Investigating Potential Acoustic Indicators for Sound Quality Standard of Ecocity Frameworks

Student: Jessica Carolina

Supervisor: Dr. Maureen Connelly

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Signed by the final Examining Committee:

LINDSAY J. MCCUNN, PHD

Dr. Lindsay McCunn, Vancouver Island University - Director Environment Psychology Research Lab

Dr. David Holloway, BCIT - School of Computing and Academic Studies

Dr. Rodrigo Mora, BCIT - Building Science Graduate Program

Dr. Maureen Connelly, BCIT - Building Science Graduate Program, Director of Centre of Architectural and Ecology

Approved by:

Dr. Fitsum Tariku, BCIT - Director of Building Science Graduate Program

Abstract

Sound quality was approved in Ecocity World Summit 2019 to be developed as a bio-geophysical indicator. The classical measures of sound pressure level are not sufficient to quantify healthy noise levels and balanced soundscapes. Additional acoustic indicators relating sound to perception were investigated for potential indicators of Sound Quality including balanced soundscape (normalized difference soundscape index and biophony / anthrophony ratio), psychoacoustical annoyance, temporal sound level variance, and spectra gravity center. The Olympic Village, Vancouver, BC was used as a proxy neighborhood to represent Ecocity fractal. ISO 12913-1-3: Soundscape standard was applied for collecting and analyzing data. The method of triangulation analysed acoustic measurements of 38 data measurement locations, 71 survey responses and taxonomy classification supports the evidence that psychoacoustic annoyance is an appropriate indicator for the Sound Quality benchmark standard in the Ecocity framework.

Keywords: *Ecocity, sound quality, balanced soundscape, psychoacoustical annoyance, sensory pleasantness, temporal sound level variance, and spectral gravity center*

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Glossary

Acum - unit of sharpness

Aures - method/standard of calculating sharpness taking absolute loudness into account

antrophony (α) - percentage of man-made sound features (traffic, construction noise, machinery, etc).

Balanced Soundscape - signal to noise ratio is high, close to *Hi-Fi*situation

Bark - unit used in critical band rate; scale 0-24

Biophony (β) - percentage of bio sound features in nature (bird sound, insects, etc.)

Building Research Establishment Environmental Assessment Method (BREEAM) - sustainable building certification that makes sure building users achieve maximum comfort, productivity and their well being.

Canada Mortgage and Housing Corporation (CMHC) - standards in Canada regulating noise based on traffic and railway noise

Critical bands - frequency bandwidth where the second tone perception interferes with the first tone which is known as masking. Scale 0-24 Bark.

Decibel (dB) - unit for sound level pressure level/ sound energy

Decibel (dBA) - unit for sound pressure level measurement calculated in logarithmic scale

DIN 45692 - method/standard of calculating sharpness not taking absolute loudness into account

Frequency - rate of vibration/ sound wave measured over a period of time; unit: Hertz (Hz)

Geophony (γ) - percentage of natural sound that exists in soundscape (wind, water, earthquake, etc).

Hertz (Hz) - unit of frequency

International Commission of the Biological Effects of Noise (ICBEN) - an organization that standardized surveys for VNAI and NNAI values.

International Ecocity Framework and Standards (IEFS) - An Ecocity organization that evaluates the city’s capability to get Ecocity certification plus regulating the Ecocity framework

LAeq - A-weighted sound pressure level / equivalent continuous sound pressure level; dBA

Leadership in Energy and Environmental Design (LEED) - An organization that regulates and certify buildings that met energy and environmental standards

Loudness (N) - human perception of sound volume; *sone*

Modulation depth - modulation amplitude

Natural Features (NF) - percentage of natural features in the scene/frame including drywall and excluding sky

Noise Criteria (NC) - noise criteria curve that regulates ambient noise from mechanical equipment or electronic equipment inside the room.

Noise Reduction Coefficient (NRC) - material sound absorptivity specification

Normalized Difference Soundscape Index (NDSI) - term to calculate balanced soundscape.

Normalized Soundscape Index (NDSI) - objective measurement to compute the percentage of anthropogenic and biophonic soundscape.

Numerical Index (NNAI) - numerical survey result to observe psychoacoustical annoyance

Psychoacoustic Annoyance (PA) - objective measurement of psychoacoustic indicator of sharpness, roughness, fluctuation strength, loudness.

Percentage of Noise Annoyance (PNAI) - percentage of noise annoyance in the soundscape

Reverberation Time - measurement of how fast sound decay by 60dB from its original level.

Sensory Pleasantness (SP) - objective measurement of psychoacoustic indicator with sharpness being the point of interest. Indicator measures include loudness, sharpness, tonality, and roughness.

Sound Transmission Class (STC) - standard that measures sound transmission between two adjacent spaces.

Spectral Gravity Center (SGC) - objective measurement to locate centre of frequency and intensity components of sound

Temporal Sound Level Variance (TSLV) - objective measurement of how often sound changes overtime, measured in dB

Tranquility Rating Tool (TRAPT) - objective measurement to measure tranquility rating in the area

Verbal Index (VNAI) - verbal scale of survey result that denotes psychoacoustic annoyance

1. Introduction

The purpose of this study is to investigate suitable acoustic indicators to be considered as parameters for the Sound Quality in the Ecocity Framework. In addition to the classical measurement used in environmental acoustics there are four acoustic indicators investigated in this research which are balanced soundscape, temporal sound level variance, spectral gravity center, and psychoacoustical annoyance. The case study selected for this study is the Olympic Village as its physical attributes strive to align with Ecocity Level 1 standards. Field measurements and surveys on site were conducted to obtain 71 participants and 38 field measurement points. The survey was adopted from the ISO 12913-2:2018 standard (Questionnaire Method A), the survey gathered raw feedback of Olympic Village's soundscape experiences. Field measurements were collected from points where surveys were conducted. The results gathered from field measurements and the surveys were calculated and modelled with binary logistic regression analysis to determine which acoustic indicators are suitable to indicate Sound Quality in the Ecocity Framework.

Context

Sound is an energy (watt/squared meters) which propagates over distance, and is attenuated over sound paths. Sound is typically expressed in a logarithmic scale with a decibel (dB) unit, measured in Leq (dB) or weighted Leq (dBA). Sound in terms of sound pressure level can be perceived as annoying or pleasant depending on types of sound sources that exist in the sound pressure level (Radicchi et al., 2021). Sound is necessary in our daily life. It has semantic content, sound can provide a listener with feelings or cognitions that represent social values, and explains how we are communicating with each other.

Unwanted sounds can be described as noise. Noise can be described as unpleasant sound that gives negative effects on human feelings and can potentially create harmful effects on human health (WHO, 2018). For example, traffic noise, aircraft noise, human-made noise (i.e. heavy equipment utilization, construction noise), etc (Bronzaft, 2020). The densification of urban population demands an increase in access to mobility, thus increasing noise pollution produced by closer human activities (Radicchi et al., 2021). Noise causes loss in many ways ranging from health loss to economic loss and is evaluated in terms of social cost (WHO, 2018). The World Health Organization (WHO) estimated a loss of 1.6 million disability adjusted life years (DAYLS) or equivalent to 1-2 days per capita per year as a result of hearing impairment, sleep disturbance (56%), cardiovascular diseases and stress and cognitive impairment. In developing countries, people are exposed to 75-80 dBA for 24 hours everyday, while a healthy range for sound pressure level is in the range of 30-50 dBA (indoor/outdoor) (WHO, 2011). Workers or people that have activities close to noisy areas such as industries, airports, and constructions develop changes in the hormonal system that lead to increases in blood pressure, heart rate and vasoconstriction; eventually resulting in cardiovascular disease (Berglund et al., 1999). Soundscape can be described as a relation of landscape and composition of sound generated from human activity and all species in the environment. A balanced soundscape supports organ and tissue development (Day 2007, Cooper-Marcus 1999). Increasing exposure to natural sounds and reducing exposure to noise contribute to reduced stress, increased relaxation, emotional balance, and improved cognitive functioning (Ulrich, 1991, Kryter 1994, Cooper Marcus 1999, Öhrström 2006).

Sound can convey positive messages and feelings to the listener. For example, during COVID-19 outbreak people in New York cheered on front-line health workers (The New York Times, 2020) and in Italy people gathered on the balcony singing and clapping to keep up with positive motivation (The Guardian, 2020). Another example of healing sound are natural sounds such as water, bird song, wind, insects, etc. (Schafer, R. M. ,1980)

Environmental and architectural acoustics, soundscape ecology, communication, and environmental psychology are all diverse fields that support the guidelines recommendations and findings published by the World Health Organization (WHO). Environmental psychology details the human responses to the range of the auditory stimulus. Human auditory system is sensitive. In order to function optimally, the human auditory system requires the appropriate auditory stimulus. Human perception of touch, hearing, smell, vision, taste depends on the habitation or adaptation of their stimuli response (WHO, 2011). In theory and practice, designing habitat should provide a healthy range of auditory stimulus.

The Ecocity concept is a modelled human settlement function by a sustainable and healthy ecosystem and living organism (Ecocity Builders, 2019). Ecocity consumes less renewable resources than it produces and generates less waste by utilizing recycling, reusing, and diluting waste into the ecosystem without polluting it. Ecocity inhabitants have a supportive lifestyle where everyone is fulfilled living in terms of social-economy status.

Ecocity emerged as a new standard and movement encouraging cities to move toward more healthy and greener sustainable cities. The Ecocity framework consists of 9 levels that are starting from unhealthy city to GAIA city (Appendix 1). Unhealthy cities will have an unhealthy score, Ecocity standard / Ecocity 1 means healthy and GAIA means restored. Quantifying subjective measures of the words unhealthy, healthy, and restored is critical for the effectiveness of the standard. The framework does not include Sound Quality as part of the evaluation. BCIT Centre of Architectural Ecology proposed a Sound Quality indicator to be added under bio-geophysical category at Ecocity World Summit 2017 Melbourne (Connelly, 2017).

Similar to the requirement of clean air, water, soil, reusable materials, energy and food, an Ecocity needs a balanced soundscape in order to create a healthy environment. A Sound Quality standard is recommended to be added under the bio-geophysical category. Currently, municipal acoustical standards are generally developed with the classical indicators of sound pressure level. As proposed in 2017 and later discussed in the Ecocity Sound Quality Workshop in 2019, several alternative acoustic indicators could be used as potential Sound Quality indicators for healthy and GAIA soundscapes. These acoustic indicators include; balanced soundscape, psychoacoustics annoyance, temporal sound level variance, spectral gravity center, sensory pleasantness, tranquility rating tool, contextual masking, and cultural compositions. These acoustic indicators are explained individually in Section 2. There are many studies that have been completed on each acoustic indicator separately.

This research aims to investigate a set of acoustic indicators for the healthy Ecocity standard. The methodology used to evaluate each indicator varies and is explained in the methodology section. The quantitative and perceptual data are investigated through a triangulation method and regression analysis.

The Olympic Village in Vancouver has been adopted for a case study site due to its neighborhood characteristics that are aligned with Ecocity's principles. Located on the shore of SouthEast False Creek, Vancouver, Canada, the Olympic Village has access to public transportation, adequate sidewalks and bike trails with supporting natural features. The area combines businesses, retail, residential and green spaces into a functional Ecocity.

2. Literature Review

2.1. Quantifying the Acoustical Environment

Exposure to noises leads to hearing impairment, cognitive impairment, intervention of speech communication, sleep disturbance, physiological effects, and mental health effects (Berglund et al., 1999). Globally, municipalities have been developing legislative frameworks to reduce noise and improve community environment by regulating outdoor-indoor maximum sound pressure levels. Below is a summary of the classical indicators and acoustic criteria to quantify outdoor and indoor noise exposure.

Classical Indicators and Acoustic Criteria

Humans respond differently towards different kinds of sounds. There are sounds that are sudden and continuous (background sound). Short and sudden sounds may communicate warning and affect human stimuli differently (WHO, 2018). For this reason, the assessment of environmental noise needs to consider background noise level, activity noises and the noise exposure level (WHO, 2018).

WHO classifies noise regulation in terms of average sound pressure level over 24 hours (LAeq) and recommends the maximum sound pressure level (Lmax) that is appropriate in a specific environment (WHO, 2018). During a specific time frame, such as LAeq 24 hours there is opportunity for a number of sound events with high and low sound levels to occur. These events are not represented in a 24 hours averaged LAeq. The time-averaged LAeq does not align with human auditory stimuli processing, that processes different kinds of sounds indepently. To regulate environmental sound pressure levels based on exposure-response is not yet possible due to the lack of scientific literature (WHO, 2018).

WHO categorized sound regulation based on type of activities, type of environments, time during the day and duration of noise/ sound (Appendix 3) . It also highlights the adverse health effects that could happen if conditions are not met in specific environments.

Human hearing system is not equally sensitive across all sound frequencies. The time-averaged sound pressure level is A-weighted which means the sound pressure level is already adjusted to the frequency of the human hearing system (20Hz to 20kHz).

The A-weighted filter is used to measure environmental sound levels to approximate human hearing which is amplitude biased to mid and high frequencies over to lower frequency (WHO,1999). For discrete events, Lmax and A-weighted sound exposure level (SEL) are more consistent in measuring single-noise events (WHO, 1999).

According to WHO, the maximum sound pressure level (SPL) outdoors varies and the indoor maximum sound pressure level ranges from 30-35 dBA. Outdoor activities zones adjacent to the bedroom building envelope location have a maximum SPL of 45 dBLAeq (8 hours); adjacent to the living areas building envelope have a maximum SPL of 55 dBLAeq (16 hours); playgrounds have a maximum SPL of 55 dBLAeq (during play hours); industrial, commercial, shopping, traffic areas have a maximum SPL of 70 dBLAeq; ceremonies, festivals, entertainment events areas have a maximum SPL of 100 dBLAeq (4 hours); impulse sound from toys, fireworks and firearms have a maximum SPL of 120 dBLAmax peak pressure of 100 mm from the receiver ear location (WHO, 1999). There are different maximum sound pressure levels allowed at each region depending on the activities being conducted in certain areas such as green spaces, residential, commercial, industrial. Additional activity zones sound regulation are detailed in Appendix 3.

The source of community noise comes from public activities, night-time city life and predominantly transportation noises. A study by WHO details exposure to community noise above the range contributes to sleep disturbance such as difficulty in falling asleep and awakenings resulting in decrease in the proportion of REM-sleep (REM= Rapid eye movement) (Hobson, 1989). For busy cities with more than 100,000 population, there are specific measurements measuring average sound pressure level over 24 hours: day-evening night sound level (Lden) also called community noise equivalent level (CNEL) and night noise level (Lnight). The indicator of Lnight addresses increased annoyance sensitivity but does not guarantee people from sleep disturbance (WHO, 1999). WHO recommends Lden and Lnight exposure levels permitted for the outdoor community from transportation and wind turbine sources shown in Table 1.

Table 1. City Exposure Level for Outdoor Community (WHO, 2018)

Activity Zones	**Day Evening Night Noise Level Maximum Sound Pressure Level***	**Night-time Maximum Sound Pressure Level****
Road	53 dBLden	45 dBLnight
Railway	54 dBLden	44 dBLnight
Aircraft	45 dBLden	45 dBLnight
Wind Turbine	53 dBLden	45 dBLnight

*Lden: day-evening-night noise level; the A-weighted (LAeq) over whole day with 10dBA penalty for night-time noise (23:00-7:00) and 5dBA for evening noise (19:00-23:00)
**Lnight: night noise level, the A-weighted (LAeq) over 8-hour period (23:00-07.00)

In addition to Lden and Lnight, Lday or day noise indicator and Ldn or day night indicator are different from the discussed Lden and Lnight. Lday is used to measure day noise level or LAeq over a 12-hour day period between 07.00 to 19.00. In addition to Lmax, there is also Lmin which quantifies the minimum sound level at a period of time and is expressed in dBA. Ln is percentile noise level or sound level that exceeds by certain percentage (0.1% to 99.9%) over a period of time and can be calculated in A-Weighted or Fast-time weighted. Numerous acoustic indicators exist in the field of acoustics to serve different acoustical analysis purposes, the most common includes C-weighting is used to measure the peak of sound pressure level or in other words to measure human response to high noise levels. C-weighting is commonly expressed in dBC or dB(C) and can be presented in terms of LCeq, LCPeak, LCz. Z-weighting indicates no weighting. Z-weighting is commonly expressed in dBZ or dB(Z) and can be evaluated as LZeq, LZFmax, LZE. most common ones.

The working context of this thesis is within Vancouver, BC, Canada. The adoption of WHO guidelines has been translated into acoustic criteria and requirements by Canada Mortgage and Housing Corporation (CMHC) guidelines and local metro Vancouver and green building practices. The CMHC standards for regulating noise are based on the average reaction of individuals to noise. Traffic noise is known to have a more prevalent effect in the dwelling zone than industrial or office zones (CMHC, 1977). Measurement of traffic noise is calculated in LAeq (average sound over a period of time - 24 hours). Maximum acceptable levels of road and traffic noise in outdoor recreation areas is 55 dB.

According to CMHC, in order to regulate noise control over a site, it is important to consider site selection, orientation of the buildings, internal layout, primary agents of sound transmission, and sound insulation materials. Site selection is important as certain arrangements result in multiple sound reflections, thus increasing the resulting noise propagation. Buildings that are located in steep gradients or near intersections have higher noise levels due to the accelerating and decelerating of vehicles engines. Therefore, site planning and building arrangement can be planned such that the traffic noise can be shielded or mitigated by locating sensitive zones further away from the noise source (See Figure 1).

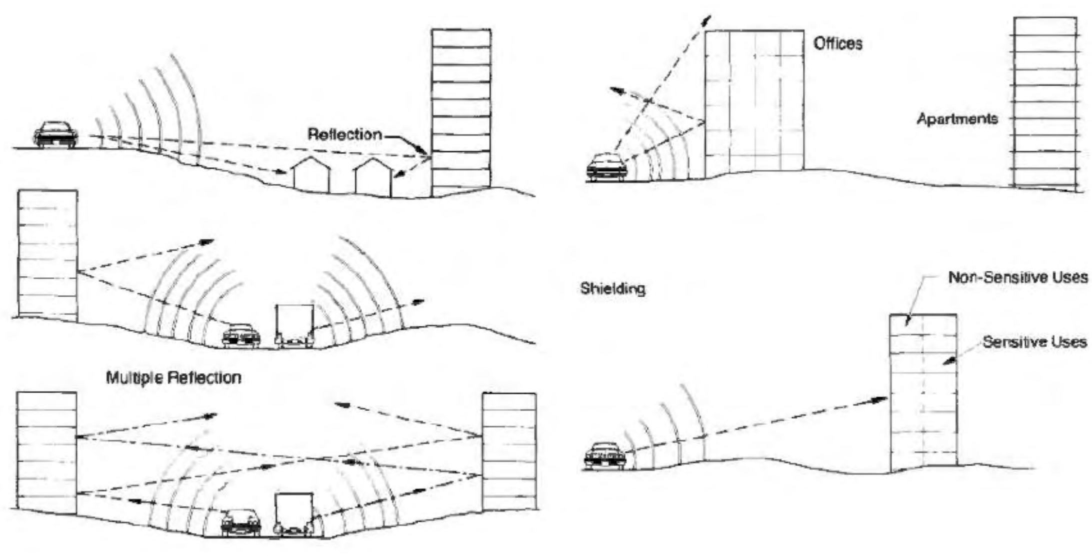


Figure 1. Site and Building Orientation Affecting Sound Waves from Traffic (CMHC, 1977)

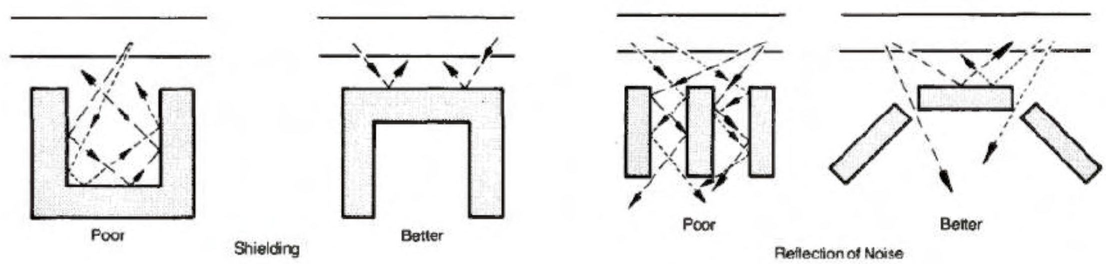


Figure 2. Building Arrangement Examples to Avoid High Noise Accumulation (CMHC, 1977)

The concept of urban proximity or densification, leads to an increase in people residing closer together. While minimizing the amount of private vehicles being used, it is also increasing urban noise and conflicts. Orientation of building masses can be adjusted to mitigate noise as illustrated in Figure 2, a lesson from CMHC and in Figure 3, a noise map of a campus provided by RWDI consultant. To support Ecocity's goals, the site planning design based on physical spatial definition of zones can be shifted to activity based acoustically zones (see Figure 4).

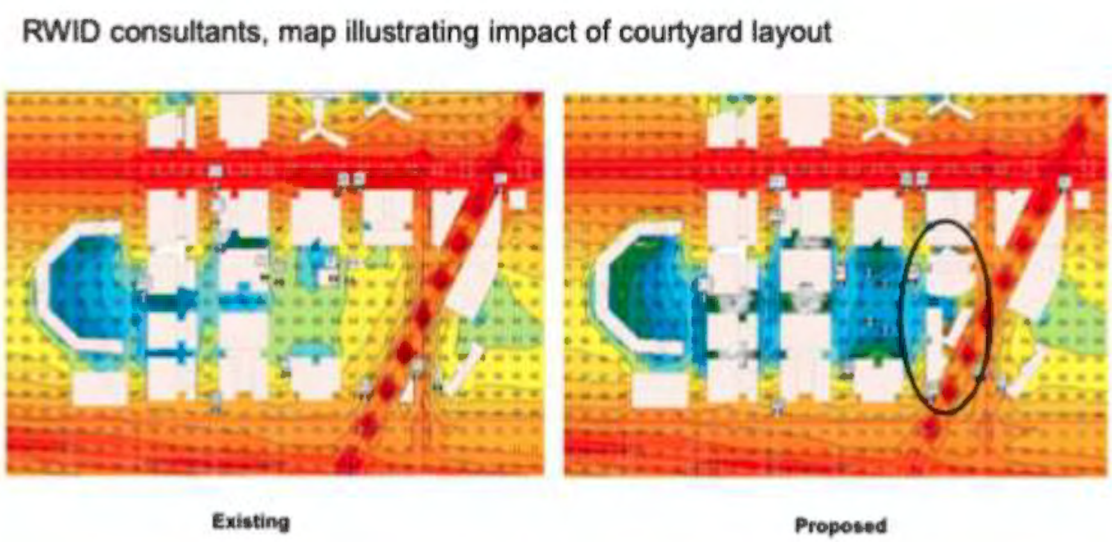


Figure 3. Building Massing Strategy to Mitigate Noise (RWDI, 2019)

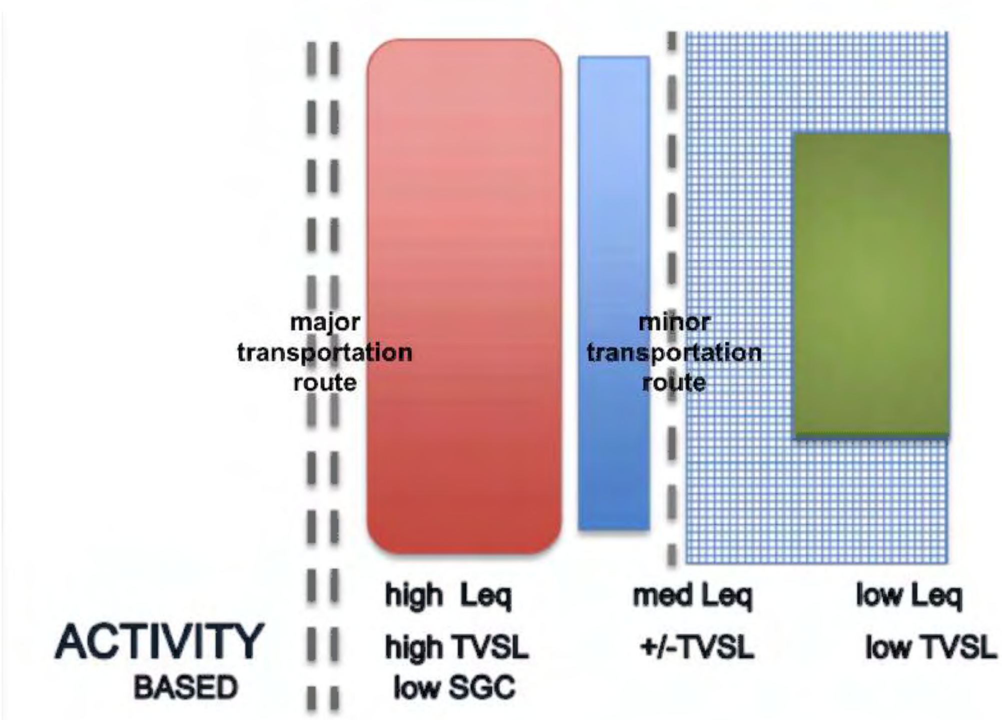


Figure 4. Acoustic Activity Based Zoning (Connelly, 2017)

CMHC regulates and calculates noise coming from traffic noise by combining the data of traffic (percentage of heavy vehicles and traffic volumes per 24 hours, speed limit), road gradient, distance from intersection, source height for road traffic, height of the receiver from above the ground (receiver on the ground versus at level 50th in an apartment), barrier availability and attenuation. Each factor has a weighted function that is applied to the calculation in order to make the level noise prediction received by the receiver.

Railway noise is slightly different from traffic noise as it has a whistle noise, wheel noise and is more steady than traffic noise. It is calculated by combining engine noise in dB, based on speed of the train, wheel-rail noise, distance from source to receiver, barrier length ratio and attenuation, whistle noise, ground surface, number of noise events per day.

Metro Vancouver regulates noise through the Noise Control By-Law 6555 which is a 43 pages document describing noise control, focusing on downtown areas that host special events, louder districts and sites. However, the Noise Control By-Law 6555 is difficult to be implemented successfully due to enforcement challenges. The Noise Control By-Law 6555 divides community regions into three categories of threshold areas; quiet, intermediate, and activity (see Table 2). Users are allowed to file complaints regarding noise interruption. Most major complaints are regarding after hours construction, noisy nightlife, and building mechanical equipment. Noise violations are subject to fines ranging from $250 to $10,000.

Table 2. Noise from Specific Source Regulation (City of Vancouver, 2017)

Activities	Regulated?	Conditions	Exceptions
Noise from specific sources	Yes	Max. 70 dB	
Commercial deliveries	No		
Construction	Yes	- Noisy construction only - Specific hours and days	By application only
Barking dogs	Yes	- 2 weeks continuous noise - Animal Control Act	
Filming	Yes	- Film guidelines and business hours - Film permits	
Leaf blowers	Yes	- Blower decal ≤ 65 dBA - Specific hours and days	Banned in West End
Mechanical Equipment	Yes	- Acceptable noise range limits - By location, hour, day of week	
People, stereos, yard cafe, and more	Yes	- Intended to keep peace	Children playing, church bells, heavy walking, people moving furniture, slamming doors, wind chimes
Power equipment	Yes	- Specific hours and days	
Private garbage and recycling trucks	Yes	- Specific hours and days	Downtown - extended hours
Pubs, clubs, restaurants and cafes	Yes	- Specific hours and days - Liquor locations***	

Green building practices

Leadership in Energy and Environmental Design (LEED) is a green building certification that encourages the use of sustainable materials, sustainable sites, energy and water-used efficiency, and emissions to the atmosphere. *LEED for New Construction* is the only LEED rating system that regulates outdoor community noise. *LEED for New Construction* measures the site background noise to ensure that additional noise generated from new construction does not exceed the maximum allowable level on boundaries located adjacent to residential areas. The maximum exterior noise level (Lmax) should not exceed 60 dBA or existing ambient levels and construction noise should not exceed 45 dBLAeq. On boundaries located not adjacent to residential areas, outdoor day-night noise level (Ldn) or Community Noise Equivalent Level should not exceed 60 dBA. LEED adopted community noise level or city exposure limit from the WHO guidelines (see Appendix 3).

Although not locally adopted, Building Research Establishment Environmental Assessment Method (BREEAM) can contribute to the discussion. Similar to LEED, BREEAM regulates noise pollution to help mitigate noise pollution under *SE 04-Noise Pollution* and *Pol 05 Reduction of Noise Pollution*. *Hea 05 Acoustical Performance* standard recommends building zoning to be in certain arrangements that minimize noise according to its activity zones. BREEAM maximum community noise criteria are also adopted from WHO.

2.2. Soundscape Indicators and Approaches

In urban soundscape ecology, people interact with animals, plants and environment (Bubolz and Sontag 2009, Douglas et al. 2015, Lawrence 2019). A healthy acoustic environment is highly associated with landscape structure (Liu et al., 2014). Green spaces are believed to promote the health and well-being of the city residents (Bertram and Rehdanz, 2015). Green spaces promote a variety of biodiversity constructing an enjoyable, pleasant and healthier soundscape (Farina, 2018). Natural scenes with vegetation are believed to improve cognitive behavior and to assess stress recovery (Ulrich et al., 1991).

Numerous researches have been done in the field of soundscape. One of the most notable soundscape researchers, Bridget Schulte-Fortkamp, has completed substantial research in noise mapping and urban soundscape. Most of her works produced noise mapping of certain locations to overview the soundscape distribution of particular areas. One of her most published studies is a square park located on Nauener Platz, Berlin, Germany. The study studied people's perception towards soundscape in the plaza by conducting soundwalks, narrative interviews, public hearing, workshops and flea markets (Schulte-Fortkamp and Jordan, 2016). The result of this study was a soundscape implication of the plaza based on the user's preferences and desires of sound, such as bird songs, ocean waves, etc. The study took several years to complete. Collection of Schulte-Fortkamp and colleagues soundscape works resulted in the development of the ISO 12913-2:2018 - Acoustics Soundscape standard which is the most recent soundscape data collection method.

Ambient Noise and Categorizations

Natural sounds include water sounds, wind, bird song, insects, water creatures and animals. They can generate restorative ambient noise. Ambient sound is a background sound that is present in the surroundings. Unwanted ambient noises are excess hiss, tapping, traffic noise. As an example, natural sounds offset the effects of urban noises reducing annoyance (Leventhall, 2004, Li 2010).

Noise regulation and policy includes maximum sound pressure level over a period of time for ambient noise, however dBLAeq is independent from the semantic contents of the noise. Every person has a different perception towards incoming sound depending on their expectation (Truax, 2001). With respect to the soundscape in planning healthy cities, placemaking includes responding to the diversity of the city's population (age and behaviors) (Radicchi et al., 2021). Humans social identities shape their perception of noise and sound in public spaces (Shankar et al., 2013). Humans develop a sense of place which is an emotional connection with the geographical environment (Jorgensen and Stedman, 2001, 2006). In an acoustic urban soundscape study, individuals' subjective measurements and perceptions aid the assessment of acoustic quality. This research can be completed with questionnaires, surveys, workshops, and soundwalking.

In ambient sound analysis, the research focused is on the source of the sound. Data collections that categorized sounds within an area are useful in the generation of mapping tools for urban planning (Raimbault, 2005). For example, maintaining the proportion of sounds generated by human activity versus not. The sounds of activities within a soundscape are analyzed based on environments, source and semantic contents.

Balanced Soundscape

A balanced soundscape, according to Schafer, is a soundscape where people still have the ability to talk or express themselves without interruption from sound inputs or impression from the surroundings (Truax, 2014). Eliminating unwanted sounds or noise completely does not indicate that a soundscape is balanced. A similar understanding that healthy cannot be translated as an “absence of diseases” (WHO, 1948).

Truax in the *World Soundscape Project* defined a balanced soundscape as a *Hi-Fi* soundscape. In a *Hi-fi* soundscape, the signal to noise ratio is favorable and the most discrete sound can be heard clearly. A *Lo-Fi* soundscape is the opposite of a *Hi-Fi* soundscape, it describes a really noisy soundscape where there is an inability to distinguish different sounds. Examples of *Hi-Fi* soundscapes are found in rural areas and parks, and *Lo-Fi* soundscapes are found in densely built-up urban areas.

Every soundscape is distinct from each other as each sound source is unique and has different volume, characteristic, rhythm, density, etc. These factors form a different “image” or perception to the listener. Thus, some analytical concepts can be derived from this concept such as keynote, signal, and soundmark.

Keynote identifies the key of a composition. It is a prevailing sound that describes the character of a place. As an example, the keynote is composed of geography and nature (e.g. ocean waves) or from traffic sound in urban settlements. The signal (foreground sound) is a sound that can be heard consciously and most of the time delivering certain messages or information. Signal examples are bells, sirens, whistles, etc. Soundmark is derived from the term landmark and can be described as a unique sound, specific to a certain area. Keynotes are now being investigated in the City of London and will be discussed further in Section 2.5.

According to Bernie Krause, soundscapes can be distinguished into three major categories such as biophony, geophony and antrophony. Biophony is a sound produced by biological organisms such as birdsong, insects, frogs, and animals. Biophony is typically above 2kHz. Biophony is considered as a restorative sound. Geophony describes sounds produced by non-biological natural sources or earth such as wind, water, and earthquake. Anthrophony describes sounds produced by human activity (machine sound, traffic, etc.). Antrophony sounds are typically below the 2 kHz frequency range.

A research study by Kasten et al. resulted in the development of a normalized difference soundscape index (NDSI) to estimate the percentage of antrophonic sound disturbance in a scene by computing the ratio of biophony (β) components to antrophony (α) components. The first step to calculate NDSI is to compute the power spectral density (PSD). Power spectral density is the strength of energy as a function of frequency and can be performed using fourier analysis. Hence, NDSI can be defined as:

$$NDSI = (\beta - \alpha) / (\beta + \alpha) \qquad \text{Eq. (1)}$$

where

β and α are the total estimated PSD for the largest 1 kHz biophony bin and the antrophony bin respectively (Kasten et al., 2012). NDSI ranges from -1 to +1 value, +1 represents a signal without any antrophony component present. Low NDSI indicates the presence of animals and sometimes the value of NDSI can fall below -1. Hence, a value of β greater than 50% denotes a biophony dominant soundscape. When the value of geophony (γ) coincides with biophony, it denotes that bio-geophony is dominant in the soundscape. Note that the climate, dew point, and temperatures have to be accounted for during measurements since they affect how biophony, geophony and antrophony sound translate in the soundscape. NDSI varies seasonality as temperature, climate, and humidity changes over time. Lite review did not find a recommendation about healthy city NDSI suggested values.

A singular ratio was used in the previous soundscape studies of bio-geo/antrophony ratio formula that can be seen below;

$$(\beta + \gamma) / \alpha > 1 \qquad \text{Eq. (2)}$$

If the ratio of biophony and geophony summation is greater than the antrophony, the soundscape of a particular area can be described to have natural content (Connelly, 2010). The proportion of biophony/antrophony ratio has not yet been identified for healthy cities.

Researchers such as Jacob Dein & Johannes Rüdisser had completed research in biophony - identifying the relationship between landscape structure and vegetation with biophony value. Pijanowski, Bryan & Villanueva-Rivera et. al. had completed research in soundscape ecology that identified components of geophony, biophony and antrophony in soundscape. The study resulted in the way animals communicate through different frequencies as well as spatial definition of landscape soundscape.

Soundscape Studies and Development of Standards

Soundscape analysis is now standardized with ISO 12913-2:2018 and ISO 1996 Acoustics — Description, measurement and assessment of environmental noise. The triangulation method approach was distilled to investigate the relationships between sound analysis, questionnaire survey and narrative interview workshop components as illustrated in Figure 5. The ISO 12913 Acoustics-Soundscape Parts 1, 2 and 3 were completed in 2018. The standard outlines are the acoustic and psychoacoustic indicators needed for soundscape analysis and data collection procedure such as soundwalk, creating questionnaire, conducting interview, sound source taxonomy, and binaural measurements.

The concept of triangulation methods is derived from land surveying techniques which identify a single point in a space by converging measurement from two distinct points (Brooks et. al, 2014). Triangulation method is a powerful tool to validate data by cross validating data from two or more sources. Triangulation has been adopted in soundscape research. To conduct a complete successful soundscape study there must be at least two established relationships between the three components of the soundscape analysis (see Figure 6), developed by Schulte-Fortkamp. Integrating subjective and contextual variables ensures soundscape study accounts people's well-being.

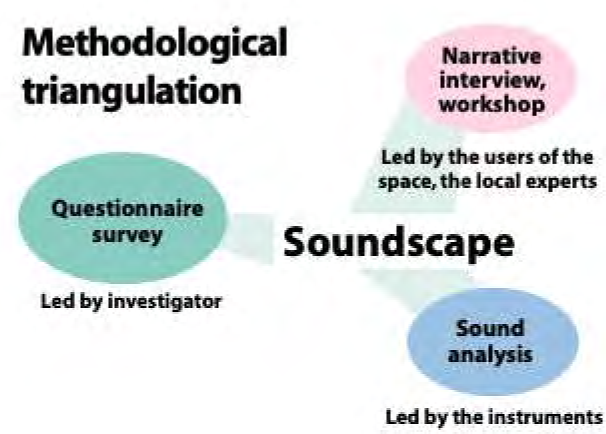


Figure 5. Basic Triangulation Model in Soundscape Research and Practice

Contextual variables can be investigated by conducting acoustic audio recordings on the site. This represents the component of sound analysis illustrated in Figure 5. The equipment used to measure sound is a binaural head with two microphones mounted on the head which represents human hearing mechanisms. The position and orientation of the binaural head are very critical. During acoustic recordings, researchers should pay attention to the exact positioning of binaural head, measurement time, atmospheric condition (wind, humidity, temperature) as those influence sound measured (Kang, J & Schulte-Fortkamp, 2016). During measurement, the sampling rate should not go below 44.1 kHz as per Nyquist-Shannon sampling theorem.

According to ISO 12913-2:2018 the binaural head must be placed at a height of 1.6m from the ground or within a range of 1.5m to 2m according to ISO 1996-2. ISO 1996-2 standard defines that measurement time should take into account human activities and variation of operation of various sounds. ISO 12913-2:2018 stated that measurement time should be at least in duration of 3 minutes per recording repeated three times and minimum of two points of measurements within the area. Both standards used LAeq or A-weighted sound pressure level as the unit of preferred noise descriptor.

Determining the points of measurements depends on the type of research being conducted. Reviewing Fortkamp’s notable works for soundscape research methodology, it is observed for noise mapping, where noise heat maps are generated, grid data collection is commonly used. For specific area noise or sound quality improvement, points of measurements can be determined based on people's activity.

Subjective variables can be investigated by conducting surveys about the soundscape with a number of respondents. This represents the component of the questionnaire survey as illustrated in Figure 5. The number of respondents is determined according to the type of research and purpose of the research. If the research is for local soundscape improvements, respondents should be local experts or people living in the area that know the area well plus are benefited from the research. If the research is for policy making or statistical use, the approach of subjective data collection should be adjusted to its purposes (Schulte-Fortkamp, B.; Jordan, P., 2016). The discussion of the survey will be detailed in the methodology section.

To visualize the survey results and understand as illustrated in Figure 6, the survey results are transformed into a two-dimensional soundscape diagram as per ISO 12913-3:2019 standard. The coordinate of the X-axis represents pleasantness versus annoyance and the coordinate of the Y-axis represents the eventfulness versus uneventfulness and are calculated based on Equation 3 and Equation 4.

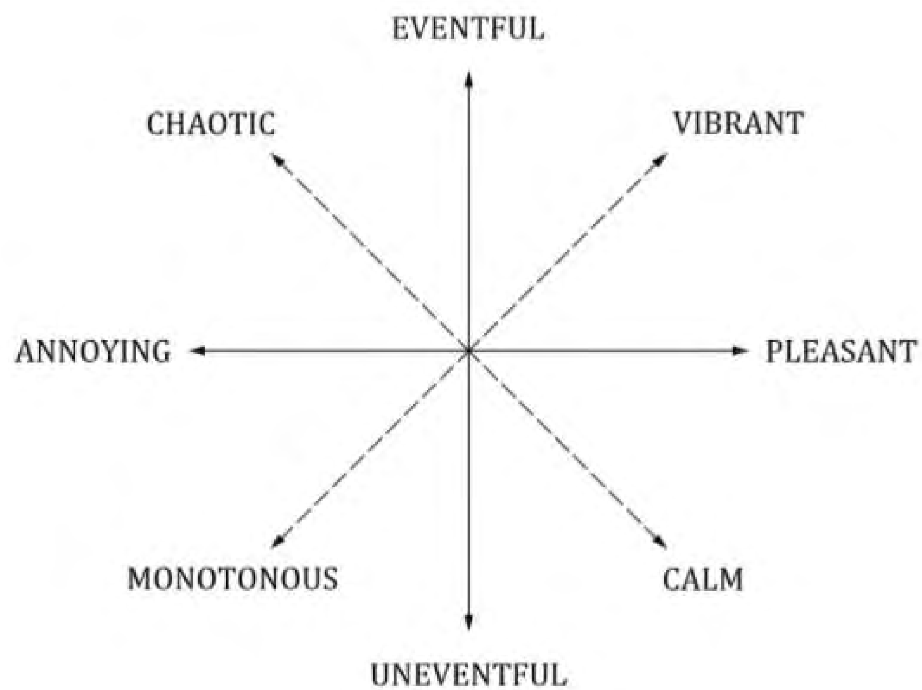


Figure 6. Two-Dimensional Soundscape Diagram, Graphical Representation of Formula Pleasantness and Eventfulness (Source: ISO 12913-3:2019)

Pleasantness P coordinate is calculated from the following equation:

$$P = (p-a) + \cos 45^{o} * (ca-ch) + \cos 45^{o} * (v - m) \quad \text{(Eq. 3)}$$

and

Eventfulness E coordinate is calculated from the following equation

$$E = (e-u) + \cos 45^{o} * (ch-ca) + \cos 45^{o} * (v-m) \quad \text{(Eq. 4)}$$

Given that the value of annoying (a), calm (ca), chaotic (ch), eventful (e), monotonous (m), pleasant (p), uneventful (u), and vibrant (v) are calculated from the median values of the responses from the survey questions following the scales shown in Table 3.

Table 3. Assigned Scale Values to Rating Scales of Method A and Statistical Measures ISO 12913-3:2019

Part (see ISO/TS 12913-2)	**Scale values to be assigned**	**Measure of central tendency**	**Measure of dispersion**
1 (sound source identification)	1,2,3,4,5	median	range
2 (perceived affective quality)	5,4,3,2,1	median	range
3 (assessment of surrounding sound environment)	5,4,3,2,1	median	range
4 (assessment of the appropriateness)	1,2,3,4,5	median	range

Sound taxonomy analysis is carried out by the investigator to complete triangulation analysis and represents the narrative interview workshop component illustrated in Figure 5. The purpose is to identify the diversity of sound sources present in the data measurement points from the investigator point of view. ISO 12913-2:2018 provided a taxonomy chart to guide the taxonomy analysis shown in Figure 7.

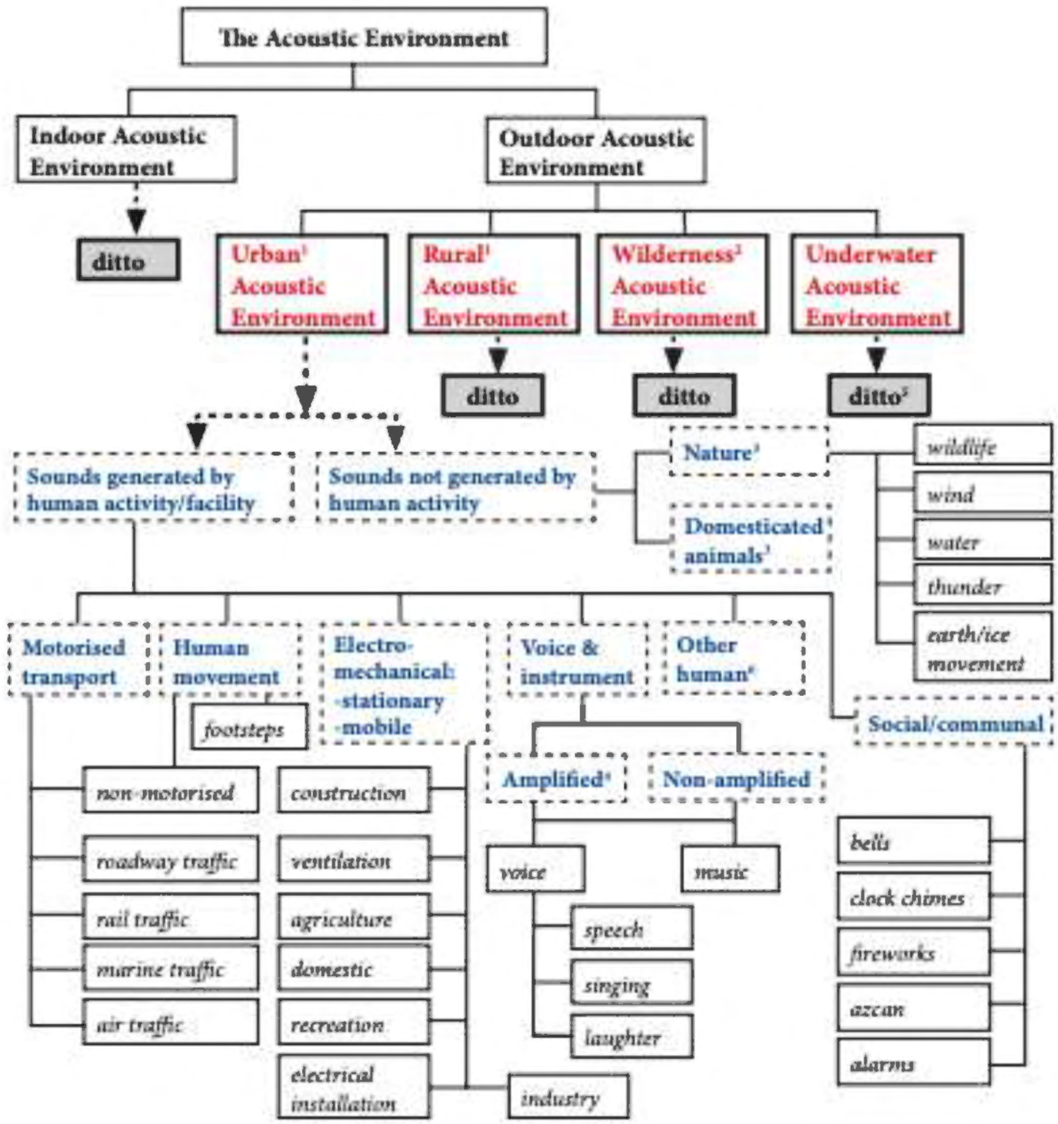


Figure 7. Sound Source Taxonomy (ISO 12913-2 2018)

2.3. Psychoacoustic Indicators and Approaches

Psychoacoustic is a field in acoustics that studies human perception and how humans respond to various sounds. Humans have an audible frequency of 20 Hz - 20,000 Hz. The older the age, the ability to hear upper frequency content decreases. Sound travels through wave propagation to the outer region of the ear, humans respond to it by processing it into neural actions which sends the information to the brain. This is called signal processing, executed by the inner ear.

There are numerous acoustical studies within the field of psychoacoustic which aim to understand how the brain will react to sound and various characteristics of the sound. Some of the psychoacoustic studies are sound localization, sound masking, loudness, sharpness, roughness, tonality, fluctuation strength, etc.

Following are psychoacoustic measures that may contribute to the Sound Quality standard.

Psychoacoustic Annoyance (PA)

Psychoacoustic Annoyance (PA) is a method to quantify noise annoyance (Fastl et al., 2007). Psychoacoustic annoyance is measured subjectively and objectively (Tristán-Hernández et al., 2016). Psychoacoustic annoyance according to Zwicker is analyzed through calculation of psychoacoustic indicators such as loudness (N), specific loudness (N_0), , roughness (R), sharpness (S) and fluctuation scale (FS). The calculation result is then compared with the survey or questionnaire standardized by the International Commission of the Biological Effects of Noise (ICBEN). From the calculation and survey, we will be able to obtain the percentage of noise annoyance (PNAI) and verbal noise annoyance index (VNAI) to aid the interpretation of noise annoyance in particular places. The survey answers can be weighted in a five point scale which is shown in Table 4 and 5 and can be interpreted in numeric or percentage scale. Another method is to weight the survey answer in a 10 points scale shown in Figure 8. By obtaining the PNAI, the VNAI value can be interpreted as shown in Figure 9 to draw conclusions about the analysis of that particular calculation.

Table 4. Verbal Answer for Annoyance Question (5-Point Scale) (Tristán-Hernández, 2016)

Verbal Answer	Numeric Scale
a) Not at all	0
b) Slightly	21.93
c) Moderately	47.34
d) Very	73.39
e) Extremely	97.72

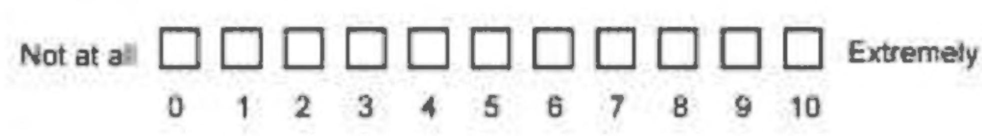


Figure 8. Numeric Scale for Annoyance Question (11-Point Scale) (Tristán-Hernández, 2016)

Table 5. The Relationship between Numerical Index (NNAI) and Percentage Index (PNAI) and Verbal Index (VNAI) (Tristán-Hernández, 2016)

Numerical Index (NNAI)	Percentage Index (PNAI)	Verbal Index (VNAI)
0-3.60	0%-3.6%	Not at all
3.61-23.55	3.61%-23.55%	Slightly
23.56-58.62	23.56%-58.62%	Moderately
58.63-89.77	58.63%-89.77%	Very
89.78-100	89.78%-100%	Extremely

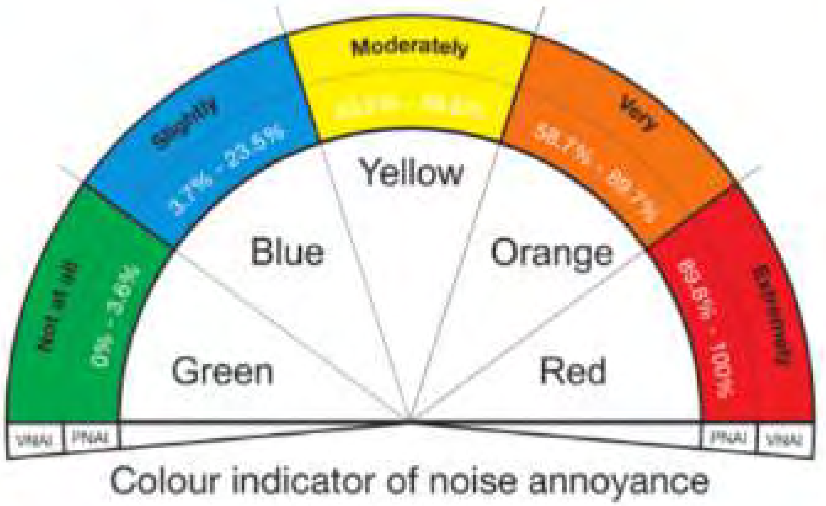


Figure 9. Color Indicator of Noise Annoyance (Tristán-Hernández, 2016)

Psychoacoustic Annoyance can be obtained from the following equation:

$$PA = N_5(1 + \sqrt{W^2{}_S + W^2{}_{FR}} \qquad \text{Eq. (5)}$$

Where N_5 is the 5th percentile of loudness, W_s is the component where sharpness is included,

$$if\ S > 1.75 \qquad Ws = 0.25\,(S - 1.75) log N_5 + 10$$

$$if\ S \leq 1.75 \qquad Ws = 0 \qquad \text{Eq. (6)}$$

W_{FR} is the modulation component where fluctuation strength (FS) and roughness (R) are included

$$W_{FR} = \frac{2.18}{N^{0.1}{}_5}\,(0.4\,(FS) - 0.6R) \qquad \text{Eq. (7)}$$

Loudness is people's perception in terms of volume that is calculated in linear scale. Loudness has a unit of *sone* (linear scale) and *phon* (logarithmic scale). A single tone of 1kHz with a sound pressure level of 40dB is equal to 1sone. Below is the formula of loudness (*N*):

$$N = \int_{0}^{24\,Bark} N'\,dx \qquad \text{Eq. (8)}$$

Specific loudness (N_0) can be defined as distribution of loudness across critical bands. The unit is *sone*/bark.

Sharpness is people's perception that is caused by high frequency in a given noise. Sharpness has a unit of acum. One *acum* is equal to a 1kHz narrow band-noise with a bandwidth smaller than 150 Hz and a sound pressure level of 60dBA. There are numerous studies on sharpness calculation; some of them are DIN 45692 , Zwicker, and Aures.

Formula of sharpness can be shown here:

$$S = c \,.\, \frac{\int_{0}^{24\,Bark} N' g'(z) \cdot z \cdot dz}{\int_{0}^{24\,Bark} N'\,dz} \qquad \text{Eq. (9)}$$

Zwicker sharpness weighing function:

$z < 14 \rightarrow g'(z) = 1$

$z < 14 \rightarrow g'(z) = 0.00012 \cdot z^4 - 0.0056 \cdot z^3 + 0.1 \cdot z^2 - 0.81 \cdot z + 3.51$ Eq. (10)

c = constant = 0.11

dz = can be estimated as 0.1 Bark

g'(z) = weighting function

DIN 45692 weighing function can be utilized as:

$$g(z) = 1 \; when \; z \leq 15.8 \; Bark$$

$$g(z) = 0.15 \, e^{0.42(\frac{z}{Bark} - 15.8)} + 0.85 \quad when \; z > 15.8 \; Bark \qquad \text{Eq. (11)}$$

Aures approach utilize weighting function as:

$$g_A(z) = 0.78 \, \frac{e^{\frac{0.171 z}{Bark}} \; N/sone}{\frac{z}{Bark} \; ln\,(0.05 \frac{N}{Sone} + 1)} \qquad \text{Eq. (12)}$$

Roughness can be defined as a method to quantify rapid (15-300) modulation produced by temporal changes. Roughness is calculated in an asper unit and one asper equals 60dB on 1 kHz tone that is 100% modulated at 70Hz. Roughness is usually utilized to measure sound with a range of frequency of 20Hz-300Hz. The formula of roughness can be seen below:

$$R = 0.3 \, \frac{f_{mod}}{kHz} \int_{0}^{24\,Bark} \frac{\Delta L_E(z)\, dz}{dB/Bark} \; asper \qquad \text{Eq. (13)}$$

Fluctuation strength is measured in *vacil* and means as a measurement of modulation or temporal changes in 40 Hz and accounting for slower modulation of 20 amplitude modulation per second. Fluctuation strength works similarly to roughness, but it measures sound with a range of frequency below 20Hz. The formula of fluctuation strength is:

$$F = \frac{0.008 \cdot \int_{0}^{24\,Bark} \Delta L \cdot dz}{(f_{mod}/4Hz) + 4\,Hz/f_{mod})} \qquad \text{Eq. (14)}$$

Evaluation of psychoacoustic annoyance can be done by calculating each psychoacoustic indicator, then comparing and computing the result to the ICBEN survey result.

2.4. Additional Acoustic Indicators and Approaches

There are other acoustic indicators in the field that can be used to measure environmental sound quality, such as temporal sound level variance (TSLV), spectral gravity center (SGC), tranquility rating tool (TRAPT), sensory pleasantness and exterior masking.

Temporal Sound Level Variance (TSLV)

Temporal sound level variance is defined as how frequent sound changes in a typical length of time. The unit for temporal sound level variance is dB^2 and the range of answers can be predicted to be around 3.6-70.4 dB^2 for urban traffic conditions (Munive et. al, 2016). The greater the value of TSLV the greater the annoyance is (Antonia et. al, 2011). Temporal sound level variance can be defined as the following:

$$\text{TSLV} = \sigma_{Li} * \sigma_{Leq} \quad \text{Eq. (15)}$$

where

σ_{Leq} : is standard deviation of L_{eq}

σ_{Li} : is standard deviation of instantaneous sound level (sound pressure level in 1 second)

L_{eq} is the energy equivalent sound pressure level over a period of time (t). The formula of L_{eq} is:

$$L_{eq}(t) = 10 \log\left[\frac{1}{t} \sum_{i=1}^{t} 10^{\frac{Li}{10}}\right] \quad \text{Eq. (16)}$$

Temporal sound level calculation can be validated with the VNAI ICBEN method explained in the Psychoacoustic Annoyance section.

Increased urban population drives demand for mobility, thus increasing the number of people being exposed to high levels of road traffic noise (EEA, 2020). Temporal sound level variance is often used to analyze the traffic noise annoyance. Sudden noise created by vehicle passing increases the sound pressure level of a given environment for a temporary period of time. Thus, it significantly affects the acoustic comfortability of the surrounding.

Several studies that have been completed in this field are the analysis of road and railway noise exposure relative to the indoor comfortability by Antonio et. al; temporal short term variations of transportation noise by Wunderli et. al; temporal and spatial factors of traffic noise and its annoyance by Fujii et. al; temporal and spatial variability of traffic-related noise in the City of Toronto, Canada by Fei et. al. All the studies found that there is a significant relationship between temporal sound level variance from traffic noise to the noise annoyance of surrounding areas. Temporal sound level variance proved to predict noise annoyance of the measured areas.

Spectral Gravity Center (SGC)

Spectral gravity center or timbre is used to locate the center frequency and the intensity of the components of a sound. In other words, it can be defined as the averaged pitch in the sound or averaged sound power in frequency spectra (A.Can et al., 2010). Spectral gravity center can be calculated as following:

$$SGC = \frac{\sum_i B_i * 10^{(L_i / 10)}}{\sum_i 10^{(L_i / 10)}}, \ with\ i \in \{63; \ ... ; 8000\} \qquad \text{Eq. (17)}$$

where

B_i = sound octave bandwidth (63Hz to 8Khz)

L_i = sound level in dB measured from each octave bandwidth

Low frequency sounds are often considered an annoyance such as traffic noise. In urban context, sSpectral gravity center aidaids to analyze the quantity of low frequency in the soundscape as well as the pitch variations in the sound quality.

Spectral gravity center is used to measure the degree of noise pollution specifically from traffic noise (B. De Coensel et. al, 2006). SGC value is useful to determine the source of the noise. As high SGC value indicates high content of high frequency sound sources in the soundscape and low SGC value indicates high content of low frequency sound sources in the soundscape which is often associated with road traffic noise (B. De Coensel et. al, 2013).

Tranquility Rating Tool (TRAPT)

The TRAPT formula was developed by a previous study done by University of Bradford. Below is the equation:

$$TR = 8.57 - 0.11\, LAeq + 0.036\, NF \qquad \text{Eq.(18)}$$

Tranquility Rating (TR) is scaled from 0 (low) to 10 (high), LAmax stands for the maximum sound pressure level in measurement and calculated in dBA, LAeq is an A-weighted measured sound pressure level or continuous sound pressure level measured in N time and dBA unit, Natural Features (NF) is the percentage of natural feature (trees, shrubs, grass) in a 10x10 grid frame of scene excluding the sky including the presence of drywall (Pheasant, Rob et al., 2010).

In order to carry out the survey in better accuracy, perceived TR scale can be described as (Watts, G.R et al., 2017):

Table 6. Perceived TR scale (Watts, G.R et al., 2017)

Tranquility Rating	Description
< 5	Unacceptable
5.0 - 5.9	Just Acceptable
6.0 - 6.9	Fairly Good
7.0 - 7.9	Good
≥ 8.0	Excellent

A conducted a study of the tranquility rating tool at the location of four bridges in Deer Lake Park, Burnaby, BC, the study indicated that there was a major flaw in this TRAPT indicator. Since it only evaluates based on sound pressure level and percentage of natural features (NF), it fails to recognize the types of sound that exist in the soundscape environment. The recording took place above the bridges where water flowed underneath and was clearly discernible over distance traffic noise. Traffic noise was shielded by the surrounding trees. The quality of sound should be considered pleasant - water is considered restorative sound (Connelly, 2019). Though the sound pressure recorded was around 50dB with above 90% natural features. The sound pressure level is becoming a weighting factor bringing tranquility ratings down to “not acceptable” - as 50dB is considered loud (Carolina, 2020). The visual representation of natural features does not critically impact the TRAPT score, considering the measured NF were almost 100%. Therefore, the TRAPT indicator is not suitable to be included into the Ecocity sound quality indicator until the formula is corrected. TRAPT has a potential to be implemented under GAIA level, but for the purpose of this research TRAPT implementation is out of scope.

Sensory Pleasantness (SP)

Sensory pleasantness regardless of its name is mostly used to test the annoyance that exists in the equipment or engine. Sensory pleasantness is a function of loudness *(N*), tonality (*T*), roughness (*R*), and sharpness(*S*). The difference between sensory pleasantness and psychoacoustic annoyance is that sensory pleasantness depends on sharpness significantly upon which roughness and tonality have less influence. The only time loudness is affecting the value of sensory pleasantness significantly is when the value of loudness is higher than the normal loudness of a conversation between two people in a quiet setting (Fastl et al., 2007).

Sensory pleasantness (SP) can be calculated as:

$$\frac{P}{P_O} = e^{-0.7\, R / R_o}\, e^{-1.08\, S/S_O}\, (1.24 - e^{-2.43\, T/T_O})\, e^{-(0.023\, N/N_0)^2} \qquad \text{Eq. (18)}$$

Loudness, roughness, and sharpness are previously explained in the previous section. Tonality describes the quality of tone in sound. It increases as sensory pleasantness increases. Tonality depends strongly on critical band or loudness.

To validate the result of sensory pleasantness, a survey with a scale 1-11 can be used (Qian et al., 2020). However, since sensory pleasantness is mostly used for the design of vehicles or equipment engines, sensory pleasantness is out of scope and not included in this research.

