Ashbourne AQMP

Technical Note

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Quality information

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Revision	Revision date	Details	Name	Position
1	1/12/22	DCC and DDDC comments incorporated	Adam Hall	Associate Director
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1 Introduction

1.1 Overview

1.1.1 This technical note presents the findings from an impact rating exercise of the current list of potential measures presented within the Derbyshire Dales District Council's (DDDC) draft Air Quality Action plan (AQAP). The AQAP has been developed with the aim of improving air quality within the Ashbourne Air Quality Management Area (AQMA).

1.1.2 In preparation of the impact rating exercise presented in Section 3, a source apportionment exercise has been completed to understand the breakdown of emission sources making up the total concentrations recorded at monitoring sites within the Ashbourne AQMA. The results of this exercise are presented in Section 2.

2 Source Apportionment

2.1 Traffic Data

2.1.1 The Ashbourne Highway Assignment Model was developed by AECOM, to support the development of the Ashbourne Relief Road. The model was developed using the SATURN suite of software and is a highway assignment and simulation traffic model. The simulation area was based on the likely region of interest identified in the Appraisal Specification Report and covers an area of approximately 15km in radius centred on Ashbourne.

2.1.2 The model was developed for four time periods, representing the AM peak hour (0800-0900), interpeak average hour (1000-1600) and PM peak hour (1700-1800) for weekdays, and a daytime average hour (1000-1600) for weekends.

2.1.3 Base Year travel demands were developed from mobile phone data. The trip demand model groups trip purposes into seven separate user classes by utilising three vehicle classes: cars, LGVs HGVs. The Base Year models conformed to TAG link flow calibration, validation and journey time criteria.

2.1.4 Future year forecasts were developed using local development assumptions and the Department for Transport's national growth forecast.

2.1.5 The data from the Ashbourne Highway Assignment model was deemed the most appropriate source of future year traffic data, for the initial emissions assessment.

2.1.6 An interrogation of the traffic model assignment provided modelled traffic flows and vehicle proportions for Buxton Road and St John's Street.

2.1.7 For the purpose of Emissions modelling, the one hour traffic model periods were expanded to represent a 24 hour period.

Table 2-1: Traffic Data – Buxton Road Northbound

Time Period	Hourly Flow (veh/hr)	Cars (%)	LGV[1] (%)	OGV[2] (%)
AM	333	75.3	17.6	7.1
IP	333	74.2	11.3	14.5
PM	442	83.5	12.0	4.5
OP	59	73.6	12.1	14.3

Table 2-2: Traffic Data – Buxton Road Southbound

Time Period	Hourly Flow (veh/hr)	Cars (%)	LGV (%)	OGV (%)
AM	165	63.9	13.1	23.0
IP	222	71.2	9.7	19.1
PM	209	81.7	8.8	9.5
OP	39	71.4	9.7	18.9

[1] Note, LGV stands for Light Goods Vehicles and includes all goods vehicles up to 3.5 tonnes gross vehicle weight
[2] Note, OGV stands for Other Goods Vehicles and includes all goods vehicles over 3.5 tonnes gross vehicle weight

Table 2-3: Traffic Data – St John Street Eastbound (One Way)

Time Period	Hourly Flow (veh/hr)	Cars (%)	LGV (%)	OGV (%)
AM	332	71.3	15.3	13.4
IP	356	73.3	11.9	14.8
PM	371	82.7	10.6	6.7
OP	66	67.9	11.0	21.1

2.1.8 It is noted that the southbound demand on Buxton Road is lower than that of the northbound direction and that the OGV proportion is higher in the southbound direction. The modelling data is representative of the observed data used in the model build. It is recommended that further analysis is undertaken to understand whether this pattern occurs at a more disaggregate level, and if so, potentially engage with the local OGV operators to further understand their scheduling of movements through Ashbourne.

