



WHIMBY (What's Happening in my Backyard?)

Community Risk-Benefit Matrix of Unconventional Gas and Oil Development



Community Impacts and Engagement Initiative

*Alan J. Krupnick, Senior Fellow and Co-Director,
Center for Energy and Climate Economics*

Community Impacts Debate

- I. UOGD will create thousands of jobs and bring local prosperity vs. Most benefits to outsiders and the State:
 - ➔ Positive national impacts in US
 - ➔ Gas prices and electricity prices, generation shares
 - ➔ Pollution
 - ➔ Small GDP effect
 - ➔ Energy independence
 - ➔ Community impacts ?
- II. Negative externalities:
 - ➔ are not systemic; are isolated, while acknowledging nuisances
 - ➔ Fracking is horribly damaging to community health, safety and the environment and must be stopped

RFF Community Initiative

- **Purpose:** Shed light on the effects that unconventional oil and gas development has on communities and improve industry-community engagement practices
- 9 projects
- Funded by the Sloan Foundation, Smith Richardson Foundation and Mitchell Foundation
- Help from Schlumberger
- Fellows: Casey Wichman, Zhongmin Wang, Lucija Muehlenbachs, Jhih-Shyang Shih, Juha Siikamaki, Kailin Kroetz, Yusuke Kuwayama, Sheila Olmstead
- Research associates, RA's, others: Daniel Raimi, Jessica Chu; Isabel Echarte, Brandon Cunningham, ElOaine Swiedler; Kristin Hayes
- Affiliated: Nathan Ratledge, Laura Zachary, Todd Bryan, Madeline Gottlieb

Methodology

- Risk-Benefit Matrix, **Literature Reviews**, original research(*)
 - Economics:
 - **Fiscal impacts** *numerical/interviews
 - **Economic impacts**
 - Health and Safety
 - **Health, Seismicity, Truck accidents** *statistical
 - Social
 - **Property values** *statistical
 - Leaseholders *statistical
 - **Education** *statistical and interviews
 - Social License to Operate *Case studies/interviews
 - Environmental
 - Air
 - Water (ground and surface) quantity and quality *statistical
 - Land *compositional analysis, legal analysis
 - Habitat Fragmentation *Modeling
- Schlumberger Model Review

Risk-Benefit Matrix: Key

	Higher quality: The majority of studies reviewed for an impact are of higher quality. Where there is one study of higher quality, it is marked as such.
	Medium quality: The majority of studies reviewed for an impact are of medium quality. Where there is one study of medium quality, it is marked as such.
	Lower quality: The majority of studies reviewed for an impact are of lower quality. Where there is one study of lower quality, it is marked as such.
	Not reviewed: Research on an impact was not reviewed.

↑	Increase: Studies show a positive, robust association with an impact (an increase in incidence or magnitude).
↓	Decrease: Studies show a negative, robust association with an impact (a decrease in incidence or magnitude).
↑↓	Heterogeneous: Across regions or areas, studies report robust results that differ.
∅	No association: Studies report results that showed no association.
~	Inconsistent: Studies report differing (contradictory) results.

Risk-Benefit Matrix: Local Government Impacts

Fiscal Impacts and Infrastructure for Counties and Cities		
Impact	Findings	Results
State revenue sharing	↑	Several studies note that in most states, allocation of state severance taxes, state lease revenues, and federal lease revenues to local governments increases.
Local tax receipts	↑∅	Several studies find increases in local sales taxes and property taxes in jurisdictions that collect them. Large variation exists across regions.
Donations	↑∅	Several studies note collaboration between operators and local governments in select regions, notably on road repair.
Water and sewage infrastructure	↑∅	One higher-quality study finds that particularly in rural regions, increased population can strain existing infrastructure.
Expenditures	↑	Several studies note that increased demand for government services requires higher expenditures. Increased revenues allows higher expenditures and improved services.
Debt	↑↓	Studies note that in rural regions experiencing rapid growth, debt loads have increased. In other regions, increased revenues have allowed debt to be paid off, while some studies note no changes.
Government staffing	↑	Several studies note staff growth in law enforcement, fire and emergency services, social services, and clerk/recorder. Increased compensation is often required to grow/retain staff.

