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13.1 Introduction

13.1.1 *Approach to the Assessment*

This assessment considers the potential noise and vibration impacts associated with the proposed Eastside development. The following steps have been taken for this assessment:

- The existing noise climate at sensitive receptors around the site has been established through an ambient noise survey;
- Noise emission levels have been predicted for the construction phases of the development using the calculation methodology set out in British Standard 5228 *Noise and vibration control on construction and open sites*;
- The predicted construction noise levels have been assessed against the existing ambient and absolute noise levels; as no current guidance exists for the latter, Advisory Leaflet (AL) 72 has been used;
- Road traffic noise levels have been predicted for the existing and future operational phases using the calculation methodology set out in *Calculation of Road Traffic Noise*;
- The changes in predicted road traffic noise levels have been assessed using the procedure outlined in the *Design Manual for Roads and Bridges (1994)*; and
- Where appropriate, mitigation measures have been set out to ameliorate any identified adverse impacts.

13.1.2 *Introduction to Noise and Vibration*

Noise is defined as unwanted sound, and the unit of measurement is the decibel (dB).

Noise levels range from the threshold of hearing at 0 dB to levels of over 130 dB at which point the noise becomes painful.

Sound consists of vibrations transmitted to the ear as rapid variations in air pressure. The more rapid the fluctuation the higher the frequency of the sound. However, the sensitivity of the human ear varies with frequency, therefore most every day noise, including road traffic noise is measured in dB(A), the (A) suffix indicating that the measured level has been modified to allow for this phenomenon. It has been found that changes in noise level when measured in dB(A) correlate closely with the changes in subjective reaction.

Table 13.1 Common Levels of Noise

Activity	dB(A) Scale
Threshold of hearing - silent	0
Quiet bedroom	25-35
Quiet rural area	45-50
Suburban areas away from main traffic routes	50-60
Conversational speech at 1m distance	60-70
Busy urban street corner	70-80
Passenger car at 60Km/hr and 7m distance	72
Heavy diesel lorry at 40 Km/hr and 7 m distance	85

Activity	dB(A) Scale
Hazard to hearing from continuous exposure	90
Pneumatic drill (unsilenced) at 7 m distance	95
Jet aircraft at 250 m overhead	103
Threshold of pain	130-140

The subjective response to noise is dependent not only upon the sound pressure level and its frequency but also on its duration and the time of day it occurs. Environmental noise is often described in terms of an equivalent continuous sound pressure level, which can be thought of as an average noise level over a time period (T). The notation for this noise descriptor is $L_{Aeq,T}$. A good correlation exists between peoples' subjective reaction to fluctuating noise levels and the $L_{Aeq,T}$ descriptor.

The index adopted by the British Government to assess traffic noise is the $L_{A10,18h}$ which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the 18 one hour periods between 6am and midnight. The $L_{A10,18h}$ index has been shown to have the best relationship with annoyance caused by road traffic noise, which is generally quite steady over the course of a day.

Generally, a change of 3 dB(A) in environmental noise is the minimum change perceptible. However, with respect to road traffic noise, immediately following a change in traffic flow or road alignment, people may find benefits or disbenefits when noise changes are as small as 1 dB(A). A change of 1 dB(A) is equivalent to an increase in traffic flow of 25% or a decrease in traffic flow of 20%. These effects last for a number of years; however, in the longer term, perceived noise nuisance may tend towards the steady state level.

Road traffic also causes vibration. Traffic vibration is a low frequency disturbance producing physical movement in buildings and their occupants. Vibration can be transmitted through the air or through the ground.

Airborne vibration from traffic can be produced by the engine or exhaust of road vehicles with dominant frequencies in the 50-100 Hertz (Hz) range. Ground-borne vibration is more often in the 8-20 Hz range and is produced by the interaction between rolling wheels and the road surface.

Vibration is often measured in terms of Peak Particle Velocity (PPV), which is the maximum speed of movement of a point in the ground during the passage of a vibration. For vibration generally, a PPV of 0.2mm/s would be imperceptible: at 0.5mm/s it is perceptible and may then become increasingly disturbing or annoying at higher levels.

However a PPV of several mm/s is needed before minor cosmetic damage is caused to a plaster finished wall, whilst the structure of a building is not affected below a PPV of about 10 mm/s.

Although every attempt has been made to ensure that this report is easily understood, the use of acoustic terms and quantities is unavoidable. Therefore a glossary of acoustic terminology can be found in Appendix G.

13.2 Assessment Methodology

There is no single piece of legislation or guidance document that covers all of the noise and vibration aspects of the development. This section sets out a summary of relevant guidance documents that have been used in undertaking this assessment.

13.2.1 British Standard 5228

British Standard (BS) 5228: Part 1: 1997 *Noise and vibration control on construction and open sites* provides a methodology for predicting noise from construction equipment (plant) at nearby sensitive receptors.

The BS5228 methodology involves calculating noise levels at chosen receptors taking into account the more significant factors, these being:

- The sound power outputs of processes and plant;
- The periods of operation of processes and plant;
- The distances from sources to receptor;
- The presence of screening by barriers;
- The reflection of sound; and
- Attenuation due to soft ground.

BS5228 states that noise from equipment is likely to vary in intensity and character with location and with time. There may also be many possible combinations of equipment of both a static and a mobile nature to consider. However, BS5228 advises that reasonably accurate predictions can be made by approaching the problem in a logical way and by analysing all activities involved.

With respect to noise propagation across ground, the difference between hard and soft ground can be important, as soft ground can offer some attenuation of noise.

A simple method of estimating the attenuation based on the percentage of soft ground between the source and receptor, and the heights of both above ground, is given in BS5228.

