**TRANSPORT AND WORKS ORDER ACT 1992**

**PLANNING (LISTED BUILDINGS AND CONSERVATION AREAS) ACT 1990**

**TRANSPORT AND WORKS**
**(INQUIRIES PROCEDURES) RULES 2004**

**THE NETWORK RAIL (ORDSALL CHORD) ORDER**

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# VOLUME 2: MAIN PROOF OF EVIDENCE

# NOISE AND VIBRATION

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## CONTENTS

## Table of Figures, Tables and Appendices

# 1. INTRODUCTION

## 1.1 Personal Details

1.1.1 My name is Alexander George Glendinning. I have a BSc in Mechanical Engineering and an MSc in Sound and Vibration Studies. I am a member of the Institute of Acoustics and a Chartered Engineer. I have specialised in noise and vibration for over thirty years and for the last twenty years have been working predominantly in the field of railway noise and vibration

1.1.2 I was author of the HS1 noise assessment and as part of this project was responsible for consultation with Local Authorities and local action groups on noise and vibration issues. I have worked within the railway industry, for Docklands Light Railway, and for the noise group at London Underground Ltd, where I was responsible for the development of a vehicle based track condition monitoring system, providing system wide noise reduction through identification of high levels of railhead roughness and misaligned track components.

1.1.3 I carried out the noise and vibration assessment of the West Coast Main Line (WCML) Modernisation and gave evidence at Public Inquiry. Subsequent work on the WCML included detail design of noise mitigation, provision of advice regarding construction noise, technical review of s.61 Applications, and final commissioning of noise mitigation. I am now working within the team that prepared the noise and vibration assessment for the Ordsall Chord Environmental Statement, on the preparation of the Environmental Statement for the Piccadilly and Oxford Road Scheme, and I thank the team for the support provided in the preparation of my evidence.

## 2. SCOPE OF EVIDENCE

2.1.1 The evidence I will present is concerned with one of the matters about which the Secretary of State for Transport has stated that he particularly wishes to be informed for the purposes of his consideration of the Transport and Works Act 1992: Proposed Network Rail (Ordsall Chord Order. That is, item 5 in the Statement of Matters, the likely impact (of noise and vibration) on residential and commercial interests, and the environment, during the construction and operation of the scheme, including impacts on residential properties in 127-133 Liverpool Rd, 1-25 Woollam Place, 2-36 Potato Wharf and 37 Potato Wharf.

2.1.2 The noise and vibration effects of the scheme were set out in the Environmental Statement (Volume 4.2 Chapter 10 and Volume 4.4). In the period following the submission of the ES, changes in the approach to construction, and assumptions regarding the operation of the railway have led to some changes, albeit non-significant, in the effects of noise and vibration on residents, in comparison with those presented in the ES. I will include discussion of these points in my evidence in 6.1.6 (construction noise) and 4.2.1 (operational noise).

2.1.3 Chapter 3 provides an explanation of the technical terms used in the measurement and assessment of noise and vibration, supplemented by a Glossary of Terms at the end of my evidence. I have also included a brief explanation of the manner in which railway noise and vibration is generated, which I hope will be a useful aid in understanding specific issues affecting

the calculation of noise generated by trains operating on the Chord and on the adjoining railway network.

2.1.4 In Chapter 4, I will summarise the methods that have been used for the calculation of construction noise and vibration, and operational noise and ground borne vibration and how they have been applied to the scheme. Legislation and guidance applicable to surface railways are described with noise and vibration criteria.

2.1.5 In Chapter 5 I will describe the existing noise and vibration environment found around the Ordsall Chord and the adjoining rail network, referring the to baseline noise and vibration studies set out in the ES.

2.1.6 In Chapter 6, the effects of the Application on the communities surrounding the Scheme, both in their homes, their places of work and the resources they may use are described, together with a review of the likely effects due to the construction noise on the closest residential receptors, and construction vibration effects. This draws together the evidence submitted as part of the TWA Application in the Environmental Statement Volume 4.

2.1.7 In Chapter 7, I review and address comments raised by Objectors to the scheme and Rule 6 Parties. If any more detailed or additional comments are raised subsequently I will deal with these by way of rebuttal evidence if required.

2.1.8 In Chapter 8, I will summarise my evidence, presented on behalf of Network Rail (the "Applicant"), the comments from the Objectors, and give my conclusions on the noise and vibration effects of the Application.

## 3. NOISE AND VIBRATION

3.1.1 Noise is often referred to as unwanted sound, which is itself the sensation produced through the human ear as a result of fluctuations in the pressure of the air. It is a form of energy that travels outwards from a noise source in a series of waves. The characteristics of these waves include sound pressure and frequency, which are perceived by the human ear as loudness and pitch.

3.1.2 The range over which the human ear responds to sound pressure or loudness is very large; the sound pressure level at the threshold of pain is over a million times that of the quietest audible sound. For convenience, therefore, a logarithmic scale of decibels (dB), based on a reference level of the lowest audible sound is normally used. The audible range of sounds lies between 0 dB (the threshold of hearing) to 120 dB (the threshold of pain).

3.1.3 Frequency or pitch refers to the rate at which pressure fluctuations occur and is expressed as cycles per second or Hertz (Hz). The human ear is most sensitive to frequencies between 1,000 and 5,000Hz, but can detect sounds in the range of 20 to 20,000Hz.

3.1.4 The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequencies to approximate the human response. This is achieved by using an ‘A’ weighted decibel reading, dB(A), which gives one of the best correlations with the perceived noisiness of rail and road noise.

3.1.5 There are several indices used to describe noise levels and these are explained in the Glossary of Terms at the end of my evidence.

3.1.6 The measure I will make most use of is the equivalent continuous sound pressure level, or LAeq,T (dB). Explained simply, this is the A weighted sound pressure level logarithmically averaged over a time period T. It is used extensively in the description of environmental noise as it takes into account variations in noise level over a period, and has been found to correlate well with community response to noise.

3.1.7 The decibel scale is logarithmic and noise levels do not add up in a simple arithmetic manner. As an example, two identical noise sources would add up to a total noise level 3 dB higher than each of the two sources. The human ear is also less sensitive to small decibel changes. A 10 dB change is perceived as a subjective doubling of noise. The noise level experienced in some common situations is given in Table 1.

**Table 1: Examples of Noise Levels**

| Noise Level, LAeq (dB) | Noise Source |
|---|---|
| 0 | Threshold of Hearing |
| 30 | Quiet bedroom at night |
| 40 | Whispered conversation at 2m |
| 50 | Conversational speech at 1m |
| 60 | Busy general office |

| | |
|---|---|
| 70 | Loud radio indoors |
| 80 | Lorry at 30 kph at 7m |
| 90 | Lawnmower at 1m |

Railway Noise

3.1.8 A primary source of railway noise is the vibration of the wheel and rail The vibration is generated by the effect of the relative roughness of the two surfaces as the wheel rolls over the rail, and causes the wheel and rail (and generally to a lesser extent the structure supporting the rail and even the vehicle body) to radiate noise. This is known as 'wheel rail' noise which increases with speed, and can be controlled by grinding of the rail head and maintenance of wheel roughness.

3.1.9 The levels of wheel roughness are influenced by train design. For example it is higher on motored axles and thus for both diesel and electrical multiple units, wheel rail noise levels will increase with number of driven axles. It is also higher on older trains using tread brakes, in comparison with modern passenger trains, which generally use disc brakes. In tread braking systems a brake block is applied directly to the wheel which has the effect of increasing the surface roughness of the wheel and increasing the level of wheel rail noise. In the ongoing studies following the ES it emerged that some of the rail vehicles currently operating on the Network around Ordsall Chord use these braking systems and the noise calculations I will set out in my evidence have been revised to take that into account.

3.1.10 One possible means of control of wheel rail noise at source is to install rail dampers, which work by reducing the active radiating length of the rail and reducing the total amount of vibrational energy in the wheel/rail system. This technique has been adopted by projects in the UK by Network Rail however it is less effective at low train speeds, when noise from the equipment that provides the motive power (usually referred to as ‘traction noise’) and the ancillary equipment will start to contribute to the overall railway noise levels. The ancillary equipment noise comes from compressors and heating, ventilating and air-conditioning systems. Generally, the level of noise from these sources is lower than that produced by the traction equipment.

