QUANTIFICATION OF METHANE EMISSIONS FROM MARGINAL OIL & GAS WELLS

DOE NETL Project DE-FE0031702

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

GSI ENVIRONMENTAL

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INTRODUCTION
Who We Are

GSI ENVIRONMENTAL

WHO	Consultants in environmental science and engineering
WHERE	Offices in Houston, Austin, Irvine, Oakland; Completed environmental projects throughout the U.S. and worldwide
WHEN	Founded 1986
WHAT	M.S. and Ph.D. Engineers, Scientists, Hydrologists, Hydrogeologists, Regulatory Permitting experts, Software Developers, Database/GIS Professionals, Field Techs, Expert Witness Staff

KEY POINT: **Environmental engineering projects for Oil & Gas industry, chemical manufacturers, law firms, R&D organizations, and government agencies.**

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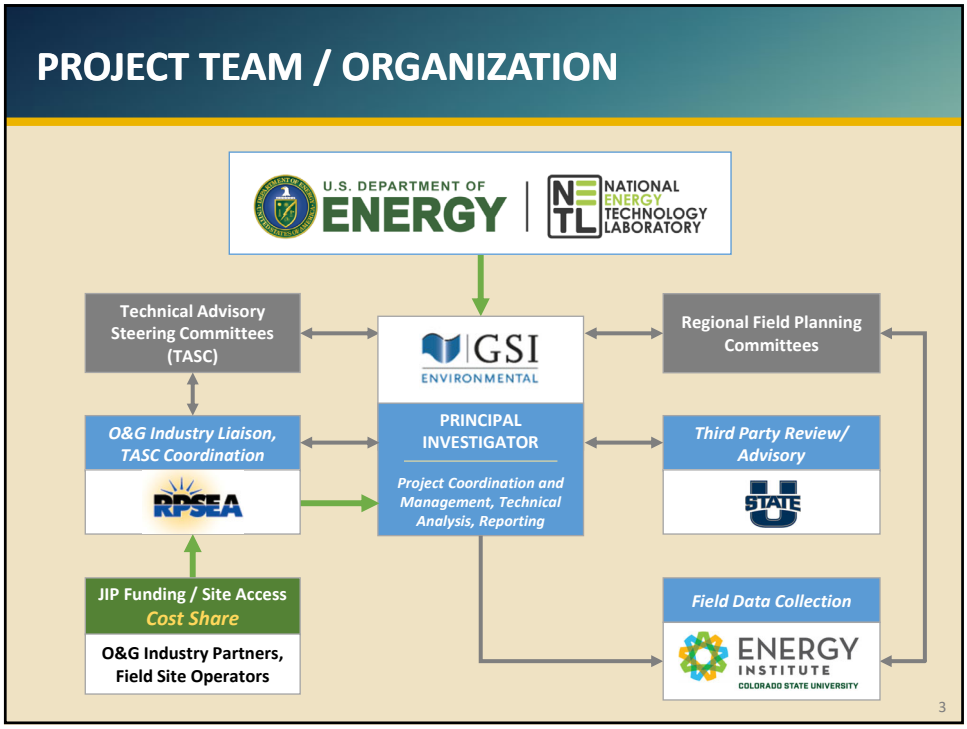
PROJECT TEAM / ORGANIZATION
U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY
Technical Advisory Steering Committees (TASC)
GSI ENVIRONMENTAL
Regional Field Planning Committees
O&G Industry Liaison, TASC Coordination
RPSEA
PRINCIPAL INVESTIGATOR
Project Coordination and Management, Technical Analysis, Reporting
Third Party Review/ Advisory
STATE U
JIP Funding / Site Access
Cost Share
O&G Industry Partners, Field Site Operators
Field Data Collection
ENERGY INSTITUTE
COLORADO STATE UNIVERSITY
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PROJECT OVERVIEW
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NEW SOURCE PERFORMANCE STANDARD
40 CFR 60, Subpart OOOOa

Issue

- ***Marginal Wells*** **(<15 bpd oil or <90 MCF/d gas) subject to costly leak detection and repair requirements (LDAR)**
- **EPA decisions based on very limited study data**

Response

- **Objective, transparent, repeatable, and reliable emissions measurements from marginal vs. non-marginal well sites**

Federal Methane Regulations

EPA Deletes Marginal Well Exemption

By Del Terkelson

WASHINGTON–U.S. Environmental Protection Agency Administrator Gina Mc-

analysis–which estimates $690 million in benefits against $530 million in costs by 2025–assumes a $4 an Mcf value for the additional natural gas that producers are

is a huge mistake on the administration's part, and a bad decision that we argued against aggressively in our work with the Small Business Administration advo-

reflected in some of the allegations.

