JACOBS

Technical Note

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Subject	**Literature Review: Local Air Quality and 20mph Limits**	**Project Name**	20mph Limit Air Quality Impacts
Attention	Kieran Boyle		
From	Mark Chapman Technical Director (Air Quality)		
Date	08 December 2017		
Copies to	**Birmingham City Council – Rajpreet Mander**		

1. Introduction

Birmingham City Council (BCC) are proposing to implement reductions in speed limits to 20 miles per hour (mph) imposed by signs and roundels at strategic locations thought the city. It is assumed that vehicles will drive at a constant speed throughout the 20 mph areas resulting in a reduced speed without the effects caused by braking and acceleration that can be associated with alternative speed calming measures. Concerns have been raised regarding air quality due to an anticipated increase in emissions and pollution caused by vehicles using lower gears.

Jacobs have been commissioned by BCC to investigate the potential effects on local air quality from implementing 20 mph traffic management measures. The investigation is limited to a high-level review of readily available publications and reports, and emission calculation tools available from Defra.

Traffic management schemes are typically implemented for the purpose of reducing congestion or accidents. Whereas environmental considerations (such as impacts on air quality) are typically secondary to the primary purpose of traffic management; they are more frequently required to be reviewed as part of approving Traffic Regulations Orders (TROs).

While the effectiveness of a scheme and appropriateness of the measures depend upon its primary objective, there is an optimism that speed reductions will give rise to better environmental conditions. There is no straight forward relationship between speed and pollutant concentrations however, and the relationship depends on a number of local factors; including:

- Location of the scheme (urban or rural area, free flowing or congested)
- Fleet mix

2. Approach

A high-level literature review was undertaken of readily available publications and reports to investigate what studies have been undertaken that consider the impacts of 20 mph traffic management measures on air quality.

The available literature was found to fall into one of two main categories of study:

1. Technical
2. Non-Technical

A summary of the findings of the literature review are presented under these headings.

It is important to note that while the studies referenced in this Technical Note may seem similar, direct comparisons should not be drawn without the full understanding of the technical details behind each study; and this Technical Note has made no attempt to draw comparisons of studies undertaken.

Consideration has also been made using Defra's Emissions Factors Toolkit (v8) which provides speed-based emission rates for nitrogen oxides (NO_x) and particulate matter (PM_{10}); two pollutants primarily associated with vehicle exhaust.

2.1 Technical

A number of UK studies have been published that investigate the impact of various traffic management measures on vehicle emissions. In order to determine the impact of such measures (including 20mph zones) on exhaust emissions, it is important to understand the complex relationships between traffic characteristics, vehicle operation and rates of emission. Factors that are directly affected by traffic calming measures, such as speed and acceleration, have been studied most; whereas other factors, such as engine type, exhaust treatments and vehicle weight, being more difficult to assess, are less well documented.

Boulter & Webster (1997)[i] undertook a literature review which included details of:

- measures employed to calm traffic
- changes in driver behaviour imposed by traffic calming schemes
- factors affecting emissions from road vehicles in the context of traffic calming
- case studies of the impact of traffic calming schemes on vehicle emissions
- damage to public service vehicles caused by traffic calming measures.

Their review concluded there was limited agreement on the effects of traffic calming on vehicle emissions. Area-wide studies suggested decreases in NO_x emissions as a result of introducing traffic calming measures; however, these same studies were less conclusive in terms of changes in emissions of carbon monoxide (CO) and hydrocarbons (HC).

Studies of the effects of traffic calming based on single sections of road produced varied results. Some studies showed decreases in NO_x emissions; whereas others showed increases. While the review could not identify why this was the case, nor why discrepancies arose between the 'single road' and 'area-wide' studies; 'single road' studies did show a consistent increase in fuel consumption.

In 2001, Boulter et al[1] developed their 1997 investigations and published a further paper examining the effects of different traffic calming measures on vehicle exhaust emissions of passenger cars. The paper concluded that traffic calming measures clearly increase emissions of some pollutants from passenger cars. Statistical tests were performed to examine the differences between the impacts of nine schemes that were investigated on emissions.

This paper identified that, where more severe traffic calming measures were implemented, the following also occurred:

- greatest speed reductions
- the greatest accident savings
- some of the largest increases in emissions

The paper did comment however that on urban traffic calming measures which had been mainly introduced on residential roads, i.e. with low traffic flows, despite leading to increased emissions per vehicle it was unlikely that such increases would result in the creation of 'poor air quality'. This statement was however caveated, to acknowledge the effect of increased emissions where air quality was already poor, such as where Air Quality Management Areas (AQMA) were concerned.