3.1.11 Another form of railway noise, which can occur on tight radius curves, and which is relevant to operations on the network in the environs of Ordsall chord, is that of wheel squeal. This occurs because the normal wheel and rail profiles that provide the train `steering' are no longer adequate and the flange of the wheel may make contact with the rail, thus producing a squealing noise. However there is an increased probability of flange contact on curves with vehicles with specific design features, including vehicles with a high rotational bogie stiffness, or in the case of the Class 142 Pacer, which operates on the network at Ordsall, and has an acknowledged problem with wheel squeal, no bogie. In the ES a worst case approach has been taken in that is has been assumed that all vehicles will cause wheel squeal on curves and a correction, referred to as Schall 03 correction has been universally applied, and it has been necessary to include that assumption in my evidence. However I consider it likely that the problems

with wheel squeal on this section of the network are restricted to Class 142 passenger trains and some types of freight. The Class 142 trains are in the process of being phased out, though as yet there is no fixed data for their complete removal from the Manchester Network. Hence the use of the Schall Correction in this case will overestimate the noise impact, particularly at Castlefield Viaduct, where the track correction applied to take account of wheel squeal is 8dB.

3.1.12 Mitigation of wheel squeal and the accompanying high rates of rail wear is usually achieved by lubrication. The design of the Ordsall Chord scheme includes the implementation of a rail lubrication regime, both on the chord itself, and curves and switches and crossings on the adjoining network. Thus it is highly unlikely that wheel squeal will occur in future operation of the railway at Ordsall.

Road Traffic Noise

3.1.13 The roads surrounding the scheme will experience an increase in traffic volumes as a result of construction activities. Noise from roads will vary depending on several factors such as traffic volume, vehicle speed, the road gradient, and the road surface. Traffic noise experienced at receptors will also be influenced by distance, the nature of the intervening ground surface and the presence of obstructions.

3.1.14 Road traffic noise is not constant but varies from moment to moment. However, for assessment purposes it is necessary to arrive at a single figure estimate of the overall noise level. The index adopted by the Government to assess traffic noise is LA10,18hour defined between 06:00 and 24:00.

Construction Noise

3.1.15 During the construction period, properties may experience temporary noise due to construction activities. Construction noise at various levels includes activities such as vehicle movement, excavation, piling and the use of compressors.

3.1.16 Construction noise levels are calculated as equivalent continuous noise level averaged over a one-hour period (LAeq,1hr), and then subsequently averaged over a time period such as a 12-hour working day to give the LAeq,12hr.

Vibration Sources

3.1.17 Some construction activities can be a significant source of ground-borne vibration, which has the potential to cause concern at the nearest receptors. Operational railways will also transmit vibration into the ground which can affect nearby properties.

3.1.18 Vibration Dose Value (VDV) is a measure of the accumulated level of ground vibration over a period and, through the application of BS 6472, is the recommended index for assessing the likelihood of adverse comments from affected building occupants. VDV is sensitive to the peak values of vibration.

3.1.19 Peak Particle Velocity (PPV) is a standard measure of peak vibration that is used to assess the potential for damage to building structures.

# 4. CALCULATION AND ASSESSMENT OF CONSTRUCTION AND OPERATIONAL NOISE

## 4.1 Calculation and Assessment of Construction Noise

4.1.1 The methods I have made use of in my evidence for the calculation and assessment of noise from construction activities are set out in British Standard BS5228-1: 2009 'Noise and vibration control on construction and open sites'. The Standard offers alternative methods to assess noise effects, of which the 'ABC Method' is generally used for large railway intra-structure schemes. Construction noise levels are calculated as equivalent continuous noise levels averaged over a one-hour period (LAeq,1hr), and then subsequently averaged over a 12-hour working day to give the LAeq,12hr and assessed against the criteria in Table 2.

**Table 2: Assessment Category and Threshold Value**

| Evaluation Period | Assessment Category (dB LAeq.T) | | |
|---|---|---|---|
| | A | B | C |
| Night-time (23:00-07:00) | 45 | 50 | 55 |
| Evening and Weekends* | 55 | 60 | 65 |
| Daytime (07:00-19:00) | 65 | 70 | 75 |
| * 19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays.<br><br>Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.<br><br>Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as Category A values. | | | |

| |
|---|
| Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than Category A values. |
| The Category (A, B or C) is to be determined separately for each time period and the lowest noise category is then used throughout the 24-hour cycle, e.g. a site which is category A by day and category B or C in the evening and night will be treated as category A for day, evening and night. |

*Source: BS5228-1: 2009*

4.1.2 Ambient noise levels most properties in the study area, fall into Category B. and a construction noise level which exceeds the Category B thresholds for the day, evening or night-time periods is considered as a significant impact in noise level. I have rated the level of impact taking into account the amount by which the values for Category B presented in Table 2 are exceeded. Increases are rated as moderate, (<5 dB), high (5<15 dB) and very high (>=15 dB). For Category B this provides a rough equivalence to the actions required in the Scheme Noise and Vibration Policy I will refer to later. For example an impact rated 'high' would correspond to a weekday daytime level of 75-85dB LAeq,12hr at which, depending on duration, the Policy would recommend provision of secondary glazing, and an impact rated as 'very high' would correspond to the weekday daytime level of 85dB LAeq,12hr and above, at which, again depending on duration, the Policy would recommend temporary re-housing.

General Assumptions: Construction

4.1.3 Construction of the Chord will involve realignment of the existing track, the construction of new track and supporting structures within the scheme extents. Seven construction compounds are proposed in the area surrounding the Ordsall Chord.

4.1.4 Normal hours of work are expected to be Monday to Friday from 0800 to 1800 hours and on Saturdays from 0800 to 1300 hours with 30 minutes either side for setting up and organising / cleaning the site. Some of the construction activities are programmed to be undertaken outside normal hours of work during railway possessions for operational reasons. Other activities may also require scheduling out of hours. In all cases, consultation with the relevant local authority will take place. Reasons for out of hours working include:

- When equipment is required to run continuously for safety reasons.
- When activities require the closure of a major road or railway.
- Construction of a major railway structure. The areas where this is most likely are where works are required on or close to the operational railway.

4.1.5 Construction activities will need to be mitigated to minimise impacts on the local community. The Control of Pollution Act 1974 is the primary legislation used to control noise from construction sites. It recognises that a balance must be struck between constraints to the construction and impacts, and uses the concept of 'Best Practicable Means' for reducing construction noise. The Alliance[1] will follow the procedures set out in Chapter 10.8 of the ES and Section 9 of the Code of Construction Practice (CoCP) to mitigate noise from construction sites.

[1] For a definition of the Alliance refer to the proof of evidence put forward by Mr Pearson in Section 3.1.3 and accompanying footnote

4.1.6 For all construction activity the Alliance will apply to the local authority for 'prior consent' under Section 61 of the Act. In order to approve a 'Section 61 agreement' the local authority will generally require noise calculations, based on the contractor's chosen methods of working, in order to demonstrate that the best practicable means will be used. The consent then legally binds the Alliance to use those means, so the mitigation measures are enforceable. Applications will be made covering six months of activities. For further detail concerning the general management of noise and vibration on site and the Section 61 process, refer to Section 5 of the proof of evidence supplied by Mr Jim Pearson, Network Rail's Environment Manager.

## 4.2 Operational Noise

4.2.1 The method by which railway noise arising from operation of the Scheme is calculated and assessed is set out in Chapter 10 of the Environmental Statement (Volume 4.2: Main Statement) and my evidence largely follows that approach. However in Section 3.1.9 I have described some additional information which has been incorporated in the noise calculations, that being the inclusion in the current and future timetables of a proportion of noisier tread-braked rolling stock. Once again, this is rolling stock which is in the process of being phased out, and the proportion running in the future timetable is therefore smaller. The result of the change is to increase the calculated noise levels pre scheme and increase the levels post scheme but to a lesser extent, thus giving a reduction in the overall noise impact of the scheme in comparison with that originally presented in the ES. Taken as a

whole, the effect of the increase in calculated railway noise levels is offset by the reduction in the noise impact, and it is my assessment that at each relevant location the change will not result in a significant difference to the noise effects originally presented in the ES. In the assessment I have also sought to differentiate between the effects of noise on residential (e.g. dwellings) and non-residential receptors (offices, commercial premises).

