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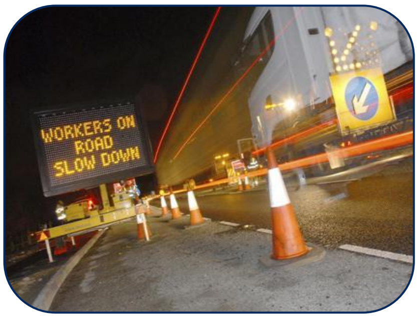


CLIENT PROJECT REPORT CPR1352

Future Managed Motorways Concept Development

Additional Task: Obscuration of Advanced Direction Signs in an MM-ALR Environment

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Executive Summary

Sign or signal obscuration can occur when a vehicle interrupts the line of sight from a driver of another vehicle to the sign or signal being viewed. The consequence of this may be that a driver passes a sign without being able to read it. This may cause a navigation problem for the driver if the sign provides route information or legal issues if required for traffic regulation enforcement; it may also present a safety issue if the sign is providing information regarding an approaching hazard or incident. Additionally, the driver may attempt to manoeuvre their vehicle to be able to view the sign which may in itself cause a hazard to traffic.

In a previous task for the Highways Agency (HA) TRL assessed the obscuration rates of signal aspects (mandatory variable speed limits and lane availability information) being displayed on verge-mounted variable message signs instead of the current lane-specific gantry mounted indicators. This was to support an investigation into design options for future Managed Motorways schemes, which resulted in a new approach known as Managed Motorways – All Lane Running (MM-ALR).

The HA provides Advanced Direction Signs (ADS) to inform road users regarding the upcoming junction – when it is and where it leads to. This is usually consists of signs at the junction itself, ½ mile in advance and 1 mile in advance. The MM-ALR design guidance issued by the HA (IAN161/12) provides two options in regards to the provision of ADS: one using cantilever- and gantry-mounted signs and one using verge-mounted signs.

In December 2011 TRL were commissioned to carry out three further tasks to provide intelligence regarding the safety and legality of the generic MM-ALR design and concept of operations by investigating driving behaviour in a simulated MM-ALR environment. To support these trials it was agreed that TRL should carry out an additional task to investigate the obscuration of verge-mounted ADS in an MM-ALR environment using the same model used to assess the obscuration of information on variable messages signs.

This task has estimated that, using the default parameters described and a 1 second viewing criterion, 18% of traffic in a MM-ALR environment would have their view of a destination shown on an ADS obscured, i.e. 18% of drivers would have to make an adjustment to their driving to be able to see the destination name for at least 1 second. The equivalent rate for the same point in a standard 3-lane motorway environment was estimated as 15%.

Varying certain parameters was found to have a significant effect on obscuration in both environments. Lowering the height of the ADS (or the point measured on the ADS) was found to increase obscuration. Conversely, increasing sign height was found to decrease obscuration and so this could be considered where obscuration is a particular concern. However, increasing sign height may have both physical design and readability implications that must also be borne in mind. Alternatively (and where possible within guidance), obscuration may be reduced by manipulating the relative height of key information within a sign.

Increasing the proportion of HGVs in the simulated traffic sample was also found to increase obscuration. Increasing the offset of the ADS from the carriageway was not found to significantly affect obscuration.

A full assessment of the impact of the levels of obscuration estimated within this task would require consideration of how some obscuration may influence driver’s ability to discern junction information, as well as driver’s understanding and preference. These elements are discussed together in CPR1353 Future MM Concept Task 3: Synthesis of Evidence.

1 Introduction

1.1 Background

Sign or signal obscuration can occur when a vehicle interrupts the line of sight from a driver of another vehicle to the sign or signal being viewed. The consequence of this may be that a driver passes a sign without being able to read it. This may cause a navigation problem for the driver if the sign provides route information or legal issues if required for traffic regulation enforcement; it may also present a safety issue if the sign is providing information regarding an approaching hazard or incident. Additionally, the driver may attempt to manoeuvre their vehicle to be able to view the sign which may in itself cause a hazard to traffic.

In a previous task[1] for the Highways Agency (HA) TRL assessed the obscuration rates of signal aspects (mandatory variable speed limits and lane availability information) being displayed on verge-mounted variable message signs instead of the current lane-specific gantry mounted indicators. This was to support an investigation into design options for future Managed Motorways schemes, which resulted in a new approach known as Managed Motorways – All Lane Running (MM-ALR).

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1.2 Task Objectives

The objectives of this task are to answer the following questions:

- What proportion of traffic will have a verge-mounted ADS sign obscured by HGVs (i.e. unable to see enough of the sign for long enough to read the information) on a carriageway with 4 running lanes and no hard shoulder?
- How does this compare with the proportion of traffic for which the sign would be obscured in equivalent traffic conditions on a carriageway with 3 running lanes and a permanent hard shoulder?
- How does this obscuration rate vary with varying parameters?

[1] CPR1602 TRL MM2 Tasks 2, 3, 4 and 5 Key Findings Report

2 Methodology

2.1 Overview

This task was investigated by adapting the existing obscuration simulation model developed for assessing the obscuration of signals and aspects on MS4 variable message signs.

For the sake of the findings detailed in this report, relevant discussions of the approach and development of the original model are reproduced here, along with the changes made to the model for application to ADS.

2.2 Quantification and Parameterisation

There are many variables that will affect sign obscuration and that needed to be considered in a model. These include, but are not limited to, the following areas:

- Sign dimensions;
- Sign location;
- Sign legibility distances and angles;
- Driver eye location and field of view;
- Obscuring vehicle dimensions;
- Traffic speed, flow and headways by lane;
- Flow composition (proportions of vehicle types);
- Number of lanes;
- Road geometry, road curvature and topography;
- Environmental conditions.

Each of these areas can be broken down into many more individual sub-variables and there is of course interdependence between them. For example, the legibility distance and angles will strongly depend on the geometry of the road on the approach to the sign and the existing weather conditions.

There is also a clear human factors element to any considerations around obscuration, which is the variability introduced by driver behaviour. The first level of complexity that this introduces is the element of driver choice in the time-dependent variables such as headway and speed. For example, drivers will have different following tolerances, different desired speeds, and different lane-changing tendencies.

