NOISE AND VIBRATION IMPACT ASSESSMENT

Proposed Seawall Replacement Works

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1 INTRODUCTION

1.1 Background

RPS was commissioned by North Ayrshire Council to undertake a noise and vibration impact assessment for a proposed seawall replacement works, located at Largs, Scotland. The existing seawall at Largs retains the promenade and protects the shore side buildings and infrastructure from wave action and coastal erosion. It is c.300m in length, with the height varying along its length following the profile of the beach below. The retained height varies from approx. 1.0m to 4.0 m, and the top level of the seawall is approximately +5.16mCD along the full length. The public have access to the seawall and the beach below when the tide allows.

1.2 Site Location

The Largs Promenade extends from Largs Harbour (south) to the mouth of the Noddsdale Water (north), with a wall along the seaward length of the promenade transitioning to a sea wall from the RNLI slipway for approximately 300m north. Largs is a coastal town, which is located due west of Glasgow, within North Ayrshire Council area. The site location is illustrated in **Figure 1.1**.

Figure 1.1: Site Location

1.3 The Proposed Development

1.3.1 Existing Seawall Structure

The existing seawall at Largs retains the promenade and protects the shore side buildings and infrastructure from wave action and coastal erosion. It is c.300m in length, with the height varying along its length following the profile of the beach below. The retained height varies from approx. 1.0m to 4.0 m, and the top level of the seawall is approx. +5.16mCD along the full length. The public have access to the seawall and the beach below when the tide allows.

It was constructed from reinforced concrete in the 1970s as a replacement facing for the old seawall. This 1970s facing was covered in a gunite (sprayed concrete) facing in more recent years, but this has since failed and become detached from the 1970s concrete wall. The gunite was partially removed in 2018.

Recent surveys have indicated that the existing seawall structure is deteriorating in several ways:

- **Concrete Deterioration**: There is clear deterioration of the gunite facing concrete, where it remains attached to the existing wall face. There are high levels of corrosion of the existing wall reinforcement, with patches of exposed reinforcement visible throughout the length of the wall. High levels of chloride ingress to the existing concrete wall have also been identified.
- **Undermining**: The seawall is undermined along a section of wall (approx. 12m in length) where the toe is exposed, and no sheet piles were installed. This undermining is the likely cause of loss of material and subsidence of the promenade surface in recent years.
- **Steps**: There are three sets of steps ranging in height from 1.8m to 3.1m located along the length of the seawall. These are unsafe for use and are currently fenced off.

1.3.2 Proposed Development Plan

The proposed seawall replacement scheme comprises the replacement/encapsulation of the existing 300m long seawall. It consists of the following main elements:

- Controlled removal of existing steps which are unsafe for use.
- Installation of precast concrete caissons along the front of the existing seawall to act as a foundation to facilitate the placement of precast concrete seawall units.
- Placement of granular infill in the concrete caisson units,
- The precast caisson base unit will be filled with granular material. The base will be topped with a mortar layer, with the concrete seawall units then installed (Example of proposed seawall units shown in Figure 4). The precast units will be shaped for them to interlock, then grouted and sealed to both sides, thus avoiding the requirement for dowels or protruding reinforcement
- Placing of granular backfill between the front face of the existing seawall structure, and the rear face of the new precast structure. Suitable drainage to be provided within the backfill. Surfacing of backfill with concrete or asphalt pavement to tie into existing promenade. New / reinstatement of handrail along the promenade.
- Placement of rock armour scour protection in-front of the new precast concrete seawall units to prevent undermining of the toe of the new structure.

Installation of steps at required intervals along seawall structure. The form of foundation and structure varies along the length of the seawall to account for the varying profiles of the existing seawall structure.

The proposed development plans are displayed in Figure 1.2 - Figure 1.5.

Figure 1.2: Proposed Seawall Replacement Works General Arrangement (North)

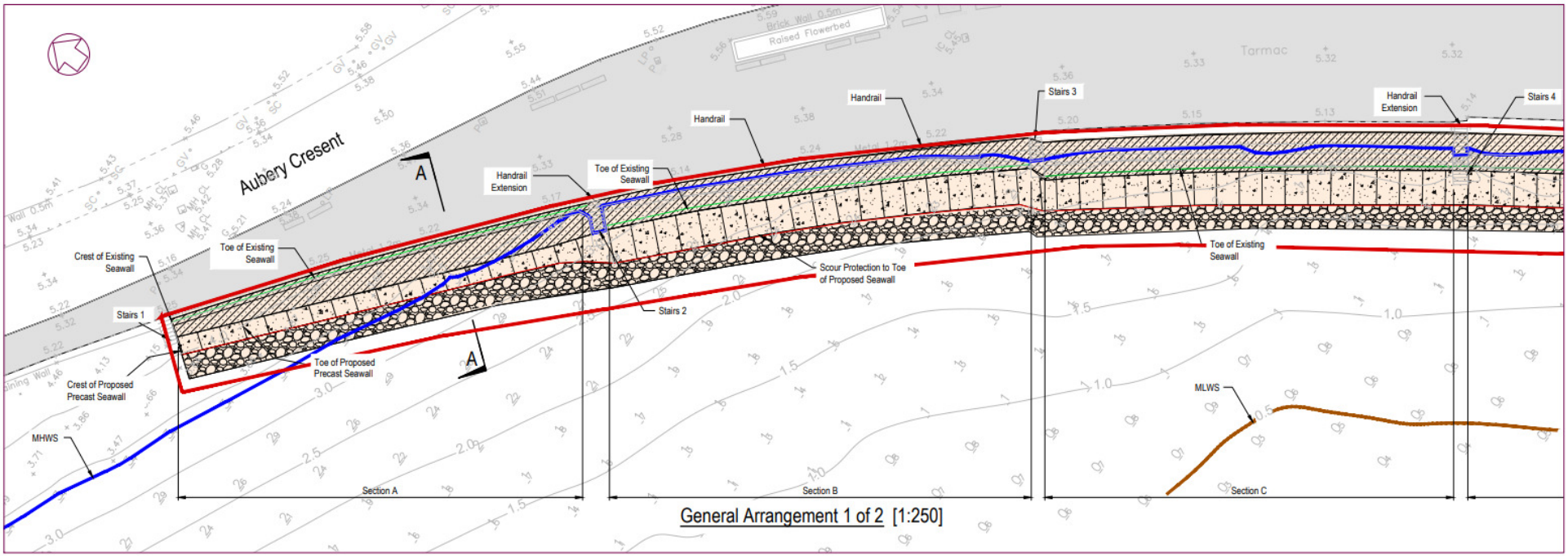


Figure 1.3: Proposed Seawall Replacement Works General Arrangement (South)

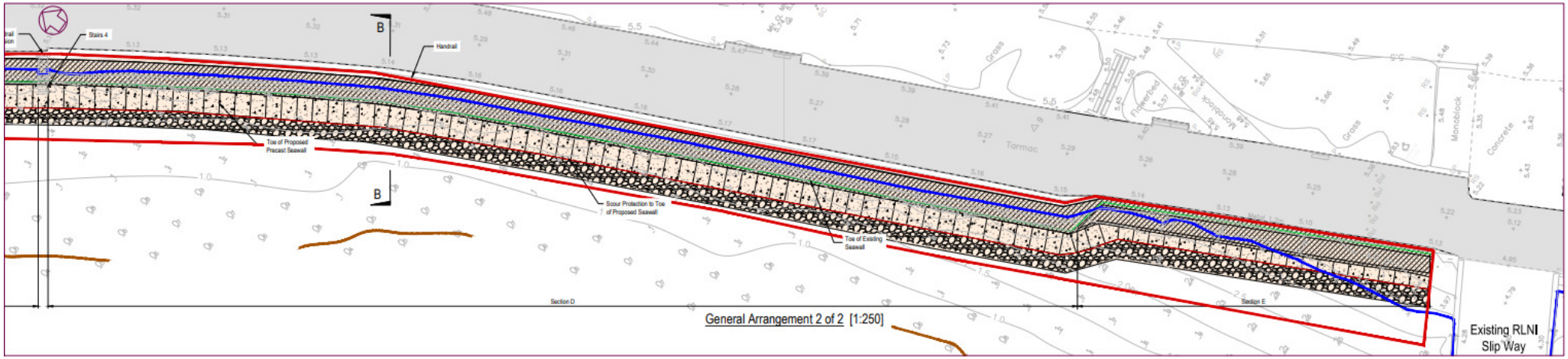


Figure 1.4: Proposed section for Northern and Southern Section of Seawall

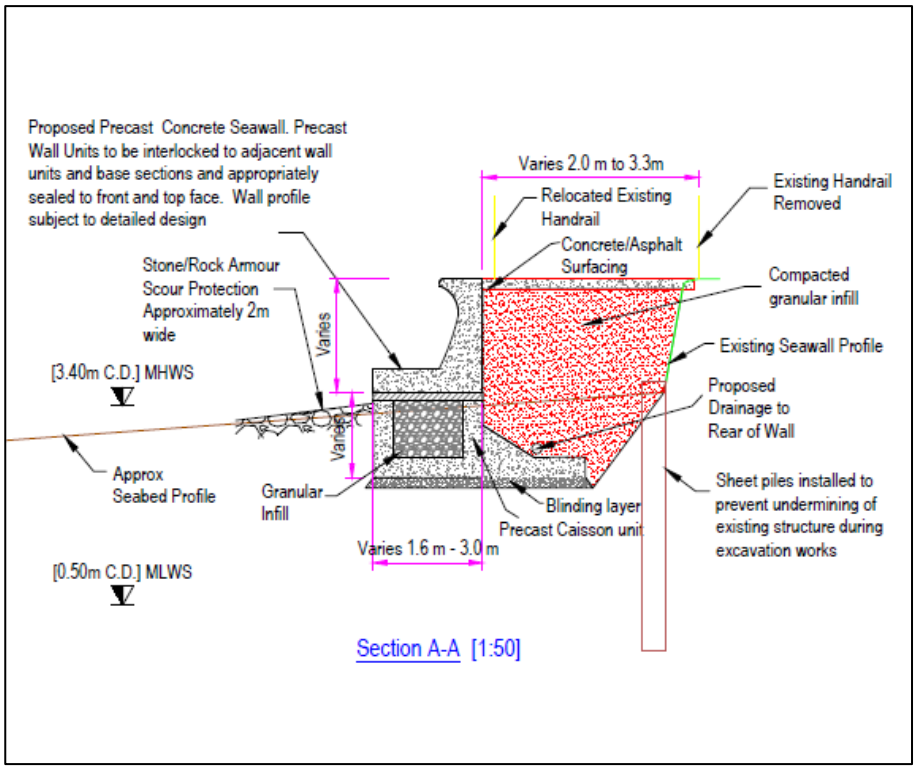
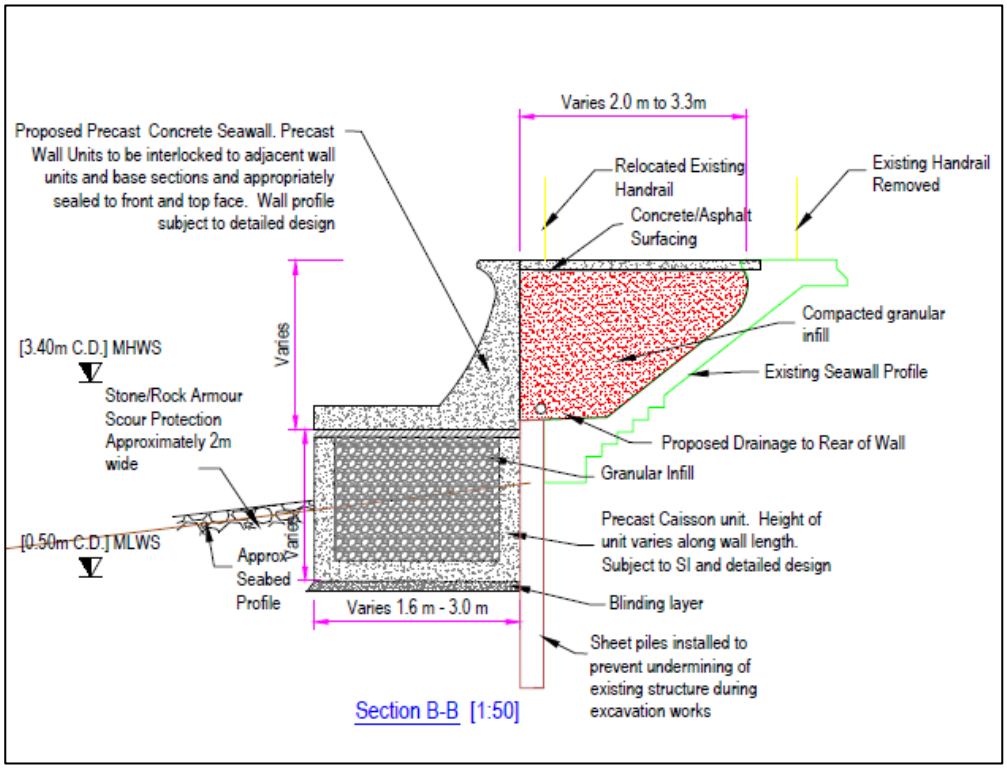


Figure 1.5: Proposed section for middle section of proposed Seawall



1.3.3 Proposed Construction Methodology

A summary of the likely project phases is set out below.

Demolition/ Site Clearance/ Site Set Up There will be a temporary site compound in the immediate vicinity of the site to support the proposed development during the construction period. The location of this has not yet been determined, however one option may be at the northern end of the seawall close to Aubrey Crescent. The area of works along the promenade and beach will be fenced off, and initial works will see the partial removal of the existing concrete steps with a rock breaker mounted on small excavator working from the beach. The existing handrail along the promenade will be removed and stored for reuse. This phase is likely to take approx. 3 weeks.

It is anticipated that the beach and the promenade will be closed for the duration of the construction work to ensure public safety, however there may be opportunities to open sections of the beach and promenade early if site security and safety measures allow. RNLI access including parking will be maintained at all times. Storage of materials on the promenade may be considered where off site storage is not feasible.

It is planned to retain a walkway along the edge of the site, creating a temporary walkway on the grassed area between Greenock Road and the promenade. Construction access to the beach is expected to be via a temporary access ramp constructed to the side of the RNLI slipway.

- **Protection Works for the Existing Seawall structure**

  Sheet piles will be installed to the front edge of the toe along the length of the existing wall to provide temporary protection against undermining whilst excavations are being carried out. These will be installed using a vibratory hammer where possible. It is expected that due to the nature of the ground conditions to the south of the site an impact hammer may be required to install the piles. It is conservatively estimated that 150 m of the 300 m anticipated length of piling may be driven by means of impact piling. This phase is likely to take approx. 6 weeks and would run concurrent to removal of the steps.

- **Excavation**

  Beach material will be excavated to facilitate the installation of the concrete caisson units using a small excavator working from the beach to prevent settlement into the sand. The material is likely to be taken offsite for disposal to a licenced facility or beneficially re-used (subject to testing to confirm suitability of material, and identification of a suitable receptor). This phase is likely to take approximately 9 weeks.

- **Seawall Installation**

  The toe of the proposed replacement wall will be excavated to low water level with a small excavator working from the beach, and bedding material added (lean mix concrete). The caisson units will be installed on top of the material by a crane or telehandler on the promenade or beach and filled with granular material. The precast concrete seawall unit will be placed on top and grouted into place. The space between the replacement seawall unit and the face of the existing seawall will be backfilled and compacted by an excavator working from the promenade, then surfaced with asphalt to tie into the existing promenade. The existing handrail will be removed. The precast installation is likely to take approximately 9 weeks, with the backfilling and surfacing works taking approximately 8 weeks. Scour protection will be installed with suitably sized/graded rock placed in layers on the beach surface to the front of the precast concrete seawall, by an excavator working on the beach area. The timing of each phase of works will be subject to tidal restrictions on working.

