Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Project

Marcellus Shale Conference

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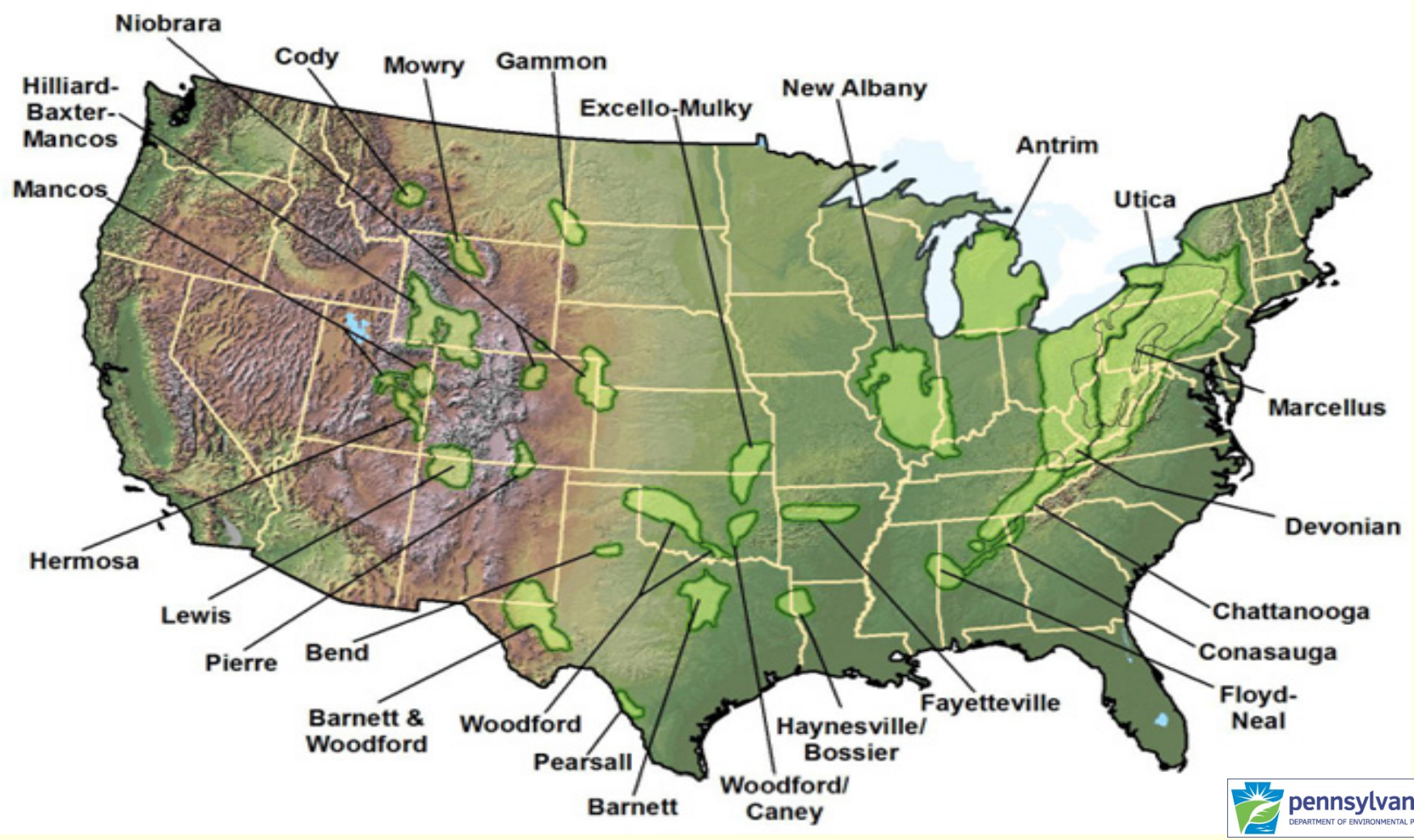
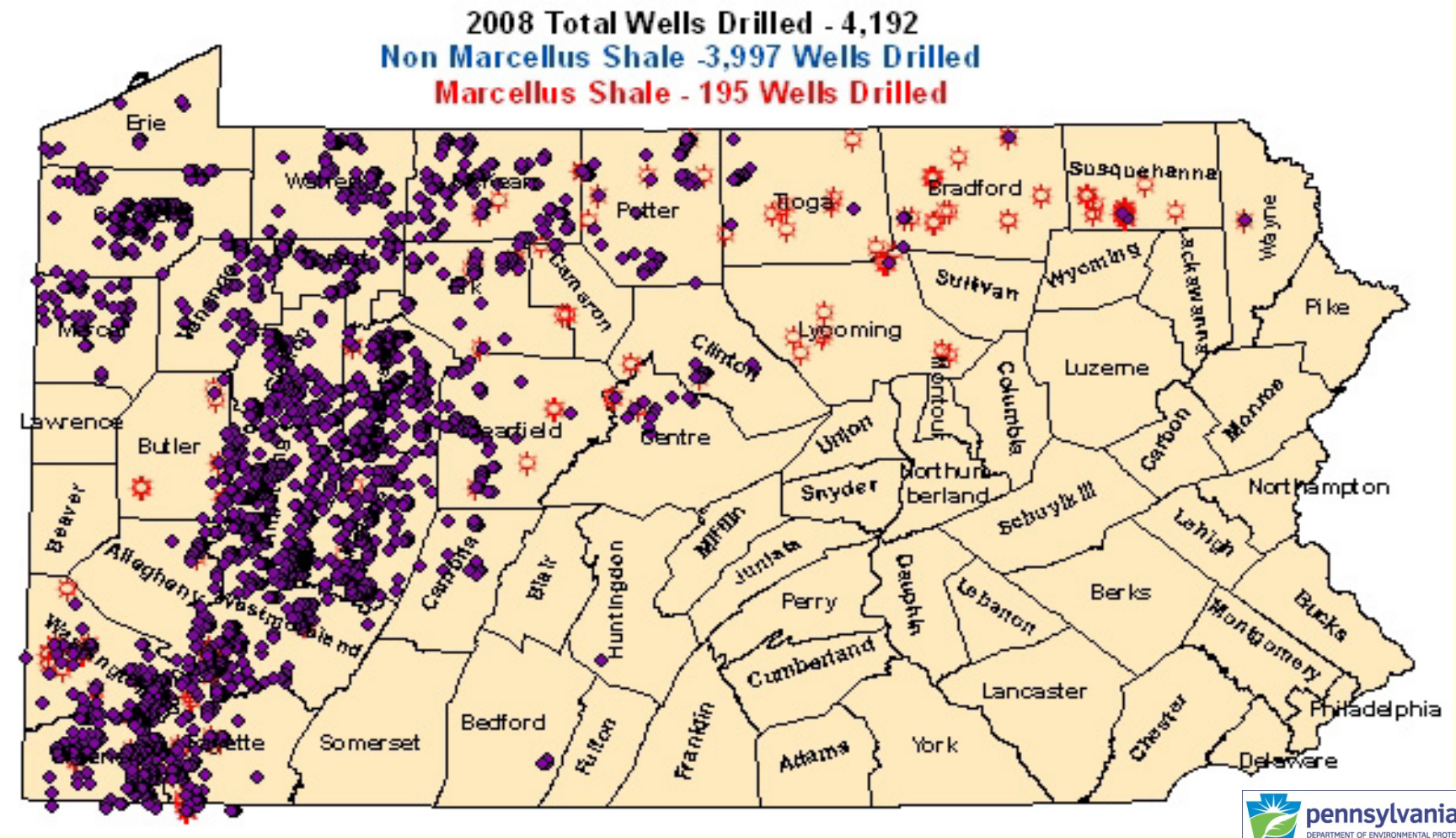
Natural Shale Gas Formations



