



When a Pipeline Facility Comes to Your Town

Experience and Recommendations
From a Grassroots Perspective

Updated – January 2016

Objective:

Provide a reference tool to help others quickly learn, organize and take effective action

Reason:

Unprecedented industry growth directly impacts many communities' safety and health

Description:

Part 1 - Summary of pipeline infrastructure

Part 2 - FERC process, PHMSA safety, and Recommendations

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Cover photo: Dec. 11, 2012 Sissonville, WV - A 20-inch natural gas pipeline explosion burned so hot that it charred 800 feet of roadway along Interstate 77, destroyed three homes, and melted the siding on houses hundreds of feet from the rupture site. The explosion was caused by external corrosion and a lack of inspections that could have discovered the corrosion.

<http://wvpublic.org/post/ntsb-determines-cause-december-2012-sissonville-pipeline-explosion>

Myersville, MD



Myersville Citizens
for a Rural Community



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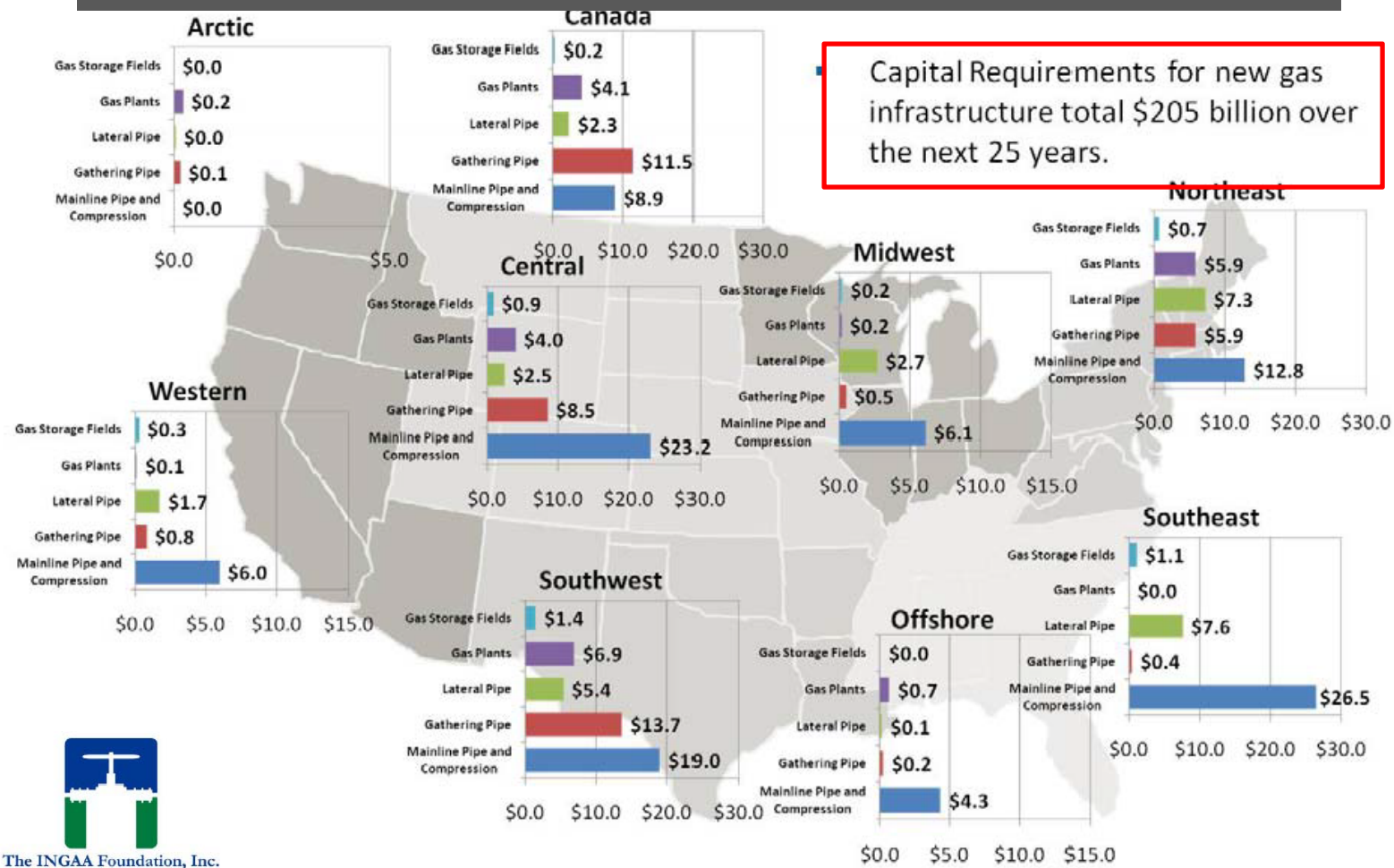
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Photos: Ann Nau

Unprecedented Growth



Interstate pipeline companies have applied for and received FERC approval to construct over 16,000 miles of interstate pipelines at estimated cost of \$46B. From Jan 2000 to Feb 2011, about 14,600 miles of expansion pipeline were constructed & placed in service.

June 28, 2011 - <http://www.ingaa.org/file.aspx?id=14911>



2014, just three years later, a 50% increase from \$205B to \$313B

March 17, 2014 - <http://www.ingaa.org/Foundation/Foundation-Reports/2035Report.aspx>

Development of North American unconventional natural gas and crude oil supplies, particularly supplies from shale formations, *has continued at an unprecedented pace*. With the ever-changing supply picture, *midstream infrastructure development is crucial for efficient delivery of growing supplies to markets*.

The following approximates the new natural gas infrastructure required:

- 850 miles new transmission lines per year
- 800 miles new laterals per year
- 14,000 miles new gathering lines per year
- More than 580,000 horsepower for pipeline & gathering compression per year
- 9 Bcfd of new LNG export capacity

(Billions of Real Dollars)	Current Study, 2014-2035 (2012\$)	Current Study Average Annual (2012\$)
Gas Transmission Mainline Pipe	\$87.2	\$4.0
Laterals to/from Power Plants, Gas Storage, and Processing Plants	\$45.2	\$2.1
Gathering Line (pipe only)	\$35.6	\$1.6
Gas Gathering Line Compression	\$23.5	\$1.1
Gas Lease Equipment	\$26.9	\$1.2
Gas Pipeline & Storage Compression	\$11.6	\$0.5
Gas Storage Fields	\$12.0	\$0.5
Gas Processing Capacity	\$27.4	\$1.2
LNG Export Facilities	\$43.7	\$2.0
Total Capital Expenditures	\$313.1	\$14.2



Shale gas contributed only 3% of United States natural gas production in 2005, rising to 35% by 2012 and predicted to grow to almost 50% by 2035. In 2012, gas extracted from shale and tight-sands combined made up 60% of total natural gas production, and this is predicted to increase to 70% by 2035

April 2013 - [http://www.eia.gov/forecasts/aeo/pdf/0383\(2013\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf)

The main contributor from natural gas growth is shale gas production which increased by 30% from 2011 to 2012.

April 14, 2014 - http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm



EPA – Clean Power Plan

Cheryl A. LaFleur - acting FERC chairman before the Subcommittee on Energy and Power - Hearing on FERC Perspective: Questions Concerning EPA's Proposed Clean Power Plan and other Grid Reliability Challenges

July 29, 2014 - <http://www.ferc.gov/CalendarFiles/20140729091732-LaFleur-07-29-2014.pdf>

With respect to infrastructure, the proposed rule contemplates power supply changes that could require *substantial investments in additional infrastructure over the multi-year compliance period* to ensure reliability, particularly with respect to increased utilization of gas-fired generation. As a result, I believe that it is important that the *Commission continue its work to support the timely development of needed energy infrastructure*.



Natural Gas Infrastructure Implications of Increased Demand from the Electric Power Sector

Feb, 2015 - http://energy.gov/sites/prod/files/2015/02/f19/DOE%20Report%20Natural%20Gas%20Infrastructure%20V_02-02.pdf

- ...recent pipeline capacity additions that were placed in service between 2007 and the present in order to realign the U.S. natural gas transmission system with changing supply and demand conditions driven by increases in shale gas production are *likely to reduce the need for future pipeline infrastructure*.
- *The U.S. pipeline system is not fully utilized* because flow patterns have evolved with changes in supply and demand.
- In some regions, available existing pipeline capacity is projected to be used before expanding existing pipelines or building new capacity.
- Given the cost of building new pipelines, *finding alternative routes that utilize available existing pipeline capacity is often less costly than expanding pipeline capacity*.
- While a future carbon policy may significantly increase natural gas demand from the electric power sector, the *projected incremental increase in natural gas pipeline capacity additions is modest* relative to the Reference Case

Cashing in on 'All of the Above':

U.S. Fossil Fuel Production Subsidies under Obama

July 2014 - http://priceofoil.org/content/uploads/2014/07/OCI_US_FF_Subsidies_Final_Screen.pdf

The United States federal and state governments gave away *\$21.6 billion in production and exploration subsidies* to the oil, gas, and coal industries in 2013.

At the federal level only, largely due to increased oil and gas, production, fossil fuel production and exploration *subsidies have grown in value by 45 percent since President Obama took office in 2009 from \$12.7 billion to a current total of \$18.5 billion.*

Although not included in the production subsidy totals, above, there are a number of additional types of support to the oil, gas, and coal industries that should be noted, including:

- U.S. federal and state consumption subsidies are on the order of \$11 billion a year. *Thus the total annual value of all known U.S. state and federal fossil fuel exploration, production, and consumption subsidies is \$32.8 billion.*
- Additional costs borne by taxpayers related to the *military, climate, local environmental, and health impacts of the fossil fuel industry are credibly estimated between \$360 billion and \$1 trillion each year* – in the United States alone.

Infrastructure Overview

GHGRP, 2013

Facility Locations by Industry Type

- Onshore Natural Gas Transmission
- Natural Gas Processing
- Underground Natural Gas Storage
- LNG Storage
- ▲ LNG Import and Export Equipment
- Natural Gas Pipeline Network (U.S. Department of Transportation)

Data Source: 2013 Greenhouse Gas Reporting Program

The EPA has determined that the informational map displayed here does not raise security concerns based on the application of the Federal Geographic Data Committee's Guidelines for Providing Appropriate Access to Geospatial Data in Response to Security Concerns.



Aug 18, 2014 - <https://optimization.mccormick.northwestern.edu/images/0/07/OilandGasFacilities.png>

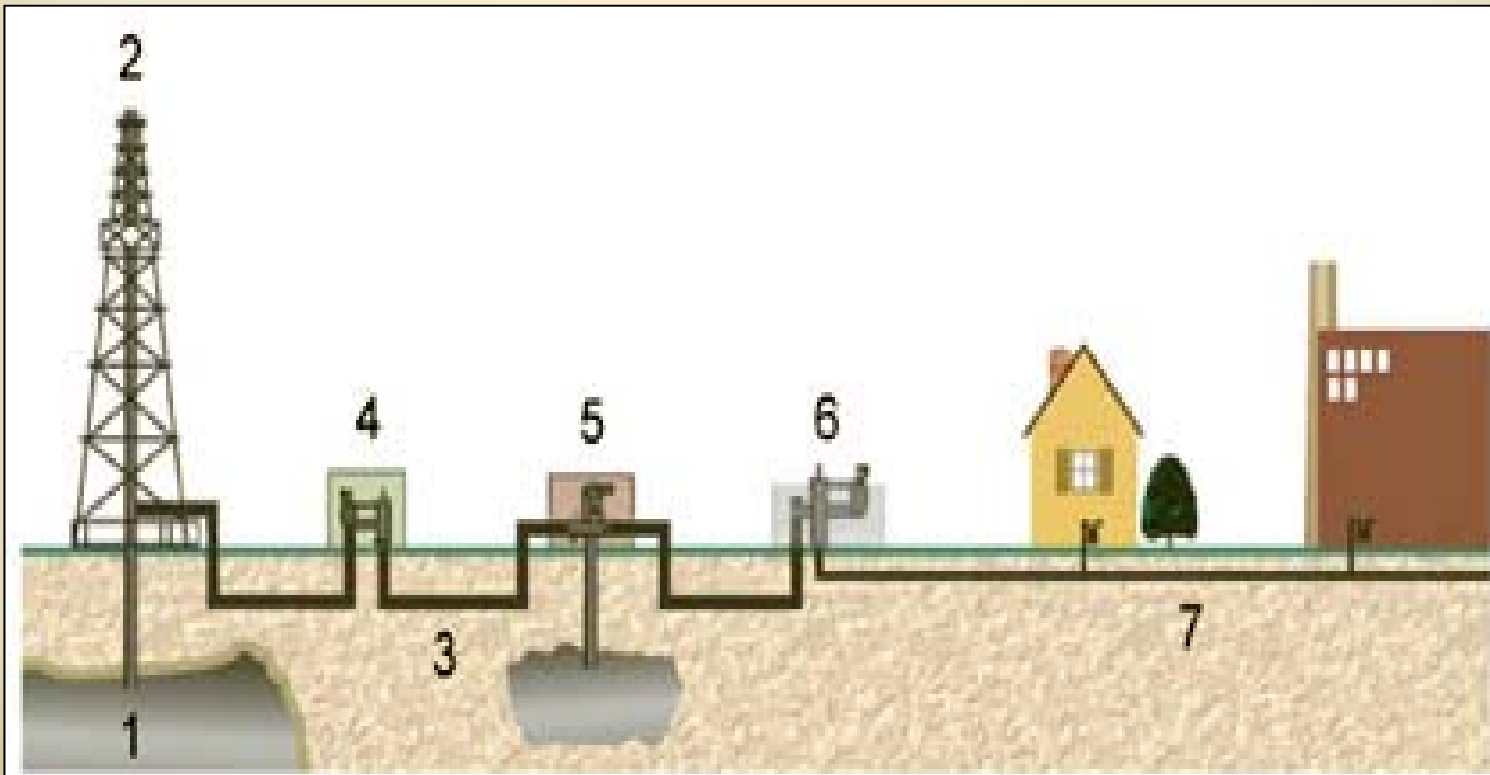
Extraction → Processing → Transport → Compression → Storage & Distribution



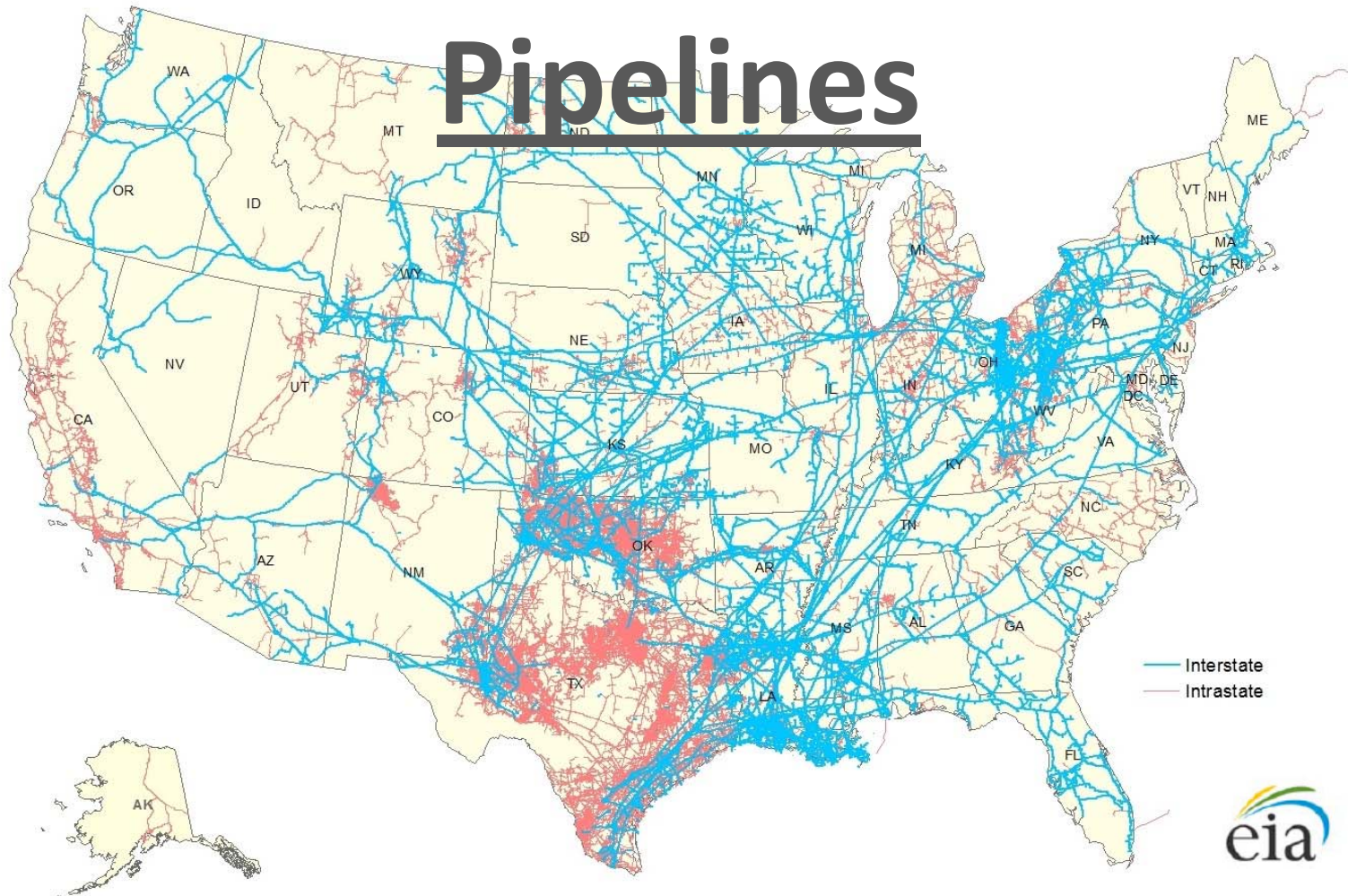
Infrastructure – Schematic

<http://pse.com/aboutpse/EnergySupply/Pages/Natural-Gas-Supply.aspx>

Deep underground deposits of natural gas (1) are brought to the surface by wellhead pumps (2). After the gas is processed and purified, it travels along interstate pipelines (3). Compressor stations (4) are located every 50 to 60 miles to maintain gas pressure. Natural gas often is stored in large underground reservoirs (5) to help meet spikes in demand. Gas eventually reaches a city gate station (6) where it is metered and delivered to customers through a distribution network (7) of local gas mains, small-diameter service lines and, ultimately, customer meters



Pipelines



<http://www.eia.gov/state/maps.cfm> (user defined parameters)

<https://www.npms.phmsa.dot.gov/PublicViewer/>

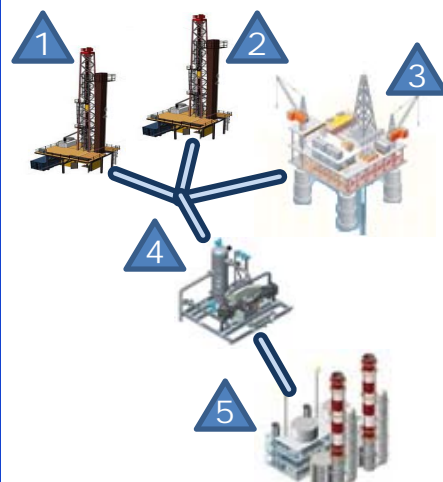
<http://www.pipeline101.com/where-are-pipelines-located/natural-gas-pipelines-map>

DOT PHMSA Building Safe Communities: Pipeline Risk and its application to Local Development Decisions

Oct. 2010 - <https://primis.phmsa.dot.gov/comm/publications/PIPA/PIPA-PipelineRiskReport-Final-20101021.pdf>

“Risks to the public from hazardous liquid and gas transmission pipelines result from the potential unintentional release of products transported through the pipelines. Releases of products carried by pipelines can impact surrounding populations, property, and the environment, and may result in injuries or fatalities as well as property and environmental damage.”