4.2.2 Current Government Policy Guidance for noise is provided in the National Planning Policy Framework and the Noise Policy Statement for England. The Noise Insulation (Railways and other Guided Transport Systems) Regulations 1996' set out the requirement to provide noise insulation and I have summarised these below, with specific terms defined the Glossary of terms.

4.2.3 It will be required to provide noise insulation at an eligible building if during the daytime (06:00-24:00 hrs) the railway wayside noise levels following completion of the additional or altered works (relevant noise levels) are greater by at least 1dB(A) than the railway noise levels immediately prior to the altered or additional works (prevailing noise levels); and the relevant noise level is greater than or equal to 68dB (A), the noise caused by the movement of vehicles on the additional or altered works makes an effective contribution to the relevant noise level of at least 1dB(A).

4.2.4 Similar criterion are provided for the night-time (00:00-06:00 hrs) however the relevant noise level must be greater than or equal to 63dB(A);

Calculation of Railway Noise

4.2.5 Railway noise has been calculated using the method set out in the Calculation of Railway Noise (CRN) 1995, supplemented by information from Additional Railway Noise Source Terms For "Calculation of Railway Noise 1995", and for the most part using the assumptions and modelling inputs as set out in Chapter 10 of the ES. CRN is a semi-empirical model based on measurements of each train type expected to run on the Chord and surrounding lines. Calculations take into account the following:

- expected passenger and freight train service frequency;
- train types;
- expected train speeds;
- train lengths;
- track type (Continuously Welded Rail (CWR) or jointed);
- source correction for bridges, structures and cuttings; and
- gradients and likely areas of acceleration.

4.2.6 CRN does not however contain a method to account for wheel squeal which may occur on tight radius curves, as I mentioned in Chapter 3. The German method Schall 03 provides a means by which to account for wheel squeal within the overall level of noise. For a radius between 300m and 500m, a 3dB correction is added to the overall level. For a radius below 300m, an 8 dB correction is added to the overall level. These corrections have been applied to the operational noise levels (see paragraph 3.1.11).

4.2.7 Operational Noise Assessment Criteria

4.2.8 The impact of airborne noise on dwellings has been evaluated by considering the change in day and night-time railway noise levels (LAeq,18hr and LAeq,6hr ) at the worst affected façade, with a noise increase of greater than or equal to 3dB considered as a significant impact. The assessment has been made by comparing the noise levels in 2016, prior to the opening of the scheme, with those in 2016, following the opening of the scheme, assuming the highest train flows likely to occur in the fifteen year period following opening i.e. 2031

4.2.9 This approach is similar to that used for the noise assessment of previous railway schemes e.g. HS1 and WCML. The use of the 3dB threshold of noise change to identify significant noise impacts was used in each of these assessments

4.2.10 The semantic scale shown below in Table 3 has been used to rate the level of noise change, with for example, an increase in noise level of 3-5 dB being described as minor.

**Table 3: Operational Noise Criteria**

| Noise change (dB) | Impact Classification | Effect |
|---|---|---|
| Decrease of 3 dB or more | Significant decrease | Positive Effect |
| Change of less than 3 dB | Negligible | No Effect |
| Increase of 3-5 dB | Minor | Negative Effect |
| Increase of 5-10 dB | Moderate | |
| Increase of greater than 10 dB | Major | |

Operational Assumptions

4.2.11 The traffic flows for the Chord and the surrounding network are categorised by the network diagram in Figure 1, which repeats Figure 10.3 in the ES, and the flows on each section are summarised in Table 4 below.

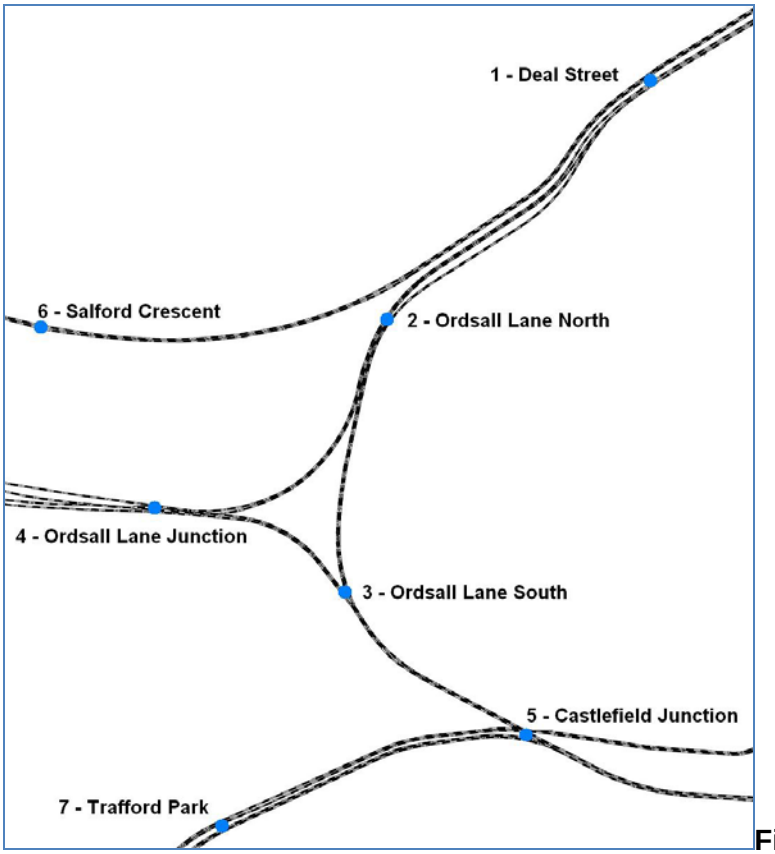


**Figure 1: Network Diagram**

| Section | | 2016 no Scheme | | 2016 with Scheme | | 2031 no Scheme | | 2031 with Scheme | |
|---|---|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night | Day | Night |
| 1 to 6 | Deal St Junction to Salford Crescent | 207 | 10 | 239 | 10 | 207 | 10 | 230 | 12 |
| 1 to 2 | Deal Street Junction to Ordsall Lane North | 57 | 10 | 278 | 24 | 57 | 10 | 368 | 22 |
| 2 to 4 | Ordsall Lane North to Ordsall lane Junction | 57 | 10 | 178 | 10 | 60 | 6 | 232 | 10 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 to 3 | Ordsall Lane North to Ordsall Lane South | - | - | 100 | 14 | - | - | 136 | 12 |
| 3 to 5 | Ordsall Lane South to Castlefield | 209 | 23 | 230 | 20 | 209 | 23 | 340 | 18 |
| 3 to 4 | Ordsall lane South to Ordsall Lane Junction | 209 | 23 | 130 | 6 | 209 | 23 | 204 | 6 |
| 5 to 7 | Castlefield to Trafford Park | 162 | 22 | 162 | 22 | 16 | 22 | 188 | 22 |

**Table 4: Train Movement Numbers with and without the scheme**

4.2.12 It can be seen from Table 4 that traffic flows in some areas are calculated to increase, some stay the same, and in one case decrease.

4.2.13 It is important to note that these changes are not solely the result of the construction and operation of the Chord. They are the outcome of the combined implementation of the Northern Hub capacity schemes and intensification of usage of the existing rail network. It is not possible to disaggregate the increase in flows due to the Chord itself and therefore in my in my evidence I have based my calculations on the total train flows above.

4.2.14 The calculations assume that the current situation (based on 2012 data) will remain the same in the opening year of 2016. They also assume that the rail network is kept in good working order, all trains operate as planned (for this section this means no stopping at signals) and that all trains run at the maximum line speed available (in this case 48 km/hr). In practice, the track speeds are unlikely to be realised at all times, and therefore the calculations represent a worst case situation.

## 4.3 Construction Vibration

Calculation Method

4.3.1 Methods for calculating vibration from construction activities which I use as the basis of my evidence are set out in Part 2 of the British Standard BS5228-2: 2009.

