UNMONITORED AND UNREGULATED
How Texas ignores oilfield pollution

Texas regulators risk the health of people in the Permian Basin

OILFIELD WITNESS

The facts are clear that the only viable path to addressing methane emissions is strong and courageous intervention from government to rapidly build out clean energy resources while phasing out oil and gas production.

Meanwhile we must protect people's health.

We need more air monitors to keep polluters accountable. We need the Barnett Shale regulations to apply to the rest of the state so all Texans can have improved and equal pollution protections. However, these pollution protections are not sufficient to end the pollution crisis. We ultimately need to end oil expansion and transition to renewable energy.

Oilfield Witness finds and documents the harmful methane gas and volatile organic compounds (VOCs) produced by the oil and gas industry.

We primarily do this work using optical gas imaging cameras and real-time field documentation to expose oil and gas pollution of all types. We leverage this intelligence and documentation to educate the public and policymakers to strengthen climate movements.

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Authors and Acknowledgments

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EXECUTIVE SUMMARY

The oil and gas industry knew about the negative health impacts from the production and use of its products for at least fifty years.

In 1968, an internal document from the oil company Shell noted that sulfur dioxide, given off by the burning of oil, can cause "difficulty in breathing."[1] In 1949, an American Petroleum Institute (API) study found that benzene is "unsafe at any level."[2] Despite this historical knowledge, the industry continues to put frontline communities at risk from oil and gas pollution. This report documents the high levels of exposure that residents of the Permian have to sulfur dioxide (SO_2), benzene, and hydrogen sulfide (H_2S).

We used publicly available Texas Commission on Environmental Quality (TCEQ) air monitoring data collected by continuous air monitoring stations (CAMS) to analyze concentrations of a variety of air pollutants in the Permian Basin including H_2S, SO_2, and cancer-causing benzene. We compare measured findings against safe levels set both by research and regulation. The results are alarming with many instances of H_2S exceeding violation levels and ongoing, unsafe, elevated concentrations of SO_2 and benzene. For example, monitoring results from the five TCEQ CAMS in the Permian Basin during the 2020 to 2023 time frame found:

- H_2S was detected over the State of Texas regulatory limit of 80 parts per billion by volume in 94 instances.
- Benzene was detected over the TCEQ long-term Air Monitoring Comparison Value (AMCV) level of 1.4 ppbv in 1,617 instances.

These are important matters for the general public, regulators, and elected officials to examine in more detail, and this report provides a starting point for that work. Improved and increased oil and gas compliance is urgently needed, along with significant intervention by state and federal regulatory agencies.

Texas air monitoring is inadequate, so sufficient data to fully evaluate the extent of pollution does not exist. We reviewed the limited data available and found cause for concern. Our findings coincide with an ever-increasing number of peer-reviewed papers that link oil and gas production to negative health impacts. These studies specifically focus on the flaring and venting of methane gas and accompanying compounds like SO_2, and reinforce the need for more robust air monitoring in Texas.

We reviewed TCEQ-generated air monitoring data and published literature, and from that review, it is evident that there is no way to produce oil and gas without directly harming frontline communities and the climate. We need to drastically reduce our dependence on oil and gas by rapidly transitioning to clean renewable energy sources. While we transition off of oil and gas, the public and affected parties deserve improved air quality. TCEQ, and the Texas Railroad Commission (RRC) must improve their regulatory enforcement in the Permian Basin and throughout Texas.

Climate change must be slowed and eventually stopped.

Texans should expect more and better from the oil and gas regulators who are supposed to protect the public from industry harms. After reviewing the data and completing this technical analysis, Oilfield Witness has four objectives:

1. Deployment of additional continuous air monitoring stations (CAMS) in the Permian Basin. This will lead to a more thorough characterization of emissions, more accurate reporting, and enhanced public complaint responses for both odors and health effects.

2. State-wide adoption of enhanced Barnett Shale oil and gas permitting, operations and maintenance regulations because *all* Texans deserve equal protection.[3]

3. Rigorous enforcement of existing environmental regulations by the TCEQ. The TCEQ has significant discretion when determining the use of mobile air monitoring equipment, investigation of air permit sites, and issuance of fines. However, monitoring, investigation and enforcement actions are limited. This needs to be remedied, and would be aided tremendously by increasing the budget of the TCEQ.

4. Implementation of a wide-scale federal jobs program to manage the decline of fossil fuel extraction, to remediate land harmed by oil and gas industrial waste, and to install extensive clean renewable energy production throughout the state. We know that the only real solution to address oil industry pollution and the climate crisis is a rapid transition to clean energy solutions to drive the phase-out of fossil fuels.

GLOSSARY OF TERMS

API **American Petroleum Institute:** the largest U.S. based oil and gas trade association.

AMCVs **Air Monitoring Comparison Values:** Air pollutant concentrations that the Texas Commission on Environmental Quality (TCEQ) considers to be the maximum value for which the TCEQ would not expect adverse health or welfare effects. These concentrations are not regulatorily enforced, but when a pollutant exceeds its AMCV, it is intended to trigger an evaluation by the TCEQ.

CAMS **Continuous Air Monitoring Stations:** Air monitoring equipment managed by Texas regulators to take air quality data for a variety of pollutants including benzene, hydrogen sulfide and sulfur dioxide.

CDC **Centers for Disease Control and Prevention:** The nation's leading science-based, data-driven, service organization that protects the public's health.

EPA **Environmental Protection Agency:** Responsible for federal environmental regulation.

GIS **Geographic Information System:** Mapping system utilized by the Railroad Commission (RRC).

OGI **Optical Gas Imaging:** A technology that makes visible the normally invisible pollution from oil and gas using the 3.2 - 3.4 micrometer wavelength band of the electromagnetic spectrum.

ppbv **Parts Per Billion by Volume:** The number of molecules in a sample of one billion molecules that are the subject of interest.

ppmv **Parts Per Million by Volume:** The number of molecules in a sample of one million molecules that are the subject of interest.

PBR **Permit by Rule:** Permits that are granted automatically to facilities that generate air pollutants as long as they comply with the rules outlined in the regulation.

PELs **Permissible Exposure Limits:** Regulatory limit set by OSHA (Occupational Safety and Health Administration), the United States federal government agency for workplace exposure to potentially dangerous pollutants.

RRC **Railroad Commission:** Responsible for the stewardship of Texas mineral resources through regulations of extractions transfer and processing of natural gas, oil, coal and uranium. This duty involves the permitting of oil and gas operations and the implementation of drilling and release regulations to minimize waste.

TCEQ **Texas Commission on Environmental Quality:** Responsible for enforcement of Texas state environmental laws and enforcement of some federal environmental laws as delegated by the EPA. This duty includes ensuring air and water quality through ongoing monitoring.

VOCs **Volatile Organic Compounds:** Organic compounds released from liquids or solids as a gas. These have been linked to a variety of health impacts and include benzene, toluene, ethylbenzene and xylene (all of which are produced in the process of fossil fuel extraction).

AIR MONITORING IN THE PERMIAN BASIN

The TCEQ is the primary state agency responsible for monitoring ambient air quality across the state and reporting to the Environmental Protection Agency (EPA). While there are over 200 air monitoring stations for the state of Texas, there are only six air monitoring stations in the west Texas portion of the Permian Basin. These six monitoring stations are clustered in the Midland/Odessa area, including four in Ector County, one in Midland County, and one in Howard County. Five of the monitors in the Permian continuously monitor for ambient air pollution that is then parsed into hourly averaged data, which were the basis for the data in this analysis. The sixth Permian air monitor does not collect continuous data and therefore cannot be used for comparison with the five monitors that are the focus of this report.

