Leeds City Council – CAZ Remodelling for 2021 – AQ Technical Note and Results

This note details the scenarios assessed and results from a second round of AQ modelling. It also includes two appendices with supplementary detail:

Appendix 5 A – January 2020 ANPR fleet methodology

Appendix 5 B – Explanation of EFT & Dispersion Modelling

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Introduction

Additional Traffic Modelling has been conducted to account for the contraflow arrangement during the repairs to Regent St Bridge on the A64.

At this location the A64 is a 40mph dual carriageway running over a dual span bridge and entering a box canyon. The repairs to the bridge will see one span demolished and replaced, before switching to the second span. During this period traffic will be narrowed to a 30mph single direction flow in both directions utilising the operational span. The contraflow operation covers approximately 1km and will be in place for 18 months from July 2020 through to December 2021.

It is of significant relevance to the Air Quality Modelling as the one Target Determination Receptor (TD58230) in exceedance of the 40µgm^3 NO2 limit is positioned to the south of the carriageway at the western end of the contraflow.

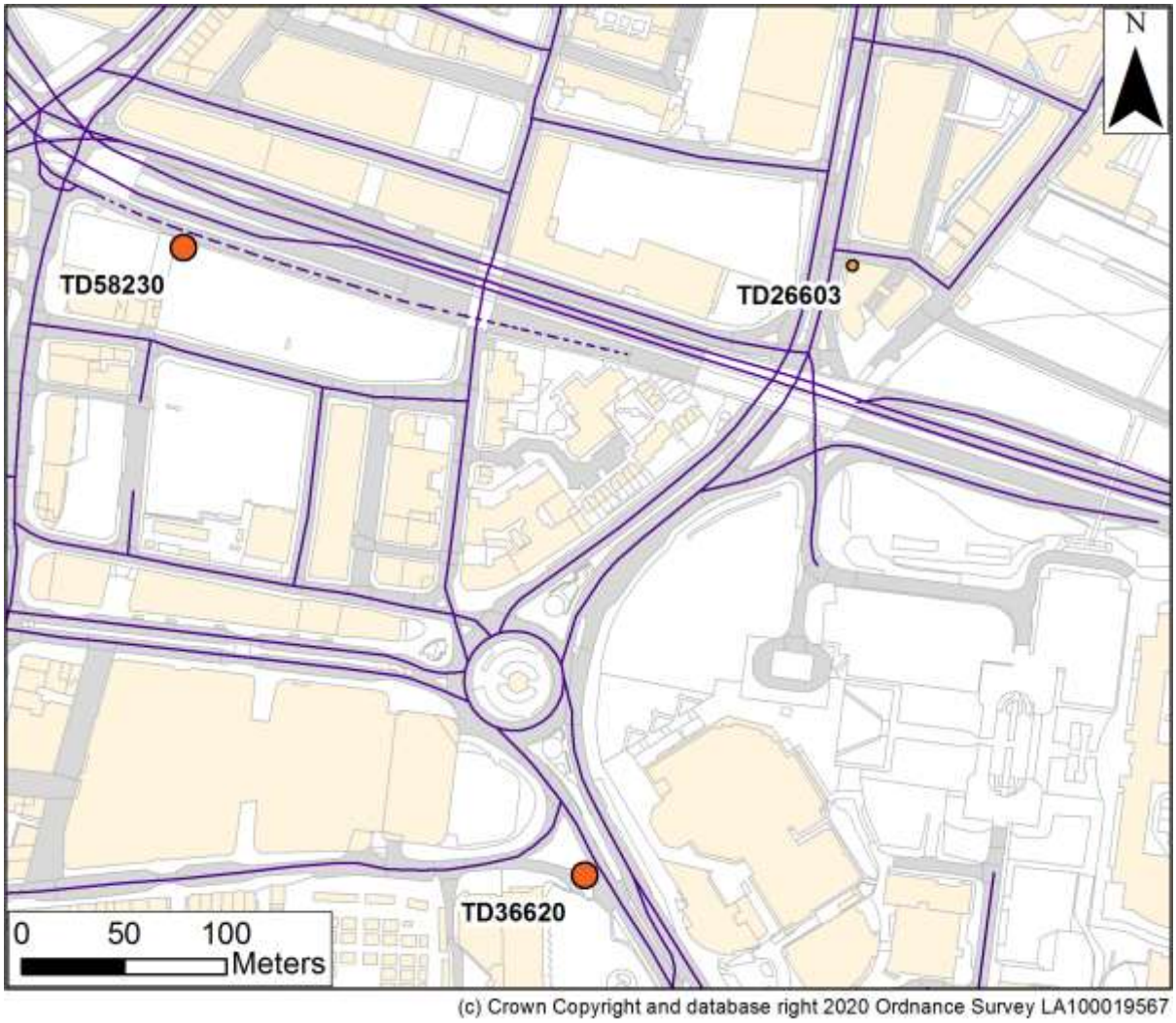

Figure 1: The A64 runs West-East through the image adjacent to TD58230. Note the blue lines illustrate the carriageway centreline used for 2021 A Contraflow Phase 1 dispersion modelling. The adjacent off slip is closed in 2021 , indicated by the dashed line..

Scenarios

The traffic modelling undertaken is reported in the accompanying note and has produced a number of scenarios which will be assessed for NO2. These are;

- 2020 Do Min (as per original business case submission)
- 2022 Do Min (as per original business case submission)
- 2021 A – Contraflow Phase one operating on Northern Bridge Span
