ENERGY AND AIR QUALITY REGULATION: PERSPECTIVE ON ENACTING SCIENCE-BASED POLICY IN THE AGE OF COMMUNITY SCIENCE

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LEGISLATIVE DRIVERS

Senate Bill 19-181

Additional public welfare protections for oil and gas operations

House Bill 19-1261

Statewide greenhouse gas (GHG) emissions reductions

Year	GHG reduction goal (relative to 2005)
2025	26%
2030	50%
2050	90%

Senate Bill 19-096

Statewide GHG emissions reporting

House Bill 20-1265
House Bill 21-1189

Increased public protection from air toxics

Senate Bill 21-260

Sustainability of the transportation system

House Bill 21-1266

Environmental justice

Senate Bill 20-204

Air quality enterprise fund

- Funding for "Air Quality Modeling, Monitoring, Assessment, Data Analysis and Research"
- Stationary monitors, aerial monitoring, exposure/risk assessment
- https://cdphe.colorado.gov/air-quality-enterprise

Fiscal year	Funding
2021-2022	$1M
2022-2023	$3M
2023-2024	$4M
2024+	$5M

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COLORADO AIR QUALITY CONTROL COMMISSION

RULE CHANGES ASSOCIATED WITH SB19-181

December 2019

- Enhanced leak detection and repair
- Pneumatic controller emission reductions
- Storage tank controls

September 2020

Revisions to oil and gas rules associated with:

- Produced water disposal
- Emission reductions from pre-production flowback tanks
- Lower emissions standards for natural-gas fired engines >1,000 hp
- Air quality monitoring for pre-production and early production activities

December 2020

Alternative proposals for ozone nonattainment boundary, offsets, mobile emissions

February 2021

Pneumatic controllers

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RECENT & UPCOMING COLORADO AIR QUALITY CONTROL COMMISSION GHG RULE CHANGES

May 2020

New Colorado Regulation 22 to implement GHG emissions reporting requirements associated with SB19-096

January 14, 2021

Colorado GHG Roadmap: Overall plan to achieve statewide GHG emissions reduction targets in accordance with HB19-1261

Planned for 2021

4 rulemakings focused on the following sectors:

- Transportation
- Oil and gas
- Building efficiency standards
- Energy-intensive manufacturing

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COLORADO OIL & GAS CONSERVATION COMMISSION

MISSION CHANGE RULEMAKINGS

COGCC mission changes

- Changed from "Prevent and mitigate" to "protect and minimize" adverse environmental effects
- "Taking into consideration cost effectiveness and technical feasibility" language was struck

Rulemaking occurred from July 2021 to November 2021

- 2,000 ft setback required relative to residential buildings, school and childcare centers
- Cumulative impact assessments

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AIR POLLUTION ISSUES ARE DISTINCT

Criteria Air Pollutants

6 pollutants

Ozone and precursors

Regulated through NAAQS

Harmful to humans and environment

Greenhouse Gases

4 primary pollutants (CH_4, CO_2, N_2O, FCs)

Regulated through GHGRP

Affects global climate

Hazardous / Toxics

187 pollutants

Regulated through NESHAP

Harmful to humans

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ENERGY, OZONE POLLUTION AND THE PATH TO ATTAINMENT

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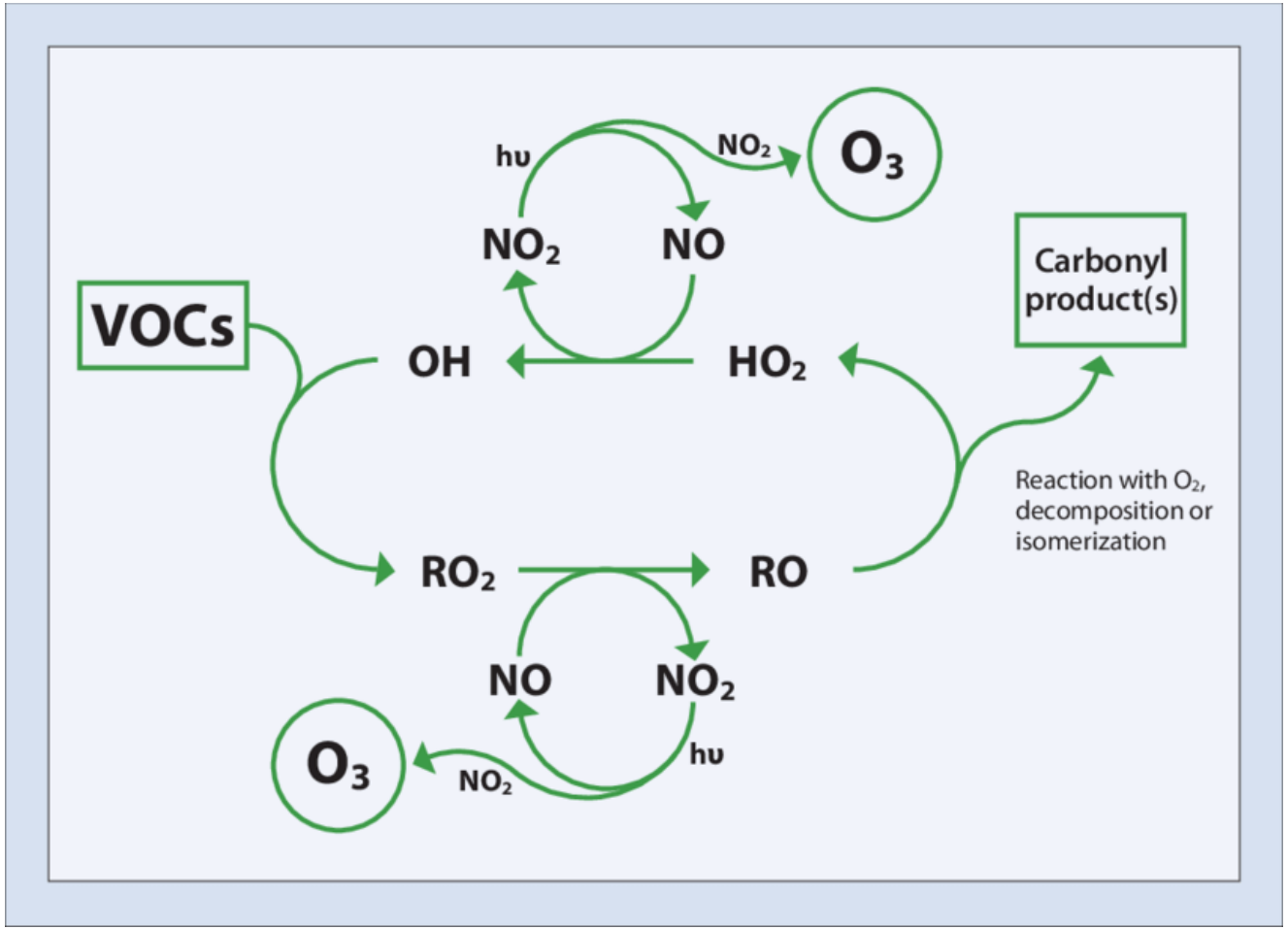
OZONE FORMATION IS COMPLEX



Source: Amann, M., et al. *Health Risks of Ozone from Long-Range Transboundary Air Pollution,* January 2008

Not directly emitted, but is formed

- Free radical reactions with VOC
- In the presence of UV radiation from sunlight
- Both catalyzed and titrated by the presence of nitrogen oxides

Very complex reaction dependent on:

- Diurnal and seasonal meteorology
- Topography
- Relative concentrations of VOC and NOx
- Speciated chemistry of the VOC in the reaction