2008 Oil & Gas Wells Drilled in Pennsylvania



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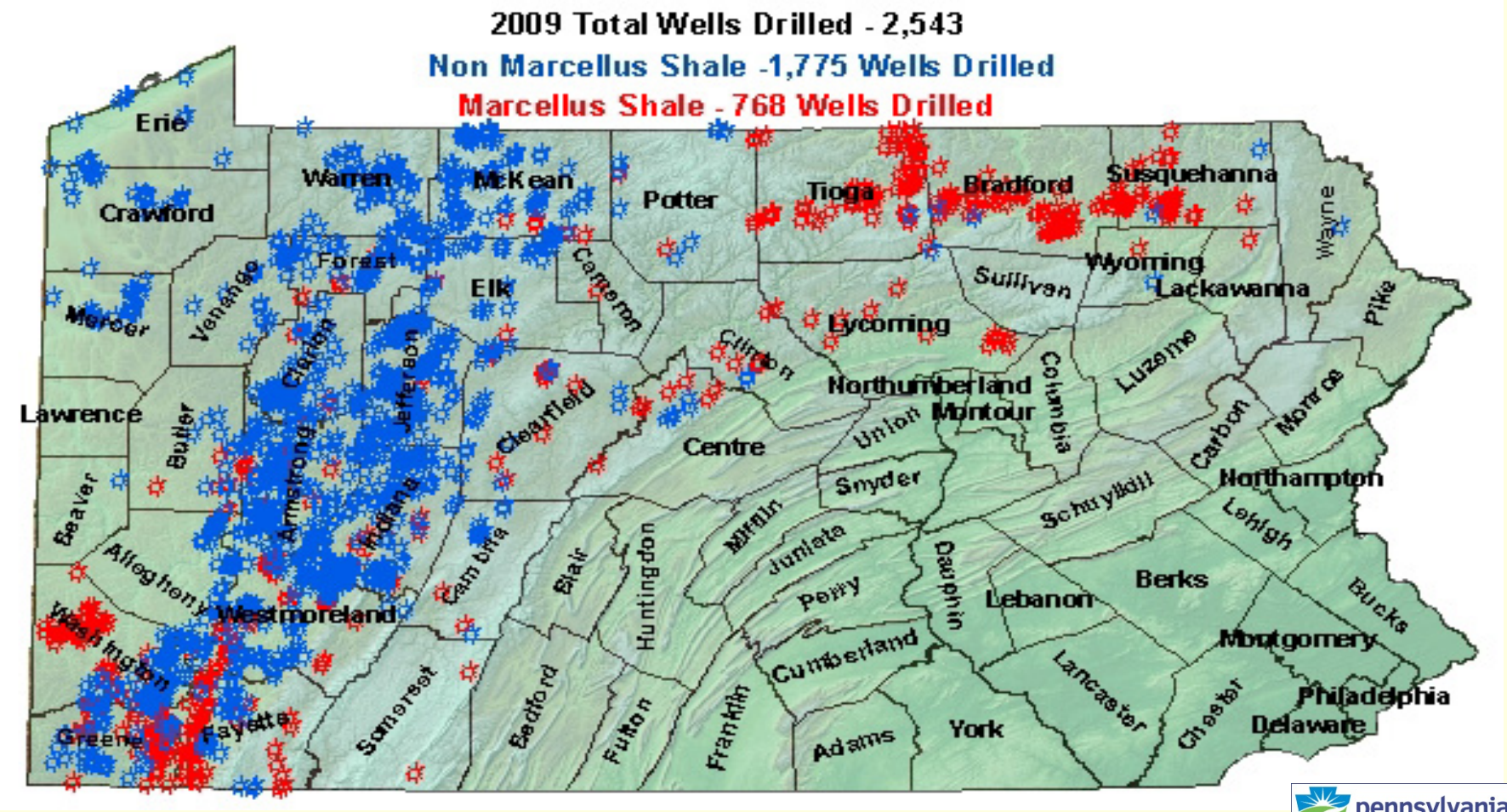
2009 Oil & Gas Wells Drilled in Pennsylvania