There is also another level of complexity to the driver behaviour aspect concerning the driver interaction with the sign. This would include consideration of questions such as: Does the driver want to see the sign? Do they speed up or slow down in accordance with this desire? Do they understand the sign? Do they move within their vehicle to view the sign? How far are they willing to turn their line of sight from the road ahead? Do they turn their head? Modelling all these factors fully and accurately would be an extremely complicated task.

Assessing obscuration for a given situation therefore, consists of a set of several known and fixed variables (e.g. road geometry, sign location and dimensions), combined with a high level of complexity associated with individual driver behaviour. It was therefore determined that for a reasonable exploration of the factors affecting the visibility of signs, obscuration should be considered in terms of geometric principles. A simulation model was then developed to express these considerations in terms of a population of traffic.

2.3 Assumptions and Parameters

The simulation model is dependent on a set of input parameters and assumptions. These are described in Table 1.

Table 1: Input Parameters and Assumptions for the models

Input Parameter	Assumptions
HGV height, length and width	The length and width of the HGVs are fixed and constant HGVs are generated with height assigned according to a defined input distribution
Position of drivers eyepoint (offset from left edge of lane and height from road surface)	The driver eyepoint is fixed and constant for all drivers
Height of the sign and offset from the verge	The road section is straight and flat
Maximum legibility distance of the sign	Daylight, good weather
Lane width by lane	
HGV proportion by lane	HGVs travel in the centre of the lane All vehicles are generated randomly
Speed by lane	Vehicles travel at a constant speed. Different lanes can have different speeds.
Flow by lane (and number of lanes)	No lane changing

2.3.1 Fixed parameter values

These parameters will be fixed for the purposes of analysis.

- *Number of lanes* – 4 permanent lanes. (Flow will be reduced to zero in Lane1 to simulate a permanent hard shoulder).
- *HGV length and width* – recommended maximum HGV in the UK is length 16.5m, 2.55m width and 4.9m height. The length and width values will be fixed and constant at these maximums in the models for convenience.
- *HGV height* – HGVs are generated according to a HGV height distribution. This distribution is described by four height categories, each with an associated proportion of the overall HGV population. The HGV distribution used for the default scenario is detailed in Table 2 below. This was based on the heights of a random sample of HGVs.

Table 2: HGV distribution

Height (m)	Proportion
4.00 - 4.25	0.47
4.25 – 4.50	0.19
4.50 – 4.75	0.25
4.75 – 5.00	0.09

- *Car height, width and length* – typical values are taken of 4m for length (as assumed in the Highway Code), 1.5m for height and 2.5m for width. (The width and height have been taken as typical for a car of length 4m since these two values are used rarely in the simulation.)
- *Position of driver's eyepoint* -1.05m from the road surface for car drivers, 2.7m from the road surface for HGV drivers, 2.5m from the left edge of the lane. These are based on values established in previous TRL studies[2].
- *Maximum legibility distance of the sign* – 180m. This is based on the well-established 'rule of thumb' that equates character height to legibility distance i.e. 6m legibility distance per cm of character height. For a motorway, LTN 1/94 (The Design and Use of Directional Informatory Signs) recommends that verge mounted ADS should have a character x-height of 300mm, which gives a legibility distance of 180m.
- *Lane width by lane* – 3.65m for Lane 1, 3.70m for Lane 2, 3.65m for Lane 3 and 3.55m for Lane 4. These lane widths are slightly wider than the minimums required for MM-ALR schemes.

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[2] McDonald M and Starkey O (University of Southampton), *Obscuration of traffic signs and signals*. Unpublished contractor report for TRRL, 1988

2.3.2 Variable parameter values

The overall aim of this analysis is to assess the difference in obscuration levels of a verge-mounted ADS in the following two scenarios:

- *Scenario A* – 4 permanent running lanes (which would usually require gantry-mounted signs)
- *Scenario B* – 3 running lanes with a hard shoulder

These two scenarios are compared for each parameter configuration. Speed and flow are fixed for each scenario and described below.

2.3.2.1 Speed and flow by lane

The default configurations have been chosen to represent conditions during a peak-hour in an MM-ALR scheme.

For Scenario A, the parameters by lane are described in Table 3 below.

Table 3: Parameters by lane for Scenario A

Lane	Speed (mph)	Flow (vph)
Lane 1	52	1200*
Lane 2	54	1500
Lane 3	56	1800
Lane 4	58	1500

**The proportion of traffic that would use Lane 1 in an MM-ALR environment during peak-hour traffic has been estimated at less than in Lane 2 but greater than the proportion that have been observed to use the hard shoulder during hard shoulder running (around 12%).*

For Scenario B, the parameters by lane are described in Table 3 below.

Table 4: Parameters by lane for Scenario B

Lane	Speed (mph)	Flow (vph)
Lane 1	0	0
Lane 2	52	1400
Lane 3	55	1700
Lane 4	58	1400

The following parameters will be varied for the purposes of analysis; the default values taken are discussed in this section.

2.3.2.2 Position of the sign

The Traffic Signs Manual Ch 1 recommends that, where possible, the lower edge of the sign should be between 900mm and 1.5m above the highest point of the carriageway alongside the sign. (The higher mounting should be used where excessive spray is likely to soil the signs.) Anecdotal evidence suggests that all such signs are mounted at least 1.5m and in many cases significantly more, particularly when the verge has a pronounced gradient. The Traffic Signs Manual Ch 1 also states that on high speed dual carriageway roads (including motorways) the clearance from the edge of the sign nearest to the carriageway and the edge of the carriageway should be at least 1200mm.

It is assumed therefore that the bottom right corner of the sign will have a default position of 1.5m above the carriageway, and -1.2m offset to the side.

2.3.2.3 *Point of measurement*

The obscuration model assesses the obscuration of a single point on the sign. When assessing the of speed limit aspects on an MS4, the bottom right point of the first numeric value was used as it was assumed that if a driver could see this point they would be able to discern rest of the aspect.