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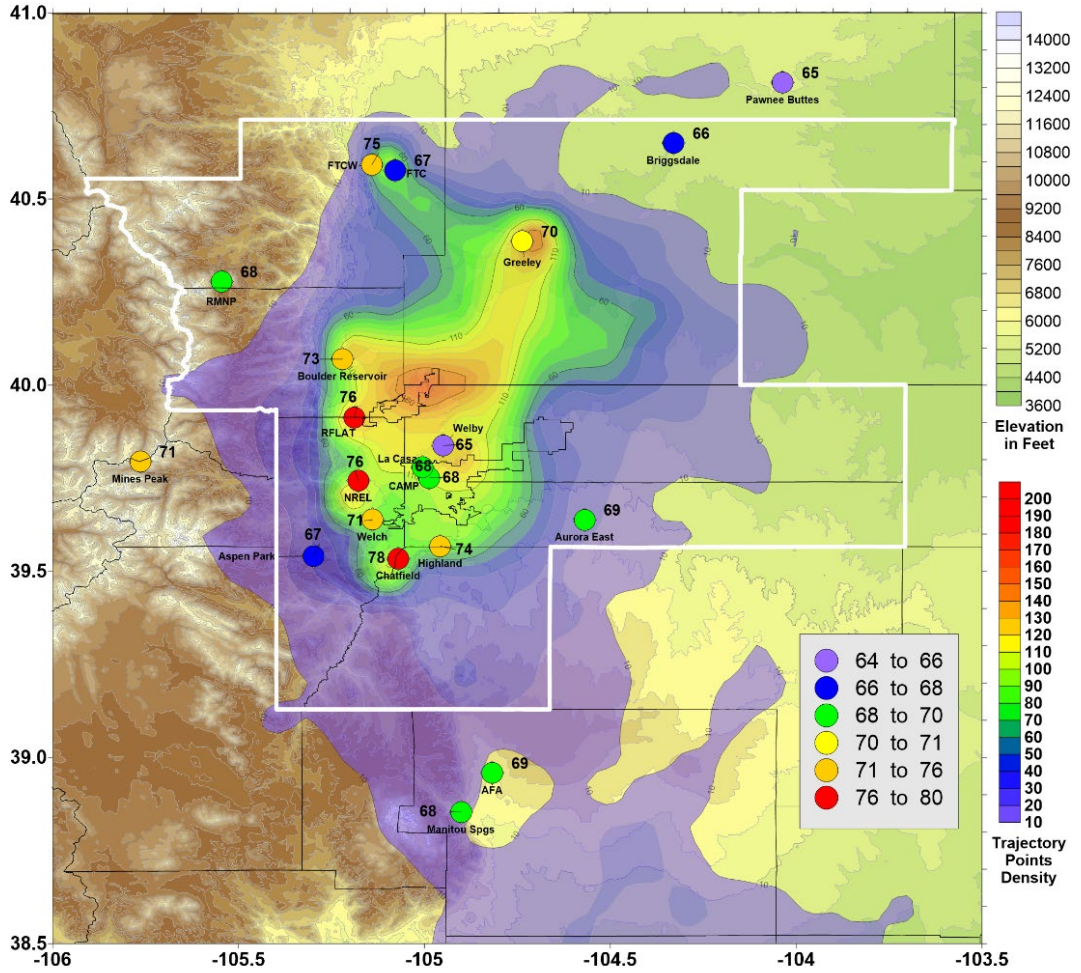
OZONE SOURCE REGIONS

- Ozone source regions estimated from back trajectory modeling for highest ozone days at:
  - Fort Collins West (FTCW)
  - Boulder Reservoir
  - Rocky Flats North (RFLAT)
  - National Renewable Energy Lab (NREL)
  - Chatfield
  - Greeley
- Isopleth shows ozone source regions most likely contributing to the highest ozone
- Identified monitoring gaps:
  - Fort Collins West monitor affected by transport from the southwest transport
  - North and East Weld County

Ozone source regions for 2017-2019

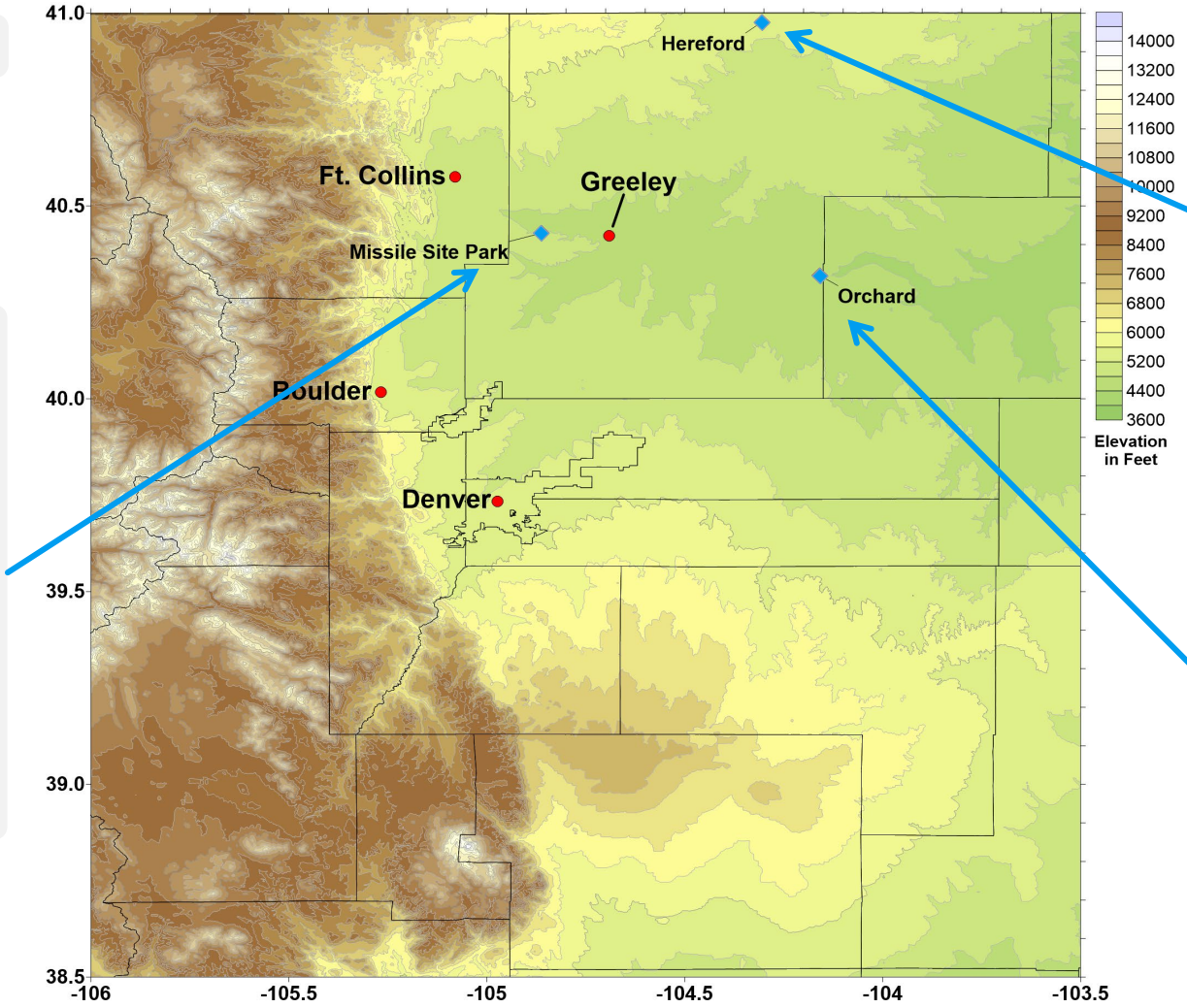


Source: Weld County Technical Support Document, August 2021

MONITORING SITE LOCATIONS

COLORADO FRONT RANGE

◆ **Monitoring site**



Missile Site Park site

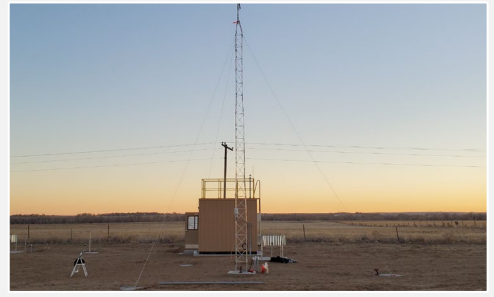
NO_x
Ozone
10 m meteorology tower
National Trends Network
Ammonia Monitoring Network

Hereford site

Ozone
10 m meteorology tower

Orchard site

Ozone
10 m meteorology tower
National Trends Network
Ammonia Monitoring Network



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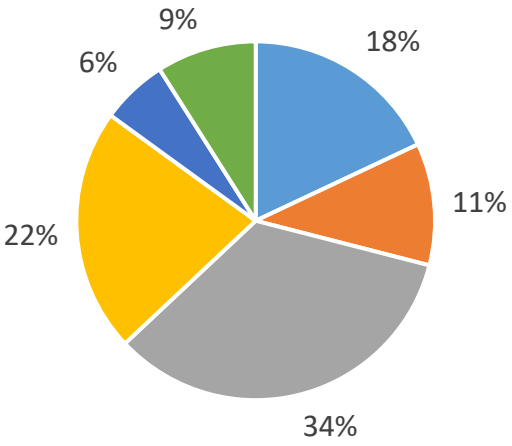
SPATIAL VARIABILITY OF SOURCE INFLUENCE

