Environmentally Friendly Drilling Systems Program

Unbiased Data from an Unbiased Source
EFD Team

Together
Everyone
Achieves
More
Awards & Recognition

EFD is the #1 Program in the Energy Industry Developing Innovative Environmental Technology

Rig Zone

Best Outreach Program
Aramco iExplore: Energy – Aramco
EMSI: High-Octane Tech Fest – Weatherford
Environmentally Friendly Drilling Virtual Site – Houston Advanced Research Center
Geoscientists Without Borders – Society of Exploration Geophysicists
Veterans Resource Group – Baker Hughes Incorporated

Best Health, Safety, Environment / Sustainable Development - Onshore Award
CleanSpacer™ III Spacer Fluid – Halliburton
Electro Water Separation (EWS) – OriginClear
Envirolift – Weatherford International plc

Environmentally Friendly Drilling Systems Program - Houston Advanced Research Center
Modular Frac-flowback & Produced Water Treatment train technology – NSERC / ARIS-ET

To further help reduce flaring of the Environmentally Friendly Drilling (EFD) program, Gulf Coast Clean and CleanTherm partnered with Envirolift to create the ElectraTherm Power Generator™, a hybrid distributed power plant that captures the natural gas flare heat and converts it into electricity and reduces the amount of flaring. ElectraTherm Power Generator™ captures the heat from a typical natural gas flare and converts it into electricity and reduces the amount of flaring. The boiler heats water to run the Power Generator™ and produces electricity that is used for on-site power. The pilot system operated with an estimated on-stream reliability of 90% or better and showed average estimated reductions in carbon monoxide of 80 percent, nitrogen oxides (NOx) of 80 percent and VOCs of 90 percent compared to flaring.
Changing US Energy Mix

Energy consumption in the United States (1776-2015)

United States primary energy consumption by source, 2014-15

U.S. energy production (2010-40)

U.S. energy consumption (2010-40)

U.S. natural gas production by source, 1990-2040
Production from Hydraulic Fracturing

U.S. natural gas production by source, 1990-2040

trillion cubic feet

history  projections

shale gas and tight oil plays

Hydraulically Fractured

tight gas

Lower 48 states offshore all other
New Record!
Utica Shale

Purple Hayes No. 1H
Guernsey County, Oh.
Longest lateral drilled onshore United States
Lateral length: 18,544 feet (drilled to TD in 17.6 days)
Total measured depth: 27,048 feet
Frac stages: 124 plug-and-perf at 150-foot spacing (completed in 23.5 days)
Total drilling and completion cost = $854/foot of lateral
Colorado Energy

Colorado Energy Consumption Estimates, 2014

- Coal
- Natural Gas
- Motor Gasoline excl. Ethanol
- Distillate Fuel Oil
- Jet Fuel
- LPG
- Residual Fuel
- Other Petroleum
- Nuclear Electric Power
- Hydroelectric Power
- Biomass
- Other Renewables
- Net Interstate Flow of Electricity

Source: Energy Information Administration, State Energy Data System

Colorado Energy Production Estimates, 2014

- Coal
- Natural Gas - Marketed
- Crude Oil
- Nuclear Electric Power
- Biofuels
- Other Renewable Energy


- Natural Gas-Fired
- Coal-Fired
- Hydroelectric
- Other Renewables
Top 20 in 2014

<table>
<thead>
<tr>
<th>Rank</th>
<th>Operator</th>
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<tr>
<td>1</td>
<td>WPX Energy</td>
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<tr>
<td>2</td>
<td>Encana</td>
</tr>
<tr>
<td>3</td>
<td>Occidental Petroleum</td>
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<tr>
<td>4</td>
<td>ExxonMobil/XTO Energy</td>
</tr>
<tr>
<td>5</td>
<td>Chevron</td>
</tr>
<tr>
<td>6</td>
<td>Bill Barrett Corporation</td>
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<tr>
<td>7</td>
<td>Ursa Operating</td>
</tr>
<tr>
<td>8</td>
<td>Caerus</td>
</tr>
<tr>
<td>9</td>
<td>Piceance Energy LLC</td>
</tr>
<tr>
<td>10</td>
<td>Wexpro</td>
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<tr>
<td>11</td>
<td>Noble Energy</td>
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<tr>
<td>12</td>
<td>Linn Energy</td>
</tr>
<tr>
<td>13</td>
<td>Marathon Oil</td>
</tr>
<tr>
<td>14</td>
<td>Black Hills Plateau Production Co.</td>
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<tr>
<td>15</td>
<td>SG Interests I, LLC</td>
</tr>
<tr>
<td>16</td>
<td>Koch Exploration Co.</td>
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<tr>
<td>17</td>
<td>Axia Energy</td>
</tr>
<tr>
<td>18</td>
<td>Whiting Petroleum</td>
</tr>
<tr>
<td>19</td>
<td>BOPCO LP</td>
</tr>
<tr>
<td>20</td>
<td>Foundation Energy Management</td>
</tr>
</tbody>
</table>