The point of interest on an ADS will differ depending on what information the driver requires, e.g. junction number, destination or distance to slip road.

Further complications arise since the size, design and information displayed on an ADS vary considerably and, therefore, the specific point of the sign that must be unobscured varies also. For simplicity, a typical ADS used in the driver simulator trial has been used to calculate the default position (see Figure 1) and it is assumed that the required information is the destination name.

Figure 1: An ADS used in the driver simulation

This sign is 4.12m x 3.56m, and so assuming that the end of the destination text lies at a point approximately two-thirds across the sign horizontally and half-way up vertically, the default position for the point used in the model is:

- Height: 3.5m
- Offset: -2.5m

2.3.2.4 *HGV percentage*

The overall HGV percentage in both default scenarios is 15% which is towards the higher end of motorway HGV percentages (e.g. M42 J3a-7 is approximately 11%; the northern quadrant of the M25 is approximately 17%).

Table 5: Default HGV percentages for the two scenarios

Lane	Scenario A HGV %	Scenario B HGV %
1	41%	0%
2	26%	40%
3	1%	7%
4	0%	0%

2.3.2.5 Two sequential signs

There is an additional option in the simulation model which allows the specification of a second sign further down the road section. The input parameters describing this second sign are the same as above for the first sign, with respect to the height and offset from the verge and the legibility distance. The parameters are defined separately for each sign and therefore can take different values, however in the analysis it has been assumed that in reality both signs would be the same.

An additional parameter that is introduced is the separation distance between the two signs. In the analysis this has been assumed to be 805 metres (or approximately 0.5 miles).

2.3.2.6 The effects of driver adjustments

It is recognised that, in practice, the obscuration rate of a particular sign will be influenced or mitigated by the actions of individual drivers, e.g. making an adjustment to their speed to enable them to see the sign. A full assessment of this is outside the scope of this task, however, an equivalent investigation was carried out in the previous obscuration task. This concluded that obscuration rates are likely to be smaller than those indicated by the simulation model.

While the specific calculations used in this investigation referred to the obscuration of speed limits and lane closure aspects on a cantilever-mounted MS4, much of the same the principles will apply to ADS and should be kept in mind when considering the findings of this report.

2.4 Model Description

Simulated vehicles are generated and each is continually assessed, to ascertain exactly and for how long its view is obscured. In this way the simulation model produces overall obscuration rates for the whole population of simulated traffic. This section briefly describes this process.

Simulated vehicles are generated randomly and enter the road section. After an initial warm-up period equal to the time taken for the first vehicle to travel the distance of the road section in each lane, the following process is carried out for each vehicle on the road, for a predefined timestep:

- Using geometric principles applied to lines of sight, the simulation checks whether there is a vehicle ahead that is blocking the driver's line of sight to the sign and if there is, whether the driver can see over the top of the vehicle.
- If the driver's view is not blocked, it is then checked whether vehicles in other lanes have the potential to obscure the sign, i.e. it identifies whether the sign can be seen over the top of a vehicle in the particular lane or if it can only be viewed through gaps in the flow. For each lane, it is then checked whether there actually is a vehicle blocking the drivers' line of sight.

At each timestep the simulation records whether the sign is currently obscured from each vehicle. Once a vehicle reaches the end of the road section (and goes past the sign) the simulation calculates the longest continuous length of time that the sign was unobscured, and compares this to the required viewing criterion to ascertain whether the driver of that vehicle could have 'seen' the sign.

If two signs have been specified for investigation, each vehicle that has passed the first sign continues through the simulation. When the vehicle reaches the legibility distance for the second sign the above calculations are again carried out for each timestep. For each vehicle the simulation will calculate whether the driver has seen each sign separately as described above, and also whether that individual driver has seen both signs, one sign or neither. This allows the calculation of an overall obscuration rate of drivers who have seen neither sign.

3 Key Findings of Model

3.1 Outputs and configurations

The main outputs of the simulation model are:

- The percentage of traffic in each lane that has an obscured/unobscured view of the sign for a given minimum time;
- Percentage of overall traffic that has an obscured/unobscured view of the sign for a given minimum time.

The analysis carried out on the output of the simulation model looked at the effects of varying parameters. The following parameter configurations were investigated for both scenarios:

1. Default (i.e. those parameters most likely to be relevant to ADS in an MM-ALR environment)
2. Varying ADS height
3. Varying ADS offset
4. Varying HGV percentage
5. Two consecutive signs
6. Three consecutive signs

3.1.1 Viewing time requirement

The viewing time requirement is highly variable due to the fact that ADS signs are not consistent in size, design or amount of information. The values chosen for consideration in this analysis are 1 second and 2 seconds. These are based on the following formula[3] for reading information on signs:

$$\text{Average reading time } T = 0.167N + 0.784 \text{ seconds,}$$

where N is the number of pieces of information on the sign. Taking N = 2 as a minimum (one off-destination and one distance value) and N = 7 as a maximum (3 ahead destinations, 3 off destinations and one distance value), gives a range between 1.118 and 1.953.

In addition to the variation inherent in the information displayed on ADS, and the impact this has on the time required to read it, there is also a human factor that is not taken into account – that of the existing level of knowledge of the driver. It can be argued that a typical driver will have a general idea of the information they are expecting to see on the sign, and will be able to comprehend it more quickly than if they had no knowledge

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[3] Hall, MacDonald and Rutley, 1989. *An experiment to access the reading times of direction signs. Vision in Vehicles, 3rd Conference, 1989*

of their location. A driver may also need to only read one specific piece of information on the sign, e.g. the junction number, and therefore will require a shorter viewing opportunity.

In summary, the analysis considers both a 1 second criterion and a 2 second criterion in all configurations, but these other factors may mean that the obscuration levels calculated will be over-estimated in many cases.

3.1.2 Margin of error in the model

The simulation model generates vehicles randomly subject to minimum headway restrictions. The type of vehicle and height (if the vehicle is an HGV) are assigned according to the input HGV distribution and HGV height distribution. This randomness in the vehicle generation leads to small differences in output between runs where the same input parameters are used.