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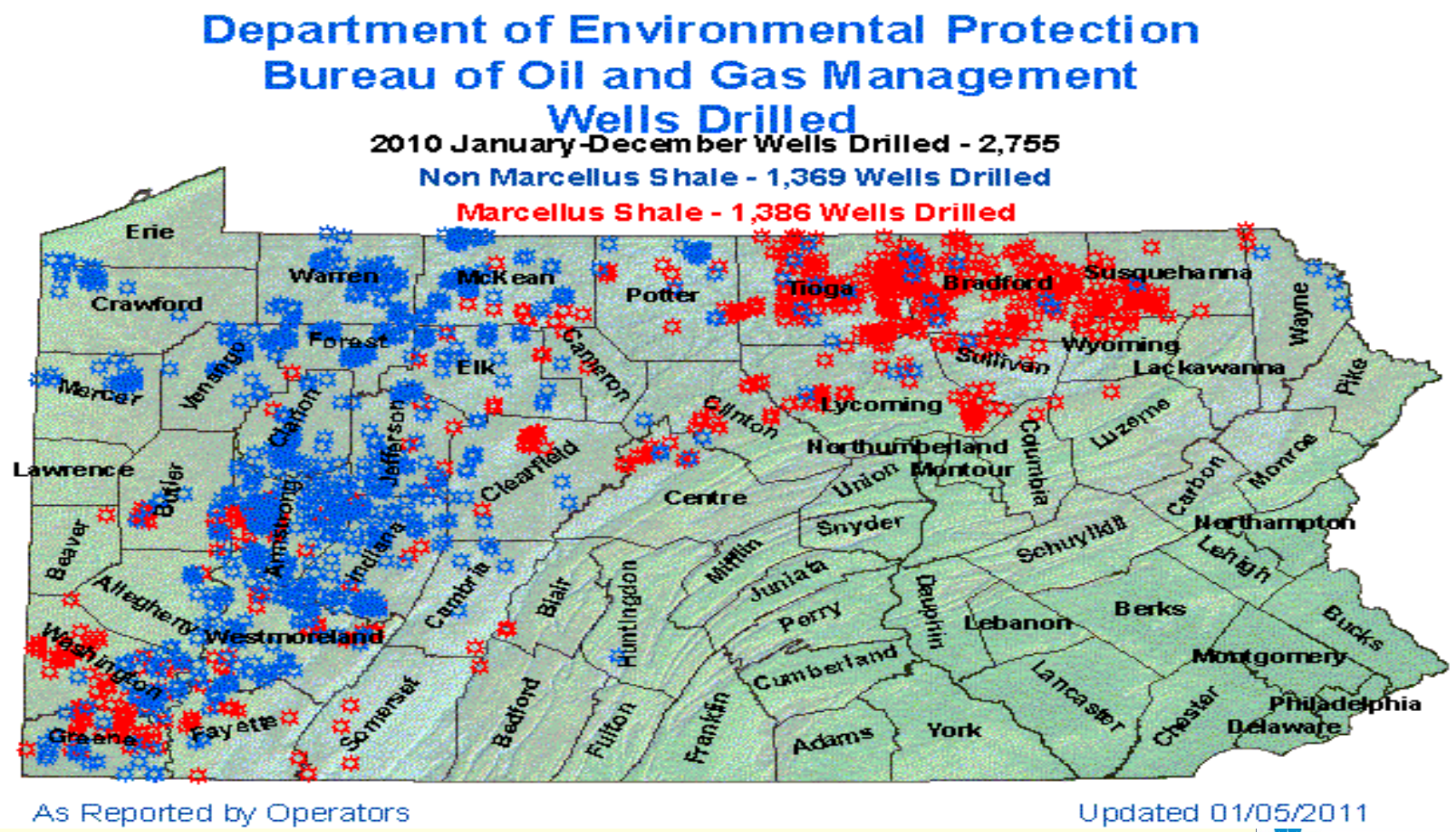
2010 Oil and Gas Wells Drilled In Pennsylvania