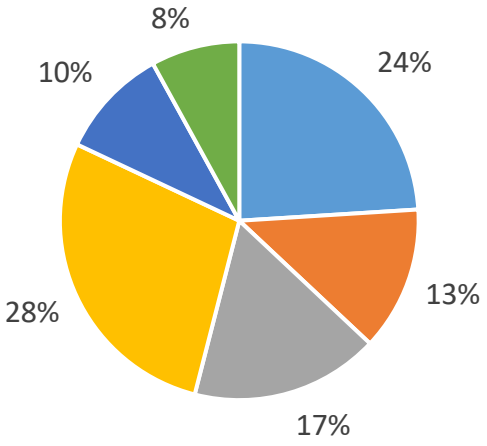
FTCW, Total: 64.8 ppb, NAA: 13.4 ppb



FTCW-Fort Collins West

NAA Sources

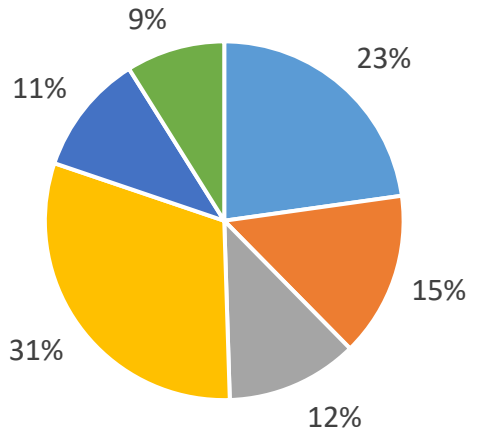
RFNO, Total: 69.0 ppb, NAA: 20.0 ppb



RFNO-Rocky Flats North

NAA Sources

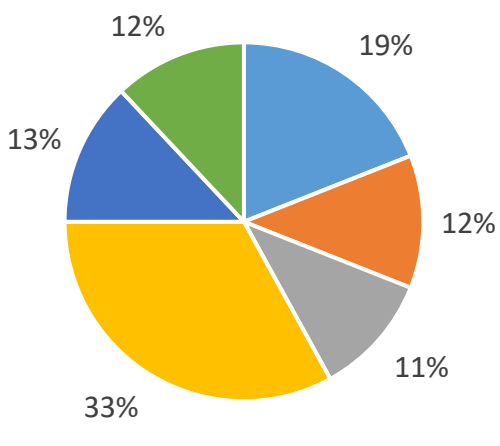
NREL, Total: 71.4 ppb, NAA: 20.1 ppb



NREL-National Renewable Energy Lab

NAA Sources

CHAT, Total: 70.3 ppb, NAA: 18.9 ppb



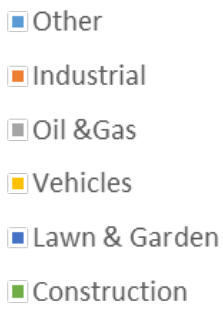
CHAT-Chatfield State Park

NAA Sources

Vehicle, Lawn & Garden, and Construction contributions increase from north to south

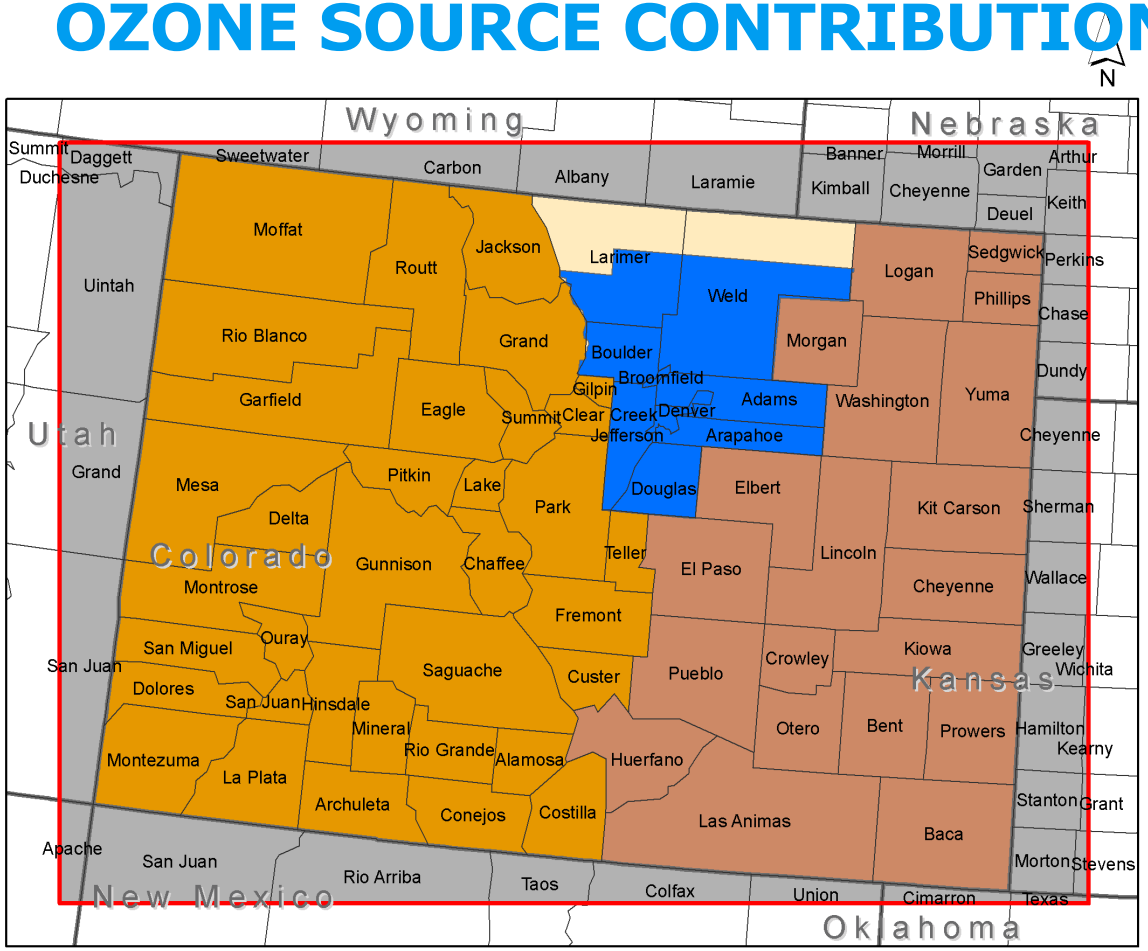
Oil and Gas contributions decrease from north to south

Industrial and Other sources have variable contributions from north to south



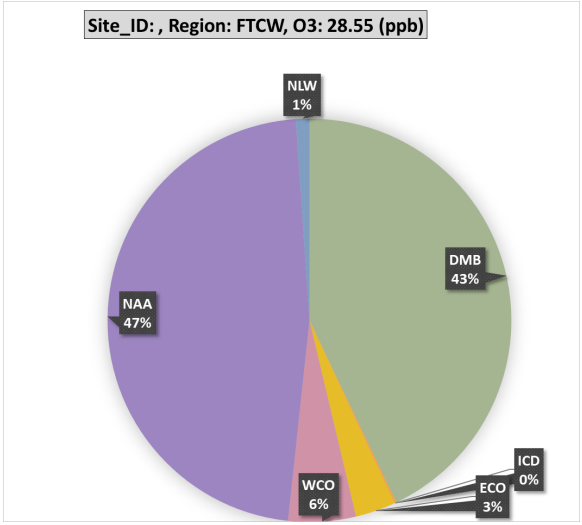
Source: CDPHE Annual Air Quality Data Reports and Regional Air Quality Council Ozone Season Summary Reports, 2021

