16 Noise and Vibration

16.1 Introduction

1 This chapter considers the potential effects of the proposed Onshore Works for the Neart na Gaoithe Offshore Wind Farm on noise and vibration. The temporary effects of construction and likely significant changes in the noise and vibration climate are considered. The assessment has been undertaken by Arup. The chapter is supported by a number of technical appendices prepared by Arup and a technical appendix prepared by Cathie Associates (a landing site vibration assessment).

2 A glossary of acoustic terminology used throughout this report is provided in **Appendix 16.1.**

16.1.1 Effects Assessed in Full

3 The following effects have been assessed in full:

- Effects of construction noise on receptors in the area surrounding the Onshore Works, taking account of the construction works programme and construction traffic routes to, from and on site;
- Effects of vibration during construction on receptors in the area surrounding the proposed cable route.

16.1.2 Effects Scoped Out

4 On the basis of the desk based and survey work undertaken, the professional judgement of the EIA team, distance to noise sensitive receptors (more than 1 km), experience from other relevant projects and policy guidance and standards, the following topic areas have been 'scoped out', as proposed in the Scoping Report:

- Operational effects of the Onshore Works, including any associated maintenance works.

16.2 Guidance and Legislation

16.2.1 UK Legislation

5 The Control of Pollution Act 1974 (as amended) provides local authorities with the power to control noise from construction sites. The powers include prosecution for failure to comply with the requirements of a notice served under section (s) 60 of the Act, and a system of providing prior consents for works to be carried out in a specified manner so as to reduce the likelihood of causing disturbance ('s.61 consents'). If a notice under s.60 is contravened, it shall be a defence to proceedings if prior consent has been granted under s.61 and the works are carried out in accordance with that consent. In addition, noise generators can use the defence that best practicable means have been employed to control noise emissions.

6 The Environmental Protection Act 1990 (as amended) provides local authorities with powers to serve abatement notices against noise (including vibration) considered to be a nuisance. Noise generators can use the defence that best practicable means have been used to control noise emissions or, in relation to construction noise, that the alleged nuisance arose from activities that were compliant with an extant consent under s.61 of the Control of Pollution Act 1974.

16.2.2 Guidance and British Standards

7 Noise significance threshold and evaluative criteria have been selected, consistent with guidelines, local policies, standards and current best practice appropriate to the noise source and potential receptors being considered and include the following:

- British Standard (BS) 5228: Parts 1 and 2: Code of practice for noise and vibration control on construction and open Sites, (British Standards Institution (BSI), 2009);
- BS 6472: Parts 1 and 2: Guide to evaluation of human exposure to vibration in buildings, (BSI, 2008);
- BS 7385: Part 2: Evaluation and measurement for vibration in buildings, Guide to damage levels from groundborne vibration (BSI, 1993);
- BS ISO 4866: Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures (BSI, 2010);
- The Design Manual for Roads and Bridges (DMRB), Volume 11, Highways Agency, Department for Transport, November 2011;
- Planning Advice Note (PAN) 1/2011: Planning and Noise (Scottish Government, 2011);
- BS 4142: Method for rating industrial noise affecting mixed residential and industrial areas, 1997;
- Measurement and assessment of groundborne noise and vibration (Association of Noise Consultants, 2001).

16.3 Data Sources

8 Data relating to the construction noise and vibration assessment have been sourced from the following:

- Neart na Gaoithe Onshore Construction Works Traffic and Personnel Assessment, Xero Energy, 29 May 2012;
- BS 5228: Parts 1 and 2: Code of practice for noise and vibration control on construction and open sites (BSI, 2009).

16.4 Engagement

9 **Table 16.1** sets out the consultation which has been undertaken in relation to the noise and vibration assessment.

Consultee	Scoping/Other Consultation	Issue Raised	Response/Action Taken
ELC	Other consultation	Proposed noise monitoring locations and periods of monitoring discussed and agreed upon with local authority.	Survey conducted in accordance with local authority requirements
ELC	Other consultation	ELC confirmed assessment to be conducted in accordance with BS 5228 Annex E, applying significance criteria as identified within the standard. (ABC methodology).	Assessment has been conducted in accordance with ABC methodology.
ELC	Other consultation	Changes to proposed night-time works location discussed to determine suitability of noise survey previously conducted.	It was determined that no further noise survey work was required as unattended noise monitoring data has been validated by previous attended noise monitoring data.
Scottish Ministers Transport Scotland	Scoping consultation	Operational and construction traffic noise should be assessed by considering the increase in traffic flows. An assessment should be undertaken in accordance with the Design Manual for Roads and Bridges Vol 11.	Operational effects from traffic increases on the surrounding road network will be negligible. The change in noise level due to construction traffic has been included in the assessment.

Table 16.1: Consultation Responses

16.5 Assessment Methodology

10 BS 5228 provides practical guidance on the control of construction site noise. The legislative background to noise control is described and recommendations are given regarding procedures for creating effective liaison between

developers, site operators and local authorities. Annex E of BS5228 introduces the 'ABC' method, which defines the threshold of potentially significant effects at residential receptors.

16.5.1 Assessing Significance

11 Sensitivity has been determined for noise and vibration from construction activities using guidance given in the relevant British Standards. Each of these aspects is discussed below.

16.5.2 Noise

12 Sensitivity has been determined on the basis of the 'ABC' method, where for the appropriate period (night, evening / weekends or day), the ambient noise level is determined and rounded to the nearest 5 decibels (dB) and evaluated in relation to the threshold values set out in **Table 16.2.** These values are applied to residential receptors only. For the purpose of this assessment, Thorntonloch Caravan Park has been assessed as a residential receptor.

Assessment Category and Threshold Value Period	Threshold Value in Decibels (dB)		
	Category A	Category B	Category C
Night (23:00 – 07:00)	45	50	55
Weekday Evening (19:00 – 23:00) / Saturdays (13:00 – 23:00) / Sundays (07:00 – 23:00)	55	60	65
Day (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

Table 16.2 Matrix for Determining Threshold of Potentially Significant Construction Noise Effects (From BS 5228)

Where:

Category A are threshold values to use when ambient noise levels (rounded to the nearest 5dB) are less than these values.

Category B are values to use when ambient noise levels (rounded to the nearest 5dB) are the same as Category A values.

Category C are values to use when ambient noise levels (rounded to the nearest 5dB) are higher than Category A values

13 The proposed standard hours of work for construction are 08:00 to 18:00 Monday to Friday and 08:00 to 13:00 Saturday, which are within the daytime threshold value period in accordance with **Table** 16.2. At the landfall area, 24-hour working may apply and this has been assessed accordingly.

