

CARDIGAN TIDAL FLOOD RISK MANAGEMENT SCHEME

Appendix 5.1 – Noise and Vibration Impact Assessment



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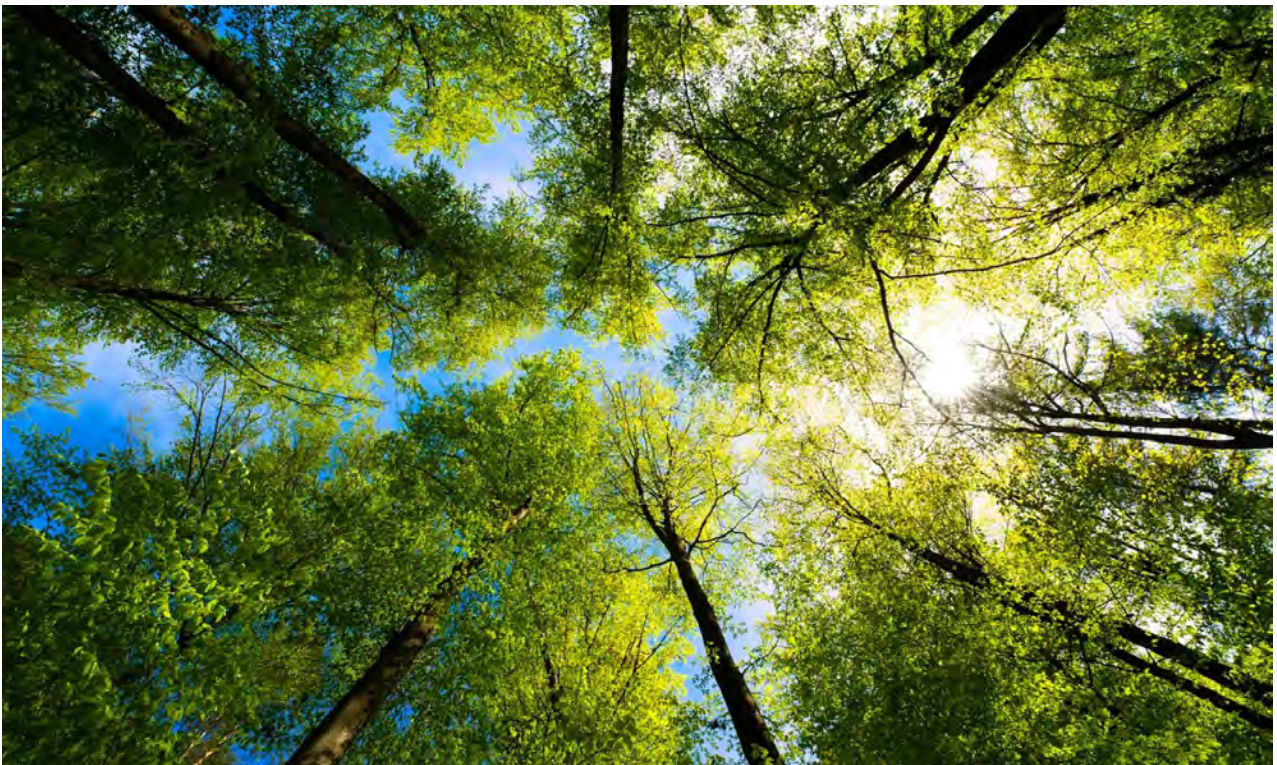
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Report
Noise and Vibration Impact Assessment

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Cardigan Tidal Flood Risk Management Scheme

Noise and Vibration Impact Assessment



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1. Introduction

Ramboll has been appointed by Binnies on behalf of Natural Resources Wales (NRW) to support the Environmental Impact Assessment (EIA) for the Cardigan Tidal Flood Risk Management Scheme (TFRMS, henceforth referred to as 'the Scheme'). The Scheme aims to reduce the risk of tidal flooding from the River Teifi to the town of Cardigan.

This report presents the Noise and Vibration Impact Assessment (NVIA). It has been prepared to identify and evaluate the likely significant environmental effects of noise and vibration associated with the Scheme's construction phase. The assessment covers both on-site activities and construction traffic on surrounding roads.

The potential effects of construction noise and vibration are central to this assessment as they can significantly impact human health, well-being, and general amenity.

For residential receptors, high noise levels can cause disturbance, sleep disruption, and interfere with the peaceful enjoyment of homes. For non-residential receptors, such as offices, retail, and hotels, noise can disrupt concentration, communication, and commercial activities. Ground-borne vibration can also cause disturbance to people and, at high levels, poses a risk of cosmetic damage to buildings.

The findings of this assessment are intended to be summarised within the 'Population and Human Health' chapter of the Environmental Statement (ES), which is being prepared by Binnies. This NVIA report will form a technical appendix to the ES.

The assessment has been undertaken to evaluate the impact of airborne noise and ground-borne vibration from on-site construction at nearby residential receptors and other noise-sensitive properties. This has been undertaken in based on guidance from BS 5228:2009+A1:2014 (parts 1 and 2).

A construction road traffic noise assessment has also been conducted based on data from the transport consultant and assessed using methodologies in the Calculation of Road Traffic Noise (CRTN) and criteria from the Design Manual for Roads and Bridges (DMRB).

This report describes the full assessment methodology; the likely significant environmental effects identified; mitigation which may avoid or minimise any significant adverse effects; and the likely residual effects after these measures have been employed.

A glossary of acoustic terms and their meanings have been included in Appendix A1 - Acoustic Glossary.

This Noise and Vibration Impact Assessment has been prepared by suitably qualified acousticians with extensive experience in environmental noise and vibration assessments of construction. The lead author holds an MSc degree in Acoustics and is a corporate member of the Institute of Acoustics (IOA).

2. Proposed Scheme

The Scheme is designed to reduce the risk of tidal flooding in Cardigan, Ceredigion, taking into account predicted sea level rises. The scheme is located in west Wales along the bank of the River Teifi, approximately covering a 327m section upstream of Cardigan Bridge.

The proposed flood defence is engineered to provide a consistent protection level of 4.95m above ordnance datum (AOD). This specification provides a 1-in-200-year annual exceedance probability (AEP) design standard, which incorporates climate change projections. The entire scheme is intended to have a 100-year design life.

The new defence will consist of sheet piles topped with reinforced concrete walls in specific sections. It will be constructed within an area bounded by Castle Street to the west and Gloster Row car park to the east. This site already contains existing infrastructure, including current flood defences, residential and commercial buildings, the car park, and local roads.

3. Assessment Methodology

3.1 Key Legislation, Policy and Guidance Considerations

The noise and vibration assessment has been undertaken within the context of relevant planning policies, guidance documents and legislation. These are summarised in Appendix A2 - Key Legislation, Policy and Guidance Considerations.

3.2 Study Area

The study area for this assessment was defined as 300m from the proposed scheme. All sensitive receptors within this area were screened, and those with the potential to be affected by construction noise and vibration have been included in this assessment.

3.3 Significance Criteria

A noise or vibration impact is a change in the acoustic environment. This can be caused by introducing a new noise source (or changing an existing one) or by introducing a new noise-sensitive receptor (such as a new residential building) into an area.

The magnitude of this impact (which can range from 'no change' to 'high') is determined by several factors, including:

- The absolute noise or vibration level;
- The change in the noise or vibration level;
- The duration and frequency of the exposure; and
- The time of day at which it occurs.

The significance of the effect depends on the impact's magnitude as well as the sensitivity of the receptor (e.g., residential, commercial, or educational). For this assessment, effects are assessed using a scale from 'major adverse' to 'negligible', and a duration of short, medium, or long term. A 'major' or 'moderate' effect constitutes a 'significant effect'.

Noise or vibration levels above the threshold for moderate adverse effect are considered 'significant' and should be avoided; above the major adverse effects threshold are considered to be unacceptable and should be prevented.

Table 1 details how these significance levels relate to the action that should be taken.

Table 1 Significance of Adverse Effect Related to mitigation actions

Significance of Effect	Action to be taken
Negligible	No specific measures
Minor adverse	Mitigate and reduce to a minimum
Moderate adverse	Avoid
Major adverse	Prevent

3.4 Construction Noise

Construction noise impacts have been assessed in accordance with BS 5228: Part 1. As a baseline noise survey has not been carried out, a worst-case baseline scenario has been assumed for all receptors. The specific criteria applied differ for residential and non-residential properties.

The noise thresholds presented are not intended as legal limits for construction noise but are the criteria used to determine the significance of effects for EIA.

Residential Receptors

For residential receptors, the 'ABC method' (BS 5228: Part 1, Section E.3.2) has been used. Given the lack of baseline data, all residential receptors are assumed to fall within Category A of the criteria, as detailed in Table 2. This represents the quietest ambient noise environment and is therefore the most stringent, worst-case approach.

