# Stream Monitoring to Identify Impacts of Oil and Gas Well Drilling in Allegany State Park Watersheds

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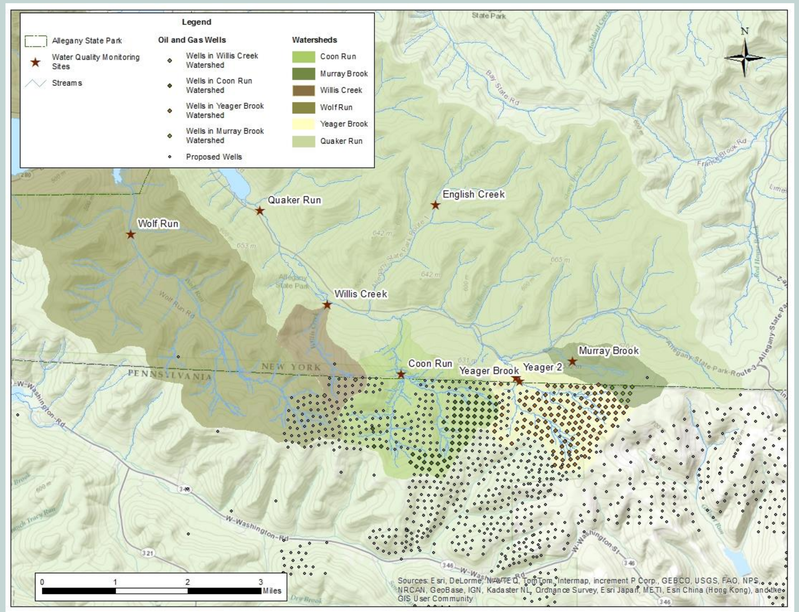
## Introduction

Beginning in 2010 the Pennsylvania Department of Environmental Protection issued hundreds of oil and gas well permits within the Allegheny National Forest which is adjacent to and includes several streams in the watershed of Allegany State Park, Cattaraugus County, NY. Based on the need to protect the water quality and aquatic ecosystems of New York's largest State Park, a stream water quality monitoring program was developed and initiated in May 2010. The program includes weekly monitoring of conductivity, temperature, salinity, pH, turbidity and other field observations in 7 streams. Since the beginning of this monitoring program significant oil and gas well and road development has occurred in the watershed of one of the streams – Yeager Brook, while the other watersheds have been less impacted or have remained relatively undeveloped offering an opportunity to compare impacts between the different intensities of oil and gas development.




**Proposed and active oil and gas wells in the Allegheny National Forest, PA, south of Allegany State Park, New York**

## Methods

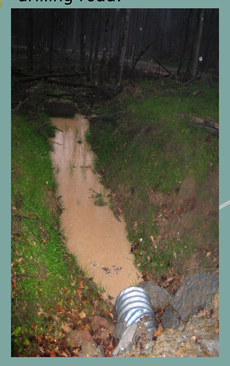
- 7 streams (6 with PA watersheds, 1 control)
- Weekly monitoring in summer, bi-weekly in winter
  - conductivity, temperature, salinity, pH, turbidity and other field observations
- 4 teams – formally trained on equipment and protocols
- Equipment calibration once per month
  - YSI 30, Hach 2100P Portable Turbidimeter
- Back up field work with lab samples
- Baseline Stream Biomonitoring in 2010 by NYS DEC
- Adaptive management


| Stream Name | Active Wells (drilled) | Current well density/km² | Proposed Wells (not drilled) | Projected well density/km² |
|---|---|---|---|---|
| Yeager Brook | 122 | 25.5 | 162 | 38.8 |
| Coon Run | 63 | 8.9 | 198 | 34.8 |
| Murray Brook | 9 | 4.4 | 34 | 77.6 |
| Willis Run | 3 | 1.3 | 23 | 39.1 |
| Wolf Run | 0 | 0.0 | 47 | 10.4 |
| English Creek | 0 | 0.0 | 0 | 0 |

Drilled and permitted wells by watershed and corresponding well density.

Turbid water from the Yeager Brook watershed flowing into Quaker Lake.

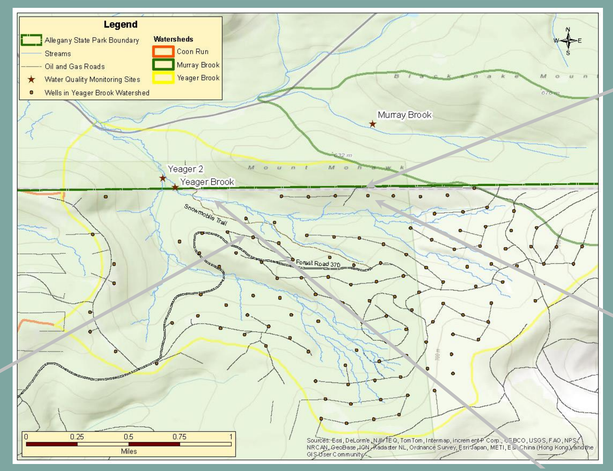
Failed erosion control (hay bale), allowing turbid water to run off drilling road.



