from proposed development. PA Code Title 25, Chapter 93 defines this classification as follows:

CWF - Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.

These streams are further protected by PADEP as High Quality, Cold Water Fishery (HQ-CWF,) from their headwaters to the Rattlesnake reservoir dam, and Whetstone Dam No. 1, respectively. This classification is special recognition of excellent water quality and habitat conditions that meet the following criteria (as excerpted from Chapter 93 regulations):

(a) Qualifying as a High Quality Water.

A surface water that meets one or more of the following conditions is a High Quality Water.

(1) Chemistry.

(i) The water has long-term water quality, based on at least 1 year of data which exceeds levels necessary to support the propagation of fish, shellfish and wildlife and recreation in and on the water by being better than the water quality criteria in § 93.7, Table 3 (relating to specific water quality criteria) or otherwise authorized by § 93.8a(b) (relating to toxic substances), at least 99% of the time for the following parameters:

<i>dissolved oxygen</i>	<i>aluminum</i>
<i>iron</i>	<i>dissolved nickel</i>
<i>dissolved copper</i>	<i>dissolved cadmium</i>
<i>temperature</i>	<i>pH</i>
<i>dissolved arsenic</i>	<i>ammonia nitrogen</i>
<i>dissolved lead</i>	<i>dissolved zinc</i>

(ii) The Department may consider additional chemical and toxicity information, which characterizes or indicates the quality of a water, in making its determination.

(2) Biology. One or more of the following shall exist:

(i) Biological assessment qualifier.

(A) The surface water supports a high quality aquatic community based upon information gathered using peer-reviewed biological assessment procedures that consider physical habitat, benthic macroinvertebrates or fishes based on Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish, Plafkin, et al., (EPA/444/4-89-001), as updated and amended. The surface water is compared to a reference stream or watershed, and an integrated benthic macroinvertebrate score of at least 83% shall be attained by the referenced stream or watershed.

(B) The surface water supports a high quality aquatic community based upon information gathered using other widely accepted and published peer-reviewed biological assessment procedures that the Department may approve to determine the condition of the aquatic community of a surface water.

(C) The Department may consider additional biological information which characterizes or indicates the quality of a water in making its determination.

It is also noteworthy that prior to Flatirons gas drilling operations, BBMA's lands were heavily forested land with no development except for BBMA's water system facilities. BBMA operates two (2) sand filtration plants to filter surface water from the reservoirs, but these operations do not involve the use of any large volumes of hazardous chemicals or ongoing land disturbance.

In summary, the streams located on BBMA lands are closely connected and vulnerable to the land uses of the nearby areas. These lands until recently were heavily forested with no development, except for BBMA's water sources and associated facilities. The streams provide all water used by BBMA, except for some groundwater from their wells that augment supplies during dry weather periods. These streams have been

classified as CWF and HQ-CWF in recognition of their excellent water quality and habitat conditions, which make these streams uniquely sensitive to disturbance and contaminants. Impacts to streams of this quality are normally irreparable.

2.0 EVALUATION OF FLATIRONS OPERATIONS

2.1 Pad 6

Flatirons constructed drilling Pad 6 in 2010 and has drilled one well to date. During drilling of the top hole for gas well DU-3-6-1H the artesian flow at BBMA's well 5 ceased and later returned. Based on these operations the gas well top hole is clearly in hydraulic communication with the fresh water bedrock aquifer, including well 5. The extent of this connection has not been determined by Flatirons. Following this event Flatirons prepared a Well 5 Protection Plan, but this plan did not adequately investigate the nature and extent of the fresh water bedrock aquifer in the area of Pad 6 and well 5. This condition is further discussed in Section 3.2 of this report.

The gas well was subsequently completed, and fracking was performed in November 2011. A pipeline is proposed to transfer gas from Pad 6 to an existing compressor station located about 3,000 feet to the east. Pad 6 lies directly north and within 1,000 feet of BBMA's Rattlesnake Reservoir. Surface water run-off from Pad 6 flows to a wetland area near BBMA's treatment building, and is subsequently conveyed to a location below the Rattlesnake Reservoir dam. The run-off from the proposed pipeline would intersect the reservoir and upstream areas of Rattlesnake Creek.

2.2 Possible Sources of Contamination at Pad 6 and Associated Operations

The following are recognized as sources/events that present a risk to the surface and subsurface/fresh water aquifer in the BBMA watershed.

Gas Well Drilling and Construction

Advancement of the borehole creates a potential connection (i.e., pathway) between the fresh water aquifer, and the lower intervals that contain saline/formation water and other objectionable water quality issues. **A clear hydrogeologic connection has already been established between Pad 6 and Well 5, and therefore any breach in the casing or grout seal places Well 5 and/or Rattlesnake Reservoir at risk.** In addition to a casing/grout seal breach, the presence of vertical fracturing intersected by the gas well may also serve as a possible pathway for saline water/fracking fluids to migrate into fresh water zones.

In addition to saline water, hydraulic fracturing (fracking) fluids, a.k.a. slickwater, include additional contaminants with various human health risks (ingestion, dermal contact, and inhalation) and ecological toxicity. Return water includes not only the slickwater chemicals added to facilitate stimulation of gas-producing zones, but also formation water which typically is very saline with very high dissolved solids (known to exceed 30% by weight), and elevated naturally occurring radioactive materials (NORM). A casing and/or grout breach could

enable fluids under pressure to leak directly into the fresh water bedrock aquifer, and/or the unconsolidated overburden. Such a breach might also result in leakage to the surface either directly or via subsurface. Given the interconnected nature of the groundwater system and surface water, both sources would be at risk of contamination. Depending on the volume of the release, the receiving surface and/or groundwater may be rendered unfit for potable use.

Drill cuttings are produced during drilling. When in contact with water these materials may produce run-off water with the same constituents as formation water, i.e., salinity and NORM.

There may be air born migration of unwanted chemicals from the pad site due to wind. These chemicals could be in the form of dust, vapors, or mists. Downwind transport and subsequent deposition directly into a water way, or onto the ground surface for later transport in run-off water, may adversely affect water quality and/or flora and fauna.

Hazardous/Toxic Fluids Handling

The large volume of aqueous-based fluids with hazardous/toxic chemical constituents represents a significant risk to surface waters and shallow groundwater. It can be expected that one (1) million gallons or more of brine water and fracking water will be stored, transferred, pumped, and transported during the course of operations. At these points of contact there is risk for spillage of relatively small volumes which is not of special concern; however, some operations involve risk of a large volume release, such as pressurized hose/pipe failure, sudden tank rupture, hidden leak that occurs over time, and transport tanker accident. Because fluid transfer to and from Pad 6 is performed with transport tankers, it is expected that there will be many hundreds, if not one (1) thousand or more individual trips. These trips generally occur over unpaved roadways constructed in mostly steep terrain, where a vehicle accident could result in rollover and sudden tank breach and subsequent release of 5,000 or more gallons of aqueous waste. Due to the steepness of the area, such a release could reach surface water as run-off, and with infiltration to shallow groundwater interflow water. Such a release could potentially result in a chronic source of contamination to surface and groundwater, since even very low concentrations of some of the known constituents in the fluids are known to be a risk to human health and the environment.

Liquid transport tanker routes are assumed to proceed further west of Pad 6 to the compressor station. Areas west of Pad 6 lie upgradient of the Rattlesnake Reservoir dam, and thus within the HQ-CWF designated use section of Rattlesnake Creek. As such, this area is considered especially sensitive to a large release of aqueous waste.

3.0 RISK EVALUATION AT PAD 6

3.1 Water Quality Impacts

It is our opinion that the identified exposure pathways described above require 1) increased safeguards by Flatirons, and 2) further effort to characterize the potential for a completed pathway to determine whether additional safeguards are needed. The following should be addressed:

- Tanker transport represents a significant risk for a large hazardous materials spill given the anticipated large number of tanker trips that will occur. There does not appear to be sufficient attention to planning for such an event, especially with regards to prevention. There must be plans in place to address operations (or cessation thereof) during inclement weather, as well as regular road inspections to ensure that road surfaces are stable. Some locations may require a barrier or fencing to preclude a tanker from leaving the road or rolling. Overall, there must be a specific response plan in place to address the potential release scenarios, which includes personnel-specific training.
- A subsurface release of fluids from the gas well, or possibly directly from the lower borehole interval via existing vertical fracturing, has the potential to serve as a long-term but possibly undiscovered contaminant source. The water resources of BBMA remain at risk until sufficient information is provided to document that these pathways are not complete, that such migration would not reasonably occur, or that a system is in place that would quickly detect such a release to allow time to prevent significant impact. A monitoring program is necessary to enable early detection of this condition.

The Field Preparedness, Prevention, & Contingency Plan (PPCP) prepared by Flatirons should be modified and expanded to address the issues described above.

3.2 Groundwater Impacts

As previously stated, the hydrogeologic conditions that resulted in the loss of artesian flow at well 5 during top hole drilling at Pad 6 were not fully characterized. Supplemental information to the Well 5 Protection Plan was provided by Flatirons as requested; however, no conclusions or assessment of the interconnectivity between the Flatiron and #5 wells were provided. There are also questions regarding the volume of groundwater removed during top hole drilling, grouting of the top hole, and the pre- and post drilling Well 5 water quality analyses based on review of the Protection Plan.

It is understood that an aquifer test and analysis will be conducted for Well #5. This test will provide additional data, provided that groundwater is monitored at the Flatiron pad site. The aquifer testing plan should be submitted to BBMA prior to testing for their review.

The following are specific items that should be addressed as part of the aquifer testing and as follow-up investigation to the Protection Plan:

1. Clearly define the interconnectivity between the Flatirons gas well top hole and Well #5, including but not limited to:
 - a. Horizontal hydraulic gradient between Well # 5 and Flatiron top-hole well
 - b. Specific dip angle and attitude in top hole well
 - c. Vertical hydraulic gradient between Well #5 and Flatiron top-hole well
 - d. Groundwater contour map based on site specific and area static water levels
2. Either the rate of discharge or total volume removed from top-hole during drilling activities should be provided. The information provided is in inches of water stream, which does not allow calculation of the total water volume or flow rates.
3. A distance drawdown analysis between Well #5 and the Flatiron top-hole well is recommended in order to define the magnitude of interconnectivity. It is understood that the proposed aquifer pumping test would provide this information. This data would also aid in determining the potential zone of influence for similar activity in other nearby areas.
4. The pre- and post-drilling Well 5 water quality parameters were not consistent and therefore a direct comparison could not be made for all parameters. Of concern was the turbidity increase from 0.27 nephelometric turbidity units (NTU) before the top hole was drilled, to 1.39 NTU afterwards.
5. It was noted that a 50% excess cement volume was used when the 11 3/4 inch surface casing was grouted, and that no return flow was observed. The impact of injecting grout within the formation should be reviewed, especially within the fresh water aquifer, to ensure that potential water bearing zones are not grouted shut and that area groundwater flow is not adversely impacted. Additionally, an alternative method should be employed during grouting of the top-hole to minimize the introduction of grout into the formation.
6. Cross sections were provided for review; however, no cross section from the Flatiron pad site to Well 5 was included. This cross section, with groundwater gradients and structural features, would help conceptualize the subsurface model being developed.

The information from the above work should be evaluated prior to expansion of gas drilling activities that are in proximity to BBMA supply wells.

4.0 RISK EVALUATION AT OTHER FLATIRON OPERATIONS

Flatirons has proposed other drilling pads, roads, a freshwater impoundment, and pipelines within the Rattlesnake Creek and Whetstone Branch watersheds. As previously stated, the additional facilities proposed for Rattlesnake Creek watershed are within the drainage area designated as HQ-CWF, which requires an additional level of evaluation for risk to water quality, and may require some additional level of permitting beyond a general permit. For the most part, all of the possible contaminants and exposure pathways described for Pad 6 are also applicable to the other operations and should be addressed.

The proposed operations at other locations may also pose additional risk to BBMA wells 1 and 2, depending on proximity. Insufficient investigation has been performed to adequately understand the bedrock aquifer hydraulics.

5.0 COMMENTS REGARDING FLATIRONS PLANS AND PERMIT APPLICATIONS

Comments regarding the erosion and sedimentation control, stormwater control, and post construction stormwater and site restoration plans and general permit applications are provided below:

Pad 6 Erosion, Sediment & Stormwater Control Plan

1. There should be additional plans with details of all the proposed E&S controls.
2. There are cross culverts shown on the construction entrance but no information provided for riprap at the discharges (stone size, pad dimensions, etc.).
3. There should be silt fence/ silt soxx on the down slope side of the topsoil stockpiles.
4. The Erosion, Sediment and Stormwater Control Plan for Oil and Gas Operations in section 5.c. and d. states there is no increase in runoff, but there is a change in cover condition. There is no discussion/demonstration in defense of the statement that the pre- and post-development runoff volume is equal.
5. The E&S Report does not contain any site specific information regarding the BMP's that are proposed. These should be completed by the plan designer and should not be left for a contractor to select and design at the time of construction.
6. Minimal information is provided for the infiltration trench, e.g., whether it is to be lined with geotextile fabric, how much cover, etc.
7. Overall limits of disturbance should be shown to delineate areas of disturbance.
8. Further information should be provided regarding how sediment is prevented from entering the infiltration trenches.
9. Further information should be provided regarding the permanency of infiltration trenches, and these should be shown on the restoration plan.
10. No construction sequence is provided.
11. The application states 14.8 acres of disturbance. The amount of disturbance required on the plans shown appears significantly less. The proposed areas to be disturbed should be clearly shown.

These questions and comments should be addressed in order to adequately describe the proposed development(s), and ensure that impacts from erosion and sedimentation are minimized, and appropriately managed for this CWF and HQ-CWF setting.

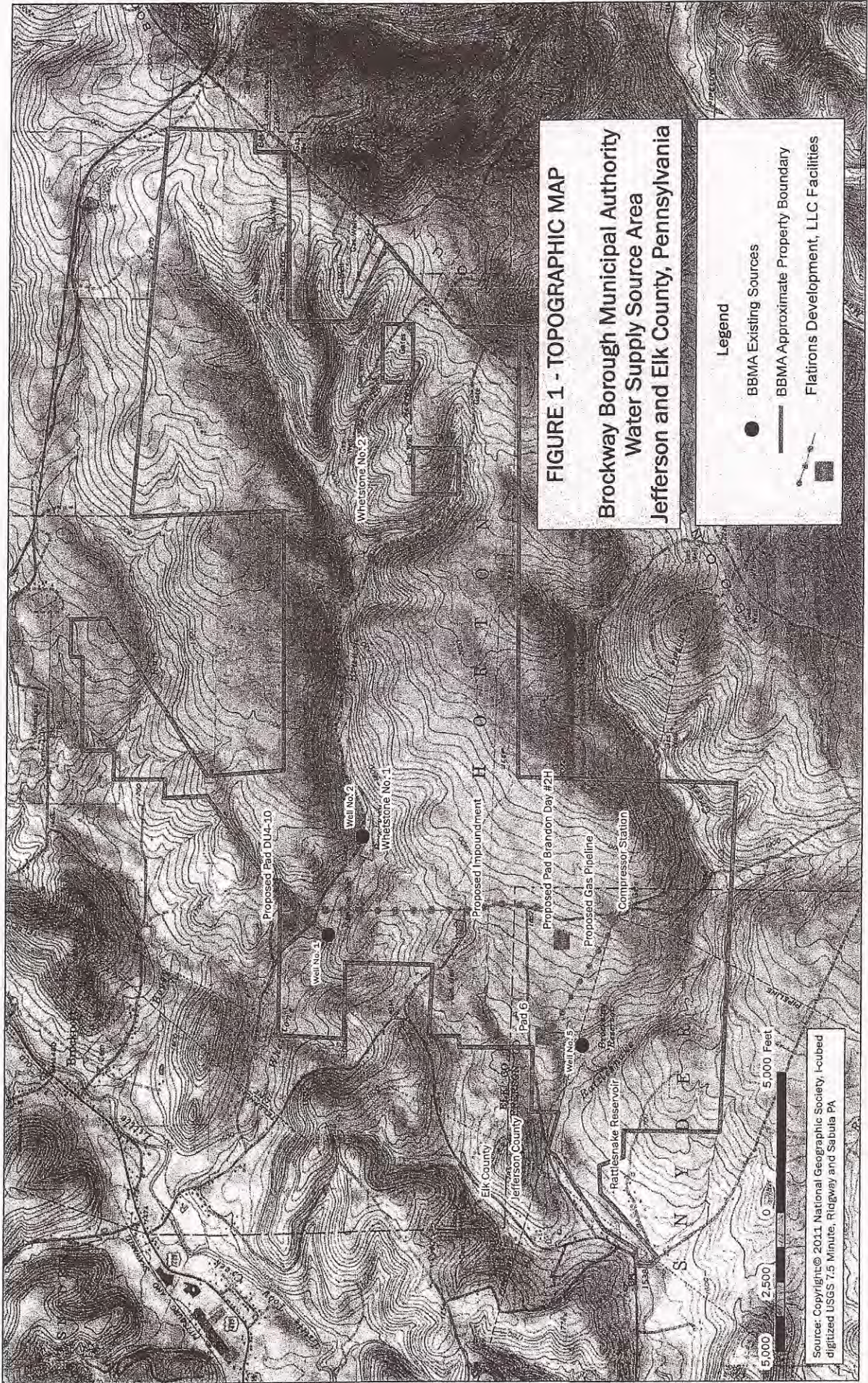
Other Locations

- Rattlesnake Creek upstream from the dam is designated HQ-CWF, so this includes the entire reservoir area. This water body is also classified by PFBC as a naturally reproducing trout stream. These classifications must be accounted for in any plan/permit application for facilities within this portion of the watershed. This may necessitate in some instances the requirement to obtain individual instead of general permits, and also meet antidegradation standards.

6.0 SUMMARY OF FINDINGS

Based on the excellent water quality and habitat conditions, and location(s) of recharge area, the Rattlesnake Creek and Whetstone Branch watersheds are especially vulnerable to degradation from development activities that have potential to introduce contaminants to the ground surface and fresh water bedrock aquifer. The drilling at Pads 5 and 6, and associated activities at other locations within these watersheds **clearly** have the potential to adversely impact the sensitive surface water and groundwater supplies relied on by BBMA to serve their water system. Prior to further gas well drilling and development activities it is recommended that the following be completed:

1. The Preparedness, Prevention, & Contingency Plan prepared by Flatirons should be modified to address all aspects of hazardous fluid storage, and tanker transport of fluids, inclement weather operations, road inspections, and the need for roadside barriers to prevent a tanker roll and/or sudden tanker breach.
2. Flatirons should provide sufficient information to document that a subsurface release of fluids from a gas well will not affect the fresh water aquifer and/or surface water in the area. A monitoring program is necessary to enable early detection of this condition.
3. Aquifer testing should be completed at Pad 6 in order to adequately characterize the interconnection between the gas well top hole and BBMA well 5. The use of excess grout and the groundwater turbidity increase should be investigated
4. All plans and permits should be modified to address the operations proposed for the HQ-CWF designated areas of Rattlesnake Creek and Whetstone Branch.
5. The Pad 6 E&S and Stormwater plans require clarification and/or additional information in order to adequately describe the proposed development(s), and ensure that impacts from erosion and sedimentation are minimized, and appropriately managed for this CWF and HQ-CWF setting.



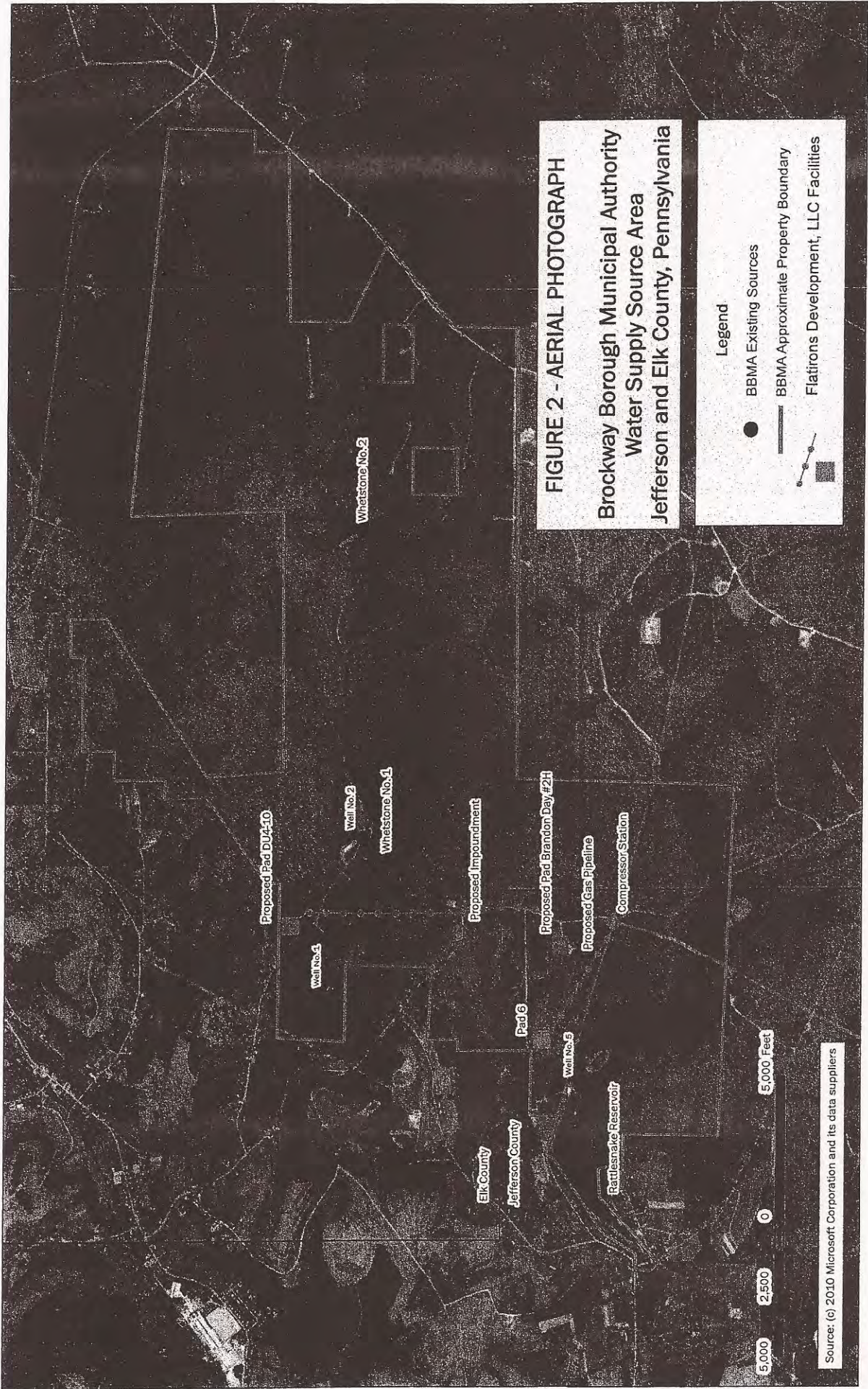


FIGURE 2 - AERIAL PHOTOGRAPH
Brockway Borough Municipal Authority
Water Supply Source Area
Jefferson and Elk County, Pennsylvania

Legend

- BBMA Existing Sources
- ▭ BBMA Approximate Property Boundary
- Flairons Development, LLC Facilities

5,000 2,500 0 5,000 Feet

Source: (c) 2010 Microsoft Corporation and its data suppliers

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11 September 2013

Delaware River Basin Commission
Commission Secretary
P.O. Box 7360
25 State Police Drive
West Trenton, NJ 08628
paula.schmitt@drbc.state.nj.us

Impacts of Natural Gas Drilling Operations

Due to the duties of work, overseeing the remediation of a school closed for asbestos contamination, I cannot attend today's hearing.

Over the last few years the Hallstead Great Bend Joint Sewer Authority has had some issues with natural gas development. Some of these include use of seismic trucks conducting tests on public roads vibrating the sewer infrastructure, failure to call PA-1-CALL before excavating roads with sewer collection lines for installation of a natural gas gathering system, and reports from customers about discolored water coming from their water wells. Even with these events Hallstead Great Bend Joint Sewer Authority is not the only municipal authority to be affected.

The reports of discolored water from customers have happened during two different time periods. The first was during the boring under the Susquehanna River for the Laser pipeline, a natural gas gathering system, in June and July of 2011. The second was boring the Laser Pipeline under Route 11 and Interstate 81 in Great Bend Township in July and August of 2011. The final event was when two natural gas wells were drilled in August 2012 on the Coyle well pad in Liberty Township, feet from the Great Bend Township line by WPX Energy.

During the summer of 2011 residents on both sides of the Susquehanna River in Great Bend Township experienced brown colored water during the both boring operations, except for residents serviced by PA American Water Company. Some people installed filters, some people were provided with limited water from the Laser Pipeline for a very short duration. One statement made by the Laser Pipeline was that they were using water and bentonite. The one

problem I had with that was, the bentonite had a high aluminum content and due to being trained as a HAZWOPER (hazardous waste operations and emergency response), I am trained on how to look up what other compounds are being used at the sites, by the markings on the containers. During this time compounds within the drilling mud were entering residents private drinking water wells and through them these compounds were entering the Hallstead Great Bend Joint Sewer Authority waste water collections system and treated at the waste water treatment plant.

In August 2012 there were complaints received by the authority about water being discolored again, but this time black. The plant operator checked the sewer collection system for flow to verify that area did not have a broken sewer line causing the black colored water. At this same time Ryan Klemish of DEP Oil and Gas was investigating reports of black colored water from residents on the west side of the Susquehanna River in Great Bend Township on New York Ave. and Baptist Hill Road. Then later in the month after the 20th the water also turned black in color again. Again the sewer authority received complaints for black colored water and had to inform these residents that the sewer lines were not broken. This prompted residents to call DEP and Jeff Hartman from DEP water quality to visit the sewer authority on 24 August 2012. In September this second instance of black colored water ended. During this time on the Coyle well pad the instances of black colored water mirrored the dates when WPX was drilling the natural gas wells through an open bore or no casings were present. There is also the issue of the directional drilling company recovering the Max Gel, for reuse, from the drilling mud, by dumping the drilling mud in to a hay bale box lined with black fabric feet from Trowbridge Creek. One of these boxes was found while inspecting the sewer line along Trowbridge Creek after flooding in September 2011. A second was found on the Stevens Property in Silver Lake Township two months earlier and he was able to obtain a sample of the Max Gel that spilled into his forested area. In March 2013 I also discovered that a few homes on Route 7A in the Town of Conklin, New York were also affected by black colored water and diminishment in August of 2012 and two of the properties had to have new water wells drilled.

These events could have affected the treatment process at the waste water treatment plant, but during the boring of the Laser pipeline in 2011 we were starting the interm-treatment system for our plant upgrade. In 2012 our final treatment system was put online days before the first gas well was drilled on the Coyle well pad, so we cannot validate data for these periods. What is interesting is that during these events our treatment system was outside of permit limits and on 27 June 2013 other members of the Hallstead Great Bend Joint Sewer Authority had a meeting with DEP over these periods. The authority is responsible to discharging effluent within the permit limits, even if there are affected water wells from gas drilling operations. After asking the question about affected water wells discharging compounds into our system, one representative from the DEP remarked to get an inflow sensor to detect it. If there is residence or group of residences that are affected and the water has enough contamination in it to affect the treatment process the authority has a responsibility and duty to physically disconnect them from the sewer system until the water meets standards that can be treated by our treatment process. Generally the DEP wants to fine the sewer authority due to the negative effects from the entire drilling operations.

