Government of **Western Australia**
Department of **Water and Environmental Regulation**

Roadside ambient air quality monitoring campaign, Como

Department of Water and Environmental Regulation

July 2025

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Summary

This report presents a summary of the data the Department of Water and Environmental Regulation (the department) collected during a short-term air quality monitoring campaign in Como, Western Australia (WA).

An air quality monitoring station was operated from 5 February 2023 to 6 February 2024 at Lot 74 Leonora Street in Como, chosen for its proximity to the Kwinana Freeway and Canning Highway.

The objective of the monitoring campaign was to collect data to better understand the influence of contemporary motor vehicle emissions in an area close to a major transport thoroughfare.

The air quality monitoring station was equipped with:

- A particulate matter (PM) monitor to measure the concentration of PM_{10}, which are particles with a diameter of up to 10 micrometres (µm) and $PM_{2.5}$, which are particles with a diameter of up to 2.5 µm.
- A high-volume air sampler (HVAS) to collect PM_{10} samples that were analysed in a laboratory to determine the metals content.
- Gas analysers to measure the concentrations of carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide.
- A meteorological sensor to measure wind speed and wind direction to assist with data analysis and interpretation.

Based on the department's analysis, the campaign's findings in relation to the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) health guidelines were:

- There were no exceedances of the guidelines for carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, PM_{10} and lead.
- The $PM_{2.5}$ annual guideline was not exceeded.
- There were three exceedances of the $PM_{2.5}$ daily guideline. These exceedances were most likely attributable to smoke events enveloping the wider metropolitan area originating from bushfires and prescribed burning activities.

The campaign's findings for metals concentrations in PM_{10} samples were:

- There was no indication of exceedances of the available daily or annual health guidelines for the metals analysed.

The campaign's findings on the relationships between air quality data and road traffic data were:

- Although low, measurements of carbon monoxide, nitrogen dioxide and sulfur dioxide show a clear association with fluctuations in traffic volume.
- Measurements of PM_{10} and $PM_{2.5}$ show a weaker association with fluctuations in traffic volume.
- Measurements of ozone do not show a direct association with fluctuations in traffic volume.

1 Background

The *Perth Air Emissions Study 2011-2012* (DWER, 2018) found that on-road motor vehicles were a major contributor to emissions of key air pollutants in Perth such as carbon monoxide (CO), oxides of nitrogen (NOx) and volatile organic compounds (VOCs).

Vehicle emissions stem from multiple sources including fuel combustion, fuel evaporation and mechanical processes. Fuel combustion and evaporation release VOCs along with combustion products including CO, NOx, and PM. Mechanical processes such as tyre and brake wear and road dust resuspension also contribute to PM emissions.

The last roadside traffic monitoring study conducted by the department was the *Perth Traffic Corridor Study* in Melville and Brentwood during 2007-2008. That study examined the variability in ambient particle concentrations, measured as total suspended particles, and assessed the presence of polycyclic aromatic hydrocarbons (a type of VOC) along major traffic corridors in Perth.

To understand the influence of contemporary motor vehicle emissions in an area close to a major transport thoroughfare, an air quality monitoring station operated from 5 February 2023 to 6 February 2024 at Lot 74 Leonora Street in Como, chosen for its proximity to the Kwinana Freeway and Canning Highway.

This report presents a summary of the data collected during the campaign.

1.1 Campaign objectives

The objectives of the monitoring campaign were to:

- Monitor the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) criteria pollutants and the metals content of PM_{10} samples and compare these levels with air quality guidelines.
- Better understand contemporary traffic emissions and local air quality near a major transport intersection.

1.2 Campaign area

Monitoring was conducted in the Perth suburb of Como, which is located 6 km south of the CBD. The monitoring site was adjacent to the intersection of Kwinana Freeway and Canning Highway. This is a high-traffic area which borders a residential neighbourhood.

The Perth climate is characterised by hot, dry summers and cool, wet winters. Figure 1 provides a climate summary based on long term data from the Bureau of Meteorology (BOM) Perth Metro weather station.