- **Production Lines** - transport natural gas and produced fluids at or near the wellhead
- **Gathering Lines** - transport natural gas from production facility to processing plant



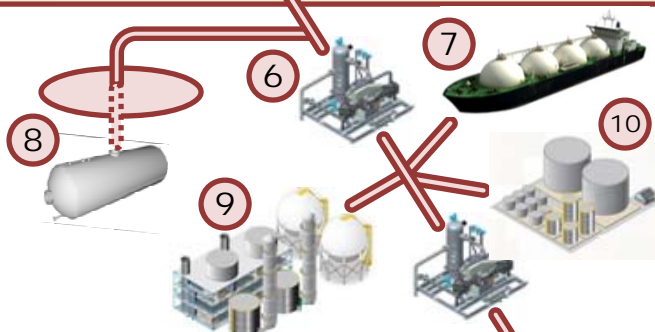
State & Local Level

Production and Gathering Lines

1. Drilling Wells
2. Producing Gas Wells - 504,000
3. Offshore Wells
4. Gas Compressor Stations
5. Gas Processing Plants - 530

Of the nation's 240,000 miles of gathering lines, only about 10 percent are regulated. In most cases, state and federal officials don't even know where they are located.
 Sept 26, 2013 - <http://insideclimatenews.org/news/20130926/boom-unregulated-natural-gas-pipelines-posing-new-risks>

- **Transmission Lines** - transport natural gas from processing plant to local distribution lines...e.g. interstate



Federal Level

Transmission Lines - 300,000 miles
Int'l pipeline points - 49

6. Gas Compressor Stations
7. LNG terminals - 12
8. Underground Storage - 418 fields
9. Gas Powered Electric Plants - 500
10. Above ground Storage

- **Distribution Lines** – distribute natural gas to end-users (intrastate)

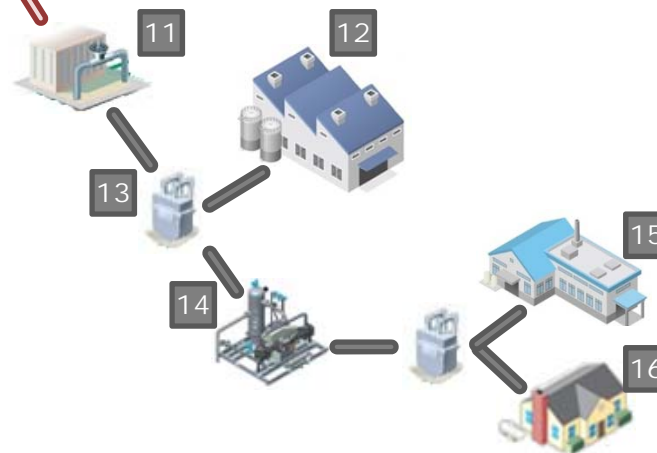
<http://www.eia.gov/naturalgas/data.cfm>
https://mitei.mit.edu/system/files/Natural_Gas_Report.pdf
<https://www.columbiagasva.com/about-natural-gas/natural-gas-delivery>

State & Local Level

Distribution Lines - 2.3M miles

Local Distribution Companies - 1,200

11. City Gate Stations - 3,000
12. Large Commercial Users - 195,000
13. Metering Stations
14. Gas Compressor Stations
15. Commercial Customers - 5M
16. Residential Customers - 67M





Risks – Right of Way & Eminent Domain

<http://www.ferc.gov/resources/guides/gas/gas.pdf>

Landowners may be subject to right of way or condemnation (eminent domain).

The company negotiates a right-of-way easement and compensation for the easement with each landowner. Landowners may be paid for loss of certain uses of the land during and after construction, loss of any other resources, and any damage to property. If the Commission approves the project and no agreement with the landowner is reached, *the company may acquire the easement under eminent domain* (a right given to the company by statute to take private land for Commission-authorized use) with a court determining compensation.



<http://www.lancasterpipeline.org/pipeline-construction/>



<http://ohvec.org/scope-ferc-acp/>

Risks – Potential Impact Radius

A site-specific planning area for a natural gas transmission pipeline uses the PIR model in the gas transmission pipeline integrity management regulations (49 CFR 192.903). The PIR is the radius within a potential failure of a pipeline could have significant impact on people or property.

This table provides PIR distances (in feet) for natural gas transmission pipelines, based on different combinations of pipeline diameters and MAOP. For example, a 30-inch pipeline with MAOP of 1,000 psig has a PIR of 655 feet. In this case, a site-specific planning area could be defined *extending 655 feet on either side of the pipeline*.

Nov. 2010 - <http://pstrust.org/docs/PIPA-Report-Final-20101117.pdf>

Pipeline MAOP (psig)	Pipeline Diameter (inches)								
	6	8	10	12	16	24	30	36	42
	PIR or Planning Area Distance from Pipeline Centerline (in feet)								
200	59	78	98	117	156	234	293	351	410
400	83	110	138	166	221	331	414	497	580
600	101	135	169	203	270	406	507	608	710
800	117	156	195	234	312	468	585	703	820
1000	131	175	218	262	349	524	655	786	916
1200	143	191	239	287	382	574	717	860	1004
1400	155	207	258	310	413	620	775	929	1084

Aerial photo of a neighborhood along that has both a gas transmission (a 30 inch diameter, Maximum Allowable Operating Pressure (MAOP) 1200psi) and gas gathering (a 16 inch diameter, 1200 MAOP) pipeline running close by.

The outer red circle shows the PIR for the transmission pipeline and the inner red circle is the PIR for the gathering line. Over 60 homes and a large church fall within the PIR of the transmission pipeline, while about 15 homes and none of the actual church building fall within the PIR of the gathering pipeline.

<http://pstrust.org/docs/FinalFW.pdf>



Sissonville, WV – Dec 11, 2012
<http://www.naturalgaswatch.org/?p=2084>



<http://pstrust.org/docs/FinalFW.pdf>



Arrow shows point of failure. Note how far from point of failure houses were destroyed

San Bruno, CA – Sep 9, 2010
<http://www.examiner.com/article/three-pipelines-solano-county-make-pg-e-risk-list>



<http://pstrust.org/docs/FinalFW.pdf>



There was no explosion or fire, the crater was created by the pressure of the gas coming out of the pipeline. Note how far the pipe was thrown upper corner.

Risks – Forreast and Waterways

Dec 16, 2011 - <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/ng-pipelines.pdf>

Forreast Fragmentation

Natural gas pipelines can impact the environment in several ways which includes natural habitat loss and fragmentation, changes in species movement, sedimentation, and air emissions



Gathering pipeline construction in Bradford County, PA
© Nels Johnson /TNC

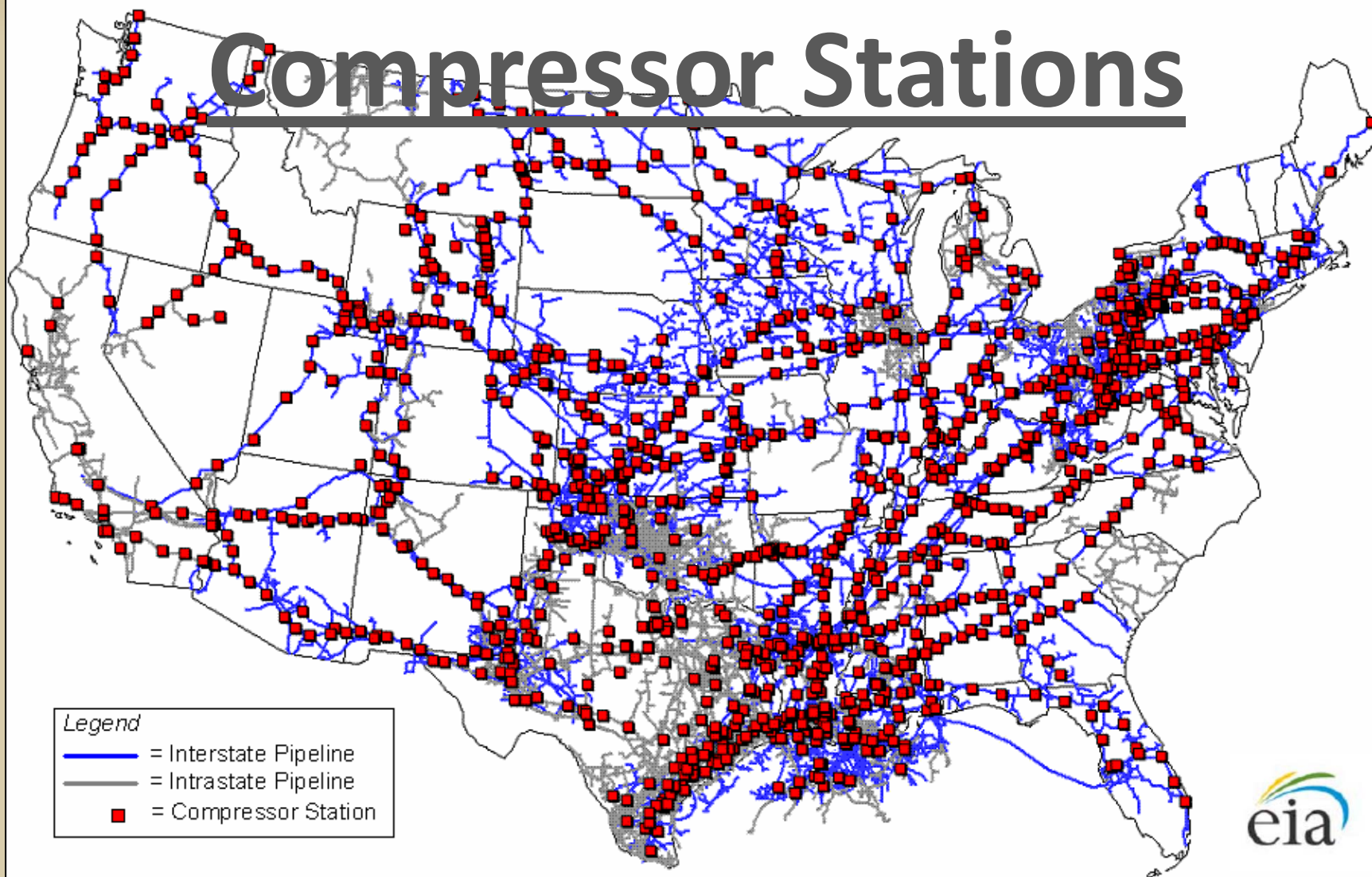
Rivers and Streams

Company will use a combination of 'open cuts' and horizontal directional drilling across and under streams and tributaries that create erosion and sedimentation affecting fish and stream life



<http://www.delawareriverkeeper.org/river-action/ongoing-issue-detail.aspx?Id=51>

Compressor Stations



http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/index.html
http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/compressorMap.html

Estimate 1,768 gas compressor stations

April 2014 - <http://www.epa.gov/airquality/oilandgas/2014papers/20140415compressors.pdf>





Compressor Station – Overview

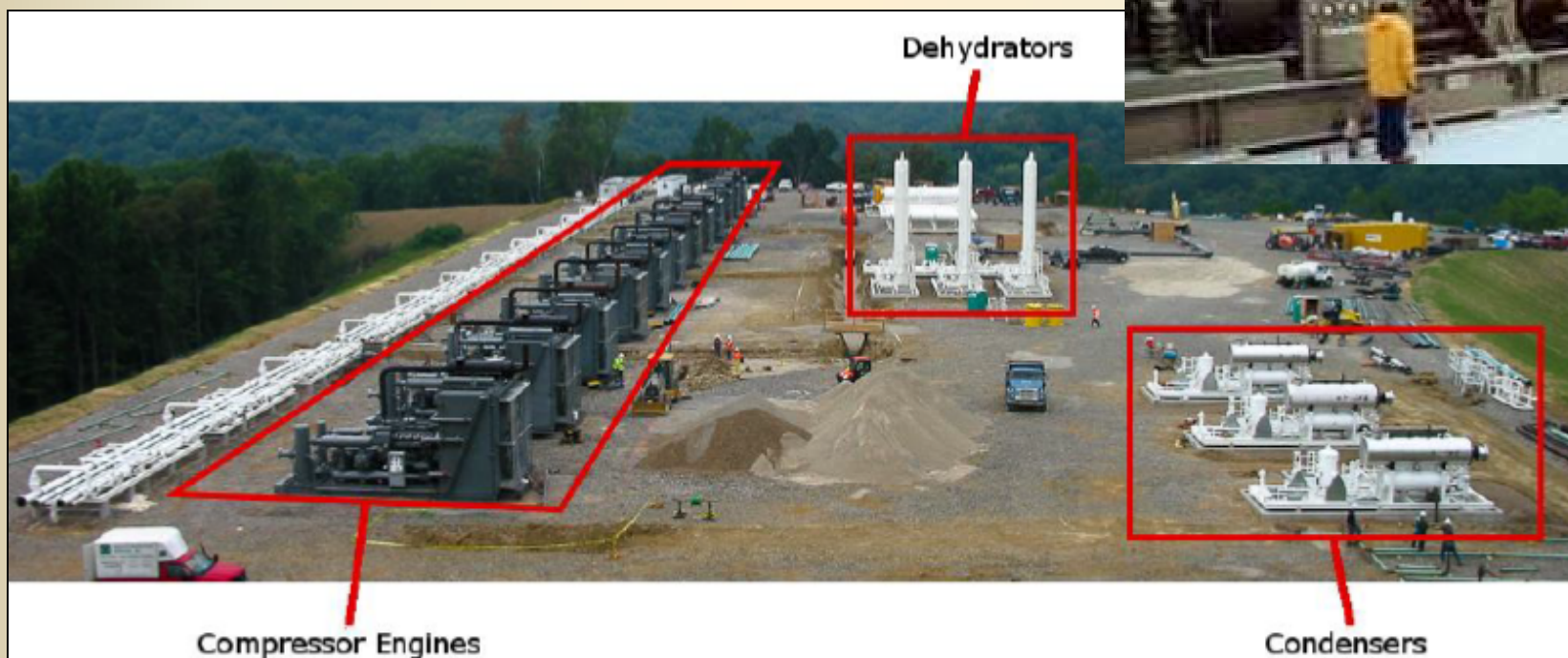
<http://www.ingaa.org/cms/129.aspx>

<http://fracdallas.org/docs/compressorstations.html>

April 2014 - <http://www.epa.gov/airquality/oilandgas/2014papers/20140415compressors.pdf>

Natural gas is highly pressurized as it travels through an interstate pipeline. To ensure flow through the pipeline, it requires periodic compression along the pipe usually placed from 40 to 100 mile intervals.

