



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION



Oil and Gas Management

CCAC

Abandoned and Orphan Oil and Gas Wells in Pennsylvania

Bureau of Oil and Gas Planning and Program Management

Division of Subsurface Activities

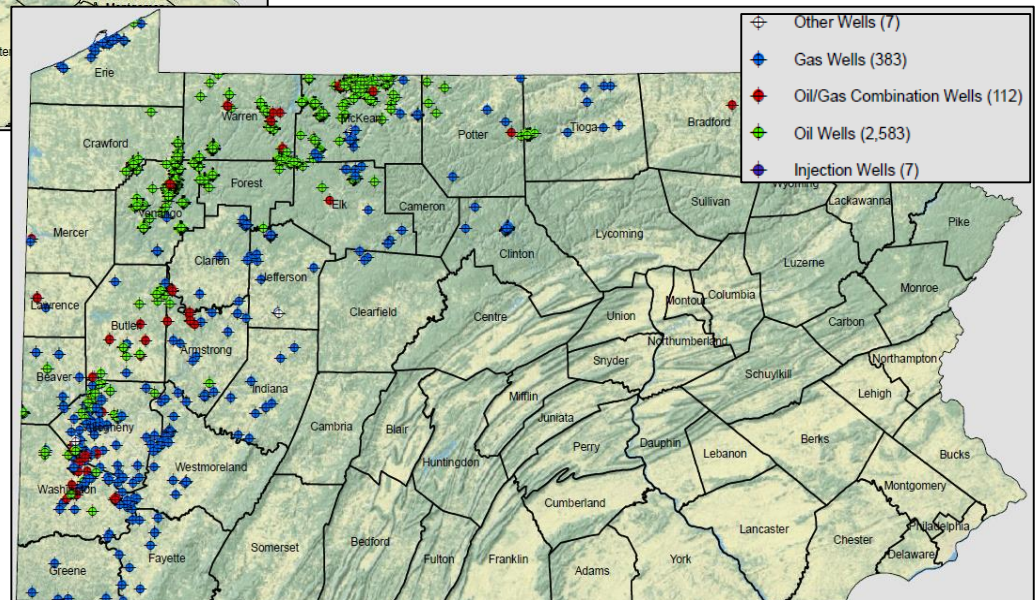
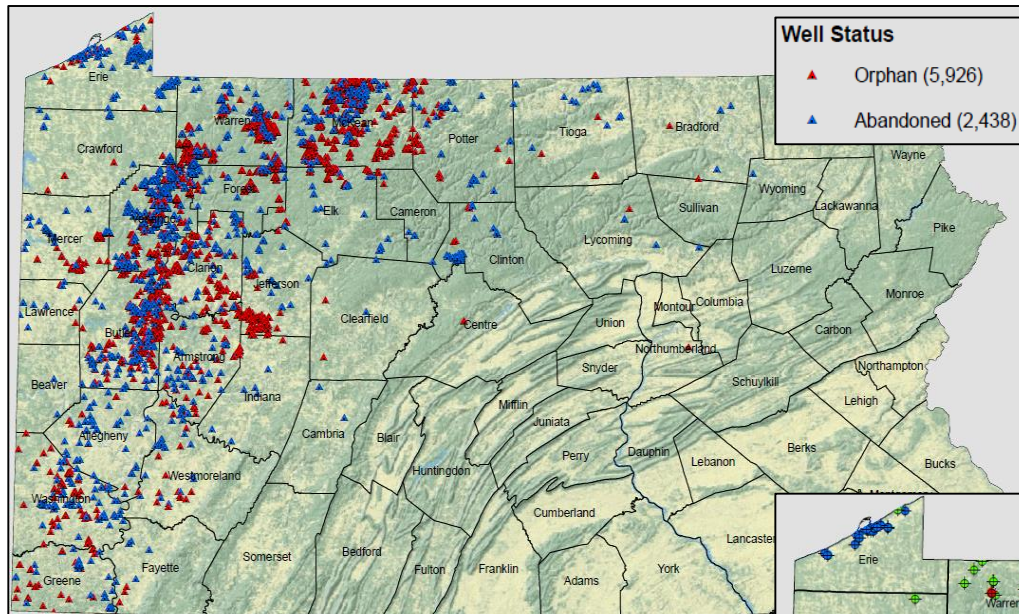
October 27, 2020