Table 2 Construction Evaluation Criteria

Assessment category and threshold value period	Threshold value, in decibels (dB) ($L_{Aeq, T}$)		
	Category A A)	Category B B)	Category C ^{C)}
Night-time (23:00 – 07:00)	45	50	55
Evening and weekends ^{D)}	55	60	65
Daytime (07:00 -19:00) and Saturdays (07:00 – 13:00)	65	70	75
Note 1: A potential significant effect is indicated if the $L_{Aeq, T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq, T}$ noise level for the period increases by more than 3 dB due to site noise. Note 3: Applied to residential receptors only.			
A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values. D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.			

Residential Receptor Significance

The thresholds from Table 2 (for residential) are used to determine the magnitude of impact, as shown in Table 4. As no baseline data is available, the minor effect threshold would be 55 dB for residential.

Table 3 Magnitude of Impact from Construction Noise (Residential)

Magnitude of Impact	Total Construction Noise Level ($L_{Aeq, T}$)
Negligible	Less than 55dB
Minor adverse	Greater than 55dB and less than 65dB
Moderate adverse	Greater than 65dB (ABC Threshold Value) and less than 70dB
Major adverse	Greater than 70dB

These impact magnitudes are then used to define the significance of the effect. If the 'Moderate Adverse' criterion is exceeded, other project-specific factors, such as the duration and character of the impact, are considered to determine the likely significant effect. All residential receptors are automatically treated as high sensitivity.

Non-Residential Receptors

For non-residential receptors (e.g., commercial and educational institutions), 'Example Method 2' (BS 5228: Part 1, Section E.3.4) has been adopted. This method assesses significance based on a change in noise level. As no baseline data is available, a lower cut-off free-field value of 65 dB $L_{Aeq,T}$ has been assumed for the daytime period. A significant effect is generally considered to be indicated if the construction noise level exceeds this 65 dB value by 5 dB or more. However, this is dependent on the duration of impact and sensitivity of the receptor.

Significance

The 65dB + 5dB threshold (for non-residential) is used to determine the magnitude of impact, as shown in Table 4. As no baseline data is available, the minor effect threshold would be the lower cut-off value of 65 dB.

Table 4 Magnitude of Impact from Construction Noise (Non-Residential)

Magnitude of Impact	Total Construction Noise Level ($L_{Aeq,T}$)
Negligible	Less than 65 dB
Minor adverse	Greater than 65 dB and less than 70 dB
Moderate adverse	Greater than 70 dB and less than 75dB
Major adverse	Greater than 75 dB

3.5 Construction Vibration

Construction works, particularly pre-auguring, piling, and surface compaction, will potentially introduce ground-borne vibration to the area.

Of these activities, vibratory piling is expected to be the most frequent and to generate the highest vibration levels. Therefore, this assessment focuses on vibratory piling as the representative worst-case scenario. Other piling methods and compaction activities are expected to result in lower, and therefore less significant, vibration levels.

Construction Vibration Impact Criteria

Predicted vibration levels have been assessed based on using two different standards:

- BS 5228: Part 2: Used to assess the effect of perceptible vibration on people.
- BS 7385: Part 2: Used to assess the effect of vibration on buildings and the potential for cosmetic damage.

Effects on Human Receptors

Table 5, reproduced from BS 5228: Part 2, provides guidance on human perception of vibration, which is measured in Peak Particle Velocity (PPV).

For this assessment, the 0.3 mm/s level is considered the minor impact threshold, and the 1.0 mm/s level is considered the moderate impact threshold.

Table 5 BS 5228 Part 2 Guidance on Effects of Vibration Levels

Vibration Level Threshold (mm/s)	Magnitude of Impact	Effect
0.14	Negligible	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Minor	Vibration might just be perceptible in residential environments.
1.0	Moderate	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if early warning and explanation has been given to residents.
10	Major	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

Effects on Buildings

Table 6, reproduced from BS 7385: Part 2, provides guide values for assessing the risk of cosmetic damage to buildings from transient vibration.

Table 6 BS 7385 Part 2: 'Transient Vibration Guide Values

Type of Building	Peak Component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures industrial and heavy commercial buildings	50mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1 Values referred to are at the base of the building Note 2 For unreinforced, at frequencies below 4Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded		

Determination of Magnitude for Building Vibration

Unlike human response, which is subjective and graded (perceptible to intolerable), building response is assessed based on the risk of physical cosmetic damage. Therefore, the magnitude of impact for buildings is determined as a threshold assessment against the BS 7385 guide values presented in Table 5:

- Negligible magnitude: Predicted PPV levels are below the Table 5 guide values. No cosmetic damage is expected.
- Major magnitude: Predicted PPV levels exceed the Table 5 guide values. There is a potential risk of cosmetic damage, requiring a specific vibration risk assessment and physical monitoring.

3.6 Off Site Construction Traffic Noise

The change in noise associated with increased construction traffic on the surrounding road network has been calculated in accordance with the Calculation of Road Traffic Noise (CRTN). The 'change' is defined as the difference between the baseline scenario and the baseline with peak construction traffic. The impacts of this change are evaluated using criteria from the Design Manual for Roads and Bridges (DMRB).

Magnitude of Change

The magnitude of the noise change is used to determine the effect as shown in Table 7.

Table 7 DMRB Short Term Traffic Noise Effect Criteria

Noise Change, $L_{A10,18hr}$ dB	Magnitude of Effect
0	No Change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

3.7 Consultation

A description of the methodology and receptor selection was sent to Ceredigion County Council by email for comment in October 2025 but no response was received. The EIA scoping opinion in October 2025 confirmed that "the proposed qualitative assessment of temporary construction effects ... is appropriate" for the Population and Human Health topic which includes noise and vibration.

4. Sensitive Receptors

4.1 Methodology for Receptor Selection

Sensitive receptors have been identified based on their proximity to the works and their potential to be affected by noise and vibration. An initial set of all receptors at all dwellings within 300m was used to understand the screening distance where effects would be minor / negligible.

Properties further back from the riverfront, which are screened from the works by other buildings (e.g., rows of houses behind the front row), will experience significantly lower noise levels. Therefore, once a row is negligible, all other rows behind will also be negligible.

The receptor dataset was reduced in size to those receptors closest to the works or within the zone of influence from construction. The remaining receptors have been grouped by their use and location. Each receptor group represents a cluster of properties, with the assessment point placed at the façade of the dwelling or building closest to the construction works (the 'worst-case' location).

In total, 33 residential receptor groups (representing approximately 170 individual dwellings) and 14 non-residential receptor groups (including pubs, hotels, restaurants, retail, offices, a school, and a church) have been identified.

4.2 Determination of Receptor Sensitivity

To determine the significance of effects, the sensitivity of the receptor must be considered alongside the magnitude of the noise or vibration impact. While BS 5228 does not provide a rigid scale for sensitivity, standard EIA practice assigns sensitivity based on the receptor's primary usage and the need for quiet or speech intelligibility within that environment.

For this assessment, sensitivity has been defined in Table 8 below.

Table 8 Receptor Sensitivity Criteria

Sensitivity	Description / Receptor Type	Justification
High	Residential Dwellings (e.g., R03, R26) Healthcare Facilities Schools & Educational Facilities (e.g., R47) Places of Worship (e.g., R30)	Receptors where people spend long periods, sleep (residential), or where high levels of concentration and speech intelligibility are essential. Disruption here causes significant impact on health and quality of life.
Medium	Offices (e.g., R35) Hotels (e.g., R02, R20)	Receptors with a reasonable expectation of amenity, but where occupation is transient (Hotels/PRoW) or where the environment is less sensitive to external noise than a residential dwelling (Offices).

Sensitivity	Description / Receptor Type	Justification
Low	Industrial / Warehouses (e.g., R17, R22) Retail / Shops (e.g., R11, R42) Restaurants / Pubs (e.g., R01, R10)	Receptors where the ambient noise level is often higher, occupancy is transient, or the activity (e.g., shopping, manual work) is not significantly disrupted by external construction noise.
Negligible	Heavy Industrial	Receptors with no noise-sensitive use

NOTE: In the Assessment of Construction Noise Effects (Section 6.4), this sensitivity criteria is used to adjust the significance of the effect. For example, a “Major” magnitude impact at “Low” sensitivity may be reduced to a non-significant effect “Minor”.

Figure 1 below shows a map of the residential and non-residential receptor groups.