- 2021 B – Contraflow Phase 2 operating on Southern Bridge Span
- 2021 – No contraflow (for comparison only)

In addition to the above traffic models, two significant variations have been made in the AQ modelling. The original business case submission used ANPR data from 2016 to derive a local vehicle fleet used in the 2015 Base AQ model and for validation. This 2016 fleet was then projected forward to 2020 and 2022. The above scenarios have been run using these projections, in the case of the 2021 Traffic Models, the 2020 Fleet Projection was used to assume worst case scenario.

Further to the 2016 Fleet Projections, additional ANPR data was captured in January 2020 and used to create and addition 2020 Fleet, see Appendix 1. This fleet has been used to create a second set of four scenarios which should be more representative of the current fleet in Leeds compared to the projections created 4 years previous.

- 2020 Do Min using 2020 ANPR Fleet
- 2021 A – Contraflow Phase 1 using 2020 ANPR Fleet as worst case
- 2021 B – Contraflow Phase 2 using 2020 ANPR Fleet as worst case
- 2021 Do Min using 2020 ANPR Fleet

In addition to the traffic models above, run with projected 2020 fleet vs actual 2020 fleet, four additional sensitivity scenarios have been run;

- 2020 D0 Min using ANPR Fleet but Scheduled Bus Services running as 50% Euro VI
- 2020 Do Min using ANPR Fleet but Scheduled Bus Services running as 70% Euro VI
- 2021 A – Traffic growth at 5% higher than Tempro and using 2020 ANPR
- 2021 B – Traffic growth at 5% higher than Tempro and using 2020 ANPR.

Results

Modelling the traffic models using the 2016 Fleet projections displays 4 exceedances. The original 2020 Do-Min, one in the 2021 A scenario and two in 2021 B. The top site is critical to compliance, with three more listed as extremely high and a risk to compliance.

Under these conditions, the AQ Objective would not be satisfied and intervention would still be required.

