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Ambient Air Quality in the Texas Panhandle

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Wide-open spaces, incomparable sunsets, bright sunshine, and fresh air—favorite things for those of us who live in the Texas Panhandle, yet we take them for granted as if they will always be ours to enjoy. As the region continues to grow, build, employ, and manufacture, we need to safeguard these resources, especially our fresh air.

The visible stuff in the air we know. The Panhandle is dry and dusty, and we know it's springtime when we can see the air. We curse La Niña or the latest drought forecast and stay inside until it blows over (Fig. 1).

Figure 1. Dust storm near Canyon, Texas. *Photo courtesy of Dr. Kevin Appel.*

The pollen we know, too. Allergy specialists do a thriving business in Texas, not least in the Panhandle. That yellow stuff on our cars in the parking lot? Pollen.

But what about the invisible stuff? Can it hurt us? What are we breathing, after all?

That's where Texas A&M AgriLife and our state and federal partners come in, monitoring and reporting on the ambient air quality in the Panhandle.

A Few Distinctions

There's air quality in the workplace and also air quality in our outdoor surroundings that affects everyone.

In the workplace, *occupational* air quality is the quality of the air we breathe 8 to 10 hours a day. In a sense, we voluntarily expose ourselves to it. If what we're breathing on the job affects us badly enough, we change jobs if we are able.

But then there's the air that we don't have a choice but to breathe simply because of where we live, walk, and play. It's the air that is made up of the combined effect of everything that goes on here: agriculture, industry, transportation, and recreation.

We also receive a fair amount of air from other places. But we're all exposed to it, so we call it *ambient* air quality—part of the *ambience* of the Texas Panhandle. This kind of air quality is voluntary only in the sense that we'd have to pick up and move our entire households to avoid it.

Ambient air quality pertains to everyone, not only the hale and healthy folks with jobs or schoolwork, but especially the young, elderly, and those who are ill, because poor air quality may affect them even more.

As a result, our research institutions, health-care communities, and government agencies work together to figure out what's in the air, how much is in the air, and how much exposure it takes to affect the health and well-being of the most vulnerable among us. That is, we need to *identify* the air pollutants, *monitor* their levels in the ambient air, and *compare* those levels to ambient air quality standards.

Identifying Ambient Air Pollutants

Of the many air pollutants that pose a health threat to people, the US Environmental Protection Agency (EPA) designates six as "criteria pollutants":

Ozone (O_3)

In the stratosphere, ozone absorbs ultraviolet radiation from the sun that would otherwise be harmful to us. But ground-level ozone, the ozone we breathe, can impair our health, both directly (damaging our pulmonary systems) and indirectly (reacting with other chemicals to form other hazardous compounds).

Sulfur dioxide (SO_2)

Burning sulfur-containing materials (for example, fossil fuels such as coal, diesel, gasoline, and natural gas) produces sulfur dioxide gas. Cars, trucks, power plants, and furnaces of all kinds are significant sources of SO_2, and when it dissolves in water, sulfur dioxide forms sulfuric acid, a powerful acid that can also react with other atmospheric compounds to form fine particles (see below).

Nitrogen oxides (NO_X)

Nitrogen forms many different oxides in the environment, and those oxides are a primary pollutant in automotive exhaust. Like sulfur dioxide, when dissolved in water, nitrogen oxide compounds can form nitric acid, a highly corrosive acid. Nitrogen oxide can also react with other atmospheric compounds to form fine particles.

Carbon monoxide (CO)

When fuels don't burn completely, carbon monoxide is a dangerous result. Carbon monoxide poisoning kills by suffocation; it prevents receptors in the body from carrying oxygen from the lungs to the body's tissues. Using a backpacking stove in a tent or starting a car in a closed garage is a common way of creating a serious CO hazard, but even lower levels can pose a threat to people with asthma, heart disease, or other chronic conditions.