2.2 Emissions Calculations

2.2.1 Emissions calculations have been completed for the above three road links, using the Defra Emissions Factors Toolkit Version 11[3]. The traffic flows and fleet mix data for each time period as set out in Section 2.1, has been used to calculate emission rates per hour using a variety of different speeds to represent different traffic conditions in the area – this has included 5 kph to represent heavy congestion and stop start traffic conditions, 10 kph to represent slow-moving traffic, and 30 kph to represent more free flowing traffic conditions. For the purposes of the emissions calculations, the OGV percentages set out in Section 2.1 have been assumed to be HGV, to align with the input options of the Emissions Factors Toolkit.

2.2.2 A gradient of 14% has been applied to the flow on Buxton Road (approximately equivalent to a 1/7 slope) to represent that the northbound flows are travelling up a steep hill, and southbound flows are travelling down a steep hill.

2.2.3 Full details showing the breakdown of emission rates from each road within each time period in g/km/s, alongside the total daily emission in g/km from all periods, are provided within Appendix 1. Tables 2-4 to 2-6 below set out the average emission rate (g/km/s) at the speeds set out above and the percentage contribution by vehicle type.

Table 2-4: Percentage of Hourly Emission by Vehicle Type at 5 kph

Road Link	Cars (%)	LGV (%)	HGV (%)	Average Emission Rate (g/km/s)
Buxton Road Southbound	15%	6%	79%	0.054
Buxton Road Northbound	28%	14%	58%	0.052
St John Street	17%	8%	74%	0.082

Table 2-5: Percentage of Hourly Emission by Vehicle Type at 10 kph

Road Link	Cars (%)	LGV (%)	HGV (%)	Average Emission Rate (g/km/s)
Buxton Road Southbound	23%	7%	70%	0.034
Buxton Road Northbound	45%	17%	38%	0.032
St John Street	35%	13%	53%	0.040

[3] Defra (2021) Emissions Factors Toolkit V11.0. Available from: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

Table 2-6: Percentage of Hourly Emission by Vehicle Type at 30 kph

Road Link	Cars (%)	LGV (%)	HGV (%)	Average Emission Rate (g/km/s)
Buxton Road Southbound	39%	13%	48%	0.014
Buxton Road Northbound	46%	18%	35%	0.022
St John Street	46%	18%	36%	0.021

2.2.4 Tables 2-4 to 2-6 indicate that emissions are highest when the emissions are calculated with a speed of 5 kph, representing heavy congestion conditions. A large proportion, 79%, of total vehicle emissions are from the HGVs travelling downhill (southbound) on Buxton Road. When travelling uphill (northbound) at 5 kph on Buxton Road, HGVs are also the biggest emitter, accounting for 58% of total vehicle emissions. On St John Street HGVs account for 74% of emissions.

2.2.5 With the emissions calculations based on traffic travelling at 10 kph (representing slow-moving traffic), emissions reduce overall, and HGVs become a smaller proportion. HGVs still account for approximately 70% of the total emissions from vehicles travelling downhill on Buxton Road (southbound) but make up only 38% of the total emissions when travelling uphill (northbound). At 10 kph HGVs account for 53% of emissions on St John Street.

2.2.6 With the emissions calculations based on traffic travelling at 30 kph (representing more free-flowing traffic conditions with better efficiency and lower emission rates), total emissions (presented within Appendix A) reduce by 74% compared to when calculated at 5 kph on Buxton Road (southbound), by 58% on Buxton Road (northbound) and by 48% on St John Street.

2.2.7 HGVs also account for a smaller proportion of total emissions with vehicles travelling at 30 kph – approximately 48% of the total emissions from vehicles travelling downhill on Buxton Road (southbound) and 35% of the total emissions when travelling uphill (northbound). At 30 kph HGVs account for only 36% of emissions on St John Street.

2.2.8 Within all scenarios, the inter peak period is the highest contributor to total daily emissions. In the 5 kph scenario the inter peak accounts for approximately 48% of total daily emissions on Buxton Road and 45% on St John Street.

2.2.9 In the 10 kph scenario the inter peak accounts for approximately 48% of total daily emissions on Buxton Road southbound, 45% on Buxton Road northbound and 44% on St John Street.

