



**METRO NORTH
ORAL HEARING
PROOF OF EVIDENCE
Steve Mitchell
Airborne Noise
Wednesday 8th April 2009**



Metro North Oral Hearing

Proof of Evidence

Airborne Noise

Steve Mitchell

1.0 NAME, QUALIFICATIONS AND ROLE IN PROJECT

- 1.1 My name is Steve Mitchell.
- 1.2 I hold an Honours Degree in Physics with Modern Acoustics. I am a Member of the UK Institute of Acoustics. I have served on the committee of the Institute's Environmental Noise Group for six years. I have worked in the field of environmental noise for 20 years specialising in the effects of transportation noise and vibration. I have published 10 academic papers on various aspects of transportation noise. I have lectured on the effects of transport noise at South Bank University, London.
- 1.3 I am a Technical Director with Environmental Resources Management (ERM). In that capacity I am responsible for a team of acousticians assessing environmental noise impacts from a wide range of developments.
- 1.4 My role on the Metro North project has been to assess the potential airborne noise impacts from the construction and operation of the scheme and to advise the RPA on appropriate mitigation measures.

2.0 EXPERIENCE

- 2.1 I have assessed noise impacts from over 30 railway systems of which 9 have been new light rail or tram proposals including; 3 extensions to the Docklands Light Railway in London, 2 extensions to the Midland Metro in Birmingham, a tram proposal in Liverpool, an extension to the tramway in Nottingham, and the Edinburgh tram that is currently under construction. I have assessed noise impacts from two airport railways; the Hong Kong Airport Railway and the Edinburgh Airport Rail Link. In Dublin I have assessed noise impacts from the C1 extension to the Luas and I have studied noise on the existing Luas for the RPA.
- 2.2 I have also managed major community noise research projects for the UK government and the European Commission.

3.0 GENERAL INTRODUCTION

Scope

- 3.1 My evidence concerns airborne noise; that is noise propagating from its source to a receiver through the air. Evidence concerning groundborne noise

(ie noise generated as a result of vibration passing through the ground) and vibration is given by Mr Taylor.

- 3.2 My evidence addressed noise during construction and operation of the Metro. For the construction phase I have assessed noise from all the construction works along the whole route. For the operational phase the majority of my evidence concerns noise from that part of the proposed railway that is above ground; for the underground sections of the railway my evidence is limited to noise from ventilation shafts and stops.
- 3.3 My evidence refers to the noise assessment reported in the EIS which was prepared under my supervision. I have been responsible for the noise assessment from the outset of the environmental impact assessment, including consideration of alternative routes, as described in the evidence of Mr Purnell.
- 3.4 My evidence has two appendices:
- Appendix A: Terminology
 - Appendix B: Detail of Construction Noise Mitigation and Effects

4.0 RECEIVING ENVIRONMENT

- 4.1 Baseline noise surveys were carried out at 31 locations along the route. Volume 1, chapter 12 of the EIS describes the baseline noise environment along the route in detail. This can be summarised as follows.

Area MN101: Belinstown Depot to Swords Stop

- 4.2 This section of the route falls into two parts, as follows.
- 4.3 In the north, the depot and the Metro route are in agricultural land. Noise sensitive receivers close to the route are limited to scattered houses. Noise levels in the area are dominated by the traffic on the M1 and local roads.
- 4.4 Through Swords the route follows the R132 corridor where it is bordered by residential noise sensitive receptors on either side of the road past the Estuary and Seatown stops to the Swords stop. Noise surveys showed high levels of traffic noise during the day, but lower levels at night which is when

noise from operation of the Metro is most likely to cause impacts in this area, and in other areas.

Area MN102: Swords Stop to Dublin Airport north portal

- 4.5 South of the Swords Stop there are residential receptors to the West of the R132. South of the Fosterstown Stop the alignment passes houses at the end of The Willows before moving away from the R132, and the sensitive receptors along it, and heading South through open land to the airport tunnel portal.

Area MN103: Dublin Airport

- 4.6 The line drops into tunnel under the airport. The only sensitive receptors exposed to airborne noise in this area are residents in the halting site near the north portal.

Area MN104: Dublin Airport south portal to Santry Avenue

- 4.7 South of the airport the main landuse is agricultural. There are no noise sensitive receptors near the Dardistown Park and Ride site. South of the M50 there is a small group of residential properties in the vicinity of the Northwood Stop location. Noise levels here are relatively high day and night due to traffic on the motorway.
- 4.8 From here the alignment drops into a cut-and-cover tunnel along Ballymun Road.

Area MN105: Santry Avenue to Albert College Park

- 4.9 The alignment is in cut-and-cover tunnel through this area. For the operating railway the main airborne noise sources are associated with the Stops (Ballymun and DCU) and from possible changes in road traffic noise. There are residential properties and educational facilities on the Ballymun Road. Ambient noise levels in this area are high, day and night due to heavy road traffic on Ballymun Road.

Area MN106: Albert College Park to Mater Stop

- 4.10 Part of Albert College Park will be used as a construction site to support tunnel boring to the south. There are residential properties around the perimeter of the park.
- 4.11 The remainder of the alignment south from here will be in bored tunnel. Noise and vibration sensitive receptors above the tunnel are discussed in the groundborne noise and vibration evidence of Mr Taylor.
- 4.12 The Griffiths Avenue Stop will be constructed within approximately 50m of housing on Griffith Avenue.
- 4.13 The Intervention Shaft in St. Patrick's College Park will be within the vicinity of educational buildings, recreation facilities with houses nearby.
- 4.14 The Drumcondra Stop will be constructed near to residential properties in St. Joseph's Avenue and St. Alphonsus Avenue.
- 4.15 The Mater Stop will be constructed near to the Mater Misericordiae Hospital, the Mater Private Hospital and residential properties in Leo Street.

Area MN107: Mater Stop to St. Stephen's Green

- 4.16 The Parnell Square Stop will be constructed within the vicinity of the Findlater's Church, Parnell Square / Gardiner's Row, the Gate Theatre, and properties on Parnell Square East including the Gael Scoil.
- 4.17 The O'Connell Bridge Stop will be constructed within the vicinity of predominantly retail properties on O'Connell Street Lower and Westmoreland Street where ambient noise levels are high.
- 4.18 The St. Stephen's Green Stop will be constructed within part of St. Stephen's Green where noise could affect users of the Green, and neighbouring commercial properties, hotels and the Royal College of Surgeons property.

5.0 CHARACTERISTICS OF THE PROPOSAL WITH RESPECT TO AIRBORNE NOISE

- 5.1 The key airborne noise sources during construction are likely to be construction plant operating on or near the alignment, at the depot and Park and Ride Sites, and in construction compounds. Noise from construction traffic has also been assessed. Works on the Metro alignment will range from ground preparation, site levelling, earthworks, Stop construction, bridge

foundation works, cut-and-cover tunnel piling and formation, concreting, tunnel portal formation works and track laying works. For each type of work a set of construction plant has been considered in predicting noise levels and hence assessing likely noise impacts. Limited construction work is expected at night.

5.2 During operation of the scheme, airborne noise sources will include Light Metro Vehicles (LMVs) using the above ground sections of the track, activities at the depot, traffic changes in the area of the alignment, the two Park and Ride sites, people at Metro stops, fans in ventilations shafts and ancillary systems such as power supply facilities. There will also be occasional maintenance activities along the route.