2.5. Planning the Acoustical Environment of Cities and Neighbourhoods

Other cities have put efforts on regulating noise by developing policy according to soundscape. This section highlights several cities' efforts in mitigating noise pollution such as the City of London, Welsh Government, City of Valencia, Municipality of London and an experiment Sound in the City study done by McGill university in Montreal. These are examples which Ecocity can consider in acoustic environment urban planning.

The City of London launched Noise Strategy 2016 to 2026 that aims to preserve and maintain city soundscape by reducing unnecessary noise while ensuring the city to function as a modern world-class business centre (City of London, 2016). The base of the study are feedback and concerns gathered from visitors and residents of the city that previously interviewed for City of London acoustic environment. The Noise Strategy 2016 to 2026 builds public awareness of sound and noise, thus rewarding and recognizing good practice. The City of London works its urban planning according to the National Planning Policy Framework (NPPF) and London Plan to sustain and to improve the acoustic environment. The strategy includes promoting tranquil areas, preserving iconic sound such as preserving the keynote of a region (church bells) and introducing sound masking installation (City of London, 2016). The city of London requires development proposals to adhere to improve and enhance the sound environment. Regarding soundscape policy, Noise Strategy 2016 to 2026 requires proper landscape design such as identifying specific sound (i.e. non-mechanical and non-amplified speech, music, moving water, acoustic installation nature, city keynote, cultural sound) to be audible in certain areas and keeping certain sound (i.e. traffic noise, sound made by people, etc.) low while maintaining speech clarity for people's conversation. Liminali installed “Organ of Corti " in Carter Lane Gardens for the purpose of absorbing the city;s traffic noise and transforming it into music in 2011. However, it was not effective, the city is open to the idea of introducing sound art installation (City of London, 2016). The mitigation of noise pollution includes working with local policy stakeholders for noise management implementation. There are limits on new construction noise. Noise mapping is performed for mitigation of road traffic noise pollution. The key to the City of London success in creating a conducive acoustic environment is relying on the solid cooperation of its local policy makers, residents and visitors (participation in surveys or soundwalks).

The Welsh Government with Noise and Soundscape Action Plan 2018-2023 that enforces a healthy acoustic environment which means creation of a spatio-temporal soundscape without eliminating unwanted sound completely (Welsh Government, 2018).The Noise and Soundscape Action Plan 2018-2023 highlights the importance of soundscape and impact of noise pollution mitigation to the health of well-being. The content highlights integration of noise and air quality policy that underline the importance of green infrastructure in the city; planning new development by introducing placemaking; importance of acoustic design and materials usage in building; developing tranquil green space in the cities; managing road traffic noise, industrial noise and railway noise in Wales by noise mapping, cooperation with local policy makers and acoustic friendly vehicle technologies. Noise and Soundscape Action Plan 2018-2023 states that noise management needs to be approached in a long term solution manner and involves public engagement to be successful. There are three agglomerations in Wales which are the Cardiff and Penarth agglomeration, the Newport agglomeration and the Swansea and Neath Port Talbot agglomeration. At each agglomeration, the Noise and Soundscape Action Plan showcases the analysis of noise pollution through roads, railways and industry by noise mapping and population model, location of quiet areas in the agglomeration, policy that needs to be followed by residents and local policy enforcers.

The City of Valencia with Noise Action Plan 2018-2023 that highlights the city regions that have a positive acoustic quality by researching districts with greenspaces or potential quiet areas and collecting of users' opinions regarding environmental and acoustic comfort by utilizing ComfortUP! App (Herranz-Pascual et al., 2019). This work is a partnership with the Delegation of Environmental Quality of the municipality. The study utilized the usage of a noise map of Valencia and resulted in a QUADMAP project or methodology which analyzes the quality of Quiet Areas. Each Quiet Area has identification of its uses and activities, evaluation of area quality (cleaning, maintenance, security, accessibility, furniture, conditions, pollution, commercial activity and conditions of surrounding building), type of people in areas, perception of public spaces and perceived acoustic quality by pleasantness rating and semantic rating. The study found that spaces that have recreational usage are perceived as less tranquil. Birds, water, wind, and natural sound were rated as pleasant. Interestingly, some human activity noises are perceived as pleasant (Herranz-Pascual et al., 2019). The study concluded that the study of quiet areas evaluation should not only consider noise levels but people's perception and opinion of those particular areas (Herranz-Pascual et al., 2019).

The Municipality of Berlin introduces “The Berlin Plan of Quiet Areas” or “Berlin wird leiser” which identifies quiet areas in Berlin and collects users soundwalks experiences using Hush City App (Berlin Senate, 2020). Berlin also has the Berlin Noise Action plan that has been revised 3 times up to the year of 2018 (Radicchi, 2018). The background of the study is based on 360,000 people which is equivalent to 12% of the Berlin population that is affected by harmful noise (Radicchi, 2018). Berlin Noise Action Plan focused on reducing noise and protecting urban quiet areas. Noise can be reduced through the usage of sound-absorbing road surfaces and soundproof windows, introducing 30km/h speed limit and new mobility concept. Similar to the QUADMAP project, the Municipality of Berlin takes user opinion and perception towards specific spaces using the Hush City App and the data obtained to improve the acoustic environment of that particular area.

Sound in the City is a project that utilized sound masking to develop a better acoustic soundscape in city parks by the University of McGill, Montreal, Ontario, Canada . This project was presented in Ecocity Workshop 2019. Pleasant sounds in urban spaces are music, bird chirping, moving water and conversation. This project believed that appropriate sound installation can be utilized to develop a positive effect in urban soundscape. Instead of reducing the percentage of noise, this project installed “pleasant” sound into the urban spaces. This is called sound masking. Installation of sound pleasant masking in the presence of construction presence construction work noise areas is proven to create a more pleasant and calmer, calmer, and quieter environment (Fraisse, 2019). Even though the maximum sound pressure level reached or exceeded the maximum sound pressure level regulation, the survey showed that urban spaces users were pleased with the sound quality (Fraisse, 2019). In this case study, some of the measured sound masking installation together with background noise exceed outdoor maximum sound pressure level of 55 dBA with the Lmax around 60 dBA. The main reason is that people focus their attention on the sound installation spaces and naturally ignore the presence of the noise. This approach is possible to be implemented under sound quality standards for GAIA level. Though, contextual masking and cultural compositions approach is not within the scope of this research.

In order to create a healthy acoustic environment there are numerous strategies that can be used to assist city and neighbourhoods planning in Vancouver. From the examples above, identifying quiet or tranquil areas in the city, preserving the region's keynote and soundmarks, preserving cultural heritages building, preserving local festivals and events, introducing more natural sounds, designing landscape, adding greenspaces, designing users mobility, using appropriate building materials and providing pleasant sound installation are proven to improve Sound Quality in the environment.A well-designed landscape and greenspaces subsequently introduce natural sound into the area, more trees and greenery invite birds, insects and other organisms to develop a tranquil soundscape. Not only that, the soil underneath grass has pores that are capable of absorbing sounds and attenuating sound. Leaves on the trees also have capability to reflect sound. Installation of green walls can also be introduced to add green elements.Urban planning and building massing plays an important role in the acoustic comfort of the user inside the building and outside the building. By ranking the areas by the acoustically high-activity to low-activity and following the design will aid acoustic comfort significantly. Placement of urban park or spaces often is in the middle of apartments building or office. The use of hard materials such as concrete and glass reflect sound and reduce the attenuation of sound.

2.6. Ecocity

Ecocity is a healthy city that encourages the use of clean energy. Ecocity consumes less than what it can produce. Ecocity Builders has been developing the Ecocity Framework that consists of standards required to aid cities assess their ecological health.

Cities are varied and have distinct cultures. However, all cities share common necessities which are clean air, clean water, healthy soil, renewable sources, education, employment, and a happy and productive life. To obtain a fair certification process for Ecocity, the framework is modified into a flexible and effective framework that is determined by invited Early Partner Cities. The dimensions taken into account are population, density, latitude, climate, ethnic diversity, primary economic driver, national or city ecological footprint, wealth distribution, and remoteness (Ecocity Builders, 2019). Then, the Early Partner City are invited into IEFS Early Partner City Program where an online city survey will be conducted to see where it is based on Ecocity Framework (Appendix 1). Not only quantitative data, qualitative data such as policy and documents are also observed in the online survey.

A city can be labelled as Ecocity if it fulfills all the standards highlighted by the framework in Ecocity level 1. Improving only one feature to exceed a certain level but not the others will not improve the score of Ecocity. Once all features meet the standard of Ecocity level 1, it can move forward to Ecocity level 2 and 3, eventually to a future GAIA level.

Ecocity Framework

Ecocity framework categorizes cities moving forward from existing conditions to Ecocity status or beyond (Figure 10). The status ranges from unhealthy, greener cities 1, greener cities 2, greener cities 3, Ecocity level 1 (Ecocity standard), Ecocity level 2, Ecocity level 3 and GAIA level (See Appendix 1).

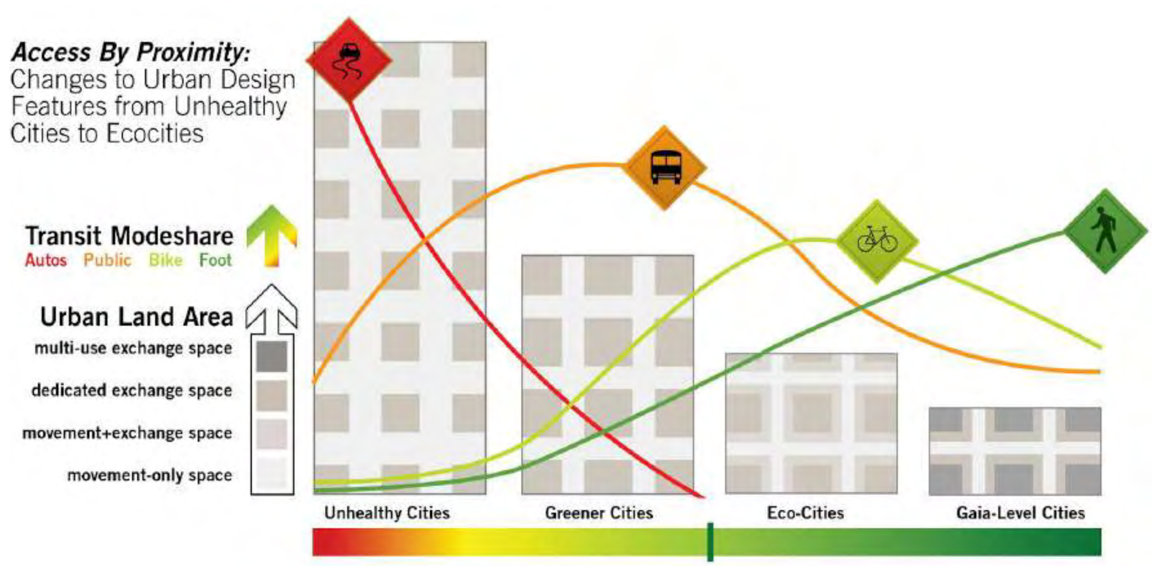


Figure 10. Unhealthy Cities to GAIA Level Cities (Eco Builders, 2019)

Figure 11 illustrates the 4 primary urban design features, 6 bio-geo physical conditions, ecological imperatives, 5 socio-cultural features, and 3 ecological imperatives. Unhealthy cities have an overall score of -10, greener city 1 is -7.5, greener city 2 is -5, greener city 3 is -2.5, Ecocity 1 (Ecocity standard) is 2.5, Ecocity 2 is 5, Ecocity 3 is 7.5 and GAIA level is 10 (Figure 2 & Figure 3). Ecocity 1 is defined as the Ecocity standard or benchmark. GAIA is the highest level in Ecocity which means that the city restores the community ecologically providing a very pleasant environment.

	Unhealthy	Greener City 1	Greener City 2	Greener City 3	Eco City 1	Eco City 2	Eco City 3	Gaia Level
Urban Design								
Access by Proximity	Low				Walkable, Accessible			Complete • Sustainable
Safe & Affordable Housing	Unsafe, unaffordable				Safe, Affordable			Safe, Affordable
Green Building	Inefficient, wasteful				Efficient, Healthy			Intensive
Env. Friendly Transportation	Env. damaging				Does not Damage			Improves Environment
Bio Geo Physical								
Air	Pollutes				Clean			Purifies
Energy	Nonrenewables				Clean and Renewable			Clean and Renewable
Food	Does not provide				Healthy and Accessible			Nutritious and Abundant
Material Resources	Depletes				Responsible			Sustains
Soil	Destroys				Healthy			Restores
Sound Quality (Proposed)	**Unhealthy, depletes**				**Healthy**			**Resonates**
Water	Pollutes, Wastes				Clean and Safe			Purifies
Socio Cultural Features								
Culture	Unsupported				Healthy, Supported			Nurtured
Community Capacity & Governance	Poorly Organized				Health, Participatory			Organised, cooperative
Economy	Destroys Nature				Healthy and Equitable			Restores Nature + Economy
Education	Not Provided				Lifelong, Accessible			Provide for All
Well-being	Violent, Unjust				Quality of Life Satisfaction			Justice, Peace & Contentment
Ecological Imperatives								
Biodiversity	Endangered				Healthy			Sustains
Carrying Capacity	Overshoot				Low Impact			Within Biosphere's Limits
Ecological Integrity	Weak, Unhealthy				Healthy			Strong, Restorative
Total Score								

Figure 11. Ecocity Framework with Sound Quality as Proposed. (Connelly, 2017).

Ecocity Pillars and Standards

Ecocity is divided into 4 major pillars; urban design, bio-geo physical, socio cultural, and ecological. Each pillar has a total of 18 different standards. Though the current Ecocity standards are improving sustainable life, some of the measures could impact Sound Quality negatively.

Urban design's first standard is structured access to proximity, meaning that the population lives close to basic service areas and eco-public transports are available within the area. Even though access to proximity decreases private vehicle count, percentage in heavy traffic and speed and community noise (LAeq 24 hr), the increase in instances of public transit pass-bys and stops increases TSLV (Temporal Sound Level Variance) and shifts SGC (Spectral Gravity Center) (After Genuit and Fiebig, 2006). In addition, increase in node density and diversity result in an increase in total noise levels. Second standard is providing safe and affordable housing. Third standard is availability of green buildings that encourage infrastructure to be built in a sustainable way, surrounded by nature and utilizing natural, reused, or eco-friendly materials. Fourth standard is the availability of an eco-friendly transportation system.

Several standards of the bio-geophysical pillar are included to define Ecocity. The first standard is that the city should have clean air and utilization of natural ventilation is being implemented on building's design. However, elimination of HVAC may decrease privacy and sound masking. Second standard is healthy soil. Soil structure contributes to an increase of sound absorption due to the existence of pore within it. Thus, sound quality can be improved by increasing attenuation of sound. Third standard is clean and safe water. In fact, water elements are believed to increase tranquility and improve sound quality for particular spaces. For example, installation of rainwater chains and water fountains are believed to create natural sounds that have been shown to improve health (Schafer, 1974). The fourth standard is responsible resources and materials. However, the use of resources and materials needs to be carefully considered, since some materials may not have a good acoustic performance in terms of preserving room sound quality. The fifth standard is clean and renewable energy. The use of wind turbines in public places negatively affects the health of people living nearby. Though the noise is not visible, it has such long frequency waves resulting from low frequency that is enough to adversely affect human's body The practice of building envelopes to reduce energy consumption from heating and air conditioning systems improves the acoustical properties of the room, thicker and well insulated walls would greatly decrease attenuation of sound from outdoor-indoor (Connelly, 2019). Within this pillar, Sound Quality will reside as the seventh bio-geophysical pillar.

The first socio-cultural's standard is healthy culture. The second standard is community or governance that describes the cultural values among the population such as everyone should participate in decision making and the community of a culture needs to be learnt to be able to build a suitable community settlement for them. The third standard is a healthy and equitable economy. We know that acoustics quality is not distributed equitably across the social-economic spectrum (Connelly, 2017). The fourth standard is lifelong education. For example, communities are taught about Ecocity mapping to locate the center of a city, determining bio-region and understanding acoustic qualities becomes an imperative. By learning their own communities and drawing maps, it enables them to grow continuously as a healthy city (Ecocity Builders, 2019).

The first ecological pillar's standard is healthy biodiversity. Healthy biodiversity is described as people living adjacent to nature preserved areas. In addition, flora and fauna are allowed to co-exist without human settlement polluting it, thus resulting in a balanced soundscape which is an indicator of a healthy ecosystem (Schafer, 1974).

Advancing the Ecocity Framework within Existing Municipalities

Cities that have adopted some Ecocity principles includes Reykjavik, Iceland; Zurich, Swiss; Bristol, South West England; Portland, Oregon; San Francisco, California; Vancouver, Canada; Malmo, Sweden; Copenhagen, Denmark; Stockholm, Sweden; Oslo, Norway (Better World Solutions, 2020). Each city has a unique focus. Reykjavik is utilizing its natural source (volcano) as a heating system and focusing on the development of their public transport and preserving green spaces. Zurich has an energy usage goal limiting 2,000 watts per person by 2050 plus 75% of the energy met by using renewable energy sources. Bristol's target is reducing carbon dioxide emission by 40% by 2020 and 80% by 2050. Portland uses 30% renewable energy compared to 15% national average plus 25% of Portland's citizens are commuting by bike. Most of these cities have goals towards greener cities by preserving their nature.

Three neighborhoods in Metro Vancouver are aligned with Ecocity's principles; Lonsdale Quay, Olympic Village and North Shore Innovation District. Lonsdale Quay has been redeveloped towards a response to the sea bus slip in 1977, located across the harbour from Downtown Vancouver. The Quay combines residential areas, food markets, businesses and leisure in one neighborhood; where people living in the area have access to their daily needs within a walkable distance. Established in 2010, the Olympic Village was comprehensively planned with similar characteristics to Lonsdale Quay in terms of its site contextual features. North Shore Innovation District is currently being designed and built to adopt the EcoDistricts Protocol framework. It is located adjacent to the Tsleil-Waututh Nation, who depend on their surroundings to fulfill their daily needs, and to the Maplewood community, established more than 1,300 community members and held over 21 public events. North Shore Innovation District will preserve existing wetlands and forests as conservation areas. It is designed to be a community that creates employment for 1,000 people, providing 600,000 square feet of new commercial places and 100 kilometers of trails (Darwin Construction, n.d.)

2.7. Summary of Literature Review

Ecocity and its standards are aiming to aid city development to a more sustainable environment. Some of the standards may have an impact on the quality of the acoustical environment. Sound largely contributes and impacts the health and life of the city users. By creating a healthy acoustic environment, health risk can be minimized and productivity can be increased. Several regulations have been adopted for the acoustic environment inside and outside the buildings (CMHC, LEED, BREEAM, local authorities). However, currently municipal regulations are only standardized in maximum sound pressure level. Sound pressure level itself does not define the meaning and characteristics of the sounds. Humans have different perceptions towards varieties of sounds. Human audio perception is subjective and depends significantly on the complexity of the sound waves and its semantic content. Soundscape approach and psychoacoustic approach are introduced in this research to complement the current maximum sound pressure level while taking accountability of human subjective perception towards characteristic of the sound. There are also examples from cities around the world that have been practicing acoustic environment restoration efforts from which the City of Vancouver can learn.

3. Problem Statement

The intent to develop Sound Quality as a condition was announced at the conference closing of Ecocity Summit Vancouver 2019. Given the complexity of sound, volume, density, spectral characteristics and semantic contents, maximum sound pressure level as generally used in current municipal zoning planning, may not be the only indicator appropriate to quantify Sound Quality. In this thesis, indicators such as psychoacoustic annoyance (loudness, roughness, sharpness, fluctuation strength), temporal sound level variance, spectral gravity centre and balance soundscape (normalized difference soundscape index and biophony/antrophony ratio) are being investigated in association with the classical indicators of sound pressure level and sound power level. There are various studies that have been completed separately on each potential acoustic indicator, however, there is not yet a study combining and comparing all of these potential acoustics indicators. Therefore, this research aims to determine an additional acoustic indicator that is suitable to be added to the Ecocity sound quality standard in addition to the maximum sound pressure level. This study has adopted the ISO 12913 Acoustic - Soundscape Parts 1, 2, 3 standard as the basis of a triangulation research methodology between measurements on site, surveys responses and taxonomy analysis.

4. Methodology

The methodology framework of this research included survey and data collection based on ISO 12913 Acoustic - Soundscape Parts 1, 2, 3 standard. Outdoor data measurements were taken in the Olympic Village-selected case study as a proxy to an Ecocity level 1. The data collected from the site measurements were processed with acoustic indicators calculations before being further processed in regression analysis with survey results. The result of the study allowed us to suggest which acoustic indicators are suitable for the Ecocity Sound Quality standard.

The study adopted a triangulation method which is a cross analysis between measurement (sound analysis), survey (questionnaire survey) and taxonomy analysis (narrative interview workshop) based on the triangulation soundscape research and practices (See Figure 12). Measurement on site was recorded at specific times at similar atmospheric conditions (wind, humidity and temperature). Survey participants should be local experts or users of the area. Survey questions adopted ISO 12913-2:2018 standard which method was approved by the Ethic Boards Review (ID: 202041) on January 12th, 2022. Following the ISO 12913 method, the survey was translated to two-dimensional soundscape analysis based on ISO 12913-3:2019. Taxonomy analysis was carried out by the researcher by subjectively identifying sound sources presented in the soundscape. Taxonomy analysis followed ISO 12913-2:2018 Taxonomy chart guide (See Figure 7). The final application of the triangulation method ensured that soundscape study accounts for people's perception and well-being in concert with collected empirical data.

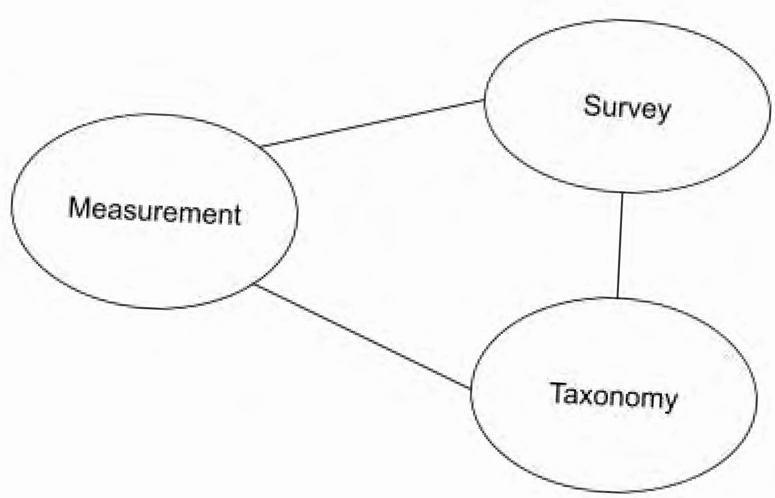


Figure 12. Research Study Triangulation Method Based on Figure 5 by Schulte-Fortkamp

4.1. Case Study

The community in Olympic Village in the area of Southeast False Creek is a 45,000 square foot community centre along the waterfront that achieved LEED Platinum certification with 6.5 million square feet of residential-commercial area. The Olympic Village supports up to 16,000 people (City of Vancouver, 2014). The Olympic Village, Vancouver, British Columbia is a neighbourhood that approximates Ecocity 1 condition and aligns with the four pillars of the Ecocity Standards.

With respect to the urban design pillar of the Ecocity standard, the Olympic Village has an immense pedestrian and bike walkway that follows the FalseCreek the seawall. It is also accessible to public transportation such as bus transit, car sharing facility, and sky train. It has 25.8 acres of public space that consist of a community garden, bike and pedestrian trail, plaza, and art installation.

With respect to the bio-geophysical pillar of the Ecocity standard, there is adequate clean air and water, healthy soil, and renewable energy in the area. The Olympic Village has an adequate sewer and water infrastructure utilizing rain water harvesting and reusing it. All buildings in Olympic Village have achieved LEED Gold which uses 50% of green roof and 50% reduction in water consumption through rain water harvesting and reusing it (City of Vancouver, 2014).

With respect to the socio-cultural pillar of the Ecocity standard, the Olympic Village supports 100 inner city jobs providing the community with employment located in proximity to the Olympic Village. The Main Science World, located on the seawall, provides the community with educational and recreational facilities. The Olympic Village itself has 252 affordable housing units (City of Vancouver, 2014).

Lastly, with respect to the ecological pillar of the Ecocity standard, the shoreline by Olympic Village is a rehabilitated one with seawall, intertidal marine habitat where flora and fauna coexist with human settlements.

Figure 13. Olympic Village, Vancouver (The Village, 2020 Retrieved from https://www.buzzbuzzhome.com/ca/the-village-on-false-creek).

Figure 14. Olympic Village Map (Daily Hive, 2020 Retrieved from: https://dailyhive.com/vancouver/olympic-village-elementary-school-vancouver).

4.2. Data Collection and Analysis

Measurements on Site

In order to evaluate the overall Sound Quality indicators in Olympic Village, measurements were distributed evenly on the site. Samples were taken over a 3-day period at 38 different points as illustrated in Figure 15. Data obtained from Day 1 was the trial day and not analyzed. Data obtained from Day 2 or Weekend data was obtained from points along the shorelines of the Olympic Village and several plazas (18 data measurement points). Data obtained from Day 3 or Weekday data was obtained from points that spread towards the interior section of the Olympic Village (20 data measurement points).

It is important to note that the data obtained from the weekend data was analyzed separately with the data obtained from the weekday. The activities on the weekend are slightly different from the weekdays where less people are gathered around Olympic Village, with no construction noise and industrial work. The weekday data were gathered closer to road traffic and pedestrian areas, where the weekend data were gathered closer to the water and plaza where people gather and sit for a longer period of time.

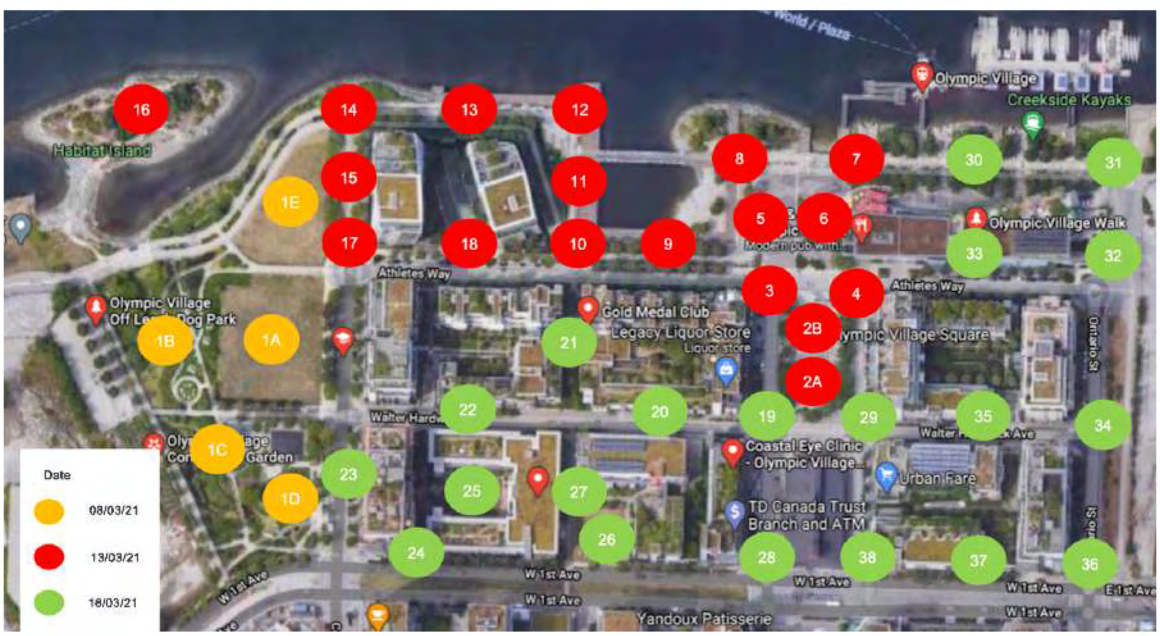


Figure 15. Points of Measurements

The time selected for the measurements was during morning to mid-afternoon-late-afternoon. The weather during measurement days were Sunny with a temperature range of 7 degree Celsius to 11 degree Celsius. The humidity had a range of 39% to 71% and wind speed had a range of 7 km/h to 15 km/h (Appendix 10). Each measurement was taken 3 times with 3 minutes intervals at each point following ISO 12913-2:2018 standard procedure. Measurements were taken on March 8th, 2021 to March 16th, 2021.

Figure 16. Noise Map of Olympic Village

The acoustic indicators evaluated in this research all have the same data collection technique. Data collection was performed using a binaural head mounted on a tripod, at a height of 1.6m connected to a soundbook computer analyzer. The measurements were taken for a duration of 3 minutes, 3 times at each data point. A canopy covered with sound absorption materials, located above the binaural head, to protect equipment in case there was rain during measurement time (Figure 17 & Figure 18). The canopy effect was evaluated to ensure no interference in the measurements. For more information about equipment see Appendix 5.

Figure 17. Equipment Setup in the Field (Soundbook placed on top or tools bag and connected to a binaural head mounted on tripod at height of 1.6m, covered with a sound absorption shelter)

Figure 18. Caution Sign

The Caution signs were posted 2 metres to 3 metres away from the equipment setup to prevent people from getting too close and interfered with data measurement and to meet BCIT Ethic boards protocol and risk management requirements. There were a total of 3 caution signs surrounding the equipment setup.

The classical indicators and the potential indicators of biophony/antrophony ratio, normalized difference soundscape index, psychoacoustic annoyance, temporal sound level variance and spectral gravity center were calculated independently as follow:

The classical attributes which are sound weighted sound pressure level (LAeq) and unweighted sound pressure level (Leq) are obtained from the soundbook in the form of excel files. Sound pressure level is presented in logarithmic scale which does not align with the other acoustic indicator data that are presented in linear scale and were adjusted to a linear scale, translation to sound power level in Pascal or N/m2 is needed for regression analysis.

Biophony (and Geophony) ratio to antrophony recorded on the site were converted into numerical data produced in a form of excel sheet by the SAMURAI software (soundbook). The numerical data is computed according to Equation 2 to the derived biophony/anthrophony ratio.

The program converted the audio file into an excel file containing the NDSI value resulting from the right and left channels of the binaural head. The results from the left and right channels are averaged to get the value of NDSI at a specific data measurement point.

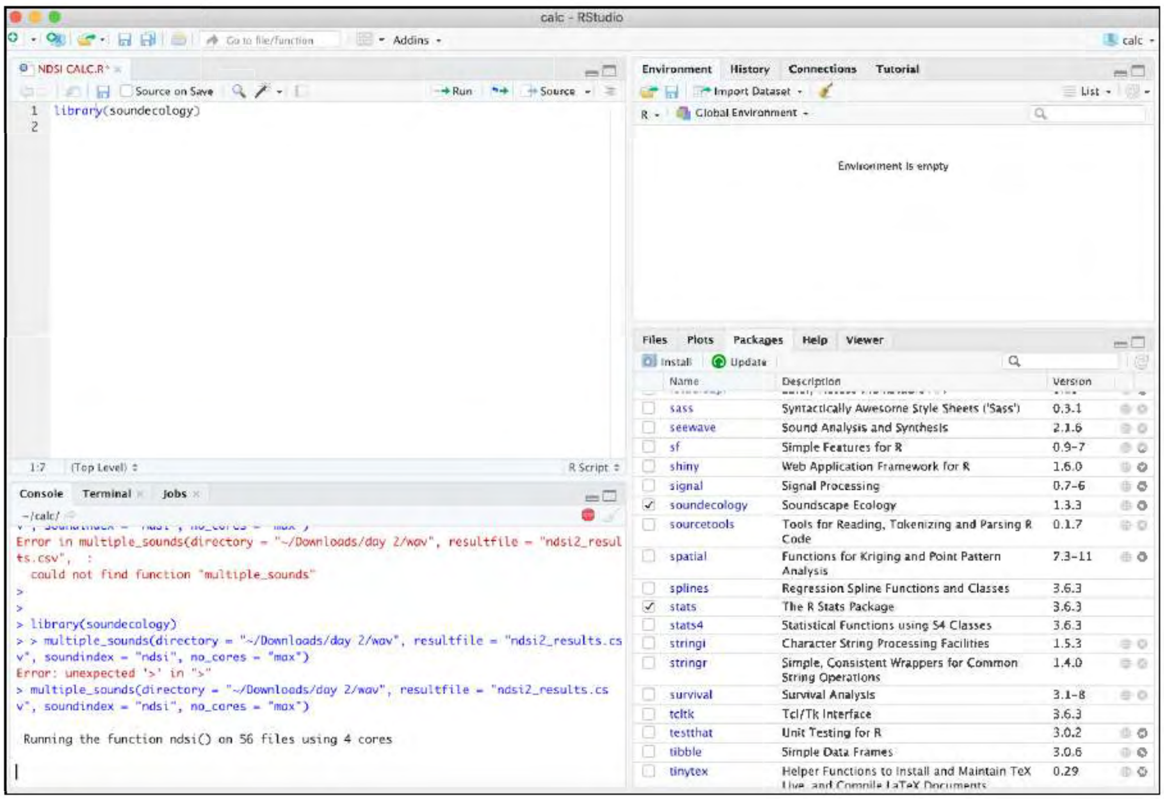


Figure 19. NDSI Calculator in RStudio Program by Luis J. Villanueva

In order to calculate psychoacoustic annoyance (PA), wav files from the field measurements were required. Wav files are uploaded into the BCIT Psychoacoustic Annoyance Calculator to produce loudness, specific loudness, sharpness, fluctuation strength, roughness, and psychoacoustic annoyance that are shown from Equation 5 - Equation 14 in Section 2.3.

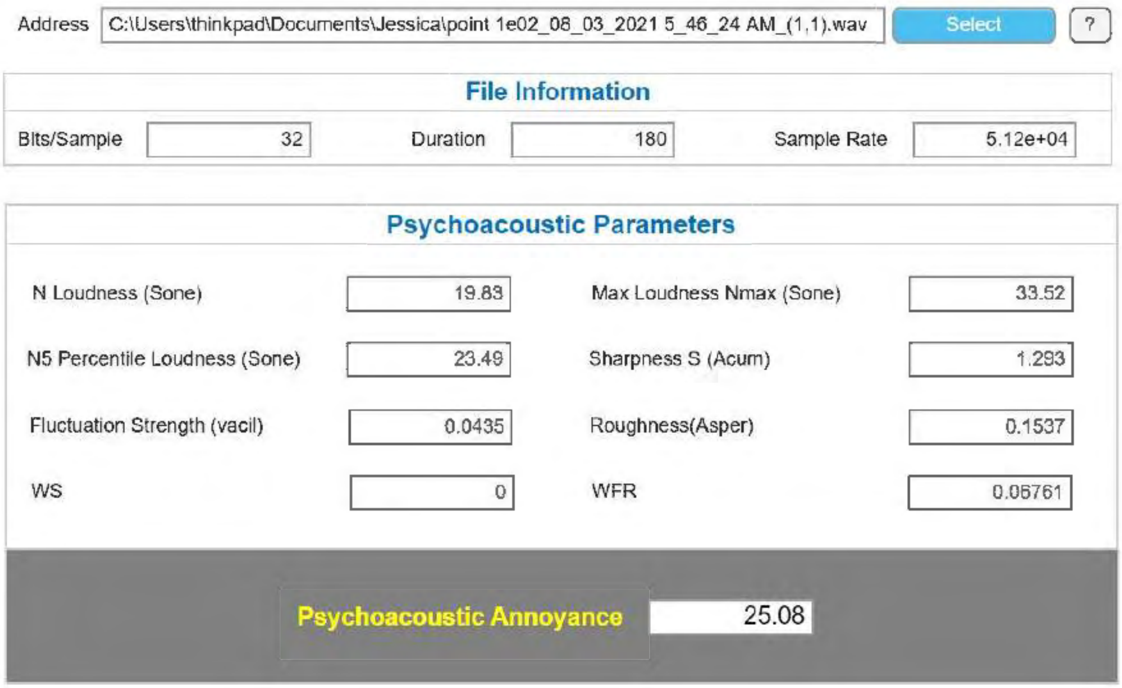


Figure 20. BCIT Psychoacoustic Annoyance Calculator

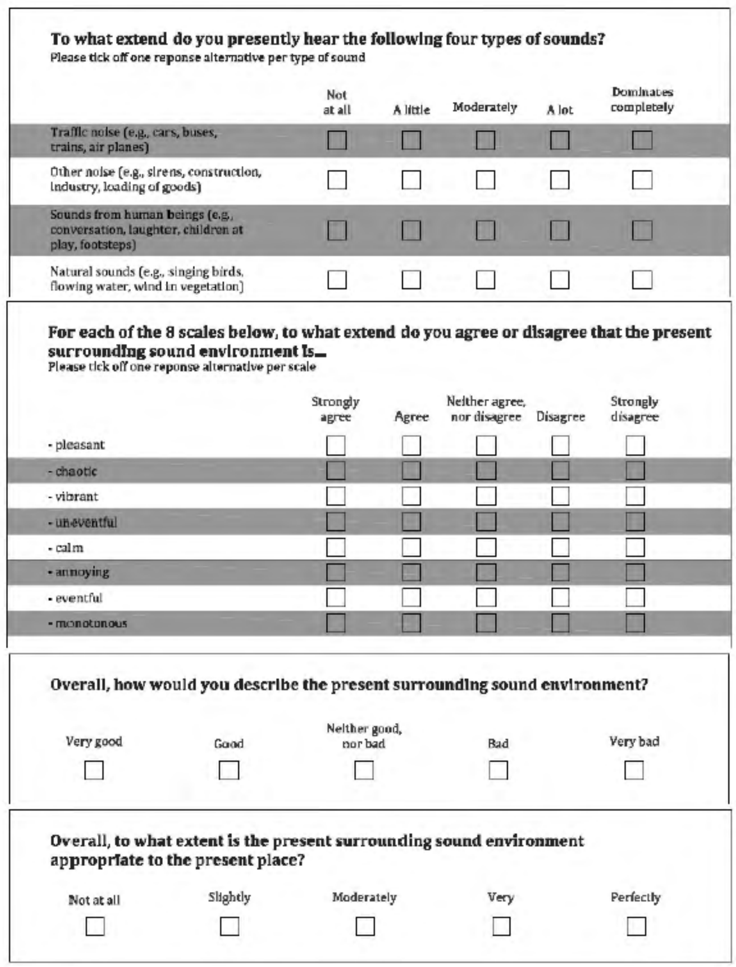
Temporal sound level variance (TSLV) obtained by calculating the data provided by the excel file exported from the soundbook. The time-history data of LZeq (unweighted equivalent sound pressure level) were taken and its standard deviation was calculated. The 1 second data from time-history data of LZeq was also taken to calculate its standard deviation. The TSLV formula is simply multiplying the standard deviation from LZeq ⅛ seconds time history data with the standard deviation of 1 second sound pressure level data obtained from the field measurements.

Spectral gravity center (SGC) is computed based on Equation 5 in excel. The data is obtained from the excel files produced from the soundbook. High SGC values indicate high-frequency content and low SGC values indicate low-frequency content.

Following acoustic indicators calculation, the relationship between each acoustic indicator was evaluated using the linear regression statistical analysis. The main reason was to investigate the relationships between each acoustic indicator. The regression analysis between sound power level towards biophony / antrophony ratio, normalized difference soundscape index, psychoacoustic annoyance, temporal sound level variance, spectral gravity center were critical to investigate if there was a strong relationship between potential acoustic indicators and sound pressure / power level. Linear regression analysis was presented in the form of matrix plot analysis. Matrix plot analysis is a regular regression analysis that linearly plots the data to each other and presents the highest correlation value to the graph (closer to 1 or -1). To scale multiple acoustic indicators investigated in this research and to support matrix plot results, principal component analysis is performed. Principal Component analysis is a method of reducing the dimension of a large data set into a smaller one by decreasing the number of variables while preserving as much information as possible. Principal Component is considered significant if the eigenvalues are larger than 1.0.

Survey on Site

The purpose of the survey was to validate the importance of acoustic indicators in evaluating the sound quality standards. The survey was designed based on the following ISO 12913-2:2018 standard (Figure 19). The method and survey question was approved by Ethic Boards Review (ID: 202041) on January 12th, 2022 (See Appendix 11). Note, due to COVID-19 protocols the survey method was limited to contactless approach.



To what extend do you presently hear the following four types of sounds?
Please tick off one reponse alternative per type of sound

	Not at all	A little	Moderately	A lot	Dominates completely
Traffic noise (e.g., cars, buses, trains, air planes)	☐	☐	☐	☐	☐
Other noise (e.g., sirens, construction, industry, loading of goods)	☐	☐	☐	☐	☐
Sounds from human beings (e.g., conversation, laughter, children at play, footsteps)	☐	☐	☐	☐	☐
Natural sounds (e.g., singing birds, flowing water, wind in vegetation)	☐	☐	☐	☐	☐

For each of the 8 scales below, to what extend do you agree or disagree that the present surrounding sound environment is...
Please tick off one reponse alternative per scale

	Strongly agree	Agree	Neither agree, nor disagree	Disagree	Strongly disagree
- pleasant	☐	☐	☐	☐	☐
- chaotic	☐	☐	☐	☐	☐
- vibrant	☐	☐	☐	☐	☐
- uneventful	☐	☐	☐	☐	☐
- calm	☐	☐	☐	☐	☐
- annoying	☐	☐	☐	☐	☐
- eventful	☐	☐	☐	☐	☐
- monotonous	☐	☐	☐	☐	☐

Overall, how would you describe the present surrounding sound environment?

Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐

Overall, to what extent is the present surrounding sound environment appropriate to the present place?

Not at all	Slightly	Moderately	Very	Perfectly
☐	☐	☐	☐	☐

Figure 21. Survey Questions ISO 12913-2:2018

To carry out an accurate survey for the research, population and sample size was determined. Population size is the total number of respondents available in the area of interest. Sample size is selected respondents chosen from the population to represent the entire population. In this case the population of the Olympic Village is 16,000 people. Given the population size is 16,000 people with a 5% margin of error and 95% confidence level, 75 respondents were required for the Olympic Village survey.

The survey questions were made in Google Forms and linked to a QR code. The poster shown below in Figure 20 was mounted using lawn sticks, during field measurements to keep the survey timing aligned with the field measurements. Each QR code is unique depending on the data measurement points where the survey is carried out. Respondents were able to scan the QR code and perform the survey. Respondents were people that pass-by the data measurement points at time of measurement. Risk management protocols limited personal recruitment of survey participants due to COVID-19.

Figure 22. Survey Poster (Total of 3 posters were placed surrounded equipment setup)

To improve the response rate of the survey, some activities were implemented as the situation permitted:

- An information letter to survey participants was embedded in the link at the beginning of the survey.
- A poster containing information about the survey and contact were installed.
- An incentive of $25 Amazon Gift Card was offered in a form of lucky draw after participants completed the survey.

To ensure high engagements from participants, a total of three posters were installed surrounding the field measurement area.

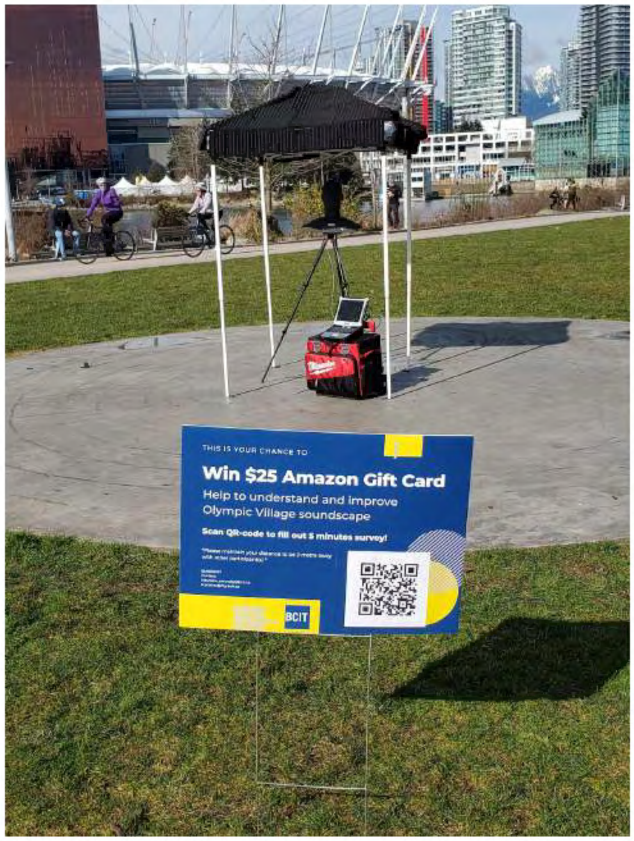


Figure 23. Survey Poster and Equipment Setup.

The survey data was processed to form a two-dimensional soundscape diagram analysis according to ISO 12913-3:2019 standard to form eight quadrants of chaotic, eventful, vibrant, pleasant, calm, eventful, monotonous and annoying See Figure 7 in literature review. The survey data was gathered in the form of Likert scale of 1 to 5. The survey questions and results were scaled according to Method A ISO Standard 1291302918. The median data of survey results gathered was scaled to compute two-dimensional soundscape diagram analysis. Survey questions number 1 to 4 regarding sound source identifications and question number 14 regarding assessment of the appropriateness have a scale of 1 to 5 according to the results. Survey questions number 5-12 regarding perceived affective sound quality and question number 13 regarding assessment of surrounding sound environment have a scale of 5 to 1 according to the results. The median data was computed according to the pleasantness formula (Equation 3) and eventfulness formula (Equation 4). Pleasantness and eventfulness results are projected to the two-dimensional soundscape diagram to identify the cluster of Olympic Village soundscape analysis.

In this research, the Sound Quality zone is described as the Vibrant-Pleasant-Calm quadrant. Any data measurement point that falls into this quadrant will be considered as a Sound Quality zone.

Taxonomy Analysis

Taxonomy analysis was carried out according to ISO 12913-2: 2018 taxonomy chart. During the time of data measurements, notes were taken regarding the amount of each sound source present in the soundscape. This includes identifying which sound source is the background noise and foreground noise.

To analyze the soundscape perception according to researchers, taxonomy analysis according to ISO 1219-2:2018 standard is performed see Figure 7 in literature review. The soundscape notes per each data measurement point were processed into a taxonomy chart. Each data measurement point sound source was classified based on the lowest level of the taxonomy chart. Sound source that is the quietest has a score of 1 (triangle), less dominating sound source has a score of 2 (square) and dominating sound source has a score of 3 (circle). Each data measurement point in Olympic Village has its own taxonomy chart analysis (see Appendix 6).

Triangulation Analysis

The goal of the study is to identify suitable acoustic indicators for the Sound Quality standard in the Ecocity framework. The study has adopted a triangulation method analyzing three potential relationships between measurement on site and survey on site, between measurement on site and taxonomy, and between survey on site and taxonomy.

Relationship between Measurement on Site and Survey on Site

To see the relationship between measurement on site and survey on site, the calculated acoustic indicator values and data measurement points location (linear data) on two-dimensional soundscape diagram (binary data) are analyzed in regression analysis. Regression analysis is a method to evaluate the strength of the relationship between two quantitative variables. In other words, regression analysis can be utilized to determine if each indicator is the best fit indicator to evaluate sound quality. To determine which acoustic indicators (psychoacoustic annoyance - PA, spectral gravity centre - SGC, temporal sound level variance - TLSV, biophony/anthrophony ratio - B/A ratio, normalized difference soundscape index - NDSI), classical attributes (sound pressure level (LAeq and Leq), sound power level (LAeq and Leq in Pascal)) and other acoustical indicators such as loudness - N, loudness percentile - N5, loudness maximum - Nmax, fluctuation strength - FS, sharpness, roughness) place data measurement points under Sound Quality zone, binary logistic regression was performed. Binary logistic regression is a regression method specialized in analyzing binary data.

Binary logistic regression shows results that are lower than p-value of 0.05 proves significant relationships. Later, the function of prediction in Minitab was run for any binary logistic regression analysis that has p-value less than 0.05 to determine acoustic indicators value and its probability to place data measurement points into the Sound Quality zone.

Relationship between Measurement on the Site and Taxonomy Analysis

Measurement on the site results varied from one point to another. Taxonomy analysis helps to identify the reason between measurement results variation. To ease the comparison for each point, the measurement results for each data measurement point is visualized to the Olympic Village heat map according to the corresponding acoustic indicator. Taxonomy notes were then compared with the heat map to draw out information of the relationship between measurement on the site and taxonomy analysis.

Relationship between Survey on the Site and Taxonomy Analysis

Cross analysis between survey result and taxonomy analysis was necessary to validate that the researcher experiences similar soundscape experience with survey participants. The taxonomy categories as defined on site were evaluated at each location to establish how categories of sounds related to the two-dimensional soundscape diagram results.

5. Results

Each classical and potential acoustic indicator is reported in terms of Weekend and Weekday data.

5.1. Acoustic Indicators Results

Sound Pressure Level / Sound Power Level

Sound pressure levels of weighted (LAeq) and unweighted (Leq) are obtained directly from the soundbook. LAeq and Leq are measured in decibel (dBA) and decibel (dB) which are in logarithmic scale. Though, both the unweighted and weighted sound pressure level need to be converted into sound power level (N/m2 or Pascal) to keep the data in linear format so that the regression analysis can be run smoothly. Below Table 7 shows the breakdown of sound pressure level and sound power level data.

Table 7. Sound Power Level and Sound Pressure Level at each Point

Point	Leq (dB)	Leq in Pascal	LAeq (dBA)	LAeq in Pascal
DAY 2 - Weekend				
Point 2A	77.81	1.55	69.93	0.63
Point 2B	77.74	1.54	72.75	0.87
Point 3	73.68	0.97	65.36	0.37
Point 4	76.58	1.35	67.04	0.45
Point 5	70.23	0.65	63.77	0.31
Point 6	77.00	1.42	68.55	0.54
Point 7	71.43	0.75	62.76	0.27
Point 8	70.48	0.67	62.16	0.26
Point 9	80.29	2.07	62.13	0.26
Point 10	69.39	0.59	63.80	0.31
Point 11	70.29	0.65	64.31	0.33
Point 12	67.34	0.47	59.02	0.18
Point 13	73.39	0.93	68.20	0.51
Point 14	67.41	0.47	61.57	0.24
Point 15	68.63	0.54	60.34	0.21
Point 16	66.03	0.40	60.41	0.21
Point 17	66.21	0.41	61.01	0.22
Point 18	66.28	0.41	58.38	0.17
AVG	74.01	0.88	65.90	0.35

MAX	80.29	2.07	72.75	0.87
MIN	66.03	0.40	58.38	0.17
STDEV	4.57	0.50	3.97	0.18
DAY 3 - Weekday				
Point 19	75.15	1.14	68.20	0.51
Point 20	73.32	0.93	67.33	0.46
Point 21	70.21	0.65	66.44	0.42
Point 22	74.75	1.09	69.49	0.60
Point 23	78.52	1.69	65.84	0.39
Point 24	83.64	3.04	68.39	0.53
Point 25	73.35	0.93	72.90	0.88
Point 26	69.75	0.61	62.15	0.26
Point 27	66.15	0.41	61.22	0.23
Point 28	74.97	1.12	68.14	0.51
Point 29	72.80	0.87	64.63	0.34
Point 30	70.27	0.65	57.72	0.15
Point 31	71.64	0.76	61.40	0.24
Point 32	73.01	0.89	62.67	0.27
Point 33	77.35	1.47	62.68	0.27
Point 34	70.41	0.66	62.54	0.27
Point 35	69.63	0.61	61.12	0.23
Point 36	76.51	1.34	71.54	0.75
Point 37	75.17	1.15	68.95	0.56
Point 38	76.68	1.36	71.65	0.77
AVG	75.60	1.07	67.54	0.43
MAX	83.64	3.04	72.90	0.88
MIN	66.15	0.41	57.72	0.15
STDEV	3.90	0.57	4.19	0.21

Figure 24. Unweighted Sound Pressure Level Map

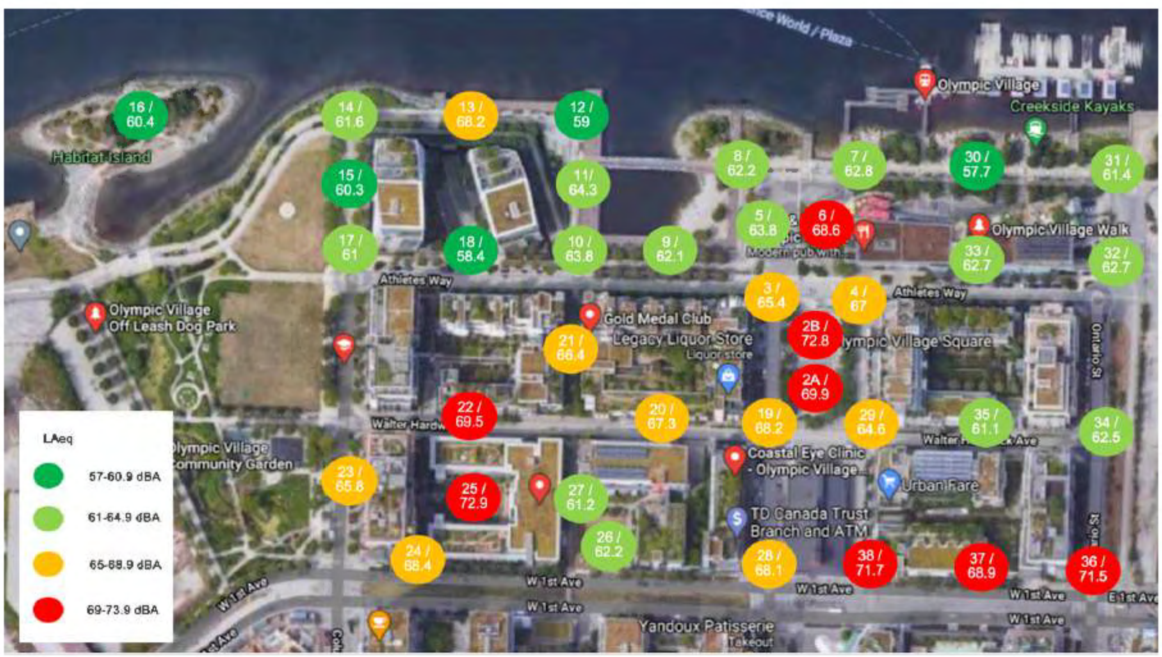


Figure 25. Weighted Sound Pressure Level Map

From the collected data above, the Weekend data of the Olympic Village has an average of 74.01 dB (0.88 Pa) unweighted sound level and 65.90 dBA (0.35 Pa) weighted sound level. The maximum unweighted sound pressure level is 80.29 dB (2.07 Pa) which occurred in Point 9 and the maximum weighted sound pressure level is 72.75 dBA (0.87 Pa) which occurred in Point 2B. The minimum unweighted sound pressure level is 66.03

dB (0.4 Pa) which occurred in Point 16 and the minimum weighted sound pressure level is 58.38 dBA (0.17 Pa) which occurred in Point 18. The unweighted sound pressure data has a standard deviation of 4.57, unweighted sound power data has a standard deviation of 0.50, the weighted sound pressure data has a standard deviation of 3.97, and weighted sound power data has a standard deviation of 0.18.

From the collected data above, the Weekday data of the Olympic Village has an average of 75.60 dB (1.07 Pa) and 67.54dBA (0.43 Pa) sound. The maximum unweighted sound pressure level is 83.64 dB (3.04 Pa) which occurred in Point 24 and the maximum weighted sound pressure level is 72.90 dBA (0.88 Pa) which occurred in Point 25. The minimum unweighted sound pressure level is 66.15 dB (0.41 Pa) which occurred in Point 27 and the minimum weighted sound pressure level is 57.72 dBA (0.15 Pa) which occurred in Point 30. The unweighted sound pressure data has a standard deviation of 3.9, unweighted sound power data has a standard deviation of 0.57, the weighted sound pressure data has a standard deviation of 4.19, and weighted sound power data has a standard deviation of 0.21.

Balanced Soundscape - Ratio of Antrophony, Biophony and Geophony

Table 8 and Figure 26 show the breakdown of the biophony/anthrophony ratio after the calculation at each point. Note that the data provided is in the form of A-weighted Leq.

Table 8. biophony/antrophony Ratio at each Data Measurement Point

DAY 2 - Weekend		DAY 3 - Weekday	
Point	LAeq - Bio/Antrophony Ratio	Point	LAeq - Bio/Antrophony Ratio
Point 2A	0.94	Point 19	0.97
Point 2B	0.99	Point 20	1.01
Point 3	0.96	Point 21	0.96
Point 4	0.97	Point 22	1.01
Point 5	0.97	Point 23	0.93
Point 6	0.94	Point 24	0.98
Point 7	0.96	Point 25	1.07
Point 8	0.95	Point 26	0.95
Point 9	0.93	Point 27	1.01
Point 10	0.95	Point 28	0.99
Point 11	0.94	Point 29	0.95
Point 12	0.93	Point 30	0.89
Point 13	0.93	Point 31	0.94
Point 14	0.93	Point 32	0.98
Point 15	0.90	Point 33	1.01
Point 16	0.92	Point 34	0.95
Point 17	1.00	Point 35	0.98
Point 18	0.99	Point 36	0.98
		Point 37	0.92
		Point 38	1.01
AVG	0.95	AVG	0.98
MAX	1.00	MAX	1.07
MIN	0.90	MIN	0.89
STDEV	0.03	STDEV	0.04

Figure 26. Biophony/Antrophony Ratio Map

From the collected data above, the Weekend data of the Olympic Village has an average of 0.95 biophony/antrophony ratio. Means that the dominant source of noise/sound in the area was produced by human activities, however closed enough to have natural sound present in the element. The maximum biophony/antrophony ratio occurred in Point 17 with a value of 1.00 and minimum biophony/antrophony ratio occurred in Point 15 with a value 0.90. The Weekend data of biophony/antrophony ratio data has a standard deviation of 0.03.

From the collected data above, the Weekday data of the Olympic Village has an average of 0.98 biophony/antrophony ratio. The maximum biophony/antrophony ratio occurred in Point 25 with a value of 1.07 and minimum biophony/antrophony ratio occurred in Point 30 with a value 0.89. The Weekday data of biophony/antrophony ratio data has a standard deviation of 0.04.

Balanced Soundscape - Normalized Difference Sound Index (NDSI)

Table 9 & Figure 27 show the breakdown of NDSI value with the interpretation of each data measurement point.

Table 9. NDSI Values Obtained from each Data Measurement Point.

DAY 2 - Weekend		DAY 3 - Weekday	
Point	NDSI	Point	NDSI
Point 2A	-0.02	Point 19	0.10
Point 2B	0.15	Point 20	0.30
Point 3	0.02	Point 21	-0.14
Point 4	0.13	Point 22	0.25
Point 5	0.15	Point 23	-0.14
Point 6	-0.08	Point 24	0.18
Point 7	0.12	Point 25	0.54
Point 8	-0.02	Point 26	0.00
Point 9	0.01	Point 27	0.28
Point 10	-0.05	Point 28	0.23
Point 11	-0.09	Point 29	-0.02
Point 12	0.00	Point 30	-0.17
Point 13	-0.17	Point 31	0.07
Point 14	-0.04	Point 32	0.21
Point 15	-0.12	Point 33	0.43
Point 16	-0.14	Point 34	-0.02
Point 17	0.28	Point 35	0.19
Point 18	0.30	Point 36	0.13
		Point 37	-0.30
		Point 38	0.26
AVG	0.02	AVG	0.12
MAX	0.30	MAX	0.54
MIN	-0.17	MIN	-0.30
STDEV	0.14	STDEV	0.21

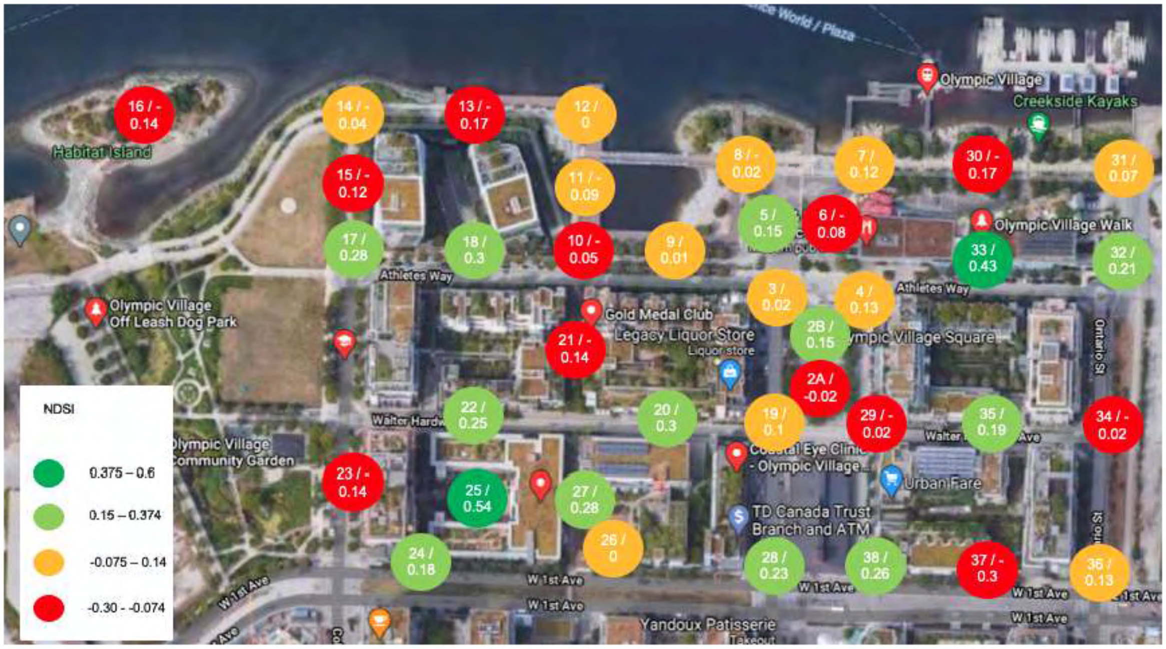


Figure 27. NDSI Map

From the collected data above, the Weekend data of Olympic Village has an average of 0.02 NDSI value. Meaning that the dominant source of noise/sound in the area was produced equally by natural sound and human activities present in the soundscape. Low NDSI indicates presence of animals and high (closer to +1) NDSI indicates less presence of antrophony. The maximum NDSI value occurred in Point 18 with a value of 0.3 and minimum NDSI value occurred in Point 13 with a value -0.17. The Weekend data of NDSI has a standard deviation of 0.14.