Then there is the Brockway Borough Municipal Authority and the problems that they have encountered with drilling operations. In November 2010 they sued to stop wells from being

drilled near one of the reservoirs that they own. In January 2011 they came to an agreement with the drilling company and drilling began a few weeks later. Then during drilling operations one of the artesian wells supplying the Rattlesnake Reservoir stopped discharging water. This was the day after the BBMA issued the position statement. There was a new well permit issued for this well pad in May 2013 with hearings being conducted, even after the BBMA had a study conducted to assess the risks to the drinking water reservoirs. This report is titled, Evaluation of Risk to Brockway Borough Municipal Authority Surface Water and Groundwater Sources form Flatirons Development, LLC Gas Drilling Operations can be found at: <http://brockwaycleanwater.wikispaces.com/file/view/Advantage%20Engineers%20Evaluation%201.pdf/297346184/Advantage%20Engineers%20Evaluation%201.pdf> This report does identify possible pathways for gas drilling operations to affect the waters that supply the reservoirs.

The affects from drilling operations can be many and hard to identify, but when a municipality has its drinking water damaged or a sewer treatment plant affected, the DEP will not protect them, but issue notices of violation to these water or waste water authorities. There is one place to turn when this happens, the 2002 Bio-Terrorism Act through the Department of Homeland Security, since the DEP is in the business of issuing permits, not protection. One USGS Scientific Investigations Report, number 2012–5282 does describe what type of effects drilling will have on a watershed. It is named: Hydrogeology of Selected Valley-Fill Aquifers in the Marcellus Shale Gas-Play Area in the Southern Tier of New York State.

Heisig, P.M., 2012, Hydrogeology of the Susquehanna River valley-fill aquifer system and adjacent areas in eastern Broome and southeastern Chenango Counties, New York: U.S. Geological Survey Scientific Investigations Report 2012–5282, 19 p., at <http://pubs.usgs.gov/sir/2012/5282>.

What I have mentioned with in this letter is from past experiences of municipal authorities in the Commonwealth of Pennsylvania.

Attachments:

1. E-mail between Bret Jennings and Jeff Hartman 24 August 2012
2. Letter Bret Jennings to Mayor, City of Binghamton 27 August 2012
3. Position statement of Brockway Borough Municipal Authority.

Bret Jennings
Councillor, Great Bend Borough
Chairman, Hallstead Great Bend Joint Sewer Authority
brett76544@hotmail.com

Attatchment 1

Water issues around the HGBJSA collection area.

From: bret jennings (brett76544@hotmail.com)

Sent: Fri 8/24/12 2:36 PM

To: jefhartman@pa.gov

Mr. Hartman

I have heard of issues of black water from my Grandfather on the west side of the Susquehanna river north of Hallstead since the 12 August 2012 and then that cleared up on 15 August 2012. On 23 August 2012 and on today the water was black or brown at my grand fathers trailer on the hill side. At the same time one of the other directors for the Hallstead Great Bend Joint Sewer Authority had his well water go black and he lives next to Trowbridge Creek across the creek from pumping state #1 on Orchard Road. He also uses 2 micron filters for his drinking water and they turned black and had to be replaced. These two sites are separated by the river and about 1100 feet. The well on the hillside west is drilled into bedrock according to the Well drillers log from the DCNR and I did not find the log for the one on Orchard road, but it is in the glacial till of the valley, not the bed rock. Both well stop within 1 to 2 feet of each other after removing the differing elevations for the top of each well. Earlier this week I was in at the sewer plant with Steve and the Chairman of the authority and there were calls to the sewer plant wondering if there was a problem since peoples water went black that have water wells and are connected to the sewer. Today I learned that you had visited the plant, when talking to Steve. I have also contacted PA American Water over this issue and other than the water main repairs done early this month that resulted in air being expelled from the system, they have not had reports of Black water.

Other than the issues with the repair of the water main, there are other thing that could have caused this

problems outside of the water distribution system:

1. the Sewer collection system leaking
2. The Coyle well pad that started drilling in Liberty Township by WPX. (one mile away from the well on Orchard Road and 4100 ft from my Grand fathers water well.) The two properties are in a straight line with the well pad on Google earth.
3. The water line that Williams is installing from the water withdrawal site on the susquehanna River up to the Coyle well pad and water impoundment southwest of Mingo lake. I saw one or two people from the SRBC walking down the road today at this site while driving to work this morning.

4. The sink hole on the Parker property in the Laser Pipeline right of way, that was discovered by another DEP representative. Possible bacteria growth in the hole has been presented as a problem to my Grandfather. This hole has orange snow fence around it with weeds growing through it. Would the directional drilling for the gas pipeline cause a conductive pathway under the river for affected water to travel?

5. Illegal/illicit discharges.

6. Past history when the Laser Pipeline was drilling under the Susquehanna to the west and under route 11, I 81 and the railroad tracks to the north both wells described were affected.

Ryan Klemish of the DEP is investigating the problem around my Grandfathers water well. 570-346-5530

My Grandfather did not have Ryan's card or I would have copied this e-mail to him.

I also just returned a call from Mike ODonnel 570- 346-5536. I included your and Ryan's name in the message. Since this area with affected water wells from some source is in Zone A for a source water assessment for the City Of Binghamton the Mayor has been informed and will receive a formal letter from me. I am planning on walking to see where the limits of this affected water ends in and around the sewer system Saturday since we have received complaints by phone.

Bret Jennings

Councillor, Great Bend Borough

Director, Hallstead Great Bend Joint Sewer Authority

cell 607-372-4959

home 570-879-4158

Attachment 2

Matthew T. Ryan
Mayor, the City of Binghamton
38 Hawley Street, 4th Floor
Binghamton, NY 13901
Office: 607.772.7001
mayor@cityofbinghamton.com

Bret A. Jennings
PO Box 73
590 Main Street
Great Bend, PA 18821
Cell: 607.372.4959
Home: 570.879.4158
brett76544@hotmail.com

27 August 2012

Water wells affected within the five hour time of travel to the water intake in Binghamton.

Mayor Ryan,

In a letter dated 9 August 2012 I informed you of an incident where water has been affected within Zone A of a source water assessment area for the City of Binghamton's drinking water intake. Now there are multiple incidences of water wells being affected on both sides of the Susquehanna River. This is a serious development and has lead to complaints to the Hallstead Great Bend Joint Sewer Authority and two branches of the PA DEP acting independently from each other. One is

from the Oil and Gas and the other is for Water Quality. Let me show you the events that I have seen that to show you what has happened:

- Drilling started in the beginning of August 2012 at the Coyle well pad in Liberty Township by WPX Energy.
- My Grandfathers water well went black from 5 to 8 August 2012 when it cleared up. His water well is about 4100 ft from the well pad.
- On 17 August 2012 I checked the WPX website and noticed that they have cut drilling time down 35% to 18 days. Now that is very interesting, so what parts were altered and what effect will this have on the long term operation of the well?
- Prior to 20 August 2012 a DEP oil and gas representative investigated the area around my Grandfathers complaint.
- On 20 August 2012 I visited another director on the sewer authority board due to a canceled meeting and his water filters had been clogged with a black substance that stained his carpet and concrete from tracking it in on his shoes. He had some brown 'stuff' form on top of the heated water when he was preparing some pasta on 19 August 2012. He uses a 2 Micron Filter on his water supply and it was replaced prior to when I talked with him. He is about 5200 ft from the well and on the other side of the Susquehanna River. The bottom of this well and my grandfathers differ by about two feet when looking at what elevation they end at. One is about 127 feet deep, but 110 higher than the river level and the other one is 30 feet deep, but 15 feet higher than the river level. So 15 to 17 feet below the top of the river. That means about 10 feet separates where the black water is compared to the bottom of the river. It is a likely point of communication that should affected water quality in the Susquehanna River.
- On 22 August 2012 I learned of multiple complaints called into the Hallstead Great Bend Joint Sewer Authority over the last two weeks for Black water, but only from people on water wells. They thought that we had some problems with our sewer lines.
- PA American water Co. only had complaints due to a water main break in the Hallstead/ Great Bend area and none for black water.
- On 23 August 2012 I learned that the DEP oil and gas representative that walked the hill side and found a sink hole along the path of the Laser Pipeline that had orange snow fence around it with grass and weeds growing up through it. At this location the pipeline was bored under the Susquehanna River and had not yet

returned to the surface to be emplaced in a ditch. This he declared without testing or knowledge of the issues on the other side of the river, to be the cause of the black water in my Grandfathers water well. This is due to the possibility with it pooling in the bottom and the bacteria turning it black.

- On 23 August 2012 my Grandfathers water was affected again.
- On 24 August 2012 the DEP water quality section visited the sewer plant for complaints from residents due to black water coming from their water wells. These residents believed that there were broken sewer lines affecting their well. I also looked at the sink hole. I could not smell the bacteria or see the water, but it is directly over the 20 inch gas pipeline. I also talked to the head of the Oil and Gas section for NERO (northeast regional office) about what was happening up here and that the water section was also investigating due to a perceived problem of the sewer lines failing and turning the resident's well water black. The water quality section representative was also contacted.

Now the question is will the DEP do its job? I cannot expect that due to a law suit where the jury awarded the plaintiff 6.5 million dollars against four DEP workers personally from the Northeast Regional Office, including an assistant regional counsel for NERO. Due to this lawsuit, I have seen a change in the DEP and I am convinced that MFS, Inc. V. Thomas A. DiLazaro, et al. has had a negative effect on the employee's of the DEP. Why would a DEP employee make a decision where the people or corporation that is harmed by that decision can file a civil rights case against you personally without the protection of sovereign or limited government immunity. There is a link to an article on the case: <http://pabrownfieldsenvironmentallaw.foxrothschild.com/2010/03/articles/bombshell-decision-holds-dep-staffers-personally-liable-for-civil-rights-violations/>

Then 16 February 2011 the case was over turned by the Pa eastern district: http://scholar.google.com/scholar_case?case=11348538898640049244&q=MFS,+Inc.+v.+Thomas+A.+DiLazaro,+et+al.&hl=en&as_sdt=2,39

The appeal to the 3rd Circuit was issued on 26 April 2012 were the PA Eastern District ruling was upheld: <http://docs.justia.com/cases/federal/appellate-courts/ca3/11-1690/11-1690-2012-04-26.pdf>

Even with these rulings in favor of the DEP employee's under sovereign immunity, one still has to wonder if this case has had a lasting effect on the performance of the DEP.

For the Hallstead Great Bend Joint Sewer Authority waste water treatment plant we do have decisions to make now. Since there was no

sewer collection line failures that caused the discoloration of the residents well water and that this discoloration was present on the other side of the river, there is only one conclusion, the sewer system did not cause the discoloration. The only issues that could have caused it are the sink hole with bacteria in it and the drilling operations at the Coyle well pad. If the discharges from these residences are affecting the treatment system right now we would not be able to identify it due to changing our system over from the interim treatment system to our current treatment system and generating a new biomass in the different treatment zones. If in the future these residences on water wells have enough contaminates to affect the operations of the treatment system then two options would have to be implemented. Removing the affected water supply from the sewage collection system or have to build and operate a treatment system to protect the present treatment system. Both of these options increases costs for the other users and will require a new National Pollution Discharge Elimination Permit for the sewer treatment plant due to a change in waste characteristic coming into the sewer treatment plant.

For the City of Binghamton, this affected water that is likely entering the Susquehanna River through the river bottom that is about 13 miles from the water intake near Broome Street and may affect the water quality. This is just one well pad in the Commonwealth of Pennsylvania that is over 11% of the watershed above the drinking water intake. There is also the issue of what about the Elmira and Corning area that does have watersheds upstream from them in the Commonwealth of Pennsylvania. There is far more drilling operations in areas of the Commonwealth of Pennsylvania, upstream from the City of Elmira.

What I see is that a new source of contamination has developed just across the NY/ PA state line from the City of Binghamton that could be temporary or permanent. The DEP may be compromised due to a recent lawsuit that may have a lasting effect on the employees performance. There is one instance in western PA where a resident, Beth, has sued the DEP to perform its job and the court on appeal agreed. I cannot say actions will not be taken in PA, but it is not likely or will have to have overwhelming evidence for the DEP to take action. At this point the only action I can say will happen is monitoring of the sewer system for monitoring of the biological process, changes in laboratory results from the discharge and the solid waste leaving the sewer treatment plant.

Bret A. Jennings
Councillor, Great Bend Borough
Director, Hallstead Great Bend Joint Sewer Authority

Attachment 3

Brockway Borough Municipal Authority

501 Main Street
Brockway, PA. 15824

Office of the Borough Manager
Phone (814)268-6565x103 Fax (814)
265-1300

To: Senate President Pro Tempore Joe
Scarnati, Speaker of the House Sam
Smith; State Representative Matt Gabler

BBMA Position on Gas Development on the Watershed's Serving as Public

Drinking Waters Sources

February 15, 2011

This letter is to provide a clear statement of the position of the Brockway Borough Municipal Authority (BBMA) relative to natural gas development on the watersheds supplying drinking water to thousands of people in the Brockway area.

We, (BBMA) believe that Rattlesnake and Whetstone Run watersheds provide drinking water of unparalleled quality in our state. In that regard, we view this natural resources and forested environment that protects it as invaluable and irreplaceable.

We in turn view the current gas development activities on the watersheds as a potential

threat to these resources as the processes employed are unconventional and too new to predict and understand the environmental impacts and consequences associated with those activities.

We believe that the Pennsylvania Department of Environmental Protection (DEP) is the primary entity charged with protecting the water resources in Pennsylvania. And that a failure by DEP to act in a prudent manner constitutes negligence by that agency.

We recognize that current oil and gas regulations may be less than adequate relative to providing explicit safeguards for our watershed; however, we also believe that DEP has authority prescribed in the Clean Stream Law and other acts which empowers DEP to limit or eliminate the activities on these watersheds to minimize the potential environmental degradation.

We recognize, as public water suppliers, we are often held to design-standards which are much more stringent than the standards applied to gas developers. We view this disparity as inappropriate and continue to lobby legislatures to change such standards.

We welcome the economic benefits that gas development creates in our region; however, also understand the true costs of this development may be more widely distributed across the population, less tangible and more difficult to assess than those benefits.

We believe air pollution from the gas development is likely to impact the quality of our water.

We believe liquid pollution from the frac water, associated chemicals, fuel, lubricants, and production water are likely to impact the quality of our water.

We believe that truck traffic, surface disturbance and equipment operating on our watershed are likely to impact the quality of our water.

We believe that the physical disturbance associated with drilling and fracking are likely to impact the quantity and quality of our water.

We have learned that surface landowners are subservient to the interests of oil and gas owners. And that water rights and ownership are recognized by few people when conflicting with industrial interests.

We entered into a surface damage agreement with a gas developer as the alternative was their continued unauthorized development as we struggled to try to control the damages inflicted by their activities. We entered this agreement with the developers to protect our customers should the gas development cause damage to the water resources which they threaten.

We have discovered that the PA constitution contains guarantees of the citizens' rights against the effects of gas development; however, no agency is enforcing these

provisions.

We believe that the technologies currently employed for gas development would allow for gas extraction beneath our watersheds by using lands outside of the watersheds. However, as our watersheds are undeveloped, it is simply more convenient to mine the gas using sensitive watersheds rather than procuring alternate development tracts.

We have been forced, to cut timber that is not mature at a time when timber prices are low, to agree to accommodate industrial development on lands which are not suited for such, and endure the anxiety which comes from the uncertainty associated with the potential impacts of this gas development.

We remain opposed to any gas development on our watershed as it jeopardizes a water resource which, if impacted, has no viable replacement.

We believe that gas development on these sensitive watersheds is 'unreasonable' and may result in 'irrefutable harm'.

We recognize that a group of citizens are organized in an effort to protect the water resources from the impacts associated with gas development activities.

We have requested and maintain hopes that the DEP will provide technical assistance to develop watershed management plans as they advocated in local press articles.

We have spent significant monies on water monitoring, legal actions and engineering reviews to protect our rights to clean water.

Under current regulatory conditions, we see no practical end to this matter, and encourage anyone, so inclined, and willing to act within legal standards, to become involved in an effort to minimize the development and associated impacts on the Rattlesnake and Whetstone watersheds.

Cc: Bob Reisinger
R Ed Ferraro
Robert P Ging
Brockway Borough Council
Brockway Area Clean Water Alliance
Files - BBMA

ΠIMPORTANT INFORMATION ABOUT YOUR DRINKING WATER

Este informe contiene informacion muy importante sobre su agua de beber.
Traduzcalo o hable con alguien que lo entienda bien.

Beaver Falls Municipal Authority Has Levels of Total Trihalomethanes (TTHMs) Above Drinking Water Standards

Our water system recently violated a drinking water standard. Although this incident was not an emergency, as our customers, you have a right to know what happened and what we are doing to correct this situation.

We routinely monitor for drinking water contaminants. After receiving our latest test results for the 3rd quarter of 2010, it shows that our system exceeded the standard or maximum contaminant level (MCL) for total trihalomethanes (TTHMs). The MCL for TTHMs is a Running Annual Average (RAA) of 0.080 mg/l, which is comprised of an average of the four (4) most recent quarterly samples. The RAA for TTHMs over the last year ending in the 3rd quarter of 2010 is 0.0857mg/l. The highest level detected was 0.1154 mg/l and the lowest level detected was 0.0733 mg/l.

What should I do?

You do not need to use an alternative (e.g., bottled) water supply. However, if you have specific health concerns, consult your doctor.

What does this mean?

This is not an immediate risk. If it had been, you would have been notified immediately. However, **some people who drink water containing trihalomethanes in excess of the MCL over many years may experience problems with their liver, kidneys, or central nervous system, and may have an increased risk of getting cancer.**

What happened? What was done?

Disinfectants can combine with organic and inorganic matter present in water to form chemicals called disinfection byproducts (DBPs), which includes TTHMs. These byproducts are produced by every public water system that uses disinfectants. The Beaver Falls Municipal Authority changed our disinfecting treatment process to include chloramines in September. Preliminary testing indicates that this has already reduced the TTHM levels in our system and should bring us into compliance with DEP regulations by the end of this year.

For more information, please contact our office at 724-846-2400 X231.

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

This notice is being sent to you by Beaver Falls Municipal Authority.

September 10, 2013

Jeff Zimmerman
Zimmerman & Associates
13508 Maidstone Lane
Potomac, MD 20854

RE: Beaver Falls Municipal Authority

Atty. Zimmerman,

The Beaver Falls Municipal Authority (BFMA) is public drinking water system that pulls water from the Beaver River in Beaver Falls, PA, which is formed by the confluence of the Mahoning and Shenango Rivers near New Castle, PA. BFMA began experiencing elevated Brominated levels in 2009. These elevated levels caused BFMA to exceed the EPA's Maximum Contaminant Level (MCL) for Total Trihalomethanes (TTHM'S) for the first 3 quarters of 2010. The MCL for TTHM's is a running annual average (RAA) of .08mg/l, which is comprised of an average of the four most recent quarterly samples. The RAA for the first quarter of 2010 was .087mg/l, for the second quarter of 2010 was .097mg/l, and for the third quarter of 2010 was .0857mg/l. Each of these occurrences required BFMA to publically notify all of our 18,000 customers that we were in violation of an EPA drinking water standard. Beginning in September 2010 BFMA began using chloramines as its primary disinfectant over chlorine which had been used by BFMA for over 50 years. The main reason for this change was that chloramines produce lower levels of TTHM's. This change will also enable BFMA reduce TTHM levels in our drinking water and remain in compliance with EPA's drinking water standards. BFMA expended over \$25,000 in capital for this conversion. Chloramine disinfection has been used for over 80

years but can cause problems to people on dialysis machines if not removed prior to dialysis. Chloramines may also be toxic to fish.

Over the past 4 years there have been at least 3 instances where individuals or companies have been prosecuted for illegally dumping frack water into the Mahoning, Shenango, or Beaver River. Unfortunately in every instance BFMA was not notified until a few days after each episode and are unsure if any of the frack water made it to our intake. While it has been documented many places that frack water has elevated levels of brominated disinfection byproducts, which are precursors to TTHM formation no correlation was traced back to any legal or illegal discharges up stream of our intake.

If you have any questions, please feel free to contact me at (724) 846-2400 Extension 231.

Sincerely,

James Riggio
General Manager

LINK to available Determination Letters as of September, 2013:
[https://www.dropbox.com/sh/4czu1lpfw91yc72/
AAChowVf2H9bEcCwqa0IYn6Ga?dl=0](https://www.dropbox.com/sh/4czu1lpfw91yc72/AAChowVf2H9bEcCwqa0IYn6Ga?dl=0)

Damascus Citizens for Sustainability would like to present the DRBC Commissioners and staff over 100 Determination Letters from the Pennsylvania Department of Environmental Protection, sent to home and business owners whose water was affected by nearby gas well drilling. As there is both a time frame after the well is completed and a distance requirement that the home or business has to be from the well to have a challengeable presumption of responsibility by the gas drilling company apply, all of these cases are in both required limits. These limits were changed recently from 6 months to one year and from 1,000 feet to 2,500 feet but the older cases will not be revisited. There would be many more receiving a positive determination of impact with even this small widening of the two requirements. A positive determination means that the DEP has to do additional investigation and drilling company has to replace the water supply in some fashion satisfactory to the DEP.

The letters are from the years 2008 through 2012. They were obtained via a Right To Know request and a lawsuit filed by the Scranton Times, taking a year and a half to acquire them. They show that the Department's investigations indicate that the home or business owners' water supplies were impacted by gas well drilling with changes in either water quantity or quality based on testing done before drilling and after. The details in the letters show what these changes are including diminished quantity and increases in minerals, salts, changes in pH and clarity of the water and gasses, often methane, moving with the water.

In addition to these letters to individual home and business owners, there are on the supplied disc about 30 investigations and consent orders covering wide areas, whole neighborhoods with multiple homes and businesses. One of these was spoken of by my colleague and has 6 maps of impacted areas each covering about 24 square miles - that's number 161 on the disc - areas where there we know the damage continues.

These letters are, at long last, proof that the hydraulic fracturing horizontal drilling process DOES impact water supplies and is doing so in Pennsylvania and that therefore, drilling should not be allowed in the Delaware River Basin.

Geologic Methane Leakage in Wyalusing PA Area and Well Failure Rates Reported by PADEP Presenter – Barbara Arrindell

First let's start with well failure rates - these are based on Pennsylvania DEP reports of wells drilled, violations and failures as assembled by Prof. Ingraffea of Cornell University.

1,609 wells drilled in 2010. 97 well failures. 6% rate of failure.

1,972 wells drilled in 2011. 140 well failures. 7.1% rate of failure.

1,346 wells drilled in 2012 120 well failures. 8.9% rate of failure.

Consistent with previous industry data, and not improving

I would like to stress that these mistakes, errors, failures result in permanent damage that impacts real places and real communities and real people and their lives and hopes and families...to say nothing of their property values. And these are only the initial failures - as the drilling proceeds, though there are nine listed types of violations possible, for many more wells, "The inspection reports indicate that many failed wells were not issued violations." according to Dr. Ingraffea's research. To pretend that allowing drilling in the Delaware Basin would produce different results is foolish.

So now to look at one of those real places certified as an impacted area by PA DEP. This is along the Susquehanna River in Bradford County where PA DEP fined Chesapeake Appalachia, LLC \$900,000. for causing "stray gas" conditions, impacting the area and contaminating water supplies. DCS sent GasSafetyUSA with a Picarro CRDS machine to record the methane levels from public roads where there were reports of bubbling in the Susquehanna River and in ponds, puddles and in residents drinking water sources. Though it is harder to record methane any distance away from its source we found elevated methane levels, as shown in figure which combines the roads covered in the June GasSafety run with two of the impact area maps in the "Consent Order" of May 16, 2011. Blue and orange markers indicate the Paradise Road and Sugar Run methane migration impact areas(4 mile radius each) mapped in that Consent Order and show about double the surrounding local methane baseline levels. There is definitely an ongoing methane leakage situation here and contamination of drinking water sources that has continued since September, 2010 through the GasSafety methane survey in June, 2013.

IN OTHER WORDS THE AREA IS STILL IMPACTED AND THE WATER SOURCES ARE STILL CONTAMINATED FROM DRILLING.

The Conclusion from the September, 2013, GasSafety Wyalusing Report “Methane from any source rapidly diffuses and rises in the air. Consequently, detection of possible methane sources from any distance away requires extremely sensitive measurement capabilities. The GSI survey approach takes advantage of extremely sensitive measurement instrumentation to detect small increases in ambient air methane levels as an indication of probable methane emissions sources in a given area. Based on the data collected using that equipment, we conclude that the Towanda-Wyalusing area is probably substantially impacted by methane emissions from shale gas wells both within and beyond the survey area. The coincidence of two DEP methane migration impact areas, Paradise Road and Sugar Run, and the most marked elevated ambient air methane levels suggests there are still gas control problems associated with the shale gas wells there, as well as in another documented impact area in Leroy Township also cursorily measured following the main survey. A rapid water test in the Leroy area confirmed the water in that area is still contaminated with methane. These survey results suggest measures taken by gas well operators with regard to methane migration problems that have occurred in these three areas have likely been only partially effective.”

IN OTHER WORDS THE AREA IS STILL IMPACTED AND THE WATER SOURCES ARE STILL CONTAMINATED FROM DRILLING.

The figure is from the GasSafety Report on these Wyalusing area measurements - found on the disc and here:



"Stray Gas" Definition • A gaseous material that is from an undetermined source that is located in area that may become hazardous. • Hazardous conditions can be flammable, toxic, or oxygen reducing that could cause suffocation. http://pa.water.usgs.gov/projects/energy/stray_gas/presentations/3_840_Graeser.pdf

\$900,000. fine - <http://www.businessweek.com/ap/financialnews/D9N9C7981.htm>
Consent order referenced here is #161 in this Determination letters folder on the disc and at this link: <https://www.dropbox.com/s/ndgx7fe2hg8f2dg/161%20Consent%20Agreem%20Susquehanna%20River.pdf>

CRDS http://www.picarro.com/technology/cavity_ring_down_spectroscopy

<http://www.damascuscitizensforsustainability.org/wp-content/uploads/2012/11/PSECementFailureCausesRateAnalysisIngraffea.pdf>

Table 1. Violation Codes Used to Identify Wells with Violations for Figure 7.

78.73 A - Operator shall prevent gas and other fluids from lower formations from entering fresh groundwater.

78.81 D2 - Failure to case and cement properly through storage reservoir or storage horizon

78.83 A - Diameter of bore hole not 1 inch greater than casing/casing collar diameter

78.73 B - Excessive casing seat pressure

78.83 GRNDWTR - Improper casing to protect fresh groundwater

78.83 COALCSG - Improper coal protective casing and cementing procedures

78.85 - Inadequate, insufficient, and/or improperly installed cement

78.86 - Failure to report defective, insufficient, or improperly cemented casing

207B - Failure to case and cement to prevent migrations into fresh groundwater

THIS BELOW IS RECENT DATA OBTAINED with a Picarro CRDS machine - very accurate to 1/2 ppm and the area picture is detailed in the May 16 PA DEP Consent Order (it is item #161) in "PA DEP determination yes" FOLDER This is information we will be publishing, but felt it must be taken into account today by those concerned about the Delaware Basin, It shows the geological leakage in an the area covered by the Consent order issued by PA DEP and Chesapeake was fined \$900,000. At least one lawsuit was settled also there for \$1.6 million. and there are many more filed.

This is not on the disc or in the dropbox folder

From: "Payne, Bryce" <bryce.payne@wilkes.edu>

Date: July 26, 2013 10:43:40 AM EDT

To: "B. Arrindell" <glassart@FortyFrogFarm.com>, Bob Ackley <bobackley@gassafetyusa.com>

Subject: **Wyalusing report images and ?**

Barbara, Bob,

Have a look at two attached images of methane levels during second Wyalusing run. The two images are same data from different directions and altitudes.

