Brent	**Highways Committee** 20 October 2014 **Report from the Head of Transportation**
For decision	Wards Affected: Dollis Hill, Dudden Hill

Petition for Road Improvements in Tanfield Avenue

1.0 Summary

1.1 This report informs the Committee of a petition received in July 2014 from Residents in Tanfield Avenue requesting improvements to the road.

1.2 The petitioners believe that:

- The condition of the road in conjunction with the type of traffic travelling upon it is causing vibrations.
- These vibrations are resulting in structural problems to their properties.
- The construction of the road is not suitable to take the load of Heavy Goods Vehicles (HGVs) and buses, which regularly use it.

1.3 Based on research by the Department for Transport (DfT) into the effects of vertical traffic calming features such as speed cushions and road humps, whilst properties within 5 metres may notice vibrations, they are at a level that poses no risk to properties. In Tanfield Avenue the average distance from the properties to the carriageway is 8 metres.

1.4 Officers have drawn up a number of actions and planned measures described in the report to mitigate the issues of noise and vibration in Tanfield Avenue.

2.0 Recommendations

Members are requested to:

2.1 Note and agree that vibrations arising from the general construction and condition of the highway are considered unlikely to be the cause of structural damage and problems to adjacent properties and reject the petition.

2.2 Note the combined actions and planned measures described in the report to mitigate the issues of noise and vibration that are sourced from the typical traffic levels and road condition that are evident in Tanfield Avenue.

2.3 Note that, a short section of approximately 50 metres in length and the full width of the road outside properties nos. 26 to 38 was identified via a condition assessment to contain defects that contribute to noise and vibration. Resurfacing of this section is programmed for completion in autumn 2014.

2.4 Note that Tanfield Avenue is in a 7.5 tonnes weight restricted area, which has been identified for periodic traffic enforcement involving CCTV camera equipped vehicles. Therefore there is no requirement to install CCTV.

2.5 Note that Transport for London (TfL) are responsible for London's safety camera programme. Their Surface Planning Team liaise with representatives from the boroughs on improvements to existing sites, identification of new sites and decommissioning sites, where it is agreed that cameras are no longer required.

2.6 Note that TFL apply stringent prioritisation criteria to determine which sites will have speed cameras installed. There must have been a minimum of 4 killed or seriously injured (KSI) collisions in a three year period, and at least 2 of these must have been identified in accident reports as being a result of speeding. There have been no reported personal injury accidents in Tanfield Avenue for the 3 year period up until the end of April 2014, therefore a speed camera would not be justified.

2.7 Note and agree that a letter will be sent to TfL highlighting the need for bus drivers to be mindful of noise and appropriate speeds when travelling along Tanfield Avenue.

3.0 The petition

3.1 The petition, received from the lead petitioner Mrs Halyna Harbuz representing residents in Tanfield Avenue, requests that the Council undertake road improvements to Tanfield Avenue.

3.2 The petition asks the Council to address and investigate the following issues and suggestions:

- Adequacy of existing road construction, with a suggestion that it is unsuitable for the HGV and bus traffic that regularly travel along it.
- For HGVs to be restricted from driving along Tanfield Avenue.
- The removal of existing speed cushions (humps) as they are causing additional vibration.
- A suggestion that CCTV or a speed camera be installed as a deterrent against speeding.
- A request for funding or a grant to made available to residents to carry out necessary repairs to their properties as a result of the vibrations.

3.3 The petition has been verified to be in accordance with Standing Orders. The full wording of the petition is found in Appendix A – 'Petition to improve the road vibration in Tanfield Avenue'. The petition has 120 valid signatures.

3.4 The petition was also accompanied with a privately commissioned Technical Report on the condition of property number, 87 Tanfield Avenue. The report was carried out by 'Davies', who provide a 'building surveying' service. This report is found in Appendix B. The report describes details of cracking damage located within the property.

3.5 In relation to the cracking damage under the reports sub-heading of 'Discussions' the following quote is pertinent to the petition: "However we note that some of this damage may have been exacerbated by vibration from road traffic".

4.0 Existing Situation

4.1 Tanfield Avenue is a two-way single carriageway road located in between A4088 Dudden Hill Lane and Crest Road. It is 500m in length and falls within the Dollis Hill and Dudden Hill Wards. It is fronted by residential properties and forms part of bus routes 182, 245 & 332. The road is currently subject to a 30mph speed limit.

4.2 Tanfield Avenue is one of London's non-principal classified C roads and provides access to the surrounding estate roads. Tanfield Avenue is subject to traffic volumes and types of vehicle which are consistent with this type of road and location.

4.3 The petition requests that HGVs are stopped from driving along Tanfield Avenue. Officers do not think this measure would be appropriate as many HGVs need to access this area to carry out their business e.g. to make deliveries to local shops and houses. There is an existing 7.5 tonne weight restriction in the area so the Council can take enforcement action against any heavy goods vehicles exceeding this weight limit that do not have a legitimate reason to be within the restricted area e.g. to load or unload. A plan showing the extent of the zone is found in Appendix D.

4.4 A visual assessment of the condition of the road in Tanfield Avenue was completed by a Brent officer following receipt of this petition. A surface defect was identified that could contribute to noise and vibration as it met the intervention level for reactive maintenance, a repair was ordered and completed by 18 July 2014.