- Powered: Natural Gas, Diesel, or Electric
- Common Types: Reciprocating and Centrifugal (Turbine)



<https://sincdutch.files.wordpress.com/2013/03/whatisacompressorstation-792304.png>



Dominion

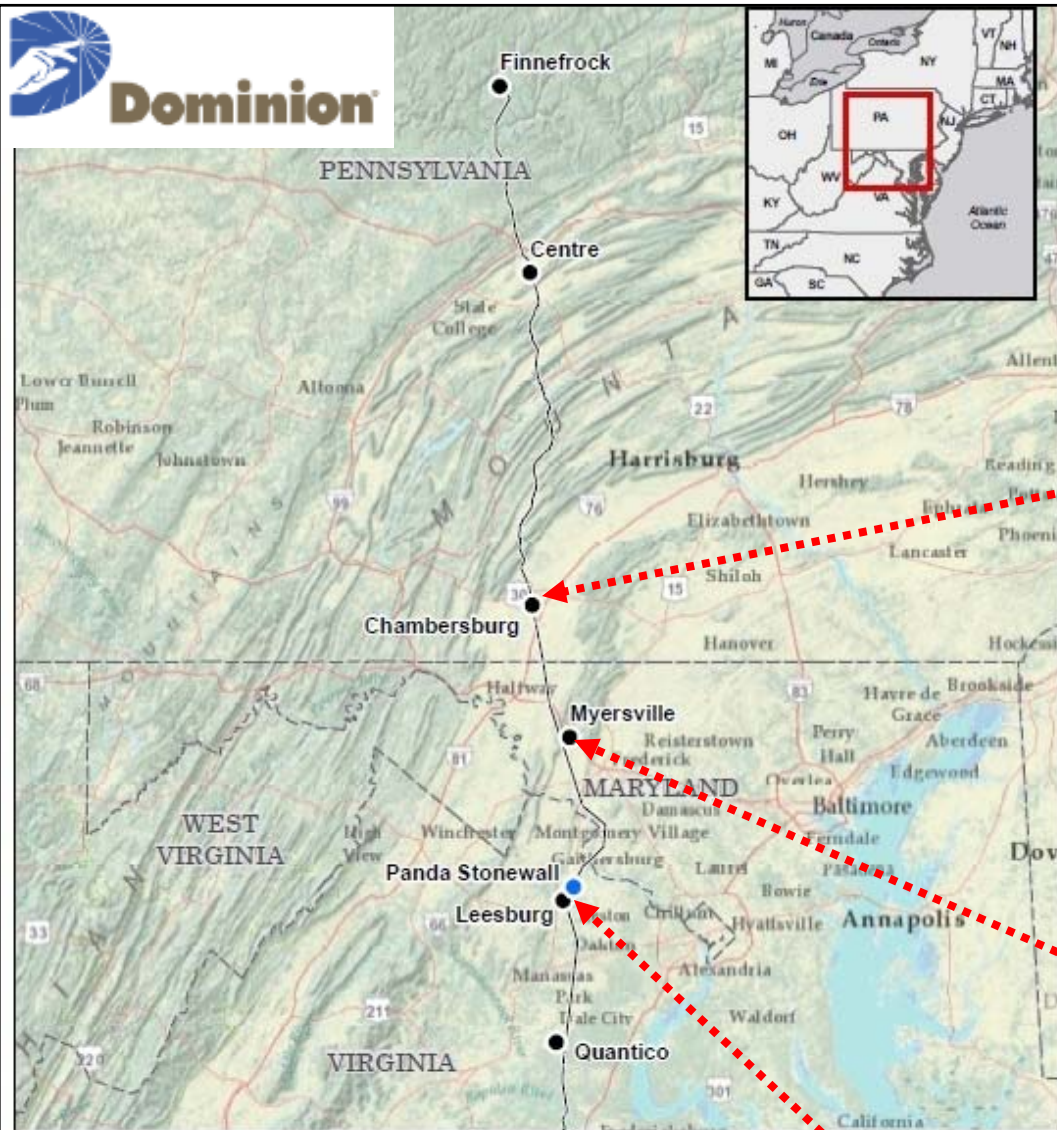
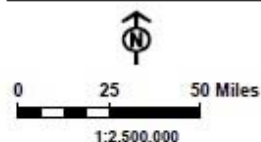


Figure 1
Overall Project Facilities
Dominion Leidy South
Pennsylvania, Maryland,
and Virginia



- Proposed Meter Station
- Proposed Compressor Station
- Station Upgrades
- Existing Pipeline



Myersville Citizens
for a Rural Community



DTI Compressor Station – Chambersburg, PA



DTI Compressor Station – Myersville, MD



DTI Compressor Station – Leesburg, VA

Nov 12, 2014 - <https://www.dom.com/library/domcom/pdfs/gas-transmission/leidy-south/leidy-south-map.pdf>

Risks – Compressor Station Emissions

Some Compounds Released by Compressor Stations include:

- Benzene
- Toluene
- Ethyl benzene
- Xylene
- Hydrogen Disulfide
- Carbon Monoxide(CO)
- Carbon Dioxide (CO₂)
- Sulfur Dioxide (SO₂)
- Methane (CH₄)
- other compounds or elements that are toxic, carcinogenic or neurotoxin

Feb 24, 2015 - <http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf>

Construction:

- Construction Dust
- Truck Traffic
- Pipeline Testing

Permanent Operation:

- Compressor Stations
- Dehydrators
- Condensation Tanks
- Venting
- Fugitive Emissions

Other Air Emissions:

- Accidents/Violations



Risks – Compressor Station Emissions

Feb 24, 2015 - <http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf>

Chronic Health Impacts Experienced by Individuals Living and Working near Compressor Stations

Damage to Lungs, Liver and Kidneys	Damage to Nervous System, Brain Impacts
Developmental Malformations	Damage to Cardiovascular System
Damage to Developing Fetus	Impacts to Blood Clotting Ability,
Reproductive Damage	Changes in Blood Cells
Mutagenic Impacts	Aplastic Anemia
Leukemia	

Acute Health Impacts Experienced by Individuals Living and Working near Compressor Stations

Tense and nervous	Drowsiness
Vision Impairment	Weakness , Fatigue
Joint and muscle aches and pains	Irritates skin, eyes, nose, throat and lungs
Personality changes	Respiratory impacts
Depression, Anxiety	Sinus problems
Irritability, Confusion	Allergic reactions, Skin rashes
Nausea, Vomiting	Dizziness, Light headedness
Irregular Heartbeat	Headaches

Risks – Compressor Station Emissions



Five-state study finds high levels of airborne chemicals near oil and gas sites

- 40 percent of the air samples found benzene, formaldehyde, or other toxic substances associated with oil and gas production that were *above levels the federal government considers safe for brief or longer-term exposure*
- By *averaging the results* over days, weeks, or months *misses the sporadic emission spikes that can harm* exposed people.
- In Pennsylvania's Susquehanna County, six of the *air samples taken near compressor stations contained high levels of formaldehyde, classified as a carcinogen* by the World Health Organization

Oct 30, 2014 - <http://www.publicintegrity.org/2014/10/07/15890/new-five-state-study-finds-high-levels-toxic-chemicals-air-near-oil-and-gas-sites>



Researchers have demonstrated the wisdom of looking at peak exposures as compared to averages over longer periods of time. Because episodic high exposures are not typically documented and analyzed by researchers and public agencies, natural gas compressor stations emissions are rarely correlated with health effects in nearby residents. However, *examination of published air emission measurements shows the very real potential for harm from industry emissions.*

The National Ambient Air Quality Standards (NAAQS), a benchmark for air quality, were not created to assess the air quality and safety in a small geographic area with fluctuating emissions. NAAQS effectively address regional air quality concerns. But *these standards do not adequately assess risk to human health for residents living in close proximity to polluting sources* where emissions can be highly variable.

NAAQS reflects what, over a region, over time, is deemed safe population-wide. *This is very different than what is safe within for instance 1200 feet of a compressor station*

Feb 24, 2015 - <http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf>

Risks – Compressor Station Emissions



Exposure to Volatile Organic Compounds

Examples of VOCs include trichloroethane; trichloroethylene; and BTEX, which includes

- Benzene, which is a known carcinogen, has reproductive toxicity
- Teratogenicity and Toluene which displays carcinogenicity and reproductive toxicity.

Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue, dizziness. VOC together with NOx can produce ground-level ozone.

<http://www.epa.gov/iaq/voc.html>



Exposure to Nitrogen Oxide (NOx)

- Human health concerns include effects on breathing and the respiratory system, damage to lung tissue, and premature death.
- Small particles penetrate deeply into sensitive parts of the lungs and can *cause or worsen respiratory disease, such as emphysema and bronchitis, and aggravate existing heart disease.*

Ground-level Ozone (Smog) is formed when NOx and volatile organic compounds (VOCs) react in the presence of heat and sunlight. Children, the elderly, and people with lung diseases such as asthma are susceptible to adverse lung function.

<http://www.epa.gov/oaqps001/nitrogenoxides/health.html>



Exposure to Particulate Matter

Both short- and long-term exposures to fine particulate matter (PM2.5) are associated with mortality. However, whether the associations exist below the new EPA standards is unclear.

Conclusion:...*we estimated significant acute and chronic effects of PM2.5 exposures below current EPA standards.*

<http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/6/ehp.1409111.acco.pdf>

We reported evidence of an association between exposure to PM2.5 and elevated risk of Pulmonary Embolism among women in the US. Our findings suggest that women with underlying health conditions may be more susceptible to increased PE risk after PM exposure

<http://ehp.niehs.nih.gov/wp-content/uploads/123/12/ehp.1408927.alt.pdf>



Risks – Compressor Station Emissions

Long-term exposure to air pollution leads a higher percentage of the population in MD to die prematurely than in any other state.

May 29, 2013 - <http://lae.mit.edu/wordpress2/wp-content/uploads/2013/08/US-air-pollution-paper.pdf>

Researchers at MIT found that the state characterized by the highest relative mortality due to all the sectors is Maryland, with about 114 early deaths per year every 100,000 inhabitants



Frederick Co. MD nonattainment status for Ozone and PM2.5

(Note: In Nov. 2014, Frederick is no longer nonattainment for PM2.5)

July 31, 2013 - http://www.epa.gov/oaqps001/greenbk/anay_md.html

Nonattainment Status for Each County by Year for Maryland

As of July 31, 2013

Listed by County, Pollutant, then Area

County	Pollutant	AreaName	Nonattainment in Year	Redesignation to Maintenance	Classification	Cty NA Whole/ Part	Population (2010)	FIPS State/ Cnty
MARYLAND								
Frederick Co	8-Hr Ozone 1997	Washington, DC-MD-VA	04050607080910111213	//	Moderate	Whole	233,385	24/021
Frederick Co	8-Hr Ozone 2008	Washington, DC-MD-VA	1213	//	Marginal	Whole	233,385	24/021
Frederick Co	PM-2.5 1997	Washington, DC-MD-VA	050607080910111213	//		Whole	233,385	24/021



Risks – Compressor Station Emissions

Proposed Requirements for Equipment at Natural Gas Transmission Compressor Stations

Aug 18, 2015 - http://www.epa.gov/airquality/oilandgas/pdfs/natgas_trans_site_summ_081815.pdf

EPA proposed updates to its 2012 New Source Performance Standards for the oil and gas industry to reduce emissions of greenhouse gases – most notably methane – along with smog-forming volatile organic compounds (VOCs). The updates would affect equipment at natural gas transmission compressor stations, which move gas along a pipeline. In addition to compressors, compressor stations often include equipment to remove and store water vapor, condensate and other remaining impurities

The proposed updates would add requirements for detecting and repairing leaks, and requirements to limit emissions from compressors, pneumatic controllers and pneumatic pumps used compressor stations



Myersville Compressor Station



On Sept 17, 2013 and the Sept 4, 2015 meetings, DTI provided the Frederick County 'averaged' data from the MDE monitor at the airport 15 miles away (green) rather than reflecting the existing ambient air in the Myersville area (red).

Pollutant	Existing Station increased emissions *	Proposed Station increased emissions **	Current emissions Frederick Co	Frederick Co – 660 sq miles Population 239,000 *** Pop density 362	Myersville – 1 Sq mile Pop density 1,600	Impact to Myersville in comparison to Fred. Co emission concentration (Myersville has 442% greater population density)
Carbon Monoxide (CO)	5.3	6.3	43,908	66.5 per sq mile	6.3 per sq mile	10% increase in Myersville
Nitrogen Oxides (NOx)	23.5	24.3	10,345	15.7 per sq mile	24.3 per sq mile	155% increase in Myersville
Volatile Organic Compounds (VOCs)	6.5	14.4	12,321	18.7 per sq mile	14.4 per sq mile	77% increase in Myersville
Particulate Matter (<10 microns)	2.8	18.4	6,080	9.2 per sq mile	18.4 per sq mile	200% increase in Myersville
Particulate Matter (<2.5 microns)	2.8	18.4	1,695	2.57 per sq mile	18.4 per sq mile	716% increase in Myersville
Sulfur Dioxide (SO ₂)	0.25	4.2	1,719	2.6 per sq mile	4.2 per sq mile	162% increase in Myersville
Green House Gases (GHGs) as CO ₂	53,892	161,881	1,716,822	2,601 per sq mile	161M per sq mile	6,224% increase in Myersville
Total Hazardous Air Pollutants	0.93	2.1	No data		2.1 per sq mile	

* <https://www.dom.com/business/gas-transmission/allegHENY-storage-project/pdf/myersville-environmental-briefing-posters.pdf>

** http://elibrary.ferc.gov:0/idmws/file_list.asp?document_id=14337873

*** 2010 Census bureau information for Frederick Co, MD - <http://quickfacts.census.gov/qfd/states/24/24021.html>



Myersville Compressor Station



Myersville Citizens
for a Rural Community

6.3 tons per year of CO = **25 Idling Semi-Trucks**

24.3 tpy of NOx = **75 Idling Semi-Trucks**

14.4 tpy of VOCs = **431 Idling Semi-Trucks**

18.4 tpy of PM2.5 = **1,732 Idling Semi-Trucks**

Average Semi-truck is 53 ft. 1,732 trucks end to end is 91,796 ft or 17.4 miles long
That averages one truck per person or three per home – Myersville Population is just 1,650



Office of Transportation and Air Quality
EPA420-F-08-025
October 2008

Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks

Table 1: Average Idle Emission Rates by Pollutant and Vehicle Type²

Pollutant	Units	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
VOC	g/hr	2.683	4.043	6.495	1.373	2.720	3.455	19.153
	g/min	0.045	0.067	0.108	0.023	0.045	0.058	0.319
THC	g/hr	3.163	4.838	7.260	1.353	2.680	3.503	21.115
	g/min	0.053	0.081	0.121	0.023	0.045	0.058	0.352
CO	g/hr	71.225	72.725	151.900	7.018	5.853	25.628	301.075
	g/min	1.187	1.212	2.532	0.117	0.098	0.427	5.018
NOx	g/hr	3.515	4.065	5.330	2.690	3.705	33.763	1.625
	g/min	0.059	0.068	0.089	0.045	0.062	0.563	0.027
PM _{2.5}	g/hr	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	1.100	N/A ¹
	g/min	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	0.018	N/A ¹
PM ₁₀	g/hr	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	1.196	N/A ¹
	g/min	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	0.020	N/A ¹



Photos: Ann Nau

Risks – Compressor Station Emissions

What you can't see can hurt you

The FLIR image shown here is done in the daytime 2:53pm (infrared reveals the emissions that occur during the day)

Minisink, NY Compressor with FLIR GasFindIR
(Frank Finan)



Risks – Compressor Station Emissions

What you can see and hear can hurt you

- Blowdown is a release of natural gas directly into the atmosphere due to excessive pressure in the pipeline - scheduled or accidental
- On average, a single blowdown will release approximately 15 thousand standard cubic feet (Mcf) of gas to the atmosphere.

Oct. 2006 - http://www.epa.gov/gasstar/documents/II_compressoroffline.pdf

- The noise level near a compressor station can be up to 100 decibels whereas the usual nighttime noise level in many rural areas is around 35 decibels

March , 2014 - <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pa/home/?cid=nrcseprd330242>



<https://www.youtube.com/watch?v=WtSH5V1YQvQ>



<https://www.youtube.com/watch?v=u3aINVVOSyc&list=PLBF06C75E515BAD58>

Risks – Compressor Station

Noise and Vibrations



According to the WHO, *noise can cause permanent medical conditions*, such as hypertension and heart disease, hearing impairment, communication problems, sleep disturbance, cognitive effects such as memory problems, reduced performance, behavioral symptoms, and more.

Low-frequency noise (LFN), *also created by compressor stations, can also cause Vibroacoustic disease*, leading to cardiovascular symptoms and decreased cognitive skills.

Feb 22, 2010 - http://switchboard.nrdc.org/blogs/amaill/live_on_tape_the_dangerous_noi.html



A review article on noise exposure and health risk published in *Noise and Health* claims there is *sufficient evidence of a causal relationship between noise for ischemic heart disease*.

Feb 24, 2015 - <http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf>

Risks – Compressor Station Accidents

- **February 16, 2013** - Springville Township, PA: An explosion at a natural gas compressor station in Susquehanna County
Source: <http://www.nofrackingway.us/2014/06/18/gas-compressor-stations-dont-make-great-neighbors/>
- **March 4, 2013** – Clinton, AR: A natural gas explosion prompted the evacuation of 25 homes Monday afternoon.
Source: http://arkansasmatters.com/fulltext?nxd_id=642532
- **April 4, 2013** – Logan Co., OK: An explosion at a natural gas compressor station forced the evacuation of homes within one square mile of the incident. Source: <http://www.news9.com/story/21886634/homes-evacuated-after-gas-explosion-near>
- **April 11, 2013** – Tyler Co. WV: Two of the four workers injured in an explosion at a Magnum Hunter-owned compression station in WV have died.
Source: http://www.upstreamonline.com/live/article1323460.ece?source=email_rt_mc_body
- **May 15, 2013** – Brooklyn Township, PA: DEP officials say there is evidence of an explosion at a gas compressor station that caught fire.
Source: <http://www.wbng.com/news/local/Late-night-gas-compression-explosion-207490961.html>
- **May 30, 2013** – Branchburg, NJ: Thirteen workers were injured at a compressor station explosion.
Source: <http://us.topnewstoday.org/us/article/6205623/>
- **November 29, 2013** – Kansas City, MO: Residents over 30 miles away from the explosion reported seeing the resulting fire light up the sky. Flames from the fire were contained about two and a-half hours after the pipeline valve was shut off.
Source: http://www.upi.com/Top_News/US/2013/11/29/No-injuries-reported-in-Missouri-pipeline-explosion/UPI-16381385729914/
- **January 6, 2014** – Windsor, NY: Several Broome County fire departments were called out to a natural gas compressor station fire
Source: <http://www.wbng.com/news/local/Nine-departments-respond-to-blaze-239028421.html>
- **January 31, 2014** – Wheeler County, TX: Two people are being treated at a burn unit in Lubbock after a flash fire at a natural gas compressor station.
Source: <http://www.newschannel10.com/story/24605246/four-people-injured-in-workplace-accident>
- **March 15, 2014** – Richie Co., WV: A Dominion compressor station fire occurred off WV Route 16.
Source: <http://www.frackcheckwv.net/2014/03/15/recent-fires-and-explosions-with-natural-gas-in-the-united-states/>
- **May 25, 2014** – Oaktown, IN: Fire and emergency crews battled a fire at a natural gas compression station in Knox County early Friday.
Source: <http://www.naturalgaswatch.org/?p=3076>
- **July 10, 2014** – Susquehanna Co. PA: A vent stack at a Williams Field Services gas pipeline compressor station caught fire.
Source: <http://golackawanna.com/news/local-news-news/1523876/Susquehanna-County-compressor-station-shut-down-after-morning-fire#.U-Xv7aNQjTo>
- **Dec 1, 2014** – Susquehanna Co. PA: A gauge leaking methane most likely caused an explosion and fire in a natural gas compressor station last week
Source: <http://thetimes-tribune.com/news/fire-broke-out-in-natural-gas-compressor-station-last-week-1.1800355>
- **July 15, 2015** – West Franklin Township, WV: Two contractors were injured Wednesday afternoon during a natural gas accident in West Franklin Township
Source: <http://www.kittanningpaper.com/2015/07/16/two-hospitalized-following-explosion-in-west-franklin-township/56588>
- **Sept 9, 2015** - Kittson County, MN: The explosion sent flames soaring into the sky and could be seen for several miles
Source: <http://www.winnipecsun.com/2015/09/06/pipeline-explosion-visible-in-emerson#>