Presentation Outline

- Plugging Program Status Update
 - Funding
 - Emergency Procurement
 - Estimated Unfunded Liability
- Emerging Environmental/Safety Issues
 - Plugging Effectiveness
 - Short-term Environmental and Safety Risks
 - Emissions/Cornplanter State Forest
- Summary

Plugging Program Status Update

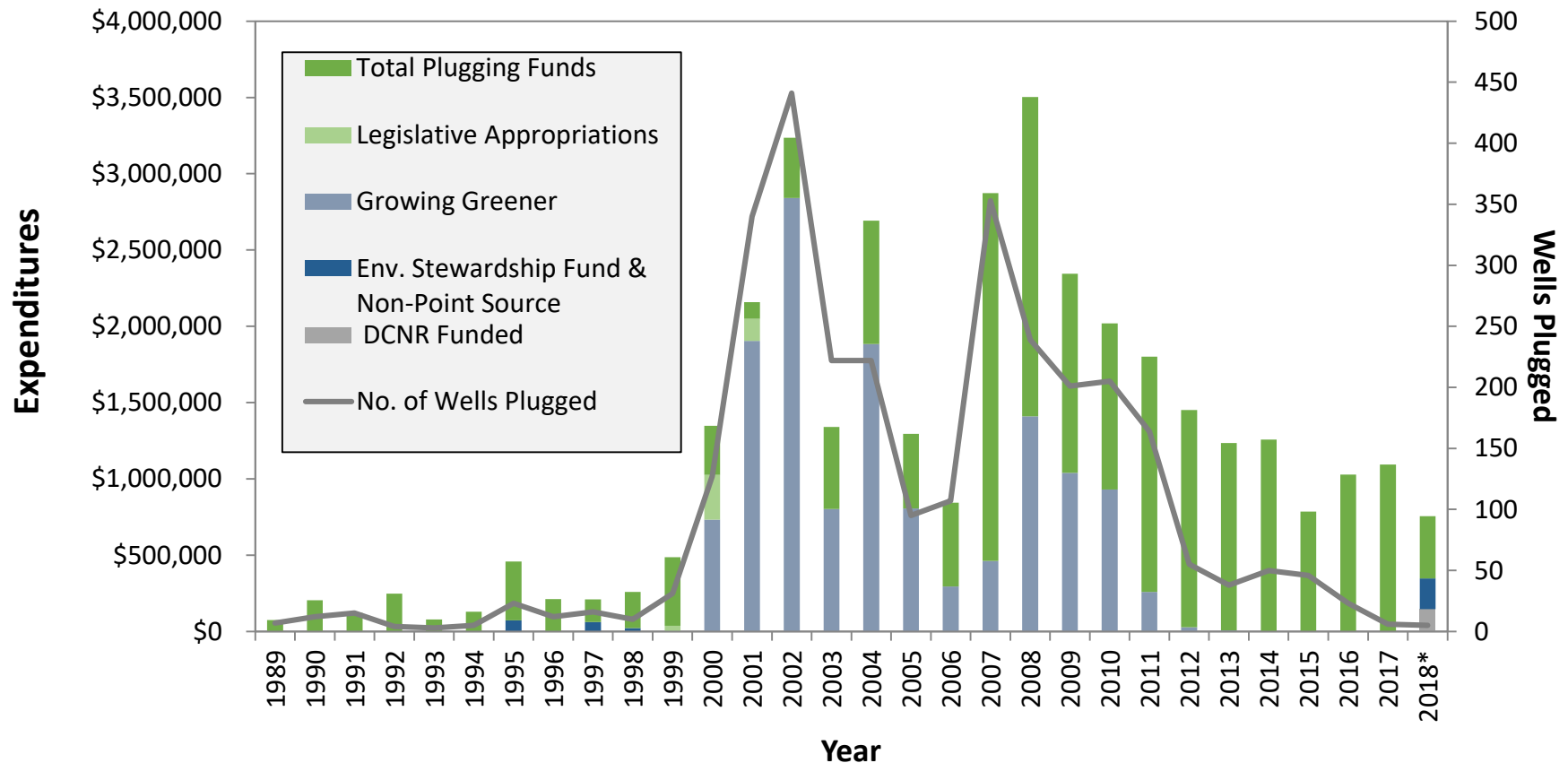
DEP Abandoned, Orphan, and Plugged Wells