- **Surfacing**

  Asphalt surfacing will be placed on the newly constructed section of promenade and resurfacing works to the existing promenade will also be carried out at this time. All areas of surfacing will include a rolled asphalt surface course containing 14mm red coated chippings. All benches, bollards, movable planters and litter bins will be removed prior to the promenade resurfacing and reinstated upon completion.

- **Street furniture and Beach Access**

  It is proposed to install a new handrail along the length of the new seawall. Access to the beach will be provided to the north and south ends of the beach, with ramp access at the Aubrey Crescent end of the seawall. Steps will be installed at an intermediate point along the wall. These will be precast concrete steps, and have a gate to the top edge and railings that tie in with the proposed new handrail along the crest of the new seawall.

1.4 Potential Effects Scoped Out

On the basis of the desk based work undertaken and professional judgement of the author the following areas have been scoped out of the detailed assessment including:

- Operational noise has not been included as there is no inclusion of new significant noise sources likely to generate perceptible noise levels when the proposed development is operational; and
- Operational vibration has not been included as there is no inclusion of new significant vibration sources likely to generate perceptible levels of vibration when the proposed development is operational.

The proposed development repairs the existing seawall and as such, no significant operational vibration or noise impacts will occur.

2 METHODOLOGY

2.1 Noise Policy and Guidance

The noise assessment has considered the following relevant policy and guidance documents:

- Planning Advice Note (Scotland) PAN 1/2011;
- World Health Organisation (WHO) – Guidelines for Community Noise (1999);
- British Standard BS5228 BS 5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites; and
- British Standard BS 7445-1 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1).

2.1.1 Planning Policy Context

2.1.1.1 Planning Advice Note

The Planning Advice Note (Scotland) PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. It should be read in conjunction with "Planning Guidance (Scotland): Planning Policy, Technical Advice Notes and circulars.

"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 includes details of the legislation, technical standards and codes of practice for specific noise issues. The PAN promotes the principles of good acoustic design and a sensitive approach to the location of new development. It promotes the appropriate location of new potentially noisy development, and a pragmatic approach to the location of new development within the vicinity of existing noise generating uses, to ensure that quality of life is not unreasonably affected and that new development continues to support sustainable economic growth. Environmental Health Officers and/or professional acousticians should be involved at an early stage in development proposals which are likely to have significant adverse noise impacts or be affected by existing noisy developments.

The Environmental Noise (Scotland) Regulations 2006 transposed the European Directive 2002/49/EC (the Environmental Noise Directive) into Scottish law. The Regulations affect large urban areas; major transport corridors and major airports. They require Scottish Ministers and airport authorities to manage noise through a process of strategic noise mapping and noise action plans. In the areas affected by the Regulations, planning authorities have a role in helping to prevent and limit the adverse effects of environmental noise. Areas affected by the Regulations can be seen on the Scottish Noise Mapping website.

2.1.2 World Health Organisation (WHO) – Guidelines for Noise

In the World Health Organisation (WHO) Guidelines for Community Noise (1999), a L_{Aeq} threshold daytime noise limit of 55 dB is suggested for outdoor living areas in order to protect the majority of people from being seriously annoyed. A second daytime limit of 50 dB is also given as a threshold limit for moderate annoyance.

The guidelines suggest that an internal L_{Aeq} not greater than 30 dB for continuous noise is needed to prevent negative effects on sleep. This is equivalent to a façade level of 45 dB L_{Aeq}, assuming open windows or a free-field level of about 42 dB L_{Aeq}. If the noise is not continuous, then the internal level required to prevent negative effects on sleep is a $L_{Amax,fast}$ of 45 dB. Therefore, for sleep disturbance, the continuous level as well as the number of noisy events should be considered.

The WHO Night Noise Guidelines for Europe was published in 2009 on the back of extensive research completed by a WHO working group. Considering the scientific evidence on the threshold of night noise exposure indicated by $L_{night,outside}$ as defined in the Environmental Noise Directive [2002/49/EC], a $L_{night,outside}$ of

40dB should be the target of the night noise guideline (NNG) to protect public, including the most vulnerable groups such as children, the chronically ill and the elderly. An interim target of 55dB is recommended where the NNG cannot be achieved. These guidelines are applicable to Member States of the European Region and may be considered as an extension to the previous WHO Guidelines for Community Noise (1999).

In 2011, the WHO published the *Methodological Guidance for Estimating the Burden of Disease from Environmental Noise*. This document outlines the principles of quantitative assessment of the burden of disease from environmental noise, describes the status in terms of the implementation of the European Noise Directive and reviews evidence on exposure-response relationships between noise and cardiovascular diseases.

In 2018, the WHO Regional Office for Europe has developed guidelines, based on the growing understanding of health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. Leisure noise in this context refers to all noise sources that people are exposed to due to leisure activities, such as attending nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and listening to loud music through personal listening devices.

The 2018 guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

2.1.3 British Standard BS 5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites

BS 5228 consists of two parts and covers the need for protection against noise and vibration of persons living and working in the vicinity of construction and open sites. The standard recommends procedures for noise and vibration control in respect of construction operations and aims to assist architects, contractors and site operatives, designers, developers, engineers, local authority environmental health officers and planners.

Part 1 of the standard provides a method of calculating noise from construction plant, including:

- Tables of source noise levels;
- Methods for summing up contributions from intermittently operating plant;
- A procedure for calculating noise propagation;
- A method for calculating noise screening effects;
- A way of predicting noise from mobile plant, such as haul roads.

The standard also provides guidance on legislative background, community relations, training, nuisance, project supervision and control of noise and vibration.

The ABC method outlined in Section E3.2 has been used for the purposes of determining whether the predicted noise levels from the construction activities will result in any significant noise impact at the nearest noise sensitive properties.

Table 2.1 outlines the applicable noise threshold limits that apply at the nearest noise sensitive receptors. The determination of what category to apply is dependent on the existing baseline ambient (L_{Aeq}) noise level (rounded to the nearest 5dB) at the nearest noise sensitive property. For daytime, if the ambient noise level is less than the Category A threshold limit, the Category A threshold limit (i.e. 65dB) applies. If the ambient noise level is the same as the Category A threshold limit, the Category B threshold limit (i.e. 70dB) applies. If the ambient noise level is more than the Category A threshold limit, the Category C threshold limit (i.e. 75dB) applies. The applicable limits that apply at each of the sensitive receptors are presented and discussed in Section 4.

Table 2.1: Noise Threshold Limits at Nearest Sensitive Receptors for Construction Activities

	Threshold Limits [dB(A)]		
	Category A	Category B	Category C
Night-time (23:00 - 07:00)	45	50	55
Evening and Weekends (19:00 - 23:00 Weekdays, 13:00-23:00 Saturdays, 07:00-23:00 Sundays)	55	60	65
Weekday daytime (07:00-19:00) and Saturdays (07:00-13:00)	65	70	75

2.1.4 British Standard BS 7445-1:2003 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1).

British Standard BS7445 provides the framework within which environmental noise should be quantified. BS 7445: Part 1 provides guidance to quantities and procedures in relation to environmental noise monitoring. BS7445-1 states that sound level meters that are used should conform to specifications of Class or Type 1 (or Class or Type 2 as a minimum) as given in BESN 61672.

The Class of a noise level meter describes its accuracy as defined by the relevant international standards. Sound level meters are defined by International Standards such as IEC 61672-1:2013 (or BS EN61672-1:2003). These standards define a wide range of complex accuracy, performance and calibration criteria that instruments must meet to be fit for purpose. Within the Standard, there are two allowable levels of tolerance and these are known as Class 1 and Class 2. Class 1 is more accurate than Class 2.

These Class 1 and Class 2 tolerances are necessary as a way of dealing with variations in the instruments. The variations are caused by the different electronic components used inside the sound level meters and because of the way different meters have been designed and verified. Even the test equipment used to check the sound level meters during manufacture will introduce some variation.

All equipment shall be calibrated and the configuration for calibration shall be in accordance with the manufacturer's instructions. A comprehensive recalibration at certain time intervals (for example annually) may be prescribed by authorities responsible for the use of the measurement results. A field check shall be made by the user at least before and after each series of measurements, preferably including an acoustic check of the microphone

Meteorological conditions are not prescribed but it is recommended that wind speed should not exceed 5 m /s at height of 3-11m above ground, any temperature inversions near ground, or heavy precipitation.

2.2 Vibration Guidance

2.2.1 BS 6472-1:2008 Guide to Evaluation of Human Exposure to Vibration in Buildings

2.2.1.1 Part 1: Vibration Sources Other than Blasting

BS 6472 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. People perceive building vibrations depending on various factors, including vibration frequency and direction.

Building vibrations as they affect people can be classified as usefully according to a combination of descriptions. The time history of the vibration input to the subject can be

- Continuous - vibration is continuous when it is uninterrupted for the assessment period. This can be either a daytime period of 16 h, e.g. 07:00 hrs to 23:00 hrs, or a night-time period of 8 hrs, e.g. 23:00 hrs to 07:00 hrs.,
- intermittent - vibration which is perceived in separately identifiable repeated bursts. Its onset can be sudden, or there might be a gradual onset and termination bounding a more sustained event. Bursts may happen several to many times in a day or night period. or
- occasional - vibration occurs less often than intermittent vibration, and might be less predictable.

Each of these categories of time history can have one of the following characteristics of vibration:

- constant amplitude;
- variable amplitude; or
- impulsive;

and can contain impulsive events in whole or in parts.

2.2.2 Vibration Dose Value

The effects of vibrations on people within buildings can be assessed using the Vibration Dose Value (VDV) which correlates well with subjective response, and provides a consistent assessment of continuous, intermittent, occasional, and intermittent vibrations. The VDV defines a relationship that yields a consistent assessment of continuous, intermittent, occasional, and impulsive vibration and correlates well with subjective response. The vibration dose value is defined below.

$$\mathrm{VDV}_{\mathrm{b/d,day/night}} = \left(\int_0^T a^4(t)dt \right)^{0.25}$$

Where:

$\mathrm{VDV}_{\mathrm{b/d,day/night}}$ is the vibration dose value (in $\mathrm{m \cdot s^{-1.75}}$);

$a(t)$ is the frequency-weighted acceleration (in $\mathrm{m \cdot s^{-2}}$), using W_{b} or W_{d} as appropriate;

T is the total period of the day or night (in s) during which vibration can occur.

NOTE The VDV should be identified with the vibration acceleration weighting function applied by adding a subscript, that is, VDVb or VDVd as appropriate. Where other identifying subscripts are necessary, they should follow the weighting function subscript, separated from it by a comma, e.g. VDVb,day.

The VDV is given as the fourth root of the time integral of the fourth power of the acceleration after it has been frequency weighted.

Estimated VDV can be predicted where measurements are not possible using the following formula, knowing the likely frequency weighted rms acceleration level of the source, a, (or estimating this from the known or measured peak particle velocity) and the duration of exposure, t, in seconds:

$$\mathrm{eVDV} = 1.4 \times a(t)_{\mathrm{r.m.s.}} \times t^{0.25}$$

When the appropriately-weighted vibration measurements or predictions have been used to derive the VDV for either 16 h (daytime) or 8 h (night-time) at the relevant places of interest, their significance in terms of human response for people in those places can be derived from **Error! Reference source not found.**. The judgement made is of the probability that the determined vibration dose might result in adverse comment by those who experience it.

Daytime (16 hr) and night time (8hr) vibration measurements or predicted VDV's can be compared to the VDV's provided in Table 2.2.

Table 2.2: Vibration Dose Values Ranges Which Might Result in Various Probabilities of Adverse Comment within Residential Buildings

Place and Time	m.s $^{-1.75}$		
	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential buildings, 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 0.16
Residential buildings, 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

In respect of vibration dose values, a VDV within or below the "*low probability of adverse comment*" range should be achieved within habitable rooms.

2.2.3 British Standard 5228-2:2009

British Standard 5228:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration gives basic methods for controlling vibration from construction operations where activities or specific operations give rise to significant levels of vibration and gives guidance on the effects of vibration, shown in Table 2.3.

Table 2.3: Guidance on the Effects of Vibration Levels

Vibration Level mms^{-1}	Effect
0.14	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies with construction. At lower frequencies people are less sensitive to vibration
0.30	Vibration might be just perceptible in residential environments
1.00	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents
10.00	Vibration is likely to be tolerable for any more than a very brief exposure to the level

2.2.4 British Standard 7385-2:1993

British Standard 7385:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration provides guidance on the transient vibration guide values for cosmetic damage in building which is shown in Table 2.4 below.

Table 2.4: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Rand of Predominant Pulse	
	4Hz to 15Hz	15Hz and above
Un-reinforced or light framed structures Residential or light commercial buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

The majority of people are known to be very sensitive to vibration, the threshold of perception being typically in the peak particle velocity (PPV) range of between $0.14mms^{-1}$ and $0.30mms^{-1}$. Vibration levels above these values can cause disturbance.

3 BASELINE MONITORING SURVEYS

3.1 Vibration Monitoring Survey

A vibration monitoring survey was not undertaken as there are not any existing operational vibration sources on proposed development site.

3.2 Noise Monitoring Survey

Unattended noise monitoring surveys were undertaken at two locations at the nearest noise sensitive properties to determine background noise levels.

The unattended monitoring was undertaken to include daytime and night time monitoring from the 3rd May 2022 to 6th May 2022 at two Noise Monitoring Locations (NML) 1 and 2.

Figure 3.1 below shows the location of NML1 and NML2.

Figure 3.1: Unattended Noise Monitoring Locations

Noise Monitoring Survey Results along with survey photographs and sound level meter calibration certificates can be found in Appendix A.

4 IMPACT ASSESSMENT

The noise and vibration impact assessment has focused primarily on the construction phase of the proposed development.

Operational noise has not been included as there is no inclusion of new significant noise sources likely to generate perceptible noise levels when the proposed development is operational

4.1 Residential Properties

The nearest sensitive receptors to the proposed development have been identified using aerial mapping. Each sensitive receptor has been assigned an ID which is shown below in Figure 4.1, together with the location coordinates and distance to the proposed site boundary summarised in Table 4.1.