2014 Production

- Oil Sales: 7,207,533 Bbls
- Gas Sales: 729,515,167 Mcf
Late Cretaceous Paleogeography showing extent of Western Interior Seaway during the Late Campanian and a depiction of the Late Cretaceous depositional environment in Utah/Colorado.

Stratigraphic cross section – distribution of deposits

Type Logs for Lower Williams Fork Formation in SE Piceance Basin
EFD Field Trial Sites

Focuses on field trials, documenting and reporting.

EFD provides unbiased science to address environmental and societal aspects in all oil and gas activities.
Environmental Risks
In Modern Well Design Ground Water is Multiple Protected

Approximately 8,000 feet To Shale

Multiple Layers of Casing and Cement Intended to Isolate Drinking Water from Completion and Production Fluids
Shale Gas Production and Theoretical Possible Contamination Risks

- Fugitive emissions of methane
- Impact on water resources from water used in hydraulic fracturing
- Contamination of groundwater due to poor well design or failure
- Contamination of groundwater due to mobilization of solutes or methane
- Contamination of soil, surface or groundwater due to spills of chemicals or return fluids
- Inadequate transport or processing of produced gas
- Inadequate transport or treatment of waste waters
MIT Study (2011) on Shale Gas Accidents in the US

Three studies combined - all reported US cases from 2000-2010 analyzed


Source 2: Hydraulic Fracturing: Preliminary Analysis of Recently Reported Contamination; September 2009; Prepared for: Drinking Water Protection Division (DWPD) Office of Ground Water and Drinking Water (OGWDW) U.S. Environmental Protection Agency (EPA); Prepared by The Cadmus Group Inc.

Source 3: Fractured Communities — Case Studies of the Environmental Impacts of Industrial Gas Drilling: September 2010; Craig Michaels, Program Director; James L. Simpson, Senior Attorney; William Wegner, Staff Scientist; Watershed

<table>
<thead>
<tr>
<th>Type of incident</th>
<th>Number reported</th>
<th>Fraction of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater contamination by natural gas</td>
<td>20</td>
<td>47%</td>
</tr>
<tr>
<td>On-site surface spills</td>
<td>14</td>
<td>33%</td>
</tr>
<tr>
<td>Off-site disposal issues</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>Water withdrawal issues</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Air quality</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Blowouts</td>
<td>2</td>
<td>4%</td>
</tr>
</tbody>
</table>

40,000+ shale gas wells drilled in the US during this period!
• Credible, transparent, understandable
• Withstands peer review
• Looks holistically at air, land, water and biodiversity
• Maintains strong linkages to research
• Monitors regional stressors
• Takes advantage of local expertise
## Monitoring Scope of Work

