White Paper

A QUIETER WORLD

A guide to barriers against environmental noise pollution

Jacksons Fencing

This document does not set out to cover the subject of environmental noise pollution in exhaustive detail. Rather to serve as a useful guide in selecting and specifying the right barrier for your application.

We have been offering our Jakoustic environmental noise barrier system since 2004, and working with noise consultants, we have installed thousands of linear metres in the UK to date.

Scope of this document:

- The growing impact of noise pollution
- Contributors to environmental noise
- Noise and its effects on people
- Propagation of noise
- How noise barriers work
- Noise, legislation and architecture
- Noise barrier designs
- Performance, sustainability and relative costs of noise mitigation solutions
- Case study

The growing impact of environmental noise on people, planning and architecture

To appreciate why noise is growing in prevalence in today's society we'll start by reviewing some of the drivers behind this.

Population growth and density

The population of the UK has grown from 56 million in 1971 to over 65 million in 2016 - and is estimated to reach 71 million by 2031.

By then, the population density per square kilometre in England is projected at 464 from 395 in 2008, that's almost double that of Germany and quadruple that of France.

Motor vehicles

In 1998, the total number of motor vehicles in the UK stood at 30.2 million units, by 2016 it had increased to over 36 million and so far as goods are concerned, over 75% of domestic tonnage is transported by road in the UK; with over 13,000 supermarkets in the UK in 2016, think of the number of daily vehicle movements taking place to keep the shelves stocked.

Road traffic makes a huge impact on the 'soundscape'; with the main components of vehicle noise being:

- Mechanical noise from engine, gearbox, transmission and exhaust
- Tyre noise relative to speed and road surface
- Braking
- Wind noise related to speed

The example above shows a reflective barrier at a school alongside a busy London 'A' road where reflected sound back into the road was not going to pose a problem to other residents - in this case, the barrier was installed to reduce the noise levels in the classrooms on the ground floor.

However, road traffic is not the only contributor to environmental, there are many other sources which we have grown to live with.

Railways

Railways contribute to the soundscape with noise from:

- Locomotives discharging exhaust gases at roof level
- Noise from overhead powerlines
- Braking
- Noise of wheels on rails
- Noise from whistles and horns
- Operating noises from stations and engineering facilities

Industry and Commerce

Vital of course to our economy, however industry and commerce bring with them attendant noise sources including:

- Air conditioning, handling and extraction
- Generators providing uninterrupted power
- Process and manufacturing equipment
- Materials handling machinery and transport
- Deliveries/vehicle movements

The example above shows the perimeter to a supermarket loading depot backing onto local housing. The 4.8m high section of absorptive barrier absorbs sound that comes from within the main loading/unloading areas.

Education and Leisure

With some 8.3 million pupils enrolled in schools, an increase of 1% on January 2013, the development of super-size schools is well under way bringing these facilities ever closer to residential locations where the associated noise from play activity and increased traffic movement cannot be underestimated.

Noise sources will include:

- Noise from play equipment
- Children at play
- Increased local traffic
- Deliveries
- Parking
- Out-of-hours activities

Construction

To support the need for housing and the infrastructure supporting communities will involve construction and the noise from construction sites which include:

- Material deliveries
- Site vehicles
- Piling
- Cranes
- Cement mixers
- Excavation
- Welding
- Hammering
- Boring
- Cutting

Retail & Home Shopping

Finally, our need to shop 24/7 has created its own set of noise problems, especially with extended shop opening hours and home shopping deliveries.

There's is no doubt that the shopping habits of today are formed around choice, immediacy and value – this has placed retailers under pressure to ensure that their shelves and warehouses remain stocked at all times.

As far as noise is concerned, the encroachment of retail into housing, or vice versa, has created noise issues, so too has the number of primary trucking movements of goods, the activities of break-bulk and distribution hubs and home delivery.

Noise sources associated with retail and home delivery include:

- Stock deliveries
- Home deliveries
- Mechanical handling
- Waste management
- Refrigeration units
- Parking

The inevitable clash between people and noise

As an island, we're not able to easily increase our land mass, the clash between environmental noise and people is both inevitable and increasing as people, transport, commerce, industry, education and leisure share more of the same space.

This proliferation of unwanted noise can cause stress, annoyance and fatigue, interfere with communication and sleep, reduce efficiency in the workplace, disrupt learning and damage hearing.