Plugging Program Status Update

DEP Plugging Program Funding

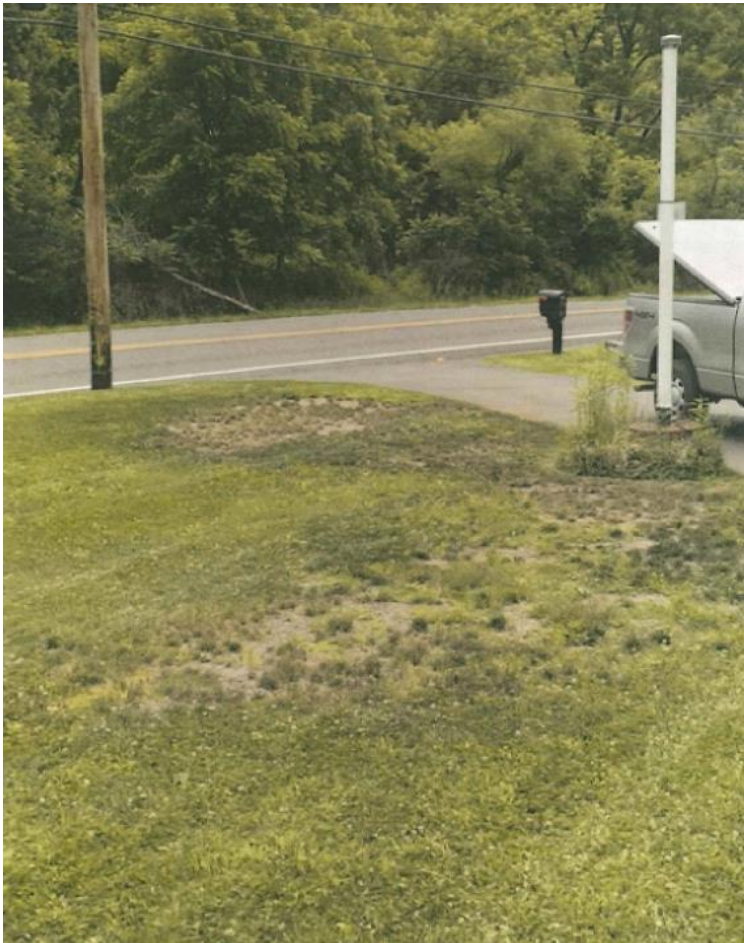
- Since 1985, DEP has received \$150-\$250 surcharges for every drilling permit