<table>
<thead>
<tr>
<th>Data</th>
<th>Reason</th>
<th>Location</th>
<th>Measurement Principle</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Quality/Particulate</strong></td>
<td>Exhaust gases from operations, methane from production, heavy traffic along transport routes</td>
<td>Close to pads, close to surface installation, along heavy traffic transportation routes</td>
<td>Monitoring stations measure CO, NO2, O3, SO2, H2S, methane, particulates</td>
<td>Automated</td>
</tr>
<tr>
<td><strong>Water Quality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Water</td>
<td>Contamination from spills during drilling, production, transport, treatment</td>
<td>Close to pads, along transportation routes, close to populated and agricultural areas, in natural reserves, at sewage plants</td>
<td>Sample containers, laboratory testing on chemistry, total metals, organics, hydrocarbon</td>
<td>Manual</td>
</tr>
<tr>
<td>Ground Water</td>
<td>Contamination from surface spills, bad cementing, casing integrity, fracture migration</td>
<td>Close to pads, close to agricultural and populated areas, in natural reserves</td>
<td>Sample containers, laboratory testing on chemistry, total metals, organics, hydrocarbon</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Water Quantity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Streams/Volumes</td>
<td>Withdrawal for drilling &amp; fracturing</td>
<td>Rivers, streams, etc.</td>
<td>Level/velocity</td>
<td>Automated</td>
</tr>
<tr>
<td>Ground Water Level/Streams</td>
<td>Withdrawal may influence ground water level</td>
<td>Close to pads, close to agricultural and populated areas, in natural reserves</td>
<td>Level measurement, different stream flow measurement methods available</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Soil Quality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deposit of contaminated material</td>
<td>Close to pads</td>
<td>Sample containers, laboratory testing on physical, chemical &amp; biological content</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>Engines required during drilling, production, transport</td>
<td>Close to populated areas</td>
<td>Decibel meter</td>
<td>Automated</td>
</tr>
<tr>
<td><strong>Biodiversity</strong></td>
<td>General environmental impacts</td>
<td>Rivers, lakes, forests, agricultural areas, natural reserves</td>
<td>Taxonomic richness</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Seismic Waves</strong></td>
<td>Hydraulic fracturing, heavy transport</td>
<td>Close to pads, close to other industry, close to populated areas</td>
<td>Geophones</td>
<td>Automated</td>
</tr>
<tr>
<td><strong>Tectonic Movements</strong></td>
<td>Production and re-injection</td>
<td>Close to pads</td>
<td>Optical level instrument</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Street Conditions</strong></td>
<td>Heavy Traffic</td>
<td>Site access roads</td>
<td>Visual, photographic</td>
<td>Manual</td>
</tr>
<tr>
<td><strong>Traffic Density</strong></td>
<td>Liquids and equipment transport</td>
<td>Site access roads</td>
<td>Video traffic detection</td>
<td>Automated</td>
</tr>
<tr>
<td><strong>Pipeline Integrity</strong></td>
<td>Corrosion, erosion</td>
<td>Between check stations</td>
<td>Pressure abnormalities</td>
<td>Automated</td>
</tr>
</tbody>
</table>
Water Management – West TX

Assisted with development of water management strategies.

Delta Pressure as a Function of Total Volume

Microfiltration – Permeate Flow Rates

October, 2014
NanoStone Field Trial
Questions about Dual Fuel vs. Diesel

♦ Tail Pipe Emissions
  - NO\textsubscript{x}
  - CO
  - CH\textsubscript{4} – Non-Combusted Methane (NCM) aka “Methane Slip”
  - NMHC – Non-Methane Hydrocarbon
  - CH\textsubscript{2}O – Formaldehyde (Carcinogen)
  - Soot – Main Component of Particulate Matter (PM)

♦ Crankcase Emissions

♦ Emission Control Device
  Diesel Oxidation Catalyst (DOC) Efficiency
D&C Ops: Field Setup

Instruments / Sampling
Determined emission differences between hydraulic fracturing engines powered by diesel and engines powered with natural gas/diesel dual fuel.

- Natural gas dual fuel engine does not have clear advantages in emissions compared with diesel, further studies needed
- Un-combusted Methane is up to 30% of total natural gas fuel supply under high substitution rate, reduces fuel economy
- Further research is needed to address these issues
  - Have tested four different pump engines
Emissions from Hydraulic Fracturing Engines

Gulf of Mexico report

Industry hit with BSEE Well Control Rule amid severe budget cuts, contract terminations, project cancellations - p14

Study looks at emissions, economic characteristics of dual-fuel, high-horsepower engine used in hydraulic fracturing application

Measurements of NOx, soot and non-combusted methane were collected over progression of engine loads, speeds from 1,500-1,950 RPM
Successfully developed and tested technology to capture VOC’s. System tested at CITGO Refinery.

- Currently testing at production stock tank.