Lead (Pb)

Lead is a poisonous metal used to make many useful items such as batteries, bullets, fishing weights, and solder. Until 1978, it was an essential ingredient in paints. It also occurs in the environment, especially in fuels, and when those fuels burn, lead becomes part of the exhaust particles.

Particulate matter (PM_{10} and $PM_{2.5}$)

Particulate matter (PM) refers to solid or liquid particles suspended in the air. The subscripts 10 and 2.5 indicate the size of the particles in micrometers. PM_{10} refers to solid or liquid particles having diameters less than or equal to 10 micrometers. $PM_{2.5}$ consists of particles of diameters up to 2.5 micrometers. The smaller the particle, the more deeply it can penetrate into the human lung before tissues trap it. These trapped particles may coat cell surfaces, induce inflammatory responses, cause physical scarring, react chemically to damage tissues, or otherwise disrupt gas-transfer processes vital to respiratory health.

Although much of the particulate matter in the atmosphere in the Panhandle results from combustion or grinding processes, some of the finer particles form in the atmosphere when acidic gases (SO_2 and NO_X) react with alkaline gases such as ammonia (NH_3). Particles thus formed are called "secondary particulate matter."

Total suspended particulate (TSP) refers to all of the particulate matter suspended in the air without regard to the particles' size.

Air Quality Standards

The first federal Air Pollution Control Act was signed into law during the Eisenhower administra-

tion (1952–1960), and over the next few decades, the scope and scale of the act steadily increased through congressional amendments and intensified regulation. Now known as the Clean Air Act, the law gives the EPA the authority to regulate a wide variety of air pollutants through permitting and enforcement programs.

In the case of the six criteria pollutants, the EPA has established National Ambient Air Quality Standards, or NAAQS. These standards identify airborne concentrations of each pollutant that, if exceeded often enough, pose a health threat to humans exposed to that air. Different pollutants threaten human health at different concentrations and exposure times, so each of the six criteria pollutants has a unique set of "acute" (short-term, sometimes reversible or curable health effects) and "chronic" (longer-term, often incurable health effects) standards.

States may also regulate air quality, but for federally regulated pollutants, state rules must be at least as stringent as the federal ones. States may also choose to regulate air contaminants that the EPA does not regulate.

Monitoring Air Quality

How do we know if the ambient air quality in the Panhandle meets federal standards? That's the role of ambient air quality monitoring, an expensive enterprise involving many monitoring sites, instruments designed uniquely for each pollutant, high-tech laboratories, and labor. Federal dollars supplied to the states by the EPA pay for most monitoring sites. Individual state or local governments also fund some sites.

In Texas, the Texas Commission on Environmental Quality (TCEQ) administers the air-quality monitoring program. The TCEQ operates and maintains some of the monitoring sites, but in many cases, the TCEQ contracts with other organizations to do the work.

Since these sites are expensive to establish and operate, state and federal governments tend to locate them in the more densely populated areas where the monitoring data represent the greatest number of people. At present, Amarillo is the TCEQ's primary focus for air monitoring in the Texas Panhandle, but the agency plans to install new monitoring sites near Borger during the late fall of 2016.

In the Amarillo metro area, the TCEQ contracts with Texas A&M AgriLife Research to operate three

Figure 2. Ambient air quality monitoring sites operated by Texas A&M AgriLife Research in Amarillo. These sites were selected to reflect Amarillo's southerly prevailing winds and the hubs of human and industrial activity.

monitoring sites (Fig. 2) to measure particle-bound lead (TSP-Pb), sulfur dioxide (SO_2), and fine particulate matter ($PM_{2.5}$).

- SH 136 – This site, on State Highway 136, measures the airborne lead present in particulate matter. A fiberglass filter captures airborne particles for 24 hours every 6 days. Then the exposed filter is sent to a laboratory for chemical analysis.
- CAMS 1025 – Located on City of Amarillo property near the US Army Reserve Center, this site uses a pulsed fluorescence analyzer to monitor sulfur dioxide.
- CAMS 320 – This site, at the Harrington Regional Medical Center, continuously measures fine particulate matter using a tapered element oscillating microbalance.