What We Found

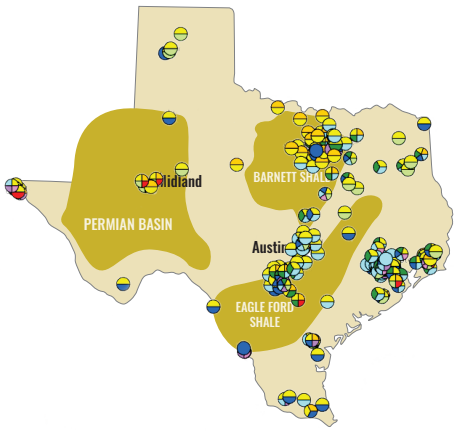
Monitoring results from the five TCEQ CAMS in the Permian Basin resulted in the following exceedances from the 2020 to 2023 time frame.

> **Hydrogen sulfide was detected over the State of Texas regulatory limit of 80 parts per billion by volume in 94 instances.**
>
> **Benzene was detected over the TCEQ long-term Air Monitoring Comparison Value (AMCV) level of 1.4 ppbv in 1,617 instances.**
>
> **Benzene which is only safe at concentrations of 0 ppbv was also detected during 98% of the time during the three-year window.**

The results of our analysis clearly show that current operations are putting Permian frontline communities at risk. However, the insufficient data currently available is not providing the whole picture. The five continuous monitoring stations and one non continuous monitoring location are not nearly sufficient to monitor the widespread air emission impacts of the many thousands of oil and gas wells, processing facilities and pipeline infrastructure throughout the entire Permian Basin. Oil and gas infrastructure is located throughout the Permian Basin, yet there are large geographic sections with cities, towns, and populated areas that have no ambient air monitoring coverage to analyze air quality and the potential for public exposure and harm. Texas air monitoring is inadequate, so sufficient data to fully evaluate the extent of pollution does not exist.

There are a number of oil and gas basins in Texas. There are over 200 air monitoring stations for the state of Texas.

There are only six air monitoring stations in the Texas portion of the Permian Basin.



Data from the 2020 Census for 13 counties in West Texas Permian Basin including Total Population and Hispanic Population numbers is presented in the table below along with the number of TCEQ air monitors in each county. Only 3 of 13 counties have TCEQ air monitors. This leaves the remaining 10 counties and the 84,203 people who live there without air quality data for the levels of air pollution from oil and gas activities where they live, work, recreate and breathe. Beyond the obvious inequity between those who receive air monitoring and those who don't in the Permian, that lack of information also makes evaluating regulatory shortcomings more difficult.

Air monitoring information is critically important both for gauging health impacts and providing valuable information for use in self advocacy. This chronic lack of accessible information is an environmental injustice.

84,000+ people have no air monitors at all in the Permian Basin. 370,034 have a total of 6 monitors. Thats only 3 of the 13 counties with air monitors.

AIR MONITORS IN TEXAS PERMIAN COMPARED TO POPULATION

County	Total Population	Hispanic/Latino Population	Air Monitors
Ector	165,171	100,051	4
Howard	34,880	16,174	1
Midland	169,983	73,331	1
Total Population	370,034	189,556	6 monitors

The remaining counties in the Permian Basin have no monitors at all			
Andrews	18,610	10,400	0
Crane	4,675	3,158	0
Glasscock	1,116	387	0
Loving	64	1	0
Mitchell	8,990	3,454	0
Pecos	15,193	10,845	0
Reeves	14,748	12,510	0
Sterling	1,372	449	0
Ward	11,644	6,325	0
Winkler	7,791	4,732	0
Total Population	84,203	51,861	0 monitors

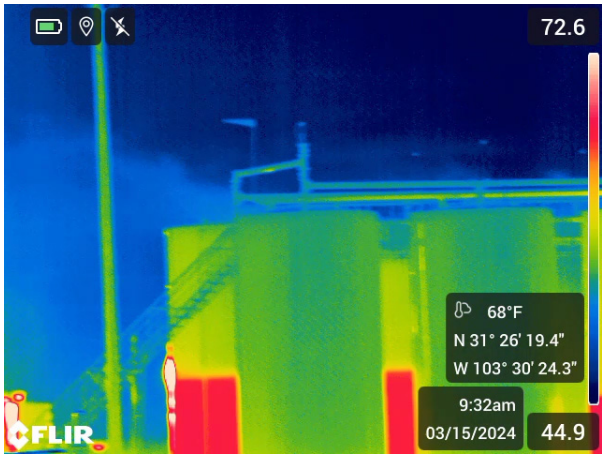
This table shows each of the counties in the Permian Basin and the large population without air monitors.

Creating a comprehensive air monitoring program for Texas is no small task. The west Texas portion of the Permian Basin alone encompasses 80,000 square miles, 17 counties, and over 7,000 production fields — an area of land roughly equivalent to the state of Kansas. Since 2006, the RRC has issued 117,334 drilling permits for the Permian Basin.[4] Despite that huge increase in drilling, air monitoring has not increased proportionally.

The people that live, work, and play in West Texas deserve to know the constituents and quantities of air pollution actively spewing from oilfield storage tanks, stripper wells, flares, gathering lines, compressors, gas plants, and pipelines. This infrastructure handles not only oil and natural gas (treated and untreated) but also acidic H_2S laden gas and highly volatile liquids.

Poor communication and polluting oil and gas facilities are disproportionately impacting Hispanic communities

This inequity is further compounded by the high proportion of Hispanic/Latino and Spanish-speaking residents in the Permian Basin. TCEQ has historically done a poor job making its communications accessible to Spanish-speakers. These issues were so severe they prompted a lawsuit in 2022 alleging that the TCEQ's lack of Spanish accessibility was discriminatory.[5] In response to that suit, and to keep EPA funding, the TCEQ agreed to begin translating its documents into Spanish as well as providing interpreters at public hearings. However, the quality of the translations resulting from this agreement have been questioned, with some public advocates accusing the TCEQ of just running documents through Google Translate without any input from a Spanish-speaker, resulting in unclear or unintelligible translations.[6] It is not surprising therefore that in Texas, fracking wastewater facilities are disproportionately located in Hispanic communities. This leads to a higher risk of pregnancy complications for Latina mothers.[7]



Using Optical Gas Imaging (OGI) technology, Oilfield Witness is able to visualize and record otherwise invisible methane plumes. In this case the plume is arising from a series of storage tanks.

LITERATURE REVIEW OF OIL AND GAS POLLUTION IMPACTS

While the lack of data on Permian air pollution hampers our ability to characterize the full risks to the frontline communities living with the pollution, there is a growing body of scientific evidence that clearly details the risks of oilfield pollution on local populations. This research is another reason we are calling for increased air monitoring in the Permian Basin.

2024 GeoHealth

In March 2024, the journal *GeoHealth* published the paper, "Air Quality and Health Impacts of Onshore Oil and Gas Flaring and Venting Activities Estimated Using Refined Satellite-Based Emissions." The paper found that oil and gas pollution exposure from the U.S. onshore oil and gas industry is estimated to cause 7,500 premature deaths and 410,000 asthma exacerbations annually.[8] The paper estimates the cost of this pollution and the resulting human health impacts due to "hospitalizations, emergency room visits, worsening asthma, and premature death among downwind populations" to be $7.3 billion per year.

2020 Environmental Health Perspectives

Earlier studies reported the localized health impacts for oil and gas production for specific U.S. oil fields. The 2020 paper, "Flaring from Unconventional Oil and Gas Development and Birth Outcomes in the Eagle Ford Shale in South Texas," published in the journal *Environmental Health Perspectives*, suggests exposure to Eagle Ford Formation flaring from oil and gas development is associated with an increased risk of preterm birth.[9]

2022 Journal of Public Economics

The 2022 paper, "Natural gas flaring, respiratory health, and distributional effects," published in the *Journal of Public Economics* identified a causal relationship between flared natural gas exposure and respiratory health hospital visits in the oil and gas areas of North Dakota's Bakken Shale.[10] Co-author Wesley Blundell, an assistant professor at the School of Economics at Washington State University, explained the impacts of flaring, including the many contaminants contained in unprocessed gas.