From the collected data above, the Weekday data of Olympic Village has an average of 0.12 NDSI value. Means that the dominant source of noise/sound in the area was produced by natural sound with some human activities present in the soundscape. The maximum NDSI value occurred in Point 24 with a value of 0.54 and minimum NDSI value occurred in Point 37 with a value -0.30. The Weekday data of NDSI has a standard deviation of 0.21.

Psychoacoustic Annoyance (PA)

Below (Table 10 & Figure 28) show the breakdown of PA values obtained from each point.

Table 10. PA values obtained from each data measurement point.

Point	N	Nmax	N5	Sharpness	Roughness	Fluctuation Strength	PAnnoyance
Day 2 - Weekend							
Point 2A	35.31	83.25	46.58	1.34	0.16	0.04	49
Point 2B	35.06	100.12	55.17	1.54	0.19	0.07	58
Point 3	31.85	93.07	42.07	1.48	0.21	0.07	45
Point 4	32.87	98.39	47.82	1.38	0.13	0.05	50
Point 5	28.29	66.50	37.75	1.53	0.20	0.08	41
Point 6	39.38	94.46	62.90	1.46	0.16	0.25	68
Point 7	25.43	92.09	34.95	1.52	0.19	0.06	38
Point 8	24.99	57.33	33.59	1.35	0.12	0.05	35
Point 9	26.84	61.29	37.54	1.40	0.16	0.04	40
Point 10	25.07	88.33	35.55	1.52	0.17	0.06	38
Point 11	24.22	87.61	34.84	1.43	0.18	0.05	37
Point 12	20.53	47.97	26.30	1.43	0.14	0.10	28
Point 13	31.13	121.91	50.72	1.39	0.14	0.10	54
Point 14	24.80	65.90	31.88	1.41	0.18	0.04	34
Point 15	24.04	55.98	30.31	1.38	0.17	0.04	32
Point 16	21.74	41.70	27.87	1.34	0.12	0.05	30
Point 17	18.70	91.61	25.81	1.69	0.21	0.08	28
Point 18	20.62	55.85	27.58	1.52	0.19	0.04	30
AVG	27.27	77.96	38.29	1.45	0.17	0.07	41
MAX	39.38	121.91	62.90	1.69	0.21	0.25	68
MIN	18.70	41.70	25.81	1.34	0.12	0.04	28
STDEV	5.81	21.86	10.57	0.09	0.03	0.05	11
Day 3 - Weekday							
Point 19	35.23	117.45	56.60	1.45	0.14	0.05	59
Point 20	34.30	92.28	49.18	1.50	0.15	0.04	52
Point 21	30.34	111.62	39.65	1.47	0.20	0.05	43
Point 22	40.59	105.46	56.88	1.54	0.16	0.04	60
Point 23	37.07	82.06	45.41	1.29	0.16	0.06	48

Point 24	42.61	80.01	58.14	1.31	0.14	0.03	60
Point 25	52.94	90.43	64.40	1.88	0.20	0.03	74
Point 26	26.63	65.84	38.87	1.42	0.17	0.07	42
Point 27	25.18	47.83	31.72	1.57	0.14	0.03	33
Point 28	33.94	89.37	55.73	1.41	0.17	0.04	59
Point 29	30.62	69.30	40.35	1.52	0.18	0.04	43
Point 30	20.21	46.71	25.69	1.37	0.20	0.03	28
Point 31	25.86	58.47	34.94	1.54	0.17	0.04	37
Point 32	26.48	83.77	36.13	1.70	0.16	0.05	41
Point 33	24.76	68.04	39.28	1.68	0.16	0.03	47
Point 34	25.73	72.73	42.39	1.49	0.18	0.04	45
Point 35	23.87	53.45	39.31	1.50	0.12	0.03	41
Point 36	39.07	124.00	71.53	1.68	0.16	0.06	84
Point 37	35.78	98.23	62.23	1.41	0.17	0.05	65
Point 38	32.04	160.03	59.14	1.63	0.19	0.19	63
AVG	31.87	83.74	46.77	1.52	0.17	0.05	51
MAX	52.94	160.03	71.53	1.88	0.20	0.19	84
MIN	20.21	46.71	25.69	1.29	0.12	0.03	28
STDEV	8.27	28.81	12.92	0.15	0.02	0.04	15

Figure 28. Psychoacoustic Annoyance Map

Psychoacoustic Annoyance (PA) data from the Olympic Village has an average value of 41 PA value on the weekend and 51 PA value on the weekday. The PA recorded at the Olympic Village has a range from 28 PA value (Point 12 and Point 17) to 68 PA value (Point 6) on the weekend and has a range from 28 PA value (Point 30) to 84 PA value (Point 36). This indicates that the Olympic Village should not fall under the annoying category. The PA data has a standard deviation of 11 on the weekend and 15 on the weekday.

Sharpness (S) from the collected data above, the Olympic Village has an average of 1.45 on the weekend and 1.52 on the weekday. The Sharpness data recorded at the Olympic Village has a range from 1.34 (Point 16) to 1.69 (Point 17) on the weekend and has a range from 1.29 (Point 23) to 1.88 (Point 25). The Sharpness data has a standard deviation of 0.09 on the weekend and 0.15 on the weekday.

Roughness (R) from the collected data above, the Olympic Village has an average of 0.17 on the weekend and on the weekday. The Roughness data recorded at the Olympic Village has a range from 0.12 (Point 16) to 0.21 (Point 17) on the weekend and has a range from 0.12 (Point 35) to 0.2 (Point 21, Point 25 and Point 30). The Roughness data has a standard deviation of 0.03 on the weekend and 0.02 on the weekday.

Fluctuation Strength (FS) from the collected data above, the Olympic Village has an average of 0.07 on the weekend and 0.05 on the weekday. The Fluctuation Strength data recorded at the Olympic Village has a range from 0.04 (Points 2A, 9, 14, 15, 18) to 0.25 (Point 6) on the weekend and has a range from 0.03 (Point 24, 25, 27, 30, 33, 35) to 0.19 (Point 38). The Fluctuation Strength data has a standard deviation of 0.05 on the weekend and 0.04 on the weekday.

Loudness (N) from the collected data above, the Olympic Village has an average of 27.27 sones on the weekend and 31.87 sones on the weekday. The Loudness data recorded at the Olympic Village has a range from 18.70 sones (Point 17) to 39.38 sones (Point 6) on the weekend and has a range from 20.21 sones(Point 30) to 52.94 sones (Point 24). The Loudness data has a standard deviation of 5.81 on the weekend and 8.27 on the weekday.

Loudness Maximum (Nmax) from the collected data above, the Olympic Village has an average of 77.96 sones on the weekend and 83.74 sones on the weekday. The Loudness Maximum data recorded at the Olympic Village has a range from 41.70 sones (Point 16) to 121.91 sones (Point 13) on the weekend and has a range from 46.71 sones (Point 30) to 160.03 sones (Point 38). The Loudness Maximum data has a standard deviation of 21.86 on the weekend and 28.81 on the weekday.

Loudness Percentile (N5) from the collected data above, the Olympic Village has an average of 38.29 sones on the weekend and 46.77 sones on the weekday. The Loudness Percentile data recorded at the Olympic Village has a range from 25.81 (Point 17) to 62.90 sones (Point 6) on the weekend and has a range from 25.69 sones (Point 30) to 71.53 sones (Point 36). The Loudness Percentile data has a standard deviation of 10.57 on the weekend and 12.92 on the weekday.

Temporal Sound Level Variance (TSLV)

Table 11 and Figure 29 show the breakdown of TSLV values obtained from each data measurement point.

Table 11. TSLV values obtained from each data measurement point.

DAY 2 - Weekend		DAY 3 - Weekday	
Point	TSLV	Point	TSLV
Point 2A	8.41	Point 19	12.32
Point 2B	16.95	Point 20	6.51
Point 3	7.53	Point 21	6.13
Point 4	12.95	Point 22	13.14
Point 5	9.35	Point 23	3.01
Point 6	12.94	Point 24	8.89
Point 7	9.40	Point 25	4.41
Point 8	9.11	Point 26	8.18
Point 9	6.91	Point 27	4.69
Point 10	14.99	Point 28	17.92
Point 11	12.41	Point 29	9.33
Point 12	7.90	Point 30	3.92
Point 13	20.28	Point 31	6.69
Point 14	6.26	Point 32	9.38
Point 15	4.64	Point 33	12.64
Point 16	5.67	Point 34	12.61
Point 17	13.91	Point 35	10.94
Point 18	5.66	Point 36	24.50
		Point 37	24.13
		Point 38	24.15
AVG	10.29	AVG	11.17
MAX	20.28	MAX	24.50
MIN	4.64	MIN	3.01
STDEV	4.34	STDEV	6.74

Figure 29. TSLV Map

From the collected data above, Weekend data of Olympic Village has an average of 10.3 TSLV value. The TSLV recorded at Olympic Village on the weekend has a range from 4.64 (Point 15) to 20.28 (Point 13). The Weekend TSLV data has a standard deviation of 4.34.

From the collected data above, Weekday data of Olympic Village has an average of 11.17 TSLV value. The TSLV recorded at Olympic Village on the weekend has a range from 3.01 (Point 23) to 24.50 (Point 36). The Weekday TSLV data has a standard deviation of 6.74.

Spectral Gravity Center (SGC)

Below (Table 12 & Figure 30) show the SGC breakdown values in the Olympic Village.

Table 12. SGC values obtained from each data measurement point.

DAY 2 - Weekend		DAY 3 - Weekday	
Point	SGC (Hz)	Point	SGC (Hz)
Point 2A	1576	Point 19	1908
Point 2B	2103	Point 20	2248
Point 3	1875	Point 21	1995
Point 4	1858	Point 22	2334
Point 5	2043	Point 23	1633
Point 6	1639	Point 24	1953
Point 7	1939	Point 25	2945
Point 8	1703	Point 26	1812
Point 9	1642	Point 27	2397
Point 10	1855	Point 28	1982
Point 11	1766	Point 29	2000
Point 12	1662	Point 30	1425
Point 13	1526	Point 31	1808
Point 14	1644	Point 32	2338
Point 15	1400	Point 33	2777
Point 16	1588	Point 34	1892
Point 17	2269	Point 35	2073
Point 18	2077	Point 36	2197
		Point 37	1624
		Point 38	2267
AVG	1787	AVG	2080
MAX	2269	MAX	2945
MIN	1400	MIN	1425
STDEV	232	STDEV	372

Figure 30. SGC Map

From the collected data above, the Weekend data of the Olympic Village has an average of 1787 Hz. The SGC recorded at the Olympic Village on the weekend has a range from 1400Hz (Point 15) to 2269Hz (Point 17). The Weekend SGC data has a standard deviation of 232.

From the collected data above, the Weekday data of the Olympic Village has an average of 2080Hz. The SGC recorded at the Olympic Village on the weekend has a range from 1425Hz (Point 30) to 2945Hz (Point 25). The Weekend SGC data has a standard deviation of 372.

Summary of Acoustic Indicator Results

Table 13 sums the results obtained from each acoustic indicator analysis. In terms of the average of data collected during Weekend and Weekday, there is no significant difference on sound pressure and sound power level, biophony/antrophony ratio, temporal sound level variance, sharpness, roughness, and fluctuation strength. The table showcases the maximum and minimum values of each acoustic indicator on the Weekend and Weekday. The table shows on which data measurement point the maximum and minimum data occurred each day.

Table 13. Summary of Acoustic Indicators Analysis

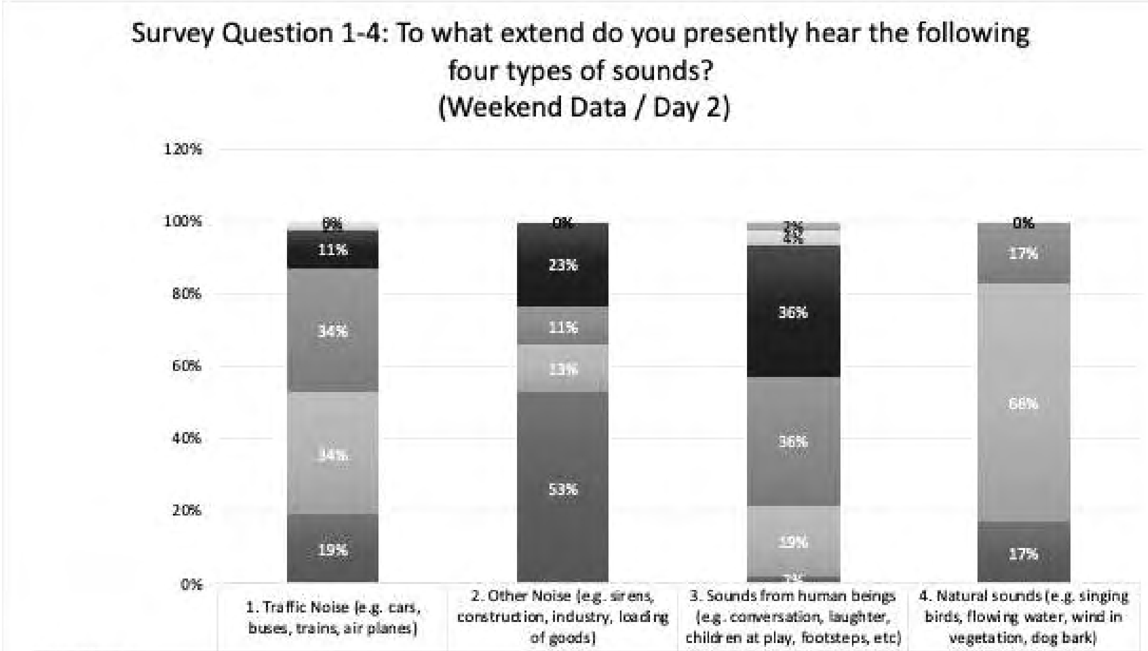
Acoustic Indicators	Day 2 - Weekend	Day 3 - Weekday	Day 2 - Weekend	Day 3 - Weekday
	Average	Average	StDev	StDev
Unweighted Sound Pressure Level (Leq) - dB	74.01	75.6	4.57	3.90
Unweighted Sound Power Level (Pascal)	0.88	1.07	0.5	0.57
Weighted Sound Pressure Level (LAeq) - dBA	65.9	67.54	3.97	4.19
Weighted Sound Power Level (Pascal)	0.35	0.43	0.18	0.21
Biophony/Antrophony Ratio	0.95	0.98	0.03	0.04
Normalized Difference Sound Index (NDSI)	0.02	0.12	0.14	0.21
Temporal Sound Level Variance (TSLV)	10.29	11.17	4.34	6.74
Spectral Gravity Centre (SGC) - Hz	1787	2080	232	372
Psychoacoustical Annoyance (PA)	41	51	11	15
Loudness (N) - sone	27.27	31.87	5.81	8.27
Loudness Maximum (Nmax) - sone	77.96	83.74	21.86	28.81
Loudness Percentile (N5) - sone	38.29	46.77	10.57	12.92
Sharpness (S)	1.45	1.52	0.09	0.15
Roughness (R)	0.17	0.17	0.03	0.02
Fluctuation Strength (FS)	0.07	0.05	0.05	0.04

Acoustic Indicators	Day 2 - Weekend		Day 3 - Weekday	
	Maximum	Max Data Measurement Point	Maximum	Max Data Measurement Point
Unweighted Sound Pressure Level (Leq) - dB	80.29	9	83.64	24
Unweighted Sound Power Level (Pascal)	2.07	9	3.04	24
Weighted Sound Pressure Level (LAeq) - dBA	72.75	2B	72.9	25
Weighted Sound Power Level (Pascal)	0.87	2B	0.88	25
Biophony/Antrophony Ratio	1	17	1.07	25
Normalized Difference Sound Index (NDSI)	0.3	18	0.54	24
Temporal Sound Level Variance (TSLV)	20.28	13	24.5	36
Spectral Gravity Centre (SGC) - Hz	2269	17	2945	30
Psychoacoustical Annoyance (PA)	68	6	84	36
Loudness (N) - sone	39.38	6	52.94	24
Loudness Maximum (Nmax) - sone	121.91	13	160.03	38
Loudness Percentile (N5) - sone	62.9	6	71.53	36
Sharpness (S)	1.69	17	1.88	25
Roughness (R)	0.21	17	0.2	21, 25, 30
Fluctuation Strength (FS)	0.25	6	0.19	38

Acoustic Indicators	Day 2 - Weekend		Day 3 - Weekday	
	Minimum	Min Data Measurement Point	Minimum	Min Data Measurement Point
Unweighted Sound Pressure Level (Leq) - dB	66.03	16	66.15	27
Unweighted Sound Power Level (Pascal)	0.4	16	0.41	27
Weighted Sound Pressure Level (LAeq) - dBA	58.38	18	57.72	30
Weighted Sound Power Level (Pascal)	0.17	18	0.15	30
Biophony/Antrophony Ratio	0.9	15	1	30
Normalized Difference Sound Index (NDSI)	-0.17	13	-0.3	37
Temporal Sound Level Variance (TSLV)	4.64	15	3.01	23
Spectral Gravity Centre (SGC) - Hz	1400	15	1425	25
Psychoacoustical Annoyance (PA)	28	12, 17	28	30
Loudness (N) - sone	18.7	17	20.21	30
Loudness Maximum (Nmax) - sone	41.7	16	46.71	30
Loudness Percentile (N5) - sone	25.81	17	25.69	30
Sharpness (S)	1.34	16	1.29	23
Roughness (R)	0.12	16	0.12	35
Fluctuation Strength (FS)	0.04	2A, 9, 14, 15, 18	0.03	24, 25, 27, 30, 33, 35

5.2. Survey Results

The survey resulted in 71 total responses. Weekend (Day 2) data has a total of 47 responses and Weekday (Day 3) data has a total of 24 responses. The breakdown of the survey results for overall Olympic Village are first presented, followed by the two-dimensional soundscape diagram analysis to aid the triangulation analysis with physical data measurements and taxonomy analysis results.



	1. Traffic Noise (e.g. cars, buses, trains, air planes)	2. Other Noise (e.g. sirens, construction, industry, loading of goods)	3. Sounds from human beings (e.g. conversation, laughter, children at play, footsteps, etc)	4. Natural sounds (e.g. singing birds, flowing water, wind in vegetation, dog bark)
No Answer	0%	0%	2%	0%
Dominates Completely	2%	0%	4%	0%
A Lot	11%	23%	36%	0%
Moderately	34%	11%	36%	17%
A Little	34%	13%	19%	66%
Not At All	19%	53%	2%	17%

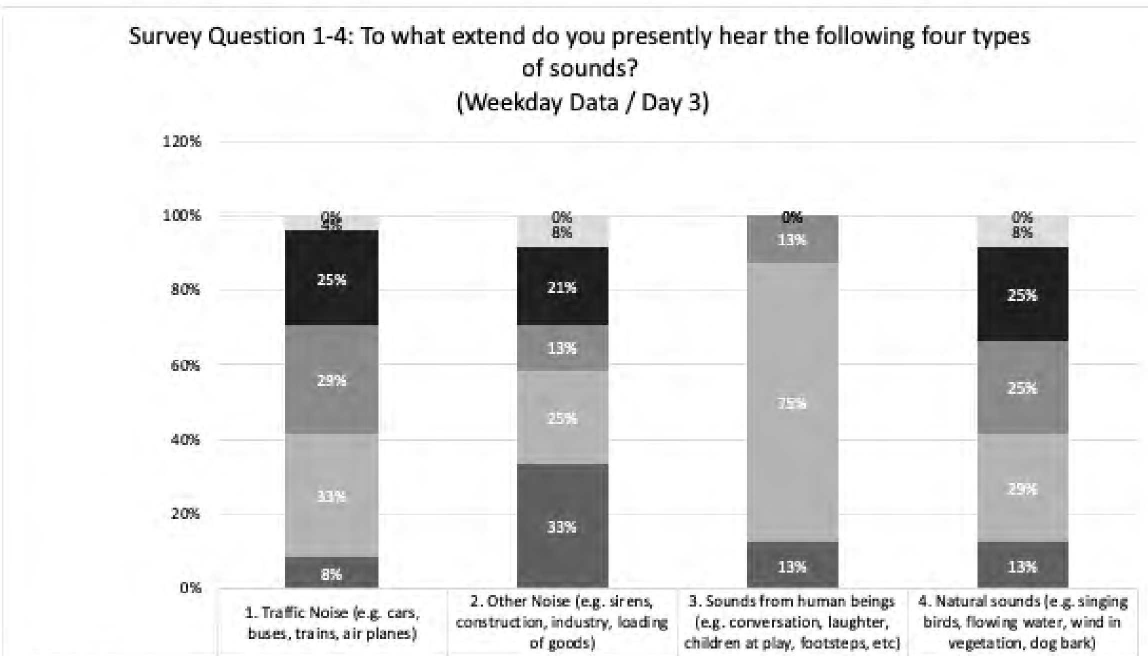
Figure 31. Survey Results Question 1-4 Collected on the Weekend (Day 2)

From a total of 47 Weekend respondents, 2% reported traffic noise was dominating the soundscape while 11% reported that there was a high amount of traffic noise present, 34% reported traffic noise were moderate, 34% reported that there was just a slight amount of traffic noise present, and 19% respondents reported traffic noise were not at all to be heard.

For other noise produced by constructions, sirens, industry, or noise produced by loading-unloading goods (other noise), none thought other noises were dominating, 23% reported there were a significant amount of other noises present, 11% reported other noises present were moderate, 13% reported they could only hear a slight amount of other noises, and the majority 53% reported other noises were not at all to be heard.

Regarding sound produced from human beings, 2% of respondents did not provide any answers, 4% of respondents reported that human noise was dominating completely, 36% reported that there was a significant amount of human noise present, 36% reported human noise present was moderate, 19% which is the majority of the respondents reported that there was just a slight amount of human noise that was heard, and 2% reported human noise were not at all to be heard.

For natural sound, none reported that natural sound was dominating the soundscape, none reported that there was a high amount of natural sound present, 17% reported that natural sound present was moderate, majority of 66% reported only a slight amount of natural sound was present, and 17% reported natural sound was not at all to be heard.



	1. Traffic Noise (e.g. cars, buses, trains, air planes)	2. Other Noise (e.g. sirens, construction, industry, loading of goods)	3. Sounds from human beings (e.g. conversation, laughter, children at play, footsteps, etc)	4. Natural sounds (e.g. singing birds, flowing water, wind in vegetation, dog bark)
No Answer	0%	0%	0%	0%
Dominates Completely	4%	8%	0%	8%
A Lot	25%	21%	0%	25%
Moderately	29%	13%	13%	25%
A Little	33%	25%	75%	29%
Not At All	8%	33%	13%	13%

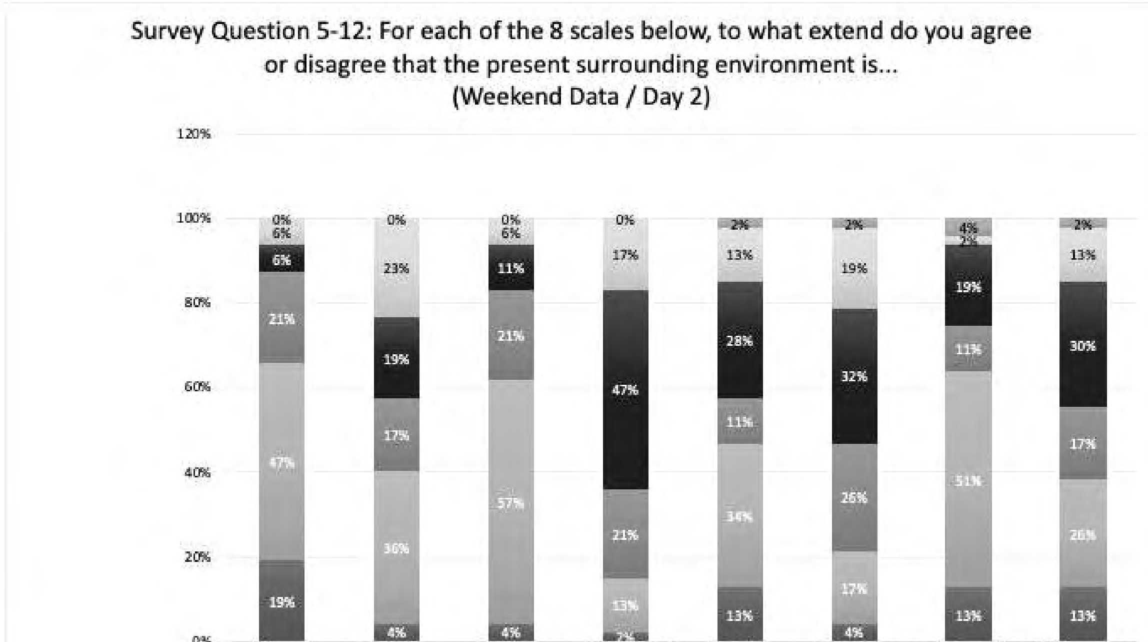
Figure 32. Survey Results Question 1-4 Collected on the Weekday (Day 3)

From a total of 24 Weekday respondents, 4% reported traffic noise was dominating the soundscape while 25% reported there was a significant amount of traffic noise present, 29% reported traffic noise present was moderate, 33% reported that there was just a slight amount of traffic noise present, and 8% respondents reported traffic noise was not at all to be heard.

For other noise produced by constructions, sirens, industry, or noise produced by loading-unloading goods (other noise), 8% of the respondents reported other noises were dominating, 21% reported there was a significant amount of other noises present, 13% reported other noises present were moderate, 25% reported there were only a slight amount of other noises were present, and the majority 33% reported other noises were not at all to be heard.

Regarding sound produced from human beings, none reported that human noise was dominating completely and none reported there was a significant amount of human noise present, 13% reported human noise present was moderate, 75% respondents reported there was just a slight amount of human noise present, and 33% reported human noise were not at all to be heard.

For natural sound, 8% of the respondents reported natural sound was dominating the soundscape, 25% of the respondents reported there was a significant amount of natural sound present, 25% reported that natural sound present was moderate, the majority which is 29% of the respondents reported that there was just a slight amount of natural sound present, and 13% reported natural sound was not at all to be heard.



	5. Pleasant	6. Chaotic	7. Vibrant	8. Uneventful	9. Calm	10. Annoying	11. Eventful	12. Monotonous
No Answer	0%	0%	0%	0%	2%	2%	4%	2%
Strongly Disagree	6%	23%	6%	17%	13%	19%	2%	13%
Disagree	6%	19%	11%	47%	28%	32%	19%	30%
Neither Agree Nor Disagree	21%	17%	21%	21%	11%	26%	11%	17%
Agree	47%	36%	57%	13%	34%	17%	51%	26%
Strongly Agree	19%	4%	4%	2%	13%	4%	13%	13%

Figure 33. Survey Results Question 5-12 Collected on the Weekend (Day 2)

Participants of 24 Weekend respondents were asked to rate the characteristics of Olympic Village soundscape based on these factors; pleasant, chaotic, vibrant, uneventful, calm, annoying, eventful, and monotonous.

For pleasant factors, 6% of the respondents strongly disagreed, 6% disagreed, 21% were neutral, 47% agreed, and 19% strongly agreed that the soundscape was pleasant.

For chaotic factors, 23% of the respondents strongly disagreed, 19% disagreed, 17% were neutral, 36% agreed, and 4% strongly agreed that the soundscape was chaotic.

For vibrant factors, 6% of the respondents strongly disagreed, 11% disagreed, 21% were neutral, 13% agreed, and 2% strongly agreed that the soundscape was vibrant.

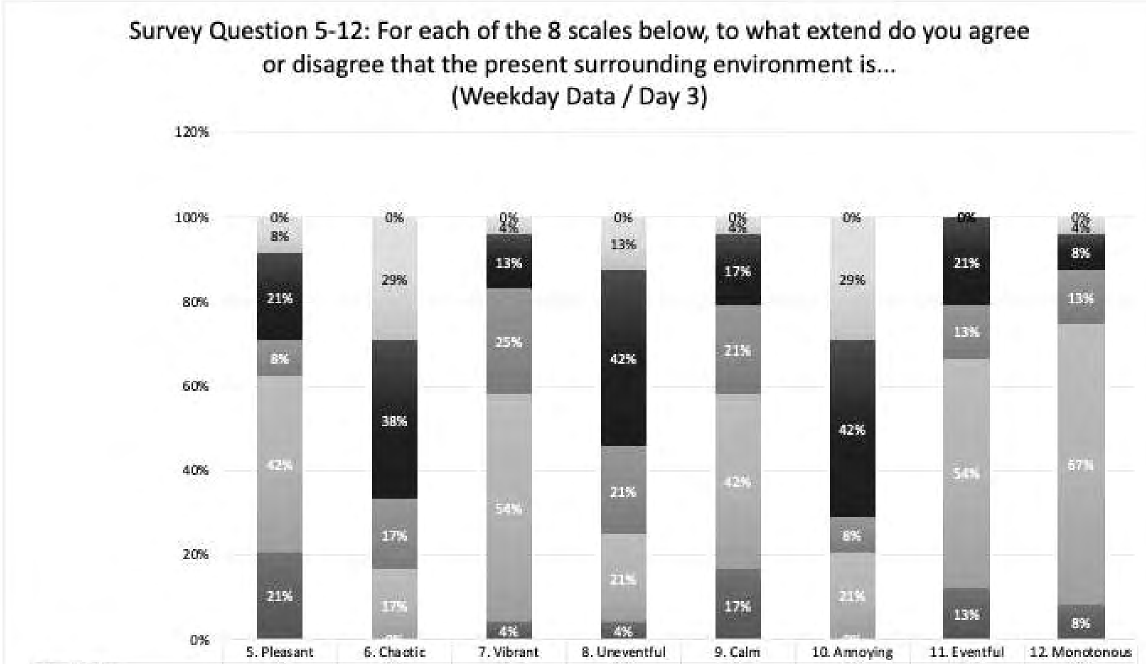
For uneventful factors, 17% of the respondents strongly disagreed, 47% disagreed, 21% were neutral, 13% agreed, and 2% strongly agreed that the soundscape was uneventful.

For calm factors, 2% of the respondents did not answer, 13% strongly disagreed, 28% disagreed, 11% were neutral, 34% agreed, and 13% strongly agreed that the soundscape was calm.

For annoying factors, 2% of the respondents did not answer, 19% strongly disagreed, 32% disagreed, 26% were neutral, 17% agreed, and 4% strongly agreed that the soundscape was annoying.

For eventful factors, 4% of the respondents did not answer, 2% strongly disagreed, 19% disagreed, 11% were neutral, 51% agreed, and 13% strongly agreed that the soundscape was uneventful.

For monotonous factors, 2% of the respondents did not answer, 13% strongly disagreed, 30% disagreed, 17% respondents were neutral, 26% agreed, and 13% strongly agreed that the soundscape was monotonous.



	5. Pleasant	6. Chaotic	7. Vibrant	8. Uneventful	9. Calm	10. Annoying	11. Eventful	12. Monotonous
No Answer	0%	0%	0%	0%	0%	0%	0%	0%
Strongly Disagree	8%	29%	4%	13%	4%	29%	0%	4%
Disagree	21%	38%	13%	42%	17%	42%	21%	8%
Neither Agree Nor Disagree	8%	17%	25%	21%	21%	8%	13%	13%
Agree	42%	17%	54%	21%	42%	21%	54%	67%
Strongly Agree	21%	0%	4%	4%	17%	0%	13%	8%

Figure 34. Survey Results Question 5-12 Collected on the Weekday (Day 3)

Participants of 24 Weekday respondents were asked to rate the characteristics of Olympic Village soundscape based on these factors; pleasant, chaotic, vibrant, uneventful, calm, annoying, eventful, and monotonous.

For pleasant factors, 8% of the respondents strongly disagreed, 21% disagreed, 8% were neutral, 41% agreed, and 21% strongly agreed that the soundscape was pleasant.

For chaotic factors, 29% of the respondents strongly disagreed, 38% disagreed, 17% neutral, 17% agreed, and none strongly agreed that the soundscape was chaotic.

For vibrant factors, 4% of the respondents strongly disagreed, 13% disagreed, 25% neutral, 54% agreed, and 4% strongly agreed that the soundscape was vibrant.

For uneventful factors, 13% of the respondents strongly disagreed, 42% disagreed, 21% were neutral, 21% agreed, and 4% strongly agreed that the soundscape was uneventful.

For calm factors, 4% of the respondents strongly disagreed, 17% disagreed, 21% were neutral, 42% agreed, and 17% strongly agreed that the soundscape was calm.

For annoying factors, 29% of the respondents strongly disagreed, 42% disagreed, 8% were neutral, 21% agreed, and none strongly agreed that the soundscape was annoying.

For eventful factors, none of the respondents strongly disagreed, 21% disagreed, 13% respondents were neutral, 54% agreed, and 13% strongly agreed that the soundscape was uneventful.

For monotonous factors, 4% of the respondents strongly disagreed, 8% disagreed, 13% were neutral, 67% agreed, and 8% strongly agreed that the soundscape was monotonous.

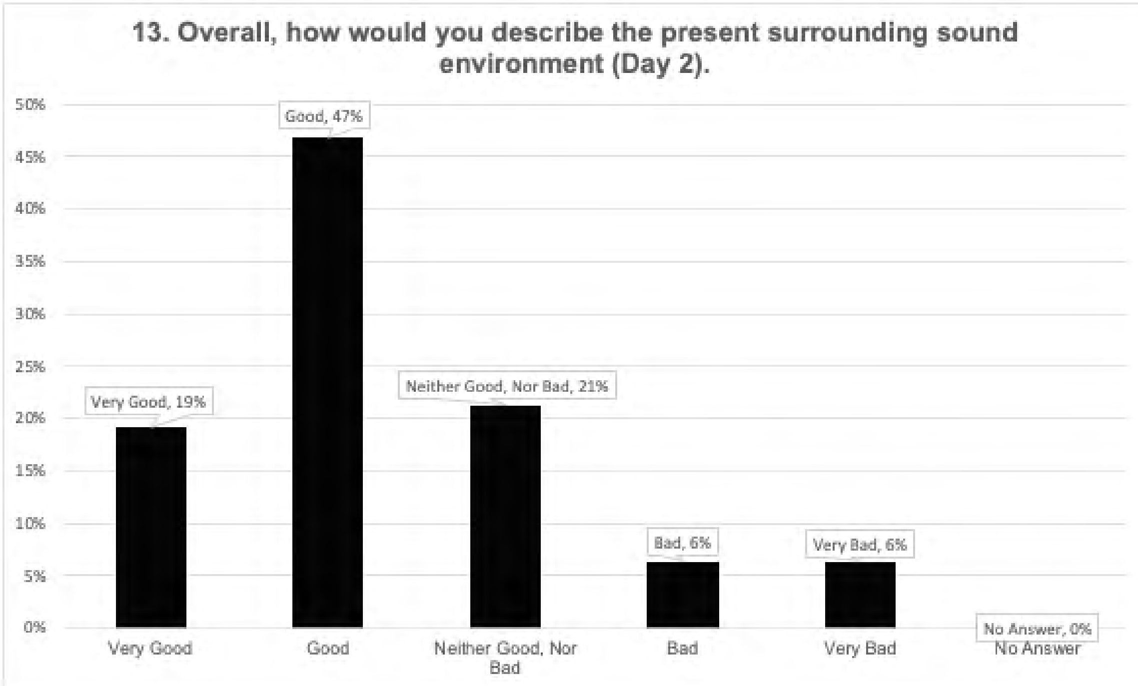


Figure 35. Survey Result Question 13 Collected on the Weekend (Day 2)

Participants of 47 Weekend respondents were asked to describe the Olympic Village surrounding the sound environment. The majority, 47% of the respondents reported the Olympic Village sound environment was good, 19% reported it was very good, 21% provided neutral responses, 6% reported it was bad, and 6% thought it was very bad (See Figure 34).

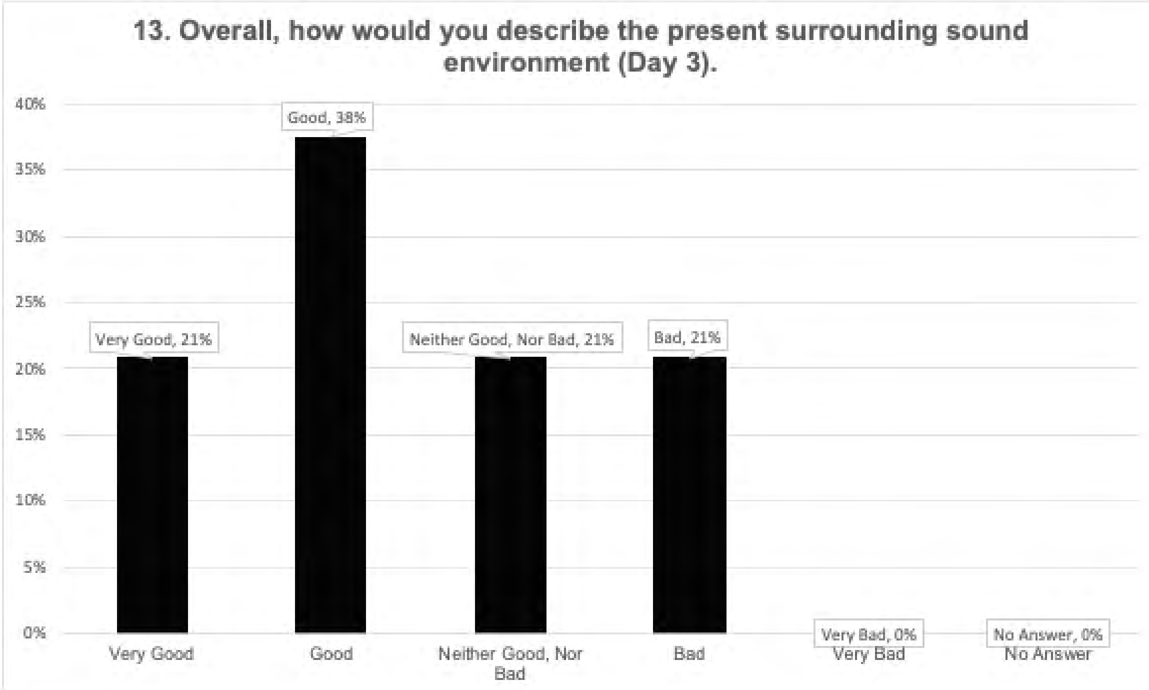


Figure 36. Survey Result Question 13 Collected on the Weekday (Day 3)

Participants of 24 Weekday respondents were asked to describe the Olympic Village surrounding the sound environment. The majority, 38% of the respondents, reported the Olympic Village sound environment was good, 21% reported it was very good, 21% provided neutral responses, 21% reported it was bad, and none reported it was very bad (See Figure 35).

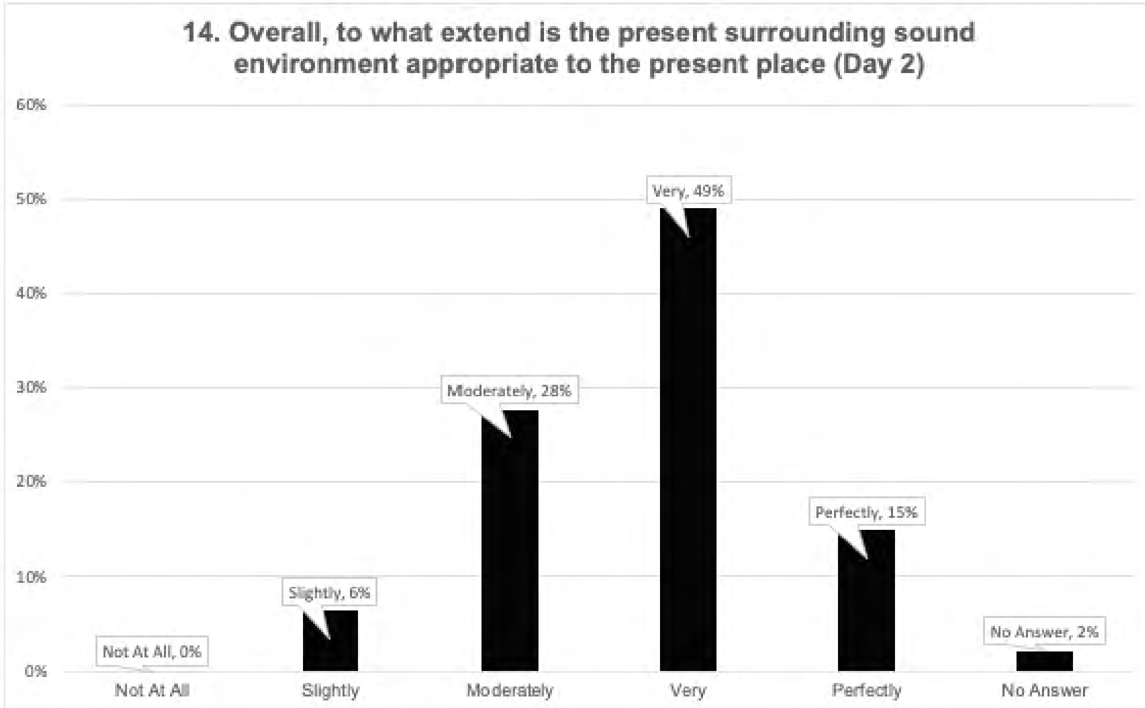


Figure 37. Survey Result Question 14 Collected on the Weekend (Day)

Participants of 47 Weekend respondents were asked to rate if the sound environment of Olympic Village appropriate to the sound environment. The majority, 49% of the respondents reported the Olympic Village sound environment was very appropriate to the environment, 28% provided neutral responses, 15% reported it fits perfectly with the surrounding environment, 6% reported it was slightly appropriate, and 2% provided no answer (See Figure 36).

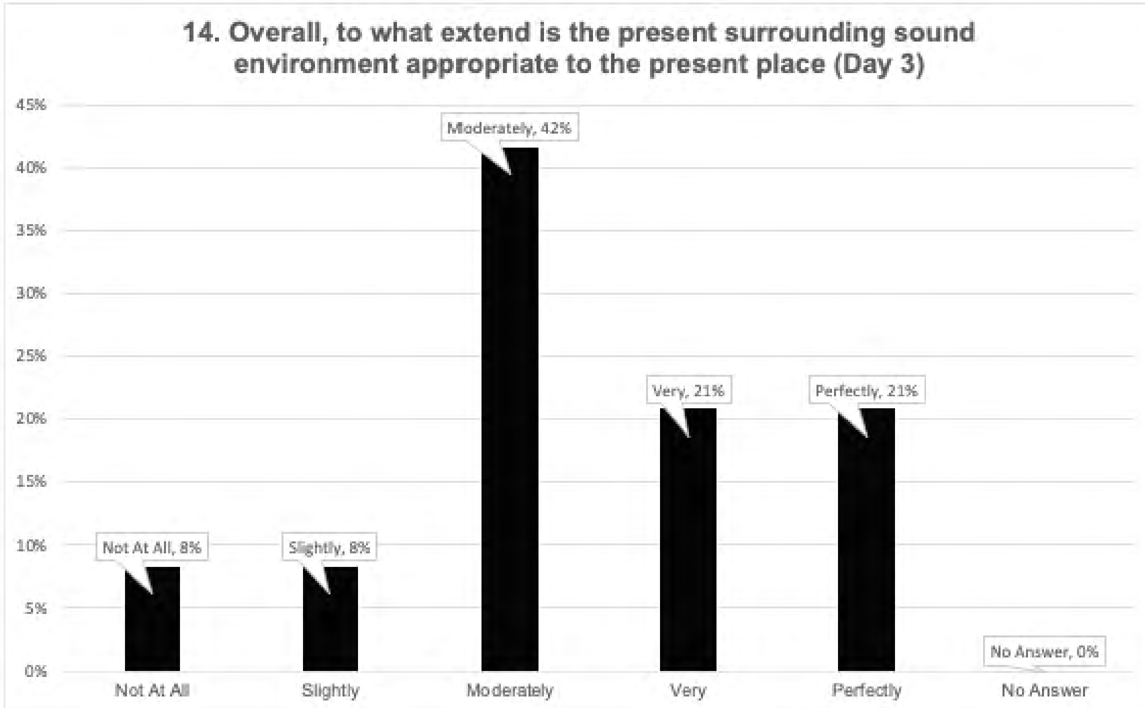


Figure 38. Survey Result Question 14 Collected on the Weekday (Day 3)

Participants of 24 Weekday respondents were asked to rate if the sound environment of Olympic Village appropriate to the sound environment. The majority, 42% of the respondents reported the Olympic Village sound environment was moderately appropriate to the environment, 21% reported it was very appropriate, 21% reported it fits perfectly with the surrounding environment, 8% reported it was slightly appropriate, and 8% reported it was not appropriate at all to the surrounding environment (See Figure 37).

Summary of Survey Result

On the weekend the dominating noise according to respondents are sounds produced by human beings, with very little natural sounds and moderate traffic and other noise sounds. On weekdays the dominating noise according to respondents are sounds produced by traffic noise, other noise and natural sounds, while sound from human beings were barely heard. On the weekend respondents agreed that the soundscape of Olympic Village is pleasant, vibrant and eventful and somehow chaotic and monotonous at some point. On the weekday respondents agreed that the soundscape of Olympic Village is pleasant, vibrant, eventful, monotonous, and calm. In terms of the surrounding environment and appropriateness of sound to the present environment, more than 50%

of the respondents on the weekend and weekday agreed that the present surrounding environment is good/very good and appropriate to the present place.

5.3. Taxonomy Results

To further investigate the data collected from field measurements, soundscape taxonomy or contents of noise/sound recordings are noted (Table 14). Taxonomy analysis is being used to cross-checked the data gathered from questionnaire (two-dimensional soundscape analysis) and physical data measurements. Detailed description per each data measurement point aids explanation of the psychoacoustic annoyance, spectral gravity centre, temporal sound level variance, normalized soundscape index and biophony/ anthrophony ratio results.

Table 14. Soundscape Note at each Data Measurement Point

Point	Note
2A	The main source at this point was mostly people talking around the area, with some sudden noise from dogs barking, cars honking, and kids shouting. Birds occasionally appeared here and there in the background.
2B	Kids screaming is the dominant sound and the recording showed many events happening such as dog barking, baby crying, and steady people talking in the background. Almost no natural sounds such as wind and birds were heard at this point.
Point 3	This point was also dominated by kids screaming, in addition to it, noises of cars passing in the background were heard. Footsteps, people talking in the background, and birds chirping were the least significant sound heard at this point.
Point 4	This point is close to the intersection, the dominant sound came from vehicles passing, which in this particular recording mostly are trucks or big engine vehicles and motorbikes, with people talking and laughing in the background. Kids screaming were also heard throughout the measurement points. Natural sounds like birds chirping, wind as well as dog barking were not often heard here.
Point 5	Many events happened in this recording, like people standing close to the equipment and talking loudly, people screaming or laughing close to the equipment, high frequency bird noise that is slightly loud, sound basking, traffic noise, and skytrain could also be heard in the background. Bicycle sounds were occasionally heard in the background as well.
Point 6	The dominant sound at this point was from sound busking, some pedalling sound from bicycles,footsteps, and conversations from people passing by. Dogs barking and birds chirping were heard here and there occasionally (very vague skytrain and airplane noise).
Point 7	Mostly the noise came from people passing by such as people’s footsteps, conversations, people riding bicycles, and people on skateboards. Birds chirping, dogs barking, and vague skytrain noise were also heard in between.
Point 8	By the water at this point, sky train noise was more prominent, boat noise, wind noise, super vague sound busking, footsteps of people passing by, people’s conversation, bicycles, sometimes kids screaming, crow, and dogs barking were heard.
Point 9	Crows in the background, people conversing, footsteps, wind noise, bicycles (not loud at all), and birdsongs were heard at this point.

Point 10	This point was placed close to pedestrians. Many events happened like kids screaming, people laughing, loud music carried by people passing, birds singing occasionally, continuous bicycles passing, airplanes,skytrains, and dogs barking.
Point 11	Similar to the previous point, vague busking noise, skytrain, people passing by, conversations,footsteps, kids screaming, more bird noise in the background, cars passing, and airplanes were heard. There was an incident where someone came close to the equipment and was screaming at iton file number 2.
Point 12	Vague skytrain, birds chirping, people's conversations, footsteps, slight busking noise which blended in with the overall background noise, quite a lot of dog barkings, and traffic noise were heard at this point.
Point 13	Dominating sounds were sound busking (so close to it), dogs barking, people's footsteps passing by, traffic noise. Skytrain noise, bicycle, loud bangs, birds chirping, and goose honking were also heard.
Point 14	At the beginning of the recording there were sounds of people dancing with music, bicycles, footsteps of people passing by, conversations, very vague sound basking which was not as loud as at point 13, skytrain noise, bird's chirping, boat engines, and airplanes were heard.
Point 15	Noises from bicycles, footsteps, and conversations from people passing by , very vague sound basking which was not as loud as at point 13, skytrain, traffic, birds chirping, and airplanes were heard at this point.
Point 16	The most dominating sound at this point was people's conversations , the second dominating noises were birds chirping & goose honking, faint noises from skytrains, footsteps, and boats were also heard.
Point 17	Noises from people's conversations, bicycles, footsteps, wind,water, birds chirping , dogs barking, crows cawing, cars passing by and breaking, and very vague genset sounds were heard at this point,
Point 18	At this point, noises from people's conversations, footsteps, water fountain, birds chirping, crows cawing, cars passing,breaking, and honking, bicycles, traffic, and dogs barking were heard.
Point 19	The most dominant noise at this point was from construction, then traffic noise from the intersection. Noises from big trucks passing by, footsteps, people's conversations, airplanes, food trucks, and vague birds chirping were also heard at this point.
Point 20	Birds chirping was the most dominant noise at this point. Noises from cars passing, footsteps, continuous mechanical sounds, and people passing by were present at this point.
Point 21	Birds chirping was the most dominant noise in the beginning of the recording, then there were noises from cars passing, construction, traffic, footsteps, and continuous mechanical sounds. Towards the end of the recording, there were dump truck noises that were really dominant.
Point 22	The most dominant noises at this point were coming from cars passing and stopping by, and construction. There were also noises from people's conversation, footsteps, and birds chirping.
Point 23	The noises heard at this point were construction noise, airplanes, vague birds chirping, crow cawings, bicycles passing, traffic noise, car passing, people's footsteps, and conversations.
Point 24	This point was mostly dominated by noises from birds chirping, mechanical engines, and cars passing by. There were also noises from construction, traffic, wind, dogs barking,

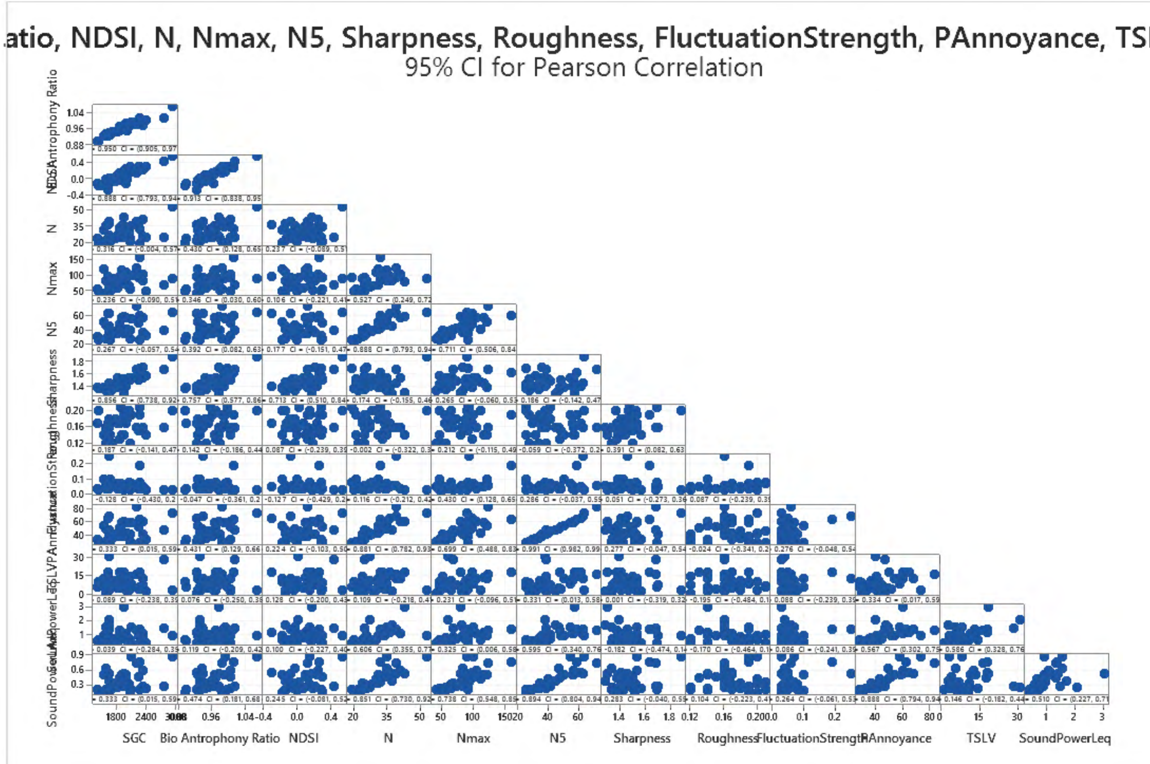
	people’s footsteps, conversations, and airplanes.
Point 25	Mostly, the noises heard at this point were heard from the water fountain and people cleaning the building. There were also noises of birds chirping, people’s footsteps, and conversations.
Point 26	The most dominant noise at this point was birds chirping, with noises from people‘s conversations, cars passing, footsteps, and vague construction noise.
Point 27	Birds’ chirping was the most dominant noise at this point. There were also noises from people’s conversations, footsteps, crows’ caws, and vague noises from traffic.
Point 28	The most dominant noise was from traffic, there were also construction noises that were heard occasionally, people’s footsteps, conversations, and traffic lights noises.
Point 29	At this point, noises from people passing by and people’s conversation were dominating. There were also noises from cars passing by, dogs barking, construction, traffic, and vague noises of birds chirping.
Point 30	Bicycle noises, people footsteps and conversations, crows cawing, and birds chirping were heard at this point.
Point 31	There were noises from bicycles, construction, airplanes, and very vague noises of people’s footsteps, conversations, and birds chirping at this point.
Point 32	Very similar to point 31, there were noises from bicycles, airplanes, cars passing, and vague noises of people’s footsteps, conversations, and birds chirping. However, the construction noises at this point were louder than at point 31.
Point 33	Noises from cars passing by were really dominant in the beginning of the recording at this point. There were also other noises from people’s footsteps, conversations, birds chirping, construction, and airplanes.
Point 34	The most loud and dominant noise from the recording is from cars passing by, however, in the second recording, people’s footsteps and conversations were dominant. There were also vague birds chirping noises in the background of the recordings.
Point 35	This point is mostly dominated by noises from cars passing by. People’s footsteps and conversations are very occasionally heard, and bird songs were even less heard.
Point 36	Significantly loud noises of cars passing by was heard at this point. There were noises of people’s footsteps, conversations, skateboards, construction, very occasional crow caws, and vague birds chirping at this point as well.
Point 37	Very loud noises of cars passing by were dominating this point. There were also noises of people’s footsteps, conversations, very occasional crows caw, vague birds chirping, and construction noises at the beginning of the recording and at the end.
Point 38	Similar to points 36 and 37, the dominant noise at this point was from cars passing by. There were also noises of people’s footsteps, conversations, bicycles, and very vague bird noises.

6. Data Analysis

Measurement on Site

Relationship between acoustic indicators is evaluated using a matrix plot and principal component analysis. Quadrant data are entered in the form of binary data, hence not suitable to be analyzed using either matrix plot or principal component. Matrix plot methods allow us to see if there is a correlation between the attributes by looking at the linear relation between variables and r-value. The closer it is to 1 or -1 means a significant relationship.

Below Figure 39, Figure 40, and Figure 41 display matrix plots of all physical attributes of All Data (Weekend and Weekday), Weekday and Weekend data.

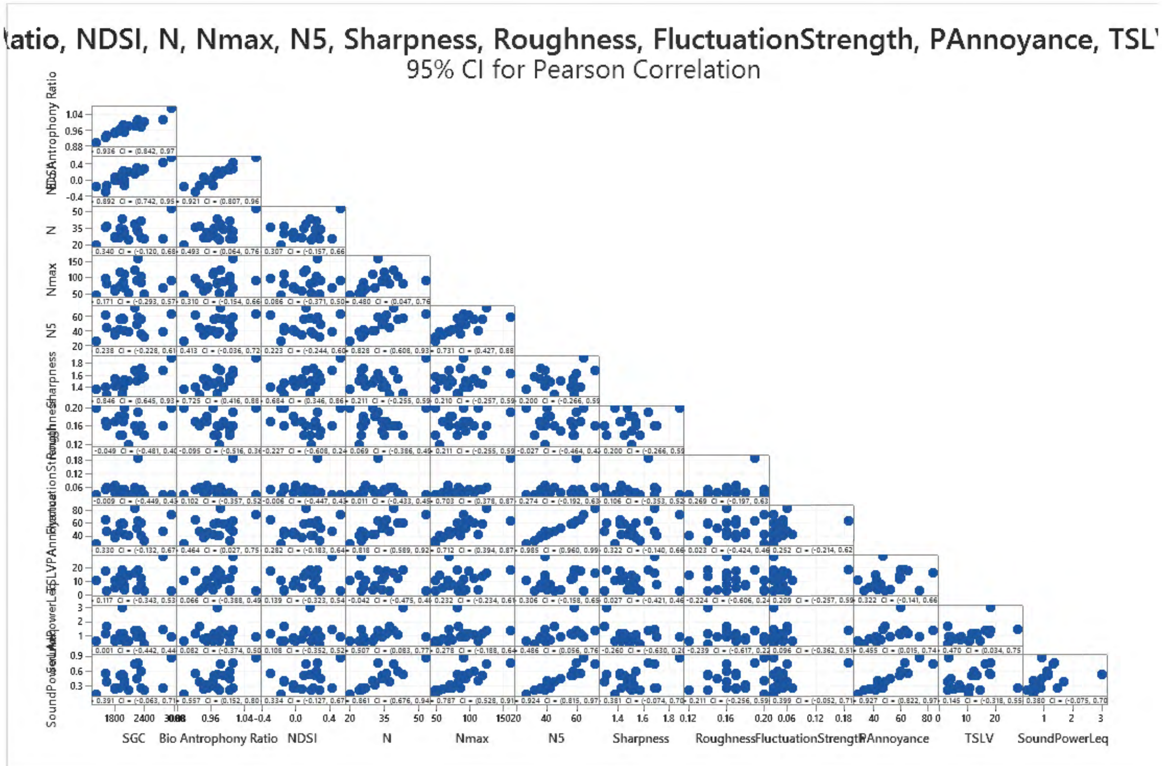


Correlations

	SGC	Bio Antrophony Ratio	NDSI	N	Nmax	N5	Sharpness	Roughness
Bio Antrophony Ratio	0.950							
NDSI	0.888	0.913						
N	0.316	0.430	0.237					
Nmax	0.236	0.346	0.106	0.527				
N5	0.267	0.392	0.177	0.888	0.711			
Sharpness	0.856	0.757	0.713	0.174	0.265	0.186		
Roughness	0.187	0.142	0.087	-0.002	0.212	-0.059	0.391	
FluctuationStrength	-0.128	-0.047	-0.127	0.116	0.430	0.286	0.051	0.087
PAnnoyance	0.333	0.431	0.224	0.881	0.699	0.991	0.277	-0.024
TSLV	0.089	0.076	0.128	0.109	0.231	0.331	0.001	-0.195
SoundPowerLeq	0.039	0.119	0.100	0.606	0.325	0.595	-0.182	-0.170
SoundPowerLAeq	0.333	0.474	0.245	0.851	0.738	0.894	0.283	0.104

	FluctuationStrength	PAnnoyance	TSLV	SoundPowerLeq
Bio Antrophony Ratio				
NDSI				
N				
Nmax				
N5				
Sharpness				
Roughness				
FluctuationStrength				
PAnnoyance	0.276			
TSLV	0.088	0.334		
SoundPowerLeq	0.086	0.567	0.586	
SoundPowerLAeq	0.264	0.888	0.146	0.510

Figure 39. Matrix Plot of All Data (Weekend and Weekday) of Physical Attributes, Classical Attributes and Supporting Acoustical Attributes

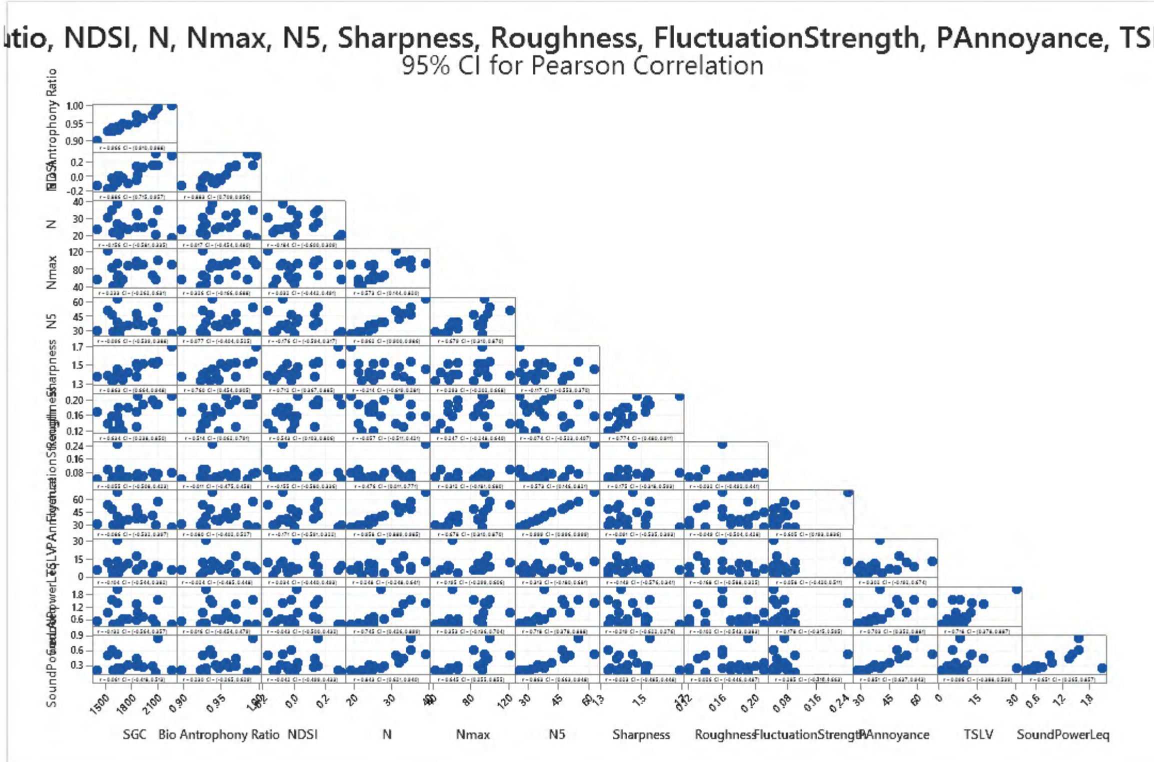


Correlations

	SGC	Bio Antrophony Ratio	NDSI	N	Nmax	N5	Sharpness	Roughness
Bio Antrophony Ratio	0.936							
NDSI	0.892	0.921						
N	0.340	0.493	0.307					
Nmax	0.171	0.310	0.086	0.480				
N5	0.238	0.413	0.223	0.828	0.731			
Sharpness	0.846	0.725	0.684	0.211	0.210	0.200		
Roughness	-0.049	-0.095	-0.227	0.069	0.211	-0.027	0.200	
FluctuationStrength	-0.009	0.102	-0.006	0.011	0.703	0.274	0.106	0.269
PAnnoyance	0.330	0.464	0.282	0.818	0.712	0.985	0.322	0.023
TSLV	0.117	0.066	0.139	-0.042	0.232	0.306	0.027	-0.224
SoundPowerLeq	0.001	0.082	0.108	0.507	0.278	0.486	-0.260	-0.239
SoundPowerLAeq	0.391	0.557	0.334	0.861	0.787	0.924	0.381	0.211

	FluctuationStrength	PAnnoyance	TSLV	SoundPowerLeq
Bio Antrophony Ratio				
NDSI				
N				
Nmax				
N5				
Sharpness				
Roughness				
FluctuationStrength				
PAnnoyance	0.252			
TSLV	0.209	0.322		
SoundPowerLeq	0.096	0.455	0.470	
SoundPowerLAeq	0.399	0.927	0.145	0.380

Figure 40. Matrix Plot of Weekday Data of Physical Attributes, Classical Attributes and Supporting Acoustical Attributes



Correlations

	SGC	Bio Antrophony Ratio	NDSI	N	Nmax	N5	Sharpness	Roughness
Bio Antrophony Ratio	0.966							
NDSI	0.886	0.883						
N	-0.156	0.017	-0.184					
Nmax	0.233	0.326	0.032	0.573				
N5	-0.096	0.077	-0.176	0.962	0.679			
Sharpness	0.863	0.760	0.712	-0.214	0.293	-0.117		
Roughness	0.634	0.514	0.543	-0.057	0.247	-0.074	0.774	
FluctuationStrength	-0.055	-0.011	-0.155	0.476	0.312	0.573	0.175	-0.032
PAnnoyance	-0.086	0.080	-0.171	0.958	0.678	0.999	-0.091	-0.049
TSLV	-0.104	-0.024	0.034	0.248	0.195	0.313	-0.149	-0.168
SoundPowerLeq	-0.132	0.016	-0.043	0.745	0.353	0.718	-0.219	-0.102
SoundPowerLAeq	0.061	0.230	-0.042	0.843	0.645	0.863	-0.023	0.026

	FluctuationStrength	PAnnoyance	TSLV	SoundPowerLeq
Bio Antrophony Ratio				
NDSI				
N				
Nmax				
N5				
Sharpness				
Roughness				
FluctuationStrength				
PAnnoyance	0.605			
TSLV	0.058	0.302		
SoundPowerLeq	0.178	0.703	0.718	
SoundPowerLAeq	0.285	0.851	0.096	0.651

Figure 41. Matrix Plot of Weekend Data of Physical Attributes, Classical Attributes and Supporting Acoustical Attributes

Matrix plot shows that there is a strong correlation between biophony/antrophony (B/A) ratio and spectral gravity center (SGC) on All Data (Weekend and Weekday), Weekday and Weekend data, the correlation values are 0.950, 0.936, and respectively. There is a strong correlation between normalized difference soundscape index (NDSI) and spectral gravity center (SGC), on All Data (Weekend and Weekday), Weekday and Weekend data the correlation values are 0.888, 0.892, and 0.886 respectively. There is a strong correlation between normalized difference soundscape index (NDSI) and biophony/antrophony (B/A), on All Data (Weekend and Weekday), Weekday and Weekend data, the correlation values are 0.913, 0.921, and 0.883 respectively.