These sites use highly standardized procedures designed for accuracy, repeatability, and reliability. Imagine what would happen if the State of Texas were subjected to millions of dollars in penalties for violating air quality standards, only to find out that the monitoring data used to justify those penalties came from a defective instrument, careless operators, or sabotage.

The TCEQ enforces strict security, quality-assurance, and quality-control measures that its employees and contractors must use. These measures and procedures, known as a Quality Assurance Project Plan or QAPP, are compiled in an EPA-approved document that is continually reviewed and updated as new or better techniques emerge. Only monitoring data collected in full compliance with QAPP provisions are used to enforce air quality standards.

How Clean is Amarillo's Air?

Like all cities, Amarillo certainly has its bad-air days. But in terms of the federally regulated criteria pollutants measured around town, Amarillo's air quality is excellent (Fig. 3).

First, let's consider lead, a poisonous metal found in particulate matter. The NAAQS for particle-bound lead is 150 nanograms per cubic meter of air (Fig. 5). That standard is equivalent to suspending 1 pound of pure lead dust in the entire interior volume of the Dallas Cowboys' stadium in Arlington, Texas (104 million cubic feet). But as Figure 4 shows, the concentration of lead in Amarillo's air, at least since December 2013, has been less than 14 nanograms per cubic meter, or less than 10 percent of the NAAQS. That's less than a teaspoon of lead dust distributed evenly inside the Cowboys' stadium. Most of the time, Amarillo's air has about 2 nanograms per cubic meter of particle-bound lead. It's not zero, but it's close.

What about sulfur dioxide? Figure 6 shows the daily average concentrations of sulfur dioxide in Amarillo since November 2013. These units are parts per billion by volume (ppbv), and 1 ppbv is roughly equivalent to dissolving 1/2 teaspoon of sugar in an Olympic-size swimming pool (660,000 gallons).

Amarillo's air averages less than 5 ppbv of sulfur dioxide on any particular day (Fig. 5), and over the 2 years represented in Figure 6, the highest hourly concentration reported was about 30 ppbv. That is less than half of the NAAQS for sulfur dioxide, which is 75 ppbv averaged over 1 hour. Amarillo's air quality easily beats the federal standard here, too.

Now look at fine particulate matter (Fig. 7). The NAAQS for fine particulate matter is 35 micrograms of particles per cubic meter (red line) on a 24-hour average, or about what you'd have if you suspended 1/3 cup of flour in an Olympic-size pool.

Amarillo can be a dusty place, usually during the summer, as the cyclical form of Figure 7 shows. According to these data, only once in the last 10 years has the 24-hour average fine particulate concentration exceeded the federal standard, and that occurred during the spring of 2014 when the Texas Panhandle experienced several haboobs (an intense dust storm with a high wall of dust on the leading edge of the storm), otherwise known in regulation-speak as, "acts of God."

Figure 3. Unlike many metropolitan areas, Amarillo enjoys clear air year round. *Photo courtesy of the Amarillo Convention and Visitor Council.*

