

2009 Air Quality Ozone Season Summary for the Coeur d'Alene Area



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List of Acronyms and Abbreviations

AQI	air quality index
DEQ	Idaho Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
NAAQS	National Ambient Air Quality Standards
NO	nitric oxide
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
O ₃	ozone
ppb	parts per billion
ppm	parts per million
VOC	volatile organic compound
w/m ²	watts per square meter

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Introduction

The national Clean Air Act, last amended in 1990, requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for air pollutants considered harmful to public health and the environment. The standards are designed to primarily protect the general public, including sensitive populations such as asthmatics, children, and the elderly. They are also intended to safeguard public welfare by reducing effects such as decreased visibility and damage to animals, crops and other vegetation, and buildings. EPA has established standards for six main pollutants, known as criteria pollutants: carbon monoxide, lead, nitrogen dioxide, particulate matter, fine particulate matter, sulfur dioxide, and *ozone*¹.

The objective of this report is to summarize the results of ozone monitoring in the greater Coeur d'Alene, Idaho area for the 2009 ozone season. For the purpose of this report, the Coeur d'Alene area is defined as an estimated Coeur d'Alene *airshed*. This airshed is essentially the Rathdrum Prairie, including Coeur d'Alene, Hayden, Rathdrum, and Post Falls. This summary will present monitoring data collected during the ozone season of 2009 at the Lancaster Road multi-pollutant monitoring site (Lancaster site), and compare the monitoring results to current and proposed NAAQS.

In Idaho, monitoring for the criteria pollutants occurs primarily in areas of high population where the potential for human exposure is greatest. As a first step to characterize ozone concentrations in the greater Coeur d'Alene area and Kootenai County, the Idaho Department of Environmental Quality (DEQ) installed an ozone monitor and a weather tower at the Lancaster site, north of Hayden, during the summer of 2005.

Ozone monitoring in Kootenai County takes place for two reasons. The first is to quantify the impacts of *ozone precursors* from Spokane on Kootenai County. The travel time from the numerous precursor sources in Spokane to the Coeur d'Alene area during average wind conditions is roughly the same as the length of time it takes for the ozone forming reaction to occur. This suggests that precursors released in Spokane may cause increased ozone in areas of Kootenai County. The second reason for monitoring ozone in the Coeur d'Alene area is that EPA's AIRNOW maps previously included Kootenai County with Spokane County on the national ozone maps; this was because Kootenai County was not monitoring ozone. This inclusion led to Kootenai County being listed incorrectly in the "moderate" category for ozone on a number of days during each ozone season.

The choice of the Lancaster site for monitoring was made through the understanding of basic ozone development processes and the assumption that a majority of the sources of ozone-forming pollutants were located west, and therefore upwind, of Kootenai County. The ozone formation reaction requires ozone-forming pollutants to be subjected to at

¹ See the glossary at the end of this document for definitions of italicized terms.

least 3 hours of heat and intense sunlight to reach its peak. The average wind speeds and predominance of southwesterly winds at the Lancaster site during the ozone season indicated this site would likely measure the maximum ozone concentrations in Kootenai County. As when identifying any monitoring site, security, accessibility, and potential interference from nearby activity were also considered. DEQ relied on EPA's Guidelines on Ozone Monitoring Site Selection, EPA-454/R-98-002, to help select the monitoring site at Lancaster. The Lancaster site is currently the only monitoring site for ozone located within Kootenai County.

Real-time ozone monitoring data in the state of Idaho are available May through September on the Internet at <http://www.tcsn.net/family/Idaho/index.html>. Please visit the DEQ Web site at <http://www.deq.idaho.gov/> to find more extensive air quality data, educational materials, and discussions of current topics.

Why is Ozone an Issue?

In the upper atmosphere, ozone is considered beneficial because it helps to protect the Earth from the sun's rays. In contrast, ozone formed at ground level is unhealthy. Elevated concentrations of ground-level ozone can cause reduced lung function and respiratory irritation and can aggravate asthma. The damage ozone causes to the lungs usually heals within a few days, but repeated or prolonged exposure may cause permanent damage. People with respiratory conditions should limit outdoor exertion if ozone levels are high. Even healthy individuals may experience respiratory symptoms on a high-ozone day. Ground-level ozone can also damage agricultural crops and forests by interfering with their ability to produce food and grow.

Ozone is generally not directly emitted by pollutant sources, but can be in certain circumstances. It forms when *photochemical pollutants* emitted from gas stations, cars, any combustion source, industrial sources, and biogenic sources react with sunlight. These photochemical pollutants are called ozone precursors and include *volatile organic chemicals* (VOCs) and the various *oxides of nitrogen* (NO_x).

Monitoring stations measuring ozone are located in both urban and rural areas (see Figure 1), although many of the precursor compounds that react with sunlight to produce ozone are generated primarily in large metropolitan areas. Because summers in northern Idaho are normally hot and dry, the Coeur d'Alene area tends to see daily ozone levels that begin to rise in the late morning and then peak in the late afternoon and early evening. This phenomenon aligns very closely with the time of day that the temperatures are the hottest and the sun is the highest in the sky.

The federal standard for ozone, known as the National Ambient Air Quality Standard (NAAQS), is based upon a 3-year average of the annual 4th-highest daily maximum 8-hour average. Although this report focuses on the 2009 season, a comparison between the NAAQS and the entire applicable data set will be presented. The 2009 data used for this report are considered preliminary and have not been completely certified for quality assurance by DEQ. Certification of the data will occur by June 30, 2010.

For additional information on ozone, visit <http://www.epa.gov/air/ozonepollution>. The final section of this report, [More About Ozone](#), also contains additional information on ozone in question/answer format.



Figure 1. Map of Coeur d'Alene and surrounding areas, and ozone monitoring locations

Ozone Season Basics

Ozone monitoring in the Coeur d'Alene area occurs each summer ozone season from May 1 to September 30. This time period is the accepted ozone season for the northern latitudes of the lower 48 states and is determined to be the part of each year when ozone levels have the potential to exceed the NAAQS. Ozone formation is enhanced by the presence of temperatures near or greater than 30 degrees Celsius (86 degrees Fahrenheit) and intense sunlight.

While Idaho generally enjoys good air quality, our airsheds are faced with new challenges each year. Over the last decade, criteria air pollutant levels in Idaho have generally decreased to levels well below the federal standards, due to better control of air pollution; however, ozone levels in the Coeur d'Alene area, while not violating current federal standards, are not far below them.

The ozone season of 2009 was distinguished by a nearly average first half of summer with temperatures being below average in August. These cooler temperatures are not optimal for ozone formation; therefore, ozone levels were relatively low again in 2009. Ozone concentrations did not reach the MODERATE range on the Air Quality Index (AQI) scale during 2009. The highest 8-hour reading of the year was 0.058 parts per million (ppm) on May 25, 2009.

Considerations when interpreting data from a sampling site include temperature, solar radiation, and wind direction, which are discussed in the body of this report. Obvious correlations with temperature and solar radiation were seen in the data this season, as was a less obvious relationship with wind direction. The wind data suggest that the transport of ozone or its precursors to the Lancaster site was a factor in the highest readings at the site. Study beyond the scope of this document is needed to determine if a definitive link to wind direction exists.

NO_x is also an important component of ozone formation and can be a limiting factor for ozone development. For this reason, DEQ monitors NO_x at the Lancaster site during ozone season. In this report NO_x results will not be compared to the NAAQS for nitrogen dioxide (NO₂) but will illustrate the relationship between ozone formation and NO_x concentrations. This relationship is critical in evaluating the airshed and forecasting daily ozone buildup.

2009 Ozone Season Summary

Coeur d'Alene's ozone concentrations remained below the NAAQS for 2009. A true comparison to the ozone NAAQS is made by averaging the annual 4th-highest daily maximum 8-hour average measurement over the past three years (see Figure 2). For the 2009 season, that would include the 4th highest 8-hour value for 2009, 2008, and 2007. These three-year averages are called the *design value* for that ozone season. Comparisons to the ozone NAAQS will not be official until the 2009 ozone data for the Coeur d'Alene area are accepted by EPA in June 2010. The 2009 ozone data used for this report are considered preliminary until certified by DEQ on June 30, 2010. The figures on pages 6 and 7 are used only to illustrate how 2009 ozone levels relate to the ozone standard and do not indicate a determination of whether the NAAQS was exceeded.

Figure 2 depicts ozone values from the Lancaster site versus the ozone NAAQS. The NAAQS line is set at 0.075 ppm. Eighty-five percent of the NAAQS line, which represents a trigger level established by the Idaho Legislature in Idaho Code 39-116B and requires implementing increased control of ozone precursors, is currently at 0.064 ppm. The 4th-highest daily 8-hour average concentration is shown for each year since sampling started in 2005. The blue bars show the 3-year averages of the 4th-highest daily values. The ozone NAAQS determination requires three years of data to be evaluated and compared to NAAQS limits. Data from 2007, 2008, and 2009 produce a design value that puts Kootenai County at 81% of the current ozone NAAQS. The 2009 design value for the Lancaster site is 0.061 ppm. For the 2009 season, the 4th highest average was 0.057 ppm, which makes 2009 a lower than average year for ozone formation.

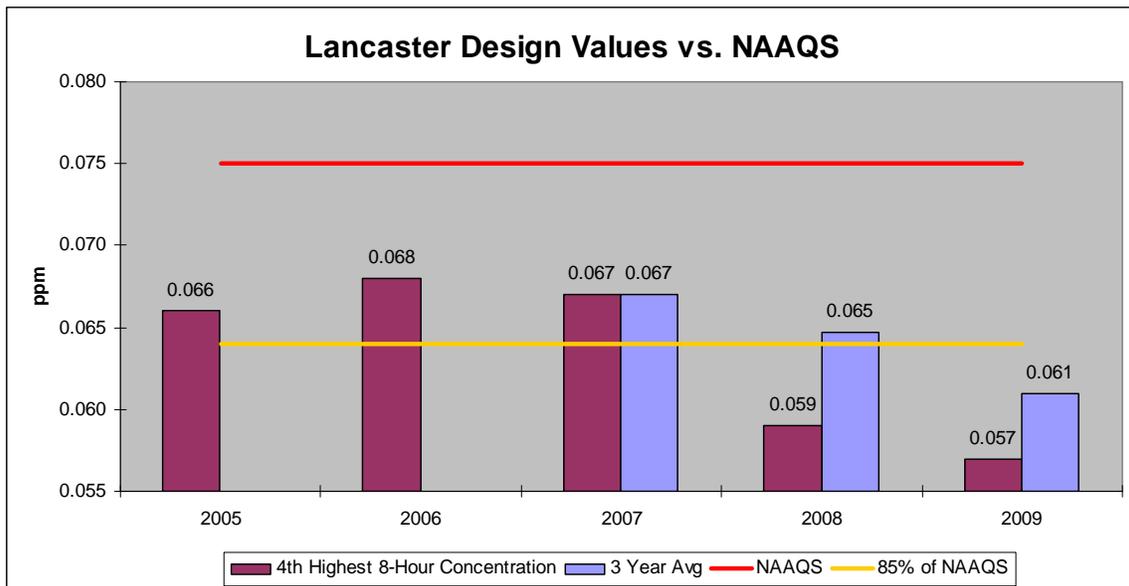


Figure 2. Lancaster site ozone monitoring design values vs. ozone standard (ppm = parts per million)

Figure 3 shows the ten days that had the highest 8-hour average concentrations and the hour each highest average occurred. The ozone NAAQS is measured in a running 8-hour average format. The 8-hour average values measured in 2009 ranged from a high of 0.058 ppm to 0.055 ppm. These values all fall well below the NAAQS of 0.075 ppm for ozone. Figure 4 shows the 10 highest 8-hour averages of ozone levels in 2009.