2.2.10 In the 30 kph scenario the inter peak accounts for approximately 47% of total daily emissions on Buxton Road southbound, 44% on Buxton Road northbound and 43% on St John Street.

2.3 Discussion of Results

2.3.1 The results of the source apportionment exercise have demonstrated that a large proportion of emissions are expected to be from slow moving HGVs on Buxton Road and St John Street. It also indicates that the inter peak period of the day contributed the most to total daily emissions.

2.3.2 In the AQMA, monitoring has identified a maximum annual mean NO_2 concentration of 57.4 µg/m^3 in 2019 (the last year of monitoring not impacted by covid lockdowns) at site 19, located on the 1/7 road sign opposite 5 Buxton Road[4]. Defra's modelled background concentration estimates[5] for the region estimate a background NO_2 concentration of 8.1 µg/m^3 in the area of Buxton Road. This indicates that road traffic emissions account for 49.3 µg/m^3 (or approximately 85%) of total concentrations of NO_2 at this worst-case location.

[4] Derbyshire Dales District Council (2021) LAQM Annual Status Report 2021. Available from: https://www.derbyshiredales.gov.uk/images/DerbyshireDales_ASR2021revFinalwith_DPHendorcement.pdf
[5] Defra (2022) Background Mapping data for local authorities – 2018. Available from: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

2.3.3 Using this example, a reduction in concentrations of >17.4 µg/m^3 would be needed to lower concentrations below the annual mean objective, which equates to an approximate 36% reduction in total traffic emissions.

2.3.4 It is recognised that site 19 is a worst-case example, and in other locations on the same road - for example at site 12 (located just down this hill from site 19 on Buxton Road) measured concentrations were 47 µg/m^3 and so a smaller reduction of >7 µg/m^3 would be needed to lower concentrations below the annual mean objective for NO_2. This equates to an approximate 17.3% reduction in total traffic emissions being required.

2.3.5 The above calculations at specific monitoring sites are broadly in line with the findings of the Draft Derbyshire Dales District Council AQAP[6] which indicated that a 20% reduction in road traffic emissions was required, though they do demonstrate that in some locations a large reduction that previously identified may be required.

2.3.6 The source apportionment has indicated that measures which aim to reduce HGV numbers within the AQMA, in particular during the interpeak period, will have a benefit to emissions and local air quality.

2.3.7 The source apportionment has also indicated that measures which reduce stop-start and congested traffic conditions and allow traffic to operate at more free flowing speeds will have a benefit to emissions and local air quality.

2.3.8 Given the percentage of emissions associated with HGVs and the potential reduction in emissions associated with improved speeds, measures that achieve the above two outcomes of reducing HGV numbers and optimising speeds have the potential to reduce concentrations of NO_2 by the greatest amount. Depending on the baseline speeds there is potential that such a reduction could be sufficient such that annual mean concentrations would be reduced below the annual mean objective value.

2.3.9 Whilst the Traffic Model provides the most appropriate data source for this initial assessment, given the demonstrated sensitivity of the emissions and air quality results, more disaggregate observed data will be required to inform a detailed quantitative assessment. The most appropriate tool to support this assessment, would be a micro-simulation model of the route with corresponding transient emissions module. This would allow for better representation of the route, reflecting gradients and link friction (on-street parking, pedestrian crossing etc) and analysis of varying interventions in terms of vehicle behaviour and emissions.

3 Impact Rating of Action Plan Measures

3.1.1 Table 3-2 below presents the impact rating of all measures included within the Derbyshire District Council draft AQAP. Qualitative and quantitative comments regarding the potential impact of measures on local air quality have been included. The indicative impact rating of each measure has been generated by assigning each Action Plan measure an indicative rating for potential Air Quality impacts (5 = largest benefits, 1 = lowest benefit) and potential costs (Figure 3-1). In addition, an assessment of likely timescale for intervention implementation and the timescale for Air Quality impacts to be realised has been included using the following criteria:

[6] Derbyshire Dales District Council (2022) Draft Derbyshire Dales District Council Air Quality Action Plan 2022.