**Removal Efficiency during field test period**

<table>
<thead>
<tr>
<th>Sampling Dates</th>
<th>July 3 - July 4</th>
<th>July 4 - July 5</th>
<th>July 5 - July 6</th>
<th>July 6 - July 7</th>
<th>July 7 - July 8</th>
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</thead>
<tbody>
<tr>
<td>Data-log</td>
<td>Inlet</td>
<td>Outlet</td>
<td>Inlet</td>
<td>Outlet</td>
<td>Inlet</td>
</tr>
<tr>
<td>Peak (ppm)</td>
<td>15000</td>
<td>3725</td>
<td>1805</td>
<td>321</td>
<td>243</td>
</tr>
<tr>
<td>Minimum (ppm)</td>
<td>66</td>
<td>5</td>
<td>175</td>
<td>17</td>
<td>96</td>
</tr>
<tr>
<td>Average (ppm)</td>
<td>4600</td>
<td>1443</td>
<td>318</td>
<td>75</td>
<td>159</td>
</tr>
<tr>
<td>% Removal Efficiency (Based on Average)</td>
<td>69</td>
<td>76</td>
<td>88</td>
<td>91</td>
<td>96</td>
</tr>
</tbody>
</table>

% RE Average** | 84 |
Emission Characterization

• Open Path Fourier Transform Infrared Spectrometer, with integrated weather station in combination with a thermal imaging camera were used to collect emissions from an aging production facility.

• The facility known as “Central” was located in Dimmit County Texas on SHAPE ranch.
Emission Characterization

- Data was collected monthly from March – November 2015
- 256 analytes were measured simultaneously during each sampling event
- Approximately 50 analytes were detected and quantified above trace

SHAPE Ranch Sampling Team
Reducing Dust
Flaring Issues, Solutions, and Technologies (FIST)

Develop and Demonstrate Technologies to monetize stranded gas and to reduce or eliminate gas flaring and/or methane emissions associated with gas production.
Field Test – Flaring Mitigation

**Objectives**
Identify & test simple/robust technologies to reduce flaring

**Location**
- Field trials in the Bakken

**Status**
- ORC equipment installed, commissioned, operated.

Technology identified through assessment of RPSEA technologies.
Power From Produced Water

(Previous RPSEA Funded Effort)
The ORC

- Recover Heat from Flare Gas
- Use the heat to drive an Organic Rankine Cycle System
- Use pressure of expanded working fluid to spin a generator
Provide Beneficial Use for Flare Gas

Gas Fueled Boiler

kW Output

Reduced Flaring
Field Test

Trial Objectives

• Test simple/robust ORC Technology to reduce flaring
• Demonstrate ability of the Power + to produce electricity from flare
• Demonstrate electricity production does not interfere with well operations
• Determine emissions offset and prove technology works

• 90 day pilot trial on the HA-ROLFSRUD site
• July 29, 2015 to Nov 11, 2015
• Emissions testing completed Oct 2015
Results

Total Run Time: 1857 HR
Total kWh Produced: 99,000

Emission Reduction

October 2015

CO2 avg ↓ 89%
NOx avg ↓ 48%
VOC avg ↓ 93%
Summary

• The trial has demonstrated that a beneficial use of flare gas is possible
• The system requires very little maintenance with approx. 1 man hour/week
• The Power+ system is an economical alternative to curtailing oil production due to flaring regulations
• Emissions can be reduced significantly
Development of LUSSIT

- GIS based analytical tool that aggregates spatially distributed attributes and considerations in the region(s) of interest to support site selection decisions.
- Tool now commercial!

Tools for planning and evaluating infrastructure placement anyone can use

Simulate spill flow and termination scenarios
D&C Ops EFD Scorecard
(www.efdscorecard.org)

EFD Facts

<table>
<thead>
<tr>
<th>Max</th>
<th>Score</th>
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<tbody>
<tr>
<td>AIR</td>
<td>13</td>
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<tr>
<td>WATER</td>
<td>21</td>
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<tr>
<td>SITE</td>
<td>18</td>
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<tr>
<td>WASTE MANAGEMENT</td>
<td>20</td>
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<tr>
<td>BIODIVERSITY/HABITAT</td>
<td>15</td>
</tr>
<tr>
<td>SOCIETAL</td>
<td>13</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
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</table>

Project:
Location:
Ecosystem:

We regularly work with our industry peers on biodiversity-related issues. For example, we are an active member of the Biodiversity and Ecosystem Services working group of IPECA, the global oil and gas industry association for environmental and social issues. In October we helped lead and had several staff members participate in the working group's first peer-to-peer training workshop on managing biodiversity and ecosystem services in the oil and gas industry.

We also participate in the 2016 Sector Biodiversity Initiative (OSBI), a partnership of IPECA, the International Council on Mining and Metals and the Equator Principles Association. This initiative brings the mining, oil and gas and financial sectors together to develop and share good practices for safeguarding biodiversity and ecosystems. In 2014 the OSBI published a toolkit designed to help align project development, biodiversity impact management, and financial timelines and milestones.

