

# What is noise?

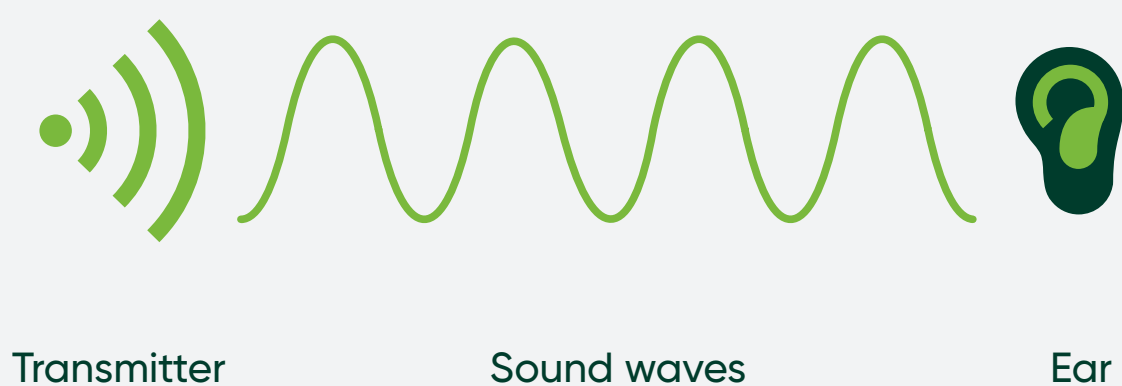


## Definition of noise

A term used to describe everything we hear. It includes the sound elements present in the environment.

## Overview

Noise is the energy produced by vibrations that propagate in the form of waves, like a stone thrown in water.

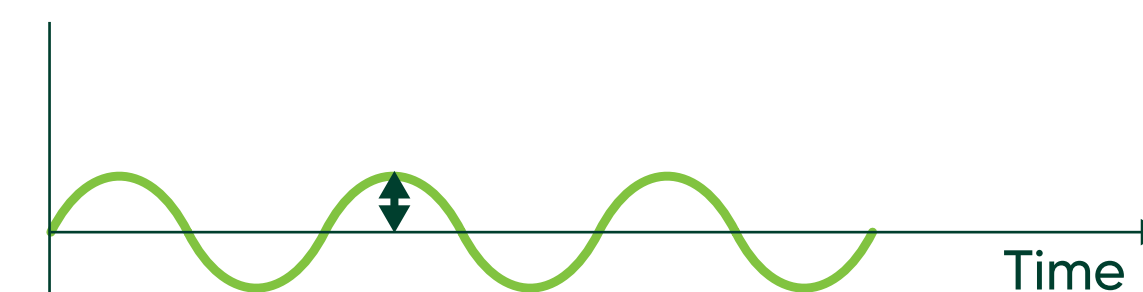


## Amplitude, or sound volume

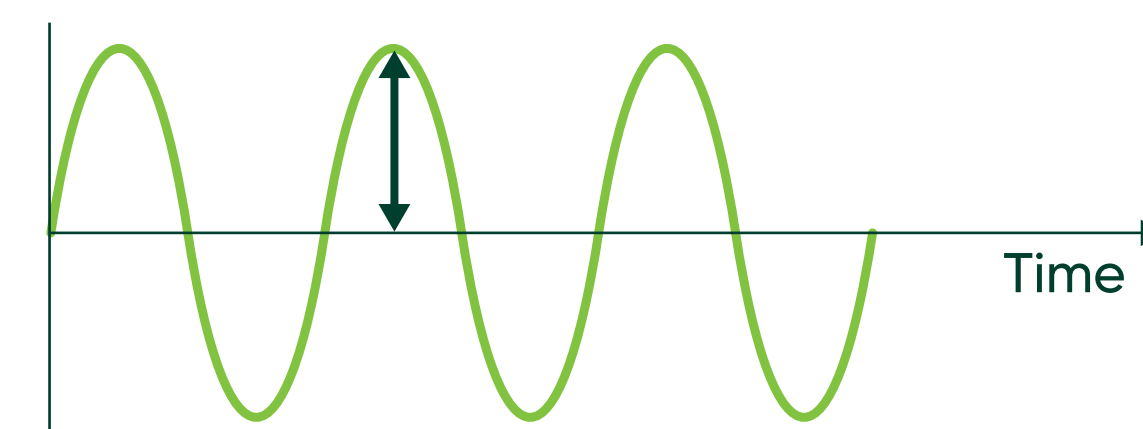
The power of noise is determined by the amplitude of the sound wave, i.e. its height, which is measured in decibels (dB).

This measurement can be adjusted to take account of the way the human ear hears sounds. This is known as decibel "A" (dBA).

**The greater the amplitude, the greater the number of decibels.**



Soft



Loud

## Frequency, from high to low

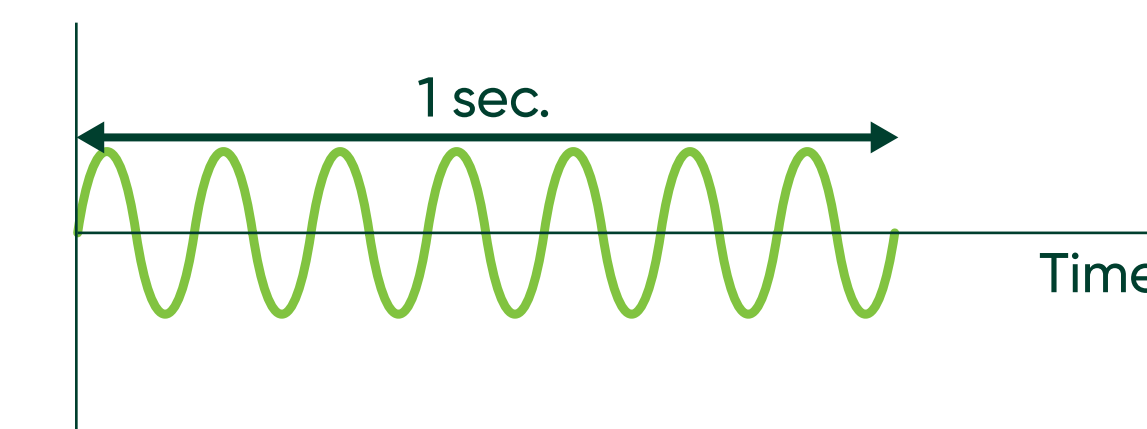
A wave's frequency determines whether the sound is perceptible to humans, who generally pick up midrange frequencies.

Wave frequency is calculated in hertz (Hz), which corresponds to the repetition of the wave in one second.