BS5228 also notes that although methods for calculating both the effects of screening and soft ground attenuation, the corrections should not normally be combined. Either the attenuation from screening and hard ground propagation or the attenuation of soft ground, whichever is the greater, should be taken.

BS5228 also states that at distances over 300m, noise predictions should be treated with caution, especially where a soft ground correction factor has been applied, because of the increasing importance of meteorological effects.

13.2.2 Classification of Noise Impacts

The Highways Agency is currently updating DMRB Volume 11 Section 3 Part 7. The draft document contains a table giving an example of classified noise impacts.

Although these guidelines are at a draft stage at present, they are of use for this assessment, and an example of how changes in noise level may be assessed is shown in Table 13.2.

Table 13.2 Impact Scale for Comparison of Future Noise against Existing Noise

Noise Change $L_{A10,18h}$ dB	**Impact Level**
0 – 0.9	Neutral impact
1 – 2.9	Minor impact
3 – 9.9	Moderate impact
10+	Major impact

The above significance criteria are used in this assessment.

13.2.3 *Absolute Construction Noise Criteria*

There are no national criteria for limiting noise levels from construction sites/activities.

However, a value that has been widely applied in the United Kingdom as a limit for daytime construction activities in large civil engineering projects is 75dB(A), measured as an equivalent level, ($L_{Aeq,T}$) at the nearest noise sensitive location.

This value was recommended in the former Department of Environment Advisory Leaflet (AL) 72 Noise Control on Building Sites, which is now out of print. BS5228 suggests that the noise limit should be 10dB(A) lower during the evening period and that noise levels at night may need to be as low as 40dB(A) to avoid disturbance.

13.2.4 *The Design Manual for Roads and Bridges*

The Design Manual for Roads and Bridges (DMRB) was introduced by the overseeing highway authority in 1992 in England and Wales, and subsequently in Scotland and Northern Ireland. It provides a comprehensive manual accommodating current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads (including motorways).

Volume 11, Section 3, Part 7 *Traffic Noise and Vibration* of DMRB provides guidance on the assessment of noise and vibration from road traffic to establish the magnitude and significance of any change to a road. Although Eastside is not a road scheme, the DMRB methodology is suitable for assessing the noise and vibration impacts caused by the changes in road traffic on the surrounding road network.

When considering changes to the wider road network, assessment is required where traffic flow is likely to increase by 25% or more, or reduce by at least 20%, which correspond to noise level change of 1dB. DMRB indicates that it is not necessary to assess the noise or vibration impact of traffic changes less than these. The area that can be assessed also depends on the geographical extent of the traffic impact assessment.

DMRB compares the change in noise levels that would occur between the Do-Minimum and the Do-Something scenarios. The scenarios are defined as follows:

- Do-Minimum – this is the noise climate that would exist without the implementation of the proposed development.
- Do-Something – this is the noise climate that would exist with the implementation of the development.

DMRB requires that Do-Minimum and Do-Something scenarios are considered for the opening year of the development, and the 15th year after opening (known as the design year). In some cases, the greatest traffic flow associated with the development will occur some time between the opening and design year; if this is the case the year with the highest traffic flow should be used for the assessment in place of the design year. Stage 2 of Eastside is expected to be completed and at full occupancy by 2020, which is taken to be the development *opening year*.

The *design year* for the assessment would normally be 15 years after this, in 2035.

The traffic impact assessment on which this noise impact assessment is based does not predict any further growth in traffic flow once the Eastside and Both World developments are fully occupied in 2020. Similarly, the Do-Minimum situation, if the development were not to proceed, does not show any increase between the *existing* (2006), *opening year* (2020) or *design year* (2035) situations. Therefore, only the opening year (2020) scenarios are considered by this assessment.

The future situation with both stages of Eastside completed, and the cumulative impact of both stages of Eastside and the Both Worlds development completed, have both been considered.

Changes in traffic noise levels are required to be identified for properties within existing noise level bands of <50, 50<60, 60<70 and > 70dBLA10,18h. The number of properties experiencing noise level changes of 1<3, 3<5, 5<10, 10<15 and > 15dBLA10,18h are identified for each noise level band for the Do-Something situation (DS). Parallel calculations are also made for the Do-Minimum (DM) situation.

13.2.5 Calculation of Road Traffic Noise (CRTN)

CRTN, published by the former United Kingdom Department of Transport and Welsh Office, sets out the methodology for the assessment of road traffic noise.

Road traffic noise levels in the United Kingdom are currently measured and predicted in units of A-weighted decibels, specifically the 18 hour, ten percentile level, or the level exceeded for 10% of the measurement period, ($L_{A10,18\text{-hour}}$ dB). The 18-hour period is between 06.00 and 24.00hrs.

DMRB recommends that road traffic noise predictions are undertaken in accordance with the methodology outlined in CRTN. The base data required in the calculation includes the following:

- The number of vehicles using the road (18 hour Annual Average Weekday Traffic Flows (AAWT);
- The number of HGV's as a percentage of the total number of vehicles using the road;
- The road surface type and depth;
- Vehicle speed/road speed limit;
- Road gradient;
- The distance between the carriageway and receiving position;
- The relative heights of source and receiving positions;
- The effects of barriers between carriageway and receiving position;
- The effects of intervening ground cover (i.e. reflective or absorbent) between carriageway and receiving position; and
- The angle of view of the road, and reflections from facades.

The CRTN level is predicted one metre from the facade of a building, normally at first floor height, as noise levels are usually greater at the upper storey of a building. At free-field locations, i.e. open locations free from reflective surfaces such as buildings, noise levels are predicted at a height of 1.5m above ground level.