Hess is also a sponsor and active member of the Environmentally Friendly Drilling EFD program. The EFD program is a partnership among multiple oil and gas companies, associations and environmental organizations. It is coordinated by the Houston Advanced Research Center. Its aim is to provide superior science and develop solutions to address environmental hazards associated with oil and gas development.

For example, the EFD developed a protocol that provides oil and gas companies with a means for objectively assessing and community-improving their environmental performance and that of their service providers. In 2014 we used the protocol to assess and improve...
1. Perception is a key factor in explaining:
   a. attitudes toward, and
   b. actions taken – either in support of or opposition to –

   the development of oil and gas.

2. Transparent communication between/ among all stakeholders is paramount
   a) Potentially positive aspects and negative consequences
   b) Industry – share more information about shale gas technologies with government and regulatory officials and the general citizenry

3. Probability of risks exists
   • Of rapid industrialization (boom and bust)
   • Of uneven distribution of cost and benefit
   • Of social-psychological stress
Environmental Friendly Drilling Rig
# Technology Transfer

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<td>Exhibits</td>
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<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2016
- July  *Nominated* – Environmental Partnership Category, IOGCC Chairman’s Stewardship Awards

2015
- October *Oil and Gas Awards* – VZ Environmental Award for Excellence in Environmental Stewardship
- October *Finalist* – Best Health, Safety, Environmental Program – Onshore, World Oil Awards

2014
- November *Nominated – Protection of the Environment Prize*, Eni Award
- October *Finalist – Best Outreach Program*, World Oil Awards
- August *Nominated* – Energy Education Category, IOGCC Chairman’s Stewardship Awards
Intermountain Oil & Gas Best Management Practices Project

http://www.oilandgasbmmps.org
Intermountain Oil & Gas BMP Project

- Geographic Scope
  - CO, MT, NM, UT, WY
  - Beyond the Region
- Databases (searchable)
  - BMPs (>10,000)
  - Bibliography (> 800)
- Laws and Regulations (LawAtlas)
- Website Background Materials
  - Resource Pages
  - Law and Policy (Federal, state, local, tribes)
- Research Services
- Workshops
**Water Quality**

Impacts of oil and gas development on water quality are a concern across the Intermountain West. Of particular concern are: stormwater runoff from construction activities, pollution from pits, hydraulic fracturing, and use and disposal of CIP produced water. The following resources provide an introduction to the problems and best practices for each of these issues.

For a complete overview of the Clean Water Act, as it addresses these issues visit the [Red Lodge Clearinghouse](#).

**SOURCE WATER PROTECTION**

Drinking water comes from both ground water and surface water sources. While all fresh water is a precious commodity in the arid West, drinking water sources deserve special protection. Many activities, including oil and gas development, can deplete or contaminate drinking water sources. Surface water can be contaminated by stormwater runoff and spills. Ground water can be contaminated through surface spills, leaching waste pits, or poor disposal practices. In rare circumstances, a poorly constructed oil and gas well may allow gas and other pollutants to escape due to incomplete casing or cement failures. On a national level, EPA provides a variety of resources for mapping source water areas, assessing the potential for contamination, and planning for source water protection. For information on protecting ground water sources during underground injection disposal of wastewater, see the [EPA UIC Class II webpage](#) or see "Disposal issues" on our Water Quantity Resource page.

**STORMWATER RUNOFF**

Pollution from stormwater is an issue with all types of development from urban to rural areas. Regulation of stormwater discharges from oil and gas exploration, production, processing and treatment activities has been particularly controversial in the last few years. Resources on EPA's web pages address both the problem and some of the solutions.

**State by State**

**Comparative Legal Data**

Improved technological development include new ways to produce oil and gas. Information Administration analyzed production boom states, Alaska, Arkansas, California, Colorado, New York, North Dakota, Ohio, Utah, West Virginia, and Wyoming, and natural gas by the end of the year development in regions unsuitable for conventional drilling. Risk of contamination in areas where directional drilling is utilized. Rapid development and suburban areas, coupled with a boom in energy, can lead to soil contamination. This comparative legal database can be a useful tool for those in the oil and gas industry who want to understand the laws and regulations in these states. It's important to consider the impact of oil and gas activities on water quality.

**Protecting Source Water in Colorado**

During Oil and Gas Development - This guide, produced by the Colorado Oil and Gas Conservation Commission (OGCC), is intended for water professionals interested in learning more about protecting source water in Colorado.