Assessment Method

4.3.2 The primary effects of construction vibration, usually quantified in terms of peak particle velocity (PPV) are two-fold. In order of increasing magnitude, it may initially cause adverse response from occupants of affected buildings, and at a much higher level, may cause cosmetic or structural damage to those buildings. Guidance with regard to both these effects is provided in BS5228-2: 2009 and threshold levels of vibration are set out below in Table 5.

| **Vibration Level (ppv)** | **Effect** |
|---|---|
| 0.14 mm/s | Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. |
| 0.3 mm/s | Vibration might be just perceptible in residential environments. |
| 1.0 mm/s | It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents. |
| 10 mm/s | Vibration is likely to be intolerable for any more than a very brief exposure. |
| 15 mm/s | Cosmetic damage to Un-reinforced or light framed structures, Residential or light commercial buildings |

| | |
|---|---|
| 50 mm/s | Cosmetic damage to Reinforced or framed structures, Industrial and heavy commercial buildings |

**Table 5: Assessment Category and Threshold Value**

4.3.3 The most effective mitigation to limit vibration activities is the selection of the most appropriate method, which balances the vibration impact against the time taken. Where significant impacts are calculated, a Section 61 application will be made as detailed previously.

## 4.4 Operational Vibration

Calculation Method

4.4.1 Levels of vibration arising from operation of the railway have been calculated using a semi empirical method, based on the measurements of existing levels of vibration reported in the ES. . The method takes into account the effect of the increase in timetabled traffic flows and changes in separation between the railway and vibration sensitive receptors.

Assessment Method

4.4.2 The effect of vibration at residential receptors has been rated using the criteria in Table 6, which have been derived specifically for the assessment of perceptible vibration from railway schemes, e.g. HS1, and is based on guidance set out in British Standard BS 6472: ‘Guide to evaluation of human exposure to vibration in buildings’.

| Description of Impact | No existing appreciable vibration | | Appreciable existing levels of vibration |
|---|---|---|---|
| | Vibration m/s1.75 (Daytime) | Vibration m/s1.75 (Night time) | % increase in VDV |
| Slight | >0.22-0.31 | >0.13 – 0.18 | >25% - 40% |
| Moderate | >0.31 - 0.44 | >0.18 – 0.26 | >40 – 100% |
| Substantial | >0.44 - 0.62 | >0.26 - 0.37 | >100 – 185% |
| Severe | >0.62 | >0.37 | >185% |

**Table 6. Evaluative Criteria: Operational Vibration**

## 4.5 Significance

4.5.1 I have considered the significance of noise and vibration effects arising from the construction and operation of the Ordsall Chord within the context of previous projects e.g. HS1 and WCML. The significance of effects on residential dwellings is related to both the number of properties that experience impacts within a community, and to the severity of those impacts. In the case of operational noise and vibration, I consider impacts on dwellings of minor and above to contribute significant effects. I have also considered the significance of noise effects on non-residential dwellings taking into account factors including the severity of the impact, the use of the building, and the quality of the resource.

4.5.2 In the case of construction noise and vibration, the temporary nature of noise and vibration exposure means that in determining the significance of noise and vibration effects on residential dwellings, the duration of the

activity must be taken into account in addition to the severity and number of properties. This also applies to non-residential properties.

4.5.3 In consideration of the duration of construction activities, a significant effect has been identified at a receptor where the noise change I have just described is calculated to occur on at least 10 days in any 15 consecutive day period or for a total of 40 days in a 6 month period. These duration criteria have been used previously for the assessment of significance of construction noise effects from railway schemes, including for example Thameslink programme. For further detail refer to Mr Pearson's proof of evidence.

## 5. BASELINE CONDITIONS

5.1.1 The existing ambient noise levels, as baseline surveys in the environs of the Scheme were reported in the ES. Noise levels are currently dominated by transportation noise consisting of road traffic on the surrounding road network, and rail movements on the existing lines, with a smaller contribution from over-flying aircraft. In addition activities at nearby construction currently sites are elevating the noise levels during the daytime at a few locations. I have carried out site visits to the area and I am familiar with the noise and vibration environment.

5.1.2 The railway is elevated throughout on a viaduct with a parapet wall, which serves to screen a reasonable degree of railway noise from properties at

ground level. However, there are large high rise buildings bordering the railway on which the upper floors will have direct line of sight to the railway.

5.1.3 In order to simplify the assessment, yet still report the worst case impacts of the scheme, the ES and my proof have made the following assumptions:

- The contribution of road traffic noise to the ambient noise level at each receptor have been ignored, and only rail noise is reported;
- Large buildings have been split into floors and facades rather than individual properties. This is because there are 4760 postal addresses in the 173 residential buildings within 300m of the scheme;
- When reporting worst case impacts for construction or operational noise, the highest noise level on a facade has been reported, but other locations within the same building will experience lower levels.

5.1.4 Existing levels of vibration measured at locations representative of those buildings nearest to the railway are currently below the level at which there would be a low probability of adverse comment, that is below the day and night-time threshold levels in Table 6.

## 6. SUMMARY OF ASSESSMENT OF EFFECTS

### 6.1 Construction Noise Assessment

6.1.1 Construction of the scheme is expected to take approximately two years, and whilst the majority of the activities will take place during normal working hours, night and weekend possessions will be required.

6.1.2 The assessment of construction noise in the ES considered the unmitigated construction noise activities only, which gives a worst case view of the likely noise impacts. The Alliance will be required to reduce construction noise as far as is practicable. Mr Pearson's proof of evidence details the management processes that will be in place to ensure this is the case.

6.1.3 The proximity of residential properties to the scheme, coupled with the need for night-time and weekend possession work to construct the scheme will lead to significant adverse impacts which cannot be avoided. Mitigation at source will be implemented under the s61 process to use best practicable means, but even then, it may be necessary to offer noise insulation and then temporary relocation for some occupiers, particularly for properties adjacent to Castlefield Viaduct and the southern most section of the Chord, including Liverpool Road, Woollam Place and potentially the old Potato Wharf.

6.1.4 In the ES the effects of construction were reported at selected NSR's which were considered to be representative of groups of properties likely to experience similar levels of effect. I retain this approach in my evidence and the receptors at which assessments have been made are set out in Figure 2 below.

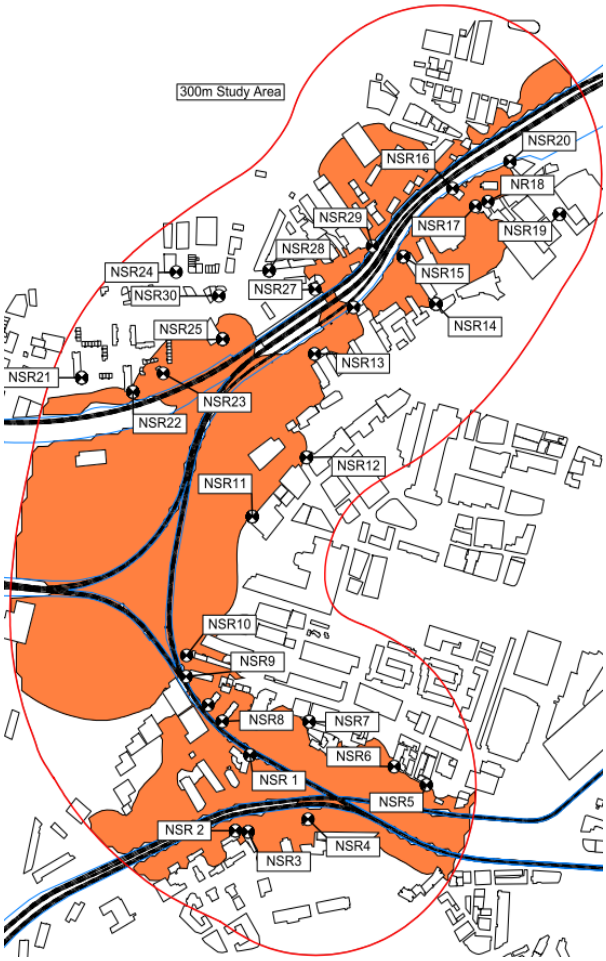


**Figure 2: Location of Noise Sensitive Receptors: Construction Noise**

6.1.5 The results of the construction noise calculation and assessment for weekday day and night-time periods are presented in Tables A1-A4 (Volume 3: Appendix A to my proof of evidence) for contiguous six month periods of construction. Whilst noise levels have been calculated at all the receptors in Figure 1, I have only presented results for those at which significant noise impacts have been identified. For ease of use, where a significant impact will occur at a receptor, construction noise levels have been highlighted according to the scale of impact, i.e. moderate, high and very high. As I explained earlier in paragraph 4.1.2, the latter two categories

correspond roughly to the levels at which, depending on the duration of the impact, noise insulation and separately if noise levels are very high temporary re-housing may be offered.