4.5 The petition suggests that core samples be taken to establish thickness of the carriageway. As noted elsewhere within this report, it is unlikely that the vibrations sourced from the highway construction are the causes of any damage to the properties. Therefore officers do not recommend taking any core samples, however as a check we will be investigating the condition of the carriageway construction when we carry out planned resurfacing work in Tanfield Avenue.

Enforcement/CCTV

4.6 The Council's parking and traffic enforcement team currently undertake enforcement throughout the borough of the HGV weight restriction. CCTV enforcement vehicles and cameras are used to enforce vehicles in contravention of traffic orders, which results in vehicles being subject of Penalty Charge Notices. The parking appeals team consider representations that are received from affected motorists and organisations who are required to adduce evidence exempting them from the contravention.

4.7 Speeding enforcement is not undertaken by the Council. This function is the responsibility of the Metropolitan Police.

4.8 The Council will review existing traffic speeds and any additional measures required to reduce traffic speeds in developing and implementing the Dollis Hill Area 20mph zone in 2014/15 and 2015/16, (Refer to para 5.8). In the meantime residents should report any concerns about traffic speeding to the Metropolitan Police Safer Neighbourhoods team.

Buses

4.9 TfL provide bus services to meet the needs of Londoners across the capital and make decisions on the routes based on demand modelling and logistics. The Council liaises with TfL to ensure that the services provided meet the needs of the community and to ensure any community concerns regarding service provision and infrastructure are taken into account.

4.10 At present, Tanfield Avenue is serviced by three double-decker bus routes: 182, 245 and 332. At their busiest (weekdays between 11am and 7pm), these three routes are timetabled to have between 19 and 31 services per hour per direction along the length of Tanfield Avenue. Frequencies are lower outside of peak hours and on weekends and bank holidays.

4.11 By comparison, nearby Dollis Hill Lane is serviced by one single deck bus route (232) which generally has four services per hour per direction from 6am to 9pm. The A406 (North Circular Road) is also serviced by one single-deck bus route (112) which generally has 5-6 services per hour per direction from 7am to 9pm.

4.12 The petition requests that "sleeping policeman be removed particularly as buses drive over them without attempting to slow down". Speed cushions located along the length of Tanfield Avenue are in place to control the speed of all vehicles using the road. The Council are opposed to removing these speed control devices as this would encourage greater speeding by all drivers. TfL are responsible for managing the behaviour of their drivers on all roads in Brent. As such, the Council is limited in what actions can be taken to influence the behaviour of drivers. Notwithstanding this, in an effort to mitigate any issues of inappropriate speeds and noise caused by buses, The Council will prepare a letter to be sent to TfL with regards to bus driver behaviour on routes within Brent and in particular Tanfield Avenue.

5.0 Detail

Noise and vibration

5.1 Research has been carried out by the Department for Transport (DfT) and their Traffic Advisory Leaflet 8/96 Road humps and ground-borne vibrations advises on the effects of vertical traffic calming features such as speed cushions and road humps. This report is found in Appendix E. The same principles apply with regard to defects in the carriageway surface. For properties built on London Clay, the type of sub-soil found in the Tanfield Avenue area, the research indicated that there may be potential for minor damage to properties that are within 2 metres of a speed reducing measure such as a speed cushion or a speed hump. However, the DfT report also identified that whilst properties within 5 metres may notice vibrations, they were at a level that posed no risk to properties. Furthermore, properties within 15 metres may also sense vibrations, but at a level which is immeasurable.

5.2 In Tanfield Avenue the average distance from the properties to the carriageway is 8 metres.

5.3 Taking into account the DfT research findings and the visual assessment completed by a technical officer vibrations sourced from the general highway construction are unlikely to be the cause of structural damage and problems to adjacent properties. Any vibrations sourced from the highway will most likely be caused by vehicles travelling over surface defects such as potholes and also traffic calming features such as speed cushions, exacerbated if vehicles are travelling at inappropriate (i.e. high) speeds.

Planned Major resurfacing – Short sections

5.4 The council has a limited budget to carry out major repairs to short sections of the highway which are beyond the scope of reactive maintenance and have not been included in our planned maintenance programmes. These short sections are based on condition and risk assessments of areas that are a cause for local concern.

5.5 In Tanfield Avenue, a short section of approximately 50 metres in length and the full width of the road outside properties nos. 26 to 38 was identified as an area containing defects that could be contributing to noise and vibration. Resurfacing of this section is programmed for

completion in autumn 2014. The outcome of this resurfacing is expected to help mitigate noise and vibration caused by existing surface defects.

Planned Major resurfacing – Classified Carriageways

5.6 The Council undertakes annual condition surveys on the entire classified road network (A, B and C Roads) and a fixed percentage of the unclassified (residential) roads in the borough. In addition to this annual borough-wide exercise, other sections of carriageways are also nominated for inclusion in the survey by stakeholders e.g. Members, residents, businesses etc. These annual condition surveys are undertaken by independently appointed consultants. Based on these surveys, prioritised lists of carriageways are compiled that determine those to be considered for inclusion in future major works programmes for carriageway upgrades. The prioritisation process takes into account a number of important factors that include findings of the independent condition survey data, engineering assessments, degree of usage, future maintenance costs, proximity of schools and future planned utility works.