The World Health Organisation recommends a guideline level of under 30 dBA for undisturbed sleep, and a daytime level for outdoor sound levels of 50dBA to prevent people from becoming 'moderately annoyed'.

Sound Levels and Relative Loudness

Noise is one of the most persistent forms of environmental pollution in today's society.

Let's put this in context:

Noise source	Weighted (dBA)	Subjective Impression	Relative Loudness
Jet aircraft take off from carrier (15.2m)	140	Threshold of pain	64 times as loud
50 hp siren (30.5m)	130		32 times as loud
Loud rock concert near stage	120	Uncomfortably loud	16 times as loud
Jet takeoff (609.6m)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Pneumatic drill (15.2m	80	Moderately loud	Reference loudness
Vacuum cleaner (3m)	70		1/2 as loud
Large store air conditioning unit (6.1m)	60		1/4 as loud
Light vehicle traffic (30.5m)	50		1/8 as loud
Conversation (1.8m)	45-60		1/12 - 1/4 as loud
Bedroom or quiet living room, bird calls	40		1/16 as loud
Quiet library, soft whisper (4.6m)	30	Very quiet	

Noise measurement:

dB: Intensity is the loudness of a sound, or the pressure it exerts through the ear.

dBA: 'A' Weighted scale of dB to 'mimic' the sensitivity of the human ear to different frequencies.

dBc: 'Decibels relative to the carrier' is the power ratio of a signal to a carrier signal, expressed in decibels.

In an acoustic testing or anechoic chamber, the human ear can just discern sound at 10dBA. In practice 15dBA is the human threshold of hearing. If we take the WHO guidelines of 30dBA and 50dBA, most of the noise sources in everyday life would fall outside the recommended levels.

Unless in extreme situations, it's the constant exposure of noise at levels, especially at high frequency that causes permanent damage to hearing.

In the USA over 10 million people attribute their hearing impairment to noise exposure and the US Government's Occupation Health & Safety Administration provides more detailed guidelines (table below):

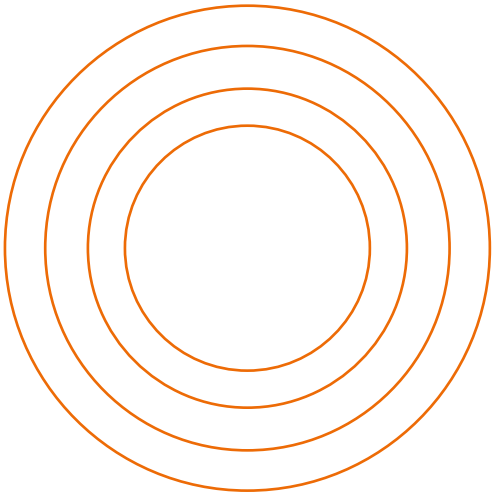
Permissible noise exposure scale

Duration - hours per day	Sound level (dBA)
8	90
4	95
2	100
1	105
1/2	110
1/4 or less	115

If we take these guidelines into everyday life, living or working close to a major road would certainly result in hearing problems.

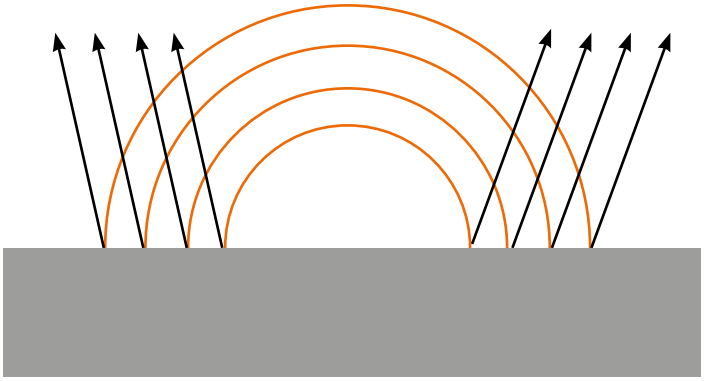
It is environmental noise, especially in the confines of the industrialised cities and their feeders in England, more so than the rest of the UK, which will increasingly become a factor of life.

Noise propagation and mitigation
How sound travels: Free Space



In free space without any reflective surfaces, sound propagates or radiates spherically...