**The more ripples, the higher-pitched the sound. The fewer the ripples, the lower the sound.**



Low

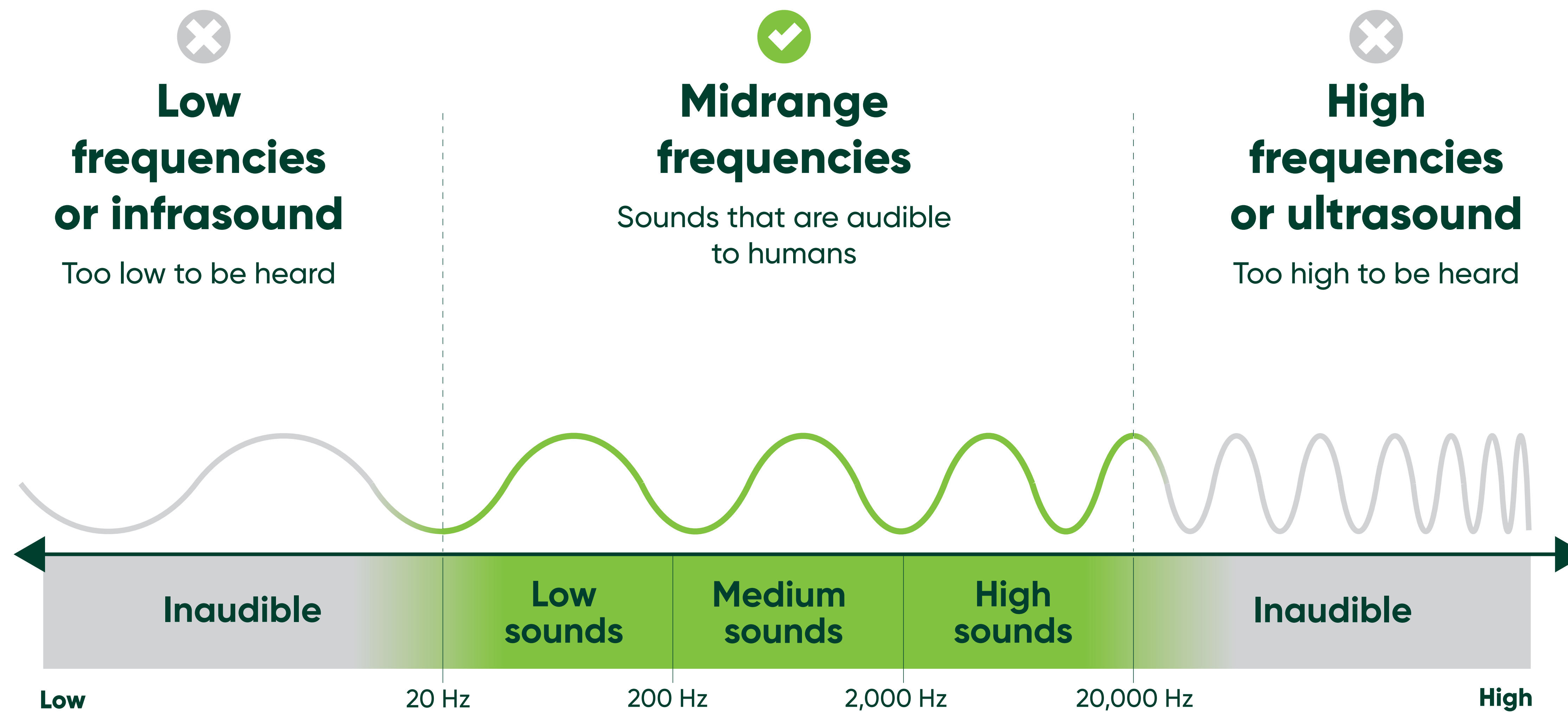


High

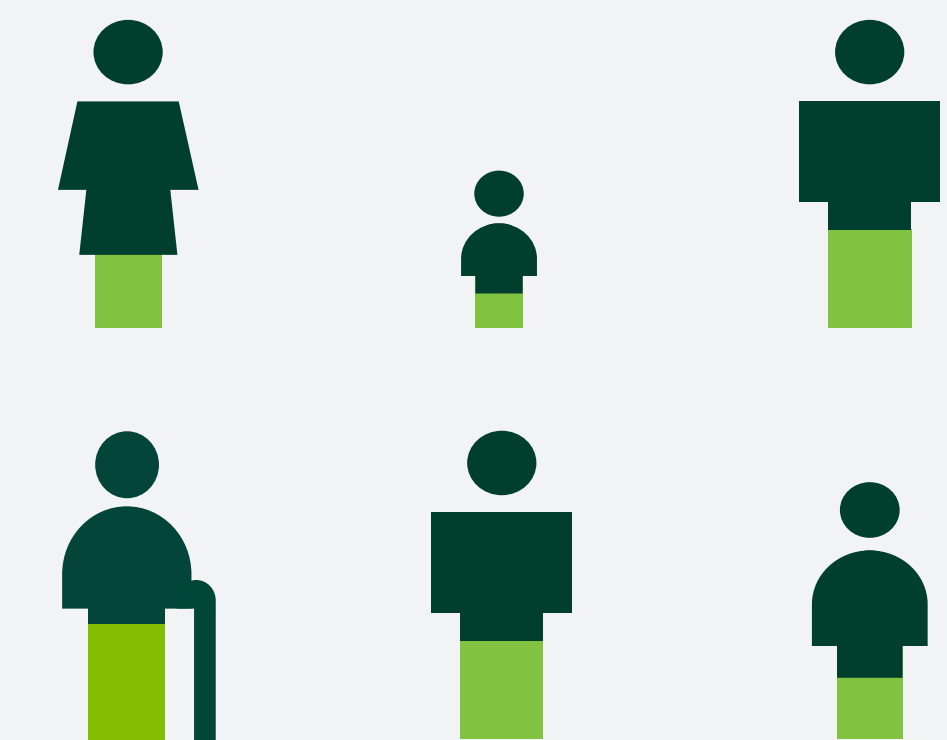
# What sounds can we hear?



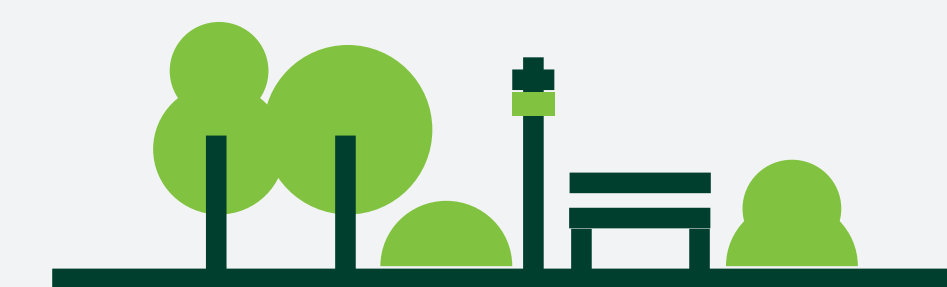
Not all sounds are audible to the human ear. Here are the three categories of sound, according to the frequency of the waves generated by a noise source:



## Sound perception varies:



From one person to another, depending on age and sensitivity,



From one environment to another, depending on the surrounding noise level.



# Sound level meter



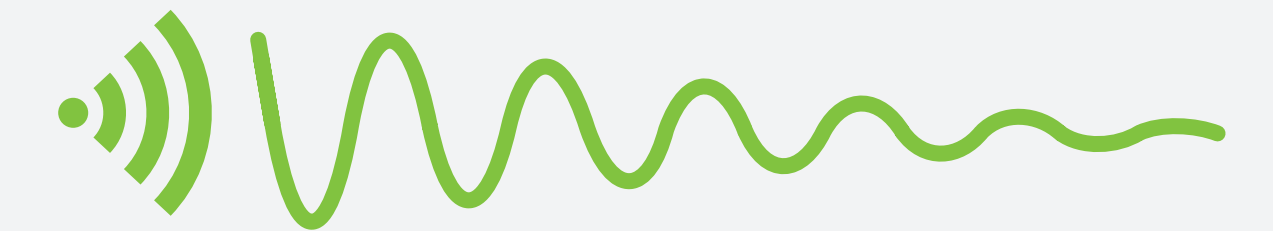
## Definition

Tool used to measure decibel levels. Its microphone measures the number of particles in the air that are “displaced” and which we perceive as sound.