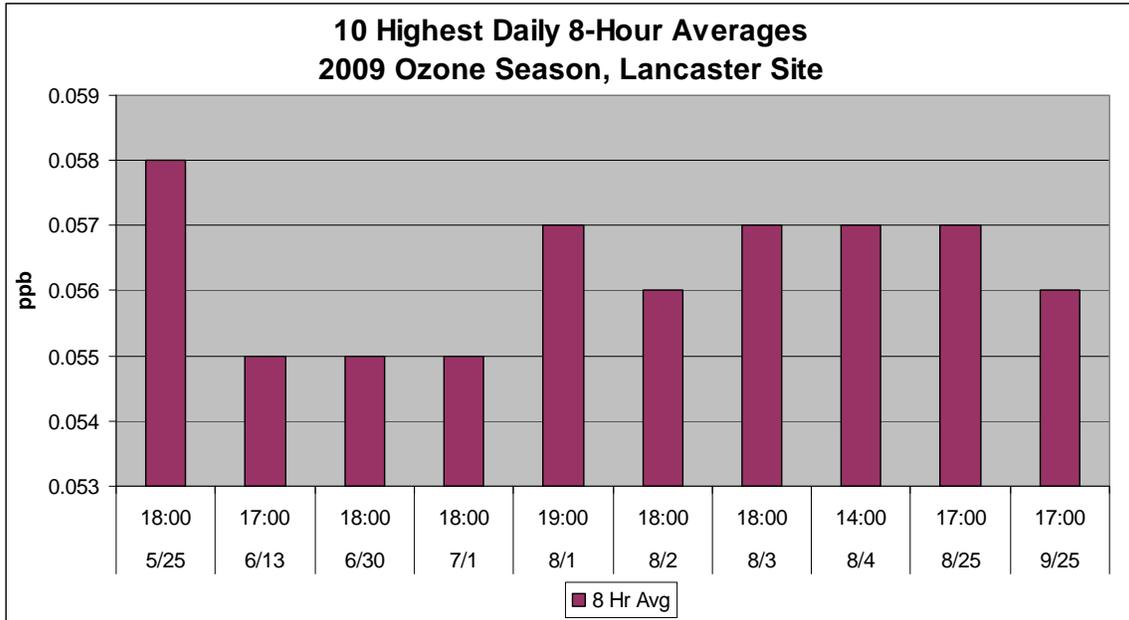


Figure 3. Ten days with the highest 8-hour ozone average concentrations in 2009 (ppb = parts per billion)

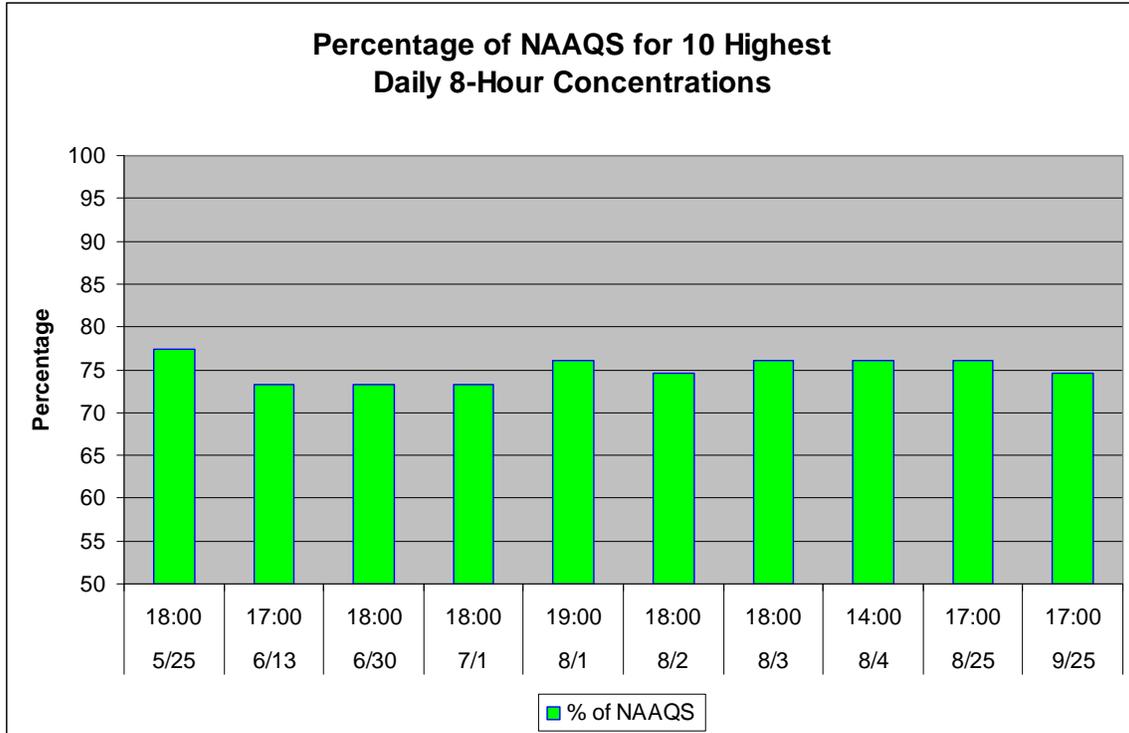


Figure 4. Ten highest 8-hour averages of ozone concentration in 2009, as a percentage of the ozone standard

Because temperature is one factor in the formation of ozone, the lower temperatures during the summer of 2009 most likely had some effect in reduced ozone formation. With no days that hit the 100 degree F level, the summer of 2009 did not have peak ozone production. Nevertheless, ozone in the area still measured at 73% – 77% of the federal standard during highest concentration days.

Figure 5 shows the average monthly temperatures at the Lancaster site during 2009 as well as the historical average for each month. The Lancaster averages were computed from data measured at the monitoring site, and the historical averages were from the National Weather Service Web site for data from the Coeur d'Alene Airport. The graph depicts how much higher the historical averages were than the 2009 averages. Overall, the average monthly temperatures during the 2009 summer months were 0.5 degrees Celsius lower than during a typical summer. It is worth noting that temperatures were markedly below average for July and August, which are typically when the highest ozone concentrations occur.

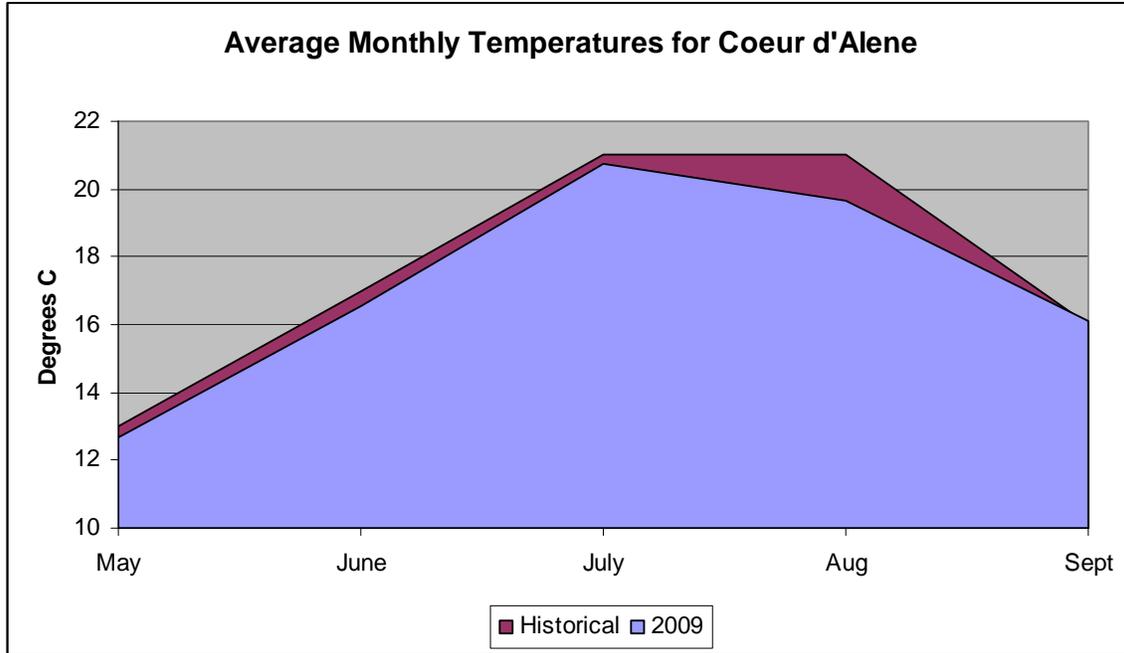


Figure 5. 2009 monthly average temperatures at the Lancaster site versus historical averages

Table 1 compares the average precipitation amounts for the May to September ozone season to the actual 2009 precipitation amounts. Rainfall data are now collected at the Lancaster site, but the historical averages are for the National Weather Service site in Spokane, Washington.

Table 1. Precipitation totals over the ozone season, historical average compared with 2009

Month	Historical Average Precipitation (inches)	2009 Average Precipitation (inches)
May	1.60	0.93
June	1.18	1.18
July	0.76	0.48
August	0.68	0.74
September	0.76	0.49
Total	4.98	3.82

Precipitation does not directly affect ozone formation, but when it occurs, it generally is accompanied by decreased temperatures and increased cloud cover. The lower temperatures inhibit ozone formation as does the decreased solar radiation due to the cloud cover. Therefore, less precipitation generally correlates with more ozone. Although

the 2009 season was marked by lower than average precipitation, this was not reflected by higher ozone levels. The lower temperatures for the season likely played a big role in keeping ozone levels down.

The relationship between temperature and ozone concentration can be seen in Figure 6. The temperature values come from the Lancaster site, where temperature is measured at 2 meters above the ground in degrees Celsius. The contours of the two lines follow the same general pattern of highs and lows, suggesting that temperature has an influence on the ozone concentration. The fact that ozone formation does not have a perfectly linear relationship with temperature is evident. The influence of factors other than temperature, such as availability of precursors, transport into the area of ozone from other areas, and cloud cover, also has strong effects on the ozone levels on any given day.