5.3 The service frequencies of the LMVs are important. The following operating hours were used in the noise assessment:

- From Monday to Thursday, the service starts at 0500 hours and ends at 0030
- On Fridays the service starts at 0500 hours and ends at 0230 hours
- On Saturdays the service starts at 0600 hours and ends at 0230 hours
- On Sunday the service starts at 0700 hours and ends at 2330 hours

- 5.4 The most intense service frequency during the day will occur from Monday to Friday, and for the night on Friday. These service periods have been assessed in order to consider the highest day and night noise levels and hence a worst case assessment. The noise assessment has taken into account noise from all trains expected to operate during the full 16 hour daytime period from 0700 to 2300 hours and the full 8 hour night-time period from 2300 to 0700 hours.
- 5.5 When Metro North opens train services will operate at 4 minute headways (ie a train every 4 minutes in a given direction) during peak hours. The assessment is based on the likely service patterns that can be foreseen within the period up to 2029 (3 minute headways during peak hours).
- 5.6 The southbound service headways envisaged for the period up to the year 2029 are:
- 4 minute (2014) and 3 minute (2029) service headways between 07.00 to 10.00 hours and 15.30 to 19.00 hours
 - 7.5 minute (2014) and 6 minute (2029) service headways between 05.00 to 07.00 hours, 10.00 to 15.30 hours and 19.00 to 21.00 hours (with the exception of 05.00 and 07.00 hours in 2014 when 10 minute service headways will be operated)
 - 10 minute service headways between 21.00 to 00.00 hours
- 5.7 The northbound service headways are:
- 4 minute (2014) and 3 minute (2029) service headways between 07.30 to 10.30 hours and 16.00 to 19.30 hours
 - 7.5 minute (2014) and 6 minute (2029) service headways between 05.00 to 07.30 hours, 10.30 to 16.00 hours and 19.30 to 21.30 hours (with the exception of 05.00 and 07.30 hours in 2014 when 10 minute service headways will be operated)
 - 10 minute service headways between 21.30 to 00.30 hours

- 5.8 On Friday and Saturday nights, services will continue at 20 minute headways until 02.00 hours southbound and 02.30 hours northbound.
- 5.9 Some Metro vehicles will need to run empty to St. Stephen's Green from the depot in the morning before the service starts (from approximately 04.30 to 05.00 hours), and back to the depot when the service ends (up to approximately 03.00 hours on Friday and Saturday nights). Although out of service vehicles will be empty they will run at the same speed as in service trains. The top speed will be 70kph.
- 5.10 Service levels may be varied on particular occasions, such as during major public events in the city or at Christmas. Noise impacts on these occasions have not been assessed because they will be very infrequent and ambient noise conditions will be unusual.
- 5.11 Noise impacts from road traffic may arise from realignment of the roads, road closures, traffic diversions, and modal shift from the private car. Substantial changes in road traffic flow, speed, and/or composition are required to produce noise changes greater than 3dB.
- 5.12 People at Metro stops may cause additional noise, but in general Stops with nearby noise sensitive receptors are located in busy areas where ambient noise levels are relatively high, and any such affects will be small. The Belinstown and Lissenhall stops are in area where ambient noise levels are currently quite low, but they are also well separated from noise sensitive properties.
- 6.0 POTENTIAL IMPACTS OF THE PROPOSAL
- 6.1 There is potential for widespread disturbance due to noise from the construction works if noise control measures are not adopted. To assess this, levels of construction noise have been predicted at 97 representative noise sensitive receptors. In most cases noise prediction locations are the closest sensitive receptors to the works and represent a group of properties, for example a row of houses. 18 types of construction work have been considered, and the EIS reports the predicted impacts for the noisiest type of work expected adjacent to each representative receptor.

- 6.2 Predicted construction noise levels without mitigation have been compared to recognized noise impact assessment criteria, and potential impacts have been identified where these levels are likely to be exceeded. For dwellings and offices a daytime noise criterion of $L_{Aeq, \text{daytime}}$ 75 dB has been used in urban areas (70dB in rural areas). For educational buildings the criterion is $L_{Aeq, \text{period}}$ 65 dB. Without mitigation there is potential for noise impact at the majority of the representative receptors. Mitigation is discussed below.
- 6.3 Levels of airborne noise from Metro vehicle operations have been predicted at 37 representative locations along the route. As for construction noise, these have been chosen to represent all receptors along the route. Daytime and night-time noise levels have been predicted and compared to threshold noise levels below which environmental noise has insignificant effects. Changes in noise below these thresholds may be noticeable but would not result in significant environmental noise impacts.
- 6.4 Where noise from the LMVs is above the threshold values, the impact depends directly on the change in noise levels or the extent to which the noise levels exceed the threshold values. For example, if the ambient noise level is currently high (well above the threshold), a small change in noise levels may be unnoticeable and a larger change may cause disturbance. In such cases the scale of the impact will depend on the degree of noise change. If the ambient noise level is currently low (below the thresholds) then the scale of the impact is dependent on the extent to which the predicted noise levels exceed the threshold.
- 6.5 Without mitigation noise impacts are predicted at 17 of the 37 noise assessment locations. The noise modelling in this EIS made a worst case assumption for the basic noise emission level of the Metro vehicle, as well as a number of other conservative assumptions, including estimations of train speeds and operating patterns. So, I do not expect noise impacts to be higher than those assessed in the EIS. Mitigation is discussed below.
- 6.6 Traffic noise has been assessed in a similar way. Road traffic changes with the potential to cause greater than 3 dB changes in noise levels on the road network have been considered by analysis of traffic flow forecasts for roads along and adjacent to the route. Changes of this order have only been identified on the slip road coming from the R132 to the M1 (southbound)

where an increase of 3 dB is expected in 2014, increasing to 5 dB by 2029. Mitigation is not considered practicable. These noise impacts will affect the six houses to the east of junction.

- 6.7 There is potential for noise impacts at the closest property to the Depot, and mitigation has been considered as discussed below.

7.0 REMEDIAL OR MITIGATION MEASURES

Construction Noise

- 7.1 Best practical means will be used to minimise construction noise through implementation of the recommendations set out in BS 5228, 2009. The following specific noise mitigation measures have been identified in the EIS and will be implemented:
- 7.2 Proper use of plant with respect to minimising noise emissions and regular maintenance will be required. All vehicles and mechanical plant will be fitted with effective exhaust silencers and will be maintained in good efficient order.
- 7.3 The use of inherently quiet plant where appropriate - all major compressors and generators will be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which will be kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers.
- 7.4 Machines in intermittent use will be shut down in the intervening periods between work or throttled down to a minimum.
- 7.5 All ancillary plant such as generators and pumps will be positioned so as to cause minimum noise disturbance, and where necessary, acoustic enclosures will be provided.
- 7.6 Where practicable the use of noisy plant will be limited to core daytime periods.
- 7.7 Site hoarding along the site boundaries will be designed as noise barriers where they can be effective at screening noise emissions.
- 7.8 Localised noise barriers will be erected as necessary around items such as generators or high duty compressors.
- 7.9 Construction compounds will be laid out so as to minimise noise impacts to neighboring noise sensitive receptors, by locating noisy operations well away from receptors and using on-site structures and materials to screen noise where practicable and necessary.
- 7.10 The contractors will be required to comply with S.I. No 632 of 2001 European Communities (Noise Emission by Equipment for Use Outdoors) Regulations

2001, amended by S.I. No 241 of 2006. This directive sets limits on noise emissions from certain construction plant.