▶ Plugging Program Status Update

Recent Emergency Procurement Trends

- Antaki Well: \$14,000 for stray gas mitigation system



▶ Plugging Program Status Update

Recent Emergency Procurement Trends

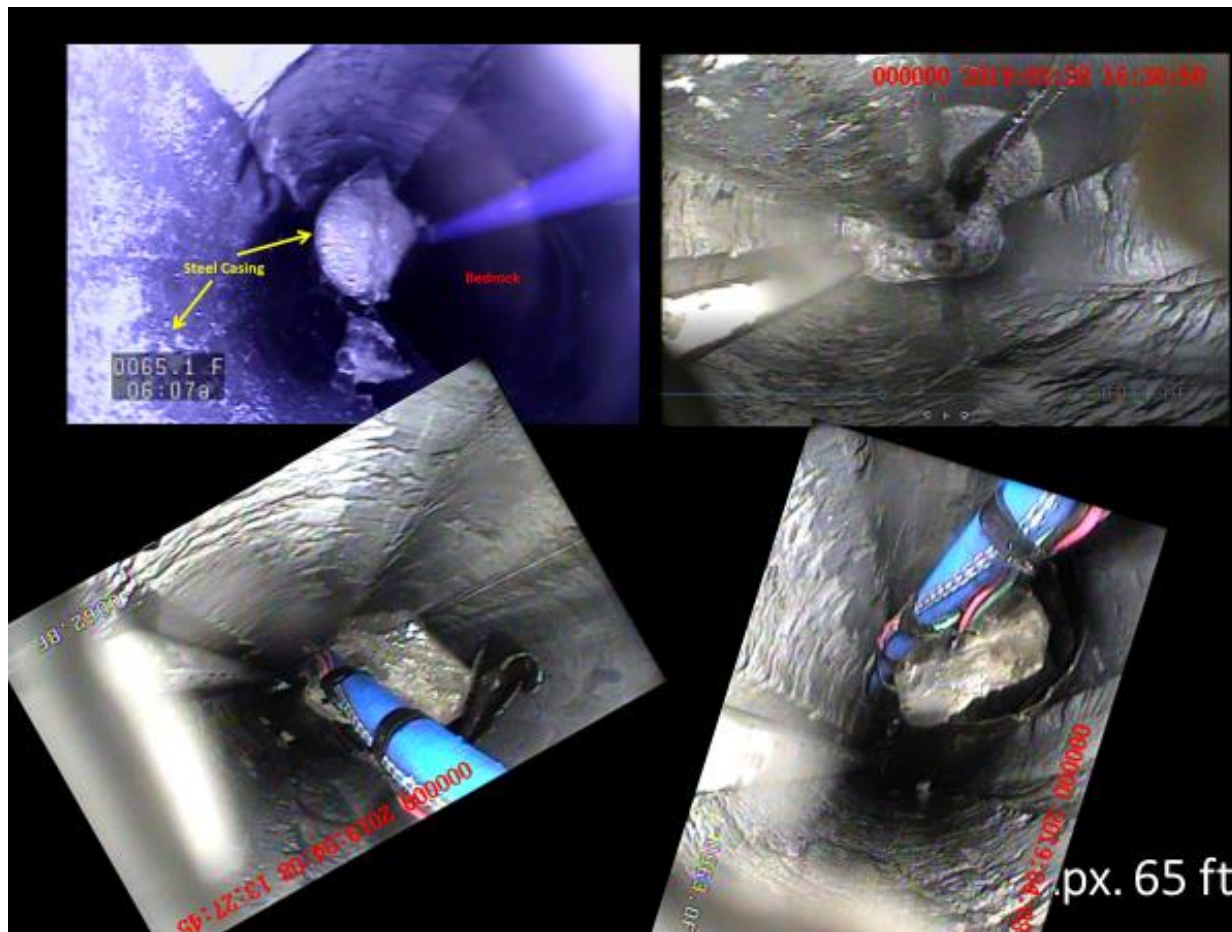
- Antaki Well: \$14,000 for stray gas mitigation system