In terms of classical attributes, the matrix plot shows strong correlation between unweighted sound power level (Leq) with loudness (N), loudness percentile (N5), psychoacoustic annoyance (PA), and TSLV on All Data with correlation values of 0.606, 0.595, 0.567, and 0.586 respectively for the Weekday data. While in Weekend data the correlation values with the same attributes are higher which are 0.745, 0.718, 0.703, and 0.718 respectively. The matrix plot shows a strong correlation between weighted sound power level (LAeq) with loudness (N), loudness maximum (Nmax), loudness percentile (N5), and psychoacoustic annoyance (PA) on All Data with correlation values of 0.851, 0.738, 0.894, and 0.888 respectively. While in Weekday data the correlation values with the same attributes are 0.861, 0.787. 0.924, and 0.927 respectively and in Weekend data, the correlation values with the same attributes are 0.843, 0.645, 0.863, and 0.851 respectively.

In terms of acoustical attributes, Sharpness and SGC on All Data (Weekend and Weekday), Weekday and Weekend data the correlation values are 0.856, 0.846, and, 0.863 respectively. There is a strong correlation between sharpness and biophony/antrophony ratio on All Data (Weekend and Weekday), Weekday and Weekend data the correlation values are 0.757, 0.725, and 0.760 respectively. There is a strong correlation between sharpness and NDSI on All Data (Weekend and Weekday), Weekday and Weekend data the correlation values are 0.713, 0.684, and 0.712 respectively. There is a strong correlation between sound power and loudness percentile (N5) on All Data (Weekend and Weekday), Weekday and Weekend data, the correlation values are 0.711, 0.605, and 0.806 respectively.

There is a strong correlation between psychoacoustic annoyance and loudness indicators. In All Data (Weekend and Weekday) data psychoacoustic annoyance correlates with loudness (N), loudness maximum (Nmax) and loudness percentile (N5) having values of 0.881, 0.699, and 0.991 respectively. In Weekday data psychoacoustic annoyance correlates with loudness (N), loudness maximum (Nmax), and loudness percentile (N5) having values of 0.818, 0.712, and 0.985 respectively. In Weekday data psychoacoustic annoyance correlates with loudness (N), loudness maximum (Nmax) and loudness percentile (N5) having values of 0.958, 0.678, and 0.999 respectively.

Principal components analysis is performed to see the correlation between physical attributes. Below Figures 42 to Figures 44 are the All Data (Weekend and Weekday), Weekday and Weekend principal components analysis.

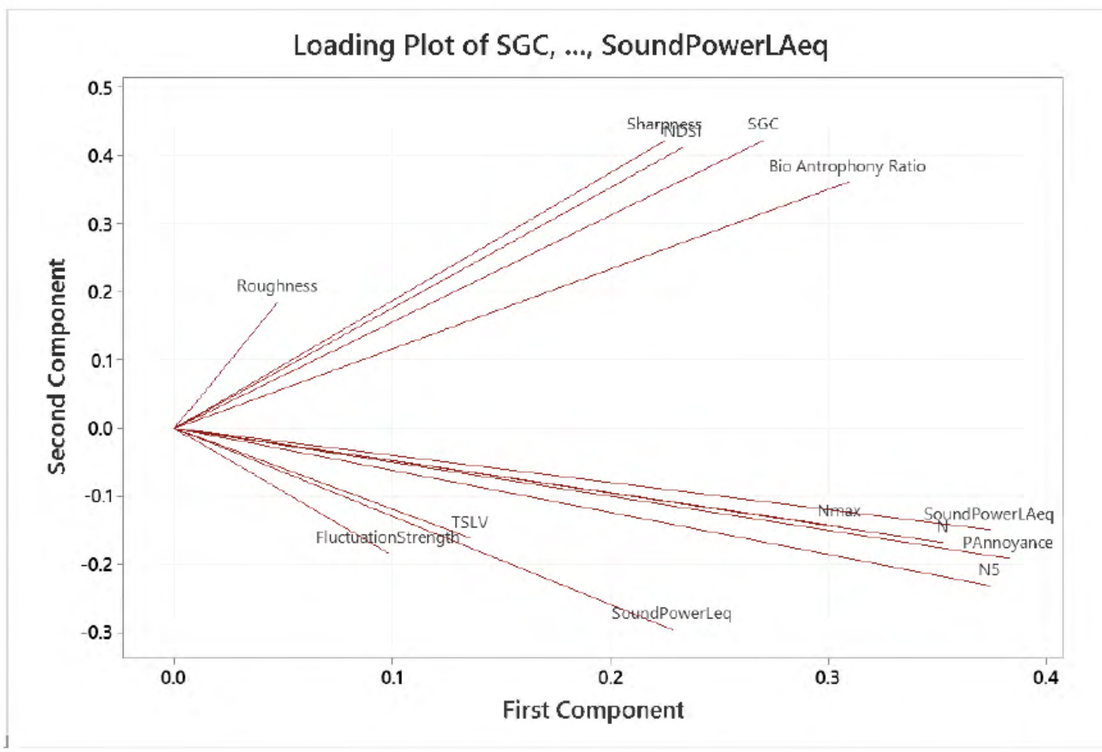


Figure 42. All Data (Weekend and Weekday) PC Analysis. Eigenvalue of PC 1 is 5.6118 and PC 2 is 2.9905

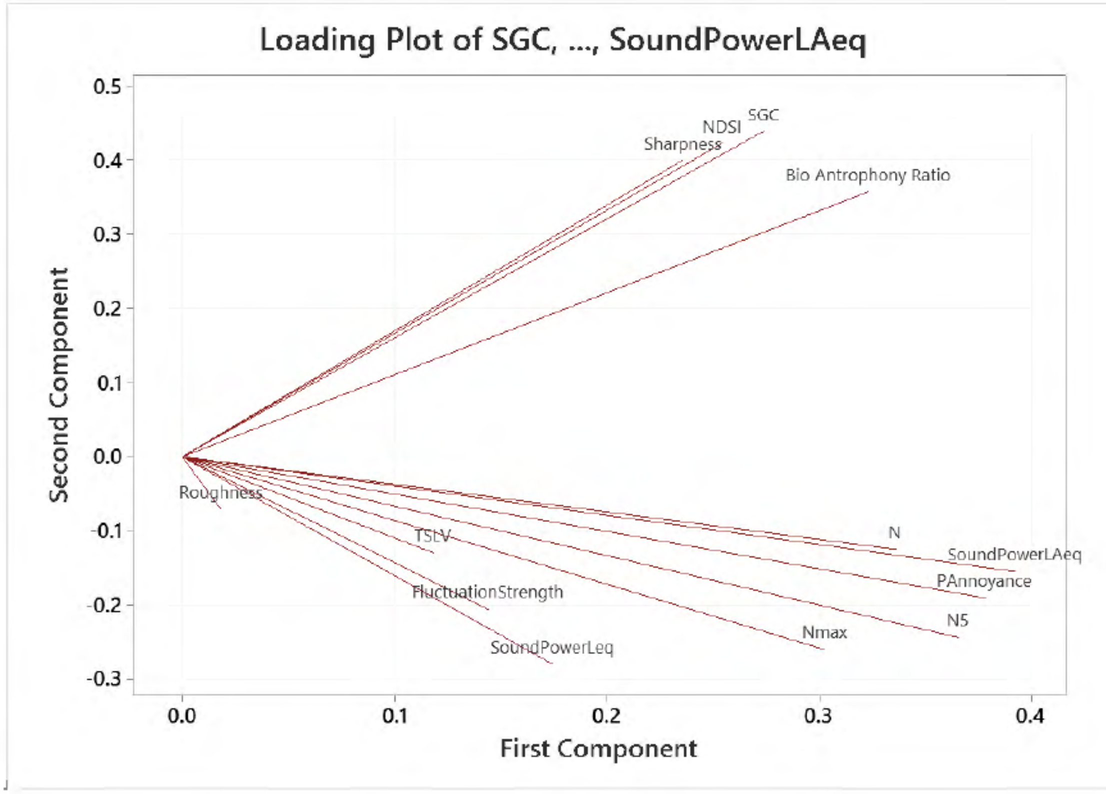


Figure 43. Weekday PC Analysis. Eigenvalue of PC 1 is 5.6649 and PC 2 is 2.7565

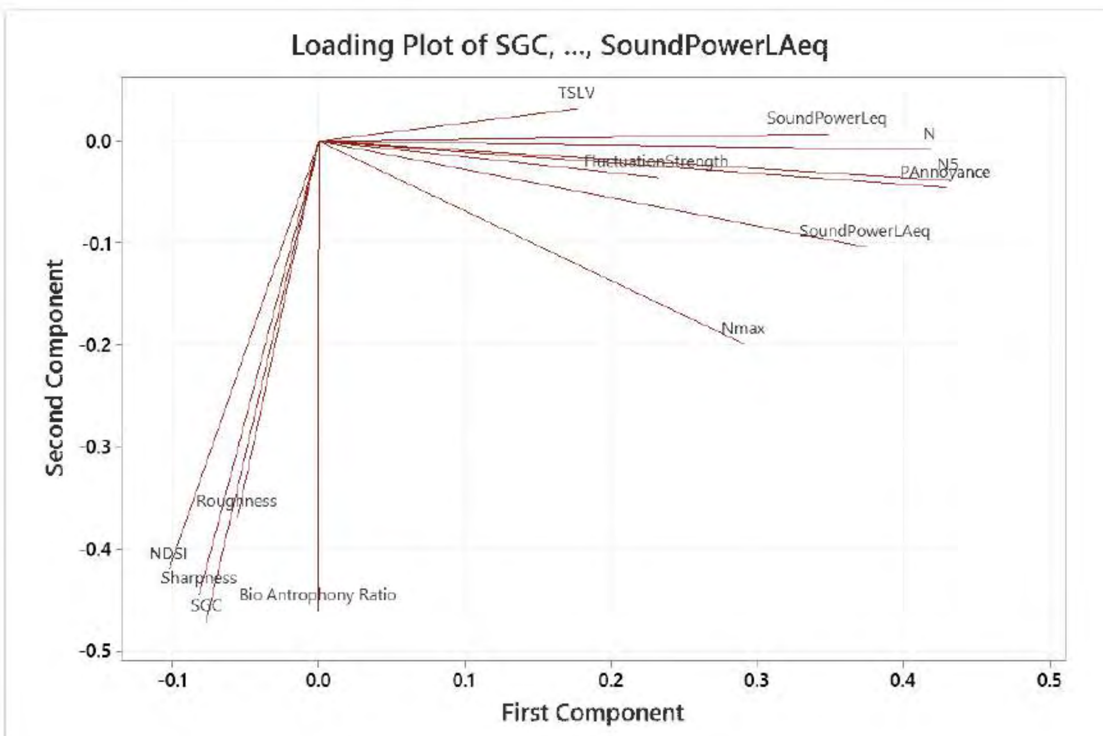


Figure 44. Weekend PC Analysis. Eigenvalue of PC 1 is 5.2411 and PC 2 is 4.1452

In terms of physical attributes, principal component 1 in Weekend, Weekday, and All Data is defined by PAnnoyance. There is also a strong correlation between SGC, NDSI, and B/A as explained in the matrix plots shown in Figures 43, 44, and 45.

In terms of classical attributes, principal component 1 in Weekend, Weekday, and All Data is defined by Weighted Sound Power Level (LAeq). Weighted Sound Power Level (LAeq) placed close together with psychoacoustic Annoyance (PA) on all 3 graphs as matrix plot shown in Figures 39, 40, 41.

In terms of supporting acoustical attributes, principal component 1 in Weekend, Weekday, and All Data is defined by loudness (N), and loudness percentile (N5). Sharpness and NDSI positioned close together proving strong correlation as explained in matrix plots shown in Figures 39, 40, 41.

Combining Weekend and Weekday data, it can be observed that psychoacoustic annoyance is clustered with that is positioned close to loudness (N), loudness maximum (Nmax), and loudness percentile (N5) which indicates strong correlation between those elements as explained in matrix plots shown in Figures 39, 40, 41.

From the principal analysis of All Day, Weekend and Weekday data, eigenvalues of principal component 2 are significant (eigenvalue greater than 1) and worth to be explored further. On the All Day data, Weekend data and Weekday data, principal component 2 have eigenvalues of 2.9905, 2.7565 and 4.1452 respectively with Sharpness, NDSI, SGC and Bio/Antrophony being clustered together.

Survey on Site

To analyze the survey results further, two-dimensional perceptual analysis (ISO 12913-3:2019) was generated. Following the scale and calculation for two-dimensional soundscape diagram perceptual analysis by the ISO 12913-3:2019 standard (Figure 7), a two-dimensional Olympic Village soundscape diagram can be shown in Figure 45 below.

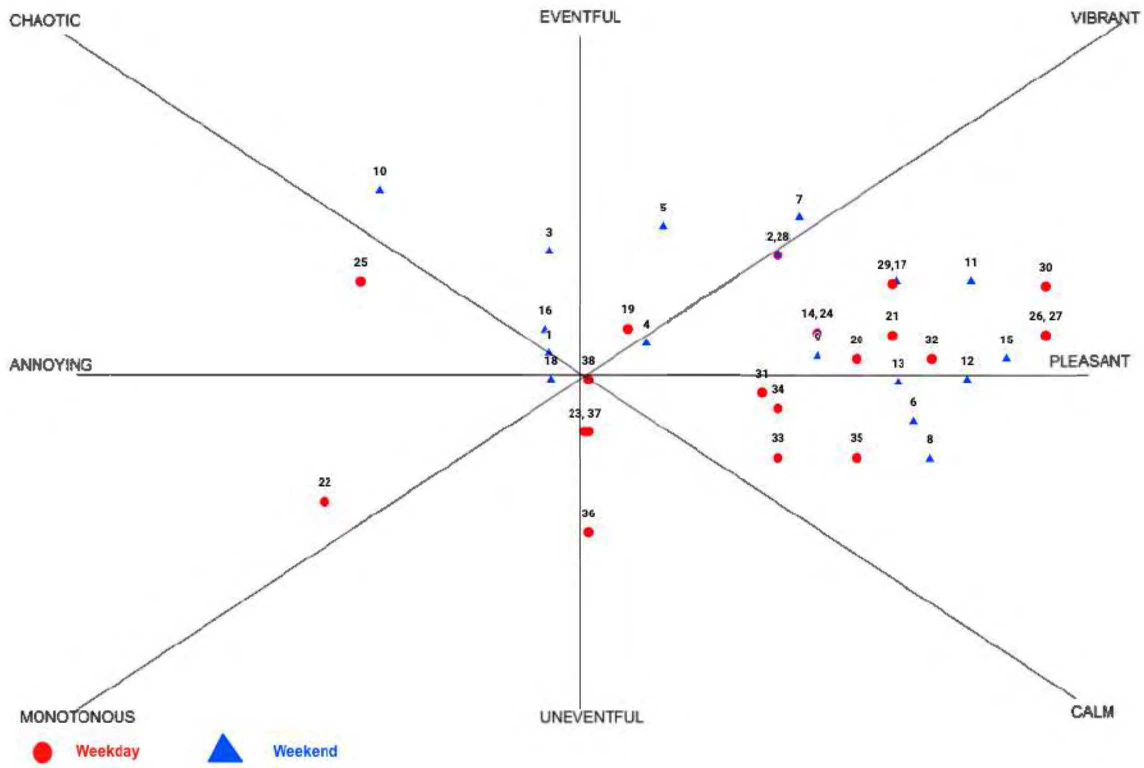


Figure 45. Two-Dimensional Soundscape Diagram

On the observation of the two-dimensional soundscape diagram analysis, most of the data measurement points are located on the Vibrant-Calm Quadrant or can be defined as “Sound Quality Zone” (See Figure 47, 48, 49). The result of the measurements positions in each quadrant are mapped in the Olympic Village map to see if there is a relation between approximation to road traffic, green spaces, water, and pedestrian to the two-dimensional soundscape diagram result (See Figure 46). There is no correlation between two-dimensional soundscape diagram results and approximation to road traffic, green spaces, water, and pedestrians, since the data measurement points that are located on Pleasant-Vibrant quadrant and Pleasant-Calm quadrant are spread throughout the Olympic Village.

Figure 46. Quadrants positions in Olympic Village Map Shows Randomly Distributed Data

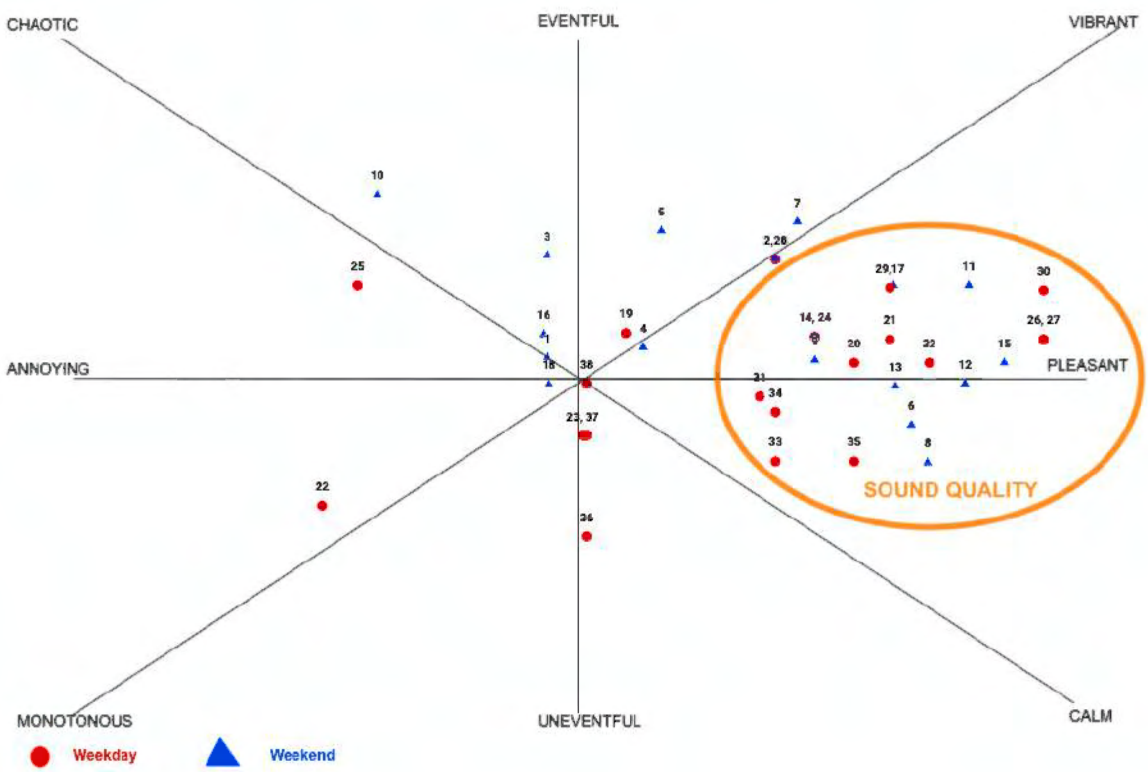


Figure 47. Two-Dimensional Soundscape Diagram - Sound Quality Zone

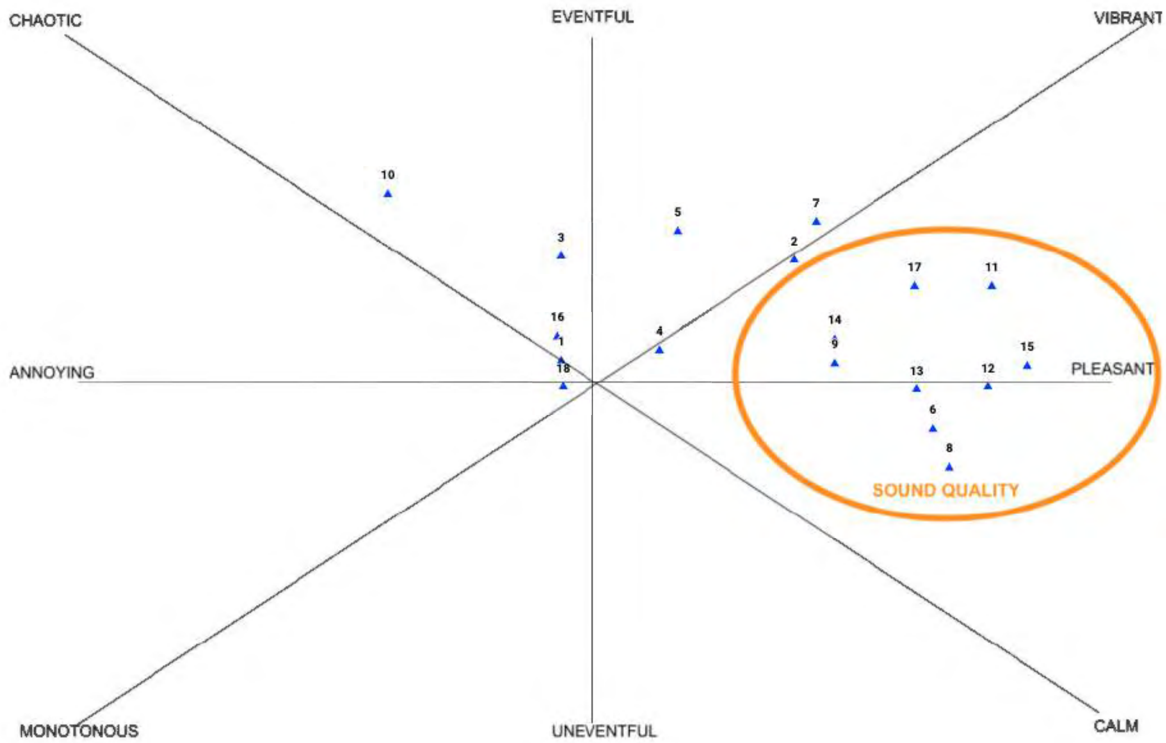


Figure 48. Two-Dimensional Soundscape Diagram - Sound Quality Weekend Data

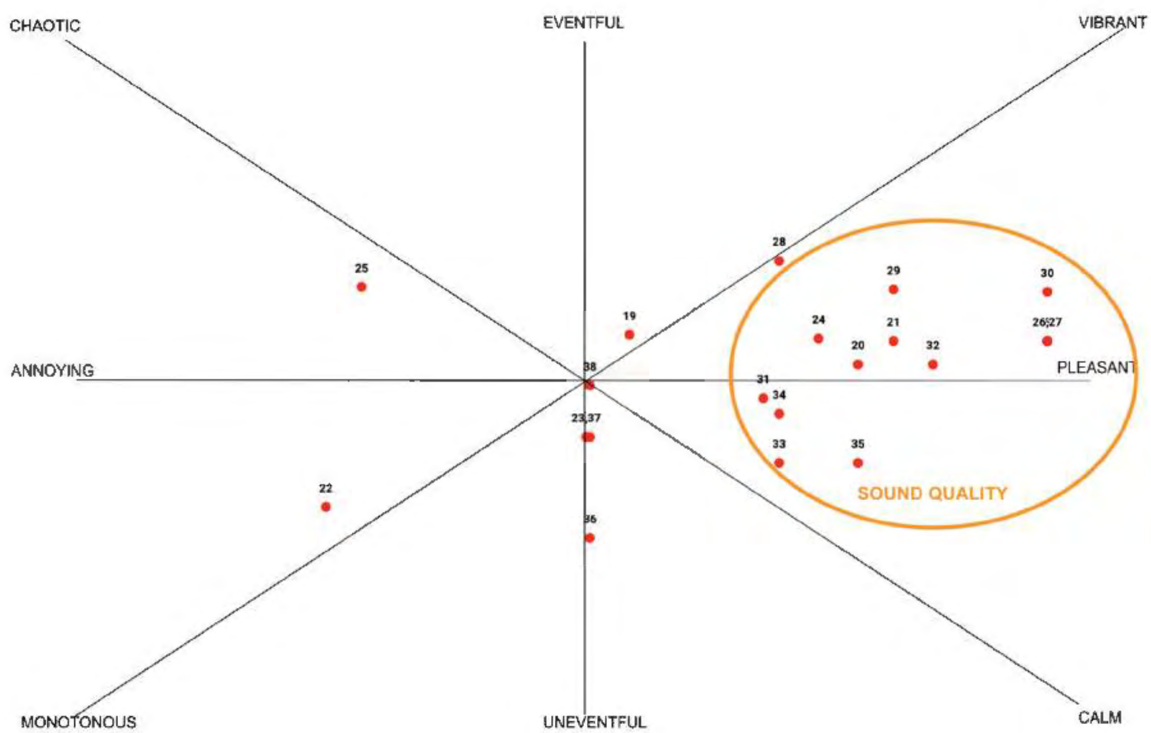


Figure 49. Two-Dimensional Soundscape Diagram - Sound Quality Weekday Data

In the Sound Quality zone there are 20 data measurement points where 9 data measurement points (45%) are from the Weekend data and 11 data measurement points (55%) are from the Weekday data, which there are almost equal amounts of data measurement points being on the Sound Quality zone from the Weekend and Weekday data. The Weekend and Weekday data have potential to have data measurement points in the Sound Quality zone. Thus, both Weekend and Weekday data is analyzed together as All Data (Weekend and Weekday). For the reason that Weekend and Weekday data have very different circumstances during data collection, each data gathered on the weekend and weekday data is analyzed collectively as two independent sets.

Taxonomy Analysis

Each location has an independent chart located in Appendix 6. Tables 15, 16 and 17 present a summary of dominant sound sources (3 or circle), less dominant sound sources (2 or square) and quietest / vague sound sources (1 or triangle). The taxonomy results are analyzed and presented with the triangulation analysis.

Table 15. Analysis of Taxonomy I

Points	Wildlife	Wind	Water	Domestic Animal	Non Motorised Vehicle	Roadway Traffic	Rail Traffic
Point 2A	2	0	0	2	0	1	0
Point 2B	2	0	0	2	0	1	0
Point 3	2	0	0	2	0	2	0
Point 4	2	0	0	2	0	3	0
Point 5	3	0	0	0	2	1	1
Point 6	2	0	0	2	3	0	1
Point 7	1	0	0	1	2	0	1
Point 8	1	0	1	1	2	0	2
Point 9	2	1	0	0	1	0	0
Point 10	1	0	0	2	2	0	0
Point 11	2	0	0	2	2	0	1
Point 12	2	0	0	3	0	2	1

Point 13	1	0	0	2	1	1	1
Point 14	1	0	0	0	2	0	1
Point 15	1	0	0	0	2	1	1
Point 16	3	0	0	0	0	1	0
Point 17	2	2	2	2	2	3	0
Point 18	2	0	3	2	2	3	0
Point 19	1	0	0	0	0	3	0
Point 20	2	0	0	0	0	3	0
Point 21	2	0	0	0	0	3	0
Point 22	3	0	0	0	0	3	0
Point 23	1	0	0	0	1	3	0
Point 24	3	1	0	2	1	3	0
Point 25	3	1	3	0	0	0	0
Point 26	0	0	0	0	0	3	0
Point 27	3	0	0	0	0	1	0
Point 28	1	0	0	0	0	3	0
Point 29	1	0	0	0	0	3	0
Point 30	3	0	0	0	3	3	0
Point 31	1	0	0	0	3	3	0
Point 32	3	0	0	0	3	3	0
Point 33	3	0	0	0	0	3	0
Point 34	1	0	0	0	0	3	0
Point 35	1	0	0	0	0	3	0
Point 36	1	0	0	0	0	3	0
Point 37	1	0	0	0	1	3	0
Point 38	1	0	0	0	1	3	0

Table 16. Analysis of Taxonomy II

Points	Marine Traffic	Air Traffic	Footsteps	Construction	Ventilation Sound	Domestic Machine	Recreation
Point 2A	0	0	3	0	0	0	3
Point 2B	0	0	3	0	0	0	3
Point 3	0	0	3	0	0	0	0
Point 4	0	0	3	0	0	0	0
Point 5	0	0	3	0	0	0	0
Point 6	0	1	3	0	0	0	0
Point 7	0	0	3	0	0	0	0
Point 8	1	0	3	0	0	0	0
Point 9	0	0	3	0	0	0	0
Point 10	0	0	3	0	0	0	0
Point 11	0	1	3	0	0	0	0
Point 12	0	0	3	0	0	0	0
Point 13	0	0	3	0	0	0	0
Point 14	1	2	3	0	0	0	0
Point 15	0	2	3	0	0	0	0
Point 16	1	0	2	0	0	0	0
Point 17	0	0	2	0	0	0	0
Point 18	0	0	2	0	0	0	0
Point 19	0	2	2	3	0	0	3
Point 20	0	0	3	0	3	0	0
Point 21	0	0	3	3	3	0	0
Point 22	0	0	1	0	0	0	0
Point 23	0	1	1	1	0	0	0
Point 24	0	1	2	3	2	0	0
Point 25	0	0	3	0	0	0	0
Point 26	0	0	3	1	0	0	0

Point 27	0	0	3	0	0	0	0
Point 28	0	0	3	1	0	0	0
Point 29	0	0	3	1	0	0	0
Point 30	0	0	0	0	0	0	0
Point 31	0	1	0	1	0	0	0
Point 32	0	2	3	2	0	0	0
Point 33	0	1	2	0	0	0	0
Point 34	0	0	3	0	0	0	0
Point 35	0	0	0	0	0	0	0
Point 36	0	0	0	0	0	0	0
Point 37	0	0	1	1	0	0	0
Point 38	0	0	1	0	0	0	0

Table 17. Analysis of Taxonomy III

Points	Electrical Installation	Voice Speech	Voice Singing	Voice Laughter	Music	Other Human
Point 2A	0	3	0	3	0	0
Point 2B	0	3	0	3	0	0
Point 3	0	3	0	3	0	0
Point 4	0	3	0	3	0	0
Point 5	0	3	3	3	3	0
Point 6	0	3	3	3	3	0
Point 7	0	3	3	0	0	0
Point 8	0	3	1	3	1	0
Point 9	0	3	0	3	0	0
Point 10	0	3	0	3	0	0
Point 11	0	3	1	3	1	0
Point 12	0	3	1	3	1	0
Point 13	0	3	0	3	3	0

Point 14	0	3	0	3	1	0
Point 15	0	3	1	3	1	0
Point 16	0	3	0	3	0	0
Point 17	1	3	0	3	0	0
Point 18	0	3	0	3	0	0
Point 19	0	2	0	0	0	0
Point 20	0	2	0	0	0	0
Point 21	0	0	0	0	0	0
Point 22	0	1	0	0	0	0
Point 23	0	1	0	0	0	0
Point 24	0	2	0	0	0	0
Point 25	0	3	0	0	0	3
Point 26	0	3	0	0	0	0
Point 27	0	3	0	0	0	0
Point 28	0	3	0	0	0	1
Point 29	0	3	0	0	0	1
Point 30	0	3	0	0	0	0
Point 31	0	1	0	0	0	0
Point 32	0	1	0	0	0	0
Point 33	0	2	0	0	0	0
Point 34	0	3	0	0	0	0
Point 35	0	1	0	0	0	0
Point 36	0	1	0	0	0	0
Point 37	0	1	0	0	0	0
Point 38	0	1	0	0	0	0

Triangulation Analysis

There are three relationships investigated in triangulation analysis which are between measurement on site and survey on site, between measurement on site and taxonomy analysis and between survey on site and taxonomy analysis. Success in analyzing any of two relationships assists the assignment of appropriate acoustic indicators to be used in the Sound Quality standard.

Relationship between Measurement on Site and Survey on Site

Binary logistic regression was performed to predict what physical attributes (psychoacoustic annoyance - PA, spectral gravity center - SGC, normalized difference soundscape index - NDSI, biophony/ antrophony ratio- B/A, temporal sound level variance - TSLV), classical attributes (sound power level in energy - LAeq and Leq), and supporting acoustical attributes (loudness - N, loudness percentile - N5, loudness maximum - Nmax, sharpness, roughness, fluctuation strength) that place data measurement points on Vibrant and Calm quadrant in the Sound Quality zone. Additional analysis was performed to determine if any of the physical attributes or classical attributes or supporting acoustical attributes determine the placement of measurement points in Eventful versus Uneventful quadrants, Annoying versus Pleasant quadrants and Outside Vibrant and Calm quadrant in the Outside Sound Quality zone. The analysis was split into Weekend, Weekday and All Data (Weekend and Weekday).

Sound Quality zone consists of equal amount of Weekend data (45%) and Weekday data (55%), it can be seen below from Table 36 which is the All Data (Weekend and Weekday) data that psychoacoustic annoyance (PA) is the only physical attribute that predicts data measurement points being in the Sound Quality zone with p-value of 0.05. The following psychoacoustic annoyance (PA), loudness (N), loudness percentile (N5), loudness maximum (Nmax), and weighted sound power level (LAeq) also predicts data measurement points being in the Sound Quality zone with p-values of 0.05, 0.05, 0.04, 0.06 and 0.014 respectively. This confirms that psychoacoustic annoyance (PA) values predict data measurement points being in the Sound Quality zone.

Table 18. All Data (Weekday and Weekend) Binary Logistic Regression Analysis

		All Data (Weekend and Weekday)					
Response	Predictors	**EQUATION**	**Coef**	**SE Coef**	**Z-value**	**P-Value**	**VIF**
Sound Quality Zone	SGC	Y' = 1.04 - 0.000482 SGC	-0.000482	0.000968	-0.5	0.619	1
Sound Quality Zone	NDSI	Y'= 0.202 - 1.20 NDSI	-1.29	1.82	-0.71	0.478	1
Sound Quality Zone	B/A	Y'= 11.4 - 11.73 B/A	-11.73	9.85	-1.19	0.234	1
Sound Quality Zone	PA	Y'= 2.66 - 0.0554 PAnnoyance	-0.0554	0.0283	-1.96	**0.051**	1
Sound Quality Zone	TSLV	Y'= -0.163 + 0.0268 TSLV	0.0268	0.0507	0.53	0.597	1
Sound Quality Zone	Sound Power - Leq	Y'= 0.429 - 0.330 SoundPower Leq	-0.33	0.623	-0.53	0.596	1
Sound Quality Zone	Sound Power - LAeq	Y'= 2.297 - 5.69 SoundPower LAeq	-5.69	2.31	-2.46	**0.014**	1
Sound Quality Zone	N	Y'= 3.34 - 0.1087 N	-0.1087	0.0552	-1.97	**0.049**	1
Sound Quality Zone	Nmax	Y'= 2.51 - 0.0293 Nmax	-0.0293	0.0155	-1.89	**0.059**	1
Sound Quality Zone	N5	Y'= 2.75 - 0.0614 N5	-0.0614	0.0305	-2.01	**0.044**	1
Sound Quality Zone	Sharpness	Y'= 1.57 - 0.99 Sharpness	-0.99	2.65	-0.37	0.71	1
Sound Quality Zone	Roughness	Y'= 1.47 - 8.2 Roughness	-8.2	13.3	-0.61	0.54	1
Sound Quality Zone	Fluctuation Strength	Y'= 0.337 - 3.89 Fluctuation Strength	-3.89	7.92	-0.49	0.624	1
Annoying Zone	SGC	Y'= -2.22 + 0.00046 SGC	0.00046	0.00114	0.4	0.688	1
Annoying Zone	NDSI	Y'= -1.325 + 0.04 NDSI	0.04	2.19	0.02	0.985	1
Annoying Zone	B/A	Y'= -7.3 + 6.2 B/A	6.2	11.1	0.56	0.577	1
Annoying Zone	PA	Y'= -2.14 + 0.0173 PAnnoyance	0.0173	0.0286	0.61	0.544	1
Annoying Zone	TSLV	Y'= -0.550 - 0.0850 TSLV	-0.085	0.0795	-1.07	0.285	1
Annoying Zone	Sound Power - Leq	Y'= -0.872 - 0.478 SoundPower Leq	-0.478	0.865	-0.55	0.58	1
Annoying Zone	Sound Power - LAeq	Y'= -2.255 + 2.23 SoundPower LAeq	2.23	1.94	1.15	0.25	1
Annoying Zone	N	Y'= -3.63 + 0.0748 N	0.0748	0.0543	1.38	0.169	1
Annoying Zone	Nmax	Y'= -1.3 + 0.0003 Nmax	-0.0003	0.0159	-0.02	0.985	1
Annoying Zone	N5	Y'= -2.2 + 0.0199 N5	0.0199	0.0322	0.62	0.536	1
Annoying Zone	Sharpness	Y'= -3.44 + 1.42 Sharpness	1.42	3.12	0.46	0.648	1
Annoying Zone	Roughness	Y'= -3.36 + 12.1 Roughness	12.1	16.7	0.72	0.469	1
Annoying Zone	Fluctuation Strength	Y'= -0.4 - 17.4 Fluctuation Strength	-17.4	20.4	-0.85	0.394	1
Pleasant Zone	SGC	Y'= 2.22 - 0.00046 SGC	-0.00046	0.00114	-0.4	0.688	1
Pleasant Zone	NDSI	Y'= 1.325 - 0.04 NDSI	-0.04	2.19	-0.02	0.985	1
Pleasant Zone	B/A	Y'= 7.3 - 6.2 B/A	-6.2	11.1	-0.56	0.577	1
Pleasant Zone	PA	Y'= 2.14 - 0.0173 PAnnoyance	-0.0173	0.0286	-0.61	0.544	1
Pleasant Zone	TSLV	Y'= 0.550 + 0.0850 TSLV	0.085	0.0795	1.07	0.285	1
Pleasant Zone	Sound Power - Leq	Y'= 0.872 + 0.478 SoundPower Leq	0.478	-0.865	0.55	0.58	1

Pleasant Zone	Sound Power - LAeq	Y'= 2.255 - 2.23 SoundPower LAeq	-2.23	-1.94	-1.15	0.25	1
Pleasant Zone	N	Y'= -3.63 + 0.0748 N	-0.0748	-0.0543	-1.38	0.169	1
Pleasant Zone	Nmax	Y'= 1.3 - 0.0003 Nmax	0.0003	-0.0159	0.02	0.985	1
Pleasant Zone	N5	Y'= 2.2 - 0.0199 N5	-0.0199	-0.0322	-0.62	0.536	1
Pleasant Zone	Sharpness	Y'= 3.44 - 1.42 Sharpness	-1.42	-3.12	-0.46	0.648	1
Pleasant Zone	Roughness	Y'= 3.36 - 12.1 Roughness	-12.1	-16.7	-0.72	0.469	1
Pleasant Zone	Fluctuation Strength	Y'= 0.4 + 17.4 Fluctuation Strength	17.4	-20.4	0.85	-0.394	1
Uneventful Zone	SGC	Y'= -0.57 - 0.00017 SGC	-0.00017	0.00107	-0.16	0.875	1
Uneventful Zone	NDSI	Y'= -0.781 - 1.93 NDSI	-1.93	2.09	-0.92	0.356	1
Uneventful Zone	B/A	Y'= 3.4 - 4.5 B/A	-4.5	10.4	-0.43	0.666	1
Uneventful Zone	PA	Y'= -3.45 + 0.0531 PAnnoyance	0.0531	0.0284	1.87	0.062	1
Uneventful Zone	TSLV	Y'= -1.749 + 0.0800 TSLV	0.08	0.0551	1.45	0.146	1
Uneventful Zone	Sound Power - Leq	Y'= -1.336 + 0.437 SoundPower Leq	0.437	0.647	0.68	0.499	1
Uneventful Zone	Sound Power - LAeq	Y'= -1.272 + 0.93 SoundPower LAeq	0.93	1.79	0.52	0.603	1
Uneventful Zone	N	Y'= -2.39 + 0.0490 N	0.049	0.0492	1	0.319	1
Uneventful Zone	Nmax	Y'= -1.42 + 0.0064 Nmax	0.0064	0.0141	0.45	0.652	1
Uneventful Zone	N5	Y'= -3.44 + 0.0569 N5	0.0569	0.0312	1.82	0.068	1
Uneventful Zone	Sharpness	Y'= -0.69 - 0.14 Sharpness	-0.14	2.92	-0.05	0.962	1
Uneventful Zone	Roughness	Y'= 4.05 - 30.3 Roughness	-30.3	16.2	-1.87	0.062	1
Uneventful Zone	Fluctuation Strength	Y'= -1.266 + 5.99 Fluctuation Strength	5.99	7.89	0.76	0.448	1
Eventful Zone	SGC	Y'= 0.57 + 0.00017 SGC	0.00017	0.00107	0.16	0.875	1
Eventful Zone	NDSI	Y'= 0.781 + 1.93 NDSI	1.93	2.09	0.92	0.356	1
Eventful Zone	B/A	Y'= -3.4 + 4.5 B/A	4.5	10.4	0.43	0.666	1
Eventful Zone	PA	Y'= 3.45 - 0.0531 PAnnoyance	-0.0531	0.0284	-1.87	0.062	1
Eventful Zone	TSLV	Y'= 1.749 - 0.0800 TSLV	-0.08	0.0551	-1.45	0.146	1
Eventful Zone	Sound Power - Leq	Y'= 1.336 - 0.437 SoundPower Leq	-0.437	-0.647	-0.68	0.499	1
Eventful Zone	Sound Power - LAeq	Y'= 1.272 - 0.93 SoundPower LAeq	-0.93	-1.79	-0.52	0.603	1
Eventful Zone	N	Y'= 2.39 - 0.0490 N	-0.049	-0.0492	-1	0.319	1
Eventful Zone	Nmax	Y'= 1.42 - 0.0064 Nmax	-0.0064	-0.0141	0.45	0.652	1
Eventful Zone	N5	Y'= 3.44 - 0.0569 N5	-0.0569	-0.0312	-1.82	0.068	1
Eventful Zone	Sharpness	Y'= 0.69 + 0.14 Sharpness	-0.14	-2.92	0.05	0.962	1
Eventful Zone	Roughness	Y'= -4.05 + 30.3 Roughness	30.3	-16.2	1.87	0.062	1
Eventful Zone	Fluctuation Strength	Y'= 1.266 - 5.99 Fluctuation Strength	-5.99	-7.89	-0.76	0.448	1
Outside Sound Quality Zone	SGC	Y'= -2 + 0.00075 SGC	0.00075	0.000994	0.75	0.45	1

Outside Sound Quality Zone	NDSI	Y'= -0.593 + 0.7 NDSI	0.7	1.85	0.38	0.705	1
Outside Sound Quality Zone	B/A	Y'= -8.97 + 8.74 B/A	8.74	9.74	0.9	0.369	1
Outside Sound Quality Zone	PA	Y'= -2.15 + 0.0344 PAnnoyance	0.0344	0.0258	1.33	0.182	1
Outside Sound Quality Zone	TSLV	Y'= -0.170 - 0.0376 TSLV	-0.0376	0.0551	-0.68	0.495	1
Outside Sound Quality Zone	Sound Power - Leq	Y'= -0.225 - 0.325 SoundPower Leq	-0.325	0.672	-0.48	0.629	1
Outside Sound Quality Zone	Sound Power - LAeq	Y'= -1.449 + 2.26 SoundPower LAeq	2.26	1.76	1.29	0.199	1
Outside Sound Quality Zone	N	Y'= -2.46 + 0.0637 N	0.0637	0.0488	1.31	0.192	1
Outside Sound Quality Zone	Nmax	Y'= -2.28 + 0.0309 Nmax	0.0209	0.0144	1.45	0.146	1
Outside Sound Quality Zone	N5	Y'= -2.06 + 0.0349 N5	0.0349	0.0283	1.23	0.218	1
Outside Sound Quality Zone	Sharpness	Y'= -5.16 + 3.1 Sharpness	3.1	2.8	1.11	0.368	1
Outside Sound Quality Zone	Roughness	Y'= -2.58 + 12.2 Roughness	12.2	14	0.87	0.386	1
Outside Sound Quality Zone	Fluctuation Strength	Y'= -0.923 + 6.23 Fluctuation Strength	6.35	8	0.79	0.427	1
[redacted]							

A predict function on Minitab was run to identify which range of psychoacoustic annoyance (PA) values, loudness (N) values, loudness percentile (N5) values, loudness maximum (Nmax), and weighted sound power level (LAeq-Pa) values are significant to predict data measurement points being located on Sound Quality zone. Below, tables 37, 38, 39, 40, 41 breakdown all the necessary values needed for the data measurement points to be located in the Sound Quality zone.

Table 19. Psychoacoustic Annoyance (PA) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on All Data (Weekend and Weekday)

Regression equation			
Y' = -2.66 - 0.0554 PAnnoyance			
PA Setting	**Fitted Probability**	**SE Fit**	**95% CI**
28	0.752368	0.113684	0.478847, 0.909474
30	0.73116	0.110937	0.473613, .891550
33	0.697275	0.105507	0.463737, 0.859847
34	0.685458	0.107466	0.467344, 0.871052
35	0.673396	0.101282	0.455370, 0.835644
37	0.648583	0.0968927	0.445125, 0.809385
38	0.635858	0.0947489	0.439153, 0.795672
40	0.609845	0.0908289	0.425182, 0.767608
41	0.596589	0.0891679	0.417052, 0.753513
42	0.583191	0.0877838	0.408078, 0.739562
43	0.56967	0.0867307	0.398213, 0.725901
45	0.542332	0.0857973	0.375718, 0.699985
47	0.514736	0.0866063	0.349643, 0.676675
48	0.500894	0.0876754	0.335416, 0.666176
49	0.487051	0.0891624	0.320538, 0.656488
50	0.473227	0.0910315	0.305144, 0.647606
52	0.445723	0.0957242	0.273412, 0.632149
54	0.418548	0.101317	0.241458, 0.619454
58	0.3658	0.113404	0.181181, 0.600564
59	0.353049	0.116324	0.167444, 0.596890
60	0.340504	0.119123	0.154367, 0.593549
63	0.304236	0.126493	0.119368, 0.585167
65	0.281309	0.130333	0.0996178, 0.580671
68	0.248967	0.134229	0.0750812, 0.575145
74	0.192097	0.135134	0.0413661, 0.567132
84	0.120225	0.12019	0.0145221, 0.558939

PA values between 43 to 28 have 60% to 75% probability to place data measurement points in the Sound Quality zone.

Table 20. Loudness (N) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on All Data (Weekend and Weekday)

Regression equation			
Y' = 3.34 - 0.1087 N			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
19	0.78154	0.115478	0.487260, 0.930881
20	0.762421	0.11403	0.483043, 0.916816
21	0.742181	0.11178	0.478109, 0.900455
22	0.720849	0.108793	0.472283, 0.881669
24	0.675101	0.101157	0.456966, 0.836890
25	0.65083	0.0969588	0.446814, 0.811368
26	0.62575	0.0929347	0.434438, 0.784455
27	0.599975	0.0894877	0.419354, 0.756972
28	0.573636	0.0870445	0.401109, 0.729926
30	0.519833	0.0865522	0.354286, 0.681137
31	0.492679	0.0887836	0.326186, 0.660811
32	0.465567	0.0925005	0.295963, 0.643525
33	0.438657	0.0973626	0.264719, 0.629101
34	0.412104	0.102952	0.233591, 0.617180
35	0.386052	0.108848	0.203584, 0.607345
36	0.360637	0.114673	0.175470, 0.599203
37	0.33598	0.120113	0.148760, 0.592416
39	0.289341	0.12894	0.106441, 0.581868
41	0.24677	0.13416	0.0737426, 0.574136
43	0.208624	0.135453	0.0501516, 0.568265
53	0.0816706	0.100616	0.0063733, 0.552188

Loudness values between 28 to 19 have 57% to 78% probability to place data measurement points in the Sound Quality zone.

Table 21. Loudness Maximum (Nmax) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on All Data (Weekend and Weekday)

Regression equation			
Y' = 2.51 - 0.0293 Nmax			
Nmax Setting	**Fitted Probability**	**SE Fit**	**95% CI**
42	0.781943	0.11995	0.474578, 0.934370
47	0.755892	0.117522	0.470527, 0.915181
48	0.750436	0.116845	0.469568, 0.910826
53	0.721959	0.112566	0.463840, 0.886279
56	0.703945	0.109363	0.459500, 0.869286
57	0.697792	0.108209	0.457971, 0.863247
58	0.691567	0.107017	0.456140, 0.857026
61	0.672478	0.103273	0.450268, 0.837319
66	0.639379	0.0968356	0.437708, 0.801519
68	0.625738	0.0943653	0.431489, 0.786462
69	0.61884	0.0931871	0.428080, 0.778844
73	0.590791	0.0890735	0.412195, 0.748263
80	0.540361	0.085589	0.374366, 0.697859
82	0.525752	0.08572	0.361071, 0.685016
83	0.51843	0.0859973	0.354030, 0.678934
84	0.511099	0.086412	0.346743, 0.673090
88	0.481761	0.0893817	0.315472, 0.652191
89	0.474438	0.0904253	0.307227, 0.647585
90	0.467126	0.0915753	0.298859, 0.643221
92	0.452548	0.0941604	0.281852, 0.635187
93	0.445288	0.0955773	0.0273264, 0.631502
94	0.438051	0.0970645	0.264655, 0.628026
98	0.409394	0.103526	0.230470, 0.616027
100	0.395281	0.106936	0.213830, 0.611034
105	0.360797	0.11545	0.174644, 0.600908
112	0.314892	0.126067	0.127564, 0.590972
117	0.284126	0.13195	0.100150, 0.585985
122	0.255246	0.136055	0.0777292, 0.582235
124	0.244249	0.137169	0.0700476, 0.581008
160	0.10101	0.114881	0.0093254, 0.572859

Loudness maximum (Nmax) values of 73 to 42 have 59% to 78% probability to place data measurement points in the Sound Quality zone.

Table 22. Loudness Percentile (N5) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on All Data (Weekend and Weekday)

Regression equation			
Y' = 2.75 - 0.0614 N5			
N5 Setting	**Fitted Probability**	**SE Fit**	**95% CI**
51	0.9406270	0.102687	0.229033, 0.611819
26	0.760629	0.112956	0.485051, 0.914673
26	0.760629	0.112956	0.485051, 0.914673
28	0.737553	0.110469	0.478700, 0.895840
30	0.713091	0.107086	0.471176, 0.873947
32	0.687316	0.10299	0.462140, 0.849020
34	0.660329	0.098566	0.451151, 0.821353
35	0.646419	0.096233	0.444756, 0.806676
36	0.632258	0.0940238	0.437658, 0.791585
38	0.603261	0.0900756	0.421025, 0.760735
38	0.603261	0.0900756	0.421025, 0.760735
39	0.588472	0.0884831	0.411331, 0.745313
39	0.588472	0.0884831	0.411331, 0.745313
40	0.573521	0.0872402	0.400631, 0.730133
42	0.543238	0.0860439	0.376069, 0.701205
45	0.497281	0.0879561	0.331710, 0.663450
47	0.4662	0.0916066	0.29836, 0.642832
48	0.451369	0.094008	0.281064, 0.633882
49	0.436209	0.0967041	0.263617, 0.625774
55	0.348624	0.115082	0.165432, 0.591017
56	0.334809	0.117929	0.151313, 0.586936
57	0.321271	0.1120586	0.138024, 0.583202
58	0.308028	0.123018	0.125587, 0.579773
59	0.295092	0.125199	0.114007, 0.576614
62	0.258258	0.130054	0.0842701, 0.568469
63	0.246668	0.131074	0.0759309, 0.566119
64	0.235433	0.131788	0.0683157, 0.563919
72	0.158523	0.127323	0.0281947, 0.550206

Loudness percentile (N5) values between 40 to 51 have 57% to 94% probability to place data measurement points in the Sound Quality zone.

Table 23. Weighted Sound Power Level (LAeq-Pa) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on All Data (Weekend and Weekday)

Regression equation			
Y' = 2.297 - 5.69 SoundPowerLAeq			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
0.15	0.809095	0.0963347	0.555209, 0.935024
0.17	0.790904	0.0970433	0.544943, 0.922764
0.18	0.781342	0.0971908	0.539548, 0.915945
0.21	0.750796	0.096832	0.522112, 0.892565
0.22	0.740002	0.0964654	0.515817, 0.883775
0.23	0.72891	0.0959916	0.509243, 0.874487
0.24	0.717525	0.0954244	0.502364, 0.864711
0.26	0.693909	0.0940802	0.487581, 0.843777
0.27	0.681697	0.0933452	0.479617, 0.832679
0.31	0.630429	0.0905916	0.443240, 0.785185
0.33	0.603554	0.0897331	0.421962, 0.760481
0.34	0.589867	0.0895327	0.410490, 0.748151
0.37	0.548045	0.0901042	0.372803, 0.712133
0.39	0.519744	0.0915674	0.345251, 0.689549
0.42	0.47711	0.0952999	0.301465, 0.658605
0.45	0.434807	0.100387	0.256757, 0.631431
0.46	0.420884	0.102248	0.242074, 0.623176
0.51	0.353532	0.111384	0.173826, 0.587018
0.53	0.327986	0.114442	0.149954, 0.574527
0.54	0.315574	0.115755	0.138883, 0.568620
0.56	0.291533	0.117872	0.118523, 0.557394
0.6	0.246852	0.119828	0.0848101, 0.536877
0.63	0.216512	0.119215	0.0651604, 0.522809
0.75	0.122531	0.102209	0.0212093, 0.473657
0.77	0.110816	0.097889	0.0174719, 0.466218
0.87	0.0659128	0.0745699	0.0065281, 0.431096
0.88	0.062496	0.072254	0.0059101, 0.427741

Weighted sound power level values (LAeq-Pa) values between 0.34 Pa (64.6 dBA) to 0.15 Pa (57.5 dBA) have a 59% to 91% probability to place data measurement points in the Sound Quality zone.

The All Data (Weekend and Weekday) has a strong correlation with the Weekday data. There is no significant relationship discovered from the Weekend data physical attributes, classical attributes, and supporting acoustical attributes data binary logistic regression against lacement of data measurement points in the two-dimensional soundscape diagram (see Appendix 7). Below Table 21 is the binary logistic regression analysis results of Weekday data physical attributes, classical attributes, and supporting acoustical attributes data towards placement of data measurement points in the two-dimensional soundscape diagram.