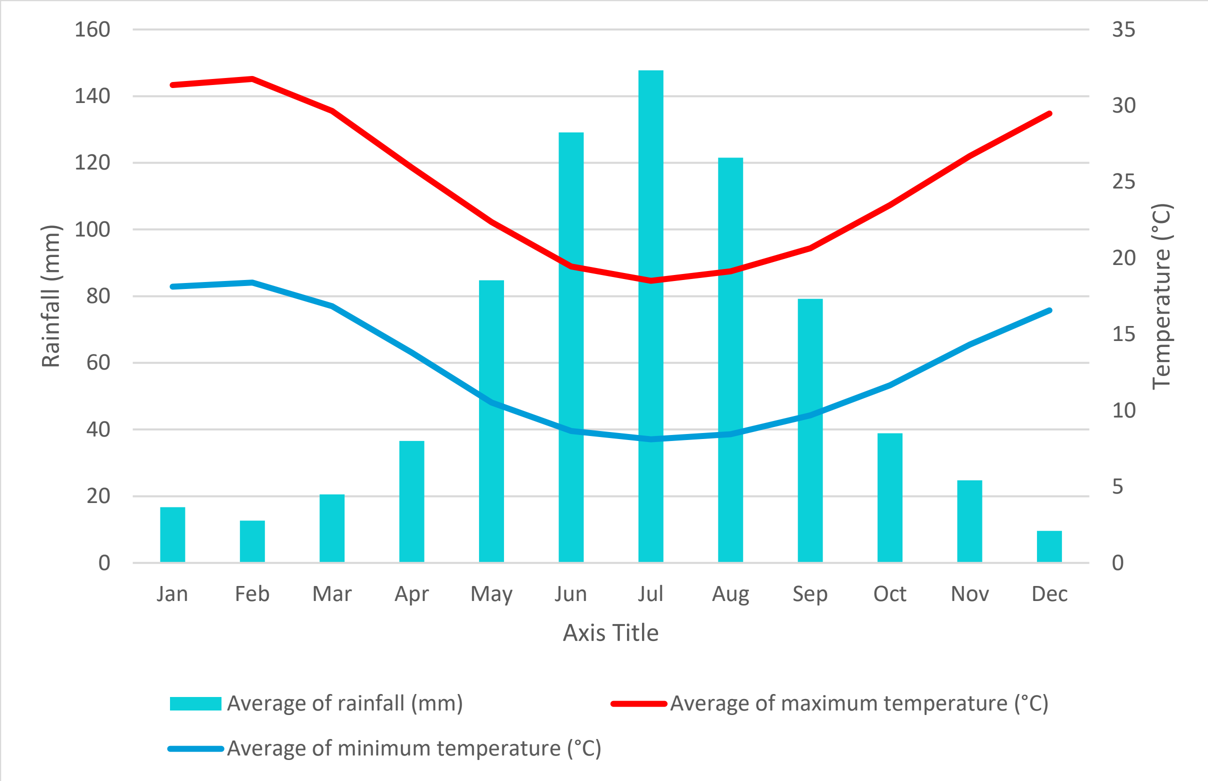


Figure 1. Climate summary based on the BOM Perth Metro weather station

1.3 Carbon monoxide (CO)

CO is formed from fuel combustion in motor vehicles. The *Perth Air Emissions Study 2011-2012* found that on-road vehicles were the largest source of CO emissions, contributing about 55% of annual emissions. High traffic volume, particularly of petrol vehicles, is associated with higher levels of CO emissions.

Other sources of CO in urban areas include:

- Prescribed burning and bushfires.
- Domestic sources such as petrol-fuelled lawn mowers, gas appliances and wood heaters.
- Off-road mobile sources such as recreational and commercial boating.
- Industrial combustion processes.

1.4 Nitrogen dioxide (NO_2)

NO_2 is primarily generated through fuel combustion in vehicles and industrial processes. The *Perth Air Emissions Study 2011-2012* (DWER, 2018) found that on-road vehicles were the largest single source of NO_2 emissions. NO_2 is a precursor to ozone (smog) formation as well as being a toxic air pollutant.

1.5 Photochemical oxidants as ozone (O_3)

O_3 is a 'secondary' pollutant, meaning it is not directly emitted from motor vehicles or other sources but forms in the atmosphere from reactions between oxides of nitrogen and VOCs which are 'primary' or 'precursor' pollutants that are directly emitted.

O_3 formation in Perth occurs due to complex interactions between precursor substances, prevailing winds and sunlight. During summer, it is common for precursor substances to be transported offshore with easterly winds during the morning and the afternoon sea breeze pushes an O_3-rich plume back over the city.

1.6 Sulfur dioxide (SO_2)

SO_2 from motor vehicles is formed from fuel combustion and emissions are relatively low compared to other sources. The *Perth Air Emissions Study 2011-2012* (DWER, 2018) found that on-road vehicles contributed about 2% of the annual emissions.

1.7 Particles

In air quality terminology, 'particles' refer to particulate matter (PM) comprising very small solid particles of earth, organic matter, manufactured products or waste matter. These may become airborne by natural forces (such as wind) and/or by mechanical processes (such as crushing, grinding, milling, conveying, stockpiling or haulage). PM can also include combustion particles, organic compounds, metals, pollen and mould.

PM is classified into different size fractions based on the particle diameter (equivalent aerodynamic diameter) measured in micrometres (µm). The common size fractions are:

- $PM_{2.5}$ – particulate matter of diameter approximately 2.5 µm or less.
- PM_{10} – particulate matter of diameter approximately 10 µm or less.

These particle sizes are important for public health assessment because they are sizes small enough to breathe in and reach the respiratory tract and lungs, potentially causing health issues.

Figure 2 shows the $PM_{2.5}$ and PM_{10} size fractions compared with other common materials.

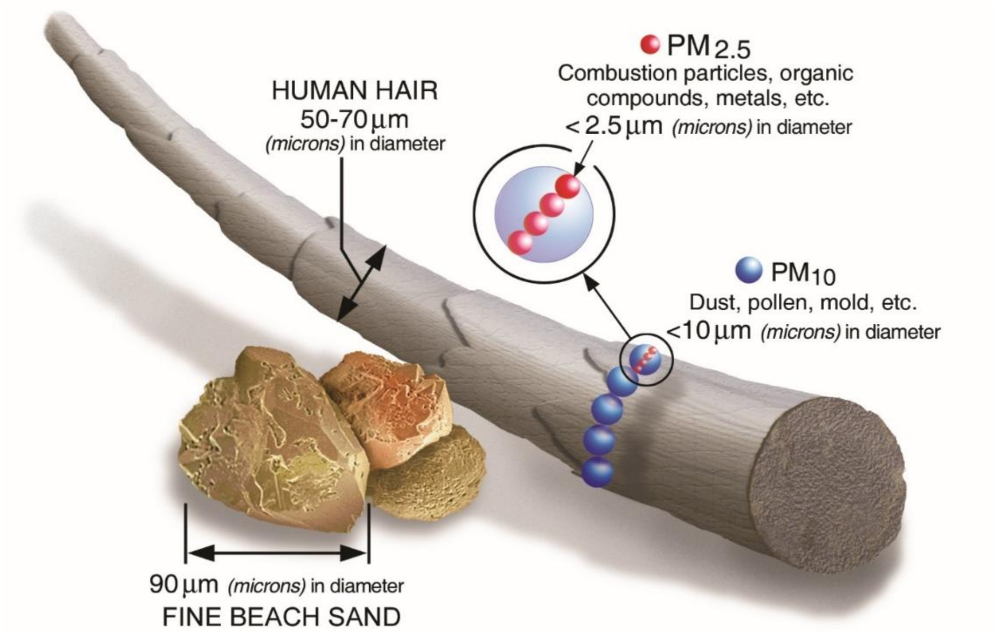


Figure 2. Size comparisons for particulate matter (PM) (USEPA 2018)

Various factors can influence PM_{10} and $PM_{2.5}$ levels. For example, the *National Pollutant Inventory 2021* (Australian Government, 2022) found that the largest sources of PM_{10} from natural and human activities include metal ore mining (50%), prescribed burning and wildfires (17%), windblown dust (15%) and emissions from paved and unpaved roads (13%).