To account for this random error, several large sets of model runs with the same input parameters were performed and the standard deviations for the samples were calculated. The "independent two-sample t-test" was used to test for statistically significant differences between model runs (to a 99% confidence interval). The margin of error for each parameter configuration will be different, however for simplicity's sake in the analysis the largest margin of error is taken to represent a maximum error in all configurations. This was a maximum margin of error of 3% which means that if the difference between model runs is 3% or less, it is 99% likely that this difference is due to chance.

3.2 Findings

3.2.1 Parameter configuration 1: Default

Figure 2 displays the percentage of traffic with view of the sign obscured in the default configuration for both scenarios.

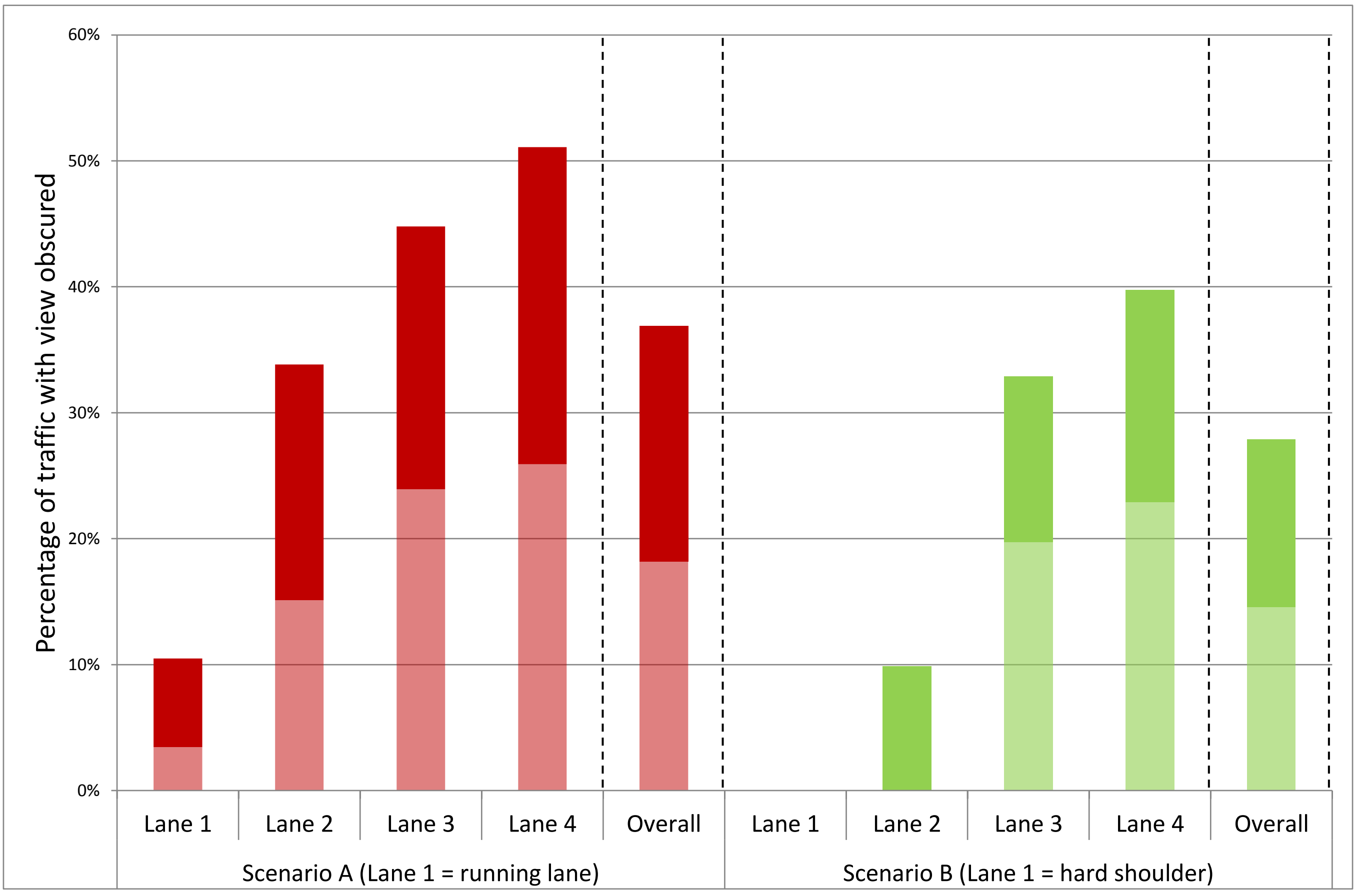

Figure 2: Percentage of traffic with view of sign obscured (light colours represent the 1 second criterion, dark colours represent the 2 second criterion)

In both scenarios overall obscuration levels are high. In Scenario A, more than half the drivers are unable to view the sign for 2 seconds and more than a quarter are unable to view the sign for even 1 second. Overall the obscuration levels drop by approximately 10% from Scenario A to Scenario B. A similar drop is seen in Lane 3 and Lane 4; obviously the drop in Lane 2 is more significant (approx 25%) since in Scenario B there is no traffic in Lane 1 and therefore all obscuration in Lane 2 is caused by traffic ahead in the same lane. It is also worth noting that in Scenario B, 100% of drivers in Lane 2 are able to view the sign for at least 1 second.

3.2.2 Parameter configuration 2: Varying ADS height

Figure 3 illustrates the impact of varying the height of the point of measurement above the carriageway (i.e. the height of the destination on the sign represented in Figure 1).