Table 24. Weekday Data Binary Logistic Regression Analysis

		WEEKDAY (Day 3)					
Response	Predictors	EQUATION	Coef	SE Coef	Z-value	P-Value	VIF
Sound Quality Zone	SGC	Y'= 1.22 - 0.00039 SGC	-0.00039	0.00126	-0.31	0.757	1
Sound Quality Zone	NDSI	Y'= 0.476 - 0.58 NDSI	-0.58	2.23	-0.26	0.794	1
Sound Quality Zone	B/A	Y'= 12.8 - 12.7 B/A	-12.7	13	-0.97	0.331	1
Sound Quality Zone	PA	Y'= 14.18 - 0.262 PAnnoyance	-0.262	0.108	-2.41	**0.016**	1
Sound Quality Zone	TSLV	Y'= 0.912 - 0.0460TSLV	-0.046	0.071	-0.65	0.517	1
Sound Quality Zone	Sound Power - Leq	Y'= 1.38 - 0.906 SoundPower Leq	-0.906	0.938	-0.97	0.334	1
Sound Quality Zone	Sound Power - LAeq	Y'= 8.74 - 18.61 SoundPower LAeq	-18.61	8.71	-2.14	**0.033**	1
Sound Quality Zone	N	Y'= 10.43 - 0.307 N	-0.307	0.136	-2.26	**0.024**	1
Sound Quality Zone	Nmax	Y'= 8.71 - 0.0952 Nmax	-0.0952	0.0434	-2.2	**0.028**	1
Sound Quality Zone	N5	Y'= 12.82 - 0.2512 N5	-0.2512	0.0989	-2.54	**0.011**	1
Sound Quality Zone	Sharpness	Y'= 2.77 - 1.55 Sharpness	-1.55	3.28	-0.47	0.636	1
Sound Quality Zone	Roughness	Y'= 2.11 - 10.2 Roughness	-10.2	21.8	-0.47	0.639	1
Sound Quality Zone	Fluctuation Strength	Y'= 2.9 - 54.5 Fluctuation Strength	-54.5	43.3	-1.26	0.209	1
Annoying Zone	SGC	Y'= -5.78 + 0.00187 SGC	0.00187	0.00171	1.09	0.274	1
Annoying Zone	NDSI	Y'= -1.907 + 1.25 NDSI	1.25	3.11	0.4	0.687	1
Annoying Zone	B/A	Y'= -21.8 + 20.4 B/A	20.4	17.8	1.15	0.252	1
Annoying Zone	PA	Y'= -7.59 + 0.1026 PAnnoyance	0.1026	0.0591	1.74	0.082	1
Annoying Zone	TSLV	Y'= -1.84 + 0.0094 TSLV	0.0094	0.0947	0.1	0.921	1
Annoying Zone	Sound Power - Leq	Y'= -1.69 - 0.05 SoundPower Leq	-0.05	1.15	-0.04	0.968	1
Annoying Zone	Sound Power - LAeq	Y'= -5.99 + 8 SoundPower LAeq	8	4.23	1.89	0.059	1
Annoying Zone	N	Y'= -12.57 + 0.299 N	0.299	0.173	1.73	0.084	1
Annoying Zone	Nmax	Y'= -3.26 + 0.0169 Nmax	0.0169	0.0214	0.79	0.429	1
Annoying Zone	N5	Y'= -9.59 + 0.1463 N5	0.1463	0.0875	1.67	0.094	1
Annoying Zone	Sharpness	Y'= -9.79 + 5.19 Sharpness	5.19	4.45	1.17	0.243	1

Annoying Zone	Roughness	Y'= -6.8 + 29.7 Roughness	29.7	32.4	0.92	0.359	1
Annoying Zone	Fluctuation Strength	Y'= -0.56 - 26.9 Fluctuation Strength	-26.9	52.8	-0.51	0.611	1
Pleasant Zone	SGC	Y'= 5.78 - 0.00187 SGC	-0.00187	0.00171	-1.09	0.274	1
Pleasant Zone	NDSI	Y'= 1.907 - 1.25 NDSI	-1.25	3.11	-0.4	0.687	1
Pleasant Zone	B/A	Y'= 21.8 - 20.4 B/A	-20.4	17.8	-1.15	0.252	1
Pleasant Zone	PA	Y'= 7.59 - 0.1026 PAnnoyance	-0.1026	0.0591	-1.74	0.082	1
Pleasant Zone	TSLV	Y'= 1.84 - 0.0094 TSLV	-0.0094	0.0947	-0.1	0.921	1
Pleasant Zone	Sound Power - Leq	Y'= 1.69 + 0.05 SoundPower Leq	0.05	-1.15	0.04	0.968	1
Pleasant Zone	Sound Power - LAeq	Y'= 5.99 - 8 SoundPower LAeq	-8	-4.23	-1.89	0.059	1
Pleasant Zone	N	Y'= 12.57 - 0.299 N	-0.299	-0.173	-1.73	0.084	1
Pleasant Zone	Nmax	Y'= 3.26 - 0.0169 Nmax	-0.0169	-0.0214	-0.79	0.429	1
Pleasant Zone	N5	Y'= 9.59 - 0.1463 N5	-0.1463	-0.0875	-1.67	0.094	1
Pleasant Zone	Sharpness	Y'= 9.79 - 5.19 Sharpness	-5.19	-4.45	-1.17	0.243	1
Pleasant Zone	Roughness	Y'= 6.8 - 29.7 Roughness	-29.7	-32.4	-0.92	0.359	1
Pleasant Zone	Fluctuation Strength	Y'= 0.56 + 26.9 Fluctuation Strength	26.9	-52.8	0.51	0.611	1
Uneventful Zone	SGC	Y'= 0.62 - 0.00049 SGC	-0.00049	0.00129	-0.38	0.702	1
Uneventful Zone	NDSI	Y'= -0.213 - 1.72 NDSI	-1.72	2.29	-0.75	0.454	1
Uneventful Zone	B/A	Y'= 9 - 9.6 B/A	-9.6	12.7	-0.76	0.45	1
Uneventful Zone	PA	Y'= -1.4 + 0.0193 PAnnoyance	0.0193	0.0336	0.57	0.566	1
Uneventful Zone	TSLV	Y'= -1.45 + 0.0940 TSLV	0.094	0.077	1.22	0.222	1
Uneventful Zone	Sound Power - Leq	Y'= -0.564 + 0.148 SoundPower Leq	0.148	0.812	0.18	0.856	1
Uneventful Zone	Sound Power - LAeq	Y'= -0.07 - 0.77 SoundPower LAeq	-0.77	2.32	-0.33	0.74	1
Uneventful Zone	N	Y'= 0 - 0.127 N	-0.127	0.0598	-0.21	0.832	1
Uneventful Zone	Nmax	Y'= 0.19 - 0.007 Nmax	-0.007	0.0171	-0.41	0.68	1
Uneventful Zone	N5	Y'= -1.23 + 0.0174 N5	0.0174	0.0379	0.46	0.647	1
Uneventful Zone	Sharpness	Y'= -0.18 - 0.15 Sharpness	-0.15	3.27	-0.05	0.964	1
Uneventful Zone	Roughness	Y'= 3.39 - 23 Roughness	-23	22.9	-1	0.316	1
Uneventful Zone	Fluctuation Strength	Y'= 0.161 - 11.8 Fluctuation Strength	-11.8	19.2	-0.62	0.538	1
Eventful Zone	SGC	Y'= -0.62 + 0.00049 SGC	0.00049	0.00129	0.38	0.702	1
Eventful Zone	NDSI	Y'= 0.213 + 1.72 NDSI	1.72	2.29	0.75	0.454	1
Eventful Zone	B/A	Y'= -9 + 9.6 B/A	9.6	12.7	0.76	0.45	1
Eventful Zone	PA	Y'= 1.4 - 0.0193 PAnnoyance	-0.0193	0.0336	-0.57	0.566	1
Eventful Zone	TSLV	Y'= 1.45 - 0.0940 TSLV	-0.094	0.077	-1.22	0.222	1
Eventful Zone	Sound Power - Leq	Y'= 0.564 - 0.148 SoundPower Leq	-0.148	-0.812	-0.18	0.856	1
Eventful Zone	Sound Power - LAeq	Y'= 0.07 + 0.77 SoundPower LAeq	0.77	-2.32	0.33	0.74	1

Eventful Zone	N	Y'= 0 + 0.127 N	0.127	-0.0598	0.21	0.832	1
Eventful Zone	Nmax	Y'= -0.19 + 0.007 Nmax	0.007	-0.0171	0.41	0.68	1
Eventful Zone	N5	Y'= 1.23 - 0.0174 N5	-0.0174	-0.0379	-0.46	0.647	1
Eventful Zone	Sharpness	Y'= 0.18 + 0.15 Sharpness	0.15	-3.27	0.05	0.964	1
Eventful Zone	Roughness	Y'= -3.39 + 23 Roughness	23	-22.9	1	0.316	1
Eventful Zone	Fluctuation Strength	Y'= -0.161 + 11.8 Fluctuation Strength	11.8	-19.2	0.62	0.538	1
Outside Sound Quality Zone Zone	SGC	Y'= -1.82 + 0.00057 SGC	0.00057	0.00129	0.44	0.657	1
Outside Sound Quality Zone Zone	NDSI	Y'= -0.623 + 0.04 NDSI	0.04	2.28	0.02	0.987	1
Outside Sound Quality Zone Zone	B/A	Y'= -11.2 + 10.8 B/A	10.8	13	0.83	0.407	1
Outside Sound Quality Zone Zone	PA	Y'= -12.41 + 0.2188 PAnnoyance	0.2188	0.0958	2.28	**0.022**	1
Outside Sound Quality Zone Zone	TSLV	Y'= -1.118 + 0.0449 TSLV	0.0449	0.072	0.62	0.533	1
Outside Sound Quality Zone Zone	Sound Power - Leq	Y'= -1.56 + 0.865 SoundPower Leq	0.865	0.906	0.96	0.34	1
Outside Sound Quality Zone Zone	Sound Power - LAeq	Y'= -8.19 + 16.23 SoundPower LAeq	16.23	7.86	2.06	**0.039**	1
Outside Sound Quality Zone Zone	N	Y'= -10.47 + 0.296 N	0.296	0.136	2.18	**0.029**	1
Outside Sound Quality Zone Zone	Nmax	Y'= -9.17 + 0.0957 Nmax	0.0957	0.044	2.17	**0.03**	1
Outside Sound Quality Zone Zone	N5	Y'= -11.63 + 0.2173 N5	0.2173	0.0904	2.4	**0.016**	1
Outside Sound Quality Zone Zone	Sharpness	Y'= -4.98 + 2.86 Sharpness	2.86	3.43	0.83	0.404	1
Outside Sound Quality Zone Zone	Roughness	Y'= -2.08 + 8.8 Roughness	8.8	22.3	0.39	0.693	1
Outside Sound Quality Zone Zone	Fluctuation Strength	Y'= -3.54 + 63 Fluctuation Strength	63	45.6	1.38	0.167	1

In Weekday data, it is shown that psychoacoustic annoyance (PA), loudness (N), loudness maximum (Nmax), loudness percentile (N5), and weighted sound power level (LAeq) predict data measurement points being in the Sound Quality zone with p-values of 0.016, 0.024, 0.028, 0.011, and 0.033 respectively and predicts data measurement points being in the Outside Sound Quality zone with p-values of 0.022, 0.029, 0.03, 0.016 and 0.039 respectively.

By running a predict function on Minitab, PA values that best predict data measurement points being in the Sound Quality zone and Outside Sound Quality zone can be identified by calculating psychoacoustic annoyance (PA), loudness (N), loudness maximum (Nmax), and loudness percentile (N5) probability shown in Tables 43, 44, 45, 46, 47, 48, 49, 50, 51, 52.

Table 25. Psychoacoustic Annoyance (PA) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = 14.18 - 0.262 PAnnoyance			
PA Setting	**Fitted Probability**	**SE Fit**	**95% CI**
28	0.998945	0.0030584	0.762377, 1
33	0.99611	0.0092456	0.704527, 0.999964
37	0.989006	0.021566	0.648394, 0.999772
41	0.969327	0.0474783	0.580156, 0.998618
41	0.969327	0.0474783	0.580156, 0.998618
42	0.960521	0.0570417	0.560564, 0.997850
43	0.949318	0.0680242	0.539695, 0.996669
45	0.917368	0.0941217	0.493382, 0.992161
47	0.868077	0.124313	0.439420, 0.982218
48	0.835145	0.139855	0.408922, 0.973750
52	0.640247	0.19003	0.261036, 0.899661
59	0.221966	0.170046	0.0397672, 0.662764
59	0.221966	0.170046	0.0397672, 0.662764
60	0.180085	0.165519	0.0272316, 0.632793
63	0.0910937	0.106382	0.0080130, 0.554271
65	0.0560724	0.0772892	0.0033835, 0.509663
74	0.0056124	0.0130416	0.0000579, 0.355009
84	0.0004127	0.0013921	0.0000006, 0.235367

If the psychoacoustic annoyance (PA) value is between 52 to 28 it has a 64% to 100% chance for data measurement points being in the Sound Quality zone.

Table 26. Loudness (N) Values that Predict Data Measurement Point Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = 10.43 - 0.307 N			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
20	0.986466	0.0249601	0.651272, 0.999649
24	0.955251	0.0585721	0.592741, 0.996816
25	0.940134	0.070411	0.574913, 0.994546
26	0.920335	0.0832561	0.555098, 0.990738
27	0.894721	0.096549	0.532693. 0.984463
30	0.771868	0.131167	0.440021. 0.935767
31	0.713386	0.139161	0.396020, 0.904292
32	0.646772	0.145994	0.343526, 0.864991
34	0.497718	0.159895	0.220508, 0.776338
35	0.421618	0.166222	0.160822. 0.734944
36	0.349068	0.169577	0.110476, 0.698383
37	0.282896	0.16804	0.0721821, 0.666714
39	0.175933	0.148902	0.0277296, 0.615107
41	0.103571	0.116361	0.0098094, 0.574012
43	0.0588468	0.0827767	0.0033297, 0.539217
53	0.002894	0.008037	0.0000124, 0.405321

If the loudness (N) value is between 32-20 it has a 65% to 99% chance for the data measurement points being in the Sound Quality zone.

Table 27. Loudness Maximum (Nmax) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = 8.71 - 0.0952 Nmax			
Nmax Setting	**Fitted Probability**	**SE Fit**	**95% CI**
48	0.9894294	0.0284071	0.630986, 0.999565
47	0.985699	0.0264752	0.634564, 0.999635
53	0.974958	0.0399413	0.611942, 0.998961
58	0.960297	0.054857	0.590449, 0.997542
66	0.918652	0.08507	0.548110, 0.990579
68	0.90324	0.0933097	0.535242, 0.986956
69	0.894594	0.0974273	0.528343, 0.984687
73	0.852925	0.113298	0.496882, 0.971472
80	0.748626	0.135683	0.420225, 0.924453
82	0.711132	0.140704	0.391365, 0.904076
84	0.670507	0.145458	0.358942, 0.880893
89	0.558347	0.157923	0.264886, 0.816024
90	0.534757	0.160607	0.244900, 0.802898
92	0.487213	0.165953	0.205370, 0.777429
98	0.349239	0.176766	0.104631, 0.711366
105	0.216053	0.166555	0.0385618, 0.654421
112	0.123982	0.133607	0.0125388, 0.612019
117	0.0808186	0.105484	0.0054086, 0.587051
124	0.0432018	0.0701288	0.0016212, 0.556636
160	0.0014641	0.004674	0.0000028, 0.435683

If the loudness maximum (Nmax) value is between 84-48 it has a 67% to 99% chance to place the data measurement points on the Sound Quality zone.

Table 28. Loudness Percentile (N5) Values that Predict Data Measurement Point Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = 12.82 - 0.2512 N5			
N5 Setting	**Fitted Probability**	**SE Fit**	**95% CI**
26	0.998146	0.0047928	0.770884, 0.999988
32	0.991681	0.016772	0.689139, 0.999844
35	0.982488	0.0303532	0.638652, 0.999439
36	0.977598	0.0367176	0.620081, 0.999144
39	0.953568	0.062995	0.558090, 0.997015
40	0.941088	0.0744169	0.534994, 0.995512
40	0.941088	0.0744169	0.5394994, 0.9995512
42	0.906236	0.10106	0.484372, 0.990044
45	0.819772	0.146307	0.395066, 0.969400
49	0.62477	0.192775	0.249395, 0.892978
56	0.222904	0.164077	0.0428867, 0.647418
57	0.182416	0.149672	0.0302655, 0.614647
57	0.182416	0.149672	0.0302655, 0.614647
58	0.147883	0.134346	0.0210235, 0.0583768
59	0.118936	0.118819	0.0144160, 0.554733
62	0.0597343	0.0764007	0.0043974, 0.477468
64	0.0370143	0.054346	0.0019324, 0.432804
72	0.0051242	0.0114052	0.0000642, 0.292394

If the loudness percentile (N5) value is between 49-26 it has a 62% to 100% chance to place the data measurement points in the Sound Quality zone.

Table 29. Weighted Sound Power Level (LAeq) Values that Predict Data Measurement Points Being in the Sound Quality zone (Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = 8.74 - 18.61 SoundPowerLAeq			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
0.41	0.752449	0.170234	0.336369, 0.947992
0.61	0.0684615	0.0948612	0.0039665, 0.575609
0.65	0.0337311	0.058455	0.0010372, 0.539942
0.66	0.0281641	0.0512464	0.0007380, 0.532079
1.36	0.0281641	0.0512464	0.0007380, 0.532079
0.76	0.0044861	0.0120082	0.0000232, 0.466986
0.87	0.0005814	0.0021014	0.0000005, 0.410688
0.89	0.0004008	0.001517	0.0000002, 0.401424
0.93	0.0001904	0.0007859	0.0000001, 0.383567
0.93	0.000190	0.0007859	0.0000001, 0.383567
1.09	0.0000097	0.0000533	0.0000000, 0.319257
1.12	0.0000055	0.000032	0.0000000, 0.308267
1.14	0.0000038	0.0000227	0.0000000, 0.301109
1.15	0.0000032	0.0000191	0.0000000, 0.297580
1.34	0.0000001	0.0000007	0.0000000, 0.236438
1.36	0.0000001	0.0000005	0.0000000, 0.230626
1.69	0	0	0.0000000, 0.150280
3.04	0	0	0.0000000, 0.0211174
1.47	0	0.0000001	0.0000000, 0.200666

If the weighted sound power level (LAeq) value is lower than 0.41Pa (66dBA) it has a 75% chance to place data measurement points in the Sound Quality zone.

Table 30. Psychoacoustic Annoyance (PA) Value that Predict Data Measurement Points Being in the Outside Sound Quality zone (Outside Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = -12.41 + 0.2188 PAnnoyance			
PA Setting	**Fitted Probability**	**SE Fit**	**95% CI**
84	0.997439	0.0071486	0.617583, 0.999989
74	0.977621	0.0413512	0.518113, 0.999437
65	0.869109	0.138387	0.393423, 0.982855
63	0.797434	0.161993	0.355441, 0.965639
60	0.671277	0.183453	0.285879, 0.912409
59	0.621325	0.185714	0.258864, 0.885160
52	0.261855	0.157045	0.0673069, 0.635552
48	0.128811	0.116903	0.0188303, 0.532518
47	0.106187	0.1065576	0.0132488, 0.512476
45	0.0712345	0.0836022	0.0064031, 0.477215
43	0.0471799	0.0640431	0.0030254, 0.446896
42	0.0382634	0.0554869	0.0020671, 0.433161
41	0.0309772	0.047801	0.0014080, 0.420206
37	0.0131487	0.0251899	0.0002965, 0.374415
33	0.0055227	0.0126382	0.0000611, 0.335537
28	0.0018563	0.0051135	0.0000083, 0.293539

If the psychoacoustic annoyance (PA) value is between 59-84 it has a 62% to 100% to place data measurement points in the Outside Sound Quality zone.

Table 31. Loudness (N) Values that Predict Data Measurement Points Being in the Outside Sound Quality zone (Outside Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = -10.47 + 0.296 N			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
53	0.994722	0.0140412	0.499295, 0.999972
43	0.90684	0.117736	0.387977, 0.993354
41	0.843301	0.153074	0.357232, 0.981172
39	0.748447	0.177491	0.319219, 0.949696
37	0.621917	0.179512	0.269214, 0.880166
36	0.550173	0.172369	0.237991, 0.827279
35	0.476279	0.162454	0.202386, 0.765223
34	0.403409	0.1522222	0.163702, 0.700227
32	0.272113	0.134659	0.0897702, 0.586274
31	0.217507	0.126051	0.0611205, 0.542728
30	0.17128	0.116326	0.0398175, 0.507413
27	0.0783084	0.0810745	0.0093114, 0.434392
26	0.0594191	0.0691778	0.0055528, 0.416812
25	0.0448645	0.0581149	0.0032811, 0.401281
24	0.0337471	0.0481807	0.0019258, 0.387327
20	0.0105624	0.0207103	0.0002195, 0.341680

If the loudness (N) value is between 36-53 it has a 55% to 99% chance to place data measurement points in the Outside Sound Quality zone.

Table 32. Loudness Maximum (Nmax) Values that Predict Data Measurement Points Being in the Outside Sound Quality zone (Outside Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = -9.17 + 0.0957 Nmax			
Nmax Setting	**Fitted Probability**	**SE Fit**	**95% CI**
160	0.997845	0.0067037	0.506939, 1.00000
124	0.936631	0.0951944	0.389319, 0.997090
117	0.883247	0.137056	0.358612, 0.990325
112	0.824212	0.16565	0.332768, 0.977817
105	0.705866	0.188809	0.287614, 0.934489
98	0.551228	0.181257	0.226099, 0.837771
92	0.408917	0.160224	0.158732, 0.717238
90	0.363593	0.153134	0.135066, 0.676401
89	0.341755	0.149737	0.123458, 0.656810
84	0.243445	0.133661	0.0720080, 0.571624
82	0.209947	0.127108	0.0558724, 0.544062
80	0.179962	0.120194	0.0425783, 0.519913
73	0.100982	0.0931071	0.0148256, 0.456050
69	0.0711551	0.0770511	0.0077366, 0.429442
68	0.0650851	0.0731618	0.0065526, 0.423554
66	0.0543659	0.0656426	0.0046851, 0.412519
58	0.0260446	0.0403006	0.0011866, 0.375741
53	0.0163032	0.028728	0.0004948, 0.356851
48	0.0101674	0.0201038	0.0002047, 0.340035
47	0.0092482	0.0186846	0.0001715, 0.336870

If the loudness maximum (Nmax) value is between 98-160 it has a 55% to 100% chance to place data measurement points in the Outside Sound Quality zone.

Table 33. Loudness Percentile (N5) Values that Predict Data Measurement Points Being in the Outside Sound Quality zone (Outside Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = -11.63 + 0.2173 N5			
N5 Setting	**Fitted Probability**	**SE Fit**	**95% CI**
72	0.982326	0.0319822	0.600452, 0.999514
64	0.907158	0.101973	0.476611, 0.990552
62	0.863517	0.126246	0.436669, 0.981004
59	0.767262	0.158947	0.365479, 0.949669
58	0.726237	0.167121	0.338073, 0.932335
57	0.680987	0.173414	0.308696, 0.910752
56	0.632048	0.177749	0.277480, 0.884833
49	0.272873	0.162454	0.0701199, 0.651278
45	0.135955	0.122029	0.0201282, 0.546541
42	0.075774	0.0873915	0.0070547, 0.486150
40	0.0504118	0.0669778	0.0034085, 0.451769
39	0.0409692	0.058043	0.0023558, 0.435927
39	0.0409692	0.058043	0.0023558, 0.435927
36	0.0217744	0.0366124	0.0007657, 0.392675
35	0.0175964	0.0311382	0.0005244, 0.379452
32	0.009247	0.0188033	0.0001670, 0.342686
26	0.0025274	0.006472	0.0000165, 0.279607

If the loudness percentile (N5) value is between 56-72 it has a 63% to 98% chance to place data measurement points in the Outside Sound Quality zone.

Table 34. Weighted Sound Power Level (LAeq) Values Predict Data Measurement Points Being in the Outside Sound Quality zone (Outside Vibrant-Calm) Quadrant Based on Weekday Data

Regression equation			
Y' = -8.19 + 16.23 SoundPowerLAeq			
N Setting	**Fitted Probability**	**SE Fit**	**95% CI**
1.69	1	0	0.650888, 1
3.04	1	0	0.853447, 1
1.47	1	0.0000012	0.605757, 1
1.34	1	0.0000087	0.577408, 1.00000
1.36	1	0.0000064	0.581858, 1.00000
1.15	0.999972	0.0001485	0.533259, 1.00000
1.14	0.999967	0.0001721	0.530825, 1.00000
1.12	0.999954	0.000231	0.525915, 1.00000
1.09	0.999925	0.0003585	0.518441, 1.00000
0.93	0.999	0.0035692	0.475578, 1.00000
0.89	0.998088	0.0062344	0.463701, 1.00000
0.87	0.997357	0.0082101	0.457502, 0.99999
0.76	0.984438	0.0349831	0.418628, 0.999820
0.66	0.925795	0.107267	0.369004, 0.996257
0.65	0.913842	0.117533	0.362551, 0.994970
0.61	0.847109	0.159338	0.331998, 0.984068
0.41	0.177299	0.138975	0.0322283, 0.582403

If the weighted sound power level (LAeq) value is above 0.61 Pa (69.7 dBA) it has a 85% to 100% chance to place data measurement points in the Outside Sound Quality zone.

Table 35 summarizes the values of predicting factors that predict data measurement points being in the Sound Quality zone and Outside Sound Quality zone of All Data (Weekend and Weekday) data and Weekday data.

Table 35. Summary of Binary Logistic Regression Analysis

Day	To Predict	Predictor(s	P-value	Predict Value	Probability
All Day	Sound Quality	Psychoacoustic Annoyance (PA)	0.05	43-28	57%-75%
All Day	Sound Quality	Loudness (N)	0.05	28-19	57%-78%
All Day	Sound Quality	Loudness Maximum (Nmax)	0.06	73-42	59%-78%
All Day	Sound Quality	Loudness Percentile (N5)	0.04	40-51	57%-94%
All Day	Sound Quality	Sound Power (LAeq)	0.033	0.34-0.15	59%-81%
Weekday	Sound Quality	Psychoacoustic Annoyance (PA)	0.016	52-28	64%-100%
Weekday	Sound Quality	Loudness (N)	0.024	32-20	65%-99%
Weekday	Sound Quality	Loudness Maximum (Nmax)	0.028	84-48	67%-99%
Weekday	Sound Quality	Loudness Percentile (N5)	0.011	49-26	62%-100%
Weekday	Sound Quality	Sound Power (LAeq)	0.014	<0.41	75% up
Weekday	Outside Sound Quality	Psychoacoustic Annoyance (PA)	0.022	59-84	62%-100%
Weekday	Outside Sound Quality	Loudness (N)	0.029	36-53	55%-99%
Weekday	Outside Sound Quality	Loudness Maximum (Nmax)	0.03	98-160	55%-100%
Weekday	Outside Sound Quality	Loudness Percentile (N5)	0.016	56-72	63%-98%
Weekday	Outside Sound Quality	Sound Power (LAeq)	0.039	0.61-1.69	85%-100%

Relationship between Measurement on Site and Taxonomy Analysis

To analyze the relationship between measurement on site and taxonomy analysis, heat maps that are made in the previous section and taxonomy notes are utilized. Taxonomy notes hope to explain different values of acoustic indicators computed.

a. Classical Attributes with Taxonomy Analysis

A-Weighted sound pressure level data shown in Figure 25. is used to analyze the relation between sound pressure level and taxonomy. The primary reason is that the human ear is subjected to A-weighted function and taxonomy analysis is carried out based on the researcher's perception.

Points 2A, 2B, 6, 22, 25, 36, 37, 38 have the highest sound pressure level recorded on Olympic Village. It has a range of 69 dBA to 73 dBA. The dominating noise on points 2A, 2B, 6 are coming from people's activities such as people's conversation and kids shouting. While other noises such as traffic noise and dog barking present in the soundscape as well. Points 22, 36, 37, 38 are dominated by traffic noises judging from its location being close to the main road and point 22 being close approximation with the intersection. Points 25 soundscape dominated by people cleaning the window using a high water pressure.

Points 3, 4, 13, 19, 20, 21, 23, 24, 28, 29 have a sound pressure level range of 65 dBA to 68 dBA. Points 3 and 4 are dominated by traffic noises and kids screaming. Points 13 is dominated by sound busking. Points 19, 20, 21 are dominated by bird songs with traffic noise in the background. Points 23, 24, 28 are dominated by construction and traffic noise. Point 29 is dominated by people's conversation and footsteps.

Points 5, 7, 8, 9, 10, 11, 14, 17, 26, 27, 31, 32, 33, 34, 35 have a sound pressure level range of 61 to 65 dBA. Points 5, 7, 8, 9, 10, 14, 17, 31, 32, 33 are dominated by people passing by and people talking. Points 26 and 27 have people's conversation and bird chirping as dominant sounds. Points 34 and 35 have traffic noise as the dominant sound source.

Points 12, 15, 16, 18, 30 are the quietest with a sound pressure range of 57 dBA to 60 dBA. All have equal sound sources coming from people, bird songs, traffic noise and skytrain.

WHO labelled 55 dBA as a serious annoyance sound pressure level recorded on outdoor living areas. For a healthy soundscape, WHO recommended 50 dBA as the maximum sound pressure level in outdoor living areas . The entire Olympic Village soundscape exceeds the WHO requirement for a healthy soundscape.

Sound source from people's activity does not always produce the highest sound pressure level. In the Olympic Village soundscape analysis, kids screaming, traffic noise, and cleaning equipment raised the sound pressure level significantly. However, if the sound source is equally presented even though there is a lot of sound source diversity it can still produce lower sound pressure level of a soundscape.

b. Biophony/antrophony Ratio with Taxonomy Analysis

The biophony/antrophony ratio of Olympic Village is presented in Figure 26. The closer to 1 biophony/antrophony ratio, the more natural sound sources exist in the soundscape. Literature review did not specify a city standard for recommended biophony/antrophony ratio values. Olympic Village has a range of 0.89 to 1.07 biophony to antrophony ratio values. To cross analyze biophony/antrophony ratio with taxonomy, taxonomy notes are utilized.

Points 9, 12, 13, 14, 15, 16, 23, 30, 37 are the lowest biophony/antrophony ratio values with a range of 0.890 to 0.932. There are still significant biophony values that exist judging from the ratio value, however taxonomy analysis reported that points 9 hass dominating noise from cros and bird song. Points 12 and 13 are dominated by sound busking, while Points 14, 15, 16, 30 are dominated by people passing by sound. Points 23 is dominated by equal sound of construction, traffic noise and people passing by. Points 37 is dominated by traffic noise

Points 2A, 3, 4, 5, 6, 7, 8, 10, 11, 19, 21, 24, 26, 31, 32, 34 have a range of biophony/antrophony ratio values of 0.936 to 0.977 which indicates significant proportion of biophony element in the soundscape. Points 2A, 3, 4, 5, 6, 7, 8, 11, 10 are dominated by kids screaming and people passing by activity with natural sound in the background. Points 19 has traffic noise dominating the soundscape. Points 21 has a bird song with traffic noise in the background. Points 24, 26 have equal noise from bird songs, traffic noise and people conversation. Points 31, 32, 34 are a mixture of traffic noise and people passing by plus bicycle sound.

Points 2B, 17, 18, 20, 22, 27, 28, 29, 35, 36 have a range of biophony/antrophony ratio values of 0.981 to 1.006. Points 2B is dominated by people activity sound and kids screaming. Points 17, 28 are dominated by equal sound sources from bird songs and people passing by. Points 20, 27 are dominated by bird songs. Points 22, 28, 35, 36 are dominated by traffic noise . Points 29 is dominated by people's conversation.

Points 25, 33, 38 have the highest biophony/antrophony ratio with a range of 1.013 to 1.070. Though, point 25 is one of the loudest data measurement points with people cleaning the building using water pressure being the sole dominating sound source in the soundscape. Points 33 and 38 have traffic noise as dominating followed by people activity sound source.

Although the ratio tells the values of certain points are close to 1 which means more natural sound present in the soundscape. Taxonomy analysis tells completely opposite results which make the biophony/antrophony ratio less accurate. In fact the highest biophony/antrophony ratio rating occurs at a point where human activity (antrophony) is dominating the soundscape.

c. Normalized Difference Soundscape Index with Taxonomy Analysis

Normalized difference soundscape index (NDSI) is presented in Figure 27. The cross analysis between normalized difference soundscape index values and taxonomy is utilizing taxonomy notes. Normalized difference soundscape index value close to +1 indicates presence of biophony greater than antrophony. Literature review does not find recommended city soundscape NDSI value. The entire Olympic Village soundscape has an NDSI range of values of -0.3 to 0.54.

Points 2A, 6, 10, 13, 15, 16, 21, 23, 29, 30, 34 and 37 have the lowest NDSI value which has a range of -0.3 to -0.02. This means there is a high presence of antrophony in these data measurement points. Points 2A and 6 have kids screaming dominating the soundscape. Points 10, 15, 16, 29, 30 are dominated by people passing by sound source. Point 13 is dominated by people passing by and sound busking. Points 13, 21, 23, 34 are dominated by traffic and mechanical sound sources.

Points 3, 4, 7, 8, 9, 11, 12, 14, 19, 26, 31 and 36 have NDSI values ranging from 0 to 0.13. These NDSI values almost indicated the equal presence of natural and antrophony sound in the soundscape. Points 3 and 4 are dominated by kids screaming and traffic noise (engine braking) sounds while having dog barking and bird songs in the background. Points 7, 8, 9, 14, 31 are dominated by people passing by sound source with bird songs, bicycle, dog barking in the background. Points 11 and 12 are dominated by sound busking with people passing by. Points 19, 26 and 36 are dominated by traffic noise.

Points 2B, 5, 17, 18, 20, 22, 24, 27, 28, 32, 35, 38 have NDSI values ranging from 0.15 to 0.3. These NDSI values indicated antrophony still present in the soundscape while there are also elements of biophony sound sources. Points 2B and 5 are dominated by kids screaming with a fair amount of sound coming from people passing by. Points 17, 18 are dominated with sound from people passing by. Points 20, 24, 27 are dominated by bird chirping or bird songs. Points 22, 28, 32, 35 are dominated by traffic noise and construction noise. In this case, points with antrophony sound dominating almost have the same NDSI values with points that are dominated by bird chirping of bird songs.

Points 25 and 33 have the highest NDSI values of 0.43 and 0.54. According to theory, these two points should have the lowest antrophony compared to the other data measurement points in Olympic Village. However, point 25 is actually the highest sound pressure level point which is dominated by the sound of high water pressure that someone uses to clean the building which may be rated as annoying by users around the space. While point 33 is a mixture of traffic noise, people passing by, construction, airplanes and bird songs.

In a complex soundscape, the NDSI indicator is not accurate in determining pleasant and annoying soundscapes. One can have a high NDSI rating which according to theory is good but accounting for a lot of particular human activity noise. The assumption is that within the soundscape there are many sound sources that cannot be classified into a certain frequency range in which NDSI is calculated.

d. Psychoacoustic Annoyance with Taxonomy Analysis

Psychoacoustic annoyance is presented in Figure 28. Cross analysis between psychoacoustic annoyance values and taxonomy is utilizing taxonomy notes. Olympic Village has psychoacoustic annoyance values ranging from 28 to 84. There is no literature review yet that is suggesting the recommending psychoacoustic annoyance values for a healthy city. The larger the psychoacoustic annoyance values, the greater the annoyance.

Points 25 and 36 have the greatest psychoacoustic annoyance values in Olympic Village of 74 and 84 respectively. Taxonomy note describes point 25 as a soundscape with high antrophony or human activity noise of people cleaning the window using a high pressure water system. Points 36 is described as a soundscape with high traffic noise. In this case, psychoacoustic annoyance indicators match with the taxonomy analysis.

Points 2B, 6, 13, 19, 22, 24, 28, 37, 38 have psychoacoustic annoyance values ranging from 54 to 65. Points 2B are dominated by people's activity , especially kids screaming which psychoacoustic annoyance values show a fairly high annoyance in that point. Points 6 is dominated by sound busking. While points 22 and 24 contain a mix of sound sources coming from traffic noise, construction, people and natural sounds. Points 28, 37 and 38 are highly dominated by traffic noise. Psychoacoustic annoyance values between 54 to 65 range can be classified as quite annoying to the Olympic Village psychoacoustic annoyance standard. These points also show that sound sources such as kid screaming and traffic noise are likely to result in higher psychoacoustic values.

Points 2A, 3, 4, 5, 9, 20, 21, 23, 26, 29, 32, 33, 34, 35 have psychoacoustic annoyance values ranging from 40 to 52. These psychoacoustic annoyance values are within the lower range of the Olympic Village psychoacoustic annoyance scale. In other words according to psychoacoustic annoyance theory, these data measurement points can be considered less annoying. Point 2A is described as a soundscape that is dominated by people activity, sound from food trucks and kids screaming. Points 3, 4, 5 are similar to points 2A with points 3 and 4 having higher traffic noise coming from the intersection.

Points 9, 29, 32, 33 are dominated with people's conversation with natural sound sources present in the environment as less dominating. Points 20, 21, 26 are dominated with natural sound sources from bird chirping with people passing by as less dominating sound. Points 23, 34, 35 are dominated by traffic noises but having people sound and natural sound present on the soundscape. It seems like the presence of traffic noises does not guarantee to increase psychoacoustic annoyance values significantly. While the presence of natural sound can be said to reduce psychoacoustic annoyance values as several points within this range have considerable amounts of natural sound.

Points 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 27, 30, 31 have the lowest psychoacoustic annoyance values in Olympic Village with a range of 28 to 38. These data measurement points are supposedly points with the greatest pleasantness in Olympic Village according to psychoacoustic annoyance theory. Points 7, 8, 10, 14, 15, 16, 17, 18, 30 and 31 are dominated mostly by sound sources from conversation, people talking, people biking on the Olympic Village trail combined with natural sound in the background. Points 11 and 12 are highly dominated with sound busking. Point 27 is dominated by bird songs with people conversing in the background. These points show that even though conversation, people talking are the dominating sound sources in the environment, if it is kept within certain psychoacoustic parameters, it can still have a low psychoacoustic annoyance rating. Uniformity of sound busking and presence of bird song also proved a low psychoacoustic annoyance rating.

Psychoacoustic annoyance measurement results seemed to be aligned with the taxonomy analysis. High psychoacoustic annoyance values correspond with unpleasant sound sources such as people cleaning the building, traffic noise, construction. Low psychoacoustic annoyance values correspond with pleasant sound sources such as natural sound (bird song) and sound busking.

e. Temporal Sound Level Variance with Taxonomy Analysis

Temporal sound level variance (TSLV) is presented in Figure 29. Temporal sound level variance is cross analyzed with taxonomy analysis by utilizing taxonomy notes. The higher the value of TSLV, the higher the amount of traffic noise present within the soundscape. Literature review does not find specific TSLV values required for the healthy city. Olympic Village has a range of TSLV values of 3 to 24.5.

Points 13, 36, 37, 38 are the data measurement points with the highest TSLV values ranging from 20.3 to 24.5. Point 13 according to taxonomy analysis is dominated by sound busking noise with less dominating noise coming from dog barking, loud bang from installation, traffic noise and natural sound. Points 36, 37 and 38 are dominated by traffic noises and correspond to high TSLV values.

Points 2B, 10, 17, 28 have TSLV values ranging from 14 to 18. Points 2B is dominated with kids screaming, people activities and food truck noise with traffic noise present in the background. Points 10 and 17 are also dominated by people activity noises, there are some kids screaming in point 10. Points 28 has traffic noise as the dominating sound source. It seems like an uneventful soundscape such as kids screaming also raises the value of TSLV.

Points 2A, 4, 5, 6, 7, 8, 11, 19, 22, 24, 26, 29, 32, 33, 34, 35 have TSLV values ranging from 8.4 to 13.1. Points 2A is dominated by people activity and conversation with presence of natural sound but still has traffic noise in the background. Points 4, 5, 6, 19, 22, 24, 26, 29, 32, 33, 34 and 35 have close approximation to the road or intersection and have traffic noise as part of the soundscape. However, the presence of other sound sources and the amount / strength of traffic noise in these points kept the TSLV values low as of Olympic village TSLV values range. Points 7, 8, 11 are dominated by people activity sound sources along the Olympic Village trail, thus the TSLV values recorded are not high.

Points 3, 9, 12, 14, 15, 16, 18, 20, 21, 23, 25, 27, 30, 31 have the lowest TSLV values in Olympic Village with a range of 3 to 7.5. Points 3, 9, 20 and 23 have proximity to the road and intersection, however the most dominant sound sources are coming from people's activities. Same with points 12, 14, 15, 16, 18, 21, 27, 30, 31 that are dominated by people activities along the Olympic Village trail. Points 25 has other sound sources but not traffic noise that is dominating the soundscape (people cleaning the building using high pressure water). Points 21 and 27 are dominated by bird songs.

The cross analysis between TSLV and taxonomy analysis proved that TSLV is accurate to predict the amount of traffic noise present in the soundscape. However, to evaluate a healthy city the analysis of soundscape cannot be just concluded from TSLV values since traffic noise does not guarantee pleasantness or annoyance. A soundscape can have a high TSLV and still be pleasant if other pleasant sound sources (sound busking, music) exist in conjunction with traffic noise.

f. Spectral Gravity Center with Taxonomy Analysis

Spectral gravity center (SGC) is presented in Figure 30. The cross analysis between SGC and taxonomy analysis is utilizing the taxonomy notes data. SGC is an acoustic indicator to measure the dominant frequency within a soundscape. Literature review did not find recommended SGC values for a healthy city but stating that low SGC values indicates low frequency sound which is not desirable to human ear and health. In this case, Olympic Village has a range of SGC values of 1400 Hz to 2945 Hz. Olympic village soundscape is dominated by the lower end of SGC values rating.

Points 2A, 3, 4, 6, 8, 9, 11, 12, 13, 14, 15, 16, 19, 23, 30, 37 have the lowest SGC values with a range of 1526 Hz to 1908 Hz. The definition of low frequency is frequency under 500 Hz. This does not necessarily mean that these points are harmful for human ear and well-being just based on the SGC values. Points 2A, 3, 4, 6, 8, 9, 11, 14, 15, 16, 30 are dominated by the people activity sound sources on the Olympic Village trail. Points 12 and 13 are dominated by sound busking. Points 19, 23, 37 are dominated by traffic noise and construction with some background noise of bird song and people conversation.

Points 2B, 5, 7, 10, 18, 21, 24, 26, 28, 29, 31, 34, 35, 36 have SGC values with a range of 1808 Hz to 2197 Hz. Points 2B, 5, 7, 10, 18, 31 are dominated by human activity noises or antrophony noise. Points 21 and 24 are dominated by bird songs with point 24 has traffic noise dominating the soundscape as well. Points 26, 28, 29, 34, 35, 36 are dominated by traffic noise.

Points 17, 20, 22, 27, 32, 38 have SGC values with a range of 2248 Hz to 2397 Hz. Points 17 has equal sound from people activity, natural sounds and traffic noise. Points 20 and 27 are dominated by bird songs. Points 22, 32, 38 are dominated by traffic noise.

Point 25 has 2945 Hz and point 33 has 2777 Hz. Point 25 is dominated by sound from people cleaning the building using high water pressure and point 33 is dominated by construction noise and airplanes.

SGC averaged sound source frequency present in the sound scape but failed to identify the quantity of sound source present in a soundscape. It does not describe the characteristics of the soundscape accurately as well. It has meaning when combined with other acoustic indicators. Higher sound frequency cannot be translated as pleasant sound. For example point 25 is dominated by sound coming from a high water pressure which is an annoying sound but it has high frequency and point 33 is dominated by construction noise and airplane noises which are also annoying sounds.

Relationship between Survey on Site and Taxonomy Analysis

Taxonomy data is analyzed qualitatively to obtain findings of which sound source affects the Sound Quality zone (See Figure 45). Each sound source in particular soundscape is categorized into three scoring scales with 3 being dominant (green), 2 is a less dominant source (red) and 1 is background noise (yellow). There are 20 data measurement points (53%) that are located in the Sound Quality and 18 data measurement points (47%) that are located in the outside of Sound Quality.

After completing the taxonomy sheet in Appendix 6 for each point, sound sources are tabulated to see if a sound source predicts a location being in the Sound Quality zone. The calculated result is then weighted with the percentage of data measurement points in the Sound Quality zone (53%) and Outside Sound Quality zone (47%) divided by the total sound source value in each Sound Quality zone and Outside Sound Quality zone and multiplied by 10,000 to provide easier comparison values.

The Sound Quality zone has more variety of sound sources than the Outside Sound Quality zone, this can be seen in Table 33 below. Sound Quality zone has a total of 294 counted sound source score and Outside Sound Quality zone has a total of 248 counted sound source score.

Table 36. Sound Quality Zone versus Outside Sound Quality Zone Total Sound Sources

Sound Source	Outside Sound Quality Zone	Sound Quality Zone	Total
Wind	1	4	5
Wildlife	32	35	67
Water	6	3	9
Domestic Animal	16	11	27
Non Motorised Vehicle	11	25	36
Roadway Traffic	35	39	74
Rail Traffic	3	7	10
Marine Traffic	1	2	3
Air Traffic	3	11	14
Footsteps	40	48	88
Construction	6	11	17
Ventilation	0	8	8
Domestic Machine	0	0	0
Recreation	9	0	9
Electrical Installation	0	1	1
Voice Speech	43	48	91
Voice Singing	7	6	13
Voice Laughter	27	24	51
Music	4	10	14
Other Human	4	1	5
TOTAL	248	294	542

Wildlife sound source analysis shown in Table 37. Generally wildlife sound source is described as a sound source coming from birds, insects and other surrounding animals. The result of the taxonomy analysis is that there is almost equal amount of wildlife sound source coming from wildlife in the Sound Quality zone and Outside Sound Quality zone.

Table 37. Wildlife Sound Taxonomy Analysis

Wildlife	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	8	8	16
2 - Less Dominant	12	12	24
3 - Dominant	12	15	27
Total	32	35	67
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	8	8	
2 - Less Dominant + 3 - Dominant	24	27	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	152	144	
2 - Less Dominant + 3 - Dominant	455	487	

Wind sound analysis is shown in Table 38. The Sound Quality zone has a higher score than the Outside Sound Quality zone. Means that wind sound source significantly predicts data measurement points to be in the Sound Quality zone.

Table 38. Wind Sound Taxonomy Analysis

Wind	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	2	3
2 - Less Dominant	0	2	2
3 - Dominant	0	0	0
Total	1	4	5
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	2	
2 - Less Dominant + 3 - Dominant	0	2	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	36	
2 - Less Dominant + 3 - Dominant	0	36	

Water sound analysis is shown in Table 39. The Outside Sound Quality zone has a higher score of water sound source, which means water sound source does not predict data measurement points to be located under the Sound Quality zone.

Table 39. Water Sound Taxonomy Analysis

Water	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	1	1
2 - Less Dominant	0	2	2
3 - Dominant	6	0	6
Total	6	3	9
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	1	
2 - Less Dominant + 3 - Dominant	6	2	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	18	
2 - Less Dominant + 3 - Dominant	114	36	

Domestic animal sound analysis is shown in Table 40. Domestic animal sound source can be described as sound/noise coming from dogs barking. The Outside Sound Quality zone has a higher score of domestic animal sound source. Domestic animal sound source predicts data measurements points to be Outside Sound Quality zone.

Table 40. Domestic Animal Sound Taxonomy Analysis

Domestic Animal	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	1	2
2 - Less Dominant	12	10	22
3 - Dominant	3	0	3
Total	16	11	27
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	1	
2 - Less Dominant + 3 - Dominant	15	10	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	18	
2 - Less Dominant + 3 - Dominant	284	180	

Non-motorised vehicle sound analysis is shown in Table 41. Non-motorised vehicles can be described as bicycle sounds. The Sound Quality zone has twice as much non-motorised vehicle sound source present on data measurement points.

Table 41. Non-Motorised Vehicle Sound Taxonomy Analysis

Non-Motorised Vehicle	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	3	6
2 - Less Dominant	8	10	18
3 - Dominant	0	12	12
Total	11	25	36
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	3	
2 - Less Dominant + 3 - Dominant	8	22	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	57	54	
2 - Less Dominant + 3 - Dominant	152	397	

Roadway Traffic sound analysis shown in Table 42. The Sound Quality zone has a higher presence of roadway traffic sound source than Outside Sound Quality zone. Though, the values are too close to draw a conclusion that roadway traffic sound source predicts the data measurement points being in the Sound Quality zone.

Table 42. Roadway Traffic Sound Taxonomy Analysis

Roadway Traffic	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	4	3	7
2 - Less Dominant	4	0	4
3 - Dominant	27	36	63
Total	35	39	74
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	4	3	
2 - Less Dominant + 3 - Dominant	31	36	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	76	54	
2 - Less Dominant + 3 - Dominant	588	649	

Rail traffic sound analysis is shown in Table 43. Rail traffic sound source is described as the sound coming from skytrains. The Sound Quality zone has a higher rail traffic sound source score than the Outside Sound Quality zone.

Table 43. Rail Traffic Sound Taxonomy Analysis

Rail Traffic	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	5	8
2 - Less Dominant	0	2	2
3 - Dominant	0	0	0
Total	3	7	10
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	5	
2 - Less Dominant + 3 - Dominant	0	2	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	57	90	
2 - Less Dominant + 3 - Dominant	0	36	

Marine traffic sound analysis is shown in Table 44. The Sound Quality zone has a higher marine traffic sound source compared to the Outside Sound Quality zone. The sound source from marine traffic is considered to be a background sound. The score of marine traffic sound source between Sound Quality zone and Outside Sound Quality zone are almost the same. Marine traffic sound source does not predict data measurement points being in the Sound Quality zone.

Table 44. Marine Traffic Sound Taxonomy Analysis

Marine Traffic	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	2	3
2 - Less Dominant	0	0	0
3 - Dominant	0	0	0
Total	1	2	3
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	2	
2 - Less Dominant + 3 - Dominant	0	0	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	36	
2 - Less Dominant + 3 - Dominant	0	0	

Air traffic sound analysis is shown in Table 45. The Sound Quality zone has three times higher air traffic sound source than Outside Sound Quality zone.

Table 45. Air Traffic Sound Taxonomy Analysis

Air Traffic	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	5	6
2 - Less Dominant	2	6	8
3 - Dominant	0	0	0
Total	3	11	14
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	5	
2 - Less Dominant + 3 - Dominant	2	6	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	90	
2 - Less Dominant + 3 - Dominant	38	108	

Footsteps sound analysis is shown in Table 46. The Sound Quality zone has a higher footsteps sound source than the Outside Sound Quality zone.

Table 46. Footsteps Sound Taxonomy Analysis

Footsteps	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	4	0	4
2 - Less Dominant	6	6	12
3 - Dominant	30	42	72
Total	40	48	88
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	4	0	
2 - Less Dominant + 3 - Dominant	36	48	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	76	0	
2 - Less Dominant + 3 - Dominant	682	865	

Construction sound analysis is shown in Table 47. The Sound Quality zone has twice higher construction sound source than the Outside Sound Quality zone.

Table 47. Construction Sound Taxonomy Analysis

Construction	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	3	6
2 - Less Dominant	0	2	2
3 - Dominant	3	6	9
Total	6	11	17
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	3	3	
2 - Less Dominant + 3 - Dominant	3	8	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	57	54	
2 - Less Dominant + 3 - Dominant	57	144	

Ventilation sound analysis is shown in Table 48. The Outside Sound Quality zone has no ventilation sound source while the Sound Quality zone has ventilation sound source.

Table 48. Ventilation Sound Taxonomy Analysis

Ventilation	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	0
2 - Less Dominant	0	2	2
3 - Dominant	0	6	6
Total	0	8	8
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	0	8	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	0	144	

Recreation sound analysis shown in Table 49. Recreation sound source is sound coming from the food truck's engine. The Sound Quality zone has no recreation sound source.

Table 49. Recreation Sound Taxonomy Analysis

Recreation	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	0
2 - Less Dominant	0	0	0
3 - Dominant	9	0	9
Total	9	0	9
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	9	0	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	171	0	

Electrical Installation sound analysis is shown in Table 50. The Outside Sound Quality zone has no electrical installation sound source, while Sound Quality has little background electrical installation sound source.

Table 50. Electrical Installation Sound Taxonomy Analysis

Electrical Installation	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	1	1
2 - Less Dominant	0	0	0
3 - Dominant	0	0	0
Total	0	1	1
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	1	
2 - Less Dominant + 3 - Dominant	0	0	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	18	
2 - Less Dominant + 3 - Dominant	0	0	

Voice speech sound analysis is shown in Table 51. The Sound Quality zone and Outside Sound Quality zone have almost equal values of voice speech sound source.

Table 51. Voice Speech Sound Taxonomy Analysis

Voice Speech	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	5	3	8
2 - Less Dominant	2	6	8
3 - Dominant	36	39	75
Total	43	48	91
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	5	3	
2 - Less Dominant + 3 - Dominant	38	45	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	95	54	
2 - Less Dominant + 3 - Dominant	720	811	

Voice singing sound analysis is shown in Table 52. The Sound Quality zone has less voice singing sound source than the Outside Sound Quality zone.

Table 52. Voice Singing Sound Taxonomy Analysis

Voice Singing	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	3	4
2 - Less Dominant	0	0	0
3 - Dominant	6	3	9
Total	7	6	13
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	3	
2 - Less Dominant + 3 - Dominant	6	3	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	54	
2 - Less Dominant + 3 - Dominant	114	54	

Voice laughter sound analysis is shown in Table 53. The Sound Quality zone and the Outside Sound Quality zone have almost equal voice laughter sound source.

Table 53. Voice Laughter Sound Taxonomy Analysis

Voice Laughter	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	0
2 - Less Dominant	0	0	0
3 - Dominant	27	24	51
Total	27	24	51
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	27	24	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	0	0	
2 - Less Dominant + 3 - Dominant	512	433	

Music sound analysis shown in Table 54. Music can be described as sound busking during data measurements in the Olympic Village. The Sound Quality zone has a higher music sound source than the Outside Sound Quality zone, which means music sound source predicts data measurement points being in the Sound Quality zone.

Table 54. Music Sound Taxonomy Analysis

Music	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	4	5
2 - Less Dominant	0	0	0
3 - Dominant	3	6	9
Total	4	10	14
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	4	
2 - Less Dominant + 3 - Dominant	3	6	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	72	
2 - Less Dominant + 3 - Dominant	57	108	

Other human sound analysis is shown in Table 55. Other human sound sources can be described as sound coming from people cleaning the buildings or other activities. The Sound Quality zone has no other human sound source.

Table 55. Other Human Sound Taxonomy Analysis

Other Human	Number of Sound Source		Total
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	1	2
2 - Less Dominant	0	0	0
3 - Dominant	3	0	3
Total	4	1	5
*Addition of Background vs Less Dominant + Dominant			
Score	Outside Sound Quality	Sound Quality	
1 - Background	1	1	
2 - Less Dominant + 3 - Dominant	3	0	
(Score from *) x % of Data in Sound Quality or Outside Sound Quality / Total Sound Source in Table 15 x 10,000			
Score	Outside Sound Quality	Sound Quality	
1 - Background	19	18	
2 - Less Dominant + 3 - Dominant	57	0	

Summary of Relationship between Survey on Site and Sound Taxonomy Analysis

Table 35 summed all the sound sources above and the result is the presence of positive sound of wind and music sound sources place data measurement points in the Sound Quality zone in a two-dimensional soundscape diagram. There is a higher presence of negative sound sources such as bicycles, rail traffic, air traffic, footsteps, construction, and ventilation sound in the Sound Quality zone. Sound sources from domestic animals (dog barking), food trucks engine, people singing, and other human activities place data measurement points in the Outside Sound Quality zone.

Table 56. Summary of Sound Taxonomy Analysis

Sound Source	Outside Sound Quality		Sound Quality		Bigger Values
	Background	Less Dominant + Dominant	Background	Less Dominant + Dominant	
Wildlife	152	455	144	487	Almost same
Wind	19	0	36	36	Sound Quality
Water	0	114	18	36	Outside Sound Quality
Domestic Animal (Dog Barking)	19	284	18	180	Outside Sound Quality
Non-Motorized Vehicle (Bicycle)	57	152	54	397	Sound Quality
Roadway Traffic	76	588	54	645	Almost same
Rail Traffic	57	57	90	161	Sound Quality
Marine Traffic	19	0	36	0	Almost same
Air Traffic	19	38	90	108	Sound Quality
Footsteps	76	682	0	865	Sound Quality
Construction	57	57	54	144	Sound Quality
Ventilation	0	0	36	108	Sound Quality
Recreation (Food Trucks)	0	171	0	0	Outside Sound Quality
Electrical Installation	0	0	18	0	Almost same
Voice Speech	95	720	54	811	Almost same
Voice Singing	19	114	54	54	Outside Sound Quality
Voice Laughter	0	512	0	433	Almost same
Music	19	57	72	108	Sound Quality
Other Human	19	57	18	0	Outside Sound Quality
Minimum Background	0		Minimum Less Dominant + Dominant	0	
Medium Background	27.5		Median Less Dominant + Dominant	111	
Maximum Background	152		Maximum Less Dominant + Dominant	865	

7. Discussion

This research aims to investigate suitable acoustic parameters for the Sound Quality benchmark standard in the Ecocity framework. In addition to the current municipal practices that regulate sound in the form of maximum sound pressure level, there are several other acoustic indicators that define characteristics of the sound. The acoustical indicators investigated in this research are balanced soundscape (normalized difference soundscape index and biophony/antrophony ratio), psychoacoustic annoyance, temporal sound level variance, and spectral gravity center. Total of 71 survey responses were collected on site during field measurements. The field measurements were obtained from 38 data measurement points.

It was discovered that there is a strong correlation between weighted sound pressure level (LAeq) and psychoacoustic annoyance (PA) and between psychoacoustics annoyance (PA) and loudness parameters. There is strong correlation between spectral gravity center (SGC) and biophony/antrophony (B/A), between normalized difference soundscape index (NDSI) and biophony/antrophony (B/A) ratio. In the principal component analysis it is shown that SGC, NDSI, B/A ratio, Sharpness are placed close together.

The methodology highlights the utilization of triangulation methods by cross analysis between, measurement on site, survey on site and narrative interview workshops performed by the researcher. To identify the relationship between measurement and survey results, regression analysis is the bridge. In the two-dimension soundscape diagrams there are 8 quadrants in which data measurement points are located. Researchers suggested a zone within the Vibrant-Calm quadrant as the Sound Quality goal for a healthy Ecocity. Regression analysis determined which acoustic indicator best predicted a measurement location to lay in this specific soundscape zone. Comparison between the taxonomy notes and heat map of each acoustic indicator facilitated investigation of the relationship between measurement on site and taxonomy. The number of sound sources in the Sound Quality zone versus the number of sound sources outside the Sound Quality zone was investigated between the survey results and taxonomy categorization.

Following the survey result analysis, 56% of the data measurement points are located in the Sound Quality zone. This means the majority of Olympic Village can be described as pleasant.

Figure 50. Visualization of Data Measurement Points Included and Excluded from Sound Quality Zone

Following the binary logistic regression analysis, it is determined that psychoacoustic annoyance data in All Data (Weekend and Weekday) shows a strong correlation (p-value equals to 0.05) with the Sound Quality zone. The data obtained from Weekday data shows a p-value of 0.016 which is a stronger correlation between psychoacoustic annoyance and Sound Quality zone. Specifically, if the psychoacoustic annoyance values fall between 28 and 52 there is a higher chance that the measurement points will be placed in the Sound Quality zone which can be described as vibrant, pleasant, and calm. This statement is supported by the inverted analysis of the data against Outside Sound Quality zone data where the predictor is also psychoacoustic annoyance data that has a p-value of 0.022 on Weekday data analysis.

Taxonomy analysis proved that there is a correlation between psychoacoustic annoyance values with the activity occurring at that particular point. Points 8, 9, 11, 12, 14, 15, 16, 17, 20, 21, 26, 27, 29, 30, 31, 32, 33, 34, 35 have low psychoacoustic annoyance values which soundscapes consist of sound sources from bird songs, water, sound busking, bicycle, people footsteps, wind (See Figure 28, Figure 50, Table 14, Table 53). Specifically points 11, 12, 13 have high sound busking noise where respondents of the survey reported the soundscape at these data measurement points as pleasant while the researcher reported that points 11,12 and 13 are highly contained sound busking noise. The psychoacoustic annoyance value between all these three points are 28, 27 and 38 respectively, which according to Sound Quality binary regression analysis considered the range needed for psychoacoustic annoyance to fall under the Sound Quality zone. This suggests that contextual masking has positive responses. The existence of pleasant sound busking possibly masked or removed focus away from the people's conversation noise, footsteps and other noises, thus shifting human perception to rate these days measurement points as pleasant.

Bicycle, rail traffic, air traffic, footsteps, construction, and ventilation independently are typically considered to be noise or unwanted sound but collectively place the location on Sound Quality zone. This may be explained by the concept of Lo-Fi soundscape and Hi-Fi soundscape. It is possible that the existence of bicycle, rail traffic, air traffic, footsteps, construction, and ventilation noises, independently unwanted sound, collectively placed the measurement points in the Hi-Fi soundscape, where the combination of all these sounds are forming a background noise in a way where people are still able to communicate without any intervention from these noises.

Points 2B, 6, 19, 25, 22, 24, 28, 37, 38 have high psychoacoustic annoyance values which soundscapes consist of sound sources from people cleaning the building, food trucks, construction noise and traffic noise, thus placing these data measurement points outside the Sound Quality zone (See Figure 28, Figure 50, Table 14, Table 53).

Certain points such as points 2A, 2B, 3, 4, 5, 6, 7, and 19 are marked as Outside Sound Quality zones; these areas are plazas where people usually sit and hang for a long period of time. In the review of the soundscape taxonomy (Table 14), points 2A, 2B, 5, and 6 were dominated by kids screaming and people talking, many other noises exist such as traffic, sound busking, food trucks generator, dog barkings and bicycles that place these points out from the Sound Quality zone. Soundscape taxonomy analysis summary suggested that food truck sound and dog barking (domestic animals) can place data measurement points in the Outside Sound Quality zone. Points 2A, 2B, 3, 4

,5, 6, 7, 19 have the highest sound pressure levels of the Olympic Village soundscape, which are within the range of 65 dBA to 73 dBA. According to municipal regulation, this exceeds the 55 dBA maximum outdoors. Points 2B, 6 and 19 exceed the 28-52 psychoacoustic annoyance range and are located outside the Sound Quality zone.

Points 3, 4, and 19 have considerably high traffic noise due to its measurement locations being in close proximity to intersections where cars are accelerating and decelerating. Points 3 and 4 have a large proportion of kid screaming noises. These points fall under the Outside Sound Quality zone. They have 65 dBA, 67 dBA and 68 dBA sound pressure levels respectively which exceed the municipal regulation of 55 dBA. Spectral Gravity Centre (SGC) values of 1875 Hz, 1858 Hz and 1908 Hz respectively explained the amount of low frequencies at these data measurement points. Even though SGC is useful to average the frequencies of sound source within one soundscape, it is missing the capability to identify single events noise that can be perceived as annoying at times when participants filled the survey. For example, it has one event of kid screaming and participants rated the data measurement point as unpleasant thus putting the data measurement point on the Outside Sound Quality zone. However, in SGC calculation this frequency sinks within the average overall frequency and loses the capability to explain this single event scenario. In addition, the psychoacoustic annoyance values and temporal sound level variance are not on the worst rating for these points, in fact psychoacoustic annoyance values for points 3 and 4 are within the range where these data measurement points could fall under Sound Quality zone, while point 19 has 59 psychoacoustic values. Based on the literature review, data measurement points with high activity of vehicles accelerating and decelerating raised the temporal sound level variance. However, in the analysis points 3, 4, and 19 temporal sound level variance (TSLV) values fall under the lowest TSLV rank. The assumption is because there are other data measurement points with higher TSLV values and points 3 and 4 do not entirely consist of traffic noises but also kid screaming. In this case, TSLV is proved that it cannot be the only acoustic indicator supporting Sound Quality or maximum sound pressure level, since a soundscape may contain many sound sources, while TSLV is specifically used to calculate traffic noise annoyance.