5.7 The results of previous annual condition surveys do not indicate that Tanfield Road requires major structural works, therefore with the exception of the short section identified in para 5.5, there are currently no plans to undertake major resurfacing in Tanfield Avenue. However any footways and carriageways that meet the criteria for major improvement works in the most recent condition survey will be put forward for consideration for inclusion in future maintenance programmes.

Proposed Safety Improvement Scheme

5.8 The Council plans to invest £320,000 in the Dollis Hill Area scheme to design and implement a 20MPH Zone and safety improvements during 2014/15 and 2015/16, to reduce accidents and improve conditions for vulnerable road users. This will include Tanfield Avenue. A plan showing the extents of this scheme is found in Appendix C.

5.9 This scheme will reduce traffic speeds and consequently the levels of noise and vibration from vehicles travelling over traffic calming measures at inappropriate speeds. Therefore there is no requirement to remove or modify existing traffic calming features.

6.0 Conclusion

6.1 Considering the findings from the annual condition survey and the visual assessment on the general condition of the road for the traffic using it, and including the DfT research findings, it is considered unlikely that the road construction is the cause of the vibrations.

6.2 Any vibration sourced from the highway will most likely be caused by vehicles travelling over surface defects such as potholes and also traffic calming features such as speed cushions at inappropriate speeds. Measures are either in place or identified to mitigate possible vibration to residents as a result of this, through reactive repair and implementation of a 20mph zone.

6.3 The petitions “request for funding or a grant to be made available to residents to carry out necessary repairs to their properties as a result of the vibrations”. Based on the information described in this report, it is unlikely that the vibrations sourced from the highway are the causes of damage to the properties in Tanfield Avenue. It would therefore be inappropriate for this request to be agreed.

7.0 Financial Implications

7.1 The cost for the identified and completed reactive maintenance repairs and the cost for the short section area of resurfacing works programmed for completion in autumn 2014, is contained within existing budgets.

7.2 The Council plans to invest £320,000 in the Dollis Hill Area scheme to design and implement a 20MPH Zone and safety improvements in 2014/15 and 2015/16, which will include Tanfield Avenue.

7.3 There is £30k TfL funding and £75k S106 Funding in 2014/15 for this scheme and the balance is within the TfL 2015/16 funding priorities.

8.0 Legal Implications

8.1 There is a general duty of care upon public bodies and all landowners to take reasonable steps to avoid the condition of their land causing damage to neighbouring properties.

8.2 Annual maintenance programmes and a graded response to known issues consistent with recognised best practice and standards in highway management is the method by which highway authorities seek to undertake the performance of that general duty.

8.3 In summary nuisance is the physical interference with the enjoyment of a property.

8.4 The courts assess the application of the duty of care in nuisance by what is on balance considered to be fair, just and reasonable given the nature of the perceived risk and having regard to a range of factors including the age and location of the road and the available measures to remedy the matter consistent with recognised best practice.

8.5 Much depends on establishing a causal link between the use of the road and the alleged damage and the response to known issues in recognised best practice in respect of dealing with road vibrations and road conditions.

8.6 Damages relate principally the cost /expense of remedying any physical damage /conditions arising from road condition and any diminution in value if nuisance is proven.

9.0 Equalities implications

There are no equalities implications arising from this report.

10.0 Background Papers

Petition (Appendix A); Technical Report on the condition of property number, 87 Tanfield Avenue, by 'Davies' (Appendix B); Department for Transport (DfT) - Traffic Advisory Leaflet 8/96 Road humps and ground-borne vibrations (Appendix E).

11.0 Contact Officers

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Appendix A – Petition letter from residents in Tanfield Avenue

Petition to improve the road vibration in Tanfield Avenue

We, the residents of Tanfield Avenue, submit our petition for improvement to the road problems which are causing structural problems to our properties on the road.

Thus far we have established that the concrete core/base is not suitable for either HGV or buses to be regularly moving on it.

We suggest a core sample should be extracted to establish the exact thickness of the foundation of the core/base on which the tarmac is laid.

We suggest that HGV lorries etc be stopped from driving on the road. Also that the 'sleeping policman' be removed, as they are causing even more vibration, particularly as the buses drive over them without attempting to slow down. Or, perhaps, set up a camera or CCTV as deterrent against speed.

This issue needs to be addressed between all relevant authorities - TFL, Brent Council, London Mayor's Office, to establish a suitable solution, budgets and timescales to finally put a stop to this problem. Spreading another layer of tarmac has proven over the years to be a waste of time and resources as it has not resolved the issue.

We strongly suggest that whilst a solution is being found HGV Lorries should be stopped from driving on the road, without special council permission and until further notice.

We also require a fund or grants for the residents to carry out necessary repairs on their properties to damage already caused. Failure to cover these costs will leave the residents with no other recourse but to approach their insurance companies for compensation. This could result in a hefty bill to the authorities responsible.

We have a document detailing the problems the inappropriate road surfacing has caused and signatures of the residents who await your actions to resolve this issue.