Mechanical processes associated with vehicle travel include tyre and brake wear and road dust resuspension and these also contribute to PM emissions.

1.8 Metals

Metals occur naturally in the earth's crust, mainly in the form of solid metal particles or metals attached to the surface of other particles. Metals are elements and thus cannot be broken down, nor can their properties be altered easily.

Metals enter our bodies through food, drinking water and air. Small amounts of some metals, like iron and magnesium, are needed for good health but too much can be harmful.

PM_{10} samples for this campaign were analysed for the presence of metals and results compared with health guidelines. The metals analysed included lead, which is one the criteria pollutants in the AAQ NEPM. Historically, airborne lead was common in urban areas because it was added to petrol to improve combustion. Lead is no longer added to petrol and consequently levels of this metal in air are generally very low.

2 Monitoring campaign scope

The campaign scope was to monitor the following for 12 months:

- levels of AAQ NEPM pollutants using particle and gas monitoring equipment.
- levels of metals contained in PM_{10} samples.
- wind speed, wind direction, humidity and temperature.

The campaign used the department's mobile air quality monitoring station, fitted with equipment that complied with Australian Standards and operated in accordance with the department's standard procedures. The monitoring location and equipment setup are shown in Figure 3 and Figure 4.

Figure 3. Air quality monitoring location in Como

Figure 4. The department’s mobile air quality monitoring station

3 Monitoring methods

Particle monitoring for this campaign used both a Tapered Element Oscillation Microbalance (TEOM) and a High-Volume Air Sampler (HVAS) operated in accordance with Australian/New Zealand Standards (AS/NZS).

In parallel with the continuous TEOM monitoring, the HVAS was deployed to collect 24-hour PM_{10} samples. The HVAS operated on a one-in-six-day sampling regime. The PM_{10} samples were then sent to a laboratory for analysis. During the campaign, a total of 60 PM_{10} samples were collected and analysed. A laboratory accredited by the National Association of Testing Authorities (NATA) Australia conducted the analysis, which included measuring the mass concentration of PM_{10} and identifying the concentrations of various metals in the samples.

A summary of the gas and particle monitoring methods used in the campaign is shown in Table 1.

Table 1. Summary of monitoring methods

Air pollutant	Monitoring method
CO	AS 3580.7.1 Determination of carbon monoxide – Direct-reading instrumental method
NO_2	AS 3580.5.1 Determination of oxides of nitrogen – Direct-reading instrumental method
O_3	AS 3580.6.1 Determination of ozone – Direct-reading instrumental method
SO_2	AS 3580.4.1 Determination of sulfur dioxide – Direct-reading instrumental method
Particles as $PM_{2.5}$ and PM_{10}	AS/NZS 3580.9.7 Determination of suspended particulate matter — Dichotomous sampler – Gravimetric method AS/NZS 3580.9.13 Determination of suspended particulate matter – $PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance monitor AS/NZS 3580.9.16 Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance monitor incorporating a filter dynamic measurement system (FDMS) unit
Metals in PM_{10}	AS/NZS 3580.9.6 Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – Gravimetric method

4 Data quality

4.1 Data validation

The department's technical specialists assessed data quality in accordance with standard procedures and with the Australian Standard method *AS/NZS 3580.19:2020 Ambient air quality data validation and reporting*. The assessment comprises the following:

- Data checking for spikes, flat-lines, negative or spurious data.
- Checking of equipment operational modes or status conditions that indicate invalid data and instrument stability after power outages or maintenance.
- Validation that the instrument enclosure temperatures were between 20 and 30 degrees Celsius during operation.
- Examination of data trends and other indicators of instrument stability.
- Examination of logbooks, maintenance records, field sheets and chain of custody records.

4.2 Data availability

AAQ NEPM Technical Paper No. 8 states that data availability (also called data recovery) must be at least 75% for each calendar quarter. Data for all the pollutants that were monitored continuously met the 75% threshold as shown in Table 2.

Table 2. Monitoring data availability rates

Pollutant	Data availability rates (% of hours)					
	2023				2024	Annual
	Q1	Q2	Q3	Q4	Q1	
CO	99.5	100.0	99.2	99.2	98.0	99.3
NO_2	97.8	97.8	97.8	97.7	97.3	97.7
O_3	99.5	100.0	99.2	99.3	98.0	99.3
SO_2	97.9	97.9	97.6	97.8	97.3	97.8
PM_{10}	99.7	98.6	99.5	99.2	98.9	99.2
$PM_{2.5}$	99.7	98.0	99.4	99.2	98.9	99.0

5 Traffic information

Traffic volume data (the number of cars) for road links (sections of road) near the monitoring station were provided by Main Roads WA. The Kwinana Freeway and Canning Highway are major corridors for commuters and freight movement and have consistently high traffic levels on both weekdays and weekends. Traffic volume data for Kwinana Freeway and Canning Highway links in the vicinity of the monitoring station were used in the analysis (Figure 5). Appendix E shows the hourly traffic volumes and average traffic speeds for these links.