Figure 1 Noise and Vibration Sensitive Receptor Groups

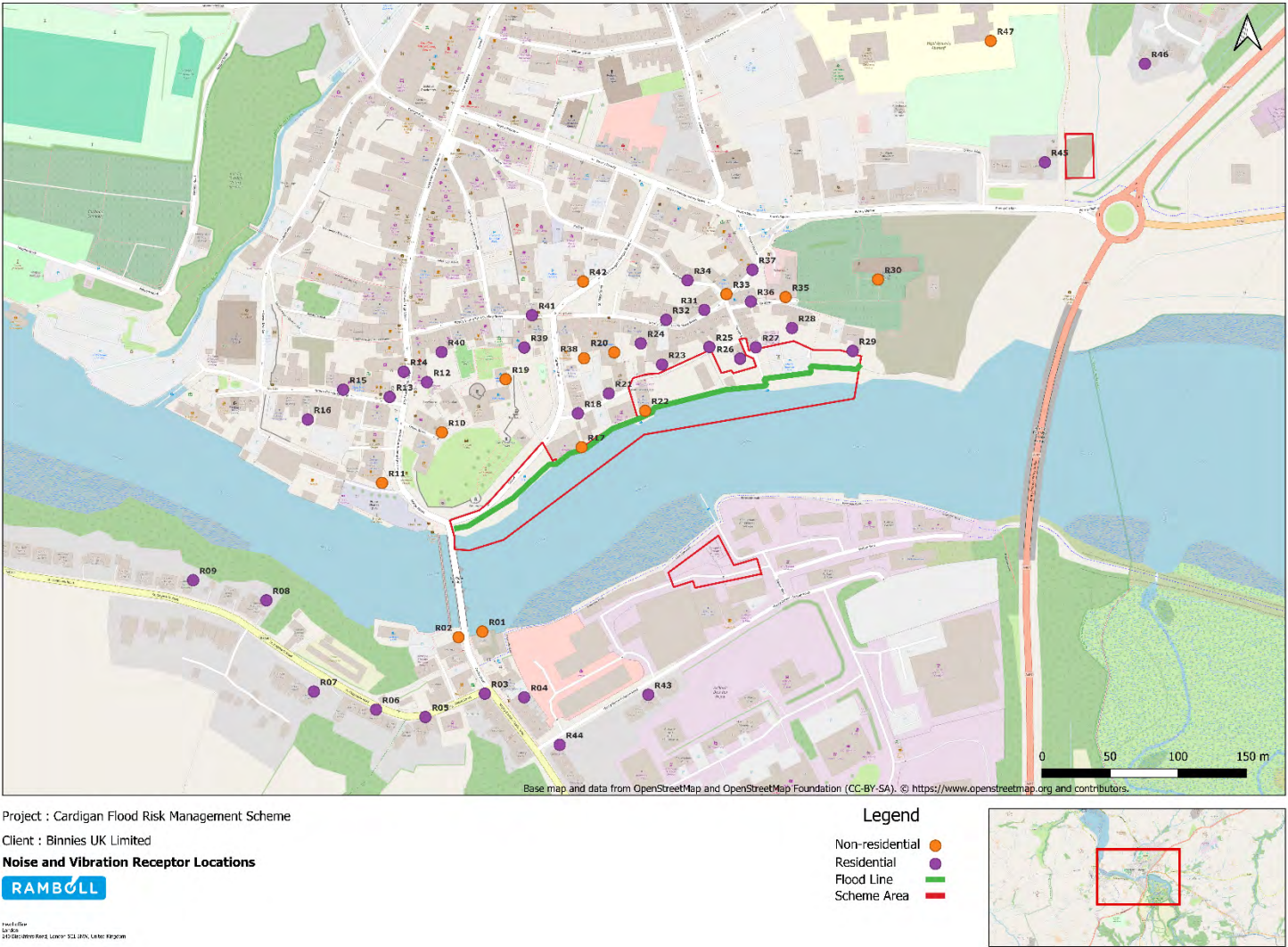


Table 9 provides a list of the receptor groups used in this assessment, detailing their name, type, and the approximate number of dwellings represented.

Table 9 Sensitive Receptors

Receptor ID	Receptor	Type	Approx. Number Represented
R01	The Castle Inn, 1 Castle Street	Non-residential - Pub	1
R02	Hotels on Castle Street	Non-residential - Hotels	3
R03	20 – 26 Castle Street	Residential	7
R04	6 – 10 Castle Street	Residential	5
R05	27 – 29 & Garden Cottage, St. Dogmaels Road	Residential	4
R06	1 – 8 Teifi Terrace & Neian, Brecon Terrace	Residential	9
R07	1 – 14 Brecon Terrace	Residential	14
R08	Pen-Y-Marian Villas & Bryncoed, Spring Gardens & Properties to South of St. Dogmaels Road	Residential	10
R09	Ramleh, Carlton Villa, Caer-Neos, Tivy-Glen, Spring Gardens & Properties to South of St. Dogmaels Road	Residential	7
R10	Cardigan Castle & Restaurant	Non-residential - Restaurant	2
R11	Commercial Properties on Bridge Street	Non-residential – Retail/Offices	5
R12	Rear of Properties on High Street	Residential	9
R13	Properties on Quay Street / Bridge Street	Residential	5
R14	Commercial Properties on High Street	Residential	10
R15	Residential Properties on Quay Street	Residential	10
R16	Rear of Residential Properties on Quay Street	Residential	10
R17	Non-residential Properties on The Strand	Non-residential - Retail/Offices	4
R18	Castle View & 1 -3 Carrier's Lane	Residential	4
R19	East Wing Cottage Cardigan Castle	Non-residential - Hotel	1
R20	Rear of The Angel Hotel	Non-residential - Hotel	1
R21	13 Strand	Residential	1
R22	Non-residential Properties on Strand	Non-residential – Retail/Offices	5
R23	Rear of 1 – 3 Riverside Mews	Residential	4
R24	Rear of 33 - 35 St. Mary Street	Residential	3
R25	Rear of 26 - 32 St. Mary Street	Residential	7
R26	Teifi House, Gloster Row	Residential	1
R27	1 – 5 Gloster Row	Residential	5
R28	4 - 6 Church Street	Residential	3
R29	Caerhuan (adj. to St Mary's Church)	Residential	1
R30	Saint Mary's Church	Non-residential – Church	1
R31	23 - 25 St. Mary Street	Residential	3

Receptor ID	Receptor	Type	Approx. Number Represented
R32	17 - 22 St. Mary Street	Residential	6
R33	Red Lion Inn	Non-residential - Hotel	1
R34	22 – 25 Pwllhai	Residential	5
R35	Royal Mail - Cardigan Delivery Office	Non-residential - Office	1
R36	2 Imperial House / 7 Church Street	Residential	1
R37	Finch's Square / St. Mary's Street	Residential	3
R38	Rear of Commercial Properties on St Mary's Street	Non-residential - Retail/Offices	3
R39	Properties on St Mary's St / Carrier's lane	Residential	3
R40	Rear of St Mary's St / High Street	Residential	5
R41	8 - 9 St. Mary Street	Residential	2
R42	Commercial Properties on Morgan Street	Non-residential - Retail/Offices	4
R43	Arfryn, Arfryn Flat, O'r Diwedd & Brynafon on Station Road	Residential	4
R44	12 – 29 Castle Street	Residential	8
R45	Wrthy Llan, Ivyleigh, Hendy & Grasmere on Pont-y-Cleifion	Residential	4
R46	Rear of 54 – 58 Bro Teifi	Residential	5
R47	Ysgol Gynradd Abeteifi Primary School	Non-residential – Primary School	1

5. Incorporated Mitigation Measures

5.1 Best Practical Means

As part of the works, a Construction Environmental Management Plan (CEMP) will be developed to manage and minimise environmental impacts as far as practicable during construction. The CEMP will detail mitigation measures specific to the construction phase and help to demonstrate the Scheme's commitment to environmental protection and sustainability. The CEMP will include various management plans which contain specific guidance and mitigation measures for certain environmental topics.

Throughout the construction programme, the primary strategy for managing noise and vibration will be the application of Best Practicable Means (BPM). BPM involves minimising site noise levels at all times, whilst having due regard to the practicability and economic implications of any mitigation measure.

BS 5228 does not set specific criteria for acceptable construction noise. The preferred approach is therefore to reduce noise at the source where possible. In some cases, a higher noise level may be acceptable if it significantly reduces the overall construction time and, consequently, the long-term duration of the disturbance.

The application of BPM could include a range of standard site practices, such as:

- **Plant Selection:** Selecting plant and equipment that complies with relevant EU/UK noise limits (or BS 5228:2009+A1:2014), is fitted with effective exhaust silencers, and is maintained in good working order.
- **Generators & Compressors:** Using sound-reduced models and ensuring sealed acoustic covers are kept closed during operation.
- **Tools:** Fitting pneumatic tools with manufacturers' recommended mufflers or suppressors.
- **Operational Use:** Shutting down or throttling down machines in intermittent use when idle. Starting plant sequentially rather than simultaneously.
- **Site Layout:** Positioning plant with directional noise characteristics to minimise noise at nearby properties. Locating site equipment, loading, and unloading areas away from noise-sensitive properties where possible.
- **Working Hours:** Planning works to take place primarily during normal daytime hours (07:00-19:00 weekdays, 07:00-13:00 Saturdays).
- **Staff Briefing:** Briefing all staff and operatives on minimising nuisance through toolbox talks and site inductions.
- **Maintenance:** Regularly inspecting plant and equipment and ensuring defective items are not used. Keeping internal haul routes well-maintained to reduce noise from vehicle movements.
- **Reversing Alarms:** Using broadband (low-impact) reversing alarms or banksmen instead of tonal alarms where practicable.
- **Material Handling:** Minimising drop heights of materials.
- **Demolition:** Using "munching" equipment for concrete breaking where possible, with percussive breaking limited to agreed hours.
- **Site Hoarding:** Applying standard site hoardings to all site perimeters to provide baseline acoustic screening – *NOTE: Hoarding has only been included in the model around the site compounds.*

6. Construction Noise

6.1 Assessment Data and Assumptions

The construction methodologies, data, and indicative programme used in this assessment have been provided by Binnies. At the time of writing, a detailed final methodology for construction was not available. Therefore, the assessment is based on this indicative information. The estimated plant, dates of use, percentage on-times, and quantities were selected based on this data and have been agreed in principle with project engineers.