2.2 Non-Technical

A small number of qualitative reports on the subject of the effects of traffic calming measures on air pollution were also reviewed, mainly undertaken/published by local authorities or local government organisations. These studies indicated mixed views over the effects of traffic calming measures on air pollution.

A recent publication by ROSPA (2017)[ii] which looked at casualty reduction and the implementation of traffic measures, made reference to studies undertaken by local authorities and Transport for London. The conclusions from studies in Wales[iii] indicated that a default speed of 20 mph could reduce casualties, at worst not lead to a direct change in air pollution and indirectly, encourage modal change and therefore reduction in air pollution across a wider-area. This conclusion was not however supported by any evidence.

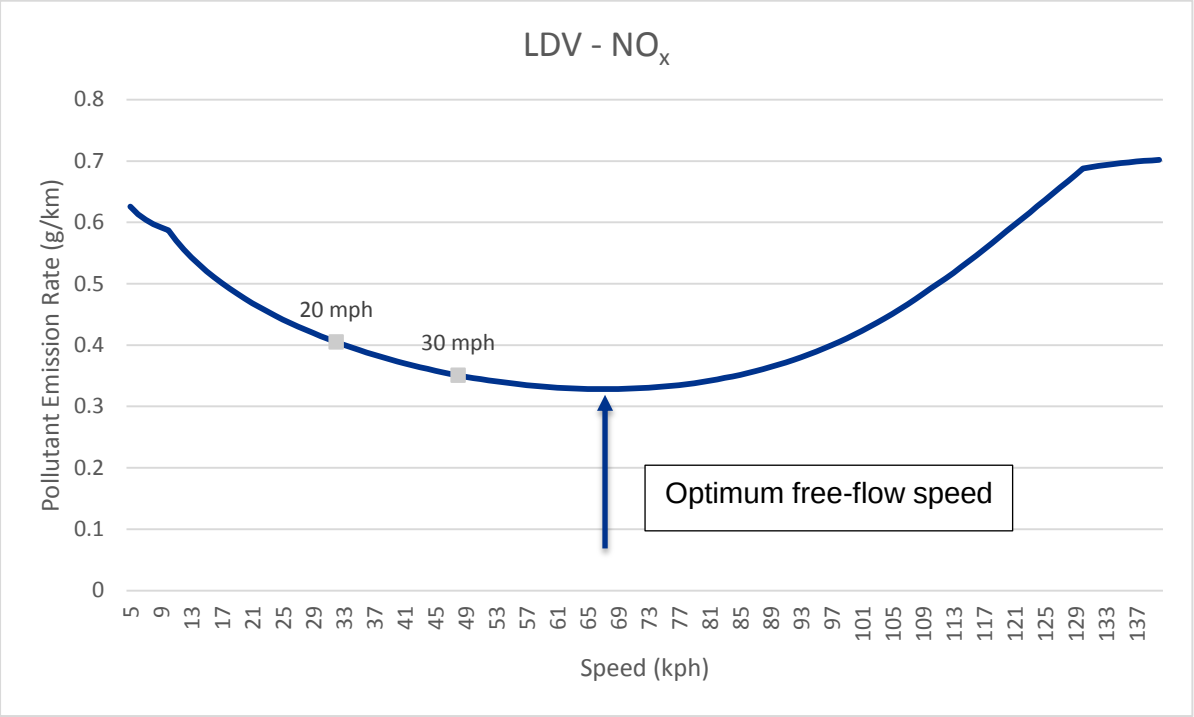
Bristol City Council commissioned a study, which concluded that the introduction of 20mph traffic management measures was associated with negligible changes in emissions. However, it is recognised that uncertainties exist within the processes of emissions estimation and dispersion modelling, and that conclusions should not be taken as precise representations of the impact of the scheme.

3. Free-Flow Speed/Emission Curves

Defra's Emissions Factors Toolkit (v8) provides speed-based emissions rates for NO_x and PM_{10} for a number of vehicle classes. Emission curves for Light Duty Vehicles (LDV) and Heavy Duty Vehicles (HDV) were calculated and used to describe the difference in emissions rates expected for vehicles travelling in free-flow conditions at 30 and 20 mph. The results of the calculations are presented in Figures and Tables below.