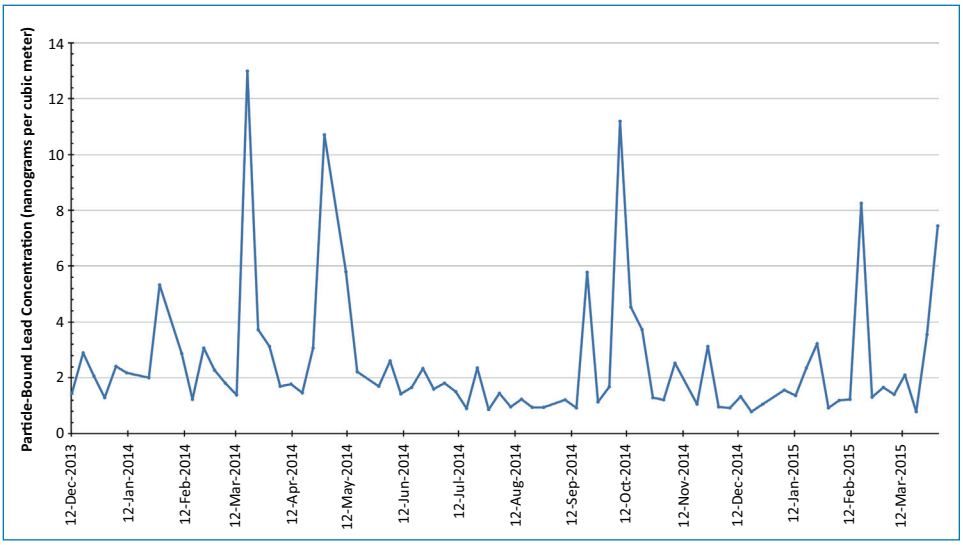

Figure 4. Daily particle-bound lead concentrations in Amarillo. The federal air quality standard for particle-bound lead is 150 nanograms per cubic meter.

Amarillo Air at a Glance		
Criteria Pollutant	**Federal Standard**	**Amarillo's Air**
Particle-bound lead (TSP-Pb)	150 nanograms per cubic meter (daily average)	1–13 nanograms per cubic meter
Sulfur dioxide (SO_2)	75 parts per billion by volume (1-hour average)	0–5 parts per billion by volume
Fine particles ($PM_{2.5}$)	35 micrograms per cubic meter (daily average)	0–30 micrograms per cubic meter
Coarse particles (PM_{10})	—	Not monitored
Nitrogen oxides (NO_x)	—	Not monitored
Carbon monoxide (CO)	—	Not monitored
Ozone (O_3)	—	Not monitored

Figure 5. Monitoring data show that levels of particle-bound lead, sulfur dioxide, and fine particles in the air in the Amarillo area are well below federal standards.

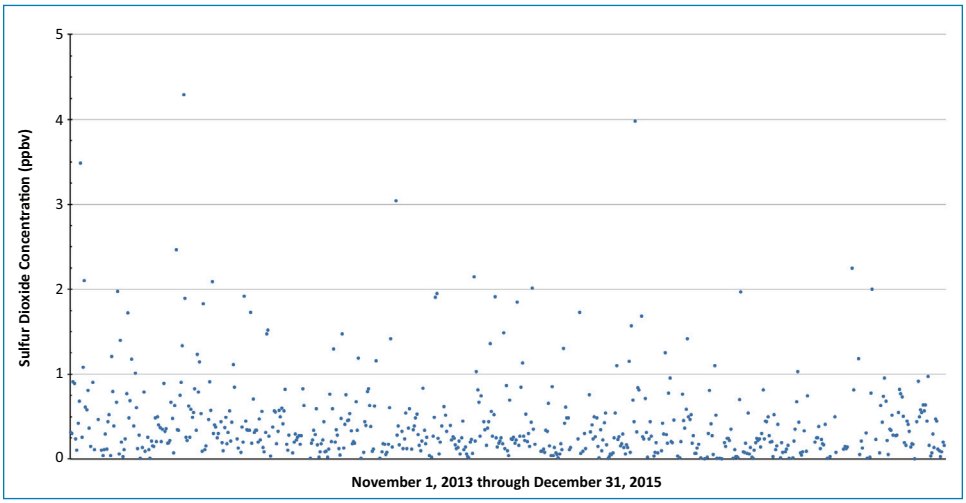

Figure 6. Daily average sulfur dioxide concentrations in Amarillo since November 1, 2013.