6.1.6 The results of noise calculations largely follow those presented in ES however additional calculations have been carried out for daytime construction of the extensions to the Castlefield viaduct in Period 1.

Period 1. c.1-6 months

6.1.7 Table A1 in Volume 3: Appendix A of my proof of evidence shows the construction noise levels for the first six months when the main civils activities include piling of the extensions to the viaduct. The majority of this work will be carried out on the south side of the viaduct. The archways though the viaduct will be screened off, which in combination with the structure of the viaduct itself, will provide protection for properties to the north of the viaduct in 127-133 Liverpool Rd. The exception to this is the piling of the bases for the three colonnades outside 133 Liverpool Rd apartments at which daytime noise levels will cause a high noise impact. These figures still represent a worst case, for, as I will explain later, it is now planned to use a much smaller (and quieter) piling rig in this location (and adjacent to the Youth Hostel) and piles will be finished using a hydraulic pile cropper rather then a hydraulic breaker as was assumed in the noise calculations.

6.1.8 At the rear of 127-133 Liverpool Rd apartments, screening is provided by a substantial boundary wall, and it is proposed to extend this by construction of a 2.5 hoarding between the wall and the viaduct, thus providing some

screening for 1-25 Woollam Place from ground level civils works at the base of the viaduct.

6.1.9 Under current proposals by the Alliance construction team, there is the potential to erect temporary barriers on new colonnades to the east of the Castelfield viaduct. It is also currently planned to utilise mobile noise screens for non-static noisy plant and equipment. These measures would aid in reducing predicted construction noise levels during the 10-day possession.

6.1.10 To the south of the viaduct, with the exception of the Youth Hostel, the nearest dwelling 37 Potato Wharf is c.80m from the railway and construction noise levels are consequently reduced.

6.1.11 The majority of construction noise effects during this period will be caused by night-time working during possessions. High to moderate noise impacts will affect all the dwellings overlooking the viaduct including 127-133 Liverpool Rd Apartments, 1-25 Woollam Place, 2-36 Potato Wharf, 37 Potato Wharf and the Youth Hostel. In total c. 120 dwellings will experience a night-time noise impact, which taking into account the severity and duration of the impact, would be a significant effect.

Period 2, c.6-12 months

6.1.12 Prior to the 2015 Christmas blockade, completion of the Castlefield viaduct will require work to be carried out during night-time possessions. Activities will include demolition of the existing parapet, lifting in pre-cast sections of parapet and fitting OLE brackets and structures. During the Christmas

blockade (10 days) 24 hour working will take place which will give rise to very high and high noise impacts at c.120 dwellings overlooking the Viaduct, including 127-133 Liverpool Rd Apartments, Woollam Place, 2-36 Potato Wharf, and 37 Potato Wharf, which would be considered a significant effect. A temporary noise barrier will be erected under current proposals where possible inside the existing parapet wall to minimise these noise effects during the 10-day possession, however with this in place, there would still be a significant effect. It is highly likely that through the implementation of the Noise and Vibration Policy, residents would be offered re-housing during this period. Refer to Mr Pearson's proof of evidence for the detail of the Noise and Vibration Policy that will broadly be compliant with the Thameslink policy currently being implemented. Night-time noise levels at the Youth Hostel, and Commercial and Castlefield Hotels during the possession may cause sleep disturbance to occupants of rooms overlooking the railway. A moderate night-time impact would occur at the Marriott Hotel though this would be unlikely to affect its usage.

Period 3 c.12-18 Months

6.1.13 During this period construction activities will include erection of OLE structures on Middlewood Viaduct and track work, taking place over weekend possessions including night-time working. Civlis work will include daytime works on the Trinity Way and River Irwell bridge structures, and completion of the widening of the Middlewood viaduct, of which some of the latter must be carried out under possession including night time working. To

a lesser extent there will be night-time works on Castlefield viaduct completing trackwork and installing cabling.

6.1.14 As a result, of these activities, very high night-time noise impact will occur at Arthur Millwood Court (NSR 22) and at nearby Canon Hussey Court, thus affecting c.110 dwellings with windows in the affected facades. At the same time, high night-time noise impacts will occur at the dwellings (c.50) adjacent to these buildings in Rodney Street, thus in total c.160 dwellings will experience night-time noise impacts in this area, which is considered to be a significant effect. Further towards Salford Central dwellings on Chapel Street overlooking the railway will also experience high to moderate night-time noise impacts. Dwellings around the Castlefield viaduct will also experience very high to moderate night-time noise impact, though of a lesser duration in than in the previous 12 months of working.

6.1.15 During this period, noise levels at the Marriott Hotel will give rise to a high noise impact and occupants may experience sleep disturbance. Similarly occupants of the Youth Hostel at Potato Wharf are very likely to experience sleep disturbance and the usage of both these facilities may be compromised during this construction period.

Period 4 c.18-24 Months

6.1.16 Principal construction works during this period include the completion of the Trinity Way overbridge and the River Irwell Bridge. These structures are sufficiently are at sufficient distance from nearby receptors that there will be no noise effects during daytime working, Noise impacts are therefore restricted to the night-time period, resulting from possession works. A very

high night-time noise impact will occur at Arthur Millwood Court (NSR 22) and a high impact will occur at nearby Canon Hussey Court, thus affecting c.110 dwellings with windows in the affected facades. High to moderate night-time noise impact will occur at Left Bank affecting c.35 dwellings thus in total c. 145 dwellings will experience night-time noise impacts.

6.1.17 During night-time possession works noise levels at the Marriott Hotel will give rise to a high noise impact and occupants may experience sleep disturbance.

Construction Road traffic

6.1.18 Materials, personnel and equipment will need to be transported to and from the work sites during the construction of the scheme. The largest increase in traffic flows on the nearby roads resulting from these movements is less than 10%. This will produce a noise change at properties adjacent to these roads of c.0.3 dB, which would not be considered a significant impact, and hence noise from construction traffic will not cause a significant effect.

## 6.2 Construction Vibration Assessment

6.2.1 The construction activity most likely to cause increased levels of vibration at sensitive receptors is piling. Two different methods of piling are currently proposed at different locations, as follows:

- Auger Bored – BG12H Piling Rig or Klemm 906
- Vibratory – PTC/ICE Vibro Hammer + Hydraulic Pack

6.2.2 Auger bored piling will be used at the Castlefield Viaduct, Nikal Car Park and the Middlewood Viaduct, whilst the vibratory piling rig will be used for piling carried out in the River Irwell and surrounds.

6.2.3 Auger bored piling will produce less vibration than other available methods such as percussive or vibratory piling rigs. BS 5228-2 provides a summary of data on vibration levels measured during rotary bored piling. The continuing review of the construction programme has shown that due to limited access, a smaller rig must be used (Klemm 906) adjacent to properties in 133 Liverpool Rd and the Youth Hostel, which will give lower levels of vibration in comparison with those reported in the ES.

6.2.4 The calculated PPV at the nearest property (133 Liverpool Road) which is c. 2.5m from piling activities on the base of colonnade 125 at Castlefield Viaduct is 1.5 mms-1. The calculated PPV from piling activities in/ on the River Irwell is 1.7 mms-1.

6.2.5 Using the criteria in BS 6472, adverse comment would be probable from residents at 133 Liverpool Road for the short period whilst piling is being carried out immediately adjacent to the building. At the Youth Hostel the nearest pile is c. 7m away, resulting in a lower calculated ppv of 0.35 mms-1 which whilst it will still be perceptible, there would be a low probability of adverse comment. The calculated levels of vibration at both these properties are well below those that are likely to cause cosmetic damage.