In the "Wya regional SW view.jpg" file Wyalusing survey area is apparent on left, Leroy gas leak area in right background, with reference travel to/from runs on highways plotted to provide reference methane levels in image.

In the other image view is closer to Wyalusing from south. Leroy leak area is apparent in far left background, and reference methane level areas plotted in immediate foreground and far background.

These images work for you guys? Do we know if there is nat gas service in the surveyed area? I am presuming not -- not enough houses in sufficiently close proximity, but need to know for sure before concluding that the fairly widespread methane elevations are due to fracking/transmission lines and not distribution lines.

Bryce

Wellbore Integrity: Recent Operator Performance in Pennsylvania

1,609 wells drilled in 2010.
97 well failures.
6% rate of failure.

1,972 wells drilled in 2011.
140 well failures.
7.1% rate of failure.

1346 wells drilled in 2012
120 well failures.
8.9% rate of failure.

Consistent with previous
industry data, and not
improving.

Figure 7. Preliminary results of survey of leaking wells in the Pennsylvania Marcellus play based on violations issued by the DEP. Violations data from http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/OG_Compliance

"Should New York State and/or Starkey Township Allow High Volume Shale Gas Extraction?"

Anthony R. Ingraffea, Ph.D., P.E. (NYS No. 081309-0)

Dwight C. Baum Professor of Engineering

Cornell University

and

President

Physicians, Scientists, and Engineers for Healthy Energy, Inc.

January 23, 2013

No.

Why? I Will Focus on Two Important Reasons, Using Quotes from

“Where the science of fracking is concerned, engineer **Tony Ingraffea** and geologist **Terry Engelder** agree on almost everything except this:

"Tony thinks fracking should stop, and I don't," says Engelder... **"I believe that economic health has to come before environmental health is worked out. Tony is arguing for environmental health at any cost."**

<http://www.villagevoice.com/2012-09-19/news/boom-or-doom-fracking-environment/3/>

Reason #1:

Yup. Because that

Shale Gas Production Must Use Clustered, Multi-Well Pads and High-Volume Long Laterals

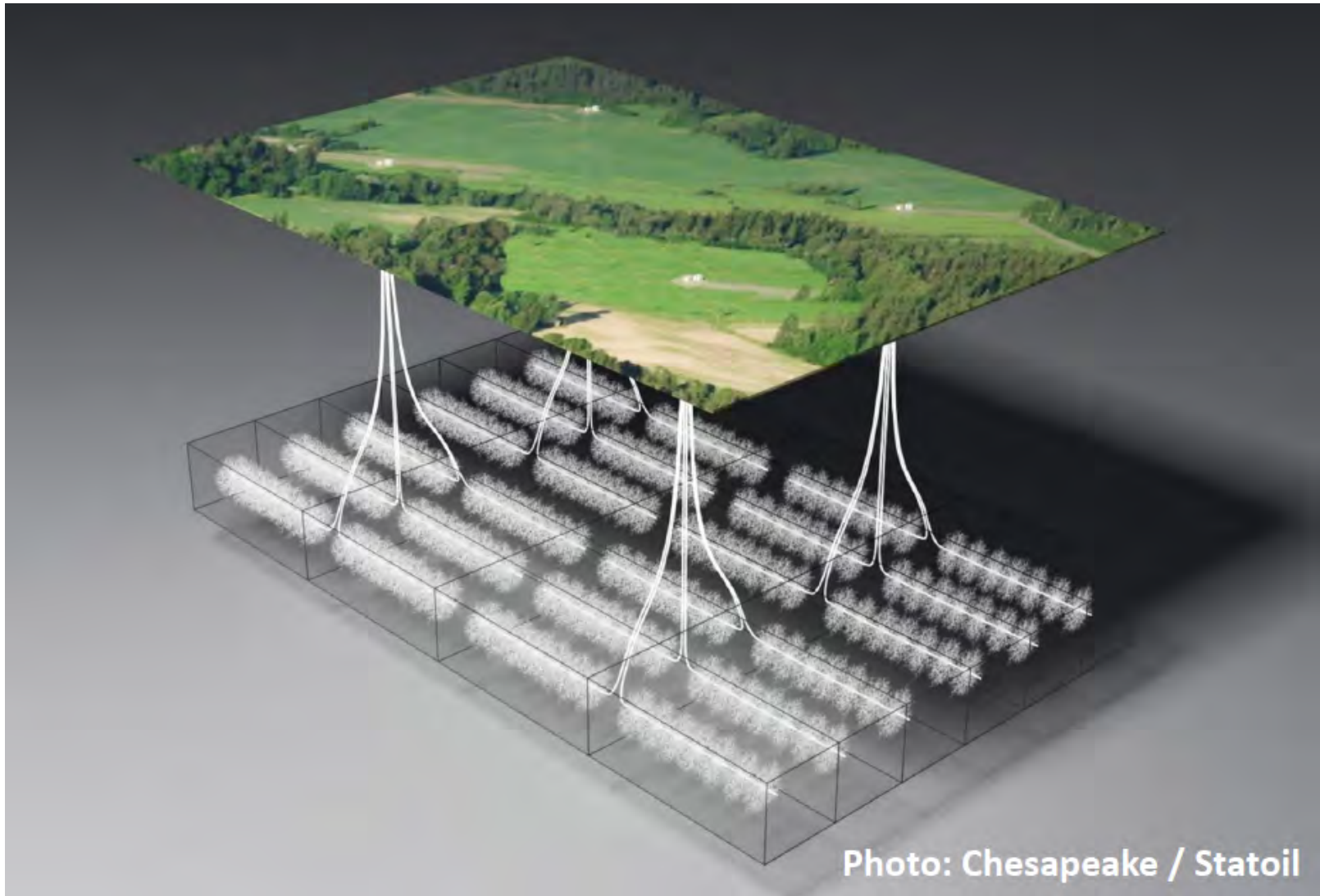
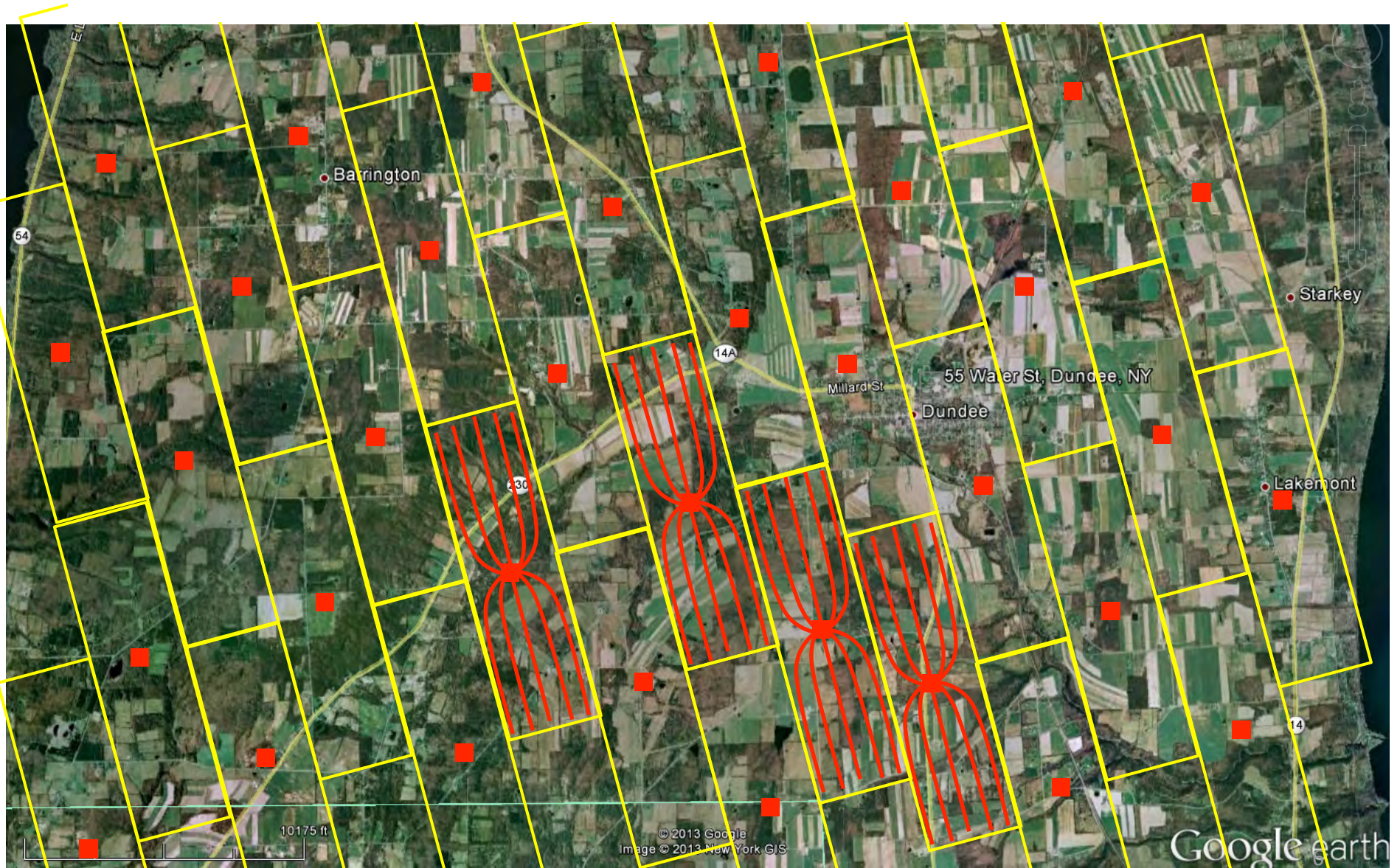
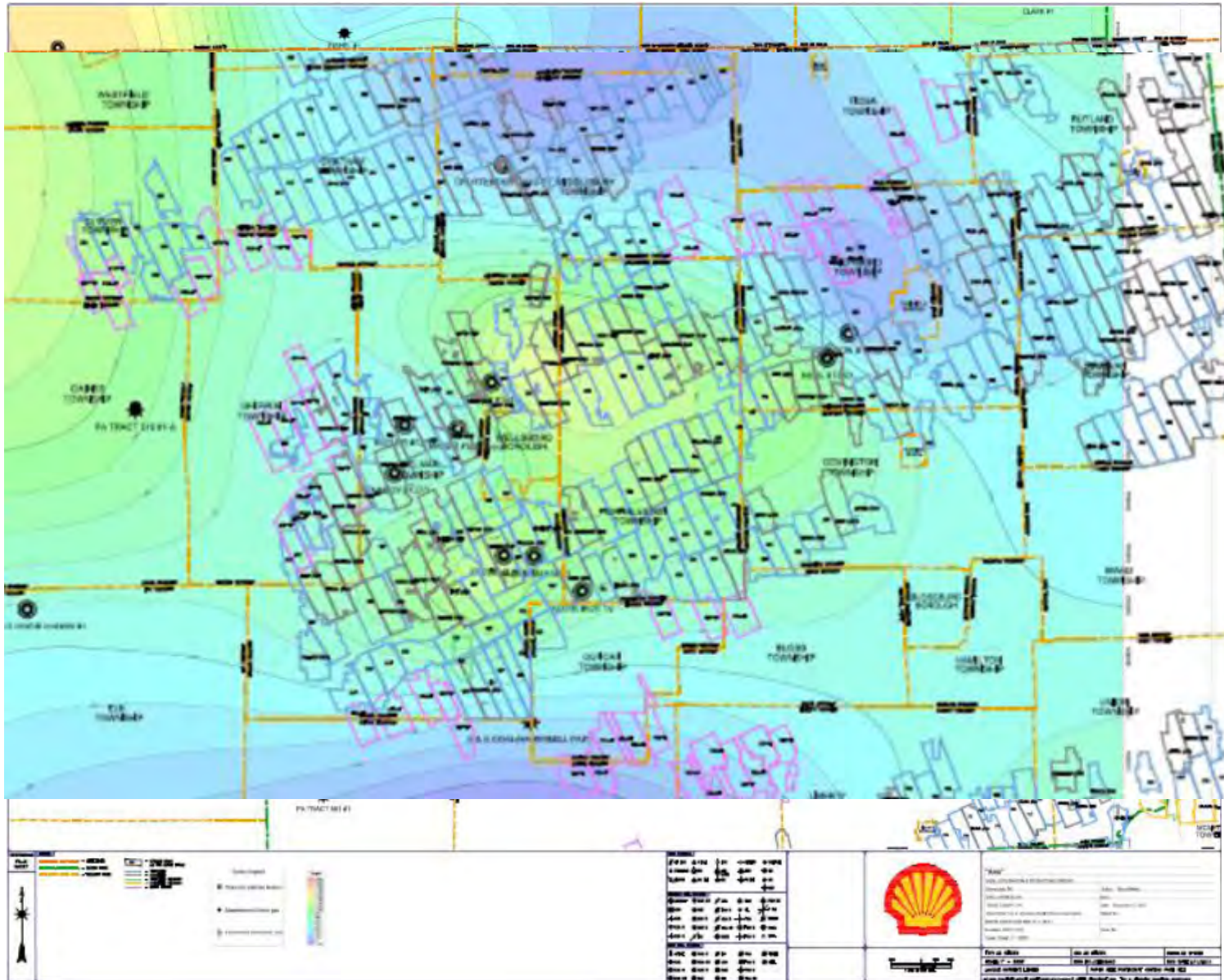


Photo: Chesapeake / Statoil

An Industrial-Ideal Pad/Well Buildout Scenario



Clustering of Pads in Tioga County, PA





Yeager Impoundment 6-3-11

In the large U.S plays, shale gas development has only just begun, and it requires a large number of large, multi-well, clustered pads and significant ancillary infrastructure

Shale Gas Production Requires 100's of Thousands of New Wells



With an Unacceptable Rate of Failure
to Contain Hydrocarbon Migration

Wellbore Integrity: Recent Operator Performance in the Pennsylvania Marcellus Play

1,609 wells drilled in 2010.
97 well failures.
6% rate of failure.

1,972 wells drilled in 2011.

**~100,000 Marcellus and Utica Wells in NYS:
You Do The Math**

1346 wells drilled in 2012
120 well failures.
8.9% rate of failure.

Consistent with previous industry data, and not improving.

What Are the Implications of

Each leaking well has the potential for contamination of one or more private or public water sources, and will leak volatile organic compounds into the atmosphere.

High Volume Hydraulic Fracturing Proposed Regulations 6 NYCRR Parts 550-556, 560 Among My Comments and Recommendations

Recommendation: As a minimum, DEC should perform and publish its own statistical analysis of documented incidents of hydrocarbon migration into underground sources of drinking water in the Marcellus play in Pennsylvania, and develop its own prediction of immediate and long-term rate of well failures for shale gas development in New York.

Recommendation: It is not possible to perform a rational cost-benefit analysis of shale gas development in New York without a science-based, probabilistic estimate of the number of expected well contamination incidents due to faulty wells. DEC should estimate the cost associated with mitigation of such contamination in its economic analysis of shale gas development. Each leaking well will, unless completely stopped from leaking natural gas, contribute to methane emissions and exacerbation of climate change. DEC should estimate the impact of such emissions on NYS goals for reduction of CO_{2eq} .

Why? I Will Focus on Two Important Reasons, Using Quotes from Prof. Engelder for Motivation

“These renewable have a huge upside”, Engelder said.
“In my view, the subsidies are really very appropriate”.

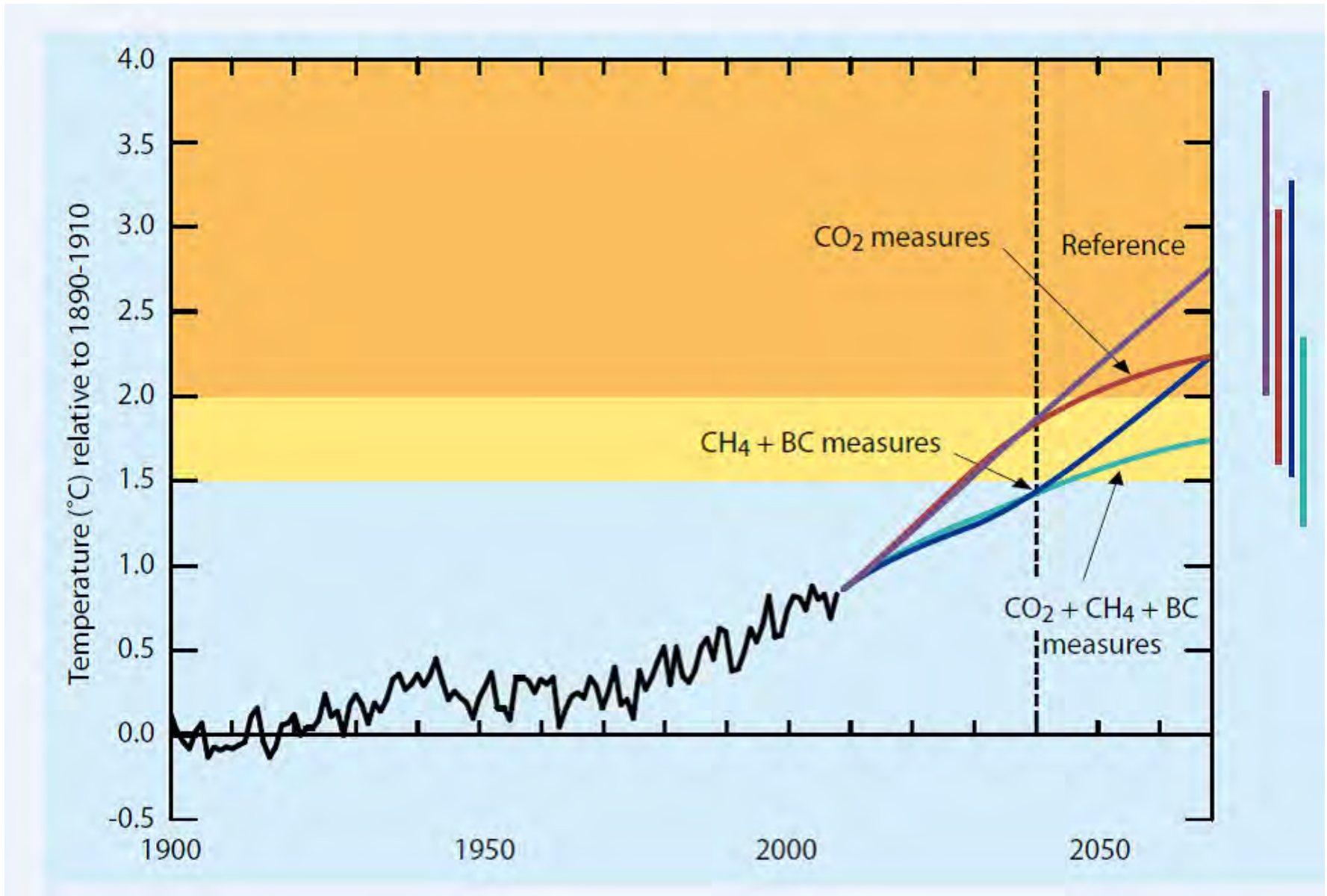
Engelder, who’s been both praised and criticized for his support of gas drilling, said he is sure that research and technology will ultimately deliver innovations that make renewable a major force.

“There’s no doubt about it’, he said, adding that **“the payout might not happen until 2042”**”.

Reason #2:

2042 is too late!!

Why Is Controlling Methane (CH₄) Emission So Important?



Shindell, *et al. Science* **335**, 183 (2012)

Methane Is a Much More Potent Greenhouse Gas Than Carbon Dioxide

- 33 times more potent over 100 years*
- 105 times more potent over 20 years*
- Therefore, even small leakage rates important:
Each 1% lifetime production leakage from a well produces about the same climate impact as burning the methane twice.

*Shindell DT, Faluvegi G, Koch DM, Schmidt GA, Unger N, and Bauer SE (2009). Improved attribution of climate forcing to emissions. *Science* 326: 716-718.

Upstream/Midstream Methane Emission Measurements are Coming in Very High

Uinta Basin, Utah:

Up to 9% of total production

Nature 493, 12 (03 January 2013) doi:10.1038/493012a

Denver–Julesburg Basin, Colorado:

2.3% to 7% of total production

Pétron, G. *et al.* *J. Geophys. Res.* 117, D04304 (2012)

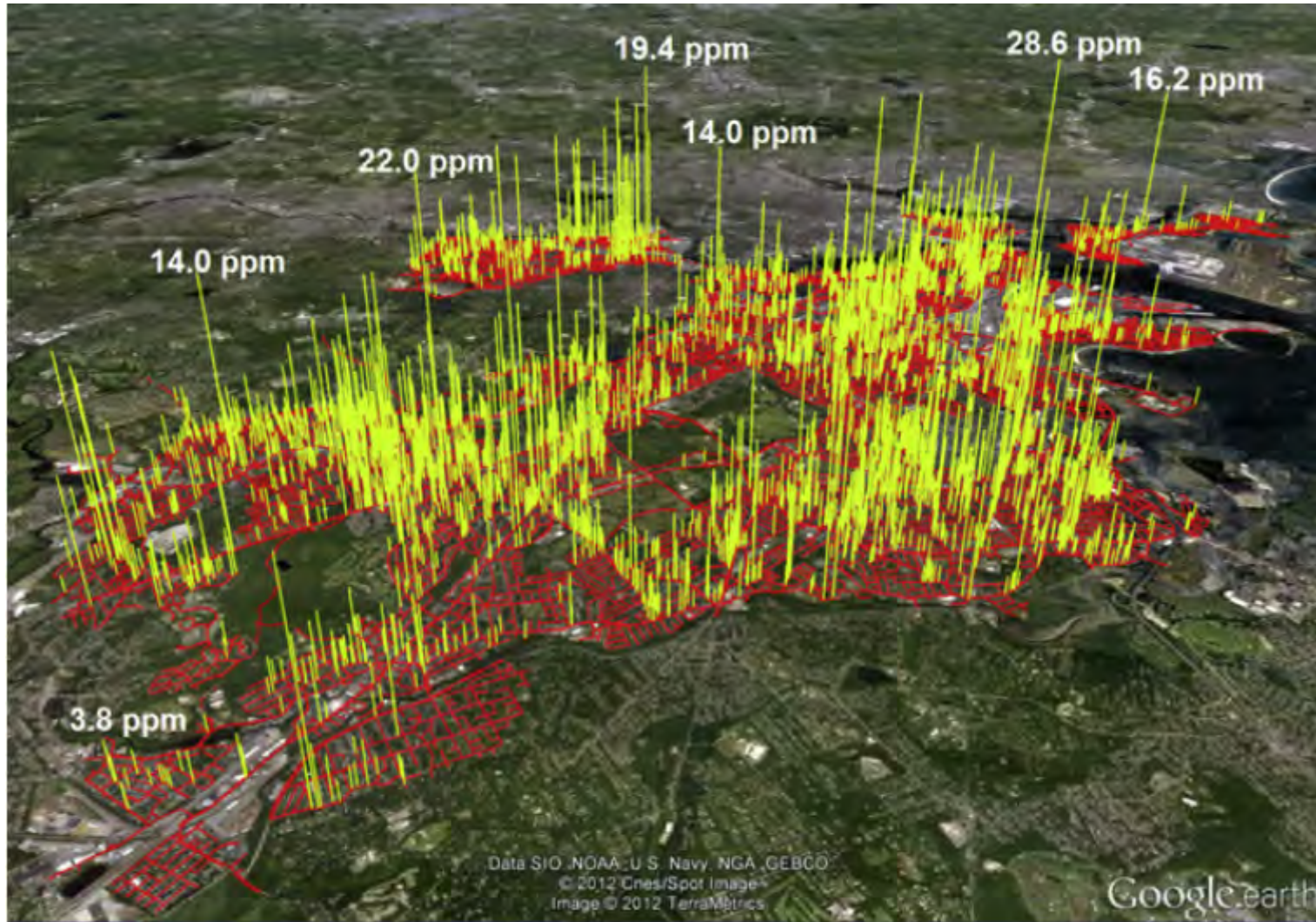
Note: Howarth, Santoro, Ingraffea predicted

TOTAL (UPSTREAM/MIDSTREAM/DOWNSTREAM)

emission range of 3.6% to 7.9%.

Climatic Change Letters, 2011

Downstream Methane Leakage from Aging Urban Distribution Pipelines: Boston MA



N.G. Phillips et al. / Environmental Pollution 173 (2013) 1–4

NO to HVHF, YES to a Much Better Plan

Convert New York State's (NYS's) all-purpose -- electricity, transportation, heating/cooling, industry -- energy infrastructure to one derived entirely from wind, water, and sunlight (WWS).

We the people own the sun. We own the wind. We own the water. Those fuel costs are \$0.00.

Or, we can have 50,000 to 100,000 Marcellus and Utica Wells;
8,000 to 16,000 pads;
500 to 1,000 compressor stations;
Thousands of miles of new pipelines;
Thousands of incidents of well water contamination;
Increase New York's contribution to global warming;
Sequester forever twice the tonnage of the US Navy
in non-recyclable steel casing.

1% tidal (2600 1-MW turbines)

5.5% hydroelectric (6.6 1300-MW plants, of which 89% exist).

NO to HVHF, YES to a Much Better Plan

The plan would:

- Reduce NYS's end-use power demand ~37%.
- Stabilize energy prices since fuel costs would be zero.
- Create more jobs than lost because nearly all NYS energy would now be produced in-state, ~58,000 new, permanent, full-time jobs by 2025.
- Reduce NYS air pollution mortality and its costs by ~4000/yr, and ~\$33 billion/yr (3% of 2010 NYS GDP), respectively, repaying the 271 GW installed power needed within ~17 y.
- NYS's own emission decreases would reduce 2050 U.S. climate costs by ~\$3.2 billion/yr.

We Own the Wind, the Sun, the Water: Their Fuel Cost is Zero.

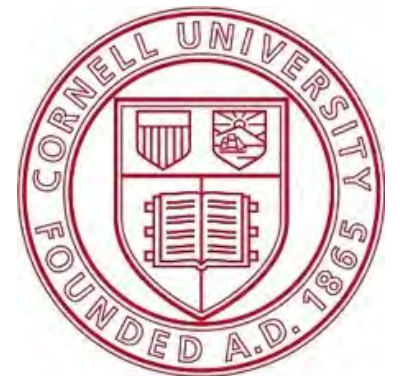
Wind, water and solar energy will provide a stable, renewable source of electric power not subject to the same fuel supply limitations as fossil fuels and nuclear power. Due to the eventual depletion of coal, oil, natural gas, and uranium resources, their prices will continue to rise.

We Own the Wind, the Sun, the Water: They Make Us Energy Secure and Independent

"Should New York State and/or

No.

Thank you !



Projected Unit Costs of Selected Conventional Fossil Fuels Over the Period 2009-2030 in NYS.

Fuel Type	Projected Changes in Fuel Cost, 2009-2030		
	2009	2030	Percent Change
Gasoline – all grades	\$19.30	\$40.39	109%
Natural Gas – Electric	\$6.30	\$10.14	27%
Natural Gas – Commercial	\$10.57	\$15.00	27%
Natural Gas – Industrial	\$8.73	\$11.98	37%

Source: NYSEPB (2009), Energy Price and Demand Long-Term Forecast (2009-2028). Annual growth rate factors provided in reference document have been extrapolated for the period 2029-2030.

