

Sound Design Guide

Part 1: Streets

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Who is this guide for?

You are a professional of the built environment, perhaps working for a city or regional government, non-profit, or consultancy, from decision-maker to technician, and you are ready to be more sound- and noise-aware.

This guide offers you tested guidance to bolster your street (re)design work that takes sound into account.

Whether you work in a transportation, planning, or design department, this guide has been structured to give you tools to improve your projects.

Why this guide?

Sound presents many opportunities to improve urban projects. If you are interested in using those opportunities, there are not many places to get started.

This guide attempts to offer some pathways for thinking through the sound components to strengthen your project. We aim to be more descriptive than prescriptive or exhaustive, but please remember that there is no universal solution.

How to use this guide?

You probably already know what your design will include.

This guide can help you identify and tackle the sound aspects of your design choices to strengthen your project and to improve your communication with stakeholders on tricky technical issues.

SOUND DESIGN PRINCIPLES

Ten sound design principles

Noise is a **major pollutant** of our time. This is why cities focus on reducing noise levels. But **sound is more than just noise!**

Considering sound can make our cities healthier and more enjoyable. How to do that in practice? Here are a few principles to get started¹.

SOUND DESIGN PRINCIPLES

Sound is more than just noise

Depending on the context, some sounds can annoy or distract us, while others can help us orient ourselves, relax, and/or get energized. Sound is an environmental resource.

Sound does not exist in a vacuum

Sound exists in relation to other senses and as a part of broader systems. For example, the same traffic noise can be annoying or neutral depending on if you are in a green park or on a busy street.

Dialogue is essential

Building sound awareness is key. We all play an active part in shaping sound environments around us, we are not just affected by sounds. We often think about the noise of others, but our decisions also influence and affect others.



We all experience sound differently

Someone's personal, social, and cultural background will change how they make and experience sound.

Sound environments are linked with environmental (in)justice

Vulnerable groups are more exposed to noise. We don't all have the same access to sound environments of 'high quality'.

Sound levels capture only part of the story

Noise exposure can affect our health and most of the time, we don't even realize it. But it is not just about how



loud it is, other properties affect perception: temporal evolution, spectral content, the meaning attributed to sounds and who makes them. 55dB of your favorite music doesn't feel the same as 55dB of traffic or construction.

Sound reflects life

Quiet is not always a good goal, as sounds can animate spaces. Sound is the heartbeat of the city. Can you imagine a festival or bustling street without sound? A morning walk in the park without birds?

Sound environments are dynamic

Sound environments change over time, space, and use and user. Consider the sounds around you at different times of the day, in different seasons, in different locations.

Sound environments support or hinder what people do and feel

What do you do when you can't hear the person you are talking to in a restaurant because it is too loud? Conversely, do you feel energized at a concert or relaxed when you walk along a waterfront?

Sound contributes to a sense of place

Think about important sounds valued by your community (e.g., street vendors, cow bells). Sound can help reinforce the identity of, and attachment to, a place.

A visual illustration: Sound outcomes of a street redesign

This section of our guide offers an illustrative example of a contemporary street redesign that a transportation planner might encounter. The purpose is not to prescribe the “right” way to design a street, but instead to show how a sound expert might break down the sound component of the environment and approach creating their own recommendations.

This example illustrates how a street redesign sets off a complex process, with a mix of changes that can present surprising and emergent challenges. Most importantly, an intervention cannot really be thought of as simply inducing “more noise” or “less noise” – new sound conditions present new design, engineering, and social challenges that may require more planning to fully address.

Two-way main street

Existing

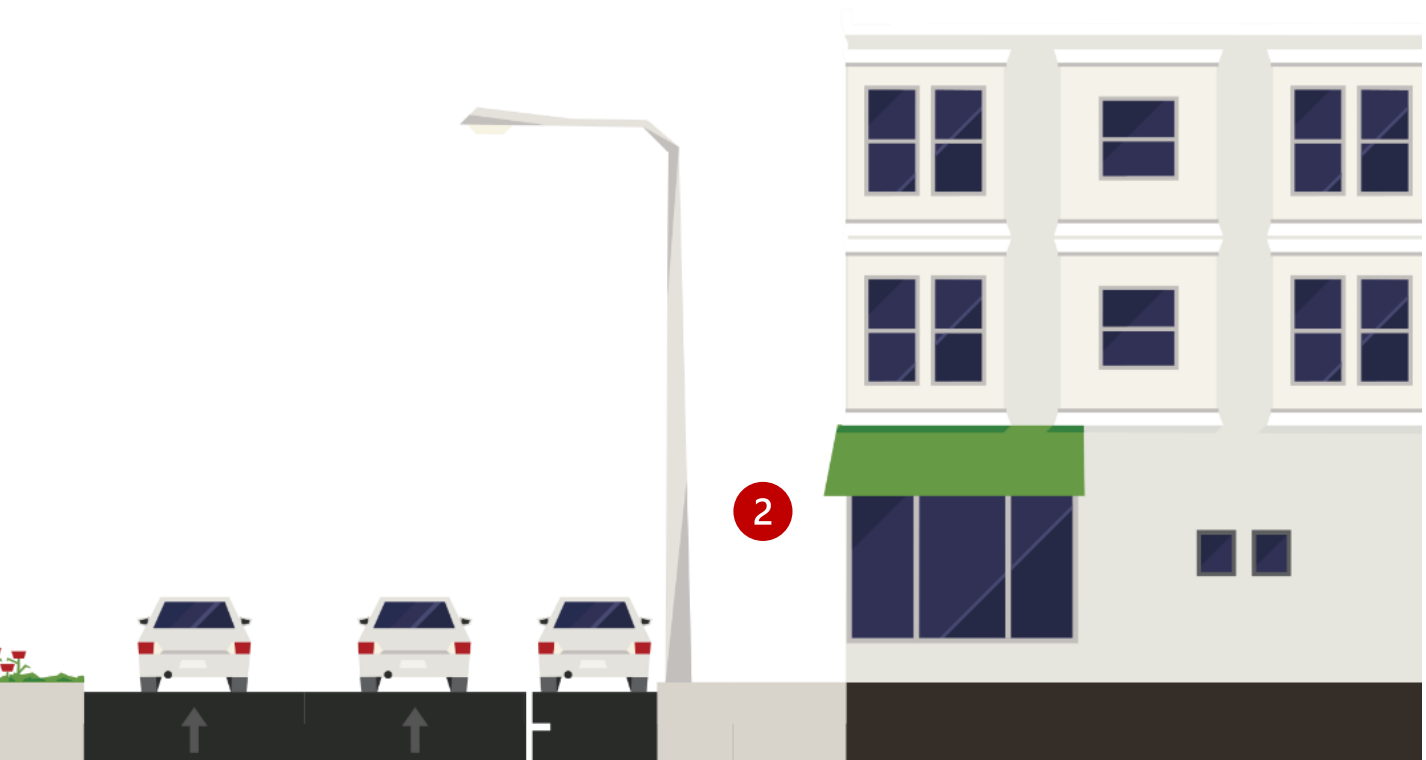


① A typical major two-way street like the one depicted here is often designed for peak traffic. You know that wide traffic lanes result in high speeds and feel dangerous to active users (e.g., pedestrians, cyclists). You should also know that noise levels increase “exponentially” with speed (more exactly, it doubles for every 10-12 km/h^{2,3}).

As you know, undelineated lane usage causes conflicts between different types of uses (e.g., delivery vehicles, bicycles). Conflicts often play out as additional congestion^a and therefore noisier conditions, especially for people on the sidewalks and inside overlooking buildings on all floors with street-facing windows.