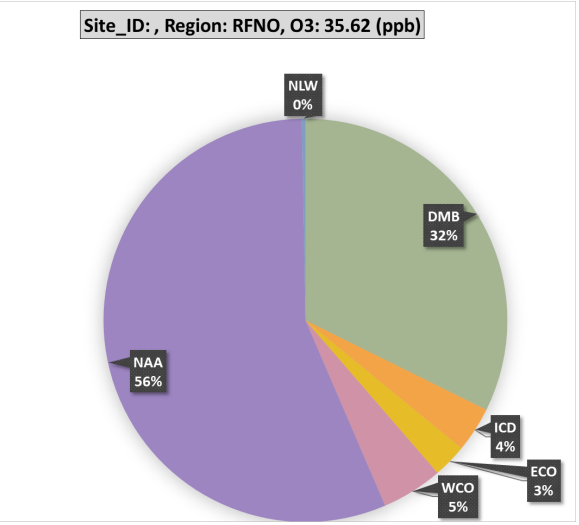
OZONE SOURCE CONTRIBUTION BY AREA

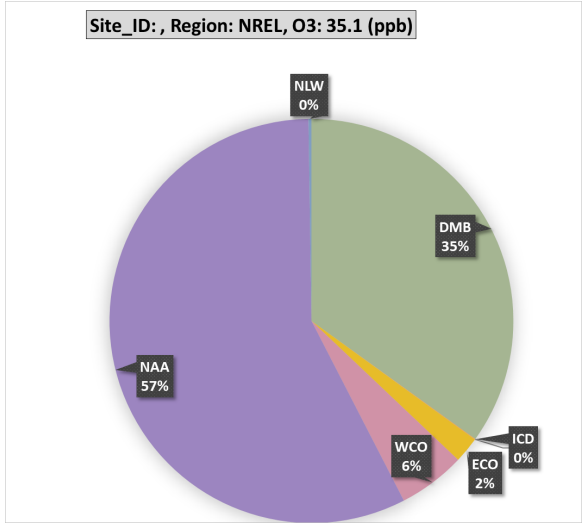


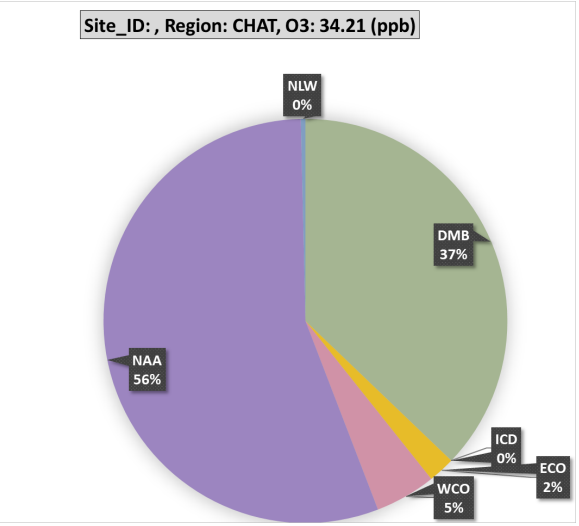
Legend

DM/NFR NAA	**NAA**
Northern Larimer and Weld County	**NLW**
Eastern Colorado	**ECO**
Western Colorado	**WCO**
Other	**DMB (includes CO and the rest of US)**
Denver 4km Domain	









Source: CDPHE Annual Air Quality Data Reports and Regional Air Quality Council Ozone Season Summary Reports, 2021

ATMOSPHERIC INFRARED SOUNDER (AIRS) SATELLITE MEASUREMENTS

AIRS Instrument is on NASA's Aqua Satellite, part of the "A-Train"

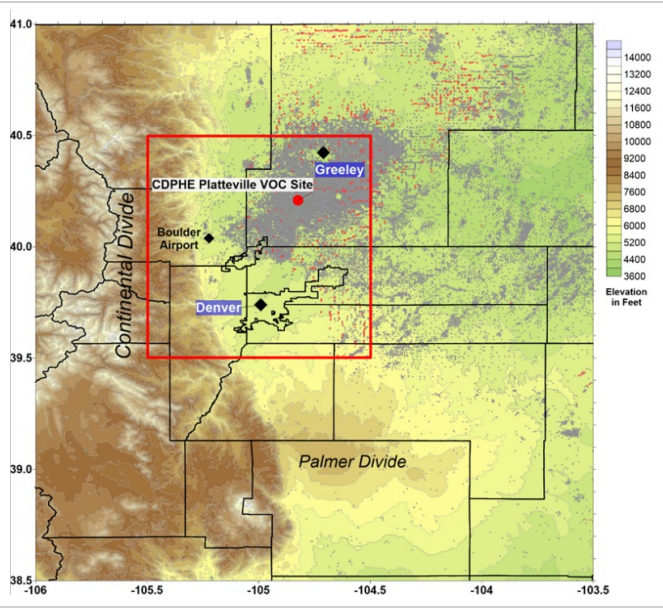
Launched in 2002

Satellite retrieval algorithms estimate:

- Air temperature and water vapor
- Ozone, carbon monoxide, carbon dioxide, methane (CH_4), dust, sulfur dioxide

Orbits pole-to-pole and overpasses occur at 1:30 am and 1:30 pm local time

AIRS CH_4 satellite retrievals were analyzed for a grid cell covering Denver Metro area and a portion of the Northern Front Range of Colorado (DDJB grid cell)



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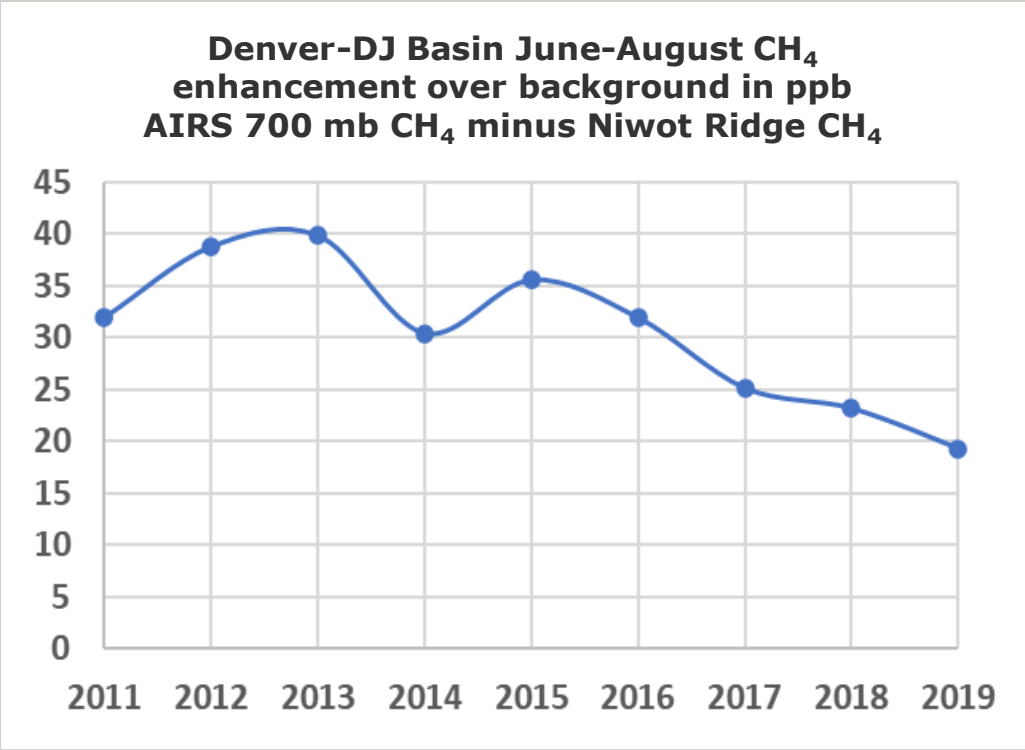
METHANE TRENDS & IMPLICATIONS



Source: Reddy, P., Taylor, C. *Preliminary Analysis of Northern Colorado Methane and Ethane Trends Using AIRS Satellite Data and Platteville Surface Measurements. February 2021.*

Based on AIRS, CH_4 has decreased in DDJB grid cell by 52% since peak in 2013

- Colorado oil production since 2013 has doubled and natural gas production has increased 20%

AIRS trends are corroborated by ground-based surface measurements

This demonstrates the efficacy of Colorado oil and gas regulatory controls

Results suggest that oil and gas emissions inventories do not adequately account for regulatory controls and operational changes in Colorado

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COMMUNITY SCIENCE AND IMPACTS TO PUBLIC POLICY FOR OZONE

Ozone formation and transport is **complex science**

- You cannot point to a single industry or source category
- Multiple factors vary regionally, sub-regionally, and seasonally
- Significant influence from transport into and within the region
- Depending on sub-regional sensitivity, emission reductions may not result in decreases in ozone on violating days, and may have a **disbenefit**
- Drivers for ozone are not the same today as they were in 2011

Modeling is **key decision tool** to test impacts of policies

- More and better monitoring improves the predictive value of the models
    - Identifies pollutant transport (particularly of highly reactive VOC and NOx)
    - Validates the model predicted values