Externality Costs for Fossil Fuel Generation

The hidden costs of:

- Air pollution morbidity and mortality
- Water pollution costs
- Global warming damage. e.g. coastline loss, agricultural and fish losses, human heat stress mortality, increases in severe weather and air pollution
- Worker health

Approximate fully annualized generation and short-distance transmission costs for WWS and new conventional power (2007 U.S. cents/kWh-delivered), including externality costs.

Energy Technology	2005-2012*	2020-2030*
Wind Onshore	4a - 10.5b	<4a
Wind Offshore	11.3c - 16.5b	7b - 10.9c
Wave	>11.0a	4 - 11a
Geothermal	9.9 - 15.2b	5.5 - 8.8g
Hydroelectric	4.0 - 6.0d	4a
CSP	14.1 - 22.6b	7 - 8a
Solar PV (Utility)	11.1 - 15.9b	5.5g
Solar PV (Commercial)	14.9 - 20.4b	7.1 - 7.4h
Solar PV (Residential)	16.5 - 22.7e	7.9 - 8.2h
Tidal	>11.0a	5 - 7a
New conventional (plus externalities)^f	9.6-9.8 (+5.3)	12.1-15.0 (+5.7) = 17.8 - 20.7

Approximate fully annualized generation and short-distance transmission costs for WWS power (2007 U.S. cents/kWh-delivered), including externality costs. Also shown are generation costs and externality costs (from Table 4) of new conventional fuels. Actual costs in California will depend on how the overall system design is optimized as well as how energy technology costs change over time.

*\$0.01/kWh for transmission was added to all technologies as in Delucchi and Jacobson (2011) except for distributed generation projects (i.e. commercial and residential solar PV)

a) Delucchi and Jacobson (2011)

c) Levitt et al. (2011)

d) REN21 (2010)

e) SEIA (2012). Residential LCOE: Calculated by multiplying the Lazard (2012) Commercial LCOE by the ratio of the Residential PV \$/Watt to the Commercial PV \$/Watt = $\$.149 * (\$5.73 / \$5.16) - \$.204 (\$5.73 / \$5.16)$

f) The current levelized cost of conventional fuels in NYS is calculated by multiplying The electric power generation by conventional source in NYS (EIA, 2012b) by the Levelized cost of energy for each source (Lazard, 2012 for low estimate; EIA, 2012c for high estimate) and dividing by the total generation. The future estimate assumes a 26.5% increase in electricity costs by 2020 (the mean increase in electricity prices in NYS from 2003-2011, EIA, 2012d), and twice this mean increase by 2030. Externality costs are from Table 4.

g) Google (2011), 2020 projection

h) The ratio of present-day utility PV to present-day commercial and residential PV multiplied by the projected LCOE of utility PV

Not Much Respect from EXXON Mobil CEO

“Now, with these new technologies that evolve always come a lot of questions. Ours is an industry that is built on technology, it's built on science, it's built on engineering, and because ***we have a society that by and large is illiterate in these areas, science, math and engineering, what we do is a mystery to them and they find it scary.*** And because of that, it creates easy opportunities for opponents of development, activist organizations, to manufacture fear.”

Rex W. Tillerson, Chairman and CEO,
Exxon Mobil Corporation
June 27, 2012
Council on Foreign Relations

Easy for Him to Say

“...And as long as we as an industry follow good engineering practices and standards, these risks are entirely manageable. And the consequences of a misstep by any member of our industry -- and I'm speaking again about the shale revolution -- ***the consequences of a misstep in a well, while large to the immediate people that live around that well, in the great scheme of things are pretty small***, and even to the immediate people around the well, they could be mitigated.”

Rex W. Tillerson, Chairman and CEO,
Exxon Mobil Corporation
June 27, 2012
Council on Foreign Relations

EXXON Mobil CEO on Global Warming

“...And as human beings as a -- as a -- as a species, that's why we're all still here. We have spent our entire existence adapting, OK? ***So we will adapt to this. Changes to weather patterns that move crop production areas around -- we'll adapt to that. It's an engineering problem, and it has engineering solutions.*** And so I don't -- the fear factor that people want to throw out there to say we just have to stop this, I do not accept. I do believe we have to -- we have to be efficient and we have to manage it, but we also need to look at the other side of the engineering solution, which is how are we going to adapt to it. And there are solutions. It's not a problem that we can't solve.”

Rex W. Tillerson, Chairman and CEO,
Exxon Mobil Corporation
June 27, 2012
Council on Foreign Relations

EXXON Mobil CEO on Journalists

“...But this is an ongoing dialogue I've been having with people in your profession now for some time; that for whatever reason, ***a large number of people in the journalism profession simply are unwilling to do their work. They're unwilling to do the homework.*** And so they get something delivered to them from the manufacturers of fear; it makes a great story. I mean, it – I mean, it does. It makes a great story. People love that kind of stuff. The consuming public loves it, because it goes to what, you know, their fears are.”

Rex W. Tillerson, Chairman and CEO,
Exxon Mobil Corporation
June 27, 2012
Council on Foreign Relations

Farmer Joe Is a Liar

“...There are a lot of sources of science-based information. There are a lot of sources that can debunk claims that are made specific -- you know, specific examples. ***Farmer Joe lit his faucet on fire, and that's because there was gas drilling going on, you know, in his back porch. And we can go out there and we can prove with science that that is biogenic gas; it's been in the water table for millions of years; it finally made its way Farmer Jones' faucet, it had nothing to do with any oil and gas activities.*** And part of when you're dealing with the subsurface strata is you've got to -- you got to understand that Mother Nature has done a lot of things in the subsurface that have nothing to do with anything man has done. And it changes. It moves around all the time. So what once was will change.”

Rex W. Tillerson, Chairman and CEO,
Exxon Mobil Corporation
June 27, 2012
Council on Foreign Relations

EXXON Mobil CEO Correct on Shale Gas Economics

“...And what I can tell you is the cost to supply is not \$2.50. We are all losing our shirts today. You know, we're making no money. It's all in the red.”

“The higher volumes are not only the result of drilling in the higher Btu area, **but are also the result of drilling longer laterals and completing them with more frac stages. We've also experimented with reduced cluster spacing, decreasing the frac interval from 300 feet to 150 to 200 feet, all of this looks very promising.** Once we extract ethane beginning late next year, this will further enhance the economics.”

Range Resources earnings call Q4 2011

Last year's earnings:

Q2 2011 was \$51,293,000.

Q3 2011 was \$34,755,000.

Q4 2011 was a loss of -\$2,989,000.

Q1 2012 was a loss of -\$41,800,000.

78.73A - Operator shall prevent gas and other fluids
from lower formations from entering fresh

78.81D2 - Failure to case and cement properly

78.83A - Diameter of bore hole not 1 inch greater

78.73B - Excessive casing seat pressure

78.83 GRNDWTR - Improper casing to protect fresh

78.83 COALCSG - Improper coal protective casing

78.85 - Inadequate, insufficient, and/or improperly

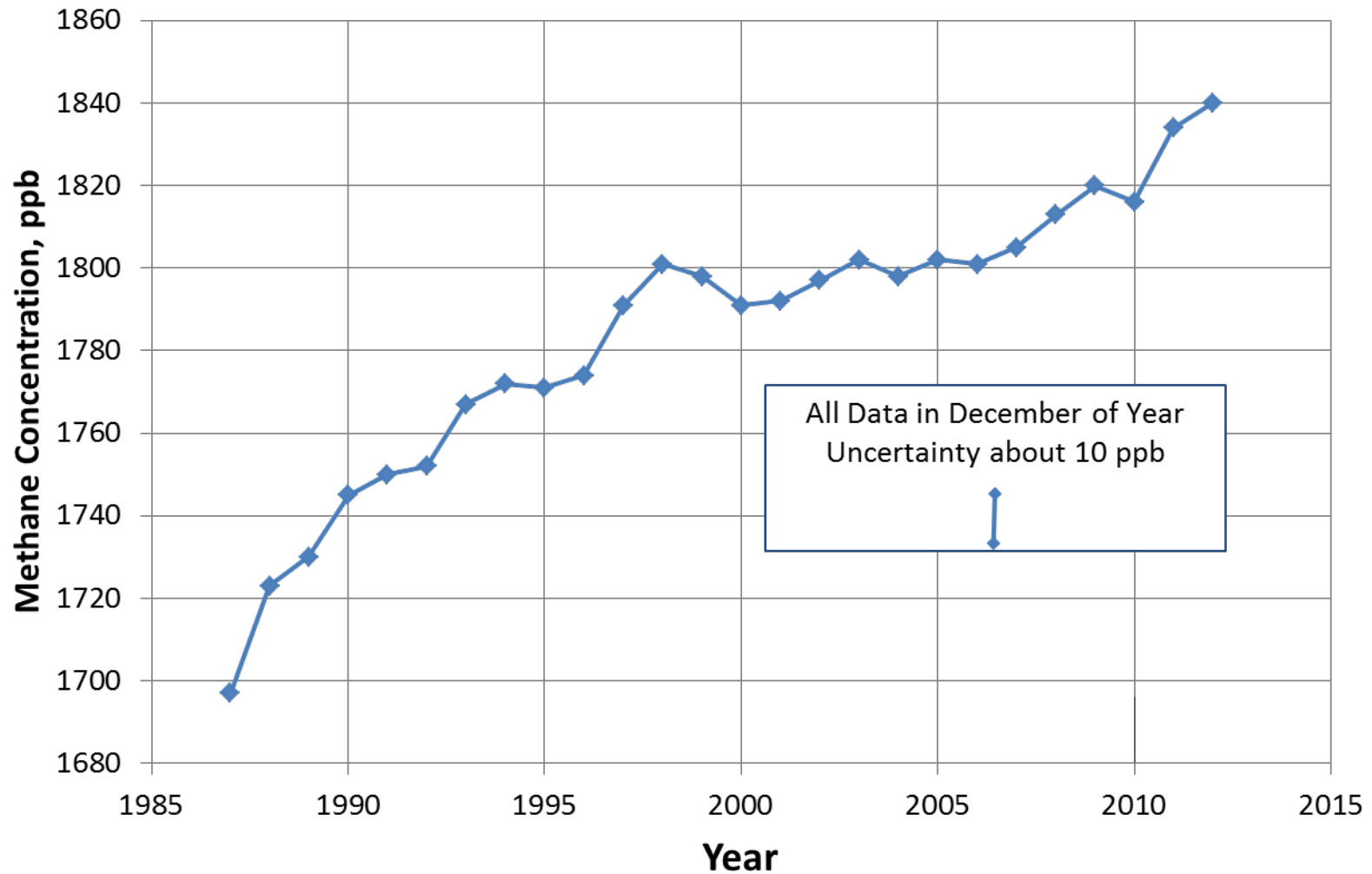
78.86 - Failure to report defective, insufficient, or

207B - Failure to case and cement to prevent

Additional Counts of Wells with

2010	64 wells with violations, 47 additional wells with loss of integrity noted in Inspection Comments
2011	97 wells with violations, 45 additional wells with loss of integrity noted in Inspection Comments
2012	44 wells with violations, 76 additional wells with loss of integrity noted in Inspection Comments

Measured Methane Concentration in the Atmosphere



DATA FROM NOAA: <http://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=MLO&program=ccgg&type=ts>

2012 International Energy Agency Report on Fossil Fuels and Climate Change

“On the November 2012 International Energy Agency report, spokesperson Michael Levi said,

"The report confirms that, given the current policies, we will blow past every safe target for emissions. This should put to rest the idea that the boom in natural gas will save us from that.” “

(http://www.nytimes.com/2012/11/13/business/energy-environment/report-sees-us-as-top-oil-producer-in-5years.html?_r=1&adxnnl=1&adxnnlx=1354623973-G4+SBz4O1YBFWAJS7XpkXA&)

Germany Sets New Solar Record By Meeting Nearly Half of Country's Weekend Power Demand

by [Timon Singh](#), 05/31/12

“Germany fed a whopping 22 gigawatts of solar power per hour into the national grid last weekend, setting a new record by meeting nearly half of the country's weekend power demand. The [Renewable Energy Industry \(IWR\)](#) in Muenster announced that [Saturday's solar energy generation](#) met nearly 50 percent of the nation's midday electricity needs and was equal to 20 nuclear power stations at full capacity.”



NO NEW TAXES

Plan seeks to close \$1.3B deficit, help municipalities



New York Gov. Andrew Cuomo presents his 2013-14 executive budget address Tuesday in Albany. His \$136 billion state budget would increase spending about 2 percent without tax increases, but New Yorkers would feel some fee hikes. ASSOCIATED PRESS

By Joseph Spector
jspector@gannett.com

ALBANY — Gov. Andrew Cuomo offered a budget proposal Tuesday that seeks to increase the minimum wage and offer tax breaks to businesses, while increasing aid to schools and closing two prisons.

The \$136 billion budget plan would increase state spending by 1.9 percent and close a \$1.3 billion deficit for the 2013-14 fiscal year, which starts April 1. It includes no broad-based tax increases.

The budget also includes an additional \$6 billion that Cuomo expects to receive from the federal government to pay for the Affordable Care Act and Superstorm Sandy recovery.

Cuomo said the nearly \$143 billion package would boost the state's struggling economy, rebuild after the storm and increase education aid by 4.4 percent.

"We're going to take this moment in time and moment in history, and we will pledge ourselves to build this state back

See BUDGET, Page 5A

\$8.75 min. wage

'We will pledge ourselves to build this state back to a level that it's never reached.'

GOV. ANDREW CUOMO

ON THE WEB

See video of reaction from state Sen. Tom O'Mara, R-Big Flats, with this story at theithacajournal.com.

INSIDE

- » Plan for regional "hot spots." Page 3A
- » Help for local governments. Page 4A
- » More aid for education. Page 4A
- » Lifton: Proposal not enough. Page 5A

NYS Doing Quite Well WITHOUT Shale Gas

1.9%

spending hike

BUDGET HIGHLIGHTS

DEFICIT REDUCTION

Closes a \$1.3 billion budget gap without new taxes or fees.

PENSION RELIEF

Starts program to help local governments fund growing pension costs.

MINIMUM WAGE

Raises from \$7.25 to \$8.75 an hour.

EDUCATION AID

Boosts by \$889 million, or by 4.4 percent, including \$75 million in competitive grants.

ECONOMIC DEVELOPMENT

Creates tax-free zones for job growth and continues \$220 million for regional development councils.

1.9%

spending hike

BUDGET HIGHLIGHTS

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PA Having Economic Problems WITH Shale Gas

Tuesday, January 22, 2013

Stunning Fact: PA Unemployment Rate Rises During Last 12 Months Even As National Rate Declines

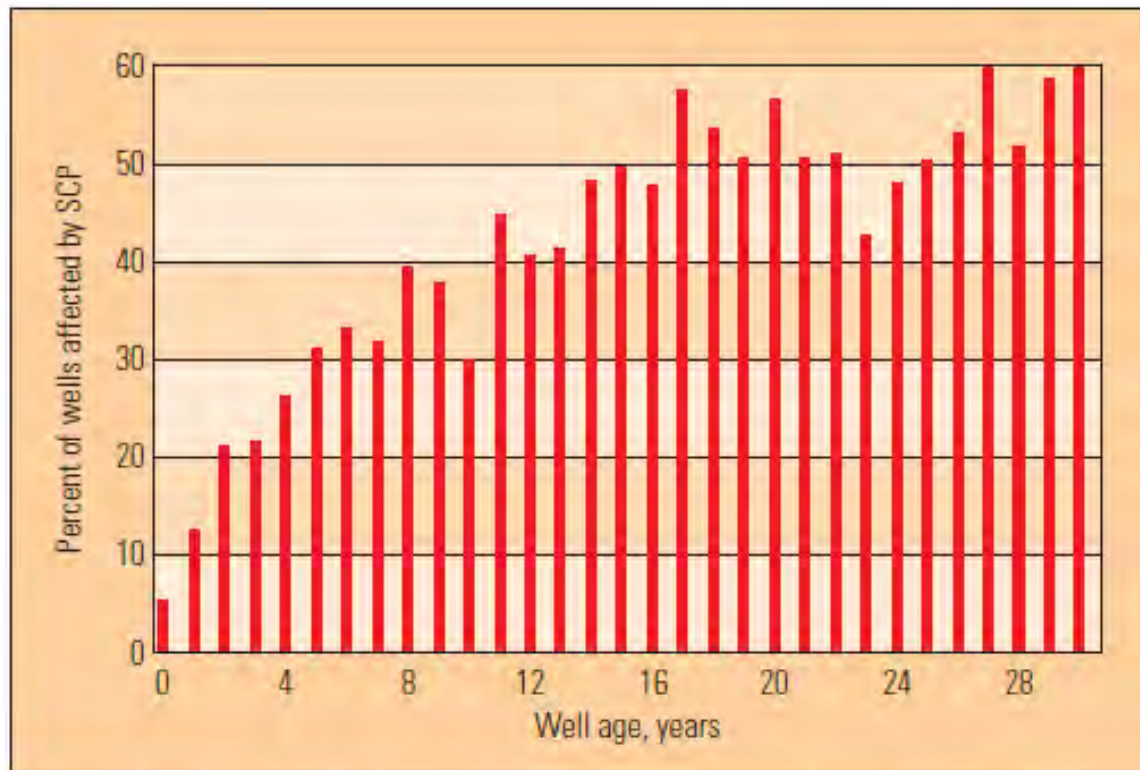
Pennsylvania is among the few states to have a higher unemployment rate in December 2012 than in December 2011. The facts are that Pennsylvania's unemployment rate was 7.9% in December 2012 and is up from 7.7% in December 2011.

Pennsylvania's economy is headed in the wrong direction, even as the national unemployment rate fell from 8.2% to 7.8%, and even as Pennsylvania becomes the third largest producer of natural gas in the country....

These are ugly facts that indict the economic development and budget policies of the Corbett Administration. Corbett's failure is rooted in an assault on public education, including our state universities, that has destroyed at least 19,000 jobs. His failure is also rooted in a mistaken belief that gas drilling and gas production alone can bring Pennsylvania a broad prosperity.

<http://johnhanger.blogspot.com/2013/01/stunning-fact-pa-unemployment-rate.html>

“Since the earliest gas wells, uncontrolled migration of hydrocarbons to the surface has challenged the oil and gas industry.”



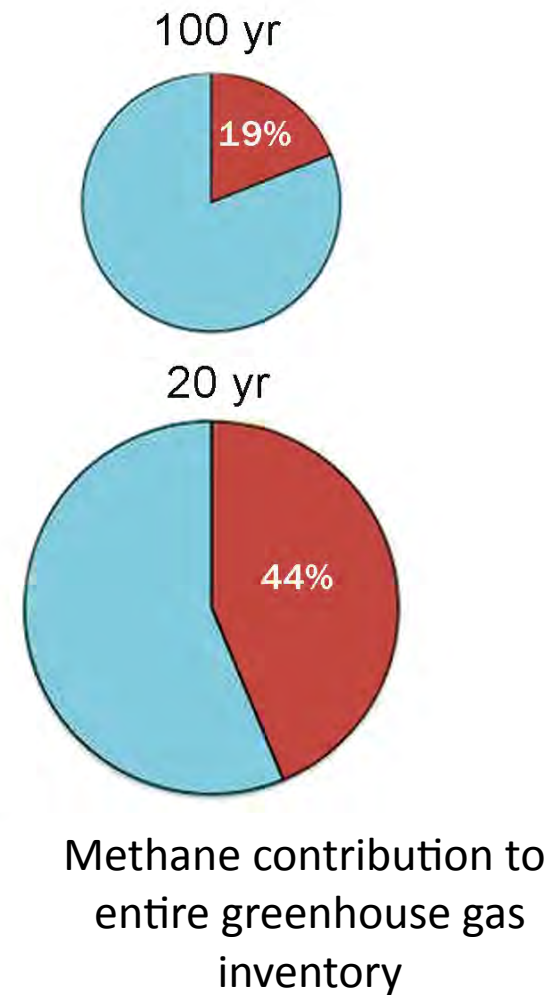
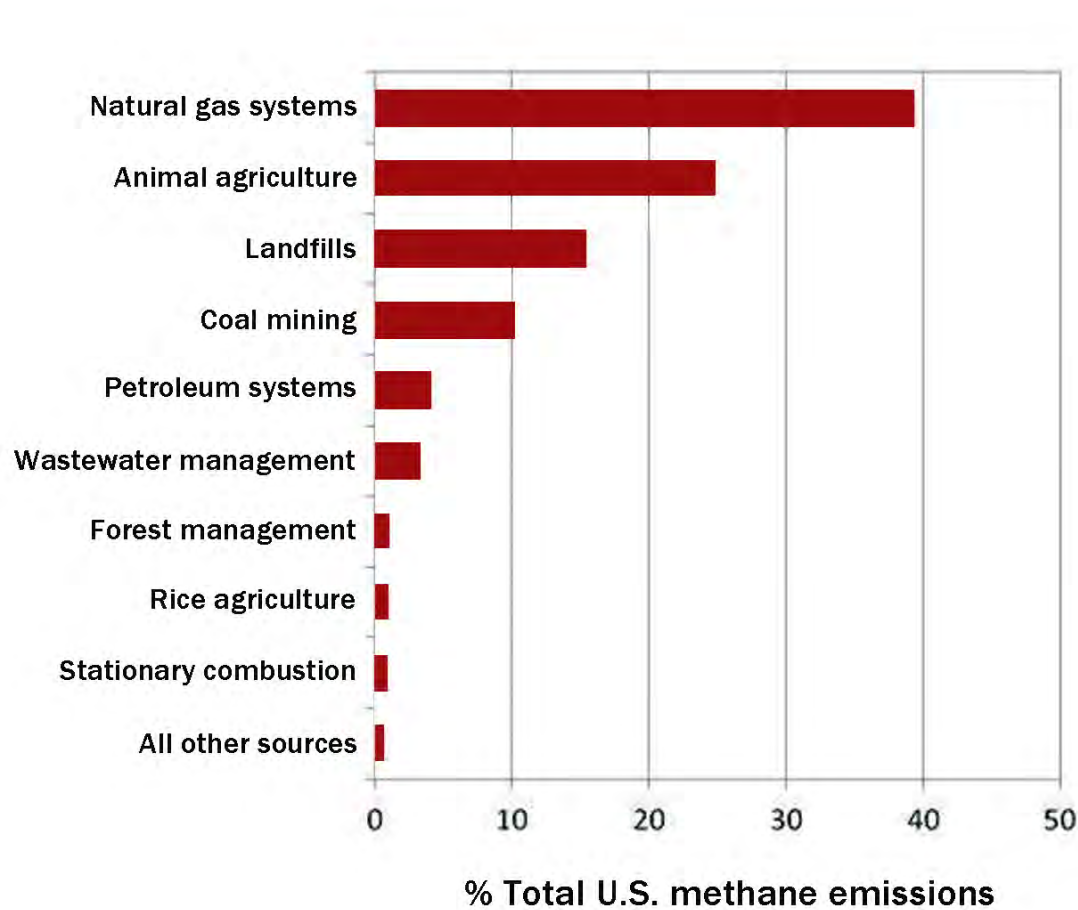
SCP=Sustained Casing Pressure. Also called sustained annular pressure in one or more of the casing annuli.

- About 5% of wells fail soon
- More fail with age
- Most fail by maturity

^ Wells with SCP by age. Statistics from the United States Mineral Management Service (MMS) show the percentage of wells with SCP for wells in the outer continental shelf (OCS) area of the Gulf of Mexico, grouped by age of the wells. These data do not include wells in state waters or land locations.

Brufatto *et al.*, *Oilfield Review*, Schlumberger, Autumn, 2003

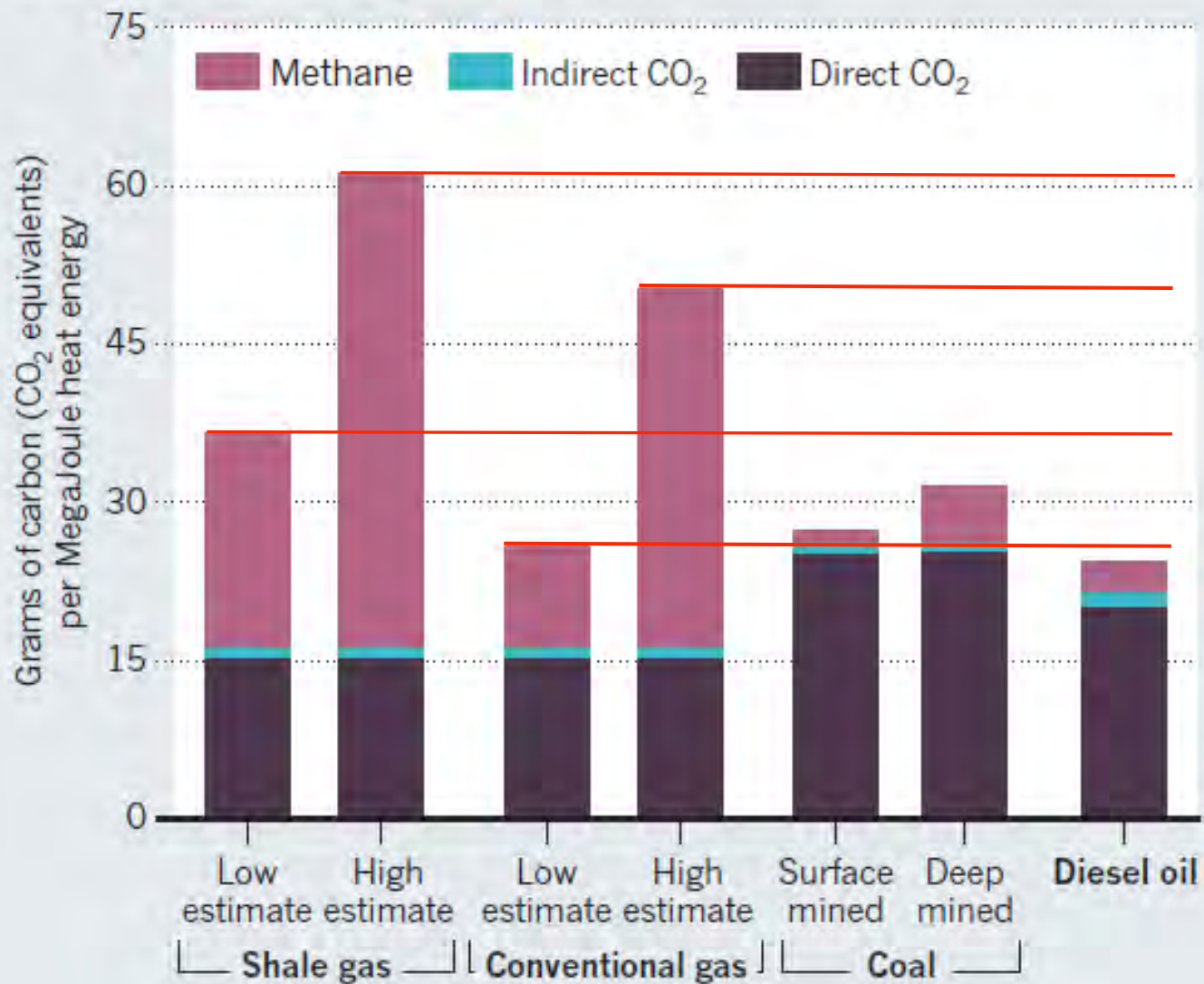
Natural Gas Systems Now Produce 39% of Total U.S. Methane Emissions



(Howarth et al. 2012, based on 2011 EPA data for 2009)

A DAUNTING CLIMATE FOOTPRINT

Over 20 years, shale gas is likely to have a greater greenhouse effect than conventional gas or other fossil fuels.