How sound travels: Ground plane

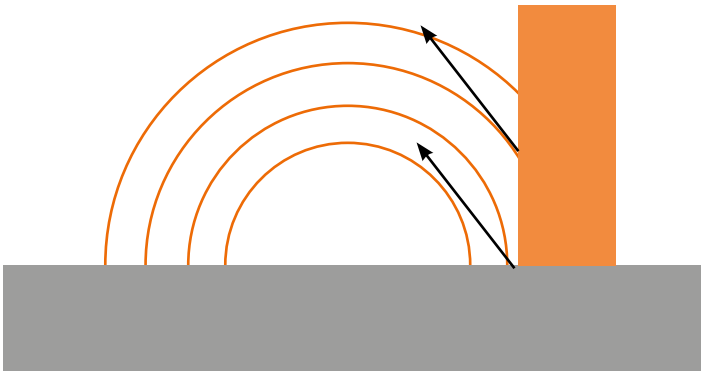


When a ground plane is introduced, sound propagates hemispherically.

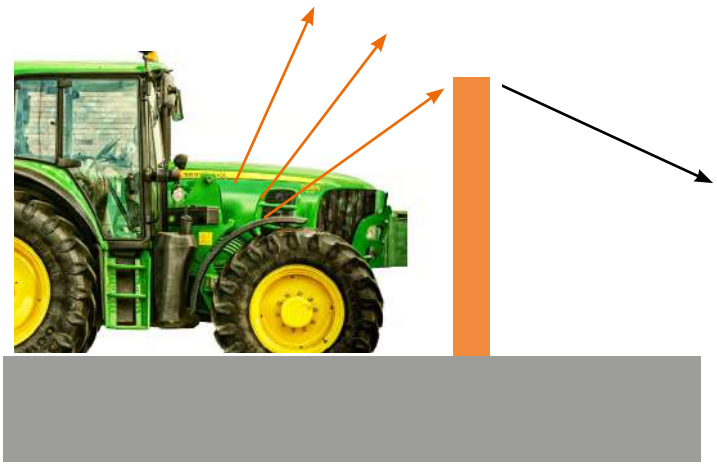
In virtually every application for an environmental noise barrier, at least one principal reflective plane will be present from which sound will be reflected.

Knowing how sound travels allows the laws of physics to be applied in the design, construction and location of barriers to mitigate the effects of noise.

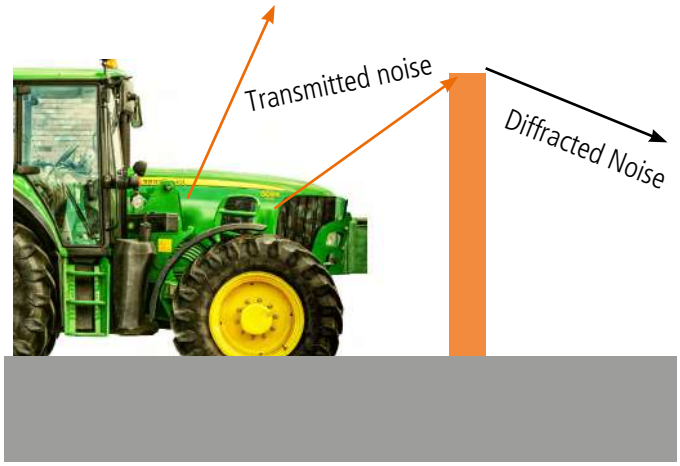
How sound travels: Ground plane + Barrier



How Barriers Work



In a linear source situation, such as road traffic - sound, or noise, has basically two ways to get from one side of a barrier to the other as shown below.



Barrier Effectiveness

The effectiveness of any environmental noise barrier is dependent on a number of key factors, namely:

1. Material Density
2. Barrier Construction
3. Barrier Height
4. Distance from noise source to receiver
5. Relative height of source and receiver with respect to the barrier

The first two factors relate to sound transmission through the barrier and in practical terms, the greater the mass of the barrier, the less sound will transmit through it regardless of material, however, whether made from timber, steel, Perspex or earth, the structural integrity of a barrier is critical to its performance - any gaps will allow sound to find a direct transmission path through the barrier.