	Higher quality
	Medium quality
	Lower quality
	Not reviewed
↑	Increase
↓	Decrease
↑↓	Heterogeneous
∅	No Association
~	Inconsistent

Risk-Benefit Matrix: Education Impacts

K-12 Education		
Impact	Findings	Results
Student-teacher ratio	↑↓	Large variation exists across regions. Increase in number of students per teacher found for Texas and North Dakota, yet significant decreases found in the Marcellus region. Appears to be led by change in student numbers and does not indicate a change in teachers.
Revenue	↑↓	Several higher-quality studies report large variation across regions with varying tax policies. One study found an increase in total revenue per pupil in the Marcellus, but a decrease in North Dakota.
Education expenditures	↑↓	Several higher-quality studies report large variation across regions. Increase in the Marcellus region, but decrease in North Dakota and Texas.
Capital expenditures	↑∅	Several studies analyzing different regions report differing results. One higher-quality study found increases for Texas and several studies found an increase for capital spending per pupil in North Dakota. However, no statistically significant association found for other regions.
Educational attainment	~	Two studies with data-related limitations (particularly for rural areas) report decreases. One study found no evidence of increased dropouts in the Marcellus region, Bakken region, or Colorado.
Performance	~	One study finds a number of mixed results across grades and subjects. One study finds slight decrease in student achievement in Texas.

	Higher quality
	Medium quality
	Lower quality
	Not reviewed
↑	Increase
↓	Decrease
↑↓	Heterogeneous
∅	No Association
~	Inconsistent

Risk-Benefit Matrix: Truck Traffic Impacts

Truck Traffic		
Impact	Findings	Results
Traffic congestion	↑	Several studies note increased vehicle traffic, particularly in regions with limited pipeline infrastructure.
Road damage	↑	Two studies measure increased road damage, while several find concern in interviews with local officials. Damage in some regions is offset with donations or increased local revenues.
Accidents	↑	Two studies note increases in accident rates for heavy-duty trucks and all traffic, with increased rates of injuries and fatalities in accidents.

	Higher quality
	Medium quality
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	Not reviewed
↑	Increase
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↑↓	Heterogeneous
∅	No Association
~	Inconsistent

Risk-Benefit Matrix: Economic Impacts

Employment		
Impact	Findings	Results
Local	↑	Several studies see increases, with large variation in magnitude across studies. Limited growth for local workers in regions without existing oil and gas workforce.
Regional	↑	Several studies see modest increases at the state- or shale play-levels; variation across studies, with some finding only short-term effects.

Income		
Impact	Findings	Results
Wages	↑	Most studies see increases, some find no association; large variation in magnitude across studies
Other income	↑	Several studies note increases in bonuses and royalties prior to and during production for those with mineral rights.

Economic Development		
Impact	Findings	Results
Long-term growth	~	A number of studies report evidence for and against the resource curse.

	Higher quality
	Medium quality
	Lower quality
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↑	Increase
↓	Decrease
↑↓	Heterogeneous
∅	No Association
~	Inconsistent

Risk-Benefit Matrix: Housing Values

Property Values		
Impact	Findings	Results
Homes near wells, piped water	↑	Several studies find modest increases in value (depending on distance to unconventional oil and gas development as well as other factors).
Homes near wells, groundwater	↓	Several studies find large decreases in value (depending on distance to unconventional oil and gas development as well as other factors).
Homes without mineral rights	↓	One study finds that homes without mineral rights see large, negative decreases in their price from nearby unconventional oil and gas development.

	Higher quality
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Risk-benefit Matrix: Birth Outcomes

Birth Outcomes		
Impact	Findings	Results
Birthweight	~	Studies of mixed quality find positive, negative, and null associations with birthweight.
Low APGAR	~	One study finds a positive association, while a high-quality study finds no association.
Preterm birth	~	Several studies report no association with development, while one higher-quality study and another lower-quality study find an increase in premature births.
Small for gestational age	~	Two studies report an increase in babies who are small for their gestational age, while another higher-quality study reports no association.
Birth defects	↑	One flawed study finds evidence of an increase in some birth defects, but no association with one defect.