② Small sidewalks and lack of greenery mean that active users and building users on floors with street-facing windows are more exposed to traffic. High noise at façades affects the health, well-being, and quality of life for the people inside, from sleep and work disturbance to not being able to open windows in the heat. When traffic noise is the dominant sound source, it likely is also masking the sounds of the life of the street. Pedestrians may also avoid walking along a noisy street as much as possible, which can affect businesses: When 60% of a customer base comes from pedestrian traffic⁴, a noisy street can lead to lower foot traffic and therefore fewer customers.

^a We will be using “congestion” as a shorthand for conditions leading to noise-producing behaviors, such as honking, revving, etc.



Redesign



The above street redesign is an example of contemporary interventions for reallocating road space from undefined traffic to other more well-defined uses (e.g., public transit, cycling, pedestrian). Such a design may be achieved by, for example, focusing on increasing safety for these other users, but it will also have an influence on the sound environment. The following is a description of this additional sound layer as an opportunity to strengthen a project's selling points.

- ① Removing car lanes will reduce traffic noise at peak times. Some stakeholders may fear it will increase traffic (noise) in surrounding streets or during the rest of the day in that street, but it is unlikely⁵ when planned well (e.g., traffic analysis, network analysis).
- ② Dedicating lanes to buses decreases conflicts with the rest of vehicle traffic, reducing congestion. In general, strengthening the public transit network, as it leads to reduced car traffic and

increased active user safety and presence, reduces traffic noise and increases human sounds (e.g., footsteps, voices, music).

Design challenge

Because traffic noise is so dominant in many streets, it masks other sounds, both ones you want to promote and others that might reveal or create other issues. For example, reducing traffic noise may reveal the ventilation system noise of local shops and institutions⁶. Consider working with your small business team to identify ways and funding programs to relocate or update noisy equipment.

- ③ Parking-buffered bike lanes, by distancing cyclists from fast moving traffic and creating a pedestrian safety island, reduce stress for cyclists and pedestrians because they do not have to attend to the noise of passing cars. Typically, the noise of a passing car informs a cyclist or a pedestrian that they



need to pay attention to a specific danger signal. When they are protected by a parking lane and a median, they feel safer and are more likely to engage in active mobility. By strengthening the cycling and pedestrian networks, buffered bike lanes encourage human activity, bringing human sounds into the space.

④ Usually, contemporary street redesigns will also try to widen sidewalks as much as possible. In addition to increasing safety and comfort for pedestrians, it will distance traffic from pedestrians and façades. Bike lanes and bus lanes on the side also contribute to the latter. The slower traffic and the larger distance compound into a double benefit on noise exposure for people on the sidewalks and in the buildings, encouraging public space use. The health, well-being, and quality of life of building users on all floors will also be improved, from better sleep to lower cardiovascular health risks⁷.

⑤ Planting strips wherever buffers are needed create opportunities for increasing both the visual and auditory pleasantness of the space with greenery. Greenery can contribute to scattering noise, and even participate in slowing down traffic (e.g., trees serving as distance markers and narrowing the perceived width of the street).

Design challenge

As you know, any redesign will involve **construction noise**, possibly for years. It will inevitably raise issues but proper communication with the impacted citizens, careful planning to limit conflicts (e.g., scheduling), and technical solutions to reduce machinery noise (e.g., broadband backup alarms) can mitigate some of the problem⁸.

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You have seen how a single street intervention can involve the use of multiple sound planning and design tools. Here is a more complete toolbox to help you think like a sound expert. We start with the physical, like sound sources and how sound travels, and go toward the perceptual and social experience of listening. As much as possible, beyond our descriptions, we provide you with tools and methods you can use on your own, and our favorite resources for you to be able to dig deeper.

The main body text for each category gives you the background to understand the sound aspects. The yellow boxes offer a stepping stone to think about! The blue boxes focus on tools and methods! Text in gold links to a further category with more information!

Sound sources

Traffic management

Contemporary street redesign interventions usually manage traffic by focusing on one or both of these outcomes: slowing traffic down, and reducing the volume of private vehicles.

Slowing traffic down can reduce traffic noise in a few ways, but with a little bit of nuance. Different vehicle types have different sound-making patterns at different speeds (e.g., cars, trucks), drivers change their behaviour (e.g., cruising, accelerating, revving, or slow and steady v. impulsive and inattentive). Vehicle flow (e.g., steady, intermittent), pavement type (e.g., quiet pavement), or weather (e.g., dry, wet, snowy)^{9,10} also affect the overall road sound in complex ways. For example, the sound of tyres on pavement is the dominant noise source when a passenger car is traveling at 40 km/h or higher (50-60 km/h for trucks)⁹.

Quiet pavement is a road surfacing asphalt designed to reduce tyre-pavement noise. Installing it on roads with lower speed would have a limited influence. Save your investment in quiet pavements for high-speed roads and aim to reduce traffic volumes on low-speed roads instead.

Additionally, when **vehicle volumes are reduced**, traffic noise may also be reduced, but not in all conditions.

Reducing traffic noise will improve the **health and well-being** of people in buildings (on all floors with street-facing windows) and on the sidewalk. It also contributes to creating a **more accessible** public environment for older people, people with disabilities, etc.

Noise levels are not linear, half as many cars does not create half the noise, but rather a maximum 3-decibel (dB) decrease (along a logarithmic scale). However, there is a tricky balance: if traffic volumes are low, more cars can be **heard from further away**. Can you implement simultaneous protection methods to get the most out of your traffic reduction? (Ask an acoustician)

Public transit

Public transit vehicles, just like all other vehicles, contribute to traffic noise.

However, there are two key ways that the sounds of public transport improve the noise situation: well-run buses and trains can greatly change (and reduce) traffic patterns; also, the sound of public buses is not **perceived** as annoying as those of private cars¹¹, especially as bus fleets around the world are rapidly electrifying.

Chicane in
Česká Třebová
(Czech Republic)

Reducing traffic noise will improve the health and well-being of people in buildings and on the sidewalk, and contribute to creating a more accessible public environment.





Bus rapid transit corridor in Montreal (Canada)

Are you planning a safe and comfortable space for people to wait for their bus? Investing in your public transit links will produce a virtuous cycle of lower and more predictable noise patterns for a healthier population and more accessible public spaces.

People waiting at, and walking to, transit stops will make sounds, such as footsteps and conversation. Are you planning a safe and comfortable space for people to wait for their bus? Think about people with disabilities, older people, women, who may have distinct needs (e.g., safety, lower background sounds levels to hear messaging and to navigate the sound environment). Conversely, consider the implications of the human presence this involves? Think about the potential for **liveliness during the day or disruption at night**.

Investing in your public transit links, besides the other benefits you are already aware of, produces a virtuous cycle of lower and more predictable noise patterns for a healthier population with the benefit of more **accessible** public spaces for people with sensory disabilities and those who are aging.

Truck noise

Delivery

Interventions that facilitate delivery may participate in reducing noisy and polluting behaviours such as double-parking, idling, and revving, reducing noise exposure for both active users and residents.

There is no universally right solution and you will know best what interventions you can implement. But these interventions

need to be carefully designed and enforced to avoid increased noise exposure. For example, a delivery truck engine may **reverberate more** in a narrow back alley than in a wide street and expose residents and active users using the alley.

Interventions may include carefully planned loading zones, scheduling delivery hours, enforcing idling bans, piloting projects with other agencies and stakeholders to reduce delivery truck traffic (e.g., electric engines, bike deliveries).

Trucking

Other types of truck use and their associated noise should also be taken into consideration. For example, road maintenance for streets with a high throughput of trucks is essential to mitigate highly disruptive truck noise such as truck beds clanking and tyres slamming over potholes, creating vibrations that can be felt inside buildings¹².

