Led by a Partnership between:

The Ohio State University

West Virginia University

MSEEL & USEEL
Led by a Partnership between:

A Collaboration of Universities, Private and Public Organizations, working together to improve production efficiency and environmental efficacy of shale energy development through field testing.
Motivation: Opportunities and Challenges

Opportunities:
- Workforce
  - Direct employment in oil and gas
  - New business development
- Economic Drivers
  - Difficult economic climate
  - Billions Invested in leases and infrastructure
  - Production numbers Impressive

Challenges:
- Public infrastructure
- Market development
- Environment
  - Surfaces and subsurface water protection
  - Air
  - Wildlife
A Field Lab in the Utica Shale to improve production efficiency
find solutions to potential environmental problems

Total Funding: $9,137,479

Primary Research Partners: WVU, EFD

Other Partnering Institutions & Companies

• WVU
• Miami (Ohio)
• Ohio University
• University of Calgary
• Environmentally Friendly Drilling (EFD)
• Texas A&M (through EFD)

• CSI Technologies
• General Synfuels Inc.
• TGS International
• Newpark
• Ohio Geological Survey
**General Approach**

<table>
<thead>
<tr>
<th>DRIVING GOAL</th>
<th>NEEDED TO ADDRESS GOALS</th>
<th>TASK TO ADDRESS THE GOAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increase production efficiency</td>
<td>• Better understand the geology (natural fractures, permeability, oil generation, rock diagenesis)</td>
<td>• Rock sampling (Core, chips)</td>
</tr>
<tr>
<td>• Improve production longevity</td>
<td>• Understand natural, injected, and returned Fluids</td>
<td>• Collecting and analyzing natural, injected, and returned Fluids</td>
</tr>
<tr>
<td>• Reduce Injected Fluids</td>
<td>• Understand and map induced fractures</td>
<td>• In situ borehole measurements (geophysical well logging, micro-seismic measurements, seismic imaging, hole-to-hole geophysics)</td>
</tr>
<tr>
<td>• Improve environmental efficacy</td>
<td>• Understand natural and introduced microbial activity</td>
<td>• Fiber optic measurements in the lateral</td>
</tr>
<tr>
<td></td>
<td>• Improved technologies for environmental measurements for pre, During, and Post drilling</td>
<td>• Other in-situ measurements for fracture definition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Documented and verified surface air and water, groundwater measurements (baseline to post production)</td>
</tr>
</tbody>
</table>
Pre-Drilling Surface Research

- Subsurface characterization
  - Seismic reflection imaging
  - Induced seismicity measurements
- Baseline environmental monitoring
  - Ecosystem/biological
  - Surface water
  - Air
  - Groundwater
Surface and Subsurface Data Collection and Analysis during Drilling, Construction, and Stimulation of Horizontal Well

Subsurface Objectives:

- Frac induced fractures frequency/orientation – conventional geophysical logs, image logs, cores

- Fluids – sampling of fluids input and returned, interstitial analysis of core for connate water

- Microbiology (natural & introduced) – core/cuttings

- Natural fracture frequency, relative age, and orientation (cores, geophysical/imaging logs, cross hole)

- Characterize geology in the Utica (pore space, mineral alteration, pore connectivity, nano-micro fracturing, chemistry, etc.) – core/cuttings analysis (SEM, imaging, neutron scattering, etc.), geophysical well logs & borehole imaging

- Rock strength (Utica) – borehole logs, cores
Subsurface Options

Subsurface and subsurface Methods:

- Geophysical well logging
- Coring (whole core, sidewall pressure cores)
- Crosshole (seismic/vibrational, DAS/IDAS detection, conventional seismic sensors and detectors in vertical hole and on the surface)
- Passive seismic – DAS and IDAS

Utica Only: Production Efficiency Testing (spacing and fracture effectiveness)

Utica + Marcellus: Fracture mapping
Operations: Research Lab Management Norms & Procedures

• Data Security, storage, interpretation, review, and appropriate communication of results is critical to the integrity of the project

• Safety is the #1 Priority in the field (Safe Land Training, minimize “Civilians” on Site & Pad)

• Maintain Normal Operations (minimize downtime, maintain production)

Advisory

• Primary Advisory & Oversight (OSU, WVU, NETL, E&P/Drillers, Community member, Science Advisory Chair)

• Science Experiment Oversight Advisory Committee (Operator, Ohio State, NETL, Primary Site Contractors)

• External Advisory Committee (Community, NGOs, Industry, Academia)
Next Steps:

1. Establish site & industry partner
2. Establish advisory boards
3. Institute process, procedures, and QA/QC

Research:

- 6 months to 1 year of environmental baseline studies
- Drilling Research (geology, well optimization, wellbore Integrity, seismicity, water)
- Post Drilling environmental measurements


4 Areas of Cooperation:
A. Marketing and Production
B. Workforce Development
C. Transportation and Infrastructure
D. Research: The Tri-State Region is home to numerous world-class academic institutions of higher learning that are actively involved in advancing cutting-edge research to help capitalize on shale gas opportunities.
Building Partnerships for Research, Education, and Outreach

“50,000 foot” Outcomes

- Advance Technologies
- Advance Education
- Ensure Integrity of Results
- Establish Trust & Partnerships