- 7.11 British Standard 5228 Part 1, Code of practice for noise and vibration control on construction and open sites, contains a great deal of practical guidance on reducing noise from construction sites, in addition to those summarised above, indicating the noise reductions that can be achieved. The Standard was updated in January 2009, replacing the previous Part 1 dated 1997, and provides an up to date and comprehensive code of practice in noise control from construction sites. Compliance with this code is an onerous requirement and will deliver substantial noise reductions, as discussed below.
- 7.12 The contractor will have to adopt this guidance, so will use noise control measures in addition to those listed above, as suitable to each activity. The RPA will put in place a number of mechanisms to enforce this, including the following.
- 7.13 The contractor will establish an Environmental Management System in accordance with ISO14001: 2004 to ensure all the required control and commitments are properly adopted. Under this system the Environmental Management Plan will include the noise control measures in accordance with those committed in the EIS. A site representative will be appointed responsible for matters relating to environment including noise. Performance will be reported monthly to check compliance with the requirements.
- 7.14 Channels of communication will be established between the contractor/ developer, local authority and residents. The contractor will provide the public with information on the scheduling of planned noisy activities on site and attend local liaison group meetings to explain the works and the measures being adopted to minimise noise disturbance.
- 7.15 The RPA will audit the contractor's performance in controlling noise on site. Levels of noise will be monitored during critical periods and at sensitive locations around each of the main construction sites, including all Stop sites.

Noise During Operation

- 7.16 For the operating railway, there are a number of mitigation measures available to reduce noise, but there is no statutory requirement to apply these mitigation, nor specific guidance as to when to apply mitigation.
- 7.17 In response to the EU Directive 2002/49/EC relating to The Assessment and Management of Environmental Noise, which was transposed into Irish legislation by the Environmental Noise Regulations SI No. 140 of 2006, the four local authorities of the defined Dublin Agglomeration have developed a Draft Action Plan Relating to the Assessment and Management of Environmental Noise. The plan gives guidance on tackling existing noise sources in terms of identifying noisy areas where reduction are desirable and ‘quiet areas’ where tranquillity should be preserved. The plans aims relate primarily to permanent noise, so have less relevance to construction noise generated by the Metro works. For the operating Metro, the RPA’s approach to noise mitigation, as discussed below, is considered to meet the requirements of the Draft Action Plan by ensuring that the Metro does not create new high noise areas or impact valued quiet areas.
- 7.18 On 1st May 2008, the Bord Pleanála Inspector’s Report for the Luas Line A1 (Belgard to Saggart) Railway Order application was published. The report recommended granting the Order, and, in Schedule 12, attached a condition relating to noise, as follows:
- 7.19 *The Operational Noise Level criteria to be applied and the design goals adopted shall be those of the National Roads Authority as published in the document entitled “Guidelines for the Treatment of Noise and Vibration in National Road Schemes” (Revision 1, October 2004).*
- 7.20 *Reason: To achieve uniform noise criteria in an area where new road proposals are scheduled to be carried out in the same time period and adjacent to the light railway.*
- 7.21 The application of the NRA design goal for railway noise from the Luas A1 scheme was linked to the fact that the scheme included road scheme proposals. It could be argued that this is not the case for the entirety of the Metro North scheme. However, the majority of the Metro North above ground alignment follows road corridors, and the RPA considers it appropriate to adopt the NRA design goal for designing mitigation for noise from the normal

running of Metro vehicles, in any case where that noise will be higher than the prevailing traffic noise level.

- 7.22 There are differences in the characteristics of road traffic and railway noise, and it has been shown that railway noise is less disturbing than road traffic noise, at a given level. This effect has been called a railway 'bonus' and is greater at higher noise levels. However, for the purposes of considering the NRA guidance for Metro North the railway bonus has been ignored.
- 7.23 The NRA design goal is stated in the guidance as follows:
- 7.24 Day-evening-night 60dB L_{den} (free-field residential facade criterion).
- 7.25 The guidance notes:
- 7.26 *Noise and vibration design goals are required in order to ensure that the current roads programme proceeds on a path of sustainable development. Achieving sustainable development in practice requires that economic growth supports social progress and respects the environment, that social policy underpins economic performance and that environmental policy is cost effective. In devising design goals for national roads the Authority has balanced environmental and economic considerations. With this in mind, the Authority acknowledges that it may be appropriate to adopt different design goals for diverse situations, e.g. design goals for existing situations may be different from new situations and there are different design goals for the construction phase of road schemes.*
- 7.27 *This [operational phase] design goal has been shown to be significantly more onerous than the 68dB(A) L10(18 hour) value previously employed on national road schemes.*
- 7.28 *This design goal is applicable to new road schemes only. In EIS terms, this means that it is to be applied to existing sensitive receptors in respect of both the year of opening and the design year (i.e. 15 years after projected year of opening).*
- 7.29 *Following confirmation of the EIS, the issue of noise mitigation for new receptors is a matter for the Planning Authority within the planning legislation.*

- 7.30 *The Authority accepts that it may not always be sustainable to provide adequate mitigation in order to achieve the design goal. Therefore, a structured approach should be taken in order to ameliorate as far as practicable road traffic noise through the consideration of measures such as alignment changes, barrier type (e.g. earth mounds), low noise road surfaces etc.*
- 7.31 The guidance goes on to give conditions that must be satisfied for mitigation to be considered. In adopting this guidance for Metro North, the RPA considers it is only appropriate where ambient noise levels are to be increased by noise from LMVs in operation. The RPA recognises that the 24 hour distribution of noise from Metro North may be different from traffic noise in the adjacent roads, in particular it may be comparatively noisier at night. Hence, the condition for the design goal to be applied to railway noise shall be that railway noise must be above road traffic noise as measured in any hour of the day or night, in terms of $L_{Aeq\ 1\ hour}$. This is the adopted railway noise design goal. In such cases the resultant $L_{Aeq\ 1\ hour}$ noise level would increase by at least 3dB, and the railway noise L_{den} would be above 60dB.
- 7.32 The railway noise assessment has therefore computed L_{den} noise levels, as defined in Annex 1 of EC Directive 2002/49 Relating to the Assessment and Management of Environmental Noise, based on the Metro service levels described above.
- 7.33 Above the railway noise design goal mitigation measures are considered to reduce noise impacts as follows.
- 7.34 The railway noise modelling is based on a series of conservative assumptions. These will be revisited at the final design stage through a further detailed noise modelling study that will determine the exact form of noise mitigation. At this stage a number of measures are possible, as follows.
- 7.35 The noise modelling in this EIS has made a cautious assumption for the basic noise emission level of the Metro vehicle. The RPA will encourage metro rolling stock tenderers to provide a quieter vehicle within the constraints to the competitive tendering process. It is quite possible the metro vehicle will be quieter than assumed. For example, some vehicles are equipped with 'skirts' extending below the vehicle body downwards to close to the ground which help to contain noise under the vehicle.