## 6.3 Operational Noise Assessment

6.3.1 The results of operational noise calculation for residential and commercial properties are set out Volume 3: Appendix B:Table B1: Operational Noise Assessment: Residential and Volume 3: Appendix C: Table B2: Operational Noise Assessment: Commercial respectively. The accompanying noise assessment plans, Figures B1-B3 and Figures B4-B6 for the day and night-time periods can be reviewed in Volume 3: Appendix D and Appendix E of my proof of evidence respectively. Both the Tables and Plans are coloured to indicate levels of noise change, though the plans only show noise effects at residential buildings. Each building at which noise calculations have been carried out is identified on the plans by a building number (e.g. B1442), which corresponds to the number in the first column of the Tables. The plans have been prepared to show a worst case in that the colouring indicating calculated noise change at each building represents the highest noise change on the worst affected façade of the building, thus in the case of multi-storey flats, dwellings on other floors, or on other facades of the building will often experience lower levels of noise change.

6.3.2 I will describe the operational noise effects by area, starting from Castlefield Viaduct, moving in an anticlockwise direction around the scheme.

<u>Castlefield Viaduct (Figure B3 daytime and Figure B6 night-time)</u>

6.3.3 Residential properties around Castlefield viaduct include (B1182) 133-127 Liverpool Rd, (B1181) 1-25 Woollam Place, (B1180) 1-36 Potato Wharf, (B1177 & B1176) 117 & 119 Liverpool Rd, (B1220) 37 Potato Whart and (B1219) flats under construction. In total c.120 dwellings will experience a

minor increase during the daytime as a result of the increase in traffic flows. Some of these will experience a decrease in rail noise during night-time as a result of the reduction in freight movements on this section of the railway. Though the daytime noise increase is minor, taking into account the number of dwellings this will be a significant effect on this area.

6.3.4 The design in this area already includes mitigation in the form of absorbent treatment to the inner face of the new parapet walls. The noise calculations at this location include corrections of c.8dB and c. 3dB to allow for wheel squeal however mitigation of this mode of noise generation will be incorporated in the form of track lubrication, and taking this into account the noise increases at dwellings in the area would not be significant and the residual effect on the area is unlikely to be significant.

Non-Residential Receptors-Castlefield Viaduct

6.3.5 There will be a minor increase in daytime noise levels at the Youth Hostel however this will be mitigated as described above. Night-time noise levels will show a significant decrease which may result in a reduced risk of sleep disturbance for users of the Hostel. Day time and night noise levels at the facades of the Commercial and Castlefield Hotels will show similar changes. The minor increase in daytime noise level at the façade of the MOSI would not affect usage of the internal building space, and once again the calculated increase will be mitigated.

River Irwell, East Bank (Figure B2 daytime and Figure B5 night-time)

6.3.6 Dwellings on the east bank of the River Irwell overlooking the railway include Left Bank Apartments (B1263, B1264), and Century Buildings

(B1317). Noise levels at each of these buildings will show moderate and minor increases for the daytime and night-time periods respectively, which result from intensification of traffic on the existing railway through the centre of Salford, including an increase in night-time freight movements, and the addition of the new track to the south of Salford Central Station. Taking into account the number of individual dwellings within these apartments (c.95) I would consider this to be a significant effect. However, the combination of distance of the buildings from the railway and the contribution to ambient noise levels from road traffic on Trinity Way and Chapel Street makes the assessment very much a worst case.

Non Residential Receptors- River Irwell, East Bank

6.3.7 Noise levels at the Marriott Hotel (B1161) are calculated to show a moderate increase during the daytime, but no significant change during the night-time. There are a combination of public and commercial buildings on the east bank of the river including The Peoples' History Museum, Cardinal House, Alberton House; and the Granada TV Buildings.

6.3.8 Railway noise levels at the facades of these buildings are calculated to show moderate or minor noise increases during the daytime, however the usage of these building, in respect of the internal spaces, would not be affected. The comment I made above regarding the limitations of the assessment at this location also applies to these buildings, and the calculated change in noise levels is very much a worst case.

West Bank of Irwell: bounded by Blackfriars Rd, Chapel St. & New Bailey St. (Figure B1 daytime and Figure B4 night-time)

6.3.9 The area of Salford to the west of the Irwell and to the south of the railway bounded by the roads above contains several high and medium rise residential buildings which overlook the railway including:

- (B1246) and (B1249) Textile Apartments, (B1250) 1-28 The Gallery, (B1306) 29-53 The Gallery, (B1308-B1310) 10-275 The Edge, (B1255) Barnfield House Apartments, (B1015) The Bridge Apartments, and (B1009) Bayley Apartments

6.3.10 These dwellings are calculated to experience moderate to minor noise increases during the day and mostly minor increases at night, resulting from intensification of rail traffic on the existing railway through Salford. Similar noise changes will occur at residential accommodation within the Black Lion (B1248) and the Rovers Return (B1243). On the lower floors of buildings directly overlooking Chapel Street and Blackfriars Rd, road traffic noise will make a substantial contribution to ambient noise levels and in these locations the assessment is very much a worst case. However taking into account the number of dwellings with in the area (c 360) this is a significant effect.

6.3.11 Non residential properties

6.3.12 Non residential properties include (B1255) Barnfield House Units 1 To 3, (B1325) Warehouse, (B1016) HMRC Offices, Trinity Bridge House, and Ralli Courts.

6.3.13 Railway noise levels at the facades of these buildings are calculated to show moderate or minor noise increases during the daytime, however the usage of these building, in respect of the internal spaces, would not be affected. At Ralli Courts a major increase in noise level has been calculated, however the implementation of the track lubrication system will mitigate this effect and the use of the buildings as office space will not be affected.

Area bounded by Blackfriars Road, Viaduct St. and Gravel Lane (Figure B1 daytime and Figure B4 night-time)

6.3.14 The area to the north of the railway bounded by the above streets also contains several high and medium rise residential buildings which overlook the railway including: (B1058-1061) Spectrum Apartments and (B1257) Abito Apartments.

6.3.15 There is considerable variation in noise change over the height of these buildings and during the day time moderate noise increases will be experienced on the upper floors, with minor increases on the lower floors, resulting from intensification of rail traffic on the existing railway through Salford. During the night-time period there will be a minor increase in railway noise level. However taking into account the number of dwellings (c.840) with in the area this is a significant effect.

6.3.16 The noise assessment plans show minor and moderate increases at dwellings to the west side of the inner relief road, Trinity Way. Given the distance from the railway and the contribution to ambient noise levels from

road traffic noise these calculated changes in railway noise are unlikely to give rise to noise effects at these locations.

Non-Residential Properties

6.3.17 There are several commercial buildings in this area on Kings Street at which minor noise increases will occur, but these changes would not affect the usage of the buildings.

Area bounded by Chapel Street, Trinity Way and Blackfriars Road (Figure B1 daytime and Figure B4 night-time)

6.3.18 Once again, the area to the north of the railway bounded by the above streets contains several high and medium rise residential buildings which overlook the railway including:

- (B1048 & B1049) Quebec Building Apartments, (B1294) Fresh Apartments, (B1028) Chapel Street Flats, (B1020 & 1022) City Point Apartments and (B1034) Model Lodging House Apartments

6.3.19 These dwellings are calculated to experience moderate/minor noise increases during the day and mostly minor increases at night, resulting from intensification of rail traffic on the existing railway through Salford. However taking into account the number of dwellings (c.520) within the area this is a significant effect.

6.3.20 The noise assessment plans show minor and increases at dwellings to the west side of the inner relief road, Trinity Way in this area. The combination of distance from the railway and the contribution to ambient noise levels

from road traffic noise makes it highly unlikely that these calculated changes in railway noise will give rise to noise effects at these locations

Non-Residential Properties

6.3.21 There are several commercial buildings on Blackfriars Road at which minor noise increases will occur, but these changes would not affect the usage of the buildings. A minor noise increase will also occur at the majority of the commercial units in the nearby Brewery Yard/Deva Centre however the function of the units will not be affected. Manchester City College of Technology (B1069) directly overlooks the railway but will only experience a minor noise increase on the second floor, and the usage of the building will not be affected.

Area bounded by Chapel Street and East Ordsall Lane (Figure B2 daytime and Figure B5 night-time)

6.3.22 Residential properties affected by the operation of the Chord in this area comprised of a mixture of traditional two storey buildings in Rodney St et al. and medium rise apartments, the latter including (B1096) Cornwall House, (B1100) Edinburgh House and (B1140) Chapel Point.