Figure 4.1: Residential Sensitive Receptors

Table 4.1: Distances from Sensitive Receptors to Site Boundary

Sensitive Receptor ID	Easting	Northing	Distance from Boundary (m)
1	219979	660366	69.5
2	219987	660359	66.2
3	219992	660355	65.2
4	219996	660352	63.9
5	220001	660348	62.7
6	220007	660345	63.0
7	220014	660342	62.6
8	220019	660339	62.9
9	220025	660336	63.1
10	220030	660333	63.5
11	220042	660330	68.4
12	220054	660332	77.5
13	220092	660245	48.0
14	220077	660374	124.5
15	220075	660411	153.3
16	220063	660442	174.4
17	219828	660563	288.5
18	219844	660550	270.2
19	219868	660556	267.4
20	219876	660573	280.8
21	219899	660543	246.1
22	219977	660566	265.7
23	220017	660535	242.6
24	220001	660526	229.2
25	219970	660516	214.8
26	219937	660513	210.9
27	219951	660491	189.3
28	219941	660467	165.4
29	219920	660467	167.3
30	219907	660490	193.3
31	220081	660532	263.1
32	220196	660210	121.8
33	220215	660130	103.1
34	220133	660304	116.1
35	220179	660264	130.5
36	220218	660178	127.5
37	220231	660181	139.8
38	220245	660181	152.7
39	220259	660184	166.6
40	220258	660205	175.3
41	220254	660220	177.6
42	220236	660214	159.1
43	220245	660152	138.8

Sensitive Receptor ID	Easting	Northing	Distance from Boundary (m)
44	220257	660154	151.4
45	220269	660157	163.1
46	220281	660161	175.4
47	220292	660163	186.1
48	220236	660025	101.5
49	220240	660011	110.3
50	220244	660000	118.3
51	220249	659986	129.6
52	220254	659972	140.9
53	220284	659982	162.1
54	220295	659984	171.1
55	220285	660010	152.9
56	220279	660026	143.0
57	220274	660042	136.3
58	220305	660045	166.8
59	220309	660034	171.4
60	220313	660020	178.3
61	220322	659998	192.0
62	220339	660001	207.0
63	220353	660005	220.2
64	220346	660026	209.2
65	220339	660041	200.5
66	220335	660050	196.6
67	220366	660054	227.8
68	220370	660043	231.7
69	220379	660020	242.8
70	220395	660023	258.3
71	220405	660025	267.8
72	220269	659923	184.7
73	220263	659937	171.0
74	220288	659944	185.4
75	220297	659948	190.1
76	220308	659952	197.5
77	220315	659955	202.5
78	220326	659959	210.4
79	220336	659962	218.1
80	220353	659909	258.3
81	220342	659943	232.2
82	220344	659936	237.1
83	220346	659930	241.5
84	220349	659924	247.3
85	220351	659917	252.5
86	220371	659944	256.8
87	220373	659939	260.9

Sensitive Receptor ID	Easting	Northing	Distance from Boundary (m)
88	220374	659932	264.9
89	220376	659926	269.9
90	220360	659969	237.2
91	220369	659972	244.4
92	220382	659977	255.1
93	220389	659979	261.6
94	220408	659930	296.3
95	220405	659938	290.0
96	220403	659945	285.5
97	220401	659952	281.3
98	220398	659959	276.7
99	220338	659862	276.8
100	220414	659988	283.6
101	220424	659991	292.4
102	220311	660165	204.0
103	220319	660166	211.8
104	220336	660170	228.3
105	220345	660172	238.1
106	220365	660176	257.9
107	220374	660179	266.6
108	220288	660190	194.6
109	220284	660209	199.7
110	220282	660223	204.4
111	220280	660237	208.5
112	220269	660251	205.4
113	220260	660249	195.9
114	220247	660245	182.5
115	220236	660244	172.9
116	220222	660242	159.0
117	220212	660242	149.7
118	220207	660271	158.1
119	220223	660272	173.1
120	220236	660274	186.1
121	220252	660276	201.3
122	220265	660278	213.5
123	220279	660280	227.0
124	220294	660281	240.7
125	220300	660282	246.8
126	220307	660282	253.1
127	220314	660284	259.8
128	220320	660284	265.9
129	220304	660192	209.8
130	220312	660193	218.2
131	220303	660244	232.3

Sensitive Receptor ID	Easting	Northing	Distance from Boundary (m)
132	220311	660246	240.3
133	220323	660232	244.8
134	220325	660222	242.0
135	220331	660200	237.5
136	220351	660207	258.5
137	220362	660212	271.0
138	220372	660214	281.0
139	220185	660313	162.4
140	220203	660315	179.1
141	220221	660317	195.2
142	220235	660319	207.4
143	220252	660321	223.1
144	220266	660325	237.0
145	220281	660327	250.6
146	220286	660372	280.2
147	220272	660386	275.7
148	220254	660388	263.4
149	220240	660390	253.6
150	220226	660392	243.4
151	220211	660393	233.0
152	220197	660396	224.5
153	220186	660395	215.2
154	220173	660395	205.6
155	220161	660393	195.9
156	220133	660322	127.5
157	220131	660340	138.4
158	220131	660366	155.2
159	220132	660386	169.6
160	220247	660429	283.7
161	220231	660431	273.2
162	220216	660434	264.4
163	220203	660436	255.5
164	220188	660437	245.2
165	220172	660437	234.4
166	220158	660435	223.8
167	220124	660431	199.0
168	220122	660443	206.9
169	220122	660461	220.9
170	220114	660481	233.5

Sensitive Receptor ID 13 is closest to site boundary at 48m.

4.2 Construction Phase - Noise

Construction noise sources are temporary, are transient and therefore will vary in location throughout the construction period. The potential impacts of construction noise from the proposed development have been undertaken. Construction noise levels are predicted at residential properties in accordance with BS 5228. At this planning stage, the exact construction programme is unknown therefore a "worst case" approach has been adopted which is based currently on assumptions.

4.2.1 Construction Activities

Typical noise levels from various construction activities and associated plant have been assumed and detailed below in Table 4.2. The assumed construction plant shown is generally representative of the type of plant that will be in use for the construction phase of the proposed development.

Table 4.2: Construction Plant Noise Levels (REF: BS 5228:2009+A1:2014)

Construction Activity	Plant (Reference from Tables C1 & C2, Annex C, BS5228:2009+A1:2014)	Activity Equivalent Continuous Sound Pressure Level L_{Aeq} at 10m (dB)	Combined Construction Noise Level L_{Aeq} at 10m (dB)
Demolition / Site Clearance/ Site Set Up	1 Excavator with Rock Breaker (C9, Ref 12) (2 weeks)	79	85
	1 Wheeled backhoe loader (C2, Ref 8) (2 weeks)	68	
	1 Articulated Dump Truck (C4, Ref 2) (2 weeks)	78	
	1 Hand Held Pnuematic Breaker (C1, Ref 6) (1 week)	83	
Protection Works for the Existing Seawall structure	1 Piling Rig (C3, Ref 8) (6 weeks)	88	89
	1 Tracked excavator (C2, Ref 15) (3 weeks)	76	
	1 Wheeled loader (C2, Ref 27) (3 weeks)	80	
	Pressed-in steel tubular piles; power pack pressing unit (C12, Ref 1) (6 weeks)**	68	
Excavation	1 Dump Truck (tipping fill) (C2, Ref 30) (7 weeks)	79	88
	1 Dump Truck (empty) (C2, Ref 30) (7 weeks)	87	
	1 Tracked excavator (C2, Ref 15) (7 weeks)	76	
	2 Water pump's (C3, Ref 13) (7 weeks)	63	
Seawall Installation	1 Telehandler (C4, Ref 55) (14 weeks)	70	74
	1 Crane (C4, Ref 41) (6 weeks)	71	
	1 Small Cement Mixer (C4, Ref 23) (8 weeks)	61	
Surfacing	1 Road Planer (C5, Ref 7) (1 week)	82	86
	1 Wheeled excavator (C4, Ref 10) (1 week)	66	
	1 Dozer (C5, Ref 12) (1 week)	77	
	1 Articulated Dump Truck (C4, Ref 2) (1 week)	78	

Construction Activity	Plant (Reference from Tables C1 & C2, Annex C, BS5228:2009+A1:2014)	Activity Equivalent Continuous Sound Pressure Level L_{Aeq} at 10m (dB)	Combined Construction Noise Level L_{Aeq} at 10m (dB)
	1 Asphlat Paver and Tipper Lorry (C5, Ref 30) (1 week)	75	
	1 Road Roller (C5, Ref 19) (1 week)	80	
Street furniture and Beach Access	1 Small Cement Mixer (C4, Ref 23) (8 weeks)	61	61

***Pressed-in steel tubular piles; power pack pressing unit has been selected for the purpose of presenting an indicative construction noise prediction, as BS 5228 does not provide a reference for impact piling equipment.*

4.2.2 Predicted Impact of Construction Noise from Proposed Development

The precise construction strategy to be adopted will be a matter for the contractor, but it is likely that any construction related noise levels experienced will be similar to the typical noise levels indicated in Table 4.2 for the various plant.

In order to assess the worst-case construction related noise levels from the proposed development, the noise level for each of the activities detailed in Table 4.2, at 10m distance has been added to get a cumulative noise level for that particular construction activity.
These cumulative noise levels have then been used for the purpose of the construction noise assessment.

Noise levels were calculated at construction sensitive receptors using the distance attenuation calculation:

$L_{p2} = L_{p1} - 20 \log (D_2 / D_1)$

L_{p2} = calculated sound pressure level in dB at a distance of D_2 meters from the noise source

L_{p1} = measured sound pressure level in dB at a distance of D_1 meters from the noise source

D_2 = Construction sensitive receptor distance from noise source (detailed in Table 4.1)

D_1 = measurement distance of noise source (10m)

The calculation above assumes a direct line of sight from the noise source to the receiver, no barrier effect considered, which is a worst case scenario.

A construction noise barrier will be used throughout the construction of the proposed seawall replacement works, located at Largs, Scotland. as a worst case scenario; 10 dB construction barrier attenuation has been applied to all construction noise predictions, referred to as attenuated construction noise predictions.

Using the distance attenuation calculation above and distances detailed in Table 4.1 construction activities, including Demolition/Site Clearance, Protection Works for the Existing Seawall structure, Excavation, Seawall Installation, New Asphalt Pavement Installation / Resurfacing and Installation of Handrail, noise predictions were calculated at each of the construction sensitive receptors. Predicted construction noise levels have been calculated using the noise source levels of construction plant outlined in Table 4.2.

The calculated construction noise levels have been undertaken based on the construction plant operational continuously throughout the full working day (100% utilisation) and using site boundary distances. 10 dB has also been subtracted from the predicted construction noise levels and presented below in **Error! Reference source not found.** - Table 4.8 as attenuated noise predictions. These attenuated construction noise predictions assume minimum 10 dB from construction noise barrier.

The predicted construction noise impacts are assessed in accordance with Table 2.1: Noise Threshold Limits at Nearest Sensitive Receptors for Construction Activities.

4.2.3 Predicted Construction Noise Levels at Sensitive Receptors

Table 4.3 - Table 4.8 below illustrates the predicted construction noise levels and attenuated construction noise levels from construction at the construction sensitive receptors for Demolition/ Site Clearance/ Site Set Up, Protection Works for the Existing Seawall Structure, Excavation, Seawall Installation, Surfacing and Street furniture and Beach Access.

The construction noise predictions detailed within this assessment are deemed to be worst case based on the following:

- Full power operation of each construction activity throughout the daytime period.
- Free field conditions are assumed, and ground effects are ignored.
- Equipment is assumed to be operational at closest point at each construction phase boundary to construction noise receptors (resulting in over-estimation);
- Closet distance from boundary of site to noise receptors.
- Predictions are based on the noisiest pieces of equipment simultaneously operational; and
- No barrier effects have been applied.

4.2.3.1 Predicted Construction Activity Noise Levels from Demolition/ Site Clearance/ Site Set Up

Table 4.3: Predicted Construction Activity Noise Levels from Demolition/ Site Clearance/ Site Set Up

Sensitive Receptor ID	Construction Noise Limit	Demolition/ Site Clearance/ Site Set Up	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	**68.2**	58.2
2	65	**68.6**	58.6
3	65	**68.7**	58.7
4	65	**68.9**	58.9
5	65	**69.1**	59.1
6	65	**69.0**	59.0
7	65	**69.1**	59.1
8	65	**69.0**	59.0
9	65	**69.0**	59.0
10	65	**68.9**	58.9
11	65	**68.3**	58.3
12	65	**67.2**	57.2
13	65	**71.4**	61.4
14	65	63.1	53.1
15	65	61.3	51.3
16	65	60.2	50.2
17	65	55.8	45.8
18	65	56.4	46.4
19	65	56.5	46.5
20	65	56.0	46.0
21	65	57.2	47.2
22	65	56.5	46.5
23	65	57.3	47.3
24	65	57.8	47.8
25	65	58.4	48.4
26	65	58.5	48.5
27	65	59.5	49.5
28	65	60.6	50.6
29	65	60.5	50.5
30	65	59.3	49.3
31	65	56.6	46.6
32	65	63.3	53.3
33	65	64.7	54.7
34	65	63.7	53.7
35	65	62.7	52.7
36	65	62.9	52.9
37	65	62.1	52.1
38	65	61.3	51.3
39	65	60.6	50.6
40	65	60.1	50.1
41	65	60.0	50.0
42	65	61.0	51.0
43	65	62.2	52.2
44	65	61.4	51.4
45	65	60.8	50.8
46	65	60.1	50.1
47	65	59.6	49.6
48	65	64.9	54.9
49	65	64.1	54.1

Sensitive Receptor ID	Construction Noise Limit	Demolition/ Site Clearance/ Site Set Up	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
50	65	63.5	53.5
51	65	62.7	52.7
52	65	62.0	52.0
53	65	60.8	50.8
54	65	60.3	50.3
55	65	61.3	51.3
56	65	61.9	51.9
57	65	62.3	52.3
58	65	60.6	50.6
59	65	60.3	50.3
60	65	60.0	50.0
61	65	59.3	49.3
62	65	58.7	48.7
63	65	58.1	48.1
64	65	58.6	48.6
65	65	59.0	49.0
66	65	59.1	49.1
67	65	57.8	47.8
68	65	57.7	47.7
69	65	57.3	47.3
70	65	56.8	46.8
71	65	56.4	46.4
72	65	59.7	49.7
73	65	60.3	50.3
74	65	59.6	49.6
75	65	59.4	49.4
76	65	59.1	49.1
77	65	58.9	48.9
78	65	58.5	48.5
79	65	58.2	48.2
80	65	56.8	46.8
81	65	57.7	47.7
82	65	57.5	47.5
83	65	57.3	47.3
84	65	57.1	47.1
85	65	57.0	47.0
86	65	56.8	46.8
87	65	56.7	46.7
88	65	56.5	46.5
89	65	56.4	46.4
90	65	57.5	47.5
91	65	57.2	47.2
92	65	56.9	46.9
93	65	56.6	46.6
94	65	55.6	45.6
95	65	55.8	45.8
96	65	55.9	45.9
97	65	56.0	46.0
98	65	56.2	46.2
99	65	56.2	46.2
100	65	55.9	45.9
101	65	55.7	45.7
102	65	58.8	48.8
103	65	58.5	48.5
104	65	57.8	47.8

Sensitive Receptor ID	Construction Noise Limit	Demolition/ Site Clearance/ Site Set Up	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
105	65	57.5	47.5
106	65	56.8	46.8
107	65	56.5	46.5
108	65	59.2	49.2
109	65	59.0	49.0
110	65	58.8	48.8
111	65	58.6	48.6
112	65	58.7	48.7
113	65	59.2	49.2
114	65	59.8	49.8
115	65	60.2	50.2
116	65	61.0	51.0
117	65	61.5	51.5
118	65	61.0	51.0
119	65	60.2	50.2
120	65	59.6	49.6
121	65	58.9	48.9
122	65	58.4	48.4
123	65	57.9	47.9
124	65	57.4	47.4
125	65	57.2	47.2
126	65	56.9	46.9
127	65	56.7	46.7
128	65	56.5	46.5
129	65	58.6	48.6
130	65	58.2	48.2
131	65	57.7	47.7
132	65	57.4	47.4
133	65	57.2	47.2
134	65	57.3	47.3
135	65	57.5	47.5
136	65	56.7	46.7
137	65	56.3	46.3
138	65	56.0	46.0
139	65	60.8	50.8
140	65	59.9	49.9
141	65	59.2	49.2
142	65	58.7	48.7
143	65	58.0	48.0
144	65	57.5	47.5
145	65	57.0	47.0
146	65	56.0	46.0
147	65	56.2	46.2
148	65	56.6	46.6
149	65	56.9	46.9
150	65	57.3	47.3
151	65	57.7	47.7
152	65	58.0	48.0
153	65	58.3	48.3
154	65	58.7	48.7
155	65	59.2	49.2
156	65	62.9	52.9
157	65	62.2	52.2
158	65	61.2	51.2
159	65	60.4	50.4

Sensitive Receptor ID	Construction Noise Limit	Demolition/ Site Clearance/ Site Set Up	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
160	65	55.9	45.9
161	65	56.3	46.3
162	65	56.6	46.6
163	65	56.9	46.9
164	65	57.2	47.2
165	65	57.6	47.6
166	65	58.0	48.0
167	65	59.0	49.0
168	65	58.7	48.7
169	65	58.1	48.1
170	65	57.6	47.6

Attenuated calculated Site Set Up noise predictions (-10 dB) do not exceed 65 dB construction noise limit.