The noise and vibration levels presented in this assessment represent a conservative worst-case scenario. Piling activities are anticipated to be the dominant source of these effects; however, actual emissions will vary depending on the final pile dimensions, plant selection, and localised ground conditions. Consequently, real-time monitoring will be required during construction to verify predictions and facilitate the adaptive management of mitigation measures.

It is assumed that initial works including the temporary haul road and working platform will be built first. This construction will start in Area 1 and progress upstream to Area 4. After this, it is assumed that works will proceed in the opposite direction with works beginning in Area 4 and work back to Area 1. The majority of works are assumed to be sequential with a small amount of overlap (i.e. Area 4 work starts for one activity as Area 1 finishes from the previous). It is assumed that landscaping work in Area 1 and saltmarsh works in Area 4 inundation area to allow estuarine/riverine habitats to establish will coincide.

A northern and southern compound has been modelled for the duration of the works. It is expected that these compounds will be used for laydown and welfare. A diagram showing the site Areas and Compounds is provided in Appendix A3 - Scheme Layout.

6.2 Working Hours & Programme

The core site working hours are assumed to be:

- Weekdays (Summer): 0730 – 1800,
- Weekdays (Winter): 0800 – 1630 and
- Saturdays (if required): 0730 – 1300.

There may be deviations from these hours as some riverside works are tide dependent. However, any works outside of core hours will be agreed in advance with Ceredigion Council and/or the Local Authority Environmental Health Officer via Section 61 consent.

Tidal restrictions may in practice reduce the actual daily working time for some activities. This assessment does not assume this reduction and therefore models a conservative, worst-case noise exposure. Tidal working is limited to weekdays, and no piling is expected to take place outside of normal working hours.

The construction works are expected to start in early 2027 (pending approvals) and will take approximately 18 months to complete. The outline programme used in this assessment is presented in Table 10 below:

Table 10 Indicative Programme

Activity	Duration (weeks)
Mobilisation	2
Installation of haul roads / temporary piling platform	22
Sheet pile installation	7
Concrete pours	7
Stonework cladding	15
Copings	4
Remove/regrade piling platform	11
Rip rap	4
Various reinstatements	2
Landscaping (Area 1 only)	4
Embankment Regrading and Saltmarsh Creation (Area 4 only)	4
Demobilisation	2
Compounds (Northern & Southern)	81

6.3 Prediction Methodology

To quantify potential construction noise impacts, worst-case activity noise levels ($L_{Aeq,T}$) have been predicted at the façades (1m distance) of the defined receptor groups. The assessment follows the methodologies within BS 5228: Part 1 and utilises a 3D acoustic model (built in CadnaA noise modelling software). This model calculates likely noise levels during peak construction periods and accounts for:

- Screening from buildings;
- Screening from hoarding (NOTE: hoarding has only been included around site compounds)
- Ground absorption;
- Reflections from nearby structures; and
- The likely "percentage on-time" of plant (the proportion of time the plant is operational).

The model inputs are based on the anticipated construction methods and phasing. Full details on the construction phases, indicative plant lists, 'on-time' assumptions, and sound power levels used in the model are provided in Appendix A4 - Construction Plant.

Using this model, predictions were completed for each week of the construction programme. The results presented identify the highest predicted noise level for each week at each receptor group. It is important to note that these figures represent a conservative worst-case; in practice, typical noise levels are likely to be lower, fluctuating up to this peak level but frequently remaining lower depending on the specific activity and plant in operation at any given moment. These worst-case levels have been assessed against the assessment criteria to calculate the magnitude of the effects and the likely duration. Table 11 presents the results of the assessment at each residential and non-residential receptor group.

Table 11 Predicted Noise Levels and Assessment at Receptor Groups

ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R01	The Castle Inn, 1 Castle Street	Non-residential - Pub	1	70	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R02	Hotels on Castle Street	Non-residential - Hotels	3	69	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R03	20 – 26 Castle Street	Residential	7	55	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R04	6 – 10 Castle Street	Residential	5	64	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R05	27 – 29 & Garden Cottage, St. Dogmaels Road	Residential	4	51	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R06	1 – 8 Teifi Terrace & Neïan, Brecon Terrace	Residential	9	46	0	Negligible	Remove/regrade piling platform
R07	1 – 14 Brecon Terrace	Residential	14	51	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R08	Pen-Y-Marian Villas & Bryncoed, Spring Gardens & Properties to South of St. Dogmaels Road	Residential	10	63	0	Minor	Pre-auguring, removal of existing walls & sheet piling

ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R09	Ramleh, Carlton Villa, Caer-Neos, Tivy-Glen, Spring Gardens & Properties to South of St. Dogmaels Road	Residential	7	60	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R10	Cardigan Castle & Restaurant	Non-residential - Restaurant	2	58	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R11	Commercial Properties on Bridge Street	Non-residential – Retail/Office	5	54	0	Negligible	Temporary Haul Roads / Temporary piling platform
R12	Rear of Properties on High Street	Residential	9	50	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R13	Properties on Quay Street / Bridge Street	Residential	5	47	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R14	Commercial Properties on High Street	Residential	10	47	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R15	Residential Properties on Quay Street	Residential	10	43	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R16	Rear of Residential Properties on Quay Street	Residential	10	42	0	Negligible	Pre-auguring, removal of existing walls & sheet piling

ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R17	Non-residential Properties on The Strand	Non-residential – Warehouses / Showroom	4	91	16	Minor ¹	Pre-auguring, removal of existing walls & sheet piling
R18	Castle View & 1 -3 Carrier's Lane	Residential	4	66	1	Minor ²	Pre-auguring, removal of existing walls & sheet piling
R19	East Wing Cottage Cardigan Castle	Non-residential - Hotel	1	63	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R20	Rear of The Angel Hotel	Non-residential - Hotel	1	57	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R21	13 Strand	Residential	1	68	3	Minor ³	Pre-auguring, removal of existing walls & sheet piling
R22	Non-residential Properties on Strand	Non-residential – Warehouses / Workshops	5	87	12	Minor ⁴	Pre-auguring, removal of existing walls & sheet piling
R23	Rear of 1 – 3 Riverside Mews	Residential	4	77	7	Moderate ⁵	Pre-auguring, removal of existing walls & sheet piling
R24	Rear of 33 - 35 St. Mary Street	Residential	3	57	0	Minor	Pre-auguring, removal of existing walls & sheet piling

¹ Reduced to Minor due to low sensitivity of non-residential receptor

² Reduced to Minor as duration above moderate impact threshold is less than one month (1 week) and max level is just above the 65 dB threshold for those weeks.

³ Reduced to Minor as duration above moderate impact threshold is less than one month (3 weeks) and max level is just above the 65 dB threshold for those weeks.

⁴ Reduced to Minor due to low sensitivity of non-residential receptor

⁵ Reduced to Moderate as duration above Major threshold is less than one month (2 weeks)

ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R25	Rear of 26 - 32 St. Mary Street	Residential	7	73	4	Moderate ⁶	Pre-auguring, removal of existing walls & sheet piling
R26	Teifi House, Gloster Row	Residential	1	78	13	Major	Pre-auguring, removal of existing walls & sheet piling
R27	1 – 5 Gloster Row	Residential	5	77	10	Moderate ⁷	Pre-auguring, removal of existing walls & sheet piling
R28	4 - 6 Church Street	Residential	3	76	8	Moderate ⁸	Pre-auguring, removal of existing walls & sheet piling
R29	Caerhuan (adj. to St Mary's Church)	Residential	1	81	19	Major	Pre-auguring, removal of existing walls & sheet piling
R30	Saint Mary's Church	Non-residential – Church	1	54	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R31	23 - 25 St. Mary Street	Residential	3	55	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R32	17 - 22 St. Mary Street	Residential	6	55	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R33	Red Lion Inn	Non-residential - Hotel	1	56	0	Negligible	Pre-auguring, removal of existing walls & sheet piling

⁶ Reduced to Moderate as duration above Major threshold is less than one month (2 weeks)

⁷ Reduced to Moderate as duration above Major threshold is less than one month (3 weeks)

⁸ Reduced to Moderate as duration above Major threshold is less than one month (3 weeks)

ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R34	22 – 25 Pwllhai	Residential	5	53	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R35	Royal Mail - Cardigan Delivery Office	Non-residential - Office	1	52	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R36	2 Imperial House / 7 Church Street	Residential	1	54	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R37	Finch's Square / St. Mary's Street	Residential	3	63	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R38	Rear of Commercial Properties on St Mary's Street	Non-residential - Retail/Office	3	52	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R39	Properties on St Mary's St / Carrier's lane	Residential	3	61	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R40	Rear of St Mary's St / High Street	Residential	5	55	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R41	8 - 9 St. Mary Street	Residential	2	48	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R42	Commercial Properties on Morgan Street	Non-residential - Retail/Office	4	49	0	Negligible	Pre-auguring, removal of existing walls & sheet piling
R43	Arfryn, Arfryn Flat, O'r Diwedd & Brynafon on Station Road	Residential	4	63	0	Minor	Pre-auguring, removal of existing walls & sheet piling

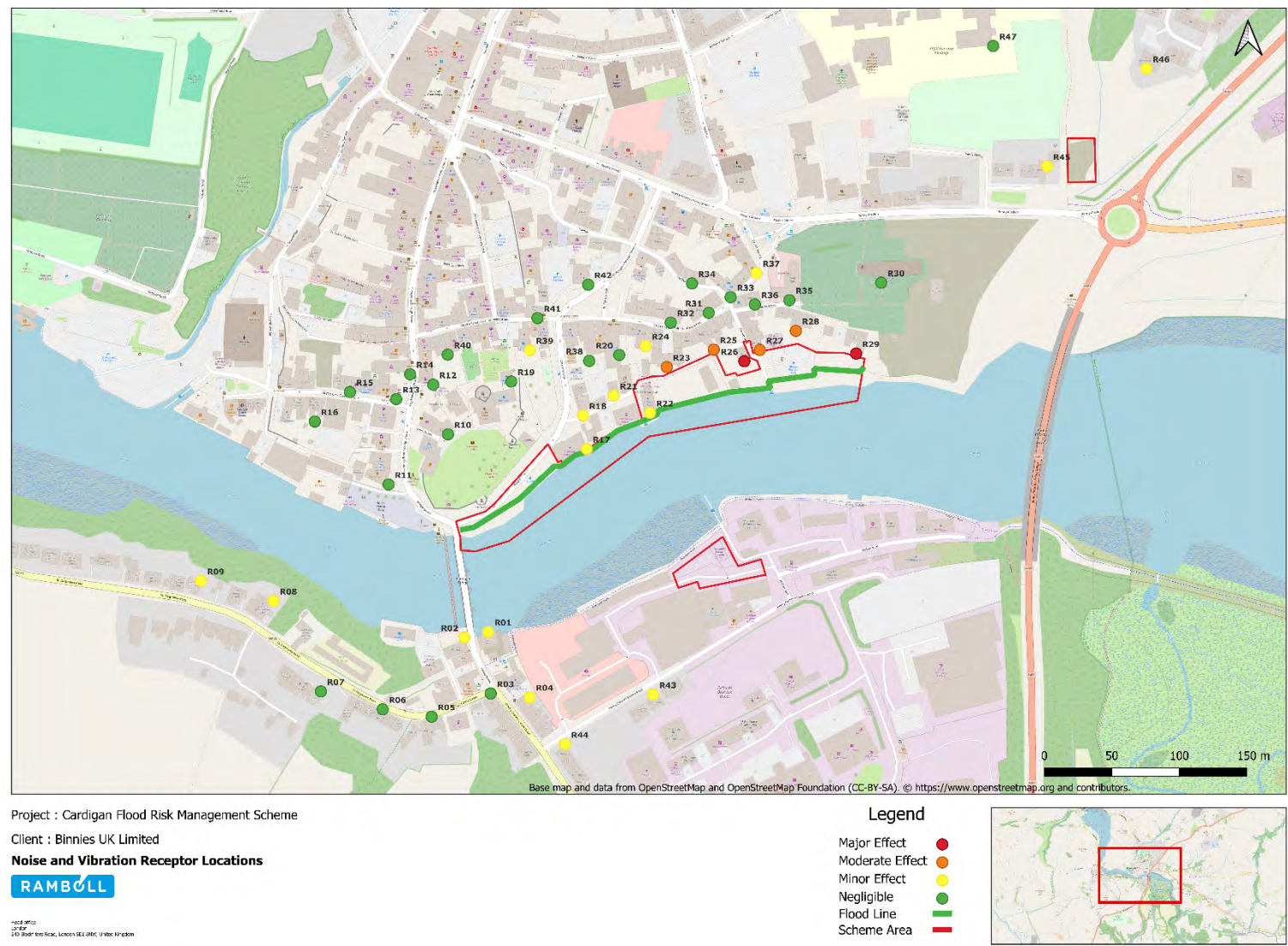
ID	Location Name	Type	Approx. Number Represented	Max Construction Level at façade ($L_{Aeq,T}$ dB)	Duration Above Moderate Threshold (Weeks)	Significance	Worst Activity
R44	12 – 29 Castle Street	Residential	8	63	0	Minor	Pre-auguring, removal of existing walls & sheet piling
R45	Wrthy Llan, Ivyleigh, Hendy & Grasmere on Pont-y-Cleifion	Residential	4	62	0	Minor	Compound (North) Establishment & Operation
R46	Rear of 54 – 58 Bro Teifi	Residential	5	57	0	Minor	Compound (North) Establishment & Operation
R47	Ysgol Gynradd Abeteifi Primary School	Non-residential – Primary School	1	50	0	Negligible	Compound (North) Establishment & Operation

6.4 Assessment of Construction Noise Effects

The prediction methodology, when applied to the identified receptor groups, indicates that significant adverse effects from construction noise are likely at several locations. The results are detailed below, grouped by their significance. A 'Major' or 'Moderate' effect is considered significant.

Figure 2 below presents a map showing the significance (accounting for any adjustments due to duration or sensitivity) at each receptor group.

Figure 2 Noise Effects at Receptor Groups



Major Adverse Effects (Significant)

Two non-residential receptors (R17 and R22), representing warehouses and showrooms on the Strand) are considered to have a low sensitivity to noise as these will generally have a higher ambient noise level, occupancy is transient, and the activity/use is not significantly disrupted by external construction noise. Due to this low sensitivity, the residual effect at these locations is considered to be not significant (Minor), rather than significant (Major).

Four residential groups R23, R25, R27 and R28 are predicted to be above the threshold for a Major adverse effect for less than one month (2 – 3 weeks) and therefore are reduced to a Moderate adverse effect and detailed in the Moderate adverse effects section.

Two residential groups, representing 4 dwellings, where significant Major adverse effects are predicted are:

- R26 (Teifi House, Gloster Row) representing 1 dwelling - A maximum construction noise level of 78 dB $L_{Aeq,T}$ is predicted, exceeding the Moderate impact threshold for 13 weeks and the Major threshold for 5 weeks.
- R29 (Caerhuan (adj. to St Mary's Church)) representing approx. 1 dwelling - A maximum construction noise level of 81 dB $L_{Aeq,T}$ is predicted, exceeding the Moderate impact threshold for 19 weeks and the Major threshold for 7 weeks.

Moderate Adverse Effects (Significant)

Two residential groups (R18 & R21) are subject to moderate adverse effects; however, the effects are of short duration (less than a month) and the noise levels are just above the 65 dB threshold. Therefore, these impacts are not considered significant and are re-classified as Minor adverse effects.

Four Moderate adverse effects are predicted at four residential receptor groups representing approximately 19 dwellings:

- R23 (Rear of 1 – 3 Riverside Mews) representing approx. 4 dwellings – exceeding the Moderate impact threshold for 7 weeks with the highest predicted noise level peaking at 77 dB $L_{Aeq,T}$. (reduced from Major due to duration)
- R25 (Rear of 26 - 32 St. Mary Street) representing approx. 7 dwellings - exceeding the Moderate impact threshold for 4 weeks with the highest predicted noise level peaking at 73 dB $L_{Aeq,T}$. (reduced from Major due to duration)
- R27 (1 – 5 Gloster Row) representing approx. 5 dwellings - A maximum construction noise level of 77 dB $L_{Aeq,T}$ is predicted, exceeding the Moderate impact threshold for 10 weeks. (reduced from Major due to duration)
- R28 (4 - 6 Church Street) representing approx. 3 dwellings - A maximum construction noise level of 76 dB $L_{Aeq,T}$ is predicted, exceeding the Moderate impact threshold for 8 weeks. (reduced from Major due to duration)

Minor and Negligible Adverse Effects (Not Significant)

Following the re-classification of R17, R18, R21, and R22, a total of 13 residential groups (representing approx. 62 dwellings) and 4 non-residential receptor groups (representing 13 commercial properties) are predicted to experience Minor adverse effects.

All other effects at the remaining receptors are predicted to be Negligible. These effects are not considered significant.

7. Construction Vibration

7.1 Human Response

Calculations for vibratory piling have been carried out in accordance with BS 5228 Part 2 to predict Peak Particle Velocity (PPV) levels at various distances. The sheet piling activity is expected to last for approximately seven weeks.

The predictions establish key screening distances for human perception:

- Receptors within 30m of piling may experience vibration levels above the 1.0 mm/s moderate impact threshold.
- Receptors within 5m of piling may experience levels above the 10 mm/s 'intolerable' threshold.