Figure 5. Main Roads WA traffic volume monitoring network links

On weekdays, traffic volumes on Kwinana Freeway show a northbound peak towards the CBD between 6am and 8am, associated with congested conditions. In contrast, the southbound morning peak occurring earlier, between 5am and 7am, indicates smoother flow. Both directions show an afternoon peak between 3pm and 4pm.

On weekends, traffic volumes on Kwinana Freeway increase from mid-morning with peak flows observed between 10am and 2pm. Vehicle movement remains relatively smooth as indicated by consistently high travel speeds.

Hourly traffic volumes and other parameters for Kwinana Freeway and Canning Highway are summarised in Appendix E.

6 Results and analysis

6.1 AAQ NEPM pollutants

The AAQ NEPM has established air quality guidelines for the criteria pollutants CO, NO_2, O_3, SO_2, PM_{10}, $PM_{2.5}$ and lead. Assessment against the AAQ NEPM guidelines is summarised in Appendix A with further detail provided in the following sections.

6.1.1 Carbon monoxide (CO)

CO concentrations were compared with the AAQ NEPM eight-hour guideline of 9.0 ppm. There were no exceedances of this guideline during the monitoring period. CO concentrations were all less than 10% of the guideline (Appendix A).

Figure 6 shows weekday average hourly CO concentrations generally align with the hourly variations in traffic volumes in the area, with prominent morning and afternoon peaks.

The CO concentration peak in the afternoon also extends into the evening. This may be influenced by other sources of CO in the area that are active at these times (especially in colder months) such as domestic fuel combustion for cooking and home heating. There are also influences from differences in atmospheric conditions such as wind direction and atmospheric stability.

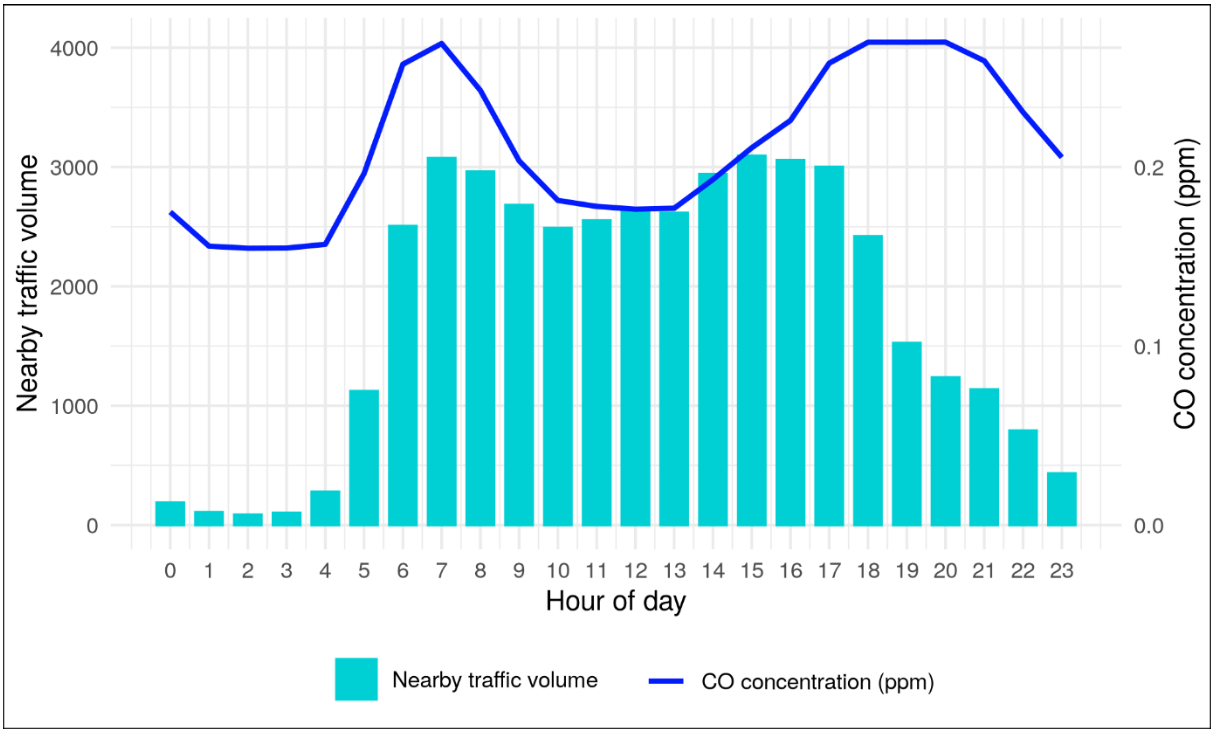


Figure 6. Comparison of weekday average hourly CO concentrations and nearby traffic volumes

6.1.2 Nitrogen dioxide (NO_2)

NO_2 concentrations were compared with the AAQ NEPM hourly guideline of 0.08 ppm and annual guideline of 0.015 ppm. There were no exceedances during the monitoring period, however measured concentrations reached about 75% of the guidelines showing a clear influence of vehicle emissions in the area (Appendix A).

Figure 7 presents the weekday diurnal patterns of traffic volumes and average hourly NO_2 concentrations. NO_2 concentrations appear to be closely linked to traffic volume.

Like the CO results, the NO_2 concentration peak in the afternoon also extends past the traffic peak, although this is less marked. This too may be influenced by other sources that are active at these times. The influence of atmospheric conditions may also be important, such as calm (very low wind) conditions late in the day that are common in autumn and winter may result in limited dispersion of emissions near the monitoring station.

