Bath Clean Air Plan

Bath and North East Somerset Council

Analytical Assurance Statement

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Contents

1. Overview

This Analytical Assurance Statement has been prepared in accordance with the requirements set out in the Joint Air Quality Units (JAQU) Evidence package of guidance. It considers the development of the base and baseline models, and the assessment of the shortlisted options.

2. Limitations of the Analysis

2.1 Has the analysis been constrained by time or cost, meaning further proportionate analysis has not been undertaken? Could this further analysis lead to a substantive change in the conclusions?

Timescales for the project have been minimised as much as possible in order to comply with the Ministerial Directive, however this has not been at the expense of the quality of the traffic and air quality modelling. All modelling produced complies with JAQU guidance. In addition, the air quality modelling is compliant with Technical Guidance TG16, and the traffic modelling is largely compliant with WebTAG.

The only element of the traffic model not completely compliant with WebTAG is the variable demand element, which it has been necessary to revise for this project. Development of a full variable demand model would delay the project substantially, so instead a more proportionate approach has been implemented following discussions with JAQU. Full details of the methodology and discussions with JAQU are provided in OBC-13 'T3 Traffic Modelling Methodology Report' in Appendix E of the OBC.

The air quality modelling has a greater level of detail in central Bath where there are exceedances of the objective and at locations where there is the greatest traffic impact of the scheme. Outside of this area the model has a lower level of detail to reduce model run times to a manageable level.

It is not anticipated that either assumptions outlined above regarding the modelling methodology will substantially alter the outcome of the analysis. No further analysis is proposed as it is not expected to lead to different conclusions.

2.2 Does the analysis rely on appropriate sources of evidence? (Rate the source of evidence high/moderate/low)

The project has made best use of data sources available at the time of completion. The key data sources are discussed below, and a rating is provided to indicate the quality of the data source.

The original 2015 base year traffic model was developed with, and validated against, a comprehensive set of traffic surveys conducted in 2014 in accordance with WebTAG criteria. As such it is considered to be reliable evidence for use in the study. Rating: HIGH.

The local fleet has been established from ANPR surveys, collected from 31st October to 13th November 2017. The survey covers all major routes into the city, during a neutral representative period, and captured traffic movements both into and out of 3 different cordons. As such, it is considered to be reliable evidence of the fleet composition within Bath. Rating: HIGH.

Speed data is taken from the traffic model. Alternative sources of speed data are available for the base year, for example Traffic Master or surveys, but such sources would not provide speed data for forecast years or for option assessments. Journey times within the traffic model have been validated, giving some confidence in the modelled speeds, however this validation necessarily covers a limited number of routes. A comparison between modelled speeds and TrafficMaster data has been assessed as part of the sensitivity analysis submitted within the OBC (see OBC-31 'Sensitivity Test report' in Appendix N). Rating: MEDIUM.

The base year air quality models rely on Defra's Emissions Factor Toolkit, and other Defra tools to provide background concentrations, convert NOx to NO_2, and incorporate location specific primary NO_2 fractions. These are industry standard tools, and usage of them follows best practice as well as recommendations within the JAQU guidance. There are known limitations to some of these tools, particularly the Emissions Factor Toolkit.

AQC, who form part of the project team, has reviewed the assumptions contained within Defra's latest Emission Factor Toolkit (EFT) (v8.0.1)[1]. One point of note is that the EFT makes a range of assumptions, which appear to be very conservative, regarding the continued use of diesel cars into the future and the relatively slow uptake of non-conventional (e.g. electric) vehicles. Thus, despite previous versions of Defra's EFT being over-optimistic regarding future-year predictions, it is not unreasonable to consider that EFT v8.0.1 might under-state the scale of reductions over coming years (i.e. over-predict future-year traffic emissions). For assessment years beyond 2020, EFT v8.0.1 makes additional assumptions regarding the expected performance of diesel cars and vans. While there is currently no reason to disbelieve these assumptions, it is sensible to consider the possibility that this future-year technology might be less effective than has been assumed. This has been assessed as a sensitivity test within the Outline Business Case (see OBC-31 'Sensitivity Test report' in Appendix N). Overall, it is considered that the EFT provides a robust method of calculating emissions. Rating: MEDIUM.