April 4, 2013 in Logan Co. OK:



April 11, 2013 in Tyler Co. WV:

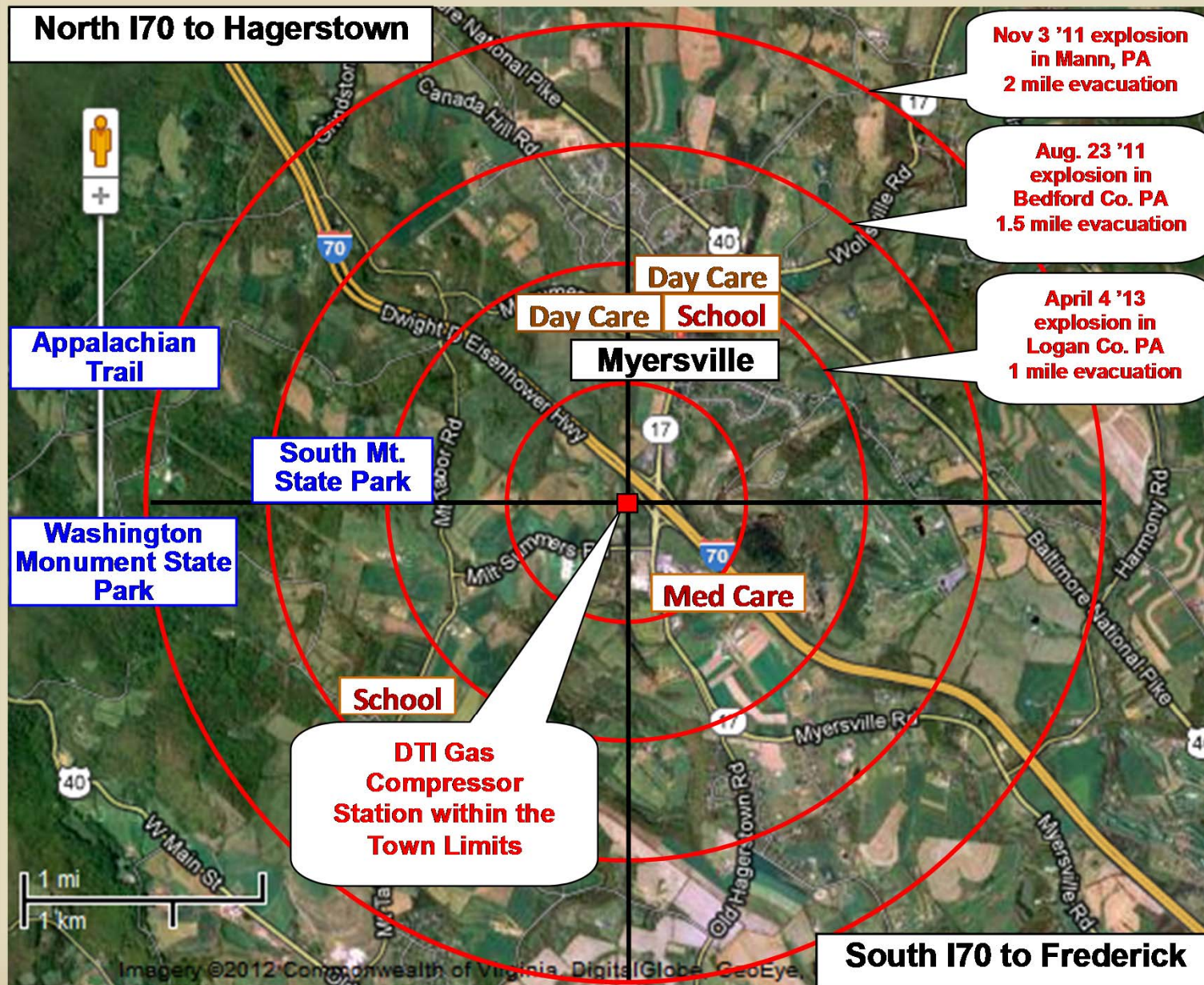


May 30, 2013 in Branchburg, NJ:

Risks – Compressor Station Evacuations



Myersville Citizens
for a Rural Community



21 homes within 0.5 mile: 305 homes within 1.0 mile (total 326): 490 homes within 1.5 mile (total 816).



Risks – Compressor Station

Farm Land

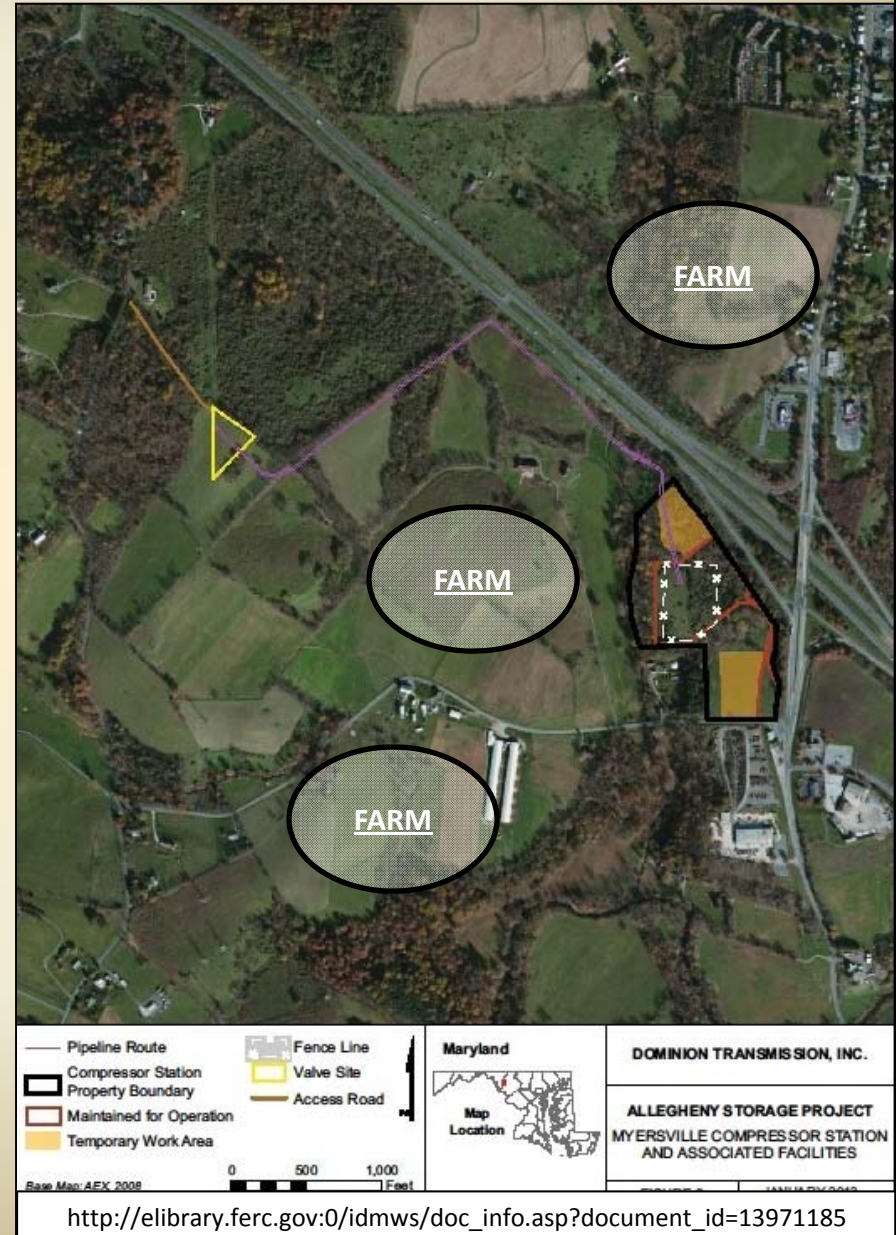


Long-term yield reductions for farmers due to topsoil disturbance, increased heat from the pipeline, and water evaporation

PM2.5 can be carried over long distances by wind and then settle on ground or water. The effects of this settling include: making lakes and streams acidic; changing the nutrient balance in coastal waters and large river basins; *depleting the nutrients in soil; damaging sensitive forests and farm crops; and affecting the diversity of ecosystems.*

(Farms identified for emphasis)

<http://www.epa.gov/air/particlepollution/health.html>





Risks – Compressor Station

Rivers and Streams



Company will use a combination of open cuts and horizontal directional drilling across and under streams and tributaries. Erosion and sedimentation affecting fish and stream life

- NOx and sulfur dioxide react with other substances in the air to form acids which fall to earth as rain, fog, snow, or dry particles. ... *Acid rain damages forests; causes deterioration of cars, buildings, and historical monuments; and causes lakes and streams to become acidic and unsuitable for many fish.*
- Increased nitrogen loading in water bodies, particularly coastal estuaries, *upsets the chemical balance of nutrients used by aquatic plants and animals.*



Photo: Town of Myersville

Risks – Compressor Station

Cost versus Best Available Technology



According to INGAA, the best available technology is an electric gas compressor

Electric motors are more reliable and more efficient as stand-alone pieces of equipment than either reciprocating engines or gas turbines. They also have an advantage where air quality regulations are an issue because they do not emit NOx and CO2 at the point of use.



Nov. 1, 2010 - <http://www.ingaa.org/11885/Reports/10927.aspx>

Gas STAR Alliance - Partner Reported Opportunities for Reducing Methane Emissions Fact Sheet No. 103

Installing an electric motor in place of a gas driven engine will increase operational efficiency, reduce maintenance costs, and yield significant methane savings. The primary reasons for implementation are fuel gas savings and maintenance savings. An additional benefit is the faster permitting process as a result of lower noise output and no emissions.

2011 - <http://www.epa.gov/gasstar/documents/reducethefrequencyofenginestarts.pdf>



FERC's Allegheny Storage Project Environmental Assessment

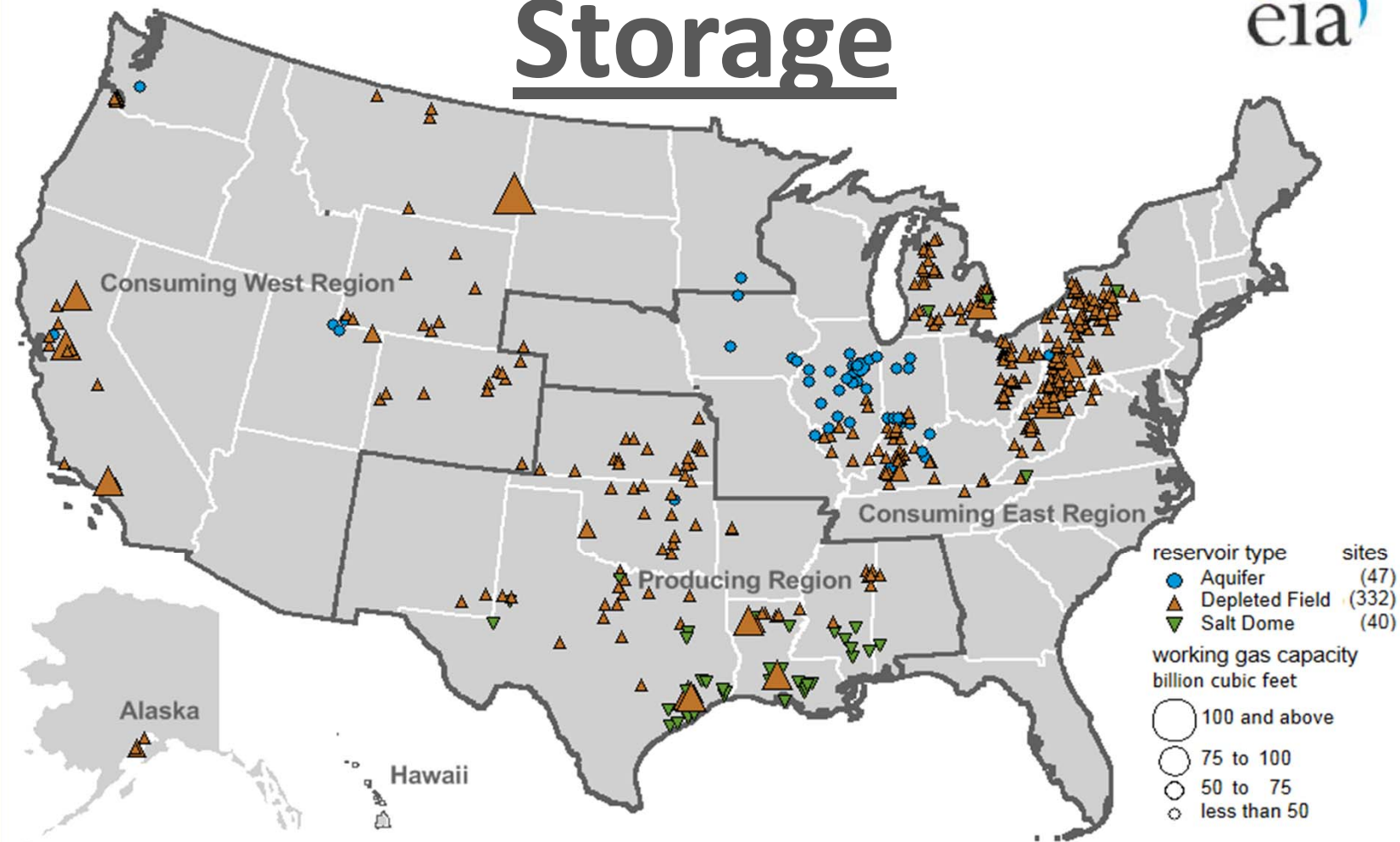
As proposed, the Myersville Compressor Station would be a minor emissions source for federal and state air permitting requirements. Because electric-driven compressors would cause an increase in land use impacts and direct impacts on a landowner without providing a significant advantage over the proposed design, we eliminated this alternative from further consideration

June 14, 2012- http://elibrary.ferc.gov:0/idmws/file_list.asp?document_id=14030537




U.S. Underground Natural Gas Storage Facilities, by Type (December 31, 2013)



Storage



Dec. 2013 - http://www.eia.gov/cfapps/ngqs/images/storage_2013.png

-  **Aquifers** are reconditioned underground porous, permeable rock formations - 47
-  **Depleted reservoirs** are the most common form of underground storage consists of depleted gas reservoirs already tapped of all their recoverable natural gas - 332
-  **Underground salt dome** formations are another option for natural gas storage - 40

Risks – Storage

Underground natural gas storage poses inherent risks that include :

- migration of the natural gas out of the storage formation, *posing risks for contamination of groundwater*
- vertical migration of natural gas through existing wells, which may be particularly hazardous in close proximity to the well
- wellhead and casing degradation or failure that may expose other strata above the storage formation to the risk of contamination
- methane emissions, through off-gassing at the wellhead *methane contamination of groundwater*, which may be hazardous when exposed to air

Our results indicate that underground natural *gas storage activities bear risks that are substantial enough to affect nearby residents*, and that these impacts are more severe in proximity, concentration, and for properties without access to public water.

June 2014 -

http://www.nardep.info/uploads/Brief24_RisksUndergroundGasStorage.pdf

1. ***The Company Behind's LA Methane Disaster Knew Its Well Was Leaking 24 Years Ago.*** The resulting methane leak is now being called one of the largest environmental disasters since the BP oil spill, has pushed thousands of people out of their homes...