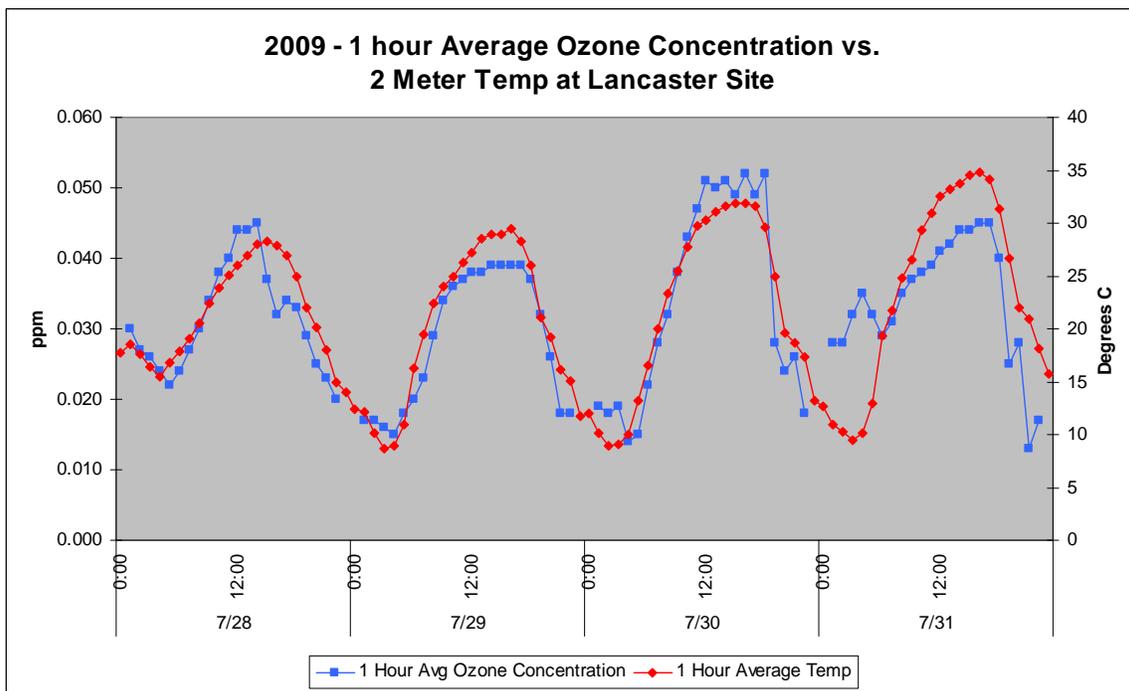


Figure 6. 2009 hourly ozone concentrations compared with temperature (ppm = parts per million)

Solar radiation is measured in watts per meter squared (w/m^2) and represents the amount of energy provided by the sun to drive the chemical reactions that form ozone. As seen previously, temperature follows closely the shape of the ozone line, while the solar radiation line tends to peak before the others. This phenomenon occurs partially because of our latitude and the resultant sun angles. The important message conveyed by Figure 7 is that there is a correlation between solar radiation, ambient temperature, and resulting ozone concentrations.

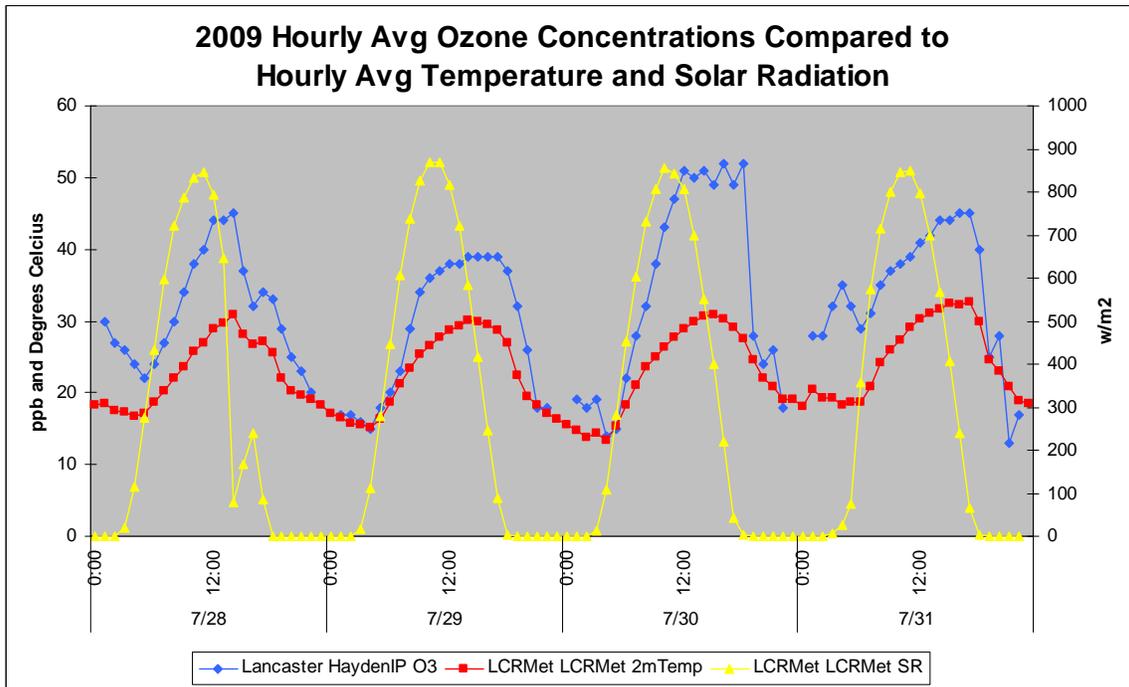


Figure 7. Hourly ozone concentration, temperature, and solar radiation compared (ppb = parts per billion, O3 = ozone, SR = solar radiation, w/m2 = watts per square meter)

Figure 8 shows that subtle changes in the amount of solar radiation have an effect on ozone levels. As seen in the lines in the chart, solar energy in 2007 was slightly higher than in 2008, and solar energy levels in 2008 were higher than in 2009. The corresponding design values for the 3 years starting in 2007 were 0.067, 0.065, and 0.061 ppm. Unfortunately, the data for 2007 are incomplete because the weather tower at the Lancaster monitoring site was not operational until mid-summer 2007. The unpredictability of late spring and early summer weather make it hard to predict what conditions were in early summer 2007.

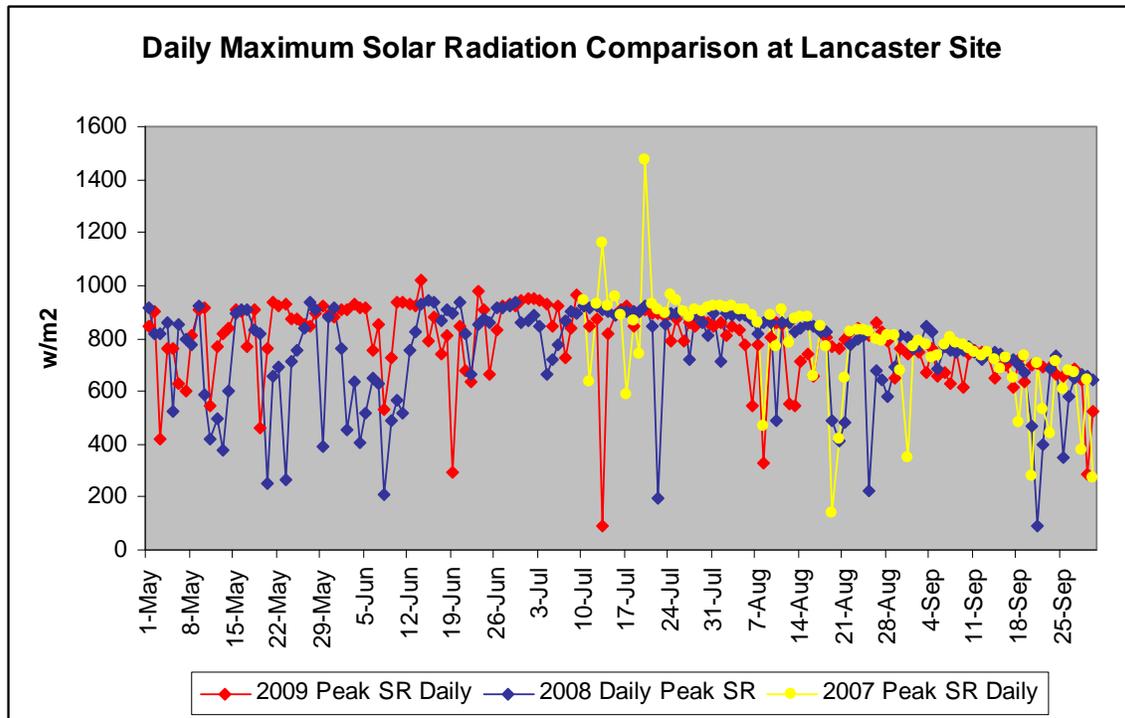


Figure 8. Comparison of daily maximum solar radiation readings during the ozone season over three years (w/m² = watts per square meter, SR = solar radiation)

The effect of temperature on ozone concentrations is less obvious than that of solar radiation, as seen in Figure 9. The temperature differences between the years appear to be more variable than the solar radiation readings. This makes it hard to say definitively that temperature is a good predictor for ozone levels at this site.

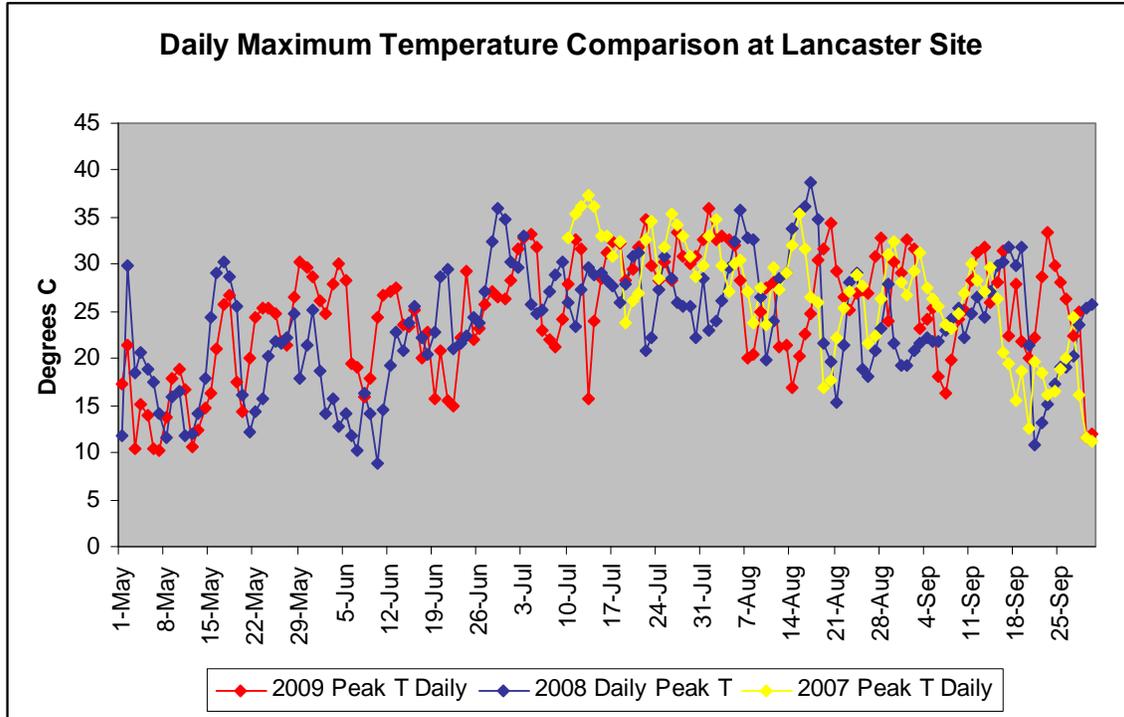


Figure 9. Comparison of daily maximum temperatures during the ozone season over three years (T = temperature)

While NO_x is another EPA criteria pollutant, it is not monitored at the Lancaster site expressly for compliance determination. It is mainly monitored to help forecast ozone levels. In Figure 10, note that when ozone is at its peak concentration for the day, NO_x concentrations are at their lowest. When ozone concentrations start to drop late in the day, NO_x concentrations rise, and NO_x reaches its peak early in the morning at the lowest point of ozone. This inverse relationship is a representation of the fact that as the day warms up and sunlight is at its strongest, NO_x and other available precursors are converted to ozone. As the sun sets and temperatures cool, NO_x begins to reform as the ozone molecules disassociate, allowing NO_x concentrations to build up again.