Plugging Program Status Update

Recent Emergency Procurement Trends

- Antaki Well: Approximately \$350,000 for plugging



▶ Plugging Program Status Update

Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging



Plugging Program Status Update

Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging



▶ Plugging Program Status Update

Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging



Plugging Program Status Update

Recent Emergency Procurement Trends

- Monahan Well: \$160,000 for plugging



▶ Plugging Program Status Update

Recent Emergency Procurement Trends

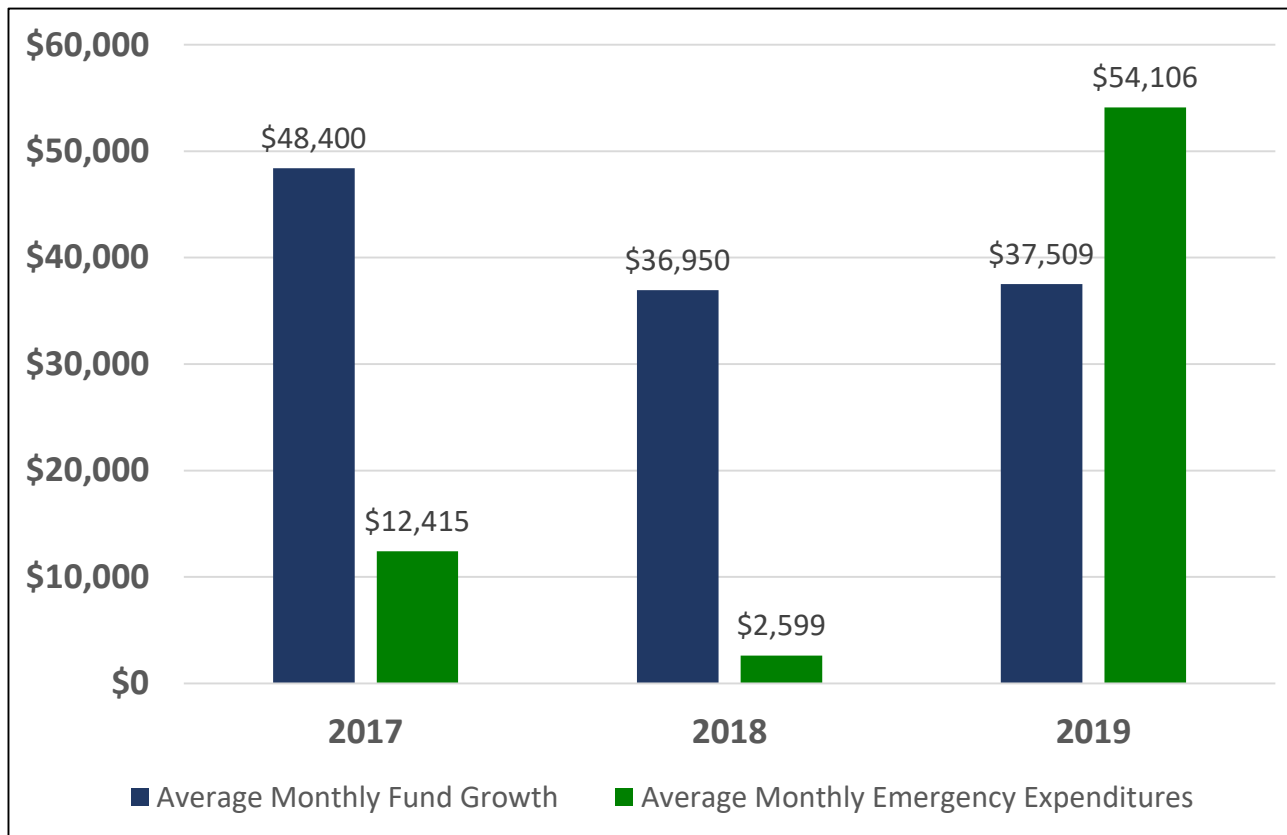
- Monahan Well: \$160,000 for plugging



Plugging Program Status Update

Recent Emergency Procurement Trends

- DEP's emergency procurement trends also suggest expenditures have the potential to exceed fund growth



Plugging Program Status Update

Mass Abandonment

- In 2018 two operators with major holdings have abandoned approximately 2,750 wells
- Tens of thousands of conventional oil and gas wells will eventually need to be plugged but they may not have a viable owner that can afford to plug them
- Bonding levels do not equate to actual plugging costs
 - \$2,500 single conventional well bond
 - \$25,000 blanket bond (unlimited number of conventional wells)
 - Thousands of wells are under a single blanket bond or have no bonds at all (Pre-Act wells)