July 2016
Intermountain Oil and Gas BMP Project

Memorandum of Understanding (MOU)

A Memorandum of Understanding (MOU) memorializes an agreement between the parties signing the document. In the oil and gas development context, parties to these agreements may include federal, state or local governments, tribes, and operators. In Colorado, such agreements are often negotiated by a local government and an oil and gas operator and may be called an MOU, a memorandum of agreement (MOA), operator agreement, or development agreement. In these documents (that we collectively call “MOUs”), the parties agree on how the oil and gas operator will develop and/or operate oil and gas facilities within the purview of the local jurisdiction.

Over a decade ago, La Plata County Commissioners and operators started developing MOUs — agreeing to disagree on the authority of local governments to regulate oil and gas beyond the requirements of the Colorado Oil and Gas Conservation Commission (COGCC). Beginning in 2005, La Plata County and several operators negotiated and signed MOUs that recognized this disagreement and agreed to terms of development that would guarantee the county certain operating standards and pay certain road fees. In exchange, the operator could avoid protracted formal hearings of the County’s standard land use permitting process. Over the next decade, 10 additional communities negotiated over 40 MOUs with operators.

Just prior to the 2014 elections, Governor Hickenlooper created the Colorado Oil and Gas Task Force, as an alternative to contentious ballot initiatives on local control in order to address conflicts between local and state regulation, multiple-well production areas, and drilling operations near and within communities. The Task Force meetings included discussions of MOUs and several Task Force proposals for action included MOUs.

Anatomy of an MOU

MOUs and the processes used to develop them are as different as the communities, operators and issues that they address. Yet they have commonalities as well.

MOU Negotiations
The process of negotiating MOUs varies substantially from jurisdiction to jurisdiction. Local governments have developed site-specific MOUs after intense negotiation with particular operators and more general MOUs that are subsequently signed by several operators (with minor tweaks). Individual operators, industry groups (e.g., Colorado Oil and Gas Association), and the COGCC have been involved in various negotiations. For some MOUs, the parties have used public information meetings, Council/Commission hearings, and informal discussions to inform community members and other stakeholders. Other MOUs have been negotiated with little or any public participation.

MOU Components: Administrative Clauses and Substantive Elements
MOUs generally begin by naming and describing the parties and setting out the understanding between the parties that have led to signing an MOU (Reitals, Background or “Whereas” sections). Common, but not universal, administrative provisions of the MOUs include an applicable

Databases of MOUs

In response to both the recent interest in and skepticism surrounding MOUs, the BMP Project has developed a repository of information from Local Government / Operator MOUs within the BMP Project’s existing searchable database of documents and searchable database of BMPs. These databases allow users to access the MOUs and to compare the BMPs included in them. The databases also allow users to compare the BMPs to state regulatory requirements and to monitor the incorporation of MOU provisions into COGCC permits and orders.

Catalog of MOU Documents:

All known MOUs are included in the BMP Project’s searchable bibliography. These MOUs (including draft, final but unsigned, and signed MOUs) were obtained through Internet searches, and contributions from individuals working on these issues, including the COGCC.

These MOUs are accessible via this website’s “SEARCH” tab. A keyword search (using “MOU”) in the bibliographic database will yield research.
**Comparative Law Database**
- Water Quality – Lifecycle of field development
- Water Quantity – Administration, reporting, conservation, etc.
- Air Quality – Flares, engines, leak detection, storage, etc.

**Current Database:**
- States (17)
- Federal
  - BLM/BIA, USFS
  - EPA
- Local Jurisdictions (4)

**2016 Expansion:**
- Setbacks
- Induced Seismicity
- Comparative analysis factsheets
Oil & Gas - Water Quality, Water Quantity, and Air Quality

Improved technological developments in horizontal drilling and hydraulic fracturing, more commonly known as “fracking,” have resulted in an oil and gas production boom nationwide. These technological advancements are used to unlock oil and gas from shale deposits across the country, including regions unaccustomed to the industry and those that have a century-long relationship with oil and gas extraction.