14 A significant noise effect is indicated where the construction noise L_{Aeq} level exceeds the threshold level for the category appropriate to the ambient noise level. If the ambient noise level exceeds the highest threshold values given in the table (i.e. the ambient noise level is higher than the Category C values), then a potential significant effect is identified if the total L_{Aeq} noise level for the period increases by more than 3dB due to construction activity (in accordance with BS5228.1).

15 Where an effect is predicted on the above basis for residential receptors then the significance of the potential adverse effect is evaluated for an area taking account of matters such as:

- number of receptors subject to the noise impact;
- the proportion of the community subject to the impact;
- existing absolute noise levels (particularly very noisy and quiet/tranquil areas).

16 Road traffic noise from construction traffic has been assessed based on guidance provided in the DMRB, Vol 11, and the following significance criteria have been applied (**Table 16.3**):

Predicted noise change	Impact of scale	Rating of likely significant effect
Increase of more than 10dB	Substantial increase	Potentially significant adverse effect (Major/Moderate)
Increase of 6-10dB	Moderate increase	
Increase of 3-5dB	Slight increase	
Increase of less than 3dB	Negligible change	Non- significant effect (Minor/Negligible)
Decrease of more than 3dB	Slight decrease	Potentially beneficial effect, not significant (Minor/Negligible)

Table 16.3: Significance of Road Traffic Noise Effects

16.5.3 Vibration

17 Few construction activities give rise to appreciable groundborne vibration. The following activities have been assessed that may give rise to appreciable vibration at nearest sensitive receptors to the works:

- vibratory compaction;
- horizontal directional drilling (HDD) (and other trenchless techniques).

18 If Open Cut Trenching is undertaken at the landfall, rock breaking would be conducted using excavators with additional rock breaking equipment (such as breakers mounted on excavators). This methodology will not result in adverse levels of vibration at sensitive receptors as the equipment used produces low levels of vibration at the source (typically peak particle velocity of 0.9mm/s at 7 m from source) and as such, has not been included in the predicted vibration levels.

19 Vibration predictions have been made based upon the information presented in:

- Transport Research Laboratory (TRL) Report 429, Ground vibration caused by mechanised construction works, 2000;
- United States Transit Noise and Vibration Impact Assessment, Federal Transit Administration, 2006;
- BS5228: Part 2: 2009 Code of practice for noise and vibration control on construction and open sites: vibration, British Standards Institute (BSI);
- BS6472: Part 1: 2008 Guide to evaluation of human exposure to vibration in buildings (1Hz to 80Hz), specifies guidance regarding human response to vibration, BSI;
- BS 7385: Part 2: Evaluation and measurement for vibration in buildings, Guide to damage levels from groundborne vibration (BSI, 1993);
- BS ISO 4866: Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures (BSI, 2010).

20 For construction works and residential receptors, criteria and procedures for vibration control are specified for two purposes and assessed using two different sets of parameters:

- to protect the occupants and users of buildings from disturbance, for which the vibration dose values (VDVs) are assessed;
- to protect buildings from risk of physical damage, for which peak component particle velocities are assessed in accordance with BS 7385 and BS ISO 4866:2010.

21 To assess the potential effect of construction vibration on the occupants and users of buildings, it is standard practice to use the following VDVs defined in BS 6472:2008 as the basis for assessment criteria (**Table 16.4**):

Place and Time	Low Probability of Adverse Comment ($ms^{-1.75}$)	Adverse Comment Possible ($ms^{-1.75}$)	Adverse Comment Probable($ms^{-1.75}$)
Residential buildings (16h day)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings (8h night)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 16.4: Human Response to Vibration Dose Value Ranges in BS6472

22 To assess the magnitude of any vibration effect, assessment categories defined below (**Table 16.5**) have been used in the assessment (measured on a normally loaded floor of any bedroom or living room).

Effect Classification	VDV ($ms^{-1.75}$) Daytime (07:00-23:00)	VDV ($ms^{-1.75}$) Night-time (23:00-07:00)
Negligible	<0.2	<0.1
Minor	>0.2 and ≤0.4	>0.1 and ≤0.2
Moderate	>0.4 and ≤0.8	>0.2 and ≤0.4
Major	>0.8	>0.4

Table 16.5: Vibration Effect Magnitude Criteria: Human Response

23 Guidance to protect against building damage is provided within BS ISO 4866:2010 Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures. The Standard notes that the risk of damage (even cosmetic damage) to modern robust buildings from transient vibration tends to zero below a peak particle velocity of 12.5mm/s. For convenience, and to err on the side of caution, this value is often rounded down to 12mm/s peak particle velocity (PPV).

24 When considering continuous vibration, it is generally accepted that the guide values should be reduced by up to 50%. The criteria below have therefore been adopted to identify potential significant adverse effects on buildings arising from construction vibration associated with the Onshore Works.

25 These criteria are summarised below and have been used to determine if the effect is significant (**Table 16.6**).

Type of Vibration	Threshold of Significant Effect (PPV at building foundation)
Continuous vibration	6mm/s
Intermittent vibration	12mm/s

Table 16.6: Construction Vibration Significance Criteria: Building Damage

16.5.4 Study Area

26 The area surrounding the proposed cable route is a mixture of rural and residential, mainly scattered farmhouse properties with more residential dwellings located within village areas. Residential properties along the cable route are located in the following areas:

- Thorntonloch;
- Skateraw;
- Thurston Manor;
- Innerwick;
- Woodhall.

27 The area surrounding the substation does not have any noise sensitive receptors within close proximity of the works (i.e., more than 1 km away), and as such noise or vibration from these works are expected to have a negligible effect at any noise sensitive receptors.

16.5.5 Cumulative and In-combination Assessment Approach

28 Noise and vibration effects from other developments expected to coincide with this development have been considered in the cumulative assessment. Where no significant effects from other developments are expected to occur, or where there are no noise sensitive receptors from this assessment within 1 km of other developments, it is predicted that there will be no cumulative effect.

29 In-combination effects in association with other aspects of the Neart na Gaoithe Wind Farm Onshore Works which have been considered as part of the assessment include offshore components of the works at the landfall area.

16.5.6 Baseline Description

30 As part of the noise assessment, an assessment of the existing noise climate in the area around the proposed cable route has been necessary. This section details the attended and unattended baseline noise surveys which have been conducted. A summary of noise survey results has been included, full survey results provided in **Appendix 16.2**.