	Higher quality
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Risk-Benefit Matrix: Cancer

Cancer		
Impact	Findings	Results
CNS Tumors	↑	One study finds evidence of positive association.
Childhood cancers	∅	One lower quality study finds no association.
Leukemia and lymphoma	~	Studies report evidence of an increase or no association. One risk assessment finds an elevated risk of leukemia and other cancers based on air measurements of benzene, though another study finds air measurements of pollutants to be below a threshold of concern.

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↑	Increase
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Risk-Benefit Matrix: Other health

Other Health		
Impact	Findings	Results
Asthma	↑	One study reports increases in asthma hospitalizations, ER visits, and prescriptions for asthma medications.
Hospitalization	↑	One study finds an increase in hospital rates for some types of inpatient cases, but no associations for most cases.
Migraines	~	Two medium-quality studies report no association, while one lower-quality study reports an increase; all are self-reported symptoms.
Multiple symptoms	↑	One study finds positive and no associations for different types of self-reported symptoms.

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Study Span Chart: Health Impacts Literature

Study		Activities Specific activities or the presence of fracking in a community.	Burdens Initial consequences of shale development (e.g., emissions).	Concentration The intensity of a burden present in the environment (e.g., air quality changes).	Exposure Evidence or amount of exposure (e.g., air pollution exposure).	Impacts The effects felt by the community (e.g., low birth weight babies).
Risk factors and hypothesis-generating studies	Elliot et al. (2017)					
	Colborn et al. (2011)					
	Aminto and Olson (2012)					
	Ferrar et al. (2013)					
	Saberi et al. (2014)					
	Kassotis et al. (2013)					
	Colborn et al. (2014)					
	Bunch et al. (2013)					
	Hays et al. (2016)					
	Casey et al. (2015)					
Community-based participatory research (CBPR)	Mitchell et al. (2016)					
	Steinzor et al. (2013)					
	Macey et al. (2014)					
Occupational exposure	Esswein et al. (2013)					
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	Bloomdahl et al. (2014)					
	Durant et al. (2016)					
	Harrison et al. (2016)					
Health impact assessment (HIA)	Mason et al. (2015)					
	McKenzie et al. (2012)					
	Witter et al. (2013)					
Epidemiological studies	Casey et al. (2016)					
	McKenzie et al. (2014)					
	Hill (2013a)					
	Hill (2013b)					
	Stacy et al. (2015)					
	Rasmussen et al. (2016)					
	Jemielita et al. (2015)					
	McKenzie et al. (2017)					
	Fryzek et al. (2013)					
	Rabinowitz et al. (2015)					
	Tustin et al. (2017)					



WHIMBY (What's Happening in my Backyard?): Health Impacts

Isabel Echarte, Research Assistant
Resources for the Future

Is fracking harmful to your health?

Fracking Is Dangerous To Your Health -- Here's Why



(Forbes)

The Evidence Of Fracking's Health Effects Keeps Mounting

Fracking has already been linked with pollution and earthquakes.

(ThinkProgress)

BUSINESS > ENERGY

Colorado Health Department finds little evidence of health harms from living near oil and gas sites

Report says more research is needed to understand drilling's impact on public health



(The Denver Post)

What is included in the review?

- 32 studies
- Almost all are peer reviewed
- We focus on epidemiological studies, though also discuss:
 - health impact assessments (HIA)
 - community-based participatory research (CBPR) studies
 - occupational exposure studies
 - and hypothesis-generating studies
- Studies that directly relate to unconventional oil and gas development
 - Studies that assess whether a certain chemical causes cancer, for example, were not included

What is included in the review?

- Key takeaways of each of the studies, discussions and critiques of methodologies, and impact pathways addressed
- We use the Risk-Benefit Matrix to classify the overall findings and quality of the literature for each impact
- Impacts include:
 - Birth outcomes (birthweight, Apgar score, preterm birth, small for gestational age, and birth defects)
 - Cancer (central nervous system (CNS) tumors, childhood cancers, leukemia, and lymphoma)
 - Asthma
 - Hospitalization rates
 - Migraines
 - Other symptoms

What impact pathway elements does each study cover?

