Noise effects of barrier west of A1(M) Todds Green Stevenage

on complaint properties north of the Fishers Green Bridge

Summary report on the outcome of site monitoring and measurements

and

Discussion on the findings.

By

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1.0 Executive Summary in Lay Terms of the findings and discussion on noise measurements.

1.1 Noise measurements and observations were undertaken following results of noise modelling, a method of theoretically predicting decibel levels. This is a theoretical change as modelling has many limitations and cannot reflect many important real life issues that actually modify noise levels in an environment.

1.2 One of the main strengths of modelling is in predicting the change in noise or reduction in noise behind a barrier that protects housing directly behind it. Its weaknesses include a range of matters that the commonly applied modelling scenarios used cannot address including inaccuracies. This modelling indicated substantial improvement of the sound environment for the new housing to the west. However it also indicated some just perceptible increase due to reflected noise might occur in very limited locations close to and directly opposite the new noise barrier at a limited area south of the Fishers Green bridge. The noise barrier was erected to protect housing on the western side of the A1M as part of the Todds Green development just south of Fishers Green for which it is successful.

1.3 Complaints of increased noise post the erection of the barrier have been made by some residents on the eastern side of the A1M who are located north of the Fishers Green bridge. Their locality is away from where, potentially slight increases in noise are indicated as may theoretically arise. Perceptible increases in noise at these complainant properties due to the barrier would be contrary to the science of acoustics. This is due to the following facts:

a) Any added reflected noise in the northerly direction is at a much wider angle to the barrier meaning less noise is reflected in that direction compared to that directly opposite the barrier.

b) Only a just perceptible change was predicted directly opposite the barrier where reflected content is greatest meaning at other locations at different angles of reflection it must be less. Thus at the worst case location for added reflected noise, at most the increase might just be perceptible.

c) The limited locations or hotspots identified where potentially perceptible increased noise arose were away from dwelling facades as they were focal

centres of reflection between different buildings. Noise hitting individual facades is less, therefore than found at these hotspots. This means the change at buildings was predicted as below perceptibility.

d) The Fishers Green Lane bridge passes over the A1M providing substantial screening of the nearest part of the barrier further reducing any noise reflected off it in a northerly direction.

1.4 Due to the reasons given above and the fact the size of any modelling error is potentially far greater than any change in noise level, assessment beyond the area directly opposite the barrier was not considered. This was also undertaken before it was known complainants were located north of Fishers Green Lane. It was wrongly assumed complainants would be located where a change might just be perceptible.

1.5 For the avoidance of any doubt, if you measured 1m in front of a perfectly reflecting glass wall with a road parallel to the glass wall only a few metres the other side, the maximum increase you will get is 3dBA. At best an increase might approach 2.5dBA and this was commonly rounded up to provide a more robust assessment. Even in this perfect scenario the maximum increase cannot exceed 3dBA.

1.6 Where a model includes a high barrier on one side and a lower barrier on the other it means that theoretically some noise might be reflected from the higher barrier over the lower barrier that previously screened the noise and reflect again off of houses back towards the ground floor level. Multiple buildings could produce a hotspot rise. This factor is likely partly why the modelling indicated a couple of hotspots closer to a 3dBA rise. This is a hypothetical worst case that does not reflect reality. It does give a more robust assessment in terms of higher predicted noise but is in practice unrealistically high.

1.7 The measurement and observation exercise undertaken independently on 21st August 2023 identified other noise contributions due to downwind refraction is a greater contributor to the sound environment than any possible reflected content. This is the case even at the locations the reflection element is theoretically greatest, i.e. when directly opposite the barrier. As a consequence the potential reflected contribution is not perceptible even directly opposite the barrier and under the most common conditions when road traffic noise is

highest. Under other less common conditions such as an easterly wind the noise from road traffic would be substantially lower overall.

1.8 This raises the question why some people complain in an area expected to be imperceptibly affected by the noise change. It is not uncommon or unnatural for residents who perceive some act or change in their environment must have caused a change in their sound environment to then perceive such a change. This arises as the human brain unconsciously focuses on sounds which may be considered negatively when focussed upon and trigger our 'fight or flight' response mechanisms. A classic example is a quiet but unusual sound at night such as a door creak can commonly lead to awakening but we sleep through much louder sounds. It is an unconscious response to a possible threat.

1.9 There are always exceptions but generally over time humans can either sensitise to sounds or habituate to them. In general we progressively habituate to road traffic noise as it does not trigger any 'fight or flight' response mechanism and we notice it less as time goes on. In comparison a new neighbour with anti-social habits is likely to trigger increased sensitivity, regardless of how loud or quiet those noises are.

1.10 In this case there has been complaints which have in turn received considerable attention and focus both by the Council, investigators, and complainants, to the extent the latter have taken noise measurements. Such focus must naturally lead to sensitisation. Further complaining is a combative response triggering a 'fight' response which unconsciously raises its noisiness. In turn this does not mean that levels of noise have or have not increased but care is needed considering observations that are not independent.

1.11 The measurement exercise on 21st August 2021.

1.12 The observations and the measurements made were undertaken by an independent and highly experienced expert Mr Daniel Baker of Broodbakker Acoustic Consultants who had not previously been to the location. He also had no prior involvement with this issue and his observations are entirely independent of the MAS Environmental analysis.

1.13 The exercise was undertaken on Monday 21st August 2023 when the prevailing south-westerly wind was present. This reflects the most common wind direction

and therefore the most commonly occurring set of circumstances when noise will be higher to the east and north-east of the A1M.

1.14 The observations and measurements were deliberately made during the period between 1Oam and 3pm as this is in accordance with national guidance due to greater stability within traffic movements over this time period. The date selected was during school holidays but this is not considered detrimental to the assessment not least as this period of the day is outside of the going to and coming home from school periods so unaffected by that. There is also more people travelling on holiday during this daytime period. To quote Highways England, *"Typically during a school holiday, traffic levels do drop during peak times with slight increases in traffic levels during the traditionally quieter daytime".* Thus there is predicted to be more traffic during the survey, a time selected as it is in accordance with guidance when traffic flow is reasonably stable.

1.15 The observations and measurement data recorded indicated no discernible nor any measurable contribution from road traffic noise that was reflected off of the new noise barrier even at the location where such reflected noise was predicted to be greatest and possibly discernible. As identified, this point is directly opposite the centre of the barrier and relatively close to it.

1.16 The outcome of this assessment is that what was predicted as a possible effect in a very limited area on the eastern side of the A1M and away from dwelling buildings (free field locations) was not seen to occur. This then agrees with the observations of the independent expert who did not identify any contribution of reflected noise off the barrier at any location.

1.17 The advantage of an experienced and skilled independent observer is with their binaural hearing (two ears) there is the ability to determine the direction of noise in most cases and compare this with both measurements and their experience in other cases. A sound level meter with a single microphone cannot provide directional information.

1.18 The observer did identify, contrary to the prediction of a potential slight increase opposite the barrier, the primary contribution of road traffic noise was actually due to longer distant noise from the part of the motorway located to the south and south-west of this area. This occurs as the sound energy is being refracted

downwards over these larger distances towards ground level. This longer distance refraction contribution is not identified in the Calculation of Road Traffic Noise (CRTN) modelling used in the UK nor within IS09613-2 prediction software and as used by most of the world. This contribution to the noise is therefore excluded from the modelling exercise as the methods in the standards exclude it.