Table 1: Traffic scenarios using 2016 Fleet Projections

SiteID	X	Y	Validation Zone	DM20	DM21 Contraflow A	DM21 Contraflow B	DM22
TD58230	430502	433899	Central	**43.71**	38.65	**40.14**	39.38
TD36620	430698	433593	Central	39.84	**41.00**	**41.05**	35.95
TD18451	429216	433687	IRR	39.81	39.14	39.05	35.91
TD28288	430766	433168	Central	39.08	39.27	39.38	35.56
TD74892	430978	433467	Central	36.31	34.63	34.63	32.98
TD36055	429507	426437	Outer	35.87	34.75	34.77	31.36
TD47438	420263	434243	Outer	35.61	34.53	34.52	31.65
TD26603	430829	433890	A64	35.49	33.69	33.53	32.21
TD9050	428923	431681	Central	35.29	26.16	26.16	31.50
TD81387	430724	433133	Central	35.12	35.01	35.10	32.00
TD8548	425067	428031	Outer	35.06	34.74	34.74	31.05

The January 2020 ANPR data reports a significantly improved picture compared to the original 2016 Fleet projections for a Do-Minimum scenario. Buses and HGVs are operating at close to 90% compliance with Euro VI standards, and half the private car fleet matches the CAZ-D requirements.

In these scenarios compliance is achieved at all target determination points and in both contraflow scenarios. Compared to the original Do Min 2020 prediction, the current situation has improved by 4.78µgm^3 of NO_2 at TD58230 which would continue into a 'normal' 2021 and during both contraflow scenarios.

Table 2: Traffic scenarios using Jan-2020 ANPR Fleet.

SiteID	X	Y	Validation Zone	DM20	DM20 ANPR	DM21 ANPR	DM21 Contraflow A ANPR	DM21 Contraflow B ANPR
TD58230	430502	433899	Central	**43.71**	38.93	38.68	34.82	35.08
TD36620	430698	433593	Central	39.84	34.44	34.48	34.24	34.24
TD18451	429216	433687	IRR	39.81	37.23	36.96	36.89	36.80
TD28288	430766	433168	Central	39.08	36.80	37.01	36.33	36.23
TD74892	430978	433467	Central	36.31	33.34	33.21	31.53	31.48
TD36055	429507	426437	Outer	35.87	34.39	34.72	34.77	34.72
TD47438	420263	434243	Outer	35.61	33.29	32.99	32.99	32.93
TD26603	430829	433890	A64	35.49	33.32	33.16	31.95	31.66
TD9050	428923	431681	Central	35.29	33.50	24.89	25.01	24.95
TD81387	430724	433133	Central	35.12	33.07	32.89	32.51	32.44
TD8548	425067	428031	Outer	35.06	34.39	34.54	34.46	34.37

Additional sensitivity scenarios have been run which explore variation in traffic and scheduled bus service compliance. The two different contraflow scenarios have been run with traffic growth at 5% higher than Tempro.

The two scenarios on bus variation use the 2020 Do-Min traffic model with the 2020 ANPR data but assume that bus compliance drops from the observed 92% Euro VI, to 50% and 70% respectively, with remainder assumed to be Euro V. This is modelled on scheduled bus services only.

In both the scenarios with reduced bus compliance, exceedances are expected at TD58230. This site is in proximity to the major bus route into the city centre for the north-eastern wards located along the A61 and A58.

Table 3: Sensitivity scenarios.

SiteID	X	Y	Validation Zone	DM20	DM21 Contraflow A ANPR 105%	DM21 Contraflow B ANPR 105%	DM20 ANPR Bus50%	DM20 ANPR Bus70%
TD58230	430502	433899	Central	**43.71**	35.36	36.76	**42.34**	**40.83**
TD36620	430698	433593	Central	39.84	34.77	34.85	39.14	36.99
TD18451	429216	433687	IRR	39.81	37.53	37.42	38.61	37.99
TD28288	430766	433168	Central	39.08	37.00	37.13	38.10	37.54
TD74892	430978	433467	Central	36.31	31.99	32.04	35.31	34.38
TD36055	429507	426437	Outer	35.87	35.33	35.33	34.44	34.42
TD47438	420263	434243	Outer	35.61	33.83	33.83	34.47	33.93
TD26603	430829	433890	A64	35.49	32.39	32.16	34.66	34.05
TD9050	428923	431681	Central	35.29	25.46	25.48	33.98	33.74
TD81387	430724	433133	Central	35.12	33.05	33.17	34.25	33.73
TD8548	425067	428031	Outer	35.06	34.84	34.84	34.49	34.46

Alternate scenarios

Given that the 2020 Do-Min scenario using the ANPR data is returning compliance, further scenarios exploring reduced traffic flows were not explored.