Table 3-1: Score Definitions

Score	Timescale	Cost
1	> 3 years	> £500,000
2	2-3 years	£100,000 - £500,000
3	1-2 years	£50,000 - £100,000
4	6 months – 1 year	£10,000 - £50,000
5	< 6 months	<£10,000

3.1.2 Each proposed measure below is considered individually. It is not considered likely that any one measure alone would be sufficient to improve air quality to concentrations below the air quality objective value. However, a number, or all, of these measures introduced together could lead to changes such that air quality improves to concentrations below the objective.

3.1.3 It is also noted that a number of these measures refer to investigating the potential of the measure to consider the potential improvement that may be obtained and the costs and logistics of implementation. The anticipated costs and benefits associated with these measures can be updated and refined as more detail on these measures are defined. As such, a conservative approach to ascribing air quality benefits to these types of measures has been adopted with regards to the ratings given in Table 3-2.

Table 3-2: Impact Review of Proposed Measures

Action Plan Measure No.	Measure Description	Cost Estimate	Air Quality Impacts (Qualitative)	Air Quality Impacts (Quantitative)	Cost Rating	Air Quality Benefit Rating	Timescale for Implementation	Timescale for Impact	Impact Rating
1	Investigate the use of Urban Traffic Management Control to optimise traffic flows within Ashbourne town centre	£100-500k	Traffic light timing could be used to reduce the stop/start traffic and congestion on Buxton Road, improving air quality in this location. This may result in moving congestion from Buxton Road to St John Street and as such could increase pollutant concentrations on St John Street and other roads. This measure would allow for dynamic management of congestion.	Emissions calculations have shown improvements between vehicles travelling at 5 kph (representing start stop/heavy congestion) and vehicles travelling at 30 kph on Buxton Road (representing free flowing traffic). This change in speed provides an indicative 48-74% reduction in emissions over the day when comparing 5 kph to 30 kph on Buxton Road (north and south bound) and St John Street.[7]	2	2	3	3	10
2	Investigate town centre priority or capacity changes to improve heavy goods and other vehicle flows on A515 Buxton Road, Ashbourne	£100-500k	Town centre priority and capacity changes could be used to reduce the stop/start traffic and congestion on Buxton Road, improving air quality in this location. This may result in moving congestion from Buxton Road to St John Street and as such could increase pollutant concentrations on St John Street and other roads.	Emissions calculations have shown improvements between vehicles travelling at 5 kph (representing start stop/heavy congestion) and vehicles travelling at 30 kph on Buxton Road (representing free flowing traffic). This change in speed provides an indicative 48-74% reduction in emissions over the day when comparing 5 kph to 30 kph on Buxton Road (north and south bound) and St John Street.[7]	2	3	4	4	13
3	Influence route selection via live traffic information systems	<£10k	This measure could be used to reduce total traffic travelling through the AQMA which would have an associated improvement in air quality.	Air quality monitoring from before and after the introduction of the intervention could show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]	5	1	1	3	10
4	Investigate Improved Tree Canopy Pollution Dispersion	<£10k	This measure allows for better dispersion of pollutant emissions from vehicles travelling on Buxton Road. The work to cut back the vegetation and tree canopy is now complete.	Ongoing monitoring within the AQMA can be used to evaluate the improvement in air quality achieved from implementing this measure.	5	1	5	5	16

[7] The speeds modelled of 5kph are an estimate of the congested conditions when stop start traffic is occurring. The speed is unlikely to be stop start throughout the whole day, which would have periods of more free flowing traffic. The percentage emissions reductions presented here are therefore only provided as an indication and may not be wholly achieved. Further detail on the speed at which traffic is currently travelling through the area could be used to refine these estimates.

[8] Where more than one intervention is introduced at the same time it would not be possible to identify the contribution from each intervention separately.