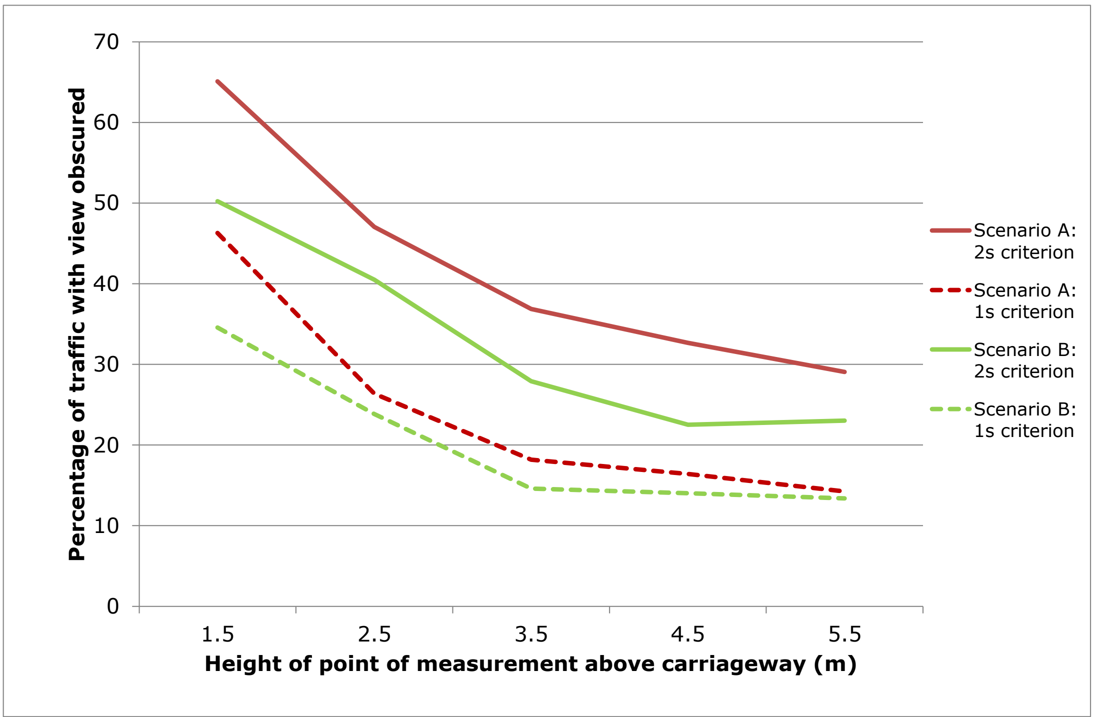

Figure 3: Percentage of traffic with view of sign obscured for both scenarios

As expected, obscuration levels are extremely dependent on the height of the point of measurement above the carriageway. When the point is below the default of 3.5m the obscuration levels increase rapidly for both scenarios. At the minimum height of 1.5m, in Scenario B approximately 65% of drivers cannot view the point for 2 seconds and even in Scenario A the rate is 50%. These high values are due to fact that at low sign heights, drivers' views are obscured by other cars rather than just HGVs. Varying the percentage of HGVs in the traffic view at this minimum sign height shows very little variation in obscuration levels which confirms this analysis.

As the height of the point of measurement increases, the rate of change in obscuration levels decreases. For heights greater than 5.5m the difference in obscuration levels between the two scenarios becomes smaller than the margin of error in the model and therefore these results are not displayed on the graph. Note that a point of measurement height of 5.5m, as defined in Section 2.3.2.3, means that the top of the whole sign assembly will be over 7m. This is the height at which legislation requires sign design to be certified by a chartered engineer due to wind load values. It seems unlikely that the small reduction in obscuration gained by increasing the height beyond this point is would worth mounting the sign itself higher. However, when designing a sign, it is probably worth considering whether the key information on the sign (all other sign design factors considered) can be set as high as possible to take advantage of this small effect.

Comparing Scenario A and Scenario B in this parameter configuration, it can be seen that ADS height has a very similar impact in both scenarios. The drop in obscuration levels from Scenario A to Scenario B is roughly maintained for all heights considered.

3.2.3 Parameter configuration 3: Varying ADS offset

Figure 4 illustrates the impact of varying the offset of the ADS from the edge of the carriageway (or the lateral position of the information on the sign).

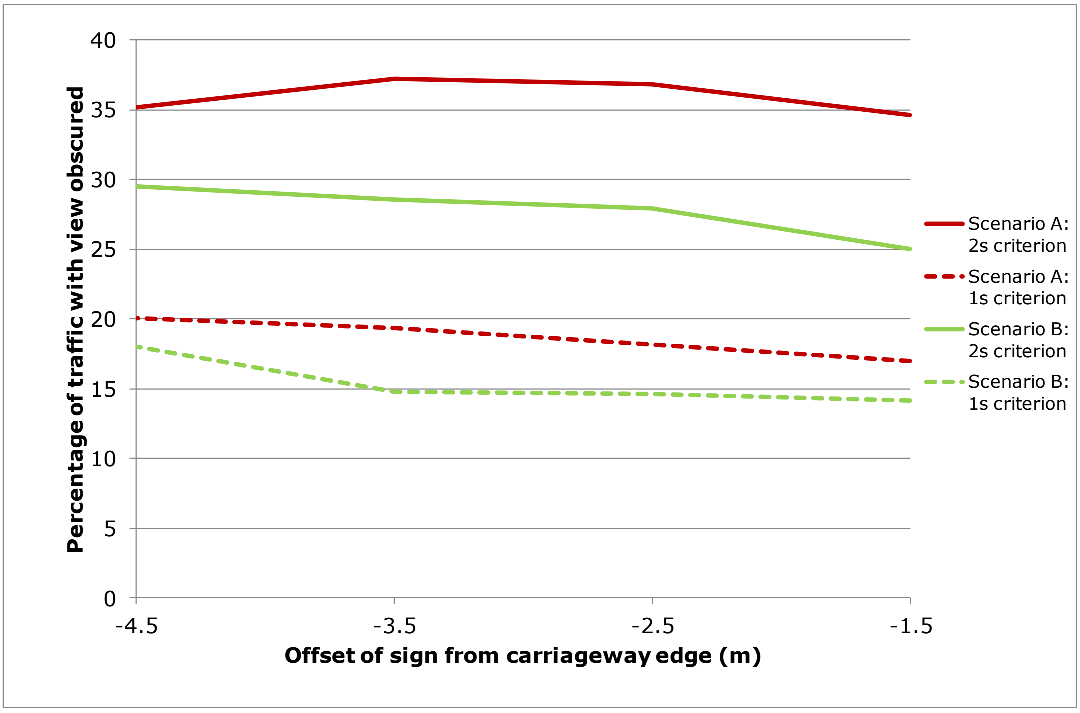

Figure 4: Percentage of traffic with view of sign obscured in both scenarios

As the position of the ADS is moved further away from the edge of the carriageway, the impact on the obscuration levels in both scenarios is minimal and inconsistent between the two scenarios and two viewing criteria shown. Given the margin of error in the model, the results suggest that the ADS offset position does not affect the obscuration levels (within the range of positions considered).