- 7.36 Preferred operating speeds may be lower than assessed herein, which would reduce noise, as could other operational factors. Track design could reduce noise levels. Rail dampers can reduce rail generated noise, and absorptive materials within the trackbed can attenuate noise reflections.
- 7.37 On elevated sections it is possible to modify the trackbed to include low level noise screening structures close in to the wheel rail interface, and between the tracks. Such structures would be barely visible from adjacent receptor locations. The RPA considers it essential to minimise the visual impact of the railway viaducts, and in general will not construct highly visible noise barriers on viaducts.
- 7.38 Noise barriers may be considered but they have a number of dis-benefits that would need to be considered including potential conflicts with road traffic, concerns of track safety, driver sight lines, visual impact, security and crime considerations, and construction and maintenance issues. For these reasons noise barriers will not generally be suitable for built up areas near road traffic and pedestrians. It is likely that noise barriers will be appropriate to mitigate the noise impacts predicted in the area south of the Lissenhall Stop where the alignment is away from roads and pedestrians. Noise barriers incorporating suitable vegetation may be appropriate in this area, so that they appear similar to a hedge, minimising visual impacts.
- 7.39 Although the precise requirements for noise mitigation are not currently known, the EIS has identified the most likely form of mitigation in each of the 17 locations where the modified NRA design goal is likely to be exceeded, on the basis of the worst case noise predictions undertaken at this stage. On this basis the scheme has made provision for landscaped noise barriers at four locations south of the Lissenhall Stop, a possible barrier or modified trackform at the Willows south of the Fostertown Stop, and modified trackform in 12 areas mainly through Swords but also around the Northwood Stop south of the M50.

Depot

- 7.40 The depot has potential to create noise impact at the closest residential properties. The landscape bunds and the Park and Ride building will provide noise screening, but some increase in ambient noise is expected. To address

this further noise screening will be included within the depot adjacent to tracks such as the track from the Stop heading north and to the southern stabling area.

- 7.41 Within the depot the track geometry of the tightest bends will be carefully designed to minimise the possibility of wheel squeal and if necessary track lubrication measures will be employed to prevent it.

Ventilation Shafts

- 7.42 Ventilation shafts at underground Stops, and the Intervention Shaft in St. Patrick's College Park, will include emergency fans that will be tested up to once every two weeks. Fan testing will be carried out during the day to reduce noise impacts in residential areas, and planned outside of sensitive hours for neighbouring sensitive uses, such as sensitive college hours at the St. Patrick's college, if necessary.
- 7.43 Mitigation will involve fan attenuators, ensuring that the outlet of the ventilation fan faces away from noise sensitive properties, control of fan speed or selection of low noise fan systems.

8.0 PREDICTED, RESIDUAL IMPACTS AND SUMMARY

Construction Noise

- 8.1 This section describes the likely residual noise impacts (ie impacts after mitigation) around the main work sites in each route section. It provides a summary of those impacts drawn from Appendix B gives greater detail site by site along the route. For each site Appendix B identifies the properties most likely to be disturbed by construction noise, as assessed in the EIS. It then discusses specific mitigation measure that may be effective in each case, and then outlines the phases of the works most likely to cause disturbance after mitigation measures have been adopted.
- 8.2 It is important to appreciate that whilst the overall construction programme at most worksites is many months in duration, the periods of time within this overall programme when noise disturbance is expected are much shorter.

Appendix B gives an indication of what periods of time disturbance is expected within the overall works programme in each route section.

- 8.3 It is also important to appreciate that at this stage it is not possible to predict the full benefit of all the noise mitigation measures the contractor will adopt because the exact equipment to be used is not known at this stage. The NRA guidelines (as referred to in paragraph 7.19 above) recognise this, and in paragraph 6.7 advise as follows:
- 8.4 *'The Authority acknowledges that it is often not possible to conduct detailed noise assessments in respect of the construction phase of a road scheme due to the fact that the programme is not sufficiently detailed. However, due consideration should be given to the potential for high construction noise levels, particularly where work is anticipated over prolonged periods in the vicinity of noise sensitive properties. In such circumstances, it is appropriate to predict indicative construction noise levels.'*
- 8.5 The guideline goes on to explain that it should be possible to draw up a schedule of mitigation measures and it provides a lists the types of measures that should be included. These mitigation measures have been described in the EIS, and in Section 7 above. Details of specific measures that may be effective at each site are given in Appendix B. However, a cautious approach has been taken throughout, so as not to under-estimate likely construction noise effects, and it is quite possible that the contractor will find additional measures to further reduce noise disturbance.
- 8.6 Since the publication of the EIS, BS5228 has been revised. The new standard includes a revised database of construction plant noise source levels based on measurements reported in 2005, whereas the EIS is based on measurements reported in the 1997 standard, many of which were unchanged from the 1984 standard. In the 25 year period between the 1984 and 2009 versions of the standard there have been a number of EC directives limiting noise from construction plant, and developments in the field have lead to some construction plant becoming quieter. It is therefore possible that the standard used to assess construction noise in the EIS has lead to over-estimated noise levels because it was based on 25 year old data that has now been updated.

- 8.7 I have carried out a review of the changes in the BS5228 databases in the 2009 standard, and how this effects the noise levels used in the plant teams adopted in the EIS, and hence the impacts predicted. Given the uncertainty about the exact plant to be used this can only be an approximate analysis. I reviewed the old and new noise emission data for 11 of the common items of plant that will be used to construct Metro North. In five cases the new noise emissions data is lower than the old and there is a case for reducing the noise emission levels assumed in the EIS. For three types of concreting plant (concrete pumps, concrete mixer trucks, poker vibrators) noise reductions of 2-3dB would be justified. For compressors, which have been subject to EC regulation since the old standard, a reduction of about 10dB would be justified. For bored piling a reduction of about 5dB would be justified. Hence for some types of work the EIS has over-predicted noise levels.
- 8.8 In general these over-predictions are small, but in a few cases, such as for concreting works and bored piling, the revised BS5228 database would imply significant reductions in predicted noise levels.
- 8.9 The likely construction noise impacts of the scheme, as described site by site in Appendix B, can be broadly summarised as follows.
- 8.10 Construction of Metro North involves a series of major engineering structures to be built using heavy engineering plant. Most of these structures are required in built up areas in order that the Metro is readily accessible. A degree of disturbance from construction noise is therefore inevitable. The RPA has put in place a process to ensure that disturbance is minimised, but some residual disturbance will arise even after mitigation.
- 8.11 Construction of the underground Stops is likely to cause the greatest noise disturbance. Utility diversions, generally under pavements, often close to properties, will cause brief periods of disturbance. Piling of the station box perimeter walls will be in close proximity to noise sensitive receptors and in some cases, for example near hospitals, special modifications to piling plant may be needed to achieve acceptable conditions. This phase will take about 6 month for each Stop, but the highest noise levels will affect individual properties for only a few days as the plant progresses along the perimeter of the station box wall. The excavation of Stops, taking 1-3 years, will create less noise as the works progress underground, and in most cases will be

done underneath partly of fully decked-over work site. The remaining works to complete the facilities within the underground Stop boxes, generally lasting 2-3 years, will also be relatively quiet.