The base year air quality model also relies heavily on the 2017 air quality monitoring data which is used to verify the AMDS model. This data is collected across the city, in accordance with procedures outlined in TG16, with diffusion tubes bias adjusted in line with current guidance. The level of confidence in the verification process is necessarily enhanced when data from a number of automatic analysers have been used, as is case in this assessment. It is therefore considered to be reliable evidence. Rating: HIGH.

A local Stated Preference survey was undertaken to establish the response rates of Cars and partially inform the response rates of other vehicle classes. The survey was undertaken by an online market research panel and targeted at a demographically representative sample of panel members in Bath and the surrounding area. 1160 questionnaires were completed, and the data provided good coverage in terms of ages, trip travel purposes and origins. Stated Preference surveys do have limitations in that they rely on participants to make predictions about their future behavioural responses and there is often some difference in these predictions and how people actually respond. However, without these surveys, the analysis would have relied on stated preference work undertaken for London which has a number of differences to Bath in terms of demographics, travel patterns and travel options. Therefore, the use of locally collected data is considered more appropriate. Rating: MEDIUM.

2.3 How reliable are the underpinning assumptions? (Rate level of reliability high/moderate/low)

A comprehensive assessment of the underpinning assumptions has been undertaken by the project team in order to establish the quality of the base/baseline modelling and to consider the sensitivity tests which may be appropriate within the Outline Business Case. The table below summarises the key assumptions which relate to the base and baseline modelling, along with a rating of reliability.

Assumption	Source	Rating
Base year fleet composition	ANPR data	High
Base year traffic flows	GBATH traffic model	High
Growth in traffic flows	TEMPRO v7.2	Medium
Traffic speeds	GBATH traffic model	Medium
Fleet projections (fuel split and Euro standard split)	EFT projections applied to ANPR data	Medium
Background concentrations	Defra maps (modelled) adjusted with local monitoring	Medium
Measured concentrations	Diffusion tube and real-time monitoring sites	High
Canyon effects	ADMS canyon definition	Medium
Road widths	OS mapping	High

[1] AQC. (2018a). Development of the CURED v3A Emissions Model. Retrieved from http://www.aqconsultants.co.uk/Resources/Download-Reports.aspx

Gradients	Lidar	Medium
Primary NO_2 Fraction	Emission Factor Toolkit	Medium
Meteorological data	Meteorological office (via a supplier)	Medium

3. Risk of Error / Robustness of Analysis

3.1 Has there been sufficient time and space for proportionate levels of quality assurance to be undertaken? Have sufficient checks been made on the analysis to ensure absence of errors in calculations?

Quality Assurance (QA) plays an essential part in any analytical project and allowing sufficient time for appropriate quality assurance processes has been a priority within the project team. Effective QA ensures that decisions are made with an appropriate understanding of evidence and risks, and helps analysts ensure the integrity of the analytical output. Jacobs and AQC both have a robust QA System certified under ISO9001.

Extensive QA has been undertaken on the traffic and air quality models by staff who are independent of the model development team. This has been undertaken within Jacobs for the traffic modelling, and within Jacobs and the Air Quality Consultants (AQC) for the air quality modelling. The models for this project are complex and include thousands of individual road-links. As such, there is a large amount of data and it is not practical to individually check every link. Instead, checks have focused on methodologies, model set-up, model calculations, consistency of inputs using sample data at key locations, and sense checks of model outputs using sample data at key locations. Checking has covered all model inputs and outputs.

Wherever anomalies have been identified further checks have been undertaken to explore for errors in the data or calculations.

This system is proportionate to the time and budget available, and the decisions been made based upon the model outputs. As such, the accuracy of the model results is expected to be reasonable and consistent. However, it is not an absolute guarantee that there are no errors within the model.

3.2 Have sufficiently skilled staff been responsible for producing the analysis?

All members of staff used in all aspects of the modelling are suitably qualified, the majority being senior consultants and above, reflecting the complexity of the modelling and the need for robustness of outcomes. The project has oversight from senior members of staff in all areas (traffic modelling, air quality modelling and economics) who are able to call on their extensive modelling and project experiences to guide the assessment process.