24th June 2014

Appendix B – Technical report (Davies)

DAVIES

First & Final Technical Report

Date of Issue:	02 September 2010
Our Ref:	71011492
Your Ref:	46671062002
LV= 3rd Floor 69 Park Lane Croydon London CR9 1BG	Mr N Khan 87 Tanfield Avenue London NW2 7SB

Introduction

The technical and insurance aspects of this claim are being dealt with by our Regional Technical Manager Greville Marchant Tech RICS, ACIOB, MFPWS, Cert CII (Claims) in accordance with our project managed service.

This report has been prepared specifically in connection with the current insurance claim and is not a structural survey. As such, this report should not be relied upon as a statement of structural adequacy. It does not deal with the general condition of the building, decorations, services, timber rot, infestation or the like and does not include any part of the building that is either covered or inaccessible.

Description of property

The property is a two storey, four bedroomed, left hand, semi detached house with a two storey front bay and a rear single storey addition to the left and a loft conversion. The property is of solid brick construction with suspended timber floors at ground and first floor level, all under a pitched, tiled roof.

Topography of site and general location

The property is situated in a well established, residential area close to all amenities of NW2. The property is sited on an averaged sized plot which slopes down gently from right to left and steeply from front to back. We understand from the Insured that the loft was converted around 2006. The property was purchased with the benefit of a Survey which we have had sight of and there is no mention of any structural defects.

Geology

With reference to the British Geological Survey Website, the anticipated bedrock is London Clay Formation - Clay, Silt and Sand.

Vegetation

There was no vegetation noted that would have had any influence on the damage present.

Technical Circumstances

The Policyholder was concerned that the foundations may have been undermined by recent repairs in the road, following the laying of utility pipe work and services. The Policyholder feels that the property is now vibrating a lot more than it used to due to the local traffic, he has been in touch with the Local Authority who advised that his Insurers should be notified to inspect the property for possible foundation movement.

Description of damage

The Insured pointed out various areas of damage as follows:

- Front retaining wall adjacent to the left flank showing signs of cracking and is leaning out slightly
- Cracking over various doors at first and second floor levels
- Cracking at landing level to the partition wall between the WC and the staircase
- Wall/ceiling separation at first and second floor levels and various other places

Cause of damage

The damage present relates to general building defects expected in a property of the age and construction. In addition the construction of a loft conversion has caused an element of additional loading resulting in some of the cracks that are present above doors and on the wall/ceiling junctions causing separation.

Externally the cause of the boundary wall showing signs of cracking and distortion is most likely due to the additional pressure of the retaining front garden; however it must be noted that vibration from the local traffic is likely to exacerbate the elements of damage noted above. It is difficult to quantify the extent of damage that the vibration may cause.

Category of cracking

The category of cracking in accordance with Table 1, BRE Digest No.251 (as reproduced below) would be between categories 1 and 2.

Category 0	Negligible	Less than 0.1mm
Category 1	Very slight	0.1-1.0mm
Category 2	Slight	1mm to 5mm
Category 3	Moderate	5mm to 15mm
Category 4	Severe	15mm to < 25mm
Category 5	Very severe	More than 25mm

Discussions

The damage present is consistent with normal defects expected in a property of this age, style and construction and is mainly due to normal flexure, wear and tear. However we note that some of this damage may have been exacerbated by vibration from road traffic.

Recommendations

We recommend to the Insured that repairs are carried out during the next maintenance period and that they contact their Local Authority with regard to monitoring the extent of vibration being caused by the local traffic.

