SOUNDSCAPE

THE BACKGROUND CITY

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LISTEN UP!

This document has interactive aspects to it. On various pages there will be an opportunity to listen to various field recordings and soundscapes in reference to associated diagrams. The audio files can be accessed from this link and location:

<https://drive.google.com/drive/folders/1c9kSdEUS3zwaIVbkfMIGDffCFIp6ZjiZ?usp=sharing>

Look for these icons pictured below and then play the referenced recording, listed adjacent to or below, and experience the background city for yourself.

BELLS

Including but not limited to church bells and the bells of the Peace Tower.

Typical Amplitude: 60 - 70 dB

Classification: anthropogenic

Location: Parliament Hill, churches

AIRPLANES

Including but not limited to passenger planes, jets and The Snow Birds.

Typical Amplitude: 120-140 dB (exterior) 85 - 105 dB (cabin)

Classification: anthropogenic

Location: above us in the sky, airports

BIRDS

Including but not limited to native species such as pigeons, geese, seagulls, blue jays and robins.

Typical Amplitude: 10 - 15 dB

Classification: biophonic

Location: city streets, campuses, parks, above us in the sky

"The Ottawa Bird Count estimates that there are approximately 2 million birds within the urban area of Ottawa," city of Ottawa

BUSES

Including but not limited to OC Transpo, Greyhound and STO.

Typical Amplitude: 65-90 dB

Classification: anthropogenic

Location: city streets, transit ways

BUSKERS

Including but not limited to musicians and entertainers.

Typical Amplitude: 60 - 70 dB

Classification: anthropogenic

Location: city streets, public spaces

MOTORCYCLES

Limited to all 2 wheel motor vehicles

Typical Amplitude: 95 - 100 dB

Classification: anthropogenic

Location: city streets, parking lots

AUTOMOBILES

Limited to all 4 wheel vehicles both recreational and commercial

Typical Amplitude: 80 - 89 dB

Classification: anthropogenic

Location: city streets, parking lots

LRT TRAINS

Limited to OC Transpo

Typical Amplitude: 95 - 100 dB

Classification: anthropogenic

Location: city streets, parking lots

"It sounds like a CF-18 fighter jet!" (Drazen Hermon (Ottawa Resident))

HELICOPTERS

Limited to 1 propeller aircrafts

Typical Amplitude: 75 - 87 dB

Classification: anthropogenic

Location: above us in the sky

SIRENS

Including but not limited to emergency vehicle sirens.

Typical Amplitude: 120 - 130 dB

Classification: anthropogenic

Location: city streets, transit ways

CONSTRUCTION

Including but not limited to industrial vehicles and power equipment such as jackhammers, power saws, and cranes.

Typical Amplitude: 60 - 125 dB

Classification: anthropogenic

Location: everywhere

MECHANICAL UNITS

Including, but not limited to air conditioning units and HVAC systems.

Typical Amplitude: 45 - 70 dB

Classification: anthropogenic

Location: city streets, roof tops, alleyways

SHOUTING

Including, but not limited to protests, arguments, and conversation from a distance.

Typical Amplitude: 90 - 95 dB

Classification: anthropogenic

Location: everywhere

CONVERSATIONS

Including, but not limited to one on one discussion, small groups, and greetings.

Typical Amplitude: 45 - 65 dB

Classification: anthropogenic

Location: everywhere

CAR HORNS

Limited to the sound of horns from motor vehicles.

Typical Amplitude: 107 - 109 dB

Classification: anthropogenic

Location: city streets, highways

TRAFFIC

Limited to the overall ambient sound of motor vehicle congestion on city streets and highways.

Typical Amplitude: 80 - 89 dB

Classification: anthropogenic

Location: city streets, highways

SOUND & CITY

"Pedestrians, crammed on often too narrow sidewalks, are subjected to incessant car horns, sirens, the startling honks of cars being locked or unlocked via remote, news and police helicopters hovering overhead, planes dragging advertising banners and a plethora of other noise that we associate with the city. Together they form the urban hum one can hear for miles."

P H I L I P S E N
A QUIETER CITY THROUGH DESIGN AND ARCHITECTURE

CREATIVITY

Certain types of sounds have been observed to increase creativity within certain people. The results include, but not limited to increased ability to think, and desire to create or collaborate.

Sounds linked to Creativity:

- Music:**
 - Classical
 - Ambient
 - Jazz, but nothing too sporadic
- General Ambiance:**
 - Environmental noises
 - Coffee shops
 - White noise

"For most creatives there is a 'Goldilocks' zone of just the right amount of noise," David Burkus, ASAE

"Settings like coffee shops contain the right level of ambient noise that just happens to 'tickle' our minds to think more creatively," David Burkus, ASAE

"Researchers found that those in the 70 decibel group, exposed to a moderate level of ambient noise, significantly out-performed those in the other three groups. The background noise boosted their creative thinking," David Burkus, ASAE

INTIMACY

Certain types of sounds have been observed to increase intimacy within certain people. The results include, but are not limited to increased connection to individuals, feelings of love and compassion.

Sounds linked to Intimacy:

- Human:**
 - The voice of someone close or a loved one
 - Whispers
- Music:**
 - Classical
 - Romantic
- Spatial Ambiance:**
 - Reverberation associated with smaller spaces

"A room is generally judged intimate when the first reverberant sound reaches the listener within about 20 milliseconds of the direct sound," Professor Bressan

"While a great deal of sexual attraction may revolve around the visual, evidence suggests sounds are just as important," Renee Messer

HAPPINESS

Certain types of sounds have been observed to increase happiness within certain people. The results include, but are not limited to mood boost, and feelings of well-being + involvement.

Sounds linked to Happiness:

- Music:**
 - Faster tempo
 - Major key
- Human:**
 - Laughter
 - Sounds of collaborative activity
 - Children
- Nature:**
 - Water/rain
 - Animals (birds, mammals)
 - Wind

"According to a 2012 study published in the Journal of Positive Psychology, listening to upbeat music can make you feel happier, particularly if you do so with the intention of improving your mood," Renee Messer

"Some say the happiest sound is the noise of children's laughter. Happiness could be the sound of birds chirping or waves crashing upon the beach. Others, the 1% might say the clang of the stock market bell puts a smile on their faces," Renee Messer

RELAXATION

Certain types of sounds have been observed to cause increased relaxation within certain people. The results include, but are not limited to increased ability to sleep or meditate.

Sounds linked to Relaxation:

- Nature:**
 - Water/rain
 - Animals (birds, mammals)
 - Wind
- Music:**
 - Classical
 - Ambient
- General Ambiance:**
 - Chimes
 - White Noise

"The gentle bubbling of a brook, or the sound of the wind in the trees can physically change our mind and bodily systems, helping us to relax," University of Sussex

"Current findings indicate that music around 60 beats per minute can cause the brain to synchronize with the beat causing alpha brainwaves (frequencies from 8 - 14 hertz or cycles per second). This alpha brainwave is what is present when we are relaxed and conscious," University of Sussex

RESTORATION

Certain types of sounds have been observed to provide mental restoration within certain people. The results include, but not limited to decreased stress and anxiety.

Sounds linked to Restoration:

- Nature:**
 - Rain/water
 - Animals (birds, mammals)
 - Wind
- Spatial Ambiance:**
 - High quality acoustic

"An existing body of literature provides evidence that experiences in nature can promote restoration and improve overall health and well-being," Lauren C. Asker

"Findings suggested that participants who received the natural sound condition outperformed those in the no sound or control condition. Results from the study indicate that natural sounds can potentially facilitate attention restoration," Lauren C. Asker

STRESS & ANXIETY

Certain types of sounds have been observed to cause stress and anxiety within certain people. The results include, but not limited to increased blood pressure, irritability and erratic behavior.

Sounds linked to Stress & Anxiety

- City:**
 - Traffic
 - The background city
 - Car horns
 - Sirens
- Mechanical:**
 - HVAC hum
 - Construction
- Music:**
 - Overly aggressive and loud
 - Overly quick tempo
- Human:**
 - Shouting
 - Aggressive behavior

"The city is loud enough to raise one's blood pressure and heart rate, and cause stress, loss of concentration, and loss of sleep," Renee Messer

"Researchers suspect that noise aggravates these health conditions by inducing higher levels of stress," Renee Messer

SADNESS

Certain types of sounds have been observed to cause stress and anxiety within certain people. The results include, but not limited to increased blood pressure, irritability and erratic behavior.

Sounds linked to Stress & Anxiety

- City:**
 - High noise levels
 - Traffic
- Music:**
 - Depressing lyrics
 - Minor key
- Human:**
 - Crying
 - Insults
 - Begging

"Another study found that people living in areas with more road traffic noise were 25 percent more likely than those living in quieter neighborhoods to have symptoms of depression," Renee Messer

"Our emotional reactions to keys are informed by our cultural preconceptions. The Western musical canon has always attached sentiment and gravity to minor key," David Messer

ENERGY INCREASE

Certain types of sounds have been observed to increase energy within certain people. The results include, but not limited to increased stamina, motivation, energy level, and desire to participate in physical activity.