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GREENHOUSE GAS EMISSIONS

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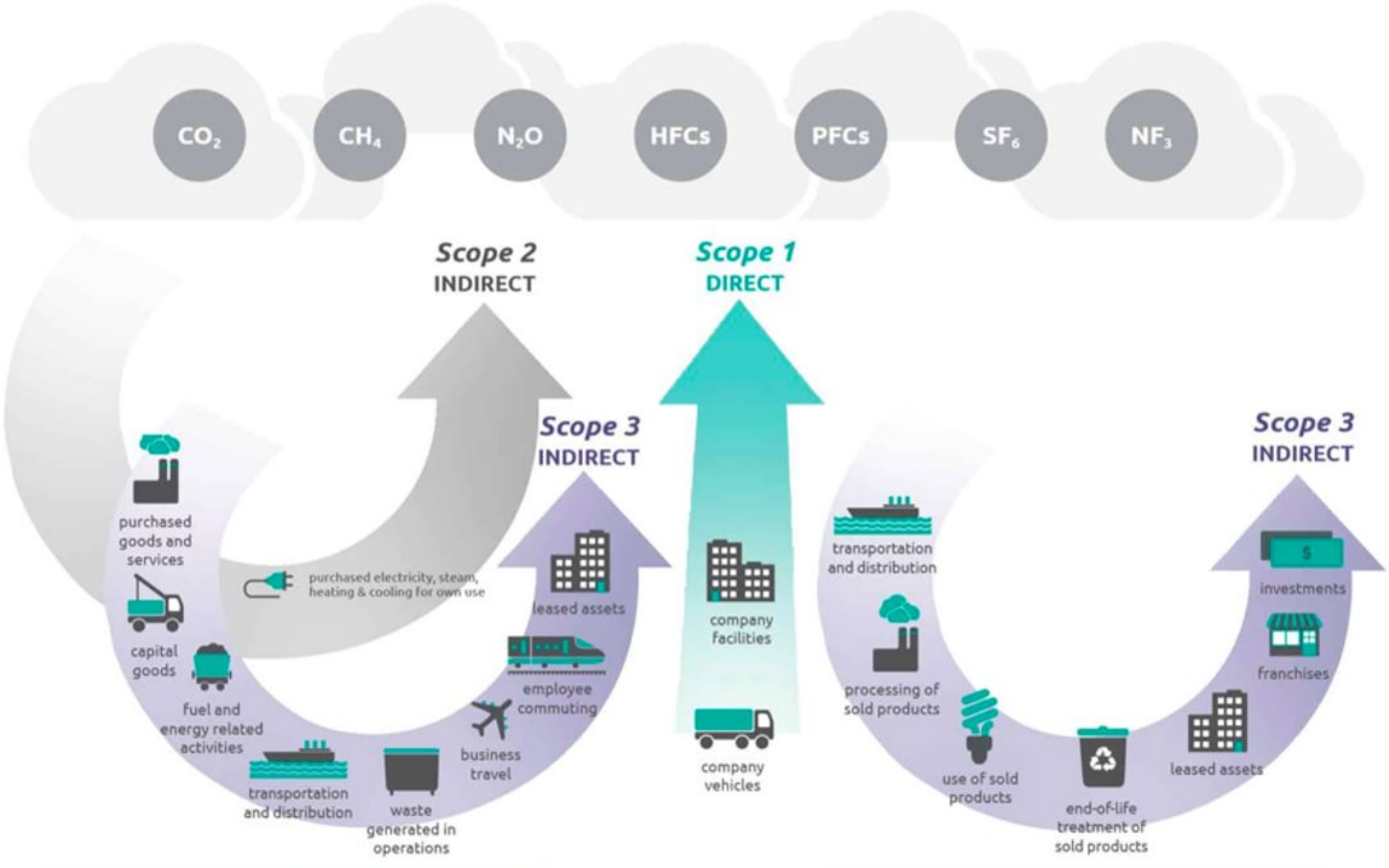
DEVELOP BASELINE GHG INVENTORY EMISSION SOURCES & SCOPES



Consider the entire supply chain

- Scope 1 – Direct emissions owned or controlled by the company
- Scope 2 – Indirect emissions from purchased energy (heat, steam, electricity)
- Scope 3 – Indirect emissions upstream or downstream
  - Supply chain emissions to produce or consume
  - Optional for reporting, **but –**
  - Orders of magnitude higher than Scope 1 and 2

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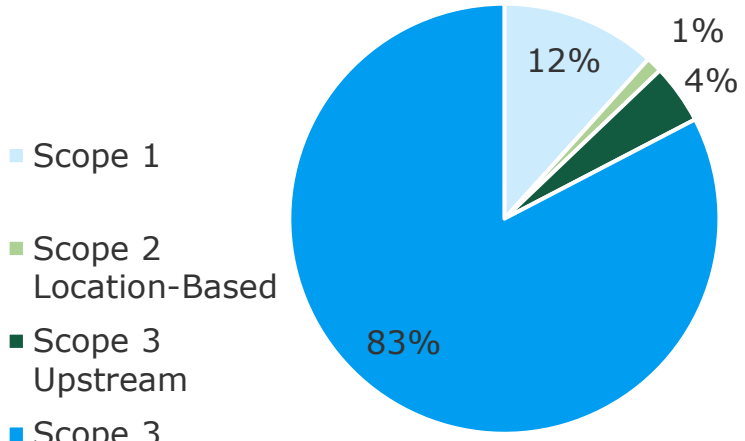
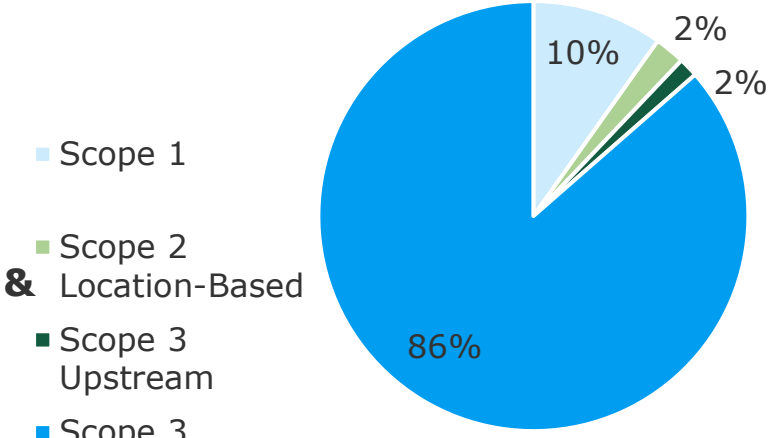
Source: US Environmental Protection Agency