Point 22 is close to the intersections and points 23, 28, 38, and 37 have a really close proximity with the road and according to sound taxonomy analysis have a high proportion of sound sources coming from traffic noises. Thus, these points are located outside of the Sound Quality zone. The sound pressure level at these points are 70 dBA, 66 dBA, 68 dBA, 72 dBA and 69 dBA that exceed municipal regulation maximum sound pressure level significantly. Psychoacoustic annoyance values are 60, 48, 59, 63, 65 respectively which the majority are falling above the 52 recommended psychoacoustic values for data measurement points to be in Sound Quality zone. TSLV values are 13.1, 3, 17.9, 24.1, 24.1 respectively. Only points 38 and 37 fall under the worst rank TSLV values recorded among all data measurement points of Olympic Village.

Point 25 is not included in the Sound Quality zone despite it being a courtyard and shielded from the road, it has a high other human activity noises (people cleaning the building using high pressure water spray) at times of measurement that is also proved by soundscape taxonomy analysis in Table 35. The psychoacoustic annoyance value is 74 which is second highest in the entire Olympic Village soundscape and outside the psychoacoustic annoyance values range of 28-52. The sound pressure level of 73 dBA supported the statement by 18 dBA points exceeding the recommended municipal regulation. At this point, the data measurement point is highly dominated by sound from people cleaning the building. For this statement the value of normalized difference soundscape index (NDSI) and bio/antrophony ratio should be at the bottom rank. As a result, the NDSI and bio/antrophony ratio values are not on the bottom rank but very good rank. This questioned the validity of NDSI and bio/antrophony ratio to be used as acoustic indicators supporting Sound Quality.

Points 2A, 2B, 3, 4, 5, 6, 7, 10, 16, 28, 25 are located by the water edge and plazas, one may expect visual bias to favor this location. However, certain noise such as kids screaming or noisy human activities happening during data measurements recording and survey collection can place data measurement points outside the Sound Quality zone. The result of a rating at a certain point heavily depends on the soundscape activities that happened at that particular time. One way to reduce the error and improve data sampling is to repeat the data collection method on different days with the same weather, temperature and humidity.

In addition to psychoacoustic annoyance (PA), loudness maximum (Nmax), and loudness percentile (N5) place data measurement points in the Sound Quality and

Outside Sound Quality zones. Loudness (N), loudness maximum (Nmax) and loudness percentile (N5) are used in psychoacoustic annoyance calculation. Matrix plots and principal components shown in Figures 39-41 indicate that there is a significant correlation between psychoacoustic annoyance and loudness (N), loudness maximum (Nmax), and loudness percentile (N5). Combining data collected on All Data analysis and Weekday data, the values of loudness (N), loudness maximum (Nmax), and loudness percentile (N5) should have a range of 19-32, 42-84, and 26-51 respectively to place data measurement points in the Sound Quality zone with probability of 60% to 100%.

In terms of classical indicators, findings indicate that weighted sound power level (LAeq) places data measurement points in the Sound Quality zone whether it's in All Data or Weekday data only. Weighted sound power level (LAeq) should have a value of 0.41 Pa (66 dBA) or below to place data measurement points in the Sound Quality zone with probability of 59% to 100%. In the binary regression analysis, sound power level which is presented in linear is used instead of sound pressure level which is presented in logarithmic. The overview of classical attributes with taxonomy analysis indicated that the level of sound pressure level corresponded with the activities occurring at each point.

Based on the discussion above, there are some data measurement points that are identified as unpleasant and fall outside the Sound Quality zone. Olympic Village as a place that approximate Ecocity Level 1 can have a better acoustic environment with better planning. To improve Sound Quality in public areas there are few steps that urban planners and government can form. For example selection of materials (by choosing more absorptive materials and less reflective materials), zoning planning (separate high acoustic activity areas with low acoustic activity area), installation of cultural or tranquil sound masking, landscape planning (introducing additional greenspace invites biodiversity).

7.1. Limitation

The efficiency of data collection created a limitation in the study, in which the measurement points were not taken randomly and were taken on two distinct days which were weekday and weekend. Thus, the analysis of the data needs to be done independently between data collected on the weekday and on the weekend, even though on the Sound Quality soundscape analysis, the data were combined.

Following the data collection stage, later it was realized that the data gathered on Day 1 cannot be used for the data analysis, due to the incompatibility between data measurement points and survey results. This reduced the number of survey participants by 10%.

The design of the survey questions is limited to ISO 12913-2:2018 standard. Due to COVID-19 protocols, risk management limited the collection of survey data to a contactless approach and advisable to be as concise as possible because one cannot create a gathering near the poster. For this reason, participants were unable to express feelings regarding their soundscape experience but limited to the Likert scale provided by the questionnaire. Researchers also lost the ability to hold participants in the data measurement points while filling up the survey, thus the accuracy of the survey result and data measurement points is questionable.

In binary regression analysis, there is a potential bias reading the data due to the usage of continuous versus categorical variables. In this case, whether the data is in the Sound Quality zone or not is a binary categorical data. There is no specific limit on each calculated acoustic indicator's values (continuous variables), hence the smaller and largest value obtained from the result becomes the parameter or limit of each indicator.

7.2. Future Directions

This research has many potential to be expanded into a new topic, replicated with modifying the variables, or even replicated to improve the accuracy of the result. These points below are some of the topics that can be done in continuation of this research.

- Replicating the study with addition of expanded survey (inclusion of originality of participant), open-ended questions or soundwalk and in-person recruitment.
- Replicating the study with a greater number of participants. In this case, physical sampling can be designed to be more robust.
- Replicating the study in different time or the day or different season in a year. As seasons change, urban environment activities change too.
- Replicating the study using a completely opposite case study with a high annoyance rating (i.e. downtown Vancouver, nightclub districts, dwelling under skytrain, etc) to test the validity of this research.
- Testing the relation between each acoustic indicator based on the principal component analysis found in this research. For example, if there is a relation between variables clustered in principal component 2 (Sharpness, NDSI, SGC and Bio/Antrophony).
- Testing if other psychoacoustic annoyance variables (sharpness, fluctuation strength, roughness, loudness, loudness maximum, loudness percentile) have the same strength with loudness in terms of influencing psychoacoustic results as shown in this research. This can be done in a different neighbourhood.

8. Conclusion

Ecocity aims to create a better living environment for people, an environment that is sustainable, healthy mentally and physically for human beings. Sound Quality, healthy acoustic environment benchmark standard is necessary for the Ecocity framework. Currently sound is regulated under municipal policy in terms of sound pressure level, however sound has characteristics that sound pressure level fails to describe. This research investigates acoustic indicators of psychoacoustic annoyance, spectral gravity centre, temporal sound level variance, normalized difference soundscape index and bio/antrophony ratio as potential addition to sound pressure level based criteria. Findings suggest that psychoacoustic annoyance be the predominant indicator for Ecocity Level 1 standard and psychoacoustic values of 28 to 52 are recommended.

Even though the psychoacoustic annoyance indicator is shown in a form of number, the calculation involved several sound characteristics such as sharpness, roughness, fluctuation strength, loudness, loudness percentile and loudness maximum. This study evaluated each of psychoacoustic indicators and found loudness, loudness percentile and loudness maximum as indicators that predict data measurement points to fall within the Sound Quality zone. Hence, loudness can be also suggested as an alternative to maximum sound pressure level given that it is calculated in *sones* which is a linear scale. However, the drawback of loudness is the same with sound pressure level that it is lacking other characteristics exist in sound.

The study also identifies data measurement points in the Olympic Village that exceed current outdoor maximum sound pressure level regulation. Improving urban planning such as proper selection of materials, well-planned zoning based on acoustic activity, adding greeneries to landscape design and sound masking installation are believed to enhance the acoustic environment significantly.

On practical grounds, this study highlights psychoacoustic annoyance as supplemental acoustic indicators for sound pressure level in Sound Quality under Ecocity Level 1 Framework. There are numerous additional topics that can be explored from this study to complete the Sound Quality standard for Ecocity Framework such as replication study (with more participants, with more longer data measurement points, different seasons, etc,) and other acoustic indicators that are not examined in this study.

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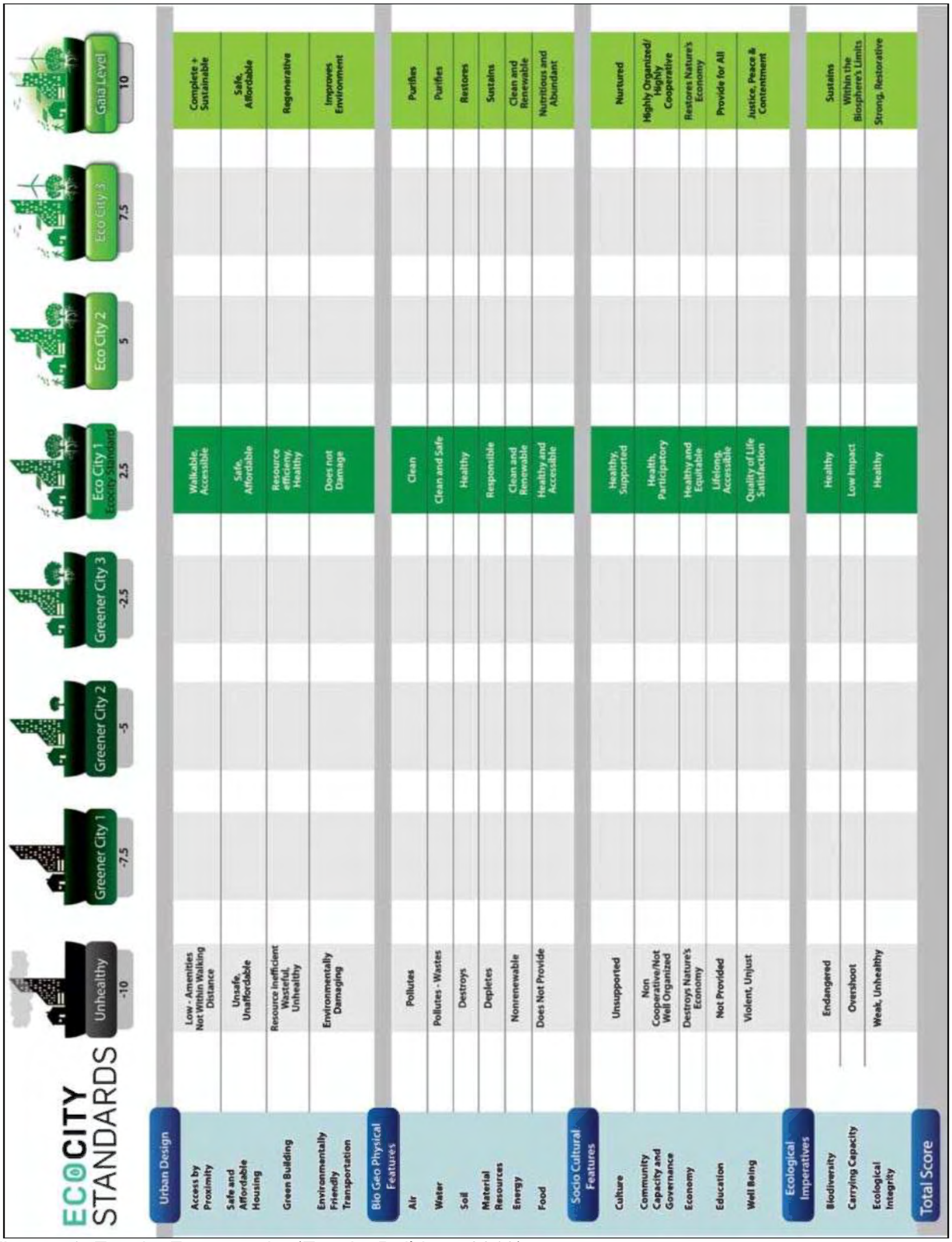
Appendix 1. Ecocity Frameworks (Ecocity Builders, 2019)



ECOCITY STANDARDS

	Unhealthy -10	Greener City 1 -7.5	Greener City 2 -5	Greener City 3 -2.5	Eco City 1 2.5 Ecocity Standard	Eco City 2 5	Eco City 3 7.5	Gaia Level 10
Urban Design								
Access by Proximity	Low - Amenities Not Within Walking Distance				Walkable, Accessible			Complete + Sustainable
Safe and Affordable Housing	Unsafe, Unaffordable				Safe, Affordable			Safe, Affordable
Green Building	Resource Inefficient Wasteful, Unhealthy				Resource efficiency, Healthy			Regenerative
Environmentally Friendly Transportation	Environmentally Damaging				Does not Damage			Improves Environment
Bio Geo Physical Features								
Air	Pollutes				Clean			Purifies
Water	Pollutes - Wastes				Clean and Safe			Purifies
Soil	Destroys				Healthy			Restores
Material Resources	Depletes				Responsible			Sustains
Energy	Nonrenewable				Clean and Renewable			Clean and Renewable
Food	Does Not Provide				Healthy and Accessible			Nutritious and Abundant
Socio Cultural Features								
Culture	Unsupported				Healthy, Supported			Nurtured
Community Capacity and Governance	Non Cooperative/Not Well Organized				Health, Participatory			Highly Organized/ Highly Cooperative
Economy	Destroys Nature's Economy				Healthy and Equitable			Restores Nature's Economy
Education	Not Provided				Lifelong, Accessible			Provide for All
Well Being	Violent, Unjust				Quality of Life Satisfaction			Justice, Peace & Contentment
Ecological Imperatives								
Biodiversity	Endangered				Healthy			Sustains
Carrying Capacity	Overshoot				Low Impact			Within the Biosphere's Limits
Ecological Integrity	Weak, Unhealthy				Healthy			Strong, Restorative
Total Score								

Figure 51. Ecocity Frameworks (Ecocity Builders, 2019).

Appendix 2. Ecocity 1 Conditions (Ecocity Builders, 2019)

ECOCITY 1 CONDITIONS

A city meeting the following conditions will have achieved "ecocity" status.

ECOCITY URBAN DESIGN FEATURE

ACCESS BY PROXIMITY
The city provides the majority of its residents with walkable access from housing to basic urban services. It also provides walking and transit access to close-by employment options.

ECOCITY BIO-GEO-PHYSICAL CONDITIONS

CLEAN AIR
The city maintains a level of air quality that is conducive to good health within buildings, the city's air shed, and the atmosphere.

HEALTHY SOIL
Soils within the city and soils associated with the city's economy, function and operations meet their ranges of healthy ecosystem functions as appropriate to their types and environments; fertility is maintained or improved.

CLEAN AND SAFE WATER
All residents are ensured access to clean, safe, affordable water; the city's water sources, waterways and water bodies are healthy and function without negative impact to ecosystems. Water consumed is primarily sourced from within the bioregion.

RESPONSIBLE RESOURCES/MATERIALS
The city's non-food and non-energy renewable and non-renewable resources are sourced, allocated, managed and recycled responsibly and equitably, and without adversely affecting human health or the resilience of ecosystems. Resources/Materials are primarily sourced from within the bioregion.

CLEAN AND RENEWABLE ENERGY
The city's energy needs are provided for, and extracted, generated and consumed, without significant negative impact to ecosystems or to short- or long-term human health and do not exacerbate climate change. Energy consumed is primarily generated within the local bioregion.

HEALTHY AND ACCESSIBLE FOOD
Nutritious food is accessible and affordable to all residents and is grown, manufactured and distributed by processes which maintain the healthy function of ecosystems and do not exacerbate climate change. Food consumed is primarily grown within the local bioregion.

ECOLOGICAL IMPERATIVES

HEALTHY BIODIVERSITY
The city sustains the biodiversity of local, bioregional and global ecosystems including species diversity, ecosystem diversity and genetic diversity; it restores natural habitat and biodiversity by its policy and physical actions.

EARTH'S CARRYING CAPACITY
The city keeps its demand on ecosystems within the limits of the Earth's bio-capacity, converting resources restoratively and supporting regional ecological integrity.

ECOLOGICAL INTEGRITY
The city maintains essential linkages within and between ecosystems and provides contiguous habitat areas and ecological corridors throughout the city.

ECOCITY SOCIO-CULTURAL FEATURES

HEALTHY CULTURE
The city facilitates cultural activities that strengthen eco-literacy, patterns of human knowledge and creative expression, and develop symbolic thought and social learning.

COMMUNITY CAPACITY BUILDING
The city supports full and equitable community participation in decision making processes and provides the legal, physical and organizational support for neighborhoods, community organizations, institutions and agencies to enhance their capacities.

HEALTHY AND EQUITABLE ECONOMY
The city's economy consistently favors economic activities that reduce harm and positively benefit the environment and human health and support a high level of local and equitable employment options that are integrated into the ecocity's proximity based layout and policy framework – the foundation for "green jobs" and "ecological development."

LIFELONG EDUCATION
All residents have access to lifelong education including access to information about the city's history of place, culture, ecology, and tradition provided through formal and informal education, vocational training and other social institutions.

WELL BEING – QUALITY OF LIFE
Citizens report strong satisfaction with quality of life indicators including employment; the built, natural and landscaped environment; physical and mental health; education; safety; recreation and leisure time; and social belonging.

Figure 52. Ecocity 1 Conditions (Ecocity Builders, 2019)

Appendix 3. Acoustic Criteria and Requirement According to WHO

Table 57. Acoustic Criteria and Requirement According to WHO

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hours]	LAmax, fast [dB]
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	- -
Dwelling, indoors Inside bedrooms	Speech intelligibility and moderate annoyance, daytime and evening Sleep disturbance, night-time	35 30	16 8	 45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School class rooms and pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	during class	-
Pre-school Bedrooms, indoors	Sleep disturbance	30	sleeping -time	45
School, playground outdoor	Annoyance (external source)	55	during play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30 30	8 16	40 -
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Industrial, commercial, shopping and traffic areas, indoors and Outdoors	Hearing impairment	70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment (patrons:<5 times/year)	100	4	110
Public addresses, indoors and outdoors	Hearing impairment	85	1	110
Music through headphones/ Earphones	Hearing impairment (free-field value)	85 #4	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment (adults) Hearing impairment (children)	- -	- -	140 #2 120 #2
Outdoors in parkland and conservation areas	Disruption of tranquillity	#3		

#1: as low as possible;
#2: peak sound pressure (not LAmax, fast), measured 100 mm from the ear;
#3: existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low;
#4: under headphones, adapted to free-field values

Appendix 4. Sample Sound Quality Ecocity Benchmark

Table 58. Sampe Ecocity Framework - Sound Quality

Acoustic Indicators	Unhealthy Cities	Ecocity 1	GAIA Level
Current Standard	Unhealthy	Healthy	Restores
Excess Noise	Maximum Sound Pressure Level	Healthy	Restores
Balanced Soundscape	n/a	Healthy, TBD*	Restores
Psychoacoustical Annoyance	n/a	Healthy, TBD*	Restores
Sensory Pleasantness	n/a	Healthy, TBD*	Restores
Temporal Sound Level Variance	n/a	Healthy, TBD*	Restores
Spectral Gravity Center	n/a	Healthy, TBD*	Restores
Cultural Compositions - Sound in the City	n/a	n/a	TBD*
Keynotes	n/a	n/a	TBD*
Soundmarks	n/a	n/a	TBD*
Indicators x,y,z	n/a	n/a	TBD*

* Note: TBD standards will be filled after research is completed.

Appendix 5. Equipment Lists

Binaural Head

Binaural recording is a method of recording sound by using a binaural head and microphones are placed on the ear of each side. The primary intention of binaural recording is to reproduce recordings exactly like how a human's hearing system works. Binaural recording is used to find the data related to ISO 12913-2:2018 soundscape theory, temporal sound level variance, psychoacoustic annoyance, sensory pleasantness and possibly tranquility rating. According to ISO12913-2:2018 binaural head must be placed of typical adult height of 1.6m ± 0.1 m above the ground, hence it should be paired with a tripod.

Figure 53. Binaural Head (Source: Binaural Enthusiast, 2020)

Soundbook_MK2 from SINUS

Soundbook_MK2 is a universal multi-channel acoustic and vibration measurement tool that has PTB type approval of 21.21/13.05. It is based on the Apollo platform that has 24-bit ADCs. The base PC is Panasonic Toughbook CF-19 with 3rd generation Intel® Core™ i5-3340M vPro™ processor. The weight of the devices is 3kg. It is rotatable, mobile, and low power consumption. Soundbook_MK2 complies with IEC 61672-1 Class 1 and calibratable up to 8 measuring channels. It is MIL-STD 810F vibration and shock resistant, thus able to withstand harsh conditions. Basic SAMURAI software is included in the device. Soundbook is connected to the binaural head for data processing. The data captured by Soundbook from the binaural head is converted into audio file and MS Excel file to be analyzed.

Figure 54. Soundbook SINUS (Source: MRA, 2020)

AmazonBasics 60-inch Lightweight Tripod

The tripod is used to hold the binaural head and 360 camera during measurement. The tripod weighs 3lbs and is able to hold up to 6.6lbs load. It can be extended from 25 inches to 60 inches. The tripod has two built-in bubble view levels and three-way head allowing tilt and swivel movement including portrait and landscape options.

Laptop / Computer

The hardware recommended to perform the analysis and simulation is below:

Processor: Intel or AMD x86 processor running at 1GHz or higher

Memory: 1GB RAM or more recommended

Minimum free drive space: 800MB

DVD drive

Super VGA (800x600) or higher-resolution monitor

Web browser: Internet Explorer 7 or 8

Canopy

The canopy was made to protect the instrument from rainy weather. The canopy is a sun cover that is covered in acoustic foam. The main purpose of covering the canopy with acoustic foam is to prevent sound resulting from rain water and canopy cover surface area. Acoustic foam's role is to absorb the sound from the contact between rain water and the canopy, thus allowing the sound produced by rain to be recorded naturally from the surrounding and protect the instrument from the water. A laboratory test was carried out to test the canopy effect to the measurement result. The sound pressure level produced without and with canopy at the same time and same weather should have the same or similar result. The canopy was tested inside the room (no rain) and outside the room (with rain). First, a sound pressure level of 3 times 30 seconds is recorded inside the lab without the canopy using Larson Davis equipment. Second, the sound pressure level of 3 times 30 seconds is recorded inside the lab underneath the canopy at the same location with the first step. Third, a sound pressure level of 3 times 30 seconds is recorded outside the lab during the rain without the canopy using Larson Davis equipment. Fourth, the sound pressure level of 3 times 30 seconds is recorded outside the lab during the rain with the canopy.

The results (Figure 54 - Figure 57) are compared and concluded that there is no significant effect on canopy placement during data measurement. However, to eliminate error and keep the uniformity of the data, it is suggested to have the canopy installed at all times during the data measurement process.

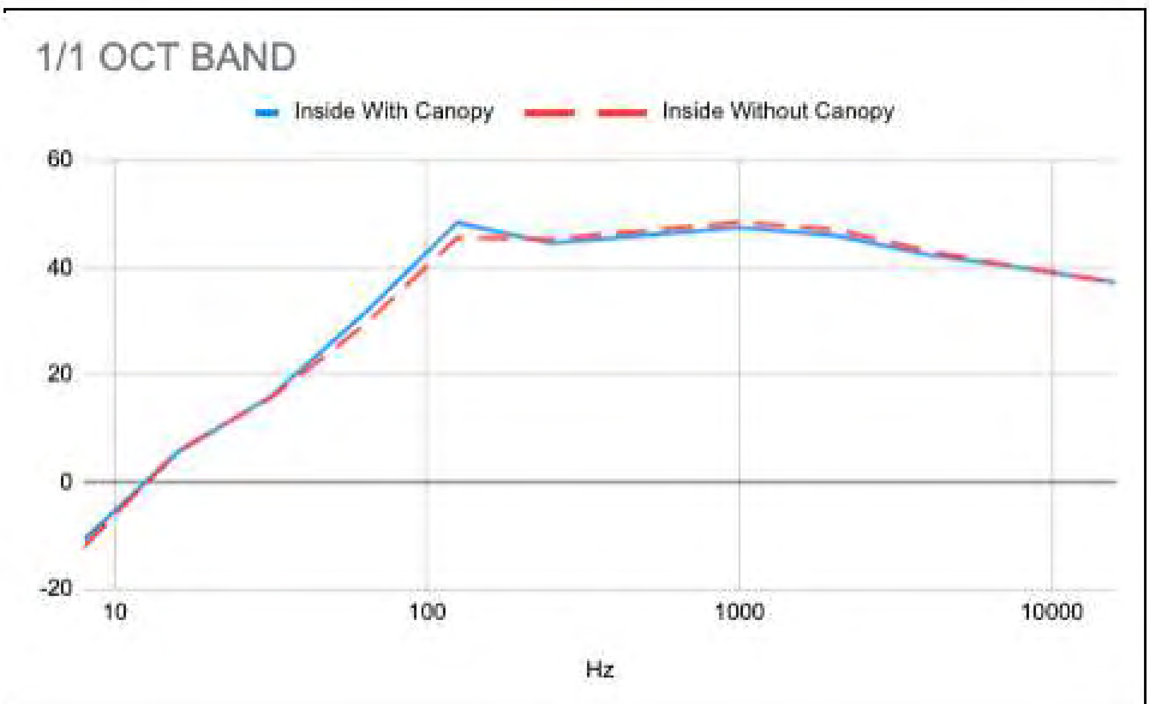


Figure 55. One Octave Band Data of Measurements on the Inside with Canopy versus Inside Without Canopy

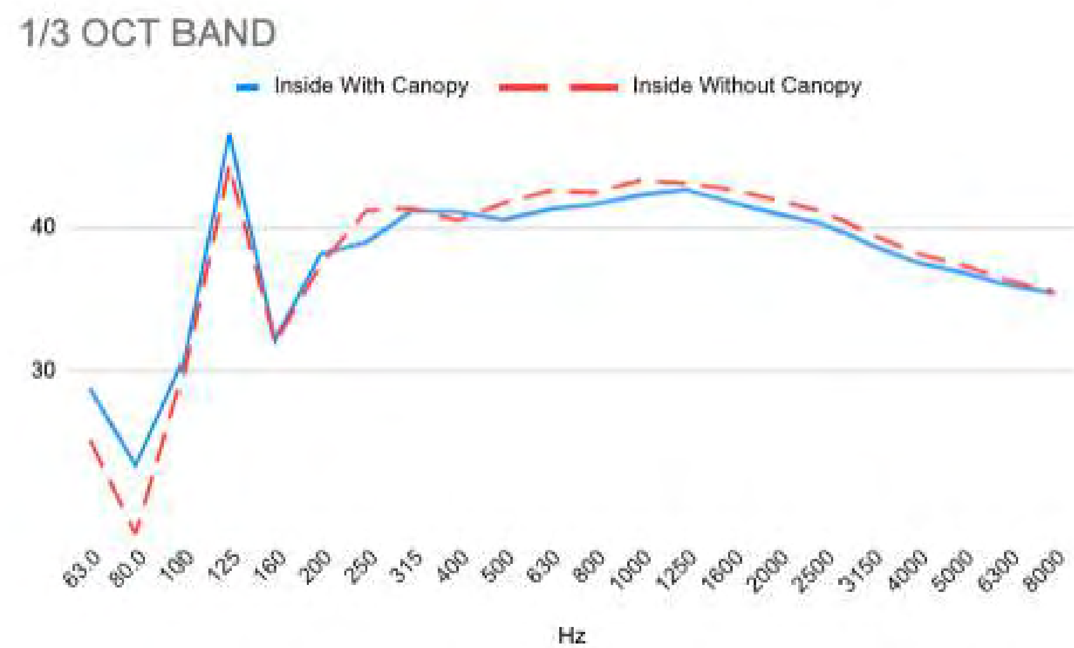


Figure 56. Third Octave Band Data of Measurements on the Inside with Canopy versus Inside Without Canopy

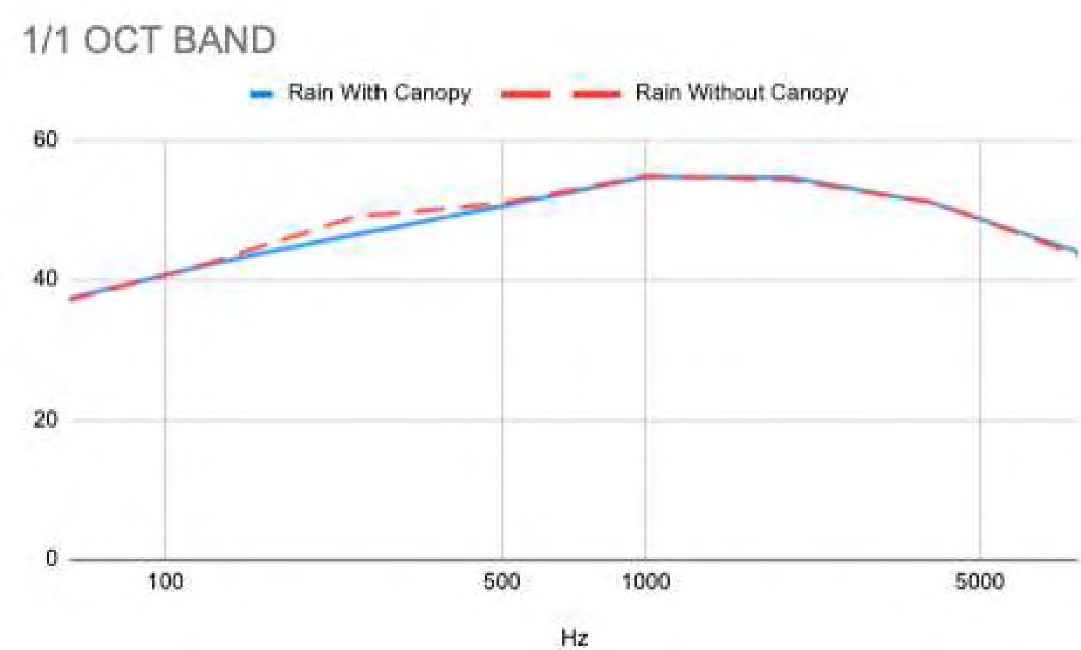


Figure 57. One Octave Band Data of Measurements on the Outside with Canopy versus Outside Without Canopy

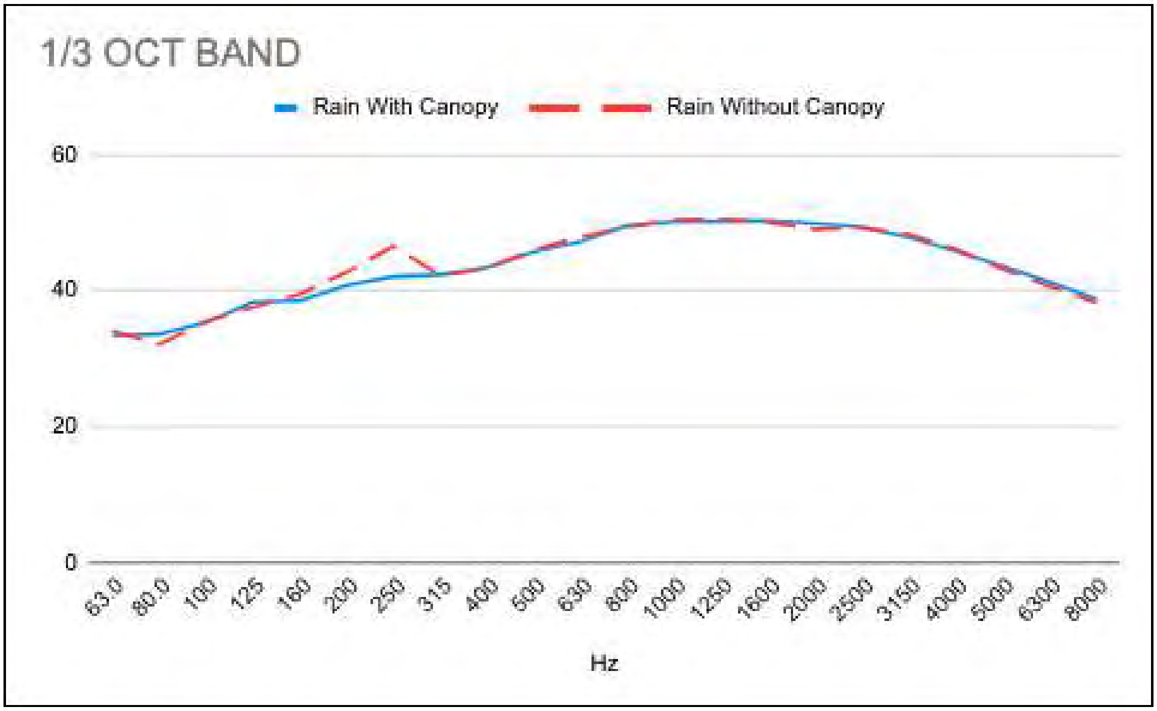


Figure 58. Third Octave Band Data of Measurements on the Outside with Canopy versus Outside Without Canopy

Appendix 6. Soundscape Analysis Point 2-38

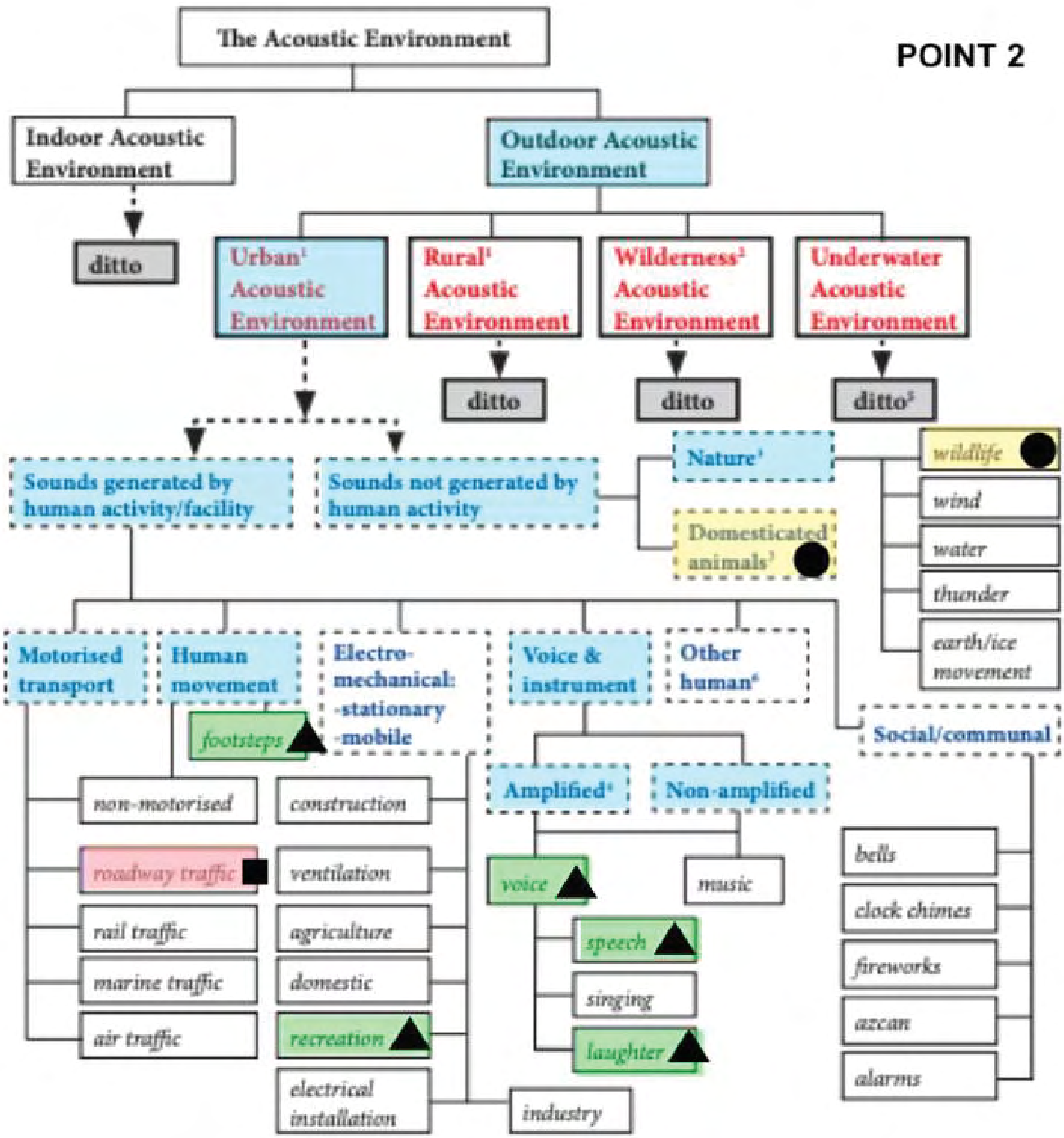


Figure 59.Sound Taxonomy Analysis Point 2 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

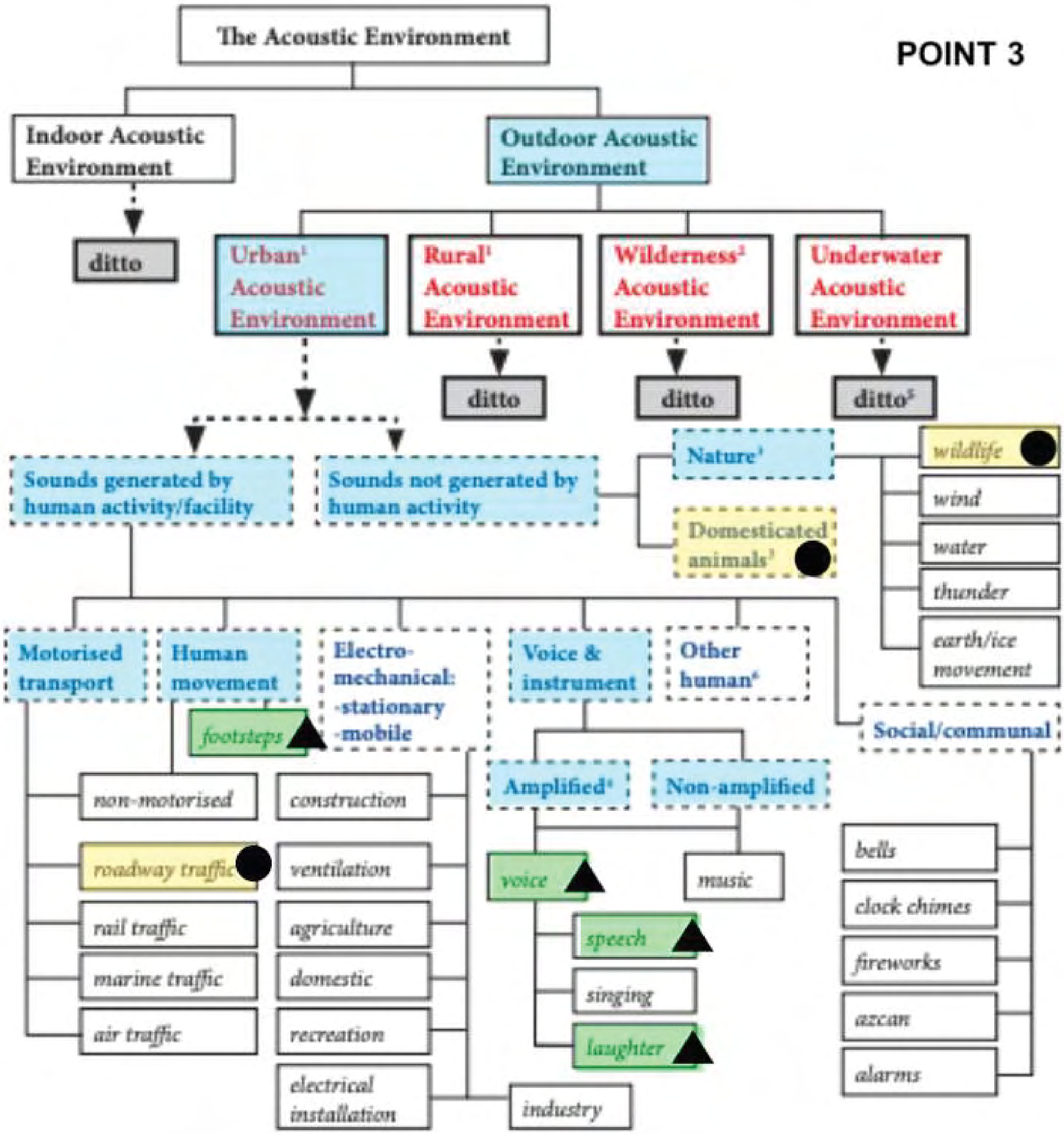


Figure 60.Sound Taxonomy Analysis Point 3 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

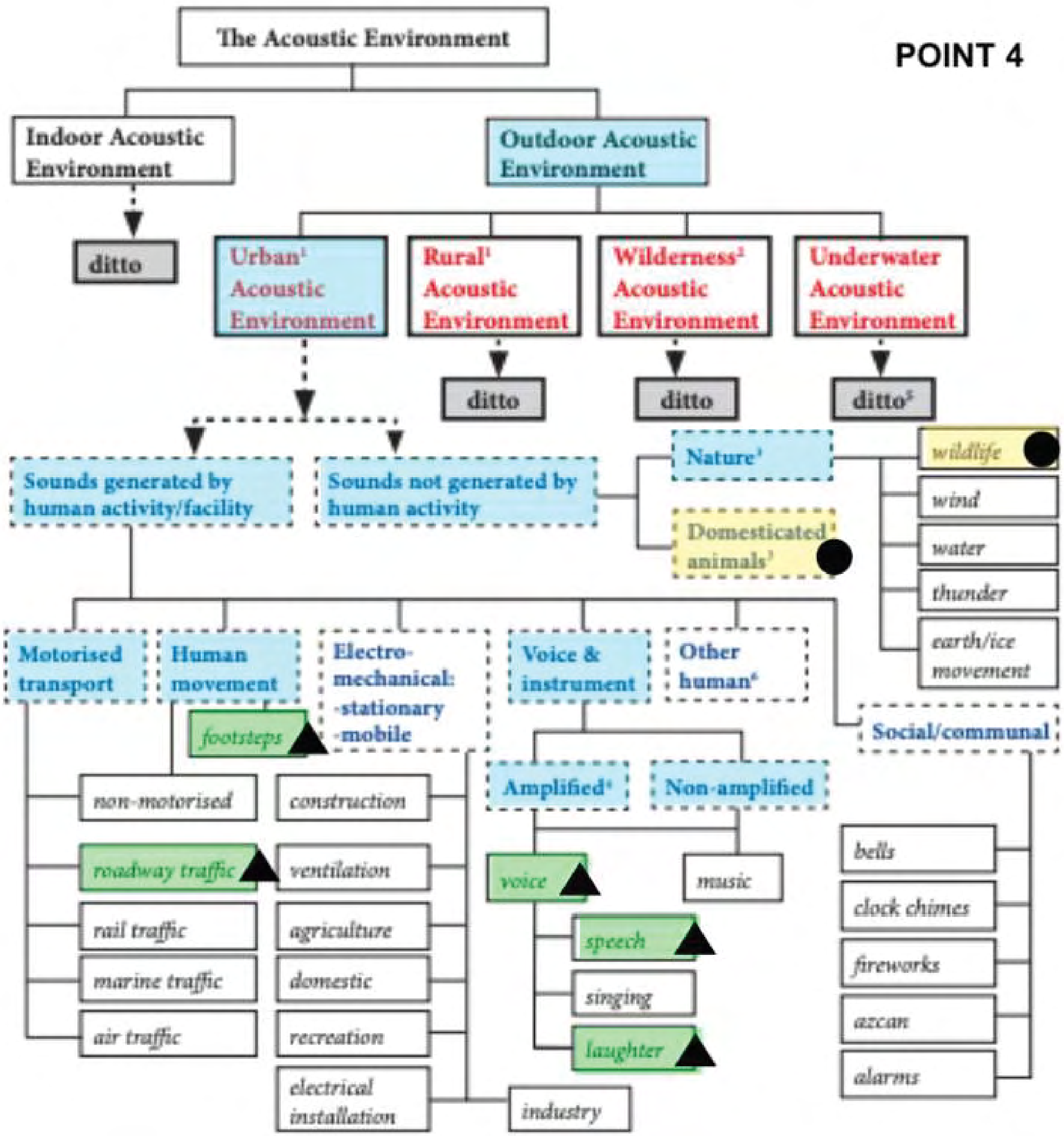


Figure 61.Sound Taxonomy Analysis Point 4 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

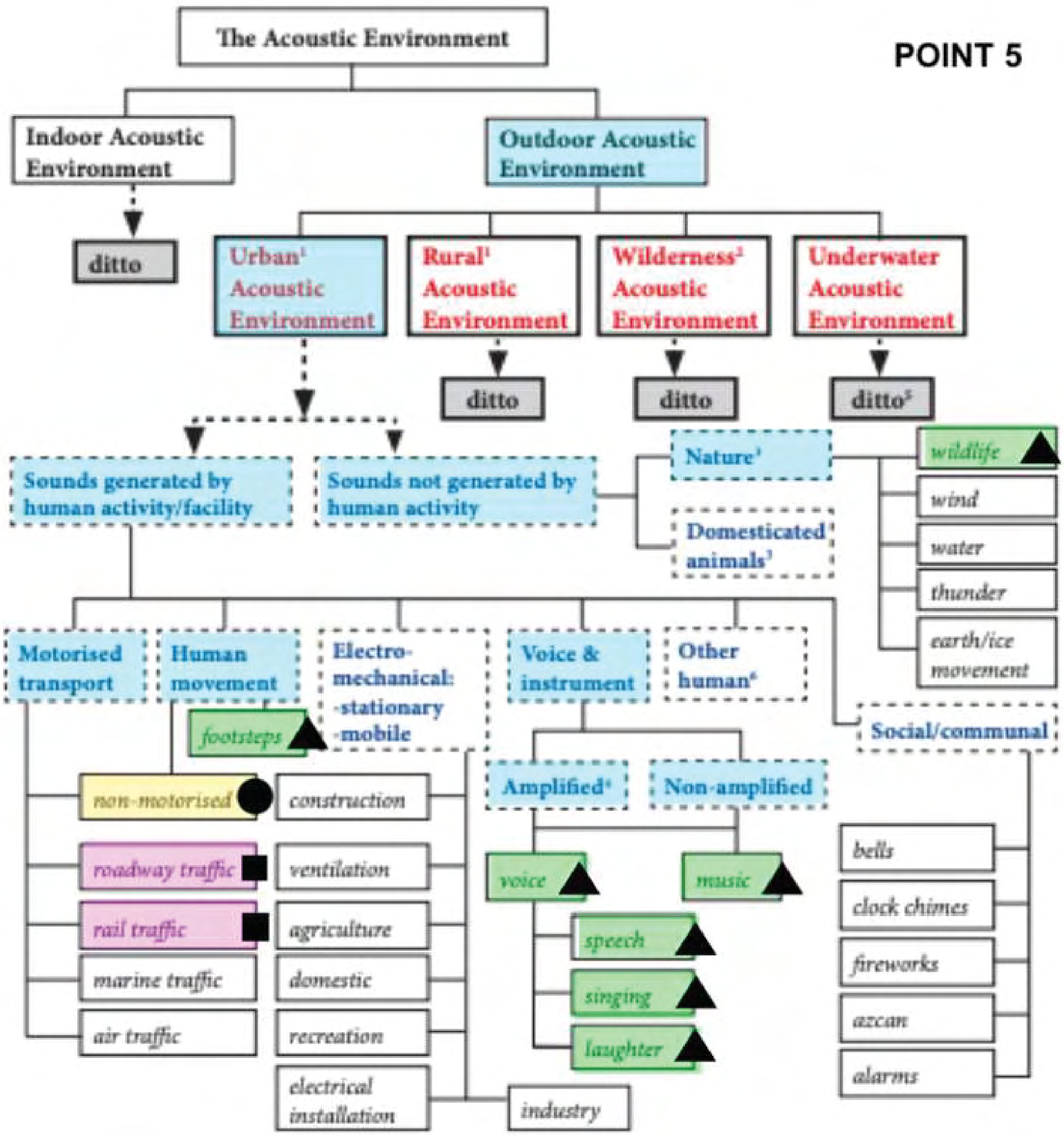


Figure 62.Sound Taxonomy Analysis Point 5 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

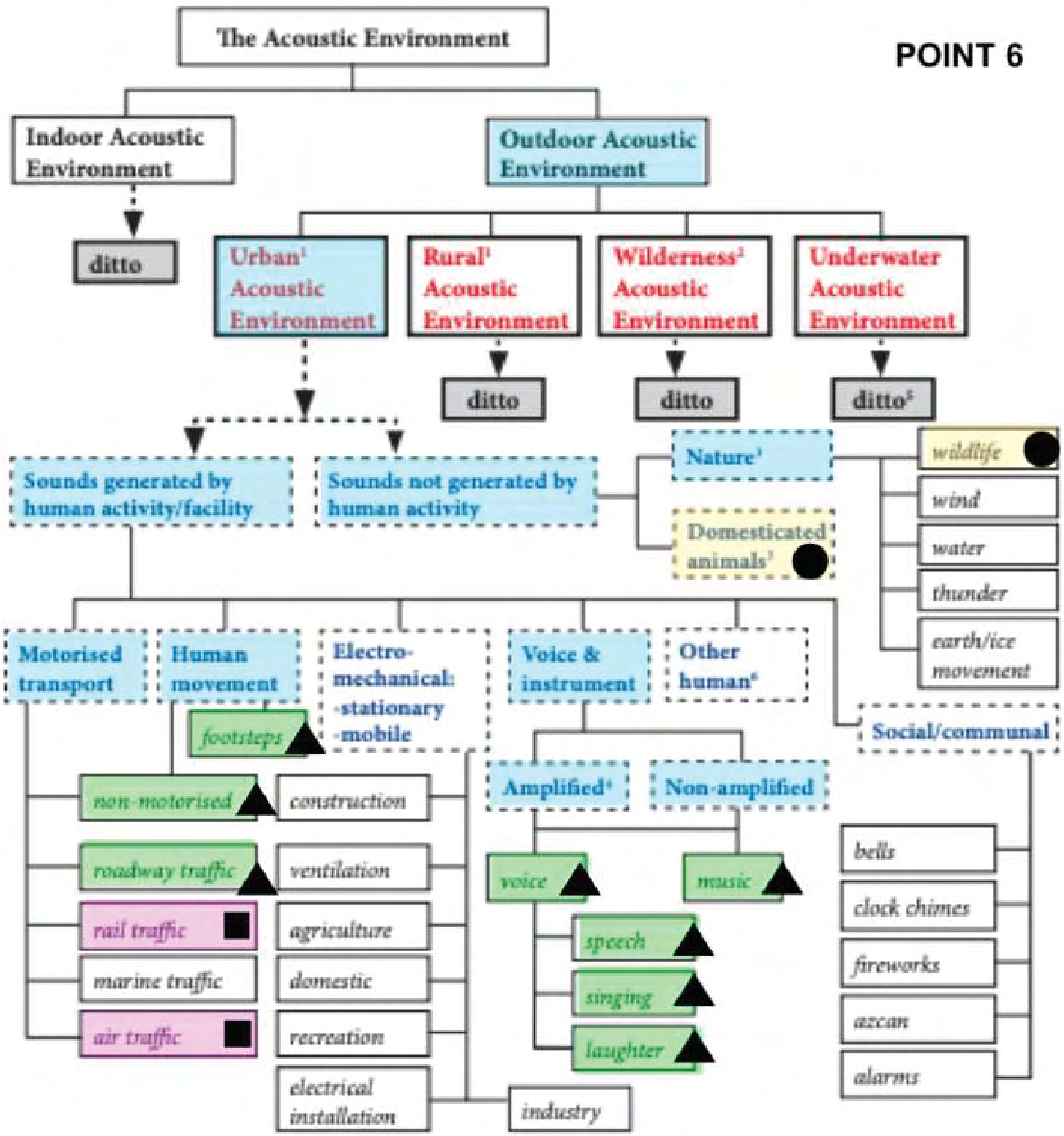


Figure 63.Sound Taxonomy Analysis Point 6 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

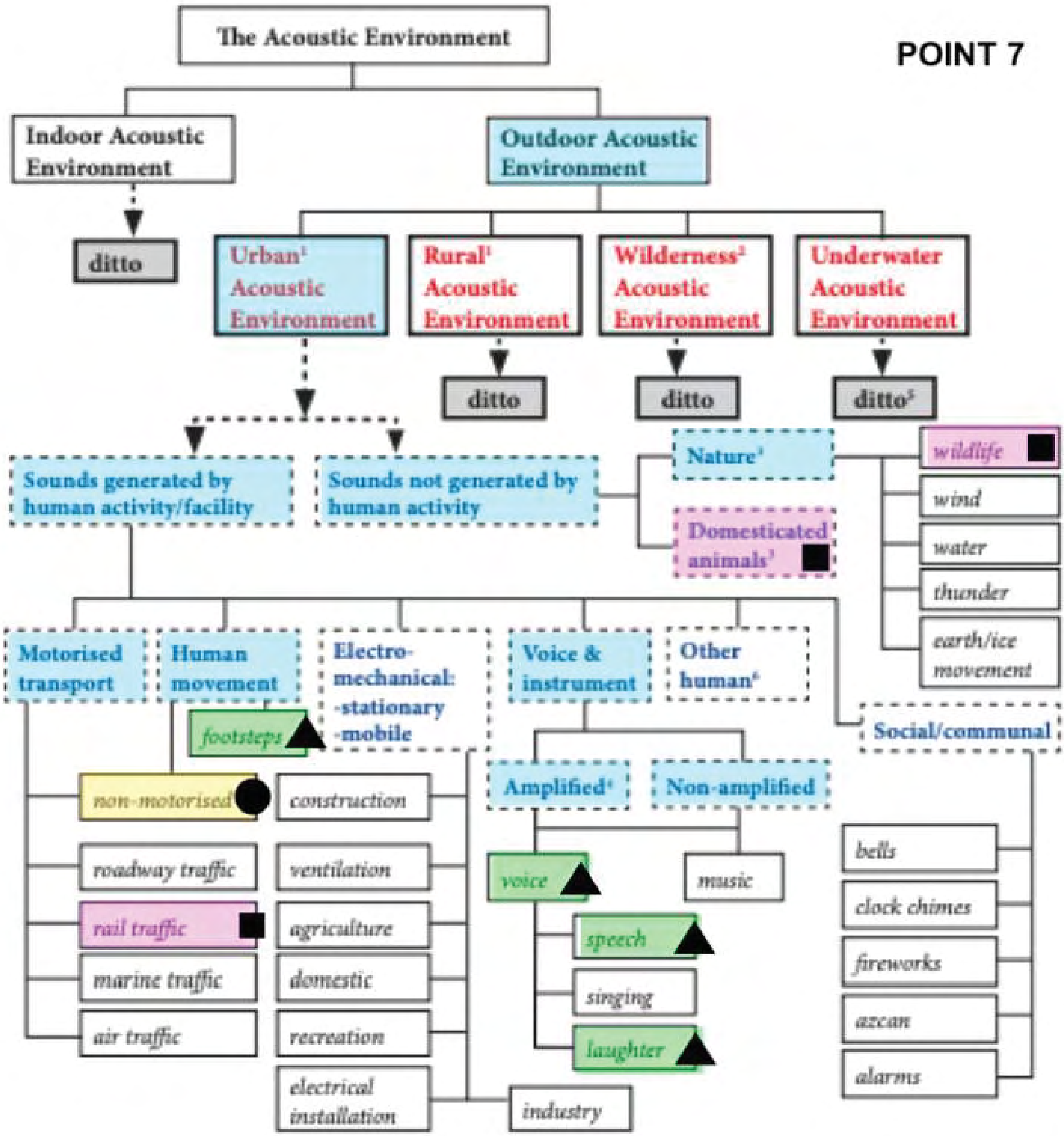


Figure 64.Sound Taxonomy Analysis Point 7 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

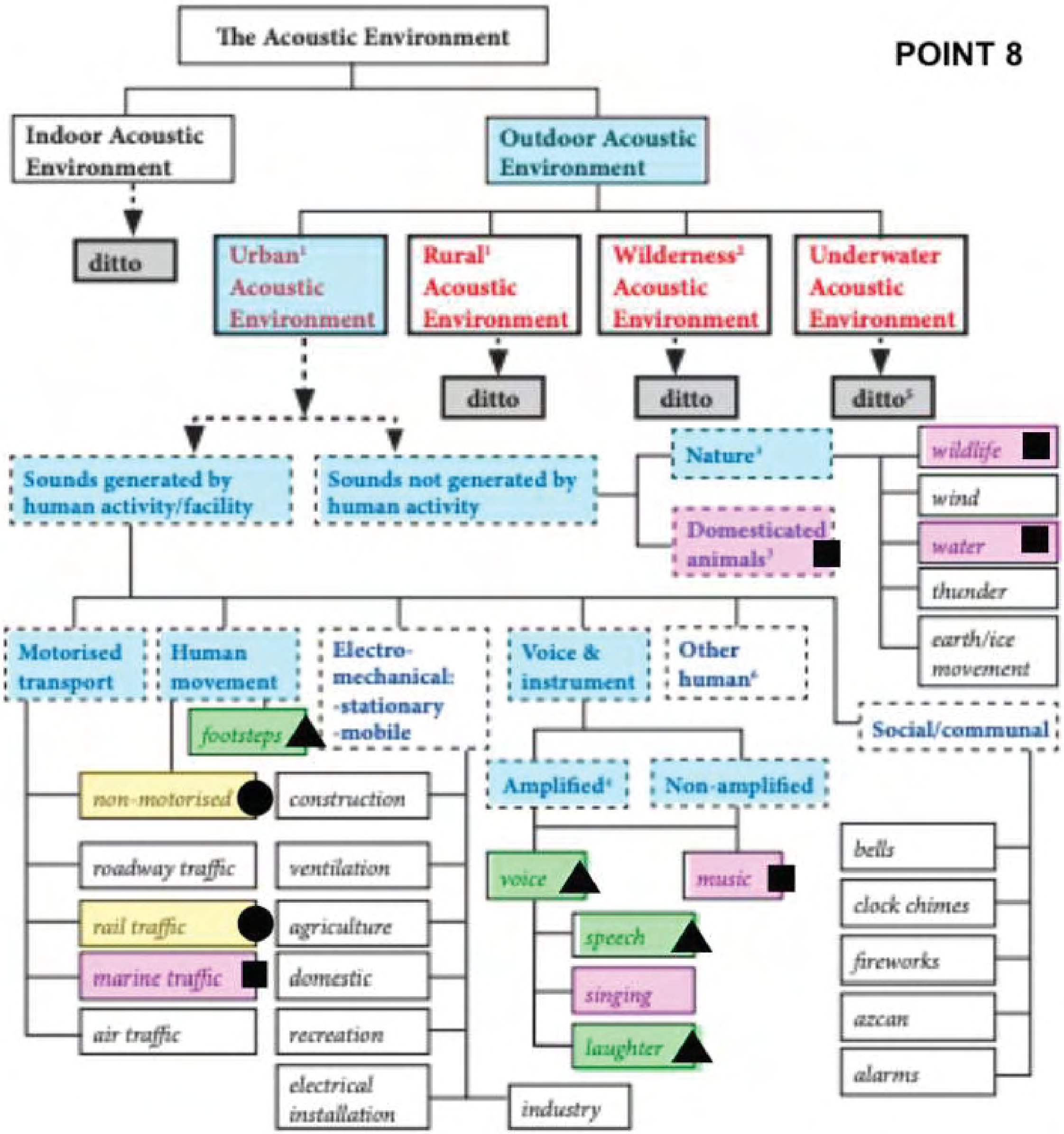


Figure 65.Sound Taxonomy Analysis Point 8 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

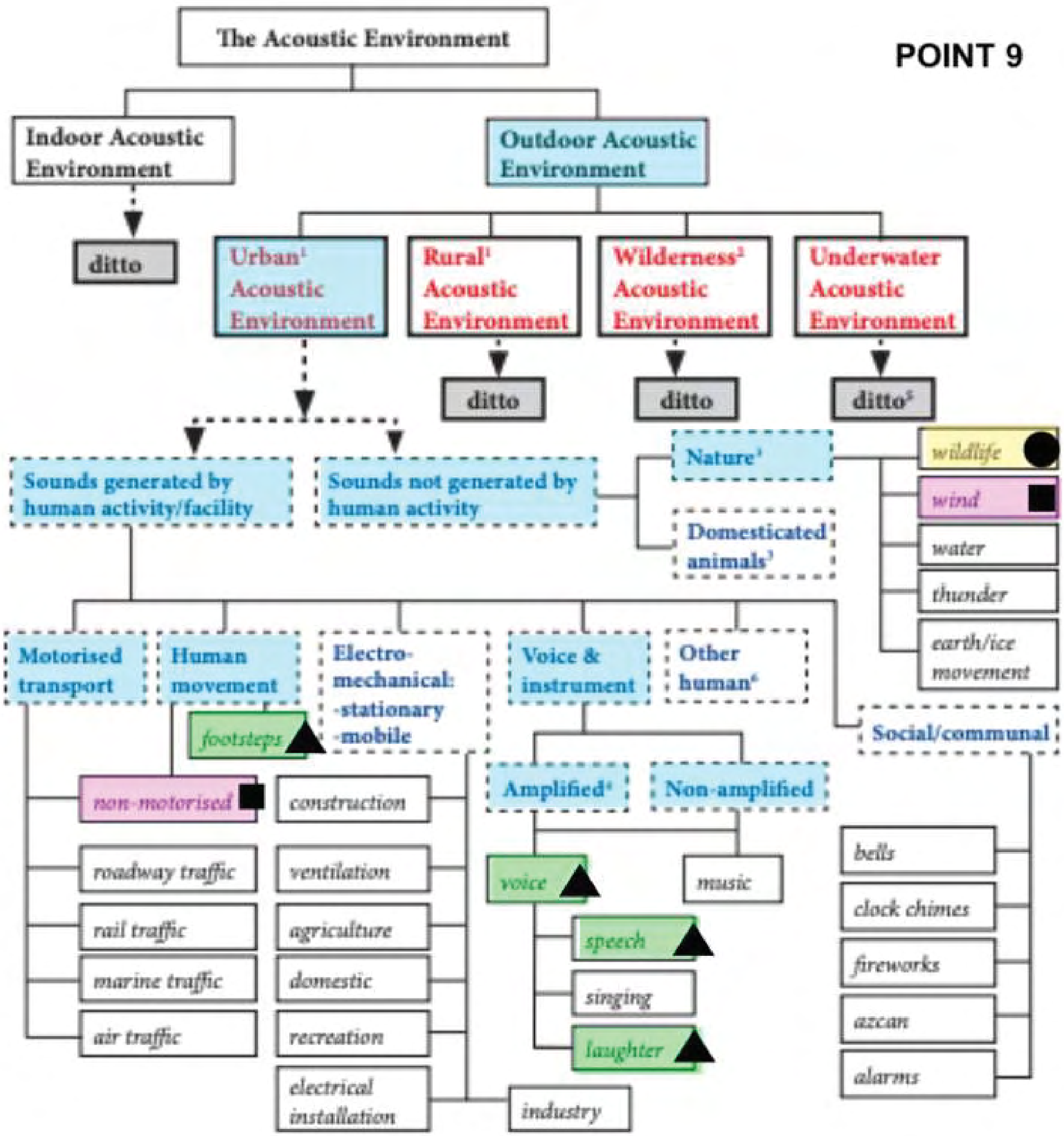


Figure 66. Sound Taxonomy Analysis Point 9 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