Plugging Program Status Update

Crunching the Numbers

- There are more than 8,000 wells in DEP's Abandoned and Orphan Well database – DEP has the statutory authority to plug these wells
- Over the last four years, DEP has added 345 wells to its Abandoned and Orphan Well database
- Mass abandonment is likely to continue increasing DEP's plugging liability
- Since 1989, DEP has plugged a little over 3,000 wells

Plugging Program Status Update

Crunching the Numbers

- Dilmore et al. (2015) and Engelder (2017) have estimated that somewhere between 330,000 and 350,000 wells were likely drilled in the commonwealth between 1859 and 2016 – Kang et al.'s (2016) estimate more than doubles the upper end of this range
- DEP and the industry have plugged 65,000 wells between 1910 and 2016, but many of these wells have not been decommissioned in accordance with current standards
- Approximately 100,000 conventional wells are “active” and around 40,000 of these have never reported production – it is possible that the 40,000 wells will become future liabilities for the commonwealth
- Conservatively, these studies and data suggest that there are likely at least 200,000 additional legacy wells, many of which will require plugging as they are discovered

Plugging Program Status Update

Cost Modeling/Liability Forecasting

- A conservative estimate of \$33,000 per well has been derived from reviewing contract costs
- Liability forecasting changes significantly based on per-well cost assumptions
 - At \$33,000 per well, DEP's plugging liability ranges somewhere between \$280 million (8,500 wells) and \$6.6 billion (200,000 wells)

Emerging Environmental/Safety Issues

Plugging Effectiveness: Field Investigation and Statistical Analysis

- Conduct well site investigations utilizing high sensitivity gas monitoring equipment to determine if plugs are leaking
- Analyze field data and compare to other leaking plugged wells and non-leaking plugged wells to determine variables that may be influencing rate of plug failure



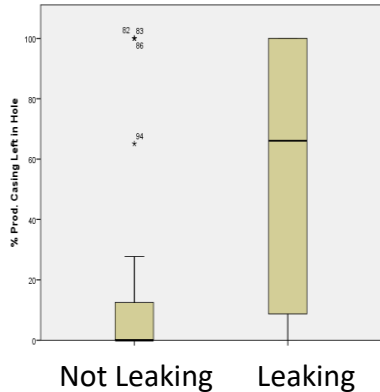
Emerging Environmental/Safety Issues

Statistical Testing

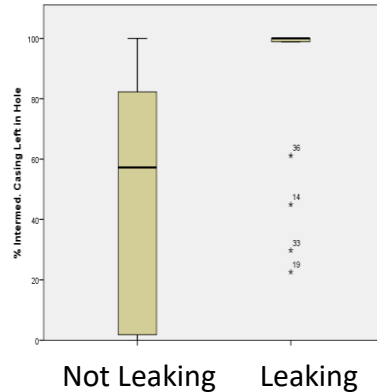
- Compared leaking well (n = 41) to confirmed non-leaking well data from BOGPPM Legacy Well Integrity and Emissions Study (n = 52) (GSA, 2017)
- Removed 2 Marcellus wells from leaking well data
- SPSS: One-Way ANOVA, Comparison of Medians, Mann-Whitney U, Kruskal-Wallis

Emerging Environmental/Safety Issues

% Production Casing Left



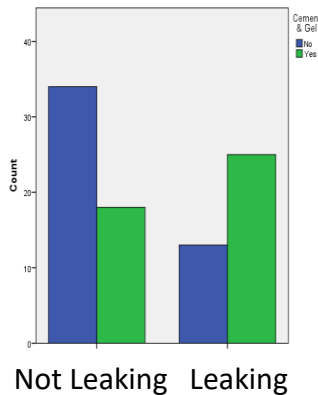
% Intermediate Casing Left



Box Plots Suggest:

- Leaking wells have substantially more production or intermediate casing left in the ground than non-leaking wells – differences are statistically significant ($p < 0.05$)

Cement & Gel



Bar Charts Suggest:

- Leaking wells have a greater ratio of cement & gel plugs

Emerging Environmental/Safety Issues

Shallow Charged Zones Possibly Attributable to Legacy Activities



Emerging Environmental/Safety Issues

Risks associated with Abandoned, Orphan, and improperly plugged wells can be compounded by mine-influenced water in areas of coal mining



Emerging Environmental/Safety Issues

Encroachment

- High population density areas/regions of active development may introduce intersections between legacy wells and occupied enclosed spaces
- During Phase I/Phase II site assessments, a thorough review of legacy development is critical for mitigating client liability
 - PA Geologic Survey Farmline Maps
 - PASDA
 - DEP Oil and Gas Mapping Tool
 - Local Government Resources
- The Good Samaritan Law affords liability relief for third parties who volunteer to decommission legacy wells for which there is no responsible party

Emerging Environmental/Safety Issues

Encroachment



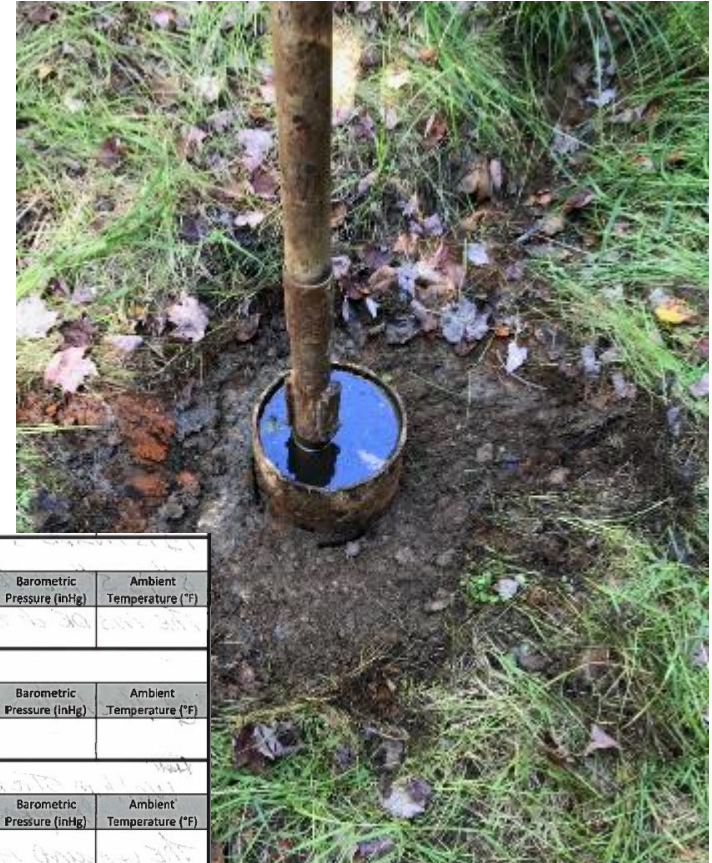
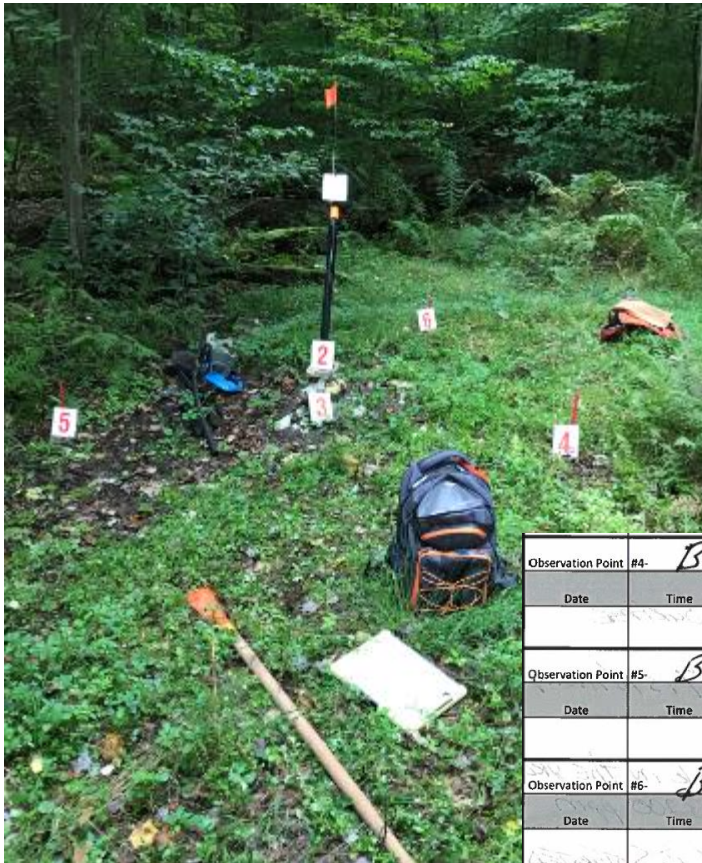
Emerging Environmental/Safety Issues