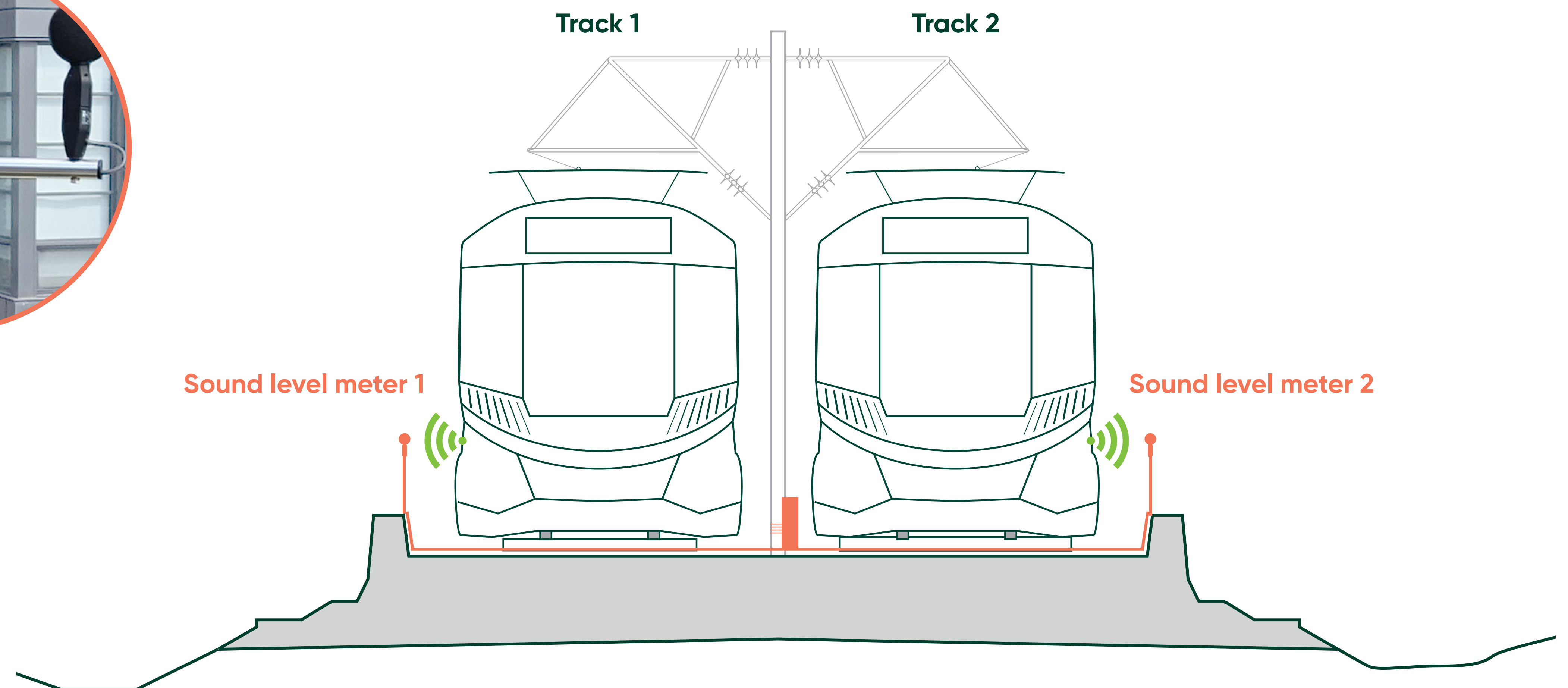
## How does it work?

The sound level meter is placed close to the noise source you want to measure, called measuring noise at source. This ensures that the noise measurement is as unpolluted as possible by other surrounding noises.

Noise levels are influenced by distance from the noise source



The further away we are from it, the quieter the sound.

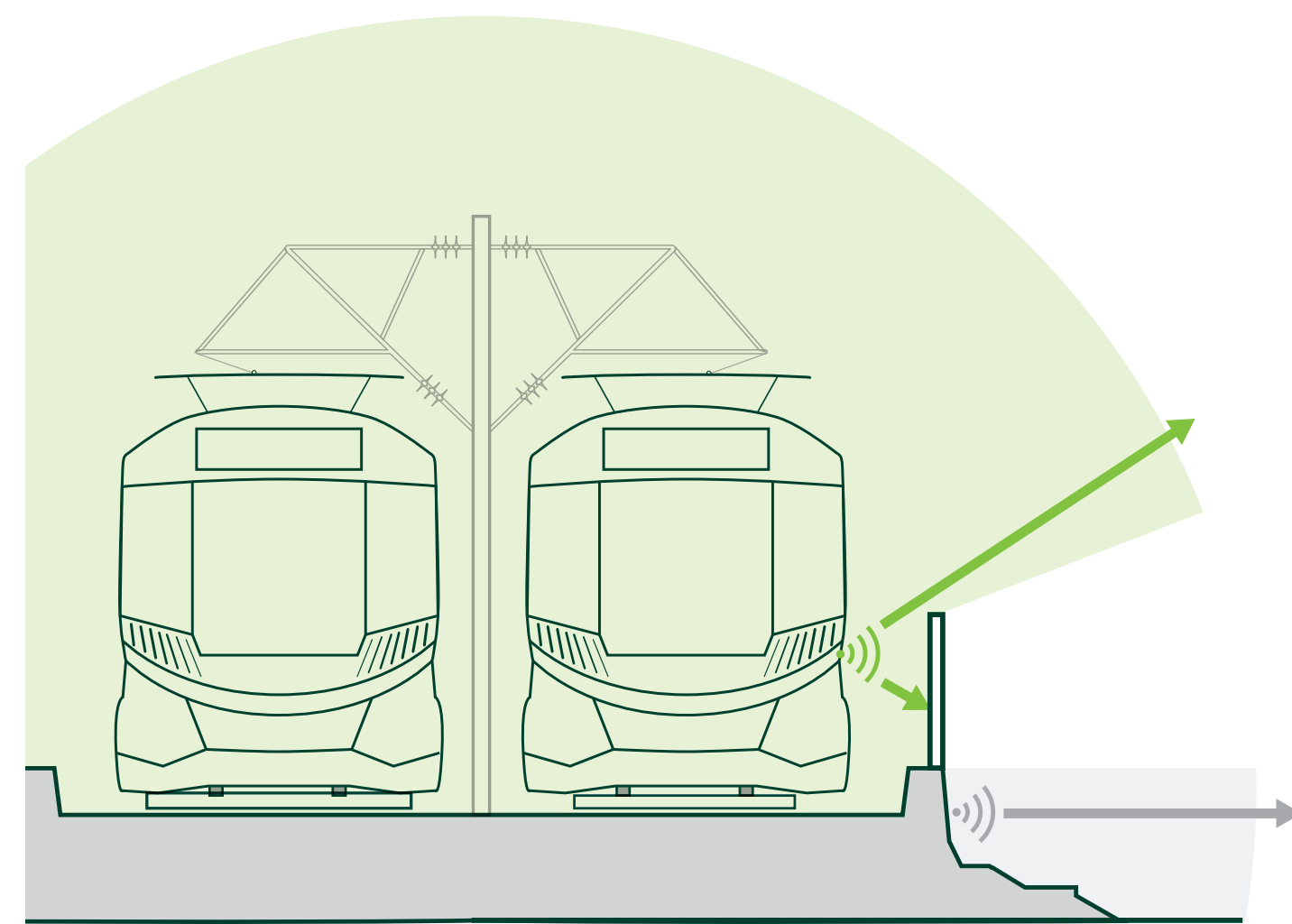
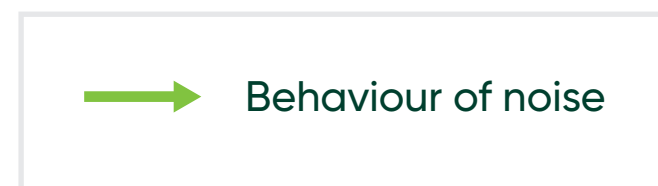




# Sound propagation



Sound waves behave differently depending on the obstacles encountered and the configuration of the space.