13.2.6 Computer Modelling of Traffic Noise

IMMI Version 5.3.1 has been used to calculate noise levels for all buildings within 300m of the wider road network expected to experience a change in traffic flow of at least +25% or -20%. The program applies the calculation procedure detailed in CRTN and has been used to create three-dimensional models of the existing and proposed road scheme and surrounding areas including features such as buildings, landforms and barriers. Other inputs to the program include traffic numbers and speed, nature of the road surface and type of intervening ground cover between each road segment and each receptor.

The assessment has been carried out on the assumption that development construction will be completed and full occupancy will be achieved by 2020. For the Do-Minimum scenarios there are no road improvements associated with the development. For the 2020 Do-Something scenario, the proposed new road layout associated with the development has been considered.

The traffic data provided by Halcrow Group Limited has been used to predict the noise levels for situations with and without the development. Calculations have been carried out for first floor levels of all properties, as the upper floor is generally the most exposed.

The supplied Ordnance Survey LandLine dataset has been used to establish building outlines and road centrelines in the road noise model. Contour data at 10m vertical intervals has been used for the Digital Terrain Model.

13.3 Baseline Conditions

13.3.1 Baseline Noise Survey

A number of background noise measurements were undertaken in Catalan Bay, Eastern Beach Road and Devil's Tower Road during 19th until 25th April 2006 to establish the noise climate in the local area.

All of the measurements were carried out with a Type 1 01dB Solo Master sound level meter (Serial Number 11144) and microphone type ½ inch MK250 (Serial Number 11790). The sound level meters were calibrated prior to each measurement, using the 01 dB-stell acoustic calibrator (serial number 51231413).

The calibration was checked upon completion of each measurement and no calibration drifts were found to have occurred.

The weather during the surveys was dry with wind speeds of less than 2 m/s; these conditions are suitable for environmental noise measurements.

Measurements were undertaken at potentially noise-sensitive areas in close proximity to the proposed development. The locations were:

- **Location MP1**: Catalan Bay Road situated at the northern end of Catalan Bay adjacent to a residential block (6 storeys), the public conveniences and Catalan Bay Road. The microphone was 4.0m above the ground (façade);
- **Location MP1a**: The Caleta Hotel at Catalan Bay overlooks the sea and the proposed site of the Eastside development. The microphone was on the 5th floor of the hotel (façade);
- **Location MP2**: Sunrise View, Eastern Beach Road situated 3 metres from the edge of the road adjacent to the beach. The residential block is 4 and 5 storeys high. The microphone was 1.5m above the ground (free-field);
- **Location MP3**: Devil's Tower Road situated 4 metres from the edge of the road adjacent to a residential block. The microphone was 1.5m above ground, (façade); and
- **Location MP4**: Devil's Tower roundabout situated 4 metres from the edge of the road adjacent to a residential block. The microphone was 1.5m above ground, (free-field).

The measurement locations are shown in Figure 13.1 contained in Appendix G and a description of the noise sources evident at each measurement positions is given below.

13.3.2 Baseline Survey Results

The measured noise levels are summarised in Table 13.3:

Table 13.3 Summary of Measured Noise Levels, dB(A)

Location	Time Period	Measured Noise Levels		
		$L_{Aeq,T}$*	L_{A90}	L_{A10}
MP1	Daytime	60.7	51.9	60.9
	Night-time	53.0	45.4	54.5
MP1a	Daytime	47.0	40.2	48.0
	Night-time	46.0	41.1	48.0
MP2	Daytime	63.2	55.0	64.1
	Night-time**	64.4	61.3	65.5
MP3	Daytime	72.1	57.5	73.7
	Night-time	64.8	45.9	67.5
MP4	Daytime	71.3	62.2	74.1
	Night-time	-	-	-
*Note: The values in this table are based on sample measurements. These are regarded as representative of a 16-hour daytime period (07.00 to 23.00) and an 8-hour night-time period (23.00 to 07.00). ** Values affected by vehicles driving aggressively along Eastern Beach Road.				

Façade incident noise levels have been calculated for positions where free-field noise measurements were conducted. These are presented in Table 13.4 below:

Table 13.4 $L_{A10,18\text{-hour}}$ Noise Levels at Residential Façades dB

Location	Measurement Position	Microphone Height	Measured Noise Levels	Residential Noise Levels (Façade)
			$L_{A10,18hour}$	$L_{A10,18hour}$
MP1	Façade	4.0m	59.9	59.9
MP2	Free-Field	1.5m	61.1	64.1
MP3	Façade	1.5m	74.4	74.4
MP4	Free-Field	1.5m	73.1	73.7

13.3.3 *Baseline Noise Survey Summary*

The noise levels at MP1, and MP1a were typical of a coastal environment. Seagulls, fishing boats and the action of the sea were the main noise sources. MP1 is occasionally influenced by residents' vehicles accessing Catalan Bay Road.

At MP2 there was a steady flow of traffic driving up and down Eastern Beach Road during the day and night-time.

At MP3 and MP4, road traffic noise dominated the ambient climate during the day and night-time.

Regular aircraft noise from aircraft landing and taking off at Gibraltar airport is audible at all locations.

13.4 Predicted Impacts

13.4.1 *Construction Phase: Construction Noise Predictions*

These predictions are based on the published sound power levels for equipment in British Standard (BS) 5228: Part 1: 1997 *Noise and vibration control on construction and open sites*.

The assessment is based on the best available information at the time of the report and may be subject to change at later stages of the project. Preparation of an Environmental Management Plan for reference throughout the construction phase would also assist in identifying potential impacts and provide specific mitigation measures where considered necessary.

Stage 1 is applicable to the southern section of the development (Hotel and Development Plots 1-7) and Stage 2 is the northern section (Development Plots 8-15).