4.2.3.2 Predicted Construction Activity Noise Levels from Protection Works for the Existing Seawall Structure

Table 4.4: Predicted Construction Activity Noise Levels from Protection Works for the Existing Seawall structure

Sensitive Receptor ID	Construction Noise Limit	Protection Works for the Existing Seawall structure	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	**72.2**	62.2
2	65	**72.6**	62.6
3	65	**72.7**	62.7
4	65	**72.9**	62.9
5	65	**73.1**	63.1
6	65	**73.0**	63.0
7	65	**73.1**	63.1
8	65	**73.0**	63.0
9	65	**73.0**	63.0
10	65	**72.9**	62.9
11	65	**72.3**	62.3
12	65	**71.2**	61.2
13	65	**75.4**	**65.4**
14	65	**67.1**	57.1
15	65	**65.3**	55.3
16	65	64.2	54.2
17	65	59.8	49.8
18	65	60.4	50.4
19	65	60.5	50.5
20	65	60.0	50.0
21	65	61.2	51.2
22	65	60.5	50.5
23	65	61.3	51.3
24	65	61.8	51.8
25	65	62.4	52.4
26	65	62.5	52.5
27	65	63.5	53.5
28	65	64.6	54.6
29	65	64.5	54.5
30	65	63.3	53.3
31	65	60.6	50.6
32	65	**67.3**	57.3
33	65	**68.7**	58.7
34	65	**67.7**	57.7
35	65	**66.7**	56.7
36	65	**66.9**	56.9
37	65	**66.1**	56.1
38	65	**65.3**	55.3
39	65	64.6	54.6
40	65	64.1	54.1
41	65	64.0	54.0
42	65	65.0	55.0
43	65	**66.2**	56.2
44	65	**65.4**	55.4
45	65	64.8	54.8
46	65	64.1	54.1
47	65	63.6	53.6
48	65	**68.9**	58.9
49	65	**68.1**	58.1

Sensitive Receptor ID	Construction Noise Limit	Protection Works for the Existing Seawall structure	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
50	65	**67.5**	57.5
51	65	**66.7**	56.7
52	65	**66.0**	56.0
53	65	64.8	54.8
54	65	64.3	54.3
55	65	**65.3**	55.3
56	65	**65.9**	55.9
57	65	**66.3**	56.3
58	65	64.6	54.6
59	65	64.3	54.3
60	65	64.0	54.0
61	65	63.3	53.3
62	65	62.7	52.7
63	65	62.1	52.1
64	65	62.6	52.6
65	65	63.0	53.0
66	65	63.1	53.1
67	65	61.8	51.8
68	65	61.7	51.7
69	65	61.3	51.3
70	65	60.8	50.8
71	65	60.4	50.4
72	65	63.7	53.7
73	65	64.3	54.3
74	65	63.6	53.6
75	65	63.4	53.4
76	65	63.1	53.1
77	65	62.9	52.9
78	65	62.5	52.5
79	65	62.2	52.2
80	65	60.8	50.8
81	65	61.7	51.7
82	65	61.5	51.5
83	65	61.3	51.3
84	65	61.1	51.1
85	65	61.0	51.0
86	65	60.8	50.8
87	65	60.7	50.7
88	65	60.5	50.5
89	65	60.4	50.4
90	65	61.5	51.5
91	65	61.2	51.2
92	65	60.9	50.9
93	65	60.6	50.6
94	65	59.6	49.6
95	65	59.8	49.8
96	65	59.9	49.9
97	65	60.0	50.0
98	65	60.2	50.2
99	65	60.2	50.2
100	65	59.9	49.9
101	65	59.7	49.7
102	65	62.8	52.8
103	65	62.5	52.5
104	65	61.8	51.8

Sensitive Receptor ID	Construction Noise Limit	Protection Works for the Existing Seawall structure	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
105	65	61.5	51.5
106	65	60.8	50.8
107	65	60.5	50.5
108	65	63.2	53.2
109	65	63.0	53.0
110	65	62.8	52.8
111	65	62.6	52.6
112	65	62.7	52.7
113	65	63.2	53.2
114	65	63.8	53.8
115	65	64.2	54.2
116	65	65.0	55.0
117	65	65.5	55.5
118	65	65.0	55.0
119	65	64.2	54.2
120	65	63.6	53.6
121	65	62.9	52.9
122	65	62.4	52.4
123	65	61.9	51.9
124	65	61.4	51.4
125	65	61.2	51.2
126	65	60.9	50.9
127	65	60.7	50.7
128	65	60.5	50.5
129	65	62.6	52.6
130	65	62.2	52.2
131	65	61.7	51.7
132	65	61.4	51.4
133	65	61.2	51.2
134	65	61.3	51.3
135	65	61.5	51.5
136	65	60.7	50.7
137	65	60.3	50.3
138	65	60.0	50.0
139	65	64.8	54.8
140	65	63.9	53.9
141	65	63.2	53.2
142	65	62.7	52.7
143	65	62.0	52.0
144	65	61.5	51.5
145	65	61.0	51.0
146	65	60.0	50.0
147	65	60.2	50.2
148	65	60.6	50.6
149	65	60.9	50.9
150	65	61.3	51.3
151	65	61.7	51.7
152	65	62.0	52.0
153	65	62.3	52.3
154	65	62.7	52.7
155	65	63.2	53.2
156	65	**66.9**	56.9
157	65	**66.2**	56.2
158	65	**65.2**	55.2
159	65	64.4	54.4

Sensitive Receptor ID	Construction Noise Limit	Protection Works for the Existing Seawall structure	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
160	65	59.9	49.9
161	65	60.3	50.3
162	65	60.6	50.6
163	65	60.9	50.9
164	65	61.2	51.2
165	65	61.6	51.6
166	65	62.0	52.0
167	65	63.0	53.0
168	65	62.7	52.7
169	65	62.1	52.1
170	65	61.6	51.6

Attenuated calculated Protection Works for the Existing Seawall Structure noise predictions (-10 dB) do not exceed 65 dB construction noise limit, except at construction sensitive receptor 13.

The following attenuated construction noise prediction exceedances at sensitive receptor ID 13 is summarised as Protection Works for the Existing Seawall structure 0.4dB.

4.2.3.3 Predicted Construction Activity Noise Levels from Excavation

Table 4.5: Predicted Construction Activity Noise Levels from Excavation

Sensitive Receptor ID	Construction Noise Limit	Excavation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	**71.2**	61.2
2	65	**71.6**	61.6
3	65	**71.7**	61.7
4	65	**71.9**	61.9
5	65	**72.1**	62.1
6	65	**72.0**	62.0
7	65	**72.1**	62.1
8	65	**72.0**	62.0
9	65	**72.0**	62.0
10	65	**71.9**	61.9
11	65	**71.3**	61.3
12	65	**70.2**	60.2
13	65	**74.4**	64.4
14	65	**66.1**	56.1
15	65	64.3	54.3
16	65	63.2	53.2
17	65	58.8	48.8
18	65	59.4	49.4
19	65	59.5	49.5
20	65	59.0	49.0
21	65	60.2	50.2
22	65	59.5	49.5
23	65	60.3	50.3
24	65	60.8	50.8
25	65	61.4	51.4
26	65	61.5	51.5
27	65	62.5	52.5
28	65	63.6	53.6
29	65	63.5	53.5
30	65	62.3	52.3
31	65	59.6	49.6
32	65	**66.3**	56.3
33	65	**67.7**	57.7
34	65	**66.7**	56.7
35	65	**65.7**	55.7
36	65	**65.9**	55.9
37	65	**65.1**	55.1
38	65	64.3	54.3
39	65	63.6	53.6
40	65	63.1	53.1
41	65	63.0	53.0
42	65	64.0	54.0
43	65	**65.2**	55.2
44	65	64.4	54.4
45	65	63.8	53.8
46	65	63.1	53.1
47	65	62.6	52.6
48	65	**67.9**	57.9
49	65	**67.1**	57.1
50	65	**66.5**	56.5
51	65	**65.7**	55.7

Sensitive Receptor ID	Construction Noise Limit	Excavation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
52	65	65.0	55.0
53	65	63.8	53.8
54	65	63.3	53.3
55	65	64.3	54.3
56	65	64.9	54.9
57	65	**65.3**	55.3
58	65	63.6	53.6
59	65	63.3	53.3
60	65	63.0	53.0
61	65	62.3	52.3
62	65	61.7	51.7
63	65	61.1	51.1
64	65	61.6	51.6
65	65	62.0	52.0
66	65	62.1	52.1
67	65	60.8	50.8
68	65	60.7	50.7
69	65	60.3	50.3
70	65	59.8	49.8
71	65	59.4	49.4
72	65	62.7	52.7
73	65	63.3	53.3
74	65	62.6	52.6
75	65	62.4	52.4
76	65	62.1	52.1
77	65	61.9	51.9
78	65	61.5	51.5
79	65	61.2	51.2
80	65	59.8	49.8
81	65	60.7	50.7
82	65	60.5	50.5
83	65	60.3	50.3
84	65	60.1	50.1
85	65	60.0	50.0
86	65	59.8	49.8
87	65	59.7	49.7
88	65	59.5	49.5
89	65	59.4	49.4
90	65	60.5	50.5
91	65	60.2	50.2
92	65	59.9	49.9
93	65	59.6	49.6
94	65	58.6	48.6
95	65	58.8	48.8
96	65	58.9	48.9
97	65	59.0	49.0
98	65	59.2	49.2
99	65	59.2	49.2
100	65	58.9	48.9
101	65	58.7	48.7
102	65	61.8	51.8
103	65	61.5	51.5
104	65	60.8	50.8
105	65	60.5	50.5
106	65	59.8	49.8

Sensitive Receptor ID	Construction Noise Limit	Excavation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
107	65	59.5	49.5
108	65	62.2	52.2
109	65	62.0	52.0
110	65	61.8	51.8
111	65	61.6	51.6
112	65	61.7	51.7
113	65	62.2	52.2
114	65	62.8	52.8
115	65	63.2	53.2
116	65	64.0	54.0
117	65	64.5	54.5
118	65	64.0	54.0
119	65	63.2	53.2
120	65	62.6	52.6
121	65	61.9	51.9
122	65	61.4	51.4
123	65	60.9	50.9
124	65	60.4	50.4
125	65	60.2	50.2
126	65	59.9	49.9
127	65	59.7	49.7
128	65	59.5	49.5
129	65	61.6	51.6
130	65	61.2	51.2
131	65	60.7	50.7
132	65	60.4	50.4
133	65	60.2	50.2
134	65	60.3	50.3
135	65	60.5	50.5
136	65	59.7	49.7
137	65	59.3	49.3
138	65	59.0	49.0
139	65	63.8	53.8
140	65	62.9	52.9
141	65	62.2	52.2
142	65	61.7	51.7
143	65	61.0	51.0
144	65	60.5	50.5
145	65	60.0	50.0
146	65	59.0	49.0
147	65	59.2	49.2
148	65	59.6	49.6
149	65	59.9	49.9
150	65	60.3	50.3
151	65	60.7	50.7
152	65	61.0	51.0
153	65	61.3	51.3
154	65	61.7	51.7
155	65	62.2	52.2
156	65	**65.9**	55.9
157	65	**65.2**	55.2
158	65	64.2	54.2
159	65	63.4	53.4
160	65	58.9	48.9
161	65	59.3	49.3

Sensitive Receptor ID	Construction Noise Limit	Excavation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
162	65	59.6	49.6
163	65	59.9	49.9
164	65	60.2	50.2
165	65	60.6	50.6
166	65	61.0	51.0
167	65	62.0	52.0
168	65	61.7	51.7
169	65	61.1	51.1
170	65	60.6	50.6

Attenuated calculated Site Set Up noise predictions (-10 dB) do not exceed 65 dB construction noise limit.

4.2.3.4 Predicted Construction Activity Noise Levels from Seawall Installation

Table 4.6: Predicted Construction Activity Noise Levels from Seawall Installation

Sensitive Receptor ID	Construction Noise Limit	Seawall Installation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	57.2	47.2
2	65	57.6	47.6
3	65	57.7	47.7
4	65	57.9	47.9
5	65	58.1	48.1
6	65	58.0	48.0
7	65	58.1	48.1
8	65	58.0	48.0
9	65	58.0	48.0
10	65	57.9	47.9
11	65	57.3	47.3
12	65	56.2	46.2
13	65	60.4	50.4
14	65	52.1	42.1
15	65	50.3	40.3
16	65	49.2	39.2
17	65	44.8	34.8
18	65	45.4	35.4
19	65	45.5	35.5
20	65	45.0	35.0
21	65	46.2	36.2
22	65	45.5	35.5
23	65	46.3	36.3
24	65	46.8	36.8
25	65	47.4	37.4
26	65	47.5	37.5
27	65	48.5	38.5
28	65	49.6	39.6
29	65	49.5	39.5
30	65	48.3	38.3
31	65	45.6	35.6
32	65	52.3	42.3
33	65	53.7	43.7
34	65	52.7	42.7
35	65	51.7	41.7
36	65	51.9	41.9
37	65	51.1	41.1
38	65	50.3	40.3
39	65	49.6	39.6
40	65	49.1	39.1
41	65	49.0	39.0
42	65	50.0	40.0
43	65	51.2	41.2
44	65	50.4	40.4
45	65	49.8	39.8
46	65	49.1	39.1
47	65	48.6	38.6
48	65	53.9	43.9
49	65	53.1	43.1
50	65	52.5	42.5

Sensitive Receptor ID	Construction Noise Limit	Seawall Installation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
51	65	51.7	41.7
52	65	51.0	41.0
53	65	49.8	39.8
54	65	49.3	39.3
55	65	50.3	40.3
56	65	50.9	40.9
57	65	51.3	41.3
58	65	49.6	39.6
59	65	49.3	39.3
60	65	49.0	39.0
61	65	48.3	38.3
62	65	47.7	37.7
63	65	47.1	37.1
64	65	47.6	37.6
65	65	48.0	38.0
66	65	48.1	38.1
67	65	46.8	36.8
68	65	46.7	36.7
69	65	46.3	36.3
70	65	45.8	35.8
71	65	45.4	35.4
72	65	48.7	38.7
73	65	49.3	39.3
74	65	48.6	38.6
75	65	48.4	38.4
76	65	48.1	38.1
77	65	47.9	37.9
78	65	47.5	37.5
79	65	47.2	37.2
80	65	45.8	35.8
81	65	46.7	36.7
82	65	46.5	36.5
83	65	46.3	36.3
84	65	46.1	36.1
85	65	46.0	36.0
86	65	45.8	35.8
87	65	45.7	35.7
88	65	45.5	35.5
89	65	45.4	35.4
90	65	46.5	36.5
91	65	46.2	36.2
92	65	45.9	35.9
93	65	45.6	35.6
94	65	44.6	34.6
95	65	44.8	34.8
96	65	44.9	34.9
97	65	45.0	35.0
98	65	45.2	35.2
99	65	45.2	35.2
100	65	44.9	34.9
101	65	44.7	34.7
102	65	47.8	37.8
103	65	47.5	37.5
104	65	46.8	36.8
105	65	46.5	36.5

Sensitive Receptor ID	Construction Noise Limit	Seawall Installation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
106	65	45.8	35.8
107	65	45.5	35.5
108	65	48.2	38.2
109	65	48.0	38.0
110	65	47.8	37.8
111	65	47.6	37.6
112	65	47.7	37.7
113	65	48.2	38.2
114	65	48.8	38.8
115	65	49.2	39.2
116	65	50.0	40.0
117	65	50.5	40.5
118	65	50.0	40.0
119	65	49.2	39.2
120	65	48.6	38.6
121	65	47.9	37.9
122	65	47.4	37.4
123	65	46.9	36.9
124	65	46.4	36.4
125	65	46.2	36.2
126	65	45.9	35.9
127	65	45.7	35.7
128	65	45.5	35.5
129	65	47.6	37.6
130	65	47.2	37.2
131	65	46.7	36.7
132	65	46.4	36.4
133	65	46.2	36.2
134	65	46.3	36.3
135	65	46.5	36.5
136	65	45.7	35.7
137	65	45.3	35.3
138	65	45.0	35.0
139	65	49.8	39.8
140	65	48.9	38.9
141	65	48.2	38.2
142	65	47.7	37.7
143	65	47.0	37.0
144	65	46.5	36.5
145	65	46.0	36.0
146	65	45.0	35.0
147	65	45.2	35.2
148	65	45.6	35.6
149	65	45.9	35.9
150	65	46.3	36.3
151	65	46.7	36.7
152	65	47.0	37.0
153	65	47.3	37.3
154	65	47.7	37.7
155	65	48.2	38.2
156	65	51.9	41.9
157	65	51.2	41.2
158	65	50.2	40.2
159	65	49.4	39.4
160	65	44.9	34.9

Sensitive Receptor ID	Construction Noise Limit	Seawall Installation	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
161	65	45.3	35.3
162	65	45.6	35.6
163	65	45.9	35.9
164	65	46.2	36.2
165	65	46.6	36.6
166	65	47.0	37.0
167	65	48.0	38.0
168	65	47.7	37.7
169	65	47.1	37.1
170	65	46.6	36.6

Attenuated calculated construction activities noise predictions (-10 dB) do not exceed 65 dB construction noise limit.