In general terms, a noise barrier should be:

- of sufficient height to break the direct line of sight between the noise source and the receiver – if you can see it, you can usually hear it
- constructed with no air gaps to prevent noise penetration through its structure
- of sufficient mass to reflect noise
- sealed to the ground to prevent noise creeping under the barrier
- located as close as possible to the noise source

Five further points worth noting are:

1. that noise decreases over distance so that the area covered by a sound energy spread is directly proportional to the distance, sound will decrease by 3dB for each doubling of distance
2. and that because sound levels are measured using a logarithmic scale, a reduction of nine decibels is equivalent to elimination of about 80 percent of the unwanted sound and
3. concrete surfaces reflect more noise than tarmac and that grass, earth or other soft surfaces absorb rather than reflect noise
4. barriers are available in two primary 'flavours', reflective and absorptive – absorptive generally providing increased performance
5. canted barriers and angled toppings can be specified at design stage following an acoustic survey of the site.

Planning considerations

You are all of course aware of how the propagation of noise is making an impact on the projects you have been involved with since more stringent noise legislation was introduced across Europe.

This has led to environmental noise barriers becoming a feature of the landscape across most of the country. First introduced on UK motorways to mitigate noise and views of traffic, environmental noise barriers can now be seen almost anywhere there is development close to noise sources, whether from road, rail, industrial, retail or even schools – in inner cities, suburban and rural locations.

By default, environmental noise barriers have become an architectural feature in their own right and should therefore be considered not just around acoustic performance, but also in context with the local environment and the quality and character of the landscape.

The National Planning Policy Framework (NPPF) which supercedes the now withdrawn Planning Policy Guidance (PPG24) , underlines and enforces key points in the Noise Policy Statement for England (NPSE), effectively meaning that it is now the responsibility of Local Authorities to implement acoustic guidance into local policy in context with Government policy on sustainable development.

In practice, acoustics consultants are being brought in by architects, developers and construction companies at pre-planning stage on any project that could result in adverse impacts on the health and quality of life of local residents.

Environmental Noise Barrier Design

We touched on some of the characteristics required for noise barriers earlier...

- A minimum mass (also known as superficial mass) of 10kg/m2 is the minimum whatever material the barrier is constructed from
- The barrier should be free of gaps to prevent noise penetration
- The barrier design should make solid contact with the ground to prevent noise creeping under the barrier

Acoustic barriers, meeting with these criteria are freely available in:

- Timber

Probably the most cost effective and flexible solution that can be adapted to suit most ground conditions and contours. Timber is our chosen material and combines high acoustic properties within a natural facade and can in absorptive form deliver a 32dB reduction in noise in laboratory conditions.

- Steel and aluminium

Barriers are relatively costly and need to be well supported if they are to avoid the 'drumming' effect from its surface from noise vibration – both steel and aluminium are excellent materials, but costs can escalate when coatings are applied to provide a decorative appearance and long service life.

- Plexiglas/Perspex/Acrylic

barrier types can be highly effective and do allow for light and visibility through the barrier. However, they need to be kept clean and materials are subject to variation in size with climatic changes which can make it difficult to maintain the integrity of its acoustic properties.

- Earth bunds or berms and Gabions

Are probably the oldest form of acoustic barrier. Highly effective in situations where spoil and plant is readily available, earth bunds however do require a lot of space, for example a 2.5m high bund would typically slope 7.2m in each direction; a footprint of 14.4m. Gabions are a more recent addition, but do require more space than panel designs.

- Combination Barriers

Quite often any of the materials or types discussed can be combined to suit particular applications, aesthetic considerations or topography of the site – combinations of timber barriers on the tops of bunds or timber/steel barriers with Plexiglas panels and so on – in virtually every instance, combinations will add cost to the project and this needs to be weighed-up against aesthetic and performance requirements.

In the general terms of cost/performance, sustainability and environmental impact, here's how the different barriers typically perform relative to each other in a situation where a 15dBA noise reduction is targeted. We have used a standard Jakoustic® reflective timber barrier as the benchmark – mounted on timber 'tuning fork posts' and standard 34mm thick special profile tongue and groove timber boards, it has a superficial mass of 25kg/m2 and a laboratory noise reduction potential of 28dB.

All other materials are given at a superficial mass in excess of the 10kg/m2 minimum requirement.

In terms of sustainability, we have arrived at a score which factors-in maintenance and service life.

The Environmental values are based on energy expended in harvesting/producing the raw material, manufacturing, transportation and concrete and plant employed in installation.

In terms of overall performance, there is little to beat timber in circumstances where a zero visibility barrier is required.

A bund, given the space to accommodate it and availability of spoil on site would prove to be next best.