SCOPE 3 EMISSIONS

Oil & Gas Processing

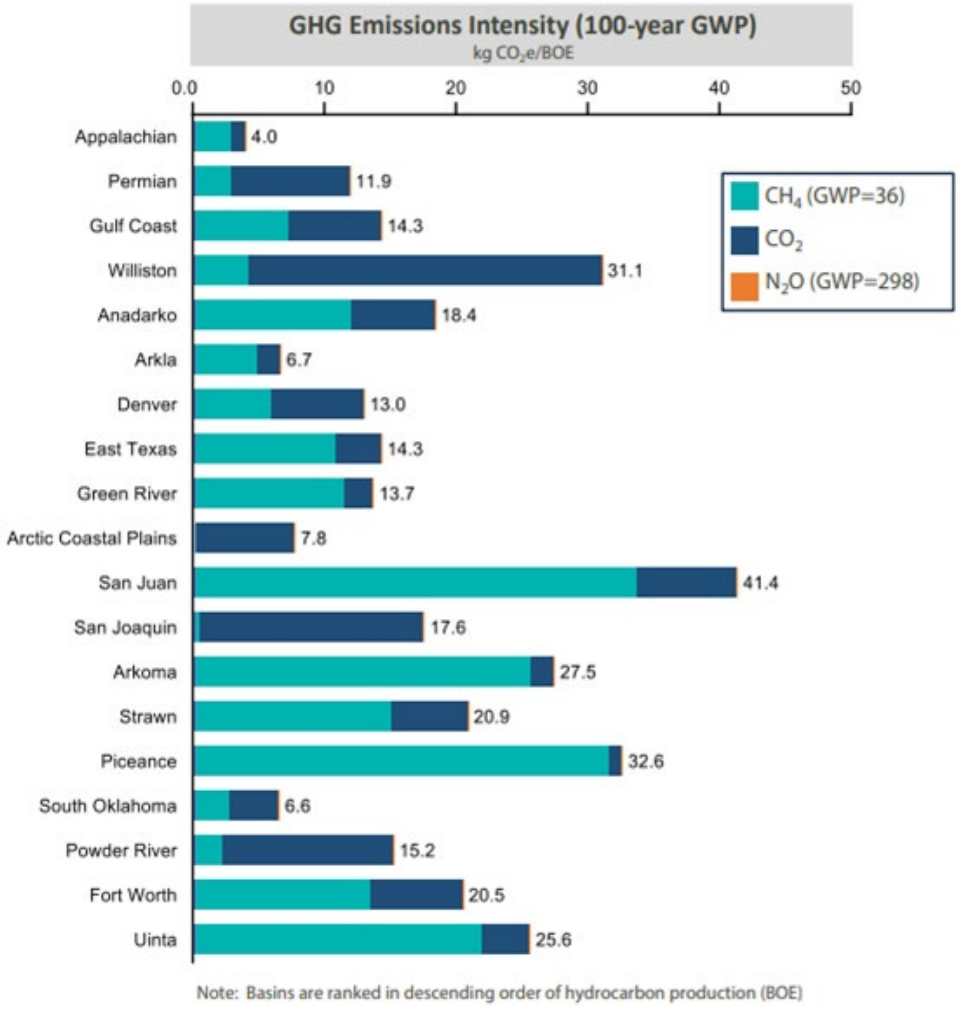


Oil & Gas Storage & Transportation



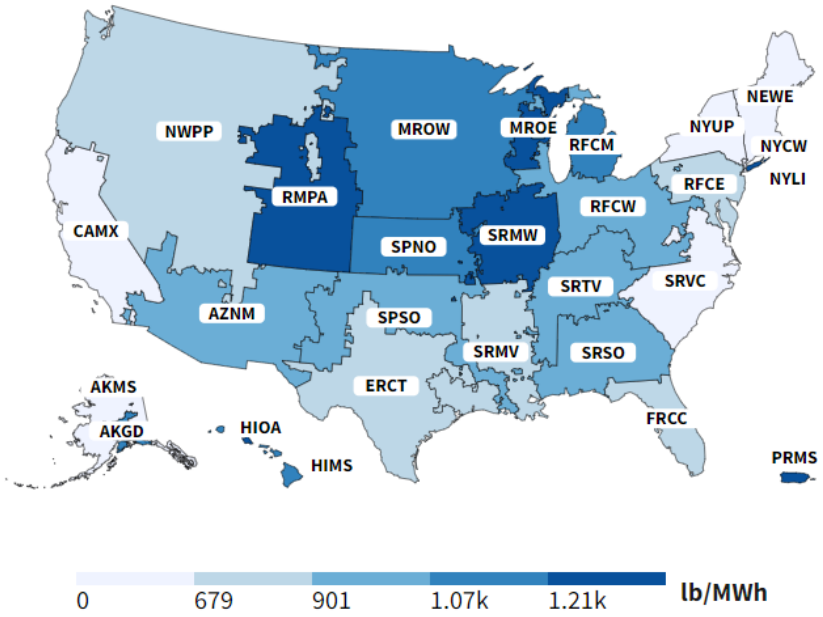
Source: 2020 Carbon Disclosure Project

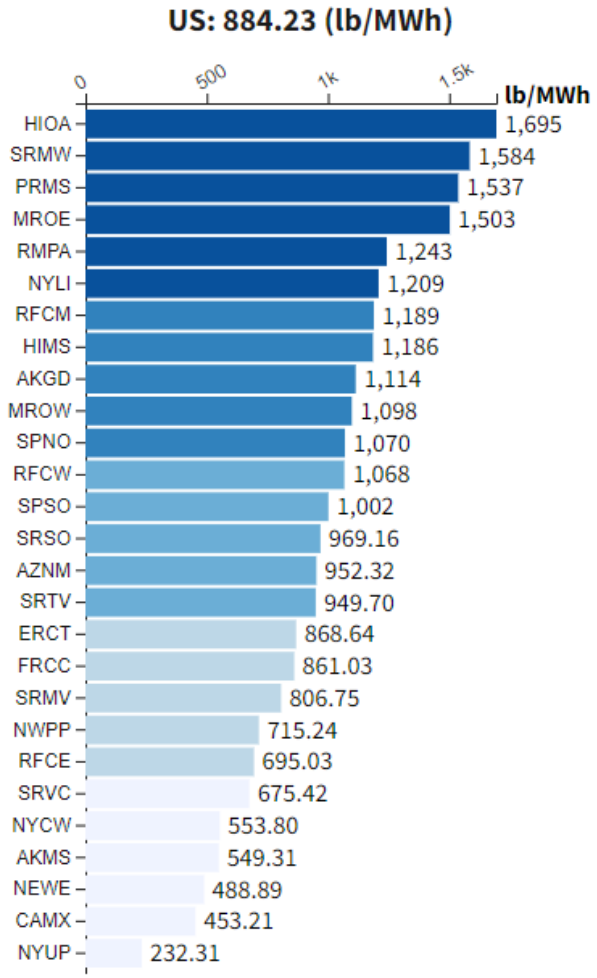
Upstream Production



Source: MJ Bradley Report - https://www.mjbradley.com/sites/default/files/OilandGas_BenchmarkingReport_2021.pdf

ELECTRIFICATION





Source: eGRID, 2021, https://www.epa.gov/egrid/data-explorer

The efficacy of electrification is regional due to the varying carbon intensity and usage

- Natural gas engines vary from ~1,000 to 1,600 lb/MWh depending on size, type, and use compared to 1,243 lb/MWh on local grid
- Electric vehicles uses 24-30 kWh/100 miles or 0.3 to 0.4 lb/VMT in RMPA
- Average carbon intensity of fuel-fired vehicles are 0.9 lb/VMT

This considers direct emission only – must consider Scope 1 and 2 from construction, transport, infrastructure

Must consider economic, reliability, and safety concerns as well

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COMMUNITY SCIENCE AND IMPACTS TO GREENHOUSE GAS POLICIES

Greenhouse gas and climate change are **global not local** issues

- Local concentrations of methane and carbon dioxide do not correlate to global temperature impacts
- GHGs do not recognize political boundaries. Policies must consider **leakage** and not provide incentive to produce energy less efficiently.

You must consider emissions across the supply chain (life cycle analysis)

- **Direct emissions are a fraction** of energy's carbon intensity
- **Transparency** and **verification** in the inventories is vital to preclude double-counting and ensure real reductions occur

Electrification is not a panacea – but it is a tool in the toolkit to be used appropriately

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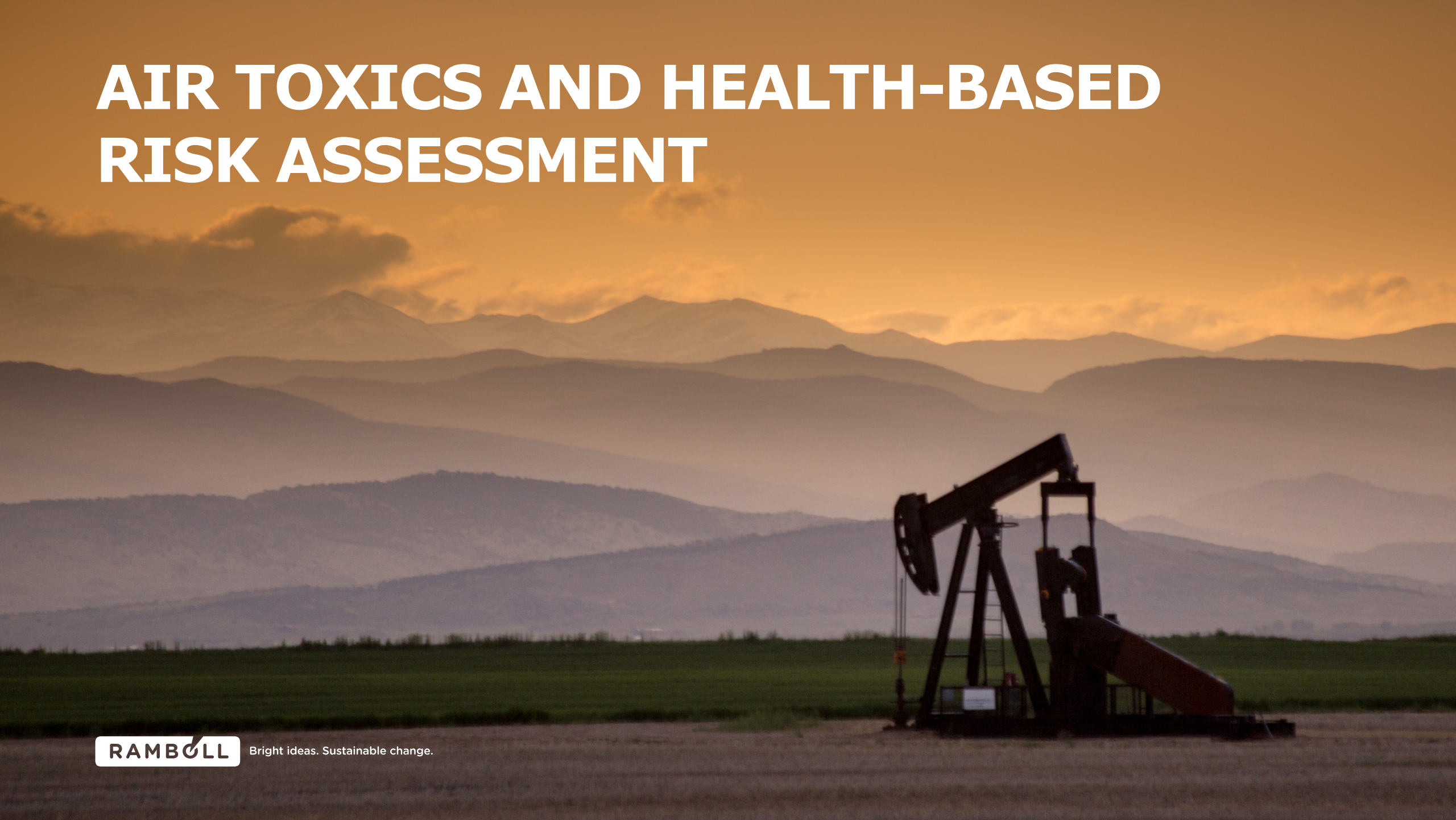
AIR TOXICS AND HEALTH-BASED RISK ASSESSMENT