"We were able to start really digging into what the relationship was and how big the relationship was between the flaring of this unprocessed natural gas and all the contaminants that come with it and the respiratory health of the individuals who live up to 60 miles downwind."[11]

2023 University of New Mexico, Journal of Environmental Management

In December 2023, researchers at The University of New Mexico published the study "Industrial Air Pollution and Low Birth Weight in New Mexico, USA" in the *Journal of Environmental Management* which linked industrial air pollution to the state's above-average rates of babies born with low birth weight.[12]

2021 IOP Science

This body of research establishes a correlation between flaring and pollution associated with oil and gas production and negative health impacts on the local populations. The 2021 paper "Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US," noted the high level of human exposure to flaring in the Permian stating, "In terms of the intensity of exposure, more people in the Permian Basin lived within 5 km of over 100 flares than in any other basin."[13]

In addition to documenting the risks to U.S. communities living near unconventional oil and gas development, the paper specifically noted the "lack of routine air quality monitoring" in these areas.

"Together, this evidence indicates that a substantial number of people in the US could be at risk of health-damaging exposures due to flaring from UOG [unconventional oil and gas development aka hydraulic fracturing of shale]. However, the lack of routine air quality monitoring in these rural areas or systematic regulation and reporting of flaring activity limits efforts to estimate potential flaring-related exposures and associated health risks."

2024 California Oil & Gas Public Health Rulemaking Scientific Advisory Panel

A literature review conducted by the California Oil & Gas Public Health Rulemaking Scientific Advisory Panel found that, "Consistent with findings observed from studies focused on Pennsylvania, in Texas, Willis et al. (2020) also observed an increased odds of pediatric asthma hospitalizations associated with natural gas development, for both conventional drilling and unconventional drilling activities, and increased well production volumes. Furthermore Li et al. (2023) observed an increase in asthma rates in census blocks with higher counts of oil and natural gas wells in Texas."[14]

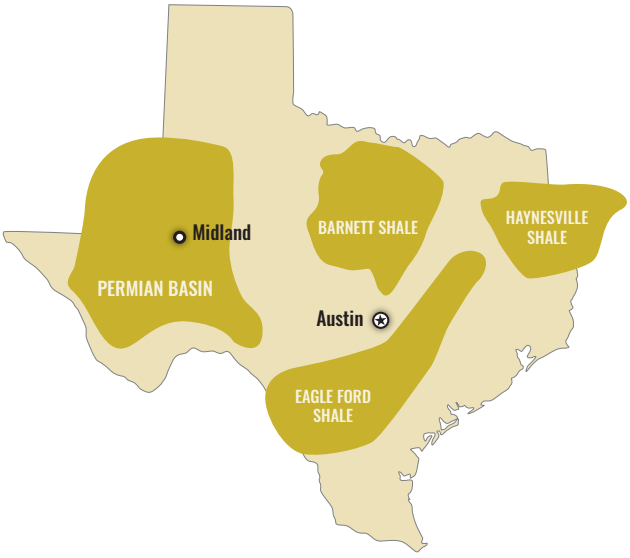
There is a growing body of research documenting the health impacts of oil and gas flaring on frontline communities. It is also clear that we are unable to quantify the true risks due to the lack of air monitoring, which is clearly the case for the Permian region.

Old leaking oil wells are another source of air pollution in Texas.

REGULATORY CONTEXT:
HOW OPPOSITION TO FRACKING POLLUTION DROVE BARNETT SHALE REGULATIONS

Reviewing the history of oil and gas development in the Barnett Shale guides the understanding of the current regulatory landscape that has enabled widespread pollution. Increases in pollution in Texas are a direct result of the huge boom in Texas oil production driven by the technology known as hydraulic fracturing (aka fracking), which began in the Barnett Shale. The pollution experienced in the early days of fracking drove impacted community members to demand, and ultimately receive, enhanced air quality regulations from TCEQ. However, as the shale oil boom continued across Texas and in the Permian, those improved regulations did not follow to other regions.

In the 1990s, Barnett Shale fossil fuel operators began to experiment with combining horizontal drilling and hydraulic fracturing to access difficult to extract oil formations. Their eventual success led to the process now known as fracking, which rapidly proliferated across the state. As fracking spread, the TCEQ began receiving environmental and odor complaints from the community. As a result, the Austin-based TCEQ Mobile Monitoring Team conducted the Barnett Shale Formation Area Monitoring Project — Phase I from August 24 – 28, 2009. The program used a variety of sampling methods to evaluate air quality in the Barnett Shale. Field staff observations and measured pollutant concentrations were alarming and documented that the citizens making complaints were merited in their concerns, including benzene at 15,000 ppbv in a neighborhood where there was potential for public exposure. (Benzine is a known carcinogen dangerous at any level.)



After Phase I of a monitoring operation showed carcinogenic benzene at 15,000 ppbv in the Barnett Shale, further investigations led the TCEQ's Chief Toxicologist to note that, the results were so bad that they could not be ignored. New minimal operating rules were applied, but efforts to apply those rules statewide were stymied by Texas oil and gas companies, politicians, and their special interest groups.

These concerns led members of the public and local governments to hire third-party contractors to perform environmental and health assessments. One of these studies was conducted by Wolf Eagle Environmental Engineers and Consultants, LLC in southwest Denton County in the town of Dish, Texas. Here, elevated levels of pollutants were detected that exceeded multiple health standards established by TCEQ's Toxicology Division.[15] In November 2009, an article in the Texas Observer noted that the tipping point for TCEQ came after that study by Wolf Eagle was released to the public. That same article quoted Michael Honeycutt, TCEQ's Chief Toxicologist at the time, saying, "The highs that we found are relatively high, some pretty high numbers, a thousand parts per billion. That would be equivalent to opening a can of gasoline and holding it up under your nose."[16]

This acknowledgment of the severity of the problem by the TCEQ was called out in that *Texas Observer* article which also noted the TCEQ's weak track record on these issues calling the agency, "perhaps the laissez-est of laissez faire regulatory agencies." However, as TCEQ's Honeycutt noted, the results were so bad that they could not be ignored.

TCEQ attempted to quell concern by issuing a memorandum requiring all Barnett Shale air complaints to be treated as high priority with an investigation turnaround of no more than twelve hours. However, pollution problems persisted, and pressure continued to mount for stronger action. In response, TCEQ issued a non-rule Air Quality Standard Permit for Oil and Gas Handling and Production Facilities for 23 counties in North Central Texas associated with the Barnett Shale Region on January 26, 2011.[17] The new standard permitting requirements required stricter site monitoring and more intense infrastructure requirements for new facilities. Per TCEQ, this update was particularly critical for oil and gas activities in urban locations or in close proximity to the public.

Analysis of these rules indicated that those stricter regulations were beneficial but insufficient to effectively reign in oil and gas production. They set only a minimal setback for new facilities from homes, they fail to consider how low levels of multiple different pollutants may be collectively dangerous and they lack provisions to account for the aggregate effect of many new facilities.[18] However, the regulations were and still are a notable improvement from the regulatory landscape for the rest of the state.