3.2.4 *Parameter configuration 4: Varying HGV percentage*

Previous work – and common sense – suggests that obscuration rates are greatly influenced by the number of HGVs in a traffic population. Parameter configuration 4 considers the influence on obscuration of the number of HGVs.

Figure 5 represents the effect on obscuration rates of varying HGV percentage. Overall traffic flows have been kept constant at the default values, as well as the ratio of HGV percentage across lanes.

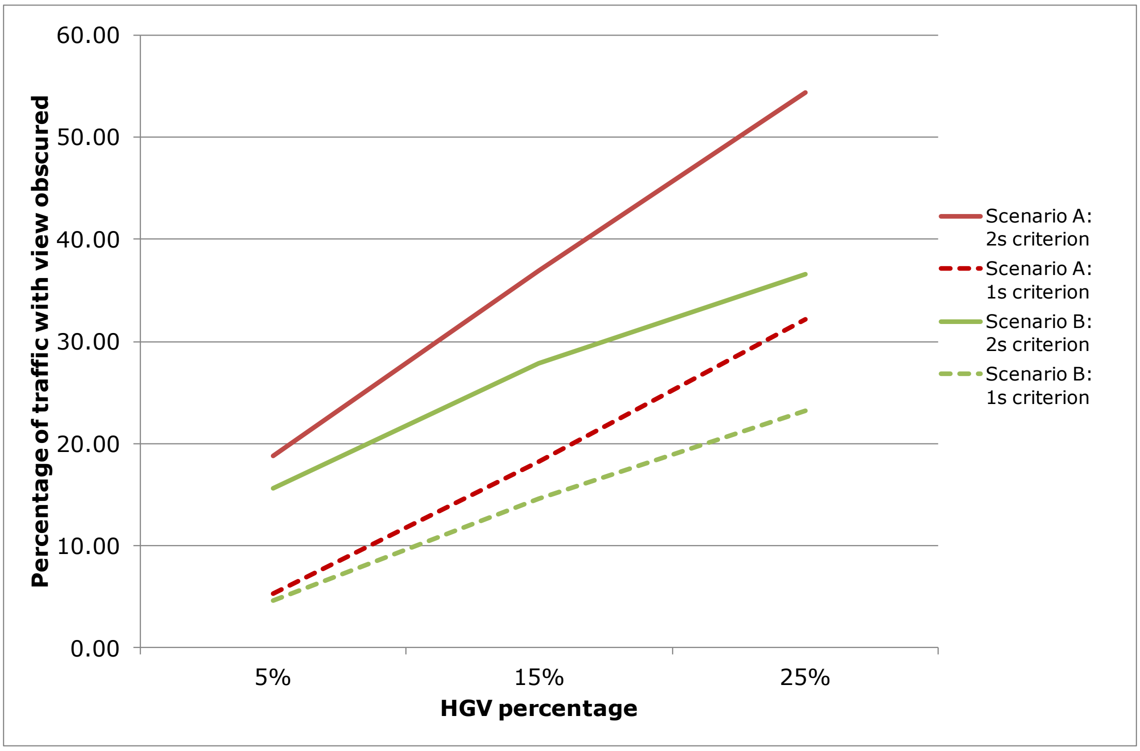

Figure 5: Percentage of traffic with view obscured for varying HGV percentages for both scenarios

As expected, varying the percentage of HGVs in the traffic flow significantly affects the obscuration levels. As the density of HGVs increases, the obscuration levels increase roughly linearly in both scenarios and for both viewing criteria. The results also show that as the percentage of HGVs increases, the difference between Scenario A and Scenario B also increases; at 5% HGVs the two scenarios have roughly equal levels of obscuration and the difference increases as the HGV percentage increases. This is due to the impact of the extra lane of traffic present in Scenario A – when the traffic is mostly cars the extra lane has little effect, when the percentage of HGVs is high it has a significant effect.

3.2.5 *Parameter configuration 5: Two consecutive signs*

Figure 6 illustrates the percentage of traffic in the two scenarios with the view of two consecutive signs obscured. The distance between the two signs is 805 metres which is approximately 0.5 miles, to represent the 1 mile ADS and the 0.5 mile ADS.