A 2022 scenario utilising the ANPR data has not been run. The ANPR data was collected in January 2020 and has been assumed not to change for the 2020 and 2021 scenarios to represent worst case. It is unrealistic to not expect fleet change to 2022. As such conducting a 2022 scenario would require creating additional fleet projections. This step has not been taken.

It is also not expected that the local vehicle fleet will progress backwards. SMMT data for July indicates new car sales are 20% down on the same time last year indicating a continuation of normal trends, if on a reduced basis. No data was easily available reflecting the impact post-lockdown on second hand car sales.

Comparing the T105% scenario with the equivalent normal growth produces a variation of -0.59 / +0.78 μgm^3 of NO_2 across the 183 Target Determination points. Decreases are only present at 4 sites and attributed to reallocation of traffic flows to alternate routes.

Increased traffic flows have only been slightly explored as Tempro forecasts are predicting higher growth than currently demonstrated on local roads. As such a 5% increase beyond Tempro is deemed optimistic. Given the reluctance of office workers to return to the 5 day commute in a post-lockdown environment, running additional higher growth scenarios was not deemed to be necessary.

The two contraflow scenarios have been modelled independently. The switch is expected in April 2021 and it is arguable that the two scenarios should be combined to represent the full year. The 2021 B scenario is worst-case as traffic is closest to the critical receptor, and yet given a full year of traffic rather than 8 months compliance is still achieved. A combination of the two flows would only provide a reduction on the 2021 B scenario.

Conclusion

The original CAZ modelling made a conservative assumption in relation to local fleet turnover. The January ANPR data indicates that the local fleet is cleaner than expected, whether this is due to normal trends or as a benefit of the proposals towards the CAZ is unknown. The city has however benefited from the cleaner fleet and as a result the modelling demonstrates compliance in all scenarios where the fleet is represented by that from the ANPR data.

The modelling demonstrates compliance in 2021 in both contraflow scenarios and in the 2020 scenario.

As such, it is recommended that a Clean Air Zone is not needed.

Given the sensitivity around the critical receptor to bus traffic, it is recommended that monitoring of the local fleet be maintained and agreements sought with bus operators to keep cleaner vehicles in Leeds.

Appendix A – January 2020 ANPR Methodology

The aim of using the ANPR data was to provide an updated snapshot of the local fleet make-up for the purposes of assigning to Euro emission types for input into the Euro tab in the Emission Factor Toolkit.

The January data was collected over a 7-day period running Thursday 9th January to Wednesday 16th January. It utilised 17 of the recently installed Siemens Sicore II cameras installed for CAZ enforcement. Siemens collected the data at the request of LCC and it was passed over in a raw unedited format. Note that the cameras available were those that had been installed and were ready for 'Go-Live'.

The cameras were located in 8 pairs capturing traffic in both directions and one single device capturing inbound traffic.

4 pairs and the single were positioned on radials in the suburban area on key radial routes of the A61, A58, A65, A647 and B6159.

Two pairs are located at Ingram Distributor (J2 M621) and on the A58 (R.Aire Wellington Bridge) capturing traffic orbiting the city centre on the inner ring road.

The final two pairs are on the city centre cordon and capture traffic entering the city centre.

The received data was cleaned by LCC. This process removed;

- Returns longer than 7 characters
- Strings flagged as parking rather than approaching or departing
- All text only strings
- All numeric only strings
- Sequential sightings within 10s
- Linear subsets of repeat sightings within 10s
- Strings shorter and 50% similar to sightings within 3s

The remaining dataset contained approximately 1.9million lines. This was passed to DfT via JAQU and for each line contained;

- Vehicle Registration Mark (VRM)
- Camera ID
- Capture Timestamp
- Capture confidence
- Direction
- Length of String
- VRM Captures – Number of times vehicle observed
- VRM Sites – Number of sites vehicle observed at

DfT processing returned a 97% match rate and provided additional fields consisting of;

- BodyType
- Month First Registerd

- Year of Manufacture
- Engine Size (in cc's)
- Propulsion Type ID (Fuel type; - Diesel, Petrol, Gas, EV etc)
- Type Approval
- Wheel Plan ID
- Gross Weight
- CO2 Emissions

The original business case used 'Trips' rather than individual vehicles to assume the percentage split between Euro types. This accounts for some vehicles making more trips than others.