6.3.23 With the exception of Chapel Point, at which a moderate noise increase has been calculated, dwellings will only experience a minor increase in noise levels during the daytime, and no significant change during the night-time period. However taking into account the number of dwellings affected (c.70) this would be considered a significant effect.

## 6.4 Operational Vibration

6.4.1 At Castlefield Junction the new alignment of the chord comes within c.2.5m of the Apartments at 133 Liverpool Road, the closest residential building. The combination of the new position of the railway closer to the building and the increased traffic flows will result in an increase in levels of vibration during the daytime and night-time, however future levels would still be below the level described as ‘slight’ using the criteria in Table 6.

6.4.2 Vibration levels at the Youth Hostel on the south side of the railway would remain below 0.22ms-1.75 and 0.13ms-1.75 (i.e. below the level described as ‘slight’ using the criteria in Table 6 during the daytime and night-time periods respectively, and future operation of the chord would not give rise to adverse vibration effects.

## 6.5 Mitigation

Construction Phase

6.5.1 The management of construction noise and vibration, which includes all reasonable efforts to minimise construction impacts is set out in the CoCP in Section 9 of that document. As a minimum, this will include the maintenance and operation of a noise and vibration management plan. Details of how this would work are contained in the evidence of Mr Jim Pearson.

6.5.2 Current proposed methods to mitigate noise and vibration impacts in line with best practice management have been detailed previously in my proof of evidence and include:

- The use of a smaller and quieter piling rig (Klemm 906) than reported in the ES, in the vicinity of 133 Liverpool Road apartments (Section 6.1.7)
- The current proposed use of a hydraulic pile cropper rather than a noisier hydraulic breaker as assessed in the ES, in the vicinity of 133 Liverpool Road apartments (Section 6.1.7)
- The potential to include a vertical extension of an external boundary wall to offer added protection particularly to 1-25 Woollam Place apartments (Section 6.1.8)
- The potential to insert a temporary noise barrier on the inside of existing parapet walls to serve as a vertical extension of the Castlefield viaduct for added protection during the 10-day possession (Section 6.1.12)
- The potential to erect a temporary noise barrier on the new colonnades east of the Castlefield viaduct that are required for the southern section of the Ordsall Chord for protection particularly of residents in 127-133 Liverpool Road apartments from high noise levels during the 10-day possession (Section 6.1.9)
- The potential to use mobile noise barriers around particularly noisy plant if on further assessment temporary noise barriers are considered not to be wholly effective at reducing predicted noise levels (Section 6.1.9)
- The use of the smaller Klemm 906 piling rig will reduce predicted vibration levels at 133 Liverpool Road apartments (Section 6.2.3)

6.5.3 The measures outlined in Section 6.5.2 will all be aimed at reducing the higher noise predictions outlined in my proof of evidence and it should be

noted that this process of reducing predicted noise and vibration levels is ongoing as part of the Alliance construction detailed design remit.

Operational Phase

6.5.4 Due to the elevated nature of the scheme in such a built up area, options to mitigate the operational noise are limited. The route already benefits from the parapet walls which screen receptors where line of sight to the railway is broken, i.e. those which are at or below the level of the parapet walls.

6.5.5 In order to mitigate operational noise effects, the scheme design incorporates the application of absorptive treatments to the inside face of new parapet walls in critical locations where it is feasible to accommodate without additional changes to the existing infrastructure. Such treatments can provide up to 3 dB of additional attenuation where installed, depending upon the relative geometry of the track in relation to nearby dwellings.

6.5.6 It is impracticable to provide any additional noise barriers on the Chord as these would interfere with line of sight for signalling and impose increased wind loads onto the structure. Furthermore, they would provide little benefit for upper floors of the surrounding buildings.

6.5.7 The proposed mitigation of wheel squeal on the chord and adjoining railway by means of implementation of track lubrication system is discussed in paragraph 3.1.12.

6.5.8 A study of the effectiveness of rail dampers to mitigate railway noise levels from the new track on the Chord is currently underway and I hope to be able to report the outcome of this study at Inquiry.

## 7. RESPONSE TO SCHEME OBJECTIONS

7.1.1 In this Chapter I review and address comments raised by Objectors to the scheme and Rule 6 Parties. If any more detailed or additional comments are raised subsequently I will deal with these by way of rebuttal evidence if required.

7.1.2 Objectors to the scheme are located in the areas close to and including Water Street, Liverpool Road, Potato Wharf and the Scarborough Development area, and range from residential to commercial users. Where the response is covered within my proof, I will refer back to section 6.1 for construction noise, 6.2 for construction vibration, 6.3 for operational noise, 6.4 for operational vibration, and 6.5 for scheme mitigation.

7.1.3 Objections have been received from residents in 127-133 Liverpool Road from Zoe Colver (Obj 11), Phil Marley (Obj 13), Simon Smith (Obj 18), and Mike Walling (Obj 21). Their concerns relate to the level of detail provided in the Environmental Statement and the level of noise and vibration impacts from construction and operation of the Chord. Residents in this building were considered in the ES using NSR9 for both construction and operation, although this was the worst affected part of the building, and therefore represents a worst case.

7.1.4 In relation to construction impacts, I have given consideration to more recent information about the construction program in section 6.1 of my proof, and the evidence of Jim Pearson describes how construction impacts will be

managed, the physical mitigation that can be provided, and how the process for the provision of noise insulation and temporary re-housing would work.

7.1.5 For operational impacts, I have provided in Appendix B a complete listing of operational noise changes by building within the study area, and Building B1182 covers 127-133 Liverpool Road, providing the data for second and third floors on their respective facades. The change in operational vibration is listed specifically for 133 Liverpool Road in section 6.4. Here vibration levels are calculated to increase as a result of the reduced separation between the building and the railway, though the future level is below that described as slight and this would not be considered to be an impact.

7.1.6 A similar objection has been received from Angela Chung (Obj 35), at 1-25 Woollam Flats in relation to operational noise. Her Building, listed as B1181 in Appendix B of my proof will be subject to similar noise and vibration effects as for Objectors 11, 13, 18 and 21 above.

7.1.7 An objection in relation to operational and construction noise was received from Chris Hanson (Obj 10) from a residential property in 37 Potato Wharf Road. The response in relation to construction noise is as per the previous objection. Mr Hanson is also concerned about noise from operation. His Building is listed as B1220 in Appendix B of my proof, which reports a slight decrease in noise at night. This is due to the changes in flows on the various railway tracks which contribute to the overall noise level at this building, most of which show a decrease at night.

7.1.8 An objection has been made by Objector Number 14 (MOSI) who raised concerns in relation to noise and vibration from construction and operation. In relation to operational noise impacts, the closest building of MOSI to the scheme is represented by building NSR10 and in Appendix B of my proof by Buildings B1170, 1171 and 1172 I have discussed operational effects in Section 6.3.5 of my evidence.

7.1.9 A detailed study of the vibration impacts on MOSI was undertaken in August 2013. Since this study there have been changes to the piling equipment likely to be used on the nearest colonnades to MOSI, which I referred to in 6.2. The use of a smaller piling rig will reduce the calculated vibration levels previously reported.

7.1.10 Notwithstanding this comment, the contractor's will implement all best available techniques to minimise the effects of vibration from the proposed works. A revised assessment of the likely vibration impacts would be made once a contractor is appointed, and the proposed methods agreed.

7.1.11 Scarborough Estates (Obj 16) have raised concerns relating to noise impacts for the proposed site. It is not possible to calculate exact levels for a new residential development without details of the layouts, but it likely that any proposed residential dwellings can be set back sufficiently from the operational lines that satisfactory residential noise levels can be achieved through appropriate design when a detailed planning application is made by Scarborough Estates.

7.1.12 The Youth Hostel (Obj 19) has objected to high impacts from construction and operation. Construction impacts will be as per the response to Objection 10. Operational Noise effects were reported and are represented by Building B1210 in Appendix B of my proof. I have also discussed them in detail in Section 6.3.5

7.1.13 A general objection was received from Cllr Joan Davies (No.28), representing residents on Water St and Liverpool Rd. The concerns have been covered above in relation to specific objectors in those properties.

## 8. CONCLUSION

8.1.1 In my evidence I have calculated and assessed the noise and vibration effects which will arise from the construction and operation of the Ordsall Chord.