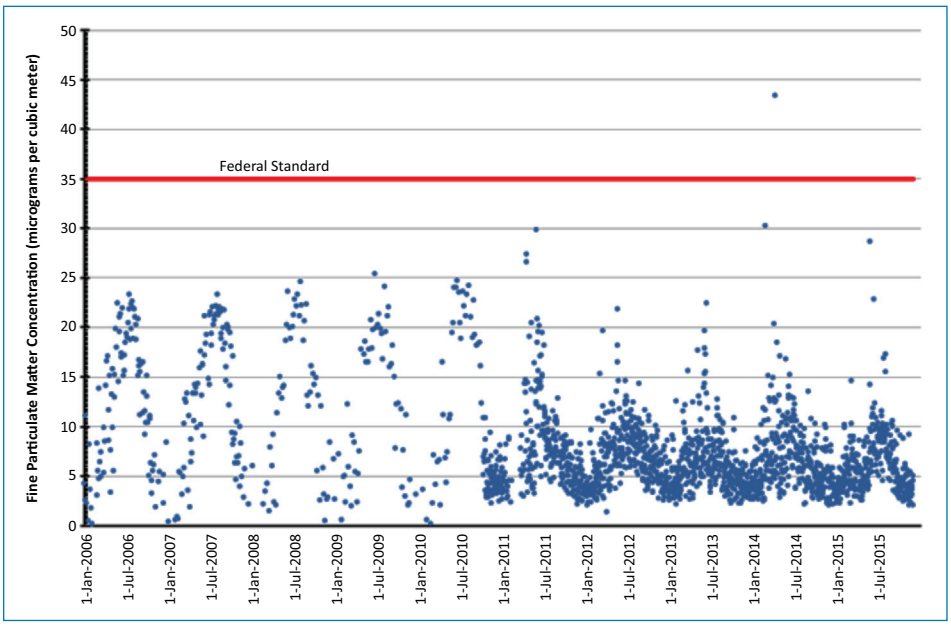

Figure 7. Daily average fine particulate concentrations in Amarillo, TX, since 1/1/2006. The increased density of data points after 2010 reflects the reporting interval changing from every 6 days to every day.

Other Questions

Surely the six criteria pollutants aren't the only pollutants the EPA cares about?

There are hundreds of chemicals that can become airborne and pose a threat to human health. Depending on the EPA's legal authority in the case of hazardous air pollutants and hazardous substances, some categories of chemical pollutants are regulated at their individual sources using emission permits, on-site monitoring, reporting, and fees, rather than on the basis of community (ambient) monitoring.

For example, using its authority under the Emergency Planning and Community Right-to-Know Act (EPCRA), the EPA requires facilities that release more than a threshold quantity of a hazardous substance to report that release, with steep civil penalties (up to $25,000 per day) and even criminal penalties for failure to report.

What about odor? Isn't that air pollution?

The US Congress has not granted the EPA any statutory authority to regulate odor *per se,* so states and smaller administrative divisions are free to regulate odor

however they see fit. Most states, including Texas, regulate odors on the basis of complaints under generalized nuisance laws that do not necessarily specify odor at all. "Nuisance" is a legal theory that refers to conditions created by one person who unreasonably interferes with another person's use and enjoyment of his own property.

It is true that many of the chemicals regulated under EPCRA or other federal statutes are themselves odorants, ammonia and hydrogen sulfide being just two examples. But the applicable regulations have to do with those chemicals as chemicals, not in terms of the complicated human perception of odor.

Summary

- Ambient air quality in the Texas Panhandle affects everyone, especially the young, elderly, and those who are ill.
- Texas A&M AgriLife Research, along with state and federal partners, monitors selected air pollutants in the Amarillo metro area.
- Amarillo hosts three sites where TCEQ monitors air quality to ensure compliance with state and federal air quality regulations. Monitoring data show that Amarillo's air quality is excellent concerning particle-bound lead and sulfur dioxide, and concentrations of fine particles are typically well below federal, health-based standards.
- The TCEQ enforces strict, EPA-approved quality measures and procedures in collecting and reporting accurate monitoring data.
- Besides ambient air quality, the EPA also regulates many chemicals that can become air pollutants by checking them at their source through emission permits, monitoring, reporting, and fees.
- States and smaller administrative divisions regulate odor, often based on complaints and nuisance laws.

Cover photo: View of North Ceta Canyon in Palo Duro Canyon State Park from an air quality monitoring site. *Photo courtesy of Brent Auvermann.*

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