1.19 If any small contribution of reflected noise does arise directly opposite the barrier, its contribution is simply swamped. It is swamped by the much greater contributory effects of both direct road noise experienced at that location and the greater distant refracted sound from what is a long line source of noise (the A1M) to the south. To better understand what is actually experienced and place the actually experienced sound environment in context it is necessary to provide some background information on road traffic noise that is rarely discussed.

1.20 Background discussion on road traffic noise.

1.21 In reality motor vehicles are generating noise from three main sources, the exhaust and the engine which are both directly just above the reflecting road but more importantly from the tyres that are interacting directly with the road surface. This third tyre reaction contribution is the main source when vehicles are moving at speed as on this road. There are exceptions such as some motorbikes with noisier engines and exhaust and less tyre contact.

1.22 The result is that road traffic emits noise right next to and mainly directly in connection with a hard reflective and relatively horizontal road surface. As a result much of this noise is distributed either directly upwards or at a significant upward angle to the ground. As a matter of science much less noise is emitted to the sides. This means most of the noise is radiated away from the ground and upwards. A smaller element is emitted sideways towards houses. In comparison to these features of the source of the sound (very close to the road), the noise barrier is much further away. It also does not interact with the majority of the noise that is radiated upward. Even when the upward directed noise strikes the barrier it is still reflected up into the atmosphere at a significant angle.

1.23 Absent any wind most of this noise simply radiates upwards into the atmosphere with some limited scatter by that atmosphere. When this happens from a road which has high rise building development either side and close to it as found in

some densely built cities, then a canyon type effect can be observed. This canyon effect of increased noise arises at higher floor levels due to the greater upward directed noise from the road along with the multiple reflections from each side of the road. In this A1M case upward directed sound striking the barrier mainly continues at an acute angle upwards. It is not reflected back towards the ground but upwards.

1.24 Anyone who has travelled in a hot air balloon over a busy road should have experienced the high levels of upward travelling noise that is greater than that experienced at ground level. We rarely concern ourselves over this noise as most commonly it is travelling away from residential properties.

1.25 Over distances, typically in excess of 500m from a source of noise and when there is wind that is faster the higher you rise, a normal atmospheric state, the upward directed sound waves are increasingly refracted back towards the ground by the wind. This occurs on the downwind side of the source of noise.

1.26 Upwind of a source of noise, the sound waves are refracted further upwards and away from the ground meaning there is less noise, commonly termed a 'sound shadow'. The degree of this effect depends on a range of meteorological factors as well as the amount of noise transmitted upwards and other factors such as topography. There is only a token consideration of this in modelling due to much uncertainty within the effects and in models where they have tried to include it much controversy still arises.

1.27 In summary, in the case of a motorway, the vast majority of the noise travels upwards and is curved (refracted) over larger distances either further upwards or downwards depending on the wind direction and speed. This is shown diagrammatically below, not for a source directly on the ground but one above it. The principle is however, the same, except when a source is at ground level then more noise is first directed upwards and then bent down (refracted) towards the ground at greater distances from where it occurred.

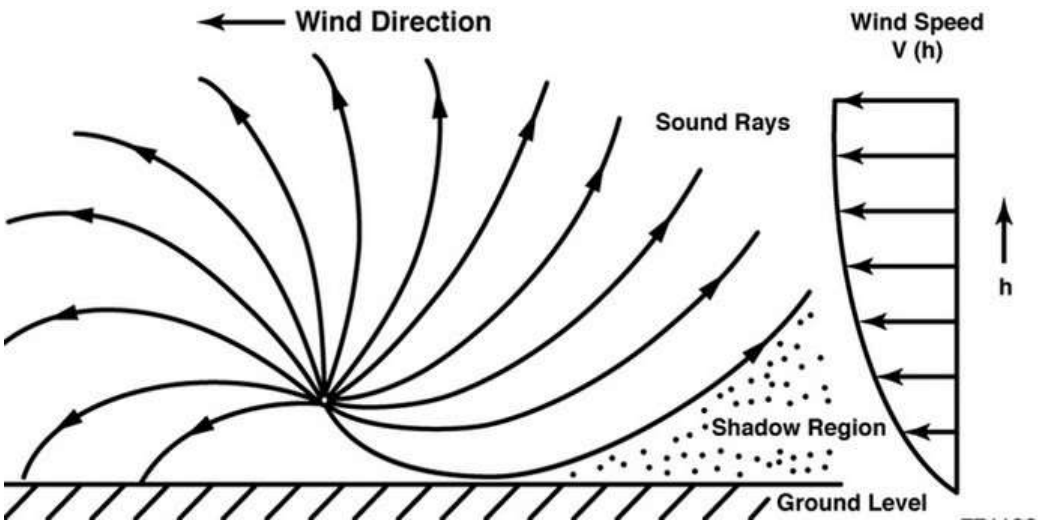

Figure 1 - Refraction effects on noise emission - in this case for a source above the ground and with sound shadow upwind and increased sound downwind.

1.28 In one noise prediction modelling programme Nord 2000, used in parts of Europe, it identifies that in the case of road traffic noise, even over distances of about 200m refraction effects can be substantial. This is shown in the diagram below as extracted from Nord 2000 and ISO1996. It provides a comparison of weather extremes and downwind versus upwind are shown, which can lead to actual differences in road noise experienced of the order of 20dBA. Compare the extreme of the meteorological state M1 on the left hand side (10m/s wind speed upwind) with the extreme of M4 (favourable 10m/s downwind propagation) on the right hand side. We do not normally measure noise during such extreme wind speeds and typically keep measurements in winds below 5m/s.

1.29 A difference in decibel level at 10m/s upwind versus 10m/s downwind is 20dBA and at 5m/s this reduces to a difference of 15dBA between upwind and downwind. It can also be seen that being upwind produces less of an effect than being downwind with the main increase in noise level from 0-6m/s winds downwind after which there is little added change. This methodology has not been adopted in the UK and only provides a range of variables at a distance of 200m. It does, however, show the importance of refraction effects that can be far greater than any reflection effects. Refraction effects are there regardless of reflection effects.

1.30 Wind speeds at 1Om height above ground level on 21st August were 5-6m/s indicating likely maximum downwind increases due to refraction effects. This accords with the observations of Mr Baker who confirmed that directionally the main contribution was from more distant parts of the A1M to the south and south-west.