		Study	Activities	Burdens	Concentration	Exposure	Impacts
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What impact pathway elements does each study cover?

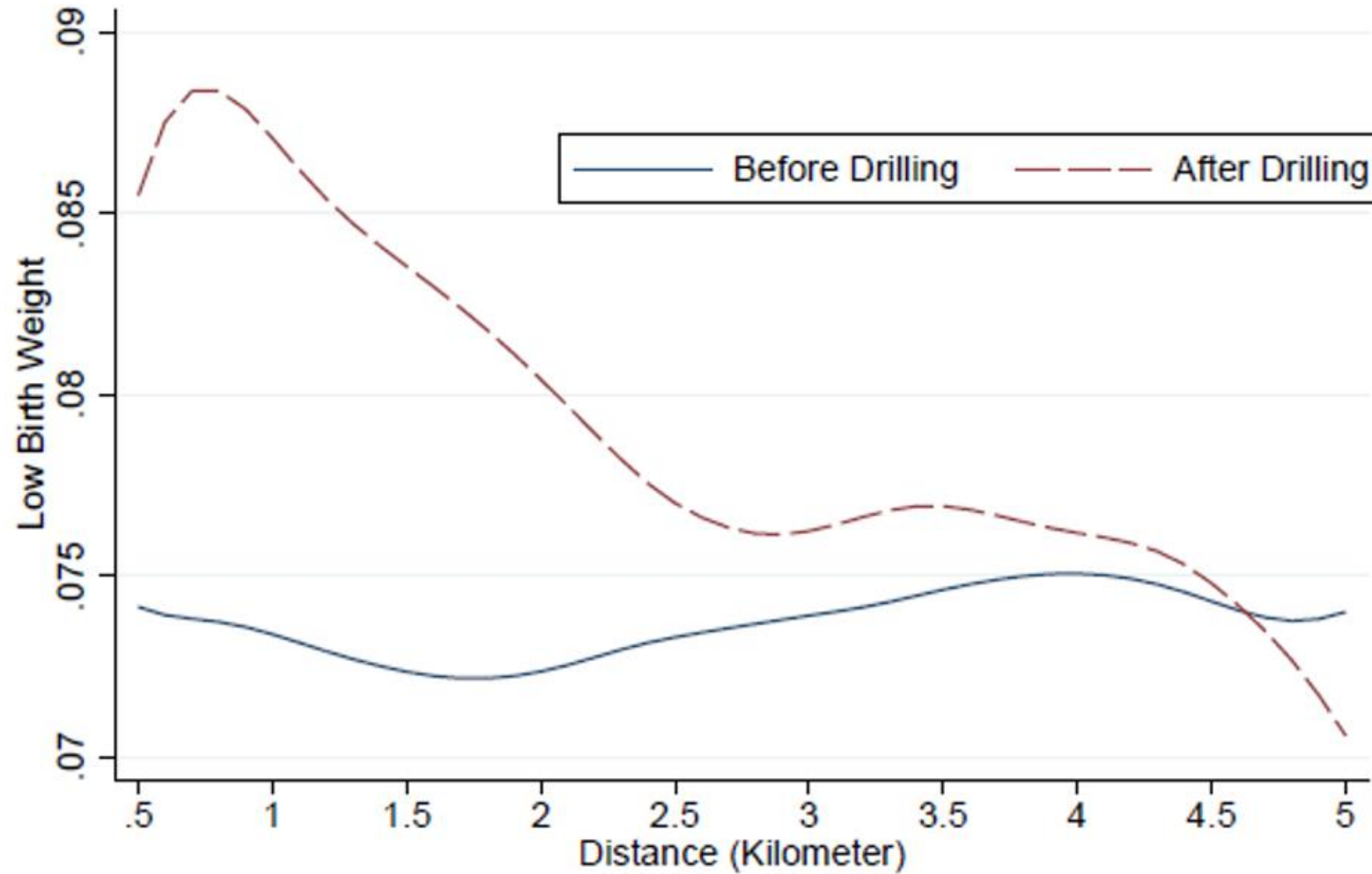
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Incidence of Low Birthweight