Howarth & Ingraffea, *Nature*, 15 September 2011

Aubrey McClendon, CEO of Chesapeake Gas on Climate Change

Mr. McClendon promotes natural gas as a carbon-light fuel, but that doesn't mean he's convinced that man is really changing the climate. "There have been times in the past on this planet where it's been hotter but CO2 levels have been lower. And there have been times when CO2 levels have been higher and the climate's been cooler. . . Would people cheat on climate science? Sure. Because all it is a model into which there are 2,000 variables and if I want this outcome I nudge that one up a little and down a little bit and there you go."

Wall Street Journal, April 27, 2012

ERCB: Alberta frac job leak caused by insufficient spacing

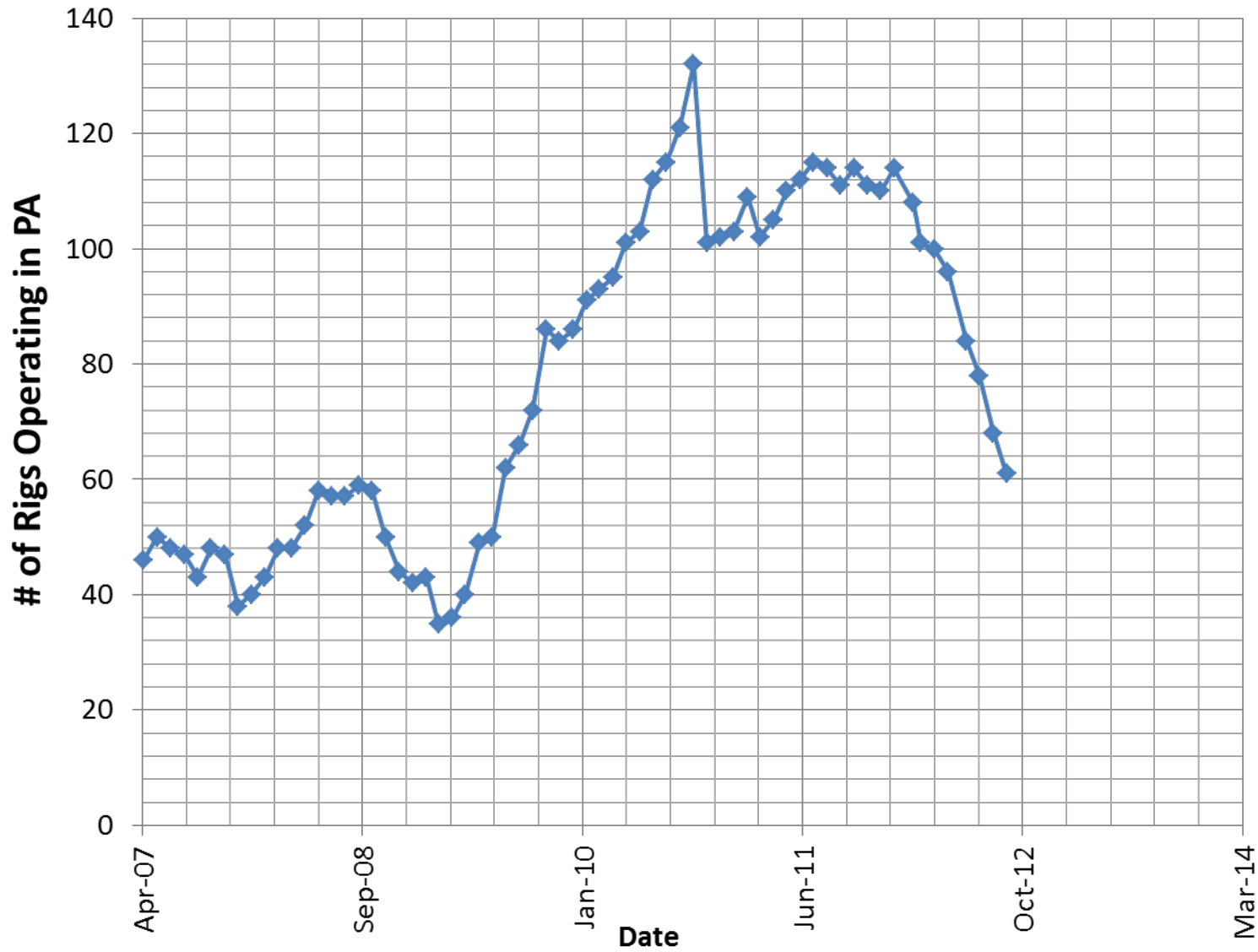
HOUSTON, Dec. 14
12/14/2012

[By OGJ editors](#)

Insufficient distance between wellbores caused a vertical oil well to leak fluids after hydraulic fracturing of a nearby horizontal well last January in Red Deer County, Alta., an investigation by the Alberta [Energy Resources Conservation Board](#) has determined.

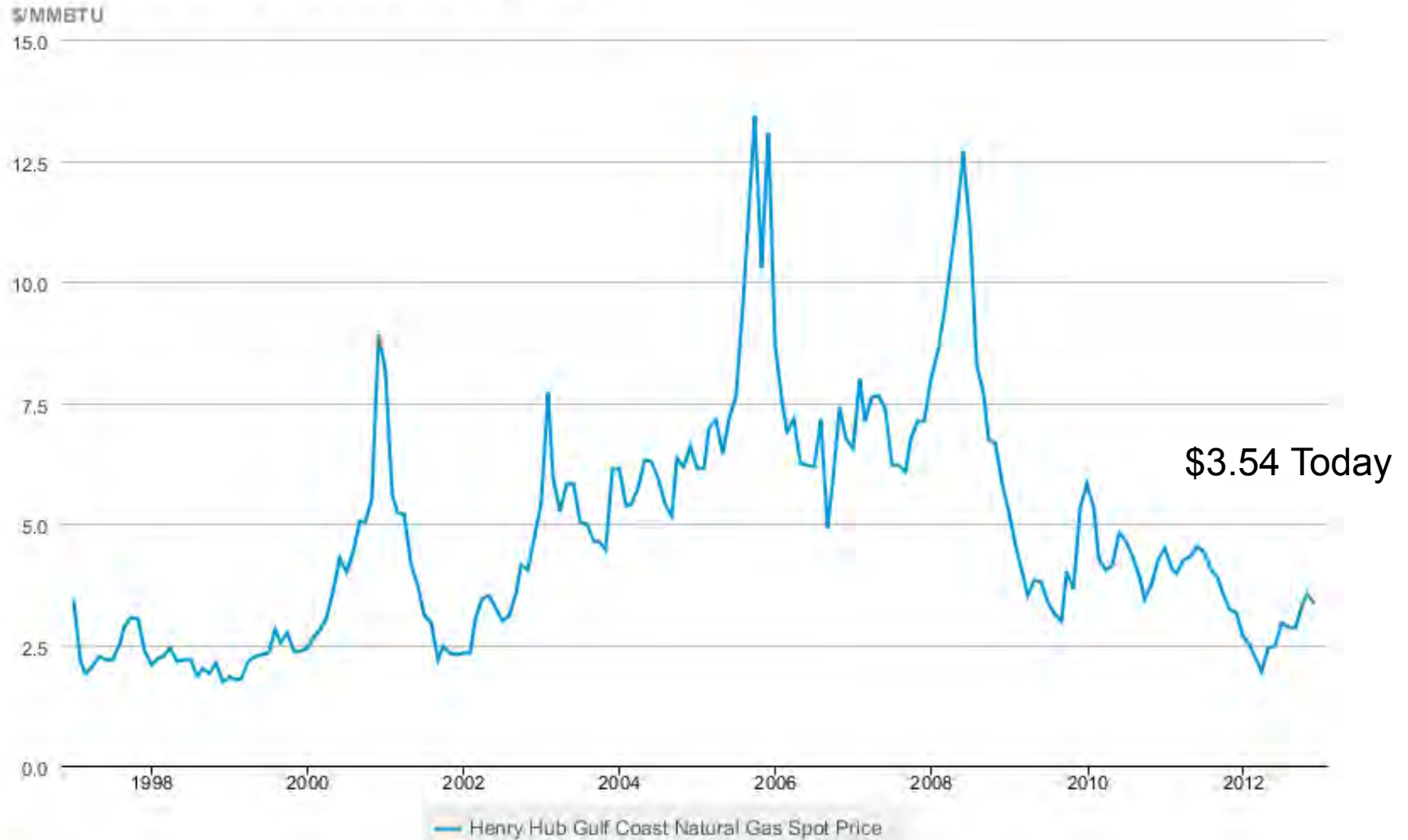
The agency said communication between wells didn't occur until about 1 hr and 45 min after the frac job, so no significant decrease in pressure was observed at the Midway well during the operation. Increased pressure and flow rates in the Wild Stream vertical well caused surface components, which weren't rated for hydraulic fracturing, to fail.

Trends in Drilling Rig Count in PA



Natural Gas Price is Volatile

Natural Gas Spot and Futures Prices (NYMEX)



Source: U.S. Energy Information Administration



UNEP Global Environmental Alert Service (GEAS)

Taking the pulse of the planet; connecting science with policy

Website: www.unep.org/geas

E-mail: geas@unep.org



November 2012

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Thematic Focus: Resource Efficiency, Harmful Substances and Hazardous Waste

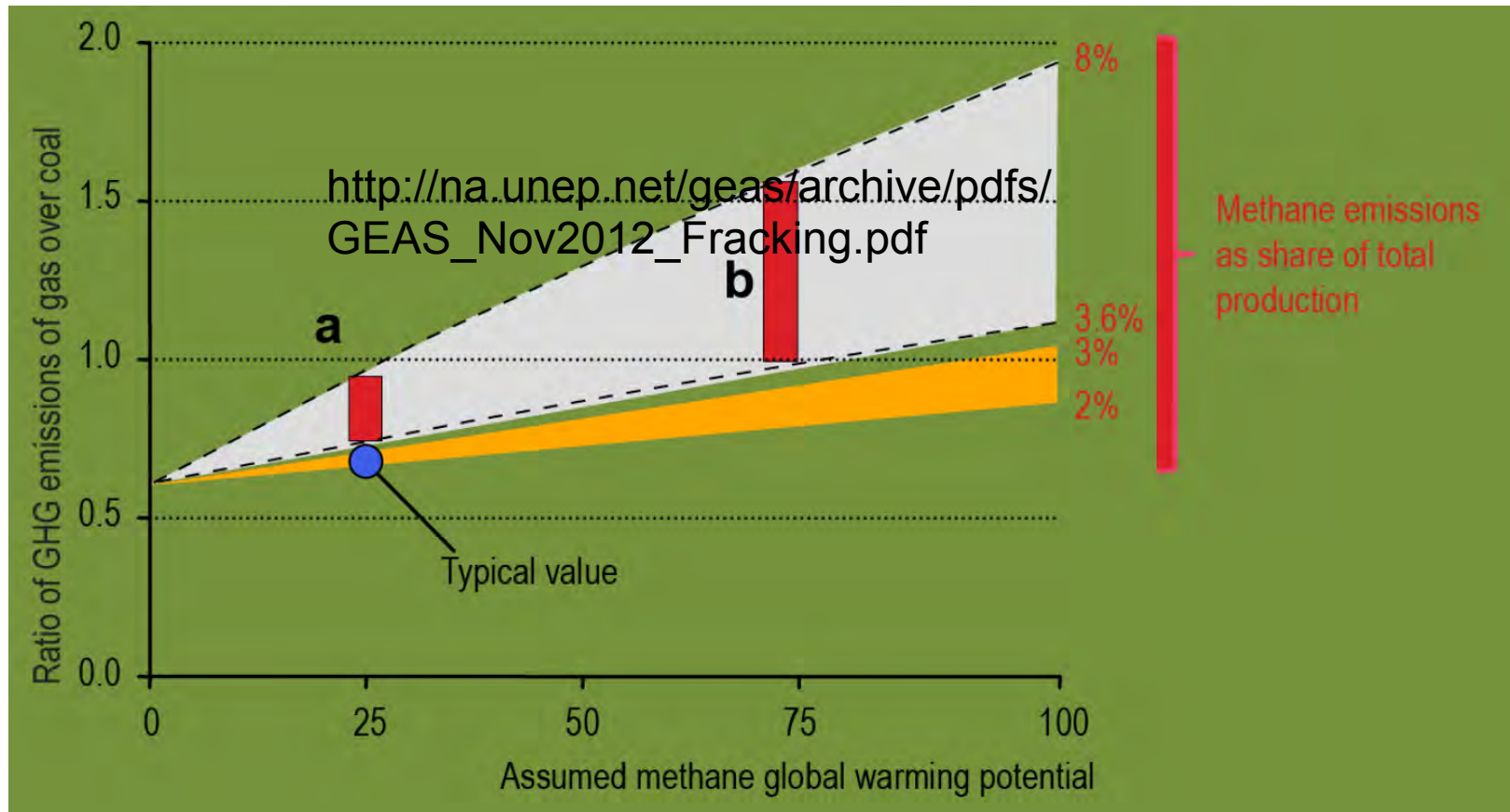
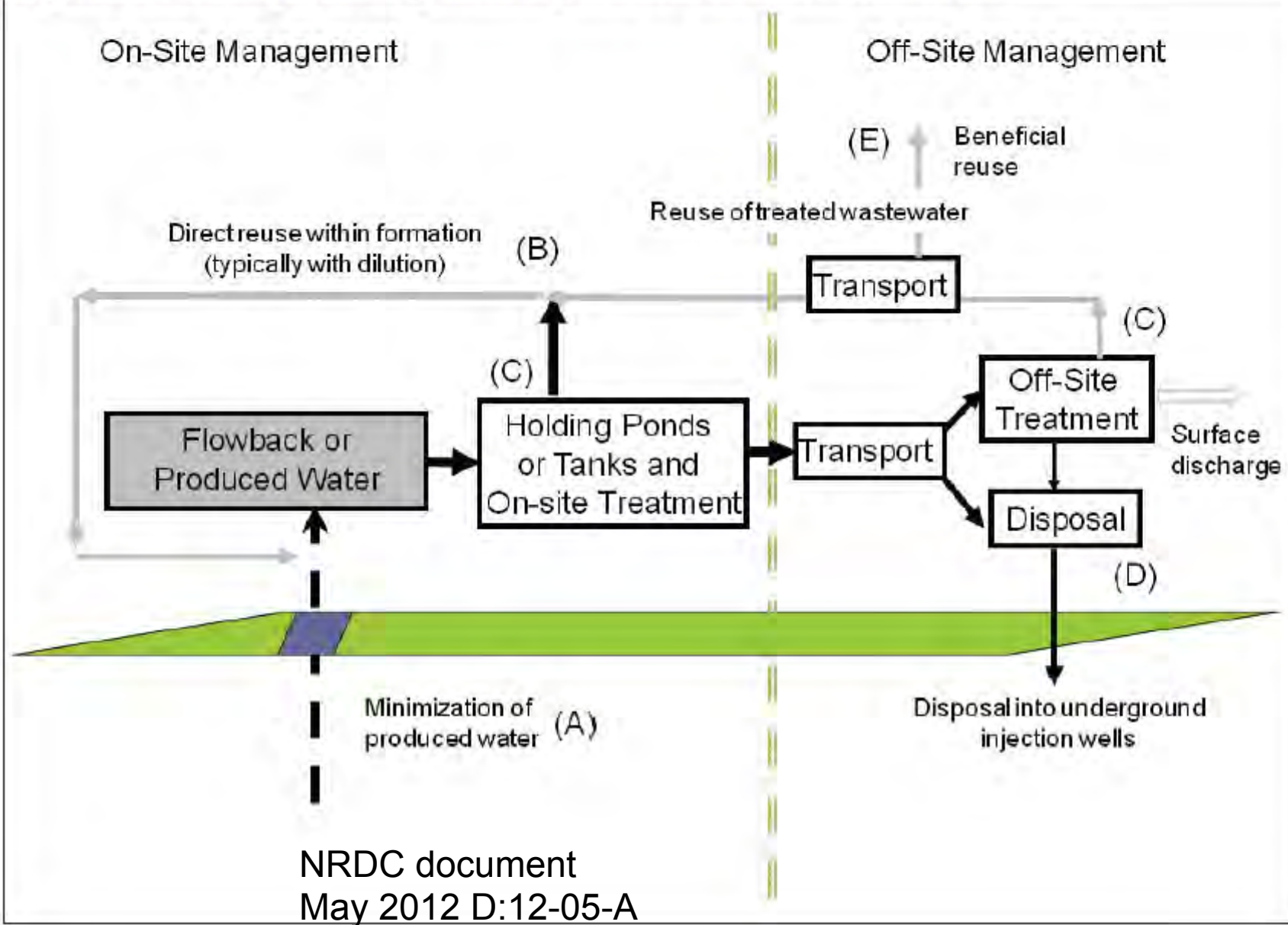


Figure 1. Summary of Management Options for Shale Gas Wastewater



NRDC document
May 2012 D:12-05-A

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

IN THE MATTER OF:

Chesapeake Appalachia, LLC	:	Violations of The Oil and Gas Act,
Tuscarora, Terry, Monroe, Towanda,	:	and The Clean Streams Law
and Wilmot Townships	:	
Bradford County	:	

CONSENT ORDER AND AGREEMENT

This Consent Order and Agreement is entered into this 16th day of May, 2011, by and between the Commonwealth of Pennsylvania, Department of Environmental Protection (hereinafter "Department"), and Chesapeake Appalachia, LLC (hereinafter "Chesapeake").

The Department has found and determined the following:

A. The Department is the agency with the duty and authority to administer and enforce the Oil and Gas Act, Act of December 19, 1984, P.L. 1140, as amended, 58 P.S. §§ 601.101-601.605 ("Oil and Gas Act"); The Clean Streams Law, Act of June 22, 1937, P.L. 1987, as amended, 35 P.S. §§ 691.1-691.1001 ("Clean Streams Law"); Section 1917-A of the Administrative Code of 1929, Act of April 9, 1929, P.L. 177, as amended, 71 P.S. §§ 510-17 ("Administrative Code"); and the rules and regulations promulgated thereunder (hereinafter "Regulations").

B. Chesapeake Appalachia, LLC (hereinafter "Chesapeake") is an Oklahoma Limited Liability Company authorized to do business in Pennsylvania which maintains a business address of P.O. Box 18496, Oklahoma City, OK 73154-0496.

C. Chesapeake constitutes a “person” as that term is defined by Section 103 of the Oil and Gas Act, 58 P.S. § 601.103, and by Section 1 of the Clean Streams Law, 35 P.S. § 691.1.

D. Chesapeake is the “owner” and “operator,” as those terms are defined by Section 103 of the Oil and Gas Act, 58 P.S. §601.103, of certain gas wells within the areas defined by the Department as follows: the _____ area of Towanda Township, Bradford County (hereinafter “_____ Area”); the _____ area in Tuscarora Township, Bradford County (hereinafter “_____ Area”); the Paradise Road area of Terry Township, Bradford County (hereinafter “Paradise Road Area”); the _____ area in Monroe Township, Bradford County (hereinafter “_____ Area”); the Sugar Run area of Wilmot Township, Bradford County (hereinafter “Sugar Run Area”); the Spring Hill Road area of Tuscarora Township, Bradford County (hereinafter “Spring Hill Road Area”); and the _____ residence. Maps of the _____ Area, _____ Area, Paradise Road Area, _____ Area, Sugar Run Area, Spring Hill Road Area, and _____ Area, are attached as Exhibit A and incorporated herein.

Area

E. In February of 2010, _____ contacted Chesapeake to complain about his water supply well producing black water and “churning.”

F. Chesapeake responded and provided _____ with temporary replacement water.

G. On February 26, 2010, Chesapeake contacted the Department about the water well and the actions Chesapeake intended to take in response to _____ complaint.

H. The Department reviewed Chesapeake’s planned tasks and asked that additional measures be taken, including on-site gas screening of residences, low lying areas, and springs/streams; and that the annulus pressures at the Miller, Farr and Kent well pads be checked.

I. Chesapeake carried out the additional measures requested by the Department.

J. On March 1, 2010, informed Chesapeake that a pond on his property was bubbling.

K. On March 3, 2010, Chesapeake installed a PVC riser pipe (vent stack) on the water well. An elevated concentration of methane was detected in the well headspace. Methane also was detected at low levels in the basement and upstairs of the residence.

L. On March 4, 2010, Chesapeake installed a methane monitor in the basement of the residence.

M. On March 24, 2010, a second landowner, , contacted Chesapeake about problems with his water well. Chesapeake responded and notified the Department.

N. Chesapeake installed methane monitoring equipment in a total of five residential locations in the area.

O. On March 29, 2010, with the approval of the Department, Chesapeake began remedial work at the Miller gas wells.

P. On April 13, 2010, the Department issued Chesapeake a Notice of Violation for the failure to prevent the migration of gas into sources of fresh groundwater and for defective casing or cementing of the Miller gas wells.

Q. By approximately April 20, 2010, visible water disturbance had subsided in the pond. Chesapeake drilled a new water well for the residence in May, 2010.

Area

R. On June 25, 2010, the Department received a complaint of bubbling in a beaver pond in Tuscarora Township, Bradford County.

S. The nearest gas wells to the beaver pond are operated by Chesapeake. Chesapeake's Siverson well pad is 1,700 feet from the pond and Chesapeake's Mowry 2 well pad is 3,600 feet from the beaver pond.

T. The Department notified Chesapeake of this complaint on June 30, 2010 and Chesapeake initiated an investigation.

U. On July 26, 2010, Chesapeake provided the Department with a summary of its investigation relating to the Sivers well pad, including an isotopic analysis of the gas emitted from the beaver pond and of gas found in the annular space of the surface casing of Chesapeake's wells on three surrounding pads. A plan of action was also submitted that called for modifying the wellbore construction, particularly with respect to cementing; additional testing; and implementing a 3-string casing design.

V. On August 6, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and failure to prevent the migration of gas into sources of fresh groundwater for the Sivers area.

W. On August 7, 2010, Chesapeake instituted a monitoring plan which included inspections of the beaver pond, private residences, and gas wells in the Sivers area.

X. Gas emitted from the beaver pond had similar characteristics to gas found in the annular space of the surface casing of Chesapeake's Mowry 2 gas well.

Y. Bubbling at the beaver pond continued from June 25, 2010, in diminishing amounts, to August 26, 2010.

Z. Chesapeake completed remedial work on their nearby gas wells between August 18, 2010, and August 30, 2010.

AA. Since August 26, 2010 to the present, no bubbling has been observed at the beaver pond.

Paradise Road Area

AB. On July 13, 2010, the Department became aware of water supply complaints by _____ and _____, who reside on Paradise Road, Terry Township, Bradford County.

AC. On July 15, 2010, the Department investigated the complaints and collected groundwater samples at the _____ residences.

AD. On July 21, 2010, the Department became aware of a water supply complaint by _____ also on Paradise Road, Terry Township, Bradford County. The Department investigated and collected samples of the _____ well on the same day.

AE. On August 2 and 3, 2010, Chesapeake collected water samples and installed methane alarm systems at the _____ residences.

AF. On August 6, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and failure to prevent the migration of gas into sources of fresh groundwater for the Paradise Road Area.

AG. Chesapeake has provided temporary replacement water, installed water well vent stacks, drilled replacement wells, and installed water treatment systems at the _____ residences.

AH. Isotopic analyses of gas from a residence and water wells in the Paradise Road Area indicate that the gas at the homes is not microbial in origin and is consistent with isotopic analyses of gas found in the annular space of surface casing of Chesapeake's Welles gas wells.

Area

AI. On August 4, 2010, Chesapeake responded to a landowner complaint of possible methane intrusion in a water supply at a home on Brockton Road, Monroe Township, Bradford

County. Chesapeake responded and, that same day, notified the Department that methane was detected in three private water supplies and one home along Brockton Road.

AJ. On August 6, 2010, the Department confirmed the presence of methane in the headspace of the three home water wells along Brockton Road.

AK. On August 6, 2010, Chesapeake instituted a monitoring plan of certain residences in the area of Chesapeake's Dan Ellis well pad, which is located approximately 4,700 feet to the South.

AL. On August 6, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and the failure to prevent the migration of gas into sources of fresh groundwater for the Dan Ellis area.

Sugar Run Area

AM. On September 2, 2010, the Department received information of bubbling in the Susquehanna River near the community of Sugar Run, in Wilmot Township, Bradford County.

AN. On September 3, 2010, the Department inspected the Sugar Run Area and found gas bubbling at numerous locations in the Susquehanna River. A sample of the gas was collected and sent to an independent laboratory to be analyzed. In addition, the Department inspected numerous residential dwellings in the Sugar Run Area and found methane in several water supply wells.

AO. On September 3, 2010, Chesapeake began screening the locations of bubbling in the river, certain residential water wells, and soils in the Sugar Run Area.

AP. On September 7, 2010, the Department collected water samples from the potentially impacted water wells in the Sugar Run Area.

AQ. Chesapeake installed vent stacks on water supply wells at residences in the Sugar Run Area owned or occupied by

and . Chesapeake also provided temporary replacement water for

AR. On September 9, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and the failure to prevent the migration of gas into sources of fresh groundwater for the Sugar Run Area.

Spring Hill Road Area

AS. On September 16, 2010, Chesapeake notified the Department that methane gas was detected in a water supply located along Spring Hill Road in Tuscarora Township, Bradford County.

AT. The nearest drilled Marcellus well, Chesapeake's Champdale well, is approximately 880 feet from the water supply referenced in paragraph AT, above.

AU. On September 24, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and the failure to prevent the migration of gas into sources of fresh groundwater for the Spring Hill Road Area, and for defective casing or cementing of the Champdale/Champluvier gas wells.

Residence

AV. On or about June 24, 2010, contacted Chesapeake with a complaint about their water at in Granville Township, Bradford County. Chesapeake initiated an investigation and determined that an elevated concentration of methane gas was present in the well headspace.

AW. A water sample collected from the water supply on June 26, 2010, indicated an elevated level of methane.

AX. On July 8, 2011, filed a complaint with the Department alleging her water supply had been impacted by gas drilling activity.

AY. On July 14, 2010, methane was detected in the headspace of the water well.

AZ. On September 15, 2010, the Department issued Chesapeake a Notice of Violation for the unpermitted discharge of polluting substances and the failure to prevent the migration of gas into sources of fresh groundwater.

Additional Investigations

AAA. Since August of 2010, the Department has inspected various Chesapeake gas wells in the Sivers, Dan Ellis, Paradise Road, Sugar Run, and Spring Hill Road Areas. As a follow-up and precaution, Chesapeake has perforated and squeezed additional cement behind the casing in a number of its gas wells in the subject areas.

AAB. In the course of its investigation, the Department has collected water samples from drinking water wells at residences in the Paradise Road, Dan Ellis, Sugar Run, and Spring Hill Road Areas. The Department also has collected isotopic gas samples to compare the gas from various gas wells drilled by Chesapeake to gas from various locations.

Determination of Discharge of Natural Gas into the Groundwater

AAC. Chesapeake has caused or allowed the unpermitted discharge of natural gas, a polluting substance, into the groundwater, which constitutes a “water of the Commonwealth” as that term is defined in 35 P.S. §691.1, in violation of Section 401 of the Clean Streams Law, 35 P.S. §691.401.

AAD. As of the date of this Consent Order and Agreement, Chesapeake has taken certain actions approved by the Department to prevent the ongoing, unpermitted discharge of natural gas into the waters of the Commonwealth.

Determination of Gas Migration Violations

AAE. Chesapeake failed to properly case and cement the gas wells and to prevent the migration of gas into sources of fresh groundwater in violation 25 Pa. Code §§ 78.73(a), 78.81(a), and 78.86, as in effect prior to February 5, 2011.