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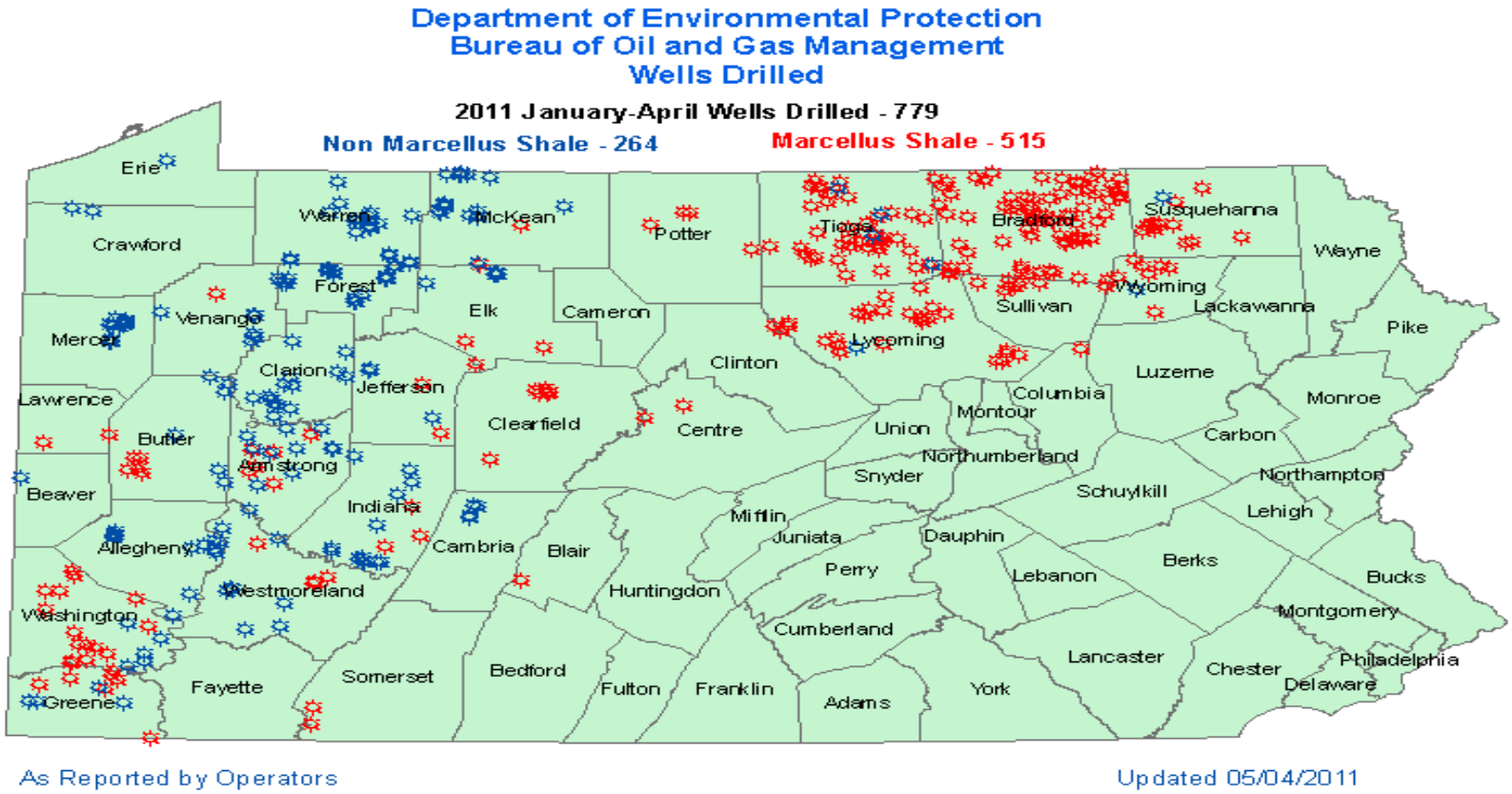
2011 Oil and Gas Wells Drilled In Pennsylvania



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Marcellus Shale Short-Term Ambient Air Sampling Protocol

- The Pennsylvania Department of Environmental Protection initiated the short-term sampling project to obtain preliminary Pennsylvania-specific data for pollutants emitted at, or near, Marcellus Shale natural gas operations in the southwest, northeast and northcentral regions.