At the time, the permitting changes were intended to be evaluated by the TCEQ to determine their effectiveness with an expectation that by 2012 they would be expanded to encompass the entire state. However, oil and gas operators and their supporters in the Texas government reacted by strongly disapproving of the new rules. As a result, Texas House of Representatives member, Mr. Tom Craddick, former Texas Speaker of the House from 2003 – 2009, and currently in his 28th term representing the Midland, Texas area introduced House Bill (HB) 3110 in March 2011 with an essential goal of limiting TCEQ's new PBR regulations to Barnett Shale operations rather than being applied statewide.[19] Though HB 3110 eventually made it to the Calendar Committee in May 2011, its companion bill, Senate Bill (SB) 1134 in the Texas Senate, was approved faster and Craddick threw his support behind its passage. It was signed into law on June 17, 2011 by former Governor Rick Perry.[20, 21] Disguised as common sense changes to the permit amendment process, the bill required extensive air monitoring data collection before permit modifications could be evaluated. With sparse funding for new monitors provided by the legislature, the bill's passage was obviously intended to prevent the TCEQ from expanding Barnett Shale regulations. As a result of these actions, additional efforts to regulate other Texas-based oil and gas plays—including the Permian Basin—using the more stringent engineering and operating controls that were enacted in the Barnett Shale Formation were stymied by Texas oil and gas companies, politicians, and their special interest groups.

Tom Craddick, the 2011 Texas Speaker of the House from 2003 – 2009, and in his 28th term representing the Midland, Texas area introduced House Bill (HB) 3110 in March 2011 with an essential goal of limiting TCEQ's new PBR regulations to Barnett Shale operations rather than being applied statewide.

The result was no air quality rules for the rest of the state of Texas, and more pollution.

OIL AND GAS POLLUTANTS IN TEXAS

The production of oil and gas generates significant pollution. Apart from the climate pollutants which impact Texans and others on a broad scale (carbon dioxide and methane), other pollutants related to oil and gas production can directly and immediately harm the health of residents living in areas with oil and gas infrastructure and activities. As methane gas is produced in oil and gas wells, it brings with it many other "hitchhiker" gases like VOCs and H_2S. Extraction, storage, transportation and processing of oil and gas emit these byproduct "hitchhiker" pollutants alongside climate-harming pollutants like carbon dioxide and methane. This report details how Texas Permian communities (Midland, Odessa, Big Spring, and others) are exposed to substantial concentrations of these hitchhiker emissions including H_2S, benzene, and SO_2, and it explores how the TCEQ has failed to monitor and regulate these emissions.

HYDROGEN SULFIDE (H_2S)— SULFUR COMPOUNDS

The oil and gas extraction process releases two primary sulfur compounds — H_2S (hydrogen sulfide) and SO_2 (sulfur dioxide). H_2S is a naturally occurring compound that can be found in many underground oil and gas formations. This colorless gas, commonly identified in the oilfields by the strong "rotten egg" odor it produces, is highly toxic and harmful to human health. Many oil and gas sites include warning signs like "H_2S POISON GAS" to alert workers or nearby residents, as required by law.

Both the RRC and the TCEQ are responsible for regulating H_2S. The TCEQ's regulations primarily aim to control ambient air concentrations of H_2S throughout the state, while the RRC is responsible for regulating the handling of H_2S-laden "sour gas" to ensure the safety of workers and nearby residents.

In 2024 the Houston Chronicle found that sites managing high concentrations of H_2S are often located near residences and even schools. Nearly 80,000 people and more than 80 schools are within a half mile of a facility handling sour gas.

Complaints to regulators from residents do not seem to result in substantial fines or altered behavior from operators.

Via Texas Rule 36, the RRC is responsible for imposing more or less stringent regulations on oil and gas wells depending on the concentration of H_2S produced on site. Through a self-reporting system, well operators who are tapping into oil and gas formations known to contain high levels of H_2S are obligated to test their gas and submit a form (called an H9) to the RRC to notify when a site exceeds 100 parts-per-million (ppm) — the concentration at which the gas stream is considered "sour gas." A 2022 report by Jack McDonald and Sharon Wilson, however, found that the RRC has overwhelmingly failed at tracking oil and gas wells with significant H_2S concentrations, as "51% of wells did not file required H9s to assess and inform the state of the danger their well poses and if it must operate under oversight."[22] A June 2024 analysis by the *Houston Chronicle* found that sites managing high concentrations of H_2S are often located near residences and even schools. They found that nearly 80,000 people and more than 80 schools are within a half mile of a facility handling sour gas. They also found that complaints to regulators from residents do not seem to result in substantial fines or altered behavior from operators.[23]

The TCEQ regulates H_2S through 30 Texas Administrative Code Chapter Rule 112 which sets a limit on ambient H_2S concentrations. Rule 112 sets two regulatory limits on H_2S concentrations in ambient air. If an area is populated and people downwind would be exposed to the pollution then the regulatory limit is based on a net concentration of 0.08 ppm over any 30-minute period. If the area is used for industrial purposes or other land uses that are not frequented by humans, the rule limits ambient pollution based on a net concentration of 0.12 ppm. TCEQ has the regulatory authority and resources to conduct enforceable monitoring by identifying sources of H_2S which can be issued violations and potentially fines, though it currently chooses not to do so. In response to the Houston Chronicle article noted above, Texas legislators are scrutinizing the TCEQ and RRC's practices around H_2S. Legislators are considering bills designed to increase regulation of H_2S.[24] Ideas include requiring storage tank (a major source of H_2S) locations to be reported to the RRC as well as limiting releases near residences. These potential regulations would also include stronger requirements for air monitoring in the H_2S-rich Permian Basin.

SULFUR DIOXIDE (SO_2) — SULFUR COMPOUNDS

Unlike H_2S, SO_2 is generally not found in high concentrations underground but is instead formed when gas streams bearing H_2S are burned. The combustion process causes the H_2S in the gas to react with oxygen to form SO_2. Thus, SO_2 is most commonly associated with the practice of flaring in which oil and gas operators burn methane and deliberately release the byproducts into the atmosphere.

Sulfer dioxide is formed when gas streams bearing hydrogen sulfide are burned, causing the H_2S in the gas to react with oxygen to form SO_2. Thus, SO_2 is most commonly associated with flaring.

Like H_2S, the TCEQ has the ability to regulate SO_2 through Rule 112 which sets a limit for populated areas based on a net concentration of 0.4 ppmv averaged over any 30-minute period, except for those in Galveston or Harris County and Jefferson or Orange County that can be exposed to 0.28 ppm and 0.32 ppm, respectively. The 0.4 ppmv limit is strikingly high, almost double the hourly average limit in California.[25] Many other states also have SO_2 regulations, but they use annual averages rather than hourly limits which makes comparing them to Texas difficult.

Unlike H_2S, the RRC does not actively regulate SO_2. This is a particularly bizarre regulatory quirk given that SO_2 releases are a function of the sour gas concentrations that a well produces along with the frequency and quality of the flaring activities that occur, both of which are areas that the RRC directly oversees.

Though sulfur dioxide is a dangerous pollutant, and the TCEQ has the ability to regulate it, the agency has chosen to ignore it.

Both H_2S and SO_2 are dangerous pollutants that cannot be detected with the bare eye. This makes plumes particularly dangerous since untrained local parties may not be able to identify the source or direction of travel. According to the Center for Disease Control (CDC): "At low levels, hydrogen sulfide causes irritation of the eyes, nose, and throat. Moderate levels can cause headache, dizziness, nausea, and vomiting, as well as coughing and difficulty in breathing. Higher levels can cause shock, convulsions, coma, and death."[26] The toxin is a system asphyxiant, meaning it interferes with the lungs' ability to use oxygen.[27] H_2S additionally causes nerve damage; exposure can cause the victim to fall unconscious. This threat of causing unconsciousness is especially dangerous for oil and gas workers and nearby residents who may survive the initial chemical exposure to the chemical, but then inhale deadly amounts or fall from dangerous heights while unconscious.[28] The U.S. Occupational Safety and Health Administration (OSHA) has established that prolonged exposure at even low concentrations of H_2S can be harmful. The administration has set a "General Industry" permissible exposure limit (PEL) for H_2S at 20 ppm, even though the RRC only requires operators to report oil and gas wells that exceed 100 ppm.