AAF. The violations described in Paragraphs AAC through AAE, above constitute unlawful conduct under the laws and regulations administered by the Department, including Section 509, of the Oil and Gas Act, 58 P.S. § 601.509 and Section 611 of the Clean Streams Law, 35 P.S. § 691.611; constitute a public nuisance under Section 502 of the Oil and Gas Act, 58 P.S. § 601, and Section 401 of the Clean Streams Law, 35 P.S. § 691.401; require restoration or replacement of certain water supplies pursuant to Section 208 of the Oil and Gas Act, 58 P.S. § 601.208 and 25 Pa. Code § 78.51; and subject Chesapeake to civil penalty liability under Section 506, of the Oil and Gas Act, 58 P.S. § 601.506 and Section 605 of the Clean Streams Law, 35 P.S. §§ 691.605.

Order

After full and complete negotiation of all matters set forth in this Consent Order and Agreement, and upon mutual exchange of the covenants contained herein, the parties desiring to avoid litigation and intending to be legally bound, it is hereby ORDERED by the Department and AGREED to by Chesapeake as follows:

1. **Authority.** This Consent Order and Agreement is an Order of the Department authorized and issued pursuant to Section 503, of the Oil and Gas Act, 58 P.S. § 601.503; Section 5 of the Clean Streams Law, 35 P.S. § 691.5; and Section 1917-A of the Administrative Code, supra.

2. Findings.

a. Chesapeake agrees that the findings in Paragraphs A through AAB above are true and correct and, in any matter or proceeding involving Chesapeake and the Department, Chesapeake shall not challenge the accuracy or validity of these findings.

b. The parties do not authorize any other persons to use the findings in this Consent Order and Agreement in any matter or proceeding.

c. Chesapeake disagrees with the determinations stated in Paragraphs AAC through AAF above.

3. Corrective Actions.

a. Within fourteen (14) days after the date of this Consent Order and Agreement, Chesapeake shall submit to the Department, for review and approval, a plan which:

1) includes a list of all gas wells drilled by or on behalf of Chesapeake in the areas depicted on Exhibit A and identifies the number of casings used in each well and the depth to which the strings of casing are set;

2) includes the defined logging protocol (hereinafter "wellbore evaluations") which Chesapeake shall employ to evaluate the integrity of wells appearing on the list submitted pursuant to Paragraph 3.a.1), identification of a hierarchy of the wells that will be so evaluated, and an explanation of the rationale for selecting the hierarchy of such wells, above;

3) includes an implementation schedule not to exceed six (6) months which sets forth, at a minimum, the date on which Chesapeake shall commence the wellbore evaluation on the wells identified for evaluation pursuant to Paragraph 3.a.2), above; and

4) identifies the actions Chesapeake shall take to analyze each and every gas well identified for evaluation pursuant to Paragraph 3.a.2), above, and recommendations for the rehabilitation work necessary to control and mitigate shut-in surface casing pressure and stray gas from those wells;

b. Within five (5) days of approval by the Department, Chesapeake shall implement the plan submitted pursuant to Paragraph 3.a., above, as approved by the Department;

c. Within seven (7) days of the date of the approval of the plan submitted pursuant to Paragraph 3.a, above, Chesapeake shall begin pressure testing of each accessible annuli on each of the gas wells identified for evaluation pursuant to Paragraph 3.a.2), above. Chesapeake shall pressure test each annuli for forty-eight (48) consecutive hours, and shall provide the test results for each tested well within five (5) days of completion of the pressure test on each respective well. At least twenty-four (24) hours before Chesapeake begins pressure testing in accordance with this Paragraph, Chesapeake shall provide the Department written notice of the gas well to be tested, and the date and approximate time that Chesapeake shall begin such pressure test.

d. Within sixty (60) days of the date of the approval of the plan submitted pursuant to Paragraph 3.a, above, in all cases Chesapeake shall have completed the 48-hour pressure test of the annuli on all of the gas wells identified pursuant to Paragraph 3.a.2), above, and shall provide the Department with the results of the pressure tests for all of those wells.

e. Every other Monday following the approval of the plan submitted pursuant to Paragraph 3.a., above, Chesapeake shall submit a report containing the following information for each well identified pursuant to Paragraph 3.a.2):

1) the status of the work at each well (i.e., 'Deemed Finished,' 'In Progress,' or 'Scheduled');

2) Chesapeake's analysis of each well's logs and recommended actions to be taken based on all of the information available to Chesapeake.

3) For wells In Progress:

i. the date logged; date or dates on which cement was squeezed; depth of squeezes; date and time the 48-hour casing pressure build-up test was started, supported by information in the form of a chart or digital recording;

ii. a daily well work activity summary, separate from any monitoring report, that includes a brief description of that work and of the wellhead's status; and

iii. Chesapeake's daily completion reports, including all of the days of work on each well.

f. Chesapeake's obligation to submit the weekly reports required in Paragraph 3.e. shall terminate when the Department determines in writing that Chesapeake has eliminated the unpermitted discharge of natural gas into the waters of the Commonwealth from any well owned and/or operated by Chesapeake within the areas of Bradford County identified in Paragraph D, above, in this Consent Order and Agreement.

4. **Specifications of New Wells.** All gas wells drilled by or on behalf of Chesapeake in the areas identified in Paragraph D, above on or after the date of this Consent Order and Agreement shall be cased and cemented in a manner consistent with the specifications and practices described in Exhibit D unless, based on conditions observed in advance of or at the time of drilling, Chesapeake determines that alternate specifications or practices are warranted.

In the event that Chesapeake determines that alternate specifications or practices are warranted, Chesapeake shall notify the Department of the alternate specifications or practices utilized.

5. **Installation of Pressure Gauges.** Within ninety (90) days after the date of this Consent Order and Agreement, Chesapeake shall install pressure gauges on all existing wells within the areas described in Paragraph D, above, at the surface and intermediate casing ports in a manner allowing pressures to be inspected at any time by the Department. Chesapeake shall install such gauges on all wells drilled by or on behalf of Chesapeake within the areas described in Paragraph D, above, on or after the date of this Consent Order and Agreement.

6. **Reporting Water Supply Complaints.** Attached as Exhibit B is a Protocol For Reporting Water Supply Complaints identifying (i) the procedures Chesapeake shall implement within the areas identified in Paragraph D, above, to report to the Department water supply complaints within twenty four (24) hours after Chesapeake receives any such complaint, in accordance with 25 Pa. Code § 78.51(h) (effective February 5, 2011); (ii) the actions Chesapeake shall take to investigate any such complaint; (iii) the information to be reported to the Department based on such investigation; and (iv) the timing and form of such reports. Chesapeake shall implement the plan for any future complaint within the areas identified in Paragraph D, above.

7. **Remediation of Water Supplies.**

a. Beginning upon execution of this Consent Order and Agreement, with respect to the water supplies listed on Exhibit C, Chesapeake shall:

- 1) at least once every two weeks, screen the well at each water supply listed in Exhibit C for percentage of free combustible gas, and sample the well at each of those water supplies, provided the landowner consents to such screening and sampling;

2) for each water sample collected at a water supply listed in Exhibit C, Chesapeake shall have the water sample analyzed in a Pennsylvania-accredited laboratory for dissolved methane, dissolved ethane, and dissolved propane;

3) Chesapeake shall continue to conduct the screening and sampling under Paragraph 7.a.1), above, once every two weeks at each water supply listed in Exhibit C, provided the landowner consents, until the results of the screenings and sampling done by the Department or by Chesapeake under Paragraph 7.a.1), above, show (A) that either no combustible free gas is present at the water supply's wellhead, or, that such levels of combustible free gas, if properly vented pursuant to applicable regulations and Department practice, do not pose a danger to persons or property *and* (B) that the concentration of dissolved methane is below 7 milligrams/liter. However, Chesapeake may petition the Department, based on information obtained in accordance with this Paragraph for a determination that the concentration of methane in the water supply is at background levels for the aquifer that supplies the water supply. Chesapeake may further petition the Department for a determination that the concentration of combustible free gas at the wellhead is at levels that do not present a danger to persons or property if properly vented according to applicable regulations and Department practice;

4) for each water supply that meets the standards under Paragraph 7.a.3), above, or for which a plan has been submitted and approved pursuant to Paragraph 7.b and 7.c, Chesapeake shall continue to screen each such water supply for free combustible gas and shall sample each such water supply at least once per quarter, and shall have the water sample analyzed in a Pennsylvania-

accredited laboratory for the parameters listed in Exhibit E, provided the landowner consents to such screening and sampling; and

5) unless the Department determines that the concentration of methane in the water supply is at background levels for the aquifer that supplies the water supply, Chesapeake shall continue such screenings and sampling under paragraph 7.a.4), above, for each quarter until the results of the screenings and sampling done by the Department and by Chesapeake under this Paragraph 7 show that, for eight consecutive quarters, seventy-five percent (75%) of the water samples within each monitoring point over time contain seven (7) milligrams per liter or less of dissolved methane (or meets the standard then prescribed by applicable regulations), and no individual water sample exceeds two times this standard.

b. If after 60 days beyond the date of this Consent Order and Agreement, the dissolved methane is equal to or greater than 7 mg/l, or the measured free gas in the headspace is greater than 25% of the L.E.L., then Chesapeake shall submit to the Department for review and approval a plan and schedule to address each water supply listed on Exhibit C, including such remedial actions as Chesapeake may already have implemented. The quality of a restored or replaced water supply will be deemed adequate if it meets the standards established under the Pennsylvania Safe Drinking Water Act (35 P.S. §§ 721.1—721.17), or is comparable to the quality of the water supply before it was affected if that water supply did not meet these standards. Despite the filing of such a plan, Chesapeake shall remain obligated to monitor and screen such water supplies as required by this Paragraph 7.

c. Within fourteen (14) days of the Department's approval of any plan submitted pursuant to Paragraph 7.b., above, Chesapeake shall fully implement that plan as approved by the Department, subject to any determination by the Department that the concentration of methane in the water supply is at background or otherwise acceptable levels for the aquifer that supplies the water supply and the concentration of combustible free gas at the wellhead is at levels that do not present a danger to persons or property if properly vented according to applicable regulations and Department practice.

d. In the event that the owner of a residence identified in Exhibit C does not allow Chesapeake to fully implement the plan approved by the Department pursuant to Paragraph 7.d., above, then for each such residence Chesapeake shall establish an escrow account, or a common account for all such residences, in an amount approved by the Department to be used for the exclusive purpose of funding all of the expenses associated with providing either a treatment system or a replacement permanent water supply to the residence(s).

e. Chesapeake shall be responsible for paying any fees, charges, or taxes associated with every required escrow account or any common account.

f. Chesapeake shall maintain each escrow account, or the common account, until such time as the occupants of the residence(s) for which the account has been established notify Chesapeake in writing that installation of a treatment system or a replacement permanent water supply either has occurred at the residence owner's expense, or the funds in the escrow account may be used to install a permanent water supply at the residence.

g. Within thirty (30) days of the Department's receipt of notice that the funds in an escrow account may be used to install a treatment system or a replacement

permanent water supply at a residence, Chesapeake shall make all necessary arrangements with any necessary vendors or contractors for the purchase and installation of a treatment system or replacement permanent water supply at the residence at issue. Chesapeake shall provide copies of the paid invoice(s) from the vendors or contractors to the Department.

h. Within fourteen (14) days of receiving the paid invoice(s) for the purchase and installation of the treatment system or replacement permanent water supply, the Department shall draw on the appropriate escrow account, or the common account, in the amount necessary to reimburse Chesapeake for the payments to the vendors or contractors for such.

i. Following the purchase and installation of any system or water supply using funds drawn against an escrow account, Chesapeake shall maintain the escrow account to secure the long term operation and maintenance expenses of such systems or supply.

j. In the absence of any notification referenced in Paragraph 7.g., Chesapeake shall maintain each escrow account, or the common account, until such time as other arrangements for disposition of the escrow account are made by the Department.

8. **Sampling Protocol.** All water samples gathered and analyzed by or on behalf of Chesapeake, and submitted to the Department pursuant to this Consent Order and Agreement, shall be collected in accordance with the following protocol, or other method approved by the Department:

After purging the well, fill the 5 gallon bucket with water. Attach a nozzle and 12" length of ¼ inch diameter tubing to the end of the 5/8 inch hose connected to a faucet. Make sure that the flow rates through the tubing are low. Remove the cap of the 1 L bottle (or vial) and fill it

with water. Once the bottle filled, immerse it in the 5 gallon bucket full of water, keeping the tubing at the bottom of the bottle. Place the bottle at the bottom of the bucket under a head of water, and keep water flowing at a low rate until another 2 volumes of water have been displaced from the bottle. Then slowly lift the tubing out of the bottle and immediately cap it under water. No air should be allowed into the 1 L bottle. When finished, tape the cap to the bottle around the neck, pack the bottle upside down in ice, and ship it overnight.

9. **Submission of Documents.** With regard to any document that Chesapeake is required to submit pursuant to this Consent Order and Agreement, the Department will review Chesapeake's document and will approve, modify or disapprove the document, or a portion thereof, in writing. If the document, or any portion of the document, is found to be deficient by the Department, within 14 days of receipt of the deficiencies, Chesapeake shall submit a revised document to the Department that addresses the Department's concerns. The Department will approve, modify or disapprove the revised document in writing. Upon approval by the Department, the document, and any schedule therein, shall become a part of this Consent Order and Agreement for all purposes and shall be enforceable as such.

10. **Civil Penalty Settlement.** In settlement of any claim for civil penalties which the Department is authorized to pursue under law, including Section 506 of the Oil and Gas Act, 58 P.S. § 601.506, and Section 605 of the Clean Streams Law, 35 P.S. §§ 691.605, the Department hereby assesses a civil penalty of Seven Hundred Thousand Dollars (\$700,000) for the violations set forth in the Findings, above. The payment shall be made by corporate check or the like, made payable to the "Commonwealth of Pennsylvania," and forwarded to the Department pursuant to Paragraph 17, below, or by an alternate method approved by the Department, within five days of execution of the Consent Order and Agreement.

11. **Donation to Well Plugging Fund.** Chesapeake agrees to donate Two Hundred Thousand Dollars (\$200,000) to the Department's Well Plugging Fund. Chesapeake shall make such payment in the manner described in Paragraph 10, within five days of execution of the Consent Order and Agreement.

12. **Stipulated Civil Penalties.**

a. **If Chesapeake fails to comply with any provision of this Consent Order and Agreement, Chesapeake shall be in violation of this Consent Order and Agreement and, in addition to other applicable remedies, shall pay a civil penalty as follows:** If Chesapeake fails to comply with any obligation imposed upon it pursuant to this Consent Order and Agreement, Chesapeake shall be in violation of this Consent order and Agreement, and, in addition to other applicable remedies, shall pay a civil penalty in the amount of One Thousand Dollars (\$1000) per day for each day, or any portion thereof, that Chesapeake fails to comply with its obligation.

b. Stipulated civil penalties shall be due automatically without further notice on or before the 15th day of each succeeding month, shall be made by corporate check or the like made payable to "Commonwealth of Pennsylvania," and shall be sent to the Department at the address set forth in Paragraph 17, below.

c. Any payment under this Paragraph shall neither waive Chesapeake's duty to meet its obligations under this Consent Order and Agreement, nor preclude the Department from commencing an action to compel Chesapeake's compliance with the terms and conditions of this Consent Order and Agreement for which payment is made.

13. **Additional Remedies.**

a. In the event Chesapeake fails to comply with any provision of this Consent Order and Agreement, the Department may, in addition to the remedies

prescribed herein, pursue any remedy available for a violation of an order of the Department.

b. The remedies provided by this paragraph and Paragraph 12 (Stipulated Civil Penalties) are cumulative and the exercise of one does not preclude the exercise of any other. The failure of the Department to pursue any remedy shall not be deemed to be a waiver of that remedy. The payment of a stipulated civil penalty, however, shall preclude any further assessment of civil penalties for the violation for which the stipulated civil penalty is paid.

14. **Reservation of Rights.** The Department reserves the right to require additional measures to achieve compliance with applicable law. Chesapeake reserves the right to challenge any action which the Department may take to require those measures.

15. **Liability of Chesapeake.** Chesapeake shall be liable for any violations of the Consent Order and Agreement, including those caused by, contributed to, or allowed by its officers, directors, agents, employees, contractors, successors, and assigns.

16. **Transfer of Gas Wells.**

a. Chesapeake's duties and obligations under this Consent Order and Agreement shall not be modified, diminished, terminated or otherwise altered by the transfer of any legal or equitable interest in any of the gas wells identified on the list submitted pursuant to paragraph 3.a.1), above, or any other Chesapeake gas wells covered hereby.

b. If before the termination of this Consent Order and Agreement, Chesapeake intends to transfer any legal or equitable interest in any of the gas wells on the list submitted pursuant to paragraph 3.a.1), above, Chesapeake shall provide a copy of this Consent Order and Agreement to the prospective transferee at least thirty (30) days

prior to the contemplated transfer and shall simultaneously inform the Department of such intent at the address set forth in Paragraph 17, below.

c. The Department, in its discretion, may agree to modify or terminate Chesapeake's duties and obligations under this Consent Order and Agreement and may agree to a transfer upon determination that Chesapeake is in full compliance with this Consent Order and Agreement, including payment of any stipulated penalties owed, and upon the transferee entering into a Consent Order and Agreement with the Department concerning the gas wells at issue. Chesapeake agrees to waive any right that it may have to challenge the department's decision in this regard.

17. **Correspondence with Department.** All correspondence with the Department concerning this Consent Order and Agreement shall be addressed to:

Jennifer W. Means
Environmental Program Manager
Eastern Region Oil and Gas Management
Department of Environmental Protection
208 West Third Street – Suite 101
Williamsport, PA 17701-6448
Phone (business hours): (570) 321-6557
Phone (non-business hours): (570)327-3636
e-Mail: jenmeans@state.pa.us

18. **Correspondence with Chesapeake.** All correspondence with Chesapeake concerning this Consent Order and Agreement shall be addressed to:

Tal Oden
Regulatory Manager North, East Division
Chesapeake Energy Corporation
P.O. Box 18496
Oklahoma City, OK 73154
Phone: (405) 935-4073
e-Mail: tal.oden@chk.com

Chesapeake shall notify the Department whenever there is a change in the contact person's name, title, or address. Service of any notice or any legal process for any purpose under this

Consent Order and Agreement, including its enforcement, may be made by mailing a copy by first class mail to the above address.

19. **Severability.** The paragraphs of this Consent Order and Agreement shall be severable and should any part hereof be declared invalid or unenforceable, the remainder shall continue in full force and effect between the parties.

20. **Entire Agreement.** This Consent Order and Agreement shall constitute the entire integrated agreement of the parties. No prior or contemporaneous communications or prior drafts shall be relevant or admissible for purposes of determining the meaning or intent of any provisions herein in any litigation or any other proceeding.

21. **Attorneys Fees.** The parties shall bear their respective attorney fees, expenses and other costs in the prosecution or defense of this matter or any related matters, arising prior to execution of this Consent Order and Agreement.

22. **Modifications.** No changes, additions, modifications, or amendments of this Consent Order and Agreement shall be effective unless they are set out in writing and signed by the parties hereto.

23. **Titles.** A title used at the beginning of any paragraph of this Consent Order and Agreement may be used to aid in the construction of that paragraph, but shall not be treated as controlling.

24. **Decisions under Consent Order and Agreement.** Except for Paragraph 16.c., above, any decision which the Department makes under the provisions of this Consent Order and Agreement, including a notice that stipulated civil penalties are due, is intended to be neither a final action under 25 Pa. Code § 1021.2, nor an adjudication under 2 Pa. C.S. § 101. Any objection which Chesapeake may have to the decision will be preserved until the Department enforces this Consent Order and Agreement.


25. **Termination.** Chesapeake's obligations, but not the Findings, of this Consent Order and Agreement shall terminate when the Department provides written notice that Chesapeake has completed all of the requirements of this Consent Order and Agreement, and has paid any outstanding stipulated civil penalties due under Paragraph 12, above.

26. **Execution of Agreement.** This Consent Order and Agreement may be signed in counterparts, each of which shall be deemed to be an original and all of which together shall constitute one and the same instrument. Facsimile signatures shall be valid and effective.

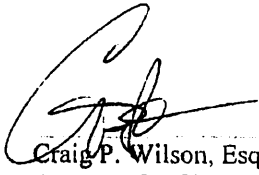
IN WITNESS WHEREOF, the parties hereto have caused this Consent Order and Agreement to be executed by their duly authorized representatives. The undersigned representatives of Chesapeake certify under penalty of law, as provided by 18 Pa. C.S. § 4904, that they are authorized to execute this Consent Order and Agreement on behalf of Chesapeake; that Chesapeake consents to the entry of this Consent Order and Agreement as a final Order of the Department; and that Chesapeake hereby knowingly waives its rights to appeal this Consent Order and Agreement and to challenge its content or validity, which rights may be available under Section 4 of the Environmental Hearing Board, the Act of July 13, 1988, P.L. 530, No. 1988-94, 35 P.S. § 7514; the Administrative Agency Law, 2 Pa. C.S. § 103(a) and Chapters 5A and 7A; or any other provision of law.

Signature by Chesapeake's attorney certifies only that the agreement has been signed after consulting with counsel.

FOR CHESAPEAKE APPALACHIA, L.L.C.:



John K. Reinhart
Vice President, Operations-Eastern Division

13 MAY 11
(Date)

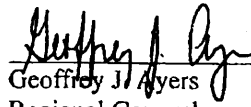

Craig P. Wilson, Esq.
Attorney for Chesapeake Appalachia, L.L.C.

5-13-11
(Date)

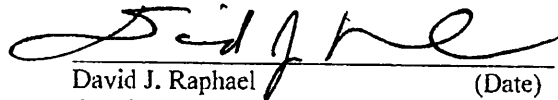
FOR THE COMMONWEALTH OF
PENNSYLVANIA, DEPARTMENT OF
ENVIRONMENTAL PROTECTION:


Jennifer W. Means
Environmental Program Manager
East Region Oil & Gas Management

5/13/11
(Date)


Geoffrey J. Ayers
Regional Counsel
Northcentral Region

5/13/2011
(Date)


David J. Raphael
Chief Counsel
Department of Environmental Protection

5/16/11
(Date)

Exhibit A

Maps of:

Miller/ Area

Sivers Area

Paradise Road Area

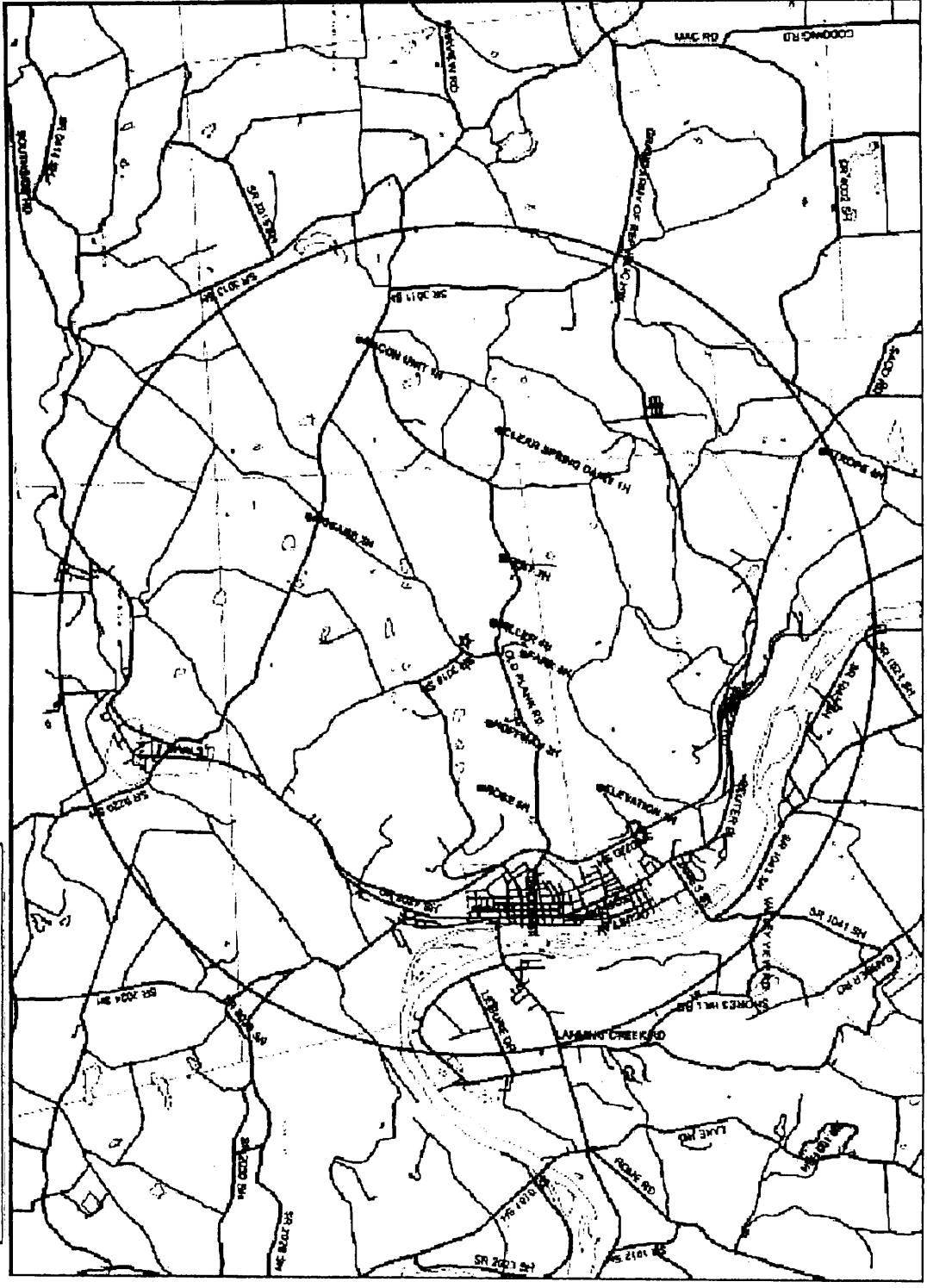
Dan Ellis Area

Sugar Run Area

Spring Hill Area

Area

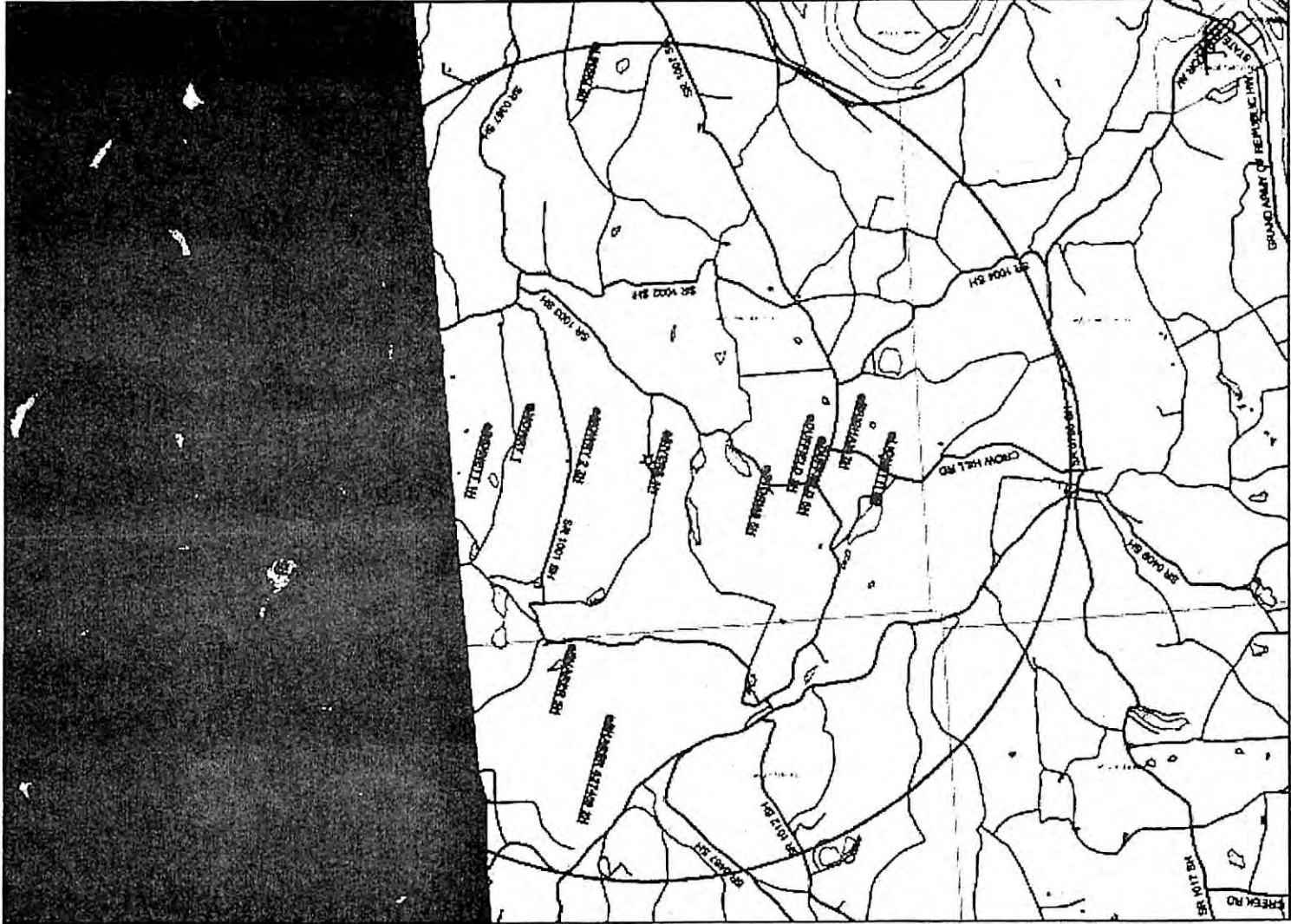
Miller / Stray Gas Area - 4 Mile Radius



- Permitted Oil and Gas Location
- * Miller
- Stray Gas

Permitted Oil and Gas Locations that contain multiple wells per location. Refer to attached table.