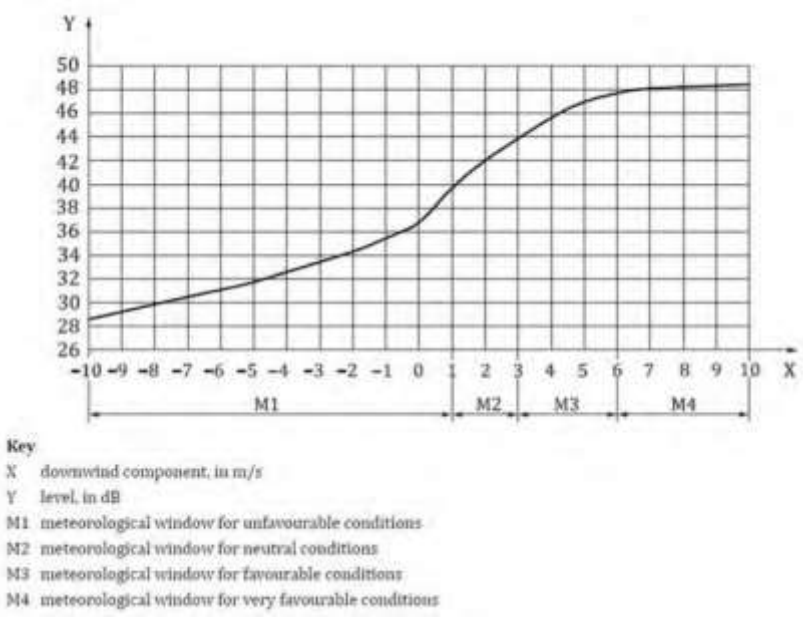

Figure 2 - Extract from Nord 2000, not used in the UK but shows four meteorological states from upwind to downwind with a difference of around 20 decibels at a distance of 200m from a motorway at ground floor level.

1.31 It follows that with increases due to wind could theoretically be of the order of 1OdBA. The more distant road contribution is likely to dominate in terms of its contribution until distances from such noise is in excess of well over a kilometre[1]. The extent of this is not readily determined due to a wide range of variables but in simple terms parts of the road much further south contributes significantly and any reflected sound wave nearby is at most a tiny fraction of this contribution.

1.32 It can be concluded there would need to be an absence of wind in the atmosphere, even at height, which is rare, for the reflected component to be theoretically perceptible directly opposite the barrier. A cross-wind at the complainant's properties such as a south-easterly wind might theoretically mean much reduced downwind refracted noise contribution but it would also reduce contribution from the road nearest their location and in turn mean lower road

[1] Closer to 1.6Km.

traffic noise overall. This means any imperceptible increase due to reflections off the barrier north of the Fishers Green bridge would be wholly counteracted by much lower road traffic noise overall from the section immediately opposite those houses.

1.33 In simple terms reflective effects are much smaller than meteorological effects even in the very limited area they are predicted to be perceptible, i.e. directly opposite the barrier.

1.34 Ignoring these wind generated effects, noise from a busy road generally reduces 3 decibels for every doubling of distance. This means at a house 200m away from the road it should be around 3 decibels lower in level than one 100 metres from the road, all other things being equal. In the case of this example house at 200m from the road, noise contribution from the part of the road 800m southwards absent wind effects would in approximate terms be 6 decibels lower than that from the nearest part of the road 200m away. However, even this more distant contribution raises the resulting decibel level by 1.

1.35 When there is downwind refraction as well, according to ISO1996 the contribution from this distant part of the source 800m away could be up to 10 decibels higher. In my experience it is typically 4-5 decibels higher. Put another way it is potentially greater than the contribution from the nearest part of the road and based on my own experience only about 2 decibels lower than the contribution from nearest part of the road. Even in those best case circumstances of my own experience it adds over 2 decibels to the resulting levels and potentially raises levels significantly based on the indications in Nord 2000. However this is not the complete picture.

1.36 As most noise from a road is reflected directly upwards towards the sky then the actual effect of refraction is one where far more noise can be added from more distant parts of a road and this can become the dominant contributor despite being further away. This appears what was observed on 21st August 2023 and is the most common set of circumstances.

1.37 Whatever way this is considered, reflection contributions are insignificant in this case even at the nearest houses opposite the barrier, compared to contributions from more distant downward refracted content in this case. This arises in this case as the road southward is an unobstructed contributor for over a kilometre.

1.38 The noise environment east of the A1M.

1.39 Often when close to a motorway the more distant refracted contribution is not dominant nor recognisable as it is much lower than the direct noise from the nearest part of the road. Also the distant part may be heavily screened or not upwind of the receiver location. This is not wholly the case at sites east of the A1M in this locality. The nearest part of the road is partially screened on the eastern side by the grassed mounds. This means there is greater attenuation from the nearest part of the road than expected.

1.40 Note any argument the traffic flow may have been lower on this date fails as this would also proportionately reduce the noise from the more distant sections of road as well.

1.41 The noise model predicted ground floor sound energy levels with the barrier in place where hotspots were also predicted of 62-65dBA. This excludes longer distance contribution from downward refracted noise that was observed. It excludes it for two reasons; the more distant road was not included in the model and should not be due to modelling limitations and modelling does not account adequately for downward refraction increases. In other words the actual noise experienced should be higher than the predicted levels as there is contribution the model does not take into account.

1.42 In contrast to this the measurements at location 3 (see measurement exercise below) nearest to the barrier and directly opposite it gave levels of 55-59dBA. These are below the predicted levels and also include the addition of the longer distance refracted noise. There appears therefore to be greater attenuation of the nearby road noise than expected.

1.43 In summary the data indicates greater than normal distance reduction, possibly due to better screening of the nearby part of the road or possibly greater ground absorption effects. It is likely a combination of both. It also identifies no identifiable reflected contribution even where it is predicted as a possible occurrence. This is not unexpected as the sound level meter would have to be located precisely at a hotspot which would be remarkable.

1.44 In contrast however there is greater noise contribution from sound refracted (effectively bent back down towards the earth) from the road further to the south

ansIng under the most common atmospheric conditions. This was directly observed by Mr Baker.

1.45 In the case of complainant properties north of the Fishers Green bridge and also those south of the bridge, it is the long distance refraction effects adding sound initially reflected directly upwards from the road that are contributing substantially to what is heard. This may perhaps be perceived, due to erroneous perceptions, as coming from the barrier but it is not and fundamentally arises from the effects much further south along the A1M as confirmed by Mr Baker. To place this in perspective, in my own experience this can rise levels 4-5dBA over distances of about 600m - 1km and in the advice in ISO1996 can raise levels 10dB over 200m.

1.46 In summary the perceptions of change, certainly in noise level terms arising from reflections off the barrier are without support in the real world circumstances. The potential increase in some limited locations directly opposite the barrier as shown by the model arises due to limitations in modelling, including factors it cannot take into account. In reality these are lost or submerged by the far greater more distant downward refracted noise. These important real life contributions due to refraction over larger distances of what is initially upward radiated noise and not considered by the model, far outweighs (swamps) the small theoretical and potentially just perceptible increases due to reflection directly opposite the barrier.

1.47 Even in the absence of any downward refracted contributions from much further south along the A1M, it is important to understand that the small theoretical increases indicated by the modelling in just two hotspots directly opposite the barrier occur away from buildings. They only arise where reflections from several buildings coincide. This is not the noise experienced at a house wall or going inside a room. It is the noise roughly equidistant from several reflective walls that are located in different positions.

1.48 The primary variable found and contributor to the road traffic noise was the longer distance downward refracted noise. It is important then to recognise that any added screening or absorbent lining of the existing screening in this case, to reduce reflected noise would have no discernible effect upon resulting levels. This arises as they are mainly dictated by the refracted noise contribution. Simply put stopping reflections off the existing screen would not address the

main sources of noise and make no discernible change in the circumstances or sound environment experienced in this case, even at those houses directly opposite the barrier.