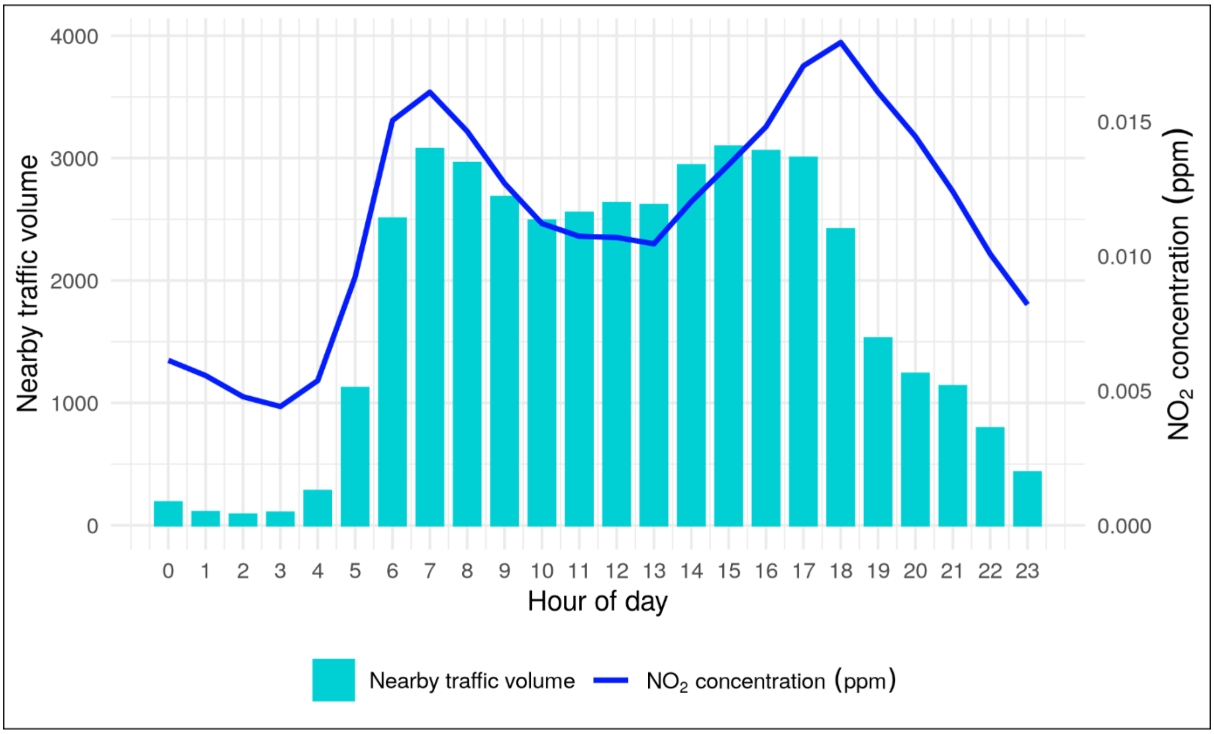


Figure 7. Comparison of weekday average hourly NO_2 concentrations and nearby traffic volumes

6.1.3 Photochemical oxidants as ozone (O_3)

O_3 concentrations were compared with the AAQ NEPM eight-hour guideline of 0.065 ppm. There were no exceedances of this guideline during the monitoring period (Appendix A).

Temperature and total solar radiation have a positive association with O_3 concentrations, because higher temperatures and more sunlight accelerate the photochemical reactions between oxides of nitrogen (NO_2 and NO) and VOCs, which are the precursors to ground level O_3 formation. The association between hourly average O_3 levels and mean temperature is shown in Figure 8.

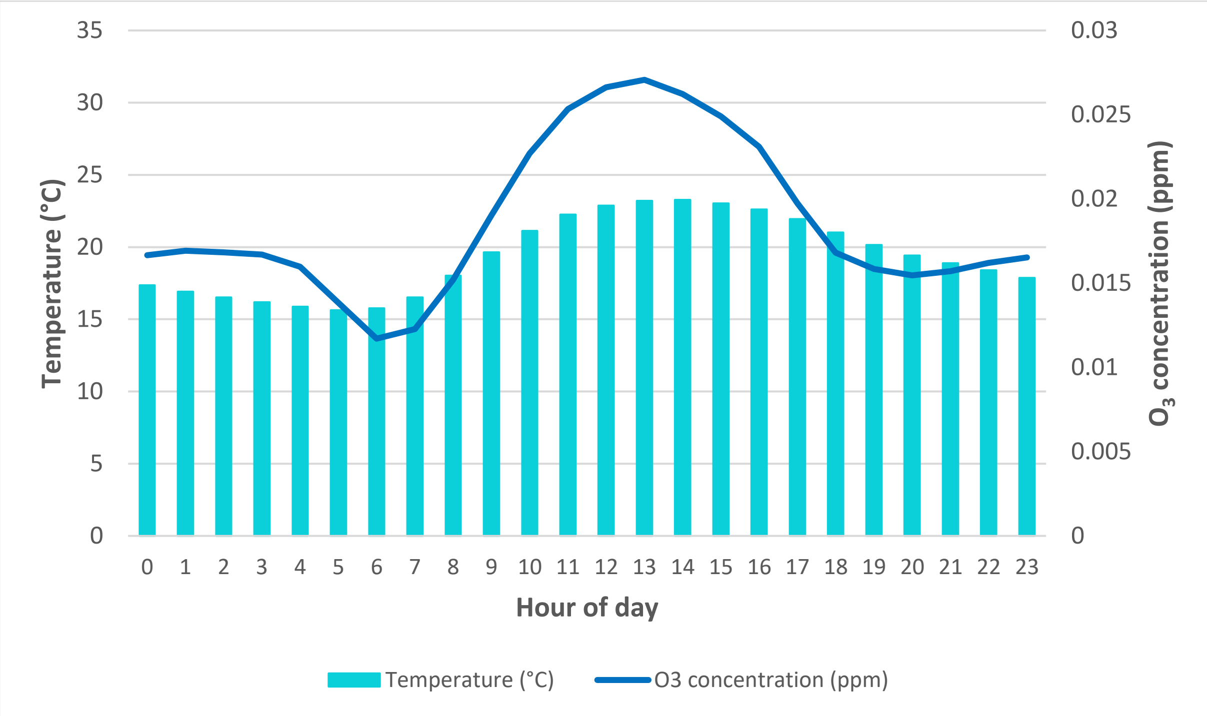


Figure 8. Comparison of average hourly ozone concentrations and temperature

6.1.4 Sulfur dioxide (SO_2)

SO_2 concentrations were compared with the AAQ NEPM hourly guideline of 0.10 ppm and daily guideline of 0.02 ppm. There were no exceedances of the guidelines during the monitoring period (Appendix A).