4. Uncertainty

4.1 Is the level of uncertainty proportionate to the decision being made?

There are many components that contribute to the uncertainty of modelling predictions. The road traffic emissions dispersion model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them. There are then additional uncertainties, as models (both traffic and air quality) are required to simplify real-world conditions into a series of algorithms.

However, these uncertainties are not specific to this project, and are inherent in any traffic and/or air quality modelling project. The development of the base and baseline models has followed government guidance and best practice throughout in order to minimise the level of remaining uncertainty.

The base year modelling, both traffic and air quality, has been verified against recent and reliable observed/monitored data, providing reasonable confidence in the 2017 model. A large adjustment factor has been applied following the identification of a correlation between the combined NOx emissions of Light Goods Vehicles (LGVs) and Heavy Duty Vehicles (HDVs) on uphill lanes of roads and model adjustment factors for monitoring sites located on roads with uphill lanes. Although there is some uncertainty associated with this adjustment factor, it is based on local monitoring and is thus considered to provide a robust representation of local conditions. This factor will predict a greater reduction from the implementation of a CAZ C when compared with using the uplift for gradients in TG(16), due to the uplift of LGVs. Predicting pollutant concentrations in a future year will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections provided by DfT and Defra as to what will happen to traffic volumes, background pollutant concentrations and vehicle emissions.

To assess the uncertainty further, a series of sensitivity tests have been undertaken on both the baseline and preferred option models as part of the Outline Business Case. Full details of this assessment are provided in OBC-31 'Sensitivity Test report' in Appendix N of the OBC but a summary of the tests undertaken and the implications is provided below.

Test	Summary	Key Results
Uncertainties in the Traffic Modelling		
Uncertainties in the Transport Model at the National Level	Defined high and low growth scenarios based on WebTAG guidance. Compared emissions and NO_2 concentrations to core scenario (CAZ D) and Baseline (no CAZ).	The interzonal matrix totals in the high and low scenarios differed from the core scenario by ±4.68%. The CAZ D high scenario is non-compliant at 10 PCM-equivalent receptor locations, with a maximum exceedance of 1 µg/m^3 (2.2%). All baseline scenarios were non-compliant.
Fleet Composition: Splits by Fuel Type	Defined alternative scenario based on using fuel type splits from the DfT's WebTAG databook instead of the Bath ANPR study. Compared emissions and NO_2 concentrations to core scenario.	Compared to the core scenario, the WebTAG data had a slightly higher proportion of cars that were diesel and a slightly lower proportion of LGVs that were diesel. The WebTAG scenario was non-compliant at 7 PCM-equivalent receptors, with a maximum exceedance of 1 µg/m^3 (1.6%)
Fleet Composition: Splits by Euro Emissions Standard: High and Low Fleet Renewal	Defined high and low scenario based on 2020 and 2022 projections, respectively, instead of the 2021 projections used in the core scenario. Compared emissions and NO_2 concentrations to core scenario (CAZ D) and baseline (no CAZ).	Later years had higher proportions of Euro 6c (cars and LGVs) or Euro 6 (HGV, buses, coaches) and lower proportions of all other categories. The CAZ D high scenario was non-compliant at 13 PCM-equivalent receptor locations with a maximum exceedance of 2 µg/m^3 (3%). All baseline scenarios were non-compliant.