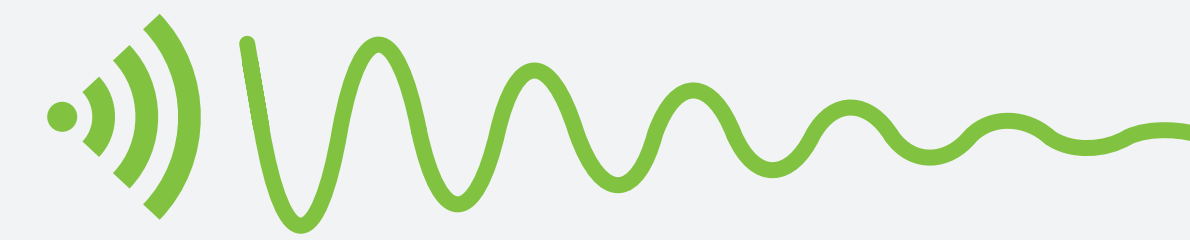
Ballasted tracks on embankments and on the ground



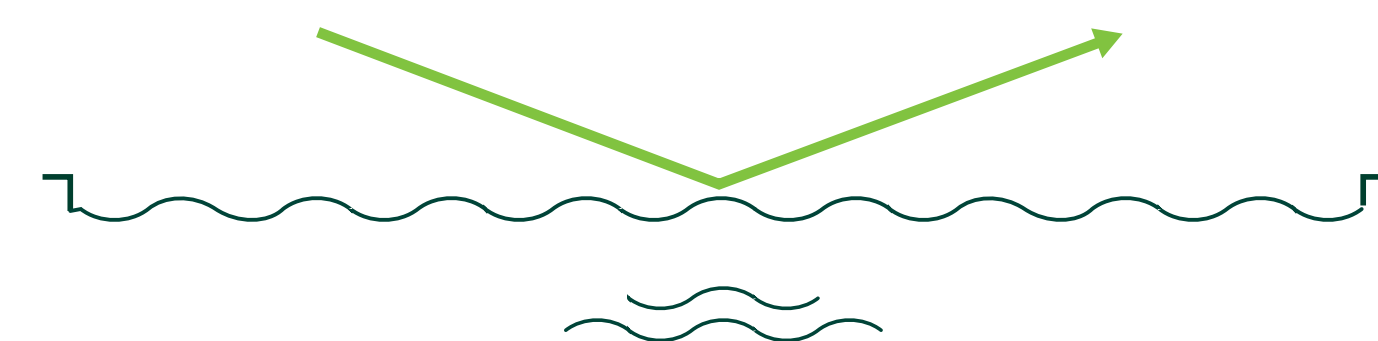
**Physical objects**  
(sheds, houses, walls)