People in communities impacted by heavy trucking may feel like their needs are underconsidered and underrepresented by their local government. How can you engage them in a meaningful manner? Think about the engagement exhaustion they may be feeling after defending their needs for years.

Tactical urbanism project
by Better Block KC in
Kansas City (USA)

By designing a human-
friendly street, you create
a virtuous cycle.



Impact noise

Special attention need to be paid to design elements such as rumble strips¹³ or speed bumps¹⁴, and to road maintenance in general, as they will increase (e.g., tyres on cobblestones, truck beds over potholes) or reduce impact noise and vibrations (e.g., road maintenance, smooth pavers).

In an area with sensitive users where you need to slow vehicles, you can implement elements to encourage traffic calming (e.g., closer-spaced side markers like trees, narrower perceived road width) to reduce noise associated with speeding and driving behaviours like braking before and accelerating after speed bumps¹⁵.

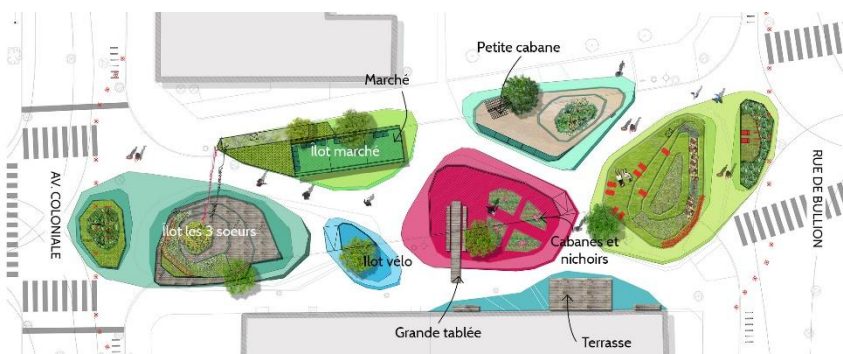
Human sounds

By designing a human-friendly street, you create a virtuous cycle: human-scale urban spaces bring human sounds of

different types that animate the environment (voices, footsteps, music) and increase **accessibility** for people with different needs.

The presence of human sounds is usually associated with happy, healthy public spaces. Think of the quiet comfort of the sound of pages being turned, the pitter-patter of children running in a street, the joyful liveliness of people sharing a meal on a sunny terrasse, or the homey ambiance of a block party.

You can even create spaces that let these outcomes cohabitate by designing it to protect quiet uses in the calm parts and to support lively uses in parts more exposed to the sounds of urban activity. Many urban design and planning interventions can contribute to this: from increasing the safety of active mobility networks to event programming.



Temporary street closure by
Castor et Pollux in Montreal
(Canada)

You can create spaces that let quiet and lively uses cohabitate by designing it to protect quiet uses in the calm parts and to support lively uses in parts more exposed to the sounds of urban activity.



The temporary street closure by Castor et Pollux in Montreal offers a gradient of activities from most protected to most exposed to the main thoroughfare (not visible at the back): from most quiet (reading, front of top photo) or vulnerable to noise (children sandbox, blue box on the right), to most lively and noisy (market, back of the bottom photo), with convivial tables in-between (red space on the left).



Pedestrian street in
Mérida (Spain)

Human-scale urban spaces bring human sounds that animate the environment and increase accessibility for people with different needs.



Whether human sounds have a positive effect on the environment will depend on many factors such as time of day, type of street and building uses, type of human activity, etc. For example, lively crowds animate a space at peak hour but can be disruptive at night¹⁶.

The pedestrianization of a street might drastically reduce the background noise of a space – but might it be too quiet to sustain life? Engage your colleagues of the small business department to explore solutions to attract space users on commercial streets, such as installing terrasses or parklets. Consider the possibilities offered by **sound art** and music to activate the space and **draw attention away** from negative sound sources like construction^{17,18}.

Natural sounds

Water sounds

Flowing water produces sound that most people have positive associations with. Water has lots of potential: it can **mask** the sounds of traffic noise and other unwanted sources, provide a sense of public privacy, and draw people together around a landmark.

It is important to tailor a solution to the space. For example, big fountains can reach sound levels as high as traffic noise¹⁹ and might not be recommended for smaller public spaces.

The meaning of a sound matters. A river can sound like mechanical equipment, and yet knowing it is a river makes it enjoyable²⁰.



Bike boulevard
in Vancouver (Canada)

Many urban design and planning interventions can contribute to the presence of human sounds: from increasing the safety of active mobility networks to event programming.

Tree-lined street
in Bronte (Australia)

People tend to have an affinity for natural sounds of many types. Hearing natural sounds sends space users a signal that they may be somewhere they can relax or rest.



Biodiversity

Designing a wildlife-friendly city, by increasing green infrastructure, corridors, and native plant species, has many benefits for residents: reducing heat islands, improving air quality, managing stormwater runoffs, and improving mental and physical health. But people also tend to have an affinity for the sounds associated with natural spaces. Hearing natural sounds sends space users a signal that they may be somewhere they can relax or rest.

The main natural sounds that people may think of when we talk about natural sounds will be the wind in the leaves of trees and greenery and the cries and songs of different birds depending on location (e.g., sparrow, pigeons, seagulls). But you can also think about other types of natural sounds that you may want to foster, like that of other less well-known animals. Perhaps, cicada songs are a marker of summer in your part of the world. Or you want to bolster your populations of pollinators. Or your city is a prime spot for amphibians or reptiles.

Natural spaces are not naturally very quiet (think of a rainforest!). Hearing natural sources in urban spaces, even over a layer of traffic noise, can bring in some of

the relaxing and restful benefits of natural spaces.

Roads around and through large urban parks make noise that can be particularly detrimental to the species living there and to the users trying to enjoy the space. “Road diets” on streets surrounding parks can protect and enhance a significant public asset.

Lower sound levels also promote higher biodiversity and can lead ecologically-concerned constituents to support your project.

When sounds interact

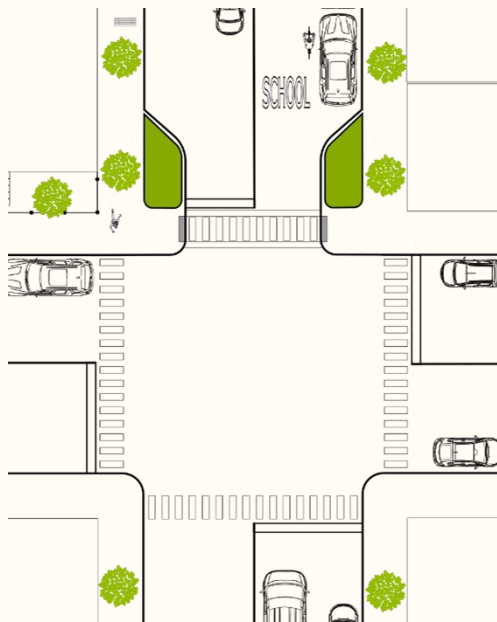
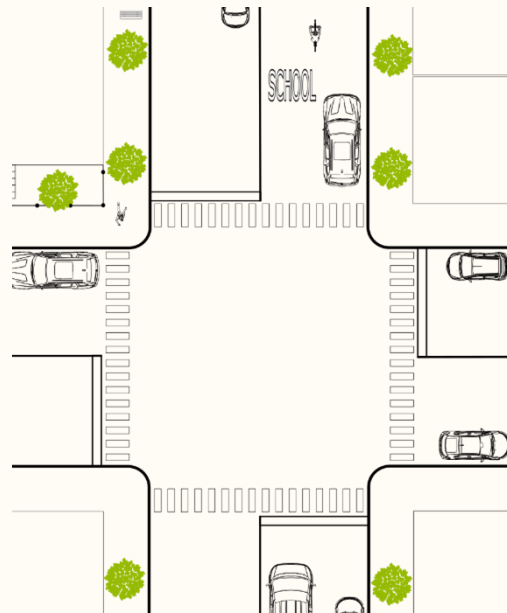
Masking

When many sounds are present, we tend to only be able to hear the loudest and most salient ones, either because they grab our attention the most or because our ears are not capable of detecting the quieter sounds. Traffic noise, usually loud and salient, will mask many of the other sounds in an environment, wanted and unwanted. For example, during the COVID lockdowns, when car traffic was highly reduced, many people were surprised to hear ventilation noise in city centres and animals in their neighbourhoods⁶.