According to the Center for Disease Control, exposure to SO_2 can severely irritate eyes, skin, and mucus membranes.[29] Exposure to the compound can also greatly negatively impact the human respiratory system. Sulfur dioxide is linked to the worsening or triggering of: bronchospasm (a constriction of small airway muscles in the lungs manifesting in wheezing[30]), pulmonary edema or "wet lung" (an accumulation of fluid in the air sacs making it difficult to breathe[31]), pneumonitis (lung tissue inflammation), and acute airway obstruction.[32] Chronic pulmonary diseases like asthma can be aggravated by inhalation of even low concentrations of SO_2. It can also induce asthma — Reactive Airway Dysfunction Syndrome (RADS) — at high concentrations. Additionally, SO_2 can contribute to the formation of particulate matter (PM), another pollutant which causes respiratory illness by lodging itself deeply in the lungs and even the bloodstream.[33]

BENZENE

Volatile organic compounds (VOCs) are often locked in oil formations and released alongside petroleum products. This category of compounds contributes to the formation of ozone[34] — which worsens or triggers respiratory illnesses.[35] This report focuses on benzene, a VOC consistently linked to both oil and gas production and deleterious human health impacts. Per the CDC, exposure to high levels of benzene can lead to drowsiness, dizziness, rapid or irregular heartbeat, headaches, tremors, confusion, unconsciousness and death (at very high levels).[36] Upon exposure, the pollutant attacks the blood. Studies of people exposed to high levels of benzene (including oil refining workers) found that exposure to this chemical increased rates of leukemia (blood cell cancer), particularly acute myeloid leukemia (AML).[37] Expert agencies such as the International Agency for Research on Cancer (IARC),[38] the US National Toxicology Program (NTP),[39] and the EPA[40] have classified benzene as a carcinogen based on animal and human evidence.

The American Petroleum Institute (API) is among the institutions which recognize that the toxin causes cancer. An API study dating back to 1949 finds that benzene is "unsafe at any level."[41] Despite that admission, the lobbying organization has worked tirelessly to promote increased oil and gas production — therefore, the level of benzene emissions — knowing the health consequences to workers and frontline communities. Since 1998, API has spent $127 million on lobbying activities.[42]

An API study dating back to 1949 finds that benzene is "unsafe at any level."

Despite the well documented health risks of benzene exposure, neither the TCEQ nor the RRC have set regulations to limit ambient air concentrations.

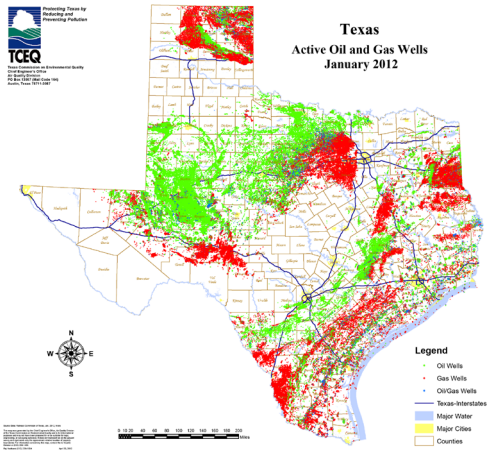
Further research since 1949 has reaffirmed the API's health assessment regarding benzene. In 2010, researchers for the CalBerkley School of Public Health conducted an extensive literature review of benzene exposure research.[43] They concluded that there is no safe level of benzene. Even minute exposures incrementally increase one's risk of developing cancer. They also concluded that these effects can be cumulative, so even low level chronic exposure can increase cancer risk.

Despite the well documented health risks of benzene exposure, neither the TCEQ nor the RRC have set regulations to limit ambient air concentrations. The TCEQ does set a Air Monitoring Comparison Value (AMCV) for benzene. An AMCV is an ambient concentration of a pollutant that is intended to be the maximum level at which "adverse health or welfare effects would not be expected to result."[44] The TCEQ does not issue fines to facilities that cause or contribute to an area exceeding an AMCV.

CUMULATIVE EFFECTS OF POLLUTION

One of the most difficult aspects of gauging the impact of oil and gas production on human health is the huge variety of pollutants and toxins that people are simultaneously exposed to which can make isolating health impacts to one particular chemical compound difficult. However, it is clear that the aggregate impact of air emissions from oil and gas is harmful to human health. Oil and gas pollution exposure is estimated to cause 7,500 premature deaths and 410,000 asthma exacerbations annually.[45]

The Texas regulatory system is insufficiently designed to address the cumulative impact potential of combined emission plumes. Air regulations are generally structured on the assumption that affected parties are only exposed to one pollutant at a time. This was one of the central critiques leveled at the enhanced Barnett Shale regulations; they failed to account for the potential for multiple pollutants and pollution sources causing harm in densely populated areas. However, the reality of Texas oil and gas production is that a huge variety of pollutants are emitted simultaneously. Even on days where pollutants do not exceed ambient air regulations or TCEQ AMCVs, the cumulative effect of multiple pollutants may pose a risk for frontline communities and workers. When accounting for all of the possible pollutants from oil and gas facilities, it is likely that safe levels are far below regulatory limits (which are nonexistent for many pollutants — ethane, toluene, cyclohexane and benzene).



While the Permian Basin has nearly 200,000 active wells, the rest of the state is also dotted with thousands of other wells.

Facilities like this one operate continuously and can release massive amounts of pollution even when all equipment is functioning properly.