4.2.3.5 Predicted Construction Activity Noise Levels from Surfacing

Table 4.7: Predicted Construction Activity Noise Levels from Surfacing Works

Sensitive Receptor ID	Construction Noise Limit	Surfacing	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	**69.2**	59.2
2	65	**69.6**	59.6
3	65	**69.7**	59.7
4	65	**69.9**	59.9
5	65	**70.1**	60.1
6	65	**70.0**	60.0
7	65	**70.1**	60.1
8	65	**70.0**	60.0
9	65	**70.0**	60.0
10	65	**69.9**	59.9
11	65	**69.3**	59.3
12	65	**68.2**	58.2
13	65	**72.4**	62.4
14	65	64.1	54.1
15	65	62.3	52.3
16	65	61.2	51.2
17	65	56.8	46.8
18	65	57.4	47.4
19	65	57.5	47.5
20	65	57.0	47.0
21	65	58.2	48.2
22	65	57.5	47.5
23	65	58.3	48.3
24	65	58.8	48.8
25	65	59.4	49.4
26	65	59.5	49.5
27	65	60.5	50.5
28	65	61.6	51.6
29	65	61.5	51.5
30	65	60.3	50.3
31	65	57.6	47.6
32	65	64.3	54.3
33	65	**65.7**	55.7
34	65	64.7	54.7
35	65	63.7	53.7
36	65	63.9	53.9
37	65	63.1	53.1
38	65	62.3	52.3
39	65	61.6	51.6
40	65	61.1	51.1
41	65	61.0	51.0
42	65	62.0	52.0
43	65	63.2	53.2
44	65	62.4	52.4
45	65	61.8	51.8
46	65	61.1	51.1
47	65	60.6	50.6
48	65	**65.9**	55.9
49	65	**65.1**	55.1
50	65	64.5	54.5
51	65	63.7	53.7

Sensitive Receptor ID	Construction Noise Limit	Surfacing	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
52	65	63.0	53.0
53	65	61.8	51.8
54	65	61.3	51.3
55	65	62.3	52.3
56	65	62.9	52.9
57	65	63.3	53.3
58	65	61.6	51.6
59	65	61.3	51.3
60	65	61.0	51.0
61	65	60.3	50.3
62	65	59.7	49.7
63	65	59.1	49.1
64	65	59.6	49.6
65	65	60.0	50.0
66	65	60.1	50.1
67	65	58.8	48.8
68	65	58.7	48.7
69	65	58.3	48.3
70	65	57.8	47.8
71	65	57.4	47.4
72	65	60.7	50.7
73	65	61.3	51.3
74	65	60.6	50.6
75	65	60.4	50.4
76	65	60.1	50.1
77	65	59.9	49.9
78	65	59.5	49.5
79	65	59.2	49.2
80	65	57.8	47.8
81	65	58.7	48.7
82	65	58.5	48.5
83	65	58.3	48.3
84	65	58.1	48.1
85	65	58.0	48.0
86	65	57.8	47.8
87	65	57.7	47.7
88	65	57.5	47.5
89	65	57.4	47.4
90	65	58.5	48.5
91	65	58.2	48.2
92	65	57.9	47.9
93	65	57.6	47.6
94	65	56.6	46.6
95	65	56.8	46.8
96	65	56.9	46.9
97	65	57.0	47.0
98	65	57.2	47.2
99	65	57.2	47.2
100	65	56.9	46.9
101	65	56.7	46.7
102	65	59.8	49.8
103	65	59.5	49.5
104	65	58.8	48.8
105	65	58.5	48.5
106	65	57.8	47.8

Sensitive Receptor ID	Construction Noise Limit	Surfacing	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
107	65	57.5	47.5
108	65	60.2	50.2
109	65	60.0	50.0
110	65	59.8	49.8
111	65	59.6	49.6
112	65	59.7	49.7
113	65	60.2	50.2
114	65	60.8	50.8
115	65	61.2	51.2
116	65	62.0	52.0
117	65	62.5	52.5
118	65	62.0	52.0
119	65	61.2	51.2
120	65	60.6	50.6
121	65	59.9	49.9
122	65	59.4	49.4
123	65	58.9	48.9
124	65	58.4	48.4
125	65	58.2	48.2
126	65	57.9	47.9
127	65	57.7	47.7
128	65	57.5	47.5
129	65	59.6	49.6
130	65	59.2	49.2
131	65	58.7	48.7
132	65	58.4	48.4
133	65	58.2	48.2
134	65	58.3	48.3
135	65	58.5	48.5
136	65	57.7	47.7
137	65	57.3	47.3
138	65	57.0	47.0
139	65	61.8	51.8
140	65	60.9	50.9
141	65	60.2	50.2
142	65	59.7	49.7
143	65	59.0	49.0
144	65	58.5	48.5
145	65	58.0	48.0
146	65	57.0	47.0
147	65	57.2	47.2
148	65	57.6	47.6
149	65	57.9	47.9
150	65	58.3	48.3
151	65	58.7	48.7
152	65	59.0	49.0
153	65	59.3	49.3
154	65	59.7	49.7
155	65	60.2	50.2
156	65	63.9	53.9
157	65	63.2	53.2
158	65	62.2	52.2
159	65	61.4	51.4
160	65	56.9	46.9
161	65	57.3	47.3

Sensitive Receptor ID	Construction Noise Limit	Surfacing	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
162	65	57.6	47.6
163	65	57.9	47.9
164	65	58.2	48.2
165	65	58.6	48.6
166	65	59.0	49.0
167	65	60.0	50.0
168	65	59.7	49.7
169	65	59.1	49.1
170	65	58.6	48.6

Attenuated calculated construction activities noise predictions (-10 dB) do not exceed 65 dB construction noise limit.

4.2.3.6 Predicted Construction Activity Noise Levels from Street furniture and Beach Access

Table 4.8: Predicted Construction Activity Noise Levels from Street furniture and Beach Access

Sensitive Receptor ID	Construction Noise Limit	Street furniture and Beach Access	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
1	65	44.2	34.2
2	65	44.6	34.6
3	65	44.7	34.7
4	65	44.9	34.9
5	65	45.1	35.1
6	65	45.0	35.0
7	65	45.1	35.1
8	65	45.0	35.0
9	65	45.0	35.0
10	65	44.9	34.9
11	65	44.3	34.3
12	65	43.2	33.2
13	65	47.4	37.4
14	65	39.1	29.1
15	65	37.3	27.3
16	65	36.2	26.2
17	65	31.8	21.8
18	65	32.4	22.4
19	65	32.5	22.5
20	65	32.0	22.0
21	65	33.2	23.2
22	65	32.5	22.5
23	65	33.3	23.3
24	65	33.8	23.8
25	65	34.4	24.4
26	65	34.5	24.5
27	65	35.5	25.5
28	65	36.6	26.6
29	65	36.5	26.5
30	65	35.3	25.3
31	65	32.6	22.6
32	65	39.3	29.3
33	65	40.7	30.7
34	65	39.7	29.7
35	65	38.7	28.7
36	65	38.9	28.9
37	65	38.1	28.1
38	65	37.3	27.3
39	65	36.6	26.6
40	65	36.1	26.1
41	65	36.0	26.0
42	65	37.0	27.0
43	65	38.2	28.2
44	65	37.4	27.4
45	65	36.8	26.8
46	65	36.1	26.1
47	65	35.6	25.6
48	65	40.9	30.9
49	65	40.1	30.1

Sensitive Receptor ID	Construction Noise Limit	Street furniture and Beach Access	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
50	65	39.5	29.5
51	65	38.7	28.7
52	65	38.0	28.0
53	65	36.8	26.8
54	65	36.3	26.3
55	65	37.3	27.3
56	65	37.9	27.9
57	65	38.3	28.3
58	65	36.6	26.6
59	65	36.3	26.3
60	65	36.0	26.0
61	65	35.3	25.3
62	65	34.7	24.7
63	65	34.1	24.1
64	65	34.6	24.6
65	65	35.0	25.0
66	65	35.1	25.1
67	65	33.8	23.8
68	65	33.7	23.7
69	65	33.3	23.3
70	65	32.8	22.8
71	65	32.4	22.4
72	65	35.7	25.7
73	65	36.3	26.3
74	65	35.6	25.6
75	65	35.4	25.4
76	65	35.1	25.1
77	65	34.9	24.9
78	65	34.5	24.5
79	65	34.2	24.2
80	65	32.8	22.8
81	65	33.7	23.7
82	65	33.5	23.5
83	65	33.3	23.3
84	65	33.1	23.1
85	65	33.0	23.0
86	65	32.8	22.8
87	65	32.7	22.7
88	65	32.5	22.5
89	65	32.4	22.4
90	65	33.5	23.5
91	65	33.2	23.2
92	65	32.9	22.9
93	65	32.6	22.6
94	65	31.6	21.6
95	65	31.8	21.8
96	65	31.9	21.9
97	65	32.0	22.0
98	65	32.2	22.2
99	65	32.2	22.2
100	65	31.9	21.9
101	65	31.7	21.7
102	65	34.8	24.8
103	65	34.5	24.5
104	65	33.8	23.8

Sensitive Receptor ID	Construction Noise Limit	Street furniture and Beach Access	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
105	65	33.5	23.5
106	65	32.8	22.8
107	65	32.5	22.5
108	65	35.2	25.2
109	65	35.0	25.0
110	65	34.8	24.8
111	65	34.6	24.6
112	65	34.7	24.7
113	65	35.2	25.2
114	65	35.8	25.8
115	65	36.2	26.2
116	65	37.0	27.0
117	65	37.5	27.5
118	65	37.0	27.0
119	65	36.2	26.2
120	65	35.6	25.6
121	65	34.9	24.9
122	65	34.4	24.4
123	65	33.9	23.9
124	65	33.4	23.4
125	65	33.2	23.2
126	65	32.9	22.9
127	65	32.7	22.7
128	65	32.5	22.5
129	65	34.6	24.6
130	65	34.2	24.2
131	65	33.7	23.7
132	65	33.4	23.4
133	65	33.2	23.2
134	65	33.3	23.3
135	65	33.5	23.5
136	65	32.7	22.7
137	65	32.3	22.3
138	65	32.0	22.0
139	65	36.8	26.8
140	65	35.9	25.9
141	65	35.2	25.2
142	65	34.7	24.7
143	65	34.0	24.0
144	65	33.5	23.5
145	65	33.0	23.0
146	65	32.0	22.0
147	65	32.2	22.2
148	65	32.6	22.6
149	65	32.9	22.9
150	65	33.3	23.3
151	65	33.7	23.7
152	65	34.0	24.0
153	65	34.3	24.3
154	65	34.7	24.7
155	65	35.2	25.2
156	65	38.9	28.9
157	65	38.2	28.2
158	65	37.2	27.2
159	65	36.4	26.4

Sensitive Receptor ID	Construction Noise Limit	Street furniture and Beach Access	
		Noise Predictions (dB)	Attenuated Noise Predictions – 10 (dB)
160	65	31.9	21.9
161	65	32.3	22.3
162	65	32.6	22.6
163	65	32.9	22.9
164	65	33.2	23.2
165	65	33.6	23.6
166	65	34.0	24.0
167	65	35.0	25.0
168	65	34.7	24.7
169	65	34.1	24.1
170	65	33.6	23.6

Attenuated calculated construction activities noise predictions (-10 dB) do not exceed 65 dB construction noise limit.

Construction noise predictions conclude that there is no exceedance of 65 dB BS 5228 noise limit at the majority of noise receptors. Worst case construction noise predictions exceed the 65 dB BS 5228 noise limit at a number of construction noise receptors .However, construction noise predictions can be reduced through use of appropriate mitigations as detailed below in Section 5 Construction Mitigation.

Construction noise predictions, which do not exceed the BS 5228 construction noise limit, would conclude “very low magnitude of impact” at construction noise receptors. Construction mitigation measures should be put in place to ensure construction noise levels are attenuated and reduced where necessary.

4.3 Construction Phase – Vibration

Some construction phase activities associated with the Proposed Development have the potential to result in vibration impacts at sensitive receptors. Activities included in the proposed construction phase that have the potential to result in vibration impacts include impact and vibratory piling and to a lesser extent demolition activities. Sheet piling being installed on the front edge of the toe along the length of the existing wall represents the most intense activity in close proximity to sensitive receptors and is therefore used as the worst-case example.

One activity will require piling as part of the Proposed Development; Protection Works for the Existing Seawall Structure, however, significant vibration from this source will not propagate to any sensitive receptor. The distance between the activity and the receptor is in most cases greater than the distance from the site boundary shown in Table4.1.

Annex E of British Standard BS5228:2009+A1:2014 provides empirical formulae to calculate a PPV for sheet piling (Protection Works for the Existing Seawall Structure). Ground conditions will affect the propagation and piling methods employed and vibration control measures and monitoring will be required during construction.

5 MITIGATION

5.1 General Mitigation Measures

British Standard BS5228:2009+A1:2014 – Noise and vibration control on construction and open sitesoutlines a range of measures that can be used to reduce the impact of construction phase noise on the construction sensitive receptors. These measures will be applied by the contractor where appropriate during the construction phase of the proposed development. Measures in BS5228 which will be deployed are listed below:

- Ensuring that mechanical plant and equipment used for the purpose of the works are fitted with effective exhaust silencers and are maintained in good working order;
- Careful selection of quiet plant and machinery to undertake the required work;
- All major compressors will be 'sound reduced' models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use;
- Any ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Machines in intermittent use should be shut down in the intervening periods between works;
- Ancillary plant such as generators, compressors and pumps will be placed behind existing physical barriers, and the direction of noise emissions from plant including exhausts or engines will be placed away from sensitive locations, in order to cause minimum noise disturbance. In potentially sensitive areas, acoustic barriers of enclosures will be utilised around noisy plant and equipment;
- Handling of all materials will take place in a manner which minimises noise emissions; and
- Audible warning systems will be switched to the minimum setting required by the Health & Safety Executive.

In order to minimise the likelihood of complaints, North Ayrshire Council and local residents will be kept informed of the works to be carried out and of any proposals for work outside normal hours. A complaints procedure will be operated by the Contractor throughout the construction phase.

5.2 Construction Noise Barrier

The implementation of a construction noise barrier in the form of hoarding around the development site perimeter will offer a minimum of 10dB attenuation to predicted construction noise levels.

In order to ensure that the appropriate level of effectiveness is achieved with a construction barrier, the following measures will be taken:

- There will be no holes or gaps in the hoarding;
- Where sections of hoarding are attached to each other, a good seal will be achieved with no obvious gaps present; and
- There will be no gap between the ground and the hoarding.

5.3 Construction Noise

As outlined in Section 4.2 of this report, there is potential for short-term noise impacts at construction sensitive receptors if worst-case construction noise levels occur. The predicted construction noise levels at varying distances from the construction noise sources. **Error! Reference source not found.** - Table 4.8 illustrate the predicted construction noise levels at construction sensitive receptors. These tables of predicted construction noise levels indicate that there is potential for noise impacts at construction sensitive receptors if suitable mitigation measures are not in place.