### Pollution Events

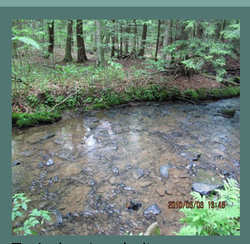
5 single-day pollution events involving storm water runoff from well sites and roads reaching Yeager Brook have been documented. These events resulted in Yeager Brook having 2-3 times the normal levels of turbidity or suspended solids which violated NYS narrative water quality standard (6NYCCRR§ 703.2). NYS DEC has commenced enforcement actions against the energy company responsible for the wells. Enforcement actions and fines are currently pending.

## Results and Discussion




**Oil and gas well sites and newly constructed roads in the Yeager Brook watershed.**

Drill cuttings in Yeager Brook, turbidity = 137 NTU



Typical water clarity.

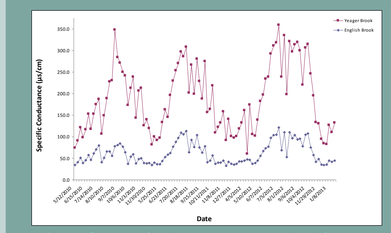
Turbid water in Yeager Brook.

Turbidity, a measure of total suspended solids, in Yeager Brook typically ranges from 3-10 NTUs, and increases to 18-137 NTUs during runoff (pollution) incidences.

Muddy road with no erosion control.

Muddy drilling road, pad site and pit.

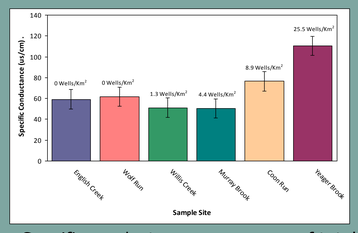
Turbid water in Yeager Brook.



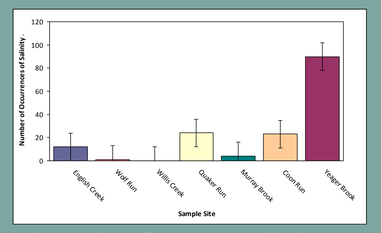

- Specific conductance is consistently higher in Yeager Brook than in the control site, English Creek.

| Stream Name | Active Wells | Well Density wells/km² | Mean Specific Conductance | Percent of Salinity > 0 | Mean Turbidity | pH |
|---|---|---|---|---|---|---|
| Yeager Brook | 122 | 25.5 | 109.90 | 47.0 | 7.46 | 6.9 |
| Coon Run | 63 | 8.9 | 76.21 | 20.2 | 7.81 | 6.7 |
| Murray Brook | 9 | 4.4 | 50.14 | 3.6 | 4.03 | 6.8 |
| Willis Run | 3 | 1.3 | 50.92 | 0.0 | 3.06 | 6.6 |
| Wolf Run | 0 | 0.0 | 61.60 | 1.1 | 4.35 | 6.7 |
| English Creek | 0 | 0.0 | 58.85 | 0.0 | 6.13 | 6.7 |

- 122 wells have been drilled in the Yeager Brook watershed in recent years, with a well density of 25.5 wells/km². Each well has a well pad of ~½ acre and several associated roads.
- The mean pH in Yeager Brook has been increasing and is now significantly higher than any other stream ($p<0.05$).
- Coon Run has 63 wells (8.9 wells/km²) in its watershed, a medium density compared to other streams. The mean turbidity was the highest in this watershed.




- Specific conductance, a measure of total dissolved solids, was significantly higher in sites with higher well density (>20 wells/km², Yeager Brook) than those with no or low well density ($p<0.05$).
- Specific conductance in Coon Run was slightly higher than in streams with lower well density.




- The number of occurrences of salinity in Yeager Brook is significantly higher than any other site ($p<0.05$).
- Salinity in Yeager Brook was >0, 47% of the time.
- Salinity in Coon Run was >0, 20% of the time.

## Conclusion

- Potential pollution near oil and gas wells can result from drilling fluids, brine, and flowback fluids (Swistock, 2010) and sediment from earth moving activities.
- Some characteristics of drilling fluids include: very high salts such as chlorides, high total dissolved solids (conductivity), and sediment (turbidity or total suspended solids) (Swistock, 2010).
- A study near Marcellus gas wells in Northeastern PA by Drexel University (2013) indicated that high well density is significantly associated with elevated levels of chemical contaminants including specific conductance and total dissolved solids. This relationship was not observed in watersheds with a low well density. Also observed was the degradation of macroinvertebrate community structure in the watersheds with high well density.
- Our data are in agreement with this study suggesting that with increasing well site and road density, there are increases in chemical contaminants. These impacts are occurring for both the conventional wells in our study and the larger but lower density Marcellus wells studied by Drexel.
- In addition to the potential for very significant environmental impacts from spills or blowouts, our data suggest that there are long term cumulative effects to water quality in watersheds with high or medium well density.
- A similar density of wells are permitted in the other watersheds, but very few wells have been drilled to date. It is anticipated that the other streams in this study are likely to experience similar trends as additional wells are drilled.
- The monitoring program is ongoing and State Parks will continue to work with NYS DEC in reporting pollution incidents. Macroinvertebrate samples will be collected again in 2013 to help identify any changes in the biotic community.

### Acknowledgements

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### Literature Cited

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