OILFIELD WITNESS AIR POLLUTION ANALYSIS IN THE PERMIAN BASIN

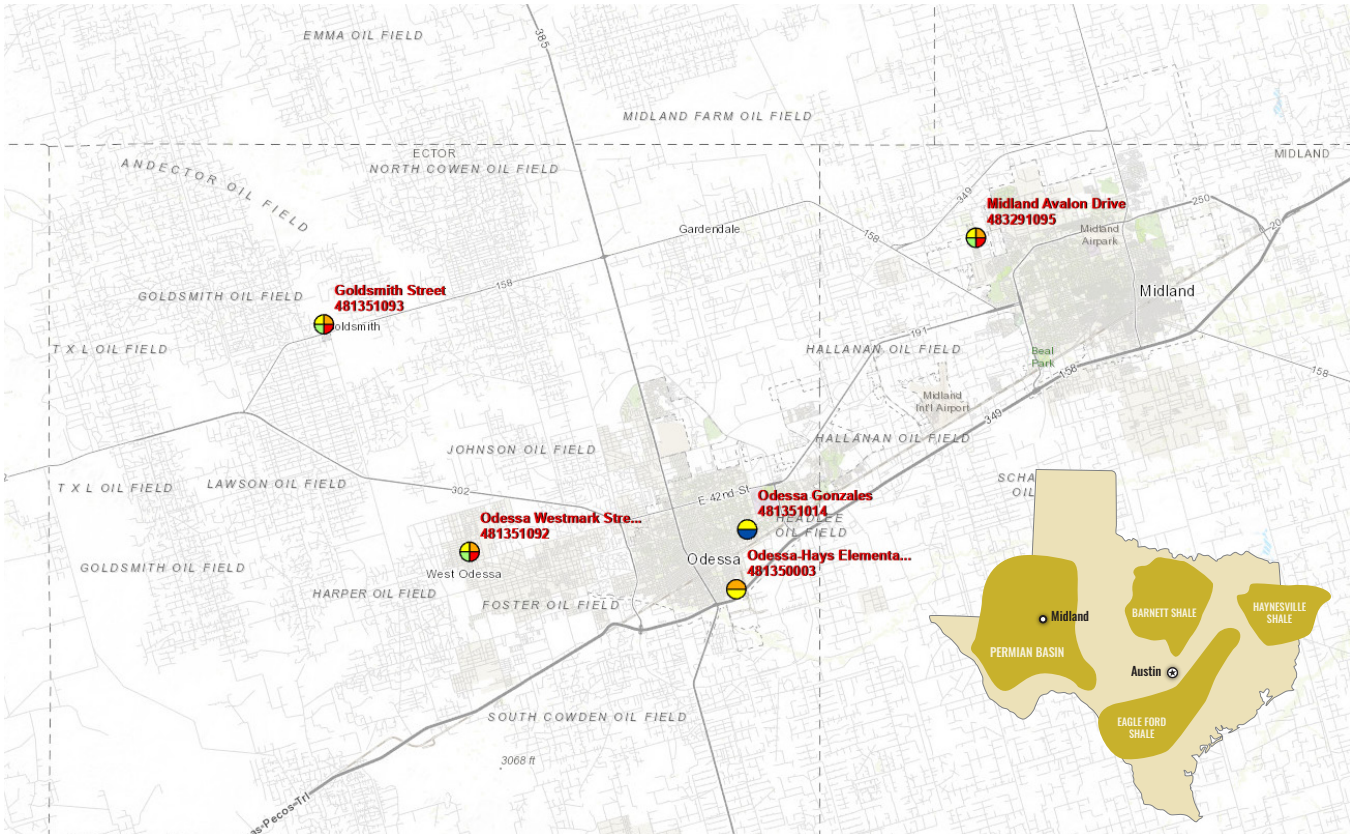
Methodology

The aim of this study was to conduct a technical assessment of ambient air quality in the Permian Basin. To do so, we compared measured ambient air emission concentrations against regulatory limits on those pollutants. To that end, this paper first identified applicable air quality monitoring data then used statistical analysis tools to compare that data against regulatory limits.

How We Accessed the Data

To ensure accurate and relevant data, the Oilfield Witness air quality assessment is based on current publicly available long-term real-time monitoring data. The TCEQ currently has five CAMS in the Permian Basin area clustered in the Midland/Odessa and Big Spring, Texas areas. Each Permian Basin CAMS is equipped to monitor specific pollutants via real-time H_2S and SO_2 instrumentation and auto GCs, (automatic gas chromatographs) along with meteorological parameters like ambient temperature, wind speed, and resultant wind direction. Only four of the CAMS in the Permian Basin collect continuous monitoring data on benzene, SO_2 or H_2S, so those four sites will be the basis for the data in this report.

TCEQ CAMS and Location	Pollutants	Monitored Parameters
Big Spring Midway (CAMS 1072) 1218 N. Midway Rd, Howard County	SO_2	Temperature and Wind Speed/Direction
Goldsmith Street (CAMS 1093) 520 North Goldsmith Street, Ector County	SO_2, H_2S, Auto GC	Temperature and Wind Speed/Direction
Midland Avalon Drive (CAMS 1095) 5510-U Avalon Drive, Midland County	SO_2, H_2S Auto GC	Temperature and Wind Speed/Direction
Odessa Westmark Street (CAMS 1092) 11695 West Westmark Street, Ector County	SO_2, H_2S Auto GC	Temperature and Wind Speed/Direction
This technical information was accessed via the TCEQ webpage which provides summary information for each air monitoring system in the state.[46]		



In the Permian Basin there are six air monitors. Background map is from the TECQ, tceq.maps.arcgis.com.

For the four monitors with data on SO_2 and H_2S, monitoring data was retrieved from the publicly accessible Texas Air Monitoring Information System (TAMIS).[47] Each of these data queries allowed Oilfield Witness to identify maximum measured average pollutant concentrations over a one-hour period for each compound and/or parameter of interest.

How We Analyzed the Data

The TAMIS data for the Permian monitors was exported to Microsoft Excel for a more complete statistical analysis covering 1-hour intervals from 2020 to 2023, where applicable. These interval ambient air pollutant concentrations were then tallied and compared against regulatory and safety limits.

SUMMARY OF CAMS DATA — HYDROGEN SULFIDE

H_2S is one of the two major pollutants analyzed in this report to have an ambient air limit that is enforceable by the TCEQ. As noted previously, Rule 112, sets H_2S regulatory limits for Texas' ambient air. The following table shows the total number of incidences during each year where emissions were detected above 20, 40, 60 and 80 ppbv (the regulatory limit).

Measured H_2S Above Texas Regulatory Limit | Also 20, 40, 60 ppbv Benchmarks					
Year	Maximum Concentration (ppbv)	# of Times Exceeding 80 ppbv Regulatory Limit	# of Times Exceeding 20 ppbv	# of Times Exceeding 40 ppbv	# of Times Exceeding 60 ppbv
2023	412	21	345	114	43
2022	246	33	510	170	60
2021	192	24	512	143	59
2020	169	16	156	43	17

One of the biggest challenges in analyzing this H_2S data is that Rule 112 is based on a half-hour average H_2S net concentration, yet the Permian Basin CAMS data is reported in hourly averages. However, for ease of explanation and to ensure the most conservative possible estimate, we have treated each hour where the average H_2S concentration exceeds Rule 112 limits as just one observance of violation level concentrations.

All three Permian Basin CAMS sites that have H_2S instrumentation have detected H_2S greater than the Rule 112 regulation limit (30-minute net average of 80 ppbv). 94 times over the past four years the Permian Basin monitors have detected 1-hour H_2S concentrations that exceeded established violation levels. Even on days where H_2S concentrations do not exceed a violation level, concentrations are consistently non-zero. This chronic exposure to H_2S is likely to cause or contribute to health impacts on both workers and frontline residents. These high H_2S levels also appear to be consistent with historical data, including a 2020 report from the TCEQ mobile monitoring team that found H_2S levels as high as five times the 80 ppbv regulatory limit.[48]

This chronic exposure to H_2S is likely to cause or contribute to health impacts on both workers and frontline residents.

SUMMARY OF CAMS DATA — SULFUR DIOXIDE

As noted above, SO_2 is also regulated by Rule 112 which sets an ambient air net concentration limit of 0.4 ppmv (400 ppbv) for populated areas in the Permian Basin. This concentration far exceeds the EPA standard of 75 ppbv despite extensive documentation that SO_2 is dangerous to human health. Four Permian Basin CAMS' sites are outfitted with SO_2 instrumentation. Of note, the highest concentrations have been detected by the Big Spring Midway CAMS site that is located just to the northeast of the Alon Big Spring Refinery, a 73,000 barrel per day capacity refinery that was constructed in 1929, and the Tokai Carbon CB - Big Spring Plant that lies just to the west of the monitoring station.

The following tables provide the maximum measured SO_2 concentrations, including time and day, at the Big Spring Midway CAMS, along with the simultaneous wind speed and resultant wind direction data. These measured 1-hour concentrations also exceeded the EPA 1-hour SO_2 regulation standard of 75 ppbv that was established based on the 3-year average of 1-hour daily maximum concentrations.

Measured SO_2 — Big Spring Midway CAMS			
Year	Maximum Concentration (ppbv)	Date	Time
2023	323	1/6/2023	9:00 PM
2022	355	12/14/2022	11:00 PM
2021	251	1/25/2021	4:00 AM
2020	399	4/19/2020	3:00 AM
2019	108	8/3/2019	7:00 AM

SUMMARY OF CAMS DATA — BENZENE

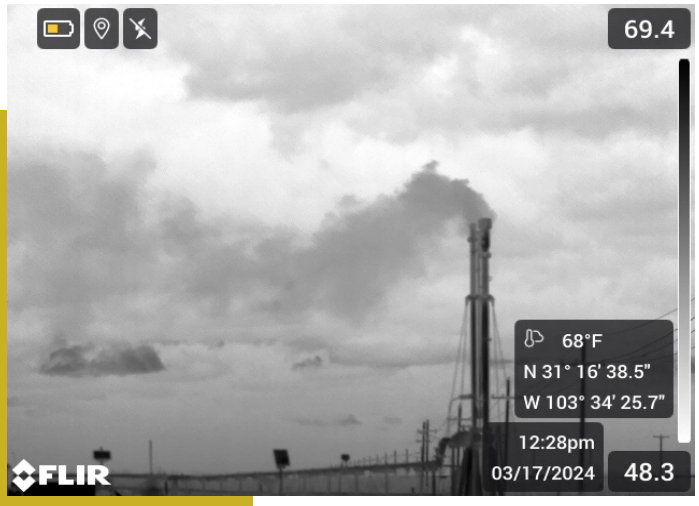
Analyzing benzene is particularly difficult because there are no federal or state regulatory limits (beyond industrial fence line measurements), even though various entities, including API, have established that there are no safe concentrations of benzene. However, out of the publicly available TCEQ-generated 62,857 hourly benzene measurements from 2020 to 2023, just 817 hours were recorded as non-detect. This means that residents living near Permian Basin CAMS air monitors experienced safe levels of benzene only 1.3% of the time.