1.49 The observations and data show there is no failure or need for extra mitigation and such steps would be a direct waste of money in terms of the alleged increase in noise complained about. Incidentally, absent of adopting modelling such as Nord 2000 as used in some parts of Europe, it supports continued reliance on the Calculation of Road Traffic Noise that excludes reflections to a significant degree, certainly in the circumstances of this complex site. This is because noise reflected upwards from a road surface is substantial and when this refracts downwards over large distances its effects cannot be satisfactorily determined. It is excluded from modelling and could not be included as major disagreement still arises over its contribution.

1.50 The greater the downward refracted noise contribution the less effective screening is predicted to be for locations downwind of such a screen. Notwithstanding that, erecting a screen to protect nearby housing is very worthwhile, especially when very close to the screen as in this case and when relating to properties on the western side of the A1M. Its effectiveness for those western houses will reduce under easterly winds when at houses furthest from the screen. It is effective at the blocking of noise directed more or less horizontally towards the housing and is therefore of substantial benefit to the new development in this case.

1.51 As distance increases its benefit reduces and refracted noise increases in importance. This is much the case for development on the west side of a road when there are easterly and south-easterly winds. However, with westerly and south-westerly winds that dominate, performance should be improved to the west of the A1M. This is the case in the UK and directly relevant to this site.

1.52 In this case when complainant properties north of the Fishers Green bridge are downwind of the road, the most important contributor to the noise other than noise directly emitted from the nearest part of the road towards those properties is the distant refracted noise that was originally radiated upwards into the atmosphere. The noise reflected off the barrier is at most potentially perceptible in limited no wind conditions at a few minor hotspots located away from houses, when close to the road and directly opposite the barrier. This is not the case

when north of the Fishers Green bridge which adds screening and with a far greater angle of reflection from the noise barrier compared to properties directly opposite the barrier. However, even at the minor points where reflected noise is greatest, its contribution is swamped by the long distance downward refracted noise content observed.

1.53 Simply put there is not any failure of the Council and the predicted potential hypothetical hotspots are not identified in the real environment. Even if they were to arise they are not where the residents complain or at any window. Contrary to the author's previous belief they are not identified to arise at all in this case. When long distance refraction is included, never before considered in road traffic noise assessment, absence of any identifiable reflected noise makes sense.

2.0 Introduction and background

2.1 Stevenage Borough Council requested modelling of the noise barrier built on the west side of the A1M at Todds Green to see if it resulted in increased noise burden at dwellings on the eastern side of the A1M and to compare with the developer's modelling findings.

2.2 This was undertaken by the author using both the Calculation of Road Traffic Noise (CRTN) method as directed by UK Government when considering proposed development impacted by road traffic noise and also using ISO9613-2 a more widely used modelling standard which can take a wider range of modifying factors into account. Neither approach considers a wider range of meteorological effects.

2.3 The findings of the modelling exercise need to be considered only in the light of extensive caveats relating to them and they merely indicated a possibility of some hotspots of increased noise that could be noticeable in some limited locations directly opposite the barrier but not elsewhere. Modelling was not extended further as it was not considered conceivable that such limited effects could arise further away and increased modelling error. This is discussed in section 1 of this report in more detail.

2.4 Post that exercise, site observations and measurements were conducted on 21st August 2023 to determine whether any measured change was determinable due to reflections from the barrier. This included at properties north of the Fishers Green bridge, an area that is not directly opposite the barrier.

2.5 Unfortunately during the author's modelling analysis it was presumed the issue was in terms of dwellings directly opposite the barrier. This was because, in the author's expert opinion and experience, this was the only area any discernible change might feasibly arise. This location is where the angle of incidence of reflected sound waves was close to 180 degrees and the distance from the barrier was relatively small. The latter point is relevant to loss of sound energy due to increased distance.

2.6 The modelling findings were presented in a report Ref Rep/Ste/Mod/220905, dated 5th September 2022. The assessment was heavily caveated due to the limitations of modelling and was indicative of a possible effect. A few points

from and relating to that report are re-iterated in section 4 of this report post the reporting of the observation and measurement exercise conducted on 21st August 2023. The reason for further analysis of the modelling report arises due to an apparent misunderstanding of how to interpret the modelling report and the incorrect extrapolation of its findings to more distant locations from the barrier. This is not addressed further as the lay descriptions in section 1 of this report address why this is incorrect.

2.7 It is important to understand that when sound energy is reflected it is also diffracted and refracted in different directions. In turn this means the quantity in any one direction is reduced compared to the original source level. This can be demonstrated diagrammatically if necessary but it should be sufficient to recognise when modelling a series of moving vehicles (point sources of noise) and reflections of their sound off a barrier behind them which is also not a flat surface, there is significant scatter and loss of sound. Furthermore the vehicles travelling at speed primarily generate tyre interaction noise with the road surface with engine and exhaust noise secondary. This then strikes the barrier at an upward angle and is reflected further upwards into the atmosphere much at an equal upward angle. This means the sound energy is reflected skyward.

2.8 When directly opposite the barrier near horizontal sound waves from passing vehicles will be reflected back towards the other side of the road with the least loss due to scatter. This is the locality where potential increases are possible, in theory.

2.9 As discussed in section 1, modelling cannot adequately address downward refraction wind effects which in turn is different for different wavelength sound and at different distances. Importantly these refraction effects affect the originally emitted sound energy more than the reflected element as the latter is scattered more. The outcome is that actual reflected effects in a model can overstate their contribution, especially when compared to the most common meteorological effects that are ignored. The models identify a theoretical set of circumstances and a little like a stopped clock, they can be right for brief periods.

2.10 This report focuses on the measurements and observation exercise but also considers the limitations of the modelling report as they appear to have been take out of context.

2.11 The observations and sound measurements undertaken on 21st August 2023 were directed at comparing levels at four locations to try to compare positions directly opposite the barrier with those north of the Fishers Green bridge and least screened by that bridge or the mass of housing north of the bridge.

2.12 Four measurement locations were adopted, three are free field (at least 3.5m away from reflective surfaces other than the ground where reflective effects can be ignored) and one within 1.5 metres of a fence. This fence reflects noise close to the microphone similar to a fac;ade location and to adjust to a free field location has been adjusted downwards by 2dBA in accordance with 8S8233: 2014. This then enables direct comparison.

3.0 Site visit and noise monitoring exercise.

3.1 This exercise was undertaken to reflect a typical busy weekday under the most common wind conditions, south-westerly winds, with measurements conducted between 10am and 3pm. This then serves to meet the guidance on taking road traffic noise measurements that can be compared, if necessary, with the UK methodology the Calculation of Road Traffic Noise (CRTN). It also meets 8S7445 and ISO1996 which describe taking environmental noise measurements. The primary element in those standards relates in terms of reflecting downwind conditions but without excessive wind that can corrupt the measurements. It also reflects the most common wind direction for this locality when noise will be highest.

3.2 To ensure independent objectivity an independent expert Mr Daniel Baker from Broodbakker Acoustic Consultants was used who has not previously been involved with this case nor had he previously visited the area.