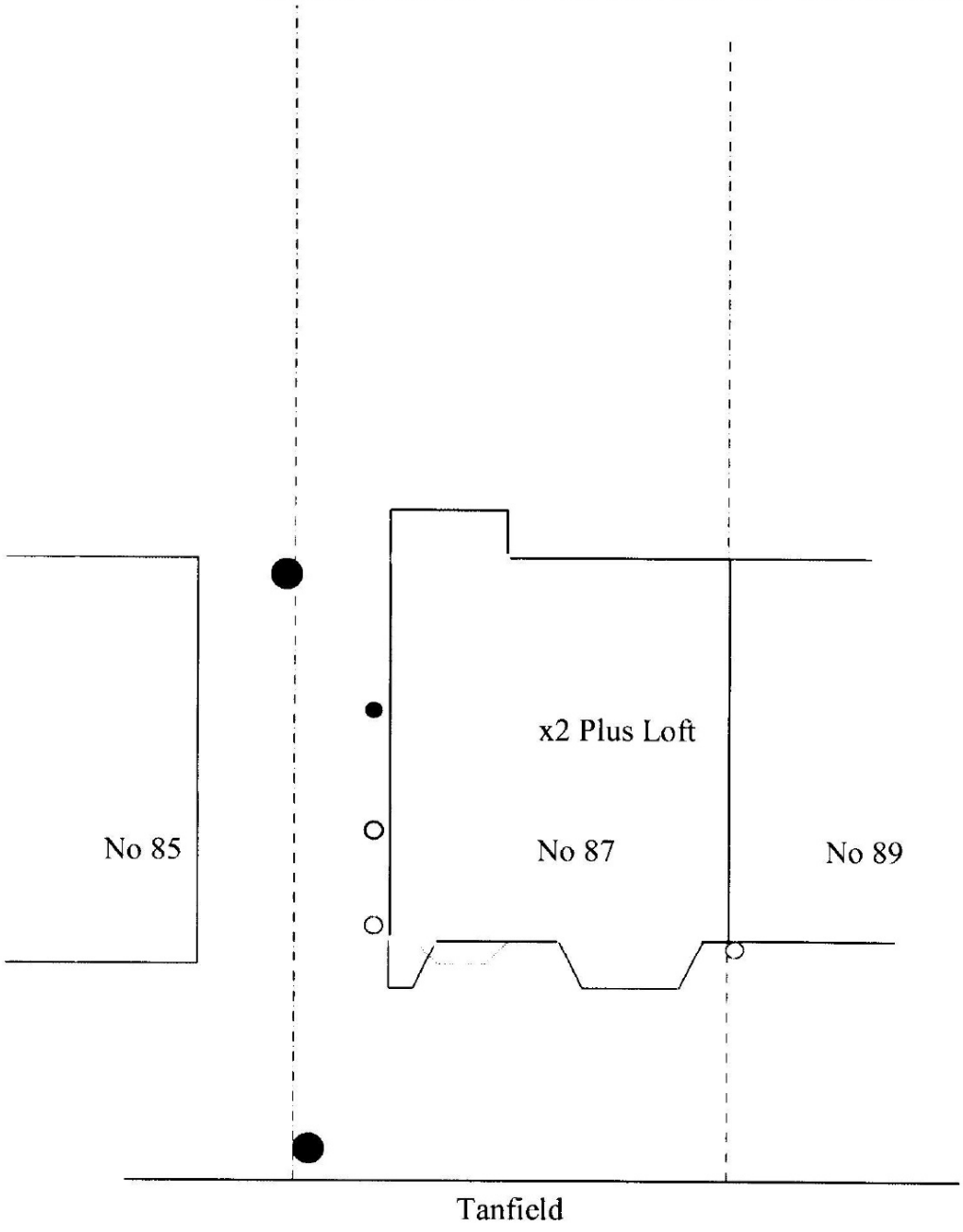
Attachments

Photographs
Site Plan

Site Plan

Not to Scale

This plan is diagrammatic only and has been prepared to illustrate the general position of the property and its relationship to nearby drains and trees etc. The boundaries are not accurate, and do not infer or confer any rights of ownership or right-of-way.