Increased shale oil and shale gas development has been accompanied by increased concerns about water quality, water quantity, and air quality issues related to the development. Wastewater discharges, hydraulic fracturing fluid chemicals, improper casing and/or cementing of the bore hole, and accidental spills pose potential water quality risks. The quantity of water used to hydraulically fracture a well also varies widely depending on geologic conditions – 2 to 7 million gallons of water per well – and a well may be fracked more than once. The amount of water consumed and the timing of the water usage are of growing concern nationwide, but particularly in and regions or in areas experiencing water shortages. Air quality concerns from the waste of methane through leaks and intentional venting and flaring of gas as well as the release of volatile organic compounds and hazardous air pollutants, like benzene and toluene, from well site operations are also prevalent.

This collection of datasets and maps includes water quality, water quantity, and air quality statutes and regulations of four federal agencies (Bureau of Land Management, Bureau of Indian Affairs, U.S. Forest Service, and the Environmental Protection Agency), 17 states (Alaska, Arkansas, California, Colorado, Illinois, Louisiana, Montana, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, Utah, West Virginia, and Wyoming). These jurisdictions

LawAtlas Interactive Maps:
- Air Quality: [Air Quality Laws Pertaining to Oil and Gas Development](#)
- Water Quality: [Permitting, Design, and Construction](#)
- Water Quality: [Well Drilling](#)
- Water Quality: [Well Completion](#)
- Water Quality: [Production and Operation](#)
- Water Quality: [Reclamation](#)
- Water Quantity: [Quantity](#)
A production boom in directional drilling and hydraulic fracturing (more commonly known as “fracking”) has resulted in oil and gas development in regions unaccustomed to the industry as well as in regions that have a century-long relationship with oil and gas extraction. Developing oil and natural gas requires numerous stages – drilling, completion, production, and operation – that have the potential to affect air quality through the release of volatile organic compounds (VOCs) that contribute to the creation of smog, hazardous air pollutants (HAPs), and methane, a potent greenhouse gas.

This dataset focuses on some of the most important laws for controlling VOCs, HAPs, and methane, and only examines laws pertaining to air quality for operations and equipment on the well pad site. It does not cover processing, transmission, storage, and distribution. The dataset includes federal regulations of the US Environmental Protection Agency (EPA), and statutes and regulations from 17 states. Under authority of the Clean Air Act, EPA rules establish the minimum requirements for the entire country. In many cases, states have adopted the federal rules by reference or explicitly incorporated comparable provisions into their state regulations. Other states, including Arkansas and New York (which are included in this dataset) have done so, but the requirements of federal law still apply.

To explore the laws pertaining to specific air quality issues related to oil and gas activities, current as of November 25, 2015, use the blue “Start here” box below. For a summary of all of the law compiled for a specific jurisdiction, click on the corresponding part of the map.
Air Quality Laws Pertaining to Oil and Gas

A production boom in directional drilling over the past decade has led to an increase in the number of wells on the US’s oil and gas fields. In the process, there has been a rise in the level of air pollution due to activities such as completion, production, and operation—such as the release of volatile organic compounds (VOCs) that contribute to both local and global climate change.

This comparative dataset focuses on some of the laws and regulations pertaining to air quality specifically in the oil and gas sector. It does not cover laws pertaining to air quality from industries such as power plants, refineries, and the petrochemical industry. The information is not exhaustive and may not represent all the laws and regulations in existence.

To explore the laws pertaining to specific aspects of the oil and gas industry, use the “Start here” box below the map to navigate to the corresponding part of the map.

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**Green Completions: Reduced emission completion requirements**

- **Yes**, for gas wells only
- **Yes**, for oil and gas wells
- **Yes**, only as of January 2015
- **Yes**, implemented prior to NSPS subpart OOOO regulations

  - **Continuous ignition source or auto-ignitor?**
    - **Yes**
    - **No**

  - **Exceptions to REC requirements**
    - **Wildcat wells**
    - **Delineation wells**
    - **Low pressure wells**
    - **Other**
    - **No exceptions listed in the law**

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**Setbacks: Requirement for well site and equipment**

- **H2S**: Ambient air quality standard
- **Flares**: Not associated with reduced emissions completions
- **Flares**: Royalties for flaring
- **Leaks**: Detection and Repair program
- **Leaks**: Forward Looking Infra-Red cameras
- **NSPS, Storage Vessels**: Emissions regulations
- **NSPS, Storage Vessels**: Emissions from compressors

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**Jurisdiction(s) Found**

17
A production boom in directional drilling and hydraulic fracturing (more commonly known as "fracking") has resulted in shale oil and gas development in regions unaccustomed to the industry as well as in regions that have a century-long relationship with oil and gas extraction. Developing oil and natural gas requires numerous stages – drilling, completion, production, and operation – that have the potential to affect air quality through the release of volatile organic compounds (VOCs) that contribute to the creation of smog, hazardous air pollutants (HAPs), and methane, a potent greenhouse gas.