- 8.12 The tunnelling site at Albert College Park will run at night for much of the 2 ½ year tunnelling period. The site is sufficiently large to implement a series of noise mitigation measures (discussed in Appendix B) so that that noise levels can be reduced to be close to ambient noise levels at most residential properties, and widespread disturbance at night would be avoided. Noise levels will be monitored at all underground Stop sites and here to check the contractor's performance in adopting the best practicable means to control noise.
- 8.13 There are no other parts of the scheme that require extensive construction work at night. Night work may be needed if concrete pours run late, but this is not planned. There will be a few nights of work required to safely demolish the Malahide South and Chapel Lane footbridges in Swords which is likely to give rise to brief noise impacts.
- 8.14 Cut-and-cover tunnelling through the Ballymun area may create noise disturbance, although, in this area, as along the alignment within the R132 corridor in Swords, ambient noise levels are high which will tend to lessen noise impacts because people will tend to have adjusted to the high ambient noise, for example, by carrying out particularly noise sensitive activities in rooms away from the road and the Metro alignment.
- 8.15 Through Swords the main areas of noise disturbance after mitigation are likely to be during construction of the underpass and viaduct structures.
- 8.16 Appendix B gives further details of specific noise mitigation and noise disturbance expected for each section of the route.

Noise During Operation

- 8.17 No residual railway noise impacts are predicted.
- 8.18 There is a possibility of some residual noise impacts from depot operations at the nearest property (NM101-1), although further measures will be explored to avoid this if practicable.
- 8.19 A residual impact is expected due to increased road traffic noise at the 6 properties east of the R132/M1 junction.
- 8.20 Maintenance of the wheel and rail surfaces is an important means of avoiding train noise increasing over the years of operation. Much of the maintenance work on the track will be undertaken at night when the railway is not in use. Most maintenance activities are not particularly noisy, but rail grinding may cause some disturbance. Rail grinding in a given location is likely to be required at a frequency measured in years and will deliver long term noise and vibration benefits.

9.0 RAILWAY ORDER CHANGES

- 9.1 Since the publication of the EIS there have been some changes made to the scheme. I have reviewed these and assessed their potential noise impacts. The majority of the changes that involve revised designs that do not move structures and facilities will not change noise impacts during the construction or operation of the Metro. There are three changes that could potentially affect noise: movement of the R132/depot access road 75m north, relocation of swords substation, and relocation of escalators on St. Stephen's Green. There would be no net change in noise impacts from the scheme as a result of these changes.

10.0 SUBMISSIONS

- 10.1 I have reviewed the Submissions that refer to airborne noise. I respond to two from St. Stephen's Green directly in Appendix B. The majority express concern that construction noise will cause disturbance and seek assurances as to how this will be minimised and some Submissions also raise concern

over noise from the operation of Metro North. My evidence addresses these concerns, in general terms in Sections 4-8, and site by site in Appendix B.

11.0 CONCLUSION

11.1 For the construction of the Metro, the RPA will put in place a series of procedures that will ensure that the Metro is built using the best practicable means to reduce airborne noise to a practicable minimum. These include a series of specific noise control measures, compliance with the relevant code of practice, BS5228 Part 1, and noise monitoring to identify potential shortfalls in noise control performance. Even with the use of the best practicable means to reduce noise, some noise disturbance will occur during unavoidably noisy activities. In the overall context of the Metro scheme, and with the mitigation measure I have described in this evidence, I do not consider these residual impacts to be unacceptable.

11.2 For the operating Metro, the RPA has developed a responsible approach to controlling environmental noise. Metro noise levels have been predicted and compared to both noise impact threshold criteria and existing ambient noise levels. Mitigation measures will be refined in the detailed design stage in accordance with the agreed standards that have been drawn from National Roads Authority guidance. Detailed noise modelling work has been completed in some areas to confirm that these measures will be effective and residual noise impacts can be avoided.

12.0 APPENDIX A: TERMINOLOGY

12.1 Noise is measured and quantified using decibels (dB). This scale is logarithmic, which means that noise levels do not add up or change according to simple linear arithmetic. For example, any two equal noise sources added together give only an increase of 3dB higher than the individual levels (e.g. 60 dB + 60 dB = 63 dB, not 120 dB). This represents what happens in practice when two equal sounds coincide; the ear perceives only a slight increase in noise and not a doubling.

12.2 The following table illustrated examples of noise levels.

Table 1 Examples of Noise Levels on the Decibel Scale

Noise Level dB(A)*	Typical noise source / example
0	Threshold of hearing (lowest sound an average person could hear)
30	Quiet bedroom at night
40	Whispered conversation at 2 metres
50	Conversational speech at 1 metre
60	Busy general office
70	Loud radio indoors
80	Tracked excavator ('JCB') operating at 10meters
90	Pneumatic breaker at 5 meters

*The dB(A) scale is a particular way of measuring the different frequencies in sound designed to match how the human ear works, called 'A'-weighting.

12.3 The way human hearing works is conveniently similar to the logarithmic changes in noise:

- An increase of 1 dB in noise levels cannot usually be heard (possible in 'laboratory' conditions).
- An increase of 3 dB is generally accepted as the smallest change that is noticeable in ordinary conditions.
- An increase of 5dB is clearly perceptible.
- An increase of 10dB seems to be twice as loud.

12.4 Levels of noise from most sources vary over time, so we need to find a way of measuring it in a manner which represents the variation in noise level that also reflects people's perception of how noisy it is. In the EIS and in this evidence I have primarily used two noise metrics to report noise levels; the equivalent sound level $L_{Aeq, period}$, and the maximum noise level, L_{Amax} which are described as follows.

- 12.5 The continuous equivalent sound level $L_{Aeq, T}$, is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. The letter 'A' denotes that 'A'-weighting has been used and 'eq' indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous sound level, measured over time period 'T'.
- 12.6 Detailed surveys have been carried out into people's responses to different sources of noise and these have been used to define which noise metrics provide good relationships with perceived noisiness. The EC Directive on the Assessment and Management of Environmental Noise, for example, advocates $L_{Aeq, period}$ for all types of transportation noise. It is important to appreciate that whilst L_{Aeq} does give a measure of the accumulated noise over a period of time it is not like a conventional (arithmetic) average. It is in fact a logarithmic average. The effect of this is to give a high weighting to high noise levels even if they are relatively short lived or infrequent peaks.
- 12.7 L_{den} is a 24 hour noise metric, defined in the EC Directive on the Assessment and Management of Environmental Noise, that incorporated weightings to the day (0700-1900), evening (1900-2300) and night (2300-0700) L_{Aeq} levels.

13.0 APPENDIX B: DETAIL OF CONSTRUCTION NOISE MITIGATION AND EFFECTS

Area MN107: St. Stephen's Green Stop

- 13.1 This section first describes mitigation and impacts expected around the St. Stephen's Green Stop site, and then addresses the Submissions of the Bank of Scotland (Ireland) and the Fitzwilliam Hotel who have raised noise disturbance as a particular concern and submitted technical evidence on the matter.
- 13.2 Construction of the St. Stephen's Green Stop will cause some noise disturbance to the Bank of Scotland Ireland, the Fitzwilliam Hotel, other

commercial properties in St. Stephen's Green West, properties on St. Stephen's Green North, and to users of the park.