Sounds linked to Energy Increase:

- Music:**
 - High energy
 - High-tempo, dance or rock
 - Steady beat
- General Ambiance:**
 - Sounds of movement
- Human:**
 - Encouragement
 - Cheering

"Music can be a powerful force. In fact, it is sometimes banned (along with steroids and stimulant drugs) to prevent athletes from gaining an unfair advantage during competitions," Renee Messer

"For some athletes and for many people who run, jog, cycle, lift weights and otherwise exercise, music is not superfluous—it is essential to peak performance and a satisfying workout," Renee Messer

SOUND & MIND

"The way sounds are made and heard (or not), the effects sounds have on your mind, your emotions, your attention, your memories, your moods, are so vast as to be almost beyond description."

H O R O W I T Z
T H E U N I V E R S A L S E N S E

ABSTRACT

Sound is a natural phenomenon shaped by time and space. Time affects a sound's pitch while the physical or built environment surrounding the sonic event directly influences its volume, clarity and its decay. Thus, architecture and sound form an inseparable bond.

Soundscape – The Background City explores various soundscapes we encounter in urban Ottawa, experienced through space and time. How are different soundscapes visualized and mapped to distinguish themselves from one another? Can they be enhanced, orchestrated or subdued to be better understood? As this transfers through to spatial production, the emerging project asks how the awareness and manipulation of daily soundscapes can be a catalyst towards sonic discovery in Ottawa's urban core. We explore how urban soundscapes, framed by architecture, affect an individual's experience of their surroundings, built or unbuilt.

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It has been a great honour to utilize the facilities and resources that the Azrieli School of Architecture has offered to me during my time at Carleton University. The Architecture Building was not just a place of learning, but a home in which I will forever hold close to my heart.

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C O N T E N T S

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UNDERSTANDING SOUNDSCAPE	0 2	>> Spectrogram studies, analysis work and soundwalking in the city of Ottawa. (23-45)
ANCHORING SOUNDSCAPE	0 3	>> Network of aural interventions aimed towards deep listening, engagement and experience, in and around Ottawa's new LRT stations. (46-65)
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G L O S S A R Y

ACOUSTIC	<p>“Of or relating to the sense or organs of hearing, to sound, or to the science of sounds.</p> <ol style="list-style-type: none">1. deadening or absorbing sound2. operated by or utilizing sound waves”¹
ACOUSTIC ARCHITECT	<p>“A builder, engineer, or physical scientist who implements the aural attributes previously selected by an aural architect.”²</p>
ACOUSTIC ARENA	<p>“The area where listeners can hear a sonic event (target sound) because it has sufficient loudness to overcome the background noise (unwanted sounds).”³</p>
ANECHOIC CHAMBER	<p>A special room used during scientific studies and music recording. All walls are clad with special panels which direct sound waves inwards, absorbing them instead of reflecting them back towards occupants. The result is a near silent space with zero reverberation and sonic reflections.</p>
ANTHROPHONIC	<p>Sounds produced by humans or human-made devices.</p>
AURAL	<p>“Of or relating to the ear or the sense of hearing.”⁴</p>
AURAL ARCHITECT	<p>“An aural architect, acting as both an artist and a social engineer, is... someone who selects specific aural attributes of a space based on what is desirable in a particular cultural framework.”⁵</p>
AURAL ARCHITECTURE	<p>“Refers to the properties of space that can be experienced by listening.”⁶</p>
BACKGROUND CITY	<p>The collection of sensory experiences within an urban area that are lost as a result of noise pollution.</p>
BIOPHONIC	<p>Sounds produced by all non-human organic life, such as birds, mammals and insects.</p>
DIFFRACTION	<p>Diffraction is a term used to describe the bending of soundwaves around corners or through small openings in opaque surfaces.</p>
DIFFUSION	<p>Diffusion is a term used to describe the scattering and delocalization of sound within a space.</p>

DRONE	“The drone effect refers to the presence of a constant layer of stable pitch in a sound ensemble with no noticable variation in intensity. Linked to music in its designation (the drone is a permanent bass note over which other elements are laid), the drone effect can also be observed in urban and industrial soundscapes.” ⁷
GEOPHONIC	Sounds produced by natural, earthy processes such as wind, rain and thunder.
KEYNOTE	“The note that identifies the key or tonality of a particular composition. It is the anchor or fundamental tone and although the material may modulate around it, often obscuring its importance, it is in reference to this point that everything else takes on its special meaning.” ⁸
LISTENING	The act of actively monitoring or perceiving sound.
MUSIC	“The science or art of ordering tones or sounds in succession, in combination, and in temporal relationships to produce a composition having unity and continuity.” ⁹
REVERBERATION	Reverberation is a term used to describe the quantity and depth of sonic reflections and echoes within a space.
SONIC ILLUMINATION	A term used to describe the animation of space through the use of sound.
SOUND	The sensation perceived by the sense of hearing.
SOUNDMARK	“Derived from landmark and refers to a community sound which is unique or possesses qualities which make it specially regarded or noticed by people in that community.” ¹⁰
SOUNDSCAPE	All sounds heard from a given location at a particular time, understood as a whole.
TUNING TUBE	A term coined by O+A (Bruce Odland and Sam Auinger) to title tubular musical instruments which transform ambient city sound into musical drones.

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I N T R O D U C T I O N

>> CITY, SOUND, SPACE, PERCEPTION, AND EMOTION

In *The Universal Sense*, musician and neuroscientist Seth Horowitz makes a compelling observation that “every city has its own background noise signature.”¹ While this is certainly true, it fails to encapsulate the diversity that is found within a given city; streets, parks, alleyways and transit stations can be vastly different in terms of their acoustic signatures. Although each site often contains similar sound generators (i.e. automobiles, humans, birds, construction, and music), every location also features ever-changing compositions and human processes that depend on the time of day and season. In addition, the varying spatial conditions—both built and unbuilt—surrounding the sonic events shape what can be heard. If one moved a sonic event from one location to another, the result would surely reflect the changes in acoustic and spatial configuration.

(Below) Bird's Eye view of cityscape.

Cities offer complex spatial environments complete with complex geometries, voids, and vast areas of varying uses. Each building within a city provides unique sonic properties which manipulate the plethora of sonic signals present.

As discussed in *Sonic Experience* by urban planner and musicologist Jean-François Augoyard, “no sound event, musical or otherwise, can be isolated from the spatial and temporal conditions of its physical signal propagation.”² Can these various sounds, sculpted by the varying *aural architectures* presented, be understood as complex soundscapes of urbanity?

Within an urban soundscape, there are two layers of sonic illumination: the *foreground* and the *background*. The foreground is composed of audible events, with high amplitude or familiarity, that capture our attention. For example, a dog barking from just across the street, somebody sneezing within close proximity on public transit, or the cheerful tune of an ice-cream truck coming down the road; all of these contribute to the foreground overlay. On the other hand, the background is perceived less consciously. It remains an ambient hum that is comprised of the city’s sounds, past or present, resonating through the aural network of planes, geometries, and voids that make up the urban fabric by means of reflection, diffraction, diffusion and absorption.

In the book *Spaces Speak... Are You Listening?*, architectural and sonic scholar Barry Blesser speaks of architecture as a resonant body that responds to aural interaction. He refers to this concept as the *meta-instrument*.⁴ That is to say, that while each building acts as a meta-instrument in its own way, as a collective, the dense urban fabric allows architecture to exist as a meta-orchestra. The materials and geometry of each structure collaborate and harmonize with each other in order to form the urban soundscape.

(Above) ‘Spaces speak, are you listening?: experiencing aural architecture’ by Barry Blesser and Linda-Ruth Salter.

Barry Blesser defines ‘aural architecture’ as “the properties of space that can be experienced by listening.”¹³

(Above) Graphic illustrating the distribution of 5 sound sources through reflection in an urban setting.

This diagram is graphic in nature and the paths of sound have been simplified into vectors opposed to radial paths.

KEY

- Sound Source
- Initial Soundwave
- - - - - Reflected Soundwave

Sound's importance within architecture has significantly diminished within the last century due to the advancement of and increased focus on visual technology. Apart from spaces exclusively dedicated to sound, such as concert halls, inclusion of thoughtful acoustics and aural architecture within everyday environments is rare. Although humans are a naturally visually oriented species, it is easy to overlook the role that sound plays in the perception of our surroundings. Aural and visual stimuli often run parallel and reinforce our understanding of each other.