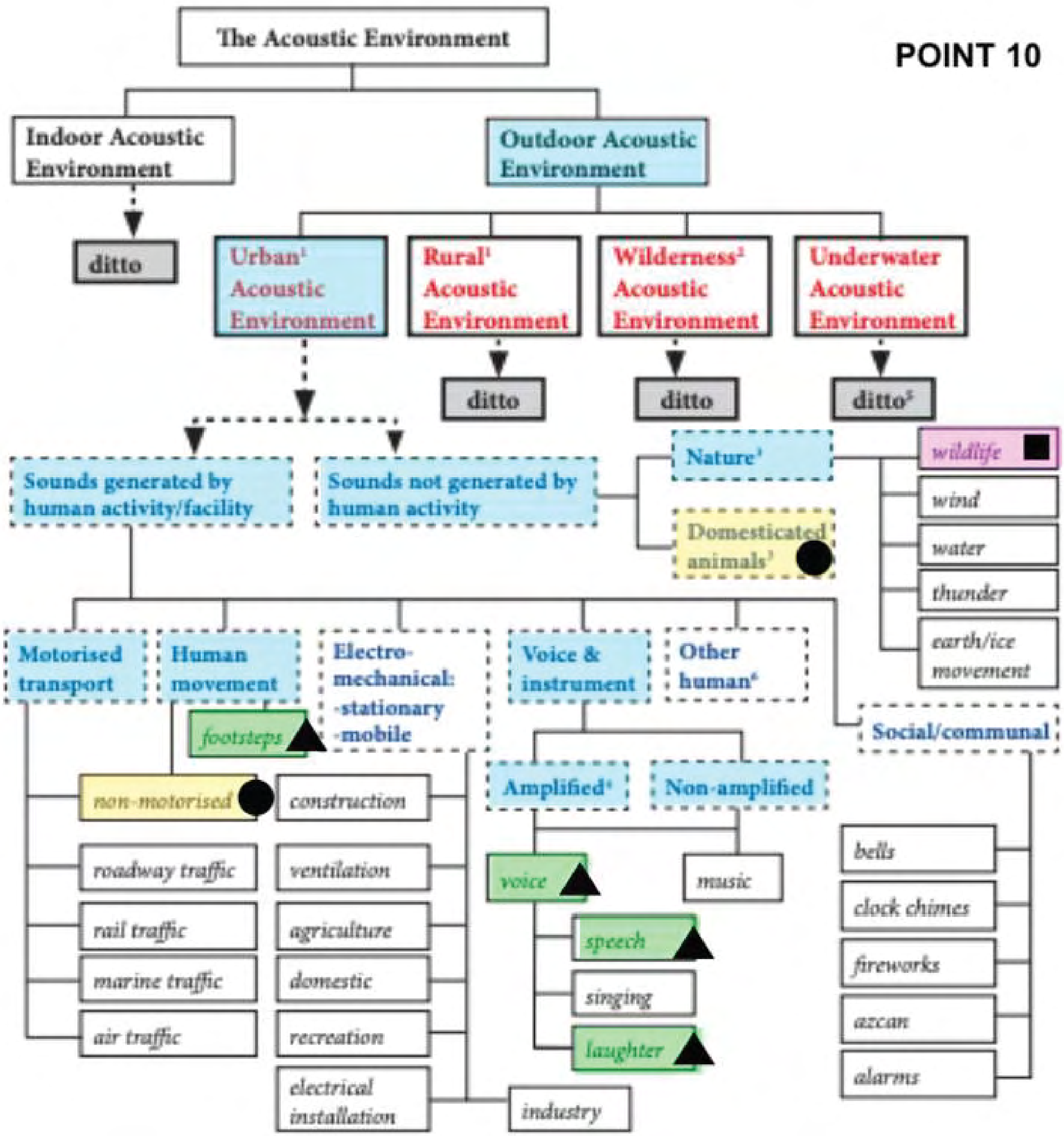


Figure 67. Sound Taxonomy Analysis Point 10 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

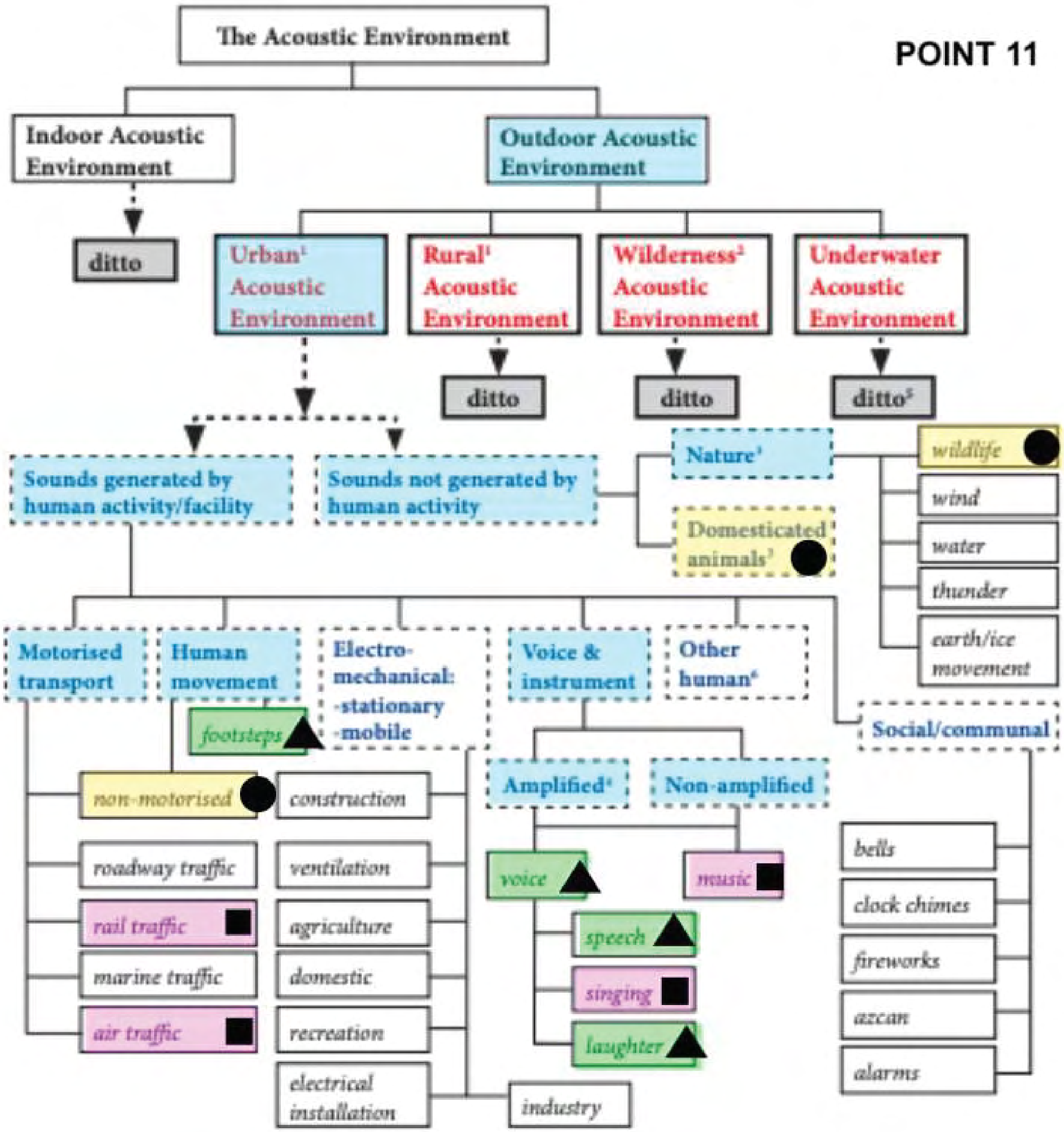


Figure 68. Sound Taxonomy Analysis Point 11 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

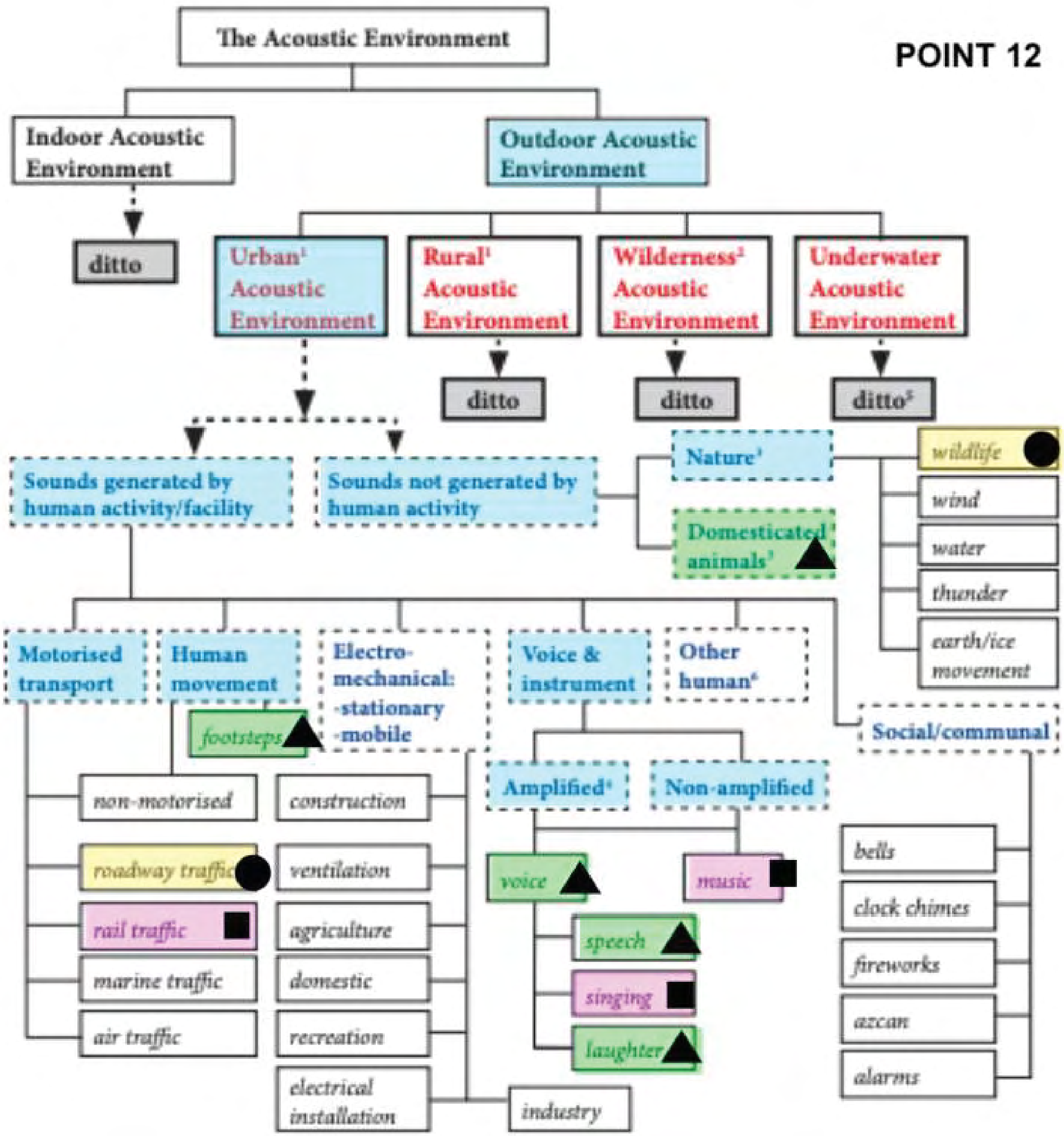


Figure 69. Sound Taxonomy Analysis Point 12 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

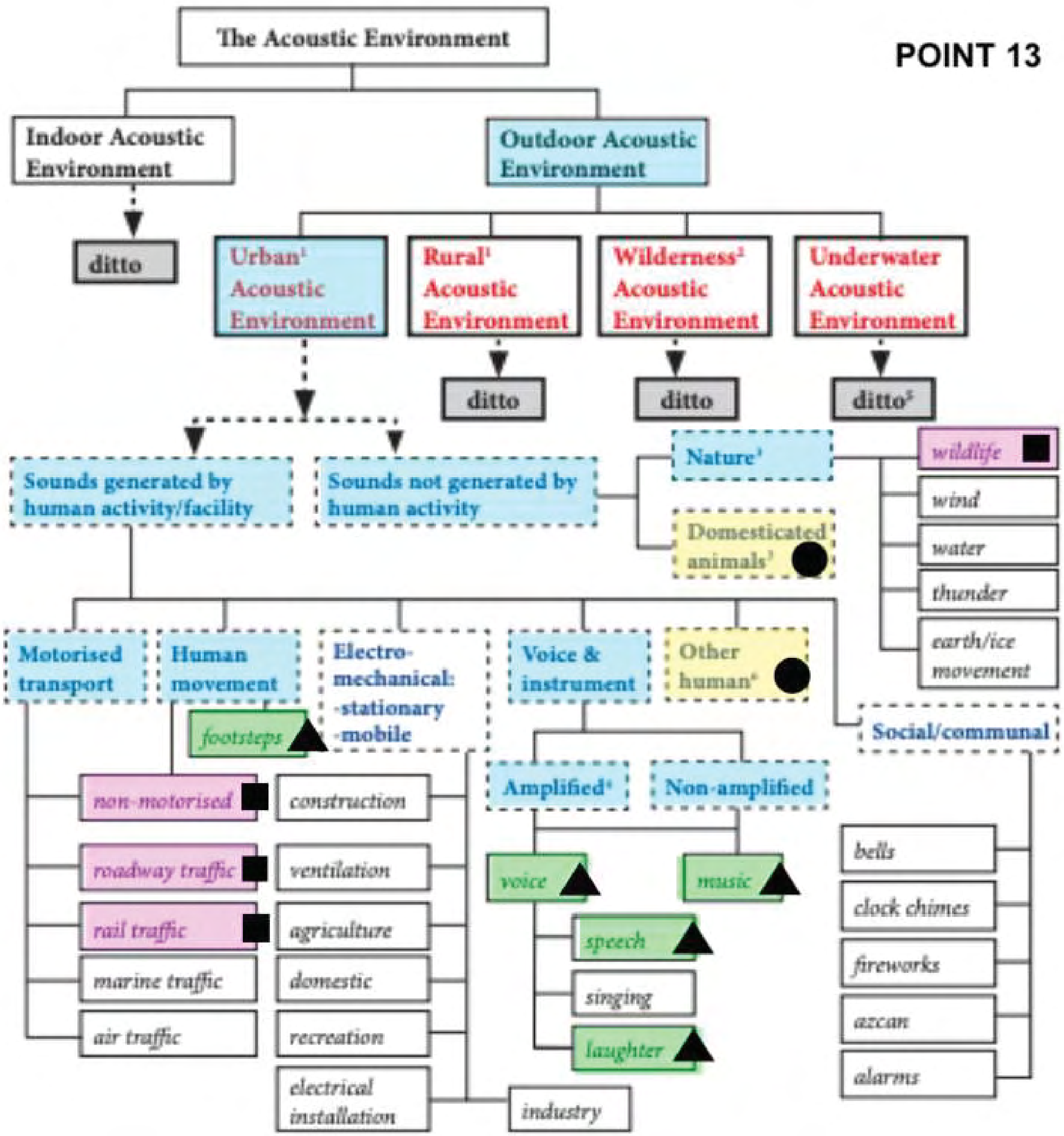


Figure 70. Sound Taxonomy Analysis Point 13 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

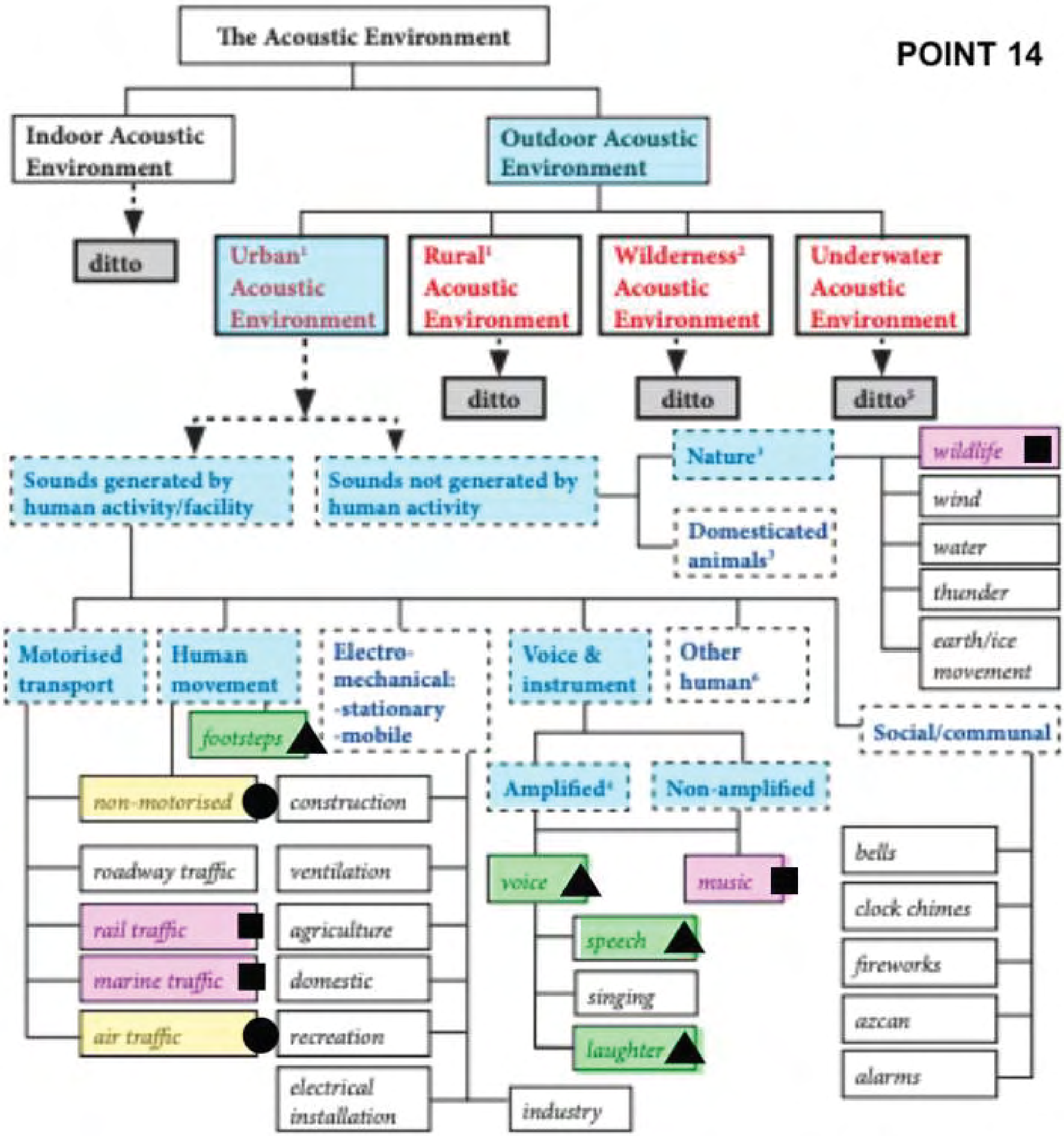


Figure 71. Sound Taxonomy Analysis Point 14 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

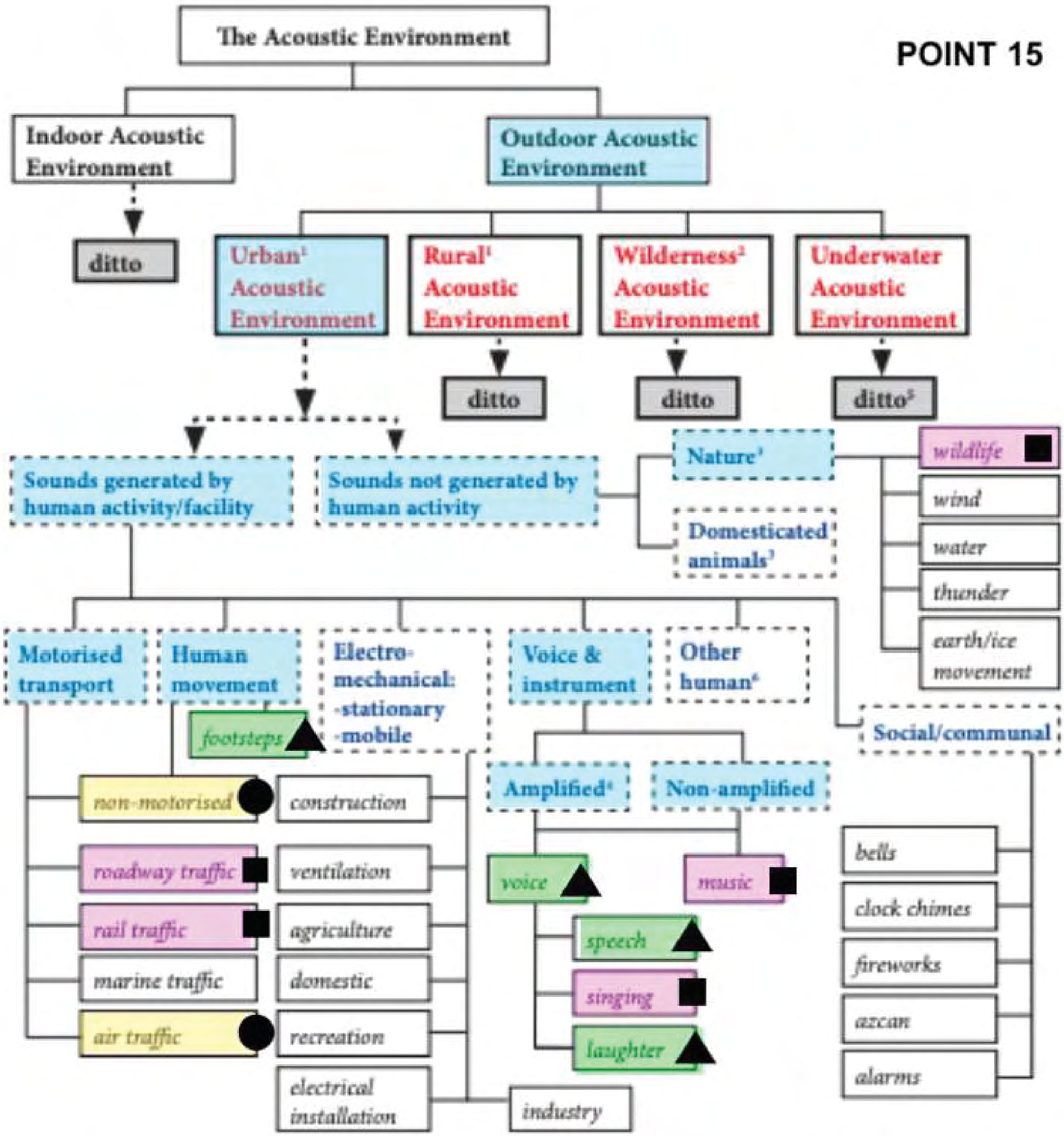


Figure 72. Sound Taxonomy Analysis Point 15 (Green / ⬤ : Dominant, Red / ■ : Medium, Yellow / ▲: Vague)

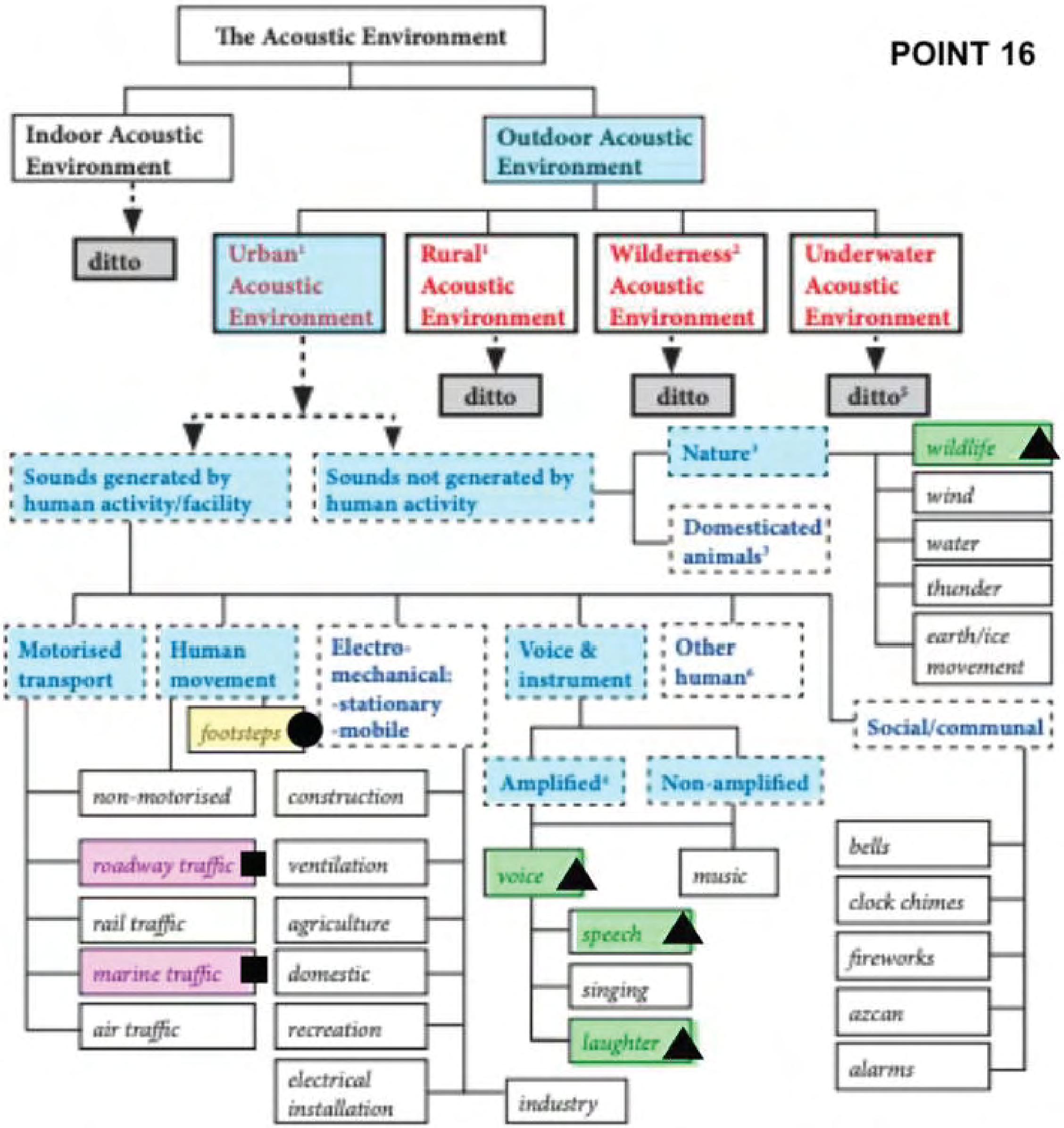


Figure 73. Sound Taxonomy Analysis Point 16 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

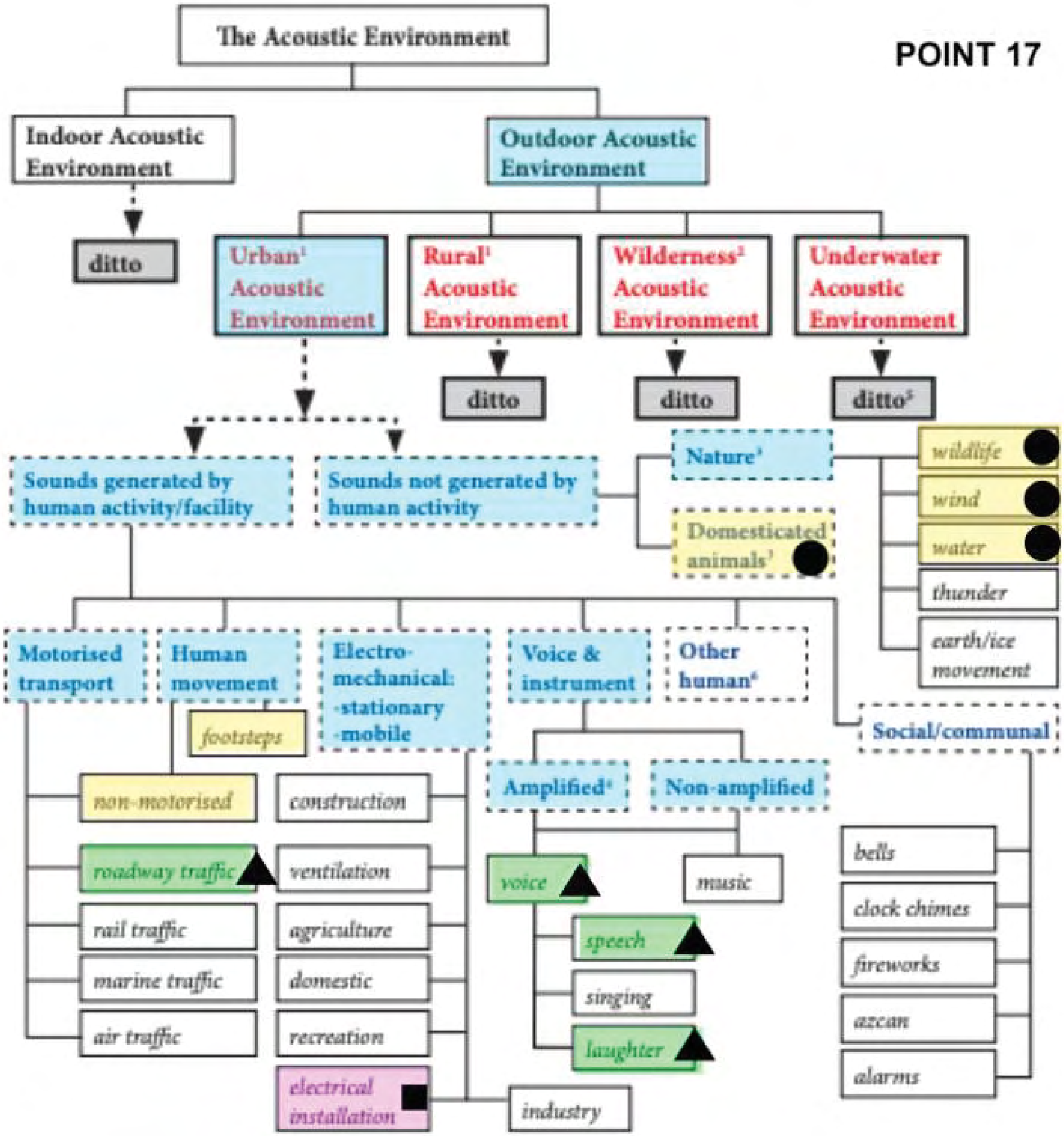


Figure 74. Sound Taxonomy Analysis Point 17 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

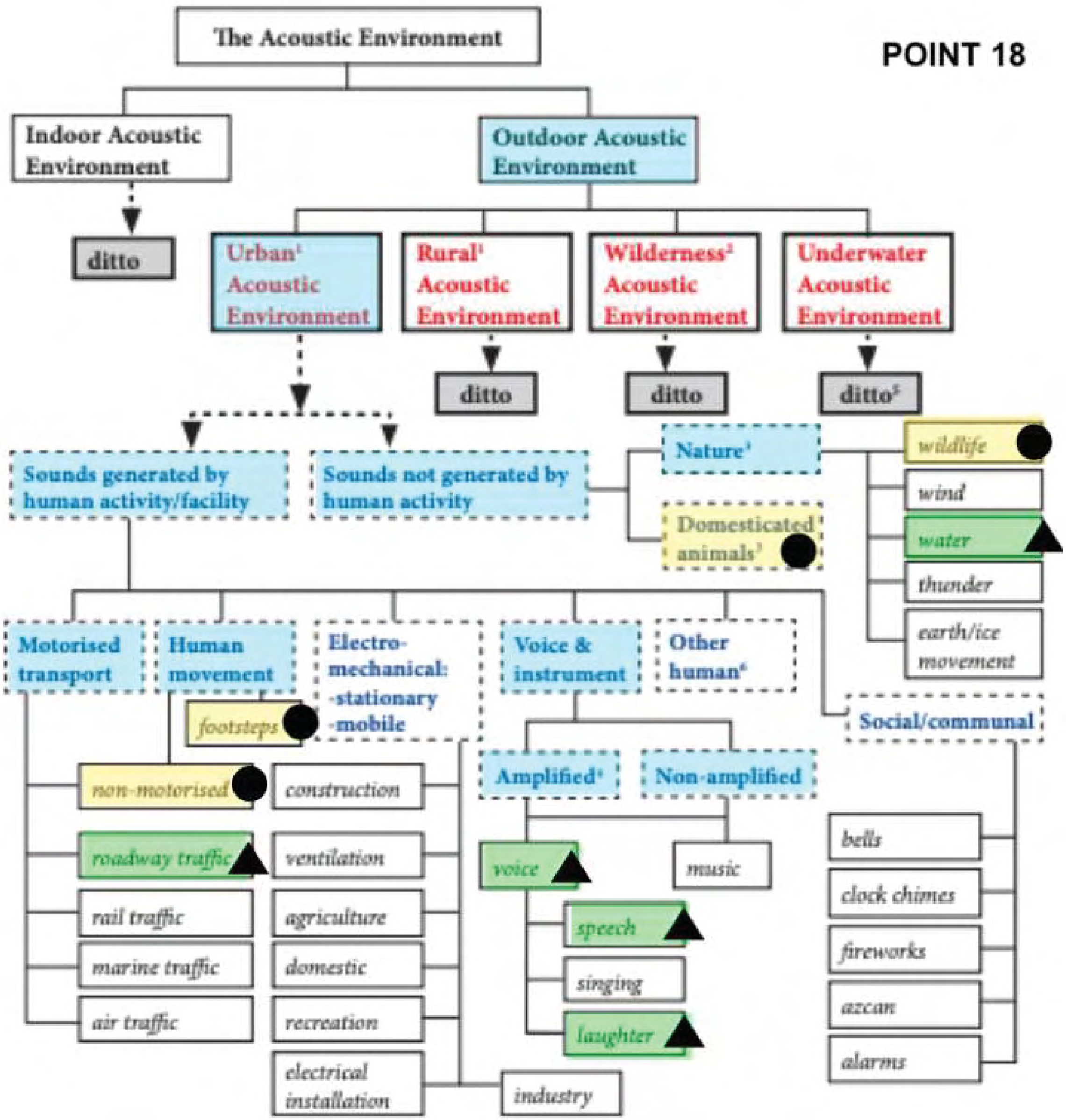


Figure 75. Sound Taxonomy Analysis Point 18 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

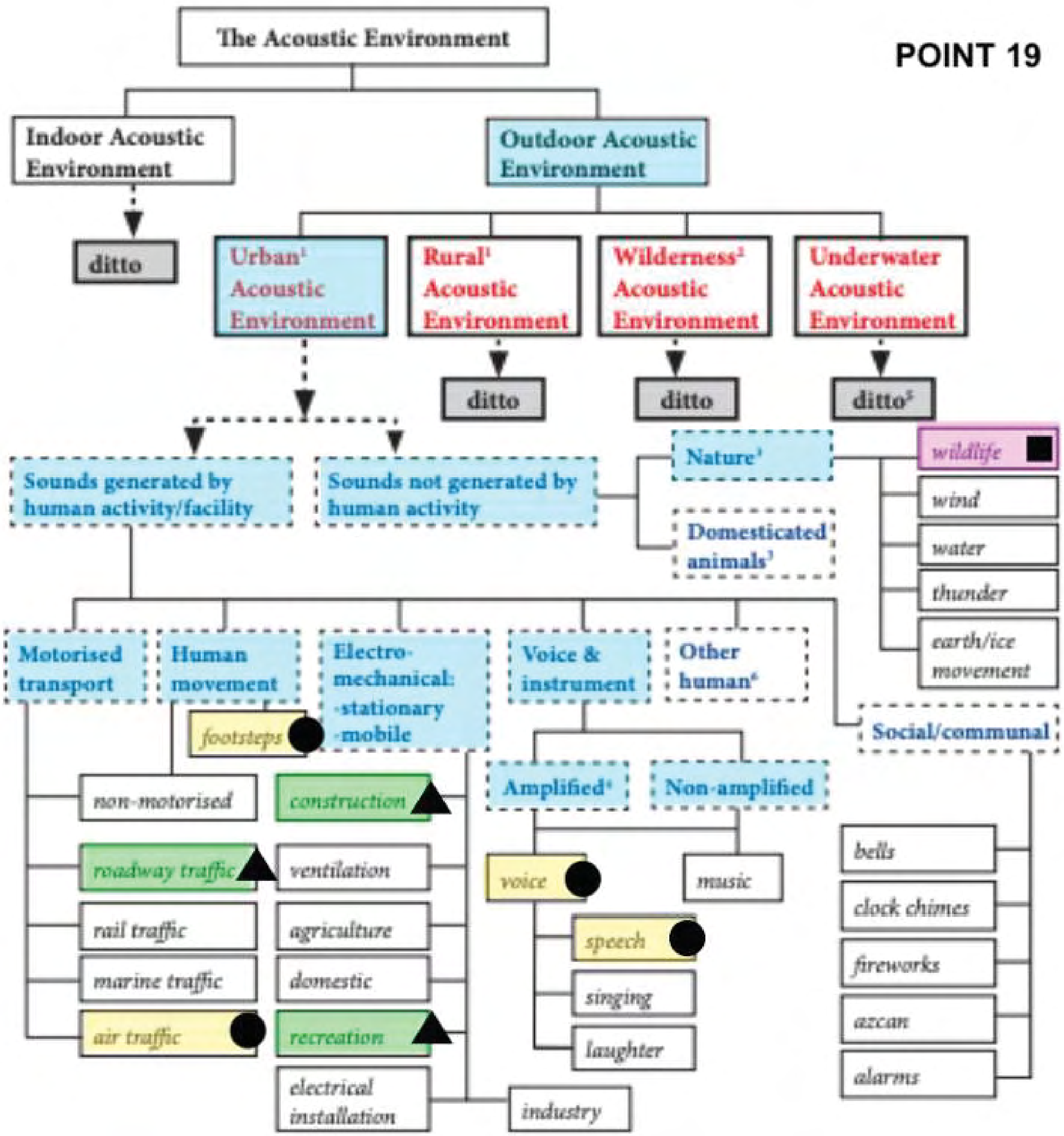


Figure 76. Sound Taxonomy Analysis Point 19 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

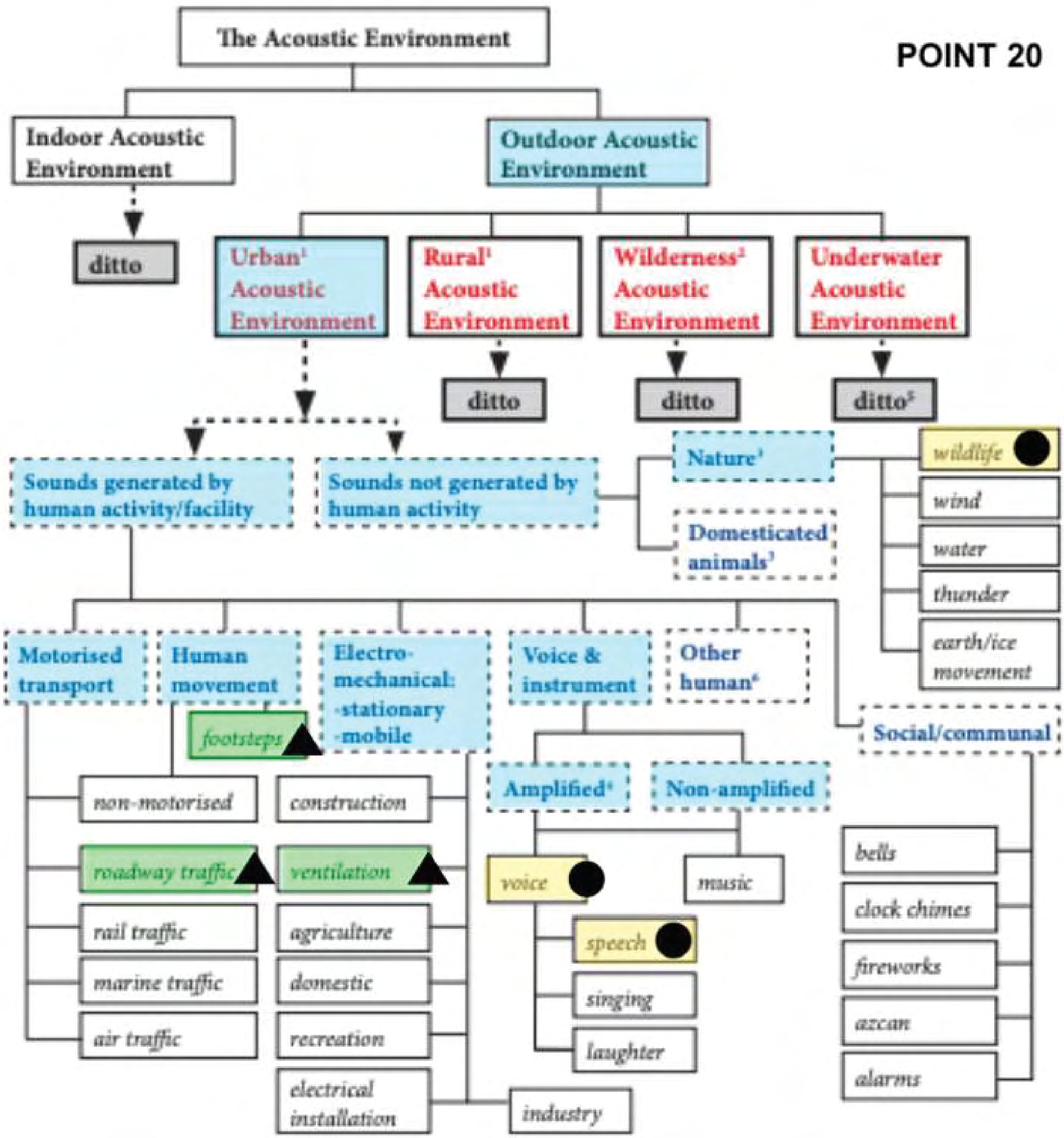


Figure 77. Sound Taxonomy Analysis Point 20 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

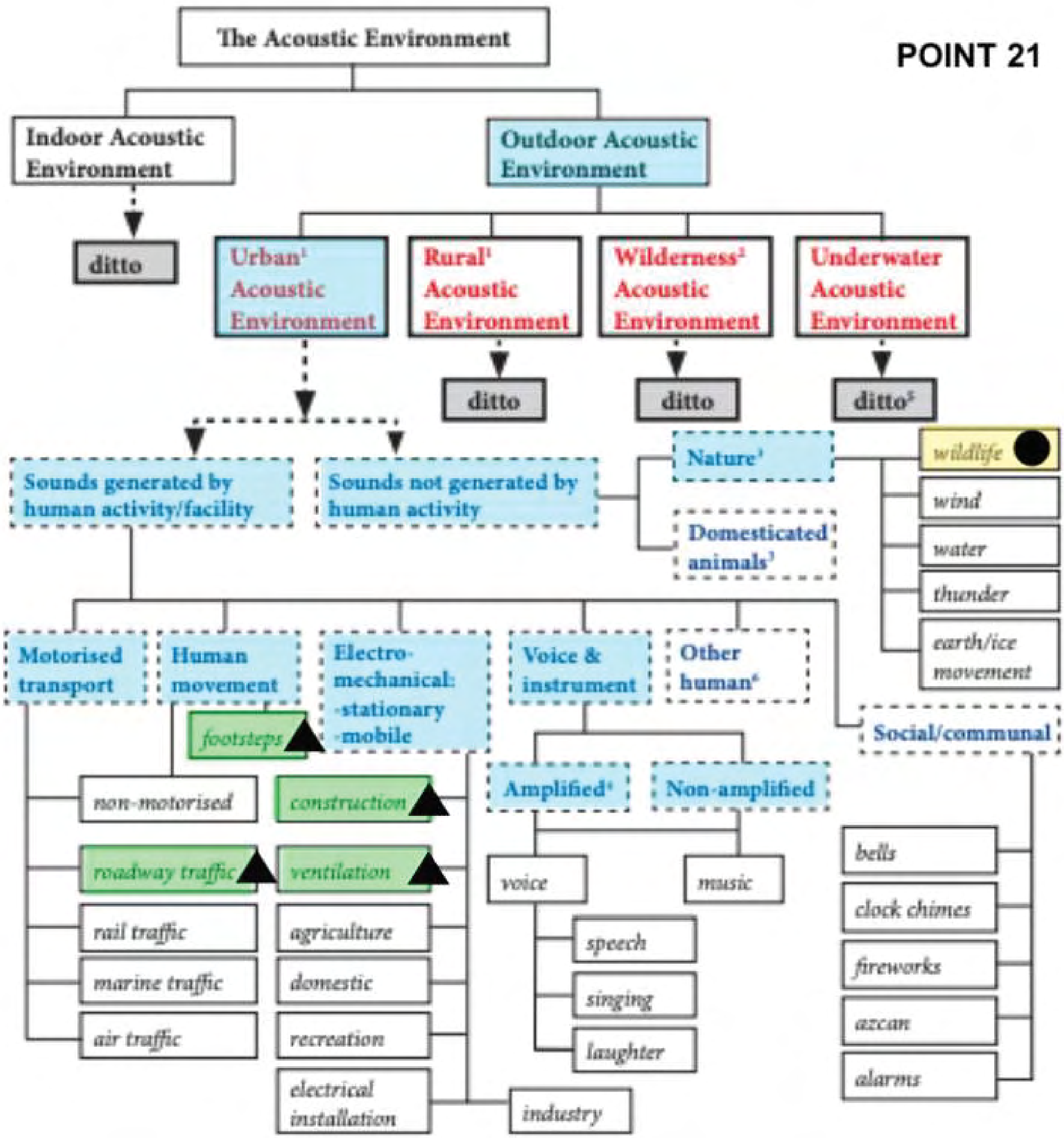


Figure 78. Sound Taxonomy Analysis Point 21 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

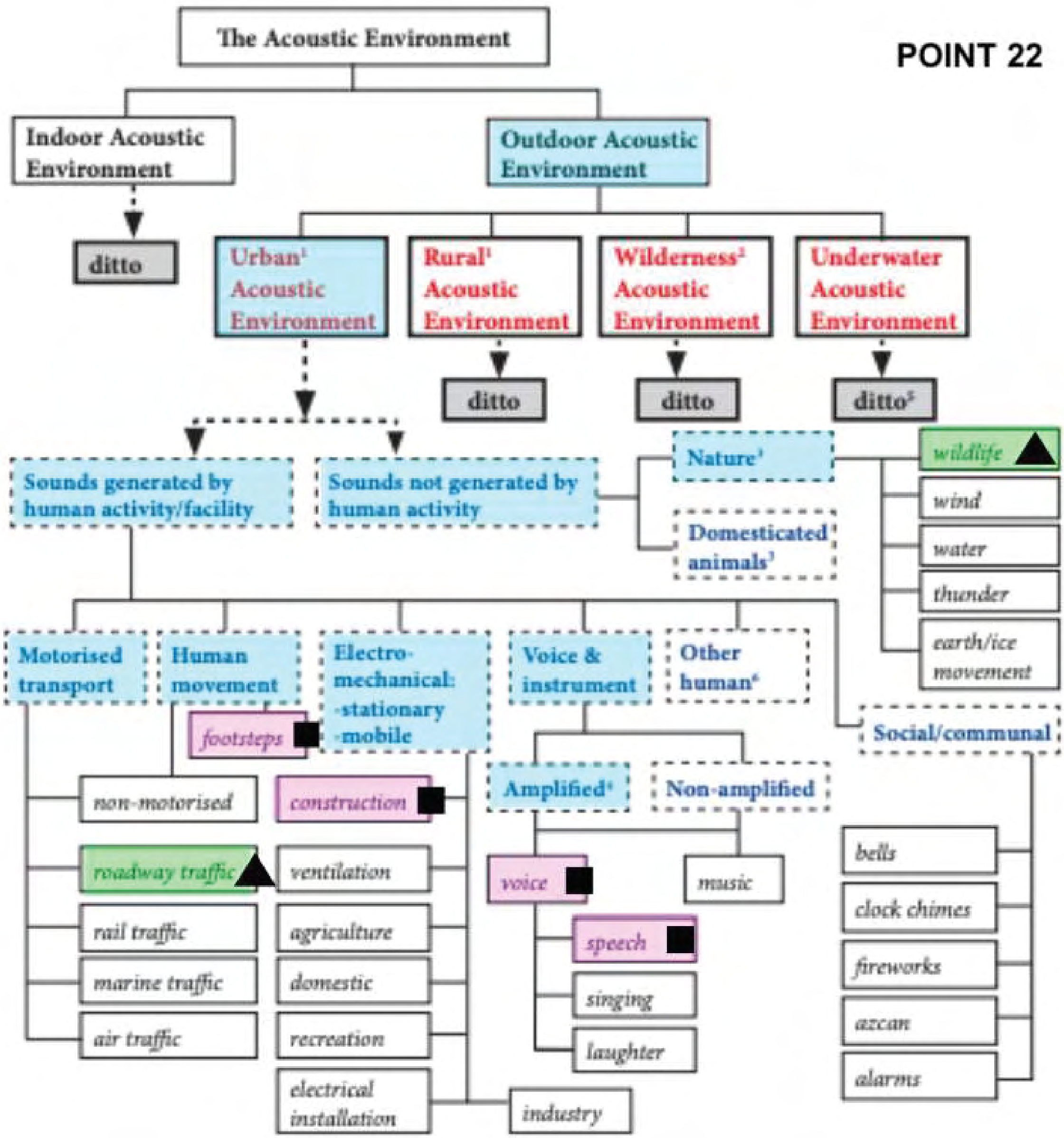


Figure 79. Sound Taxonomy Analysis Point 22 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

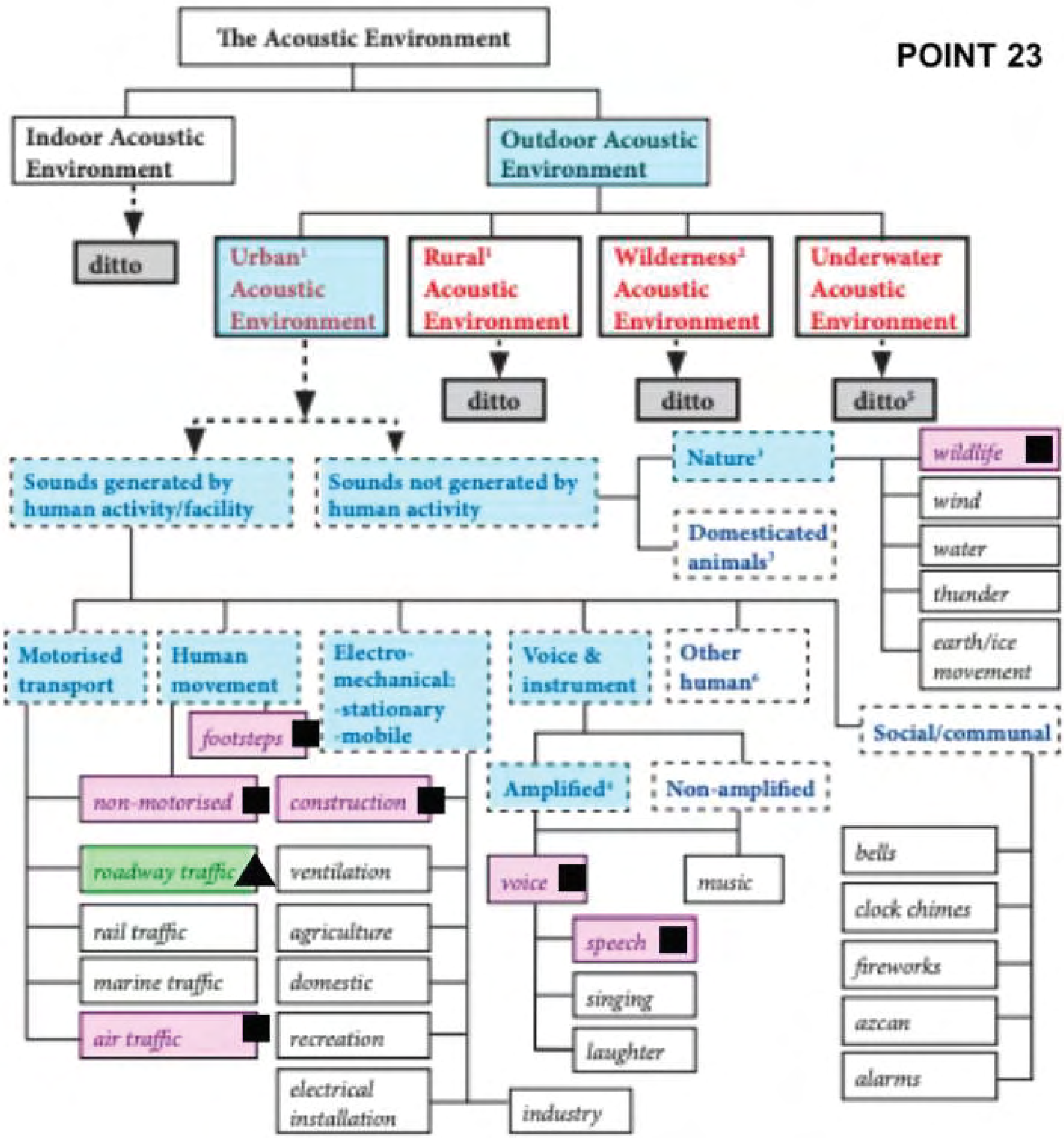


Figure 80. Sound Taxonomy Analysis Point 23 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

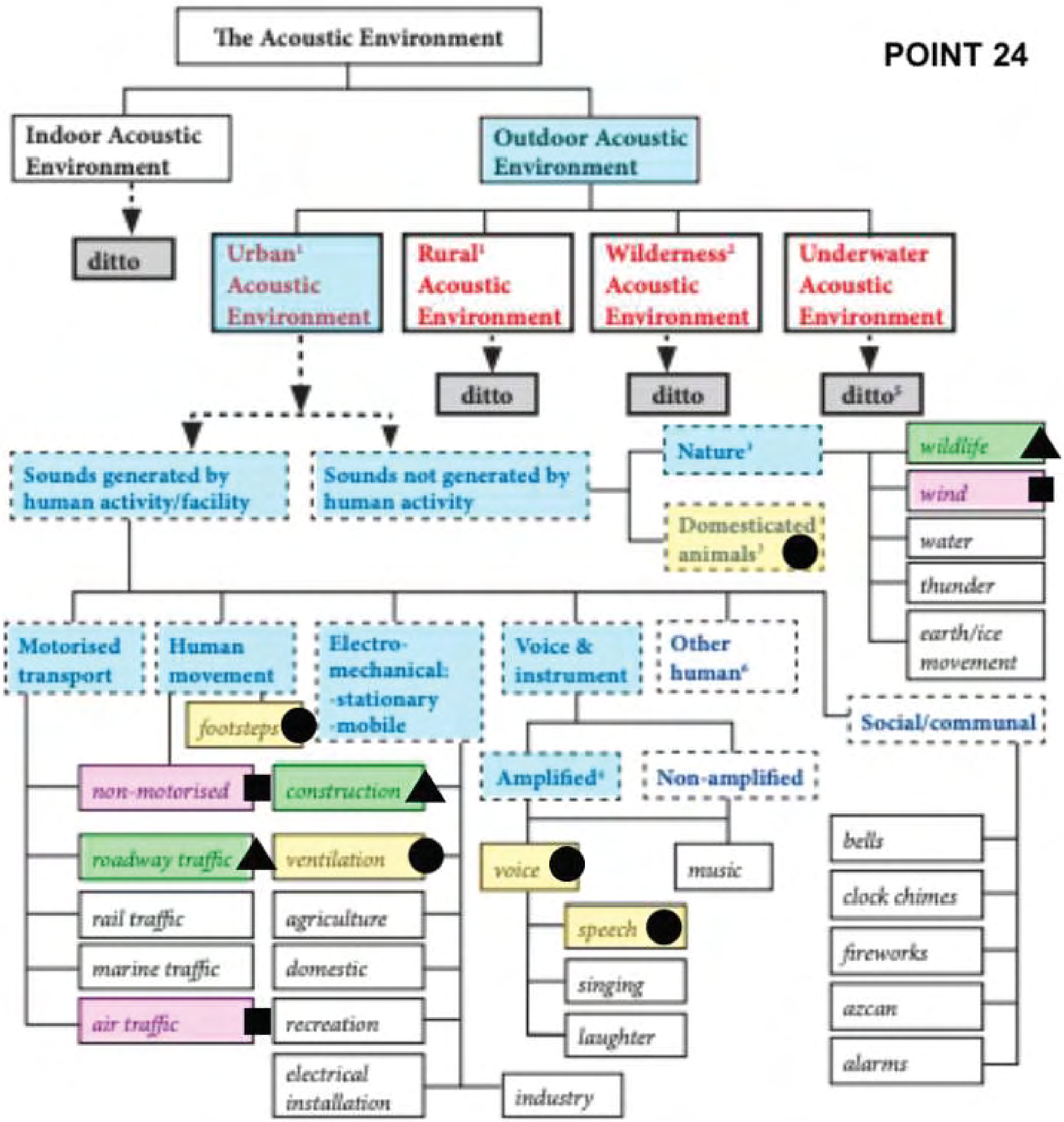


Figure 81. Sound Taxonomy Analysis Point 24 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

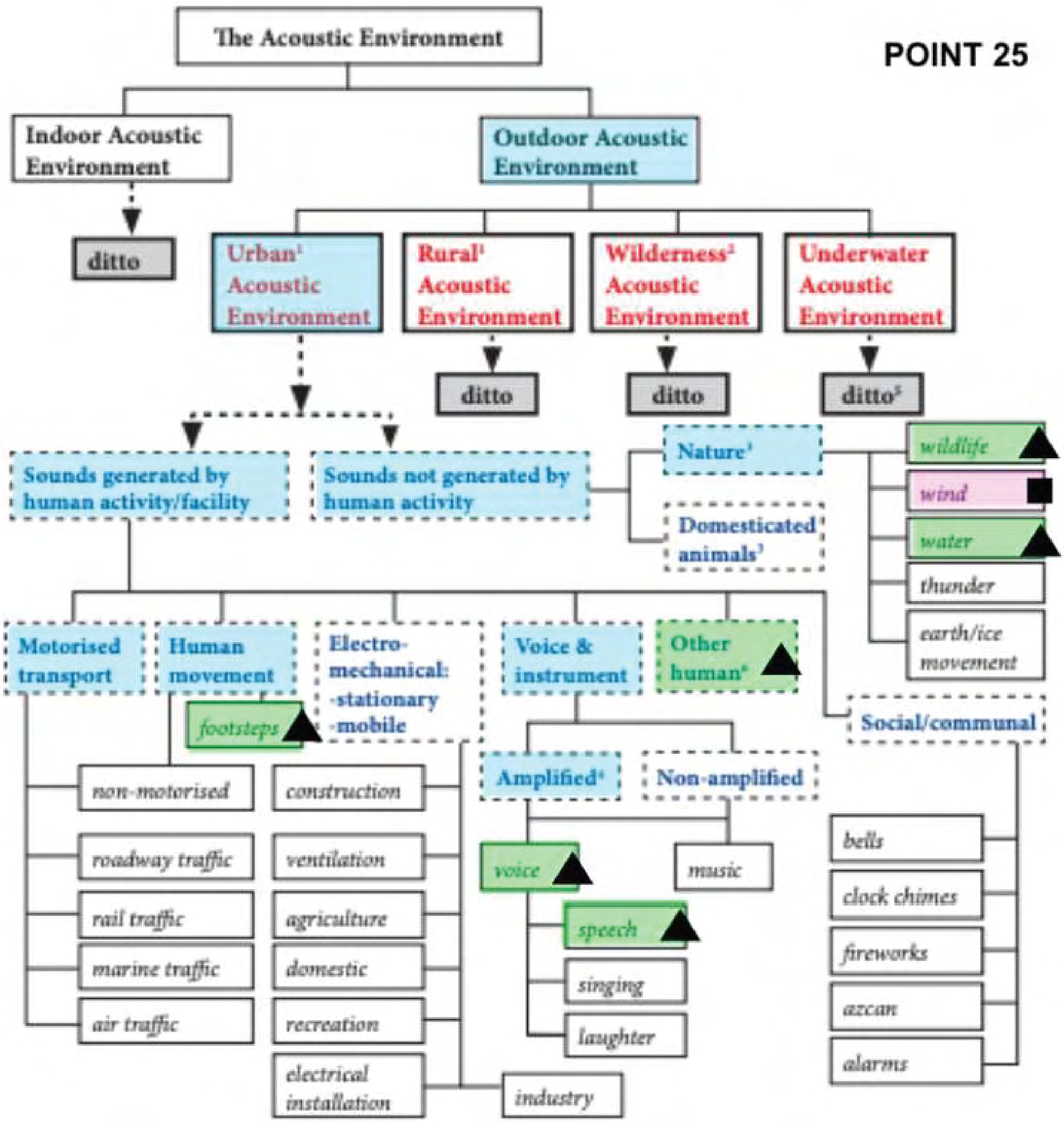


Figure 82. Sound Taxonomy Analysis Point 25 (Green / ⚫ : Dominant, Red / ⬛ : Medium, Yellow / ▲: Vague)