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BELLA ROMERO ACADEMY

Colorado Air Monitoring Mobile Lab (CAMML) to detect VOCs in the ambient air on campus

1,400 feet from production activities

3 monitoring periods (lasting 1 month each) and 17-day follow-up monitoring period from May – December 2019

- 96 days total
- 1,796 hourly samples

Benzene and other VOCs measurements spiked for 10 minutes during a 1-hour sample

A single 45-minute benzene sample exceeded a 1-hour acute health benchmark

Photo source: Michael Elizabeth Sakas/CPR News

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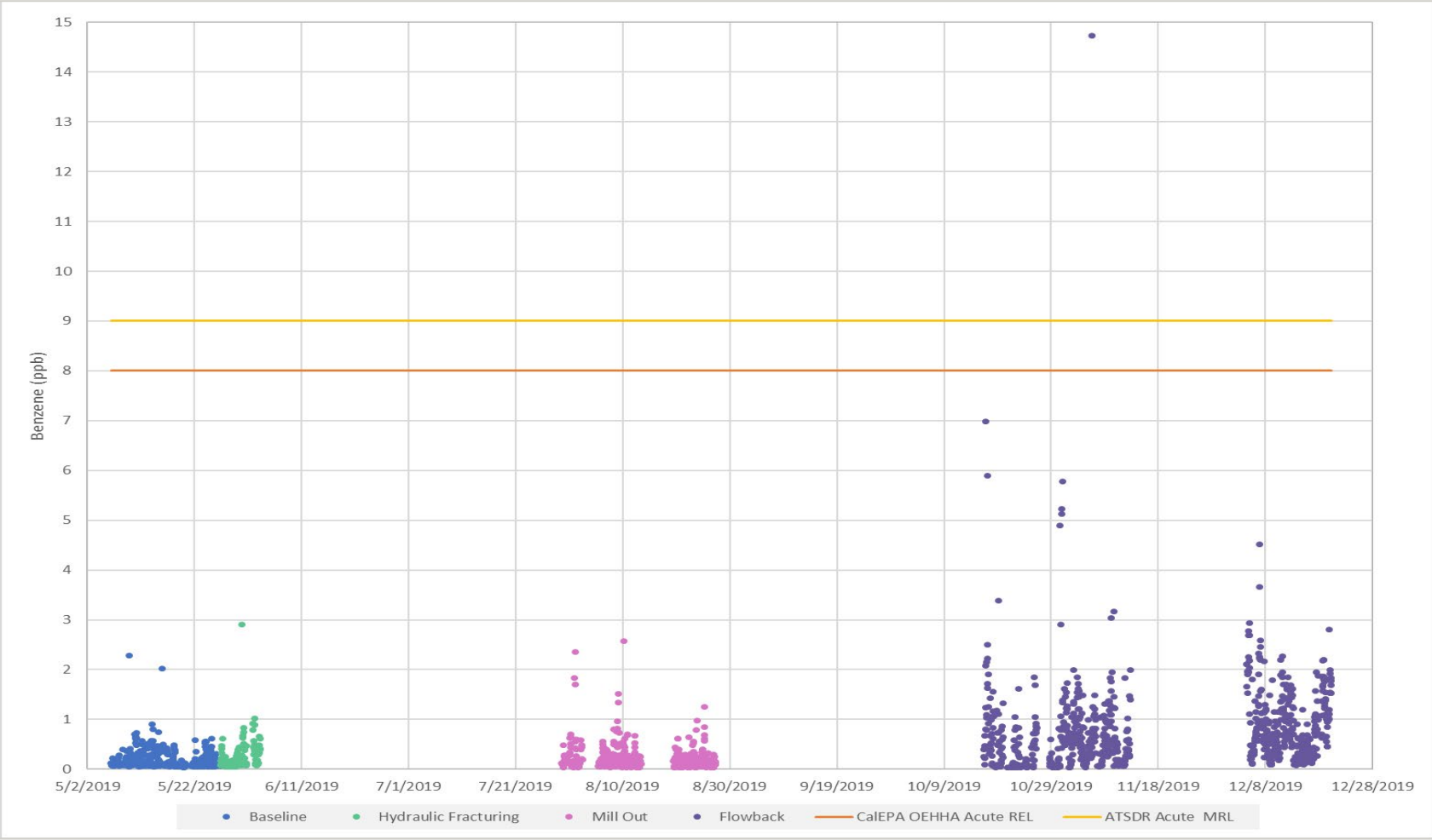
BELLA ROMERO ACADEMY

45-minute samples

Baseline
Hydraulic Fracturing
Mill Out
Flowback

Single sample that exceeds exposure guideline value

Isolated
Vast majority of samples below exposure guidelines



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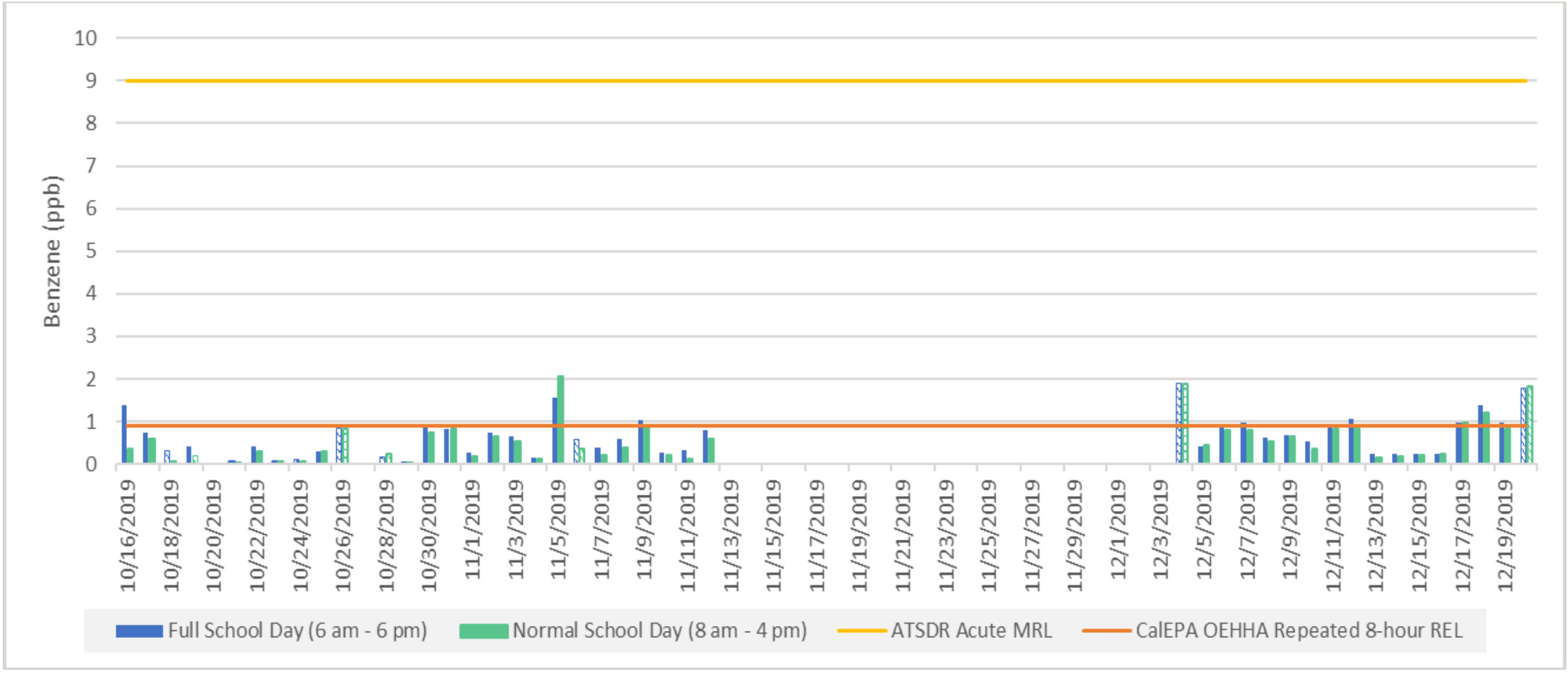
Flowback: school day benzene averages