3.3 Throughout the measurements the observations made of the type and direction of the main contributing noise was that it emanated from the length of road further south from the section of road adjacent the site. In addition no material contribution from the barrier as a reflected contribution was discernible.

3.4 There were various objectives but the primary objective was to evaluate if there was any evidence of elevated noise due to reflection from the newly installed noise barrier on the western side of the A1M directly opposite the barrier or at locations to the north of Fishers Green where complaints of increased noise have been made. It would also serve to determine the dominant source of noise.

3.5 A limitation to an exercise of this type is the absence of the barrier. We cannot therefore compare the situation with and without it. This is primarily why originally; we assessed the potential increase using noise propagation modelling programmes.

3.6 A noise propagation modelling exercise was therefore, previously undertaken by the author as discussed in section 1 and 4 of this report below. In that exercise I considered two models and identified a potential slight and perceptible increase in noise due to reflections directly opposite the barrier at sound transmission incidence angles nearer to 180 degrees. It identified a couple of

hotspots could theoretically arise in-between but away from dwelling buildings where a change in noise would be hypothetically perceptible. In other words outside on footpaths and roads. The model did not look at locations north of the Fishers Green bridge as this was well outside of any reasonable modelling reliability due to the greater distance from the barrier, the greater angle of incidence of reflected sound energy at such locations and the intervention of the Fishers Green bridge. To attempt to model these would be misleading for multiple reasons including the screening effect of the bridge obstructing much of the source to receiver path.

3.7 Even at the locations chosen for modelling, the extent of modelling error, recognised in the guidance for circumstances absent any consideration of reflected noise was in excess of double (plus or minus 3dBA = 6dBA) the potential added noise from reflections and it is not therefore a reliable determinant of potentially increased noise. It is important to recognise the guidance caveats that this error factor is without any reflection or screening intervention and error increases when this is added. The extent of error increase is unknown.

3.8 The outcome of the exercise was merely the identification of the feasibility of slight increased noise in limited and isolated locations directly opposite the barrier where it was presumed complainants lived. In lay terms it was identified a perceptible change was possible and may be identifiable for a limited period of time in some very limited locations.

3.9 The present analysis reveals other effects not modelled, which then renders this small possible change irrelevant. This was not appreciated at the time of the modelling analysis although the findings of the modelling were caveated.

3.10 The analysis of the noise measurements.

3.11 The four measurement locations are shown in Figure 3 below with the distances from the A1M marked. These were chosen to try to reflect two sets of circumstances. The first set (locations 3 and 4) was where the effects south of the Fishers Green bridge were expected to produce some reflected noise increase as feasible. This is directly opposite the noise barrier. The second set (locations 1 and 2) was just north of the Fishers Green Lane where the road and barrier is least screened by the bridge and the housing to the north of the bridge.

3.12 The distances perpendicular to the road was to try to achieve points of similar impact due to distance in isolation.

Figure 3 - Measurement locations chosen on 21st August 2023 - The A1M is shown as a dual carriageway to the left side. The new housing development is located at the fields to the far left but not shown. Fishers Green Lane curves from the bottom and turns towards the A1Mat the top.

3.13 Prediction of a hotspot was relatively close to location 3 with location 4 directly in line with location 3 and further away from the road where the noise should be similar but fractionally less.

3.14 Location 2 relates to a point closer and just south of one of the complainant properties but not obstructed by any other houses in the direction of the noise barrier. Location 1 was close to a fence for which adjustment is needed to compare but also closer to the part of the A1M without any noise barrier opposite. This is where the higher Fishers Green approaching the bridge obstructs noise reflected from the noise barrier. In other words it should be quieter at this location than equidistant locations opposite the barrier, if the barrier is a significant contributor to the noise levels.

3.15 Some photographs of measurement locations are presented below to provide further understanding and context followed by a table of the main data which is then evaluated.

Figure 4 - Measurement location 4

Figure 5 - Measurement Location 2

Figure 6 - Location 1 on LHS and location 3 on RHS with arrow showing position of microphone. No photo was apparently taken of the location to avoid capturing some resident's personal information without their consent.

Figure 7 - The noise barrier as viewed from Fishers Green Lane Bridge with the new housing beyond plus the northbound carriageways of the A1M.

Figure 8 - Part of the noise barrier viewed from the mound on the eastern side of the A1M and **south of Fishers Green Lane bridge. This mound is the primary screen of noise to the east side of the road.**

3.16 Measurements were rotated between the four locations. They mainly lasted generally for periods of 10 minutes to meet guidance requirements and using a range of average and statistical parameters enabling their direct comparison. Historically the LA10 (level exceeded 10% of the time) is used for traffic noise measurements where measurements are not for a full daytime 16 hours. These are arithmetically averaged and a deduction, depending on the circumstances, of 2-3dBA is made to reflect the average sound energy level over the day which is then identified as an LAeq value. Both short term LA10, LAeq and a range of other parameters were recorded allowing a direct comparison of the locations.

3.17 In the tables below for location 1, 2dBA has been deducted from the LAeq and LA10 measurements to adjust these fac;ade type measurements (close to a fence) to reflect free field measurements. This then allows direct comparison of

these values. It should be noted some guidance uses a deduction of 3dBA for this effect including that directed at road traffic noise assessment such as ISO1996 and the WHO Community Noise Guidelines. I have already identified in section 1 why this is the absolute maximum that could arise in any scenario but does not in practice. An extensive debate can arise over this but I consider 2dBA appropriate which follows 8S8233:2014. 3dBA could be used lowering the value at this location a further decibel. To avoid any confusion, adjustments of the other parameters recorded are not presented here. The original data (without deductions) is presented in Appendix 1.

3.18 It is also important to recognise that location 1 is only 152 metres from the A1M compared to 190m for location 3. Theoretically at such a closer distance to a line source of noise it should experience levels at least 1 decibel higher than location 3. When distance difference is considered along with adjustment to the free field levels then in some cases a reduction of 4dBA could be argued in order to directly compare these two locations.

3.19 In simple terms levels at location 3 and 4 should be higher than at locations 1 and 2 after adjustment for distance to account for some noise reflected directly back from the nearest part of the road if other factors such as meteorological effects are excluded. These meteorological effects are effectively excluded from the modelling but present during the measurements.

3.20 As the meteorological effects affect all locations, direct comparison can be made. However considered, levels at locations 3 and 4 should be higher than at locations 1 and 2 if reflected noise was a significant contributor. The position of the Fishers Green bridge should serve to amplify this difference.

3.21 Simple analysis of the data even after adjusting for the different influencing factors such as distance reveals fractionally higher levels at the properties north of the Fishers Green. In turn this indicates reflected noise is not an identifiable contributor at these properties.