Figure 9 presents weekday diurnal patterns of traffic volumes and average hourly SO_2 concentrations, showing morning and evening concentration peaks that appear to be linked to traffic peak hours.

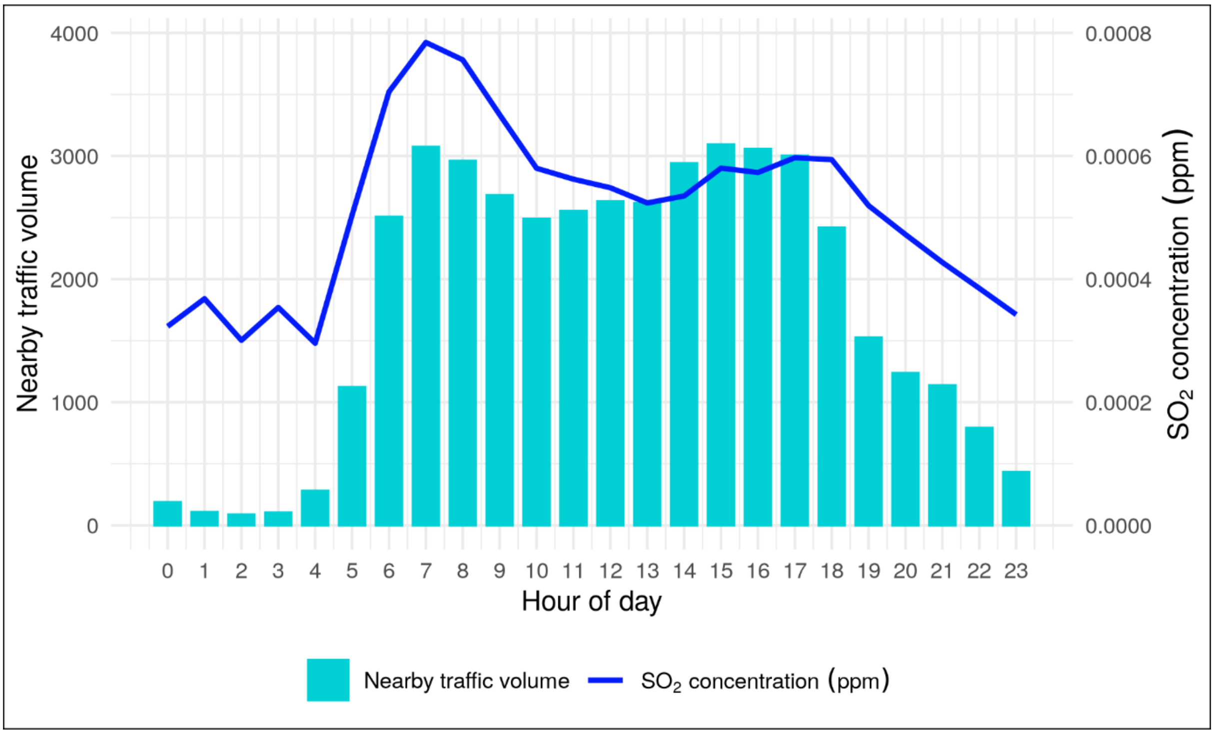


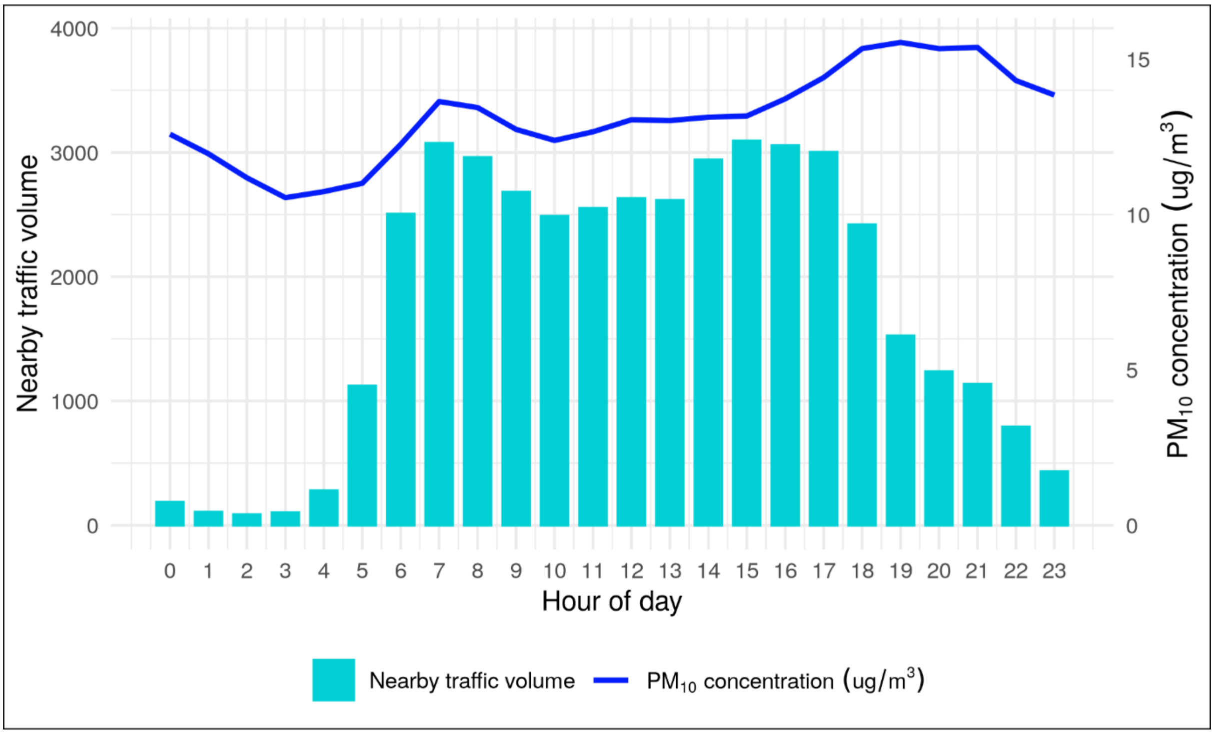
Figure 9. Comparison of weekday average hourly SO_2 concentrations and nearby traffic volumes