For the purpose of predicting the likely noise impact, the construction activities have been divided into the following stages:

- **Land Remediation and Marine Works** (Stages 1 and 2). The total sound power level for these items is assumed to be 128 dB(A);
- **Site Infrastructure** (Stages 1 and 2). The sound power level for each truck is assumed to be 126 dB(A);
- **Hotel** (Stage 1). The sound power level for these items is assumed to be 123 dB(A);
- **Development Plots 1-8** (Stage 1). The sound power level for these items is assumed to be 123 dB(A); and,
- **Development Plots 9-15** (Stage 2). The sound power level for these items is assumed to be 123 dB(A).

Predictions have been carried out of the noise levels likely to be generated by each of the above stages at the closest noise-sensitive receptors. The predictions have been undertaken for the noise sensitive receptors at the following locations:

- **CP1**: Catalan Bay is approximately 25m from Stage 1;
- **CP2**: Caleta Hotel is approximately 250m from Stage 1; and,
- **CP3**: Sunrise View, Eastern Beach is approximately 250m from Stage 2.

Locations CP1, CP2 and CP3 are shown in Figure 13.1 in Appendix G. These locations are considered representative of the majority of noise-sensitive receptors in close proximity to the proposed works. Details of the construction equipment assumed in the calculations are contained in Appendix G.

It may be noted that there is significant variation in construction noise levels at receptors over time, depending on which development plot the activities are occurring at, and what activities are undertaken. This is particularly pronounced at location CP1, where at some times the construction will be at close proximity, and at other times the construction will be relatively distant. As distance increases, construction noise levels will decrease, particularly during land remediation, site infrastructure, construction of the hotel and of development plot 1.

The predicted construction noise levels are shown below. The predictions are in terms of the $L_{Aeq,8hr}$ dB noise index, which represents the construction noise level generated over a typical working day.

Table 13.5 Predicted Construction Noise Levels, free field $L_{Aeq,\ 8\ hour}$ dB(A)

Construction Source		Predicted Noise at Receivers, dB(A)		
Construction Element	**Duration**	**CP1**	**CP2**	**CP3**
Marine works	24 months	63.1 to 90.1	55.5 to 65.1	54.7 to 65.1
Land reclamation	24 months	63.1 to 90.1	55.5 to 65.1	54.7 to 65.1
Land remediation	16 months	63.1 to 90.1	55.5 to 65.1	54.7 to 65.1
Site infrastructure	16 months	67.4 to 94.4	59.8 to 69.4	59.0 to 69.4
DP 01	21 months	82.0 to 92.7	67.3	55.2
DP 02A	20 months	76.3	64.8	55.6
DP 02B	20 months	73.5	62.8	56.4
DP 02C	19 months	70.6	61.6	57.2
DP 03	26 months	87.1 to 94.7	65.2	56.0
DP 04	31 months	78.6	63.5	56.6
DP 05	32 months	73.8	61.7	57.6
DP 06	35 months	70.1	60.5	58.6
DP 07	20 months	67.3	59.6	58.7
DP 08A	24 months	66.6	58.5	60.0
DP 08B	20 months	63.1	56.9	61.7
DP 09	32 months	67.9	59.2	59.8
DP 10	31 months	65.4	58.1	61.3
DP 11	32 months	63.8	57.0	62.7
DP 12	22 months	62.3	56.4	64.3
DP 13	26 months	60.9	55.6	64.4
DP 14	26 months	61.3	55.9	65.1
DP 15	25 months	59.7	54.9	67.7

Table 13.5 identifies that Catalan Bay will experience greater impact from construction noise than the Caleta Hotel and Sunrise View.

At Catalan Bay, the construction noise levels will exceed 75 $L_{Aeq,\ 8\text{-hour}}$ dB(A) during land reclamation and remediation works, the site infrastructure and marine works, and during the building works at development plots 1, 2, 3 and 4.

At the Caleta Hotel and Sunrise View, all construction noise levels will be below 75 $L_{Aeq,\ 8\text{-hour}}$ dB(A).

Construction Noise Assessment

The noise impact from the construction works at Eastside during the daytime period has been assessed in accordance with Draft Guidelines for Noise Impact Assessment.

Table 13.6 Construction Noise Assessment – 1 Catalan Bay, free-field $L_{Aeq,T}$ dB

Construction Element	Predicted Specific Noise Level	Typical Existing Noise Level	Total Noise Level	Change	Impact
Marine works	63.1 to 90.1	60.7	65.1 to 90.1	+4.4 to +29.4	Moderate to Major
Land reclamation	63.1 to 90.1		65.1 to 90.1	+4.4 to +29.4	Moderate to Major
Land remediation	63.1 to 90.1		65.1 to 90.1	+4.4 to +29.4	Moderate to Major
Site infrastructure	67.4 to 94.4		68.2 to 94.4	+7.5 to +34.4	Moderate to Major
DP 01	82.0 to 92.7		82.0 to 92.7	+21.3 to +32.0	Major
DP 02A	76.3		76.4	+15.7	Major
DP 02B	73.5		73.7	+13.0	Major
DP 02C	70.6		71.0	+10.3	Major
DP 03	87.1 to 94.7		87.1 to 94.7	+26.4 to +34.0	Major
DP 04	78.6		78.7	+18.0	Major
DP 05	73.8		74.0	+13.3	Major
DP 06	70.1		70.6	+9.9	Moderate
DP 07	67.3		68.2	+7.5	Moderate
DP 08A	66.6		67.6	+6.9	Moderate
DP 08B	63.1		65.1	+4.4	Moderate
DP 09	67.9		68.7	+8.0	Moderate
DP 10	65.4		66.7	+6.0	Moderate
DP 11	63.8		65.5	+4.8	Moderate
DP 12	62.3		64.6	+3.9	Moderate
DP 13	60.9		63.8	+3.1	Moderate
DP 14	61.3		64.0	+3.3	Moderate
DP 15	59.7		63.2	+2.5	Minor

The predictions at Catalan Bay indicate that construction impacts will range from *minor* to *major* during the works programme. Catalan Bay will have a full view of all areas of construction works.