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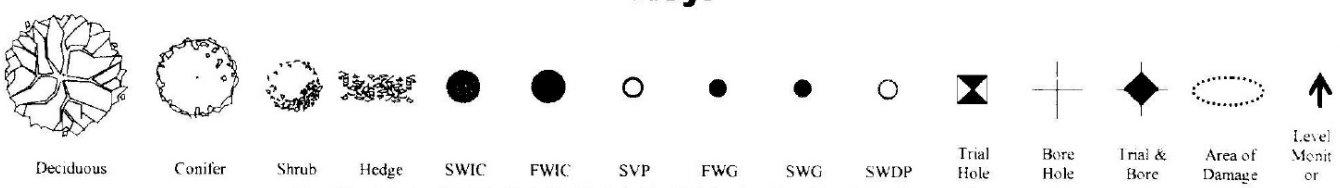
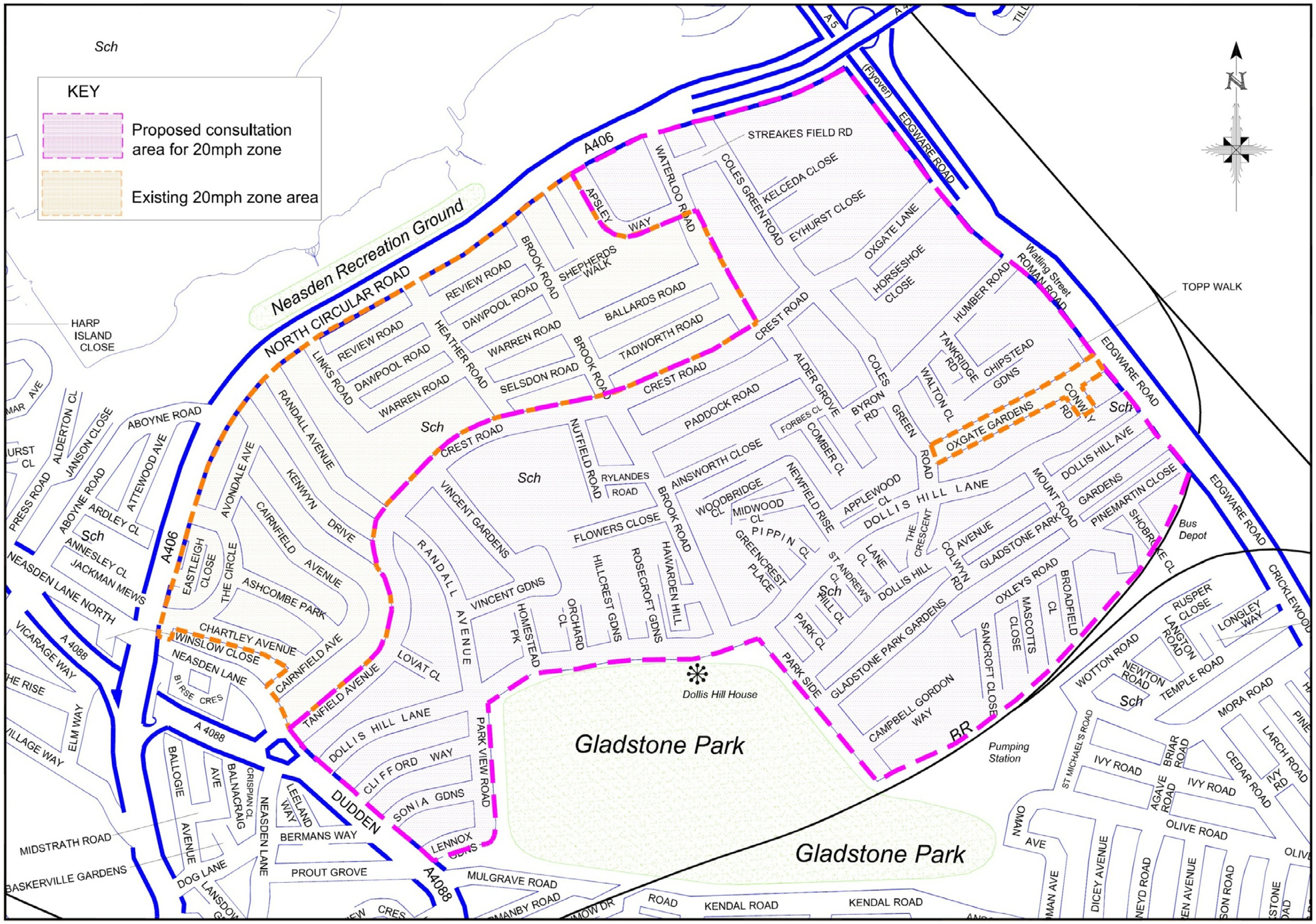
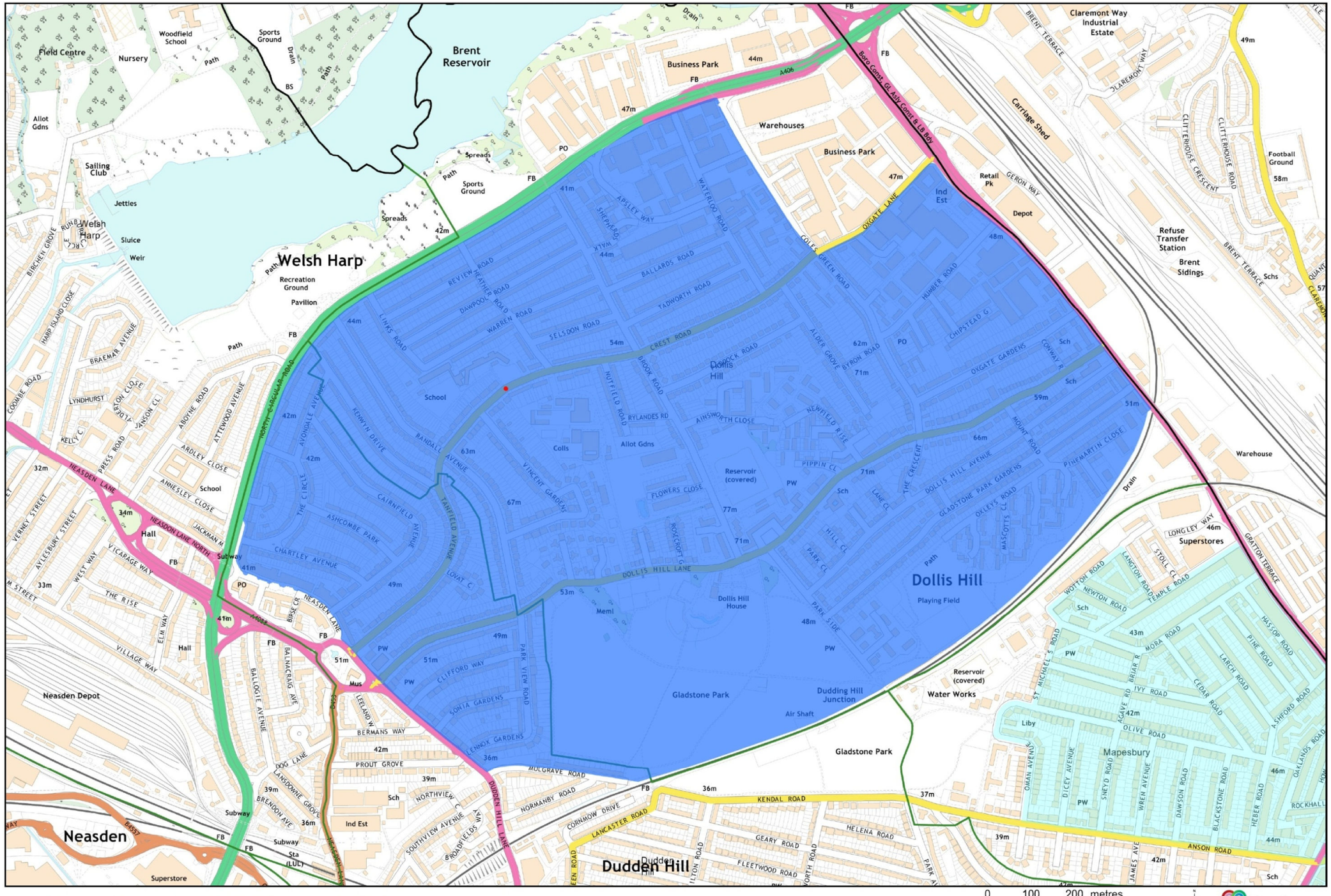