6.1.5 Particles as PM_{10} and $PM_{2.5}$

PM_{10} concentrations were compared with the AAQ NEPM daily guideline of 50 µg/m^3 and annual guideline of 25 µg/m^3. There were no exceedances of these guidelines during the monitoring period (Appendix A).

$PM_{2.5}$ concentrations were compared with the AAQ NEPM daily guideline of 25 µg/m^3 and annual guideline of 8 µg/m^3. The annual guideline was not exceeded during the monitoring period. There were three exceedances of the $PM_{2.5}$ daily guideline during the campaign, which are discussed further below.

Figure 10 presents the weekday diurnal patterns of traffic volumes and average hourly concentrations of PM_{10} and $PM_{2.5}$. PM concentrations show a weaker association with fluctuations in traffic flow compared to the other primary pollutants.



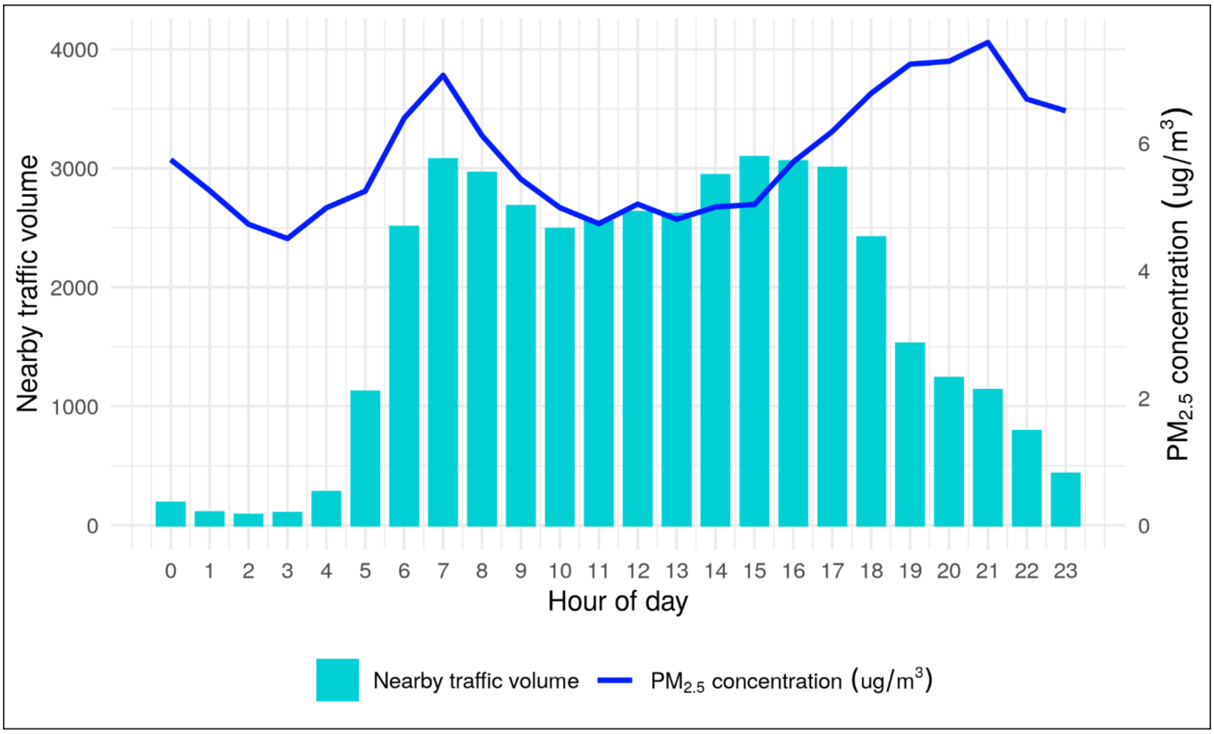


Figure 10. Comparison of weekday average hourly PM_{10} and $PM_{2.5}$ concentrations and nearby traffic volumes

The $PM_{2.5}$ exceedances are shown in Table 3. The exceedances on 22 April 2023 and 4 May 2023 were most likely associated with smoke affecting the wider metropolitan area from prescribed burns in the South West based on information from the Department of Biodiversity, Conservation and Attractions (Appendix B). The exceedance on 21 January 2024 was likely due to recirculated smoke from bushfires, based on information from Emergency WA (Appendix B) noting that 17 fires were active in the South West.

On these exceedance days at Como, there were also $PM_{2.5}$ exceedances elsewhere in the monitoring network indicating that these were regional-scale events, which is typical of smoke pollution from distant fires.