Based on these findings, Moderate adverse effects are predicted for several residential groups located within the 30m screening distance. These receptors are likely to experience vibration exceeding the 1.0 mm/s moderate impact threshold for a duration of approximately one to four weeks (depending on how quickly piling moves across the site). The affected groups are:

- R18 – Castle View & 1 - 3 Carrier's Lane
- R21 – 13 Strand
- R23 – Rear of 1 – 3 Riverside Mews
- R25 – Rear of 26 - 32 St. Mary Street
- R26 & 27 – 6 dwellings on Gloster Row, including Teifi House
- R28 & 29 – 4-6 Church Street and Caerhuan

Two non-residential groups (R17 and R22) are located within the 5m screening distance. However, due to the lower sensitivity of these commercial uses and the transient nature of the piling works as they pass these specific locations, the effect on human receptors here is not considered to be significant.

7.2 Building Response

The two non-residential groups R17 and R22 include buildings in very close proximity to vibratory piling.

Predictions indicate that these buildings may experience PPV levels exceeding the guideline values for assessing risk of cosmetic building damage (per BS 7385). Therefore, it is recommended that a vibration risk assessment be undertaken for these specific buildings prior to piling works commencing.

All other receptor groups are located at a sufficient distance and predicted vibration levels are not expected to exceed the building cosmetic damage thresholds.

8. Construction Traffic

8.1 Traffic Data

Baseline traffic flows (AAWT, 18hr) have been provided for four road links by the project transport consultants and are presented in Table 12 below.

Table 12 Baseline traffic flows (AAWT, 18hr)

Road Link	Speed (kph)	Number of Vehicles	Number of HGVs
B4546	59	5491	134
Carrier's Lane	28	4436	24
Pont-Y-Cleifion	31	6617	122
Station Road	43	2846	102

Vehicle movements for key activities have been provided by project engineers. These are total numbers of HGVs for a given activity and have therefore been divided by the number of weeks the activity is expected to last to determine the peak construction traffic in a given week. This is presented in Table 13 below:

Table 13 HGV Totals for Key Construction Activities

Activity	Total Num HGVs	Duration of Activity (weeks)	Approx. Weekly HGVs
Installation of haul roads / temporary piling platform	655	22	30
Sheet pile installation	8	7	1
Concrete Pours	133	7	19
Stonework Cladding	59	15	4
Copings	5	4	1
Remove/regrade piling platform	492	11	45
Rip rap	137	4	34

Additionally, approximately 12-18 movements of non-HGVs are expected daily, a worst-case figure of 18 daily movements has been used in the assessment.

The peak weekly construction traffic is expected to be during the removal and regrading of the piling platform. Assuming an overlap with activities before (Copings) and after (Rip rap), this would give a worst-case estimate of 80 HGVs. Dividing this by 5 gives a daily flow number that can be used along-side the daily non-HGV trips to compare against the baseline AAWT figures.

8.2 Noise Change

Construction traffic noise impacts have been assessed by calculating the noise change between the baseline traffic flows and the worst-case peak weekly construction traffic flows as described in the previous section. Table 14 shows the predicted calculated noise change due to the Scheme.

Table 14 Construction Traffic Calculation Noise Change, Baseline Plus Peak Construction Traffic

Road Name	Calculated Noise Change (dB)	Significance
B4546	+0.1	Negligible
Carrier's Lane	+0.3	Negligible
Pont-Y-Cleifion	+0.2	Negligible
Station Road	+0.3	Negligible

The assessment indicates that construction traffic will result in negligible effects on all road links and would not be significant.

9. Additional Mitigation Measures

Where significant effects are predicted after the application of standard BPM, additional mitigation measures should be adopted to reduce effects as far as practicable. The specific details of these measures will be finalised by the Principal Contractor and approved via the CEMP, or a specific Noise and Vibration Management Plan prior to works commencing. Any additional mitigation measures should also be detailed within any future Section 61 Consent.

The mitigation strategy follows a hierarchy of control, prioritising mitigation and management at the source before considering receptor-based measures.

9.1 Procedural and On-Site Measures

The following measures should be applied on-site prior to any receptor-based mitigation in order to reduce noise levels as far as practicable:

- **Community Liaison:** Proactive communication is essential. This includes notifying residents in advance of specific noisy and high-vibration activities (such as piling) and providing a dedicated point of contact for complaints or queries.
- **Localised Screening:** The contractor should install temporary noise barriers or enclosures around significant stationary noise sources, or at specific work areas close to dwellings.
- **Noise and Vibration Monitoring:** Implementation of attended or unattended monitoring at locations with the greatest potential for disturbance. This verifies that levels against predictions, allows for the use of trigger thresholds to help manage site noise and shows a proactive approach to noise management.
- **Piling and Vibration Management:** A vibration risk assessment for all piling and ground compaction activities should be undertaken prior to works commencing. This assessment should determine the need for continuous vibration monitoring at the closest buildings (e.g., R17 and R22) and worst-affected residential receptors and inform the selection of specific mitigation techniques. Such techniques may include:
 - Using "resonance-free" or "variable moment" vibratory hammers, which avoid the high-vibration "rumble" phase during start-up and shutdown.
 - Employing acoustic shrouds or enclosures around the piling rig and hammer to reduce noise at the source.
 - Utilising pre-auguring or water jetting to loosen the ground, which significantly reduces the driving time and vibration energy required.
 - Considering alternative, low-vibration piling methods (such as "press-in" piling) for the sections of work closest to the most sensitive receptors, subject to engineering and ground condition constraints.
- **Section 61 Consent:** While planning permission grants consent for the development, the Contractor should apply for a Section 61 Consent under the Control of Pollution Act 1974. This voluntary process formally agrees on working methods, mitigation, BPM, predicted noise levels and site action triggers with the Local Authority Environmental Health Officer in advance. Obtaining this consent provides the project with protection against Section 60 Abatement Notices, provided the agreed conditions are met. It is good practice for a Section 61 consent to include the following information:
 - Address or location of proposed works
 - Name and address of main contractor
 - Particulars of the works to be carried out
 - Working hours
 - Methods to be used in each stage of the development

- o Number, type and size of equipment and machinery stating Sound Power Levels.
- o Proposed steps to minimise noise and vibration
- o Predicted noise and vibration levels
- o Noise and vibration monitoring
- o Approximate duration of works
- o Community liaison
- o Other information – e.g. contact names and contact details, telephone numbers and e-mail addresses
- o List of Appendices – A list of all attached plans and documents

9.2 Receptor-Based Mitigation

Noise

If on-site mitigation is insufficient to reduce noise levels below significant thresholds and noise levels remain high for long periods, off-site mitigation should be considered in the following order of preference:

- Noise Insulation: Where noise levels above 75 dB during the day persist at residential receptors for a prolonged period (typically defined as exceeding triggers for 10 or more days of working in any 15 consecutive days, or for a total number of days exceeding 40 in any 6 consecutive months), the project should offer noise insulation to affected qualifying properties. A noise insulation assessment should be undertaken once final plant and methodologies are known to determine whether any properties qualify.
- Temporary Re-housing: This is considered a measure of last resort. It should only be offered in exceptional circumstances where construction noise levels are predicted to be intolerable for a sustained period, and where neither BPM nor noise insulation can provide adequate mitigation.

Note that there are no receptors that would currently qualify for noise insulation or temporary re-housing based on the predicted levels. Whilst levels are above the noise insulation trigger level, the durations are not such that they would qualify based on the temporal requirements.

Vibration

Given that on-site mitigation (source control) is the primary method for reducing vibration, receptor-based measures focus on managing the human response to residual effects.

The assessment predicts 'Moderate' vibration effects (between 1.0 mm/s and 10 mm/s) at the closest receptors. While significant, BS 5228-2 states that vibration of this magnitude *"can be tolerated if early warning and explanation has been given to residents"*. Therefore, the primary mitigation will be a proactive notification strategy, ensuring residents are informed of the piling schedule and reassured that levels remain well below the thresholds for cosmetic building damage.

To further ease concerns, the Contractor may offer to undertake specific attended measurements or install long-term vibration monitors at individual properties where residents express particular anxiety or concern with vibration. Determining actual levels in the presence of the resident (or providing them with visible data) is often an effective way to demonstrate that vibration, while perceptible, is well below damage thresholds.

Temporary re-housing is considered a measure of last resort. It would generally only be offered if vibration levels are predicted to be 'Intolerable' (typically exceeding 10 mm/s) for a sustained

period. As current predictions show levels remaining below this Major threshold, re-housing is not anticipated. However, it remains a residual option to be assessed on a case-by-case basis.

9.3 Noise and Vibration Monitoring Scope

To demonstrate proactive management, and verify that mitigation is effective, a robust monitoring regime should be implemented. The specific details will be agreed with the Contractor, Local Authority (EHO), and the noise consultant within the Section 61 application; however, an outline scope is provided below.