Example: school street

Existing

A two-way street in a mixed-use neighborhood alongside a school. The undifferentiated roadway with shared use and unmarked parking lanes allows to speed and feels unsafe for active users. This leads to higher traffic noise, including accelerating and breaking noise, as well as limited human sounds.



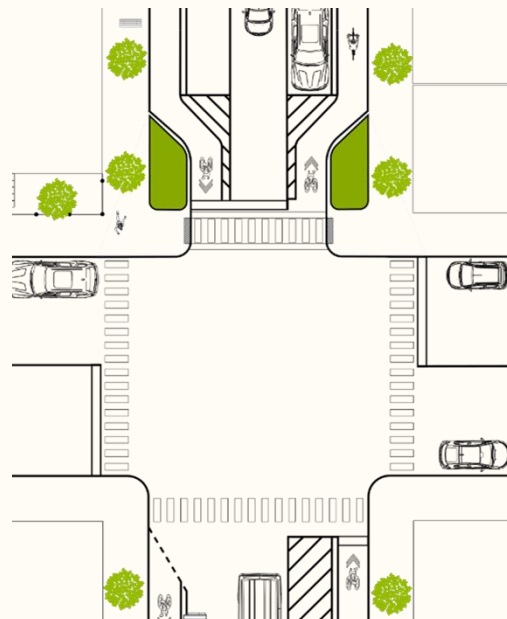
Curb extension and raised crosswalk

The narrower roadway at the intersection slows down traffic through both increasing the need for precision driving and reducing the perceived width of the street. The raised crosswalk additionally slows down traffic and prioritizes active users. The curb extensions also offer opportunities to foster biodiversity through planting native species.

These interventions combine to reduce traffic noise (revving, accelerating, braking) and encourage human and natural sounds like those of school children and pollinators.

One-way street with bike lanes

Taking away roadway space from cars by turning the street into a one-way street and creating bike lanes will further reduce traffic noise through reduced traffic and a narrower perceived width all along the street. It will also further increase the safety of active users, including pedestrians, and thus foster human sounds. A quieter street overall may also promote wildlife and their sounds.



While traffic noise is an unfortunate worldwide masking source, masking presents a rich design and planning opportunity. Sound art in the public space can mitigate some of the unpleasantness and annoyance of unwanted sounds like construction noise¹⁷.

Emergence

In opposition to masking, emergent sounds are the ones you hear over the background noise. A motorcycle can be heard easily and from far away, even on a loud highway. Conversely, on a quiet street at night, a conversation that would be normal during the day might attract attention and be disruptive.

Noise levels cannot entirely represent the experience of users. For example, the sound of a few cars passing by from time to time in an otherwise empty street can be more disruptive than a steady stream of traffic as the noise of each individual car passing by will be more salient and emergent from the calm background²¹.

Built environment

Networks

When interventions are well thought through as a part of the neighbourhood and city networks, they are more likely to be successful in improving a street sound

environment. We can think of active and collective mobility networks and increasing human sounds, the traffic network and reducing traffic noise without spreading it in time or in space, or even the green network with biodiversity corridors supporting natural life and sounds.

It is especially important to think about when vulnerable uses (e.g., schools, daycares) can be impacted.

Encouragingly, research shows that conventional road diets have not generally exacerbated traffic congestion or spread traffic to surrounding streets⁵.

Good street design, including clear wayfinding, can reduce conflicts and associated noise-inducing behaviours (like honking).

Consider collaborating with other transportation agencies to implement changes that help limit conflicts. For example, reducing the length of boarding time for public transit by offering off-board ticketing²² could improve bus flow.

Distances

Distance is one natural way for sound to die out, and its effects can be drastic. Doubling the distance that pedestrians are walking from a passing car from 5 meters to 10 meters can reduce the traffic

Wide sidewalk
in Malmö (Sweden)

Distance is one natural way for sound to die out, and its effects can be drastic. When traffic lanes are removed and other uses are given more space, the increased distance from traffic noise can lead to drastic improvement of the public space.



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noise that pedestrians are exposed to by up to 6 dB (that is a 75% reduction in the best-case scenario!). Speak to an acoustician if you need to quantify these benefits.

When traffic lanes are removed and other uses are given more space (e.g., increasing the width of sidewalks, adding bike or bus lanes, adding parking or

Take care when activating underutilized spaces bordering noisy roads. Higher speed traffic noise (even at the sometimes recommended speed of 50 km/h) might discourage users of a parklet from using it²¹. Consider protecting the users with lower speeds, better barriers, or by programming the space for activities that are less noise sensitive (e.g., sport, artistic, or cultural activities).



Parklet in Vancouver (Canada)

Take care when activating underutilized spaces bordering noisy roads. Higher speed traffic noise might discourage users of a parklet from using it. Consider protecting the users with lower speeds, better barriers, or by programming the space for activities that are less noise sensitive.

vegetation), traffic noise is distanced from both sidewalk and façades, which can lead to drastic improvement of the public space.

Back-alley access for delivery or maintenance vehicles can be an attractive solution to distance truck noise from pedestrians. However, it should be carefully planned, taking into account **urban form**, to ensure people in the buildings are not more exposed through bringing trucks closer. It is also more likely for residents' bedrooms to be facing the alley, meaning early morning deliveries would be particularly harmful to their quality of life. These alleys might also be nice, quiet spaces because of buildings **shielding** them from the streets and truck noise early in the morning will be more **emergent** and disruptive.

Barriers

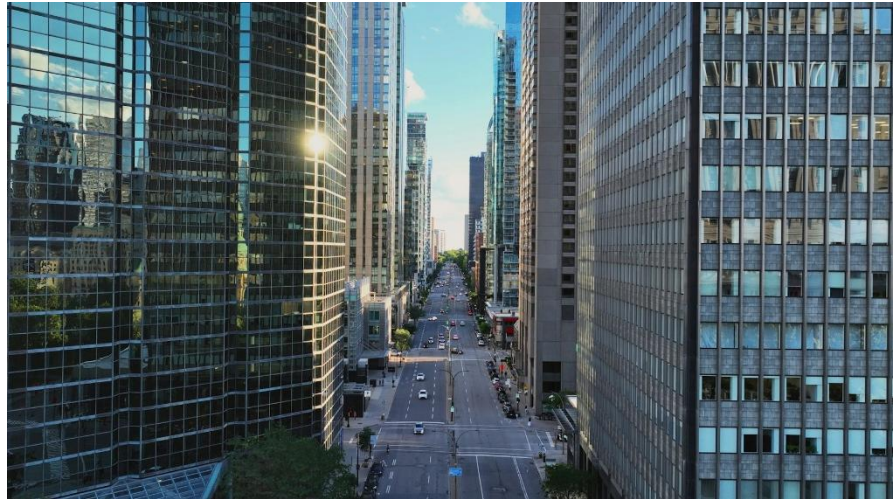
Noise barriers should be used sparingly and for well-defined purposes, as they, by definition, divide a space. If they are necessary, much guidance can be found with the relevant professionals.