Risk-Benefit Matrix: Cancer

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Conclusion

- Overall, the literature linking unconventional gas and oil development to health effects is not of high quality, sparse for most impacts
- However, the lack of high quality, conclusive evidence for an impact is not the same as proving there are no health impacts
- Many of these studies show there is the potential for health impacts to occur given the numerous findings of positive associations
- Further study and better data are needed to inform communities and policymakers



Schlumberger's Stewardship Tool

Alan Krupnick, Senior Fellow and Co-Director, RFF Center for Energy and
Climate Economics

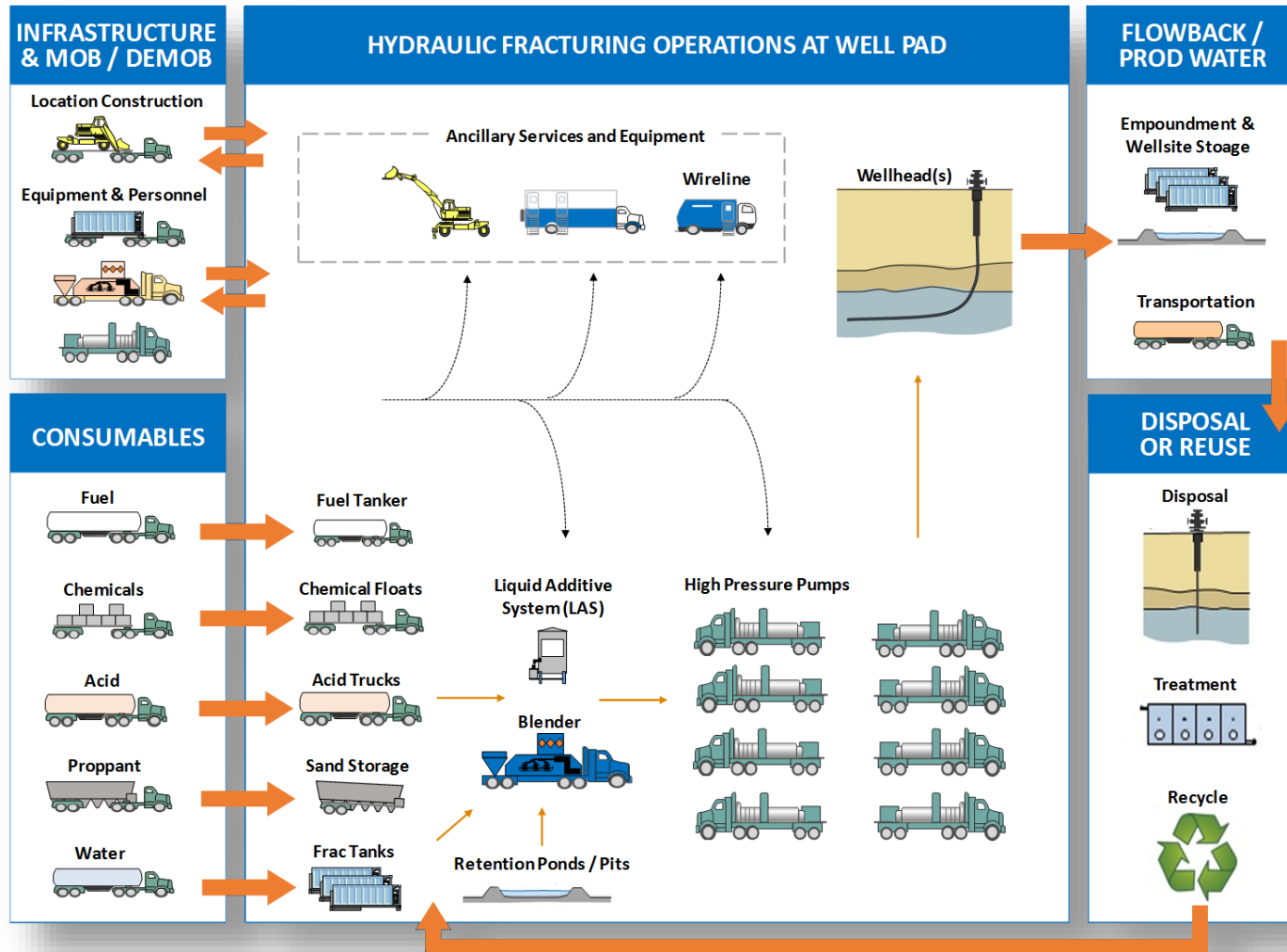
Isabel Echarte, Research Assistant, RFF

The damage function approach

Activities	Burdens	Concentration	Exposure	Impacts	Valuation
Specific activities or the presence of fracking in a community.	Initial consequences of shale development (e.g., emissions).	The intensity of a burden present in the environment (e.g., air quality changes).	Evidence or amount of exposure (e.g., air pollution exposure).	The effects felt by the community (e.g., low birth weight babies).	How these impacts are valued by those affected and by society



The Stewardship Tool



Sustainability KPIs

Water Usage

CO2 Emissions

Air Quality (NAAQS)