"Sound," says urban planner Klaus Philipsen in *A Quieter City Through Design and Architecture*, "adds dimension to both form and light."⁵ When standing in a space, its volume can be heard based on the reverberation of aural signal. Unlike hearing, all our other bodily senses have limitations. We can only see what is in front of us; balance, touch and taste are limited by the extent of our body, and something can only be smelled from a distance if of high enough concentration. While our eyes can effectively detect 15-25 events per second, our ears can detect up to 5000 vibrations per second, which suggests hearing as dominant in terms of processing our surroundings.⁶

(Above) Anatomy of the human ear.

- a- Incus
- bg- Semicircular Canals
- h- Malleus
- osd- Mastoid bone
- ot- Eustachian Tube
- ph- Tympanic Cavity
- rf- Round Window
- s- Stapes
- sb- Temporal Bone
- tf- Tympanic Membrane
- tht- Cochlea
- vh- Ampula
- vht- Corti

According to professors Jian Kang and Brigitte Schulte-Forkamp in *Soundscape and the Built Environment*, while we go about our lives, "We hear voices, vehicles, birds, wind in trees, machinery, footsteps, raindrops, telephones, the hum and beeps of our electronics, dogs barking, and sometimes the sound of blood moving through our bodies."⁷ Sound surrounds us at all times whether inside or out. When we move to a space with lower noise levels, our listening capabilities will increase, allowing the hidden, more subtle sounds of the environment

to reveal themselves. Sound is omnipresent, especially within the city, and is an evident reminder that there is no such thing as true silence.

It is obvious that sound has a notable impact on the perception of our surroundings. Perhaps less immediately obvious is the impact it has on culture, personalities and individual lives. It can bring people together, such as through the haunting 'Call to Prayer,' and can significantly influence our feelings and emotions. Seth Horowitz perhaps says it best in *The Universal Sense*: "Sound affects us in ways of which we are not aware, it changes our emotions. Changes our attention. Changes our memory, heart rate, desires, response to the opposite sex."⁸ Sound truly is a powerful experiential force interwoven into the human condition. However, it is subjective by its very nature. What could be perceived as noise to someone could equally be perceived as therapeutic and enjoyable to another.

The various psychological responses associated with sound can be perhaps best understood by exploring emotional responses to various types of music. Attending a loud rock concert can increase one's energy and alertness, leading them to join the throngs of people in front of the stage. Others may feel pleasantly stimulated and lock into the rhythms and melodies of the music, encouraging them to sing along or dance. Some will just end up with a headache and decide to leave the venue in search of a space with lower volume levels. While the soundscapes we experience within cities are more complex and require a greater level of attentional focus to comprehend, they can be understood and related to like music.

(Above) Interior of an anechoic chamber.

While complete silence can not exist in natural environments, anechoic chambers have been developed to achieve a silent atmosphere. The specially designed wall and ceiling panels direct soundwaves inwards, absorbing them and ensuring no reflections return to the listener.

(Below) A busy street crossing

(Below) A rock concert

Can the soundscapes of these varying sonic environments be understood in similar ways?

(Above) Graphic illustrating some daily sounds and their decibel ratings.

While every individual has different expectations about urban soundscapes that affect their reactions to various sonic events, studies prove that certain sounds result in predictable reactions and responses. In *Soundscape and the Built Environment*, Jian Kang and Brigitte Schulte-Fortkamp state that “a high-quality acoustic environment intrinsically provides restoration by an immediate pathway—in the same way as green or natural areas... are assumed to.”⁹ Thus we can see how sounds of nature, and quieter areas within a city that allow a reprieve from the background noise can contribute to increased mental health and well being. On the other hand, the loud and sporadic cacophony associated with car horns, sirens and other city noise can often cause long term detriment to health. Architecture critic Kate Wagner states that the high amplitude of background noise within a city “is loud enough to raise one’s blood pressure and heart rate, and cause stress, loss of concentration, and loss of sleep.”¹⁰ If that wasn’t bad enough, medical science has determined that being exposed to sounds that eclipse 85 decibels for long periods of time can permanently damage hearing; the engine of the average car can sometimes pass 90 decibels!¹¹

Consequently, it must be considered how various urban soundscapes affect us physically, psychologically and emotionally. Of course, for much of the day, our cities are ultimately considered noisy, which is generally perceived as negative. In his piece, *Dear Architects: Sound Matters*, New York Times architecture critic Michael Kimmelman states that “During the Middle Ages, smell was the unspoken plague of cities, today it is sound.”¹² According to the World Health Organization, noise pollution is the second greatest form of pollution after environmental pollution. The growing level of city noise is obscuring

natural, beautiful sounds that used to be more common such as birds, insects and wind. It is even becoming increasingly difficult to have a conversation along a street side as the sound of automobiles bombard our ears from all around, distorting our ability to listen. The increase in noise pollution is partially a result of our increasing dependence on technology. We have become reliant on the visual aspects of our surroundings and have in turn become blind of their resultant aural connotations.

Berry Blesser explains how “in controlling the sonic illumination as part of the design process, an aural architect becomes a soundscape architect.”¹³ Is it possible to not only bring order to the ambient sounds that make up urban soundscapes, but also begin to manipulate and orchestrate them through architectural design? By developing new ways to listen to our cities, we can create a more fulfilling aural experience of urban life that increases resident livelihood through the encouragement of deep listening.

(Left) Yuri Suzuki Sound Installation in Vancouver

These tubular structures encourage engagement. People can speak through one end and have their signal be modulated before reaching the other ends.

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01

THE BACKGROUND CITY

>>A LOST LAYER OF EXPERIENCE WITHIN URBAN OTTAWA

A century and a half ago, Ottawa (proceeding Bytown in 1855) sounded much different than it does today. If one could somehow travel back to this time and listen, the most obvious difference would be the absence of the roaring combustion engine, which has become the keynote of present day Ottawa and most other urban environments on Earth (except for perhaps Venice). In its place, there are the hooves of horses clacking rhythmically against rough cobblestone paired with early-industrial songs of steam powered freight trains and river-based logging. One would also notice a sense of clarity while listening, for the monolithic hum of electricity and mechanization which obscures the background city, has yet to be composed.

So, what is the background city? It can be described as the collection of experiences within an urban area that are lost as a result of noise pollution. As mentioned, within a built-up area the sound of all individual events is captured, manipulated, and amplified by the urban fabric. This ultimately overpowers the elements of a soundscape creating a complex hum which can be heard for miles. Seth Horowitz explains that “humans have a strange relationship with sound. We ignore most of it, shuffling it around in our brain stem to be monitored as ‘background,’ something that sets the stage of our world, driving attention but rarely capturing it.”¹ We have the ability to block specific sounds out, such as ones made by ourselves, in addition to the urban hum that we speak of. If we have difficulty blocking the aural stimulus out, we can thank technology for giving us headphones.

01

(Above) Horse and Buggy in Downtown Ottawa, late 1800s

When we either tune out, or obscure the sonic environment that surrounds us, we modify our perceived environment in its totality. Ears can capture an environment in 360 degrees. Hearing a sound alerts our attention and quickly redirects our gaze to the direction it came from, allowing for a further understanding of the source. By tuning out, it isn't just events that we fail to perceive, as most of what is lost is sound itself. Subtle signals are overpowered and masked by sources of higher amplitude and are moved to the background of the spectrum. Sometimes these signals are lost all together.

By emphasizing the visual, our society often disregards the aural landscapes which surround us. The thesis project proposes that the background city of Ottawa can be revealed and enhanced through architecture in order to return a deeper sensory experience of urban life. What is heard can be made more intentional by allowing an active dialogue between residents and the city. By understanding the sonic realm that surrounds us and comprehending the sounds that we make, we can design through objects and spaces, a culture which is cognizant of its sensory expression as a cumulative whole.

(Right) This image illustrates a blurry view of a street. With our vision distorted, it is tougher to perceive our environment which can ultimately lead to danger. When our mind tunes out our surrounding aural environments, our aural awareness becomes inhibited.

1. Horowitz, Seth S. *The Universal Sense: How Hearing Shapes the Mind*. New York, NY: Bloomsbury, 2012. 217

02

UNDERSTANDING SOUNDSCAPE

>> SPECTROGRAMS, SOUNDWALKING, AND ANALYSIS WORK

The soundscapes that surround us within Ottawa's urban realm are layered, complex and as unique as our fingerprints. In order to begin to understand the anatomy of these unseen landscapes and their materialization, time needs to be taken within the city practicing deep listening and indexing the various soundscapes present.

VISUALIZING

The aural indexing of Ottawa's urban soundscapes began with field recording. A stereo microphone and recorder were taken to several locations of interest within Ottawa. A wide variety of spaces (exterior, interior, public, non-public) were chosen to get an assortment of varying data. A recording was taken of each site to register the soundscape inherent to that location and the specific time of day. With the data collected, the first method of decrypting the sounds heard was to represent them in a visual way.