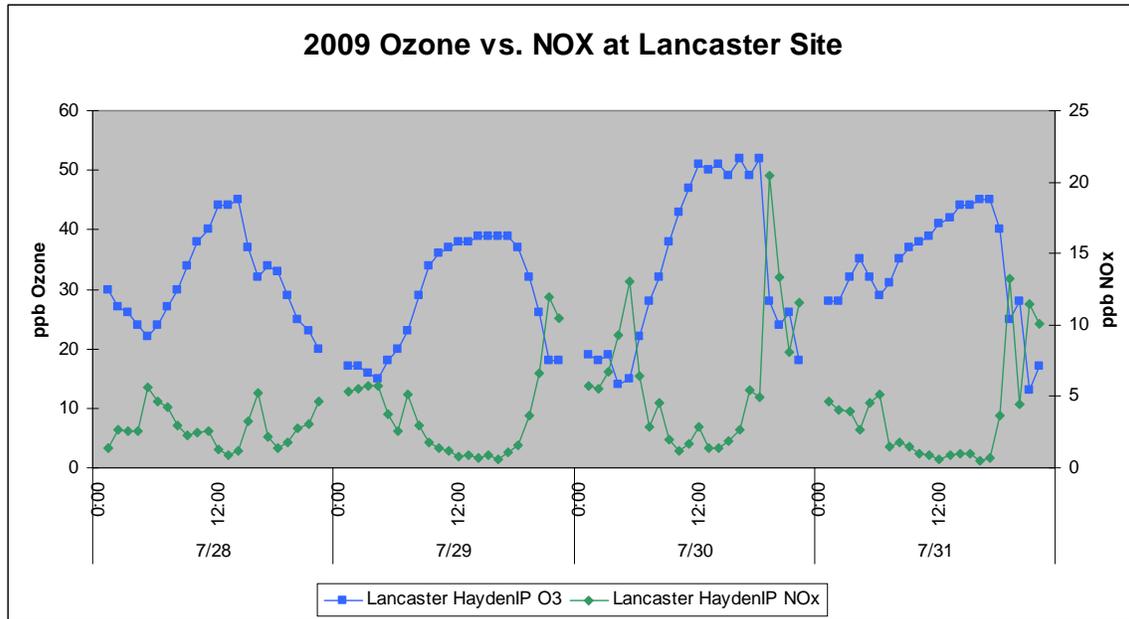


Figure 10. Ozone concentrations compared with nitrogen oxides (ppb = parts per billion, NO_x = nitric oxide, O₃ = ozone)

The early morning NO_x peak happens to coincide with morning commute times, while the rise in NO_x in the evening coincides with evening commute times. Some issues with NO_x and ozone measurement can be tied to the proximity and amount of traffic because NO_x is emitted by combustion engines. Excess NO_x near a monitoring site (fresh NO_x) has been shown to cause a “scouring” effect and inhibit ozone development in sufficient concentrations, thus biasing ozone results low. This scouring effect is counterintuitive in that increased production of a precursor should lead to more ozone. The twist here is caused by the chemistry related to these substances in ambient air. “Fresh” NO_x tends to have more nitric oxide (NO) which is very reactive and scavenges an oxygen molecule from ozone (O₃) to make NO₂ and oxygen (O₂). There is still some debate over the ability to truly isolate monitors from the effects of emissions from commuter traffic.

Another potential confounding factor is the Lancaster site’s proximity to the Coeur d’Alene airport. During the 2008 ozone season, a team from Washington State University (WSU) conducted a two-week study of ozone precursors on the Rathdrum Prairie. DEQ asked the WSU team to look for impacts from the airport at the Lancaster site. The study

report, *Rathdrum Prairie Ozone Precursor Study*², states that, “There was no obvious impact of the CDA airport emissions at the Lancaster site.” (p. 34) This does not conclusively rule out airport impacts at the Lancaster site. The current lack of higher resolution data (or shorter time increment data) collected at the Lancaster monitoring site limit the ability to look for the short-lived plumes from airplane takeoffs and landings. During the 2010 season, 1-minute data for NO_x, O₃, particulates and weather instruments will be collected at Lancaster allowing a better assessment of potential impacts from aircraft activity.

The graph in Figure 11 is called a wind rose. A wind rose depicts the direction that the wind is coming from in relation to a point such as a wind sensor. The different spokes around the wheel indicate the different directions the wind is coming from. The length of each spoke is related to the percentage of time the wind is coming from that direction. The different colored sections of the spokes represent the wind speeds, and the length of the different colored sections shows the percentage of time the wind was travelling at that speed from that direction. Wind speed is shown in meters per second; Table 2 shows the equivalents for wind speed in miles per hour.

² Laboratory for Atmospheric Research, Washington State University. 2009. Rathdrum Prairie Ozone Precursor Study. www.deq.idaho.gov/air/data_reports/reports/north_idaho/rathdrum_prairie_ozone_precursor_study.pdf.

09 May 01 - 09 Sep 31
 Station: LCRMet
 WS versus WD
 Frequency of Occurrence (%)

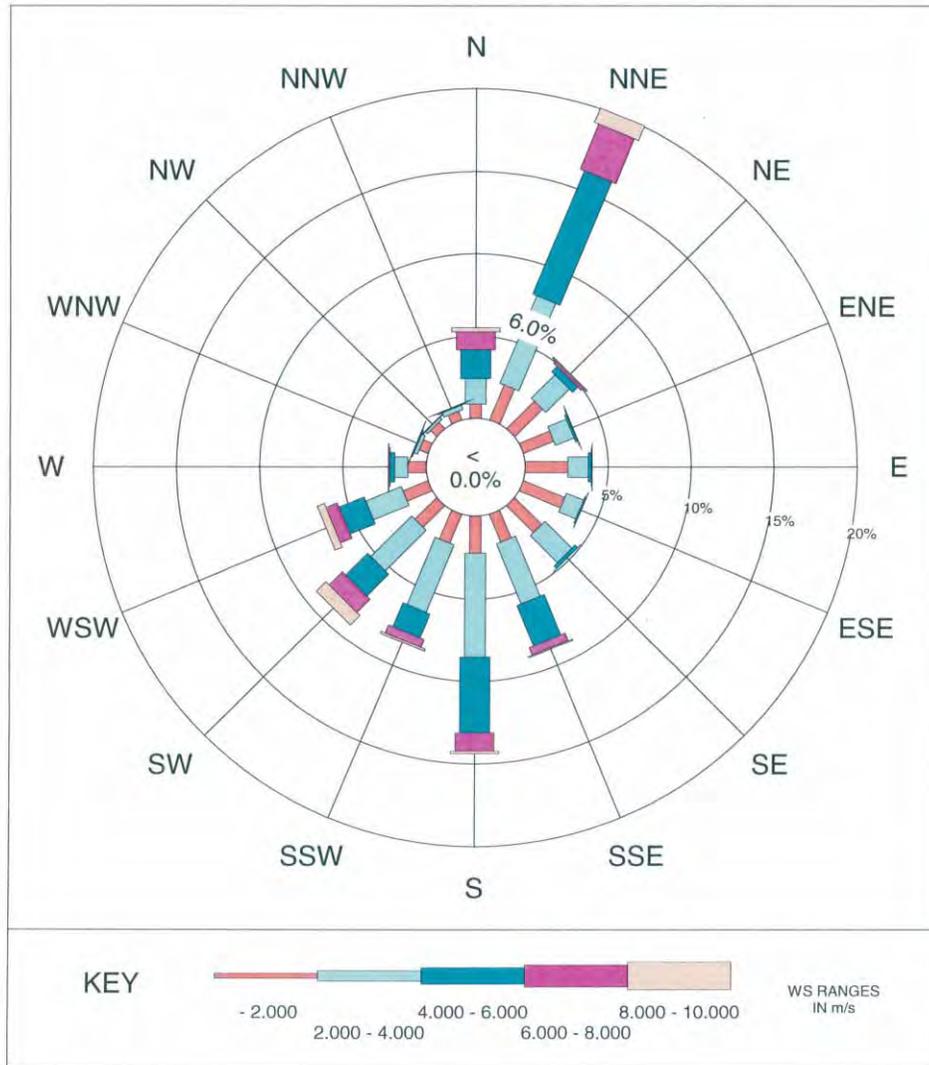


Figure 11. Wind rose for the 2009 ozone season, as measured at the Lancaster site (WS = wind speed, WD = wind direction, m/s = meters per second)

Table 2. Meters per second converted to miles per hour

Meters Per Second	Miles Per Hour
0.000 – 2.000	0.000 – 4.474
2.000 – 4.000	4.474 – 8.948
4.000 – 6.000	8.948 – 13.422
6.000 – 8.000	13.422 – 17.895
8.000 – 10.000	17.895 – 22.369

The wind rose in Figure 11 represents measurements from the entire 2009 ozone season at the Lancaster site. The purpose of the graph is to give an impression of the prevailing wind directions for the season. The wind at the Lancaster site during the ozone season came mainly from the north-northeast and secondarily from the west-southwest and south. Upwind in the southerly directions are found large urban and industrial areas. The 2009 wind rose for the Lancaster site is very similar to the 2008 wind rose for the site.

The Lancaster site is located approximately 3 hours downwind at typical wind speeds (roughly 30 miles) from the urban and industrial areas to the west and southwest. This is significant because the time needed for the photochemical reactions necessary to form ozone is 3-4 hours; thus, ozone precursors originating in the Spokane area have enough time to form ozone while they travel downwind to the Lancaster site.

The graph in Figure 12 is called a pollution rose. Rather than comparing wind speed to wind direction, this rose compares hourly ozone concentrations to wind direction. The predominant wind directions with the highest ozone concentrations (as shown by the pink and the tan bars) are between west and southwest. Once again, this suggests that either ozone or its precursors are being transported from the urban and industrial areas to the west and southwest to the monitoring site.