- The objectives of the study include the following:
  - screen for ambient air concentrations of target pollutants near certain Marcellus Shale gas drilling operations;
  - assess potential air quality impacts;
  - assess any potential health risks from exposure to ambient concentrations; and
  - determine whether the scope of the short-term Marcellus sampling initiative should be expanded.

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Marcellus Shale Short-Term Ambient Air Sampling Protocol

- The Bureau of Air Quality developed a sampling protocol for approximately 45 volatile organic compounds, carbon monoxide and nitrogen oxides.
- In collaboration with DEP's Bureau of Laboratories (BOL), Oil and Gas Program and regional offices, Mobile Analytical Units (MAU) were deployed for this initiative.
  - Many of the gas exploration operations are located in remote locations.
- The MAUs are used on-site for short-term sampling and the units also provide meteorological data.

Marcellus Shale Short-Term Ambient Air Sampling Protocol

- Each sampling event consisted of six sampling periods per site. Three sampling periods ran from approximately 4:00 AM-12:00 PM and three sampling periods ran from 4:00 PM-12:00 AM.
- The sampling periods were selected to catch temperature inversions and to cover the timeframes of the bulk of citizen complaints.
- Three locations in each region (four in the southwest) were sampled plus a background site. Background sites did not have active gas operations located within 10 miles of the site, particularly in the upwind direction.
- A minimum of three canister samples were taken at populated downwind locations for each sampling event.

Marcellus Shale Short-Term Ambient Air Sampling Project

- Sampling was focused on three areas of the state with the heaviest drilling activity:
  - Southwest Region focused on Greene And Washington Counties
  - Northeast Region focused on Susquehanna County
  - Northcentral Region Focused on Tioga and Bradford Counties

Marcellus Shale Short-Term Ambient Air Sampling Project

DEP's sampling initiative focused mainly on the following natural gas source categories:

- Compressor Stations
- Condensate Tanks
- Flaring Operations
- Wastewater Impoundments
- Wellheads