Through visualizing the soundscapes, there was intent to accomplish two things: one, to prove that each location would yield unique sonic data and two, to be able to identify the dual layers of a soundscape: the foreground and the background.

Fifteen of the roughly thirty recordings taken were loaded into a sound visualization software and spectrograms were produced. A spectrogram is a typical graph within sound analysis which displays time, frequency and amplitude. The spectrograms were then taken into Photoshop and were arrayed into circles using a polar coordinates filter. The resultant graphs are

02

(Above) The Zoom H4n Pro

This is the device used for field recording. It's dual condensor microphones in X/Y configuration facilitated the capture of Ottawa's soundscapes in stereo format.

(Above) *Glacier Ice on the Beach*

The term *polar spectrogram* is, as far as I know, coined by Josh Wallace in his Thesis entitled 'Listening to Climate Change'. Following Wallace's methodology, I attempted to make the graphics myself.

dubbed as polar spectrograms. Each spectrogram was annotated to convey the time of the sound clip as well as to break-down the sonic events and background sounds associated with each location. The annotated graphs were then accommodated with a site sketch and an infrared photo of the site to convey the temporal intent of the exercise.

Due to the varying results, these spectrograms prove to be an effective way to visualise soundscape. Utilizing these spectrograms with their associated audio files also increases knowledge, and attention to the sonic events.

1. As predicted, all fifteen of the spectrograms illustrate unique results based on the architectural environment of each location and the various sound sources within the different acoustic arenas.
2. While the foreground sounds are evident in darker bands, the background sound can be clearly seen in continuous hazy zones.

(Below) *Soundscape Layers Within A Polar Spectrogram*

This image breaks down a polar spectrogram and identifies elements from both the foreground and background.

READING A SPECTROGRAM

A Spectrogram is a visual representation of a sonic spectrum in graph form. Time is represented in the X-axis, frequency or pitch is represented in the Y-axis, and amplitude or loudness is represented as the darkness of the colours.

READING A POLAR SPECTROGRAM

A Polar Spectrogram is simply a Spectrogram that has been run through a Polar Coordinates filter within Photoshop. Data is represented by the same values with the resulting graph represented in circular form.

006_Parliament-Hill.WAV

PARLIAMENT HILL

SEPTEMBER 20th - 10:03AM

< ▶ || > 002_Tunney's-Pasture-Station.WAV

TUNNEY'S PASTURE STATION

SEPTEMBER 20th - 9:44 AM

< ▶ || > 005_Parliament-Station.WAV

PARLIAMENT STATION

SEPTEMBER 20th - 9:55 AM

< ▶ || > 010_Rideau-Station.WAV

RIDEAU STATION

SEPTEMBER 20th - 10:39 AM

< ▶ || > 009_Rideau-Centre.WAV

R I D E A U C E N T R E

SEPTEMBER 20th - 10:39 AM

< ▶ || > 001_Westboro-Beach.WAV

WESTBORO BEACH

SEPTEMBER 20th - 9:36 AM

017_Outside-Arch.WAV

The recording location is situated under the canopy of the Architecture Building. Ambient sounds of nature, machines, people and traffic reflect and reverberate within the space forming a noticable background hum.

Door shuts loudly at the front of the Architecture Building.

Loud conversation nearby. Cuts through background hum and remains audible.

B 2 2 - F R O N T C O U R T Y A R D

SEPTEMBER 22nd - 3:49 PM

◀ ▶ ⏸ ▶ 018_Canal-Building.WAV

CANAL BUILDING ATRIUM

SEPTEMBER 22nd - 3:50 PM

(Above) Max Neuhaus - Listen

Max Neuhaus, similarly to R. Murray Schafer conducted soundwalks with some of his students in New York City during the 1960s. While similar to Schafer's soundwalks, Neuhaus preferred the title "listening walk" as he was more interested in encouraging deep listening than the actual mapping of environments like Schafer.

ANALYZING

With an effective method established for visualising different soundscapes, it was necessary to dive deeper into the sonic realms and their associated locations in order to understand the conditions shaping each of the unique and unseen aural landscapes. At each spectrogram site, a new recording was taken, followed by a five minute soundwalk. In his defining book, *The Soundscape*, composer and acoustic ecologist R. Murray Schafer explains the act of soundwalking as "an exploration of the soundscape of a given area using a score as a guide."¹ In these cases, the scores that were utilized were mental maps of the spatial environments in congruence to an understanding of the sounds that are typically known to be heard at each of the studied locations. With general knowledge concerning the nature of each location in mind, focus was directed upon the act of listening and perceiving unusual sounds and ambiances as well as temporal aspects such as emotions. The following data was considered:

1. Sound sources classified by type. (*Anthrophonic, Biophonic, Geophonic*)
2. Sound sources classified by layer. (Foreground, Background)
3. Architectural conditions and their resultant sonic effects. (Reverberation, Diffraction, Diffusion, Absorption)

Once the new data was acquired, six images were developed to convey the findings. Two of the images illustrate urban streets: a typical arterial road (Queen St.) and a pedestrian street (Sparks Street). Another two illustrate light rail stations: one being interior (Rideau Station) and the other being exterior (Tunney's Pasture Station). The final two images illustrate public spaces: one being interior (Rideau Centre) and one being exterior (Byward Market). Sound sources by type are associated with various colours, while the environment has been left in monochrome to distinguish the sources from their shaping environment. An Oscillogram of the soundscape's recording was overlaid to give a sense of the loudness of the sonic dynamics in each location.

SOUND SOURCE KEY				
Anthrophonic			Geophonic	Biophonic
Electro/Mech	Human	Transport		

(Above) Sound Source Key

Please use this sound source key on the following 6 pages.

QUEEN STREET

◀ ▶ ⏮ ⏭ 057_Queen-Street.WAV

This intersection at Queen St. and O'Connor St. features an **URBAN** soundscape. Biophonic and Geophonic sounds are present, however are not heard due to the large amount of Anthroponic sounds such as traffic and construction. O'Connor Street is one way and results in a steady flow of south bound traffic throughout the day.

FOREGROUND

- Conversations
- Traffic
- Construction
- Music from adjacent bar

BACKGROUND

- Doors shutting
- Footsteps
- Birds Chirping
- Traffic
- Conversations

ARCHITECTURAL INFLUENCE

- Wide streets allow for more traffic adding more ambient traffic sounds.
- Facades are constructed with variety of materials. Majority of these materials exist as hard, non-porous types. Thus, sound is amplified slightly as more soundwaves are reflected
- Brick on ground in intersection provides a different sound than asphalt

1:54pm
20191012

SPARKS STREET

◀ ▶ ⏮ ⏭ 077_Sparks-People.WAV

Sparks Street features an **URBAN** soundscape. The street is a unique situation as it is usable by pedestrians only. Biophonic sounds of birds can be heard fairly clearly, with the addition of Anthrophonic sounds like humans talking and walking. The sound of cars exists solely in the background.

FOREGROUND

- Conversations
- Footsteps
- Construction

BACKGROUND

- Birds Chirping
- Traffic

ARCHITECTURAL INFLUENCE

- Absence of cars on street reduces overall traffic noise within the area.
- Facades are constructed from a mix of materials. Some being hard and reflective while others are soft and porous. Depending on location, one may find themselves moving from slightly dampened locations to slightly reverberations locations.
- Due to situation in the central urban area of Ottawa, cars can still be clearly heard within the background.

BYWARD MARKET

The Byward Market features an **OUTDOOR PUBLIC** soundscape. There are Biophonic and Geophonic sounds, however due to the nature of the area, sound sources are predominantly Anthropophonic. The time of recording was done around lunch time and many residents are out and about.

◀ ▶ ⏮ ⏭ 061_Byward-Market-South.WAV

FOREGROUND

- Music from Cafe
- Conversations in both French and English
- Traffic
- Victoria Trattoria demolition

BACKGROUND

- Doors shutting
- Merchandise moving within vendor tents
- Birds Chirping
- Traffic sounds
- Conversations in both French and English

ARCHITECTURAL INFLUENCE

- Wide streets allow for more traffic adding more combustion engines into the mix.
- Facades are constructed with mainly porous brick which provides some sound absorption.
- Building density and height is relatively low, causing adjacent streets to contribute to the overall soundscape.

RIDEAU CENTRE

The Rideau Centre features an **INDOOR PUBLIC** soundscape. Biophonic sounds and Geophonic sounds are absent, and all sounds heard are Anthroponic by nature. Recording location was in a primary circulation route and there is a high concentration of people present within the space.