3.22 Table 1 – Summary table of main recorded noise data.

Location	Time	Duration	LAeq,period (adj 2dB for Loc1)	LA10,period (adj 2dBfor Loc1)
1	10:17:51	0:02:08	58.4	60.5
1	10:20:01	0:09:58	58.5	60.6
1	10:30:01	0:00:49	58.6	59.7
1	11:34:03	0:05:56	57.1	59
1	11:40:01	0:09:58	59.9	61.2
1	11:50:01	0:00:53	57.6	59.2
1	12:45:13	0:10:00	58.5	60.3
1	13:55:06	0:10:00	58.7	60.3
2	10:33:07	0:06:52	56.5	57.7
2	10:40:02	0:09:57	56.4	57.8
2	10:50:01	0:00:08	56.8	57.5
2	11:53:07	0:06:52	55.6	57
2	12:00:01	0:09:58	55	57
2	12:10:01	0:00:04	53.2	54.3
2	13:00:03	0:10:00	55.4	56.9
2	13:10:37	0:10:00	56.6	57.9
2	14:09:01	0:10:00	55	56.4
3	10:54:21	0:05:38	58.6	60.2
3	11:00:01	0:09:58	57.1	57.7
3	11:10:02	0:00:02	55.7	57.1
3	12:15:01	0:10:00	57.3	60.1
3	13:25:00	0:10:00	55.2	57.1
3	14:23:23	0:10:00	56.8	58.9
4	11:12:46	0:07:13	56	59.6
4	11:20:02	0:09:57	54	57.6
4	11:30:02	0:00:04	52.5	53.2
4	12:30:01	0:10:00	55.7	59.1
4	13:40:00	0:10:00	56.5	60
4	14:35:39	0:10:00	56.2	59.8

3.23 **Note:** Figures in light grey should be ignored as too short in time to be of value. The full measurements are presented for transparency. As all sources of sound are recorded including aircraft overflights the LA10, the value exceeded for 10% of the time is often considered more reliable for road traffic noise as it excludes any short high noise events, in this case generally, which occur for less than a minute. The LA10 is the level exceeded 10% of the time meaning any higher noise lasting less than 10% of the time is ignored.

3.24 **Location 1 compared to location 3.**

3.25 At location 1 the LA10 10 minute values are generally between 60-61dBA and corresponding LAeq values range from 58-60dBA when rounded. These values are expected to be about 1dBA higher than at location 3 as it is nearer the

motorway. It is also potentially less screened from the direct noise from the A1M road north of the bridge but this cannot be readily determined. The bridge should reduce its level.

3.26 At location 3 LA10 values were 57-60dBA and the LAeq was 55-57dBA. Theoretically this location should be affected by any reflected noise off the barrier and is close to a potential hotspot. Adjusting for the distance difference the values at location 3 are still slightly below those at location 1. This may in practice be because of some of the housing screening part of the A1M at location 3. It is not due to improved screening of the road at this part as this would similarly reduce levels at location 4 which is not seen. In any event it cannot receive higher reflected noise as that would elevate levels. As levels are lower it contradicts any consideration of any significant reflected element.

3.27 Placing the slight differences aside in terms of distance and screening, it is clear there is not any enhancement of values at location 3 due to reflection off the barrier that is directly opposite. If this was a factor it should render the levels at location 3 higher than those at location 1 or at worst equal. In contrast noise levels at location 3 are notably lower.

3.28 The results obtained are consistent with the observations during the measurements that the main or most significant contribution was from the length of road further south. As discussed in some detail in this report, this is a contribution arising from further away and affected by downwind refraction effects. It is excluded from modelling. Both locations 1 and 3 will be similarly affected by this.

3.29 Location 2 compared to location 4.

3.30 The distance of these two locations from the road is similar. Potentially location 4 is screened more by the built environment than location 2 indicating levels should be higher at location 2. Both are free field measurements and no adjustment is needed for this factor.

3.31 At location 2 the LA10 range was 56-58dB and the LAeq was 55-57dB. In terms of distance difference alone compared to Location 1 it should be about 2dBA lower. However, values are 3-4dBA lower. This indicates either the values at Location 1 are higher than expected or those at location 2 are lower. As levels at location 1 are unexpectedly higher than at location 3 this indicates it may be

more impacted by the longer distance refracted noise contribution that was the dominant contributor observed at the time. It cannot come from reflections *off* the barrier as this is significantly screened by the elevated bridge road at this location. It is entirely logical it experienced higher longer distant refracted noise.

3.32 At location 4 the LA10 value range was 58-60d8 and the LAeq range was 54-57d8. These are very close to the values at location 3 and are effectively the same. In terms of distance from the road they should be expected to be about 2d8 lower. As before this implicates the longer distant refraction contributions are a significant factor and greater than the immediately adjacent road and any reflection contribution. This latter element will not increase over distance.

3.33 It is also notable the LAeq values at location 4 are almost identical to those at location 2 but the LA10 values are 2d8 higher. In turn this indicates location 2 experiences less noise than at location 4. As location 2 has an acoustically unobstructed path to the noise barrier where location 4 has some obstruction by housing, if reflected noise contributed in any meaningful way, equal and lower levels would not be experienced. It is inconceivable any identifiable contribution derives from the barrier. This is also consistent with the observations at the time.

3.34 In conclusion the measurements and observations at the time indicate hotspots caused by reflected noise from the barrier do not in fact arise. In particular they do not contribute at complainant properties. It transpires that the main cause of noise is both from the road directly adjacent housing and significantly a longer distant downward refracted noise contribution. This finding is contrary to the modelling for multiple reasons including its incapability of taking into account the longer distant refracted contribution.

3.35 Modelling does not and cannot account for the significant contribution from longer distant downward refracted road traffic noise. It does not and cannot address the effects of the most common set of meteorological conditions and even models which attempt to address meteorology cannot consider the effects over the distances involved in this case. In the case of this site, the effects were considered to make a significant difference. Commonly such a contribution is small but the prevailing wind direction and location of topographical features in this case are such it is considered a primary contributor.

3.36 Additionally the science indicates any enhanced noise due to reflections off of the barrier should impact directly opposite its location. This was not found to be the case. Furthermore and contrary to any existence of reflected noise, location 1, a location mainly screened from such reflections produced higher noise recordings.

3.37 Comparing the noise measurements and the locations indicates overall noise levels are not influenced by reflected noise and are notably lower than the predicted levels. Furthermore those modelled levels excluded the longer distant refracted noise contributions observed during the exercise. In turn this indicates the sound environment is better/ quieter than modelling indicates despite added refracted noise.

3.38 None of the measurement evidence or observations support the existence of any identifiable reflected contribution from the noise barrier, even directly opposite it and contrary to expectation. However, when additional contribution from downwind refraction of the road noise from locations further south are considered, the results are logical. Even if there was some reflected contribution it is insignificant in comparison to the refracted downwind contributions.

3.39 It can also be concluded, in the light of the refracted downwind noise contribution, any mitigation to try to address even a theoretical element is without value.

4.0 Observations and limitations of the MAS Modelling report of September 2022 {Ref: Rep/Ste/Mod/220905)

4.1 Modelling issues

4.2 It is first important to understand the modelling is predicting long term averages and actual levels moment by moment will depend on micro changes including elements such as wind gust speed, average wind speed and direction, changes with height above ground, temperature, humidity, surface water, ground absorbency, vehicle speeds, type and direction and other variations moment by moment in the source of noise such as acceleration and deceleration.