8.1.2 Noise from the construction works on the Ordsall Chord will give rise to significant effects throughout the two year construction period

8.1.3 At Castlefield Viaduct the majority of construction noise effects will be caused by night-time working during possessions. Very high to moderate noise impacts will affect the c.120 dwellings overlooking the viaduct including the 127-133 Liverpool Rd Apartments, 1-25 Woollam Place, 2-36 Potato Wharf, 37 Potato Wharf and the Youth Hostel. It is highly likely that through implementation of the Noise and Vibration Policy, residents in this area would be offered noise insulation and dependant on higher noise levels potentially re-housing at some point during the construction. Mitigation will

be provided for some of the works by way of temporary barriers within the parapet wall however with these in place there are still likely to be significant night time noise effects.

8.1.4 As construction activities move away from the dwellings adjacent to the viaduct, and away from the operating railway, more work can be carried out during the daytime, however night-time possession work is still required, during which c.200 dwellings overlooking the railway will experience noise impacts.

8.1.5 These include Arthur Millwood Court, Canon Hussey Court, and dwellings in Rodney Street, and towards, Salford Central dwellings on Chapel Street.

8.1.6 This assessment is however very much a worse case and takes no account of the mitigation that will be achieved by provision of hoardings, mobile noise barrier, and selection of low noise plant.

8.1.7 There are no significant construction vibration effects. The review of plant taking place as part of the development of the construction programme has led to selection of a smaller piling rig which will give reduced levels of vibration at adjacent dwellings in 133 Liverpool Road compared with those reported in the ES.

8.1.8 In total, changes in railway noise levels accompanying operation of the Ordsall chord will give rise to moderate and minor noise impacts during the day time at c.2000 dwellings. During the night-time the noise impacts are predominantly minor and at a reduced number of dwellings. This is

considered be a significant effect on both the separate areas around the and as a whole on the community of Salford.

8.1.9 However It is important to note that, firstly at the majority of the properties considered in my evidence, these changes are not solely the result of the construction and operation of the Chord. They are the outcome of the combined implementation of the Northern Hub capacity schemes, and intensification of usage of the existing rail network. Secondly, in my view, this is very much a worst case assessment, based on the change in levels of railway noise rather than the change in overall ambient noise level. At dwellings which are not adjacent to the railway, road traffic noise will make significant contribution to ambient noise levels and the effect of a change in railway noise is therefore lessened. This has the effect of reducing the footprint of the scheme in terms of its noise impact, and hence the number of dwellings at which noise impacts will actually occur.

8.1.10 Noise impacts are also calculated to occur at commercial and non residential properties with the environs of the scheme, however taking into account the usage of these, no significant effects have been identified.

8.1.11 Mitigation will be provided in the form of a track lubrication system to be implemented on the Chord and adjoining network and this, in combination with the provision of absorbent treatment of selected new parapet walls is likely to eliminate the noise effects at identified at Castlefield Junction. It will also mitigate the noise impacts, though not to the same extent, around Salford Central station, where a correction has been included in the

calculations to allow for wheel squeal, which the lubrication system will prevent.

8.1.12 There are no significant vibration effects calculated to arise from the operation of the Chord. Levels of vibration at dwellings nearest to the railway at 133 Liverpool Rd will increase due to the new position of the railway closer to the dwellings and increased traffic flows, however the calculated future levels are not significant.

## 9. WITNESS DECLARATION

***I hereby declare as follows:***

(i) This proof of evidence includes all facts which I regard as being relevant to the opinions that I have expressed and that the inquiry's attention has been drawn to any matter which would affect the validity of that opinion.

(ii) I believe the facts that I have stated in this proof of evidence are true and that the opinions expressed are correct: and,

(iii) I understand my duty to the inquiry to help it with matters within my expertise and I have complied with that duty.

## 10. GLOSSARY OF TERMS

### Noise and Vibration

### Noise and Vibration

| | |
|---|---|
| A-weighting | a weighting network used in acoustic measurements to represent the frequency response of the human ear |
| ambient noise level | totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far. In the context of this study it is measured in $L_{Aeq,T}$ |
| background noise level | the A-weighted sound pressure level of the residual noise that is exceeded for 90% of the time period |
| decibel | the unit normally employed to measure the magnitude of sound- on a logarithmic reference scale |
| equivalent continuous sound | the steady sound pressure level which has the same energy level as a time varying sound signal when averaged over the same time interval, written as $L_{Aeq,T}$ |

| | |
|---|---|
| $L_N$ | the noise level exceeded for N% of the measurement period, e.g. L90, L50 |
| PPV, peak particle velocity | measure of the peak vibration level, in mm/s |
| Sound level meter | an instrument for measuring sound pressure level |
| Sound pressure level | measure of the sound pressure at a point, in decibels referenced to $2e^{-5}$ Pascals |
| Sound power level | the total sound power radiated by a machine, in decibels referenced to $10^{-12}$ Watts |
| Vibration dose value | The fourth root of the time integral of the fourth power of the fourth power of the frequency-weighted vibration velocity. The frequency weightings are specified in BS 6841: 1997 and BS6472:1992. The units are $ms^{-1.75}$ |

## 11. RAILWAY TERMINOLOGY

Ancillary Equipment is the equipment installed on a train to operate systems other than the traction equipment. This can include the brakes and the air-conditioning system.

Ballast is the layer of stones around the sleepers. It provides some resilience for the track and is used to maintain the level and alignment of the track.

Bogie is a frame attached under the body of the train on which two or more wheel sets are mounted. It is able to rotate and thus allow the wheels to follow the track around curves without contact between the wheel flanges and the rail.

Coach is a railway vehicle, which may or may not be powered, used to carry passengers. It is a term most commonly used for unpowered vehicles. In some cases, parcels and mail carrying vehicles that are based on passenger carrying vehicles are referred to as coaches.

Diesel Multiple Unit (DMU) is a multiple unit that uses diesel engines to provide the traction power which is generally transferred to the wheel by a hydraulically or electrically or mechanically.

Electrical Multiple Unit (EMU) is a multiple unit that uses electrical power taken from either an overhead line or an additional rail or rails.

Locomotive is a separate vehicle, which does not carry passengers and which provides the motive power for the whole train.

Multiple Unit is a fixed formation train where the power is provided by vehicles that also carry passengers. The traction equipment may be installed on a number of vehicles in the train. Most modern passenger trains are of this type.

Power Car — see locomotive. Commonly used where the locomotive is part of a fixed formation train.

Railhead is the upper part of the rail. The top surface of the railhead forms part of the running surface in contact with the wheel.

Rolling noise is the noise generated by moving vehicles, produced by the wheels running over the track surface, often referred to as wheel rail noise.

Sleepers are the concrete, wooden or steel elements that support the rails and keep them apart.

Traction Equipment is all the equipment on the train associated with providing the traction power. This may include diesel engines, cooling fans, electric motors and hydraulic pumps.

Trailer Car is a passenger coach that is unpowered. Usually used for coaches in fixed formation trains.

## 12. NOISE INSULATION REGULATIONS: DEFINITION OF TERMS

‘Eligible buildings’ are defined in the Regulations as building or part of a building within 300m metres of the additional or altered works which is either a dwelling or a building used for residential purposes.

‘Additional works’ are defined as railway track that is installed alongside existing track, whilst ‘altered works’ are defined as track that is ‘relocated in either the horizontal or vertical plane, otherwise than as a result of re-ballasting, remodelling or renewal of the permanent way’.

Remodelling is defined as ‘relocation of trackwork within lateral limits constituted by the outer running rails of the outermost tracks of a set of tracks’.

‘Prevailing noise levels’ are the railway wayside noise levels that occur immediately before the construction of initial works or the carrying out of altered works.

‘Relevant noise level’ is the equivalent noise level that occurs on completion of the works.

## 13. WITNESS DECLARATION

***I hereby declare as follows:***

(i) This proof of evidence includes all facts which I regard as being relevant to the opinions that I have expressed and that the inquiry's attention has been drawn to any matter which would affect the validity of that opinion.

(ii) I believe the facts that I have stated in this proof of evidence are true and that the opinions expressed are correct: and,

(iii) I understand my duty to the inquiry to help it with matters within my expertise and I have complied with that duty.