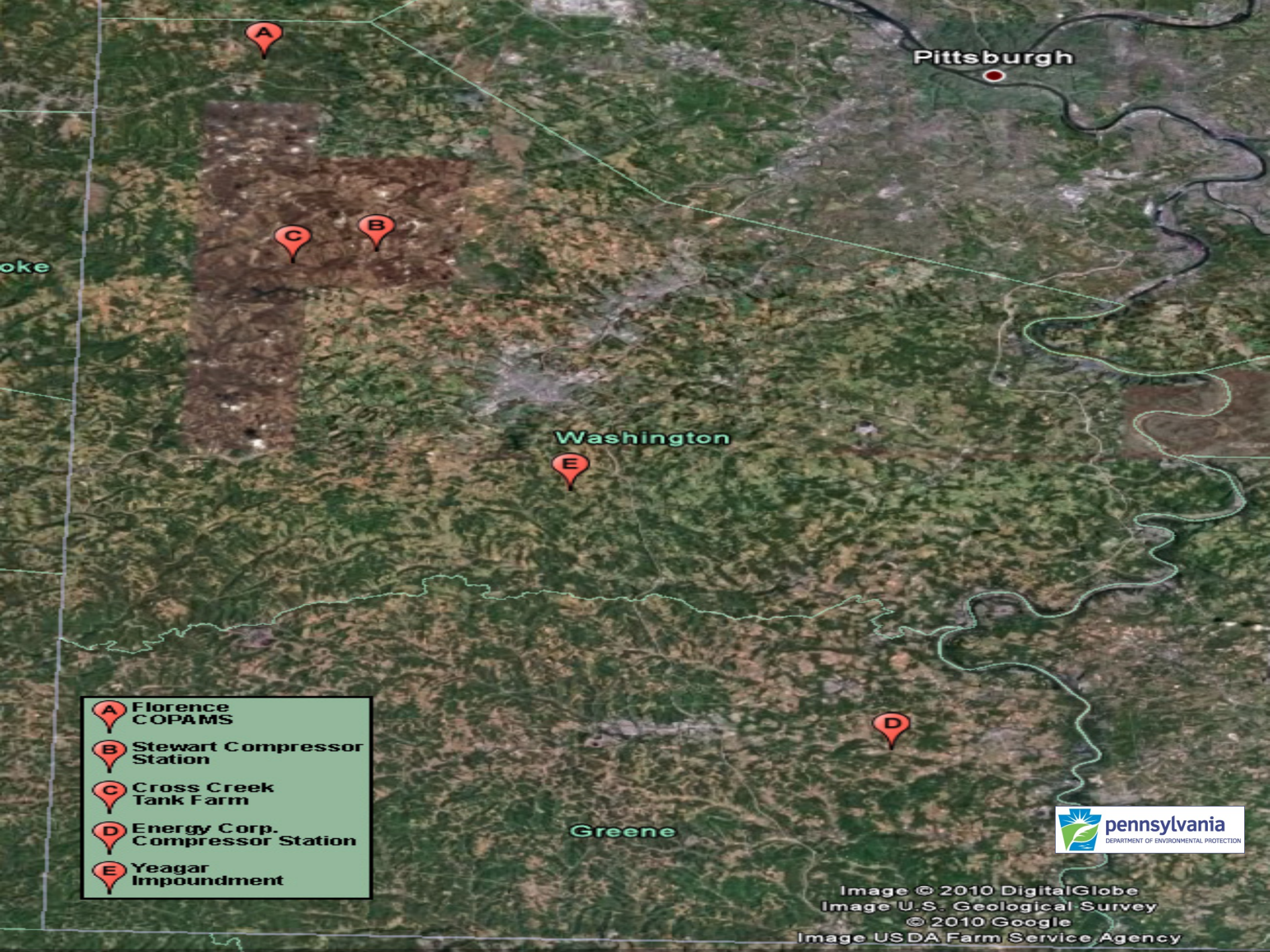
Pittsburgh
Washington
Greene
A
B
C
D
E
A Florence COPAMS
B Stewart Compressor Station
C Cross Creek Tank Farm
D Energy Corp. Compressor Station
E Yeagar Impoundment
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Image © 2010 DigitalGlobe
Image U.S. Geological Survey