Deviation

**Noise levels are influenced by distance from the noise source**

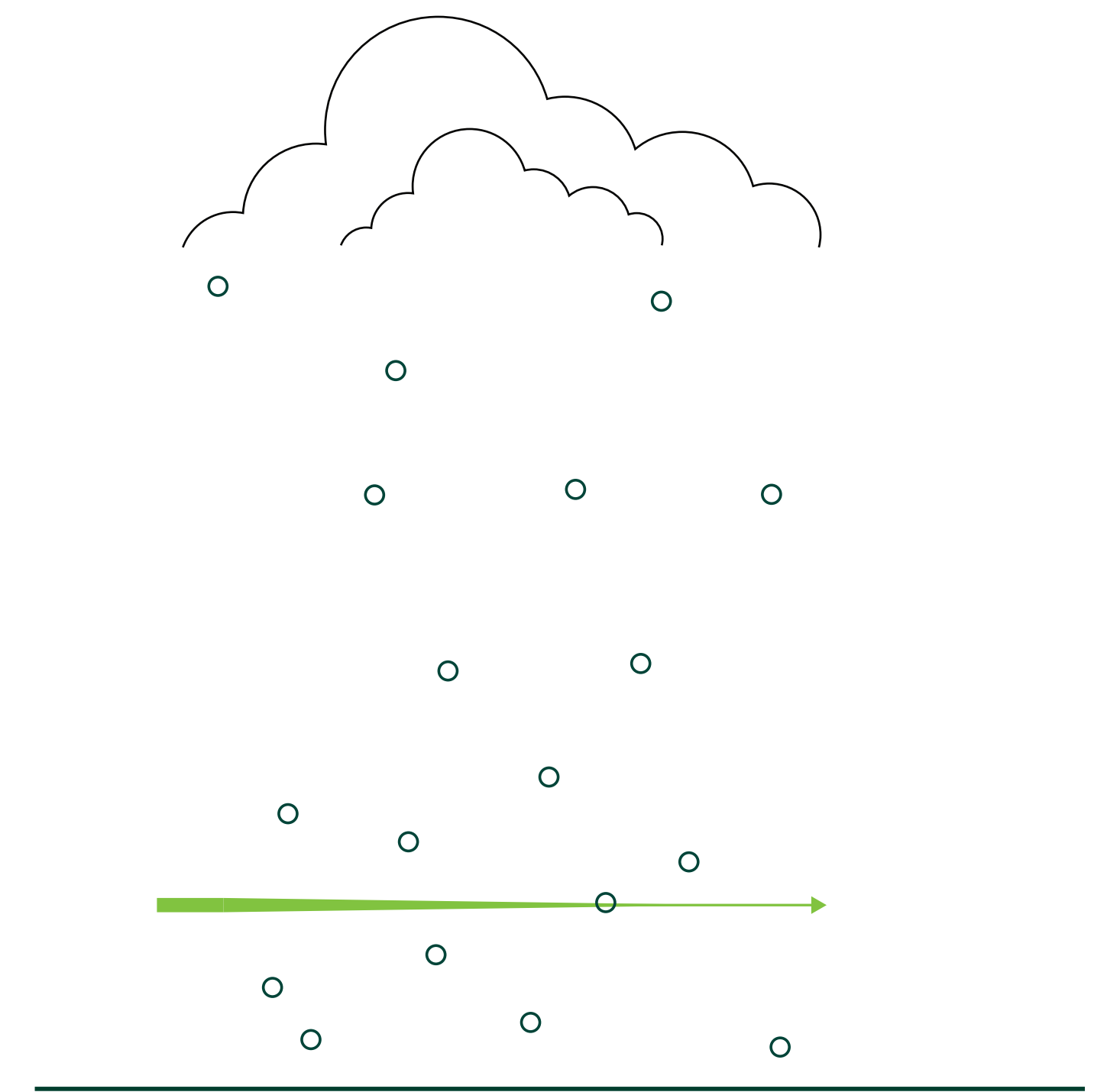


**The further away we are from it, the quieter the sound.**



**Presence of water bodies**  
(river, lake)

Ricochet



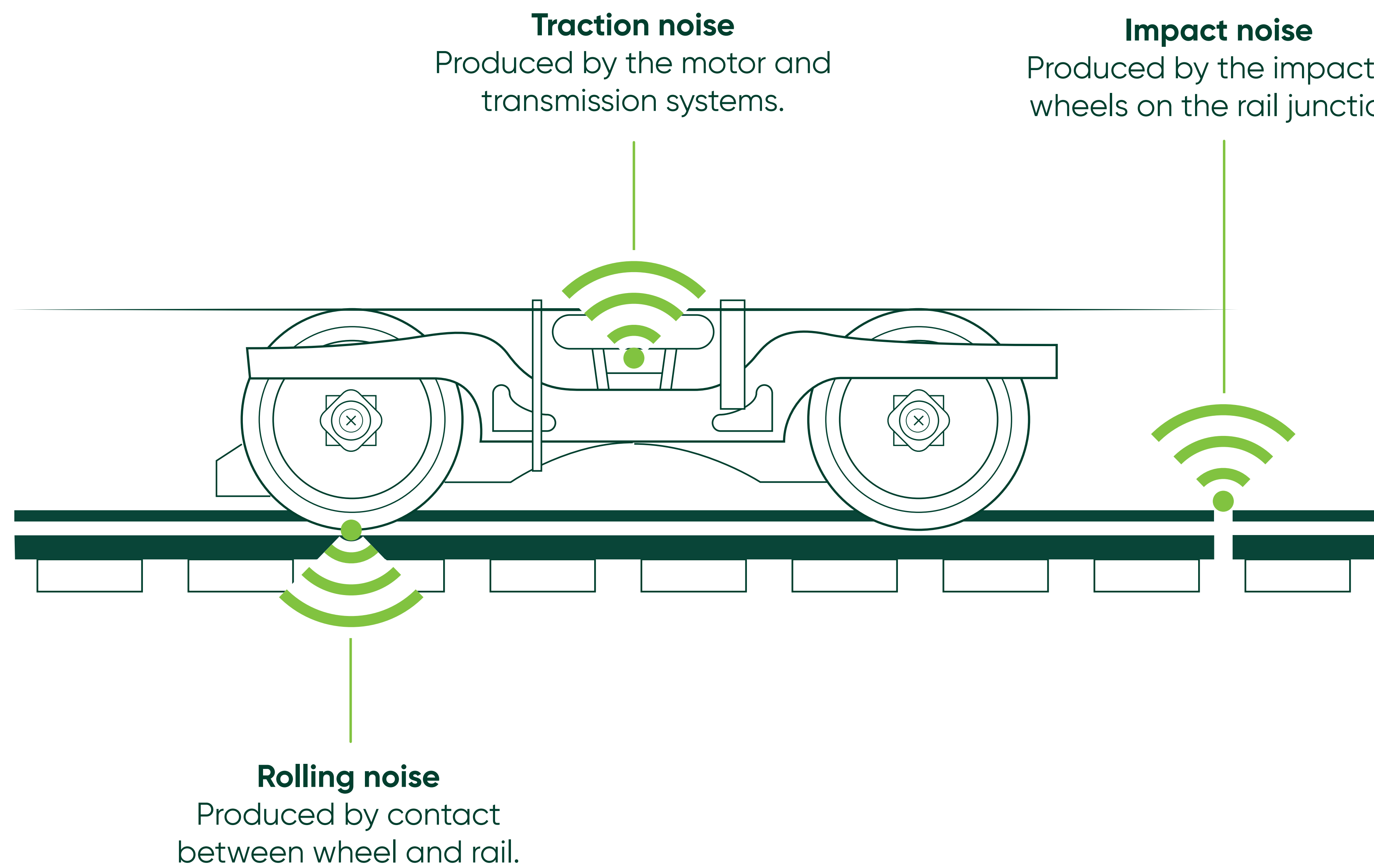
**Weather conditions**  
(snow, rain)

Absorption

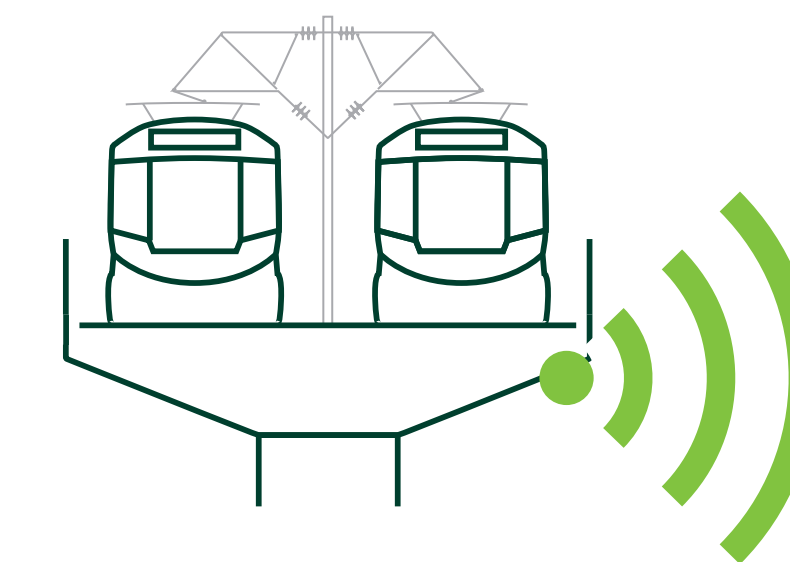
# Sources of noise



Railway noise is made up of different types of noise, such as:



**Squealing noise**  
Produced by passing cars on curves.



**Rumbling noise**  
Characterized by low frequencies (low noise), produced by the spread of vibrations through a structure.