Acoustic solutions are very efficient for very specific problems but are costly to install and maintain. For example, acoustic panelling, can be especially pertinent in reverberant spaces like underpasses. But a noise wall cannot block noise for building users above the second floor²³.

In some cases, even dense greenery grown on reflective walls can help reduce noise by dampening reverberations²⁴. Buildings themselves are a kind of protective barrier and can be used to shield courtyards, playgrounds, or vulnerable uses (e.g., an office building on

Street canyon in Montreal (Canada)

City streets lined with tall buildings can be thought of as canyons, where the noise gets trapped and bounce around. In these canyons, and without other interventions, noise increases with height and length of parallel buildings due to reverberation.



the side of a road can shield residential buildings deeper into the neighbourhood).

Building façades

It is important to think about the noise levels at building façades (on all floors with street-facing windows) because on the other side of these façades are all of the city's homes, workplaces, and third spaces. Some of the noise at a building's façade penetrates windows and walls to disturb everyone's sleep, daycare, work, or relaxation time.

The noises we are exposed to in our sleep **affect us** even if we can't tell. Passing cars and airplanes cause our heart rates and stress levels to spike while we are sleeping and disrupt our sleep quality, cutting years off our lives.

Street canyons

City streets lined with tall buildings can be thought of as canyons, where the noise gets trapped and bounces around. In these canyons, and without other interventions, noise increases with height and length of parallel buildings due to reverberation²⁵.

When there is a street canyon, try to fill it with "soft" materials, such as porous or natural surfaces and elements, from planted buffers to green walls. This will scatter the noise and limit reverberation.

Greenery

It is also often thought that a row of vegetation can be used as a noise barrier for traffic. The thickness and density of a vegetal barrier would need to be high (20-30 m densely grown^{26,27}) to audibly reduce traffic noise like a noise barrier. But any obstacle in the path of a sound wave will scatter some of it.

Greenery provides a triple benefit: it is a natural barrier, scattering noise; it attracts wildlife that make natural sounds; and it provides users with the perception that they are in a more natural space and the associated benefits²⁸.

Inclusive design

Inclusive design is a key consideration because a broad majority of public space users will experience needs along one or more of these lines at some point in their lives, and their public spaces should accommodate them.

Age

Noise-induced hearing loss is on the rise for all age populations, but affects the oldest and the youngest most²⁹. The non-auditory effects (e.g., stress, cardiovascular disease) are also debilitating, hindering our abilities to

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navigate and cope with daily life. Noisy cities are certainly a culprit in this rise.

Older people also tend to be more sensitive to noise³⁰, especially if they suffer from hearing loss. Young people, on the other hand, tend to be more vulnerable because they have not yet developed the coping skills and have less control over their environment to reduce their noise exposure.

Accessibility

Hearing disability

People with hearing disabilities can have trouble making sense of loud and complex sound environments. Their hearing loss also means that what we consider a normal sound level can hurt or bother them more, and that they are more stressed and fatigued by the effort it takes to listen in everyday life³¹.

For these reasons, they may feel unsafe and distressed outside and avoid going out into certain spaces or at certain times of the day. Their social life may even be impacted when their experience of going out in the city feels like a “going on a mission”³¹.

People with hearing loss may be using hearing aids, which improve audibility of quiet sounds by amplifying them.

However, hearing aids amplify all sounds and do not perform well in noisy environments. For example, wind noise can be over-amplified outside³¹. Hearing aids also do not fully restore the direction from which sounds are coming from. Design your space with the idea that some users have an even higher need for intelligible environments.

Visual disability

On the other hand, people with visual disabilities rely on their sense of hearing for essential navigation. It is especially important for them that informative sounds not be inaudible under dominant sounds like traffic noise.

Neurodivergence

Noisy environments have a particularly hard toll on some neurodivergent individuals, who may need access to low noise and low emergence environments at regular intervals. Providing a diversity of sound environments in public means that these users may feel more included, more comfortable, and more confident to go out in public.

Gender and other minorities

Our biology can influence how we perceive the sound environment. For example, women tend to be more

Noisy environments have a particularly hard toll on some neurodivergent individuals. Providing a diversity of sound environments in public means that these users may feel more included, more comfortable, and more confident to go out in public.



sensitive to noise than men, especially if they suffer from hearing loss³².

Beyond biological differences, people with different identities experience the city in different ways. Women tend to visit public spaces with others, so their experience of the space and of the environment tends to be more pleasant³³. Low income and racialized populations are more exposed to traffic noise in their neighbourhoods³⁴.

Big picture

(Public) health

Noise pollution is a major public health issue. It is considered by major institutions as the second most major pollution in cities after air pollution³⁵. Beyond direct hearing disabilities, chronic noise exposure leads to widespread sleep disturbances, stress, cardiovascular diseases.

Well-being and quality of life

Noise can also have less noticeable or pronounced but more widespread effects on annoyance, stress, and attention at work or school. Having quiet, accessible home environments is critical for people to destress from the accumulated noise of the day.

Perception and culture

We all connect to sounds through different personal meanings, memories, and experiences³³, and social values and norms³⁶. We all have needs, expectations, and desires concerning our daily environments, beyond health and well-being. They can even vary depending on the time of day or season.

For example, some residents of the Montreal entertainment district found the empty streets eerie and anxiety-inducing during the COVID pandemic⁶.

Talk to people! Go listen to the site! Ask the different people impacted by your project about their lived experience. Do you understand what residents, workers, commuters need, whether they are older or younger, abled or not, part of a minority or not?

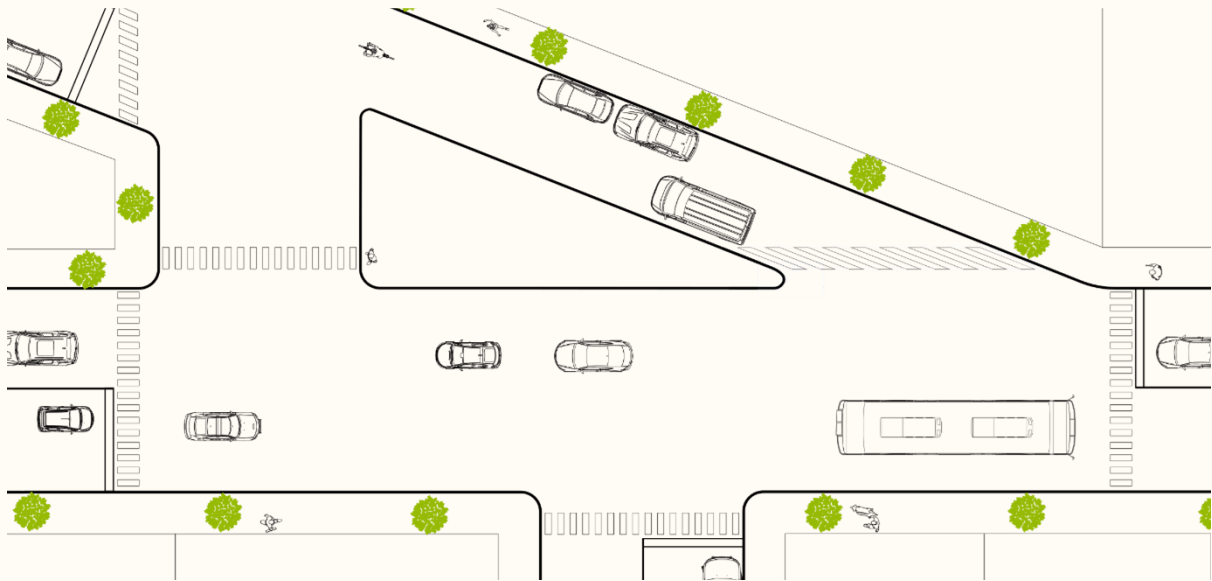
When you talk to residents and stakeholders, you can ask them what sounds or mixture of sounds they would like to hear more or less of as a result of your projects. Or you can explore with them the kind of ambiance and experience they would want from the space. Whatever approach you prefer for your project, there is no right or wrong answer! **Ask people** what they want!