31 These baseline measurements have been used to define the threshold values for construction noise from the Onshore Works associated with the scheme and have been used in combination with the baseline traffic survey conducted to determine existing road traffic noise levels and the potential change in road traffic noise levels due to construction traffic on local roads.

16.5.7 Existing Conditions

32 Baseline noise levels have been measured at various locations adjacent to the proposed cable route. A noise survey has been conducted with attended and unattended measurements. Night-time attended measurements were undertaken to help verify unattended measurements at one location at the request of ELC.

33 The noise survey was carried out over a period of approximately two weeks from 2 – 17 August 2011 to ensure representative noise level data were measured. Meteorological conditions during the unattended survey period were monitored; data affected by adverse weather conditions, e.g. high winds, have been discarded.

34 Environmental noise loggers were located on residential properties representative of nearest affected dwellings to the proposed construction works. Five measurement locations were chosen in consultation with ELC to establish representative baseline noise levels. These locations and the existing ambient noise environment are described below in **Table 16.7** and identified in **Figures 16.1** to **16.5.**

35 Loggers were located in acoustically hemispherical ‘free field’ conditions, at least 3.5 m away from any vertical reflective surfaces. The loggers were configured to measure and store data in fifteen minute samples. This enabled the time history information for ambient and background noise to be established at the measurement locations.

Location	Address	Measurements Undertaken	Description of Site	Ambient Noise Environment
1	17 Thorntonloch Holdings, EH42 1QS	Unattended, attended daytime and night-time	Residential dwelling, representative of Thorntonloch area.	Road traffic noise from the A1, railway noise
2	Skateraw, EH42 1QR	Unattended and attended daytime	Residential dwelling	Road traffic noise from the A1
3	Field opposite Hunter Steading, Thurston Mains	Unattended and attended daytime	Farmland opposite residential dwellings	Local road traffic noise
4	Temple Mains Farm, Innerwick	Unattended and attended daytime	Farmland adjacent to residential dwelling	Local road traffic noise, hum from overhead power transmission lines*
5	Woodhall Farm, Woodhall, EH42 1SH	Unattended and attended daytime	Residential dwelling located on farmland	Local farm traffic noise: tractors, livestock

Table 16.7: Measurement Locations for Noise Survey

*Note: For construction noise assessment, ambient noise levels in the absence of the noise from the overhead lines have been used to determine construction noise threshold values at this location, as the baseline measurement was affected by this.

36 Graphs showing the average weekday and weekend noise data are included in **Appendix 16.2**.

37 As all existing ambient noise levels measured at representative noise sensitive receptors across the study area were below 65dB(A), by applying the threshold category levels outlined in **Table 16.2**, the daytime construction noise threshold at all noise sensitive receptors is Category A – 65dB(A).

38 As night-time construction works are likely to be undertaken at the rail crossing near Skateraw Gate, and potentially at the landfall area (depending on which construction technique is utilised), an attended night-time noise survey was conducted to verify noise logger results. The attended night-time survey was conducted at Location 1 (Thorntonloch Holdings). The results of the attended noise survey and simultaneous noise logger measurements are included in **Appendix 16.3**. The attended survey results verify noise logger measurements, with variations between the measurements typically being less than ±1.0dB.

39 **Tables 16.8-16.12** below summarise the results for the noise survey showing ambient (L_{Aeq}) and background (L_{A90}) noise levels for each location. The time periods included are as defined in Appendix E3 of BS 5228: Part 1, as it has been proposed that standard working hours will occur within the periods defined in BS5228.

Day	Time of Day	Time Period	Noise Level, dB(A)	
			L90	Leq
Weekday	Day (07:00 – 19:00)	12 hour	50	59
	Evening (19:00 – 23:00)	4 hour	45	56
	Night (23:00 – 07:00)	8 hour	40	54
Saturday	Day (07:00 – 13:00)	6 hour	47	58
	Evening and weekend (13:00 – 23:00)	10 hour	49	59
	Night (23:00 – 07:00)	8 hour	37	52
Sunday	Weekend (07:00 – 23:00)	16 hour	49	57
	Night (23:00 – 07:00)	8 hour	36	51

Table 16.8: Location 1 Measurement Results (dB re 2 x 10-5Pa)

Day	Time of Day	Time Period	Noise Level, dB(A)	
			L_{90}	L_{eq}
Weekday	Day (07:00 – 19:00)	12 hour	54	60
	Evening (19:00 – 23:00)	4 hour	48	57
	Night (23:00 – 07:00)	8 hour	45	56
Saturday	Day (07:00 – 13:00)	6 hour	52	59
	Evening and weekend (13:00 – 23:00)	10 hour	53	60
	Night (23:00 – 07:00)	8 hour	41	54
Sunday	Weekend (07:00 – 23:00)	16 hour	52	60
	Night (23:00 – 07:00)	8 hour	40	53

Table 16.9: Location 2 Measurement Results (dB re 2 x 10-5Pa)

Day	Time of Day	Time Period	Noise Level, dB(A)	
			L90	Leq
Weekday	Day (07:00 – 19:00)	12 hour	42	51
	Evening (19:00 – 23:00)	4 hour	38	48
	Night (23:00 – 07:00)	8 hour	35	44
Saturday	Day (07:00 – 13:00)	6 hour	36	48
	Evening and weekend (13:00 – 23:00)	10 hour	39	50
	Night (23:00 – 07:00)	8 hour	35	46
Sunday	Weekend (07:00 – 23:00)	16 hour	40	49
	Night (23:00 – 07:00)	8 hour	31	41

Table 16.10: Location 3 Measurement Results (dB re 2 x 10-5Pa)

Day	Time of Day	Time Period	Noise Level, dB(A)	
			L_{90}	L_{eq}
Weekday	Day (07:00 – 19:00)	12 hour	47	52
	Evening (19:00 – 23:00)	4 hour	47	51
	Night (23:00 – 07:00)	8 hour	47	52
Saturday	Day (07:00 – 13:00)	6 hour	46	51
	Evening and weekend (13:00 – 23:00)	10 hour	48	52
	Night (23:00 – 07:00)	8 hour	46	51
Sunday	Weekend (07:00 – 23:00)	16 hour	47	52
	Night (23:00 – 07:00)	8 hour	46	51
Note: Noise levels at this location dominated by transformer hum from overhead power transmission lines.				