Action Plan Measure No.	Measure Description	Cost Estimate	Air Quality Impacts (Qualitative)	Air Quality Impacts (Quantitative)	Cost Rating	Air Quality Benefit Rating	Timescale for Implementation	Timescale for Impact	Impact Rating
5	Active travel promotion	£10-50k	This measure can be used to reduce traffic flow in the peak period during which congestion generally occurs, and can as a result improve air quality.	Air quality monitoring from before and after the introduction of the intervention could show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]	4	2	4	2	12
5a	St John Street and Dig Street/Compton Public Realm	£2M	This measure will benefit the air quality where road traffic is moved further from receptor locations and may also result in small reductions in overall traffic flows and emissions.	Emissions calculations can be used to inform the detailed design of this measure.	1	1	3	3	8
5b	Mobility hub	£50-100k	A high-quality transport hub, providing real time travel information and links to other transport such as cycling and walking routes, can be used to support reduced traffic flows in the peak period, during which congestion generally occurs, and can as a result improve air quality.	Air quality monitoring from before and after the introduction of the intervention could show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]	3	1	3	2	9
6	Electric vehicle charging points	£10-50k	Increasing use of electric vehicles can lead to reductions in air pollution. This measure supports the aim of moving towards net zero carbon emissions but is unlikely to have a measurable impact on air quality as an isolated measure.	Air quality monitoring from before and after the introduction of the intervention could show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]	4	1	4	2	11
7	Business and School Travel Planning including: 7a) Workplace Travel Plans 7b) School Travel Plans 7c) School Streets	£10-50k	This measure can be used to reduce traffic flows in the peak period, during which congestion generally occurs, and can as a result improve air quality.	Air quality monitoring from before and after the introduction of the intervention could show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]	4	2	4	2	12
8	Bus Service Improvement	£100-500k	This measure can be used to reduce traffic flow by encouraging modal shift and can	Air quality monitoring from before and after the introduction of the intervention could	2	2	3	2	9

Action Plan Measure No.	Measure Description	Cost Estimate	Air Quality Impacts (Qualitative)	Air Quality Impacts (Quantitative)	Cost Rating	Air Quality Benefit Rating	Timescale for Implementation	Timescale for Impact	Impact Rating
	Plan (BSIP) implementation including: 8a) Bus priority 8b) Mobility hub		as a result reduce flows and improve air quality.	show the effect of this intervention. Traffic data could be collected before and after the introduction of the intervention and the effect on air quality could be subsequently modelled.[8]					
9	Continue Engagement with Local Mineral and Logistics Companies	<£10k	This measure can be used to reduce HGV traffic flows by encouraging alternative routing or scheduling and can therefore improve air quality.	Emissions calculations have shown that HGVs are responsible for a large proportion of total emissions. This estimated proportion ranges depending on the speed of vehicles and the incline they are travelling on, from 35 to 79% of vehicle emissions.	5	1	3	2	11

3.1.4 The impacts ratings assigned are based on the measures as currently described within the Action Plan. For those measures where a quantitative Air Quality Impact has been described, this is theoretical and based on estimates of speeds which have been included within the emissions calculations as a means of demonstrating the potential for improvements in air quality from a measure.

3.1.5 In some instances, it would be possible to ascribe a greater Air Quality Benefit Rating to the measure if more certainty on what could be achieved via the measure was developed – for example with regard to reducing HGV numbers from Mineral and Logistics Companies, if it were possible to reduce a set number of HGV movements, it would be possible to demonstrate through more detailed emission calculations the benefit that could be achieved. Similarly, if further speed data was gathered it would be possible to provide a more accurate estimate of potential improvements in emissions.

4 Conclusions and Next Steps

4.1 Conclusions

4.1.1 There is potential for a number of the proposed measures to, either singularly or in combination with other measures, lead to measurable reductions in traffic flows and/or changes to speeds vehicles travel through the AQMA, such that annual mean concentrations of NO_2 would reduce.