Improperly Decommissioned Gathering Systems

- Stubbed off segments of gathering lines have the potential to introduce stray gas into the subsurface if not properly decommissioned during well plugging
- Recent DEP field work has identified elevated soil gas concentrations in association with such systems

Emerging Environmental/Safety Issues

Improperly Decommissioned Gathering Systems



Observation Point	Date	Time	Gas Concentration	Concentration Unit (ppm or %)	Volume ft ³ /day	Barometric Pressure (inHg)	Ambient Temperature (°F)
#4- BAR HOLE #4			6620	ppm			
#5- BAR HOLE #5			7860	ppm			
#6- BAR HOLE #6			500	ppm			
#7- BAR HOLE #7 10' AWAY			360	ppm			

Abbreviations
OH- Open Hole

VPI- Venting Pipeline

Emerging Environmental/Safety Issues

Emissions

- McGill University

- Kang et al. (2016) found a high occurrence of leaking abandoned and plugged wells
- Isotopic signatures support deep, oil-associated origin
- In some cases, gas was found to be flowing through the soil beyond the footprint of the outermost well casing
- DEP is currently working to understand if Kang et al.'s (2016) emission regression model can be used as a risk-management tool

Emerging Environmental/Safety Issues

Cornplanter State Forest



Emerging Environmental/Safety Issues

Cornplanter State Forest

- DCNR Capitol Project
 - \$1.9 million budget
 - Earmarked for use in Cornplanter State Forest
 - Project scope includes decommissioning 64 shallow oil wells on state land
 - 500-1,000 feet deep
 - Spudded in 1920s – 1980s
 - Root cause: mass abandonment by Pennsylvania Operator
- Environmental improvement synergies: surficial oil contamination and hazards tied to infrastructure, and leaking wells

Cornplanter State Forest

- Preliminary leak rate information
 - 11 of 62 wells (18%) were determined to have measurable leaks
 - Methane flux estimates are cumulatively on tenths of cubic feet per day scale (hundredths of $\text{MTCO}_2\text{e}/\text{year}$)

Summary

- Pennsylvania has a significant history of legacy oil and gas development and the potential for hundreds of thousands of wells with no associated responsible party
- Unfunded plugging liability is currently estimated at \$280 million, but could be much higher – it is forecasted to grow
- An analysis of failed plugs suggests that further improvements may be necessary to ensure long-term plug integrity
- Legacy wells are contributing to environmental and public safety risks



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Oil and Gas Management

Thank You! Questions?

Seth Pelepko, P.G.

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Rewriting Pennsylvania's Legacy (dep.pa.gov/legacy_wells)