Appendix C – Dollis Hill Area Scheme – 20mph zone



Appendix D – Area of 7.5t Weight Restriction Zone



Appendix E - Department for Transport (DfT), Traffic Advisory Leaflet 8/96, Road humps and ground-borne vibrations

Department for Transport

Traffic Advisory Leaflet 8/96
December 1996

Road humps and ground-borne vibrations

Introduction

The Driver Information and Traffic Management Division commissioned the Transport Research Laboratory (TRL) to carry out track trials to assess the effect which road humps (including speed cushions) might have in generating ground-borne vibrations when commercial vehicles are driven over them. The intention was to generate advice to local authorities, to help avoid the creation of possible nuisances. Measures of vibrations were made for a wide range of vehicle types crossing a selection of road humps, and the results were used to estimate the likely effects when placed on various soil types.

This leaflet summarises the investigations carried out and the results. More detailed information can be found in TRL Report 235, "Traffic Calming: Vehicle Generated Ground-borne Vibrations alongside Speed Control Cushions and Road Humps", which can be purchased from TRL.

Background

Vehicle generated ground-borne vibration is produced by reaction-forces imparted as a vehicle's wheels pass over discontinuities, such as road humps, on the road surface. The highest levels of vibration are generated by heavy vehicles. Traffic vibration is a common source of nuisance; most of the nuisance results from low frequency noise emitted principally by large commercial vehicles. However, in some cases the problem has been thought to be due to ground-borne vibration, which was the subject of this study.

Ground-borne vibration diminishes as it radiates from its source. The firmer the soil in the vicinity, the more localised will be the vibration effects.

The TRL Trial

Eleven vehicle types were used, selected from three categories: light vehicle; buses and large commercial vehicles. The vehicles ranged from a passenger car, through single and double decker buses and a midi bus, to rigid and articulated goods vehicles. The two rigid vehicles had gross vehicle weights (GVW) of 7.5t and 17t, and the articulated vehicles had GVW of 32.5t and 38t. The 38t vehicle was fitted with steel leaf suspension, and the 32.5t vehicle with air suspension.

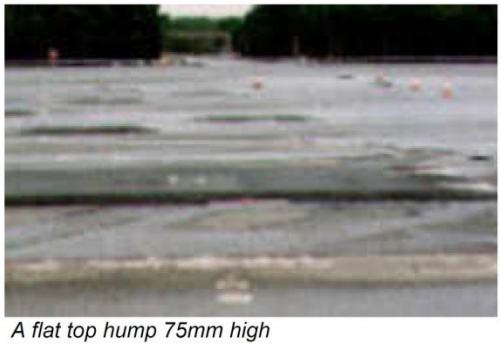
Generally the commercial vehicles were tested in both laden and unladen conditions. Special attention was to be given to whether an unladen vehicle with a steel leaf suspension axle generated more vibration than a laden one. This was thought possible, as in the unladen state the wheels can lose contact with the road surface as they run over the top of the road hump. The wheels of a laden vehicle were more likely to remain in contact with the road.

It was also considered important to establish whether ground-borne vibration was influenced by overall vehicle weight or by individual axle weight. If individual axle weight were a notable factor, a 17t two axle vehicle might cause higher levels of vibration than some multi-axle 38t vehicles.

The following types of road humps were tested:

Speed cushion installed at test site

A round top hump 65mm high



A flat top hump 75mm high

A "thump" (short hump) above the recommended height for this feature at around 75mm high, was used to examine the effect of a harsh profile on vibration generation

Objective

The objective was to determine the likely levels of vehicle generated ground-borne vibration alongside each of the road humps tested, for a range of different soil conditions. A prediction model had been developed by TRL as a result of previous studies (TRRL Report 246). With a scaling factor applied, it would enable the results from the trial to be used to predict ground vibrations for various soil types.

Results

As with previous studies, it was found that there was a tendency for vibrations to increase with increases in speed. For a given crossing speed the 74mm high "thump" generated the highest levels of vibration recorded during the study. The long flat top road hump also had high vibration levels relative to the other road hump types, though much lower than the "thump". The narrowest cushions gave results similar to each other, causing the least generation of vibration.

The side ramp gradients of the wider speed cushions also appeared to influence the level of vibration generated. The steeper the ramp, the higher the vehicles will ride over the cushion, and the greater the vibration.

In terms of commercial vehicle performance, for steel leaf suspension the vibration levels were much higher when the vehicles were unladen. However, in the case of a laden commercial vehicle with air suspension it was found that vibration levels were equivalent to, or higher than the levels measured when the vehicle was unladen. Multi-axle vehicles also tended to produce higher vibration levels than two axle vehicles, even though the axle load for the latter was greater in some cases.

Based on typical crossing speeds, for the various road hump types the longer wider cushions with the steepest side ramps (1:3) gave the highest maximum and mean vibration levels for commercial vehicles, followed by the long flap top hump. The round top hump gave the lowest maximum and mean vibration levels for commercial vehicles. Vehicles with GVW over 7.5t were found to generate the highest levels of ground-borne vibration.