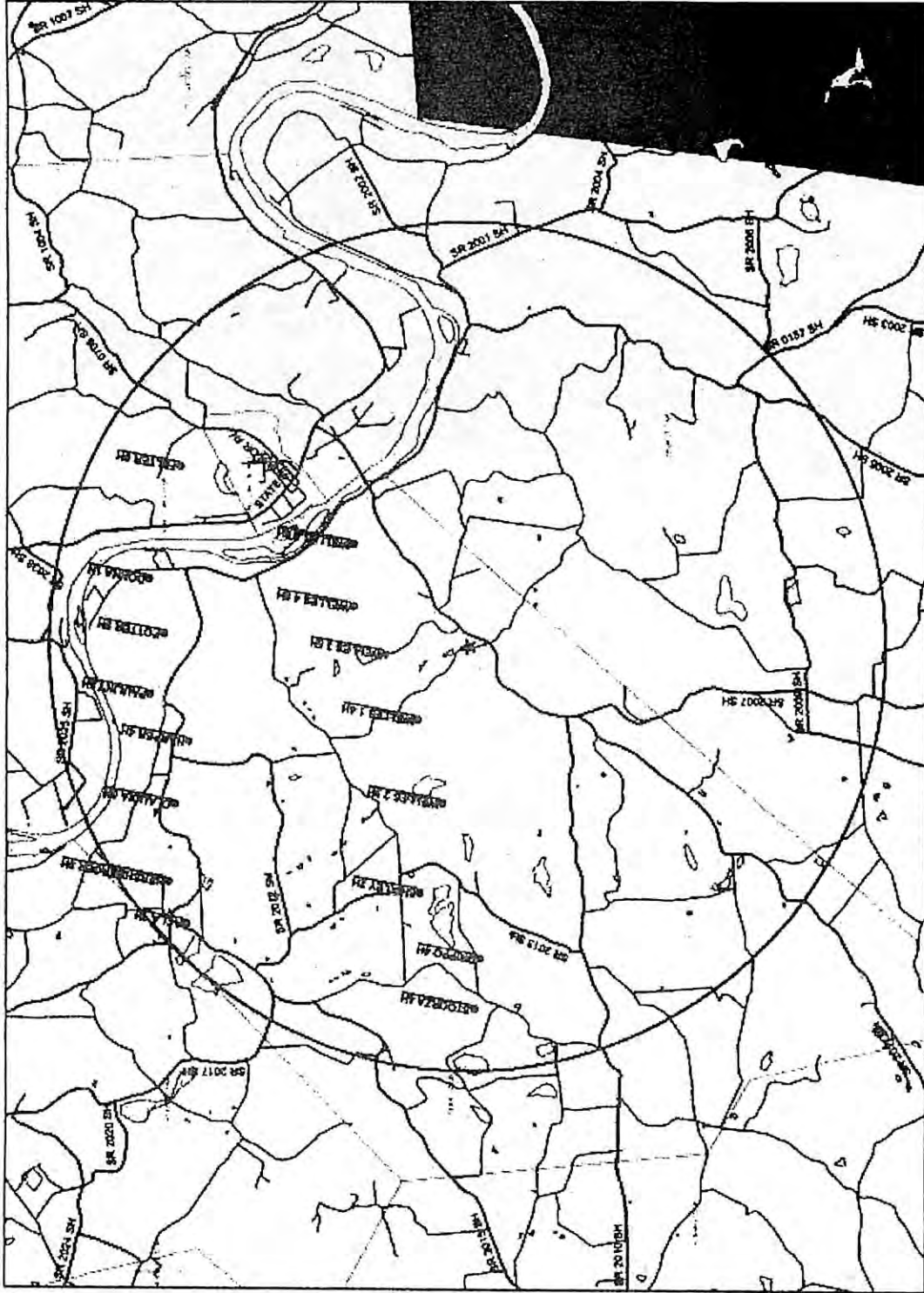
Sivers Beaver Pond Stray Gas Area - 4 Mile Radius



- ★ Sivers Beaver Pond Stray Gas
- Permitted Oil and Gas Wells

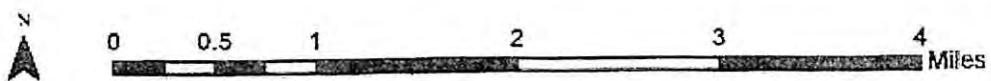
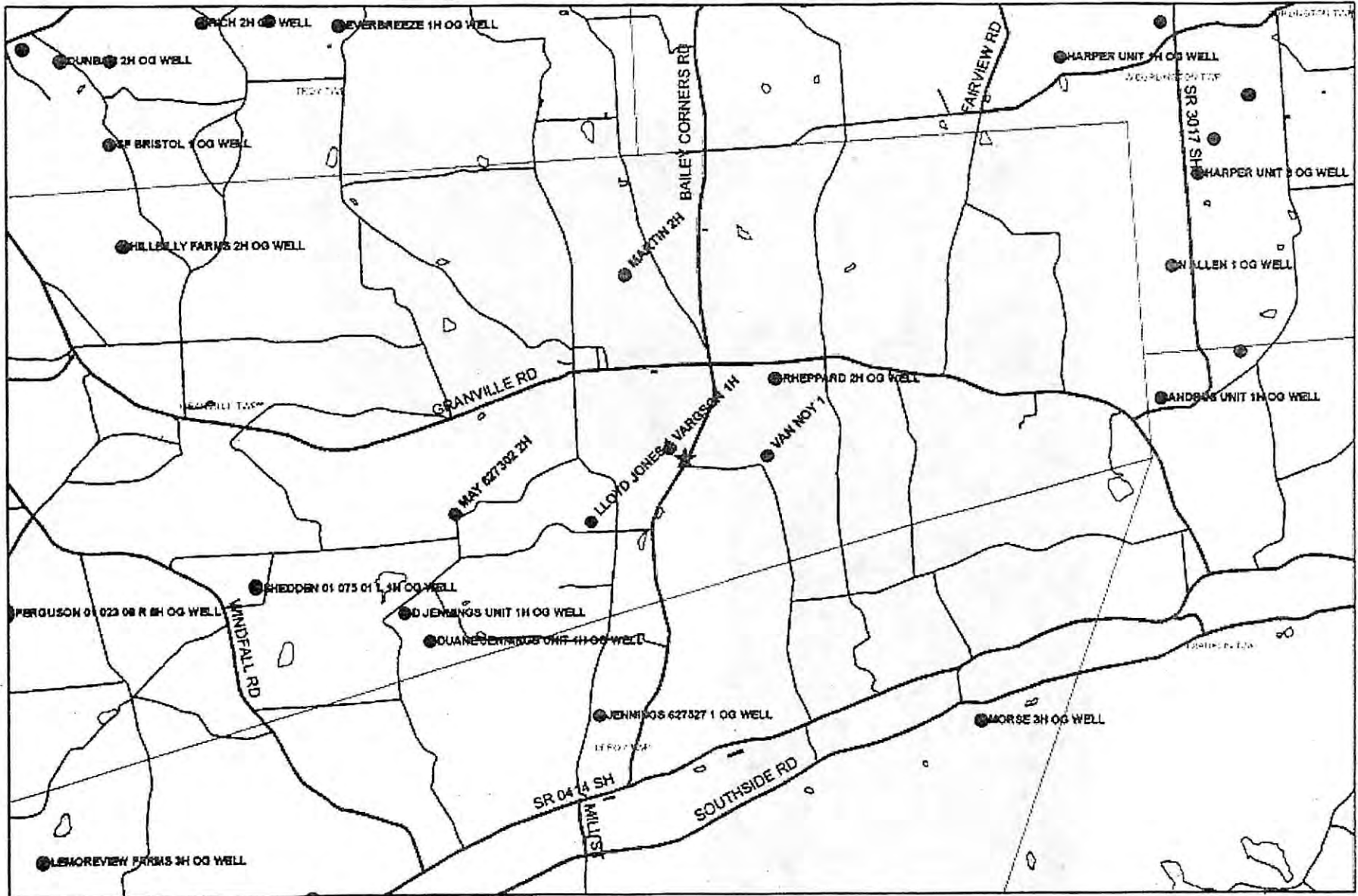
Permitted Oil and Gas Locations that contain multiple wells per location. Refer to attached table.

Paradise Rd Stray Gas Area - 4 Mile Radius



*Permitted Oil and Gas Locations that contain multiple wells per location. Refer to attached table

- Granville Twp., Bradford County



●	Investigated Gas Wells
●	Oil and Gas Well
★	Water Supply

EXHIBIT B

PROTOCOL FOR REPORTING WATER SUPPLY COMPLAINTS

(1) Reporting of water supply complaints – combustible gas detected = 10 % LEL

If combustible gas is detected inside a building or structure at a concentration equal to or greater than 10 % LEL, then (A) immediate notification shall be made to the Department, (B) a report shall be filed with the Department by phone and email within 24 hours after the interview with the complainant and field survey of the extent of natural gas, and (C) weekly reports shall be provided to the Department in accordance with (3) and (4) below.

(2) Investigating water supply complaints

All investigations of potential gas migration incidents shall be conducted in accordance with 25 Pa. Code § 78.89, or as subsequently prescribed by applicable regulation.

(3) Information to be reported to the Department

Weekly reports required by (1)(C) above shall include, in addition to what is required pursuant to 25 Pa. Code § 78.89, the following:

(A) The location and type of all gas monitoring equipment installed;

(B) Results of methane readings, if any, in tabular form and including % of methane by volume and % of LEL, from each potentially affected location (water wells, headspace, surface water);

(C) Results of water chemistry data from water well samples and surface water samples, when available, including the location of each sampling point; and

(D) An explanation of any corrective actions undertaken, including a description of any equipment installed.

The first weekly report submitted in connection with any investigation shall identify the nearest Chesapeake gas well and include the following well construction information: well depth, number of casings, length of each casing string, wellbore evaluation results, caliper logs, and cement returns.

The first weekly report submitted in connection with any investigation also shall identify the latitude and longitude and street address of each home, business, farm, water well, surface water body, and structure implicated by the complaint, and the owner or occupier of such.

(4) Timing and form of reports

Weekly reports required by (1)(C) above shall be submitted each Monday, beginning one week after the 24-hour report has been made to the Department in accordance with (1)(B) above. The obligation to submit weekly reports shall continue until a final report is submitted for the incident.

EXHIBIT C

List of Water Supplies

Determination letters pursuant to Section 208(b) of the Oil and Gas Act

Sugar Run

Sugar Run, PA	18846
Sugar Run, PA	18846
Sugar Run, PA	18846
Sugar Run, PA	18846
Sugar Run, PA	18846
Sugar Run, PA	18846
Gettysburg, PA	17325

Paradise Rd

Wyalusing, PA	18853
Wyalusing, PA	18853
Wyalusing, PA	18853

Brocktown/Dan Ellis

Monroeton, PA	18832
Monroeton, PA	18832
Monroeton, PA	18832

Springhill Rd

Laceyville, PA	18623
Laceyville, PA	18623

Vargson

Granville Summitt, PA	16926
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No determination letter

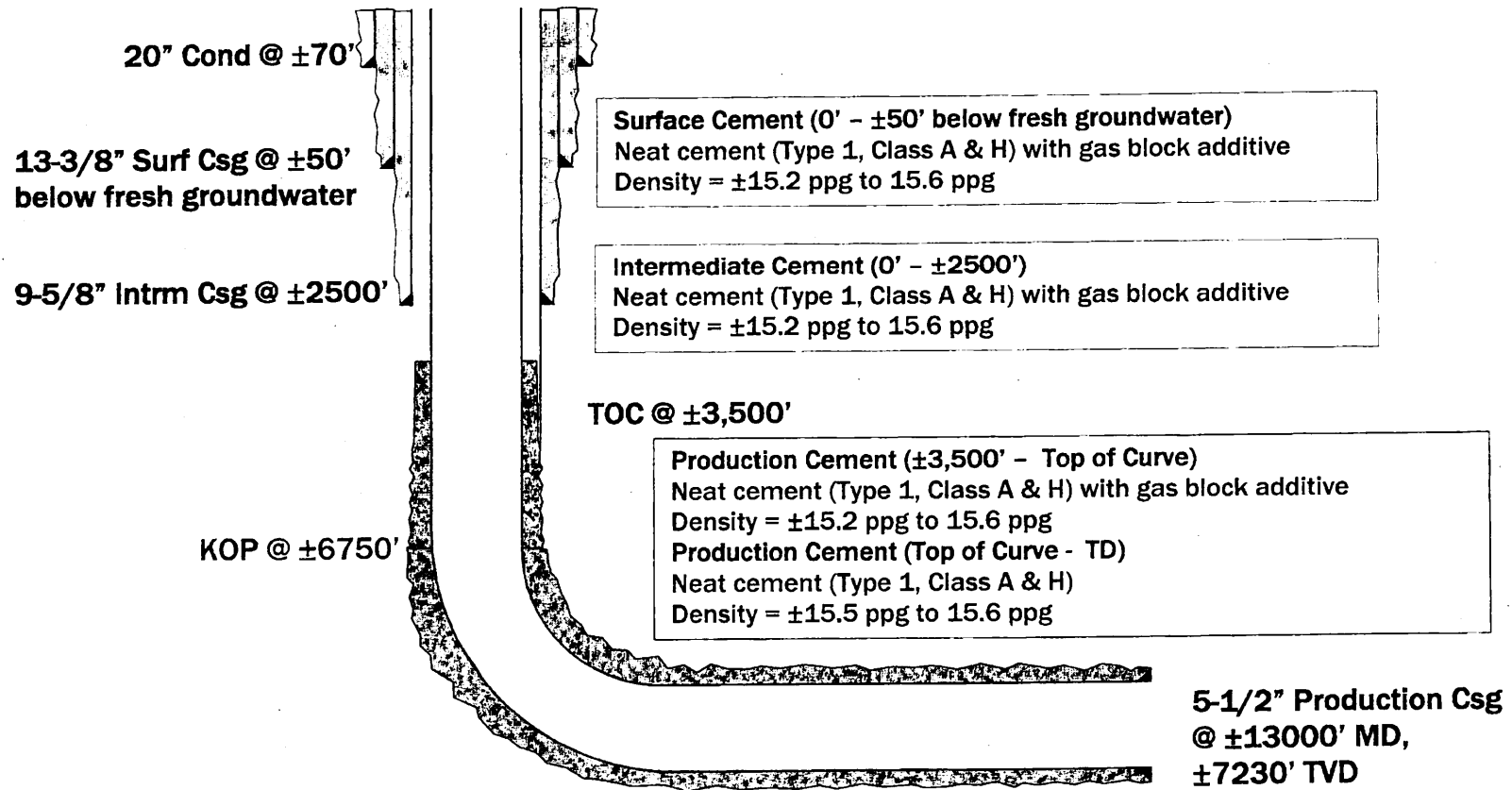
Sugar Run

Sugar Run, PA	18846
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EXHIBIT D

SPECIFICATIONS AND PRACTICES FOR CASING AND CEMENTING

Well Casing and Cement Illustration



Cementing Practices

Conductor

- 26" Hole to minimum depth of $\pm 70'$.
- 20" Conductor to be cemented with High Density Cement.
- Record all fresh ground water encountered in the Driller's Log Book.

Surface Section

- 17-1/2" hole to be drilled to minimum of $\pm 50'$ below base of fresh ground water. In the absence of other data, the depth of fresh ground water is determined primarily by using the known depths of surrounding water wells within a $\pm 2500'$ radius, and correcting for elevation differences.
- Record all fresh ground water encountered in the Driller's Log Book.
- Circulate and condition hole.
- Run new string of 13-3/8" surface casing.
- Run centralizers in the middle and top of the first joint, top of third joint, and every third to surface.
- Pump ± 35 bbls of gelled spacer, ± 100 bbls of fresh water, drop bottom plug.
- Pump High Density Cement with gas block additive.
- Drop top plug and displace with water at maximum rate.
- Record volume of cement to surface in the Driller's Log Book.
- Wait on cement for 8 hrs.
- Performing FIT to 15 ppg EMW on surface casing (squeeze shoe if less than 15 ppg EMW).

Cementing Practices (continued)

Intermediate Section

- 12-1/4" hole to be drilled to intermediate casing depth. Intermediate depth is typically at a minimum of $\pm 2000'$, but is well specific and is based on various data sources and geologic interpretation.
- Circulate and condition hole.
- Run new string of 9-5/8" intermediate casing.
- Run centralizers in the middle and top of the first joint, top of third joint, and every third to surface.
- Reciprocate casing throughout the cement job.
- Pump ± 35 bbls of gelled spacer, ± 100 bbls of fresh water, drop bottom plug.
- Pump High Density Cement with gas block additive.
- Drop top plug and displace with water at maximum rate.
- Record volume of cement to surface in the Driller's Log Book.
- Wait on cement for 8 hrs.
- Performing FIT to 16 ppg EMW on intermediate casing (squeeze shoe if less than 16 ppg EMW).

Cementing Practices (continued)

Production Section

- 8-3/4", 8-1/2", or 7-7/8" hole to be drilled to casing depth.
- Run new string of 5-1/2" production casing.
- Run centralizers at least from end of curve to TOC on every second joint.
- Prior to cementing, circulate at least three bottoms up annular volumes.
- If possible, reciprocate and rotate casing throughout the cement job.
- Pump minimum of ± 50 bbls of weighted chem wash at ± 14.0 ppg.
- Drop bottom plug.
- Pump High Density Cement with gas block additive from above curve to TOC.
- Drop top plug and displace with water at maximum rate.
- Wait on cement for 8 hrs and attempt to hold 250 psi on annulus.

EXHIBIT E

STANDARD ANALYSIS CODE 942 LIST OF PARAMETERS

SPECIFIC CONDUCTIVITY @ 25.0 C

pH, LAB (ELECTROMETRIC)

ALKALINITY TOTAL AS CaCO₃ (TITRIMETRIC)

TOTAL DISSOLVED SOLIDS (TDS)

HARDNESS TOTAL (Calculated)

CALCIUM, TOTAL BY TRACE ELEMENTS IN WATERS & WASTES

MAGNESIUM, TOTAL BY TRACE ELEMENTS IN WATERS &

SODIUM, TOTAL BY TRACE ELEMENTS IN WATERS & WASTES

POTASSIUM, TOTAL BY TRACE ELEMENTS IN WATERS &

CHLORIDE, TOTAL

BARIUM, TOTAL BY TRACE ELEMENTS IN WATERS & WASTES

IRON, TOTAL BY TRACE ELEMENTS IN WATERS & WASTES BY

MANGANESE, TOTAL BY TRACE ELEMENTS IN WATERS &

STRONTIUM, TOTAL BY TRACE ELEMENTS IN WATERS &

TURBIDITY

METHANE

ETHANE

PROPANE

**Gas Safety Incorporated
16 Brook Lane
Southborough, Massachusetts 01772
774-922-4626 www.gassafetyusa.com**

Report to

Damascus Citizens for Sustainability
25 Main Street
Narrowsburg, New York 12764

Report on a Survey of
Ground-Level Ambient Methane Levels in
the Vicinity of Wyalusing,
Bradford County, Pennsylvania

November 2013

by

Bryce F. Payne Jr.¹ and Robert Ackley²

[This report is subject to revision.]

NOTE: Figures follow text.

There have been numerous reports of methane emissions related to shale gas development in the vicinity of Wyalusing, Bradford County, Pennsylvania. In the interest of furthering the understanding of those fugitive methane events Damascus Citizens for Sustainability engaged Gas Safety, Inc. to survey ambient air methane levels in the vicinity of Wyalusing, PA. The survey covered parts of 9 townships on both sides of the Susquehanna River (Figure 1 -

¹ Consulting and research in environmental science since 1992. Associate Research Professor, Dept. Environmental Engineering and Earth Sciences, Wilkes University, Wilkes-Barre, PA and Senior Fellow of the Wake Forest University Center for Energy, Environment, and Sustainability, Winston-Salem, NC. bryce.payne@wilkes.edu

² President of Gas Safety, Inc. with 30 years experience in gas leak detection and measurement, related regulatory compliance, and training. bobackley@gassafetyusa.com

following text) from Towanda on the northwest to Wyalusing on the central eastern side. Survey coverage was restricted to readily identifiable public roadways. Consequently, the survey was most intense from the Susquehanna River west to Pennsylvania Route 187.

Though the survey results do not prove a relationship between ambient air methane contamination and groundwater contamination, it is clearly suggestive. Further, it also suggests shale gas well operations in that area still did not have control of the gas that has been developed there. In fact, as will be discussed, survey data indicates there may be gas control problems in about 10% of the survey area resulting in elevated methane levels in most of the area.

In addition, detection of any level of methane above normal background for an area indicates only two possible conditions: diffuse, non-point emissions are occurring over some portion of the area, or, one or more point sources are active within the area.

Conditions during the Survey

The survey effort involved two separate survey field work efforts, one on 31 January and the other 3–4 June 2013. Weather conditions at the time of the January survey were not ideal. Winds were from the west at speeds consistently near 20 miles per hour (29 feet per second). Under these conditions methane emissions from any source disperse rapidly. Consequently, elevated methane levels due to such emissions are more difficult to detect than under more favorable wind conditions. Functionally this means that, during a road survey, detection of elevated methane levels requires the sources be larger or more intense and in closer proximity to the survey vehicle path than under more favorable wind conditions. However, such wind conditions do cause methane emissions to be swept along the ground surface farther and faster. Consequently, methane emissions appear as a general elevation of methane levels over a wider area, instead of localized markedly elevated peaks.

During the 3–4 June field work weather conditions were more favorable. The wind was from the north–northwest at an average speed of 5 miles per hour (around 8 feet per second). Under these conditions methane emissions would be expected to be detectable as low concentration plumes extending for an appreciable distance to the south–southeast of the source. Mixing layer structure and height was not estimated during the survey, but conditions should have favored typical lower atmospheric mixing patterns in which most methane emissions diffuse rapidly upward.

Results of the January Survey

As anticipated due to the wind conditions the methane levels were moderately elevated widely over the survey area. Typical methane level observed during the survey was low. The average methane level was 1.86 ppm, with a minimum of 1.79 ppm, 90% were below 1.91 ppm, and 99% below 2.08 ppm.³ Under such high wind conditions, the layer of the atmosphere that normally forms next to the land surface⁴ is swept away by air that would normally move at altitudes of a few hundred to a few thousand feet above. Under gentler wind conditions gases released into the air tend to accumulate in plumes as they dissipate into the turbulent but lower-wind-speed layer of air next to the land surface. Under sustained high wind conditions the air from the higher layer sweeps down and across the land surface rapidly sweeping any released gases across the land surface and up into the atmosphere.

Figure 2 shows an oblique westward view of the survey area in which the data was processed to remove values lower than 2.2 ppm and vertically exaggerate those over 2.2 ppm by a factor of 1000. In effect, this approach visually defines methane levels above 2.2 ppm as elevated methane levels (EMLs). This graphical rendering shows around 18 locations with elevations above 2.2 ppm. There also appear to be many locations with EMLs near 2.2 ppm. This, however, is an artifact of the low resolution of this image and the high resolution of the survey data set. When this image is examined at higher resolution most of the apparent near-2.2-ppm EMLs disappear.

To allow examination of smaller EMLs another image of data was prepared with the methane data processed to remove values below 1.9 ppm and vertically exaggerate values >1.9 ppm by a factor of 100. The lower 1.9-ppm cutoff and vertical exaggeration preserved EMLs that were not apparent upon high resolution examination of Figure 2, as illustrated by Figures 3 and 4. The >1.9-ppm image is not shown as it is visually nearly flat at the resolution that can be rendered on a single page of this report. In the >1.9-ppm image 57 EMLs were identified as sufficiently clear to merit further examination (see Appendix B for a listing of those EMLs by location). Of those 57 EMLs, 43 were in proximity to and nearly-downwind of gas pipelines, gas well pads, farms, industrial facilities with apparent waste water treatment ponds or lagoons.

³ During survey runs the vehicle has to make stops. The CRDS methane instrument collects data continuously. Consequently, geographically disproportionate amounts of data accumulate whenever the vehicle stops. Geographically disproportionate data accumulations are removed from the data set before statistical analysis. Images are generated using the full raw data sets.

⁴ Planetary boundary layer or mixing layer. See Manhattan extended report for more detailed discussion.[NEED LINK HERE](#)

Further identification of the methane sources causing the other 14 EMLs was beyond the scope of the survey work.

Despite the strong wind conditions a relatively large methane plume was detected. The plume was detected over an area running from Wysox 2.5 miles southward along the river and up to 3.6 miles to the east. The plume was not present on a later pass through the same area. The extent and consistency of this plume over such a large area under such windy conditions, and its relatively sudden disappearance suggest a sizeable release of methane upwind of the plume area that ended sometime during the survey. Identification of a likely source was beyond the scope of the survey work. It is noteworthy that this plume was again present during the June survey. The plume may have been related to a number of gas wells generally north of Wysox.