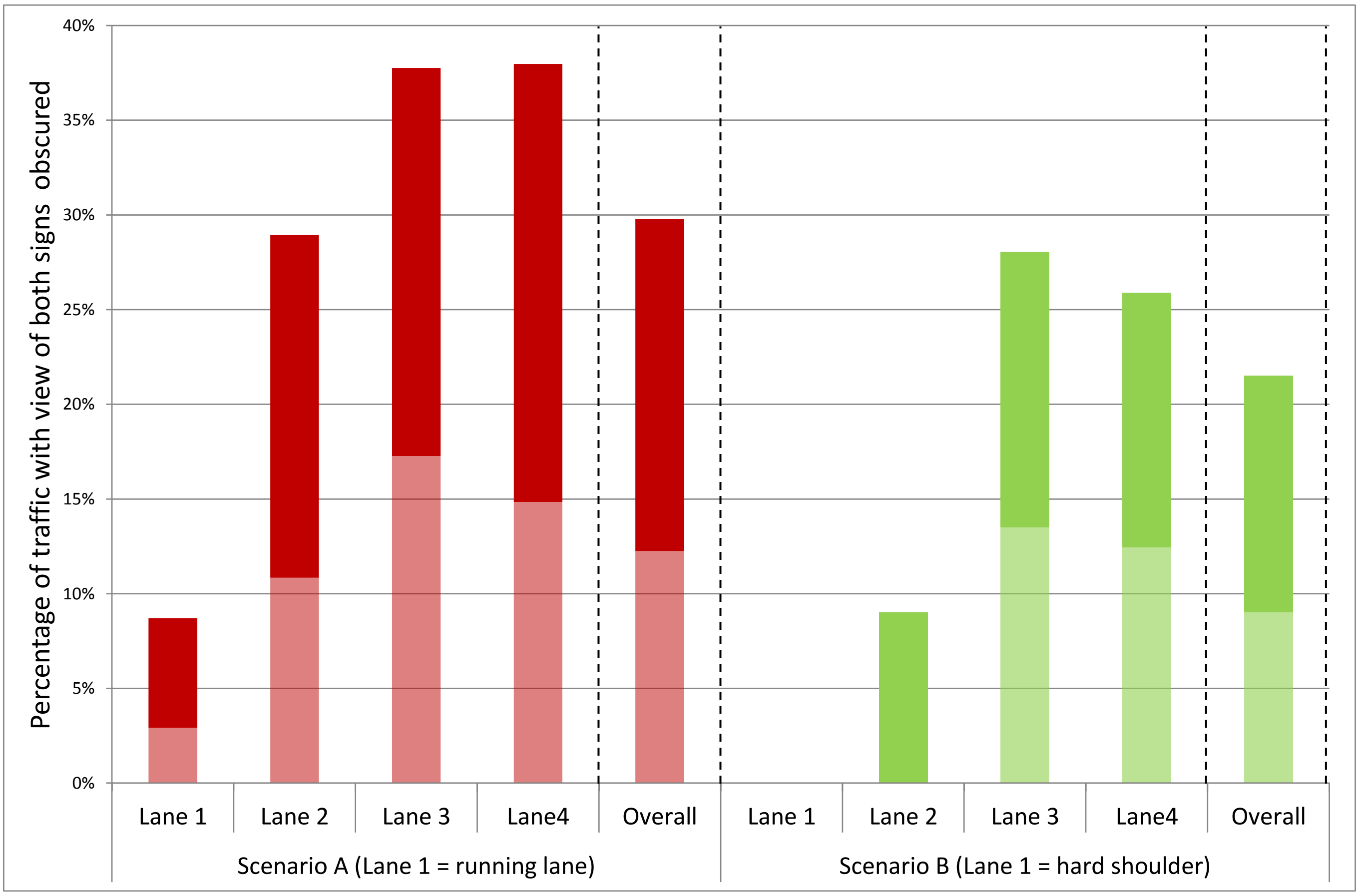

Figure 6: Percentage of all traffic with view of two consecutive signals obscured (light colours represent the 1 second criterion, dark colours represent the 2 second criterion)

Comparing both scenarios above with the respective single sign configurations, it can be seen that the addition of a second sign decreases the overall obscuration levels by approximately 5% in both scenarios. This impact is greatest in Lane 4, with very little impact in the nearside lane in both scenarios (i.e. Lane 1 in Scenario A, Lane 2 in Scenario B). This is expected because, since there is no lane changing, a view that is obscured for one sign will only 'become unobscured' for the second sign due to the relative movement of traffic in the nearside lanes, and the speed differential is greatest between Lane 4 and the nearside lane. It is notable that the reduction in Lane 4 obscuration rates due to the second sign is large enough that they become lower than the Lane 3 obscuration rates in both scenarios (except in Scenario A for the 2 second criterion, however this is within the margin of error of the model).

3.2.6 Parameter configuration 6: Three consecutive signs

In reality, the approach to a junction is marked by three signs: usually an ADS at 1 mile before the junction, an ADS at 0.5 miles before the junction and a direction sign at the junction itself. However, the simulation model is currently capable of assessing obscuration of only two consecutive two signs; therefore, this parameter configuration briefly considers the conclusions that can be drawn about the obscuration rates for three signs from the existing information.

As discussed above, since there is no lane changing and the vehicles travel at a constant speed (within each lane), any change in the obscuration rates when additional signs are added is due to the relative speeds of the lanes. If traffic in all lanes travels at the same speed then the relative physical position of each vehicle will be exactly the same approaching each sign and so the same drivers who have their view obscured for one sign will have their view obscured for the second also, i.e. the obscuration rates will be unaffected. However, if the speed differential between a viewing vehicle and an obscuring vehicle is sufficiently large then the viewing vehicle will pull ahead of the obscuring vehicle over the distance to the next sign and have an unobscured view.

Due to the relatively short distances and timescales involved, it is rare that a driver has his view obscured at the first sign and, at the second sign, has his view obscured by a different vehicle. It could be assumed, therefore, that if a driver's view is obscured at the first sign, either it will continue to be obscured at the second sign by the same vehicle or it will have become unobscured due to the relative speeds. This is best thought of in terms of the 'shadow' of the obscuring vehicle (see Figure 7) – the drop in obscuration rates for two signs is primarily due to vehicles 'emerging' from each obscuration shadow between the two signs.