Monitoring Locations

Continuous unattended monitoring should be installed to represent the most affected residential receptors. Monitors can be located either within gardens of specific receptors (if accessible) or attached to site hoardings with appropriate distance corrections applied. Supplementary attended monitoring can also be undertaken at other sensitive locations during critical activities or intense working periods to demonstrate a proactive approach.

Equipment & Systems

- Noise: Class 1 Sound Level Meters (conforming to BS EN 61672).
- Vibration: Vibration Monitors capable of measuring Peak Particle Velocity (PPV) in three orthogonal axes.
- Calibration: All equipment must hold a current UKAS laboratory calibration certificate (every 2 years for noise and 1 year for vibration). Field calibration checks for noise monitors with a reference calibrator should be undertaken every 3 months.
- Remote Access: It is recommended to use a monitoring system with an online portal (e.g., ANV LiveEnviro or SvanTek SvanNET). These systems allow for automated SMS/Email alerts, live viewing of levels, and remote data download, minimising the need for site visits.

Baseline Period

A pre-construction baseline noise survey (minimum 1 week during favourable weather conditions) should be undertaken to establish the prevailing acoustic environment and assist in setting Section 61 trigger levels.

Action Triggers vs. Fixed Limits

Generally, it is not recommended that absolute noise or vibration limits are included within consent conditions. The central mechanism for controlling construction noise and vibration under the Control of Pollution Act 1974 relies on the demonstration that Best Practicable Means (BPM) is being employed at all times.

Rigid limits can create circumstances where a contractor plans works to generate noise up to those limits, rather than adhering to BPM. Furthermore, rigid limits do not allow for the flexibility often required to benefit neighbours (e.g., short periods of higher noise with respite are often preferable to prolonged lower-level noise).

Therefore, the scheme should utilise Action Triggers. These will be derived from the Noise Insulation eligibility criteria and the specific predicted levels agreed in the Section 61 Consent.

Action Trigger Threshold Examples

- Amber Trigger:

- o Noise: Measured levels reach the S61 agreed predicted level or Moderate effect threshold level (e.g., 65 dB $L_{Aeq,T}$)
 - o Vibration: Levels reach 1.0 mm/s PPV (Moderate effect / Complaint threshold).
 - o Action: Automated alert sent to Site Manager. Review whether BPM is being strictly followed. Check if a valid reason exists.
- Red Trigger:
 - o Noise: Measured levels exceed the Noise Insulation Trigger (e.g. 75 dB $L_{Aeq,T}$) or the S61 predicted level by a specified margin (e.g., +3dB)
 - o Vibration: Levels exceed 10.0 mm/s PPV (or a specific agreed limit)
 - o Action: Works in the affected area are paused. Immediate investigation into the cause. Works to resume once mitigation is confirmed/improved, the method is changed or the exceedance is formally agreed with the Local Authority as unavoidable.

Reporting

Summary reports (including time-history graphs and detailed of any exceedances) should be issued to the Client and Local Authority on a monthly basis.

10. Residual Effects

10.1 Construction Noise

The assessment adopts a conservative approach by assuming a reduction of 5 dB following the implementation of Best Practicable Means (BPM) and additional mitigation measures. This is a robust "worst-case" assumption, acknowledging that the precise plant list and specific mitigation methods are not yet finalised.

In practice, the effective application of BPM and modern noise control measures can frequently achieve reductions of 10 dB or more. However, the 5 dB assumption is to account for potential variations in site conditions.

Based on this conservative 5 dB reduction:

- R26 & R29 (previously Major): The duration of exposure above the 'Major' threshold is predicted to fall below a month. Consequently, the residual significance at these receptors reduces from Major to Moderate Adverse.
- R23, R25, R27 & R28 (previously Moderate): While absolute noise levels will decrease, the duration of exposure above the 'Moderate' threshold is likely to remain significant. Therefore, the residual effect at these locations is assessed as remaining Moderate Adverse.

If the more typical 10 dB reduction is achieved on site, it is likely that the residual effects at several of these locations would be further reduced to Minor adverse (not significant).

10.2 Construction Vibration

The quantitative assessment presents a conservative 'worst-case' scenario assuming standard vibratory piling methods. Under these conditions, vibration levels at the closest residential receptors (R18, R21, R23, R25, R26, R27, R28 & R29) are predicted to exceed the moderate adverse threshold.

However, the implementation of the piling and vibration management measures outlined in Section 9.1 (specifically the use of resonance-free rigs and pre-augering) is expected to reduce vibration generation at the source. While these reductions cannot be accurately quantified prior to the contractor's final plant selection, it is anticipated that the effective application of these measures could reduce vibration levels below the moderate threshold at several locations.

Where the moderate threshold is still exceeded at residential receptors, levels will remain an order of magnitude below the criteria for cosmetic damage. In these instances, the residual effect is characterised by potential annoyance rather than physical impact. This will be managed through community liaison, monitoring and timing restrictions.

As stated previously, the two non-residential groups R17 and R22 include buildings which may experience PPV levels exceeding the guideline values for assessing risk of cosmetic building damage (per BS 7385). Therefore, it is recommended that a vibration risk assessment be undertaken for these specific buildings prior to piling works commencing. As above, the measures described in section 9.1 are expected to reduce vibration generation at the source which would help minimise this risk.

10.3 Construction Traffic

No significant effects are reported as a result of construction traffic, however, the use of a construction logistics plan can help ease local concerns and potentially reduce complaints.

11. Summary and Conclusions

This Noise and Vibration Impact Assessment (NVIA) has evaluated the likely significant environmental effects associated with the construction phase of the Cardigan Tidal Flood Risk Management Scheme. The assessment considered airborne noise and ground-borne vibration from on-site activities, as well as off-site construction traffic, across a study area comprising 47 sensitive receptor groups.

Mitigation Strategy

The assessment adopts a "hierarchy of control" to manage construction impacts, prioritising source reduction before considering receptor-based measures:

- **Best Practicable Means:** The primary mitigation strategy is the strict application of BPM. This includes the selection of quiet plant, localised screening, and the scheduling of works to minimise disturbance.
- **Section 61 Consent:** The Contractor is advised to obtain a Section 61 Prior Consent under the Control of Pollution Act 1974. This will provide a legally binding framework for action threshold triggers, working hours, and monitoring protocols, offering the project protection against Abatement Notices provided the agreed conditions are met.
- **Source Control (Vibration):** To mitigate vibration risks, the Contractor should prioritise the use of low-vibration piling methods (such as Movax side-grip rigs) and pre-augering where ground conditions permit.
- **Receptor-Based Measures:** Where significant effects persist despite on-site mitigation, Noise Insulation should be offered to eligible properties meeting specific noise level and duration triggers. Temporary Re-housing remains a measure of last resort, to be considered only in exceptional circumstances.

Residual Effects

The assessment relies on a conservative "worst-case" scenario. Under these assumptions:

- **Noise:** Temporary significant (Moderate adverse) residual noise effects are predicted at approximately 21 dwellings (within receptor groups R23, R25, R26, R27, R28, and R29) during the most intensive works.
- **Vibration:** Significant (Moderate adverse) residual vibration effects are predicted at approximately 22 dwellings. However, these predictions assume standard impact/vibratory piling. The adoption of modern "resonance-free" piling rigs and pre-augering is expected to significantly reduce these levels in practice, potentially reducing the impact from 'Moderate' to 'Minor' at several locations.
- **Vibration:** risk of cosmetic building damage to two non-residential groups R17 and R22. A vibration risk assessment and measures to minimise vibration from piling are required to minimise this risk.
- **Traffic:** Construction traffic noise is predicted to be Negligible on all road links.

Conclusion

While temporary significant effects are predicted during specific phases of work (particularly piling adjacent to the river wall), these can be effectively managed. It is important to note that there is no absolute legal noise limit that prohibits work; rather, the legislative requirement is to demonstrate that best practicable means (BPM) are being implemented to minimise disturbance.

Through the implementation of the Construction Environmental Management Plan (CEMP), adherence to Section 61 protocols, and a robust community liaison and monitoring strategy, the residual effects of the Scheme can be effectively managed.

12. Appendix A1 - Acoustic Glossary

Noise/Sound

Noise and sound need to be carefully distinguished. Sound is a term used to describe wave-like variations in air pressure that occur at frequencies that can stimulate receptors in the inner ear and, if sufficiently powerful, be appreciated at a conscious level. Noise implies the presence of sound but also implies a response to sound: noise is often defined as unwanted sound.

Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic, and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0dB (which corresponds to a reference sound pressure of 20 μ Pa) and the threshold of pain is around 120dB.

Frequency, Hz

Frequency is the number of occurrences of a repeating event per unit second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is usually divided up into octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency. The bands are described by their centre frequency value. In environmental acoustics the ranges typically used are from 63 Hz to 8 kHz.

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Peak Particle Velocity (PPV)

Peak Particle Velocity represents the maximum instantaneous particle velocity within a specified time frame. PPV is used in assessing ground vibrations and their potential impact on people, structures and the environment.

Ambient sound

Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far.

Ambient sound level ($L_{Aeq,T}$)

Equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T.