Test	Summary	Key Results
Fleet Composition: Splits by Euro Emissions Standard: EFT Option 1 vs Option 2	Defined alternative scenario based on using future euro emissions standard splits developed using option 2 of the EFT's fleet projection tool instead of option 1. Compared resulting non-compliance ratios to the core scenario.	Option 2 consistently gave lower future non-compliance ratios than option 1 and occasionally gave unrealistic results. No air quality analysis was performed because the core scenario was already based on the more conservative option.
Behavioural Reponses to Charging	Defined pessimistic and optimistic response rates based on confidence intervals of Stated Preference survey statistical modelling and adjusted assumptions for other vehicle types. Compared emissions and NO_2 concentrations to core scenario.	Pessimistic and optimistic scenarios differed the most for LGVs and HGVs as their response rates were the most uncertain. Pessimistic scenario was non-compliant at 16 PCM-equivalent receptor locations with a maximum exceedance of 2 $\mu g/m^3$ (3.7%).
Uncertainties in the Air Quality Modelling		
Differential Bias	Model outputs have been verified and adjusted based on the bias across the current vehicle split, which is likely to be different in future.	It is not possible to quantify the model-specific bias in the EFT without referring to alternative emissions models or emissions test data.
Euro 6 Vehicles	The EFT is based on COPERT 5 which predicts different NOx emissions from Euro 6 diesel vehicles registered in different years (based on the expectation that Euro 6 emissions will reduce over time). Sensitivity test outlined in JAQU's 'Supplementary Note on Sensitivity Testing' has been run.	The High scenario would cause non-compliance (with the central scenario lying closer to the High scenario than the Low scenario.
Inappropriate Emissions Groupings	CAZ definition of compliant and non-compliant vehicles is based on the fundamental assumption that compliant vehicles will emit less NOx than non-compliant vehicles. As a fleet-weighted average, this is expected to be the case, but on an individual vehicle basis, it often will not be.	It is not possible to carry out any sensitivity testing of this issue and is accepted to contribute to the uncertainty in the conclusions of the assessment.
Vehicle Size and Weight	The EFT contains default vehicle size distributions, which specify the proportion of passenger cars with different engine sizes and the proportion of LGVs and HDVs with different kerb weights. Low and High vehicle size distribution scenarios have been modelled (whereby vehicles are moved to a different size group within the vehicle type classification within the EFT)	Neither the 'High' or 'Low' scenario impacts on compliance (in both scenarios the CAZ D is compliant).
Average Speed Emissions Factors	The EFT provides emissions for different vehicle types which vary based on the average vehicle speed. An average speed of, say, 20kph could be achieved in a number of different ways (i.e. accelerating from 0kph, stop start driving, decelerating from a higher speed or driving at a constant 20kph) which will have different emissions associated with them.	It is not possible to carry out any sensitivity testing of this issue and is accepted to contribute to the uncertainty in the conclusions of the assessment.

Test	Summary	Key Results
Emissions at Low Speeds	Roads with queuing traffic or lots of start/stop behaviour will, in general, have lower average vehicle speeds than other roads and so stop/start driving is accounted for by way of reduced average speeds in the EFT. The speeds in the traffic model are based on the average speed along a road. In reality, the speed will very often be slower at the start and end of a road and faster in the middle. JAQU has set out a methodology to assess the uncertainty of emissions from vehicles travelling at low speeds in their 'Supplementary Note on Sensitivity Testing' which involves using a polynomial equation provided by JAQU which is based on using the COPERT emissions functions beyond their intended speed ranges.	Neither the 'High' or 'Low' scenario impacts on compliance (in both scenarios the CAZ D is compliant).
Background Concentrations	The background pollutant concentrations across the study area have been defined using the national pollution maps published by Defra, calibrated against local measurements made at a single background diffusion tube monitoring site in Bath in 2017. There may be inaccuracies in the measurements, or the site may be affected by some unidentified local emission source. To test the sensitivity of the results to this issue, NO_2 concentrations have been predicted for 2021 for both the baseline and CAZ D scenarios, with and without the local calibration applied to the background concentrations.	Without a local calibration factor being applied to Defra's national pollution maps, the predicted concentrations are generally lower than if backgrounds are calibrated, but the maximum concentration is marginally higher and non-compliant.
Model Verification	The model verification for NOx and NO_2 concentrations has been investigated in detail. A large number of parameters have been investigated. As set out in the Technical Note on Gradient Emissions in Appendix 1 of OBC – 11 'AQ3 Air Quality Modelling Report', the only parameter that was found to have a systematic effect on the verification was the combined percentage of light goods vehicles and heavy duty vehicles on hilly roads adjacent to monitoring sites. Verification for PM_{10} is based on a single monitoring site, and there is thus a significant amount of uncertainty around the adjustment factor.	Since no other correlations were found, there is no justification for sensitivity testing the verification for any other parameters for NOx and NO_2. For PM_{10} it is judged that compliance is the likely scenario.
Receptor Locations	There is uncertainty around the LAQM receptor locations being worst case. A height of 1.5m has been used, which could be interpreted differently in different situations. NO_2 concentrations have been predicted at intervals of 0.5m from a height of 0 m to 12 m at three receptor locations.	The predicted concentrations fall off with height, thus if there is relevant exposure higher than 1.5m then concentrations will be lower and thus compliant with a 2021 CAZ D scheme. Below 1.5m concentrations remain very similar to those predicted at 1.5m and all concentrations remain compliant.