Table 13.7 Construction Noise Assessment – 2 Caleta Hotel, free-field $L_{Aeq,T}$ dB

Construction Element	Predicted Specific Noise Level	Typical Existing Noise Level	Total Noise Level	Change	Impact
Marine works	55.5 to 65.1	47.0	56.1 to 65.2	+9.1 to +18.2	Moderate to Major
Land reclamation	55.5 to 65.1		56.1 to 65.2	+9.1 to +18.2	Moderate to Major
Land remediation	55.5 to 65.1		56.1 to 65.2	+9.1 to +18.2	Moderate to Major
Site infrastructure	59.8 to 69.4		60.0 to 69.4	+13.0 to +22.4	Major
DP 01	67.3		67.3	+20.3	Major
DP 02A	64.8		64.9	+17.9	Major
DP 02B	62.8		62.9	+15.9	Major
DP 02C	61.6		61.7	+14.7	Major
DP 03	65.2		65.3	+18.3	Major
DP 04	63.5		63.6	+16.6	Major
DP 05	61.7		61.8	+14.8	Major
DP 06	60.5		60.7	+13.7	Major
DP 07	59.6		59.8	+12.8	Major
DP 08A	58.5		58.8	+11.8	Major
DP 08B	56.9		57.3	+10.3	Major
DP 09	59.2		59.5	+12.5	Major
DP 10	58.1		58.4	+11.4	Major
DP 11	57.0		57.4	+10.4	Major
DP 12	56.4		56.9	+9.9	Moderate
DP 13	55.6		56.2	+9.2	Moderate
DP 14	55.9		56.4	+9.4	Moderate
DP 15	54.9		55.6	+8.6	Moderate

The predictions at the Caleta Hotel indicate that construction impacts will range from *moderate* to *major adverse* during the works programme. The Caleta Hotel will have a direct view of all areas of construction works. Construction noise impacts are great due to a low existing ambient noise climate.

Table 13.8 Construction Noise Assessment – 3 Sunrise View, Eastern Beach Road, free-field $L_{Aeq,T}$ dB

Construction Element	Predicted Specific Noise Level	Typical Existing Noise Level	Total Noise Level	Change	Impact
Marine works	54.7 to 65.1	63.2	63.8 to 67.3	+0.6 to +4.1	Neutral to Moderate
Land reclamation	54.7 to 65.1		63.8 t 67.3	+0.6 to +4.1	Neutral to Moderate
Land remediation	54.7 to 65.1		63.8 to 67.3	+0.6 to +4.1	Neutral to Moderate
Site infrastructure	59.0 to 69.4		64.6 to 70.3	+1.4 to +7.1	Minor to Moderate
DP 01	55.2		63.8	+0.6	Neutral
DP 02A	55.6		63.9	+0.7	Neutral
DP 02B	56.4		64.0	+0.8	Neutral
DP 02C	57.2		64.2	+1.0	Minor
DP 03	56.0		64.0	+0.8	Neutral
DP 04	56.6		64.1	+0.9	Neutral
DP 05	57.6		64.3	+1.1	Minor
DP 06	58.6		64.5	+1.3	Minor
DP 07	58.7		64.5	+1.3	Minor
DP 08A	60.0		64.9	+1.7	Minor
DP 08B	61.7		65.5	+2.3	Minor
DP 09	59.8		64.8	+1.6	Minor
DP 10	61.3		65.4	+2.2	Minor
DP 11	62.7		66.0	+2.8	Minor
DP 12	64.3		66.8	+3.6	Moderate
DP 13	64.4		66.9	+3.7	Moderate
DP 14	65.1		67.3	+4.1	Moderate
DP 15	67.7		69.0	+5.8	Moderate

The predictions at Sunrise View indicate that construction impacts will range from *minor* to *major adverse* during the works programme. Sunrise View will have a partial view of all areas of construction works.

The predictions indicate that mitigation will be necessary to reduce construction noise at all receptors.

13.4.2 *Construction Phase: Vibration*

There are currently no British Standards that provide a methodology to predict levels of vibration from construction activities, other than that contained within BS 5228: Part 4, which relates to percussive or vibratory piling only. It is generally accepted that for the majority of people, vibration levels in excess of between 0.15 and 0.3 mms^{-1} peak particle velocity are just perceptible.

Table 13.9 below details the distances at which certain activities give rise to a just perceptible level of vibration; these figures are based on historical field measurements.

Table 13.9 Distances at which Vibration may just be Perceptible

Construction Activity	Distance from activity when vibration may just be perceptible (metres)
Excavation	10 to 15
Heavy Vehicles (e.g. dump trucks)	5 to 10
Hydraulic Breaker	15 to 20
Auger Piling (e.g. CFA piling)	15 to 20
Compaction	30 to 40

On the basis of the above figures, it is possible that perceptible levels of vibration may occur off-site during breaking works, piling or compaction activities carried out at the site boundary. However, the vibration is only likely to be perceptible where the works are taking place very close to the site boundary and this will limit the duration of any impact.

The closest properties to the construction works are in Catalan Bay, approximately 25m from the nearest Stage 1 works.

13.4.3 *Construction Phase: Haul Route*

Access to the site will be via Devil's Tower Road. The volume of construction site traffic is estimated to be small (520 vehicle movements per day) in relation to the overall traffic flows (circa 18,000 vehicle movements per day) on the surrounding road network, and consequently imperceptible changes in traffic noise levels of less than 1dB(A) are likely to result.

13.4.4 *Operation Phase: Operational Noise Sources*

Increases in road traffic on the local road network and corresponding increases in road traffic noise at buildings within 300m of these local roads have been identified as the only significant operational noise sources caused by the development.