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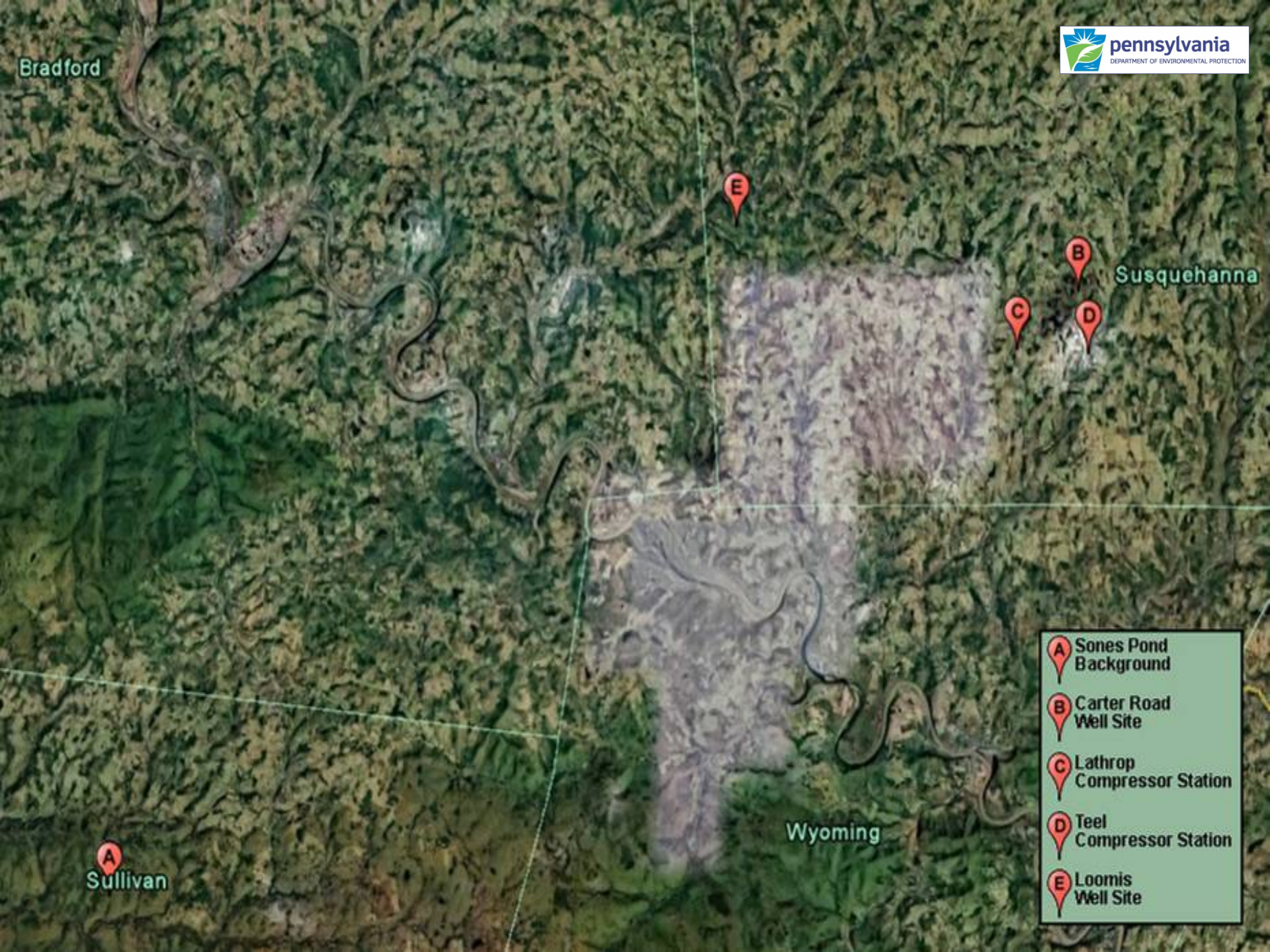
Image USDA Farm Service Agency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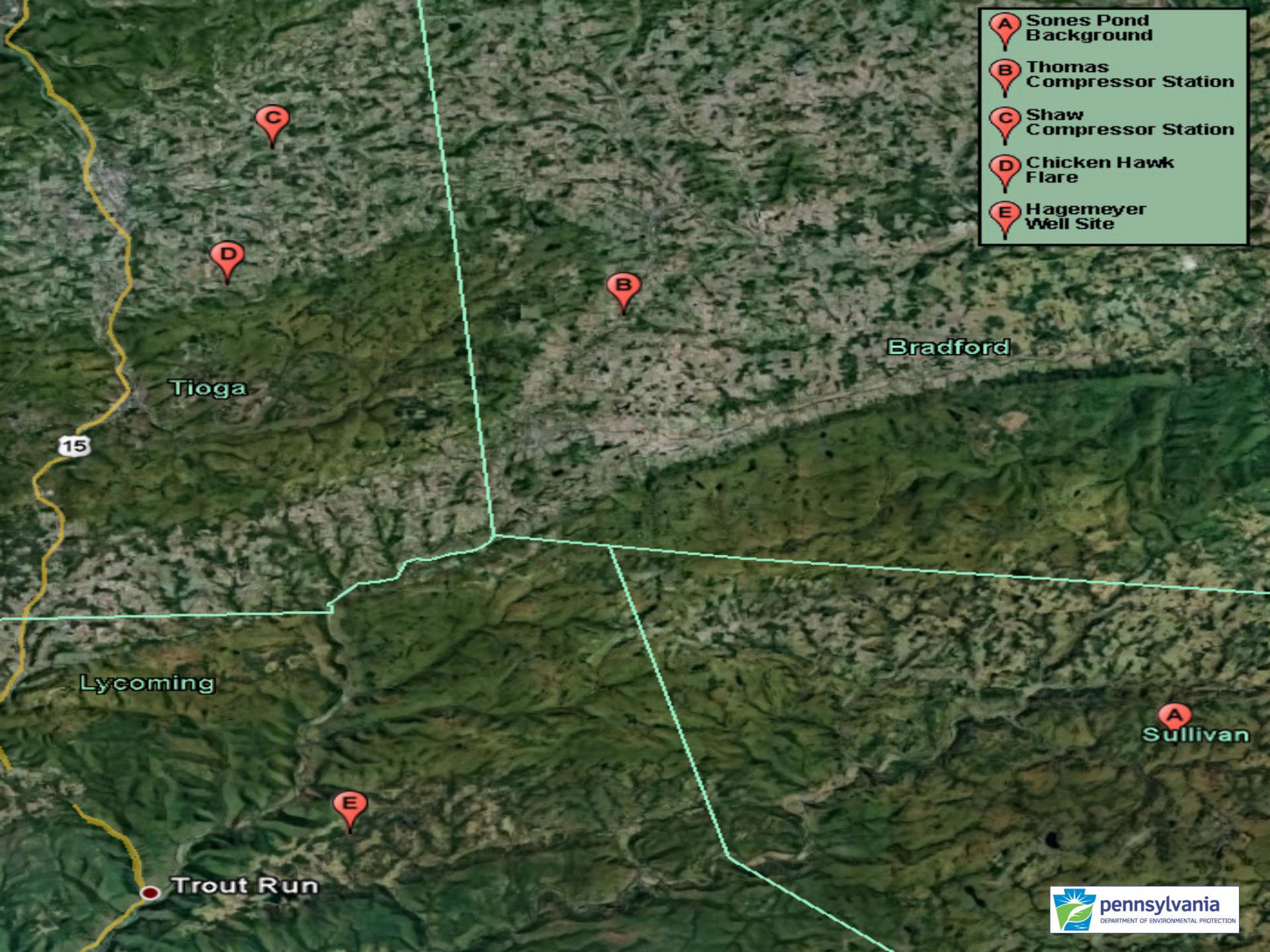
Bradford
Susquehanna
Wyoming
Sullivan
A
B
C
D
E
A Sones Pond Background
B Carter Road Well Site
C Lathrop Compressor Station
D Teel Compressor Station
E Loomis Well Site