It must be noted that these worst-case predicted noise levels are very much an overestimation of the likely construction phase noise levels as they assume that all plant will be active simultaneously from the nearest portion of the construction phase area to the respective construction sensitive receptor. In reality the noisiest activities associated with the construction phase will be limited in duration. Nevertheless there is a clear need for appropriate mitigation measures to be in place during the construction phase.
A range of measures will be taken to ensure that the quietest machinery is used or that the use of machinery is such as to be sensitive to construction sensitive receptors.
British Standard *BS5228:2009+A1:2014* – Noise and vibration control on construction and open sites outlines a range of measures that can be used to reduce the impact of construction phase noise on the construction sensitive receptors. These measures will be applied by the contractor where appropriate during the construction phase of the proposed development.
Examples of some of the construction best practice measures included in BS5228 are listed above in Section 5.1.
Construction works along the construction phase site boundary will be limited in duration; plant and machinery will not be fully operational during the working day. Mitigation measures put in place will ensure that the construction noise limit of 65 dB is adhered to.

5.4 Control of Noise at Source

There are many general measures that will be used to reduce noise levels at source. Such as:

- The avoidance of unnecessary revving of engines and switching off equipment when not required;
- Keeping internal haul routes well maintained and avoiding steep gradients;
- The use of rubber linings in, for example, chutes and dumpers reduce impact noise;
- The minimisation of drop heights; and
- Starting up plant and vehicles sequentially rather than all together.

The use of conventional audible reversing alarms can be a noise nuisance issue on some sites, the reversing alarms used on the proposed site will be of a type which, whilst ensuring that they give proper warning, has a minimum noise impact on persons outside the proposed site. Where practicable, alternative reversing alarm systems will be employed to reduce the impact of noise outside of construction sites.

Prior to the construction phase, the contractor shall review the specification for all plant and equipment to be employed on-site to ensure that the quietest plant/equipment available is to be used. Modifications to plant and equipment to improve sound reduction will be implemented if required, but any alterations shall be conducted in consultation with the plant manufacturer.

For steady state continuous noise, it may be possible to reduce noise by fitting a more effective silencer system or by an acoustic canopy to replace the normal engine cover, if the item of plant is in a stationary position. On-site generators supplying electricity for electric motors will be suitably enclosed and appropriately located.

Noise caused by resonance of body panels and cover plates will be reduced by stiffening with additional ribs or by increasing the damping effect with a surface coating of special resonance damping material. Rattling noises will be controlled by tightening loose parts and fixing resilient materials between surfaces in contact.

As far as reasonably practicable, sources of significant noise will be enclosed. The effectiveness of partial noise enclosures and of screens can be reduced if they are used incorrectly.

Care shall be taken to site equipment away from noise sensitive areas. Where possible, loading and unloading will also be carried out away from such areas. Machines shall not be left running unnecessarily. Plant from which the noise generated is known to be particularly directional should, wherever practicable, be orientated so that the noise is directed away from noise sensitive areas.

Materials shall be lowered whenever practicable and shall not be dropped. The surfaces on to which the materials are being moved will be covered by resilient material.

In order to minimise the likelihood of complaints, North Ayrshire Council and affected residents will be kept informed of the works to be carried out and of any proposals for work outside normal hours.

5.5 Project Supervision

British Standard BS5228:2009+A1:2014 – Noise and vibration control on construction and open sites provides guidance on project supervision, design, execution of works and what action to take in the event of emergencies or unforeseen circumstances during construction which may cause safety to be put at risk. This standard aims to integrate health and safety into the management of a project and recommends techniques and operational controls which are available to reduce the level of noise to which operators, residents and others within the vicinity of the site are exposed to. These measures will be applied by the contractor where appropriate during the construction phase of the proposed development. Measures which will be deployed included in BS5228 are listed below:

- Warning notices will be displayed, and ear protectors provided where high noise levels are likely to be a hazard to persons working on the site;
- Risks will be identified early on so that they can be eliminated or reduced at the design or planning stage and the remaining risks can be properly managed;
- Types of machinery will be used which will achieve less disturbance;
- Hours of working will be planned, and account will be taken of the effects of noise upon persons in the areas surrounding site operations and upon persons working on site, taking into account the nature of land use in the areas concerned, the duration of work and the likely consequences of any lengthening of work periods;
- Quiet working methods will be employed, wherever possible, including use of the most suitable plant, reasonable hours of working for noisy operations, and economy and speed of operations; and
- On-site noise levels will be monitored regularly, particularly if changes in machinery or project design are introduced, by a suitably qualified person appointed specifically for the purpose.

6 CONCLUSION

This noise and vibration impact assessment has been completed on behalf of North Ayrshire for the "proposed seawall replacement works, located at Largs, Scotland."

The construction noise impact assessment assesses the potential noise impact as a result of construction activities associated with the proposed development. It was determined that piling would be undertaken as part of the proposed seawall replacement works.

All construction noise activities were assessed in accordance with British Standard BS5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites, Category A noise threshold limit of 65dB (12 hours working weekday Monday to Friday).

Assessment of the worst case predicted construction noise levels with Category A noise threshold noise limit of 65 dB indicate exceedances at construction sensitive receptors.

However, assessment of the worst case attenuated predicted construction noise levels, with a construction noise barrier will ensure that compliance with Category A noise threshold noise limit of 65 dB.

The predicted construction noise levels presented in this noise and vibration impact assessment are worst case scenario as they assume all construction plant will be operating simultaneously at the nearest point of the construction phases to each of the construction sensitive receptors.

Construction works are transient therefore construction noise predictions will decrease with increasing distance from the construction receptors.

The implementation of mitigation and control measures as outlined in Section 5 of this construction noise plan will ensure that all construction noise levels are within BS5228 noise threshold limit of 65dB.

At construction stage the construction activities and plant will be confirmed by the contractor. If, at this stage, construction noise predictions are 65 dB or above at construction sensitive receptors then construction noise monitoring will be undertaken by the appointed contractor.

APPENDICES

Appendix A

Baseline Noise Monitoring Survey and Data

NOISE MONITORING LOCATIONS

RPS has undertaken a noise monitoring survey in relation to a proposed seawall replacement works, located at Largs, Scotland. The existing seawall at Largs retains the promenade and protects the shore side buildings and infrastructure from wave action and coastal erosion. It is c.300m in length, with the height varying along its length following the profile of the beach below. The retained height varies from approx. 1.0m to 4.0 m, and the top level of the seawall is approximately +5.16mCD along the full length. The public have access to the seawall and the beach below when the tide allows.

The noise monitoring locations are shown below in Figure A1

Figure A1: Unattended Noise Monitoring Locations

Unattended Noise Monitoring

To be representative of existing noise sources RPS have undertaken unattended noise monitoring for both daytime and night-time at 2 locations. Unattended noise monitoring has been undertaken from the 3rd May 2022 to 6th May 2022. Figure A1 above illustrates the location of the unattended noise monitoring survey.

The details of the unattended noise monitoring survey including a description of the noise monitoring location, date, time and sound level meter used are summarised in Table A1. The calibration certificates and sound level meter specifications from the noise survey equipment are detailed below.

Table A.1: Unattended Noise Monitoring Summary

Noise Monitoring Location	Description of Noise Monitoring Location	Date	Time	Noise Monitor
1	Located in the front garden of a residential property located on Beechway, south east of the proposed development site.	03/05/2022 – 06/05/2022	17:45 – 10:15	Rion NL-52
2	Located in the front garden of a B&B located on Aubrey Crescent, north of the proposed development site.	04/05/2022 – 06/05/2022	14:45 – 10:00	Norsonic 140

Methodology

At each NML the microphone was placed at a height of 1.2 - 1.5m above ground level, and equipped with an all-weather wind shield which also provides water resistance.

The proprietary wind shield used is certified by the manufacture as meeting Type 1 / Class 1 precision standards. All noise measurements were made at a height of 1.2 – 1.5m above ground level.

The following parameters were recorded during each noise monitoring period:

L_{Aeq} The continuous equivalent A-weighted sound pressure level.

L_{Amax} This is the maximum A-weighed sound level measured during the sample period.

L_{Amin} This is the minimum A-weighted sound level measured during the sample period.

L_{A10} This is the A-weighted sound level that is exceeded for noise for 10% of the sample period.

L_{A90} This is the A-weighted sound level that is exceeded for 90% of the sample period.

The weather during each set of measurements was conducive to the measurement of existing noise climate during the unattended surveys being predominately dry and with wind speeds remaining below 5 m/s.

Unattended noise survey results

Recorded noise data was analysed and visualised using RPS in house software. The software is written in Python and uses advanced statistical and visualisation libraries. The approach to analysing the recorded noise data involved compiling all observations into a single dataset for the noise monitoring location using their respective time stamps before reading into the software.

The main steps the software takes are described below:

- Before any further analysis, all monitoring data is visualised and dubious records were also highlighted and removed;
- Data was divided into 2 sets daytime (07:00 – 23:00hrs Monday to Sunday) and night time (23:00-07:00hrs Monday to Sunday)
- The daytime data analysis for L_{Aeq} and L_{A90} were calculated to hourly averages; the night time data remained as 15 minute interval averages.

NOISE MONITORING LOCATION 1 SURVEY RESULTS

Sound Level Meter Specifications and Calibration Certificates

The baseline noise monitoring survey at NML1 was carried out using a Rion NL-52 Class 1 Sound Level Analyser in conjunction with the following:

- Outdoor kit enhanced NL-32;
- Rion WS-03SO1 Windscreen head assembly (inc. WS-03051);
- Rion EC-04 2m Extension Cable (7 Pin); and
- Rion NC-74 Class 1 Acoustic Calibrator.

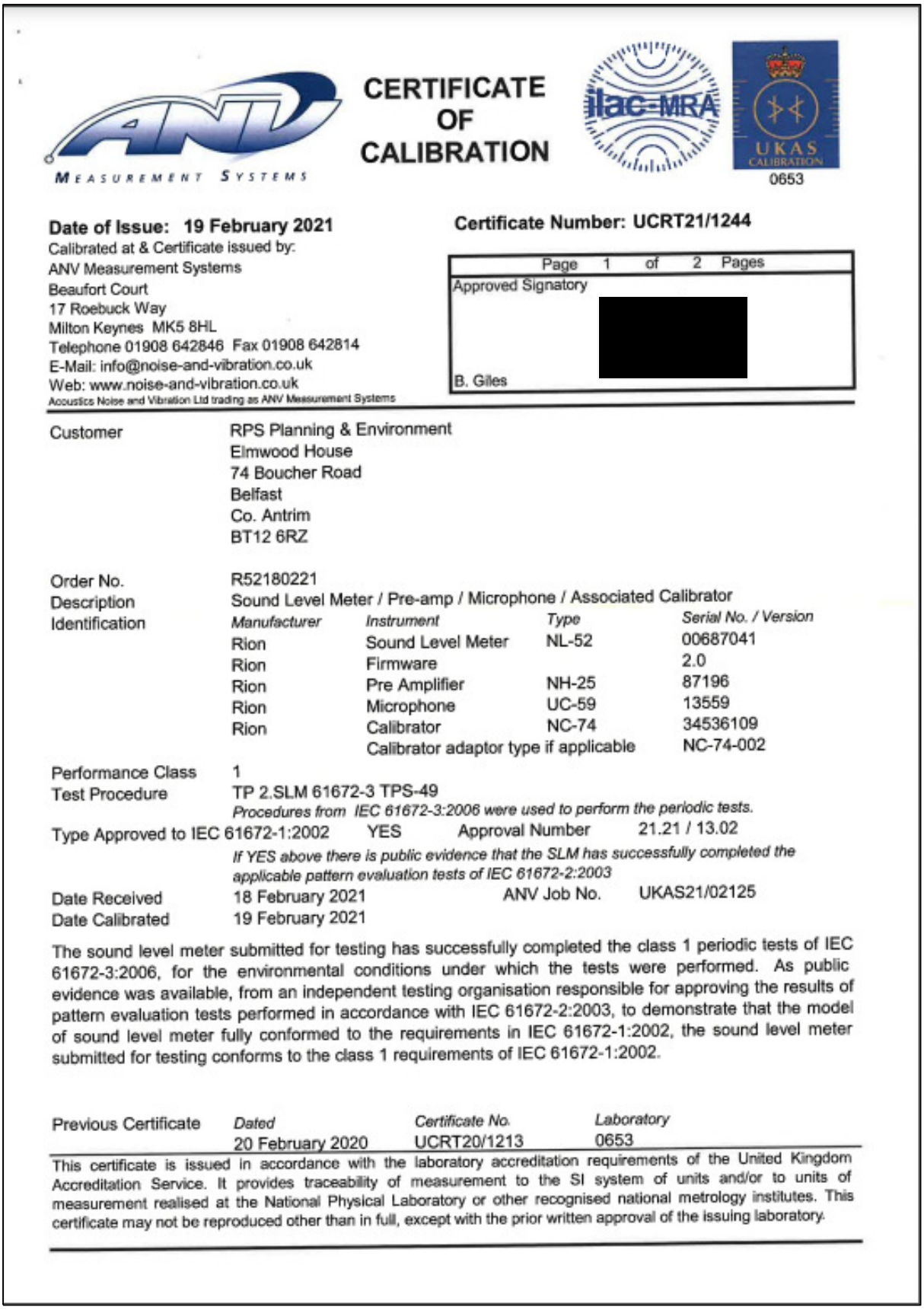
The sound level meter specifications from the noise survey equipment are detailed in Table A2.

Table A2: Rion NL-52 Noise Instrument Records

Equipment	Model / Type	Serial Number	Calibration Certificate Number	Last Calibration Date
Sound Level Meter	Rion NL- 52	00687041	UCRT21/1244	19/02/2021
Preamplifier	Rion NH-25	87196	UCRT21/1244	19/02/2021
Microphone	Rion UC-59	13559	UCRT21/1244	19/02/2021
Calibrator	Rion NC-74	35105042	UCRT21/2343	01/11/2021

The calibration certificates and sound level meter specifications from the noise survey equipment are detailed in Figure A2.

Figure A2: Calibration Certificate of Rion NL-52



MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 19 February 2021

Certificate Number: UCRT21/1244

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Approved Signatory [redacted]

B. Giles

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Customer: RPS Planning & Environment
Elmwood House
74 Boucher Road
Belfast
Co. Antrim
BT12 6RZ

Order No. R52180221

Description: Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00687041
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	87196
Rion	Microphone	UC-59	13559
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 18 February 2021 ANV Job No. UKAS21/02125

Date Calibrated 19 February 2021

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	20 February 2020	UCRT20/1213	0653

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Photographs of the Noise Monitoring Location

Photographs of Noise Monitoring Location 1 are shown in Table A3.