Chemical Exposure

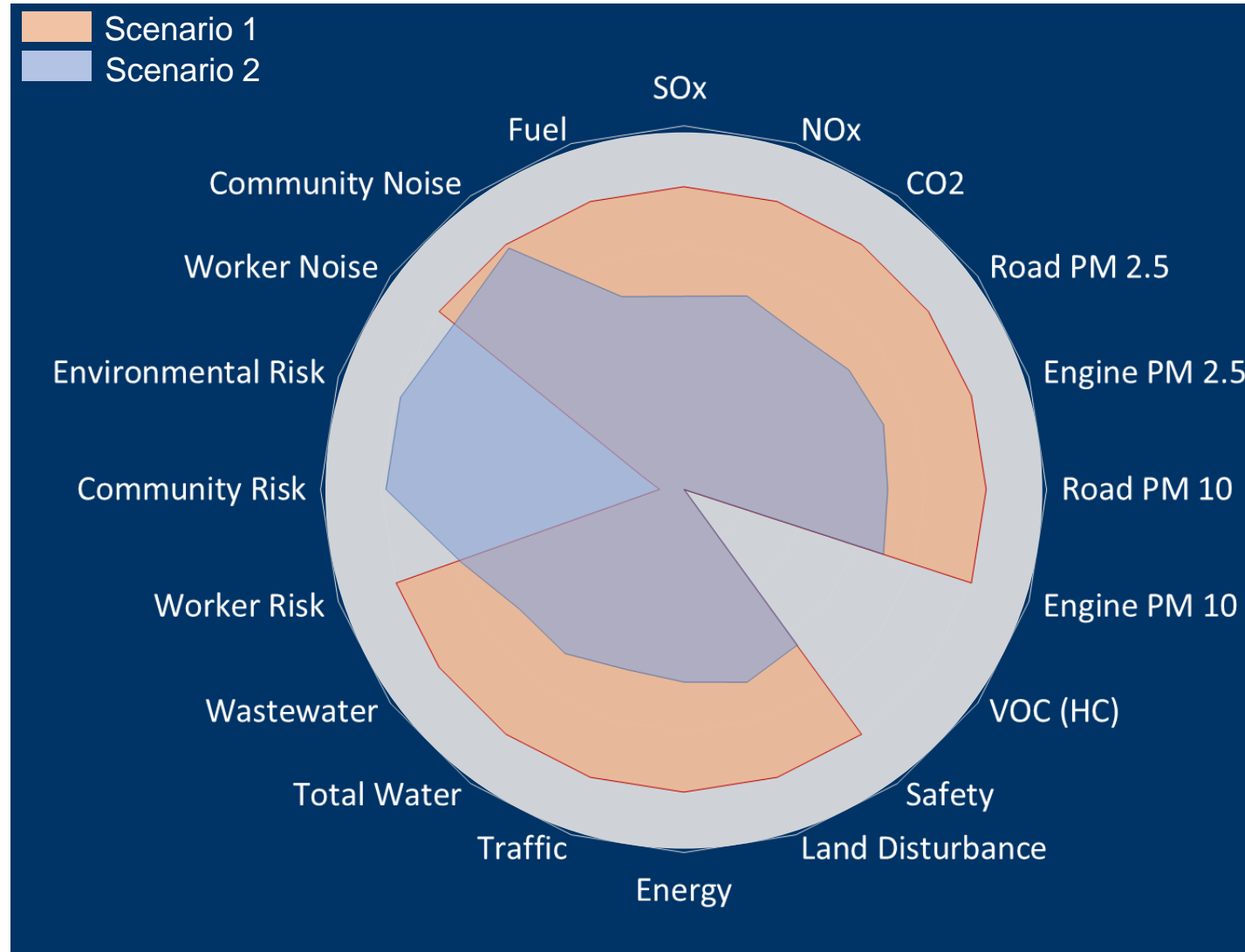
Operations Safety

Land Disturbance

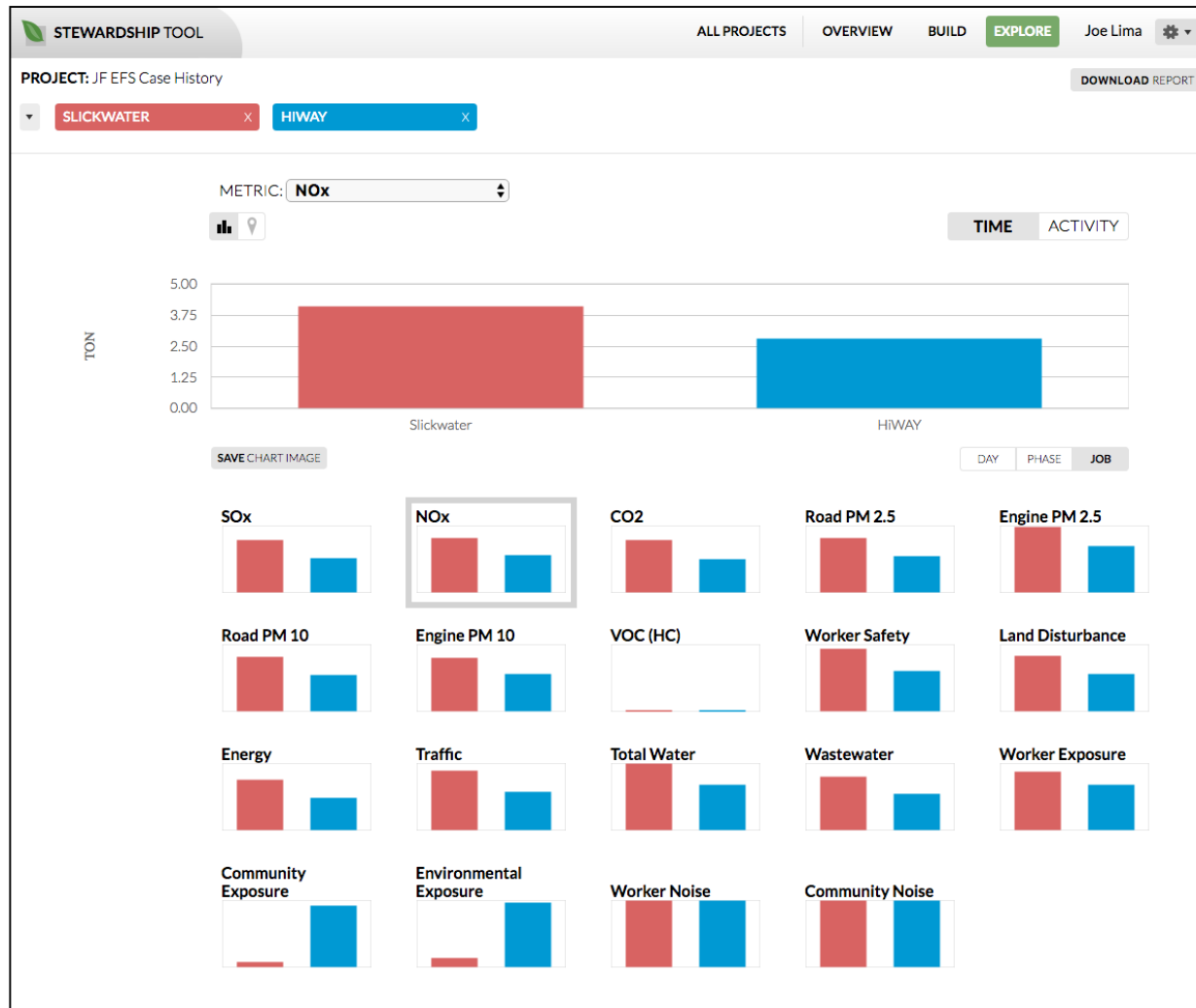
Traffic Impacts

Noise

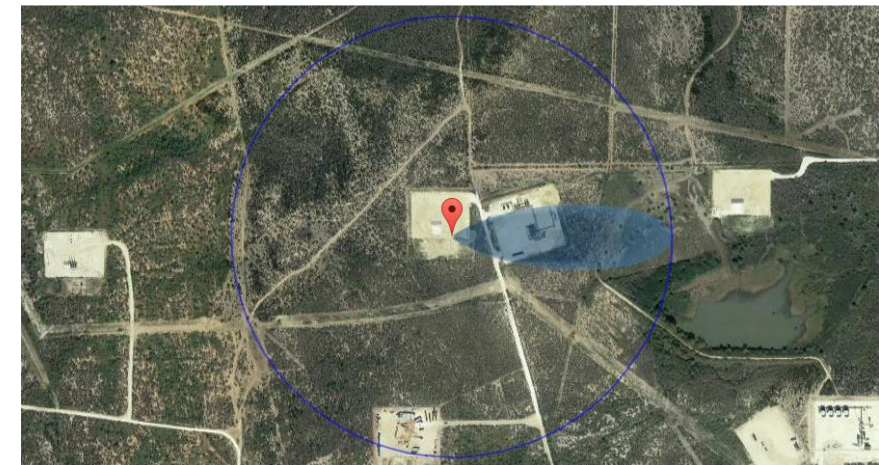
The tool's potential



What the tool does



- Evaluate the Greatest Potential for Environmental or Social Impacts
- Determine Activity with Potential for Greatest Environmental Impacts
- Engineer Technologies to Solve Specific Environmental Components of a Project



How the tool works

CASE A



GENERAL



JOB INFO



CREW



WATER



CONSUMABLES



EQUIPMENT



WASTE



NOISE

USE

ADVANCED

Target Volume per
Frac Stage

100000 gal

Target Concentration

200 ppm

Total Water Used