However, Reeves suggests, common sense does not always trump actual data. "I think EPA is looking for quantitative data and has put the onus back on the industry, basically saying, 'If you really think these sites are not a source of emissions, gather some data and make your case,'" she characterizes. "As silly as it sounds, EPA's theme seems to be 'show us the money.' Unfortunately, these days, no one in the industry has much money."

KEY OBJECTIVE: **Support common sense regulation based on defensible data.**

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KEY DATA GAPS *What we don't know*

- **Diversity and range of physical and operational characteristics of distinctive production site populations**
  - **Activity data (e.g. major equipment counts)**
  - **Frequency, timing, and duration of high-emission events**
- **Distribution of methane emissions from low-production sites**

Site-level activity data and emissions measurements are needed to better characterize methane emissions from low-production sites.

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OVERALL STUDY APPROACH

- **Desktop Study / Data Mining**
  - Literature and operator surveys
  - Database compilation / statistical analysis
- **Field Investigations**
  - Statistically-based sampling design
  - Multiple production basins/regions
  - Established measurement protocols
- **Messaging and Communication**
  - Engagement with industry, state regulators, EPA, etc.
  - Project Reporting

Emissions Detection/Screening

Emissions Measurement

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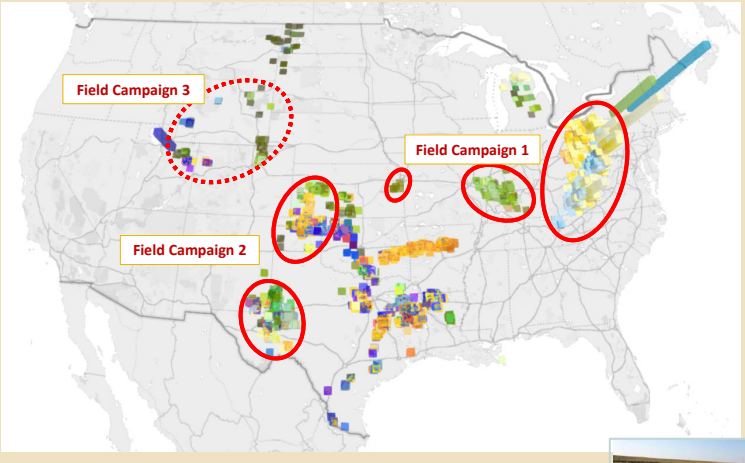
REGIONAL FIELD INVESTIGATIONS



Emissions screening/ quantification

- *300-600 well sites (>90% marginal)*
- *Access provided by operators*
- *Approx. 15 weeks total*

Access to sufficient populations of production sites is critical to obtaining representative data.

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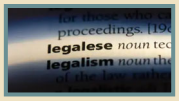
LIMITED SITE ACCESS AGREEMENT

- **Limited access**
  - *No interference with Company operations*
  - *Only with Company escort*
  - *On-site vs. fence line measurements*
- **Health & safety**
  - *Adherence to Company policies/directives*
- **Liability insurance**
- **Confidentiality**
  - *Company information*
  - *Data blinding: Company names and site locations never identifiable*
- **Indemnification**
- **List(s) of potential field sites**