For buses, the flat top road hump gave the highest maximum and mean vibration levels. The round top hump was next highest. The short (2m) length, 1.9m wide speed cushion with 1:4 side ramp gradients gave the lowest maximum and mean vibration levels.

British Standard 7385: Part 2 provides guide threshold values of vibration exposure which may give rise to minor cosmetic damage to buildings. The threshold relates to very minor damage such as the formation of hairline cracks on plaster finishes or in mortar joints and the speed of existing cracks. These values were used to calculate minimum distances which it would be desirable for road humps to be sited from dwellings, according to soil types (Table 1). Predictions have also been made of minimum distances within which sustained vibration exposure may cause superficial hairline cracks that might often go unnoticed. At lower levels of vibration exposure the table shows minimum distances required to avoid ground-borne vibration that would be perceptible or might give rise to complaint. These latter minimum distances were predicted based on a review of literature available. It can be seen that even very minor hairline cracking should not occur unless the road humps are placed less than 4m from a dwelling for even the softest soil. However, it is quite possible that the effects of a commercial vehicle crossing a road hump could, on these soft soils, be sensed up to 76m away. It is highly unlikely that any road hump will result in structural damage occurring to neighbouring buildings.

Design Guidance

Table 1 can be used as an initial guide, where similar hump designs are to be installed. This has particular relevance in trying to avoid locating road humps within distances where, because of the soil type, complaints regarding ground vibrations might arise. However, soil types locally can vary considerably. If the soil is layered, significant differences to the results in the table could occur. If there is any doubt, it is recommended that measurements should be carried out to verify the predictions. The maximum likely vibrations can be gauged by driving a heavy vehicle over a temporary profile. Any measurements should only be undertaken by persons skilled in the technique and in the interpretation of results.

Narrow cushions (1.5m - 1.6m wide) generally produce the least vibrations for a given crossing speed relative to other profiles. However, this may be counteracted by the fact that crossing speeds for narrow cushions are typically greater than crossing speeds for other road hump types.

Care should also be taken that cushions are placed so that they are likely to be straddled by the axles of heavy vehicles; when only one set of wheels encountered narrow cushions, the measured vibration levels were approximately double those when the vehicle straddled the cushion. This factor is not covered in Table 1.

The slope of the leading ramp of a road hump can also have an effect on ground vibrations. For this reason it is recommended that ramp gradients for speed cushions and flat top humps should not exceed those generally advised (see Traffic Advisory Leaflet 7/96 and Traffic Advisory Leaflet 2/96). For speed cushions this is 1:8, and for flat top road humps, 1:10. In certain cases, where for example commercial vehicles make up more than 8% of the total flow, it may be appropriate to adopt even shallower gradients. In these cases it may also be appropriate only to consider the use of the narrower cushions. Such cushions have been used on the A49 at Craven Arms in Shropshire (see TRL Report 212).

Those vehicles with the greatest GVWs tend to generate the higher levels of vibration. Therefore, if the circumstances are appropriate, consideration might be given to imposing an axle weight limit of 7.5t, in order to limit possible ground vibrations being generated.

Because of the very high level of vibrations generated by the 75mm high "thump" it is strongly recommended that if "thumps" are used for traffic calming purposes in proximity to buildings they should not be higher than 40mm. A maximum height of 50mm is already recommended for this feature in Traffic Advisory Leaflet 7/94.

TABLE 1 - PREDICTED MINIMUM DISTANCES BETWEEN ROAD HUMPS AND DWELLINGS TO AVOID VIBRATION EXPOSURE (Metres)

	Level of Perception							Complaint							Superficial cracks from sustained exposure							Minor damage (BS7385)						
Hump Type	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Alluvium	56	40	76	41	45	57	37	12	9	17	9	10	12	8	3	2	4	2	2	3	2	<1	<1	1	<1	<1	<1	<1
Peat	16	13	19	13	14	16	12	6	5	7	5	5	6	4	2	2	3	2	2	2	2	<1	<1	1	<1	<1	<1	<1
London clay	15	11	18	12	12	15	11	5	4	6	4	4	5	3	2	1	2	1	1	2	1	<1	<1	<1	<1	<1	<1	<1
Sand/gravel	4	3	6	3	3	4	3	1	1	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boulder clay	2	1	3	2	1	2	1	1	<1	1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chalk rock	1	<1	1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

A=Cushion; length 2m, width1.9m, height 0.74m, side ramp 1:4, leading ramp 1:8

B=Cushion; length 3.5m, width 1.9m, height 0.71m, side ramp 1;4, leading ramp 1:8.5

C=Cushion; length 3.5m, width 1.9m, height 0.72m, side ramp 1:3, leading ramp 1:7.7

D=Cushion; length 3.5m, width 1.6m, height 0.64m, side ramp 1:3.8, leading ramp 1:7.5

E=Cushion; length 3.5m, width 1.5m, height 0.65m, side ramp1:3.7, leading ramp 1:7.4

F=Flat top hump; length 7.8m, height 0.73m, leading ramp 1:12

G=Round top hump; length 3.7, height 0.64m

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