09 May 01 - 09 Sep 31
 Station: HaydenIP
 O3 versus WD (LCRMet)
 Frequency of Occurrence (%)

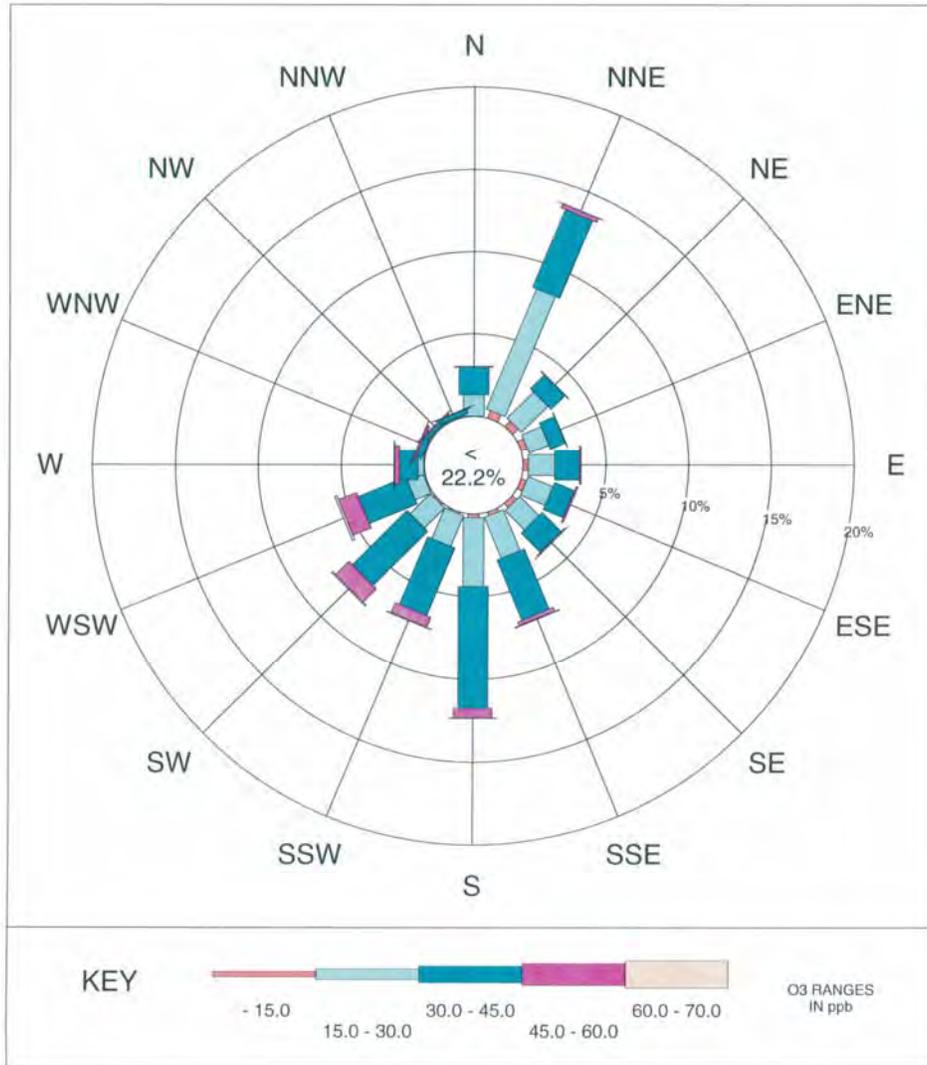


Figure 12. Pollution rose for the 2009 ozone season, as measured at the Lancaster site
 (O3 = ozone, WD = wind direction, ppb= parts per billions)

Figure 13 shows the Lancaster site with predominant wind directions during the highest and lowest ozone concentrations for 2009 ozone season. The orange-shaded triangle indicates the dominant wind direction during periods with the most ozone while the blue-shaded triangle shows the dominant wind directions during periods with the least ozone. This map indicates that transport of ozone and its precursors from the urban areas to the west and southwest of the Lancaster site may play a part in concentrations at the site on the highest days. Looking at the same depiction from the 2008 ozone season, Figure 14, suggests that the break in the mountains to the southwest of the Lancaster site likely funnels the winds coming from the west towards the site every year. Evaluation of future data will be key in confirmation of this theory.

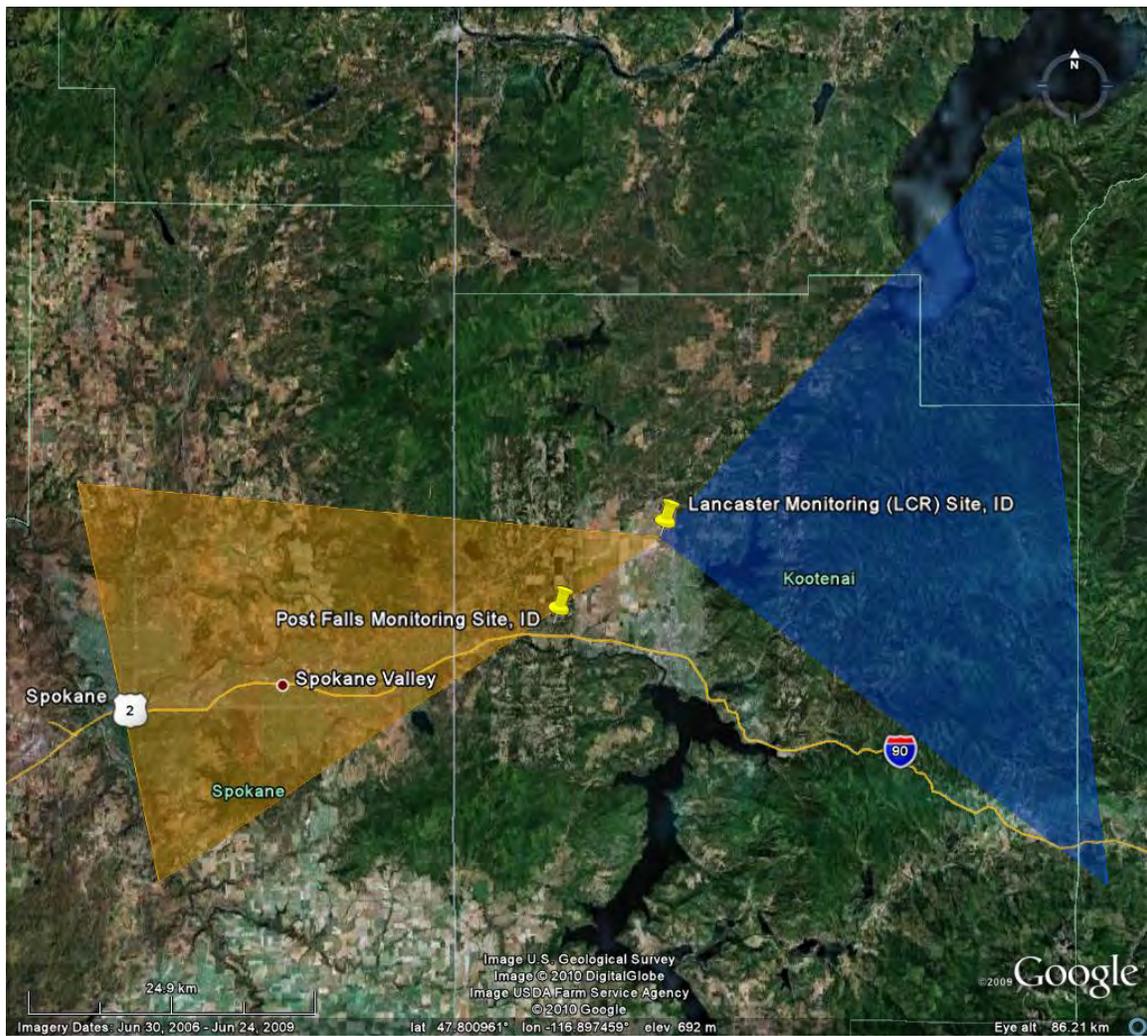


Figure 13. Map of the Coeur d'Alene area, with wind directions indicated during periods of highest ozone concentrations (orange shading) and lowest ozone concentrations (blue shading)

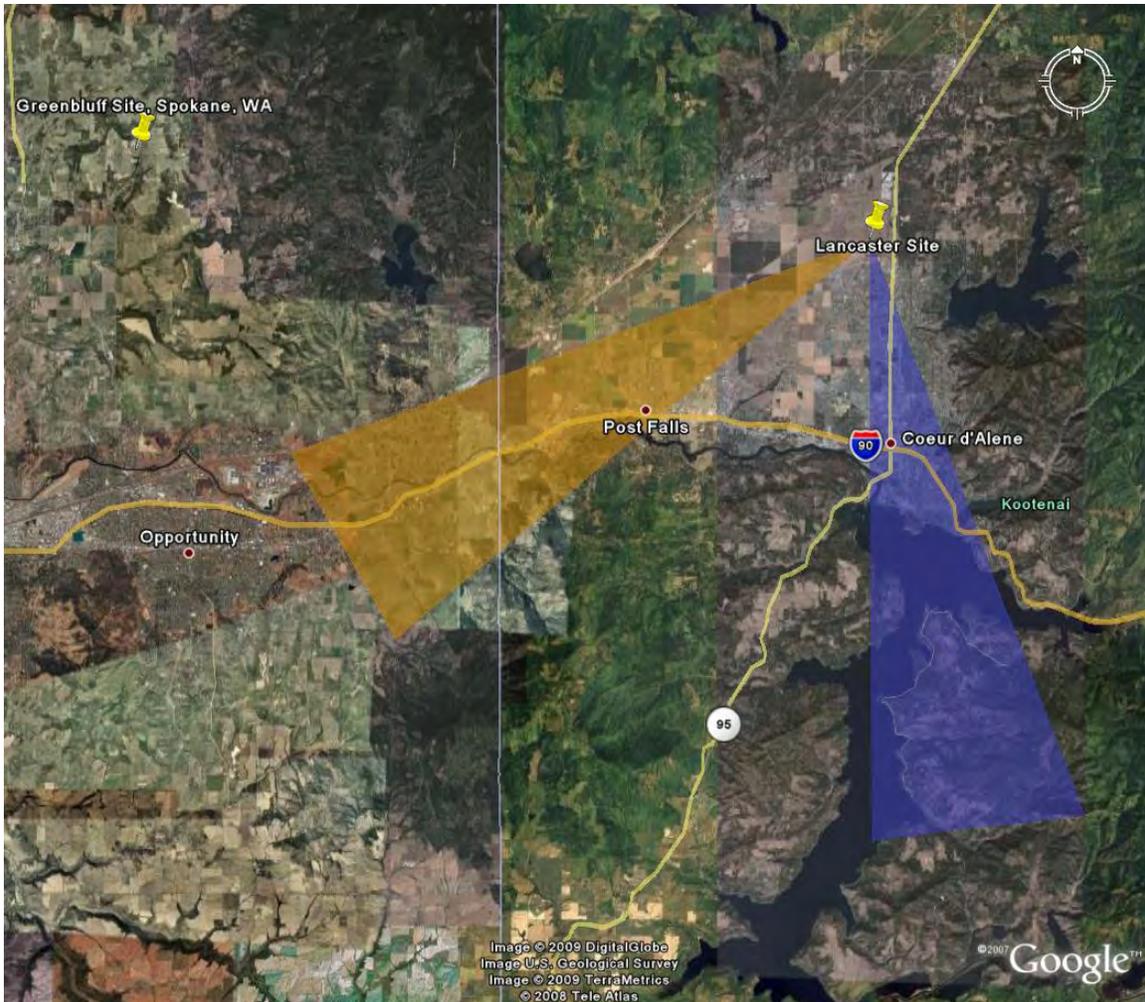


Figure 14. Depiction of winds during high ozone days (orange shading) and low ozone days (blue shading) from the 2008 ozone season

Potential Changes in 2010

The EPA has proposed a new ozone NAAQS to be between 0.060 and 0.070 parts per million (ppm). The current standard is 0.075 ppm. This proposed standard is to be established by August 31, 2010. This means that NAAQS determinations made in 2011 under the new standards will be based on the 2008, 2009, and 2010 seasons. The proposed ozone NAAQS levels are to be between 0.070 and 0.060 ppm for the design value. Also of interest related to the new NAAQS is the trigger level for the increased ozone precursor control actions required by Idaho Code 39-116B. The proposed NAAQS range will put the new trigger level between 0.060 and 0.051 ppm design values.