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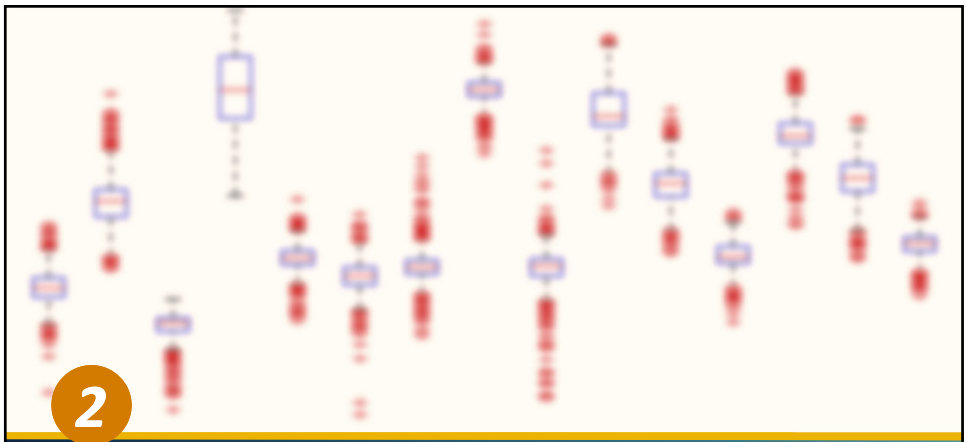

2 DESKTOP STUDY / DATA MINING

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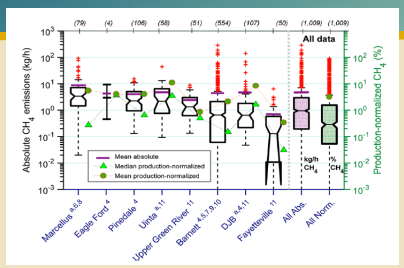
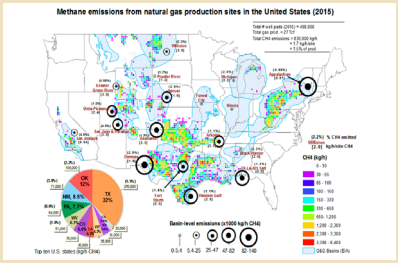
LITERATURE REVIEW - *O&G Production-Related Emissions*

- 45 articles published between 2010 and 2019
- Site-level methane emissions data
- Coverage of ~9 US producing basins; but *Low-production sites not well represented*
- Variety of emissions measurement/ estimation techniques
- Limited site-level activity data
  - Major equipment / Emission sources?
  - Operations data
  - Equipment-level emissions
- Absolute vs. production-normalized emissions estimates





Omara et al. (2018)

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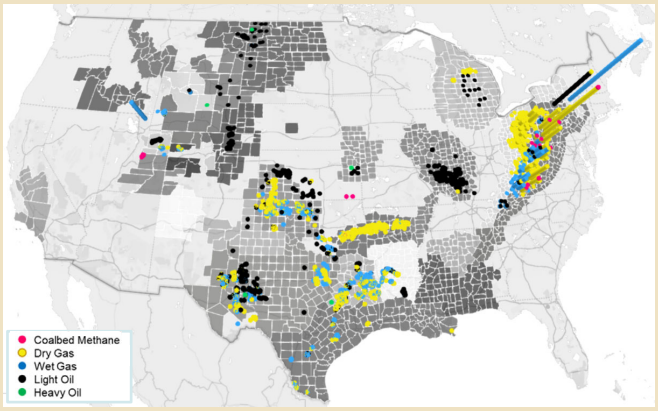
WELL SITE DATA - *Data Blinded Operator Survey*



Site location
- *Basin, state, county, etc.*

Activity data
- *Production type and rate*
- *Liquids unloading, associated gas disposition*
- *Emissions monitoring*

Major equipment
- *Active/Inactive Wells*
- *Tanks, separators, dehydrators, etc.*
- *Flares/thermal combustors*
- *Equipment components (e.g., pneumatic devices)*