13.4.5 *Operation Phase: Road Traffic Noise*

Consideration has been given to the road traffic noise levels arising from the following scenarios:

- 2020 Do-Minimum
- 2020 Do-Something (Eastside development)

Noise predictions have been carried out at all buildings within 300m of the local road network on which traffic flows are expected to change by +25% or -20% using proprietary IMMI noise modelling software, and the study area is shown on Figure 13.2 in Appendix G.

The predicted changes in road traffic noise at first floor level at the positions of the baseline measurement positions are given in Table 13.10 as an illustration. The noise change column indicates the change between the 2020 Do-Minimum and the 2020 Do-Something scenarios.

Table 13.10 Predicted Traffic Noise Levels for Selected Key Receptors, First Floor, Façade Level $L_{A10,\ 18\ hour}$ dB

Location	2020 DM	2020 DS	Change
MP1 Catalan Bay	45.3	45.6	0.2
MP1a Caleta Hotel	43.1	42.6	-0.5
MP2 Sunrise View	59.4	61.3	1.9
MP3 Devil's Tower Road	72.8	77.6	4.8
MP4 Devil's Tower Roundabout	71.4	75.9	4.5

It can be seen from the above table that changes in road traffic noise level at these locations are between -0.5 and +4.8 dB when comparing the 2020 Do-Minimum and 2020 Do-Something situations. Changes in noise levels of this magnitude can be regarded as *negligible* to *moderate adverse* impact.

The full results of the predicted road traffic noise levels have been used to prepare DMRB noise assessment summary tables, which are shown in Appendix G. Figures 13.3 and 13.4 show the predicted noise levels at each property graphically.

A summary of these tables is shown in Table 13.11 which presents the noise level changes at all properties in accordance with the DMRB guidance.

Table 13.11 Summary of DMRB Assessments

Classified Noise Level Change (dB $L_{A10,18hr}$)		Residential		Commercial		Industrial		Community	
		DS	**DM**	**DS**	**DM**	**DS**	**DM**	**DS**	**DM**
Increase in Noise Level $L_{A10\ 18hr}$ dB	1 to <3	**142**	0	0	0	**2**	0	**1**	0
	3 to <5	**110**	0	0	0	0	0	**1**	0
	5 to <10	**16**	0	**2**	0	0	0	0	0
	10 to <15	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0
Decrease in Noise Level $L_{A10\ 18hr}$ dB	1 to <3	**3**	0	0	0	**1**	0	0	0
	3 to <5	**1**	0	0	0	0	0	0	0
	5 to <10	**1**	0	0	0	0	0	0	0
	10 to <15	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0

DS = 2020 Do Something (with Eastside development)
DM = 2020 Do minimum (without Eastside development)

For the 2020 Do-Something scenario, 142 residential properties are predicted to experience an *minor adverse* noise impact of 1<3dB(A) while 110 residential properties will experience an *moderate adverse* noise impact of 3<5dB(A) and 17 residential properties will experience a *moderate adverse* noise impact of 5<10dB(A). No properties will experience a *major adverse* impact of more than 10dB(A), there will be a *slight beneficial* noise impact of 1<3dB(A) at three residential properties and a *moderate beneficial* impact at two properties.

The World Health Organisation definition of noise nuisance is *a feeling of displeasure evoked by noise.* The Design Manual for Roads and Bridges, Volume 11 *Environmental Assessment,* provides a method for calculating the change in the percentage of people bothered by noise due to changes in road traffic noise. However, it has not been possible to estimate the number of people bothered by noise due to changes in road traffic noise, as information regarding the number of households in each building is not readily available.

13.4.6 Operation Phase: Road Traffic Vibration

DMRB provides a method of estimating the percentage of the population living within 40m of the affected roads which would be annoyed by airborne vibration levels. However, this method is based on estimating the number of people bothered by noise, which is not possible as information regarding the number of households in each building is not readily available.

However, the Transport and Road Research Laboratory (now the Transport Research Laboratory, TRL) published Research Report 246 *Traffic Induced Vibrations in Buildings* in 1990.

The report summarises TRL studies of the effects of vibration from roads on people, buildings and equipment. The second section of the report, which investigates the effects of vibration on buildings, concludes that although vibration from road traffic can cause nuisance to occupants, there is no evidence to support the assertion that traffic vibrations can also cause significant damage to buildings.

13.5 Mitigation Measures

13.5.1 Construction Phase

Several safeguards exist to minimise the effects of construction noise and these will operate during the development. These safeguards include the measures specified in the various EC Directives and UK Statutory Instruments that limit noise emissions from a variety of construction plant:

- Council Directive 79/113/EEC on the approximation of the laws the Member States relating to the determination of the noise emission of construction plant and equipment;
- Council Directive 86/662/EEC amending Directive 8/538/EEC on the limitation of noise emitted by hydraulic excavators, rope operated excavators, dozers, loaders and excavator loaders;
- Council Directive 86/662/EEC on limitation of noise emitted by hydraulic excavators, rope operated excavators, dozers, loaders and excavator loaders;
- Council Directive 95/27/EC amending Directive 86/662/EEC on the limitation of noise emitted by hydraulic excavators, rope operated excavators, dozers, loaders and excavator loaders;
- Construction Plant and Equipment (Harmonisation of Noise Emission Standards) Regulations, 1988 SI 361. London: The Stationary Office. ISBN 0 11 086361 5; and
- Additional Directives that may be applicable are in Annex A of BS5228 Part 1.