Jan 8, 2016 - <http://motherboard.vice.com/read/the-company-behind-las-methane-disaster-knew-its-well-was-leaking-24-years-ago>

2. In Aug. 2013, after months of unexplained seismic activity and mysterious bubbling on the bayou, a sinkhole opened up on land leased by the Texas Brine, *forcing an immediate evacuation of Bayou Corne's 350 residents*. The sinkhole initially spanned about an acre. Today it covers more than 24 acres and is an estimated 750 feet deep
3. On Christmas Day 2003, a methane leak from a Napoleonville Dome salt cavern storing natural gas forced residents of Grand Bayou to evacuate. Dow Chemical, which owned the cavern, bought out the mostly elderly residents, leaving only concrete slabs behind.
4. A 2001 cavern leak in Hutchinson, Kansas, spewed 30-foot-tall geysers of gas and water and caused an explosion that left two people dead

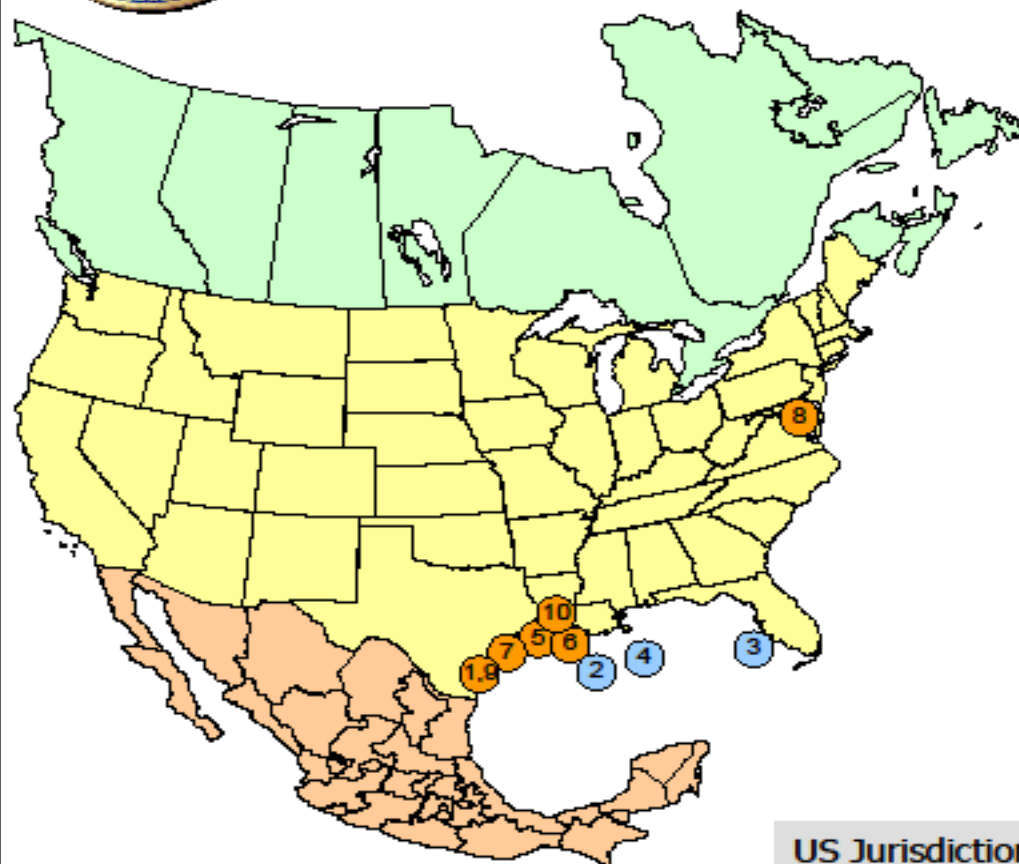
Aug. 7, 2013 -

<http://www.motherjones.com/environment/2013/08/bayou-corne-sinkhole-disaster-louisiana-texas-brine>

LNG Export Facilities



North American LNG Import /Export Terminals *Approved*



As of April 14, 2015

US Jurisdiction

- FERC
- MARAD/USCG

Import Terminal

APPROVED - UNDER CONSTRUCTION

U.S. - FERC

1. Corpus Christi, TX: 0.4 Bcfd (Cheniere – Corpus Christi LNG) (CP12-507)

APPROVED - NOT UNDER CONSTRUCTION

U.S. - MARAD/Coast Guard

2. Gulf of Mexico: 1.0 Bcfd (Main Pass McMoran Exp.)
3. Offshore Florida: 1.2 Bcfd (Hoëgh LNG - Port Dolphin Energy)
4. Gulf of Mexico: 1.4 Bcfd (TORP Technology-Bienville LNG)

Export Terminal

APPROVED - UNDER CONSTRUCTION

U.S. - FERC

5. Sabine, LA: 2.76 Bcfd (Cheniere/Sabine Pass LNG) (CP11-72 & CP14-12)
6. Hackberry, LA: 1.7 Bcfd (Semptra – Cameron LNG) (CP13-25)
7. Freeport, TX: 1.8 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction) (CP12-509)
8. Cove Point, MD: 0.82 Bcfd (Dominion – Cove Point LNG) (CP13-113)
9. Corpus Christi, TX: 2.14 Bcfd (Cheniere - Corpus Christi LNG) (CP12-507)

APPROVED - NOT UNDER CONSTRUCTION

U.S. - FERC

10. Sabine Pass, LA: 1.40 Bcfd (Sabine Pass Liquefaction) (CP13-552)

LNG Export Growth

Proposed

18 projects in the US and 3 in Canada

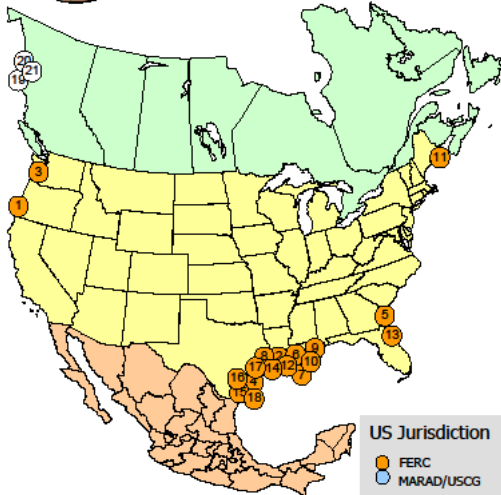
Potential

12 projects in the US and 16 in Canada



North American LNG Export Terminals

Proposed



Export Terminal

PROPOSED TO FERC

1. Coos Bay, OR: 0.9 Bcfd (Jordan Cove Energy Project) (CP13-483)
2. Lake Charles, LA: 2.2 Bcfd (Southern Union - Trunkline LNG) (CP14-120)
3. Astoria, OR: 1.25 Bcfd (Oregon LNG) (CP09-6)
4. Lavaca Bay, TX: 1.38 Bcfd (Excelerate Liquefaction) (CP14-71 & 72)
5. Elba Island, GA: 0.35 Bcfd (Southern LNG Company) (CP14-103)
6. Lake Charles, LA: 1.07 Bcfd (Magnolia LNG) (CP14-347)
7. Plaquemines Parish, LA: 1.07 Bcfd (CE FLNG) (PF13-11)
8. Sabine Pass, TX: 2.1 Bcfd (ExxonMobil - Golden Pass) (CP14-517)
9. Pascagoula, MS: 1.5 Bcfd (Gulf LNG Liquefaction) (PF13-4)
10. Plaquemines Parish, LA: 0.30 Bcfd (Louisiana LNG) (PF14-17)
11. Robbinston, ME: 0.45 Bcfd (Kestrel Energy - Downeast LNG) (PF14-19)
12. Cameron Parish, LA: 1.34 Bcfd (Venture Global) (PF15-2)
13. Jacksonville, FL: 0.075 Bcfd (Eagle LNG Partners) (PF15-7)
14. Hackberry, LA: 1.4 Bcfd (Semptra - Cameron LNG) (PF15-13)
15. Brownsville, TX: 0.54 Bcfd (Texas LNG Brownsville) (PF15-14)
16. Brownsville, TX: 0.94 Bcfd (Annova LNG Brownsville) (PF15-15)
17. Port Arthur, TX: 1.4 Bcfd (Port Arthur LNG) (PF15-18)
18. Brownsville, TX: 3.6 Bcfd (Rio Grande LNG - NextDecade) (PF15-20)

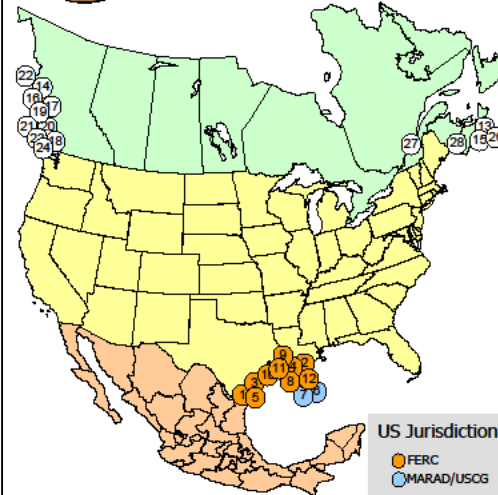
PROPOSED CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

19. Kitimat, BC: 1.28 Bcfd (Apache Canada Ltd.)
20. Douglas Island, BC: 0.23 Bcfd (BC LNG Export Cooperative)
21. Kitimat, BC: 3.23 Bcfd (LNG Canada)



North American LNG Export Terminals

Potential



Export Terminal

POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS

1. Brownsville, TX: 2.8 Bcfd (Gulf Coast LNG Export)
2. Cameron Parish, LA: 0.16 Bcfd (Waller LNG Services)
3. Ingleside, TX: 1.09 Bcfd (Pangea LNG (North America))
4. Cameron Parish, LA: 0.20 Bcfd (Gasfin Development)
5. Brownsville, TX: 3.2 Bcfd (Eos LNG & Barca LNG)
6. Gulf of Mexico: 3.22 Bcfd (Main Pass - Freeport-McMoRan)
7. Gulf of Mexico: 1.8 Bcfd (Delfin LNG)
8. Cameron Parish, LA: 1.60 Bcfd (SCT&E LNG)
9. Port Arthur, TX: 0.2 Bcfd (WesPac/Gulfgate Terminal)
10. Galveston, TX: 0.77 Bcfd (NextDecade)
11. Calcasieu Parish, LA: 0.64 Bcfd (Live Oak LNG-Parallax Energy)
12. Cameron Parish, LA: 1.84 Bcfd (G2 LNG)

POTENTIAL CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

13. Goldboro, NS: 1.4 Bcfd (Pieridae Energy Canada)
14. Prince Rupert Island, BC: 2.91 Bcfd (BG Group)
15. Melford, NS: 1.8 Bcfd (H-Energy)
16. Prince Rupert Island, BC: 2.74 Bcfd (Pacific Northwest LNG)
17. Prince Rupert Island, BC: 4.0 Bcfd (ExxonMobil - Imperial)
18. Squamish, BC: 0.29 Bcfd (Woodfibre LNG Export)
19. Kitimat/Prince Rupert, BC: 0.32 Bcfd (Triton LNG)
20. Prince Rupert, BC: 3.12 Bcfd (Aurora LNG)
21. Kitimat, BC: 2.7 Bcfd (Kitimat Energy)
22. Stewart, BC: 4.1 Bcfd (Canada Stewart Energy Group)
23. Delta, BC: 0.4 Bcfd (WesPac Midstream Vancouver)
24. Vancouver Island, BC: 0.11 Bcfd (Steelhead LNG)
25. Prince Rupert Island, BC: 3.2 Bcfd (Orca LNG)
26. Port Hawkesbury, NS: 0.5 Bcfd (Bear Head LNG)
27. Saguenay, Quebec: 1.6 Bcfd (GNL Quebec)
28. Saint John, NB: 0.67 Bcfd (Saint John LNG Development)

April 14, 2015 - <http://www.ferc.gov/industries/gas/indus-act/lng.asp>

FERC Commissioner Tony Clark..."The large amount of natural gas in the U.S. is also creating an impetus for something that was nearly unimaginable ten or fifteen year ago, LNG export, as opposed to import terminals. *This is an area of significant workload increase for the Commission*".



Dec 5, 2013 - <http://www.ferc.gov/CalendarFiles/20131205094327-Clark-12-05-2013.pdf>



Risks – LNG Export Economic Impact

DOE has already approved LNG terminals that could export 13 billion cubic feet per day (Bcf/d) of natural gas – about 18 percent of total domestic production projected in 2020.

The EIA notes that LNG exports will increase by 14-fold between 2013 and 2020 under a “business as usual” scenario. There would be another four fold increase in exports between 2020 and 2030. Under these projections, the *cost of natural gas for domestic electricity generation would rise by 32 percent between 2013 and 2020*. And the price would nearly double between 2013 and 2030.

Increased natural gas exports lead to higher domestic natural gas prices, increased domestic natural gas production, reduced domestic natural gas consumption, and increased natural gas imports from Canada via pipeline.

April 14, 2014 - <http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013ER&subject=8-AEO2013ER&table=13-AEO2013ER®ion=0-0&cases=early2013-d102312a>



Because we have found that, as proposed by Dominion Cove Point, the Generating Station and the LNG facility *will not provide net economic benefit to Maryland citizens*, we have modified the proposed conditions to require DCP to contribute \$8 million per year for five years (\$40 million total) to the State’s Strategic Energy Investment Fund

May 30, 2014 - <http://chesapeakeclimate.org/wp/wp-content/uploads/2014/05/Order-86372-Case-9318-Dominion-Cove-Point-LNG-CPCN.pdf>



LNG Export Legal Conflict

The Department of Energy has responsibility under the Natural Gas Act of 1938 to regulate the import and export of natural gas, and determines public interest. Amendments in Section 201 of the Energy Policy Act of 1992 directed that the “importation of such natural gas shall be deemed to be consistent with the public interest,” but there was no language on exports.



<https://www.law.cornell.edu/uscode/text/15/717b>

<http://www.usbr.gov/power/legislation/epa92.pdf>

Section 311 of the Energy Policy Act of 2005 added that FERC "shall have the exclusive authority to approve or deny an application for the siting, construction, expansion, or operation of an LNG terminal."

<https://www.govtrack.us/congress/bills/109/hr6/text>



This is in direct conflict with Sec 103 of the Energy Policy and Conservation Act of 1975, and Section 7 of the Export Administration Act of 1979 which orders that “The President shall...promulgate a rule prohibiting the export of crude oil and natural gas produced in the United States, except that the President may...exempt from such prohibition such crude oil or natural gas exports which he determines to be consistent with the national interest.” The Department of Commerce never promulgated rules to comply with the law’s mandate to also prohibit the export of natural gas.

<http://legcounsel.house.gov/Comps/EPCA.pdf>

Other Infrastructure

Metering Stations



Metering stations are placed periodically along interstate natural gas pipelines. These stations allow pipeline companies to monitor and measure the flow natural gas along the pipeline.

Valves



Valves work like gateways - usually open and allow natural gas to flow freely, or they can be used to stop gas flow along a certain section of pipe. Large valves can be placed every 5 to 20 miles.

Gate Station



At the local gas utility, a "**gate station**" serves three purposes: first reducing the pressure in the line from transmission levels to distribution levels. Then an odorant is added. Finally, the gate station measures the delivered gas.

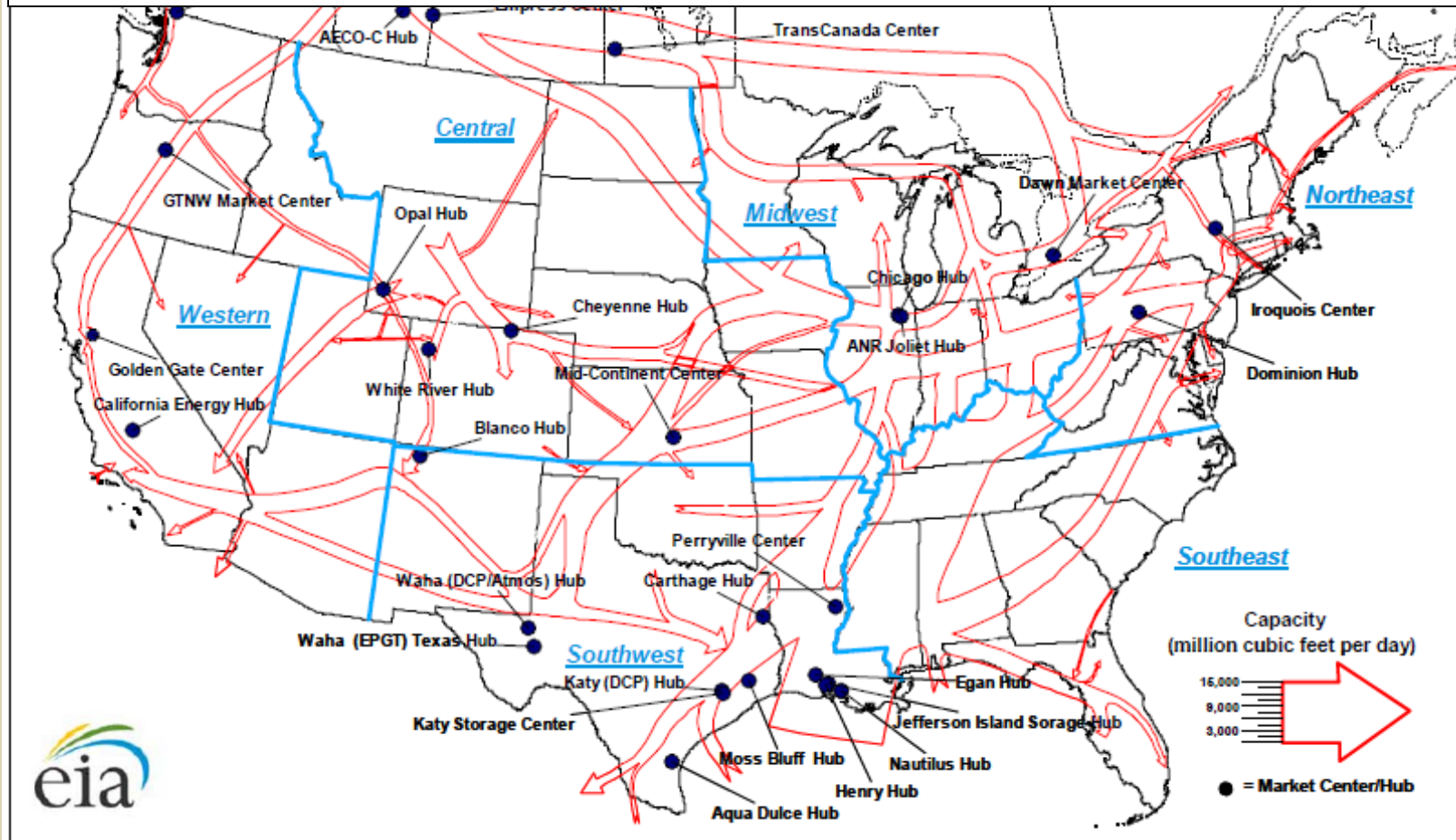
Pipeline Inspection Gage (PIG)



Devices known as "**pigs**" are used to perform various maintenance operations on a pipeline. This is done without stopping the flow of the product in the pipeline. Operations include cleaning and inspecting the pipeline.

Natural Gas Centers / Hubs

https://www.eia.gov/pub/oil_gas/natural_gas/feature_articles/2009/ngmarketcenter/ngmarketcenter.pdf



The 'Market Centers and Hubs' provide transportation between and interconnections with other pipelines for physical coverage of *short-term receipt and delivery balancing needs*.