Table A3: Photographs of Rion NL-52 Sound Level Meter at NML1 from Northern, Southern, Easterly and Westerly Directions (03/05/2022)

North	East
	
South	**West**
	

Noise Survey Results

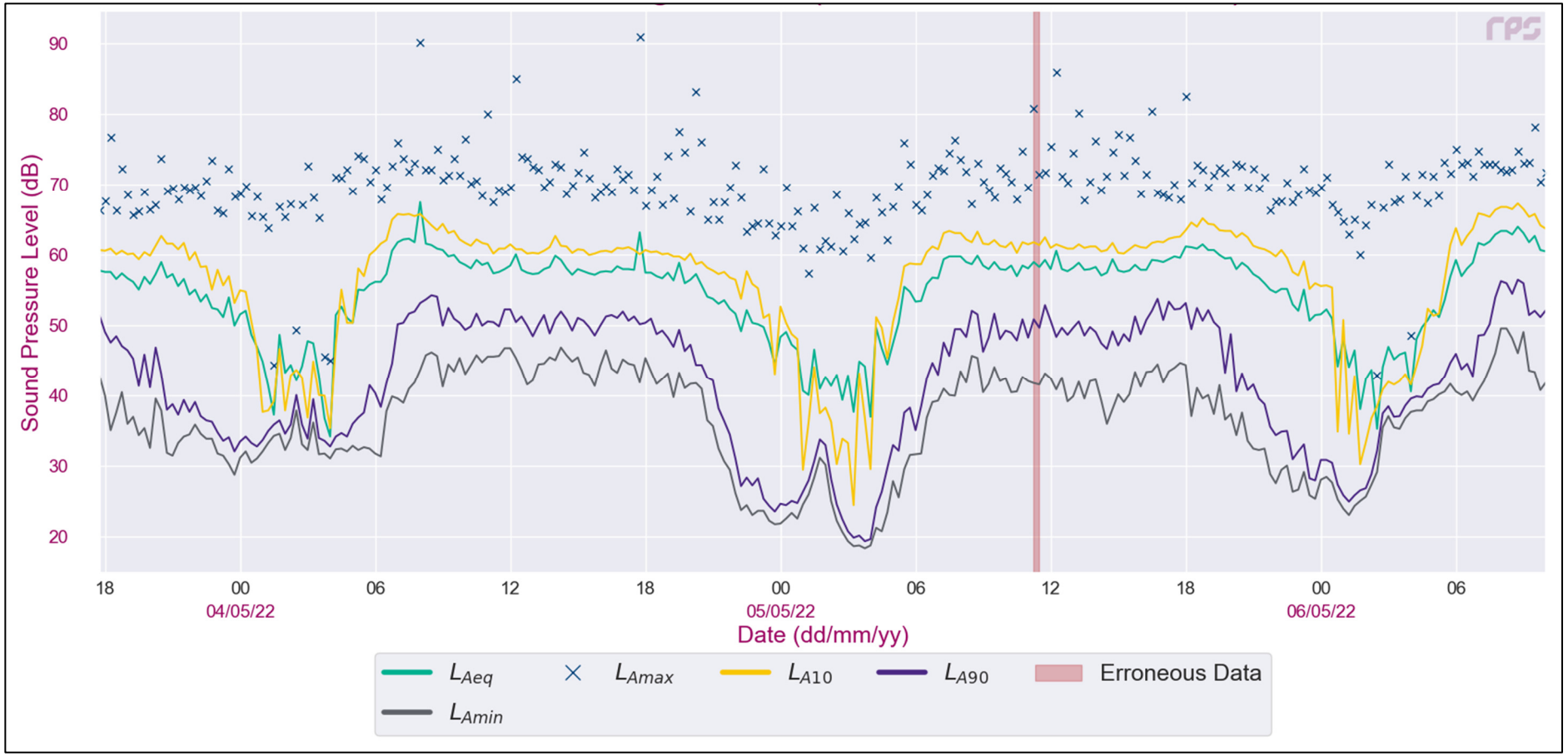
Noise Monitoring Location 1 was located in the front garden of a residential property located on Beechway, south east of the proposed development site from the 03/05/2022 – 06/05/2022. Noise monitoring commenced at 17:45hrs measuring in 15-minute intervals and was completed at 10:15hrs. Subjective notes were recorded and are summarised in Table.

Table A4: Subjective Noise Monitoring Notes at NML1

Noise Monitoring Commenced 03/05/2022	Noise Monitoring Check	Noise Monitoring Complete 06/05/2022
Upon commencement at 17:45hrs the dominant noise sources at NML1 included road traffic noise from Greenock Road. Intermittent birdsong was audible overhead. Cumbrae-Largs ferry audible entering Largs ferry terminal.	The sound level meter was checked on 5th May 2022 at 11:21hrs. The dominant noise source was road traffic noise from Greenock Road. A low hum was audible emanating from the Cumbrae-Largs ferry leaving the Largs terminal. Intermittent birdsong audible overhead.	Upon completion at 10:15hrs on 6th May 2022, the dominant noise source was road traffic noise from Greenock Road. Intermittent birdsong audible overhead.

The complete noise monitoring results at NML1 is shown below in Figure A3. Daytime and night time frequency distribution graphs were plotted L_{A90} and L_{Aeq} for the noise monitoring. The graphical displays of the analysis undertaken is detailed in Figure A4 and Figure A5.

Figure A3: NML1 Complete Noise Data (03/05/2022 – 06/05/2022)



***Note – Erroneous Data represents sound level meter check*

Figure A1: Frequency Daytime $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at NML 1 (03/05/2022 – 06/05/2022)

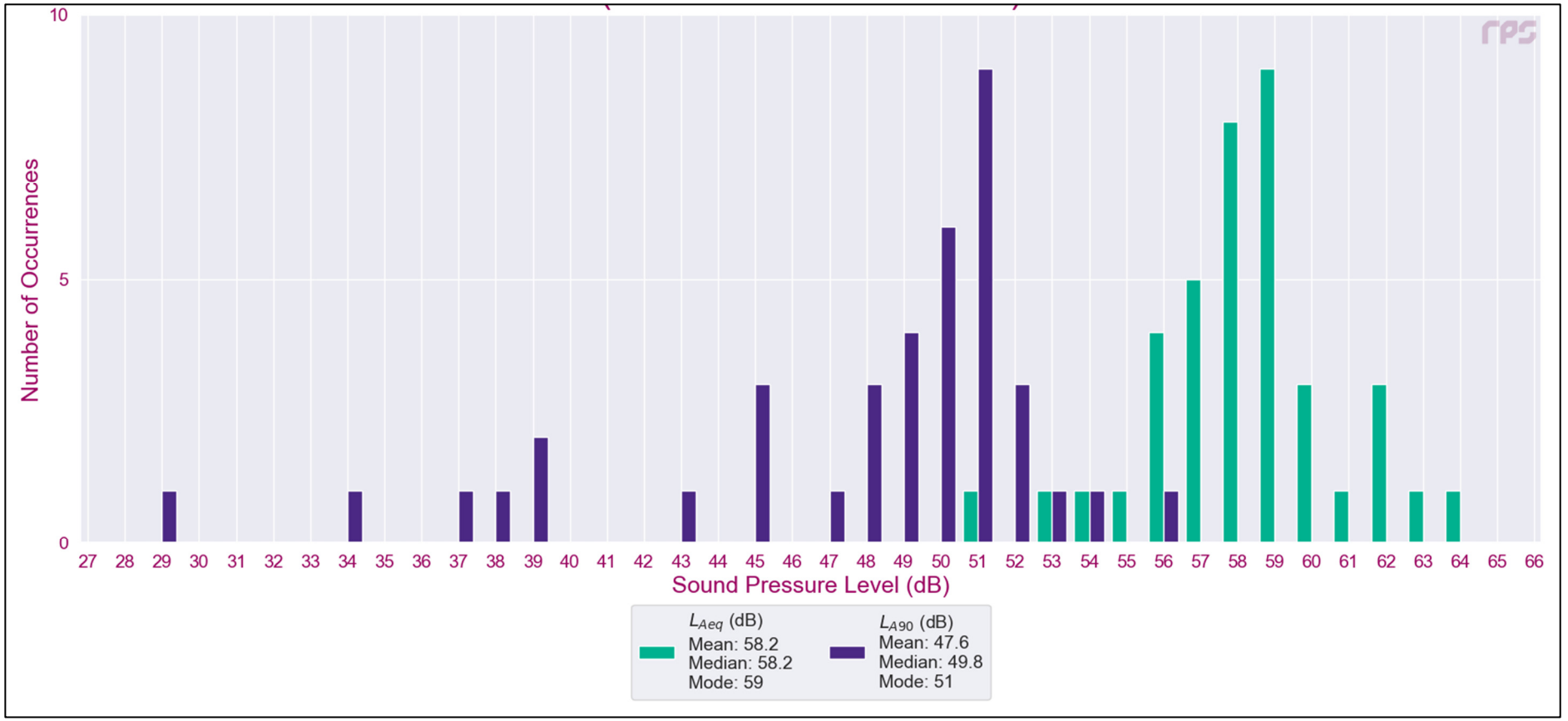
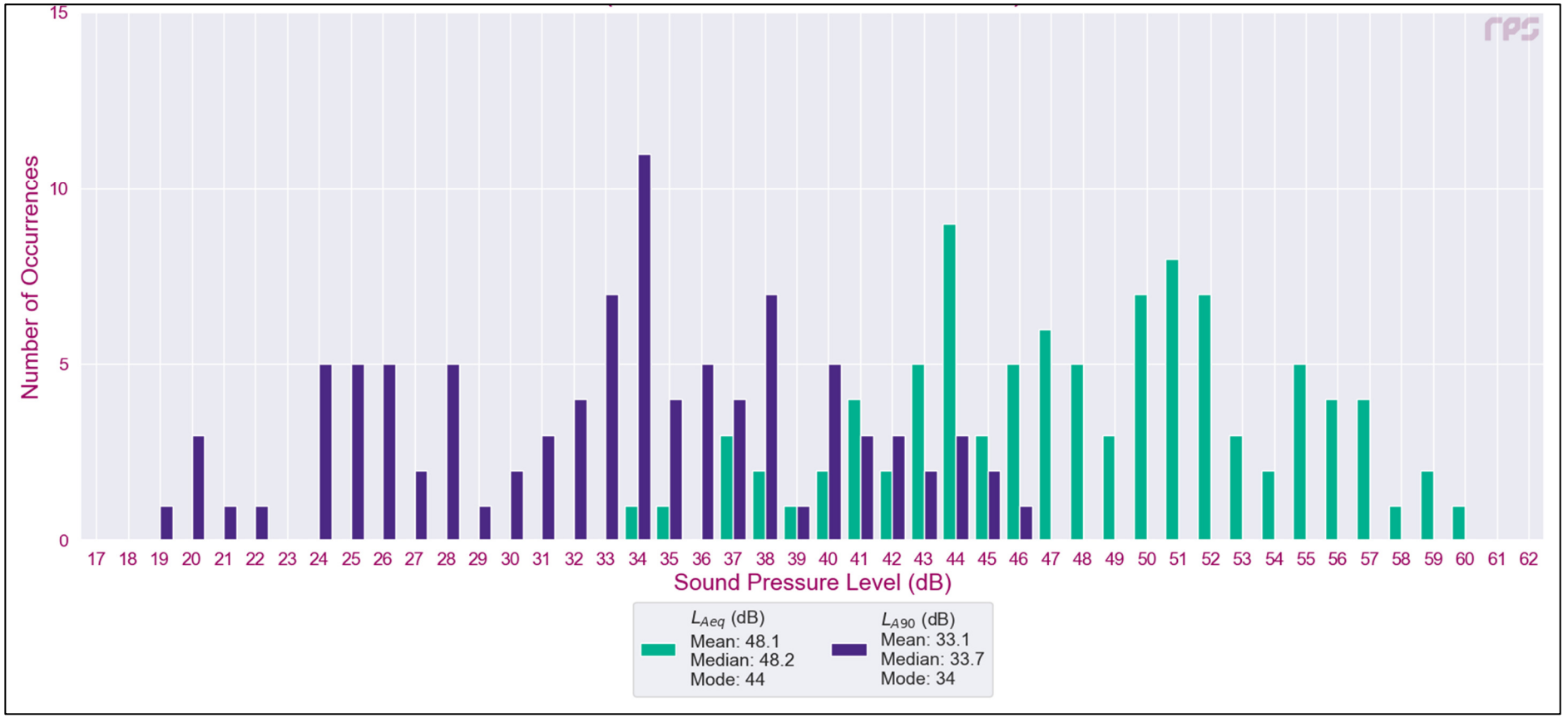


Figure A2: Frequency Night time $L_{Aeq,\ 15mins}$ and $L_{A90\ 15mins}$ at NML 1 (03/05/2022 – 06/05/2022)



The typical background noise levels in accordance with BS 4142 for each analysis completed are summarised below in Table A.5 including statistical analysis L_{A90} noise levels.

Table A.5: Daytime and Night time L_{A90} and L_{Aeq} Noise Levels NML1 (03/05/2022 – 06/05/2022)

Datasets	L_{A90} Analysis		L_{Aeq} Analysis	
	Daytime dB	Night time dB	Daytime dB	Night time dB
Complete Data	51	34	59	44

NOISE MONITORING LOCATION 2 SURVEY RESULTS

Sound Level Meter Specifications and Calibration Certificates

The baseline noise monitoring survey at NML2 was carried out using a Norsonic 140 Class 1 Sound Level Analyser in conjunction with the following:

- Norsonic 1211 Outdoor Microphone System and Storage Case;
- Norsonic 1212 – Microphone Dehumidifier Unit;
- CA 1317 – Weather Protection Kit – Type L; and
- RION NC-74 Class 1 Acoustic Calibrator.

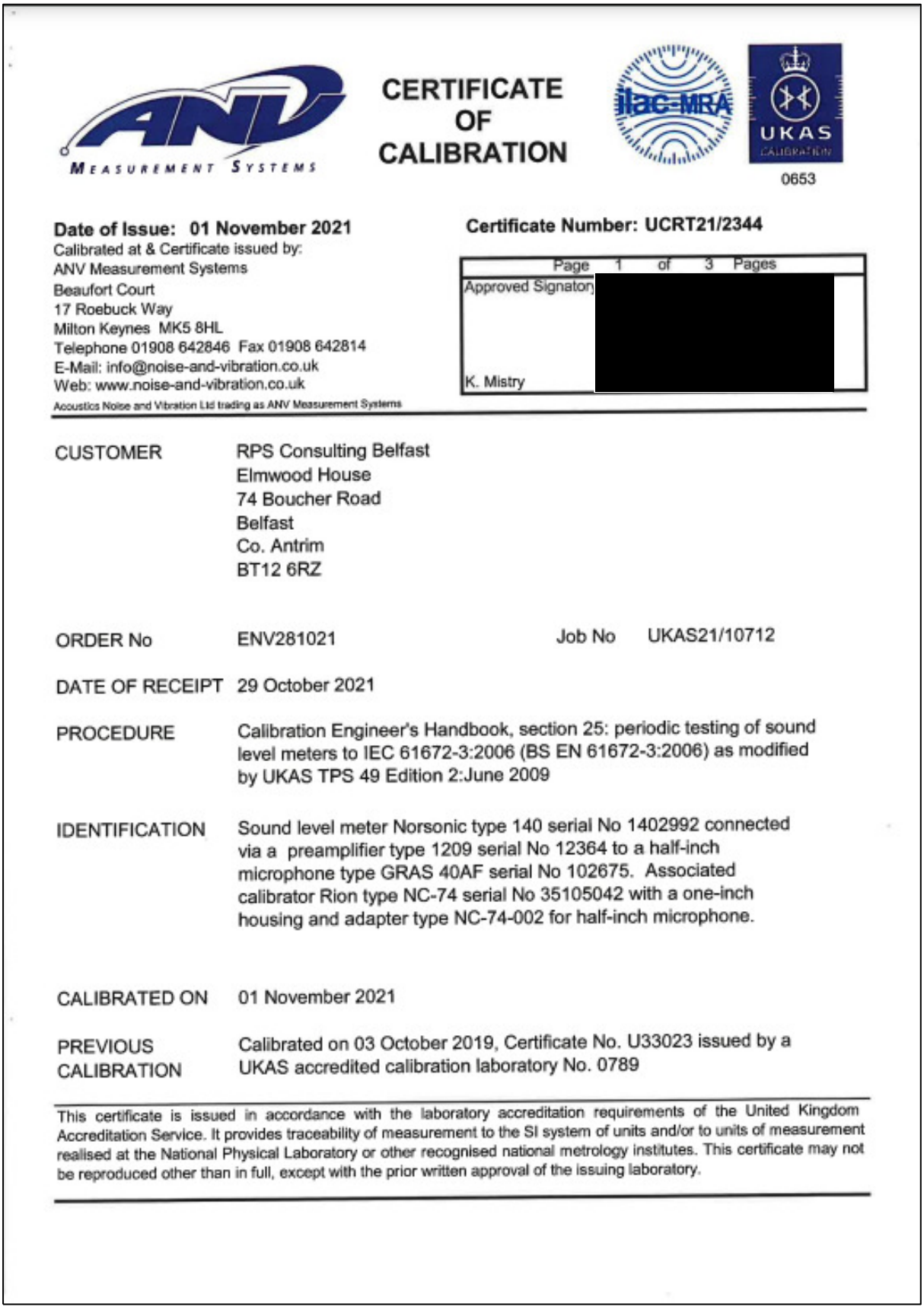
The sound level meter specifications from the noise survey equipment are detailed in Table A6.