4.3 Modelling typically assumes a standard set of factors but also ignores many important ones. An important factor the modelling can only apply very limited assessment of is downwind refraction of sound energy. In essence it ignores sound refracted back towards the ground over long distances. This is a limitation of modelling used in the UK and in most countries. Models which have sought to include different atmospheric states are subject to much debate. One that is internationally used including in part relied upon in the International Standard 1996 but not within the UK is Nord 2000. This is discussed in section 1 of this report. It serves to indicate weather effects are substantially more important than any reflected contribution from barriers that are further away than the noise source.

4.4 In general to add reflected noise in any significant way a barrier would have to be very close to the source, typically with 1-2 metres.

4.5 Observations on the MAS report.

4.6 A number of observations from the modelling report are set out below. It is important to recognise modelling is subject to many caveats and is an indicative tool for change only. This is demonstrated within ISO9613-2 which indicates a variation of plus or minus 3dBA for long term average levels along with a further caveat that variations can be much greater. This caveat applies to circumstances which do not introduce screening or reflections indicating accuracy is further reduced when such features are introduced.

4.7 At its highest therefore levels could be expected, even in simplistic situations, to differ up to 6dBA. This is increased in scenarios such as in this case where

screening is added. When it is applied, the modelling only considered extremely limited meteorological conditions and it cannot take into account downward refractive effects over larger distances. It becomes clear it can provide a hypothetical outcome in limited circumstances only in relation to additional reflected noise. This point is further demonstrated in ISO1996 which considers the change introduced to road traffic noise from meteorological effects. These can vary the levels of road traffic noise experienced of the order of 20dBA over distances of only 200m.

4.8 In the circumstances of this case the modelling was only used to identify if a change could occur when directly opposite a barrier of such dimensions and when close to it. It was not transferable to other situations not least as this places it even further outside of its tolerances and limitations.

4.9 It was not felt necessary in the modelling report to introduce a full explanation of the limitations other than in a broad sense and at its highest the modelling merely identified the possibility of a perceptible change in some very limited locations. One aspect of this is that such changes were away from buildings and not at facades. It did not indicate perceptible increased noise entering rooms through windows.

4.10 Direct observations on / and taken from the MAS modelling report:

a) CRTN is the method required to be used by UK Government. It applies little consideration of reflected noise off barriers and can therefore understate such effects. It is the method endorsed by UK Government but may not always reflect what is observed. This is why I also used ISO9613-2 to model the possible changes in the sound environment, due to the barrier reflecting noise towards the east side of the A1M.

b) Modelling has many limitations and simply compares theoretical scenarios. Reality can be very different as has now been identified in this case.

c) The CRTN method indicated very small increases in noise due to reflections off the barrier directly opposite its location. When I used this method, I obtained slightly higher levels of theoretically reflected noise than the developer's acoustician but they were still exceptionally small in terms of audible change.

d) At paragraph 2.2 of that report I identified a theoretical 1.8dBA rise in a scenario 50m from the road and assuming the barrier as a perfect reflector which it is not. In practice it must be less than this and typically at least 1dBA lower.

e) At paragraph 2.3 I identified this case presents a very complex sound field indicating any assessment would have the lowest level of accuracy as there are many real life modifiers it cannot take into account.

f) A large number of caveats are identified in the report and I reported that human response is more affected by changes in noise character, a change which is not recognised in any of the guidance that planning authorities are required to consider for road traffic noise.

g) Using CRTN I identified a change of 0.2-1.1dBA which would be considered unidentifiable as a noise level change.

h) Using ISO9613-2 I identified it wrongly assumes wind is in all directions simultaneously which is incorrect and also the barrier is not a perfect reflector reducing the reflected noise a further 1dBA.

i) I identified a theoretical rise up to 1.7dBA at first floor level using ISO9613-2 and a couple of indicative hotspots with a slightly higher change of 2.5 and 2.9dBA. In other words, in theory due to sound reflected both off the barrier when directly opposite it and buildings nearby, there could be a slightly higher level not at but between those buildings. To be clear this is not a rise of that value incident upon house facades but the possibility a point in space could arise where all reflected sound at one or two points means it could rise by just less than 3dBA when observing at that point. Put another way, at a very few specific points away from buildings it is possible a perceived change in level could arise but it is indicative of a possibility only.

j) Spectrum change which is a change in the character of the noise potentially renders it more noticeable but this is not more noise, just its change in character. Internally (inside dwellings) it is considered insignificant.

k) The predictions in Figure 1 of the report for Receiver location 24 indicated total noise levels of the order of 65dBA. In reality the actual levels observed

were substantially lower/ quieter. The outcome is this site is quieter than indicated by modelling.

l) At paragraph 2.43 of the report I identified mid frequency noise continues to dominate and thus higher frequency noise increases are not an issue or something to consider further.

m) I concluded a slight noticeable change in terms of spectrum content and a slight change in noise burden but also that there was already a high noise dose. The measurements indicate the actual noise dose is much lower.

n) I identified accurate determination of the change is not possible and the changes are indicative only. Further, it cannot be used to reflect the noise at any one location due to the limitations of modelling. However, it is safe to conclude there is some increase in some locations that is just perceptible externally but this noticeability will reduce due to human habituation. Critically I concluded it will not affect dwellings internally. This conclusion did not consider the experience observed that distant refracted noise was a greater contributor swamping any very small contribution from reflection, if in fact it occurred.

o) The change is recognisable mathematically but where it does occur, directly opposite the barrier, it is small. In any event it is only a possible theoretical change which may not actually arise as modelling cannot take into account many modifiers. In this case it missed a major modifier.

p) I concluded such an exercise as now conducted would not lead to a change in any recommendation of approval of the barrier. This position remains and is reinforced.

4.11 Important issues not explicitly set out in the Modelling report.

4.12 The report was formulated based on a number of assumptions and without going into the extensive limitations upon how it should be used. The following points arise:

a) The outcome of a possible change only relates to the area modelled directly opposite the barrier with an angle of incidence closer to 180 degrees and with about 200m of the road.

b) The modelling cannot reflect many of the actual circumstances including prevailing weather effects, the influence of other sources of noise or their absence, the actual true nature of the absorbency of the ground and the complex shapes of buildings. For example we model houses as Sm high rectangles to provide a worst case but most are about 5m to the roof which is then sloping. Sm rectangular structures reflect more sound downwards than 5m buildings with angled roofs on top.

c) The possible change only arises away from buildings where sound waves interact due to reflections off of a number of nearby buildings.

d) The modelling cannot address real life meteorological effects and especially the prevailing wind from the south-west.

e) The perception, loudness and noisiness of sound is generally more affected by non-acoustic modifiers than acoustic ones. This is well recognised in guidance such as from the WHO. For example, in simple terms once a sound is focussed upon as it is believed to have changed, it will appear more intrusive and annoying as the mind now associates it with something perceived as adverse. A classic example is we are more tolerant of noise daytime and weekdays than evening and weekends purely through expectation. We are also more tolerant of environmental noise such as road traffic than neighbour noise even though the latter may be substantially lower. The same sound energy level is perceived as noisier and unacceptable when it occurs at weekends and evenings. A belief a change has occurred is sufficient in such circumstances to trigger greater sensitivity even when such a change has not occurred. There are many more everyday life examples.