Table 16.11: Location 4 Measurement Results (dB re 2 x 10-5Pa)

Day	Time of Day	Time Period	Noise Level, dB(A)	
			L90	Leq
Weekday	Day (07:00 – 19:00)	12 hour	40	57
	Evening (19:00 – 23:00)	4 hour	32	54
	Night (23:00 – 07:00)	8 hour	32	54
Saturday	Day (07:00 – 13:00)	6 hour	39	58
	Evening and weekend (13:00 – 23:00)	10 hour	40	59
	Night (23:00 – 07:00)	8 hour	33	51
Sunday	Weekend (07:00 – 23:00)	16 hour	40	61
	Night (23:00 – 07:00)	8 hour	31	58

Table 16.12: Location 5 Measurement Results (dB re 2 x 10-5Pa)

16.5.8 The 'Do Nothing' Scenario

40 Onshore Works components affecting the existing noise environment will arise from construction activities. In the absence of the development, there will be no temporary change in noise levels due to construction activities.

16.5.9 Routeing and Design Considerations

41 The Onshore Works cover a length of 12.3 km from the landfall area at Thorntonloch, through to the existing substation at Crystal Rig. Construction works will consist of excavation and laying cable alongside the A1 from Thorntonloch, turning south past Thurston Manor towards Crystal Rig, where a new substation will be constructed.

42 The aspect of the Onshore Works likely to affect the existing noise environment in the surrounding areas is noise arising from construction activities. The location of sensitive receptors has been taken into account as a routeing and design consideration for the Onshore Works.

16.6 Assessment of Effects

16.6.1 Construction

43 As all existing ambient noise levels measured at representative noise sensitive receptors across the study area were below 65dB(A), by applying the threshold category levels outlined in **Table 16.2**, the daytime construction noise threshold at all noise sensitive receptors is Category A – 65dB(A).

44 Twenty-four hour working is likely to be conducted where the cable route passes below the East Coast Main Line railway, at the A1 and potentially at the landfall area (if HDD is employed as the construction technique).

45 Noise monitoring has been conducted at Location 1 (see **Table 16.7**), which has provided representative night-time noise data for both Skateraw and the landfall area. Using the existing ambient evening and night-time noise measurements for weekdays, the following thresholds for the evening and night-time time periods have been applied to these receptors:

- Evening – 60dB(A)
- Night-time – 55dB(A)

16.6.1.1 Assessment of Effects

46 Two methodologies have been proposed for construction of the cable route:

- open cut trenching;
- trenchless techniques (including HDD and auger boring).

47 The majority of the route will be constructed using open cut trenching, with trenchless techniques used at several locations along the route. Areas where trenchless techniques may have a significant effect (based on distance to nearest sensitive receptors) are at the following locations:

- beach works (to be confirmed);
- water crossing at Thornton Burn;
- crossing the A1 (possible use of trenchless techniques instead of open cut trench, 24 hour working over a 48 hour period);
- the Network rail crossing (24 hour works over a 3 week period, ECML).

48 These are the locations where noise sensitive receptors are in close proximity to the works.

49 It has been identified that alternative forms of trenchless working may be used, such as auger boring, or thrust boring. It has been assumed that noise from these methodologies would be similar to HDD, with noise levels dominated by equipment at surface level.

16.6.2 Assessment of Effects: Construction Noise

50 Construction noise levels have been assessed for the following situations:

- open cut trenching and haul route construction (daytime);
- rock breaking at the landfall area (using rock breaking equipment mounted on excavators).
- vibratory piling at the landfall area for installation of retaining wall;
- trenchless construction techniques (daytime at all locations identified above) and night-time (Skateraw Gate, A1 and potentially the landfall area – 24 hours);
- use of the temporary construction haul route within the application boundary by heavy goods vehicles (daytime);
- the increase in road traffic noise levels due to construction traffic on local roads (heavy goods vehicles and general construction traffic).

51 As the nearest noise sensitive receptor to the substation is more than 1 km away, it is expected that there will be no noise and vibration effect from construction of the substation structure.

16.6.2.1 Open Cut Trench

52 Based on information provided for the construction schedule, it has been assumed that approximately 160 m of the cable route will be constructed over a week long period. As it is expected that construction works will be quasi-static along the route, noise levels at noise sensitive receptors have been calculated over a one month period, which accounts for the following factors:

- location of the noise source;
- percentage on-time of activity over a one-month period.

53 This methodology is illustrated in **Diagram 16.1**.

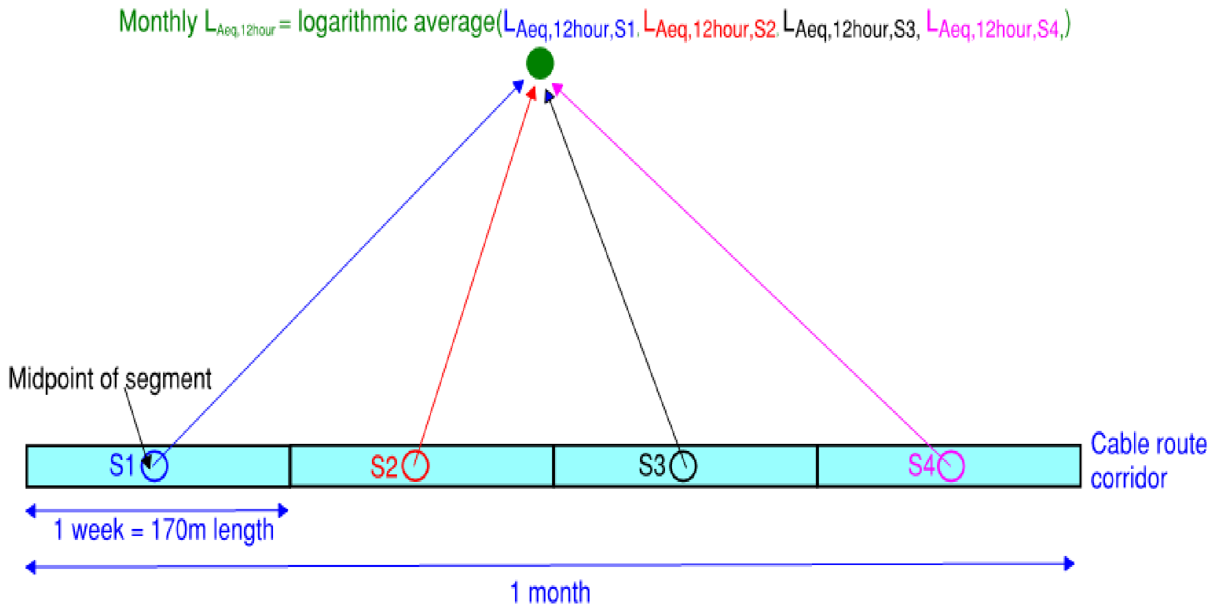

Diagram 16.1: Area Calculation of Construction Noise Levels over One Month Period