British Standard 5228 *Noise and vibration control on construction and open sites* considers the need for the protection against noise and vibration of persons living and working in the vicinity of, and those working on, such sites. It recommends procedures for noise and vibration control in respect of construction operations, including the following:

- Noise Control at Source – acoustic enclosures and sheds, the use of quieter equipment, alternative work methods;
- Acoustic Enclosures – possible solution for stationary plant such as generators and compressors;
- Acoustic Shed Design – effective screening depends on the extent to which the noise source can be enclosed without the operation of the equipment being adversely affected or the operation being adversely affected or the operator being exposed to additional occupational health and safety hazards;
- Acoustic Screens – the effectiveness of a barrier will depend upon the design, siting and construction. On level sites, the barrier should be brought as close as possible to the noise source or the receiving position. There should be no gaps or openings at joints in the barrier material. The length of the barrier should be at least five times greater than the height and the minimum height of barriers should be such that no part of the noise source will be visible from the receiving point.

The precise noise mitigation measures to control noise and vibration from the construction activities are likely to require discussion with the local authorities prior to the works starting. Generic measures below are given to illustrate the range of techniques available:

- All plant items will be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise;
- All plant should will be sited so that the noise impact at nearby noise-sensitive properties is minimised;
- The speed limit on the haul road and public highways will be observed;
- Problems concerning noise from construction works can sometimes be avoided by taking a considerate and neighbourly approach to relations with the local residents. Works will only take place during given times periods, e.g. during the daytime and not at night.

Experience from other sites has shown that by implementing these measures, typical noise levels from construction works can be reduced by approximately 5 to 10dB(A).

If a 5-10 dB noise reduction is achieved through the implementation of the above mitigation measures, construction noise impacts will still be of major adverse significance at:

- Catalan Bay during Stage 1 land remediation and site infrastructure, the hotel and DP 1;
- Caleta Hotel during Stage 1 land remediation and site infrastructure, the hotel and DPs 1, 2 and 8.

Preparation of an Environmental Management Plan for reference throughout the construction phase would also assist in identifying potential impacts and provide specific mitigation measures where considered necessary.

It is recommended that permanent noise monitoring stations are set up at noise sensitive receptors during construction works to monitor daily noise levels and to meet the requirements set by the local authorities and demonstrate that best practicable means of reducing noise are being employed.

13.5.2 *Operation Phase*

An increase in road traffic noise at buildings adjacent to local roads where traffic flows will increase by +25% or more has been identified as the only significant operational noise impact associated with the development.

It is considered that the only practical way of reducing road traffic noise over large areas is by resurfacing roads with a low noise surface. However, this is beyond the scope of the development and may not provide full benefits on roads where traffic speeds are less than 75 kph.

13.6 Residual Impacts

13.6.1 *Construction Phase*

The inclusion of the proposed mitigation measures will reduce the impact of the development. Experience has shown that during the construction phase, mitigation measures may reduce construction noise by 5 to 10dB. If such reductions in construction noise are achieved through the implementation of the mitigation measures outlined above, construction noise impacts will still be a *major adverse* impact at:

- Catalan Bay during: marine works, land remediation, site infrastructure, DP 1, DP02A, DP03 and DP04;
- Caleta Hotel during: marine works, land remediation, site infrastructure, DP01, DP02A, DP02B, DP03 and DP04.

It should be noted that the above predictions are based on worst-case conditions. However, these worst-case conditions are expected only while the nearest parts of the development are being constructed and the impacts are local and short term. Construction noise levels are expected to vary considerably at receptors over time, depending on which site area the activities are occurring at, and the construction activities that are undertaken.

13.6.2 *Operation Phase*

Eastside will result in a barely perceptible, *minor adverse* impact in road traffic noise levels at 142 residential buildings in the long term. *Moderate adverse* impacts (up to a doubling in loudness) will be observed at 126 residential buildings. Three residential buildings are expected to benefit from a *minor beneficial* impact, while a *moderate beneficial* impact is predicted at two residential properties.

13.7 Cumulative Effects

13.7.1 *Operation Phase: Noise*

A further development known as Both Worlds is currently planned. The transport assessment provides cumulative Do-Something traffic data for the situation where both Eastside and the Both Worlds development are operational.

A road traffic noise assessment comparing the following scenarios has been undertaken to determine the cumulative impact of both developments:

- 2020 Do-Minimum
- 2020 Do-Something (Eastside and Both Worlds developments).

As before, the predicted changes in road traffic noise at first floor level at the positions of the baseline measurement positions are given in Table 13.12 as an illustration. The noise change column indicates the change between the 2020 Do-Minimum and the 2020 Do-Something scenarios.

Table 13.12 Predicted Traffic Noise Levels for Selected Key Receptors, First Floor, Façade Level $L_{A10,\ 18\ hour}$ dB

Location	2020 DM	2020 DS	Change
MP1 Catalan Bay	45.3	46.7	1.3
MP1a Caleta Hotel	43.1	43.7	0.6
MP2 Sunrise View	59.4	61.3	1.9
MP3 Devil's Tower Road	72.8	77.7	4.9
MP4 Devil's Tower Roundabout	71.4	76.0	4.6

It can be seen from the above table that changes in road traffic noise levels are between +0.6 and +4.9 dB(A) when comparing the 2020 Do-Minimum and 2020 Do-Something situations. Changes in noise levels of this magnitude can be regarded as *barely perceptible* to *moderate* and are similar to those reported when considering the effects of Eastside alone. The maximum increase between Eastside alone and the cumulative Eastside and Both Worlds developments at any building is 1.5 dB(A). Increases of 1 dB(A) or more occur at 68 buildings.

The full results of the predicted cumulative road traffic noise levels have been used to prepare DMRB noise assessment summary tables, which are shown in Appendix G.

Figure 13.5 shows the cumulative predicted noise levels at each property graphically. A summary of these tables is shown in Table 13.13 which presents the noise level changes at all properties in accordance with the DMRB guidance.