OPERATOR RESPONSES TO DATE: ~86,700 wells, 29 basins, 23 states

Higher levels of participation/response produces better results

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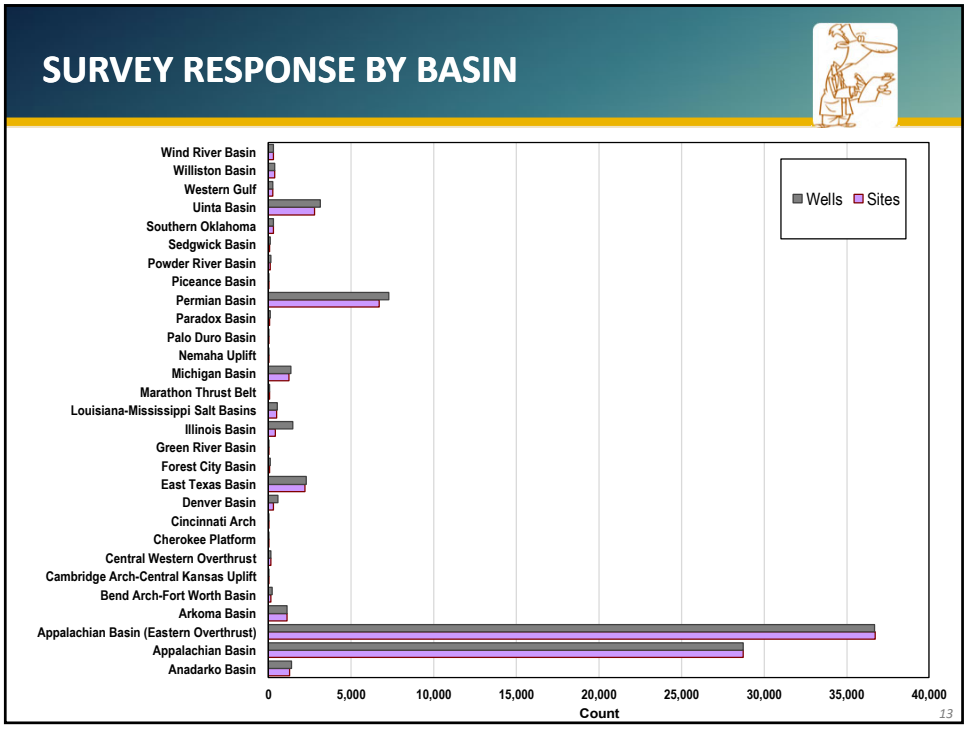
SURVEY RESPONSE BY BASIN
Wind River Basin
Williston Basin
Western Gulf
Uinta Basin
Southern Oklahoma
Sedgwick Basin
Powder River Basin
Piceance Basin
Permian Basin
Paradox Basin
Palo Duro Basin
Nemaha Uplift
Michigan Basin
Marathon Thrust Belt
Louisiana-Mississippi Salt Basins
Illinois Basin
Green River Basin
Forest City Basin
East Texas Basin
Denver Basin
Cincinnati Arch
Cherokee Platform
Central Western Overthrust
Cambridge Arch-Central Kansas Uplift
Bend Arch-Fort Worth Basin
Arkoma Basin
Appalachian Basin (Eastern Overthrust)
Appalachian Basin
Anadarko Basin
Wells
Sites
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
Count
13