5000000 gal

% to LAS

0 %

% to POD

100 %

Transfer Rate

1000 gpm

Workers Transferring
Tank Water

2

Workers Transferring
Pond Water

2

Water Type

Availability
(gal)

Concentration
(ppm)

Volume
per
Stage
(gal)

Volume
per
Stage
(%)

Trucked

Recycled

0

1000

0

0

No

Flowback

0

50000

0

0

No

Fresh

100000

40

100000

100

Yes

Water Type To
Optimize

Fresh

Optimization Method

Minimize

Estimated Gas
Production

0 billion
ft3

Energy Production

0 trillion
BTU

Water Efficiency

0 gal/MMBTU

SOURCING/ STORAGE

ADVANCED

SOURCING

% via Truck

50 %

% from On-Site Wells

20 %

% from via Pipeline

30 %

On-Site Wells To Be
Constructed

2

ON-SITE STORAGE

On-Site Volume

147000 gal

% Stored in Ponds

0 %

% Stored in Frac Tanks

100 %

TRANSPORT

Tanker Capacity

5000 gal

Tanker Quantity

500

Questions and Comments

Additional WHIMBY Webinar Series 2017 Topics

The WHIMBY webinar series will also explore the following topics related to unconventional oil and gas development:

- Impacts on public education in school districts in six states
- Solid waste disposal, water usage, and truck traffic in Pennsylvania
- Lease terms for landowners in Pennsylvania, including external benefits and lease productivity
- Community fiscal health conditions during an industry downturn
- Options for enhancing industry–community engagement

Thanks for joining!