In Figure 15 a 4th highest 8-hour average of 0.063 ppm is projected for the 2010 season, resulting in a design value of 0.060 ppm. These projections are based on an average of the 4th highest 8-hour average over the past five ozone seasons.

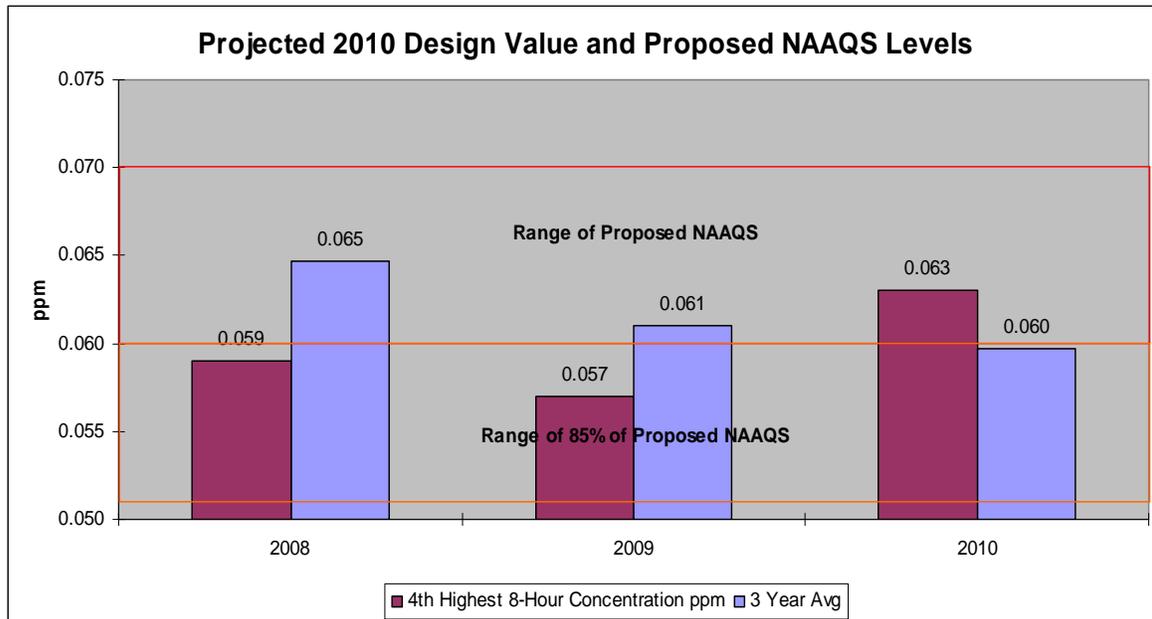


Figure 15. Proposed Ozone NAAQS, trigger levels and projected design value for 2010 (ppm = parts per million)

The graph in Figure 15 is of course based on projected numbers for 2010; ozone concentrations may vary depending on several factors.

Table 3 gives the data used to project ozone levels for 2010. Table 4 lists the proposed new NAAQS for ozone and what they would mean for the Lancaster site.

Table 3. Data used to project ozone levels for 2010

Year	4 th Highest 8-hour Value (parts per million)	Three Year Average (parts per million)
2005	0.066	---
2006	0.068	---
2007	0.067	0.067
2008	0.059	0.065
2009	0.057	0.061
Projected for 2010	0.063 (average of 2005 through 2009 values)	0.060

Table 4. Proposed new NAAQS levels and their meaning for 2010 at Lancaster site

If the new NAAQS is	The 2010 4 th highest value at Lancaster needs to be less than this to keep from exceeding the NAAQS	85% of this NAAQS level	The 2010 4 th highest value at Lancaster needs to be less than this to keep from exceeding 85% of the NAAQS
0.075 ppm (current NAAQS)	0.109 ppm	0.064 ppm	0.075 ppm
0.070 ppm	0.094 ppm	0.060 ppm	0.062 ppm
0.065 ppm	0.079 ppm	0.055 ppm	0.049 ppm
0.060 ppm	0.064 ppm	0.051 ppm	0.037 ppm

In addition to the proposed NAAQS change EPA has already adjusted the ozone season. Starting in 2010 the ozone season starts on April 1 instead of May 1. The moving up of the start date is the result of a study that showed that high ozone readings are possible in April in the northern latitudes of the lower 48 states. The ozone season still ends on September 30, however.

Monitoring Network

The Idaho air monitoring network is a composite of meteorological and pollutant-specific monitoring equipment. Data from the ozone network are sent directly to engineers and scientists through a wireless telemetry network. These data are used to update both DEQ and EPA Web sites with current pollution levels as well as to update air quality index (AQI) information. The data are checked for quality assurance, submitted to EPA, and disseminated to public and private entities that use the data for a variety of projects.

At the Lancaster site pollutants and meteorological information are measured using reference methods that are approved by EPA. Table 5 presents the methodology used for measurements of ozone concentrations at the Lancaster site.

Table 5. Pollutant monitoring methods used at the Lancaster site in 2008 in Coeur d'Alene

Pollutant Code	Measurement	Method	Units
O ₃	Ozone	UV absorption	Parts per billion
NOx	Oxides of nitrogen	Chemiluminescence	Parts per billion

Methods used for collecting the meteorological data are presented in Table 6. These data are collected by a variety of instruments on a 10-meter tall weather tower.

Table 6. Meteorology monitoring methods used in 2008 in Coeur d'Alene

Parameter Code	Measurement	Method	Units
WS	Wind speed	Propeller-type anemometer	Meters per second
WD	Wind direction	Tail wind vane	Degrees (0-360)
SR	Solar radiation	Pyranometer	Watts per meter squared (w/m ²)
2m Temp	2-meter ambient temperature	Platinum resistance thermometer	Degrees Celsius
10m Temp	10-meter ambient temperature	Platinum resistance thermometer	Degrees Celsius
Dew Point	Relative humidity	Capacitive polymer H chip	%

Coeur d'Alene Regional Air Emission Inventory

This section presents an air *emission inventory* summary for NO_x and volatile organic compounds (VOCs), as precursors of ozone, in the Coeur d'Alene area. The inventory represents Kootenai County and the greater Spokane area. The inventory was completed by DEQ in June 2008 in response to the new EPA ozone standards. An emission inventory helps to identify the sources of air pollutants in a region. Identified sources of pollutants can then be addressed with efforts to reduce emissions through improved technologies, education and encouragement to change behaviors, and economic incentives. DEQ used the customary and accepted emission inventory development process to develop the 2008 emission inventory for the Coeur d'Alene area. A more detailed emission inventory would be required if concentrations were high enough to exceed the NAAQS and trigger implementation of increased control of ozone precursors.

Source Categories

Five general categories (with hundreds of subcategories) are used to characterize air emission sources:

1. point sources
2. mobile on-road sources
3. non-road sources
4. stationary area sources
5. biogenic sources

The first four categories cover emissions of criteria air pollutants. The fifth category (biogenic sources) covers emissions that result from biological processes and are therefore probably unavoidable, but their effects need to be considered. Each of these five general source categories is described below.

Point sources are those that many people think of when considering air pollution. Point sources are stationary locations or fixed facilities from which pollutants are discharged. These include large industries that emit 10 tons per year of any of the criteria pollutants or hazardous air pollutants or 25 tons per year of a mixture of air toxics. .

Mobile on-road sources include cars, trucks, and buses, both commercial and private. This category includes vehicles that run on both gasoline and diesel fuel. On-road mobile sources contribute significantly to air pollution in Idaho, as do stationary area sources, which are described below.

Non-road sources include, for example, farm vehicles, construction vehicles, aircraft, locomotives, and garden equipment.

Stationary area sources are much smaller than point sources, but in any given area there are many of them. Area sources are defined as sources that emit less than 10 tons per year

of a criteria or hazardous air pollutant or less than 25 tons per year of a combination of pollutants. Area sources include commercial businesses such as dry cleaners, printers, and small construction operations, as well as everyday activities such as burning in a wood stove or fireplace. Although they individually emit far less pollution than point sources, the large number of stationary sources taken together make them a significant contributor to air pollution in Idaho.

Biogenic sources result from biological processes such as vegetation growth or microbial activity in the soil and need to be accounted for in ozone precursor emissions inventories. Often, only the emissions from vegetation and soils are included, but other relevant sources include volcanic emissions, lightning, and sea salt.

The emission inventory completed by DEQ in June 2008 for the Coeur d'Alene area summarized the quantities of criteria air pollutants from sources in the first four categories described above and also included anthropogenic (human-generated) sources and biogenic (naturally-generated) sources of VOCs, such as crops and other vegetation. Isoprene, which is generally produced by biogenic sources, can have a substantial impact on ozone formation. The biogenic data in the inventory are taken from EPA estimates. Data used to generate this inventory came from two sources:

- 2005 emissions inventories submitted to EPA from DEQ and the Washington State Department of Ecology for the National Emissions Inventory (NEI) (point sources)
- Biogenic data from the 2005 NEI that EPA generated

Point sources can provide the most straightforward information for the emission inventory, because point source facilities are required to report the amount of each pollutant they release each year. For stationary area sources, estimates derived from *emission factors* are used, and these may have more uncertainty associated with them, because they must take activity levels into account. For example, assumptions are made about how often an activity such as burning wood in a fireplace, driving to work, or even smaller activities that produce stationary source emissions are performed. These assumptions about activity levels are developed from sources such as surveys, census reports, etc. In addition to the uncertainty associated with activity levels, there is also uncertainty regarding the emission factors themselves. These values are typically developed by EPA in consultation with state and local air agencies and industry representatives. Additional information on emission factors and how they are derived is available at <http://www.epa.gov/ttn/chief/efpac/index.html>.