**Auxiliary noise**  
Station noise produced by ventilation and heating systems.



# Mitigation measures

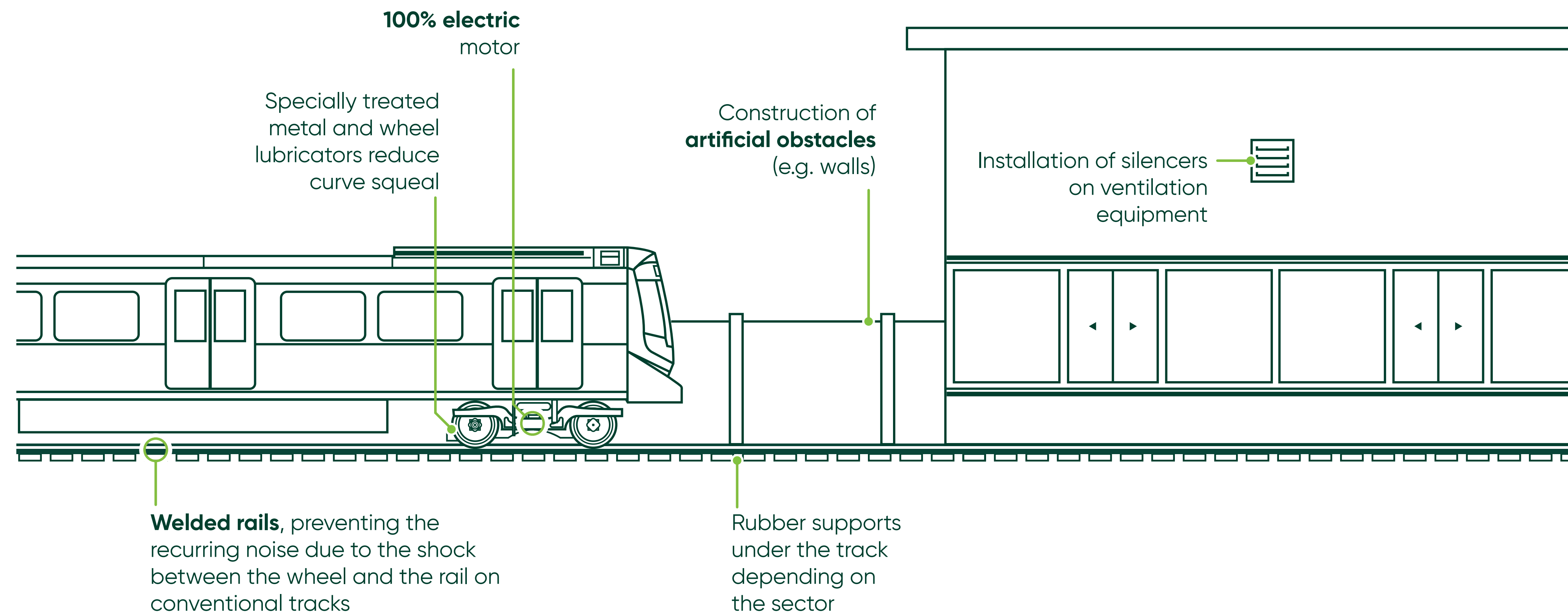


## At-source measures

**The cars** have features that help reduce the noise caused by their circulation.

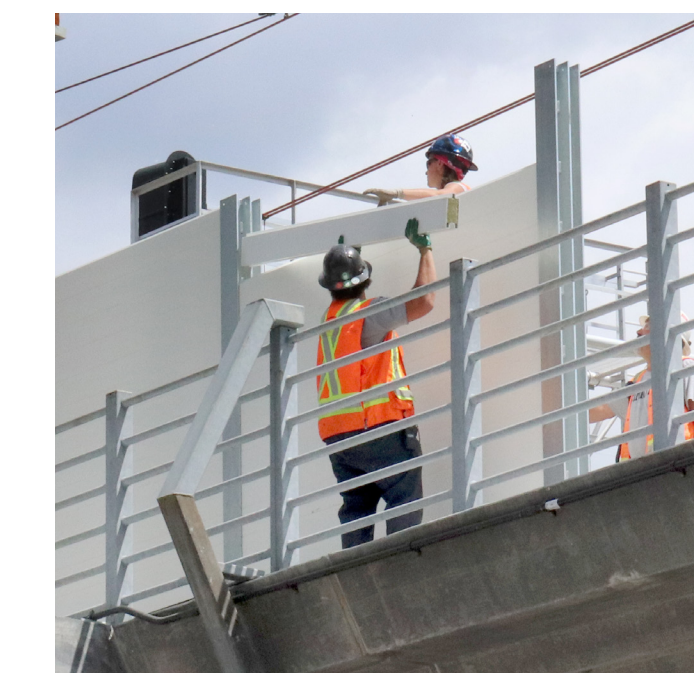
**The tracks** have been designed to avoid certain noises generated by contact between the rails and car wheels.

**The stations'** design incorporates mitigation measures (choice of equipment, installation of silencers, etc.).



## Complementary measures

Additional precautions are taken to reduce the impact of noise generated by the REM. They are adapted to the characteristics of each sector.



### Noise barriers

Panels containing acoustic insulation to absorb sound.

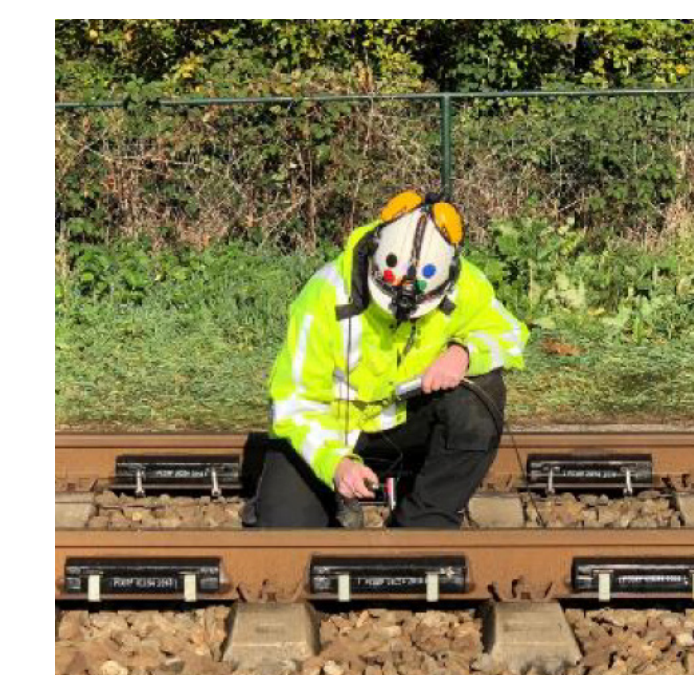


Image: Poly Corp

### Dynamic absorbers

Devices for damping vibrations transmitted to rails and structures.



Image: Vossloh

### Track and rolling stock maintenance program

Track grinding and wheel reprofiling operations to reduce friction.