This comparative dataset focuses on some of the most important law for controlling VOCs, HAPs, and methane, and only examines laws pertaining to air quality for operations and equipment on the well pad site. It does not cover processing, transmission, storage and distribution. The dataset includes federal regulations of the US Environmental Protection Agency (EPA), and statutes and regulations from 17 states. Under authority of the Clean Air Act, EPA rules establish the minimum requirements for the entire country, in many cases, states have adopted the federal rules by reference or incorporated comparable provisions into their state regulations. Other states, including Arkansas and New York (which are included in this dataset) have not done so, but the requirements of federal law still apply.

To explore the law pertaining to specific air quality issues related to oil and gas activities, current as of November 25, 2015, use the blue "Start here" box below. For a summary of all of the law compiled for a specific jurisdiction, click on the corresponding part of the map.
### Jurisdiction Requirements

#### United States - Federal
- **Jurisdiction**: United States - Federal
- **Effective Through**: 09/01/2015 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### Alaska
- **Jurisdiction**: Alaska
- **Effective Through**: 04/01/2015 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### California
- **Jurisdiction**: California
- **Effective Through**: 05/17/2015 - 12/16/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### Colorado
- **Jurisdiction**: Colorado
- **Effective Through**: 04/30/2015 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for oil and gas wells, Yes, implemented prior to NSPS subpart OOoO regulations
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Other

#### Illinois
- **Jurisdiction**: Illinois
- **Effective Through**: 11/14/2014 - 11/30/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### Louisiana
- **Jurisdiction**: Louisiana
- **Effective Through**: 09/01/2014 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### Montana
- **Jurisdiction**: Montana
- **Effective Through**: 10/11/2014 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other

#### North Dakota
- **Jurisdiction**: North Dakota
- **Effective Through**: 04/01/2014 - 11/01/2015
- **Law**: [View Law](#)
- **Green Completions: Reduced emission completion requirements**: Yes, for gas wells only, Yes, only as of January 2015
- **Continuous ignition source or auto-ignitor?**: Yes
- **Exceptions to REC requirements**: Wildcat wells, Delineation wells, Low pressure wells, Other
US Regulation 40 CFR 60-18-a and g

General control device and work practice requirements.

(a) Introduction. (1) This section contains requirements for control devices used to comply with applicable subparts of 40 CFR parts 60 and 61. The requirements are placed here for administrative convenience and apply only to facilities covered by subparts referring to this section.

(2) This section also contains requirements for an alternative work practice used to identify leaking equipment. This alternative work practice is placed here for administrative convenience and is available to all subparts in 40 CFR parts 60, 61, 63, and 65 that require monitoring of equipment with a 40 CFR part 60, appendix A-7, Method 21 monitor.

(g) Alternative work practice for monitoring equipment for leaks. Paragraphs (g), (h), and (i) of this section apply to all equipment for which the applicable subpart requires monitoring with a 40 CFR part 60, appendix A-7, Method 21 monitor, except for closed vent systems, equipment designated as leakless, and equipment identified in the applicable subpart as having no detectable emissions, as indicated by an instrument reading of less than 500 ppm above background. An owner or operator may use an optical gas imaging instrument instead of a 40 CFR part 60, appendix A-7, Method 21 monitor. Requirements in the existing subparts that are specific to the Method 21 instrument do not apply under this section. All other requirements in the applicable subpart that are not addressed in paragraphs (g), (h), and (i) of this section apply to this...
Project Contacts

For more information

Browse the websites at:
  www.oilandgasbmps.org and www.lawatlas.org/oilandgas

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303-499-1092
“Green” drilling is more than drilling

- Get in, drill and get out safely – as fast as possible with minimal disturbance to the land
- Protect surface and ground water
- Access roads
- Pad Drilling
- Reduce traffic, dust, noise, emissions, excessive lights that disturb nearby residences
- Aesthetics
- Flare/vapor recovery
- Gas captured to pipeline – flare gas only in necessary
- Pipe produced water/oil where feasible
It’s not so hard to be green

Questions?

Contact Rich:
rhaut@HARCResearch.org

Thank you

www.efdsystems.org
www.efdvirtualsite.org
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