Robin singing in the spring in Lincolnshire (United Kingdom)

We all connect to sounds through different personal meanings, memories, and experiences. Talk to people!

Example: public plaza

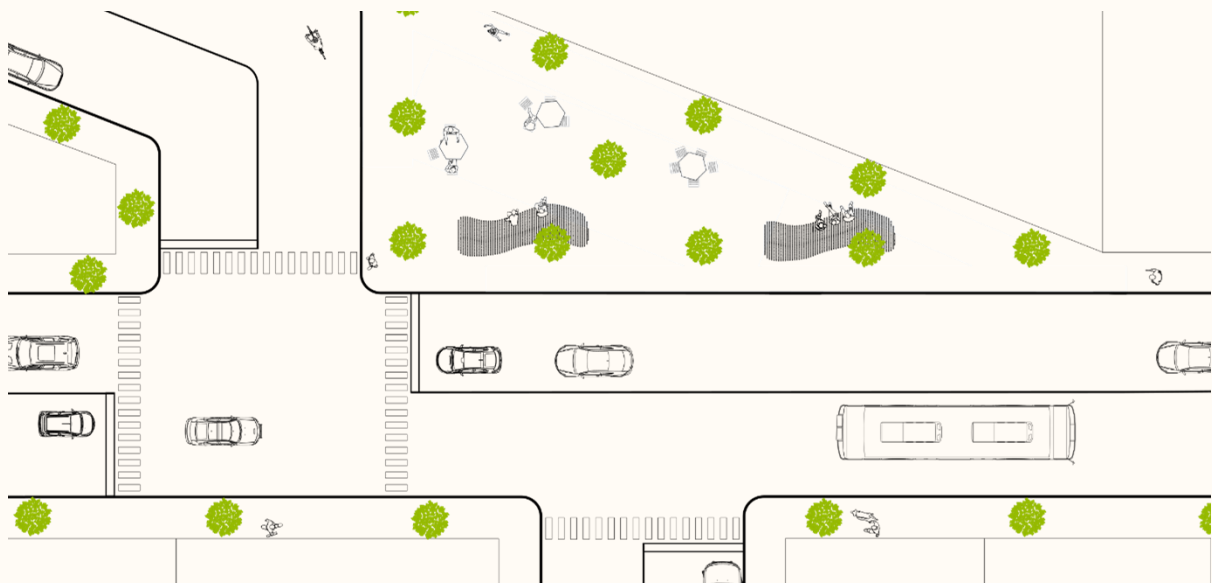


Existing

Complex intersections are confusing for all users and often prioritize car traffic and speed, increasing conflicts where active users are especially vulnerable to both noise and safety risks. Diagonal crosswalks and long pedestrian islands additionally increase crossing distance and noise exposure for pedestrians.

Intervention

Creating a public plaza by closing off one side of the intersection can simplify the interactions between all users and reduce conflict. It also distances that side from traffic, both for pedestrians and building users. You can also use furniture and amenities to mitigate the remaining traffic noise, through, for example, materials that absorb and scatter noise, furniture with high backs to shield people sitting and talking, greenery to foster biodiversity etc. Overall, these interventions will reduce traffic noise and increase human and natural sounds.



Soft strategies

Communication

We understand that many of the interventions discussed in this guide will require “buy-in” from constituents in order to succeed. Early involvement and co-design help to build support in the same ways that it works for other planning factors. **Research on what people want** can help get you to a great solution, but it will also need to be well-communicated.

Communication can cover multiple aspects. We have talked a lot about engaging with stakeholders to shape your projects throughout this guide. For example, Montreal's entertainment district, has put in place a partnership including the city, cultural and educational institutions, commercial stakeholders, and residents to promote both its economic development and its residents' needs³⁷

Communication can also look like informing the people who will be impacted, both by the construction itself and what nuisances it might mean, and by the finished intervention or (re)design. Informing people well about construction schedules, road detours, mitigation measures (noise and air quality), etc. might help alleviate fears from existing users³⁸ (e.g., residents). Communicating

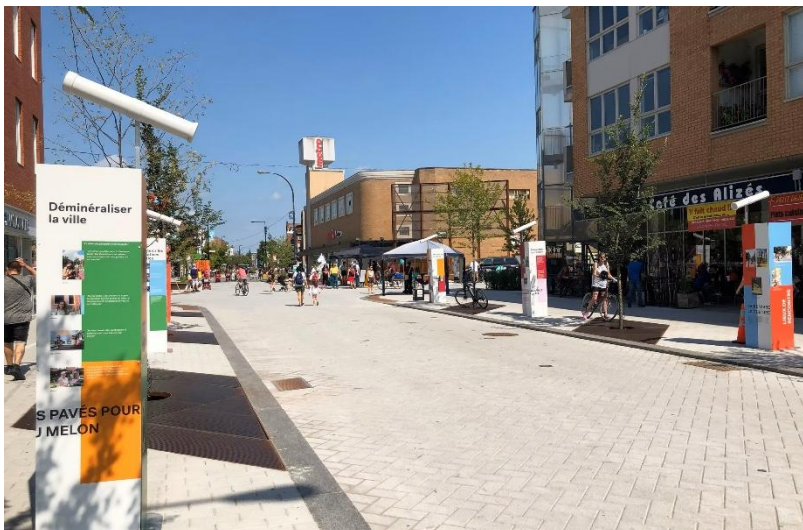
well about regulations like slower speeds or noise curfews can also help increase compliance (and reassure residents).

Communication can also matter post-implementation. Understanding how the sound environment of the space has changed and listening to people's experiences can help you both ensure that sound objectives have been attained and learn about the complexity of sound design to improve future projects. We share some ideas to get you started asking questions in the **appendix**.

Art and culture

A way to animate a street is through artistic and/or cultural installations that include a sound component. Some commercial streets play music through loudspeakers, but sound art can also be used in more subtle ways to promote different ambiances, even when space users do not realize sound art is playing¹⁷.

Get creative! Hire artists to help! There is no right or wrong solution here, as long as the installation fits the space. Is the neighbourhood recognized for a specific culture and history (e.g., Little Italy, Chinatown, indigenous), artistic practice (e.g., graffiti, music, cinema), economic activity (e.g., old industries, entertainment, seaport), or landmarks?



Sound art installation by the Audiotopie art collective and Le Comité design cooperative in Montreal (Canada)

Sound art can be used in subtle ways to promote different ambiances.

CLOSING EXERCISE

Waterfront revitalization

To put in practice the principles and tools you have now seen, we propose a redesign exercise based on a realistic case scenario of a waterfront revitalization.

