

Technical Note to support the draft Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

The NSW Environment Protection Authority (EPA) has published the draft *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* ('Approved Methods') for public consultation. The Approved Methods, first published in 2001, has undergone a significant review and update.

Technical Notes provide the scientific and regulatory basis for the major changes introduced in the Approved Methods. These notes explain the rationale behind each amendment, outline the supporting evidence, and clarify how the changes align with contemporary best practice in air quality impact assessment (AQIA).

This section is intended to help practitioners, industry and regulators understand the technical foundations of the revised requirements. It demonstrates how the updates strengthen the Approved Methods by improving consistency, enhancing transparency, and supporting more efficient assessment processes.

Impact Assessment Criteria – toxics

The impact assessment criteria for the principal and individual air toxics in the Approved Methods have been updated to reflect evidence-based health and environmental impacts. The toxics criteria, last updated in 2005, were sourced from the Victorian Government Gazette No. S240 2001.¹ The Victorian values, now superseded, were based on Worksafe Australia Occupational Health and Safety criteria, with a time-weighted factor and a safety factor for the general population applied.

Research in the last 20 years has improved our understanding of impacts to health and environmental from exposure to toxic air pollutants. Importantly, criteria have been developed that are more relevant to population and environmental health exposure, rather than to workplace exposure. The NSW EPA has updated the impact assessment criteria for the principal and individual air toxics by evaluating national and international criteria and guidelines, including (but not limited to) those of the NEPC, WHO, US EPA and California EPA. Where several jurisdictions have (differing) criteria, it is necessary to decide which is to be preferred. We did so by developing a hierarchy of sources in accordance with enHealth (2012) principles. These principles include the recency and frequency of the evaluation or review, the risk assessment methodology, the transparency of the basis of the criteria, and peer review.

We also considered how criteria would be applied – for example, whether for planning or monitoring purposes; incrementally or cumulatively; and at the premises boundary or sensitive receptors – to determine which were most appropriate for the Approved Methods. Many toxics, particularly the principal toxics, have health impacts resulting from long-term exposure at significantly low concentrations. In such cases, having only a 1-hour criterion is not likely to be protective against

¹ <http://www.gazette.vic.gov.au/gazette/Gazettes2001/GG2001S240.pdf>

chronic effects. To this end, where the evidence from health studies indicated, an annual criterion has been added in the Approved Methods. For chronic exposures to certain toxics, there can be both specific health effects and increased risk of cancer. Where there was a cancer risk in addition to other health end points, the 1 in 100,000 risk value (per enHealth guidance) was selected for the annual criterion if that number was more conservative than the other chronic health values.

Many toxics have been removed from the Approved Methods as they do not reflect current industry emissions. For example, *The Montreal Protocol on Substances that Deplete the Ozone Layer* (1987) (the Montreal Protocol) is an international agreement designed to stop the production and import of ozone-depleting substances and reduce their concentration in the atmosphere. Australia signed and ratified the Montreal Protocol. As a result, it is no longer necessary for the Approved Methods to include impact assessment criteria for ozone-depleting substances banned under the Montreal Protocol.

The list of toxics in the Approved Methods is not exhaustive or comprehensive. The absence of a substance listed in the Approved Methods and a specified criterion does not exclude assessment and evaluation of the impacts from a facility. The updated Approved Methods makes clear that, where air toxics are expected to be emitted but there is no criterion for them listed in the Approved Methods, they must still be assessed, and appropriate criteria can be developed in consultation with EPA.

Incremental criteria, thresholds and minimising emissions

The Approved Methods have only required assessment of cumulative impacts against the criteria for the pollutants SO₂, NO₂, PM_{2.5} and PM₁₀. NSW generally experiences good air quality; however, exceedances of the NEPM national standard (which are adopted as Approved Methods criteria) are recorded annually, particularly for PM₁₀ and PM_{2.5}. The Approved Methods currently requires that a proposed facility will not cause 'additional exceedances'. While this approach accounts for days when measured background concentrations are already over the criteria, especially due to extreme events (e.g. dust storms and bushfires), this does not take into consideration the prevention of deteriorating air quality from significant proposed project increments.