4.1.2 Additional, more detailed, assessment of these measures would be required to identify where measurable reductions could be achieved and which combination of measures would best achieve the required reductions and would provide the best value for money in achieving that.

Appendix A Emissions Calculation Outputs

Table A 1: Emissions Calculation – 5kph

Road Link	Time Period	Cars (g/km/s)	LGV (g/km/s)	HGV (g/km/s)	Total Emission in period (g/km)[9]	Period Emission as Percentage of Total Daily Emission
Buxton Rd SB	AM	0.010	0.006	0.076	983.3	21.0%
	IP	0.014	0.006	0.085	2,261.5	48.3%
	PM	0.015	0.005	0.039	644.9	13.8%
	OP	0.003	0.001	0.015	790.6	16.9%
	24 hour	-	-	-	4,680.3	100%
Buxton Rd NB	AM	0.023	0.016	0.033	765.7	17.2%
	IP	0.022	0.010	0.066	2,131.6	47.8%
	PM	0.033	0.014	0.027	808.2	18.1%
	OP	0.004	0.002	0.012	750.8	16.8%
	24 hour	-	-	-	4,456.3	100%
St John Street	AM	0.021	0.014	0.094	1,391.8	19.7%
	IP	0.024	0.011	0.111	3,152.8	44.7%
	PM	0.028	0.010	0.053	980.8	13.9%
	OP	0.004	0.002	0.029	1,523.7	21.6%
	24 hour	-	-	-	7,049.1	100%

[9] The calculation of Total Emission in Period (g/km) assumes a 3 hour AM, 6 hour IP, 3 hour PM and 12 hour OP period.

Table A 2: Emissions Calculation – 10kph

Road Link	Time Period	Cars (g/km/s)	LGV (g/km/s)	HGV (g/km/s)	Total Emission in period (g/km)	Period Emission as Percentage of Total Daily Emission
Buxton Rd SB	AM	0.009	0.004	0.042	603.9	20.4%
	IP	0.014	0.004	0.047	1,416.3	47.9%
	PM	0.015	0.004	0.022	441.4	14.9%
	OP	0.002	0.001	0.008	495.6	16.8%
	24 hour	-	-	-	2,957.3	100%
Buxton Rd NB	AM	0.022	0.012	0.013	514.9	18.6%
	IP	0.022	0.008	0.027	1,231.8	44.4%
	PM	0.033	0.011	0.011	593.4	21.4%
	OP	0.004	0.001	0.005	435.2	15.7%
	24 hour	-	-	-	2,775.3	100%
St John Street	AM	0.021	0.010	0.033	693.4	19.9%
	IP	0.023	0.009	0.039	1,527.3	43.9%
	PM	0.027	0.008	0.018	580.0	16.7%
	OP	0.004	0.001	0.010	678.3	19.5%
	24 hour	-	-	-	3,479.0	100%

Table A 3: Emissions Calculation – 30kph

Road Link	Time Period	Cars (g/km/s)	LGV (g/km/s)	HGV (g/km/s)	Total Emission in period (g/km)	Period Emission as Percentage of Total Daily Emission
Buxton Rd SB	AM	0.007	0.003	0.012	231.5	19.3%
	IP	0.010	0.003	0.013	562.9	46.9%
	PM	0.011	0.003	0.006	209.3	17.4%
	OP	0.002	0.001	0.002	197.5	16.4%
	24 hour	-	-	-	1,201.3	100%
Buxton Rd NB	AM	0.016	0.009	0.008	350.7	18.9%
	IP	0.015	0.006	0.017	814.2	43.8%
	PM	0.023	0.008	0.007	406.5	21.9%
	OP	0.003	0.001	0.003	288.0	15.5%
	24 hour	-	-	-	1,859.4	100%
St John Street	AM	0.015	0.007	0.012	365.4	20.2%
	IP	0.016	0.006	0.014	783.4	43.3%
	PM	0.019	0.006	0.007	338.5	18.7%
	OP	0.003	0.001	0.004	323.5	17.9%
	24 hour	-	-	-	1,810.7	100%