13. Appendix A2 - Key Legislation, Policy and Guidance Considerations

Control of Pollution Act 1974

The Control of Pollution Act 1974⁹ (CoPA) requires that 'Best Practicable Means' (as defined in section 72 of CoPA) are adopted to control construction noise on any given site.

CoPA makes reference to BS 5228 as best practicable means. Section 61 sets out the process for application to the local authority for prior consent to carry out works.

Planning Policy Wales (PPW) (Edition 12, 2024)

Planning Policy Wales (PPW) sets out the land use planning policies of the Welsh Government. It is the primary national policy that all local planning decisions in Wales must consider.

PPW states that planning policies and decisions should protect health and amenity by mitigating and reducing to a minimum potential adverse impacts from noise. It notes that "significant adverse impacts on health and the quality of life" should be avoided. This assessment's methodology, which aims to identify and mitigate significant effects, aligns with the goals of PPW.

Planning Guidance (Wales), Technical Advice Note (Wales) 11, Noise - October 1997

This note provides advice on how the planning system can be used to minimise the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business. It outlines some of the main considerations which local planning authorities should take into account in drawing-up development plan policies and when determining planning applications for development which will either generate noise or be exposed to existing noise sources. This document refers to BS5228 for assessment and control of noise from construction sites.

Technical Advice Note 11: Air Quality, Noise and Soundscape Consultation draft – January 2023

This document is currently in draft, not policy, however for reference it states that "Developers should, as a matter of course, follow all relevant codes of practice, guidelines and standards (e.g. BS 5228) to prevent significant adverse impacts and minimise adverse impacts during the construction phase of any development project. Planning authorities should ensure the impacts associated with construction phases can be adequately controlled."

Noise and Soundscape Plan for Wales Our national strategy on soundscapes 2023-2028 – December 2023

The Noise and Soundscape Plan 2023-2028 is Wales's national strategy on soundscapes, meaning the sound environment as perceived or experienced and/or understood by a person or people, in context. All forms of airborne sound that may be heard by the people of Wales are considered to be within scope of this document. This document refers to BS5228 for assessment and control of noise from construction sites.

Ceredigion Local Development Plan (2007 – 2022)

Policy DM22: General Environmental Protection and Enhancement states the following: "In order to help achieve environmental protection and enhancement, proposed development will be

⁹ Control of Pollution Act. (1974).

permitted provided that: It does not have a significant adverse effect on noise and light levels, both on and off site"

British Standard 6472

British Standard 6472-1: 2008 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting'¹⁰ presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration) above which comment is likely to occur in residential properties.

British Standard 5228

British Standard 5228: 'Code of practice for noise and vibration control on construction and open sites'^{11,12} provides a 'best practice' guide for noise and vibration control and includes sound power level (SWL) data for individual plant as well as a calculation method for noise from construction activities. Part 1 relates to noise and part 2 relates to vibration.

British Standard 7385

British Standard 7385: 1993 'Evaluation and Measurement for Vibration in Buildings'¹³ presents guide values or limits for transient vibration, above which there is a likelihood of cosmetic damage.

Calculation of Road Traffic Noise

Department of Transport/Welsh Office Memorandum 'Calculation of Road Traffic Noise'¹⁴ (CRTN) describes procedures for traffic noise calculation and is suitable for environmental assessments of schemes where road traffic noise may have an impact.

Design Manual for Road and Bridges

Highways England '*Design Manual for Road and Bridges Sustainability and Environment Appraisal LA111 – Noise and Vibration*'¹⁵ (DMRB) provides guidance on the appropriate level of assessment to be used when assessing the noise and vibration impacts arising from all road projects, including new construction, improvements and maintenance.

ISO 9613

ISO 9613 '*Attenuation of sound during propagation outdoors – Part 2: A general method of calculation*'¹⁶ gives general methods of calculating sound propagation outdoors including attenuation due to geometrical divergence (distance); air and ground absorption; screening; reflections and other effects.

¹⁰ British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings, Part 1: Vibration sources other than blasting

¹¹ British Standard 5228-1: 2009 + A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

¹² British Standard 5228-2: 2009 + A2:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

¹³ British Standard 7385-2: 1993 Evaluation and measurement for vibration in buildings — Part 2: Guide to damage levels from groundborne vibration

¹⁴ Calculation of Road Traffic Noise, Department of Transport Welsh Office, HMSO, 1988

¹⁵ Design Manual for Roads and Bridges, Volume 11, Environmental Assessment, Section 3, Environmental Assessment Techniques, LA 111, Noise and Vibration, (formerly HD 213/11, IAN 185/15), Highways England, May 2020

¹⁶ ISO 9613 Attenuation of sound during propagation outdoors – Part 2: A general method of calculation

14. Appendix A3 - Scheme Layout

15. Appendix A4 - Construction Plant

Table 15 Indicative Construction Plant and Dates Used in Modelling

Activity	Plant	On-time (%)	Quantity	Adjusted Sound Power Level Lw dB(A)	Approx. Start Date	Approx. End Date
Mobilisation	Tipper lorries	20	2	105	01/02/2027	15/02/2027
	Telehandler/forklifts	30	1	94		
	Deliveries (trucks)	10	2	102		
Temporary Haul Roads / Temporary piling platform	12t or 15t 360 excavator	10	1	87	15/02/2027	18/07/2027
	3.7t compactor (tandem vibratory roller)	20	1	99		
	Tractor (towing water bowser)	20	1	104		
	Lorry with lifting boom, 50kW, 6T	30	1	100		
	Articulated dump truck (dumping rubble), 250kW, 28T	10	1	98		
	Asphalt spreader 90kW, 13T	10	2	101		
	Deliveries (trucks)	10	1	99		
Pre-auguring, removal of existing walls & sheet piling	Large site generator	30	1	82	19/07/2027	08/09/2027
	Piling rig with pre-auger attachment	40	1	115		

Activity	Plant	On-time (%)	Quantity	Adjusted Sound Power Level Lw dB(A)	Approx. Start Date	Approx. End Date
	Tracked excavator fitted with hydraulic rock breaker	40	1	106		
	Long reach tracked excavator	10	1	96		
	12t or 15t 360 deg. Excavator	40	1	93		
	Sheet piling leader rig / side-grip rig	40	1	115		
Concrete pours	Concrete boom pump	25	1	97	06/09/2027	27/10/2027
	Concrete mixer truck	25	1	102		
	12t or 15t 360 deg. Excavator	40	1	93		
Stone Cladding	Telehandler/forklifts	30	1	94	25/10/2027	12/02/2028
	Deliveries (trucks)	10	2	102		
Copings	Telehandler/forklifts	30	1	94	07/02/2028	07/03/2028
	Deliveries (trucks)	10	2	102		
Remove/regrade piling platform	12t or 15t 360 deg. Excavator	40	2	96	06/03/2028	26/05/2028
	Tarmac machines	20	2	104		
	Line marking truck	20	1	95		
	Smooth drum rollers	30	2	106		
	Truck with crane	20	1	99		

Activity	Plant	On-time (%)	Quantity	Adjusted Sound Power Level Lw dB(A)	Approx. Start Date	Approx. End Date
Rip Rap	Lorry with lifting boom, 50kW, 6T	30	1	100	22/05/2028	20/06/2028
	Deliveries (trucks)	10	2	102		
	Telehandler/forklifts	30	1	94		
Various Reinstatements	12t or 15t 360 deg. Excavator	40	2	96	19/06/2028	03/07/2028
	Tarmac machines	20	2	104		
	Line marking truck	20	1	95		
	Smooth drum rollers	30	2	106		
	Truck with crane	20	1	99		
Landscaping (Area 1 only)	Tractor + post hole digger / post driver	20	5	103	03/07/2028	01/08/2028
	Telehandler/forklifts	30	1	94		
	Deliveries (trucks)	10	2	102		
Embankment Regrading and Saltmarsh Creation (Area 4 only)	12t or 15t 360 deg. Excavator	40	1	93	31/07/2028	29/08/2028
	Tarmac machines	10	2	101		
	Line marking truck	10	2	101		
	Smooth drum rollers	10	2	99		
	Truck with crane	10	1	96		
Demobilisation	Tipper lorries	20	2	105	28/08/2028	11/09/2028

Activity	Plant	On-time (%)	Quantity	Adjusted Sound Power Level Lw dB(A)	Approx. Start Date	Approx. End Date
	Telehandler/forklifts	30	1	94		
	Deliveries (trucks)	10	2	102		
Haul Road (Internal)	Deliveries (trucks)	30	1	104	19/07/2027	11/09/2028
Compound Establishment & Operation (North)	Large site back-up generator	100	1	87	18/01/2027	11/09/2028
	Telehandler/forklifts	50	1	96		
	Truck with crane	10	1	96		
	Deliveries	10	1	99		
Compound Establishment & Operation (North)	Large site back-up generator	100	1	87	18/01/2027	11/09/2028
	Telehandler/forklifts	50	1	96		
	Truck with crane	10	1	96		
	Deliveries	10	1	99		