The Approved Methods criteria are not values which may be polluted up to but are instead levels at which adverse health and environmental impacts are unlikely to occur (based on current evidence). However, many assessments predict high ground-level concentrations for the facility alone but which, when combined with a background that is low and indicative of good air quality, do not exceed the impact assessment criteria. While the Approved Methods outlines that the setting of emission limits includes the requirement of reasonably available technology and good environmental practices, those proposals that do not exceed the cumulative impact criteria are not pushed to further minimise emissions and maintain or improve air quality.

The objectives (s 3) of the *Protection of the Environment Operations Act 1997* (POEO Act) include to protect, restore and enhance the quality of the environment in NSW and to reduce risks to human health and prevent degradation of the environment through pollution prevention and reduction of emissions to harmless levels. Thus, the current framework to only evaluate proposals based on a

cumulative impact indicates that the full extent of the objectives of the POEO Act are not fully enforced. Implementing incremental criteria and thresholds in the Approved Methods, the NSW policy framework can balance industrial growth with environmental impacts. It will also be used to promote the increased implementation of better-practice controls and mitigation, reduce the risks of adverse impacts from projects, and provide the EPA with a stronger regulatory position to achieve improved environmental outcomes.

The use of incremental criteria is not a novel approach in national and international jurisdictions (Kristensen et al. 2024). For example, incremental criteria were developed as part of the United States' *Clean Air Act 1970*. Two forms of incremental criteria are defined in US legislation (Code 40 CFR 51.165(b)(2) and 51.166): Significant Impact Level (SIL) and Prevention of Significant Degradation (PSD) criteria. Regardless of whether a proposed project's modelled impact will be the source that causes an exceedance of the standard, the project can be approved if the source's contribution is less than the significance levels (US EPA, 1984). This is because the impact of the source is not analysed beyond the point of significant impact so therefore no violation is considered to exist (US EPA, 1984).

Significant Impact Level (SIL)

The updated Approved Methods have introduced SILs for SO₂, NO₂, PM_{2.5} and PM₁₀. If a proposal can demonstrate that the maximum incremental impact at all receptors is below these SILs, generally no further evaluation of cumulative impacts will be required. The primary purpose for the SILs is to allow low-risk proposals to move through the assessment process with less regulatory burden and to encourage better environmental controls for proposals. i.e. 'to rationalise, simplify and strengthen the regulatory framework for environment protection' (s 3 POEO Act).

The SILs represent a concentration of a pollutant at which no significant change in the airshed is likely to be observed. The US EPA determined that an 'insignificant impact' level of change in ambient air quality can be characterised by the observed variability of ambient air quality levels (US EPA 2018a). This approach is fundamentally based on the idea that an anthropogenic perturbation of air quality that is within a specified range may be considered indistinguishable from the inherent variability in the measured atmospheric concentrations and is, from a statistical standpoint, not significant at the given confidence level (CI). This 'air quality variability' approach uses the statistical method of bootstrapping on the measured air quality data (per site for each year), to determine the relative variability of an air quality statistic. The relative variability for each pollutant is then used to determine the corresponding SIL value by multiplying the variability indicator by the associated criteria (National Ambient Air Quality Standards).

The SILs for the Approved Methods have been derived using the US EPA's peer-reviewed 'air quality variability approach' (US EPA 2018b). Hourly NSW air quality measurements of SO₂, NO₂, PM_{2.5} and/or PM₁₀ were obtained from all DCCEEW monitoring stations (2000–24), and the relative variability based on bootstrapping analysis (Figure 1) was undertaken using the 'boot' R package (Canty & Ripley 2025) in RStudio Version 2024.12.0.467 (Posit team 2024).