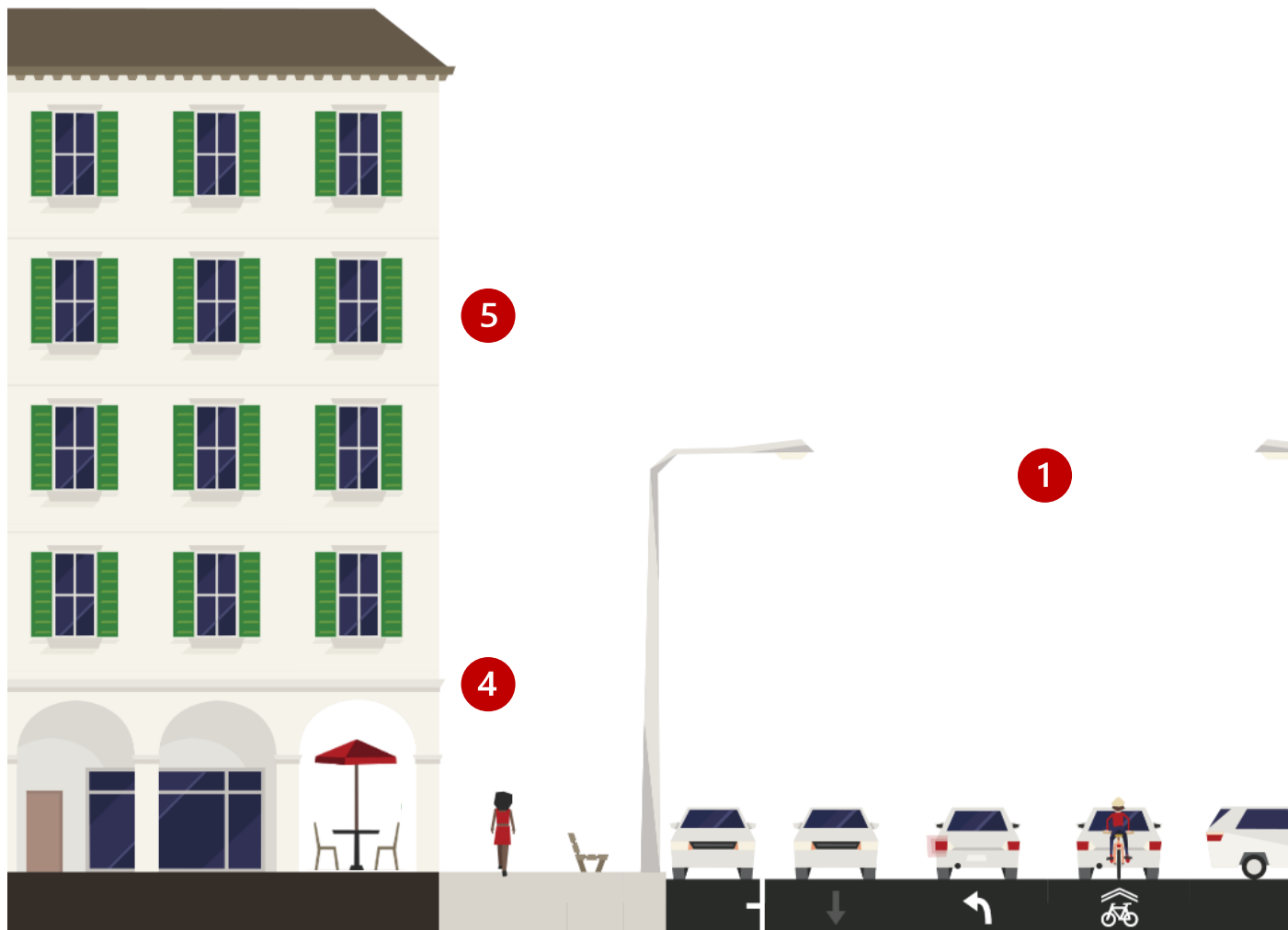
The next six pages are laid out in a centerfold design outlining three steps:

1. Analysis of the existing conditions
2. Lightly-guided design exercise to try out your own solutions and rationale
3. One possible redesign solution from us

The **project design brief** from our fictitious city states the following objectives:

- Promote commercial development while preserving livability
- Improve links to the waterfront
- Foster inclusive public space design and universal accessibility
- Promote active and collective mobility
- Reduce air and noise pollution in support of a low-emission zone policy

Existing



① Past planning choices in this neighbourhood have emphasized car access for touristic and commercial attractivity, as well as for through traffic. Wide traffic and parking lanes result in high noise for active users, workers, and residents. The shared roadway causes conflicts between different uses, often playing out with honking and other danger signals affecting people on the sidewalks and in overlooking buildings.

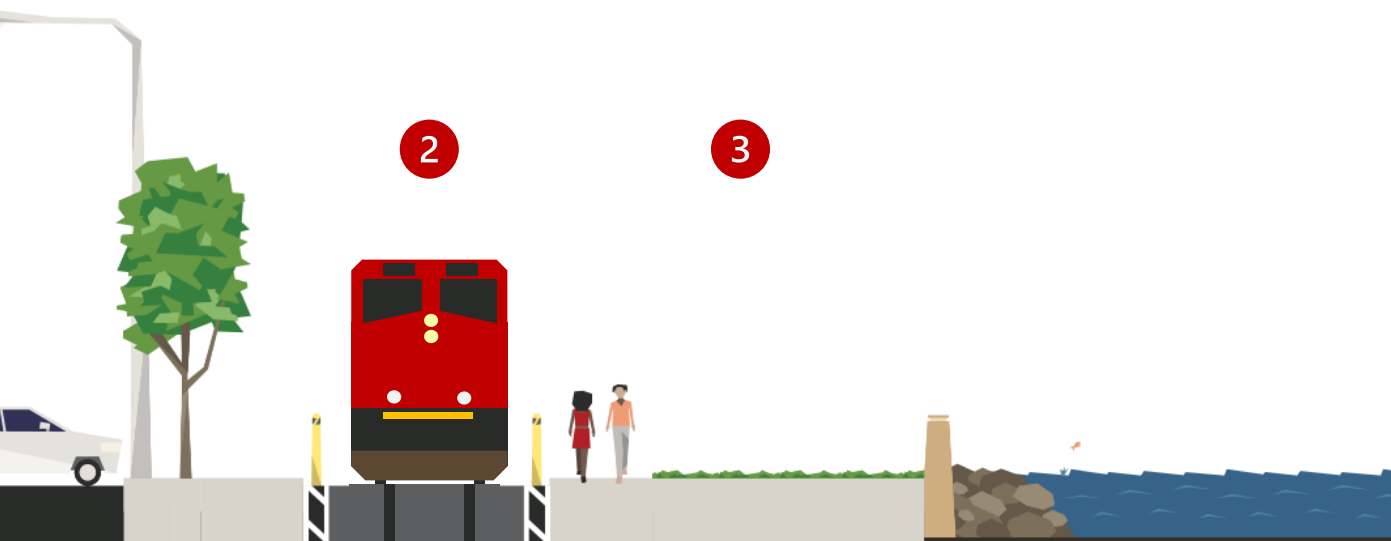
② Due to your city's historic location on the waterfront, there is a freight line on your site with infrequent non-passenger trains to a port and logistics terminal. The

businesses and residents have been cohabitating with them for generations.

③ Both visitors and residents of the neighbourhood appreciate having access to the waterfront (and its sounds) and are willing to brave non-ideal conditions for it, such as crossing a train line and walking in the sun. But they currently cannot even walk close to the water but instead next to the train where machinery and horns can exceed a dangerous 110 dB^b.

④ Small sidewalks and lack of greenery mean that active and building users are more exposed to traffic noise. When the traffic noise is the dominant source, it

^b We will not present a noise scale here but see [here](#) for more information.