# Installation of noise barriers



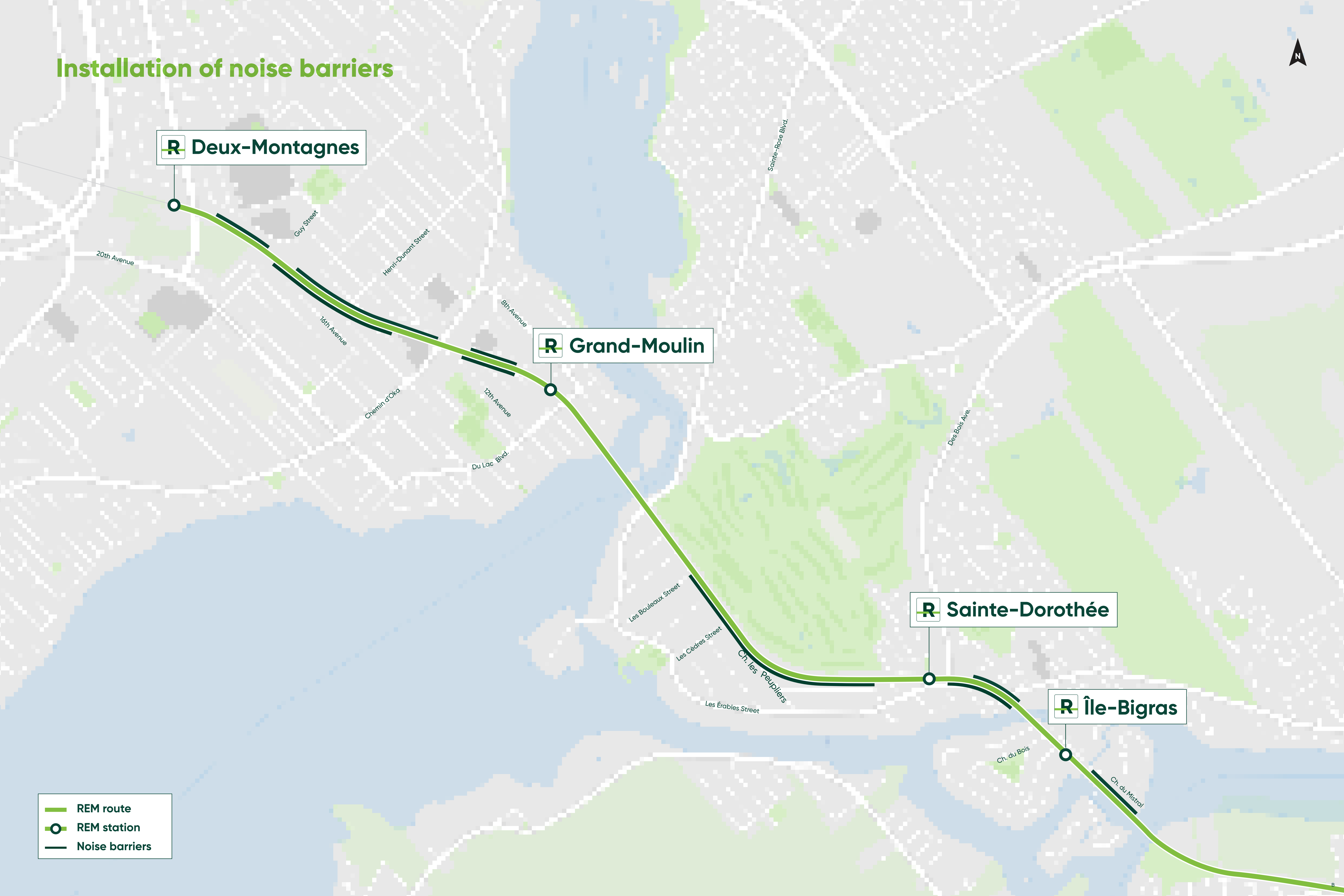
**R** Deux-Montagnes

**R** Grand-Moulin

**R** Sainte-Dorothée

**R** Île-Bigras

- REM route
- REM station
- Noise barriers

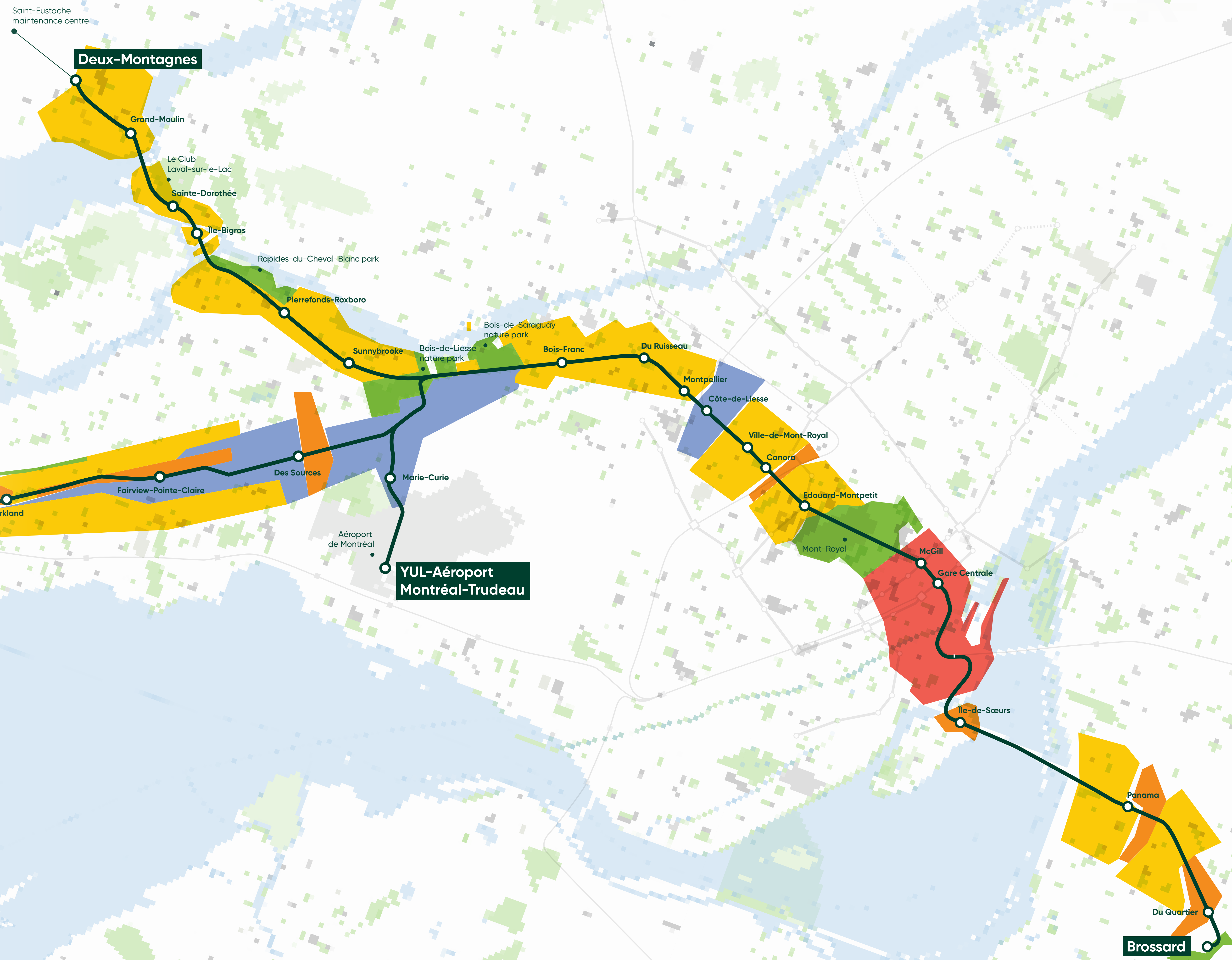




# Characteristics of zones the REM travels through

The characteristics of each sector were taken into account in the modelling and selection of mitigation measures.

- Mainly residential
- Industrial
- Diversified activities
- Agglomeration downtown
- Natural environment





# Current status



## Circulation of first cars

Early 2024

Two trips between Saint-Eustache maintenance centre and Sainte-Dorothée station.

First real data collected for the Deux-Montagnes and Laval sector.

## Start of dynamic testing

Mid-June 2024

Additional real data collection in these sectors.

Increased frequency of REM car circulation to test all systems, up to simulating the REM in operation.

## What about the rest of the network?

What's next

These car circulation and dynamic tests will gradually be carried out for the other sectors.

The noise analyses carried out in Deux-Montagnes and Laval will provide sufficient information for comparison with the modelling results of the other sectors.





# Phases of dynamic testing



## 1. Start of dynamic testing between Saint-Eustache and Sainte-Dorothée

These tests will be used to test all components and systems

- ✓ cars and stations
- ✓ electrical substations
- ✓ screen doors
- ✓ and everything that powers the REM

## 2. Gradual extension of test area

The dynamic tests will have to be repeated for the other segments of the Deux-Montagnes and Anse-à-l'Orme branches.

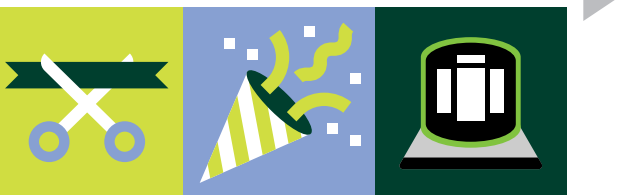
## 3. Connection of all segments

Integration of segments in test phase with South Shore branch

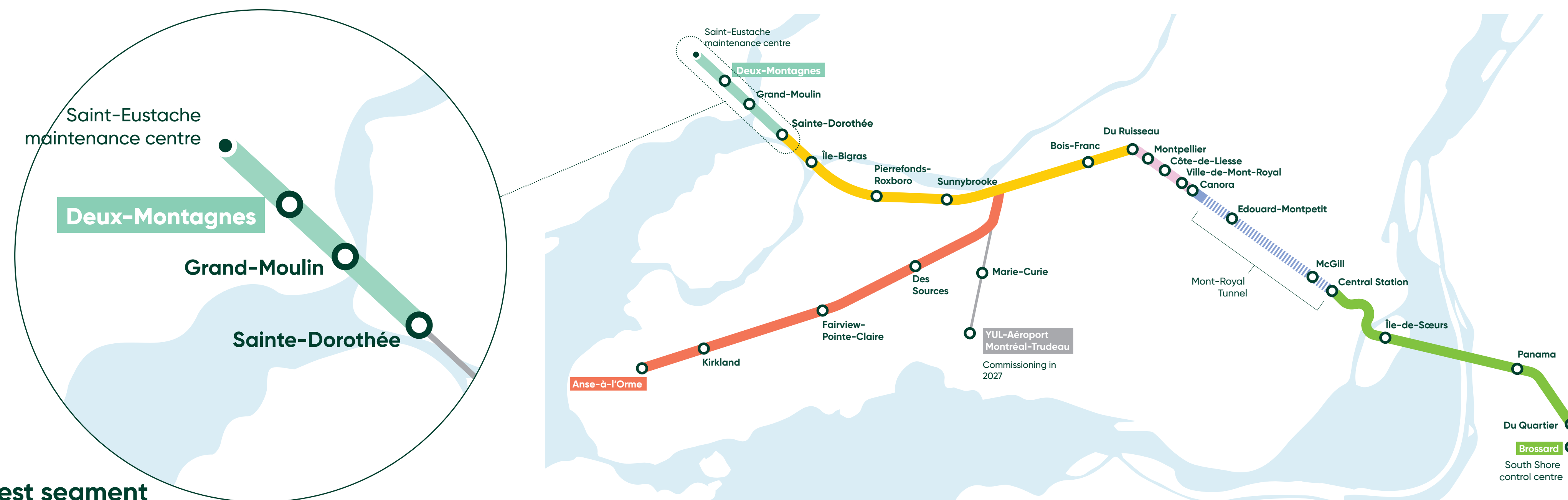
## 4. Test runs

Cars simulate regular service without passengers

## 5. Commissioning



✓ Meeting reliability and safety criteria



### Test segments

- Saint-Eustache / Sainte-Dorothée
- Sainte-Dorothée / Du Ruisseau
- Anse-à-l'Orme
- Du Ruisseau / Canora
- Canora / Central Station