54 The following assumptions have been made regarding the percentage on-time of each activity over each month:

- construction of haul route: 100% of the month, i.e. occurs at each segment for 1 week. It has been assumed that construction of the haul route is completed prior to the activities below;
- trenching: 100%; and
- cable installation: 66%

Activity	Plant	BS 5229-1 Reference	Plant Details		
			No.	% on-time	Sound power level, dB(A)
Construction of haul route	Dump truck	Table C2-30	2	80	107
	Lorry	Table C10-13	2	80	106
	Vibratory roller	Table C2-38	1	30	101
Rock breaking (at landfall only)	Breaker mounted on excavator	Table C1-1	2	50	121
Vibratory piling (installation of retaining wall at landfall and ECML)	Minicat, top-feed, electric vibrator	Table C12-62	1	20	110
Trenching (including stabilisation of trench walls)	Tracked excavator	Table C2-3	2	80	106
	Dump truck	Table C2-30	1	80	107
	Lorry	Table C10-13	1	50	106
Cable installation (delivery, distribution and compaction of materials, concrete protection, refilling of trench)	Lorry	Table C10-13	1	50	106
	Dump truck (delivery of materials)	Table C2-30	1	50	107
	Dump truck (refilling of trench)	Table C2-30	1	80	107
	Tracked excavator (distribution of materials)	Table C2-3	1	50	106
	Tracked excavator (concrete protection)	Table C2-3	1	60	106
	Tracked excavator (refilling of trench)	Table C2-3	1	80	106
	Vibratory compactor	Table C2-38	1	30	108
	Lorry with lifting boom	Table C4-53	1	30	105
	Tracked mobile crane	Table C3-28	1	30	95
	Concrete mixer truck	Table C4-20	1	40	108
	Handheld welder	Table C3-31	1	20	101
	Small compactor (mini planer)	Table C5-9	1	30	96

Table 16.13: Construction Plant Details

55 Noise levels at the nearest noise sensitive receptors have been calculated and are summarised in the tables below. Noise sensitive receptors have been grouped by location, with noise levels to the nearest noise sensitive receptor at each location assessed. Where noise levels are predicted to exceed the significance criteria these values are shown in **<u>bold and underlined</u>**. The values included represent the monthly $L_{Aeq(daytime)}$ levels. Maps identifying the representative locations for construction noise calculations have been included in **Appendix 16.2.**

		Predicted Monthly $L_{Aeq,(daytime)}$, dB			
		Haul route construction	Construction of the cable route		
Ref	Area		Trenching	Cable installation	Total monthly construction noise level
R1	Thornly	63	63	63	**66**
R2	Thorntonloch	60	59	60	63
R3	Thorntonloch Bridge	64	63	64	**67**
R4	Thorntonloch Holdings	**68**	67	68	**70**
R5	Thorntonloch Bridge	**68**	67	68	**71**
R6	Station House	52	51	52	55
R7	Skateraw	53	53	53	56
R8	Skateraw Gate (including vibratory piling for retaining wall)	63	63	63	**66**
R9	Thurston	49	48	49	52
R10	Temple Mains	60	59	60	63
R11	Ogle Lodge	62	61	62	**65**
R12	Thurston Mains Cottages	50	49	50	53
R13	Woodhall Farm	64	64	64	**67**
R14	Woodhall	47	46	47	49
R15	Weatherly	59	59	59	62

Table 16.14: Open Cut Trench Predicted Construction Noise Levels

56 A summary of the areas where the construction noise levels are predicted to exceed the threshold is included below:

Ref	Area	Noise Threshold Level	Predicted Monthly $L_{Aeq,daytime}$, dB	Number of affected properties	Existing ambient noise levels $dBL_{Aeq,12hour}$
R1	Thornly	65	66	1	59
R3	Thorntonloch Bridge	65	67	1	59
R4	Thorntonloch Holdings	65	70	6	59
R5	Thorntonloch Bridge	65	71	2	59
R8	Skateraw Gate	65	66	1	60
R11	Ogle Lodge	65	65	1	51
R13	Woodhall Farm	65	67	1	57

Table 16.15: Summary of Open Cut Trench Predicted Construction Noise Levels Exceeding Significance Criteria

57 The potential for the resulting noise to cause a significant adverse effect is evaluated for an area taking account of matters such as:

- number of receptors subject to the noise effect;
- the proportion of the community subject to the effect;
- existing absolute noise levels (particularly very noisy and quiet/tranquil areas).

58 Taking account of the factors outlined above, it is predicted that the following areas will experience moderate adverse effects from noise from construction works:

- R4 Thorntonloch Holdings (as more than 1 property will be affected);
- R5 Thorntonloch Bridge (as more than 1 property will be affected);
- R11 Ogle Lodge (because of lower existing ambient noise levels).

59 Construction of the cable route will be temporary as the works progress along the route. On this basis, areas with single receptors affected by the works and higher ambient noise levels have been considered as having a lower potential for significant adverse effects.

16.6.2.2 Trenchless Techniques (including HDD)

60 Noise levels from sections of the cable route where trenchless techniques will be employed have been calculated on a worst-case basis at the closest point to the nearest noise sensitive receptor.

61 For trenchless techniques, it has been assumed that noise levels will be dominated by equipment at surface level.

62 The following assumptions have been made with regards to plant for trenchless techniques:

Activity	Plant	BS 5229-1 reference	Plant Details		
			No	% on-time	Sound power level, dB(A)
Daytime (Trenchless Technique)	Mobile crane	Table C3-28	1	25	95
	Dump truck	Table C2-30	1	25	107
	Loading shovel	Table C2-3	1	30	106
	Directional drill (generator)	Table C4-96	1	100	105
	Lorry	Table C8-21	1	10	106
	Water tanker	Table C4-89	1	25	107
Additional plant for night-time	Power for lighting	Table C4-86	1	100	93

Table 16.16: Summary of Plant Involved in Trenchless Construction

63 Noise levels at the nearest noise sensitive receptors have been calculated and are summarised below. The values included represent the worst case levels for each time period. Where noise levels are predicted to exceed the significance criteria, these levels have been highlighted in **bold underlined** text.