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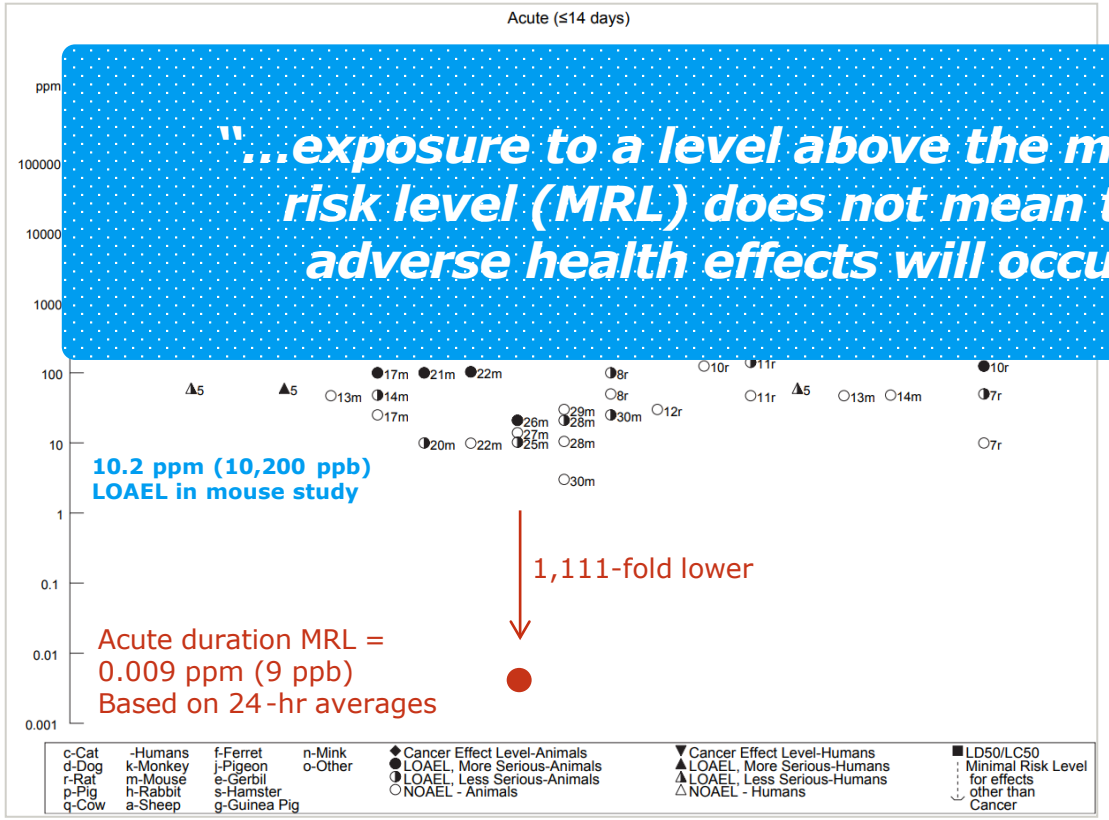
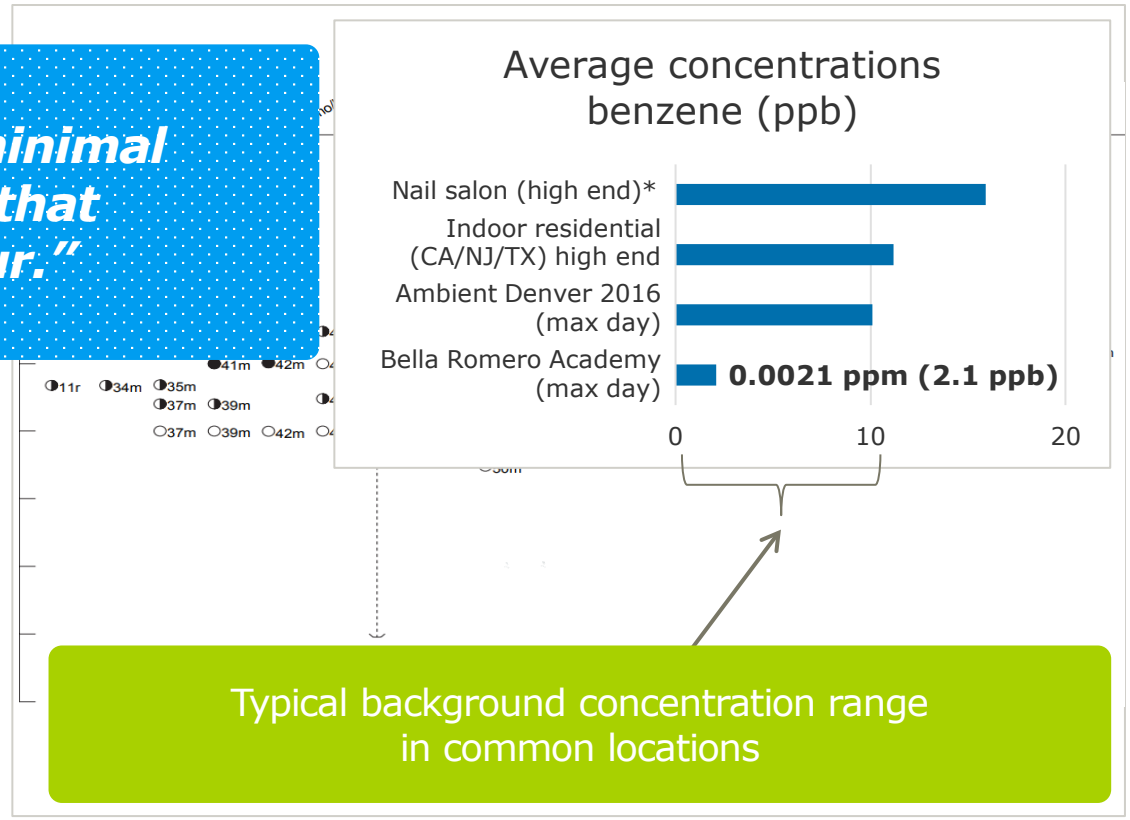
HOW HEALTH-BASED BENCHMARK RISK ASSESSMENT VALUES ARE SET

BENZENE ACUTE MRL



"...exposure to a level above the minimal risk level (MRL) does not mean that adverse health effects will occur."



Adapted from ATSDR 2007 Toxicological Profile for Benzene; Exposure values from primary literature

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CONCLUSION OF OUR RISK ASSESSMENT

Using a real-life situation and ample monitoring data, we assessed risk of exposure to benzene at a school near an oil & gas development site

01

Benzene concentrations seem to be correlated with the wellsite's phases

- Highest during hybrid flowback/ production, the phase where benzene is most likely to be emitted at highest levels

02

Calculated school day averages and compared these values to health-based benchmark risk assessment values relevant for 8-hour periods or 24-hour periods

03

The one 45-minute sample was a brief event that did not reoccur

- Surrounded by 23 other samples collected on the same day, all below 1.2 ppb

04

Significant community concern over the data

Our conclusions were consistent with CDPHE/ATSDR that this was not cause for concern

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COMMON PITFALLS

Assuming that hazard equals risk!

Exposure assessment

- Assume c
  exposures
  on a few l
  measuren
- Assume e
  lasts for longer than reality

The dose makes the poison

Dose-response

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on is the
n animals
umans

Hazard characterization

- Not putting in context to background
- Assuming the same effects from a previous scenario on the one you are evaluating
- Assuming exposure to a level above the benchmark MRL means adverse health effects

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COMMUNITY SCIENCE AND PUBLIC HEALTH POLICY

Air quality **sensors** are becoming widely available and inexpensive

- Allows for the community collection of ambient concentrations
- Vary greatly in the analytes, detection level, periodicity, and duration
- Often **pollutants of concern are not directly monitored** or use surrogates creating uncertainty and potential misinformation
- Varying degrees of quality assurance and data reduction
- While they can be useful to detect a change, often ill-suited for health risk assessment

However, community science can be useful provided proper implementation of data collection within the confines of a **rigorous, unbiased** health risk assessment framework

- You cannot have an agenda (either way)
- You must consider all available data (properly reduced) in the **context** of relevant health guidelines

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"IT IS A CAPITAL MISTAKE TO THEORIZE BEFORE ONE HAS DATA.

INSENSIBLY ONE BEGINS TO TWIST FACTS TO SUIT THEORIES, INSTEAD OF THEORIES TO SUIT FACTS"

- SIR ARTHUR CONAN DOYLE

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