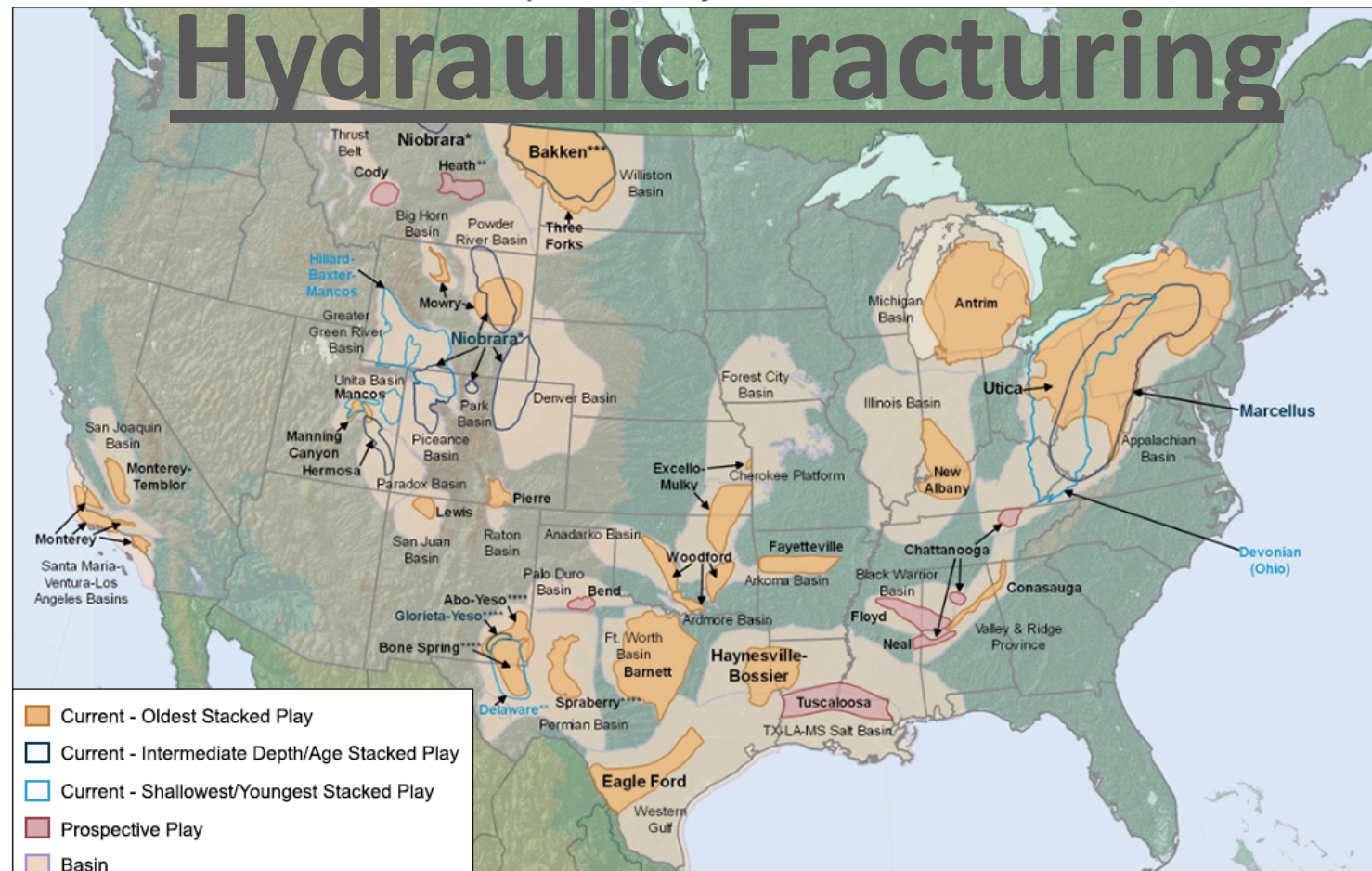
http://www.eia.gov/pub/oil_gas/natural_gas/feature_articles/2003/market_hubs/mkthubsweb.html

Order 636 requires that interstate pipelines offer services that allow for the efficient and reliable delivery of natural gas to end users....*The capacity release programs allow the resale of unwanted pipeline capacity between pipeline customers.*

<http://www.naturalgas.org/regulation/history.asp#ferc636>

New EIA Map of Shale Plays in the Lower 48 States

Hydraulic Fracturing



<http://www.naturalgasintel.com/articles/102028-eia-revamping-shale-maps-to-illustrate-geologic-history>



FERC Commissioner Tony Clark... "the biggest story in energy today, perhaps the biggest story in decades, is the emergence of the shale oil and gas plays"

Dec 5, 2013 - <http://www.ferc.gov/CalendarFiles/20131205094327-Clark-12-05-2013.pdf>

Energy Primer - A Handbook of Energy Market Basics

Pipeline capacity additions moderated in 2010 and 2011 until surging again to reach annual additions of 2.9 Bcfd in 2012 and 2.6 Bcfd in 2013. Much of this new capacity was targeted at improving access to shale gas.

July 2015 - <https://www.ferc.gov/market-oversight/guide/energy-primer.pdf>



Fracking Overview

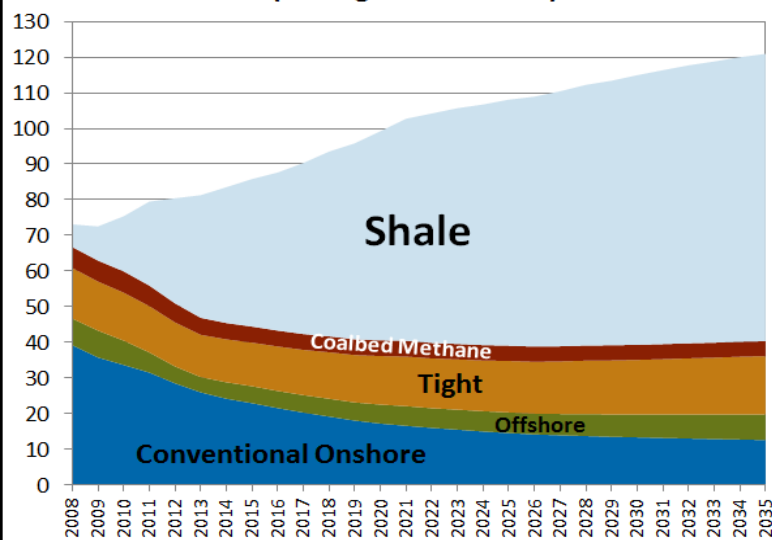
This technique uses a specially blended liquid which is pumped into a well under extreme pressure causing cracks in rock formations underground. These cracks in the rock then allow oil and natural gas to flow, increasing resource production
<http://fracfocus.org/hydraulic-fracturing-process>



Unconventional natural gas supplies account for all of the incremental supply as production from conventional areas declines. Unconventional supplies will account for approximately two-thirds of the total gas supply mix in 2035.

March 17, 2014 - <http://www.ingaa.org/Foundation/Foundation-Reports/2035Report.aspx>

**U.S. and Canadian Natural Gas Production
(Average Annual Bcfd)**



Hydraulic Fracturing at a Glance

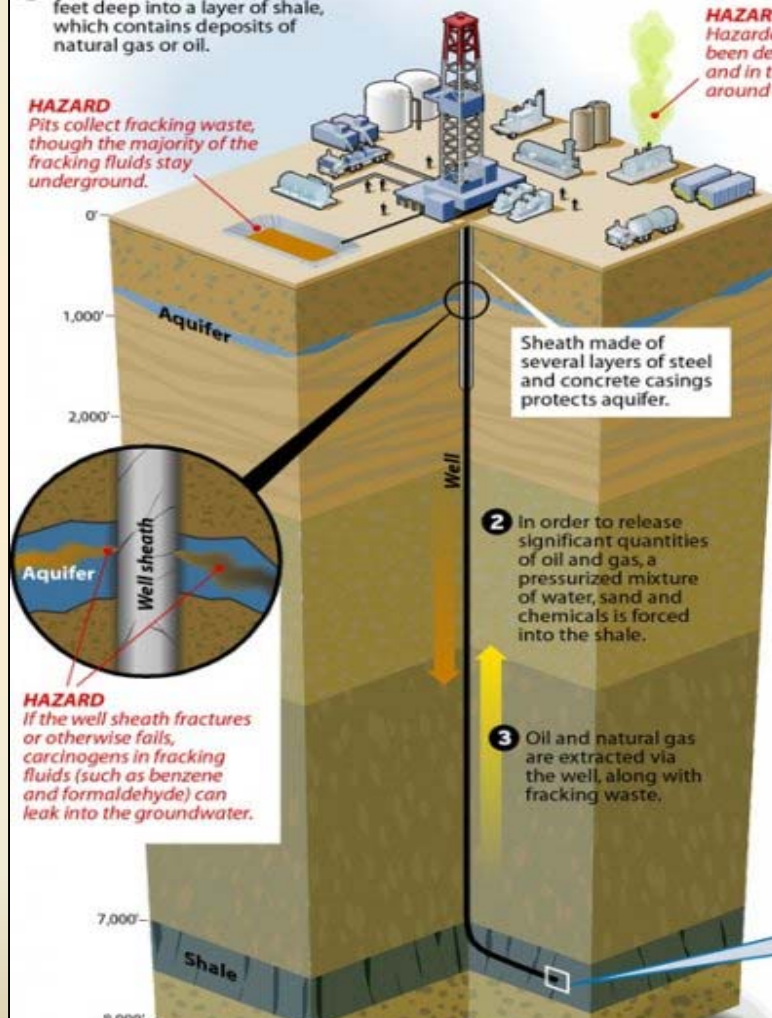
America's oil and gas boom was made possible by hydraulic fracturing, which uses a mix of water, sand and hazardous chemicals to blast through shale rock to release hydrocarbons. High-profile cases of water contamination have generated fears that fracking might endanger water supplies.

THE PROCESS

- 1 A well is drilled several thousand feet deep into a layer of shale, which contains deposits of natural gas or oil.

HAZARD
Pits collect fracking waste, though the majority of the fracking fluids stay underground.

HAZARD
Hazardous chemicals have been detected underground, and in the water and air around fracking pads.



HAZARD
If the well sheath fractures or otherwise fails, carcinogens in fracking fluids (such as benzene and formaldehyde) can leak into the groundwater.

HORIZONTAL DRILLING

- 1 A well is drilled horizontally into the shale. A casing is inserted in the borehole and sometimes surrounded with cement.
- 2 In order to release significant quantities of oil and gas, a pressurized mixture of water, sand and chemicals is forced into the shale. A perforating gun blasts small holes into the shale.
- 3 A highly pressurized mix of water, sand and chemicals is pumped into the well. Oil and natural gas are extracted via the well, along with fracking waste.
- 4 The high-pressure mix creates small fissures in the shale, releasing hydrocarbons which are collected via the well. The sand keeps the fissures open for a continuous "bleed."

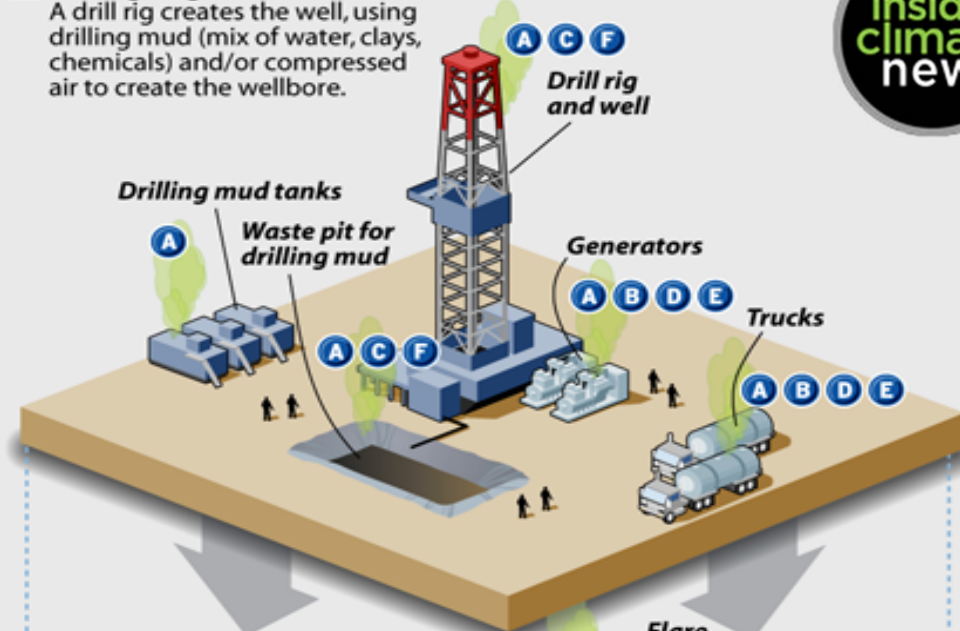
March 31, 2015 -

<http://www.insideclimatenews.org/node/38908>

1 Drilling stage

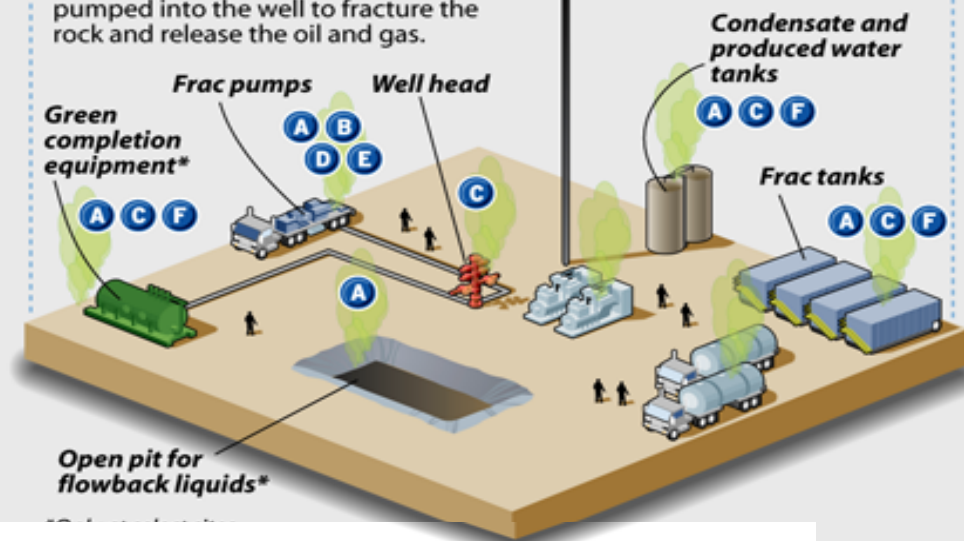
A drill rig creates the well, using drilling mud (mix of water, clays, chemicals) and/or compressed air to create the wellbore.

inside
climate
news



2 Hydraulic fracturing and well completion

Water, proppants and chemicals are pumped into the well to fracture the rock and release the oil and gas.



SOURCES: EPA and Schlumberger publications;

Emission Sources

1. Drilling mud tanks
2. Drill rig and well
3. Generators
4. Trucks
5. Frac pumps
6. Open pits
7. Well head
8. Tanks

Emission Sources

The pollutants come from a number of sources, including the diesel- or natural gas-fueled equipment, the oil and gas itself, and leaks from storage devices. The emissions' actual and relative amounts vary widely based on operator practices and local geology. The emissions occur regularly in some cases, but are intermittent in others.

CHEMICAL	WHAT IT IS	WHAT IT DOES
A VOCs	Volatile organic compounds including benzene, formaldehyde	There are dozens of VOCs that make people sick. Some can cause cancer. VOCs react with NOx to form ozone, a respiratory irritant and greenhouse gas.
B PM	Particulate matter	Affects the heart and lungs.
C CH ₄	Methane	Main component of natural gas. Much more powerful than CO ₂ as a greenhouse gas.
D CO ₂	Carbon dioxide	Major greenhouse gas.
E NOx	Nitrogen oxides	Reacts with VOCs to create ozone.
F H ₂ S	Hydrogen sulfide	Toxic gas found in some gas fields. Causes illness and death at certain concentrations.

Fugitive emissions: pipelines, valves, pneumatic devices etc. leak methane, VOCs, H₂S and CO₂ throughout the entire process.

Emission Sources

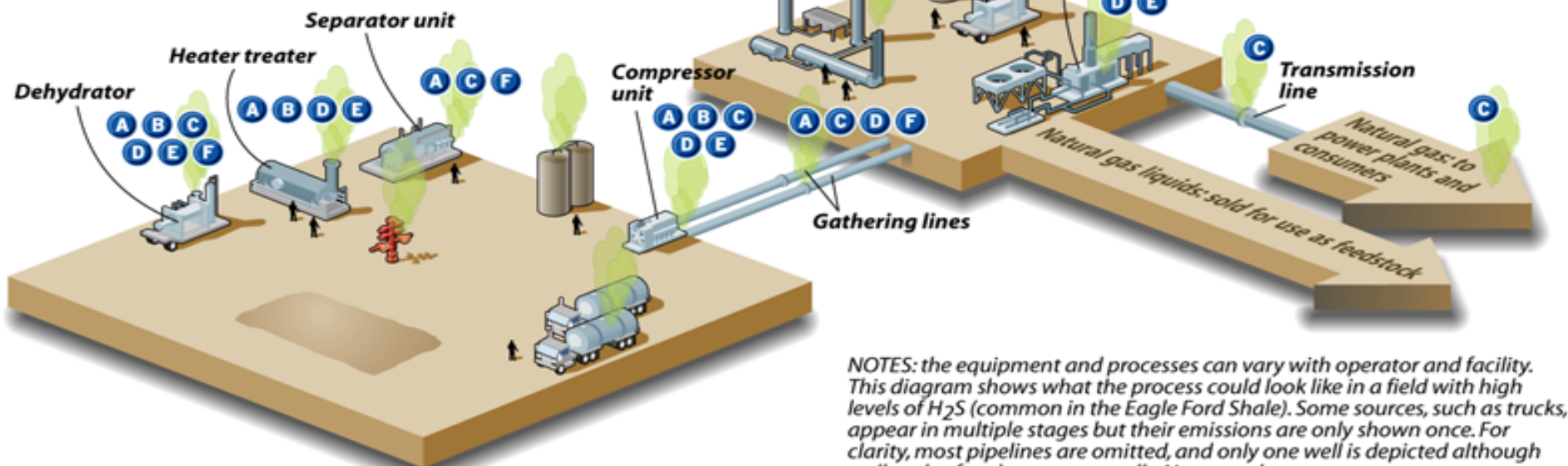
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3 Production

The well begins to produce large amounts of oil and gas. The recovered oil is shipped to refineries; gas and condensates are separated and processed.



NOTES: the equipment and processes can vary with operator and facility. This diagram shows what the process could look like in a field with high levels of H₂S (common in the Eagle Ford Shale). Some sources, such as trucks, appear in multiple stages but their emissions are only shown once. For clarity, most pipelines are omitted, and only one well is depicted although well pads often have many wells. Not to scale.

Emission Sources

1. Dehydrator
2. Heater
3. Separator
4. Compressor Unit and Stations
5. Gathering Lines and Transmission Lines

4 Dehydration, treatment and processing

Water, condensate, H₂S and other impurities are taken out of the raw natural gas. This can occur on or near the well pad or at a centralized processing facility. Additional equipment used to purify and process natural gas liquids is not shown here.

5 Distribution to market

The purified natural gas is sent to market via transmission lines. Natural gas liquids are delivered to refineries and petrochemical plants.