Ref	Area	Daytime		Night-time		No Affected	Existing Ambient Noise Levels $dBL_{Aeq,T}$
		Noise Threshold Level	Predicted $L_{Aeq,\ daytime}$, dB	Noise Threshold Level	Predicted $L_{Aeq,8hour}$, dB		
R2	Thorntonloch	65	59	N/A	N/A	1	59 (Day)
R4	Thorntonloch Holdings	65	**<u>68</u>**	55	**<u>68</u>**	1	59 (Day) 54 (Night)
R8	Skateraw Gate	65	62	55	**<u>62</u>**	1	60 (Day) 56 (Night)

Table 16.17: Summary of Predicted Noise Levels Exceeding Significance Criteria under Trenchless Construction Scenario

64 Noise levels from trenchless techniques such as HDD during the daytime are not expected to result in significant adverse effects at the nearest noise sensitive receptors, as the works along the cable route (apart from the landfall area) will be temporary in nature and are not anticipated to not take longer than one week to complete in any one location. Works at the landfall area have been assessed separately and are included below.

65 Night-time noise levels from works at the rail crossing will result in a significant moderate adverse effect at the nearest noise sensitive receptor at Skateraw Gate (ECML over a period of 3 weeks) and Thorntonloch Holdings (A1 over a period of 48 hours). With appropriate mitigation, it is expected that these levels can be reduced.

16.6.2.3 Landfall Area

66 It has not yet been determined if the landfall section of the route will be constructed using HDD or an open cut trench methodology (with rock-breaking using equipment mounted on excavators). Both methodologies have therefore been included in the assessment below. As works will be conducted over a smaller area, i.e. restricted to a specific location, the noise levels presented below are the worst-case predictions (i.e. closest points of the HDD works to the residential receptors).

	Predicted L_{Aeq}, dB					
	HDD Method		Open-cut Trench Method (daytime only)			
Receptor	Daytime (threshold 65)	Evening/ night-time (threshold 55)	Rock breaking	Installing retaining wall (including vibratory piling)	Trench-ing	Cable installat-ion
Thorntonloch Caravan Park	53	53	63	57	57	59
Thornly (nearest beach-front property, 100 m from works)	61	61	**<u>68</u>**	63	63	65

Table 16.18: Summary of Predicted Landfall Area Noise Levels

67 In general, works at the landfall area using either methodology are not expected to result in a significant effect during the day-time period (with no night-time working for open cut trench methodology), with the exception of rock breaking activities, predicted noise levels are no greater than the daytime threshold of 65dB(A). Rock breaking activities will result in a moderate adverse effect for one property (Thornly, closest property to the beach works). Due to the low number of receptors affected (1) and with the application of proposed mitigation measures, effects are not considered to be significant.

68 Twenty-four hour working will only be conducted for the HDD methodology and a significant moderate adverse effect will occur for one property (Thornly, closest property to the beach works). With the application of proposed mitigation measures, effects are not considered to be significant.

16.6.2.4 Haul Route: Heavy Goods Vehicles

69 The assessment of noise from the haul route has been completed using the recommended methodology within BS 5228.1, Appendix F, Equation F.6 which requires the following input:

- sound power level of plant;
- number of vehicles per hour;
- average vehicle speed;
- distance of receiving position from centre of haul road.

70 Construction traffic (Heavy Goods Vehicles) along the haul route is expected to comprise 134 trucks per week (with the assumption that the majority of HGV movements will occur during the 5-day week, which is a worst-case assumption), each HGV making a return trip, 268 trips total. This is based on data provided in the traffic assessment, and is the worst case weekly HGVs (per week) volume for the cable route. This equates to 5.4 HGV single trips per hour (or 2.7 HGV return trips per hour, i.e. going to and from the construction site) over a ten hour day, 8am to 6pm).

71 Based on a ten hour day (0800 to 1800 hours), the predicted noise level from the construction haul route is expected to be 50dB$L_{Aeq,10hour}$ at the nearest noise sensitive receptor along the route. This is considered to be not significant, as it is below the daytime threshold criterion of 65dB (A) and is also no greater than the existing ambient noise level (daytime), which ranges from 51 to 60dB (A).

16.6.2.5 Road Traffic Noise: Construction traffic on local roads

72 The effect of change in traffic noise at noise sensitive receptors due to construction vehicles has been assessed. Due to the low traffic flows on local roads (a maximum of 217 vehicles/12 hours), it is not appropriate to use the Calculation of Road Traffic Noise methodology to predict the changes in road traffic noise levels (which is valid for a low flow of 1000 vehicles/18 hours). The percentage change in road traffic volume due to construction vehicles (cars and HGVs) has been used to determine the change in road traffic noise levels.

73 As the existing road traffic flows on the local road network are very low, ranging from 48 to 217 vehicles per 12 hours (0700 to 1900), the existing ambient noise environment is not always dominated by road traffic noise and the change in noise levels due to the change in traffic flow may not necessarily be representative of the change in overall noise levels. For this purpose, the noise contribution from road traffic noise (existing and future) to the overall noise environment has been calculated, by calculating the $L_{Aeq,12hour}$ traffic noise level using the existing traffic flow data (with the sound exposure level of a car pass-by as the source data), which has allowed the change in overall noise levels to be determined.

Area	Affected Properties	Road	Change in Traffic Volume	Assessment (in accordance with significance criteria in Table 16.3)
Thorntonloch, Skateraw	R1, R2, R3, R4, R5, R7, R8	A1	1%	Negligible, as the increase in traffic noise level will be less than 1dB.
Thurston	Multiple properties at Thurston Manor, Hunter Steading	Unnamed road to Thurston from the A1	69%	Increase of 2dB in road traffic noise levels, 1dB increase in overall noise levels, negligible.
Ogle Lodge	R11	Unnamed road west	150%	Increase of 4dB in road traffic noise levels, increase of 1dB in overall noise levels, negligible.
Woodhall Farm	R13, R14	Unnamed road, connection to road leading to Crystal Rig	103%	Increase of 3dB in road traffic noise levels, increase of less than 1dB in overall noise environment, negligible.
Weatherly	R15	Unnamed road to Crystal Rig	313%	Increase of 6dB in road traffic noise levels, predicted increase in ambient noise environment 4dB. Although the change in traffic noise levels is significant and will be noticeable in the overall ambient noise environment, the effect is assessed as minor, due to the low number of affected properties (1).