Conclusions from 31 January Survey

The strong wind conditions during the methane survey caused rapid mixing and lateral dispersal of methane from any sources in or near the survey area. Under such conditions detection of elevated methane levels is limited to those resulting from larger emissions or those from sources in close proximity to the roadway. The rapid mixing and lateral dispersal causes methane levels in the area to appear more uniformly elevated than would be the case under less windy conditions. This was indicated by the slightly elevated mean (1.86 ppm) and narrow range of methane levels (1.79–1.91 ppm) that accounted for the 90% of the data (further discussed in comparison to the June data follows below). All the other 10% of the data indicating methane levels above 1.91 ppm occurred at less than 60 locations. Among those locations, 43 were in the vicinity of candidate potential methane sources, in most cases gas pipelines or gas well pads. At 14 locations with elevated methane levels candidate potential methane sources were not readily apparent.

Results of the 3–4 June Survey

As expected under the more favorable wind conditions on 3–4 June, methane plumes were detectable over much larger areas than during the extreme wind conditions of the 31 January survey. Elevated methane levels occurred over much of the survey area. Additionally the methane instrument (cavity ring down spectrometer⁵) was run during travel from the survey area and during a brief observational trip to the Leroy Township area. Those two legs of the

⁵ http://www.picarro.com/technology/cavity_ring_down_spectroscopy

survey trip provided methane measurements in geographically and geologically adjacent areas that can be reasonably regarded as comparable areas with limited or no shale gas well activity. That area is referred to as the Reference Area in the remainder of this report. It includes data from valleys, along a river, and two town/city areas. Hence, the Reference Area can be reasonably considered to have all likely natural and human-caused methane sources typical for the geographical/geological area, but with minimal large-scale agricultural, industrial or shale gas sources. Also, of some interest is recognition that the methane survey work included parts of two areas under Pennsylvania Department of Environmental Protection Consent Orders. An image displaying the results of the June survey is provided in Figure 5.

It should be borne in mind that the survey work was limited to publicly accessible roads. The survey, therefore, measures the impacts of methane emissions sources at considerable distances from those sources. Consequently, seemingly minor changes, in the tenths or hundredths of a part per million, in ambient air methane levels are of considerable importance in locating methane emissions sources and assessing their broader area impacts.

The June survey average methane level was 1.83 ppm, with a minimum of 1.75 ppm, 90% were below 1.88 ppm, and 99% below 2.05 ppm.³ Given the difference in wind conditions, these levels were quite similar to those seen in the January survey. For comparison, in the Reference Area the average methane level was 1.78 ppm, with a minimum of 1.76 ppm, 90% were below 1.79 ppm, and 99% below 1.81 ppm.³ Since much of the survey area is affected by the same type and frequency of methane sources that occur in the Reference Area, one would expect that much of the survey area data would be similar. This was, in fact, found to be the case. It can be seen in Figure 6 that in the Reference Area 97% of the methane levels were below 1.8 ppm, while in the survey area in June, 37% were, but in the survey area in January less than 1% were below 1.8 ppm. These results suggest that methane emissions in about 37% of the survey area are effectively similar to the Reference Area. The strong winds during the January compared to the June survey were probably the cause of the apparent reduction in total area with readings below 1.8 ppm (37% of the area in June compared to <1% in January), Emissions that on 3–4 June were rising into the air more normally, whereas on 31 January emissions were being rapidly mixed and swept over the land surface by the strong winds.

Looking at another methane value of interest, the maximum methane level measured in the Reference Area was 1.88 ppm. In the survey area on 3–4 June 10% of the measurements exceeded the Reference Area maximum, and on 31 January 16%. Consequently, it is reasonable to conclude that at least 10% of the survey area is impacted by methane sources that do not occur in the Reference Area. As previously mentioned, these are agricultural and industrial sources. Field observations and examination of satellite imagery allowed determination

that some of the methane sources causing the elevated methane were agricultural or industrial, other than shale gas development. The plumes of the ag/industrial sources appeared less extensive than the plumes of the sources associated with shale gas development. Most of the shale gas methane emissions sources appeared likely to be well pads and pipelines.

With regard to the relationship between ambient air methane surveys and locations of methane sources potentially impacting an area, it is interesting to consider the survey covered parts of the areas under two PaDEP Consent Orders. Those two Orders were between the PaDEP and Chesapeake Appalachia, LLC, dated 16 May 2011⁶. The two Orders were designated for impact areas referred to by PaDEP as Paradise Road and Sugar Run. It should be borne in mind that at the time of the survey, the Consent Order impact areas were not specifically known to GSI and were not specifically targeted. The general outline of the survey area was selected by DCS based on reports in the media and from residents. The specific area was determined by the operational conditions GSI encountered in the field. Consequently, the survey covered the Consent Orders impact areas only coincidentally. Still the survey did include about 2/3 of the Paradise Road and 1/2 of the Sugar Run Consent Order impact areas. It can be readily observed in Figure 5 that elevated methane levels were concentrated within the Paradise Road impact area compared to the remainder of the survey. There were elevated methane levels in other parts of the survey area but the concentration in the central part of the Paradise Road impact area is distinct. **Though this does not prove a relationship between ambient air methane contamination and groundwater contamination, it is clearly suggestive. Further, it also suggests shale gas well operations in that area still did not have control of the gas that has been developed there. In fact, as already mentioned, the survey data indicates there may be gas control problems in about 10% of the survey area resulting in elevated methane levels over 60–90% of the area.**

In addition, detection of any level of methane above normal background for an area indicates only two possible conditions: diffuse, non-point emissions are occurring over some portion of the area, or, one or more point sources are active within the area. Non-point sources are difficult to assess, precisely because they are diffuse. As mentioned previously, at the end of the survey work reported here a cursory evaluation run was made to the area of a previously documented shale gas well impact in Leroy Township. **NEED LINK HERE** That site is of interest in this discussion because on the land surface methane emissions occur as a non-point source, with gas emerging from many points over a area of uncertain extent. During the earlier evaluation of that site

⁶ This PA DEP Consent Order available HERE: <https://www.dropbox.com/s/3r34e3ggb88qxbo/161%20Consent%20Agreem%20Susquehanna%20River.pdf>

nearly pure natural gas was encountered within inches of the soil surface, but on the nearest road, about 100 yards away, and downwind at the time, only a few ppm of methane were detected. Despite gas well remediation measures, the 4 June run along the same roads confirmed methane levels remain in the range of a few ppm, suggesting the methane migration problem still exists. A cursory water sample test also indicated water in the area still has very high methane levels. Methane contamination was prevalent in the area during the prior evaluation. The Leroy Township situation is troubling with regard to health and safety, and discouraging with regard to the capability of industry to effectively correct gas well problems when they occur.

Point sources of methane present a slightly different set of concerns. A substantial amount of methane is necessary to raise methane levels even slightly over an extensive area, as measured from our survey over public roads. If that amount of methane is being emitted at one or a few point sources, then the concentration of methane in the vicinity of those sources will likely be hazardous with respect to explosion or asphyxiation. Consequently, the methane levels measured during the survey indicate there likely are point sources associated with some shale gas wells in the area that do give rise to hazardous conditions. Those point sources need not necessarily be at the gas well itself, as the gas may find underground pathways to emerge in water wells, homes or other structures, as occurred in Leroy Township, and the Paradise Road and Sugar Run impact areas.

Conclusions

Methane from any source rapidly diffuses and rises in the air. Consequently, detection of possible methane sources from any distance away requires extremely sensitive measurement capabilities. The GSI survey approach takes advantage of extremely sensitive measurement instrumentation to detect small increases in ambient air methane levels as an indication of probable methane emissions sources in a given area. Based on the data collected using that equipment, we conclude that the Towanda–Wyalusing area is probably substantially impacted by methane emissions from shale gas wells both within and beyond the survey area, depending on wind conditions. The coincidence of two DEP methane migration impact areas, Paradise Road and Sugar Road, and the most marked ambient air methane levels suggests there are still gas control problems associated with the shale gas wells there, as well as in another documented impact area in Leroy Township also cursorily measured following the main survey. A rapid water test in the Leroy area confirmed the water in that area is still contaminated with methane. These survey results suggest methane contamination continues and measures taken by gas well operators with regard to methane migration problems that have occurred in these three areas have likely been only partially effective.

Figure 1. Overhead image of roads traveled during the survey of ambient air methane levels in the vicinity of Wyalusing, PA on 31 January 2013 (Google Earth).

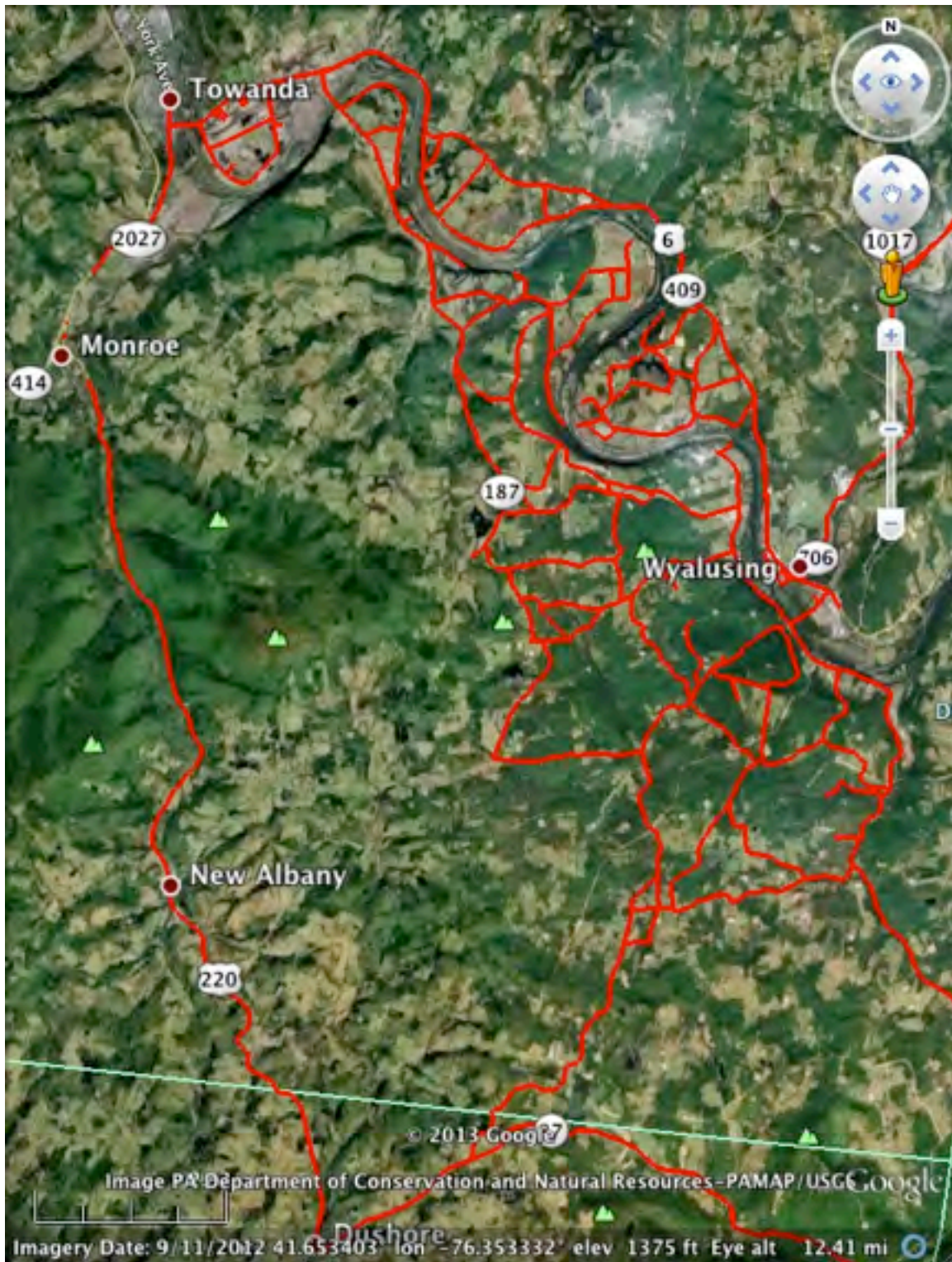
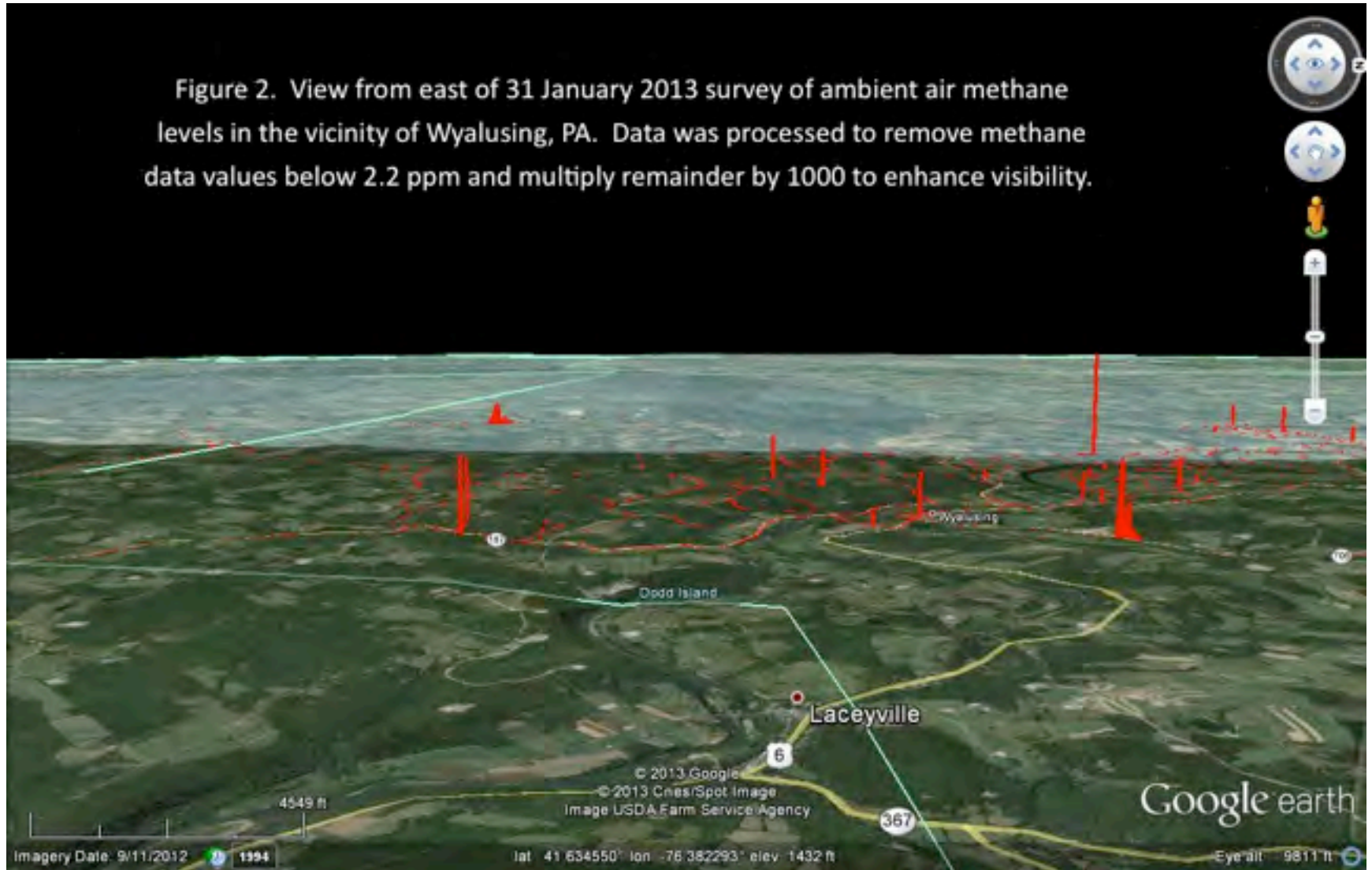


Figure 2. View from east of 31 January 2013 survey of ambient air methane levels in the vicinity of Wyalusing, PA. Data was processed to remove methane data values below 2.2 ppm and multiply remainder by 1000 to enhance visibility.



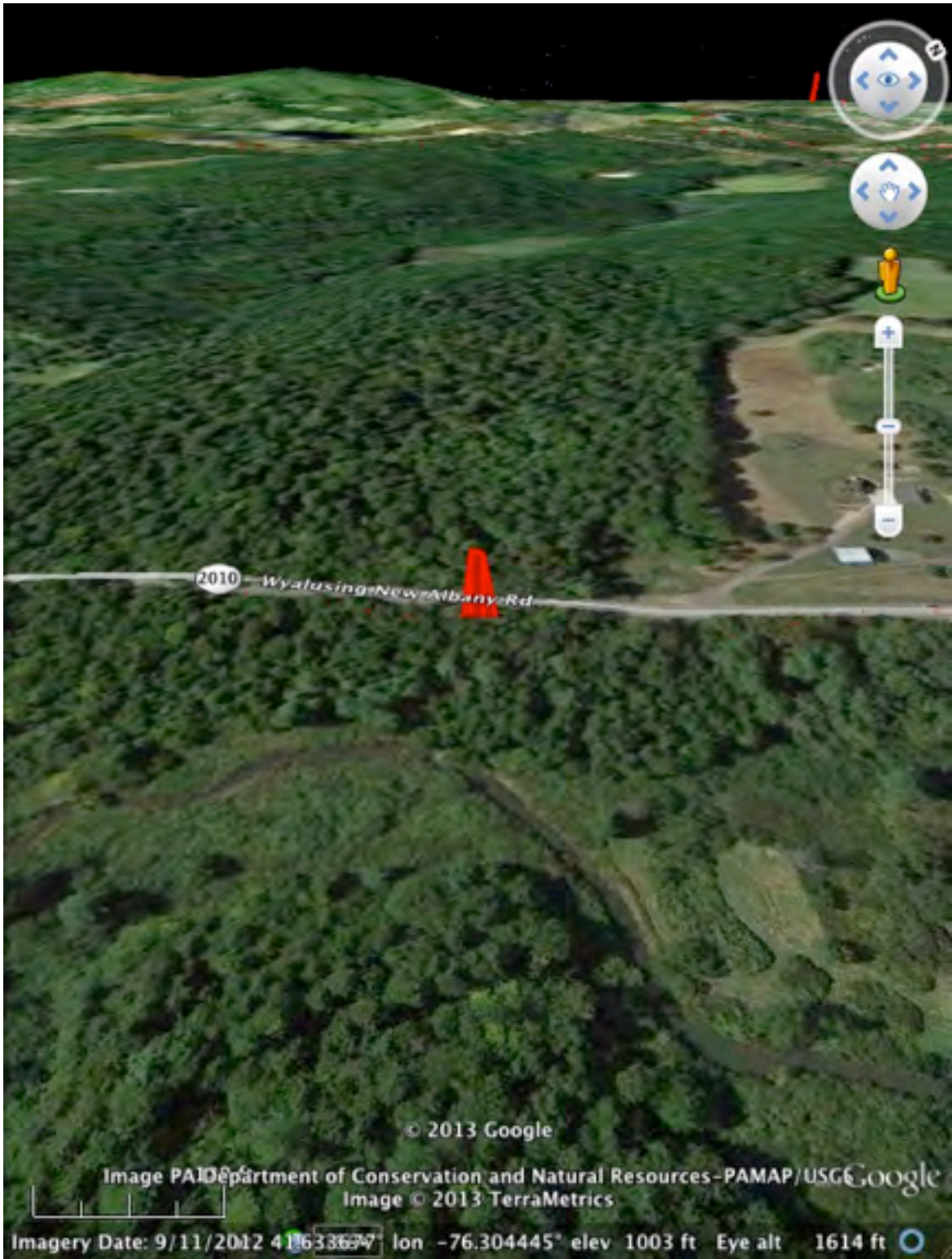


Figure 3. An elevated methane level as rendered by processing of the Wyalusing 31 January 2013 methane survey data to remove values < 2.2 ppm and multiply remainder by 1000. Compare to same elevated methane location in Figure 4.

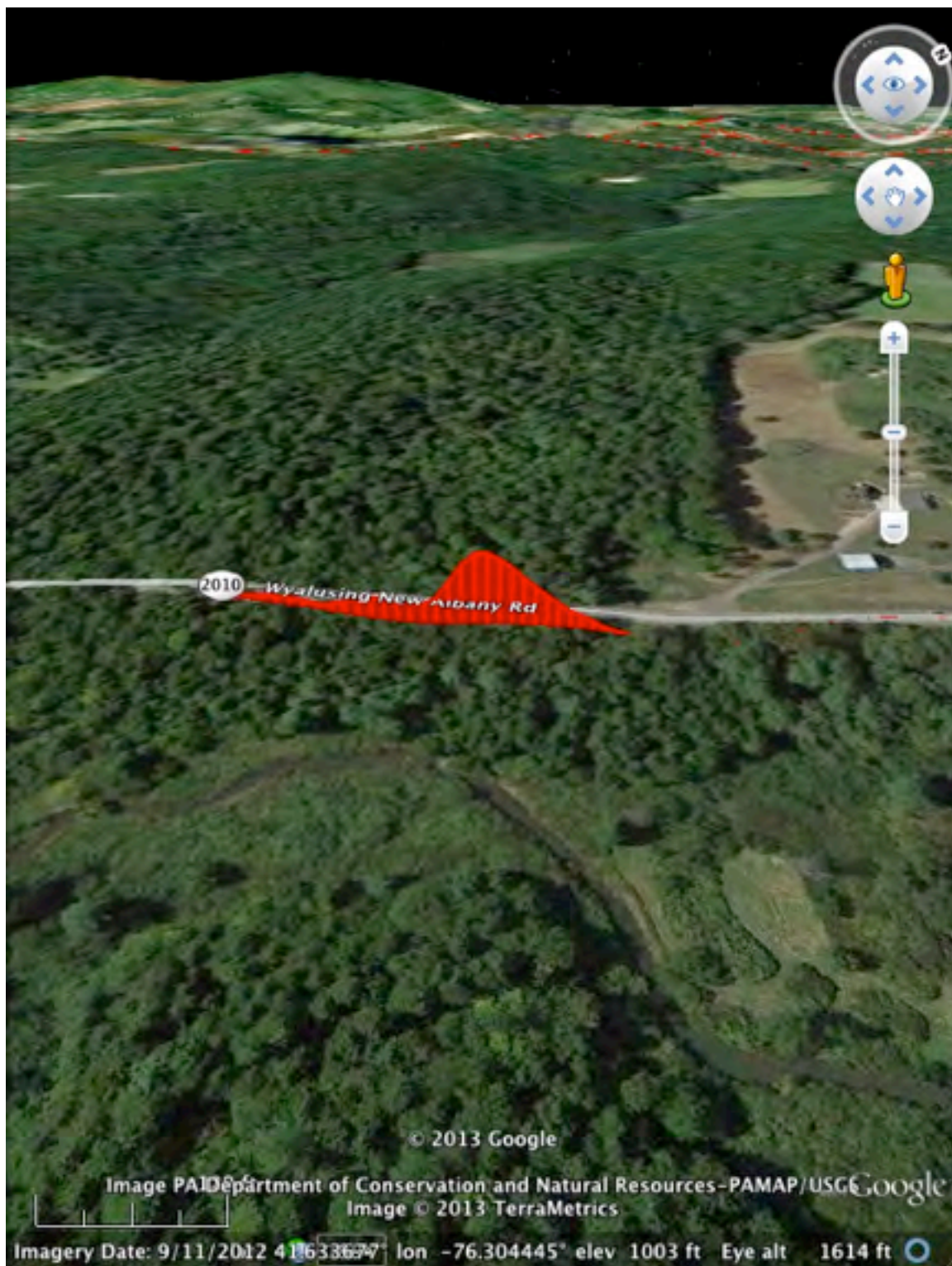
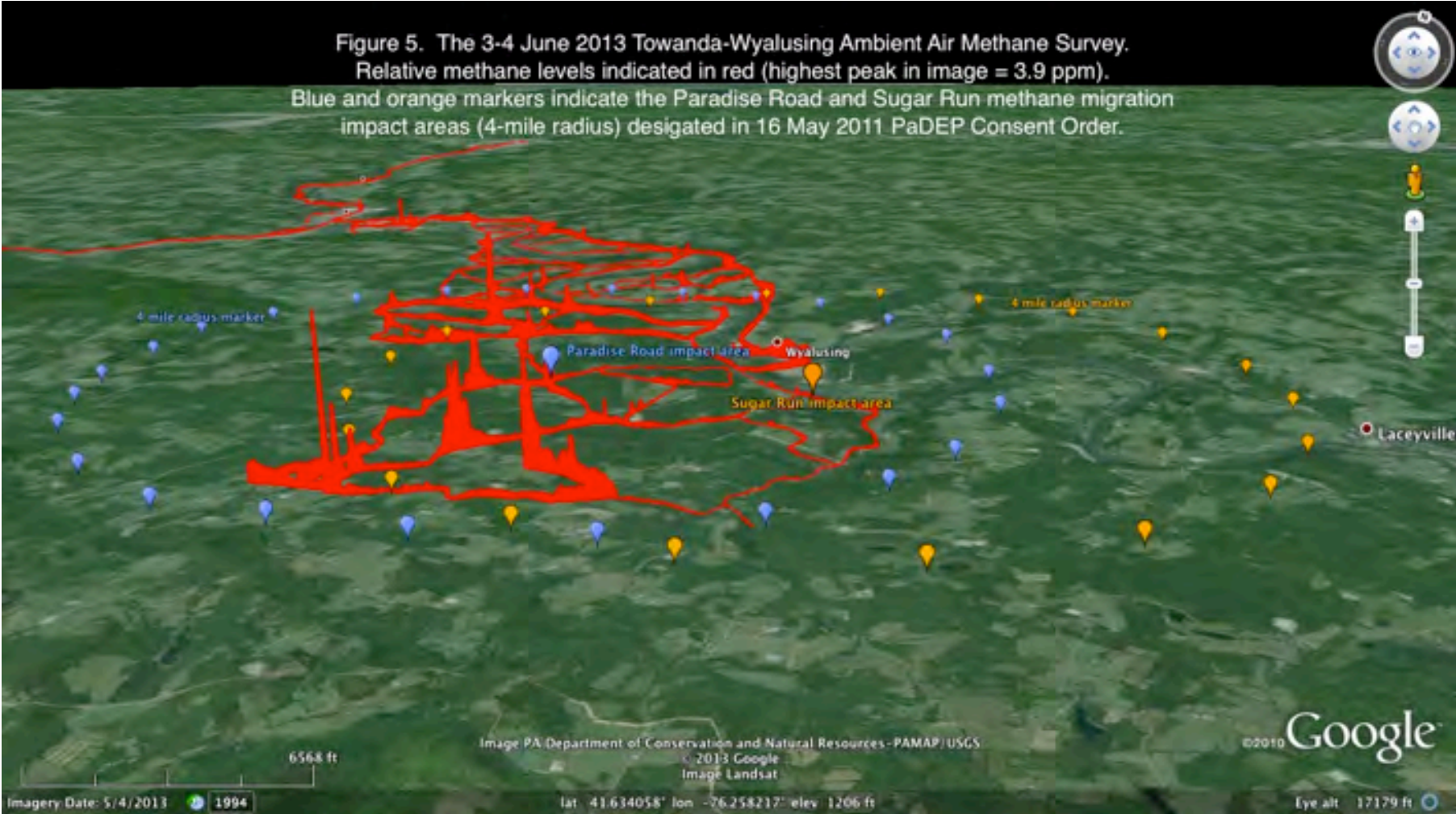


Figure 4. An elevated methane level as rendered by processing of the Wyalusing 31 January 2013 methane survey data to remove values < 1.9 ppm and multiply remainder by 100. Compare to same elevated methane location in Figure 3.



**Figure 6. Ambient Air Methane Surveys
Towanda-Wyalusing Area, PA January and
June 2013**