Table 7 presents the amounts of NO_x and VOCs in Kootenai County contributed from sources in each category.

Table 7. Idaho 2005 estimated criteria air pollutant emission inventory, summary for Kootenai County (tons per year)

Source Category	NO _x	VOC
Point Sources (Large Facilities)	275	296
On-Road Mobile Sources	3,231	2,123
Non-Road Mobile Sources	810	1,739
Stationary Area Sources	893	3,842
Biogenic Sources	0	22,528
Totals (Tons/Year)	5,209	30,528

The summary presented in Table 7 demonstrates that on-road mobile sources make up the most significant contributions to NO_x in the area's atmosphere, while biogenic sources outpace all others in VOC emissions. For the Spokane area, Table 8 lists the amounts of NO_x and VOCs contributed from sources in each category.

Table 8. Idaho 2005 estimated criteria air pollutant emission inventory, summary for Spokane Area (tons per year)

Source Category	NO _x	VOC
Point Sources (Large Facilities)	783	788
On-Road Mobile Sources	10,244	6,516
Non-Road Mobile Sources	2,240	3,280
Stationary Area Sources	2,950	6,836
Biogenics	983	20,871
Totals (Tons/Year)	17,200	38,291

As Table 8 shows, the Spokane area generates roughly the same amount of VOCs as Kootenai County, but releases over three times the amount of NO_x. The largest source, by far, of these NO_x is the on-road mobile source category.

By combining emissions inventory data with wind data, we can create some possible scenarios for determining the limiting factor in ozone formation in the Coeur d'Alene area. With the wind coming from the Spokane area during much of the time on the ten highest-ozone days of the season, one scenario is that transportation sources or large

industrial sources could be affecting ozone levels at the Lancaster site, possibly resulting from the transport of either ozone or ozone precursors from the Spokane area into the Coeur d'Alene area. Because a much smaller amount of NO_x is generated in Kootenai County (5,209 tons per year) than in the Spokane area (17,200 tons per year), it is possible that the limiting factor is the availability of NO_x for the ozone-forming reaction in the vicinity of the monitor at Lancaster. It is not possible to be certain that any such scenario is correct because of the limited amount of data on precursors. With precursor data from just one season, and with relatively cool temperatures during that season, it is difficult to say what the limiting factor on ozone concentrations is. Combining emissions data from Spokane and Kootenai County may be necessary to understand what significantly influences Kootenai County ozone concentrations. In addition, the airshed boundary for Kootenai County needs to be further evaluated and developed. DEQ has preliminary identified resources for state fiscal year 2011 to begin addressing the Kootenai County airshed boundary.

Sources of NO_x and VOCs as pollutants in Kootenai County are discussed briefly below, and information from tables 7 and 8 is presented graphically.

Nitrogen Oxides

The graph in Figure 16 shows sources of NO_x in Kootenai County. The combination of all vehicles and equipment is the greatest source of emissions of NO_x, making up 79% of the total source contribution. The largest subcategories for these contributors of NO_x are off-road vehicles and equipment, and on-road gasoline vehicles. Small area source facilities make up the bulk of the remaining contribution with 21%.

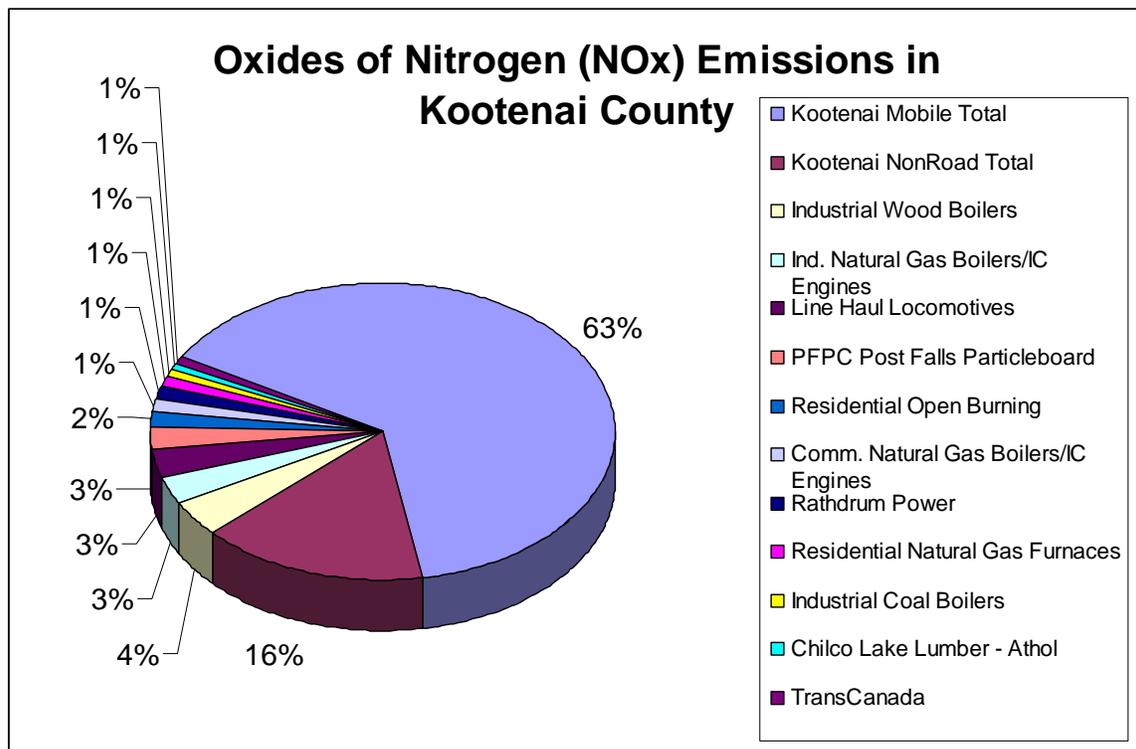


Figure 16. Sources of NO_x in Kootenai County (IC engines = internal combustion engines)

Volatile Organic Compounds

Although VOCs are not criteria air pollutants, they are included in discussion of the criteria air pollutants emission inventory because they are a primary precursor for ozone, which is a criteria pollutant. The graph in Figure 17 shows that biogenic sources are the largest contributor to VOC emissions in Kootenai County. Vehicles and associated equipment contribute the second greatest portion of VOCs to the atmosphere in Kootenai County, making up 13% of the total VOC emissions. The other largest contributing subcategories for area sources are asphalt applications, part degreasing, indoor wood burning, and surface coating (mainly of furniture and vehicles).

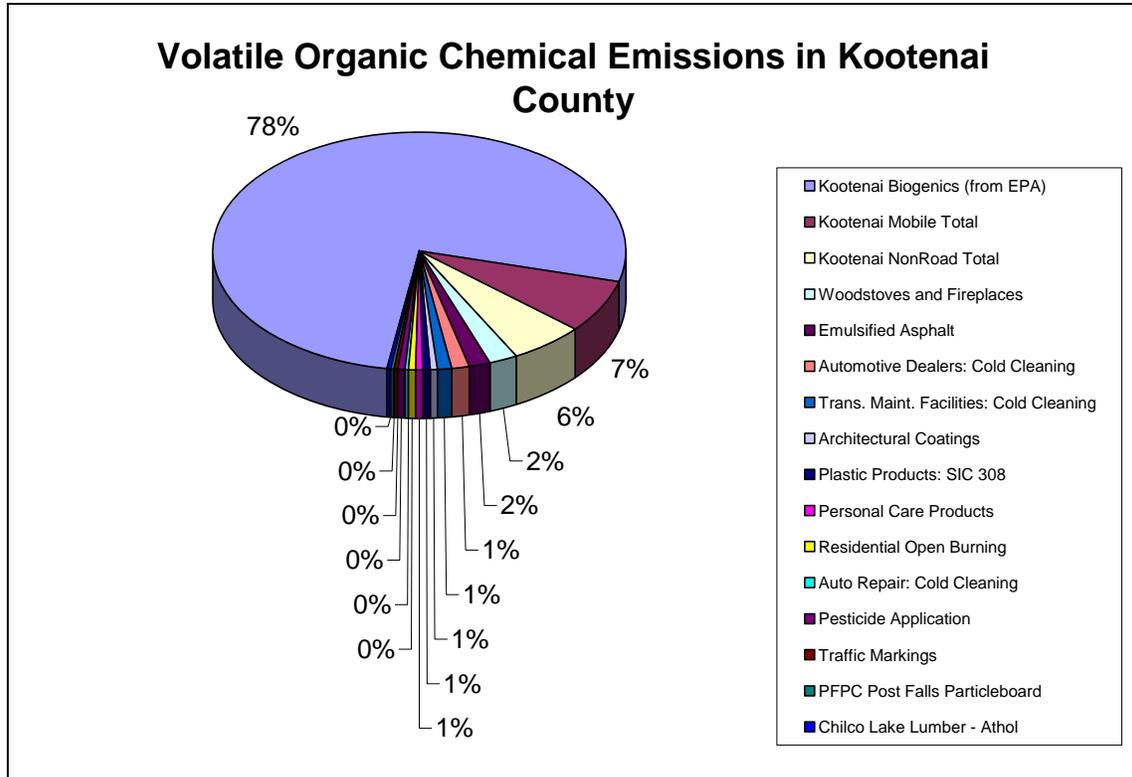


Figure 17. Sources of volatile organic chemicals in Kootenai County

Air Quality Standards

Table 9 describes the federal standard for ozone, which the state of Idaho has adopted. For more information, EPA air quality standards and supporting rationale are available at <http://epa.gov/air/criteria.html>.

Table 9. Air Quality Standard for Ozone

Pollutant	Standard	Level
Ozone	The 3-year average of the 4th--highest daily maximum 8-hour average concentration cannot exceed the level measured at each monitor within an area over each year.	0.075 parts per million

When EPA designated the new 8-hour ozone standard of 0.075 ppm this past year, they also tried to eliminate some confusion by directing agencies to treat significant figures differently than in the past when calculating compliance. The new calculating convention is to truncate (or cut off a number without rounding) the final concentration calculation after three significant figures. For example, a final concentration of 0.0759 would be 0.075 and not rounded to 0.076. The value of 0.075, shown in Table 9, is used to determine if an area is in compliance, and is reflected in the graphs in this report.

For each pollutant there typically are different standards for different averaging times (for example, annual, daily, hourly, and 8-hour averages). These different standards are created and enforced to address varied health impacts that happen as a result of shorter, higher-level exposures versus longer, lower-level exposures. These differences are addressed pollutant-by-pollutant in the following sections, and additional information is on the EPA Web site identified above. A distinction exists between “exceeding” and “violating” a standard; the two are not equivalent. This distinction is due to the nature of the standards. In most instances, it is allowable for an area to exceed the standard a few times, to allow for possible meteorological aberrances. For example, an ozone 8-hour average of 0.090 ppm clearly exceeds the standard; however, the standard is not violated if the 3-year average of the annual 4th-highest daily maximum 8-hour concentration does not exceed 0.075 ppm.