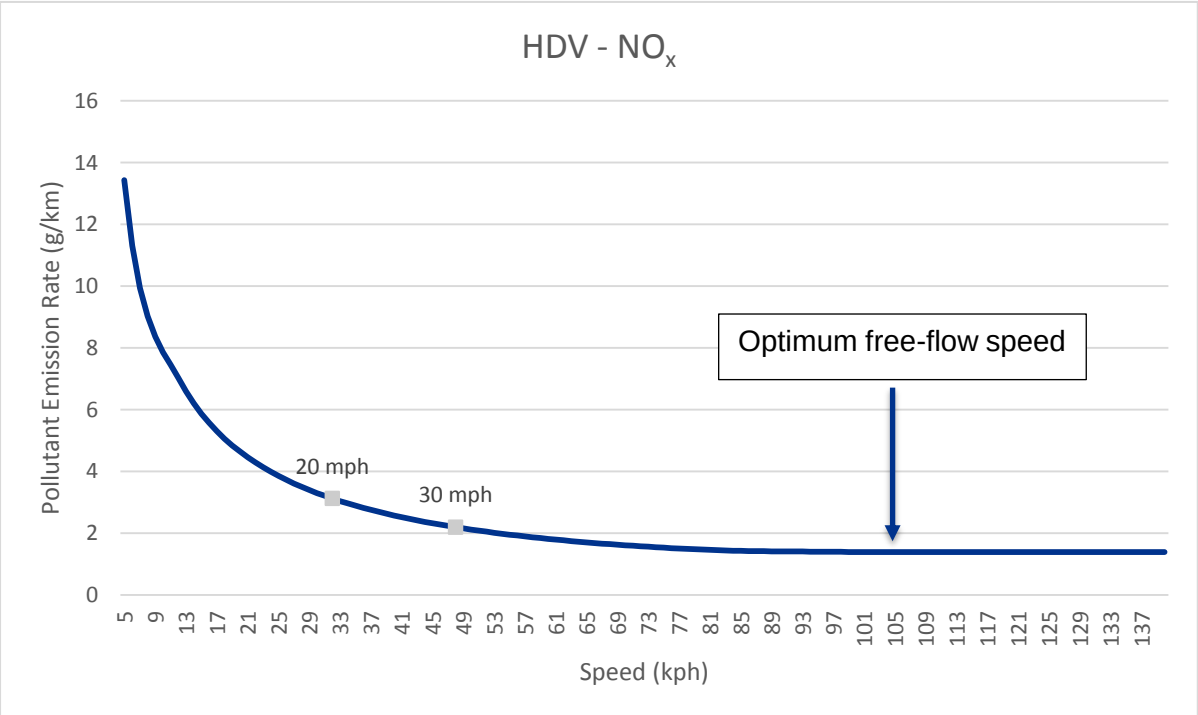
[1] TRL Report482: Boulter et al, 2001 – The impacts of traffic calming measures on vehicle exhaust emissions.

Figure 3.1 : LDV NO_x Emission Rate Speed Curve



For LDVs, lowest free-flow emission rates of NO_x occur at speeds of around 67 kph or 42 mph on urban roads.