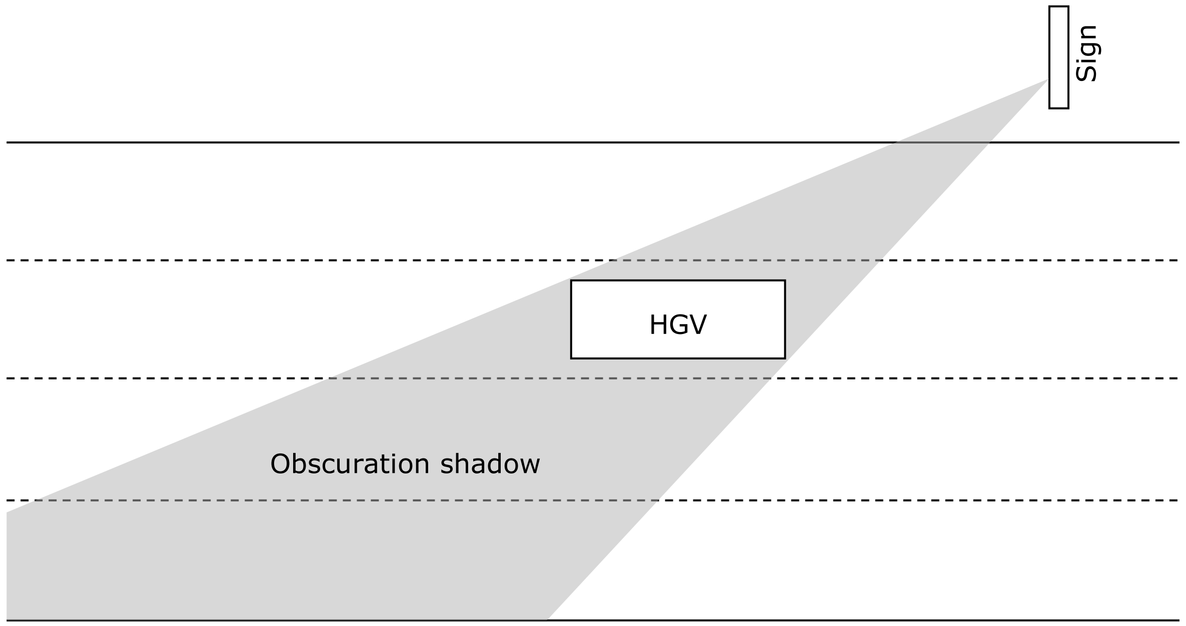

Figure 7: Obscuration shadow caused by an HGV in Lane 2 (not to scale)

It is therefore a reasonable assumption that, since the distance between the second and third signs will be the same as the distance between the first and second and the relative speeds remain constant, a similar number of vehicles will emerge from the shadow and a similar reduction in obscuration rates will be observed.

Figure 8 illustrates the reduction in overall obscuration rates achieved by a third sign situated 0.5 miles further along the road from the second sign, based on the assumptions discussed above.

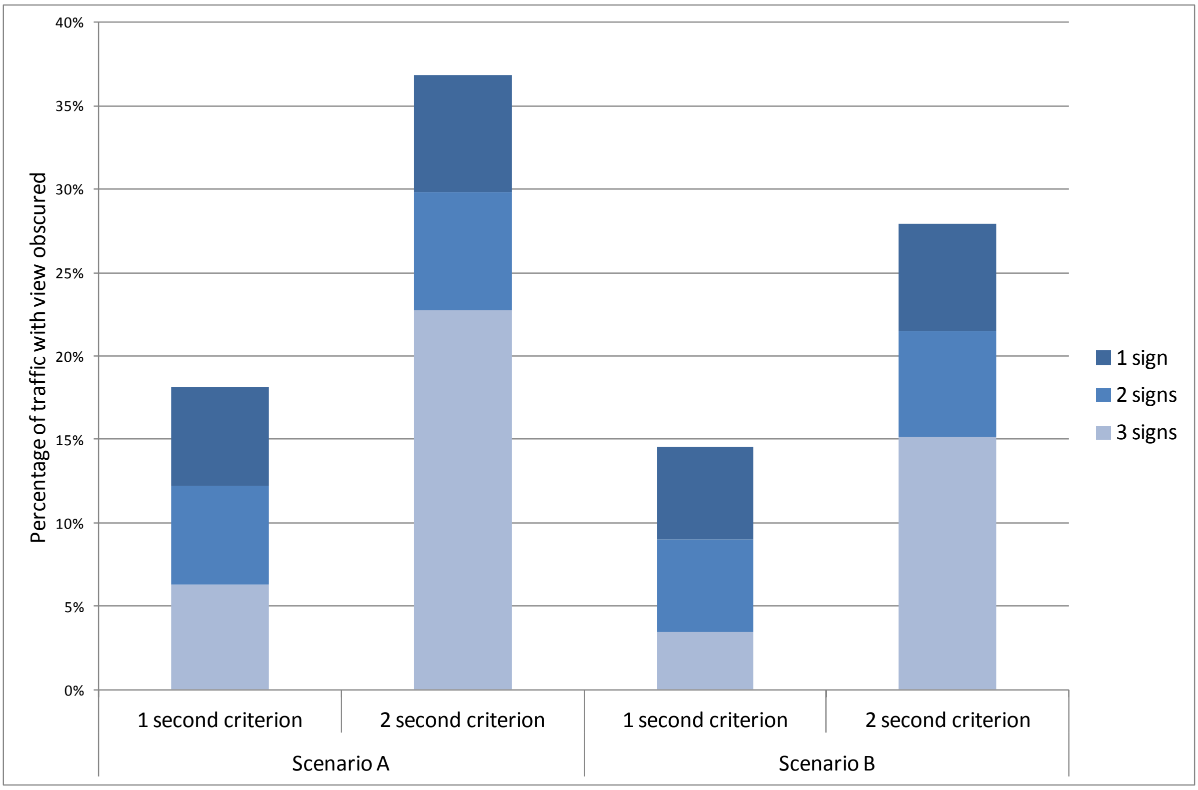

Figure 8: Overall obscuration rates for both scenarios with 1, 2 and 3 consecutive signs.

4 Conclusion

This task has estimated that, using the default parameters described and a 1 second viewing criterion, 18% of traffic in a MM-ALR environment would have their view of a destination shown on an ADS obscured, i.e. 18% of drivers would have to make an adjustment to their driving to be able to see the destination name for at least 1 second. The equivalent rate for the same point in a standard 3-lane motorway environment was estimated as 15%.

Varying certain parameters was found to have a significant effect on obscuration in both environments. Lowering the height of the ADS (or the point measured on the ADS) was found to increase obscuration. Conversely, increasing sign height was found to decrease obscuration and so this could be considered where obscuration is a particular concern. However, increasing sign height may have both physical design and readability implications that must also be borne in mind. Alternatively (and where possible within guidance), obscuration may be reduced by manipulating the relative height of key information within a sign.

Increasing the proportion of HGVs in the simulated traffic sample was also found to increase obscuration. Increasing the offset of the ADS from the carriageway was not found to significantly affect obscuration.

A full assessment of the impact of the levels of obscuration estimated within this task would require consideration of how some obscuration may influence driver's ability to discern junction information, as well as driver's understanding and preference. These elements are discussed together in CPR1353 Future MM Concept Task 3: Synthesis of Evidence.