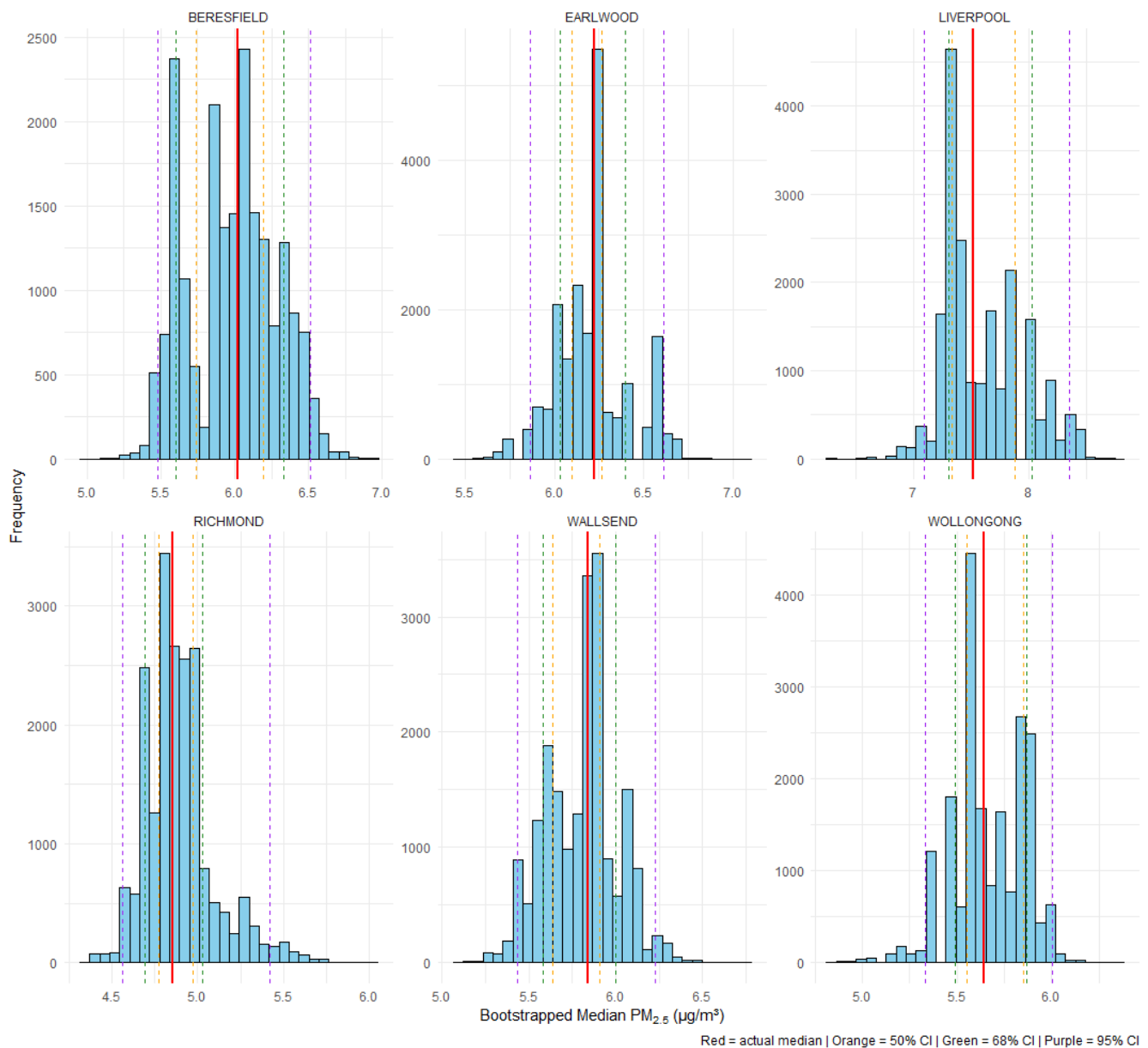


Figure 1: An example of bootstrapped $PM_{2.5}$ results for select sites in 2005

Degradation Prevention Threshold (DPT)