To further contextualize the severity of the Permian Basin's benzene problems, consider TCEQ AMCV recommendations. As noted above, the AMCVs are arbitrary measurements of safety that are not supported by safety research. They are, however, at least from the TCEQ's perspective, pollution levels where "adverse health or welfare effects would not be expected to result." The TCEQ benzene long term AMCV guideline is 1.4 ppbv. From 2020 through 2023, the three auto GCs detected benzene concentrations above the AMCV of 1.4 ppbv 1,617 times. The highest concentration measured in the Permian Basin was at Midland's CAMS 1095 on May 5, 2023, when the monitor detected a benzene concentration of 28.28 ppbv. See the table on the next page.

Residents living near Permian Basin CAMS air monitors experienced safe levels of benzene only 1.3% of the time.

Measured Benzene — Concentrations in the Permian Basin 2020-2023	
AMCV Level	Number of Times Measured
At least twice the AMCV	234
At least three times the AMCV	77
At least five times the AMCV	22
At least ten times the AMCV	10

While other anthropogenic benzene sources, especially in major metropolitan areas, can contribute to heightened benzene levels which may even exceed the levels found in the Permian Basin, the chronic observation of benzene levels exceeding the AMCV highlights the need for more monitoring, investigation and enforcement by the TCEQ.



At left with the naked eye, vs right with the OGI camera.

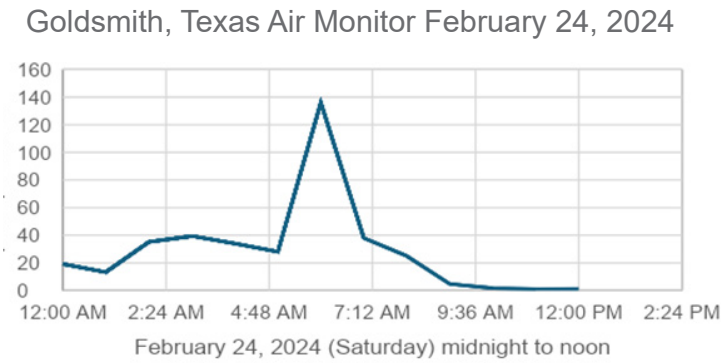
Using optical gas imaging technology, Oilfield Witness can make the invisible visible.

THE IMPORTANCE OF AIR MONITORING

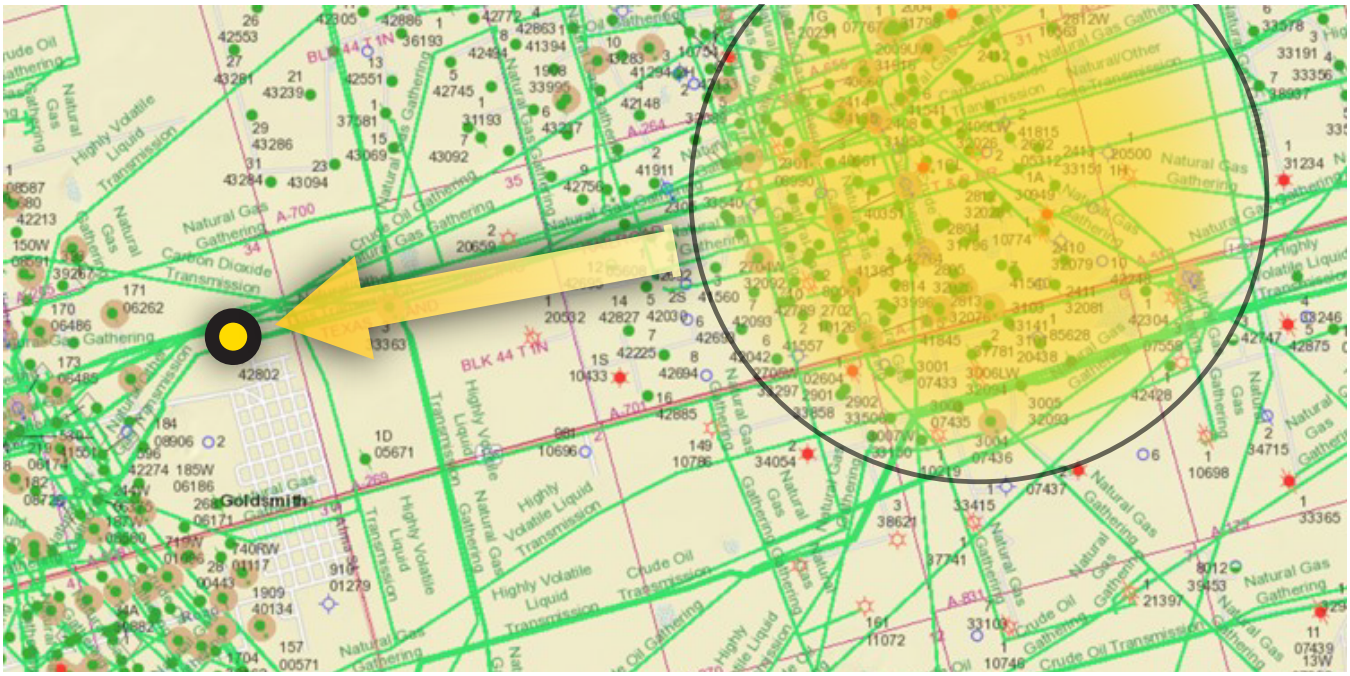
Goldsmith February 24, 2024 Case Study

Knowing the concentrations of pollutants is just one part of assessing air pollution impacts to neighboring communities. It is important to know the wind direction and wind speed that correlates to pollutant concentrations of concern to understand where the pollution is coming from and where it is blowing to. TCEQ air monitoring stations collect meteorological data, such as wind speed and resultant wind direction that can also be downloaded for a specific time frame.[49] For instance, at the Goldsmith air monitor in the Texas Permian, this large spike in H_2S concentrations can be correlated with wind speed and direction to identify likely sources of the air emissions by looking 'upwind' of the monitoring station at the time of the emissions event.

To look upwind, we can access the Railroad Commission of Texas' (RRC) Geographic Information System (GIS) Map Viewer to identify potential pollution sources. In this instance at Goldsmith, the average resultant wind direction between 05:00 - 06:00 (during the spike in H_2S gas concentration) was 85-degrees, and thus potential emission sources within that wind vector would be the source(s) for the emissions.



H_2S gas data summary plot from Goldsmith, Texas air monitor



The dot on the left is the air monitor, the arrow indicates the wind direction, and the large circle is the predicted source of the pollution. Map source is RRC GIS Map Viewer Snapshot of O&G Infrastructure East of Goldsmith CAMS, with graphics overlaid.

Moreover, when parsing and analyzing the data, by adding recent Google Earth satellite imaging, it was possible to visualize potential oil and gas emission sources near TCEQ Goldsmith Street CAMS 1093, as shown below.