Table 16.19 Road Traffic Noise Assessment

16.6.3 Assessment of Effects: Vibration

74 The main sources of construction vibration would be from earthworks compaction, trenchless construction techniques and vibratory piling for the installation of the retaining wall.

75 The calculations for vibrations have been based on:

- plant type;
- scaling factors: this assessment has used a scaling factor with a 33.3% probability of the predicted value being exceeded, which is considered to be representative of typical worst-case vibration levels; and
- distance to receptors.

76 However, it should be noted that actual values when measured on site would depend on:

- final selection of plant;
- site ground conditions.

16.6.3.1 Trenchless Techniques

77 Vibration from the HDD (and alternative forms of trenchless methodology) cannot be accurately predicted as there is no standard empirical methodology available to calculate this and there are no manufacturer's data on measured vibration levels from the drill. However, notwithstanding this limitation, an assessment of the available evidence and existing literature has been prepared by Cathie Associates and is included as **Appendix 16.5**.

78 Advice provided by an HDD contractor has reported that vibration from trenchless techniques (such as HDD) does not typically result in noticeable levels of vibration, although there is no data available to quantify the vibration arising from the works. As there is currently no established guidance or prediction methodology available to calculate vibration from trenchless techniques, it is proposed that monitoring of vibration levels from the drill rig is undertaken at the start of the works to confirm that any vibration exposure is acceptable at the nearest sensitive receptors. Based on the previous experience of these works, no disturbance is expected. However, if vibration levels were found to be noticeable, appropriate controls would be put in place to prevent significant effects by best practicable means as described in the mitigation section.

16.6.3.2 Open Cut Trench

79 Predicted vibration levels from the open cut trench methodology are summarised below. The values presented below are representative of vibration levels predicted at the ground floor slab of the nearest residential receptor from compaction works.

80 Due to the distances involved, with most receptors more than 100 m away from the works, none of the receptors will experience any significant effects due to vibration.

Ref	Area	Earthworks compaction		Effect (in accordance with Table 16.5 and 16.6)
		PPV, mm/s	VDV, $ms^{-1.75}$	
R1	Thornly	0.18	0.10	Compaction: negligible (VDV), not significant (PPV)
R2	Thorntonloch	0.12	0.07	Compaction: negligible (VDV), not significant (PPV)
R3	Thorntonloch Bridge	0.26	0.14	Compaction: negligible (VDV), not significant (PPV)
R4	Thorntonloch Holdings	0.54	0.29	Compaction: minor (VDV), not significant (PPV)
R5	Thorntonloch Bridge	0.58	0.31	Compaction: minor (VDV), not significant (PPV)
R6	Station House	0.03	0.02	Compaction: negligible (VDV), not significant (PPV)
R7	Skateraw	0.04	0.02	Compaction: negligible (VDV), not significant (PPV)
R8	Skateraw Gate	0.19	0.10	Compaction: negligible (VDV), not significant (PPV)
R9	Thurston	0.02	0.01	Compaction: negligible (VDV), not significant (PPV)
R10	Temple Mains	0.12	0.07	Compaction: negligible (VDV), not significant (PPV)
R11	Ogle Lodge	0.15	0.08	Compaction: negligible (VDV), not significant (PPV)
R12	Thurston Mains Cottages	0.03	0.01	Compaction: negligible (VDV), not significant (PPV)
R13	Woodhall Farm	0.30	0.16	Compaction: negligible (VDV), not significant (PPV)
R14	Woodhall	0.01	0.01	Compaction: negligible (VDV), not significant (PPV)
R15	Weatherly	0.10	0.05	Compaction: negligible (VDV), not significant (PPV)

Table 16.20: Summary of Vibration Levels (Open Cut Trench, Earthworks Compaction Daytime)

Receptor	Vibratory piling		Effect (in accordance with Table 16.5 and 16.6)
	PPV, mm/s	VDV, $ms^{-1.75}$	
Thorntonloch Caravan Park	N/A	N/A	Prediction methodology is only valid for distances less than 100 m
Thornly (nearest beach-front property, 100 m from works)	0.30	0.29	Minor (VDV), not significant (PPV)
Skateraw Gate	0.4	0.36	Minor (VDV), not significant (PPV)

Table 16.21: Summary of Vibration Levels (Open Cut Trench, Vibratory Piling Daytime)

16.6.4 Mitigation

81 General principles of construction site noise control would be followed according to the guidance given in BS 5228: Part 1, 2009. This requires that noise control measures would be adopted according to 'Best Practicable Means' (BPM) to prevent and reduce significant adverse effects that may arise during the proposed works. BPM is defined as those measures which are reasonably practicable having regard amongst other things to local conditions and circumstances, to the current state of technical knowledge and to programme implications.

82 To minimise the level of noise to which sensitive receptors will be exposed, BS 5228 recommends the following measures as guidance on best available techniques to be implemented on site. Construction will be undertaken in accordance with this guidance.

83 General measures:

- provide an induction to site personnel addressing their responsibilities with regard to noise and vibration management;
- plan hours of working, taking into account the nature of land use in the areas concerned and duration of the work;
- provide an out-of-hours works procedure to minimise the effect of any necessary works outside daytime working hours;
- notify potentially affected residents of construction activities likely to affect amenity due to noise or vibration in advance.

84 Construction plant and equipment measures:

- where practicable, employ quiet working methods , including the use of the most suitable plant, and suitably sized plant;
- avoid unnecessary revving of engines and switch off equipment when not required;
- minimise drop height of materials;
- start-up plant and vehicles sequentially rather than all together;
- use broadband (i.e. white noise) reversing alarms on mobile rather than tonal;
- orientate plant from which the noise generated is known to be directional, where practicable, so that the noise is directed away from noise sensitive receptors (for example, locate generators for site power in a position that provides maximum shielding to noise sensitive receptors);
- use noise barriers in the form of temporary hoarding, stacks of materials such as bricks, timber or top soil, provide screening to nearby sensitive receptors.

85 Given the quasi-static nature of the works, site hoarding may not be an appropriate mitigation measure, but will be considered for daytime trenching works when the cable route is at the nearest location to R4 Thorntonloch Holdings and R5 Thorntonloch Bridge

86 For night-time works at the rail crossing and at the landfall area (if the trenchless technique is employed) the following measures will be applied:

- all plant will be located as far away from Skateraw Gate as practicable;
- site hoarding will be used around static plant to provide shielding to Skateraw Gate.