The updated Approved Methods have introduced *Degradation Prevention Thresholds* (DPTs) for CO, lead (Pb), SO_2 , NO_2 , $PM_{2.5}$ and PM_{10} . These, like the SILs, are applied to the maximum predicted incremental impact at any receptor. However, unlike the SILs, where an evaluation is made against a DPT, a cumulative assessment and evaluation against the cumulative criteria (as per the existing assessment requirements) is also required. The purpose of the DPTs is to drive the reduction of impacts through greater consideration and uptake of mitigation measures, to prevent significant deterioration of an airshed, particularly where ambient air concentrations of the pollutant are low.

It is planned to implement the DPTs as a threshold rather than as a hard criterion. If a proposal exceeds the DPT, a Mitigation Options Analysis (MOA) must be conducted. The MOA must demonstrate that all mitigation measures are being implemented to minimise impacts of pollution as far as practicable.

A DPT of 25% for short-term averaging periods (≤ 24 hours) is proposed to align with international criteria (20–27% for Class 2 US PSD increments) and the NEPM acceptance of ambient concentrations not requiring monitoring (75%). An incremental threshold of 20% for annual time periods is proposed to align with thorough evaluation of the health evidence by WHO and specifically for the risk values for $PM_{2.5}$ (Capon and Wright, 2019).

Reduction of harmful substances

Both the WHO and NEPM, as well as numerous health exposure studies, state that there are no safe levels of exposure for the common criteria pollutants. The common criteria pollutants are emitted from natural sources, particularly bushfires, as well as non-EPA regulated sources, such as cars. Data from the NSW ambient monitoring network data shows a significant number of exceedances of the current criteria in recent years (State of the Environment reports, NSW Annual Air Quality Statements). In 2023, there were 47 days with one or more air pollutant over the NEPM and EPA standard. Particulates are the pollutant that exceeds the standards most frequently. Severe drought, dust storms and bushfires are responsible for the extreme spikes in PM_{10} and $PM_{2.5}$ exceedances.

Minimising and limiting emissions of the common pollutants and their precursors is essential to protect human health, restore and enhance air quality in NSW. The Approved Methods already requires the minimisation to the maximum extent achievable for principal toxics based on their carcinogenicity, mutagenicity, teratogenicity, high toxicity or highly persistent nature. In addition to incorporating incremental criteria (SILs and DPTs) into the assessment framework, the Approved Methods is including the requirement to minimise fine particulate matter ($PM_{2.5}$) to the maximum extent achievable through the application of best-practice process design and/or emission controls. The purpose of this requirement is to reduce the risks to human health and prevent degradation of the environment from industrial sources. It aligns with the POEO Act, the objects of which include using mechanisms that promote ‘the reduction to harmless levels of the discharge of substances likely to cause harm to the environment’ (s 3(d)(ii)).

Model period based on quality of meteorological data

The ‘tiered’ approach to the numbers of years of assessment prioritises site-specific measurements for accuracy, while requiring additional years when using less-representative data to capture a broader range of meteorological conditions.

The introduction of this requirement aligns NSW with other jurisdictions – for example, Victoria,² which mandates five years of meteorological data; and both the United States³ and Canada,⁴ which apply similar frameworks requiring one, three or five years, depending on data quality. Adopting this approach ensures consistency with national and international standards and improves the robustness of assessments.

Using multi-year datasets reduces uncertainty in dispersion modelling by accounting for year-to-year variability and worst-case meteorological scenarios, particularly along the Australian east coast where such year-to-year variability is observed (DPE, 2022; Ulpiani 2021). Correlating representative datasets with long-term climate averages and regional extremes ensures that the modelling period reflects conditions that could lead to maximum pollutant concentrations.

Table 1 summarises the advantages and disadvantages of the ‘tiered’ approach.