The Goldsmith case demonstrates the importance of CAMS data. By integrating air pollution measurements with meteorological data, it allows proactive regulators to go beyond measuring elevated pollutant concentrations. By using a complete data set, the TCEQ is capable of identifying potential emission sources so they can be actively addressed. This also makes the insufficient number of Permian Basin CAMS even more concerning. The TCEQ is leaving an opportunity to curtail air pollution on the table.

Google Earth Version 10.52.0.0 showing the DCP Midstream James Lake processing facility that lies northeast of Goldsmith CAMS 1093.

RECOMMENDATIONS

#1 Expand CAMS Network

The data evaluated here demonstrates the value of the CAMS system to control pollution in Texas. Continuous air monitoring stations in Texas allow the TCEQ to both track and archive the ambient air quality in areas so that long-term trends can be analyzed. It also allows the TCEQ to identify potential sources of pollution so that it can focus its efforts on the biggest polluters that contribute to the elevated levels. Despite these benefits, the Permian Basin has only six TCEQ air monitoring stations for thirteen counties. This is not enough. There are ten counties with no air monitors at all. This problem is not unique to the Permian Basin. State-wide, areas not on the Barnett Shale are frequently under-monitored if monitored at all. In the Eagle Ford Shale, which spans twenty six counties, there are only two air monitors. Even worse, these issues have been brought to the attention of the TCEQ but air monitoring issues are still not being addressed. Two major environmental organizations have submitted comments to the TCEQ requesting more robust monitoring in the Permian which the TCEQ rejected.[50] Each year the TCEQ submits an air monitoring plan for approval by the EPA and while the EPA has approved the plan, for the last two years they have recommended that the TCEQ deploy more monitors in the Permian Basin. The TCEQ has apparently ignored this recommendation.[51] There are several reasons why the EPA's recommendations have not been followed, but the largest is likely funding. As noted previously, SB 527 was able to fund sixteen new CAMS sites with just ten million dollars in 2011. For 2024, the TCEQ requested a budget appropriation of 43 million dollars.[52] With the extremely modest goal of placing one monitor in each of the ten Permian Basin counties currently without air monitors, funding would be achievable. There is already some legislative interest in air quality in the Permian in light of journalists' investigations into ongoing problems with regulator responses to H_2S pollution.[53,54] In addition to regulatory reforms, the legislature should also allocate more funding to TCEQ to allow it to expand the CAMS network without reallocating funding from other important environmental protection projects. The CAMS network needs to be expanded so that the TCEQ can accurately gauge air quality across the entire state.

This problem is not unique to the Permian Basin. State-wide, areas not on the Barnett Shale are frequently under-monitored if monitored at all. In the Eagle Ford Shale, which spans twenty six counties, there are only two air monitors.

These issues have been brought to the attention of the TCEQ.

#2 Expand Barnett Shale Permitting Regulations to all of Texas

It is clear from that the Permian Basin is experiencing significant air pollution issues which are not generating adequate responses from regulators. Ambient air in the Permian Basin region is regularly saturated with pollutants at levels that not even the minimal Texas rules and guidelines consider safe. At the root of this problem is the continued permitting of new oil and gas sites. To fully address the specter of climate change and environmental degradation that hangs over our energy sector, we need to stop the permitting of new facilities. Unfortunately, this seems unlikely within the current Texas regulatory landscape. However, there is precedence for tightening permitting regulations on Texas oil and gas activities. As noted previously, the TCEQ

created much more strict permitting regulations for the Barnett Shale in 2011. Despite plans to expand these regulations to the rest of the state, the Texas Legislature passed SB 1134 which dramatically limited the TCEQ's ability to amend permitting rules. Therefore expanding Barnett Shale permitting regulations to the rest of the state would either require working within the extremely limiting requirements of SB 1134 or a legislative action to repeal SB 1134. Either of which is an acceptable but insufficient solution in lieu of a total freeze on permitting.

#3 Strengthen Regulatory Enforcement

While stationary air monitoring data is limited in the Permian Basin, it is also clear that air quality in the Permian Basin is poor. The TCEQ consistently fails to utilize the full extent of its enforcement and oversight capabilities to regain control of this problem. To supplement stationary air monitoring data, the TCEQ has staff and equipment to conduct mobile monitoring using equipment that can be moved to different locations to track emissions. When deployed to the Permian Basin the team has found extremely high hydrogen sulfide levels. In 2020, at locations across Midland and Odessa they found levels two to five times the regulatory limit.[55] During their next survey in 2022, they again observed hydrogen sulfide levels as much as five times the regulatory limit.[56] These observations did not result in any change in TCEQ policy or enforcement. For no obvious reason, the TCEQ has not deployed the Mobile Monitoring Team for an hydrogen sulfide evaluation to the Permian Basin in nearly two years.[57] That is totally unacceptable, and can be rectified through independent agency action.

TCEQ must conduct more monitoring, more on-site investigations, and issue more fines if it is to have any hope of fulfilling its obligations to the people of Texas.

In 2023, nearly 40% of "investigations" the TCEQ never visited the facility in question.

Further, benzene concentrations consistently exceeding the AMCV indicate that benzene in the region is poorly controlled. Regardless of the source(s) of those emissions, the TCEQ does not appear to have investigated this problem. Whatever solution it may arrive at to help lower those benzene levels, the total disregard for them is untenable.

For the TCEQ to resolve ambient air quality issues it must reduce emissions from polluting facilities (in the Permian Basin, primarily oil and gas wells and support equipment). To do so, it must conduct site investigations. However, the TCEQ investigation record is lackluster. Last year, in nearly 40% of "investigations" the TCEQ never visited the facility they were investigating.[58] Among facilities where a violation was observed, the TCEQ issued a fine less than 10% of the time.[59] The TCEQ is failing on both monitoring and enforcement actions. This issue is partially a failure of management within the TCEQ, but it is also the result of the limited budget that the Texas legislature allocates to the agency. Funding limitations are so severe that the 2023 TCEQ enforcement report states that penalties assessed by the TCEQ have been limited by high staff turnover and vacant positions rather than by the number of facilities that had violations that would merit a fine.[60] The TCEQ must conduct more monitoring, more on-site investigations, and issue more fines if it is to have any hope of fulfilling its obligations to the people of Texas.

#4 Transition to Clean Energy with Economic Prosperity

We need a wide-scale federal jobs program to manage the decline of fossil fuel extraction, to remediate land harmed by oil and gas industrial waste, and to install extensive clean renewable energy production throughout the country. We know that the only real solution to address oil industry pollution and the climate crisis is a rapid transition to clean energy solutions to drive the phase-out of fossil fuels.

CONCLUSION

Oil and gas extraction harms the health of Texans. The Permian Basin is experiencing an overwhelming level of drilling — and therefore pollution. The health of residents who live in these oilfields must not be sacrificed for the sake of the private profits of corporations. The Texas regulatory system can be fundamentally overhauled to adapt to this unprecedented level of pollution exposure. This report identified concerning levels of hydrogen sulfide, sulfur dioxide, and benzene pollution in the Permian Basin. We expect that increased monitoring will uncover even more alarming levels of pollution. Our first three recommendations provide the TCEQ with a practical, tangible roadmap to begin addressing the Permian Basin's pollution-health crisis. Our fourth recommendation considers the long-term solution to the issue — a transition to clean energy which ensures economic prosperity for the majority of Texans. This requires bold vision and courageous leadership from our government agencies.

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We are facing a methane emergency.

There are plenty of loopholes in the regulations requiring oil and gas producers to eliminate methane emissions. But there are no such loopholes in the laws of physics. That's why the only solution to stop methane emissions from oil and gas production and transportation is to rapidly transition to clean energy and phase out the oil and gas industry completely. The laws of physics, nature, health and economics are demanding action now.