◀ ▶ ⏮ ⏭ 064_Rideau-Centre.WAV

FOREGROUND

- Conversations

BACKGROUND

- Doors shutting
- Escalator hum
- HVAC hum
- Conversations
- City hum from exterior
- Footsteps

ARCHITECTURAL INFLUENCE

- Several multi storey spaces allow for plenty of reverberation.
- Hard surfaces such as glass and tile provide echos, reverberation and amplitude increase to the various anthroponic signals present.
- Space is extremely large and conversations from far into the mall's interior can be heard reaching the recording location

2:07pm
20191002

RIDEAU STATION

The LRT station that lies below the Rideau Centre and Rideau Street features an **INDOOR TRANSIT** soundscape. Due to the station's location being situated below ground, Biophonic and Geophonic sounds are absent and all that can be heard are Anthrophonic sounds.

◀ ▶ ⏮ ⏭ 065_Rideau-Station-2Platform.WAV

FOREGROUND

- Train
- LRT operator announcements
- Turnstyle
- Conversations

BACKGROUND

- HVAC hum
- Escalator hum
- Conversations
- Footsteps

ARCHITECTURAL INFLUENCE

- Large concrete space allows for heavy reverberation due to density of material.
- Volume of space also causes sound to be diffused, there is difficulty situating a sound source's location as most signals are being evenly distributed through the space.

TUNNEY'S PASTURE STATION

054_Tunney's-Pasture-Entry-2Platform.WAV

Tunney's Pasture station features an **OUTDOOR TRANSIT** soundscape. There are Biophonic + Geophonic sounds, though due to the nature of the area, sound sources are mainly Anthroponic. Moving through the station causes variations in the soundscape as the station is at street level but the platform is located below ground.

FOREGROUND

- Train
- LRT operator announcements
- Traffic
- Conversations

BACKGROUND

- Escalator hum
- Footsteps
- Conversations
- Birds chirping
- Traffic

ARCHITECTURAL INFLUENCE

- Facility is open to above which allows Anthroponic city sounds to enter from above.
- Lower train platform area features thick concrete walls which provide loud reverberation.

1. Schafer, R. Murray. *The Soundscape: Our Sonic Environment and the Tuning of the World*. Rochester, VT: Destiny Books, 1993. 213

ANCHORING SOUNDSCAPE

>> TRAINS, INTERVENTIONS, AND OTTAWA'S AURAL NETWORK

With the rise of the industrial era and subsequent modernization of urban Ottawa, mitigation of noise pollution has been relatively unaddressed. Today, the city is loud and features a sporadically complex soundscape composed of a plethora of autonomous sound sources and the activities of urban dwellers. These are manipulated by the city's dense fabric.

With the exponential rise of technology, we can assume that city noise will continue to intensify in magnitude over the next few decades. R. Murray Schafer estimates that ambient noise within “the modern city is rising by something like half a decibel per year;”¹ alarming to say the least. The background city will only continue to be further removed from conscious perception.

Large scale renovations to the urban landscape of Ottawa aimed at improving undesirable noise pollution would prove extremely costly and not a feasible solution to the problem—the city has been long planned around the movement of the automobile.

Instead of looking for a solution to this issue of noise pollution, perhaps a better option could be to provide a series of interventions which will help to reveal the sonic beauty lost within the city's background. In *A Quieter City Through Design and Architecture*, Klaus Philipsen states that “sound cannot only be avoided through careful design, it can be manipulated and orchestrated, it can enhance experience.”² By turning to tactical urbanism and sonic architecture, we could speak of an

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(Above) Ottawa Transportation Master Plan Map 7.

This map of the Ottawa core illustrates Ottawa's automobile transportation routes within the core. As can be seen, Ottawa has been long designed around the displacement of the car.

aural network that achieves the goal of enhancing the understanding of soundscape and sense of place, while providing new and unique experiences that promote a dialogue between Ottawa's inhabitants and the city itself.

1.0 PREMISE AND SITING

Remaining sensitive to the subjectivity of sound and the unfortunate likelihood of simply creating more noise, the goal of this aural network is to provide moments of heightened sonic experience that enhance the sounds that already exist within Ottawa's urban palate. Any new sound sources will, as far as possible, avoid further densifying the already complex soundscape.

Utilizing architectural and spatial methodologies, present soundscapes will be altered through lessening amplitude, filtering or modulating aural signals, or amplifying subtle sounds which are often overlooked. By transforming sounds into different forms, we are more likely to perceive them as they differ from existing sounds.

The network will exist at both an urban and human scale. Interventions, in the form of sonic installations and pavilions, will be located in and around the LRT stations dotting the new Confederation Line in Ottawa. These stations, nodes on an integrated transportation route, are visited and utilized by tens of thousands of people a day. The areas surrounding each station also offer unique aural signals and soundscapes holding personal, social and cultural value. Seeing the enormous influx of Ottawa commuters and the resulting diversity among the soundscapes that surround each station, opportunities exist to create spatial and sonic experiences for inhabitants during the mundane ritual of the daily commute.

Ultimately, the aural network will allow for residents to experience prescribed soundwalks that alter their perception of the urban environment and the background city while going about their daily rituals.

(Above) Map of Confederation Line

This map illustrates the 13 stations in which the aural network will be established around. The Trillium line, which connects the south is shown in a dotted line.

2.0 URBAN SCALE

The urban scale of the aural network adapts the new LRT stations into listening spaces that monitor and interact with the surrounding areas that each station serves. This will be accomplished by developing a series of city-operated listening instruments that provide a unique musical keynote to each station, proffering a new sense of place and identity.

2.1 TUNING TUBES

In the 1990's, sound artists Bruce Odland and Sam Auinger (collectively known under the moniker O+A) developed a method of transforming ambient city and traffic noise into musical signals. This method involved the use of makeshift musical instruments which they coined *tuning tubes*.

In 1999 under the project title *'Harmonic Bridge'*, O+A affixed two 16-foot aluminum tuning tubes to the side of an overpass in North Adams, Massachusetts. Within these tuning tubes, microphones were affixed that recorded the sounds of traffic passing by. The recordings were played below the bridge in real time from within two concrete speaker enclosures. The result was a musical drone of traffic in the key of C. Due to the precise lengths of the tubes, a standing wave was created that resonated to the fundamental tone of C. As ambient noise entered the tubes, the sounds of traffic were warped to match this musical frequency and the resultant song was transmitted below the bridge for the enjoyment of those present.

Upon further research, we find that these tuning tubes work in a very similar manner as the functionality of a pipe organ. Using the formula for acoustic resonance within cylinders with both ends open, tube lengths can be determined and cut to reference specific wavelengths. In these equations, f refers to frequency, v refers to the speed of sound, L refers to tube length, and λ refers to wavelength. The width of the tube often does not factor into sizing; however, it can help fine tune by adding an additional factor to the equation

$$f = \frac{v}{2L}$$

(Above) O+A

Sam Auinger (left) and Bruce Odland (right) have completed an entire catalogue of projects that deal with the experience of urban sound. Together, they believe and teach that "we won't understand ourselves as a culture until we understand our noise."³

The location of the microphone is crucial to the mechanics of the heard sound. Each fundamental tone holds several harmonics that are activated as the wave moves along its path. Placement of the microphone at a specific interval of the tube (1:7, 3:7, etc.) can help to eliminate certain overtone harmonics, limiting the range of sonic expression.

(Below) Diagram depicting the harmonic overtones of a 12' F tube.

(Above) The Circle of Fifths

The notes that make up these chords (i.e: C1, C2, E2, and G2 for Tunney's Pasture Station, D1, F2, A3 and C3 for Parliament Station, and F#1, F#2, A#3, and C#3 for Hurdman Station, etc.) would be used to fabricate several tuning tubes whose lengths reference the chosen chord. Surrounding the station, within a radius of between 1-2 kilometres, these tubes would be placed at key sites opening up cultural, social, or sonic significance. The recorded signals would be sent back to each station and played through loudspeaker enclosures that could be opened and closed by commuter interaction in order to increase or decrease a certain location within the mix. The resultant effect would be an everchanging chordal drone being played by the city's soundscapes.

(Above) Tuning Tubes

For the later soundscape portion of the thesis project, I fabricated four tuning tubes from PVC pipes. The tubes lengths represent the chord of Dmin7.

The loudspeaker enclosures would be distributed evenly through the stations. As the *acoustic arenas* of each signal overlap, the various locations would harmonize with each other creating a unique and organic experience as one moves from the entry to the platforms. Ultimately, this musical collage of the surrounding areas will create a new sonic topography within each station.

In *Sonic Experience: A Guide to Everyday Sounds*, Jean-Francois Augoyard and Henry Torgue state that "background sound", in the form of a drone "is used everywhere in public spaces to mask disturbing noises, or to create an atmosphere that is considered more comfortable or more suited to encouraging consumption."⁴ These chordal drones within the LRT stations will help mask the hum of mechanical equipment and other unwanted noises. In addition, while creating a meditative atmosphere of urban wonder, a keynote identity is set that distinguishes each station from the others and provides a sense of place and familiarity.