- 13.3 The main noisy enabling works will be utility diversions in the pavements adjacent to the properties on St. Stephen's Green North and West. I discuss this in connection with Fitzwilliam hotel objection below and describe what mitigation can be effective to minimise noise impacts at the hotel.
- 13.4 The first phase of the main works will be to construct the Ticket Hall diaphragm wall and roof. A hoarding will be used as a noise barrier approximately 6m from the properties on St. Stephen's Green West and North, as shown in Figure 2 of John McLouglin's evidence. During diaphragm walling a Hydrofraise and supporting plant will be operating in close proximity to neighbouring buildings and special mitigation measures will be needed to avoid noise impacts at upper floors that would be unscreened by the noise barrier. The main noise source in the Hydrofraise plant is the diesel-driven hydraulic power unit that is usually mounted on the crane. It would be possible to enclose the power unit in an acoustic enclosure in-situ or to relocate the power unit to be at ground level in an acoustic enclosure. Other plant would need more standard mitigation measures including acoustic engine enclosures and additional exhaust silencers in order to avoid residual noise impacts. The plant will only operate at its closest proximity to a given receptor for a few days as it moves along the line of the diaphragm wall at a rate of about 6m each day, so the period of highest noise will last for only a few days.
- 13.5 After the diaphragm wall is complete, over a period of about 6 months the ticket hall will be excavated to a depth of about 6m and the roof will be constructed and infilled to road level. Mitigation measures to excavation and concreting plant, such as acoustic enclosures to engines and upgraded silencers, will be needed to avoid residual impacts.
- 13.6 After the road has been reinstated above the ticket hall the hoarding will be moved back to within St. Stephen's Green separating the work site from the properties on St. Stephen's Green North and West by a distance of approximately 20m, and the main station box will be excavated. The ticket hall will also be excavated below the road from within the station box. This will reduce noise emissions to the neighbouring properties as well as allowing

traffic to flow. The EIS assumed 23 plant noise sources for the main stop construction phase of work and predicted that despite the increased separation distance, standard forms of mitigation would be needed to avoid residual impacts from this phase of work.

- 13.7 The Bank of Scotland (Ireland) and the Fitzwilliam Hotel Submissions refer to a report prepared by Decibel Noise Consultants (Appendix 5 to the Fitzwilliam Hotel Submission) which criticises the construction noise assessment reported in the EIS, in particular suggesting that during enabling works noise levels will be much higher than reported in the EIS. The following advice is given by Decibel Noise Consultants and quoted in paragraph 3.23 of the Fitzwilliam Hotel Submission.
- 13.8 ‘the predicted noise levels will increase by at least 18dB L_{Aeq} and reach 97dB L_{Aeq} from “stops” and 88dB L_{Aeq} from “night concrete pours” and attain noise exposure levels that will potentially exceed statutory limits...’
- 13.9 The 18dB increase calculated by Decibel Noise Consultants assumes that the noise source is moved from a distance of 54m from the hotel to a distance of 7m from the hotel. The noise source assumed in the EIS for “Stops”, as listed in Table 7.13 of Annex C comprises 23 construction plant, including 6 cranes. Each of these construction plant will be performing different jobs spread around the site separated by safe working distances. It is not possible for 23 construction plant to be located 7m from a point on the hotel facade, so the noise levels calculated by Decibel Noise Consultants are too high. The advice given by Decibel Noise Consultants on statutory noise levels is therefore incorrect, as is other advice, including the suggestion in paragraph 5 of their report that fire alarm sounder levels inside the hotel would have to be increased because of the predicted levels of construction noise.
- 13.10 Paragraph 3.8 (iii) of the Fitzwilliam Hotel Submission suggests that the noise level from a jackhammer breaking up the pavement 7m from the hotel will be L_{Aeq} 82dB. At 15m this noise level would reduce to about 75dB. Breaking out the pavement to access utilities as a result of Metro North will progress rapidly as the activity moves along the road, in the same way as it would for accessing the utilities for some other purpose. Specific mitigation measures will be used during the Metro North enabling works to reduce noise and

minimise disturbance, including those given in BS5228. Noise mufflers of pneumatic breakers and an absorptive noise barrier located close to the breaker would be effective. Specific mitigation measure will be considered under the commitment given in paragraph 4.4.2.1 of the EIS to use the best practicable means to minimise construction noise disturbance to hotel guests and users of the Bank of Scotland (Ireland) is minimised.

- 13.11 The EIS assesses the impact of concrete pours in case they are required at night. This is clearly a concern to the Fitzwilliam hotel whose guests could potentially be awoken at night. No night work will be planned in this location, and if essential work is required the hotel will be given due advanced warning. Noise levels will also be monitored at the hotel to help ensure best practice and that disturbance is minimised.

Area MN107: O'Connell Bridge Stop

- 13.12 Construction of the Bailey Bridge is expected to require driven tubular piling within about 25m of the Corn Exchange on Burgh Quay and 25m of buildings on Eden Quay. Standard driven piling would lead to noise impacts, but it would be possible to avoid this using an acoustically enclosed piling system.
- 13.13 Enabling works including utility diversions on O'Connell Street and Westmoreland Street could cause disturbance to the retail and office buildings along these roads. There is also a need to install cable ducts for ESB supply along D'Olier Street. Mufflers on breakers will be used, and noise barriers located close to plant would be effective at reducing noise impacts, but some periods of disturbance are expected, albeit over a matter of days at a given property as the noisy works progress past the property. Some of this work will be done at night to reduce impacts on commercial buildings, but work that could impact on any buildings in which people sleep, such as the hotel further south in Westmoreland Street, will be avoided.
- 13.14 Construction of the station box walls will be done by Secent piles bored at a distance of within about 4m from the majority of the adjacent building fronts on O'Connell Street and Westmoreland Street. A silenced piling rig would reduce noise substantially, and localised noise barriers close to plant would attenuate noise emissions to lower floors, but some residual disturbance at

upper floors is likely unless the contractor develops a particular form of mitigation.

13.15 On O'Connell Street the east and west side station box sides will be formed in turn within the first two years of construction with the road deck being replaced. The median section will then be excavated and the underground station constructed within over the following 2-3 years. In this period the station box will be decked over with access points to lift materials in and out by gantry crane. An electric gantry crane would reduce above ground noise generation and it will be necessary to attenuate ventilation systems. The noisy works will thus be largely enclosed underground with above ground noise dominated by lorry movements in the central section of O'Connell Street, and moving to and from the site. Ambient noise levels on this section of O'Connell Street are $L_{Aeq, period}$ 70-71 dB at the shop fronts, and during this main excavation and construction phase it is anticipated that noise impacts could be avoided.

13.16 On Westmoreland Street the east and west side station box sides will be formed in turn within the first two years of construction, similarly to on O'Connell Street, except these two excavations will form the complete box (with no median excavation stage) and the main excavation will be through the western site while the road deck has been reinstated on the east side. Ambient noise levels of this section of Westmoreland Street are $L_{Aeq, period}$ 71-72 dB at the shop fronts, and during this main excavation and construction phase it is anticipated that noise impacts could be avoided.

Area MN107: Parnell Square Stop

13.17 Construction of the Parnell Square Stop will cause some noise disturbance to properties on Parnell Square East including the Gaelscoil, the Findlater's Church on the corner of Parnell Square North, the Rotunda Hospital (HARI clinic, Private Clinic) and the Gate Theatre.

13.18 During enabling work there may be residual impacts at properties along Parnell Square East during utility diversions in the adjacent street. Residual impacts from utility diversions are likely to be only a few days for any given receptor and all practicable noise control measures will be taken to minimise

disturbance. It may be that special measures can be adopted to avoid significant effects.