Figure 3.2 : HDV NO_x Emission Rate Speed Curve



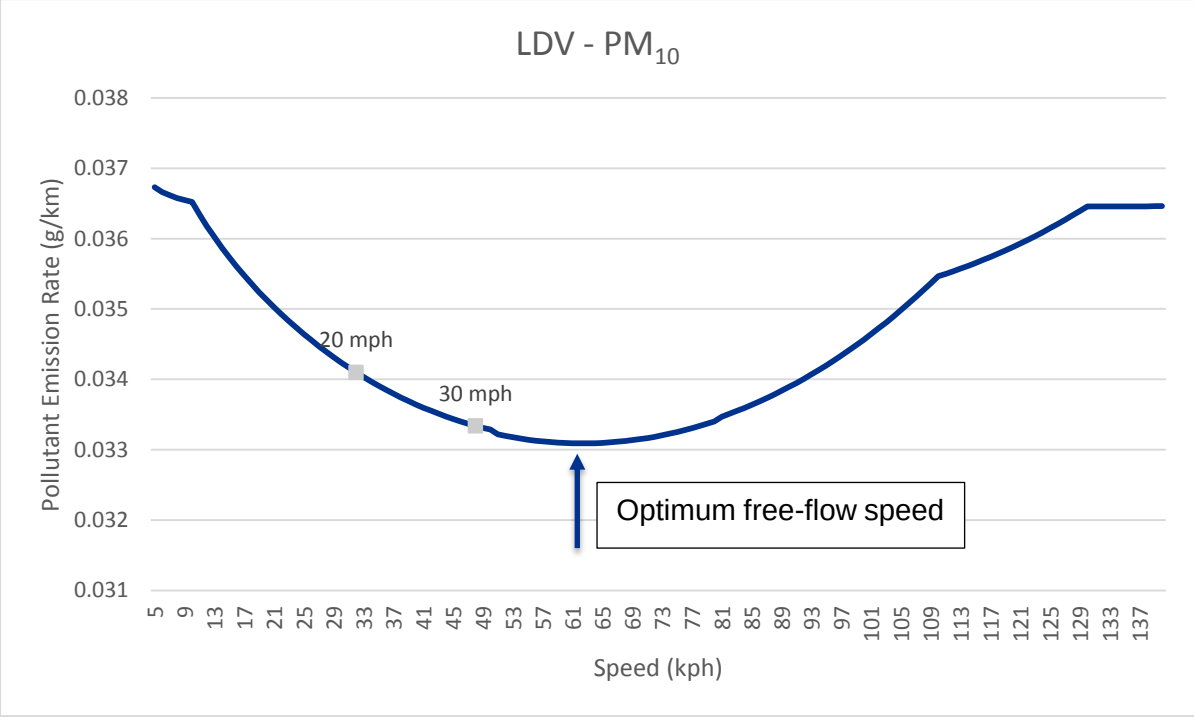
For HDVs, lowest free-flow emission rates of NO_x occur at speeds of around 105 kph or 65 mph on urban roads.

Table 3.1 : NO_x Emission Rates at 30 and 20 mph

NO_x (g/km)	30 mph	20 mph	% Increase
LDV	0.35075	0.40500	15
HDV	2.18919	3.11803	42

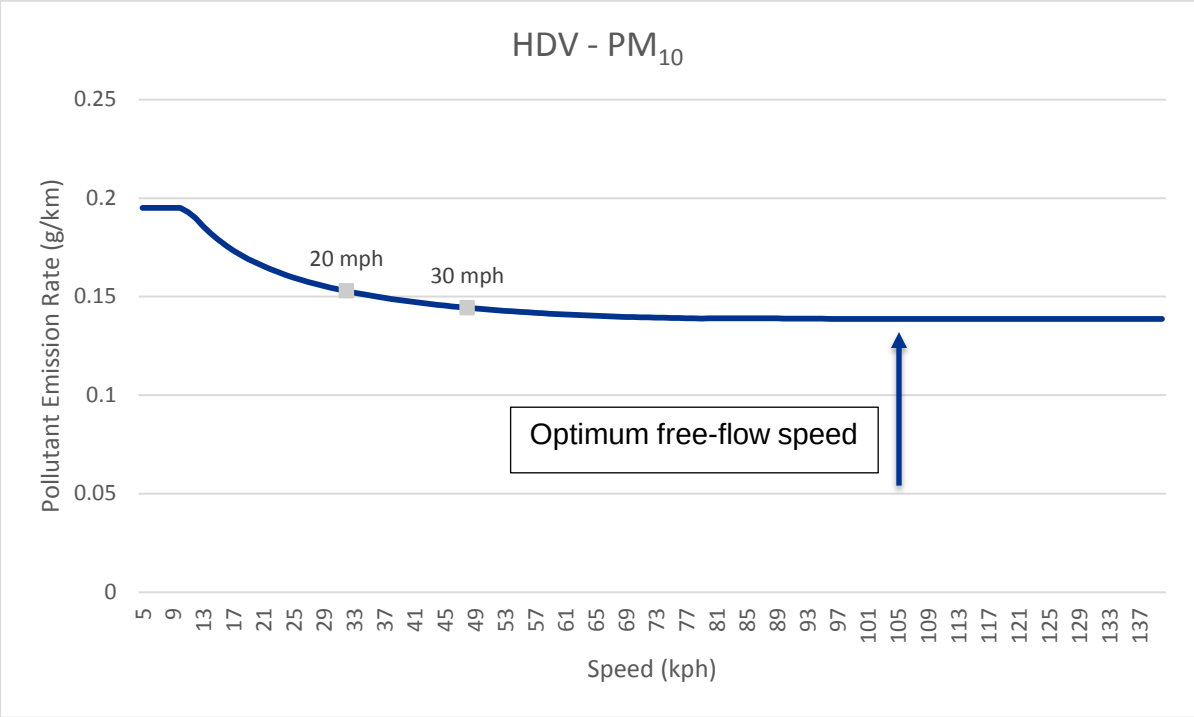
Free-flow emission rates for NO_x are calculated to increase by 15% for LDVs and 42% for HDVs between 30 mph and 20 mph.