4.13 Conclusions.

4.14 The executive summary of this report sets out the findings of this analysis in a less technical and more lay form to try to assist understanding. It is also provided to try to explain some of the complex noise and acoustic issues and effects as well as how noise is modified, especially over distance.

4.15 The conclusion is that noise reflected from the barrier is not a matter of any significance, especially as there are far greater modifiers of the sound environment.

4.16 The modelling report from September 2022 indicated a theoretical possibility of a perceptible increase in sound levels due to reflected noise off of the barrier impacting some isolated locations directly opposite the barrier. This did not and would not be expected to occur further away. The finding of a possibility of some reflected noise content was heavily caveated. The measurement and observation exercise found no evidence of it but that other modifiers of the sound environment that are not addressed by modelling are far more significant.

4.17 Extrapolation of a theoretical perceptible increase in noise due to reflected content at locations north of the barrier adjacent the A1M at Todds Green is erroneous and contrary to the science. If it did occur then far more significant contribution from reflections would be observed directly opposite the barrier. No contribution was found opposite the barrier.

4.18 Elements of the modelling report of September 2022 have been taken out of context and as a result used to support a misleading conclusion that there is an effect further away. Measurements and observations found that contrary to a theoretical increase in some locations, no contribution was identifiable.

4.19 Independent expert observations and measurements on site failed to find any contribution from reflections off the barrier affecting locations on the eastern side of the A1M. The different levels obtained at four locations taken repeatedly over several hours in successive rotation strongly indicated that even directly opposite the barrier such a contribution was not detectable.

4.20 The evidence no barrier reflected contribution at locations north of the Fishers Green bridge was stronger and this accords with the science.

4.21 In contrast to the absence of reflected noise, longer distant downwind refracted noise contribution from the portion of road further south was a significant and dominant factor. This does follow the science, particularly in relation to the topography of this locality. This additional noise is such as to swamp any minor contribution reflected off the noise barrier, even if it did arise. The refracted and more distant contribution renders the reflected content insignificant. This contribution does accord with the science.

4.22 The additional distant refracted noise contribution was far greater than expected and cannot be modelled due to distance and other limitations of modelling. Its

identification significantly changes the analysis rendering any consideration of reflected content from the barrier inconsequential.

4.23 The meteorological effects of winds in particular, in different directions either lead to refracted noise being more significant as a contributor or they serve to lower overall levels of road traffic noise to the extent any other contributions are insignificant as levels are notably lower.

4.24 Theoretically, in a rare set of circumstances where there is an absence of wind, conditions, could produce a set of circumstances where reflected noise may possibly be identifiable when directly opposite the noise barrier and at locations close to the road. This rare set of circumstances cannot be tested but would include an absence of the common contribution from refracted noise and therefore a much quieter environment would prevail.

4.25 In the light of the refracted downwind noise contribution, any mitigation to try to address even a theoretical element of noise reflected off of the barrier is without value even when considering locations directly opposite the barrier.

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Appendix 1 - Summary of main data (excluding any adjustment of Location 1 to a free field location)

Location	Time	Duration	LAeq,peri	LA0.1,per	LA1,perio	LA10,peri	LA5,perio	LA50,peri	LA90,peri	LA95,peri	LA99,peri	LAFmax,per	LAFmin,per
1	10:17:51	0:02:08	60.4	64.7	63.9	62.5	63.1	60	58.3	57.8	57.3	64.8	56.8
1	10:20:01	0:09:58	60.5	68.5	65.5	62.6	63.4	59.8	57.5	57	56.1	70.4	54.8
1	10:30:01	0:00:49	60.6	-	65.2	61.7	62.6	60.3	58.6	58.1	57.4	65.8	57
1	11:34:03	0:05:56	59.1	66.6	64.2	61	62.1	58.4	56.4	55.9	54.6	67.4	53.6
1	11:40:01	0:09:58	61.9	78.8	68.9	63.2	64.5	60.2	58.2	57.6	56.5	83.5	55.4
1	11:50:01	0:00:53	59.6	-	62.2	61.2	61.5	59.8	57	56.6	56.3	63.5	55.9
1	12:45:13	0:10:00	60.5	67.6	64.9	62.3	63	60.1	57.9	57.2	56.1	68.8	54.6
1	13:55:06	0:10:00	60.7	73	66.2	62.3	63.2	59.9	57.8	57.2	56.1	74.3	54.8
2	10:33:07	0:06:52	56.5	63.6	61.4	57.7	58.8	56	54.6	54.1	53.1	64	52.4
2	10:40:02	0:09:57	56.4	64.8	61.8	57.8	59	55.8	54.5	54.1	53.4	68.2	52.3
2	10:50:01	0:00:08	56.8	-	-	57.5	57.7	56.8	56.1	56	55.7	58.3	55.7
2	11:53:07	0:06:52	55.6	59.2	58.2	57	57.4	55.4	54.1	53.7	53.2	59.9	52.3
2	12:00:01	0:09:58	55	63.1	58.7	57	57.7	54.6	52.1	51.7	51.1	65.6	50.4
2	12:10:01	0:00:04	53.2	-	-	54.3	54.6	53.1	52.2	52	51.7	55.3	51.6
2	13:00:03	0:10:00	55.4	61.6	58.6	56.9	57.4	55	53.6	53.2	52.6	65.5	51.5
2	13:10:37	0:10:00	56.6	68.2	60.5	57.9	58.5	56.1	54.1	53.6	52.8	74.7	51.7
2	14:09:01	0:10:00	55	61.2	58.1	56.4	56.9	54.8	53.2	52.8	52	62.9	50.6
3	10:54:21	0:05:38	58.6	62.5	61.3	60.2	60.6	58.5	56.7	56.3	55.5	63.4	54.2
3	11:00:01	0:09:58	57.1	75.8	64.7	57.7	59.4	55.2	53.5	53.2	52.5	77.2	50.9
3	11:10:02	0:00:02	55.7	-	-	57.1	57.2	55.4	54.8	54.7	54.6	57.7	54.6
3	12:15:01	0:10:00	57.3	66	62.5	60.1	60.9	56.3	53.8	53.2	52.1	72.8	50.7
3	13:25:00	0:10:00	55.2	61	59.2	57.1	57.9	54.8	52.2	51.6	50.8	61.8	49.8
3	14:23:23	0:10:00	56.8	64.8	62.8	58.9	59.8	56.2	53.3	52.6	50.5	68.5	48.8
4	11:12:46	0:07:13	56	66.7	63.3	59.6	60.8	53	49.1	48.5	48	73.2	47.1
4	11:20:02	0:09:57	54	65.6	61.8	57.6	59.5	51.4	47.7	46.9	46.1	66.9	45.1
4	11:30:02	0:00:04	52.5	-	-	53.2	53.6	52.4	51.4	51.1	51	54.2	51
4	12:30:01	0:10:00	55.7	65.5	62.6	59.1	60.5	53.6	49.4	48.5	47.1	66.8	45.8
4	13:40:00	0:10:00	56.5	65.9	64.1	60	61.4	54.1	50.5	50.1	48.3	68.4	47.3
4	14:35:39	0:10:00	56.2	66.8	63.1	59.8	61	53.5	50.4	49.8	47.9	67.6	46.8