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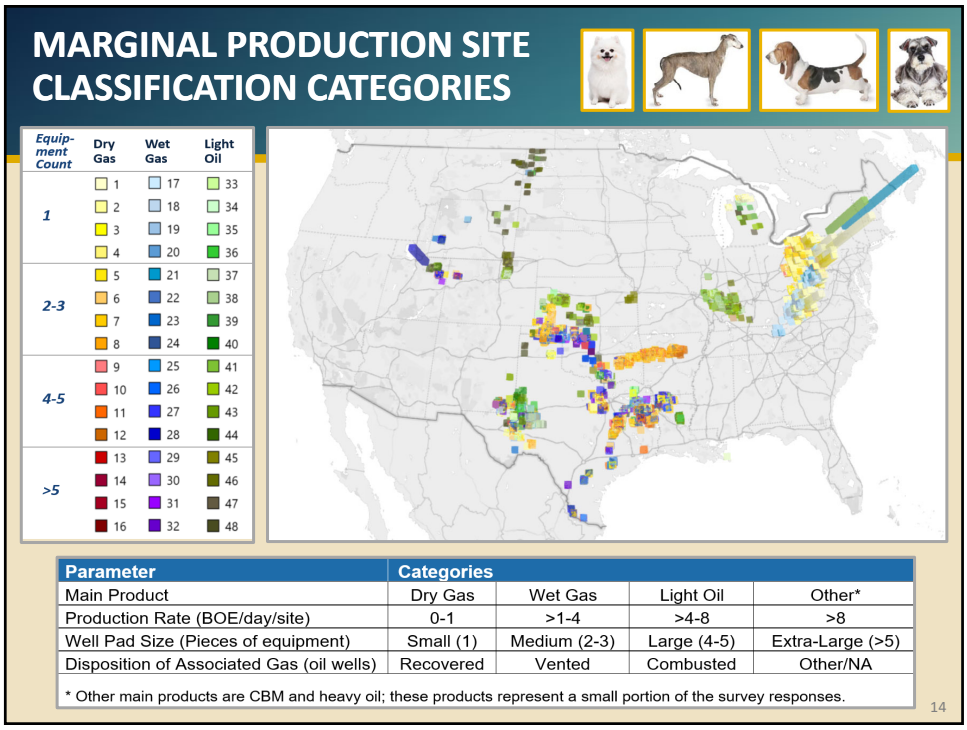
MARGINAL PRODUCTION SITE CLASSIFICATION CATEGORIES
Equip-ment Count
Dry Gas
Wet Gas
Light Oil
1
2-3
4-5
>5
Parameter
Categories
Main Product
Dry Gas
Wet Gas
Light Oil
Other*
Production Rate (BOE/day/site)
0-1
>1-4
>4-8
>8
Well Pad Size (Pieces of equipment)
Small (1)
Medium (2-3)
Large (4-5)
Extra-Large (>5)
Disposition of Associated Gas (oil wells)
Recovered
Vented
Combusted
Other/NA
* Other main products are CBM and heavy oil; these products represent a small portion of the survey responses.
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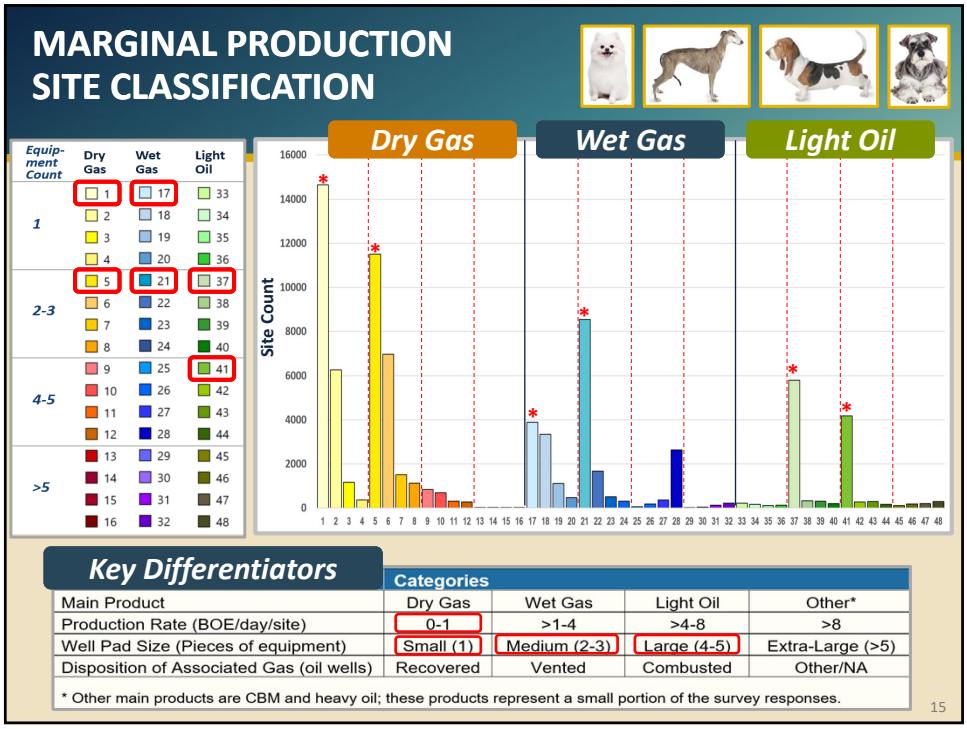
MARGINAL PRODUCTION SITE CLASSIFICATION
Dry Gas
Wet Gas
Light Oil
Equip-ment Count
Dry Gas
Wet Gas
Light Oil
1
2-3
4-5
>5
Site Count
Key Differentiators
Categories
Main Product
Dry Gas
Wet Gas
Light Oil
Other*
Production Rate (BOE/day/site)
0-1
>1-4
>4-8
>8
Well Pad Size (Pieces of equipment)
Small (1)
Medium (2-3)
Large (4-5)
Extra-Large (>5)
Disposition of Associated Gas (oil wells)
Recovered
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Combusted
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REGIONAL FIELD INVESTIGATIONS
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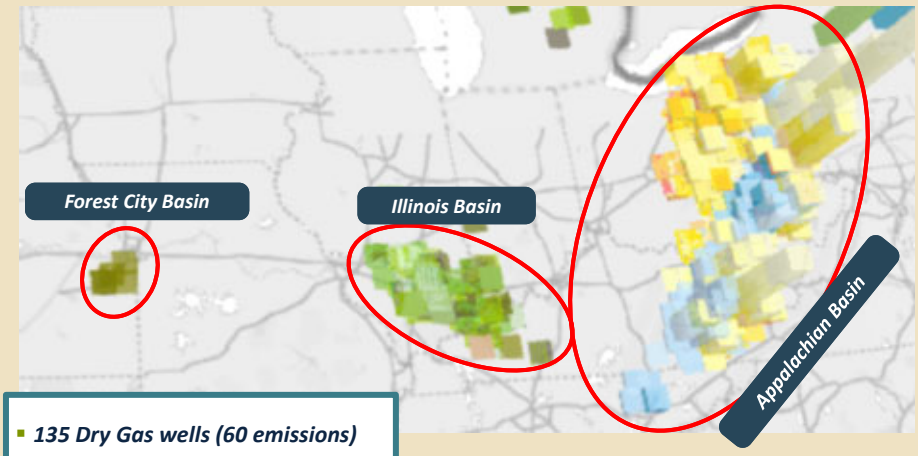
FIELD CAMPAIGN #1 – *Total Observations*