The vehicles were split down a variety of criteria to provide bandings by type for entry into EFT;

- Car – M1, split by weight band and fuel type
- LGV – N1, split by weight band and fuel type
- Rigid HGV – N2 & N3, split by Wheel Plan vs Articulated, split by weight
- Articulated HGV – N2 & N3, split by Wheel Plan vs Rigid, split by weight
- Buses – M3, split by Wheel Plan vs Coaches, split by weight
- Coaches – M3, split by Wheel Plan vs Buses, split by weight

A number of entries which did not have all the necessary data were discarded during this process.

An assumption was made that Coaches have 3 rigid axles vs 2 rigid axles for buses. This was followed up by manually entering a selection of plates for each weight band and axle type into the online MOT tool to double check vehicle type.

The Taxi fleet was created by utilising local records for registered Hackney Carriage and Private Hire and extracting those vehicles from the Car (M1) records before proceeding with analysis. Leeds HC&PH conduct approximately 80% of trips in the city centre, thus using LCC registered only vehicles to represent the Taxi fleet is deemed proportionate.

Appendix B – Explanation of EFT & Dispersion Modelling

As detailed in the original business case evidence submission, the Leeds Transport Model (LTM2) provided an output detailing Compliant and Non-Compliant vehicles for all scenarios. To model this for Air Quality, 5 EFT spreadsheets are run for each traffic scenario. The current model runs detailed above make no provision for compliance vs non-compliance, but the same system is still used and requires 3 EFT spreadsheets.

The LTM2 provides flows for Cars, LGVs, OGVs and Public Service Vehicles, over 4 time periods. There is an intermediary workbook which configures the LTM2 outputs into a format for entry into EFT. Pending the 'Traffic Format' used this can vary. The three EFT workbooks used per scenario cover Motorway Traffic, Taxis, all other Traffic.

- Motorway Traffic;
    - Flows as per LTM2
    - Speeds as per LTM2, except where outside 5/140kph
    - Emissions set for year, in this case 2020 for all 2020 and 2021 scenarios to assume worst case
    - Detailed option 2 used, Rigid vs Artic set as 32% vs 68% for all links
    - Default Euro Composition – (potentially newer than local road composition).
- Taxis Only;
    - Flow is a fixed percentage of car traffic from all links
    - Speeds as per LTM2, except where outside 5/140kph
    - Alternative Fuels Option – a fixed percentage per fuel type applied to each link, see EFT files or spreadsheet
    - Euro Composition as per ANPR data – see supplementary spreadsheet
- Non-Motorway Traffic
    - Flows as per LTM2, excepting deduction for taxis
    - Speeds as per LTM2, except where outside 5/140kph
    - Alternative Fuels Option – fixed percentage applied to each link
    - Euro Composition as per ANPR or where otherwise specified

The Outputs from the EFT sheets are combined to generate NOx emissions for each link. The f-NO2 function is also used in each EFT and combined with the NOx emission to generate an NO2 emission for each link.

Both NOx and NO2 emissions are attached to a shapefile and entered into the Airviro Dispersion Model.

In the results processing workbook, Modelled Road NO2 and NOx provide a function f-NO2 for entry into the DEFRA NOx-NO2 calculator to provide Road NO2, as no chemistry is conducted in Airviro. The Road NO2 is adjusted using a validation factor.

Background NOx and NO2 are from the DEFRA background projections, adjusted to remove Road Emissions. These are used in the NOx-NO2 calculator, and added to the adjusted Road NO2 to provide Total NO2 for reporting.