13.19 The diaphragm wall construction phase will take about 6 months to complete. With the works necessary along the station box perimeter, residual impacts are expected when the works are outside adjacent properties unless special mitigating measures are adopted. Noise levels are likely to be greatest at the upper floors of properties on Parnell Square East that will tend to overlook noise barriers. The key noise source at the site perimeter will be the Hydrofraise used to excavate the diaphragm wall. Research into specific noise control measures that may be available to attenuate noise from Hydrofraise systems indicates that it would be possible to enclose the power unit in an acoustic enclosure in-situ or to relocate the power unit to be at ground level in an acoustic enclosure. Other plant would need more standard mitigation measures including acoustic engine enclosures and additional exhaust silencers in order to avoid residual noise impacts. The plant will only operate at its closest proximity to a given receptor for a few days as it moves along the line of the diaphragm wall at a rate of about 6m each day, so the period of highest noise last for only a few days. Noise levels will be monitored to check the contractor's performance.

13.20 It is noted that ambient noise levels in the area are high (around L_{Aeq} 70dB) due to heavy traffic and buses, so that properties on Parnell Square East may have taken actions to accommodate high external noise levels and so be less affected by construction noise.

13.21 Bored piling will commence at this stage and at source measures will be taken to minimise noise disturbance.

13.22 During the initial excavating phase (down to 4m) lower noise levels are expected but mitigation will be needed to avoid residual impacts at upper floors of the adjacent properties identified above.

13.23 During the main excavation phase, excavation will proceed below a steel deck which will contain noise from below ground works. Above ground, spoil will be removed through openings in the deck by electric gantry crane and lorries, and plant will be silenced so that residual impacts are avoided.

Area MN106: Mater Stop

13.24 The Mater Stop will be constructed under advanced works that are being assessed by Mot McDonald.

Area MN106: Drumcondra Stop

13.25 Construction of the Drumcondra Stop will cause some noise disturbance to the properties on St. Joseph's Avenue, St. Alphonsus Road (lower), and St. Alphonsus Avenue.

13.26 Ambient noise levels on Drumcondra Road Lower, due to the heavy traffic, are high ($L_{Aeq\ period}$ 70-71dB), and noise impacts from the works are not expected at properties on the East side of the road.

13.27 During enabling work and site preparation there may be residual impacts during demolition works, but with mitigation these are likely to be only a few days.

13.28 The station box and ticket hall bored piling phase will take about 6 months to complete. Effective forms of mitigation include a low noise piling rig, attenuated support plant and local noise barriers. Residual impacts for a few weeks at individual properties are likely unless special mitigation measures are taken.

13.29 The excavation of the station box will take about 1 ½ years to complete. During the initial excavating phase noise levels will be highest at upper floors of the adjacent properties identified above and mitigation measures to plant, such as acoustic enclosures to engines, additional exhaust silencers would be needed to avoid impacts. Works at lower levels in the box will create less noise at the surface as screening increases.

13.30 During reinstatement some brief periods of residual impacts are likely as during site preparation.

13.31 Noise levels will be monitored to check the contractor's performance.

Area MN106: Intervention Shaft at St. Patrick's College

13.32 Advanced works to level play areas north of the college buildings will be undertaken in close coordination with the college to minimise disturbance.

13.33 The Intervention Shaft is to be constructed within 10m of the closest part of St. Patrick's College, 1-6 Milbourne Avenue and 10-11 Milbourne Avenue.

Close coordination with the college will avoid impacts in particularly sensitive college times, and no noisy work will be planned at night. Silenced piling rigs and noise barriers would be effective at reducing noise emissions to noise sensitive receivers which are low rise buildings. Some noise disturbance is expected at these three locations during the noisiest phase when the main shaft structures are being built.

Area MN106: Griffith Avenue Stop

- 13.34 The Griffiths Avenue Stop site has residential properties to the South on Griffiths Avenue, to the West of The Rise, and further away to the East on Walnut Rise. The Elmhurst Convalescent Home is approximately 50m to the North. There is potential for noise disturbance at these properties, but unlike some of the city centre Stops, Griffiths Avenue is separated from all the properties by at least approximately 50m. The Stop will follow a similar construction sequence to others, with the box perimeter being constructed by bored piling within a 6 month period, followed by an excavation period of about a year, with quieter works underground following.
- 13.35 The noisiest periods of work are likely to be initial site clearance and bored piling. There could be some periods of disturbance during site clearance when plant is working closest to properties, and it is harder to mitigate mobile plant, but these will be brief, lasting a few days or weeks at most. The EIS may have over-predicted noise from bored piling (due to recent revisions in the noise standard adopted of the analysis). Silenced bored piling rigs and noise barriers would be effective at reducing noise to noise sensitive receivers which are low rise buildings. Noise levels will be monitored to check the contractor's performance. Whilst residents will clearly hear the works on occasions, residual noise impacts are not expected.

Area MN106: Albert College Park Tunnelling Site

- 13.36 Access to the site will be directly onto Ballymun Road where the additional lorry movements will not add significantly to currently high level of road traffic noise.
- 13.37 The tunnelling support site is bordered by residential areas to the East, South and West. Tunnelling from the tunnel portal to St. Stephen's Green is

expected to be completed within a period of approximately 2 ½ years, although the Tunnel Boring Machine will operate intermittently within this period during the day and also at night. The EIS reports that noise impacts during the day are not expected, but that tunnel support work at night is likely to give rise to noise impacts if a standard level of mitigation is adopted. It is anticipated that the site will be active at night during tunnelling, but not with the same level of activity as during the day. For night work additional mitigation will be adopted to minimise impacts, and is likely to be effective at reducing noise impacts as discussed below.

13.38 The site is large, approximately 7,000m², offering opportunities for designing the site layout to reduce noise emissions to residential areas.

13.39 The eastern part of the site may be used for site offices and support facilities which would provide noise screening. The southern part of the park (south of the internal footpath) will be left outside the worksite, providing increased separation to residents on Hamstead Avenue. To the West, the nearest residences are on the far side of Ballymun Road which remains noisy at night, so impacts are less likely.

13.40 Works at night are likely to include spoil removal by gantry crane. The crane is likely to be at least 50m from the nearest house and electric models will be considered if necessary. The grout plant will be screened acoustically if necessary, and it should be possible to locate it a similar distance, or further, from housing. Generators will be acoustically enclosed. The western and southern side of the site may be used for storage. It may be possible to use stockpiles to screen noise emissions to Hamstead Avenue. This area is likely to have a perimeter haul road for lorries delivering materials and removing spoil via the Ballymun Road entry/exit point. A noise barrier along the southern side of the haul road would be effective at attenuation lorry noise propagation to housing on Hamstead Avenue. A wheel wash will be needed near the exit point, and if necessary can be enclosed to reduce noise emissions.

13.41 Further night-time baseline noise surveys will be carried out at residential buildings around the site before the works begin and the contractor will be required to use all practicable mitigation measures to avoid significantly

increasing the ambient noise at residential properties. The noise predictions in the EIS are conservative and assume standard noise mitigation. I am aware of railway tunnelling support sites that have adopted specific noise control measures to allow them to operate adjacent to residential areas at night. Through a variety of specific noise mitigation measures, including those discussed above, I would expect that noise levels can be reduced to be close to ambient noise levels in most cases, so that widespread disturbance at night would be avoided.