Table 1 Evaluation of tiered dispersion model period

	Minimum period	Advantages	Disadvantages
Site-specific	1 year	Most accurate representation of local conditions; simpler and less resource-intensive	Limited to one year and may miss year-to-year variability and worst-case conditions
Site representative	3 years	Captures broader meteorological variability; reduces risk of missing extremes; aligns with best practice	Requires more data processing and justification for selected years.
Prognostic	5 years	Ensures full range of meteorological conditions; reduces uncertainty in predictions.	Most resource-intensive; longer modelling and review time.

Introduction of AERMOD as an approved model

AERMOD has been introduced as an approved model in the draft Approved Methods. AERMOD is the USEPA-recommended regulatory model for near-field dispersion, and has been extensively evaluated. Studies consistently demonstrate that AERMOD provide improved accuracy for regulatory purposes (USEPA 2025). The shift to AERMOD aligns with EPA Victoria, which in its 2013 guideline also explicitly moved to AERMOD.

The draft Approved Methods no longer refer to Ausplume. Once foundational to the Approved Methods, Ausplume no longer meets current scientific benchmarks for air dispersion modelling.

² <https://www.epa.vic.gov.au/guide-air-pollution-modelling>

³ https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf

⁴ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/bc_dispersion_modelling_guideline.pdf

Targeted stakeholder engagement in 2024 provided strong support for removing Ausplume from the Approved Methods.

CALPUFF remains an approved model when AERMOD's assumptions are insufficient, such as in complex terrain, where coastal effects are present, or during stagnation or calm winds.

Fugitive dust

The draft updated Approved Methods introduces an additional chapter that directly addresses fugitive dust emissions. It provides greater guidance regarding assessing air emissions from fugitive sources (including mines) and includes more onerous requirements at the planning approval stage for implementation of best-practice controls. Revised guidance addresses the gaps between assessment and planning on the one hand and licence conditions on the other, for mining, metalliferous mining and the silica industry.

The new reporting requirements are not a new concept. They are designed to enable the EPA to more transparently set regulatory requirements so that auditable control measures applied in the AQIA are transferred to approval conditions and environmental protection licences. The new requirements also provide a sound basis for addressing community concern about new and existing mines.

Risk-based odour assessment and alternative method for establishing a criterion

The draft Approved Methods provides additional guidance on interpreting odour impact assessments, with a focus on odour risk. The guidance acknowledges the uncertainties with odour dispersion modelling and promotes the need for contingencies to be developed in case of future odour impacts when land-use is changed or the expected odour performance is not achieved.

The draft document contains a new method for establishing the odour performance criterion for a new or modified activity located outside 'urban centres'. This is to establish the population within the 1 Odour Unit (OU) contour from the cumulative odour dispersion model predictions. The affected population is then defined as that which is predicted to experience odour greater than or equal to 1 OU. The 1 OU is the theoretical minimum concentration that produces an olfactory response or sensation and is the numerical value equivalent to when 50% of a testing panel correctly detect an odour (DEC, 2006). This method has been included in the update to provide clarity on the spatial extent to which the nearby population is to be accounted for in establishing an appropriate impact assessment criterion.

An assessment of odour risk provides additional transparency for the EPA in the approval process. It involves putting the modelling result into context through the consideration of additional information, including: the robustness and appropriateness of the assessment input data; the degree of compliance with the assessment criteria; results of any sensitivity analysis; the proposed odour mitigation measures; and the availability of additional feasible mitigation measures.

Examples of additional information and how they inform the odour risk of a project are:

- **Level of compliance** with the odour assessment criterion at existing and future sensitive receptors. Marginal compliance with the odour assessment criterion indicates there is a risk the odour impacts may be unacceptable.
- **Level of uncertainty** in odour dispersion modelling results. The use of the following data will increase the level of uncertainty in the odour modelling results and therefore the odour risk of the project:
 - non-site-specific meteorological data
 - non-site-specific or unrepresentative odour emissions data
 - average instead of reasonable worst-case odour emissions data
- **Results of any sensitivity analysis.** A higher-risk activity would be one where a small change in any assessment assumption(s) results in a significant change in the predicted impacts. A lower-risk activity would be one where a large change in any assumptions has a minimal impact on predicted impacts. The sensitivity of the dispersion modelling predictions to the following could be investigated: odour emission rate, control efficiency of pollution controls, modelled source type and meteorological data. The sensitivity analysis could also be extended to include the influence of the above on the determination of the appropriate odour assessment criterion.
- **Analysis of dispersion modelling predictions.** A simple statistical analysis of the predicted odour concentrations provides further information regarding the range and frequency of odour concentrations predicted to be experienced at nearby receptors. Analysis that could be presented includes maximum, 99.9th percentile concentration, 99.5th percentile concentration, 95th percentile concentration and frequency distribution.
- **Likely reliability and performance** of odour mitigation measures. Unreliable, maintenance-intensive and poorly performing odour mitigation measures would indicate the proposed activity presents a higher risk. Management measures that require subjective operator intervention also increase risk.
- **Additional feasible mitigation measures** that could be implemented if the activity emits offensive odour after it is operational. An activity where there are no additional feasible odour mitigation measures has a higher risk than one where there are additional feasible odour mitigation measures that could be implemented once operational. Proponents and consent authorities should interpret assessments for projects with no contingency controls accordingly.

Some of the options to minimise uncertainty, and therefore the odour risk of the proposed activity, are:

- **Establish a meteorological station** on the site of the proposed activity. Site-specific meteorological data for a period of 12 months or longer would remove a significant amount of uncertainty in an odour assessment. Given the importance of low wind speed conditions on odour

impacts, wind data should be collected with an ultrasonic-type anemometer and measurements should be recorded at a 1-minute frequency.

- **Collect odour samples** from a similar activity under maximum odour operating conditions. Use the odour sampling data to develop the odour emissions inventory.
- **Assume worst-case conditions** when representing the activity in the modelling.
- **Identify additional feasible mitigation measures** that will be implemented if odour impacts occur when the activity is operational.
- **Undertake dispersion modelling** to demonstrate the reduction in odour impacts with the implementation of the additional feasible mitigation measures.

Sensitive receptors

The definition of *sensitive receptors* has been updated from ‘a location where people are likely to work or reside’ to ‘a location where people are likely to be present’. The previous definition primarily focused on living and working areas, whereas the updated definition provides greater clarity and better reflects the intended interpretation. It now encompasses a broader range of human activities, including recreation, worship and cultural significance, ensuring that air quality assessments consider wider community exposure.

Additional NO_x transformation method

Nitrogen dioxide (NO₂) is a criteria pollutant due to its human health impacts; however, NO₂ is only one of a group of reactive gases known as oxides of nitrogen or nitrogen oxides (NO_x). Given the significant amount of nitrogen oxide (NO) released by sources licensed by the EPA, consideration of the chemical transformation of NO to NO₂ is required during the air quality impact assessment process to evaluate impacts against the NO₂ criteria. The Approved Methods has three methods to model the chemical transformation of NO to NO₂. All existing methods in the Approved Methods remain acceptable for ongoing use and are widely used in national and international jurisdictions.

It was recognised that an additional method was needed to fill the gap between total conversion and more complex and atmospherically relevant methods that require background ozone concentration data. The updated Approved Methods includes an additional NO_x transformation method, known as the Ambient Ratio Method’ (ARM). ARM was originally developed (Chu and Meyer 1991) by analysing historical data from numerous US monitoring stations, to establish a conservative factor for estimating the proportion of model-predicted NO_x concentration for annual NO₂ averages. Following the development of the 1-hour criterion in the US for NO₂, the USEPA updated its guidance document (Appendix W) with ARM2 (RTP Environmental Associates, Inc. 2013; Podrez 2015). ARM2 was developed using ten years of ambient monitoring data from 580 stations.