Table 3. $PM_{2.5}$ daily guideline exceedances

Date of exceedance	Daily $PM_{2.5}$ (µg/m^3) NEPM daily guideline 25 µg/m^3
22/04/2023	28.3
4/05/2023	26.8
21/01/2024	27.7

6.1.6 Lead

Lead concentrations were compared with the AAQ NEPM annual guideline of 0.50 µg/m^3. The guideline was not exceeded during the monitoring period (Appendix A).

There were 60 daily samples collected during the campaign, however only four samples contained lead above the laboratory detection limit.

6.2 Metals in PM_{10}

The HVAS PM_{10} samples collected were analysed in a NATA accredited laboratory for a suite of 28 metals and metalloids as detailed in Appendix C. For 11 of the metals analysed, daily and/or annual ambient air guidelines from the department's draft *Guideline – Air emissions* or guidelines derived in consultation with the WA Department of Health (DoH) were used. For the other metals, the department has not adopted guidelines.

Where a laboratory analysis result was below the laboratory limit of detection (referred to as the Practical Quantitation Limit, or PQL), half of the PQL was assumed for the calculation of the annual average concentration. Table 4 presents the maximum daily concentrations and annual averages for those metals for which guidelines are available. There were no guideline exceedances.

Table 4. Daily and annual metals concentrations compared to the guidelines

Substance	Highest daily concentration (μg/m³)	Daily guideline (μg/m³)	Annual average concentration (μg/m³)	Annual guideline (μg/m³)
Antimony	ND[1]	NA[2]	0.003	0.03
Arsenic	0.001	0.03	0.0007	0.003
Chromium[3]	0.005	0.50	0.002	NA
Cobalt	ND	0.10	0.001	0.10
Copper	0.022	1.00	0.011	NA
Lead	0.007	NA	0.002	0.50
Manganese	0.01	0.15	0.003	0.15
Mercury	ND	NA	0.0001	0.20
Nickel	0.002	0.14	0.0007	0.02
Vanadium	ND	1.00	0.001	1.00
Zinc	0.03	50.00	0.009	NA

1. Not Detected (ND) means that all samples were below the laboratory PQL.
2. Not Applicable (NA) means that no guideline has been adopted.
3. Chromium was assumed to be present as the trivalent form Cr III, which is more common in the environment.

7 References

Australian Government 2022, *National Pollutant Inventory 2021, Results - Emissions by Source*

Department of Water and Environmental Regulation 2018, *Perth Air Emissions Study 2011-2012*

Department of Water and Environmental Regulation 2009, *Perth Traffic Corridor Study 2007-2008*

National Environment Protection Council 2021, *National Environment Protection (Ambient Air Quality) Measure*

National Environment Protection Council 2001, *National Environmental Protection (Ambient Air Quality) Measure (NEPM) Technical Paper No.5 – data collection and handling*

Standards Australia 2009*, AS/NZS 3580.9.7, Methods for sampling and analysis of ambient air: Determination of suspended particulate matter — Dichotomous sampler – Gravimetric method*

Standards Australia 2014*, AS/NZS 3580.14, Meteorological monitoring for ambient air quality monitoring applications*

Standards Australia 2015*, AS/NZS 3580.9.6, Methods for sampling and analysis of ambient air: Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – Gravimetric method*

Standards Australia 2020*, AS/NZS 3580.19, Methods for sampling and analysis of ambient air: Ambient air quality data validation and reporting*

Standards Australia 2022, *AS/NZS 3580.9.13, Determination of suspended particulate matter – $PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance monitor*

Standards Australia 2022*, AS/NZS 3580.9.16, Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance monitor incorporating a filter dynamic measurement system (FDMS) unit*

Standards Australia 2023*, AS 3580.7.1, Methods for sampling and analysis of ambient air: Determination of carbon monoxide – Direct-reading instrumental method*

Standards Australia 2023*, AS 3580.5.1, Methods for sampling and analysis of ambient air: Determination of oxides of nitrogen – Direct-reading instrumental method*

Standards Australia 2023*, AS 3580.6.1, Methods for sampling and analysis of ambient air: Determination of ozone – Direct-reading instrumental method*

Standards Australia 2023, *AS 3580.4.1, Methods of sampling and analysis of ambient air: Determination of sulfur dioxide – Direct-reading instrumental method*

United States Environmental Protection Agency 2018, *Particulate matter (PM) pollution,* Research Triangle Park, NC. www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM.

8 Shortened forms and glossary

AAQ NEPM	*National Environmental Protection (Ambient Air Quality) Measure*. NEPMs are a special set of national objectives designed to help protect or manage specific aspects of the environment. www.nepc.gov.au/nepms
BoM	Bureau of Meteorology
DoH	Western Australian Department of Health
Equivalent aerodynamic diameter	Diameter of a spherical particle of density 1 g/cm^3 which exhibits the same aerodynamic behaviour as the particle in question
HVAS	High volume air sampler
PM	Particulate matter
PM_{10}	Particulate matter with a diameter up to 10 μm (micrometres)
$PM_{2.5}$	Particulate matter with a diameter up to 2.5 μm (micrometres)
PQL	Practical Quantitation Limit: The minimum concentration of a compound that can be measured within specified limits of precision and accuracy for a particular laboratory and analytical method
The department	The department represents the Department of Water and Environmental Regulation and its predecessors such as the former Department of Environment Regulation and former Department of Environment and Conservation
USEPA	United States Environmental Protection Agency

Appendices

The appendices listed below are available on the department website at <link>

Appendix A Assessment of compliance with the AAQ NEPM

Appendix B Planned burn and bushfire information

Appendix C HVAS filter analysis results for PM_{10} and metals

Appendix D Laboratory analysis reports

Appendix E Traffic volume and speed data