Area MN105: DCU Stop

- 13.42 The DCU Stop is to be constructed to the East of Ballymun Road adjacent to a number of noise-sensitive properties immediately to the East including a church, and houses on the end of Albert College Grove, Albert College Crescent and Albert College Lawn. To the West residential properties on the West side of Ballymun Road are more distanced from the works, are currently exposed to high levels of road traffic noise, and are not expected to be impacted by noise from the works.
- 13.43 The construction method will be 'top-down' similar to that described above for the Parnell Square Stop. Mitigation measures will be similar.
- 13.44 During diaphragm wall construction noise impacts can be expected at the closest properties, and special mitigation measures, as described for Parnell Square, will be required to minimise noise disturbance. The structures are to be built within approximately 2m of the Number 16 Albert College Grove, and even with mitigation some disturbance is expected, over brief periods as described above.
- 13.45 The later stages of construction will be below the stop roof deck and it should be possible avoid residual noise impacts.
- 13.46 Noise levels will be monitored to check the contractor's performance.

Area MN105: Ballymun Stop

- 13.47 The Ballymun Stop will be adjacent to the Community Art Centre to the southeast, and new developments to the East and West. The flats on the West side of Ballymun Road are more distanced from the work, are currently

exposed to high levels of road traffic noise, and noise impacts are not expected.

13.48 Advanced works include re-routing of water and sewers through adjacent roads which may generate brief noise impacts as the works pass given properties.

13.49 The station construction method will be 'top-down' similar to that described above for the DCU and Parnell Square Stops. The site is more favourably located than the DCU Stop and lesser impacts are expected. Parts of the Community Art Centre are within 10m of the diaphragm wall, and close liaison with the Centre will be used to ensure the noisiest works do not coincide with particularly sensitive times, and special mitigation measures, as described for Parnell Square, will be required to minimise noise disturbance.

13.50 The later stages of construction will be below the stop roof deck and it should be possible to avoid residual noise impacts.

13.51 Noise levels will be monitored to check the contractor's performance.

Area MN105: Santry Avenue to Albert College Park – Cut and Cover Tunnelling

13.52 The EIS identifies a number of residential and other properties along this section of the route that could be disturbed by cut-and-cover works. Ambient noise levels are high ($L_{Aeq, period}$ 63-68dB) and whilst construction noise will be at higher levels at times, its effect on noise sensitive receptors will be less than in quieter areas because people will tend to have adjusted to the high ambient noise, for example, by carrying out particularly noise sensitive activities in rooms away from Ballymun Road and the Metro alignment.

13.53 It is anticipated that the majority of potential noise impacts in this area can be avoided by the use of standard on-site noise control measures as prescribed in BS5228 Part 1. Where residual disturbance does arise it will typically last for less than 30 days as the noisiest activities progress along the alignment.

13.54 The Trinity Comprehensive School could be affected by noise from cut and cover construction works. In response to concerns raised by Ballymun

Regeneration Ltd noisy works that could impact on students sitting state examinations will be avoided during examinations.

Area MN104: Northwood Stop and Structures

- 13.55 Construction of the Northwood Stop, the Northwood Overbridge and the M50 bridge will cause some noise disturbance to the small number of scattered properties in the Santry Lodge area.
- 13.56 The Stop construction will follow the standard sequence for above ground Stops as follows. Site clearance, excavation, and construction of civil engineering structures will take about 6 months. This engineering phase will probably be followed by a pause as other parts of the Metro are constructed. The Stop fabric will then be completed with Metro systems installed, followed by commissioning. This latter stage will not involve high noise activities. Construction of the Northwood Stop is not expect to give rise to significant noise impacts.
- 13.57 Construction of the M50 Bridge is forecast to take about a year to complete and although ambient noise levels in the area are high ($L_{Aeq, period 60}$) mitigation will be needed to reduce impacts at the closest properties.

Area MN104: Dardistown Stop

- 13.58 Noise impacts are not expected.

Area MN103: Dublin Airport

- 13.59 Noise impacts are not expected within the airport. If the Halting Site on Naul Road is occupied during construction there may be disturbance during tunnel portal work that will take approximately 6 months to complete.

Area MN102: Swords Stop to Dublin Airport North Terminal

- 13.60 Construction of this route section includes the following works that will generate construction noise; the Fosterstown underpass, the Fosterstown Stop, the Pinnock Hill viaduct and at grade track works between.
- 13.61 The alignment follows the R132 and there are several groups of residential properties along the route. Traffic on the R132 leads to reasonably high

ambient noise levels ($L_{Aeq, period}$ 64-66 dB) which will tend to lessen the effect of construction noise, as discussed above.

- 13.62 The majority of works in this area, including stop construction and at-grade track works are not expected to create residual noise impacts after mitigation. Construction of the two main structures in this area, the Fosterstown underpass and the Pinnock Hill viaduct will create some disturbance at properties at the Nevistown Lane/Dublin Road junction and near the viaduct works including the Travelodge.

Area MN101: Swords Stop to Estuary Stop

- 13.63 Construction of this route section includes the following works that will generate construction noise; the Malahide underpass, the viaduct over Seatown and Estuary roundabouts, the Swords, Seatown and Estuary stops and at-grade track works. The Malahide South and Chapel Lane footbridges will be replaced which is likely to involve some work at night.
- 13.64 The alignment follows the R132 and there are several rows of residential properties along the route. Traffic on the R132 leads to reasonably high ambient noise levels (daytime $L_{Aeq, period}$ 63-63 dB) which will tend to lessen the effect of construction noise, as discussed above.

- 13.65 Stop construction and at-grade track works are not expected to create residual noise impacts after mitigation.
- 13.66 Demolition of the Malahide South and Chapel Lane footbridges may lead to residual noise impacts during a few nights at residential properties in Seatown Walk (South), Chapel Lane, and Foxwood. Construction of the bridges may lead to daytime noise disturbance at Ashley Grove and Foxwood.
- 13.67 Ashley Grove is also adjacent to a works compound but additional mitigation, including careful layout of the site, should prevent residual impacts.
- 13.68 Construction of the Malahide Underpass will create some noise disturbance, but its location within the R132 corridor should help make it possible to avoid residual noise impacts.
- 13.69 Construction of the viaduct north of the Seatown Stop will take a total of about a year, and will create some noise disturbance, but its location within the central reservation of the R132 will help to reduce residual noise impacts after mitigation, except perhaps at properties on Mantua Drive which are the closest to the structure.

Area MN101: Estuary Stop to Belinstown Depot

- 13.70 Construction of this route section includes construction of the at-grade track from the Estuary Stop to the Belinstown Depot, and construction of the Lissenhall Stop and the Depot facility.
- 13.71 The alignment passes through open fields, with background noise levels ($L_{Aeq, period}$ 53-60dB) affected by the traffic on the motorway. There are individual houses in the area, with the closest to the alignment being single properties at the R132 end of Ennis Lane, and to the south of the proposed Lissenhall Stop, and several houses on Batter Lane to the West of the Depot. The Emmaus Retreat Centre on Ennis Lane is to the West of the proposed

construction compound. Construction noise will cause some disturbance to these properties when the works are nearby.

13.72 The Lissenhall Stop will take about 6 months to construct. Noise impacts are expected at the property to the south of the Stop as the trackworks progress through this area but mitigation will ensure these are short-lived.

13.73 Construction of the depot will take about two years. There are several properties near the corner of Batter Lane adjacent to the depot who will be directly exposed to construction noise from the depot site. Standard mitigation techniques will prevent residual noise impacts during the majority of the depot construction works but some residual disturbance is likely during initial site levelling and earthworks in the western corner of the site closest to the properties.

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