The following two maps illustrate the locations in which tuning tubes will be placed surrounding Tunney's Pasture Station and Parliament Station. In addition to pinpointing locations for implementation of the aural network, the maps also show the musical chord associated with each station, the station itself, and the density of the surrounding area.

The white passages which are connected to the axonometric plans of each station signify the anechoic entryways which will be explained within 3.0 Human Scale. The circles, which represent sites of implementation, are colour coded to represent the musical note of the tube which will be placed there. The tone of blue which is utilized on the top plane of each building references building density.

3.0 HUMAN SCALE

At each location in which a tuning tube is located, sonic installations and pavilions will be erected that change the soundscape heard by those present. Soundscapes are altered similarly to the urban scale through quieting, filtering, and amplifying aural elements of the surrounding environment.

3.1.1 QUIETING

Public spaces that are contaminated by the sound of traffic and other widely perceived forms of noise such as mechanical hums and frequent construction deserve a more intimate and sonically dampened environment for those who occupy the space.

There are several ways to create this desired atmosphere through architecture. Architectural journalist David Daniel, in his article *Timber Architecture: 10 Benefits of Wood Based Designs*, writes that “even though wood doesn’t act as a perfect sound insulator, it does prevent echoes from bouncing around the room by absorbing sound waves.”⁵ Materials such as wood, cork, and fiberglass are highly absorbent and will destroy much of a soundwave before it reflects towards occupants. This process is called dampening—as the materials reduce the likelihood of unwanted reflections. Once the form of these materials begins to be manipulated, far greater results can be achieved. Within an anechoic chamber, sound can be almost non-existent as the fabricated wall panels direct all sonic reflections away from occupants and absorb much of the signal with each bounce. Here, the absorptive material chosen is arranged into sawtooth patterns. With this form, the angle of incident will always be directed inwards.

(Below) Swiss Sound Box

An excellent example of using wood as a tool to dampen an exterior space is Peter Zumthor’s Swiss Sound Box from Expo 2000. The open-air pavilion is a timber labyrinth built around several cafes and musical performance spaces.

(Above) Anechoic Foam Panels

Anechoic panels come in all forms, but a sawtooth shape is most common. This shape is what directs soundwaves inwards. In most cases, the panels are fabricated from porous foam materials.

In addition, there are materials that are almost impervious to refraction, such as concrete. When standing close to a tall concrete wall that separates one from a busy street, most of the noise coming from motor vehicles will not be heard. Some sound will diffract at the boundaries of the wall and travel towards the occupant. However, the signal will be slightly filtered.

(Above) Anechoic Entry at Parliament Station

Both staircases which service Parliament Station will have it's walls and ceilings clad with anechoic panels. The image was made to convey the sense of silence which would be experienced. The stairway has been reduced to linework and has been deconstructed to the point of abstraction.

3.1.2 EXECUTION OF QUIETING

Two site-specific examples of quieting pavilions and spaces are proposed: an anechoic entryway at each LRT stations, and a newly planted forest of mature trees along Spark's Street.

At the entry to each station, an anechoic pathway would be constructed to act as a cleanser of the aural palette. Developing a threshold like this creates a sonic boundary between the experience of the city as it exists and the formulated listening environment within each station. For stations below ground, such as Lyon, Parliament and Rideau, the descending stairways could be fitted with anechoic panels on their walls and ceiling to deaden almost all sound within the space.

(Above) Sparks Street Forest

The image illustrates the forest of mature coniferous trees to be planted along Sparks Street. The white of the trees and the space within the forest is to represent the dampened soundscape. The coloured birds represent the sonic illumination.

For stations above ground: pavilions will be constructed at or near the main entry point, providing a similar effect of sonic cleansing. Like the anechoic stairways, these pavilions would be clad with the same interior panels. As one enters the structure and turns around a defined corner into a serpentine corridor, one will find oneself within an almost completely silent atmosphere before entering the station's concourse. The only sound perceived will be the rhythmic tapping of one's feet across the floor, providing a tempo for the sonic events beyond.

Sparks Street is in need of urban renewal. Once the talk of the town, this pedestrian concourse is now widely criticized as a failing urban space. As a pedestrian highway with no cars to traverse it, the sound of cars is still present within the background layer of the soundscape. The projected aural network proposes planting a forest of mature coniferous trees along the street in an attempt to return some significance to its prestigious site. This forest of trees will absorb the sound of traffic while inviting more birds and smaller species of wildlife to

inhabit the area and provide ambience to the environment. As mentioned previously, natural soundscapes similar to those found far out of the city are known to provide mental restoration, an added bonus to the quiet atmosphere that Sparks Street would inherit.

3.2.1 FILTERING

Urban spaces that feature high amounts of traffic sounds lend a viable opportunity to alter the perceived noise with new aural identities by means of filtering. Acoustic resonance (like the effect provided by the tuning tubes), diffraction and careful material selection are methods which can be used to provide this sonic experience.

(Below) Sonic Diffraction Diagram

This image illustrates soundwaves diffracting through openings of various sizes. Note that smaller openings will cause greater levels of diffraction.

As discussed within the section on tuning tubes, cylindrical vessels can be used to warp sound into musical tones. Diffraction is also an effective way of providing filtering. Sound, like light, can bend around objects and travel through perforations within partitions. When sound bends, its properties change ultimately changing the way it is perceived. It could be articulated in bursts or given slight spectral colouring.

Materials can also change the timbre and tone of sounds through vibration. If a hole was made within a wall, sound would diffract through it. By coating the shaft that forms the opening with a metal material such as tin, the aural signals would be given additional harmonic overtones upon entry, changing what is heard.

3.2.1 EXECUTION OF FILTERING

Two site-specific examples of filtering pavilions and installations are a concrete wall pierced with diffractive orifices along O'Connor Street and a tubular passage over the LRT tracks east of Tunney's Pasture station that resonates as the trains pass.

O'Connor Street is a one-way arterial road that moves traffic from north to south through downtown Ottawa. The soundscape located along the street is almost entirely made up of traffic and other anthropogenic signals. Where O'Connor crosses Sparks, sections of the sidewalk's edge could be extruded to form 2.5-metre-high concrete walls. When standing on the opposite side of this wall to the street, an onlooker would be shielded from much of the sound coming from the busy road. That being said, some sound would still diffract around the edges and reach those who are situated there. While concrete is almost completely impervious to refraction, small orifices could be made, allowing concentrated bursts of diffracted sound to pass through. While walking to the left of the concrete boundary that

(Above) O'Connor Diffractive Orifice Wall

This image illustrates one of the diffractive orifice walls that will be erected along O'Connor Street. The coloured paths reaching out from the barrier attempt to convey the filtering of traffic sounds.

(Above) Tunney's Pasture Sonic Bridge

The image illustrates the pedestrian bridge spanning across the light rail train trench. As the trains pass below, the tubes will resonate, as shown in white.

blocks view of the road, articulated bursts of sound could be rhythmically arranged to stimulate the right ear. This could be enhanced by casting aluminum and PVC tubes through the wall and flush with its surface. As sound diffracts through these coated openings, material related vibrations will add sonic embellishments, further modulating the signals with harmonic overtones.

When traveling between Bayview Station and Tunney's Pasture Station, the light rail trains travel through a depressed trench that once held the transitway prior to the LRT's construction. While there are some streets that cross over this depressed transit route, a pedestrian bridge has the potential to harness the sonic power of passing trains. This proposed pedestrian bridge would be located between the crossings of Parkdale Avenue and Hinchey Avenue. Spanning across the trench will be a pair of elevated corridors supported by tensile cables connected to a larger truss structure. 3-metre diameter by 5-metre long aluminum tubes will be inserted into the larger truss structure and the centremost tube will be made occupiable and uti-

lized as a central crossing point. These lengths of these tubes will capture the tone of C1 that the train has been shown to project. As trains pass beneath, the large tubes will roar in harmony with the train, filtering the sound into the musical note.

3.3.1 AMPLIFYING

Urban spaces that feature a pleasant sonic signature that is perhaps underappreciated or unnoticed could utilize architecture to amplify its signal to greater volumes. Spatial vessels could also be used to give residents of Ottawa the opportunity to observe sounds lost within the background city.

Amplification can be achieved through many spatial and architectural strategies. When a sonic event is placed within a space that allows for many sonic reflections from architectural elements or the space's perimeter—the signal will be perceived to be much louder as it has formed several echoes within its container. This is called reverberation. Careful material choice can increase the amount of reverberation within the space. For example, materials such as concrete and glass would reflect much more sound than a porous material such as wood. This phenomenon can be commonly observed in the city when a car passes under a highway overpass. The sound of the car's engine will travel in a spherical path from its origin and then reflect against the hard, concrete underside of the infrastructure, in a magnified way.