Risks – LNG Export Potential Impact Radius

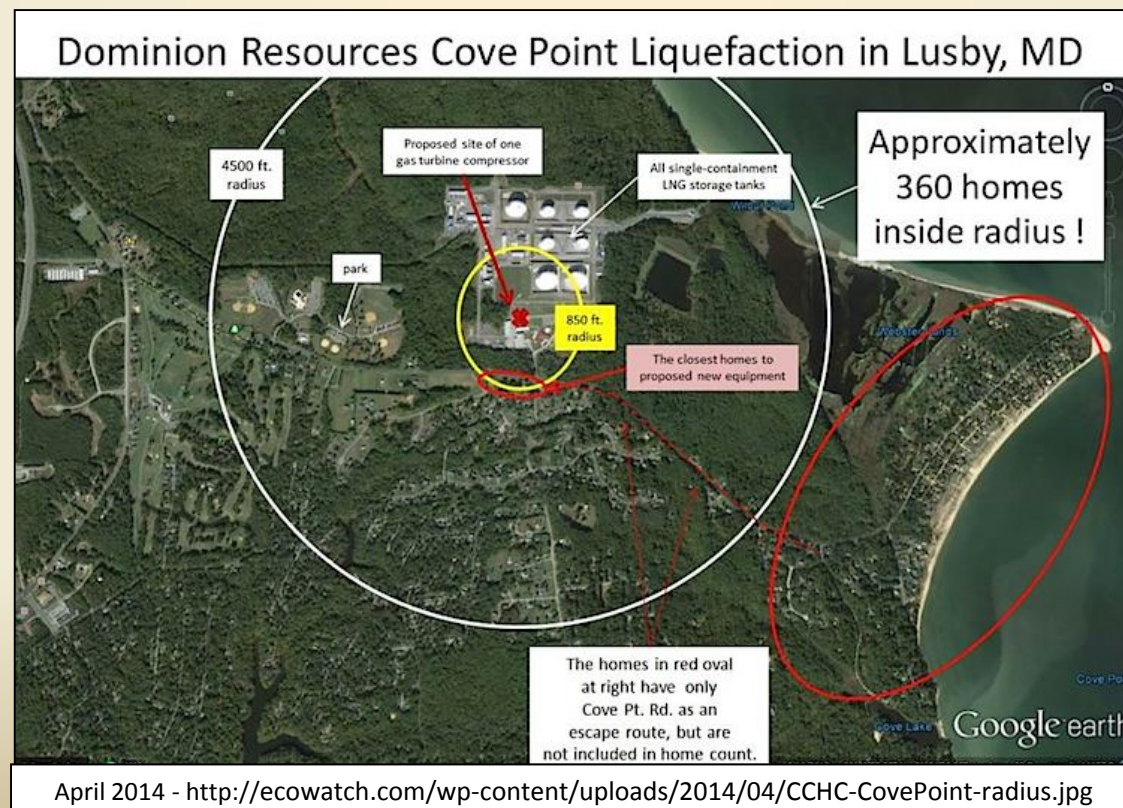
A pipeline within a liquefied natural gas facility exploded in a rural area of Washington state on Monday and emergency workers continued to work into the evening to minimize the risk of further blasts from a leaking storage tank

Mar 31, 2014 - <http://www.reuters.com/article/williamspartners-natgaspipe-fire-idUSL1N0MS1S620140331>

An unexplained blast this week at a liquefied natural gas (LNG) facility in rural Washington state, which injured workers, forced an evacuation and raised alarm about a potentially large second explosion

April 7, 2014 - http://business.financialpost.com/news/energy/blast-at-u-s-lng-site-casts-spotlight-on-natural-gas-safety?__lsa=9325-8bdf

Scary video of LNG explosion - <https://www.youtube.com/watch?v=UI0QWm4TxZU>



Risks – Fracking

Fracking by the Numbers - Key Impacts of Dirty Drilling at the State and National Level

Oct 2013 - http://www.environmentamerica.org/sites/environment/files/reports/EA_FrackingNumbers_scrn.pdf

As evidenced by the data in this report, fracking is *causing extensive damage to the environment and public health* in states across the country. States as disparate as Colorado, North Dakota, Pennsylvania and Texas suffer from *air pollution, water pollution, habitat disruption and water depletion* caused by widespread fracking. Wherever fracking has occurred, it has left its mark on the environment and our well-being.

Table ES-1. National Environmental and Public Health Impacts of Fracking

Fracking Wells since 2005	82,000
Toxic Wastewater Produced in 2012 (billion gallons)	280
Water Used since 2005 (billion gallons)	250
Chemicals Used since 2005 (billion gallons)	2
Air Pollution in One Year (tons)	450,000
Global Warming Pollution since 2005 (million metric tons CO ₂ -equivalent)	100
Land Directly Damaged since 2005 (acres)	360,000



Photo: Peter Aengst via SkyTruth/EcoFlight

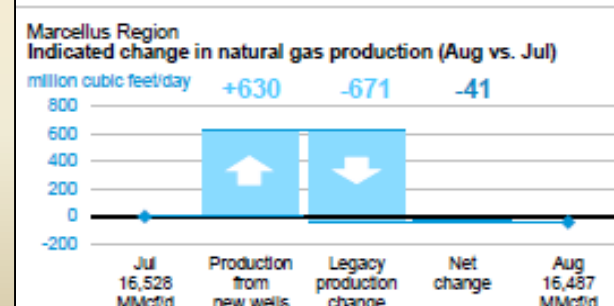
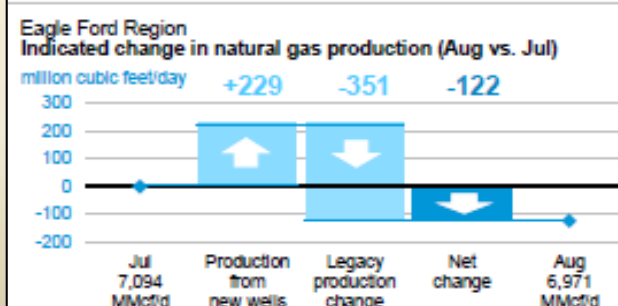
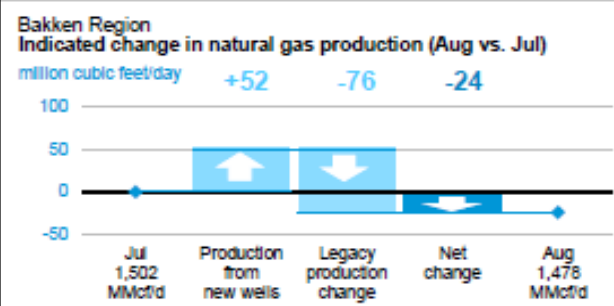
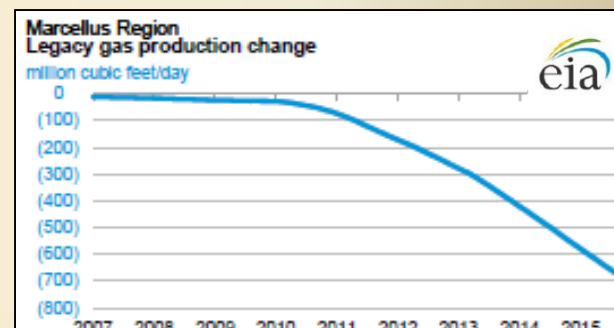
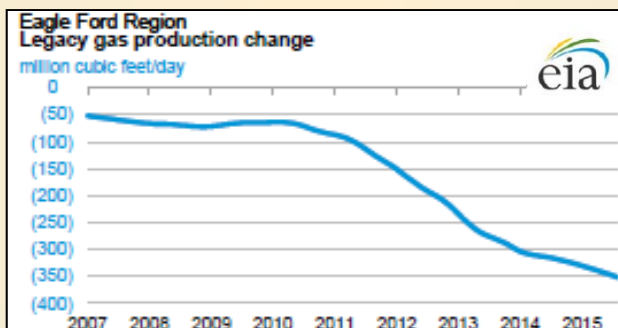
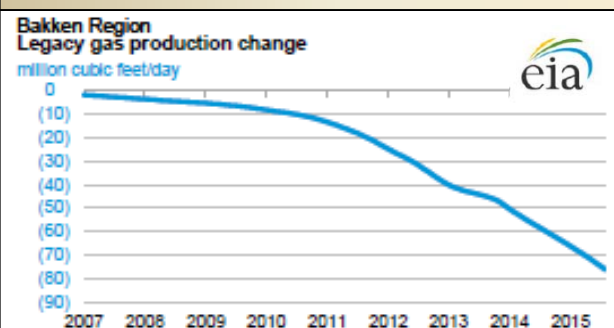
Risks – Fracking

Drilling Deeper - A reality check on US Government forecasts for a lasting tight oil and shale gas boom

Oct. 2014 - http://www.postcarbon.org/wp-content/uploads/2014/10/Drilling-Deeper_PART-1-Exec-Sum.pdf

Simply maintaining U.S. shale gas production in the medium term—let alone increasing production at rates forecast by the EIA through 2040—will be problematic

- The 3-year average *well decline rates* in the seven plays analyzed for this report (which collectively provide 88% of U.S. shale gas production) ranges between 74% and 82%.
- Approximately 130,000 additional shale gas wells will need to be drilled by 2040 to meet the projections of this [EIA April 14, 2014 forecast] report, on top of the 50,000 wells drilled in these plays through 2013.
- Between one-quarter and one-half of all production in each play must be replaced each year in order to simply maintain current production



Risks – Fracking

Drinking Water

Analyses revealed that arsenic, selenium, strontium and total dissolved solids (TDS) exceeded the Environmental Protection Agency's Drinking Water Maximum Contaminant Limit (MCL) in some samples from private water wells located within 3 km of active natural gas wells

<http://pubs.acs.org/doi/pdf/10.1021/es4011724>

Forrest Landscape

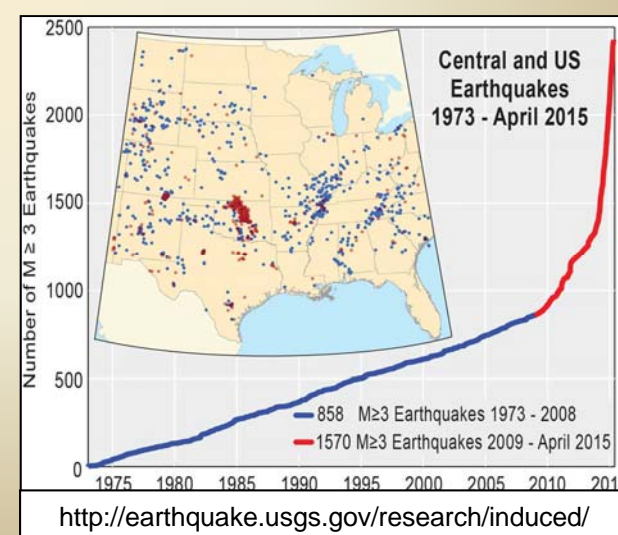
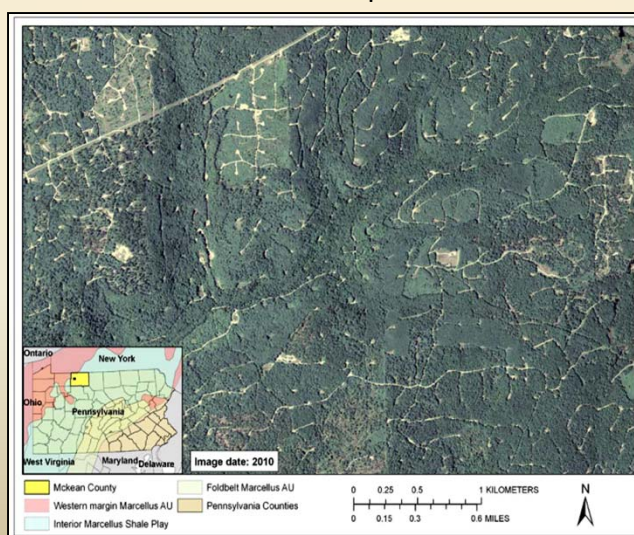
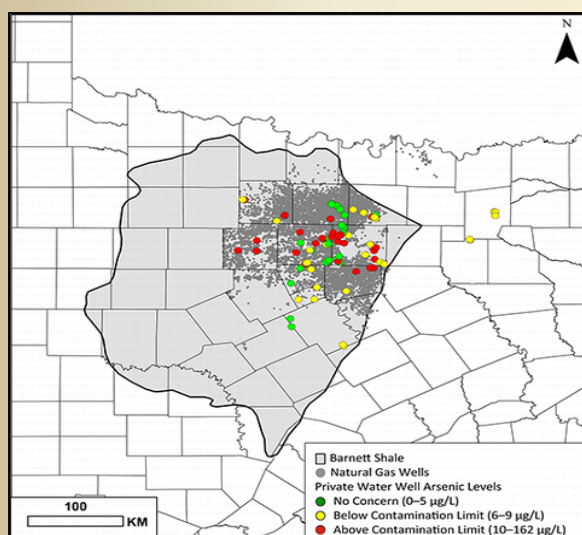
The combined effects of these two natural gas extraction methods create potentially serious patterns of disturbance on the landscape. A forested landscape in McKean County, PA, showing the spatial effects of roads, well pads, and pipelines related to natural gas development.

2012 -
<http://pubs.usgs.gov/of/2012/1154/of2012-1154.pdf>

Earthquakes

The man-made quakes jolted once-stable regions in eight states. Experts said the spike in seismic activity was mainly caused by the oil and gas industry injecting wastewater deep underground, which can activate dormant faults.

2015 -
<http://www.theguardian.com/world/2015/apr/23/oil-gas-drilling-triggers-man-made-earthquakes-usgs>





Risks – Fracking

How Fracking Is Exposing People to Radioactive Waste

May 5, 2014 - <http://www.resilience.org/stories/2014-05-05/how-fracking-is-exposing-people-to-radioactive-waste>

Rather, E.P.A. and industry researchers say, the *bigger danger of radioactive wastewater is its potential to contaminate drinking water or enter the food chain* through fish or farming. Once radium enters a person's body, by eating, drinking or breathing, it can cause cancer and other health problems, many federal studies show

Fed Government failed to inspect higher risk oil wells

May 12, 2014: <http://bigstory.ap.org/article/fed-govt-failed-inspect-higher-risk-oil-wells-0>

The government has failed to inspect thousands of oil and gas wells it considers potentially high risks for water contamination and other environmental damage. The report highlights substantial gaps in oversight due to weak controls, policies based on outdated science and incomplete monitoring data by the Interior Department's Bureau of Land Management that manages oil and gas development on federal and Indian lands



The Urgent Case for a Ban on Fracking

Sept 2014: <http://documents.foodandwatereurope.org/doc/EuropeUrgentBanFrackingFeb2015.pdf>

The evidence is clear. All of the above impacts from widespread drilling and fracking create significant public health and environmental risks and harms, and endanger society with the prospect of a wildly unstable climate. Current scientific understanding supports precaution in the face of these risks and harms. (comment – detailed footnoted resource)

Interior secretary: Major backlog of inspections for high-risk oil, gas wells on federal land

Sept 15, 2015: <http://www.usnews.com/news/business/articles/2015/09/15/interior-dept-high-risk-oil-gas-wells-checks-lack-funding>

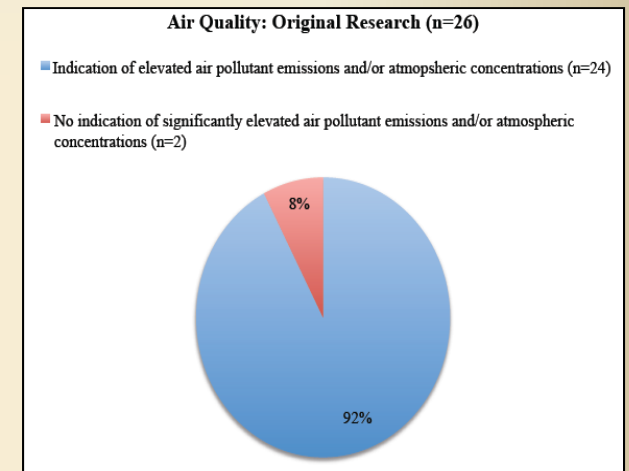
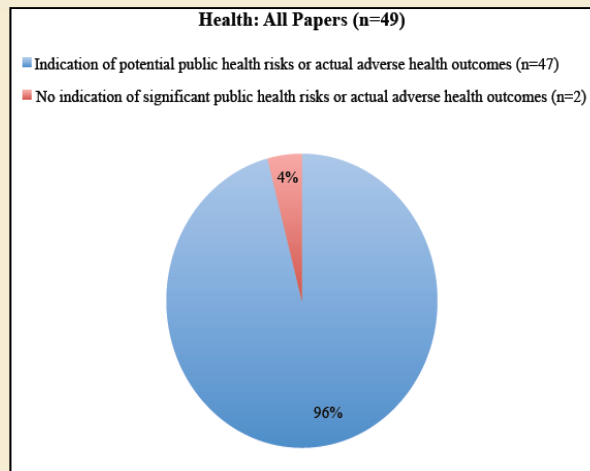
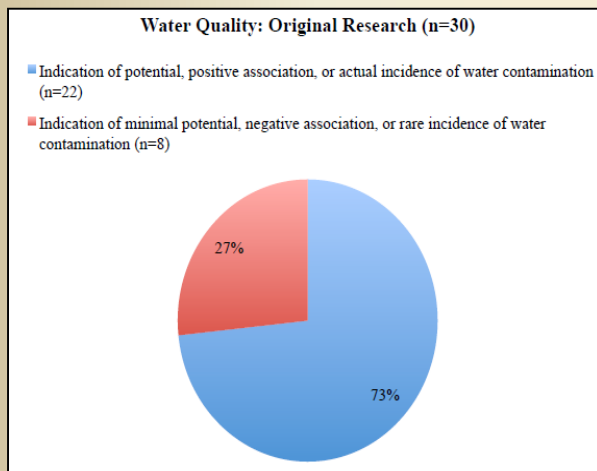
Interior Secretary Sally Jewel said, *"We do not have the resources necessary to do the job,"* The inspectors are needed to protect the environment and prevent potential health hazards caused by leaking wells. The Associated Press reported last year that 40 percent of new wells on federal and Indian land with a higher pollution risk were not inspected from 2009 to 2011

Risks – Fracking

Toward an understanding of the environmental and public health impacts of shale gas development: an analysis of the peer-reviewed scientific literature 2009 - 2014

June 2015 - http://psehealthyenergy.org/data/Database_Analysis_FINAL1.pdf

“...all the available scientific peer-reviewed literature on the impacts of shale gas development approximately 73% has been published since January 1, 2013. What this tells us is that the scientific community is only now beginning to understand the impacts of this industry on the environment and human population.”



Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates

July 15, 2015 - <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0131093>

Evidence supports an association between well density and inpatient prevalence rates for the medical categories of dermatology, neurology, oncology, and urology. These data suggest that hydraulic fracturing wells were associated with increased inpatient prevalence rates within specific medical categories in PA.



Shale Gas Extraction and Public Health

A Resource Guide - Marcellus Shale Natural Gas Extraction Study 2015 Update to Addendum Shale and Public Health Committee

<http://shale.palwv.org/wp-content/uploads/2015/12/2015-Update-LWVP-Shale-Resource-Guid.pdf>

Taking a comprehensive approach to the problem, we will discuss not only direct impacts on the general public, but also worker health and safety issues, psychological impacts, community health, and potential short- and long-term impacts on the environment.

Risks – Fracking

Endocrine-Disrupting Chemicals and Oil and Natural Gas Operations: Potential Environmental Contamination and Recommendations to Assess Complex Environmental Mixtures

Aug 27, 2015 - <http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/8/ehp.1409535.acco.pdf>

In light of the potential for environmental release of oil and gas chemicals that can disrupt hormone receptor systems, we recommend methods for assessing complex hormonally active environmental mixtures.



Fracking Industry Wells Associated With Premature Birth

Oct 8, 2015 - <http://www.jhsph.edu/news/news-releases/2015/study-fracking-industry-wells-associated-with-premature-birth.html>

Expectant mothers who live near active natural gas wells operated by the fracking industry in Pennsylvania are at an *increased risk of giving birth prematurely* and for having high-risk pregnancies



Malignant human cell transformation of Marcellus Shale gas drilling flow back water

October, 2015 - <http://www.sciencedirect.com/science/article/pii/S0041008X15300375>

This is the first report of potential cytotoxicity and transforming activity of Marcellus shale gas mining flow back to mammalian cells. Barium and Strontium were elevated in flow back water exposed cells. Flow back water malignantly transformed cells and formed tumor in athymic nude mice. Flow back transformed cells exhibited altered transcriptome with dysregulated cell migration pathway and adherent junction pathway

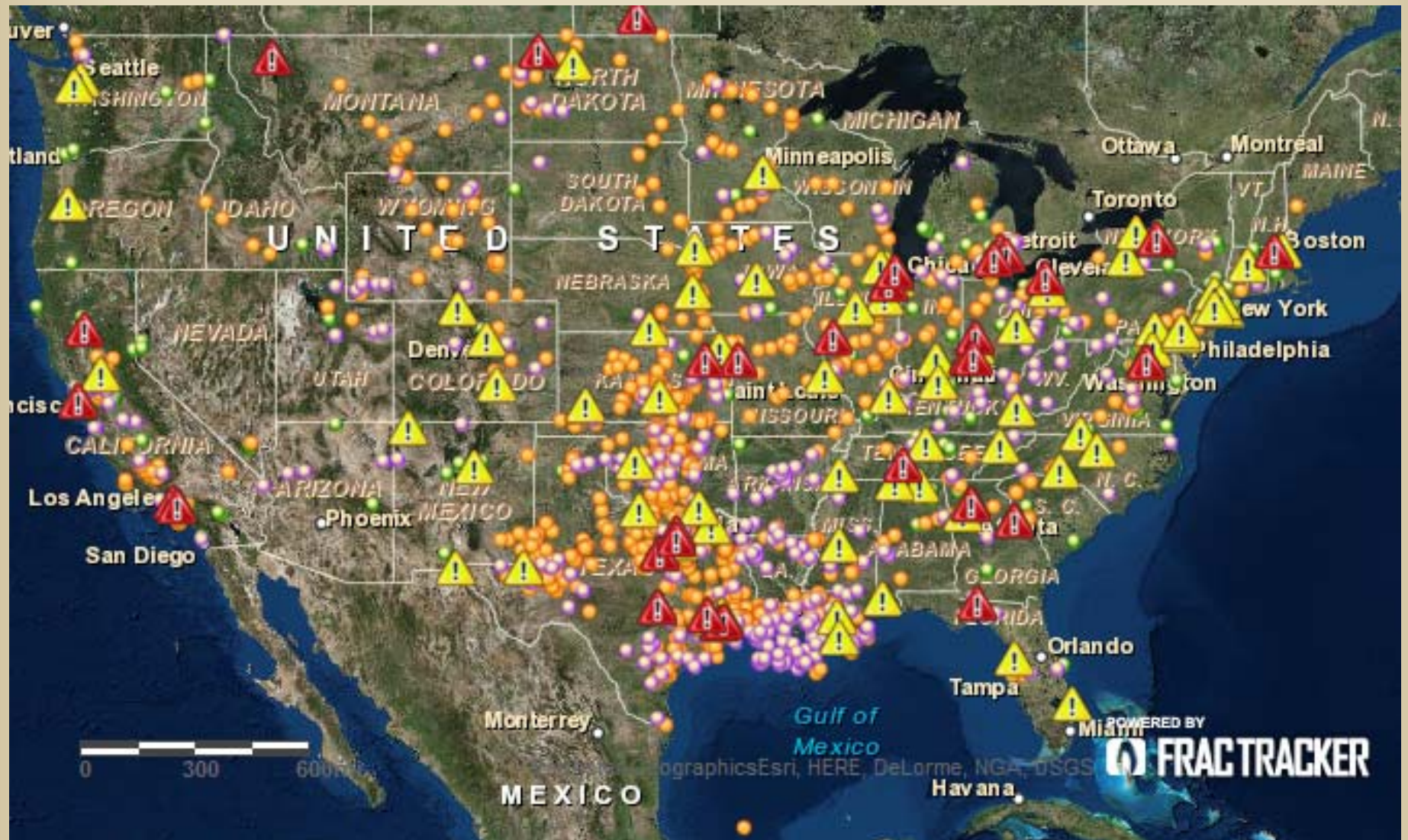


Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking

Oct 14, 2015 - <http://www.psr.org/resources/fracking-compendium.html>

Barbara Gottlieb, Director, Environment & Health, Physicians for Social Responsibility, said, "Our new report compiles and summarizes hundreds of peer-reviewed studies and other important findings on fracking, *showing overwhelming evidence that drilling and fracking pose serious threats to public health, our environment, and the climate*

Industry Risks



Pipeline incidents in the United States from 1/1/2010 through 3/29/2013. Red Triangles represent incidents leading to fatalities, and yellow triangles represent those leading to injuries

<http://www.fractracker.org/2013/04/us-pipelines-average-incidents-are-a-daily-occurrence/>



Industry Risks – Accidents

<http://www.naturalgaswatch.org/?cat=8>

https://en.wikipedia.org/wiki/List_of_pipeline_accidents_in_the_United_States

DOT PHMSA Building Safe Communities:

Pipeline Risk and its application to Local Development Decisions

Releases of products carried by pipelines *can impact surrounding populations, property, and the environment, and may result in injuries or fatalities as well as property and environmental damage.*

These consequences may result from fires or explosions caused by ignition of the released product, as well as possible toxicity and asphyxiation effects. *Some releases can cause environmental damage, impact wildlife, or contaminate drinking water supplies. Releases can also have significant economic effects,* such as business interruptions, damaged infrastructure, or loss of supplies of fuel such as natural gas, gasoline, and home heating oil.

Oct 2010 -

<https://primis.phmsa.dot.gov/comm/publications/PIPA/PIPA-PipelineRiskReport-Final-20101021.pdf>

PHMSA Pipeline Incidents: (1995-2014)

Incident Type: All Reported System Type: ALL State: ALL

Per year avg. – 542 incidents, 19 fatalities, 70 injuries and \$318mm

Calendar Year	Number	Fatalities	Injuries	Property Damage As Reported
1995	349	21	64	\$53,427,112
1996	381	53	127	\$114,467,631
1997	346	10	77	\$79,757,922
1998	389	21	81	\$126,851,351
1999	339	22	108	\$130,110,339
2000	380	38	81	\$191,822,840
2001	341	7	61	\$63,092,462
2002	642	12	49	\$102,167,588
2003	672	12	71	\$139,057,814
2004	671	23	60	\$267,836,502
2005	720	17	48	\$1,245,463,189
2006	639	21	36	\$151,983,767
2007	614	16	49	\$154,533,794
2008	660	8	57	\$565,819,340
2009	628	13	64	\$179,070,183
2010	588	22	108	\$1,504,216,126
2011	594	14	56	\$403,977,193
2012	570	12	57	\$228,107,540
2013	618	10	47	\$345,458,865
2014	703	19	96	\$306,724,951
Grand Total	10,844	371	1,397	\$6,353,946,509

https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages&NQUser=PDM_WEB_USER&NQPassword=Public_Web_User1&PortalPath=%2Fshared%2FPDM%20Public%20Website%2F_portal%2FSC%20Incident%20Trend&Page=All%20Reported



Industry Risks – Various

Information on Shale Resources, Development, and Environmental and Public Health Risks

Oct 9, 2012 - <http://www.gao.gov/products/GAO-12-732>

From the Government Accountability Office...Oil and gas development, whether conventional or shale oil and gas, *pose inherent environmental and public health risks*, but the extent of these risks associated with shale oil and gas development is unknown, in part, because the *studies GAO reviewed do not generally take into account the potential long-term, cumulative effects*



Exaggerating the Employment Impacts of Shale Drilling: How and Why

Nov 2013 - <https://pennbpc.org/sites/pennbpc.org/files/MSSRC-Employment-Impact-11-21-2013.pdf>

From the Multi-State Shale Research Collaborative...While the industry has created jobs, particularly in Pennsylvania and West Virginia, the *shale-related jobs numbers are far below industry claims*. We show how shale-related jobs are in the range of thousands to—at best—a few tens of thousands of jobs. They are not in the hundreds of thousands of jobs as claimed by the industry and its proponents



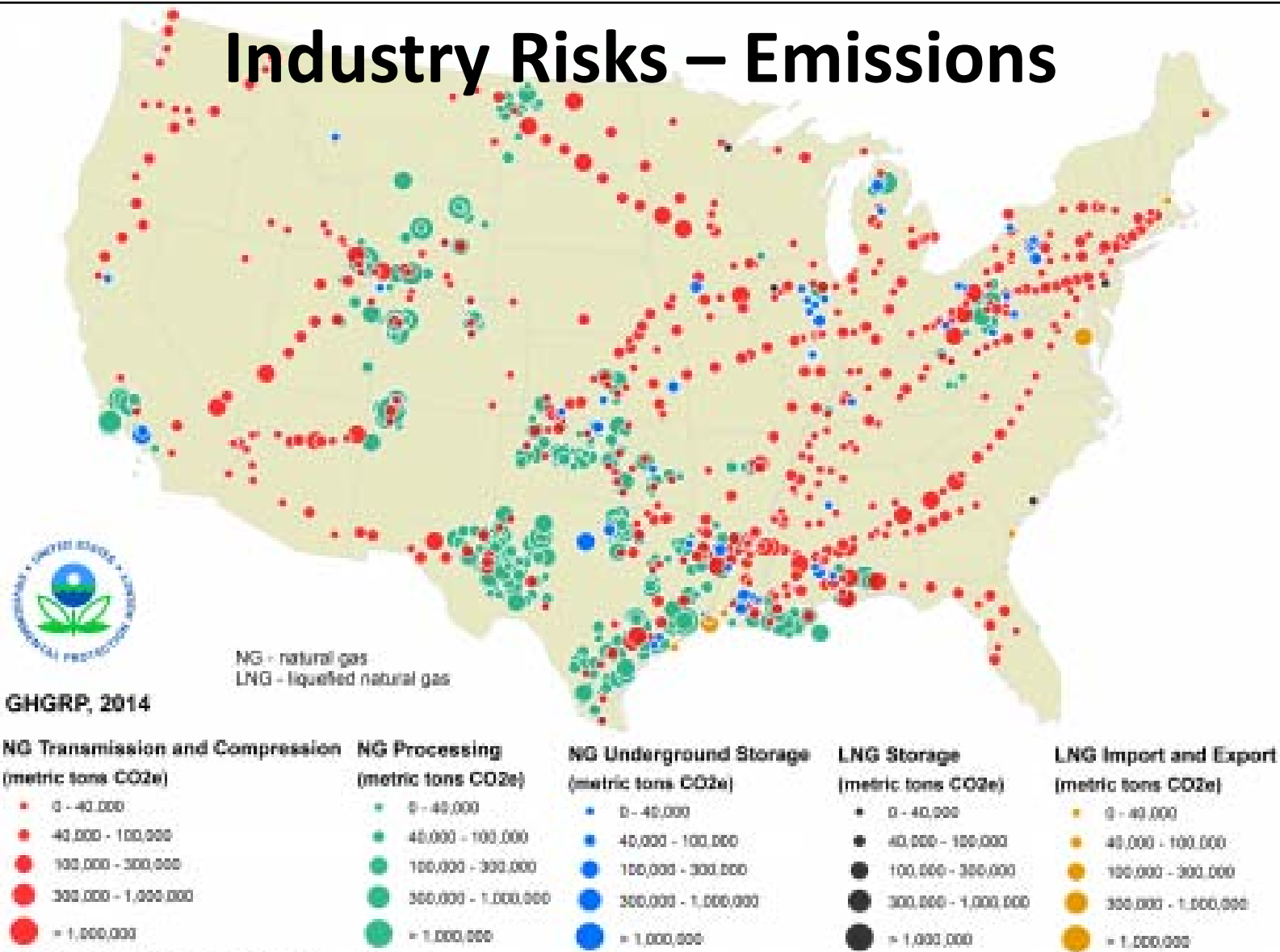
Atlantic Coast Pipeline Benefits Review

Chmura and ICF Economic Benefits Reports

June 2015 - http://abralliance.org/wp-content/uploads/Synapse_Report_ACP_June_2015.pdf

The Southern Environmental Law Center commissioned Synapse Energy Economics (Synapse) to review two reports. Regarding the results of the ICF International report, Synapse concluded that *ICF likely overestimates the economic benefits of the pipeline*...ICF's characterization of jobs stimulated by energy savings from the ACP as "permanent" is not supported

Industry Risks – Emissions



Aug 16, 2015 - <http://www.epa.gov/ghgreporting/ghgrp-2014-petroleum-and-natural-gas-systems>

Methane is 84 times more powerful at trapping heat in the atmosphere than CO₂ over a 20-year period, according to the Intergovernmental Panel on Climate Change

https://en.wikipedia.org/wiki/Global-warming_potential

Industry Risks –Emissions



A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas

April 22, 2014 - http://www.eeb.cornell.edu/howarth/publications/Howarth_2014_ESE_methane_emissions.pdf

“...comparing the warming potential of methane to carbon dioxide, the conclusion stands that both *shale gas and conventional natural gas have a larger GHG than do coal or oil, for any possible use of natural gas*”



Untapped Potential Reducing Global Methane Emissions from Oil and Natural Gas Systems

April, 2015 - http://rhg.com/wp-content/uploads/2015/04/RHG_UntappedPotential_April2015.pdf

Based on the best currently available data, around 3.6 trillion cubic feet (Tcf) of natural gas escaped into the atmosphere in 2012 from global oil and gas operations. *This wasted gas translates into roughly \$30 billion of lost revenue* at average 2012 delivered prices, and about 3% of global natural gas production.



Methane Emissions From Natural Gas Distribution Pipelines

July 25, 2014 - <http://www.epa.gov/oig/reports/2014/20140725-14-P-0324.pdf>

From the EPA Office of the Inspector General....The EPA has placed little focus and attention on reducing methane emissions from pipelines in the natural gas distribution sector. *The EPA does not currently regulate methane emissions from the distribution sector* and has not partnered with the PHMSA, which regulates pipeline safety, to control methane leaks.



Texas Fracking Zone Emits 90% More Methane Than EPA Estimated

Dec 7, 2015 - <http://insideclimatenews.org/news/07122015/methane-emissions-texas-fracking-zone-90-higher-epa-estimate>

Although gas power plants emit much less carbon dioxide than coal plants do, *even small leaks of methane—the main component of natural gas—could undermine that advantage*. Methane is 86 times more potent than CO₂ as a greenhouse gas on 20-year timescales, and 34 times more powerful on 100-year timescales



Industry Risks – Emission Monitoring

Flawed Methane Monitor Underestimates Leaks at Oil and Gas Sites

May 5, 2015 - <http://www.insideclimatenews.org/news/05052015/flawed-methane-monitor-underestimates-leaks-oil-and-gas-sites>

“Researchers find there may be drastically more methane in the air than is being reported to industry and government”. The research paper raises serious questions about the validity of existing methane data... *"It could be a big deal," especially if it turns out the EPA is underestimating methane leaks."*



Using Multi-Scale Measurements to Improve Methane Emission Estimates from Oil and Gas Operations in the Barnett Shale Region

July 7, 2015 <http://pubs.acs.org/doi/pdf/10.1021/acs.est.5b02305>

Previously published large-scale top-down studies report higher methane emissions than estimated by bottom-up emission inventories. Recent reviews suggest that differences may result from

- i. *incorrect attribution of emissions among methane sources* (e.g., fossil vs biogenic sources)
 - ii. *obsolete or incomplete emission inventories*, possibly based on emission factors developed using small or unrepresentative samples (including potential bias introduced by sampling only at cooperating facilities) and poor infrastructure activity data (e.g., site or event counts)
 - iii. failure to account for *emissions from uncommon but anomalously high emitting*
 - iv. *the impact of intermittent, short-duration events.*
-



Methane Emissions from the Natural Gas Transmission and Storage System in the United States

July 21, 2015 - <http://pubs.acs.org/doi/pdfplus/10.1021/acs.est.5b01669>

The study found that fugitive emissions account for 75 percent of all methane emissions in the transmission and storage sectors. The new model *indicates facilities consistently underestimate methane emissions at 2.6 times more methane than reported to the EPA.*