A Sones Pond Background
B Thomas Compressor Station
C Shaw Compressor Station
D Chicken Hawk Flare
E Hagemeyer Well Site
Bradford
Tioga
15
Lycoming
Sullivan
Trout Run
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List of Compounds for Marcellus Shale Short-Term Ambient Air Sampling Study

1,1,1-Trichloroethane
Ethylene Glycol
1,1-Dichloroethane
Hydrogen Sulfide
1,2-Dibromoethane
Methylene Chloride
1,3-Butadiene
n-Butane
Benzene
Tetrachloroethene
Carbon Tetrachloride
Xylenes, Mixture
Chloroform
Ethane
Nitrogen Oxides

Ethylbenzene
1,1,2-Trichloroethane
Hydrogen Chloride
1,2,4-Trimethylbenzene
Methanol
1,2-Dichloropropane
Naphthalene
Acetone
Styrene
Carbon Disulfide
Trichloroethylene
Chloroethene
Cyclohexane
Propane

1,1,2,2-Tetrachloroethane
Formaldehyde
1,1-Dichloroethene
Methane
1,2-Dichloroethane
m-Xylene
1,3-Dichloropropene
n-Hexane
Bromomethane
Toluene
Chlorobenzene
Carbon monoxide
Chloromethane
Propene

DEP Mobile Analytical Unit: MAU-1

DEP Mobile Analytical Unit: MAU-1

- MAU-1 - A RV-sized vehicle that houses an Agilent 6890/5975 MSD Gas Chromatograph/Mass Spectrometer (GC/MS) with a Dynatherm IACEM 980 Air Sampler.
- The GC/MS analyzes air samples for the presence of volatile organic compounds (VOCs).
- Air can be analyzed outside directly from the MAU or from Tedlar® Bags.
- For each sample, a total of 0.5 liters of air was acquired at a constant rate over a 5-minute time period; air samples were collected once per hour.

DEP Mobile Analytical Unit: MAU-4

DEP Mobile Analytical Unit: MAU-4

- MAU-4 -- A utility-sized truck that houses a RAM 2000 Open Path Fourier Transform Infrared Spectrometer (OP-FTIR or Open Path sampler).

- Actual emplacement of the Open Path Sampler varies depending on the topography, site layout, safety considerations and meteorological conditions.

- A tradeoff exists between the length of the open path and detection limits; the longer the path, the higher the detection limits.

Open Path Fourier Transform Infrared Spectrometer

Open Path Fourier Transform Infrared Spectrometer Results

- Detection limits are in the ppb range and vary between compounds and sampling events.
- The OP-FTIR, an open path sampler, typically reports the highest 2-minute value if a compound was detected (unless otherwise noted). If the compound was detected at a high enough level during the sampling session (approximately 8 hours) to produce an average greater than the method detection limit (MDL), that average was reported.
- Detection Limits generally higher than with gas chromatography however, OPFTIR allows sampling of C1-C4 compounds and sulfur-based compounds.
- Some detection limits are above acute reference concentrations.

Canister Sampling Equipment

Marcellus Shale Short-Term Ambient Air Sampling Protocol – Canister Sampling

- Air canister samples were collected using a method based on EPA Compendium Method TO-15 (U.S. EPA, 1999b).
- The method uses a specially-prepared canister and sampler that collects an air sample over a 24-hour period, which is sent to DEP's Laboratory for analysis utilizing GC/MS.
- The 61-compound calibration mix covers compounds of interest for various toxics projects (Urban Air Toxics, Ozone, Fuel Spill, Superfund, etc.) and includes alkanes, alkenes, aromatics, CFC's, chlorobenzenes and oxygenated compounds.

Forward Looking Infrared (FLIR) Camera

- The FLIR Model GF-320 infrared camera was used for this project. This camera is a non-contact device that detects infrared energy (heat) and converts it into an electronic signal, which is then processed to produce a thermal image on a video monitor.

- The advantages of the FLIR Model GF-320 infrared camera include the following:
  - VOC/Hydrocarbon Leak Detection (Methane, Butane, Benzene, etc)
  - Gases invisible to the naked eye, look like smoke or colors on the FLIR camera
  - Can survey a large area, then zoom in to spots of interest
  - Finds emissions safely from a distance
  - Records regular and infrared images for comparison, as well as video.

Examples of Images from the FLIR Camera

Image from TCEQ Barnett Shale Formation Area Monitoring Project Report Published January 4, 2010

Examples of Images from the FLIR Camera

Image from Energy Corp Compressor Station Khedive, PA Greene County

Technical Challenges

- Unlike other industries, the gas industry has multiple air contamination sources and facilities located over a large area.
- Area source sampling is not conducive to short-term studies because these sources are much more equipment intensive.
- Because methane, propane, ethane and reduced sulfur compounds are not standard analytes, alternative technology is required.
- The natural gas facilities are often remotely located and often located near private homes.
- The MAU equipment is not designed for off road travel.

Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Project Findings

- Certain natural gas constituents including methane, ethane and propane, and associated compounds such as benzene, were detected in the air near Marcellus Shale drilling operations.

- Most of the compounds were detected during short-term sampling at two compressor stations in Greene and Washington counties. This is can be attributed to the gas in SW PA being “wet”.

- Certain compounds, mainly methyl mercaptan, were detected at levels which generally produce odors.

Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Project Findings

- The Department has not yet determined if the potential cumulative emissions of these pollutants from Marcellus Shale natural gas exploration activities will result in or contribute to violations of the health and welfare-based national ambient air quality standards or interfere with maintenance in attainment areas.

- Results of the limited ambient air sampling initiative did not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities.

- Fugitive emissions were detected using the infrared camera at several locations. These emissions could contribute to the ambient concentrations detected at the site.

Marcellus Shale Short-Term Ambient Air Sampling Studies: Next Steps

- A comparative analysis of the findings is being conducted to determine if:
  - follow-up monitoring should be conducted
  - the sampling initiative should be expanded.
  - long-term special project monitors should be installed at certain locations.
- All three regional reports are available at:

http://www.dep.state.pa.us/dep/deputate/airwaste/aq/default.htm

QUESTIONS?

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