Quiet signals can also be amplified directionally through long tubular vessels. This effect can be observed when cupping one's hands to the mouth and shouting or when holding one end of a tube to a sound source and listening through the other end.

(Above) Parliament Hill Reverberant Dome

This image illustrates a view of the reverberant glass dome above the Centennial Flame. The blue dots which fill the dome attempt to convey the diffusion and amplification of the fountain's flow within the space. The red arrow signifies the bell's song travelling towards, and through the tubular opening.

3.1.2 EXECUTION OF AMPLIFYING

Two site specific examples of amplifying pavilions and installations within Ottawa's aural network are proposed: a reverberant dome on Parliament Hill and a set of listening devices at Westboro Beach.

Above the Eternal Flame on Parliament Hill, a glass dome is proposed. Due to the importance of the location, glass was chosen in order to not obstruct views of the Parliament Buildings. The underside of the structure is supported by thin steel columns at a height of approximately 2 metres above the stone pavers. Upon crossing under this threshold presented by the underside of the structure, the sound of the Centennial Flame's fountain will reverberate within the dome and fill the soundscape with the sound of flowing water. This will also mask most exterior sounds.

As the Eternal Flame is fueled by gas, an evacuation point must be created within the dome to avoid the collection of hazardous fumes. At the highest point of the dome, a tubular opening will extend from

the spherical geometry and be oriented directly toward the Peace Tower's bell. From this opening, fumes escape as sounds enter. When the Peace Tower's bell rings, as long as there are no physical objects blocking the path of the signal, the soundwaves will enter this orifice and enter the dome from above, layering upon the water filled soundscape.

Westboro Beach is a natural, green space on the shore of the Ottawa River adjacent to a large urban area. While one would expect a pleasant soundscape, by day its spectrum is overwhelmed by the sound of traffic on the John A Macdonald Parkway to the south. By providing two listening devices, one directed to the water's surface and another directed into a group of trees, an experience will be created that immerses an observer within nature. The listening devices would be tubular aluminum forms which widen toward the landscape and narrow towards the listener. A bench would be constructed on the beach where one may sit. The listening devices would be supported by steel frames and aim the narrow ends back to the bench; one on the left,

(Above) Westboro Beach Listening Bench

The image above illustrates the listening bench which will be established on the shores of the Ottawa River. With one device focused on rippling water and another focused on blowing leaves, the listener will be immersed in nature.

one on the right, and both at ear level. The participant sitting on the bench would be able to bathe within the sonic melody of rippling water and the wind through leaves as they stare out at the scenery.

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04

EXPERIENCING SOUNDSCAPE

>> A JOURNEY THROUGH OTTAWA'S BACKGROUND CITY

04

The following chapter narrates the sonic journey of Otto, a worker within Centre Block's library, as he commutes from the Hill to Parliament Station on his way home for the weekend. As he makes his way across the great lawn, along Wellington Street and down O'Connor Street to Queen Street, Otto will be subject to the experience of the Background City through Ottawa's new aural network. His sonic experience can be relived firsthand by means of the fabricated soundscape, titled **161_Soundscape.wav**, that has been included with this document.

Otto left work at 4:58 pm on Friday, April the 17th. By the time he exited the front doors of Centre Block, the sounds of rush hour traffic could already be clearly heard from his position atop the front terrace.

He made his way down the central path that splits the Great Lawn into two emerald halves. There were several people on Parliament Hill that day as there had been a public demonstration. The sounds of conversations could be heard on all sides as he approached the Centennial Flame.

A glass dome had been recently suspended above the Flame and its accompanying fountain. Beneath this dome, a group of people were gathered. As Otto passed under the steel structure of the pavilion, the sound of flowing water from the Centennial Flame's fountain filled the air as it was captured by the domes shape and amplified through reverberation. The sound of rush hour traffic disappeared. Otto sat on the edge of the fountain and enjoyed the soundscape for a few moments. Just then, the clock struck 5:00pm and the bells of the Peace

(Above) Section and Score of Reverberant Dome

The image above illustrates Otto's sonic experience at the Reverberant Dome. Broken down into 4/4 time, the section and score can be followed along while listening to the audio file entitled **162_Sequence-1**.

Tower chimed and entered the dome's enclosure from above through a small tubular opening. The soundmark provided by the bells snapped him from his meditative state and he regained awareness of the urban site in which he was situated.

Otto stood up and headed toward Wellington St. Ahead of the LRT station—conveniently two blocks away from the Hill—he was to make a stop at a Bank on Sparks Street.

He descended the gentle slope through the front gates to Wellington St., and as he went, the percussive taps of his footsteps against the stone pavers followed him. Once he reached the sidewalk, he waited with a hoard of pedestrians to cross over Wellington St. to the corner of Metcalfe St. Several cars whizzed by in high volume before the lights turned red and the large group proceeded in unison across the temporarily quietened street.

Upon reaching the other side of the road, Otto turned right and made his way west towards O'Connor St. The traffic resumed and soon the soundscape was once again filled with the rumbling cacophony of passing automobiles. As he walked along Wellington St, he passed several people and noticed the sounds of their footsteps and voices. He then passed a construction site to his left and was amazed by the sounds of tools striking metal. While arguably noisy, the sporadic complexity of the workers' rhythmic strikes was musical in its own, abstract sort of way.

Once he arrived at the corner of O'Connor St., the traffic lights within the intersection turned red and more people began to flood across the road towards Otto. He took a left and began

to head south down O'Connor St. in the direction of Sparks St.

As he walked, the traffic lights behind Otto flashed to an advance turn signal; the traffic resumed routed to his right down O'Connor St. As Otto approached the mouth of Sparks St., he noticed a concrete extrusion in front of him which rose from the sidewalk, following the path's curvature. Within this wall were several small orifices that made their way through its cross-section. He then observed that they were coated in various materials.

As he passed to the left of this wall, the sonic intensity of the passing traffic to Otto's right disappeared as the mass of the extrusion blocked much of the transmission of automotive sounds. Continuing along the extrusion's length, Otto's right ear began to be stimulated by diffracted bursts of sound passing through the various orifices. The bursts of filtered traffic sounds came in a rhythm which stood distinct from the tempo set by his footsteps, forming a complex pattern.

(Above) Section and Score of Diffractive Orifice Wall.

The image above illustrates Otto's sonic experience along O'Connor Street while passing a diffractive orifice wall. His experience can be followed along while listening to the audio file entitled **163_Sequence-2**.

Once at the far end of the wall, Otto had reached Sparks St. and gazed upon a forest of mature coniferous trees which had recently been planted along the pedestrian promenade. He turned left and entered the forest, following a curving path towards his bank.

(Above) Section and Score of Sparks Street Forest.

The image above illustrates Otto's sonic experience within the Sparks Street forest. His experience can be followed along while listening to the audio file entitled **164_Sequence-3**.

As he got deeper into the linear cluster of spruces and pines, the sound of traffic began to disappear almost altogether. In its place, from above Otto's sightline, came the sound of birds gently chirping from their nests among the tree branches of the foliage. He turned right in a clearing and then entered the confines of the bank.

As he passed through the vestibule, the sound of nature disappeared and Otto was subject to the joyous melody of Petula Clark's "Downtown", being played from a small speaker somewhere out of sight. Otto hummed along as his fingers tapped against the pin pad. The ATM made a mechanical whirring sound before ejecting his cash.

Upon exiting the bank, Otto stood within the clearing to enjoy the sounds of the birds for a few moments before retracing his steps back to O'Connor St.

Once exiting the forest and reaching the road, he turned left and passed by another concrete orifice wall that gave him the familiar aural stimulation.

After walking the length of the wall, Otto neared Queen St., and the entrance to the LRT station. He passed by a large garage door that emitted a monstrous hum of mechanical noise. After enjoying the peaceful atmosphere provided by the forest, this startled him. He began to wonder why on earth someone would make a mechanical unit so loud and unpleasant. Perhaps it couldn't be avoided. Perhaps it could.

Once at the intersection of O'Connor and Queen Streets, Otto waited to cross O'Connor St. to reach the entrance to the station. A plane could be heard in the sky above and several cars passed by before the lights turned red, allowing him, and a couple other commuters passage. He approached the doors and opened them with a click before passing through a vestibule and into the interior.

Ahead of him was one of the new anechoic zones that had been installed at each LRT station. As a few pedestrians hurried by Otto, he admired the sawtooth-like wedges that pinwheeled across the walls and ceiling of the stairway leading down to the station beneath the topographical surface of Ottawa's urban core.