Table A6: Norsonic 140 Noise Instrument Records

Equipment	Model / Type	Serial Number	Calibration Certificate Number	Last Calibration Date
Sound Level Meter	Norsonic 140	1402992	UCRT21/2344	01/11/2021
Preamplifier	Norsonic 1209	12364	UCRT21/2344	01/11/2021
Microphone	GRAS 40AF	102675	UCRT21/2344	01/11/2021
Calibrator	Rion NC-74	35105042	UCRT21/2343	01/11/2021

The calibration certificates and sound level meter specifications from the noise survey equipment are detailed in Figure A6.

Figure A6: Calibration Certificate of Norsonic 140



ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 01 November 2021

Certificate Number: UCRT21/2344

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

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Approved Signatory [redacted]

K. Mistry

CUSTOMER	RPS Consulting Belfast Elmwood House 74 Boucher Road Belfast Co. Antrim BT12 6RZ
ORDER No	ENV281021 Job No UKAS21/10712
DATE OF RECEIPT	29 October 2021
PROCEDURE	Calibration Engineer's Handbook, section 25: periodic testing of sound level meters to IEC 61672-3:2006 (BS EN 61672-3:2006) as modified by UKAS TPS 49 Edition 2:June 2009
IDENTIFICATION	Sound level meter Norsonic type 140 serial No 1402992 connected via a preamplifier type 1209 serial No 12364 to a half-inch microphone type GRAS 40AF serial No 102675. Associated calibrator Rion type NC-74 serial No 35105042 with a one-inch housing and adapter type NC-74-002 for half-inch microphone.
CALIBRATED ON	01 November 2021
PREVIOUS CALIBRATION	Calibrated on 03 October 2019, Certificate No. U33023 issued by a UKAS accredited calibration laboratory No. 0789

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Photographs of the Noise Monitoring Location

Photographs of Noise Monitoring Location 2 are shown in Table A7.

Table A7: Photographs of Norsonic 140 Sound Level Meter at NML2 from Northern, Southern, Easterly and Westerly Directions (04/05/2022)

North	East
	
South	**West**
	

Noise Survey Results

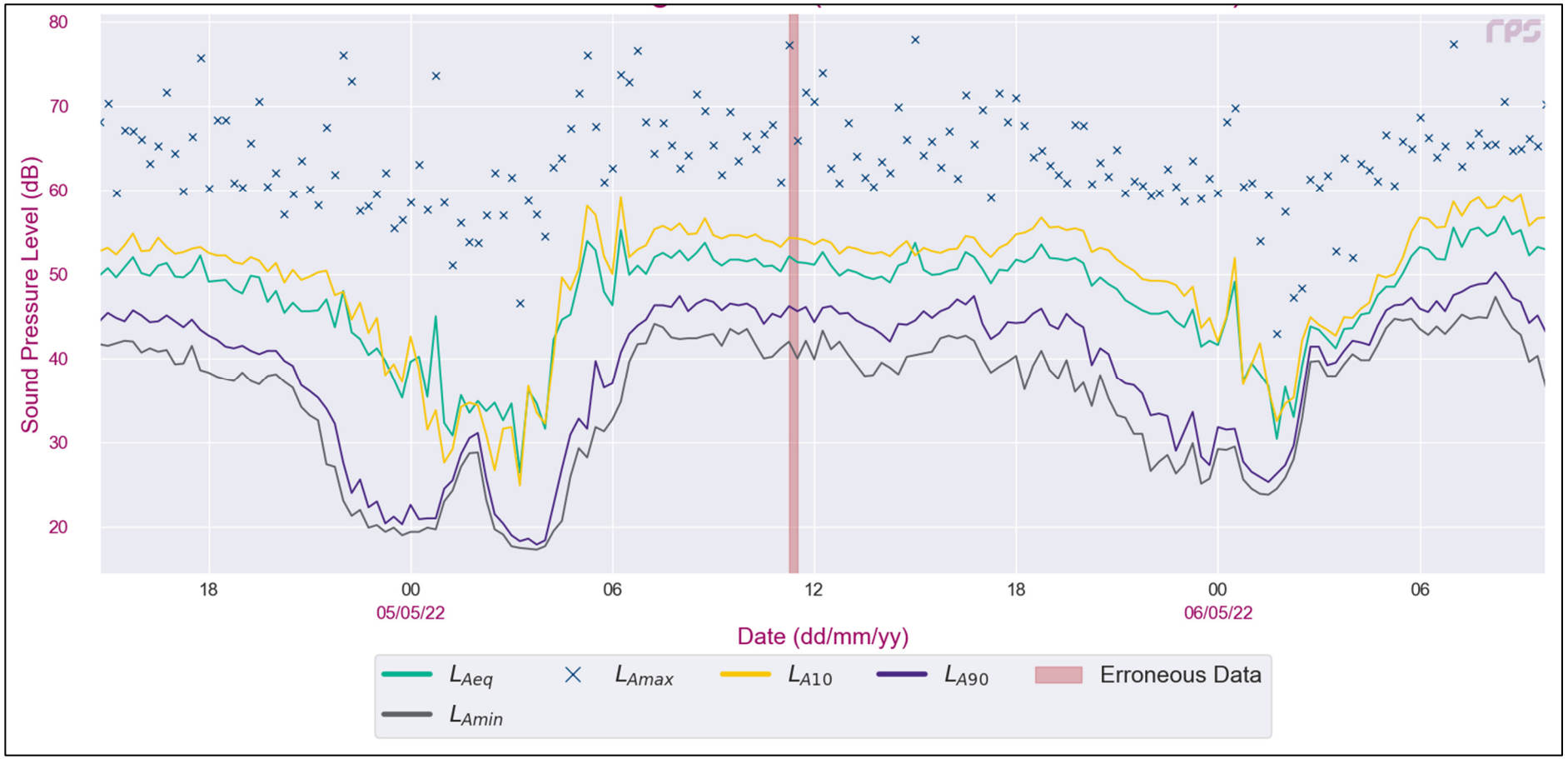
Noise Monitoring Location 2 was located in the front garden of a B&B located on Aubrey Crescent, north of the proposed development site from the 04/05/2022 – 06/05/2022. Noise monitoring commenced at 14:45hrs measuring in 15-minute intervals and was completed at 10:00hrs. Subjective notes were recorded and are summarised in Table A8.

Table A8: Subjective Noise Monitoring Notes at NML2

Noise Monitoring Commenced 04/05/2022	Noise Monitoring Check	Noise Monitoring Complete 06/05/2022
Upon commencement at 14:45hrs the dominant noise sources at NML2 included road traffic noise from Greenock Road and Aubrey Crescent. Intermittent seagulls and birdsong was audible overhead. A post-box being opened and closed located on Aubrey Crescent was audible.	The sound level meter was checked on 5th May 2022 at 11:15hrs. The dominant noise source was road traffic noise from Greenock Road. A low hum was audible emanating from a boat located in Largs Bay. Intermittent birdsong audible overhead.	Upon completion at 10:00hrs on 6th May 2022, the dominant noise source was road traffic noise from Greenock Road. Intermittent birdsong audible overhead. Intermittent dog barking audible further south on Largs promenade.

The complete noise monitoring results at NML2 is shown below in Figure A7. Daytime and night time frequency distribution graphs were plotted L_{A90} and L_{Aeq} for the noise monitoring. The graphical displays of the analysis undertaken is detailed in Figure A8 and Figure A9.

Figure A7: NML2 Complete Noise Data (04/05/2022 – 06/05/2022)



***Note – Erroneous Data represents sound level meter check*

Figure A8: Frequency Daytime $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at NML 2 (04/05/2022 – 06/05/2022)

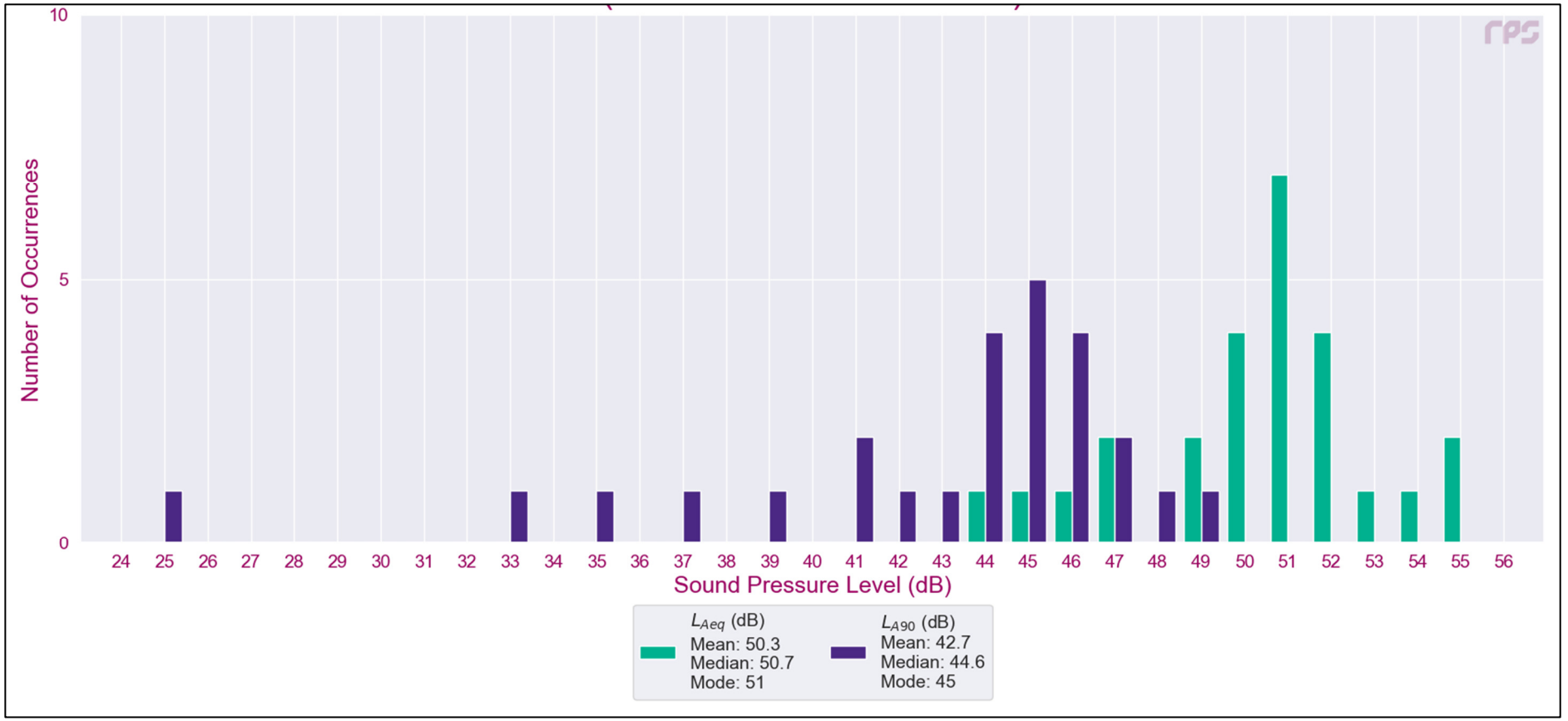
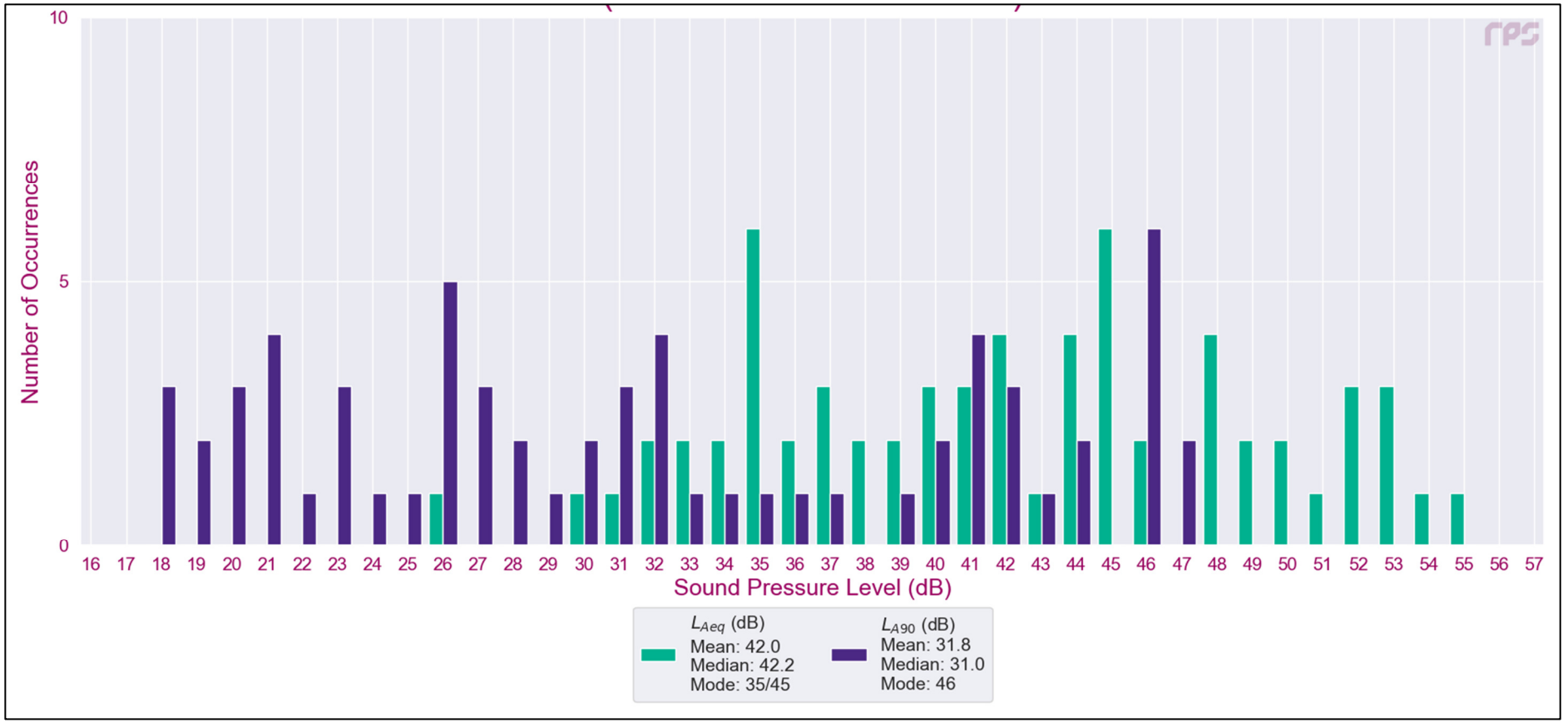


Figure A9: Frequency Night time $L_{Aeq,\ 15mins}$ and $L_{A90\ 15mins}$ at NML 2 (04/05/2022 – 06/05/2022)



The typical background noise levels in accordance with BS 4142 for each analysis completed are summarised below in Table A**.** including statistical analysis L_{A90} noise levels.

Table A.9: Daytime and Night time L_{A90} and L_{Aeq} Noise Levels NML2 (04/05/2022 – 06/05/2022)

Datasets	L_{A90} Analysis		L_{Aeq} Analysis	
	Daytime dB	Night time dB	Daytime dB	Night time dB
Complete Data	45	46	51	35/45

NOISE AND VIBRATION IMPACT ASSESSMENT

2022-07-29

NI 2523

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