Table 13.13 Summary of DMRB Assessments (Cumulative Impact)

Classified Noise Level Change (dB $L_{A10,18hr}$)		Residential		Commercial		Industrial		Community	
		DS	DM	DS	DM	DS	DM	DS	DM
Increase in Noise Level $L_{A10\ 18hr}$ dB	1 to <3	**214**	0	0	0	**2**	0	**1**	0
	3 to <5	**113**	0	0	0	0	0	**1**	0
	5 to <10	**17**	0	**2**	0	0	0	0	0
	10 to <15	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0
Decrease in Noise Level $L_{A10\ 18hr}$ dB	1 to <3	**3**	0	0	0	**1**	0	0	0
	3 to <5	**1**	0	0	0	0	0	0	0
	5 to <10	**1**	0	0	0	0	0	0	0
	10 to <15	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0

DS = 2020 Do Something (with Eastside and Both World's developments)
DM = 2020 Do minimum (without Eastside or Both World's developments)

For the 2020 Do-Something scenario, 214 residential properties are predicted to experience an *slight adverse* noise impact of 1<3dB(A) while 113 residential properties will experience an *moderate adverse* noise impact of 3<5dB(A) and 17 residential properties will experience a *moterate adverse* noise impact of 5<10dB(A). No properties will experience a *major adverse* impact of more than 10dB(A) and there will be a *slight beneficial* noise impact of 1<3dB(A) at three residential properties, and *moderate beneficial* impacts at two properties.

13.8 Transboundary Effects

Noise impacts are generally local in nature, other than those caused by road traffic increases on a wider road network. Although the traffic model only considers Gibraltar, the increase in basic noise level along Winston Churchill Avenue leading to the boarder are less than 1 dB for the cumulative impacts of both the Eastside and Both Worlds development, indicating that perceptible transboundary noise changes are unlikely and therefore the impacts will be negligible.

13.9 Uncertainty

13.9.1 Construction Phase: Noise and Vibration

At this time, only a preliminary indication is available regarding the number, type and geographical position of construction equipment. To achieve the best possible accuracy the BS5228 construction noise prediction method requires precise input data which are not available. The construction noise levels presented in this report are based on the best available information at this time and are therefore indicative only.

As noted previously, there is no accepted methodology for calculating vibration from construction activities other than piling. The distances used in this report at which certain activities give rise to a just perceptible level of vibration are based on historical field measurements and depend on a multitude of factors. Site conditions may vary and therefore some deviation from these distances is expected.

13.9.2 Operation Phase: Noise and Vibration

Predictions of the operational noise due to increased road traffic on the local road network are dependent on the predicted traffic flows and speeds. Assumptions made in the traffic assessment (see Chapter 11 and Appendix H) will therefore have an effect on the predicted

operational noise levels. In addition, the extent of the traffic impact assessment limits the study area for the noise assessment.

A number of assumptions have been made regarding the surface texture depth of the existing road surfaces, as measurements are beyond the scope of this assessment. A texture depth of 1.5mm has been used throughout the noise model to provide a conservative assessment.

Building outlines have been taken from the supplied Ordnance Survey LandLine data. It is not known when this mapping was undertaken and some buildings may have changed since the mapping was completed. Similarly, it is not known when the digital terrain model (contour lines) of Gibraltar was surveyed. However, it is considered likely that both datasets to provide sufficiently detailed and current information for an assessment of this type.

13.10 Summary

This Chapter assesses the potential noise and vibration impacts of the proposed Eastside development and considers the noise and vibration effects of both the construction and operation of the development. The cumulative impacts associated with the operation of the Eastside and the Both Worlds developments are also considered.

An environmental noise survey was undertaken to determine the existing ambient noise levels adjacent to the existing road network. Noise measurements were carried out to obtain representative noise levels at five key locations on a typical weekday.

There is no single piece of legislation or guidance document that covers all of the noise and vibration aspects of the development therefore various relevant guidance documents have been used in undertaking this assessment.

A consideration of unmitigated construction noise levels has indicated a *major adverse* impact at adjacent noise sensitive buildings. The use of best practical measures to reduce noise on site is expected to reduce the impact of the development by 5 to 10dB. However, this may still result in a *major adverse* impact during the worst-case conditions at some of the buildings considered. Construction noise levels are expected to vary considerably at receptors over time, depending on which site area the activities are occurring at, and what activities are undertaken.

Considering the residual operational impact of Eastside, predictions indicate that 142 residential properties will be subject to *barely perceptible* increases (1 to 3 dB(A)) in road traffic noise levels between the 2008 Do-Minimum and 2020 Do-Something scenarios. A total of 110 residential properties will experience a *noticeable* (3 to 5 dB(A)) increase in noise and 16 residential properties will experience an *up to a doubling in loudness* (5 to 10 dB(A)). Three residential properties are expected to benefit from a *barely perceptible* decrease (1-3 dB(A)) in noise, while one property will benefit from a *noticeable* (3 to 5 dB(A)) reduction in noise and one property will benefit from a *halving in loudness* (5 to 10 dB(A)).

Considering the cumulative effects of both the Eastside and Both Worlds developments, predictions indicate that 214 residential properties will be subject to *barely perceptible* increases (1-3 dB(A)) in road traffic noise levels between the 2008 Do-Minimum and 2020 Do-Something scenarios. A total of 113 residential properties will experience a *noticeable* (3<5 dB(A)) increase in noise and 17 residential properties will experience an *up to a doubling in loudness* (5<10 dB(A)). Three residential properties are expected to benefit from a *barely perceptible* decrease (1-3 dB(A)) in noise, while one property will benefit from a *noticeable* (3 to 5 dB(A)) reduction in noise and one property will benefit from a *halving in loudness* (5 to 10 dB(A)).