Figure 3.3 : LDV PM_{10} Emission Rate Speed Curve



For LDVs, lowest free-flow emission rates of PM_{10} occur at speeds of around 62 kph or 39 mph on urban roads.

Figure 3.4 : HDV PM_{10} Emission Rate Speed Curve



For HDVs, lowest free-flow emission rates of PM_{10} occur at speeds of around 105 kph or 65 mph on urban roads.

Table 3.2 : PM_{10} Emission Rates at 30 and 20 mph

PM_{10} (g/km)	30 mph	20 mph	% Increase
LDV	0.03334	0.03410	2
HDV	0.14437	0.15286	6

Free-flow emission rates for PM_{10} are calculated to increase by 2% for LDVs and 6% for HDVs between 30 mph and 20 mph.

4. Instantaneous Emissions Modelling

The Transport and Environmental Analysis Group, Centre for Transport Studies, and Imperial College London undertook an evaluation of the estimated impacts on vehicle emissions of a 20 mph speed restriction in central London in 2013.

The evaluation considered that while average speed models may suggest that a lower speed limit in urban areas may result in higher pollutant emissions, the stop-start nature of traffic may mean that such a method may not be suitable and that further investigation was required.

They used an instantaneous emissions model to estimate pollutant emissions for eight 30 mph and eight 20 mph urban drive-cycles and found a greater range of speeds were observed on 30 mph routes compared to 20 mph routes and a larger proportion of time was spent accelerating and decelerating on 30 mph routes than 20mph routes.

They also found there to be no relationship between average speed and speed limit on residential streets.

They concluded that emissions of NO_x were seen to be higher over 20 mph drive-cycles for petrol cars, but were and generally lower for diesel cars. Given the higher contribution of diesel vehicles to emissions of NO_x, this was considered significant. They also concluded that it would be incorrect to assume a 20 mph speed restrictions would be detrimental to ambient local air quality, as the effects on vehicle emissions are mixed.

Defra, in their 2017 UK Plan for tackling roadside nitrogen dioxide concentrations - Technical Report also state that vehicle testing typically finds that drive-cycles with lower average speeds produce lower NO_x emissions. However, this is subject to significant uncertainty and many confounding variables, including typical driving dynamics, the extent of acceleration, weather conditions, and others.

They conclude however, that overall, there is reasonable cause to expect [a lower average speed] intervention to reduce emissions in some areas.

5. Summary of Evidence

Driver behaviour, the type of calming measure and number of measures are all factors that influence speeds, patterns of driving and also route selection.

Where traffic flows are low, such as on residential roads, studies that conclude that 20 mph limit interventions may lead to increases in emissions per vehicle, also find it unlikely that such increases would result in the creation of 'poor air quality'. Local pollutant monitoring undertaken by BCC suggests that typical locations identified for 20 mph limit intervention are unlikely to be those which exceed national air quality objective thresholds.

Studies that conclude that 20 mph limit interventions may lead to decreases in emissions conclude that it would be incorrect to assume a 20 mph speed restriction would be detrimental to ambient local air quality, as the effects on vehicle emissions are mixed and specific to each case.

6. Conclusion

While there is no general consensus within the reviewed evidence to suggest, one-way or the other, that driving at lower free-flow speeds causes increases or decreases in local pollutant emissions, studies tend to agree that in locations where traffic flows are low, such as on residential roads, the impact of a 2 0mph limit intervention is not necessarily detrimental to ambient local air quality.

[i] TRL Report 307 – Traffic calming and vehicle emissions: A literature review, PG Boulter & DC Webster (1997).
[ii] Royal Society for the Prevention of Accidents, Road Safety Factsheet, June 2017.
[iii] Jones SJ & Brunt H, 2017: Twenty miles per hour speed limits: a sustainable solution to public health problems in Wales, Epidimol Community Health,0: 1-8.