Test	Summary	Key Results
Road Widths and Geometries	Road widths and geometries have been included in the model manually. Although this is time consuming, this is judged to be the most accurate way of reflecting a complex local situation within the model.	Because of the large numbers of roads and street canyons, within the model, any disparity in interpretation is unlikely to be standard across the whole modelled network. There is no objective basis for testing the effect of this issue and this will contribute to the uncertainty in the conclusions of the assessment.
Gradients	Vehicle emissions on gradients have been uplifted and the decision on whether an individual road should have this adjustment applied is important. The gradients are based on Lidar data, which will have inherent uncertainties associated with them, and with their application. A 'Low' scenario has been run where the change in height along each road has been reduced by 2m to a shallower gradient and a 'High' scenario has been run where the change in height along the road has been increased by 2m.	The results of the sensitivity tests for 2021 CAZ D scenario show higher concentrations in the 'Low' scenario and lower concentrations in the 'High' scenario, with the scenarios being non-compliant and compliant respectively.
Junctions	As with road widths, and geometries, junctions have been included in the model manually and there is thus potential for uncertainty from subjective decisions.	Any disparity in the interpretation of a junction is likely to be junction-specific, and as such there is no basis for testing any different conditions.
Meteorological Data	Meteorological conditions, in particular wind speed and direction, play a key role in the dispersion of pollution in the atmosphere. The air quality modelling has been carried out using one year of meteorological data (2017) from a single meteorological station (Filton Airfield). Although this meteorological station and year of meteorology are considered to be representative of conditions in Bath, conditions will vary from year to year and locally over different topographies.	Wind roses over 5 years, from 2 sites clearly demonstrate that the dominant wind direction is west south-westerly, between 245° and 265°, and is generally consistent for all of the wind roses.
Meteorological Parameters	The ADMS dispersion model requires a number of meteorological parameters to be set for both the meteorological station and the study area. These are: latitude, surface roughness, surface albedo, minimum Monin-Obukhov length and Priestley-Taylor parameter. The values used for these parameters have been set subjectively and there is thus scope to introduce uncertainty.	As the model has been verified against local monitoring in Bath, any inaccuracies in the values used for these parameters will essentially be accounted for in the model adjustment process. The remaining uncertainty will be minimal but will nevertheless contribute to the overall uncertainty in the conclusions of the assessment.
Primary NO_2 Fraction	There is emerging evidence that the average primary NO_2 fraction (f-NO_2) in exhaust emissions from road vehicles has begun to decrease in recent years. This is not taken into account within the EFT, as used for the air quality modelling. To account for this, JAQU suggest that a sensitivity test be carried out whereby the f-NO_2 values are reduced by 40% in the future projected year.	If the f-NO_2 values are reduced by 40% then the predicted concentrations are slightly lower, with the maximum predicted concentration being 3 µg/m^3 lower than the 'Central' scenario. Although this suggests that an earlier year could be compliant if f-NO_2 values decrease, the earliest year B&NES may be able to implement a CAZ D would be 2020 in any event and f-NO_2 values are unlikely to be as low as 40% of current values by 2020.