Current Public Outreach and Potential Actions

Current Air Quality Forecasts

During ozone season, DEQ currently provides forecasts of pollution conditions for ozone in the Coeur d'Alene area. Forecasts covering all days of the week are made using pollutant monitoring data and meteorological information. Ozone pollution can rise to very high levels when the area experiences hot days with few clouds in the sky. These optimal conditions for ozone formation are also optimal for outdoor activities. Since ozone tends to be at its worst when the weather is "best" for outdoor activities, ozone forecasts are a helpful tool for those who are easily affected. These forecasts are useful in helping people who are sensitive to ozone pollution plan their day. Additionally, forecasts allow concerned citizens to plan their activities to lower their personal impact on generating ozone precursors during high pollution periods. The ozone forecasts are available on DEQ's Web site, www.deq.idaho.gov, as well as EPA's AIRNow Web site, www.airnow.gov.

Potential for Issuing Ozone Alerts

Since we have no control over weather characteristics, controlling ozone would mean controlling what we put into our air. The possibility of issuing alerts for the Coeur d'Alene area and conducting associated activities to help curb ozone formation during high-concentration episodes is being considered. Currently, postings of the Air Quality Index (AQI) are made to the DEQ Web site, www.deq.idaho.gov, and to EPA's AIRNow site, www.airnow.gov. Possible future activities could include sending press releases to local media outlets and to others through an email notification list. Actions that could be requested of the public when ozone concentrations are high may include limiting driving and open burning, using mass transit, and postponing lawn mowing until after the alert has ended.

Information Provided by the Air Quality Index

The air quality index (AQI) is an index for reporting daily air quality. The AQI for your area tells you how clean or polluted the air is and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health (see Table 10). AQI values below 100 are generally thought of as satisfactory. When AQI values are greater than 100, air quality is considered to be unhealthy—initially for certain sensitive groups of people, then for everyone as AQI values get higher.

For more detailed information about the AQI and the pollutants it measures, go to EPA's AIRNow Web page at <http://www.airnow.gov/>.

Table 10. Calculation and breakpoints for the air quality index (AQI)

Breakpoints for Criteria Pollutants							AQI Categories	
O ₃ 8-hour (ppm)	O ₃ 1-hour ^a (ppm)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	CO (ppm)	SO ₂ (ppm)	NO ₂ (ppm)	AQI value	Category
0.000–0.059	—	0.0–15.3	0–54	0.0–4.4	0.000–0.034	(b)	0–50	Good
0.060–0.075	—	15.4–35.4	55–154	4.5–9.4	0.035–0.144	(b)	51–100	Moderate
0.076–0.095	0.125–0.164	35.5–65.4	155–254	9.5–12.4	0.145–0.224	(b)	101–150	Unhealthy for sensitive groups
0.096–0.115	0.165–0.204	65.5–150.4	255–354	12.5–15.4	0.225–0.304	(b)	151–200	Unhealthy
0.116–0.374	0.205–0.404	150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24	201–300	Very unhealthy
(c)	0.405–0.504	250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64	301–400	Hazardous
(c)	0.505–0.604	350.4–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04	401–500	

- a Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be safer. In these cases, in addition to calculating the 8-hour ozone value, the 1-hour ozone value may be calculated, and the greater of the two values reported.
- b NO_x has no short-term National Ambient Air Quality Standard (NAAQS) and can generate an AQI only above a value of 200.
- c 8-hour O₃ values are not used to define AQI values above 300. AQI values above 300 are calculated with 1-hour O₃ concentrations.

More About Ozone

This section provides more information about ozone, including how it is formed, why it is a concern, and how we calculate amounts of ozone and its precursors in our air.

General Definitions

Criteria Air Pollutants

Criteria air pollutants are often just called criteria pollutants. The federal Clean Air Act of 1970 defined six criteria pollutants (carbon monoxide, lead, nitrogen dioxide, coarse particulate matter, fine particulate matter, sulfur dioxide, and ozone) and established criteria for *ambient concentrations* of these pollutants, set at levels to protect public health. EPA has periodically revised the original concentration limits and methods of measurement, most recently for ozone in 2008. Ozone, one of the six criteria pollutants, is addressed below, along with VOCs, which are ozone precursors.

Ozone (O₃)

Ozone, a colorless gas molecule with a strong odor, is composed of three atoms of oxygen. In the upper atmosphere, ozone occurs naturally and partially absorbs the sun's harmful ultraviolet rays. However, at ground level, ozone is a summertime air pollution problem.

Volatile Organic Compounds (VOCs) – Ozone Precursors

A VOC is an organic compound that participates in atmospheric photochemical reactions. This excludes all compounds determined by EPA to have negligible photochemical reactivity and listed in 40 CFR 51.100(s) in effect July 1, 1998.

Ozone: A Criteria Air Pollutant

- **How is ozone caused?**
Ozone forms when photochemical pollutants, which come mostly from cars, trucks, and biogenic and industrial sources, react in the presence of heat and sunlight. Ozone-forming pollutants include NO_x and VOCs. Although transportation and industrial sources are the biggest contributors, even gasoline-powered yard equipment, paints, solvents, and off-road vehicle motors contribute to the formation of ozone.
- **When does ozone pollution happen?**
Ozone pollution is most common in the summer months, when sunlight and stable atmospheric conditions occur. Ozone levels are usually highest in the afternoon, as sunlight photochemically transforms NO_x and VOCs into ozone.

- **Who is affected?**

Children, the elderly, people who are active outdoors, people with respiratory disease such as asthma, and people with unusual sensitivity to ozone can all be affected by ozone pollution. During physical activity, ozone penetrates deeper into the lungs and can do more damage.

Ozone is a very reactive gas. For this reason, high concentrations of ozone can cause respiratory distress and disease in humans, decreased yields of agricultural crops and forests, and damage to some rubber products, plastics, and paints used outdoors. National crop losses from ozone exposure are estimated at \$3 billion to \$5 billion annually. Forest losses are harder to estimate.

- **What are the health effects of ozone?**

Ozone can cause coughing and throat irritation, make deep vigorous breathing more difficult, and increase the chance of respiratory infections. It increases sensitivity to allergens and can trigger asthma attacks. The damage it causes to the lungs heals within a few days, but repeated or prolonged exposure may cause permanent damage.

- **What can I do about it?**

If ozone levels are high and you have a respiratory condition or are normally active outdoors, try to limit your outdoor exertion.

In the United States, management of ozone and other photochemical oxidants has been a major goal of federal and state clean air legislation such as the Clean Air Act. Although many of the pollution control efforts required by the Clean Air Act have been implemented, efforts to decrease ozone pollution have been only partially successful.

In the Coeur d'Alene airshed, ozone concentrations are elevated, but still within the federal standards.

- **Where is ozone measured?**

Unlike other pollutants monitored in Idaho, ozone is formed by precursor compounds that react in the atmosphere. Winds transport ozone and chemical emissions from one area to another. For the Coeur d'Alene area, ozone precursors are emitted into the air in industrial areas of the airshed to the south and southwest and subsequently travel north and northwesterly to more rural areas as they react to form ozone. As a result, DEQ currently has one monitor on the Rathdrum Prairie at the Lancaster monitoring site.

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Glossary

Airshed

An area covered by a volume of air with similar characteristics and separated from other volumes of air by weather patterns or topography.

Ambient concentration

A measurement of the concentration of a substance or pollutant within the immediate surroundings of an organism. Ambient air concentrations are measured in outdoor air.

Biogenic source

Category of air emissions sources, originating from any process carried out by living organisms. Vegetation and microbial activity in soil can be biogenic sources of air emissions.

Criteria pollutant

The 1970 amendments to the Clean Air Act required EPA to set National Ambient Air Quality Standards for certain pollutants known to be hazardous to human health. EPA has identified and set standards to protect human health and welfare for six pollutants: ozone, carbon monoxide, total suspended particulates, sulfur dioxide, lead, and nitrogen oxide. The term *criteria pollutants* derives from the requirement that EPA must describe the characteristics and potential health and welfare effects of these pollutants. It is on the basis of these criteria that standards are set or revised.

Design value

The monitored reading used by EPA to determine an area's air quality status; e.g., for ozone, the average of the fourth highest reading measured over the most recent three years is the design value.

Emissions factors

A representative value that attempts to relate the quantity of a pollutant released to the atmosphere by an activity associated with the release of that pollutant. Emissions factors help estimate emissions from various sources of air pollution.

Emissions inventory

A study that estimates the total amount of any pollutant that is emitted in an area, derived by determining emissions,

either by measurement or estimation using emissions factors, from all sources within the area.

Mobile on-road source

Category of air emissions sources, consisting of vehicles running on gasoline or diesel on federal, state, county and municipal roads.

National Ambient Air Quality Standards (NAAQS)

Standards or limits set by EPA on the allowable amount of an air pollutant in outdoor air throughout the U.S. Standards are set at a level necessary to protect public health.

Nitrogen dioxide (NO²)

The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

Non-road source

Category of air emissions sources, made up of combustion engines on farm and construction equipment, gasoline-powered lawn and garden equipment, power boats and outboard motors, aircraft, and locomotives.

Ozone

A gas found in two layers of the earth's atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer 7 to 10 miles or more above the earth's surface), ozone is a natural form of oxygen that provides a protective layer shielding the earth from ultraviolet radiation. In the troposphere (the layer extending up 7 to 10 miles from the earth's surface), ozone is a chemical oxidant and major component of photochemical smog. It can seriously impair the respiratory system and is one of the most widespread of all the criteria pollutants for which the federal Clean Air Act required EPA to set standards. Ozone in the troposphere is produced through complex chemical reactions of 1) nitrogen oxides, which are among the primary pollutants emitted by combustion sources; 2) hydrocarbons, released into the atmosphere through the combustion, handling and processing of petroleum products; and 3) sunlight.

Ozone precursor

A compound that undergoes a reaction in the air to contribute to the formation of ozone. For example, volatile organic compounds (VOCs) and nitric oxides of nitrogen

react in sunlight to form ozone or other photochemical oxidants, so they are ozone precursors.

Oxides of nitrogen (NO_x)

An atom of nitrogen combined with one or more (x) atoms of oxygen. A product of combustion from transportation and stationary sources, NO_x is a major contributor to the formation of ozone.

Photochemical pollutants

Air pollutants formed by the action of sunlight on oxides of nitrogen and hydrocarbons.

Point source

Category of air emissions sources, made up of stationary locations or fixed facilities from which pollutants are discharged; any single identifiable source of pollution, such as a pipe, ditch, ship, ore pit, or factory smokestack. Point sources emit more than 10 tons per year of a criteria or hazardous air pollutant or more than 25 tons per year of a combination of pollutants

Stationary area source

Category of air emissions sources that emit less than 10 tons per year of a criteria or hazardous air pollutant or less than 25 tons per year of a combination of pollutants. Area sources include commercial businesses such as dry cleaners, printers, and small construction operations, as well as everyday activities such as burning in a wood stove or fireplace..

Volatile organic chemical (VOC)

Any organic compound that easily evaporates at room temperature. VOCs are emitted by a wide array of products, such as paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.