ARM2 consists of an equation that describes the 98th percentile NO₂/NO_x ratio for each 10-ppb increment of NO_x. The US EPA clearly states that ARM2 ratios are applied to the modelled NO_x concentration to determine total modelled NO₂. For cumulative analysis, monitored NO₂ background levels should not be adjusted by the ARM2 ratio but added to modelled NO₂ (US EPA 2014).

Technical supporting documents to the NO₂ conversion methods for the US EPA include extensive testing of the model as part of the evaluation. US EPA model evaluation databases show ARM (a Tier 2 method) consistently overpredicts in the highest NO_x concentrations compared to more complex Tier 3 methods and measured NO₂ concentrations. As all NO₂ modelling is considered screening, the US EPA prefers, where it cannot be accurate, that screening models and techniques should not be biased to under-predict, and that estimates of NO₂ should either be unbiased or conservative so as not to underestimate facility impacts (US EPA 2015).

ARM (as ARM2) is specified in guidance documents from not only the USA but also Canada (specifically Alberta, British Columbia, Saskatchewan, Quebec state jurisdictions), Hong Kong and the European Union. However, these other jurisdictions have generally developed their own equations based on local ambient measured data, or allow for site-specific development of an equation.

For the inclusion of ARM in the Approved Methods, extensive analysis of ambient NO and NO₂ concentrations (2018-2023 at 38 stations) to determine the NO₂/NO_x ratios was undertaken. As per the ARM development methodology, NO_x concentrations as a function of NO₂/NO_x were evaluated for each site for each year and in aggregate to determine an appropriate default equation applicable for NSW (see Figure 2). To align with existing methods, an empirical relationship was used to develop the NSW default equation rather than the 98th percentile, 6-order polynomial equation.

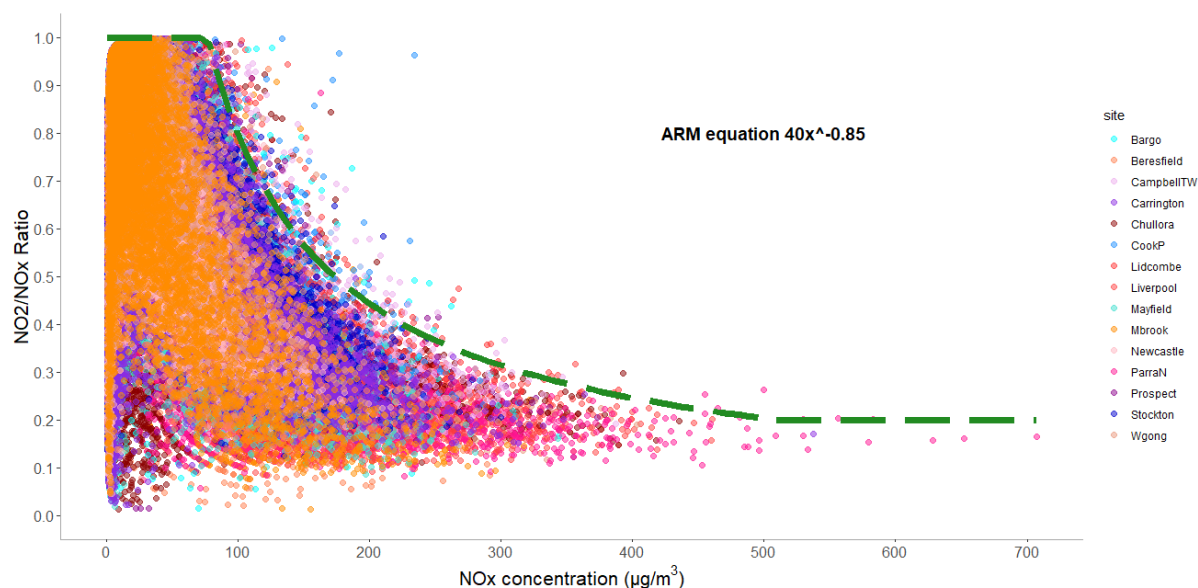


Figure 2: Empirical equation that describes the Ambient Ratio Method for NSW

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