Test	Summary	Key Results
Regional Ozone	Defra's NOx to NO_2 Calculator calculates NO_2 concentrations from NOx concentrations, based on the reactions of mixing of nitric oxide, nitrogen dioxide and ozone. This relies on tabulated concentrations of ozone above the surface layer for each local authority, for which there is an uncertainty.	There is no basis for an alternative approach, but it is acknowledged that this issue will contribute to the overall uncertainty in the conclusions of the assessment.
Non-Road Sources	Pollutant emissions from vehicles using local roads are explicitly included in the model and other sources are generally accounted for within the background concentrations. There may, however, be a number of emission sources that are not included within the background maps and may not be fully represented.	Emissions from construction works will be temporary and have therefore not been explicitly included in the model. The effect is likely to be greater for particulate matter than for NO_2. Generators and Non-Road Mobile Machinery cannot be included in the model in a robust manner. The effect of existing centralised energy plant and generators will be partially taken into account in the verification process. Emissions associated with the Great Western Main Line have been considered separately in the Diesel Train Emissions Technical Note appended to OBC – 11 'AQ3 Air Quality Modelling Report'.
Impact of Simultaneous CAZ in Bristol		
Analysis of Census Data	Review of census Travel to Work data for residents who live approximately within the Bath and Bristol CAZ regions.	4% of Bath CAZ residents commute to Bristol CAZ, while 0.8% of Bristol CAZ residents commute to Bath CAZ. 28% of commutes between Bristol and Bath CAZs occur by private vehicle.
Analysis of Stated Preference Survey Data	Comparison of results from the Bath SP survey to results from the Bristol SP survey. Combination of results from both surveys to estimate how often non-compliant drivers travel to both CAZs.	Bath SP survey respondents would drive into the Bristol CAZ with approximately the same frequency that they would drive into the Bath CAZ. Therefore, the Bristol CAZ would likely have just as strong an effect on these residents as the Bath CAZ. Combining both surveys, approximately 17% of car drivers and 41% of LGV drivers are estimated to drive into both CAZs on the same day at least once per week.
Analysis of ANPR Data	Review of ANPR data from both Bath and Bristol to determine how fleet composition changes based on frequency of trips into one or both CAZs.	Vehicles that travel into one or both CAZs more often are more likely to be non-compliant or diesel. They are also more likely to be an LGV, HGV, Bus, or Coach. Therefore, simultaneous CAZs in both cities would disproportionately affect more polluting vehicles.

In summary, a wide range of sensitivity testing has been undertaken which shows both compliant and non-compliant results. Whilst this demonstrates that there is some variability within the results (as would be expected in any modelling process), the likelihood of compliance and non-compliance occurring is fairly similar, even when taking into account cumulative aspects, and it generally supports the selection of the preferred option as the most likely scheme to achieve compliance in the required timescales. There is emerging evidence that the average primary nitrogen dioxide fraction (f-NO_2) in exhaust emissions from road vehicles has begun to decrease in recent years, and the sensitivity testing has demonstrated that this may result in significantly lower concentrations; this is thus considered to be the largest uncertainty associated with the modelling. Although this suggests that an earlier year could be compliant if f-NO_2 values decrease, the earliest year B&NES may be able to implement a CAZ D would be 2020 in any event. Given the uncertainty, the preferred option is still the most likely scheme to achieve compliance. In addition, the level of uncertainty within the modelling has been minimised as far as possible and is suitable for decision making in the Bath Clean Air Plan.

5. Use of Analysis

5.1 Does the evidence provided support the business case? Is there evidence the agreed target will be achieved?

The assessment undertaken has provided evidence of the concentrations of NO_2 anticipated on each modelled road link in Bath, with and without the proposed scheme. This has shown that the proposed scheme is sufficient to reduce concentrations of NO_2 to 40 $\mu g/m^3$ in 2021.

The level of uncertainty is very similar within each modelled scenario, since they all have been completed with the same set of assumptions. A review of these assumptions has been undertaken within a comprehensive set of sensitivity tests (OBC-31 ‘Sensitivity Test report’ in Appendix N of the OBC) using quantitative methods as far as possible. The nature of modelling is such that it is never able to provide complete certainty of a desired outcome. However, the sensitivity analysis has demonstrated that whilst there is a possibility that the proposed scheme will not achieve the agreed target, the most likely outcome is that it will. Hence, the evidence provided supports the business case for the proposed scheme.

6. Summary

This Analytical Assurance Statement for the Bath Clean Air Plan, outlines the main limitations, risks, uncertainties within the assessments undertaken, and the suitability for use. All questions set out by JAQU in the Evidence Package of guidance have been answered comprehensively within this document.

The assessments for the Clean Air Plan have been undertaken with appropriate sources of data, and any limitations and risks with the data sources or methodologies have been identified. A full range of sensitivity testing has been completed within the Outline Business Case to assess the impact of altering key assumptions on the outcomes of the modelling. Accounting for the outcomes of the sensitivity analysis, the evidence supports the business case for the proposed scheme.