Environmental Noise Barriers - Relative Cost / Performance / Sustainability

Barrier Type	Cost per meter a 2m high	Sustainability	Environmental
Relative values scale: 1 = Best			
Timber (pressure treated)	1	1	1
Steel (galvanised & coated)	3	3	3
Plexiglas	3	4	3
Brick	3/4	1	3
Stone	5	1	2
Reinforced Concrete	5	1	5
Bund	2-5	2	1/5

Jakoustic® Barriers

12k Envirofence®

- 20mm interlocking "V" boards
- Unique tuning folk posts
- Superficial mass 12kg/m^2
- Lighter weight with planed timber finish
- Anti-climb and scale design
- Matching gates availble
- Jakcure® vacuum pressure treated timber
- 25 year Jakcure® Guarantee

Jakoustic® Reflective

- Up to 28dB noise reduction
- 34mm interlocking "V" boards
- Unique tuning fork posts
- Superficial mass 25kg/m^2
- Accommodates changes in ground level
- Planed timber finish
- Anti-climb design
- Jakcure® vacuum pressure treated timber
- 25 year Jakcure® Guarantee

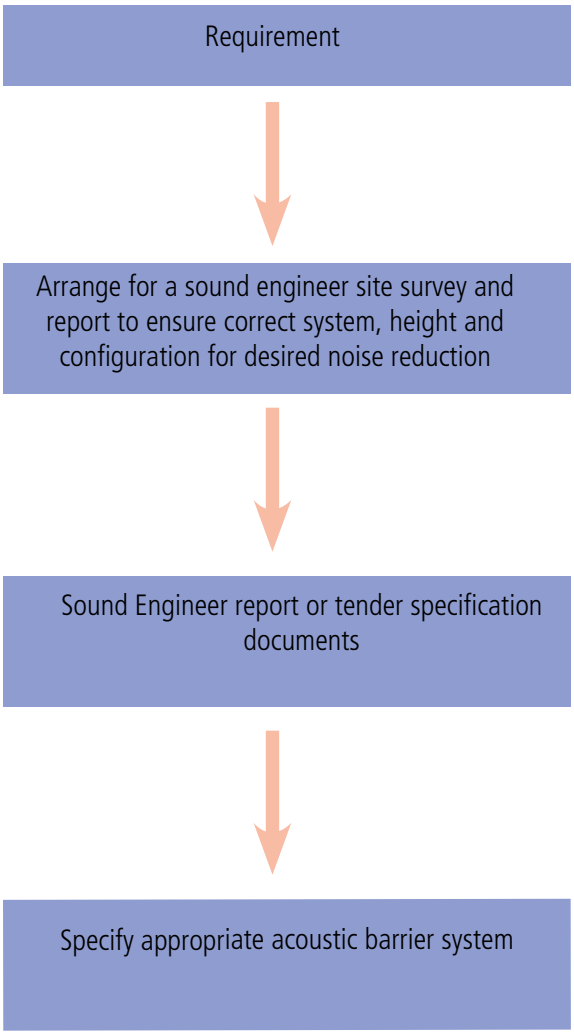
Jakoustic® Plus

- Up to 32dB noise reduction
- 34mm interlocking "V" boards
- Absorptive layer and membrane
- Superficial mass 28kg/m^2
- Unique tuning fork posts
- Accommodates changes in ground level
- Anti-climb and scale design
- Jakcure® vacuum pressure treated timber
- 25 year Jakcure® Guarantee

Jacksons' Jakoustic® range of timber barriers and gates is available in three design types in heights of up to 12m and with variations in post materials and dimensions to adapt to site conditions, heights and applicable legislation.

Specification Process

Whenever there is a requirement for an acoustic barrier, it is essential that a qualified and independent acoustic engineer is consulted ahead of a product being specified to ensure the correct barrier is selected to meet specific site and performance criteria.



Jacksons Jakoustic, Acoustic Barrier Solutions

Jakoustic 12K Envirofence
Jakoustic Reflective
Jakoustic Absorptive
Jakoustic Commercial & Highway Reflective
Jakoustic Commercial & Highway Absorptive

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RIBA CPD

Jacksons Fencing offer a RIBA Certified CPD on Environmental Noise Pollution. To book a seminar, please contact us at cpd@jacksons-fencing.co.uk

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Contact Jacksons Fencing High Security Team

For the application of Jakoustic Reflective or Absorptive barriers as a combination acoustic and security barrier system, including LPS 1175 Certified, CPNI Approved and Secured by Design preferred versions, please contact our specialist team.

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