He began to descend the stairs and before long, things were almost silent. The stairway's dampened soundscape created a vacuum-like atmosphere that was only sonically illuminated by the faint taps of shoes along the floor. As he came to the bottom, he began to hear a faint drone of a musical chord that slowly increased in amplitude as he came to the concourse situated above the platforms.

(Above) Section and Score of the Anechoic Entryway at Parliament Station.

The image above illustrates Otto's sonic experience while entering Parliament Station. His experience can be followed along while listening to the audio file entitled **165_Sequence-4**.

Upon entry into the grand concrete vaulted space, the musical hum filled the aural spectrum. After taking a moment to ground himself, Otto began to perceive familiar sounds within the dense hum.

He heard Parliament Hill, which was so familiar to him. He perceived the sounds of the fountain, the chatter of people, and the low rumble of cars. Otto then made his way towards a stairway that would take him down to the platform for the eastbound train. As he got closer, he could hear O'Connor St. and the filtered bursts of urban sound diffracting through the orifices. Descending the stairs, he then heard the faint chirping of birds and the sound of wind blowing through trees that made him think of his time in the forest on Sparks.

(Above) Section and Score of Parliament Station.

The image above illustrates Otto's sonic experience within Parliament Station. His experience can be followed along while listening to the audio file entitled **166_Sequence-5**.

Once on the platform, he heard the train approaching. The roar of the tracks increased in amplitude until it blocked out the enchanting city performed composition. The sound of Sparks Street returned as the train came to a halt and the doors opened. Otto entered the train and sat in his favourite seat. Third car, turn to the left, right side, second row, window seat. As the doors closed, he smiled, and the train departed.

Through Ottawa's new aural network, Otto was given a new perception of the city's soundscape. Sounds that were once irrelevant or that had been lost were revealed through the network's series of aural interventions. Sounds that he thought he knew well were heard in new ways.

05

BEYOND THE BACKGROUND CITY

>> THOUGHTS, REFLECTIONS, AND OTHER APPLICATIONS

05

Exploring the rationale, execution, and experience of Ottawa's aural network outlined in chapters three and four, allowed the methods and ideologies explored within this thesis to be expanded and even be applied to other areas of urban design. Not only could a new set of standards be set in place to begin fighting the growing congregation of noise pollution, soundscapes could potentially be fine-tuned to benefit the quality of life and emotional well-being of urban dwellers. The seasonality of Ottawa also lends other sonic potentials to the overall network. Recognizing snow's sound dampening effects during winter months, for example, can be enhanced by architectural and acoustic installations that bring awareness to this seasonal condition. Similarly, changing aural conditions could be harnessed by developing agency between the city's designers and residents alike. New technology could also be developed to allow for sonic understanding and collaboration among residents using smartphones. Let us now then briefly explore the potential future of these theories, methods and research.

PHASE 2

While the aural network follows the Confederation Line from West to East through Ottawa's core, it only seems logical to continue this network South along the future extension of the Trillium Line.

Expanding to the South, the aural network will connect diverse areas such as Little Italy, Carleton University, South Keys, the Macdonald-Cartier International Airport and Riverside South. While many of these sites would not be classified as strictly

urban, the various locations present opportunities for sonic manipulation given the unique sound sources and spatial conditions that they already exhibit. For example, the immense sound and vibration exuded by planes taking off over Hunt Club Drive, Riverside Drive, and Leitrim Road could be harnessed by sound sculptures to form more musical landscapes through acoustic resonance.

THE FIGHT AGAINST NOISE POLLUTION

While the aural network demonstrates ways in which quietening can be used to provide unique experiences, these methods could be established at an infrastructural scale to begin suppressing the rising noise levels within cities internationally. While noise barriers are used along highways to help diminish the influence of traffic noise, they are often an eye sore. Through inventive design, these vertical slabs could be given aesthetically pleasing forms while maintaining their deconstructive interference functions, significantly lowering sound levels beyond the barriers.

While large scale renovations to building facades would be costly, minor renovations could present significantly quieter volume levels. Along busy arterial roads and main streets, the lower stories of buildings could be re-skinned with porous materials such as limestone, wood, bamboo and other organic materials such as clay tiles. The result of these façade upgrades would lead to much lower noise levels at street level, as the new cladding materials would absorb much of the sound created instead of reflecting it. Even the addition of more trees along city streets would help to significantly lower noise pollution levels.

FOCUS ON WELL BEING

Parks are a common element of urban design, yet the natural experience they recreate is not fully realised due to the ever-present urban hum. While several new parks should be created to allow easier accessibility for residents, the perimeter of existing parks should be lined with trees to create a natural barrier that separates the soundscape from the rest of the city. This would result in higher quality acoustic environments providing a beneficial and restorative experience for visitors.

Another approach to well being could be the development of raised walkways, like the Highline in Manhattan, that allows pedestrians to travel over busy streets instead of alongside them. The underside of these raised walkways could be clad with absorptive materials to aid in the reduction of sonic reflection and diffraction. By creating these pedestrian routes which separate human traffic from automobile traffic, dwellers will be open to promenades which are free of much unwanted urban sound. In addition, pedestrians would be able to freely cross the street from above which would decongest the movement of automobiles below.

SEASONALITY

Each of the four seasons in Canada lend unique characteristics to Ottawa's urban soundscapes over the course of a year. Spring brings the sounds (and scents) of nature as flocks of birds migrate from their southern winter retreats. Summer and its warmth draw residents into the parks and streets of the city, filling the air with the hustle and bustle of human activity. Come Fall, the trees paint the horizon with warm colours before releasing their leaves to tumble through the urban landscape, scratching and crunching under foot. As the days grow

shorter in Winter, so do ambient volume levels as fresh snow coats the city and acts as a natural acoustic dampener.

The aural network should allow for a transience in both its scope and interventions that adapt to the changing of the seasons. For example, the listening bench located at Westboro Beach will cease to hold the same sonic significance during Winter as the Ottawa River will be frozen and most trees will be devoid of leaves. Come the first snow fall, the listening devices could be altered to monitor the frigid wind from the West and the sound of water flowing below the crystalline prison of ice that covers the river's surface. Interventions aside, the city could develop strategically placed sonic barriers throughout the city using its snow removal services. Public spaces can be walled-off along partial sections of the site perimeter utilizing snow collected from the surrounding area. The snow would reduce ambient noise levels within the interior of these spaces. This strategy would be especially effective around Confederation Park during Winterlude.

SONIC AGENCY

In the chapter "Being in Sound" within *Collaborative Intimacies in Music and Dance*, anthropologists Tamara Kohn and Richard Chenhall state that "because sounds are embodied, both in their production and in their perception, they allow for the creation of a shared, collaborative intimacy between humans and places."¹ The aural network indeed allows the city of Ottawa to communicate with its residents through the interventions proposed by the thesis project and the myriad tuning tubes linked to each station. Thus, a more collaborative dialogue is created through space that allows the city's inhabitants to communicate with their environment and their urban neighbours.

While the initial scope of the aural network aimed to respect subjectivity by focusing on the sounds that already exist within Ottawa's urban palette, the thesis has discovered that spaces might be developed that allow for further sonic collaboration to exist between residents. Interactive installations could be set up within public spaces allowing for the introduction of new sounds into the urban soundscape. Drawing from musician and composer David Byrne's art installation *Playing the Building*, streets and spaces could be played with percussive devices triggered by a large keyboard or similar interactive instruments and devices. While not everyone necessarily knows how to *play* a keyboard, almost everyone can understand that hitting a key might trigger a sound. This method provides a non-discriminatory way to allow for sonic collaboration.

TECHNOLOGY

Today, technology exists as a vital part of human life. Could tools used to listen to and analyse our surrounding aural environments be incorporated into our personal electronics for remote use? Moreover, could interactive elements be put into place that allow for sonic interactivity between residents as they traverse the city?

Firstly, an app could be developed that gives users the ability to browse through the various tuning tubes that lay scattered across the city. From any location, the live soundscapes recorded from within harmonic tuning tubes could be broadcast to one's smartphone and then enjoyed through headphones. While Ottawa's aural network has improved the soundscapes of many sites through the urban network, there will always be those who prefer to wear headphones for reasons of privacy, isolation, and immersion. By developing this app, the opportu-

nity to listen to the Background City may prove more convenient and desirable for headphone users.

Additionally, another app could be created to allow urban dwellers to listen to their surrounding environments with a heightened level of perception. Utilizing an external stereo microphone, which can be docked to one's smartphone through a plug-in jack, residents could reveal additional sounds lost within the Background City. Further, soundscapes could also be recorded and translated into polar spectrograms that then could then be shared with others.

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Now I will do nothing but listen...
I hear all sounds running together, combined,
fused or following,
Sounds of the city and sounds out of the city, sounds
of the day and night....

WALT WHITMAN, *Song of Myself*

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Little Italy, Preston Street: Image by authour