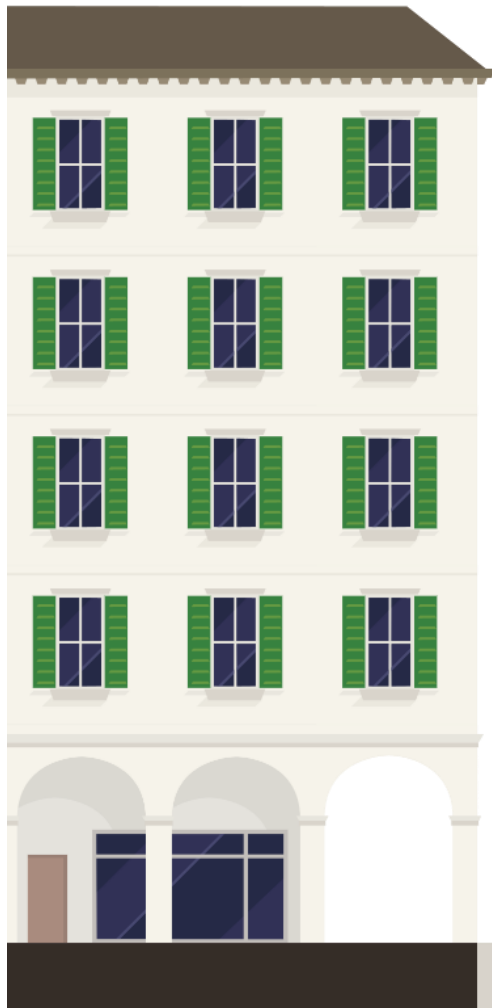


likely is also masking the sounds of the life of the street. Pedestrians may also avoid walking or lingering here because of noise or even crowding. All outdoor dining is currently tucked into the building's arcade and can be unpleasant for noise-sensitive diners because of the highly reflective hard surfaces creating a high sound level while eating.

⑤ Historically, this waterfront neighbourhood has evolved through waves of (de)industrialization and residential (re)development. There has always been some level of cohabitation between those uses, and recently tourism uses have been added to the mix.

When noise at façades is high, the health, well-being, and quality of life for people inside buildings (on all floors) is affected, from sleep and work disturbance to not being able to open windows in the heat.

Redesign: try your hand



DRAW

① How can you reduce traffic noise and its hindrances on the livability and vitality of the site? Can you prioritize active and collective mobility for local and waterfront access?

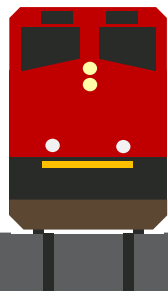
② Are there historic port sounds to emphasize? Can the freight line cohabitate better with all users? Can it less dramatically hinder access to the water (and its sounds)?

③ How can you improve access to the waterfront and its sounds for all kinds of users? Could users walk directly along the water line?

HERE!

2

3



④ Are there ways you can protect active users and the sounds they bring to animate the space? What can you implement to help local businesses contribute to the liveliness of the neighbourhood? Are there fun, active, or pleasant uses you can encourage, especially with the newly available street space?

⑤ Can you facilitate funding programs to improve the sound insulation of buildings? What can you put in place to reduce noise levels at façades? Will new street uses be disruptive? For whom? When?

Consider different stakeholders and types of uses.

Be creative! How can art support your goals?

How can you facilitate behavioral changes through communication?

Redesign: one possible solution



5

The new dining area can accommodate more diners, which could be louder. But out of the reverberant arcade and with less traffic, diners can hear each other better and don't need to raise their voice. The experience of residents should be unchanged or even enhanced.

Implementing rules, such as a curfew or regulation for open-air bars, may help alleviate issues.

4

1

① You've asked for a traffic study, which shows that traffic in the district will not be affected. You can implement a limited traffic zone to support low emission goals. You also added a bidirectional bike lane to the side of the road to encourage active mobility. Background traffic noise has dropped to a minimum and the bike lane introduces some human sounds.

② You have replaced train's safety bollards with strategically placed urban furniture and greenery that offer designated track-crossing points for pedestrians to access the water safely. **Distance** and **barriers** are added between active users and train with furniture and greenery to protect them from the loudest part of the train while it is passing. You

also engaged a group of sound artists to install an exhibit reminding and educating the public on the historic uses of the railway and port, further animating the space.

③ You relocated the path to the water's edge where people can engage with the waterway and its sounds. As the train safety bollards have been replaced by trees, people get to enjoy natural sounds, as well as the shade. Benches allow people, especially those with mobility impairments, to linger and rest as needed in this nicer sound environment while they take a break from their busy routines.

④ You talked to your small business department to facilitate permitting for

The shared bike station is placed between the pedestrian path and the train to act as both distance and barrier from the train noise for people on the path.

This was a deliberate sound design choice, even if that furniture might have been located better elsewhere for other reasons.



dining. Dining has been doubled in size and relocated to be fully open-air, allowing users to stroll directly next to open businesses. Because fewer people are congregating in the reflective arcade space, the sound environment in and spilling out of the passageway is less loud and disruptive for the residents living above it.

The lower overall sound levels create a more accessible space for all of the public space users, and especially those with sensory issues. People no longer need to shout over the traffic noise and honking to be heard. Over this lower background level, the human sounds of diners and passers-by, as well as the water sounds, are more audible and liven up the space.

You have also strategically placed wayfinding and greenery that, on top of the wider sidewalks, protect users (especially those with low vision) from wandering into the path of the bus lane, offer shade, and break the path of loud sounds from the remaining traffic.

⑤ Following the consultation with residents who were worried about the extra dining noise, especially over the lower traffic noise, you implemented a communication campaign to raise visitors' awareness of noise and a dining curfew at 11PM to ensure sound levels are not detrimental to residents' sleep. You also identified funding opportunities with the railroad agency to help install better window and wall insulation.

MOVING
FORWARD

Our *Sound Design Guide* is not just supposed to help you design better sound environments in isolation, but rather to offer you guidance in a frequently neglected dimension to strengthen the projects you already know and understand well.

We understand that some of our sample interventions appear easy and intuitive on their surface, but may amount to a mountain of work, requiring you to engage with professionals in other levels or agencies of your government, as well as professionals in your organization who may work for departments where you don't have an existing relationship. This is unfortunately the nature of sound, as it touches simultaneously on policy, environment, and design.

Please make sure that you also visit your past projects and take the opportunity to listen.

Please reach out to us if:

- You would like a guide on any other topics beyond streets
- You face barriers implementing a solution from this guide and you could use further assistance
- You would like to evaluate the sound quality of something you implemented

APPENDIX

A quick and dirty guide to asking questions

As part of engaging with the public about your project, you will want to ask residents and other stakeholders what they want from it. Whether you discuss sound or other considerations, it will be important to avoid framing your questions with an angle that fits what you want to hear. This way, you can reduce respondents feeling unheard and frustrated with engaging with you, and you can obtain a more accurate picture of their needs, desires, and expectations.

Below are a few examples you can adapt for your projects. These are questions we have asked over the years in our sound research to evaluate how people experience an existing urban space before and/or after implementation:

- Which outdoor spaces do you go to in your neighbourhood for a quiet break? For lively events? To be energized? How easy is it for you to get there? Are there any barriers? *[This can help you make a mental map of the neighbourhood so*

you can better design access for constituents.
Tailor it to your focus.]

- What would you like to hear in this space? [The responses to this question can help inform your design brief. You can offer some examples to respondents, tailor them to the space.]
- When you are in your home, does sounds from transportation ever affect your sleep, work, or daily activities? [You can separate those depending on what your focus is.]
- Can you list some sounds that you hear here in the space that are: pleasant, unpleasant, neutral? [Separate the three types to encourage people to answer all of them.]
- What is the character of this neighbourhood, in a few words? [This can help you catalogue what to preserve or highlight in a space, whether cultural identity or important sounds.]

Those examples are here to guide you. Adjust the framing and wording according to your needs. Some questions can be asked in a broad open-ended way in discussions or using a numerical scale in questionnaires.

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