- *135 Dry Gas wells (60 emissions)*
- *30 Wet Gas wells (15 emissions)*
- *97 Light Oil wells (45 emissions)*

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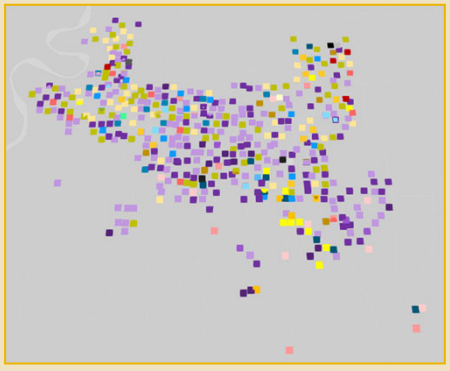
FIELD WORK PLANS

Field Investigation Design

- Site selection (criteria, procedures)
  - Representativeness of field sites
- Technology specifications (Equipment, methods, protocols, etc.)
  - Emissions Screening - ID and characterize nature and frequency of key methane emission sources
  - Emissions Measurement - Quantify emissions from representative emitting sources.
- Data analysis (criteria, procedures)



Example map with site classifications identified in different colors

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RANDOM SITE SELECTION
Regional Clustering

- Pre-planned
- Primary site for each day
- Secondary sites each day
- Driving order for planning purposes

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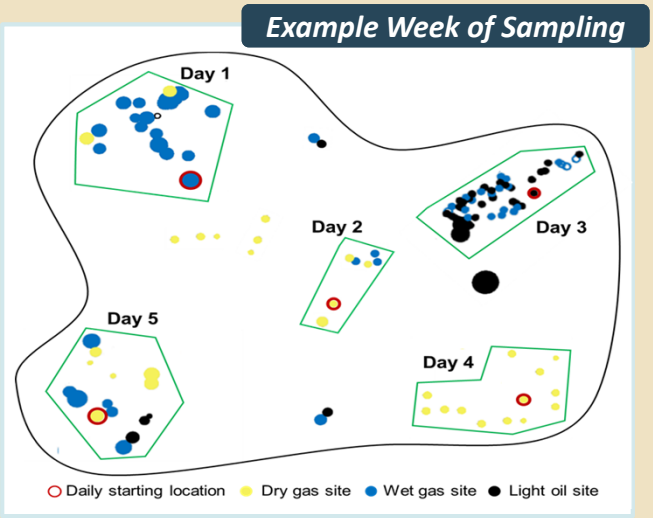
Example Week of Sampling