The order of the test segments is for information purposes only

### Segment in service

- Central Station / Brossard

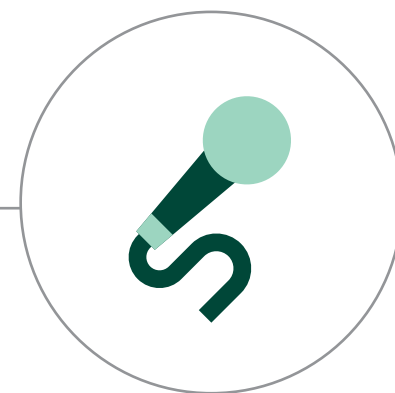
First dynamic test segment



# A supervised approach

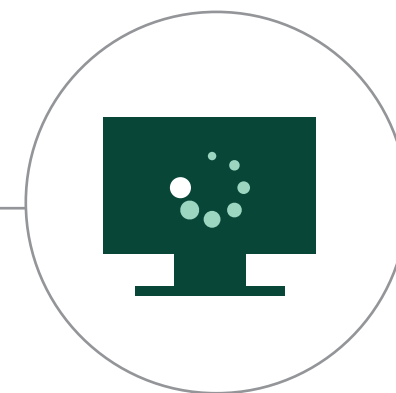


## Regulatory framework set by the Québec government



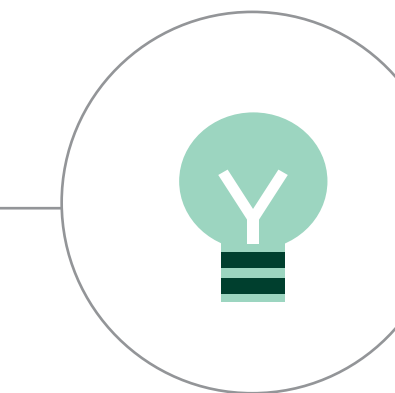
### Pre-REM sound analysis

Measurement of environmental noise levels without the REM.



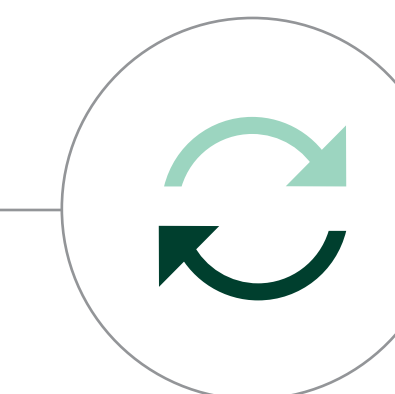
### Sound modelling

Environmental noise level prediction with the REM.



### Mitigation measures

The regulatory framework requires the addition of mitigation measures when the impact is moderate or high, to reduce it to low or zero.



### Sound level monitoring

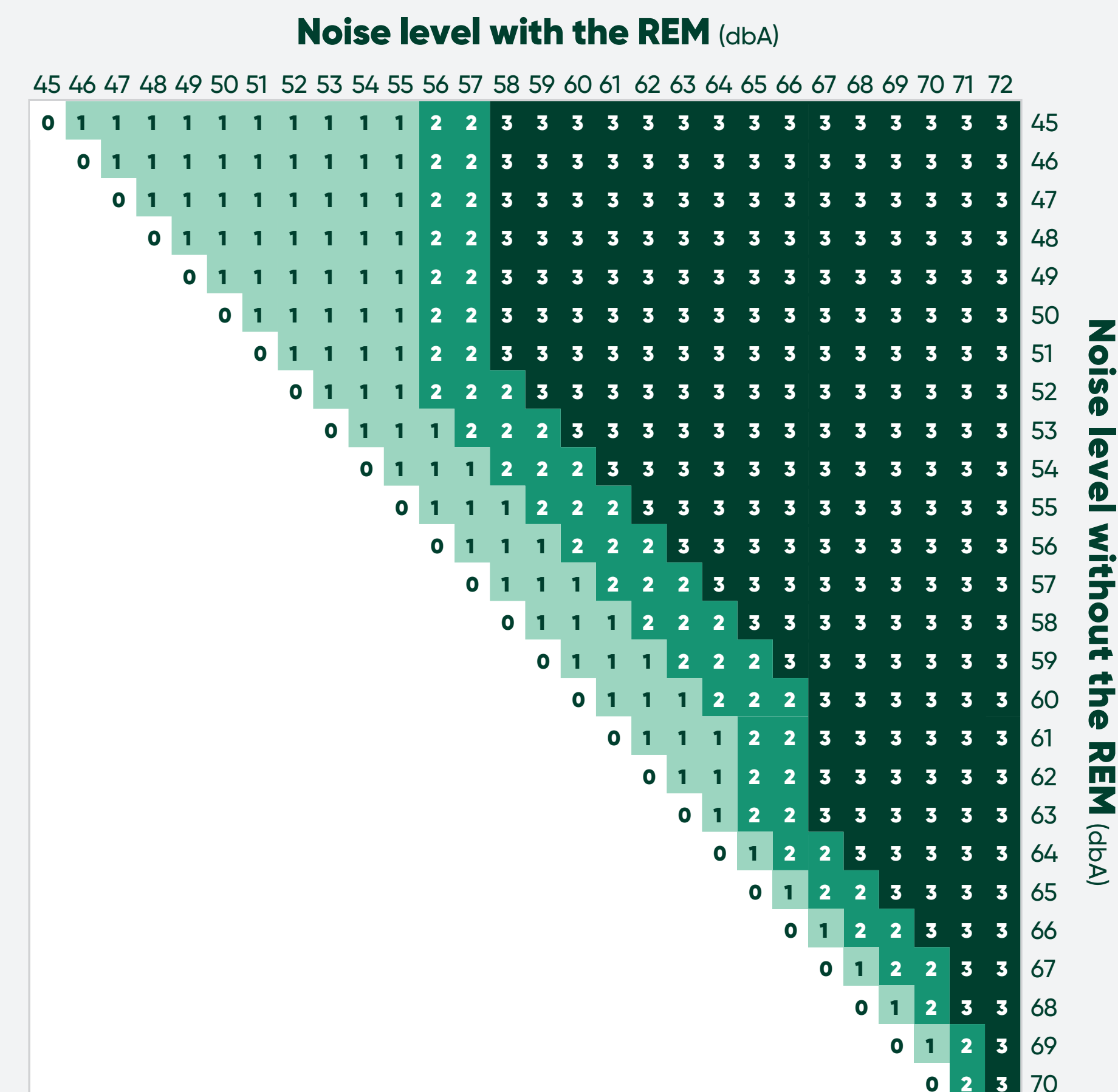
Sound monitoring must be carried out regularly once the REM is commissioned, to ensure that its impact remains low or zero.

### Noise impact matrix

Comparing before-and-after measurements on the noise impact matrix gives an indication of the impact level.

#### Impact level

- 0 No impact
- 1 Low impact
- 2 Moderate impact
- 3 Strong impact





# From theory to practice