87 At the landfall area, the possible treatment and amount of mitigation required will be dependent on the chosen construction methodology. Screening of trenchless plant will be more effective/feasible than providing screening under the open cut trench scenario, particularly given the potential for 24 hour working. Under the open cut trenching scenario, screening at the receptor may be a more viable option, due to the quasi-static nature of the works. Scheduling of works will be important under the open-cut trench scenario to ensure noisier works are completed during daytime hours where feasible.

88 Experience has shown that problems associated with construction noise and vibration can, to a large extent, be mitigated by conducting a sensitive public consultation exercise. A communication and consultation strategy will be produced to inform the local community of construction issues. Engagement will start before the works on site commence. A named person who can be contacted in the event of query or concern will also be provided. Public liaison will continue throughout the works.

89 Given the inherent difficulties in predicting with certainty whether or not vibration levels from construction activities will be at a noticeable level at the nearest residential receptors, advance notification will be given to affected residents outlining:

- details of construction activities that will result in noticeable levels of vibration at residential properties;
- a description of the likely levels of vibration;
- details of when works will take place (i.e. daytime) and of the duration of works.

90 Current industry advice has indicated that vibration from trenchless techniques such as HDD does not typically result in noticeable levels of vibration. As there is currently no established guidance or prediction methodology available to calculate vibration from trenchless techniques, a qualitative assessment has indicated that further investigation into vibration levels from the drill rig will be required comprising:

- initial vibration monitoring to confirm that vibration from the trenchless technique will not result in a significant effect at the nearest sensitive receptors;
- if a significant effect is predicted to occur following the vibration monitoring, adjustments to the equipment to reduce vibration levels at the source (dependent on final plant selection and trenchless technique).

16.6.5 Residual Effects

91 By applying best practicable mitigation means, as outlined above, and providing advance notification to residents, it is expected that the residual effect from noise and vibration will be temporary and **minor**.

16.6.6 Decommissioning

92 It is difficult to predict the likely effects of decommissioning on noise and vibration. However, likely effects will be concentrated at the eastern end of the route and are unlikely to be greater than those predicted during the construction phase.

16.6.7 Operation

93 The operational noise component has been scoped out of the assessment as there are no noise sensitive receptors within 1 km of the operational (substation) component of the works.

16.7 Monitoring

94 Where noise and vibration effects from construction works have been assessed as a significant effect, the appointed contractor will provide a schedule of noise and vibration monitoring to ensure that effects from particularly noisy activities and plant can be monitored and, where necessary, controlled.

16.8 Assessment of In Combination Effects

95 It is anticipated that the jack up rig (off-shore component of works) will be on location at the same time as the landfall works.

96 As no quantitative assessment for the off-shore component has been provided, a qualitative assessment for the potential significance of in-combination effects has been included.

97 If a trenchless methodology is used at the landfall, and assuming adequate control of noise from the off-shore works (i.e. application of best practicable means), then the likelihood of in-combination effects resulting in an adverse significant impact will be low.

98 If an open cut trench methodology is used at the landfall, it is likely that the in-combination effects will result in a moderate adverse significant impact at the Thornly property (100 m from the landfall, nearest beachfront property to the works).

16.9 Assessment of Cumulative Effects

99 The cumulative effect assessment has considered the noise and vibration effect from the following schemes:

- Aikengall II Wind Farm;
- Crystal Rig III Wind Farm;
- the SPT NnG Scheme.

16.9.1 Construction

16.9.1.1 Assessment of Effects

100 The locations of each of the developments above are far enough away from any noise sensitive receptor discussed in this assessment (more than 1 km) such that any construction works conducted concurrently will result in a negligible cumulative effect.

16.9.1.2 Mitigation

101 No mitigation is required.

16.9.1.3 Residual Effects

102 There are no residual cumulative effects.

16.9.2 Operation

103 The operational noise component has been scoped out of the assessment as there are no noise sensitive receptors within 1 km of the operational (substation) component of the works. Therefore, there are no operational cumulative effects.

16.10 Summary

104 **Table 16.22** below summarises the predicted significant effects on noise and vibration.

Predicted Effect	Significance	Mitigation	Significance of Residual Effect
Construction			
Noise: daytime (open cut trench method/haul route construction)	Moderate (temporary) at Thorntonloch Holdings (R4), Thorntonloch Bridge (R5) and Ogle Lodge (R11)	Application of best practicable means	**Minor** **(temporary)**
Noise: night-time (HDD or other trenchless techniques at rail crossing)	Moderate (temporary)at Skateraw Gate (R8)	Application of best practicable means. Site hoarding around static plant. Screening of receptor. All plant to be located as	**Minor** **(temporary)**

Predicted Effect	Significance	Mitigation	Significance of Residual Effect
		far as practicably possible from Skateraw Gate	
Noise: night-time (HDD or other trenchless techniques at A1)	Moderate (temporary)at Thorntonloch Holdings	Application of best practicable means. Site hoarding around static plant. Screening of receptor.	**Minor** **(temporary)**
Noise: daytime (rock breaking at landfall; if open cut trenching is used)	Moderate at Thornly	Application of best practicable means Site hoarding around static plant Screening of receptor	**Minor** **(temporary)**
Noise: 24 hour working (HDD or other trenchless techniques at landfall area)	Moderate at Thornly	Application of best practicable means Site hoarding around static plant Screening of receptor	**Minor** **(temporary)**
Vibration: HDD or other trenchless techniques	Unknown	Vibration monitoring for trenchless techniques. Where a significant effect is predicted to occur, adjustments to the equipment will be undertaken to reduce vibration levels at the source.	**Unknown** **(significant effects considered unlikely)** **(temporary)**
Operation			
N/A	N/A	N/A	**N/A**
Cumulative Effects			
Noise	Negligible	None proposed	**Negligible**
Vibration	Negligible	None proposed	**Negligible**
In-Combination Effects			
Noise: daytime (open cut trenching at the landfall including rock breaking in combination with offshore activities at the jack up barge)	Moderate at nearest sensitive receptor	Application of best practicable means for on and offshore activities	**Minor**
Vibration	Negligible	None proposed	**Negligible**

Table 16.22: Summary of Predicted Significant Effects

16.11 References

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BSI, BS 4142:1997, Method for Rating industrial noise affecting mixed residential and industrial areas.

BSI, BS ISO 4866 Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures, 2010.

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