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HOST OPERATOR COORDINATION
What to Expect

- **Prior to field mobilization**
  - *Inform host operators of randomly selected, geographically-clustered 'candidate' sites (~30 per sampling day)*
  - *Coordinate sampling dates/times with local reps; Confirm physical accessibility; Refine site lists if needed*

- **Each day of sampling**
  - *Meet company escort at convenient location*
  - *Discuss plan to maximize visits to random short list of sites (<15/day)*
  - *Visit sites; Operator "interview"; Screen/measure emissions*

- **After the campaign**
  - *Follow-up site data request*
  - *Share site-specific results from each host's own sites*
  - *Share preliminary blinded summary results w/ all host operators*

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FIELD DATA COLLECTION *"Activity Data"*

- *Weather data*
- *Major equipment counts*
- *Operator "Interview"*
  - *Production type and rates*
  - *Liquids unloading details*
  - *Disposition of associated gas*
  - *Emissions monitoring*
  - *Operating conditions typical/variable?*
- *Component counts (time permitting)*

Site-specific data remains confidential

Site-level activity data to characterize the significance and representativeness of conditions observed, and not observed, at the time of each site visit.

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ON-SITE EMISSION DETECTION AND QUANTIFICATION

Optical Gas Imaging

High Flow Sampler

Gas "Sniffer"

- **Vented and fugitive emissions**
  - *Opgal Eye-C-Gas IR camera*
  - *Bacharach Hi-Flow sampler*
  - *Bascom-Turner Gas Rover*

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DOWNWIND EMISSION QUANTIFICATION
Atmospheric Sampling

Tracer and OTM33A techniques, with geo-location and concurrent wind speed/direction

- **Instruments in van**
  - *Picarro G2210-I*
    - CH_4, C_2H_6, H_2O
  - *Aerodyne mini-TLDS*
    - CH_4, C_2H_2, N_2O, H_2O
  - *Licor 850A*
    - CO_2, H_2O
  - *Hemispheres GPS*
  - *Gill Windsonic*
- **Instruments on-site**
  - *Tracer gas mass flow controllers*
  - *Weather stations at tracer gas release points*

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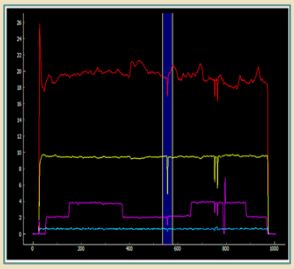
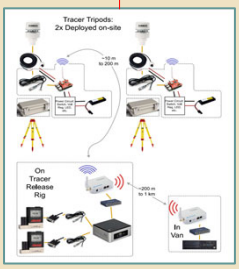
Van Off-site

Tracer Rig On-site





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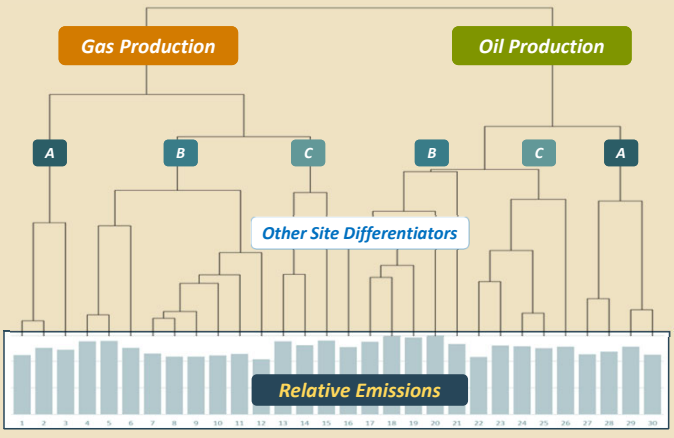
EXAMPLE DATA ANALYSIS



- **Data Sources**
  - Desktop study
  - Regional field investigations
- **Site Category Differentiators**
  - Product type
  - Equipment count
  - Production rate
  - Etc., etc.
- **Statistical Comparisons**

  How different are methane emission rates and sources?
- **Extrapolation to other basins/regions**

GOAL: **Compare representative methane emissions estimates/profiles among relevant *Production Site* populations.**

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THANK YOU! QUESTIONS?

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