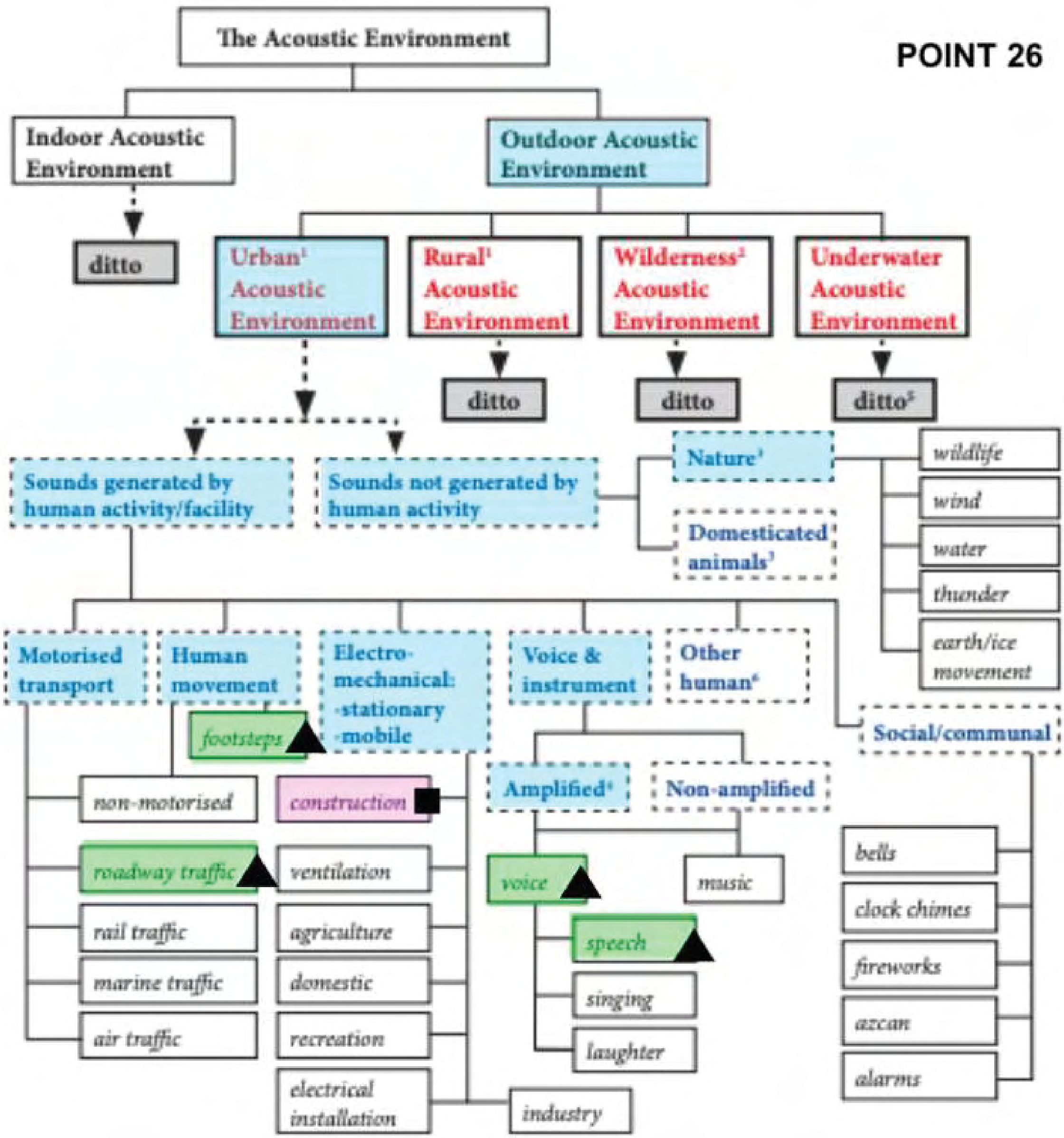


Figure 83. Sound Taxonomy Analysis Point 26 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

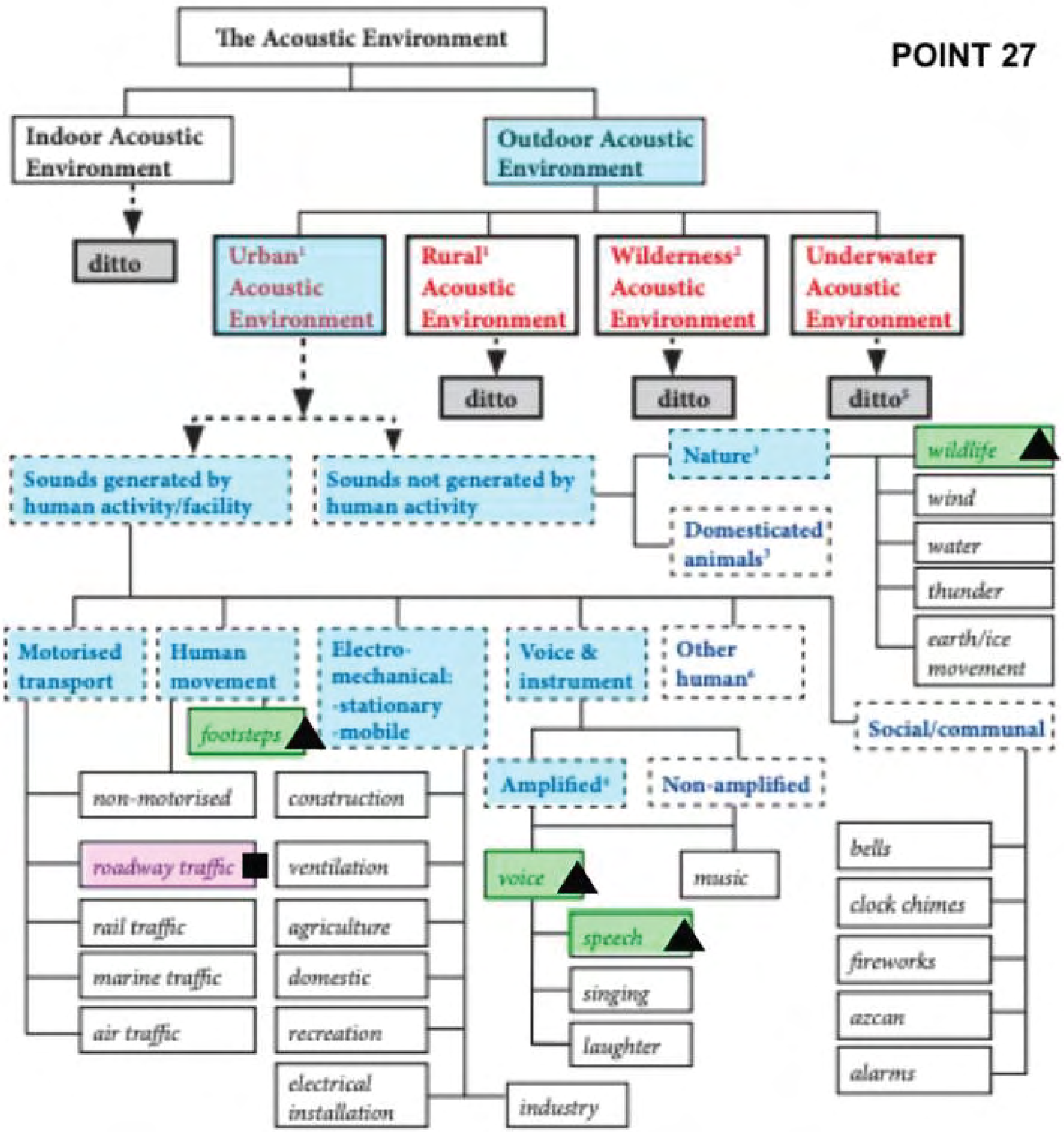


Figure 84. Sound Taxonomy Analysis Point 27 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

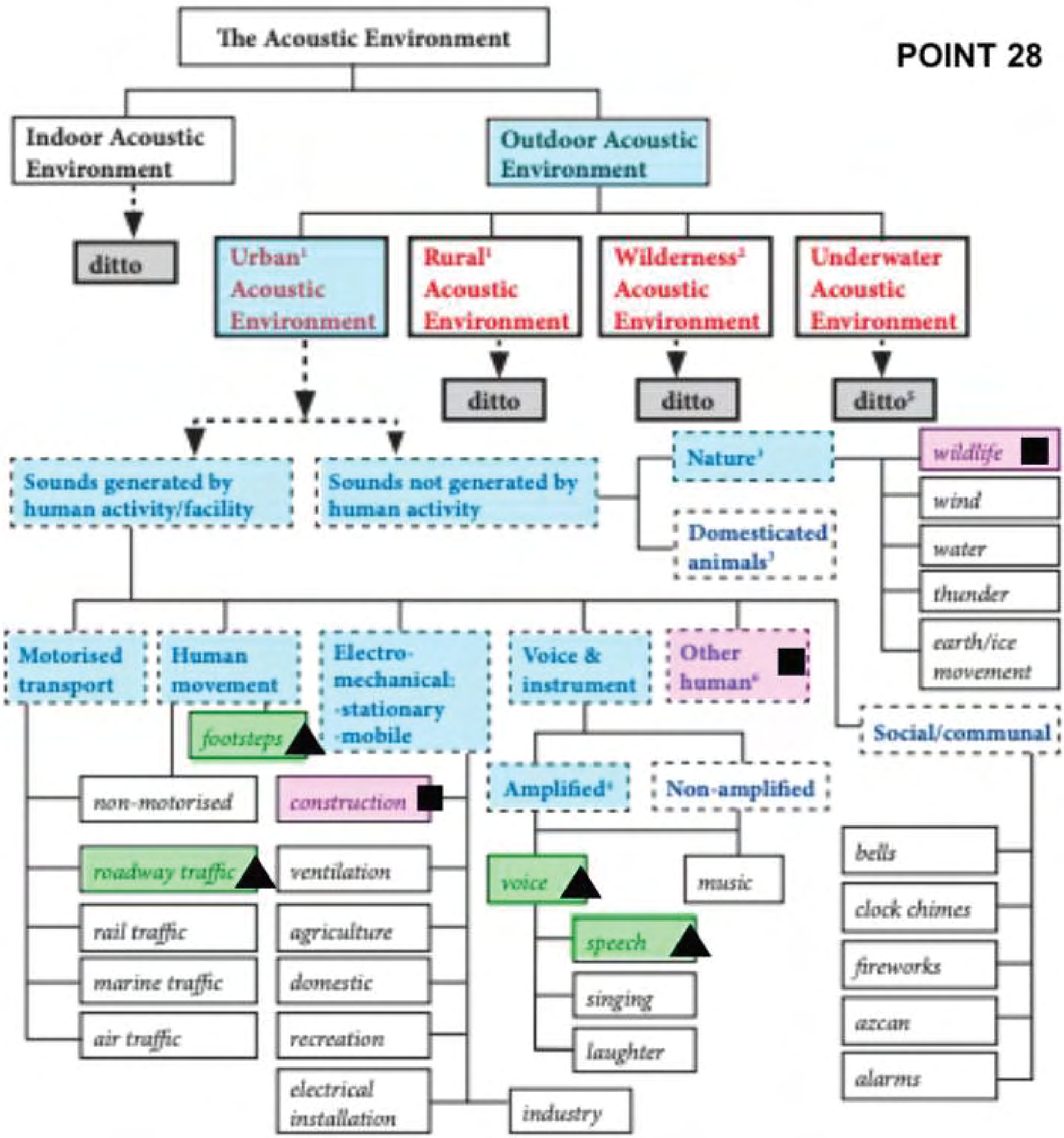


Figure 85. Sound Taxonomy Analysis Point 28 (Green / ⬤ : Dominant, Red / ■ : Medium, Yellow / ▲: Vague)

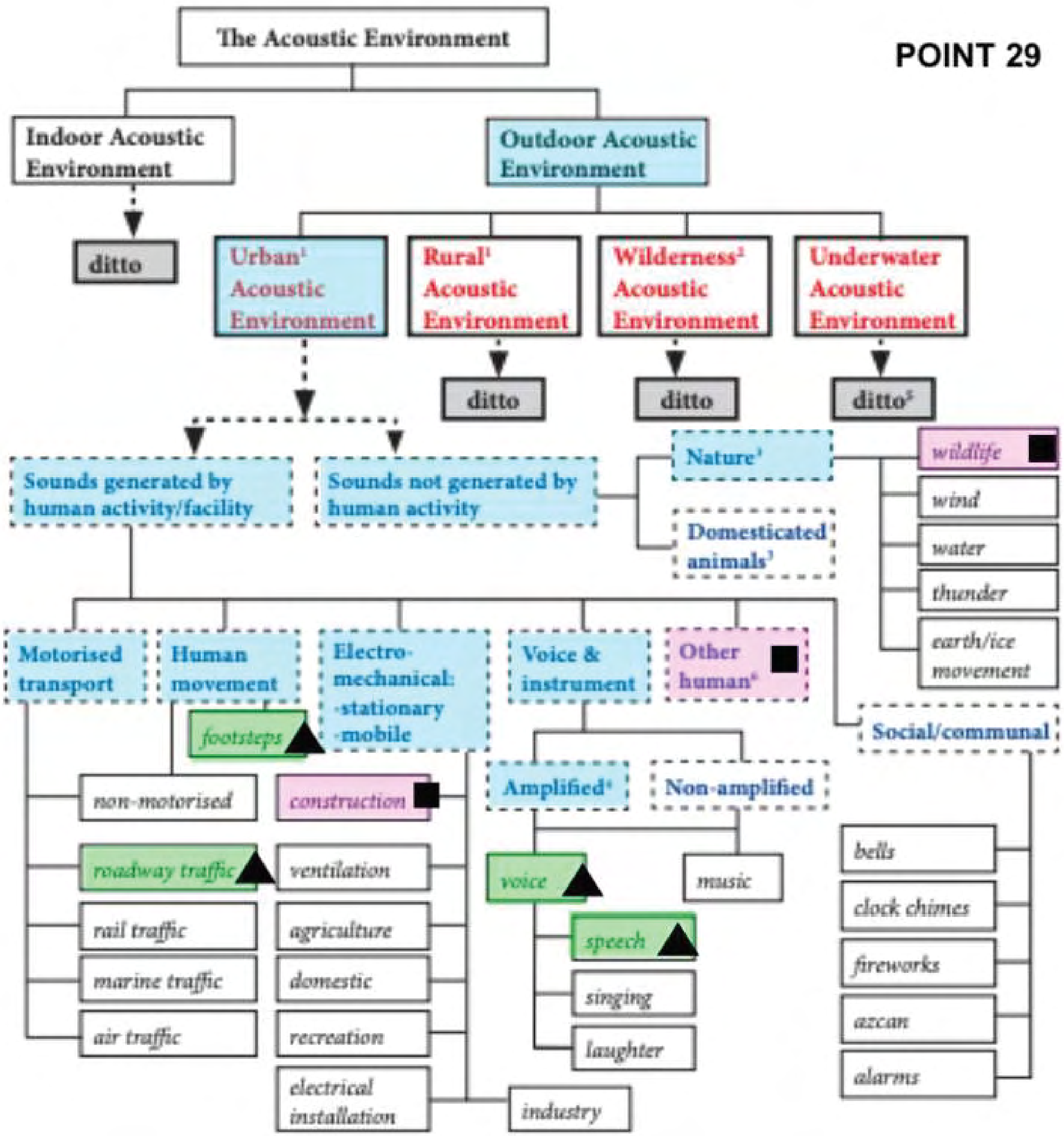


Figure 86. Sound Taxonomy Analysis Point 29 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

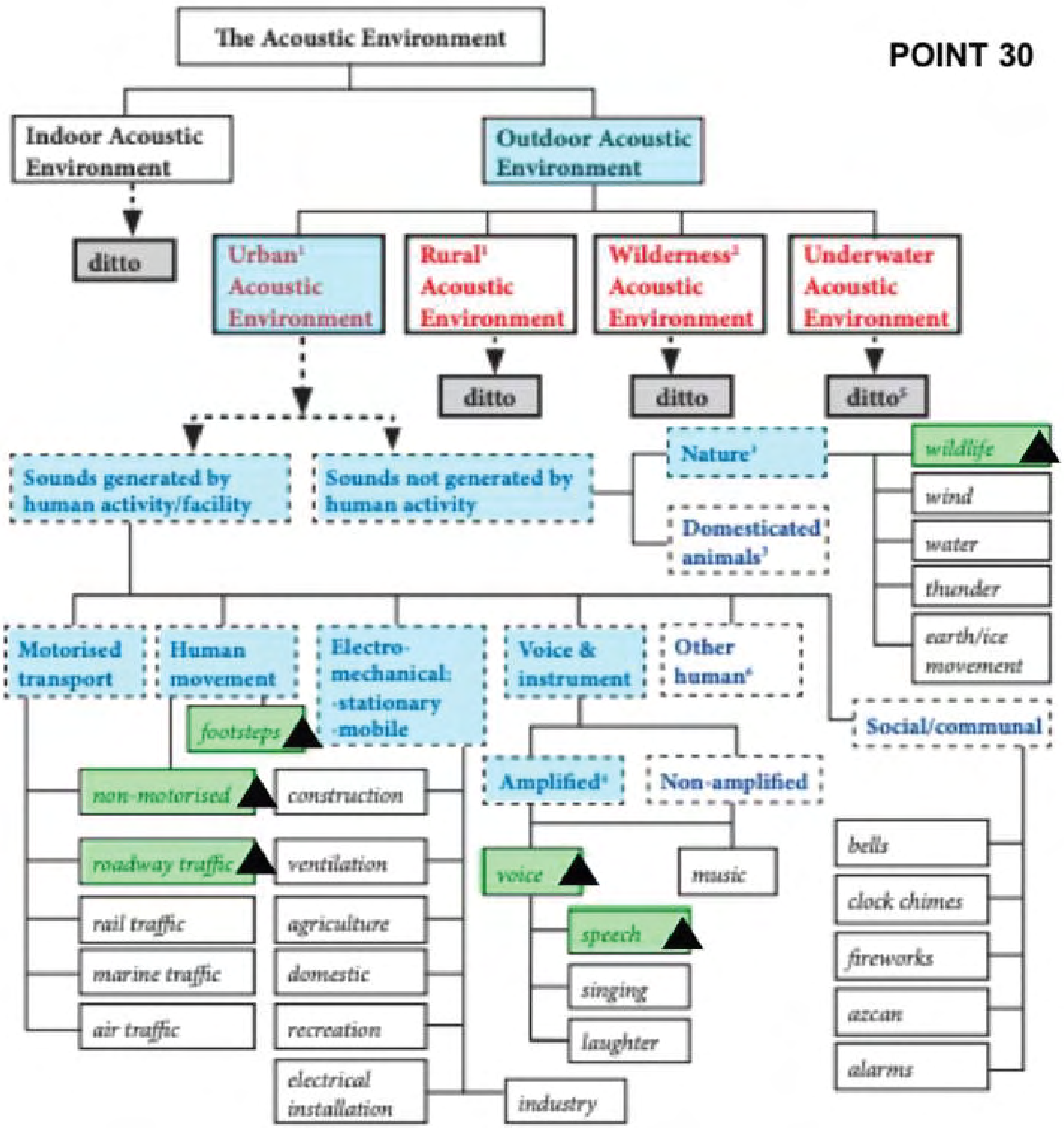


Figure 87. Sound Taxonomy Analysis Point 30 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

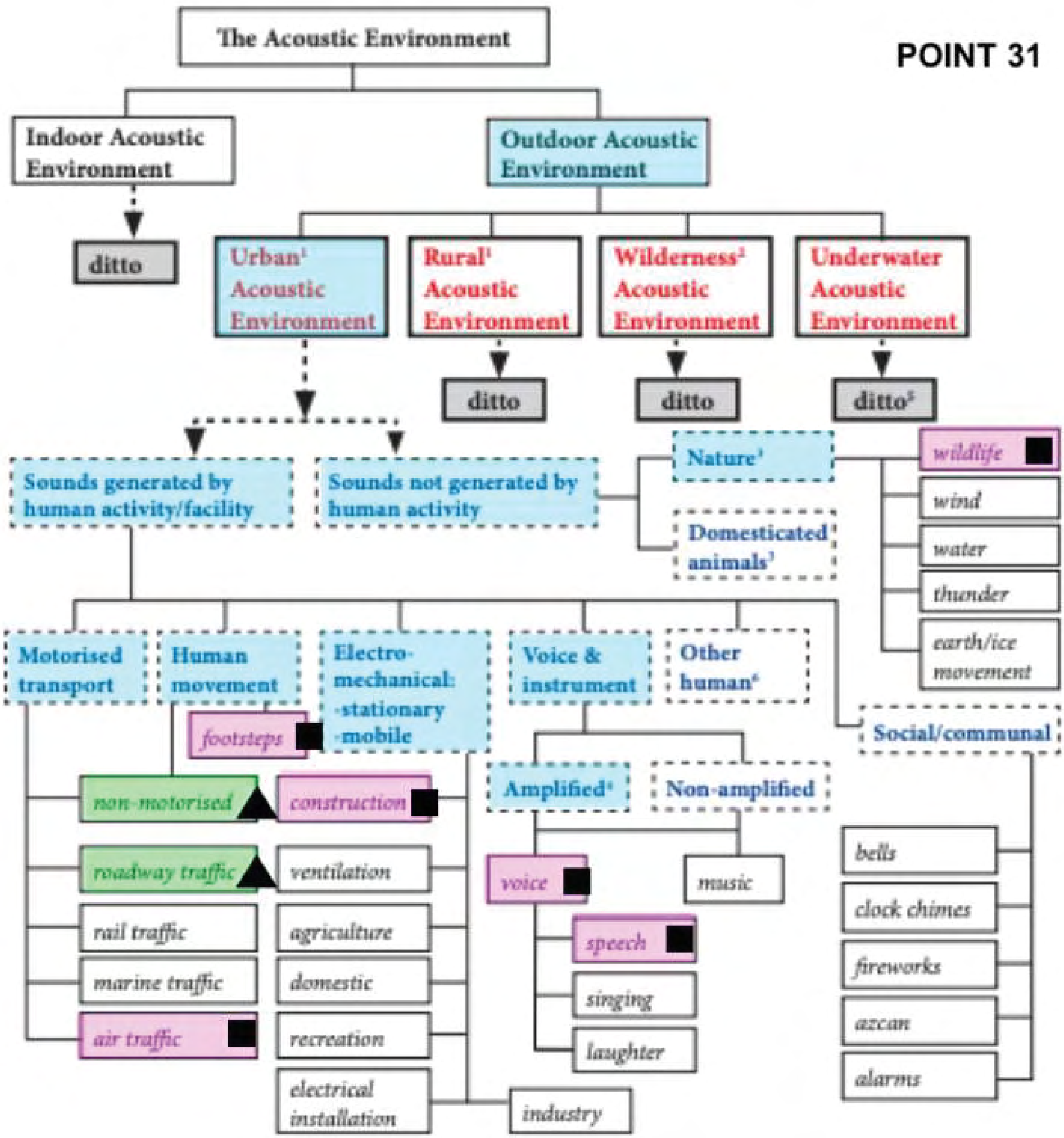


Figure 88. Sound Taxonomy Analysis Point 31 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

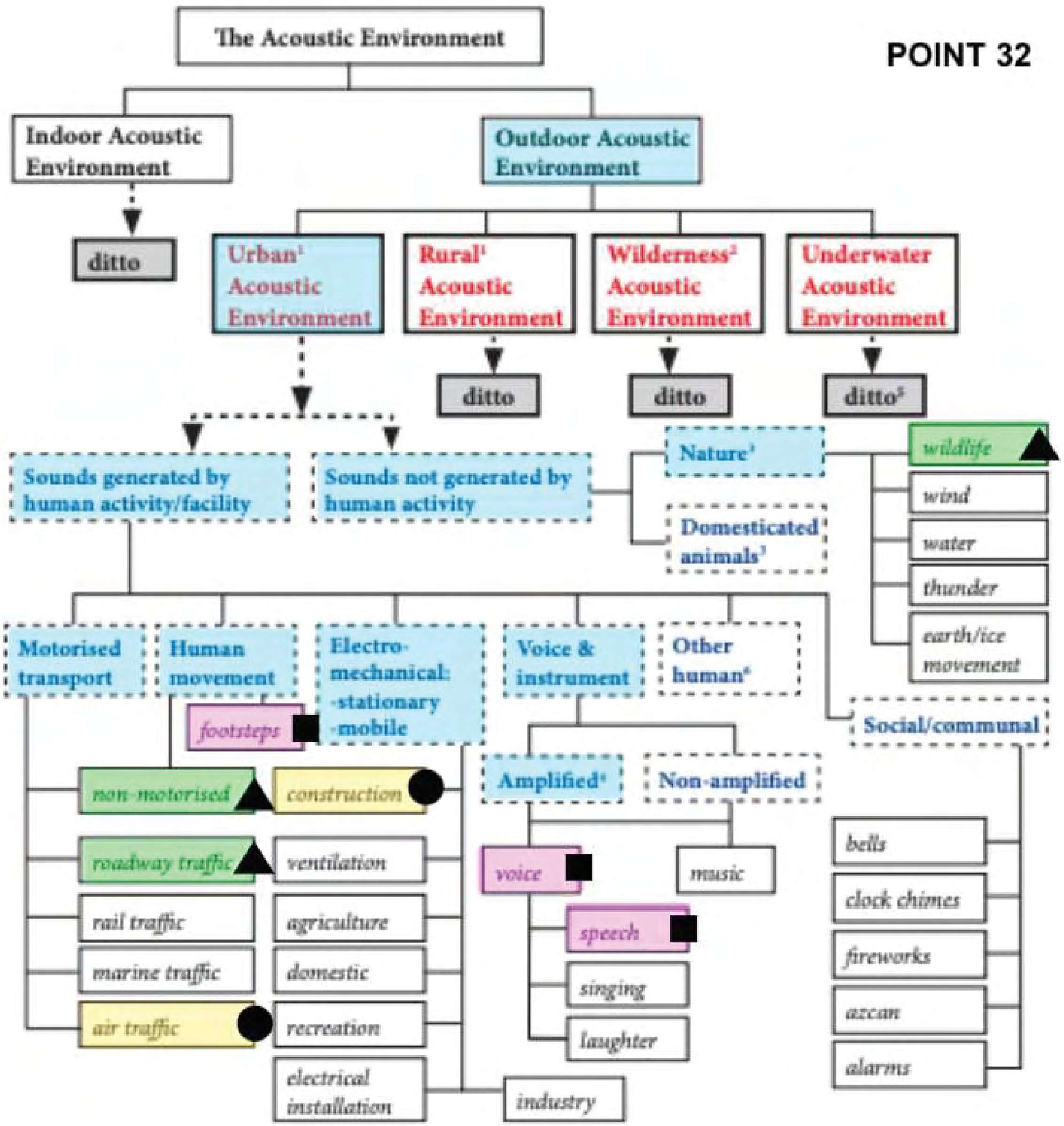


Figure 89. Sound Taxonomy Analysis Point 32 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

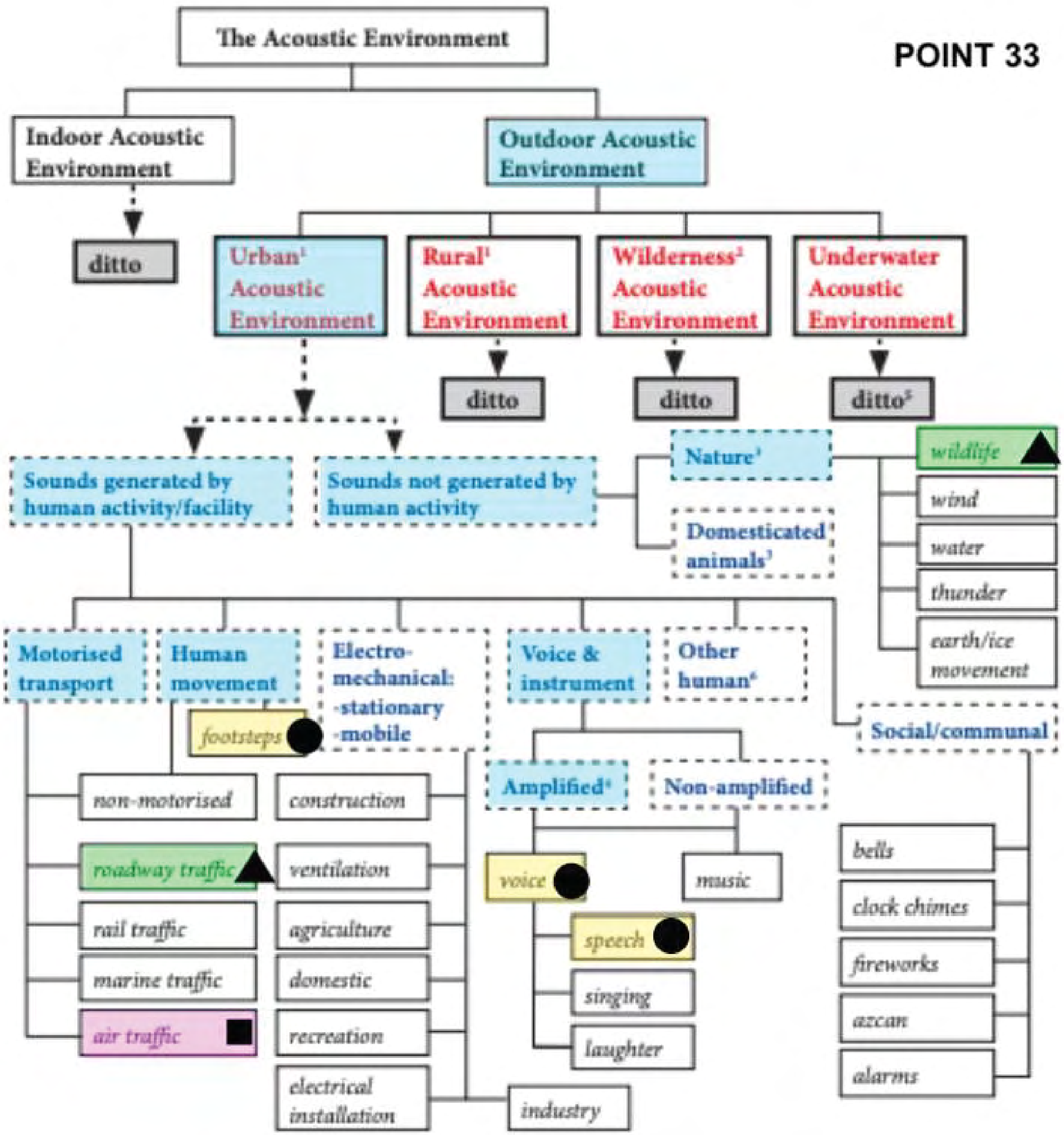


Figure 90. Sound Taxonomy Analysis Point 33 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

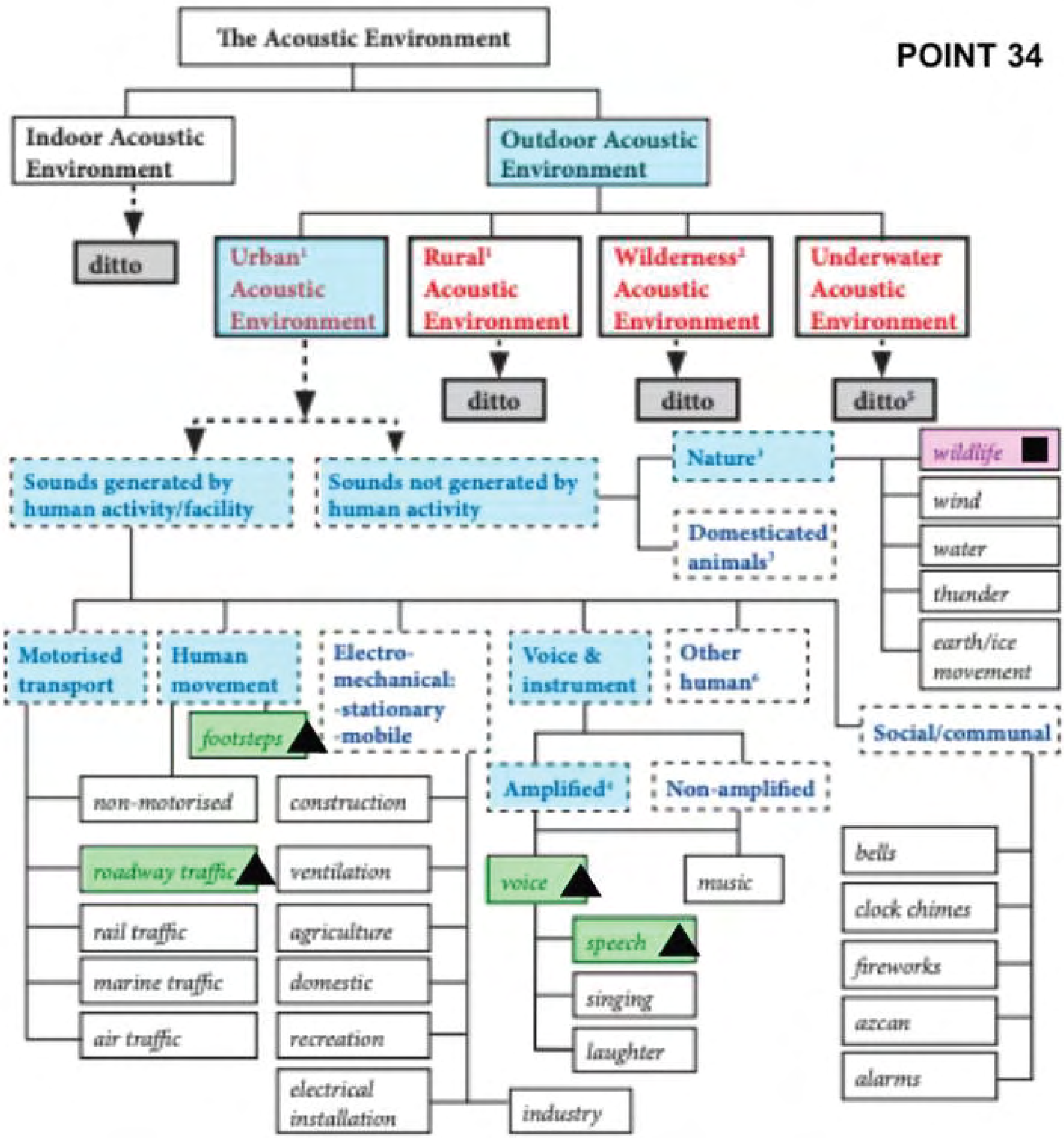


Figure 91. Sound Taxonomy Analysis Point 34 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

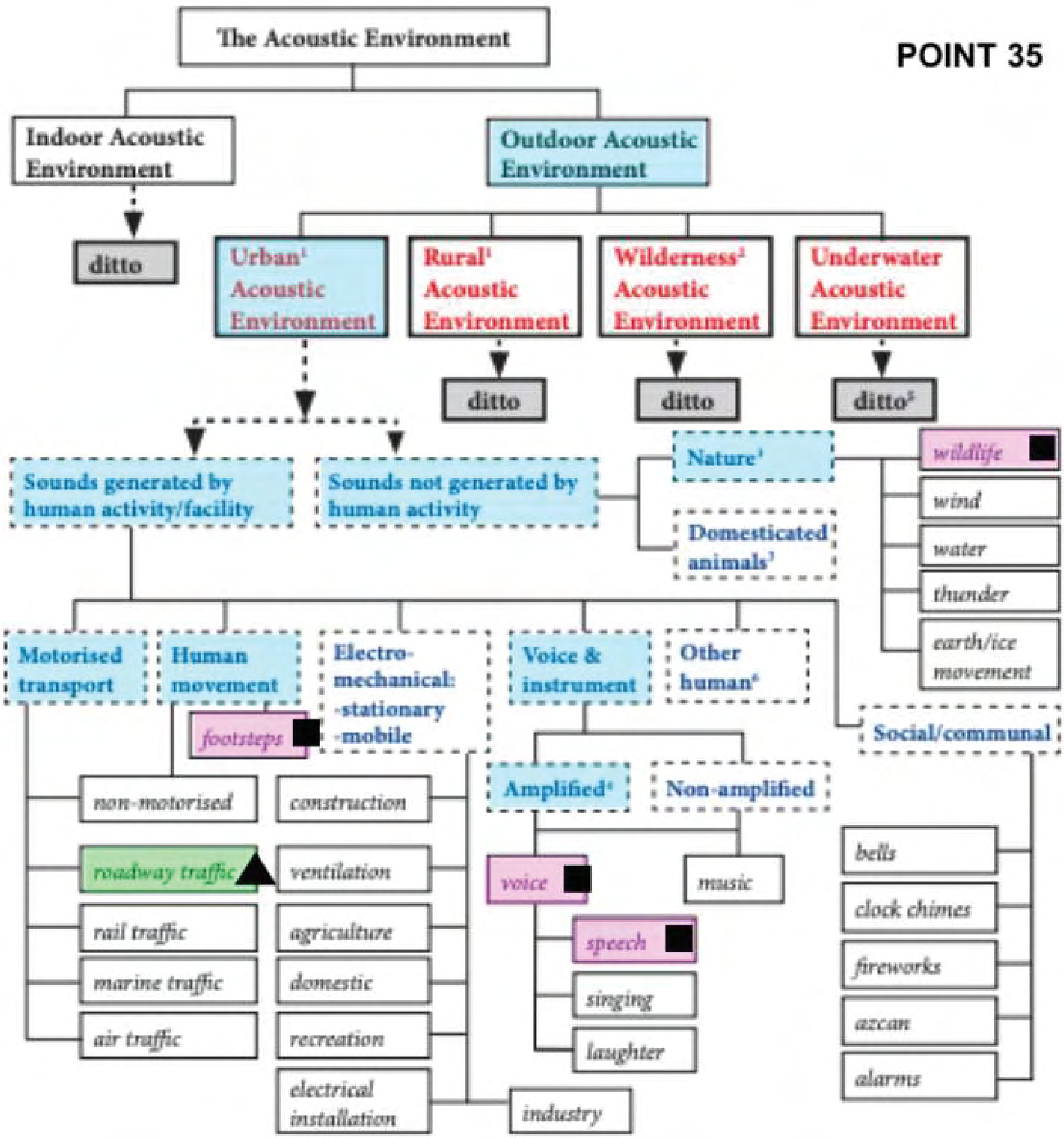


Figure 92. Sound Taxonomy Analysis Point 35 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

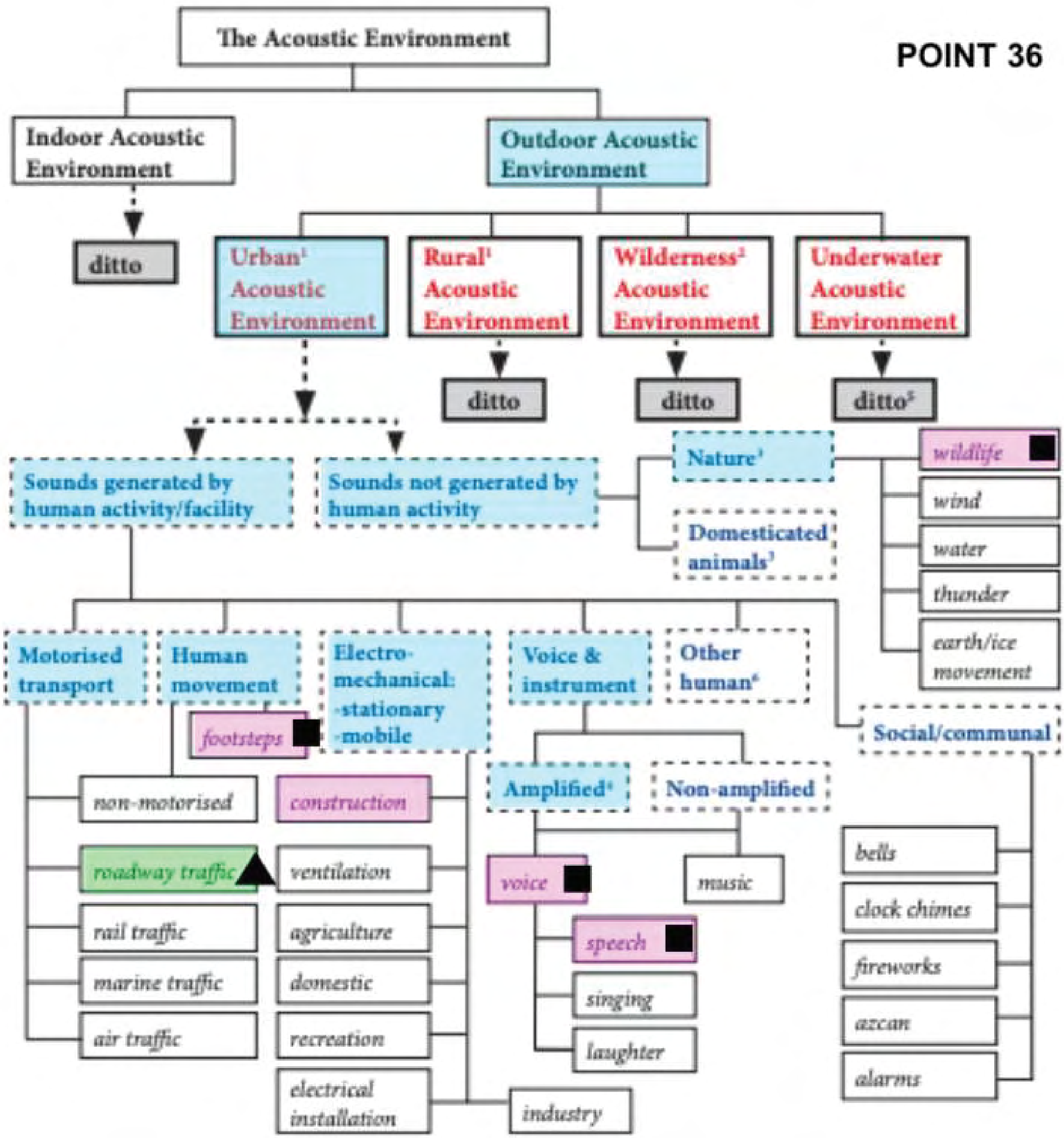


Figure 93. Sound Taxonomy Analysis Point 36 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

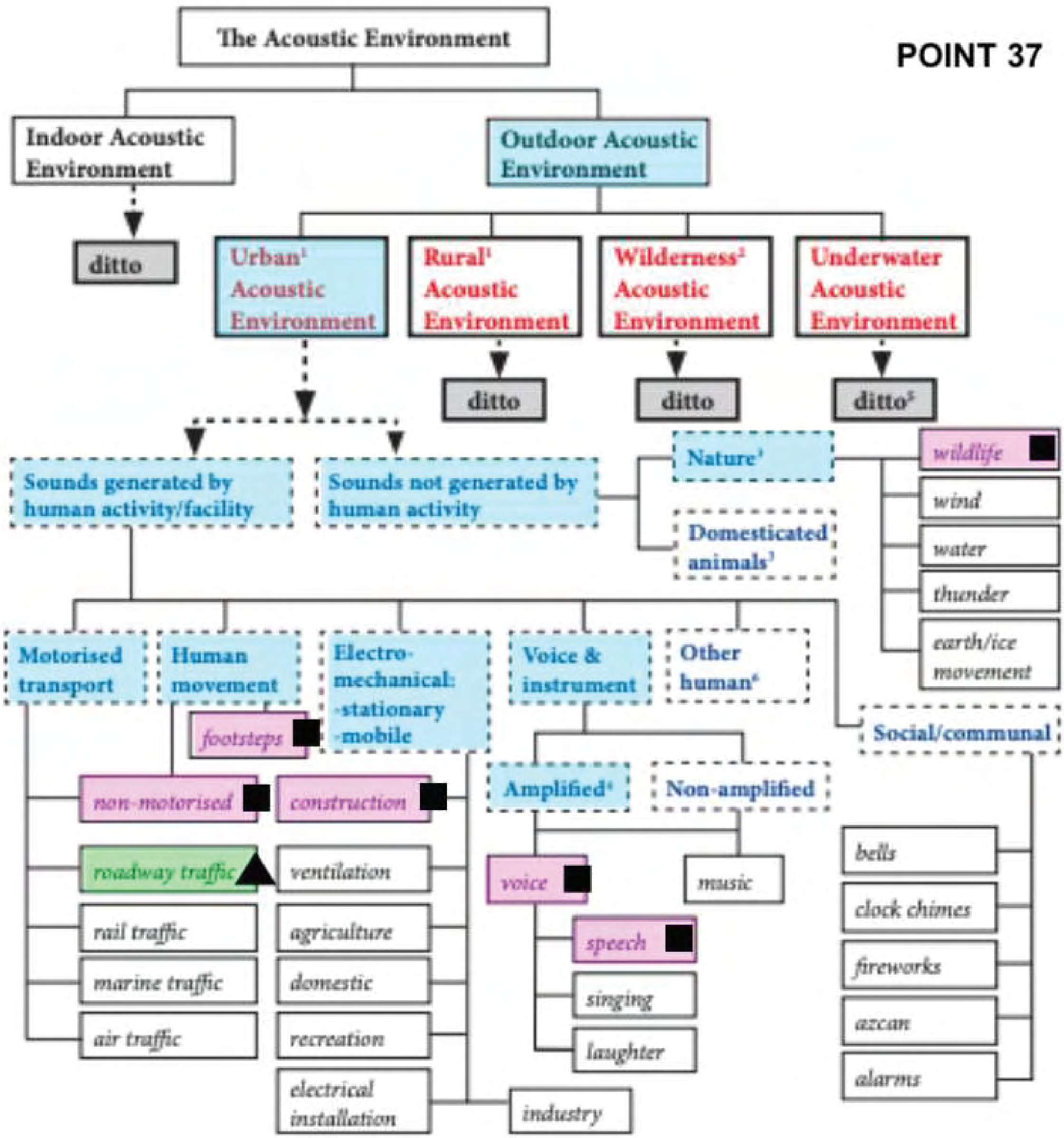


Figure 94. Sound Taxonomy Analysis Point 37 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

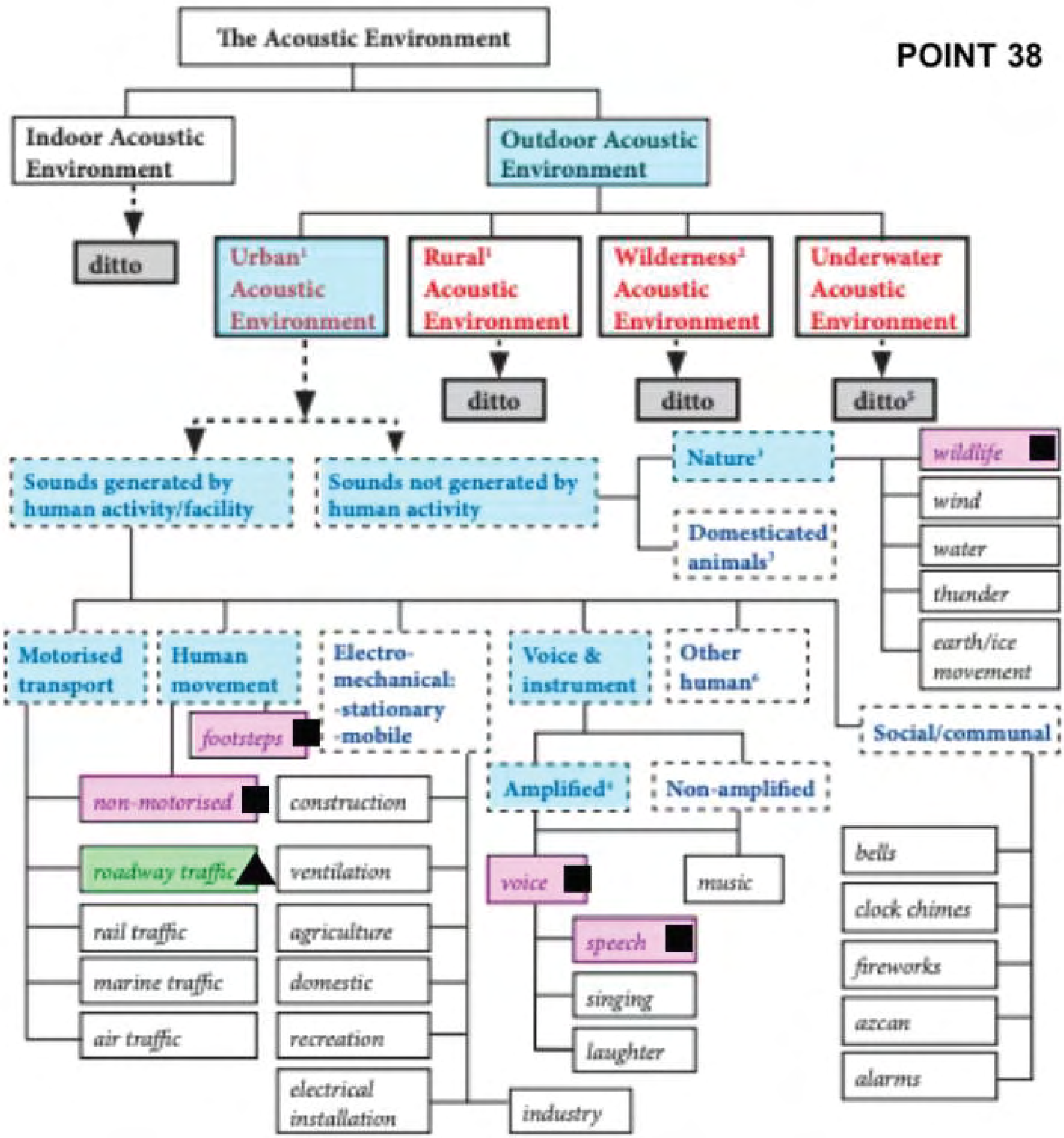


Figure 95. Sound Taxonomy Analysis Point 38 (Green / ●: Dominant, Red / ■: Medium, Yellow / ▲: Vague)

Appendix 7. Binary Logistic Regression of the Weekend Data

Table 59. Binary Logistic Regression of the Weekend Data

		WEEKEND - DAY 2					
Response	Predictors	EQUATION	Coef	SE Coef	Z-value	P-Value	VIF
Sound Quality Zone	SGC	Y'= 6.10 - 0.00357 SGC	-0.00357	0.00253	-1.41	0.158	1
Sound Quality Zone	NDSI	Y'=-0.13 2 - 6.23 NDSI	-6.23	4.4	-1.42	0.157	1
Sound Quality Zone	B/A	Y'= 32.2 - 34.2 B/A	-34.2	22.9	-1.5	0.134	1
Sound Quality Zone	PA	Y'=-0.33 + 0.0025 PAnnoyance	0.0025	0.0436	0.06	0.954	1
Sound Quality Zone	TSLV	Y'=-1.244 + 0.1136 TSLV	0.1136	0.0993	1.14	0.253	1
Sound Quality Zone	Sound Power - Leq	Y'=-0.325 + 0.115 SoundPower Leq	0.115	0.98	0.12	0.906	1
Sound Quality Zone	Sound Power - LAeq	Y'= 0.42 -1.86 SoundPower LAeq	-1.86	2.88	-0.64	0.519	1
Sound Quality Zone	N	Y'= 0.64 - 0.0318 N	-0.0318	0.0875	-0.36	0.716	1
Sound Quality Zone	Nmax	Y'= -0.73 + 0.0065 Nmax	0.0065	0.0225	0.29	0.774	1
Sound Quality Zone	N5	Y'= -0.34 + 0.0031 N5	0.0031	0.0461	0.07	0.947	1
Sound Quality Zone	Sharpness	Y'= 3.85 - 2.81 Sharpness	-2.81	5.58	-0.5	0.615	1
Sound Quality Zone	Roughness	Y'= 0.85 - 6.4 Roughness	-6.4	17	-0.38	0.707	1
Sound Quality Zone	Fluctuation Strength	Y'= -0.880 + 9.4 Fluctuation Strength	9.4	12.1	0.78	0.435	1
Annoying Zone	SGC	Y'= -1.31 + 0.00020 SGC	0.0002	0.00233	0.08	0.932	1
Annoying Zone	NDSI	Y'= -0.952 -0.15 NDSI	-0.15	3.98	-0.04	0.97	1
Annoying Zone	B/A	Y'= -4.1 + 3.4 B/A	3.4	20.4	0.16	0.869	1
Annoying Zone	PA	Y'= 0.29 - 0.0312 PAnnoyance	-0.0312	0.0536	-0.58	0.561	1
Annoying Zone	TSLV	Y'= 0.96 - 0.257 TSLV	-0.257	0.188	-1.37	0.171	1
Annoying Zone	Sound Power - Leq	Y'=-0.43 - 0.62 SoundPower Leq	-0.62	1.2	-0.52	0.605	1
Annoying Zone	Sound Power - LAeq	Y'= -0.73 - 0.64 SoundPower LAeq	-0.64	3.07	-0.21	0.835	1
Annoying Zone	N	Y'= -0.61 - 0.0129 N	-0.0129	0.0967	-0.13	0.894	1
Annoying Zone	Nmax	Y'= 0.36 - 0.0173 Nmax	-0.0173	0.0257	-0.67	0.5	1
Annoying Zone	N5	Y'= 0.24 - 0.0318 N5	-0.0318	0.056	-0.57	0.57	1
Annoying Zone	Sharpness	Y'= 1.87-1.95 Sharpness	-1.95	6.23	-0.31	0.754	1
Annoying Zone	Roughness	Y'= -1.62 - 4 Roughness	4	19	0.21	0.835	1
Annoying Zone	Fluctuation Strength	Y'= 1.14 - 35.4 Fluctuation Strength	-35.4	33.8	-1.05	0.296	1
Pleasant Zone	SGC	Y'= 1.31 - 0.00020 SGC	-0.0002	0.00233	-0.08	0.932	1
Pleasant Zone	NDSI	Y'= 0.952 + 0.15 NDSI	0.15	3.98	0.04	0.97	1
Pleasant Zone	B/A	Y'= 4.1 - 3.4 B/A	-3.4	20.4	-0.16	0.869	1
Pleasant Zone	PA	Y'= -0.29 + 0.0312 PAnnoyance	0.0312	0.0536	0.58	0.561	1

Pleasant Zone	TSLV	Y'= -0.96 + 0.257 TSLV	0.257	0.188	1.37	0.171	1
Pleasant Zone	Sound Power - Leq	Y'= 0.43 + 0.62 SoundPower Leq	0.62	-1.2	0.52	0.605	1
Pleasant Zone	Sound Power - LAeq	Y'= 0.73 + 0.64 SoundPower LAeq	0.64	-3.07	0.21	0.835	1
Pleasant Zone	N	Y'= 0.61 + 0.0129 N	0.0129	-0.0967	0.13	0.894	1
Pleasant Zone	Nmax	Y'= -0.36 + 0.0173 Nmax	0.0173	-0.0257	0.67	0.5	1
Pleasant Zone	N5	Y'= -0.24 + 0.0318 N5	0.0318	-0.056	0.57	0.57	1
Pleasant Zone	Sharpness	Y'= -1.87 + 1.95 Sharpness	1.95	-6.23	0.31	0.754	1
Pleasant Zone	Roughness	Y'= 1.62 + 4 Roughness	-4	-19	-0.21	0.835	1
Pleasant Zone	Fluctuation Strength	Y'= 1.14 - 35.4 Fluctuation Strength	35.4	-33.8	1.05	0.296	1
Uneventful Zone	SGC	Y'= 7.6 - 0.00539 SGC	-0.00539	0.00425	-1.27	0.205	1
Uneventful Zone	NDSI	Y' = -2.14 - 14.4 NDSI	-14.4	10.1	-1.43	0.152	1
Uneventful Zone	B/A	Y'= 21.2 - 24.1 B/A	-24.1	28	-0.86	0.389	1
Uneventful Zone	PA	Y'= -6.7 + 0.1136 PAnnoyance	0.1136	0.0669	1.7	0.089	1
Uneventful Zone	TSLV	Y'= -2.09 + 0.0487 TSLV	0.0487	0.0844	0.58	0.564	1
Uneventful Zone	Sound Power - Leq	Y'= -2.17 + 0.6 SoundPower Leq	0.6	1.23	0.49	0.623	1
Uneventful Zone	Sound Power - LAeq	Y'= -2.63 + 2.69 SoundPower LAeq	2.69	3.13	0.86	0.391	1
Uneventful Zone	N	Y'= -6.68 + 0.175 N	0.175	0.126	1.39	0.163	1
Uneventful Zone	Nmax	Y'= -4.81 + 0.0384 Nmax	0.0384	0.0347	1.11	0.269	1
Uneventful Zone	N5	Y'= -6.82 + 0.1231 N5	0.1231	0.0719	1.71	0.087	1
Uneventful Zone	Sharpness	Y'= 14.1 - 11 Sharpness	-11	10.6	-1.04	0.296	1
Uneventful Zone	Roughness	Y'= 6.28 - 50.7 Roughness	-50.7	30.8	-1.64	0.1	1
Uneventful Zone	Fluctuation Strength	Y'= -4.7 + 40.5 Fluctuation Strength	40.5	33.9	1.19	0.232	1
Eventful Zone	SGC	Y'= -7.6 + 0.00539 SGC	0.00539	0.00425	1.27	0.205	1
Eventful Zone	NDSI	Y' = 2.14 + 14.4 NDSI	14.4	10.1	1.43	0.152	1
Eventful Zone	B/A	Y'= -21.2 + 24.1 B/A	24.1	28	0.86	0.389	1
Eventful Zone	PA	Y'= 6.7 - 0.1136 PAnnoyance	-0.1136	0.0669	-1.7	0.089	1
Eventful Zone	TSLV	Y'= 2.09 - 0.0487 TSLV	-0.0487	0.0844	-0.58	0.564	1
Eventful Zone	Sound Power - Leq	Y'= 2.17 - 0.6 SoundPower Leq	-0.6	-1.23	-0.49	0.623	1
Eventful Zone	Sound Power - LAeq	Y'= 2.63 - 2.69 SoundPower LAeq	-2.69	-3.13	-0.86	0.391	1
Eventful Zone	N	Y'= 6.68 - 0.175 N	-0.175	-0.126	-1.39	0.163	1
Eventful Zone	Nmax	Y'= 4.81 - 0.0384 Nmax	-0.0384	-0.0347	-1.11	0.269	1
Eventful Zone	N5	Y'= 6.82 - 0.1231 N5	-0.1231	-0.0719	-1.71	0.087	1
Eventful Zone	Sharpness	Y'= -14.1 + 11 Sharpness	11	-10.6	1.04	0.296	1
Eventful Zone	Roughness	Y'= -6.28 + 50.7 Roughness	50.7	-30.8	1.64	0.1	1
Eventful Zone	Fluctuation Strength	Y'= 4.7 - 40.5 Fluctuation Strength	-40.5	-33.9	-1.19	0.232	1

Outside Sound Quality Zone Zone	SGC	Y'= -5.01 + 0.00254 SGC	0.00254	0.00229	1.11	0.268	1
Outside Sound Quality Zone Zone	NDSI	Y'= -0.542 + 3.11 NDSI	3.11	3.73	0.83	0.405	1
Outside Sound Quality Zone Zone	B/A	Y'= -12.8 + 13 B/A	13	19.2	0.67	0.5	1
Outside Sound Quality Zone Zone	PA	Y'= 3.19 - 0.0928 PAnnoyance	-0.0928	0.0632	-1.47	0.142	1
Outside Sound Quality Zone Zone	TSLV	Y'= 1.53 - 0.252 TSLV	-0.252	0.168	-1.49	0.135	1
Outside Sound Quality Zone Zone	Sound Power - Leq	Y'= 1.85 - 2.97 SoundPower Leq	-2.97	1.81	-1.64	0.101	1
Outside Sound Quality Zone Zone	Sound Power - LAeq	Y'= 2.14 - 8.25 SoundPower LAeq	-8.25	5.44	-1.52	0.129	1
Outside Sound Quality Zone Zone	N	Y'= 3.66 - 0.154 N	-0.154	0.11	-1.41	0.16	1
Outside Sound Quality Zone Zone	Nmax	Y'= 2.14 - 0.0338 Nmax	-0.0339	0.0256	-1.32	0.185	1
Outside Sound Quality Zone Zone	N5	Y'= 3.45 - 0.1058 N5	-0.1058	0.0683	-1.55	0.122	1
Outside Sound Quality Zone Zone	Sharpness	Y'= -8.76 + 5.71 Sharpnesss	5.71	5.81	0.98	0.316	1
Outside Sound Quality Zone Zone	Roughness	Y'= -2.83 + 14.1 Roughness	14.1	18.1	0.78	0.437	1
Outside Sound Quality Zone Zone	Fluctuation Strength	Y'= -0.187 - 3.8 Fluctuation Strength	-3.8	11.2	-0.34	0.734	1
[redacted]							

Appendix 8. Raw Data

Table 60. Raw Data of Leq, LAeq and SGC

Site Data		Leq (dB)			LAeq (dBA)			SGC (Hz)		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
13/03/2021 12:39:03 PM (1615639144)	2A1	73.70	73.15	76.44	67.30	66.72	70.03	1633.88	1707.04	1670.46
13/03/2021 12:42:03 PM (1615639324)	2A2	74.57	74.22	77.41	67.70	67.58	70.65	1474.26	1546.13	1510.20
13/03/2021 12:45:03 PM (1615639504)	2A3	76.18	76.06	79.13	66.67	65.07	68.95	1564.20	1527.67	1545.94
	2A	74.94	74.65	77.81	67.24	66.58	69.93	1557.45	1593.61	1575.53
13/03/2021 1:17:52 PM (1615641473)	2B1	74.43	72.75	76.68	69.70	67.32	71.68	1992.22	1939.55	1965.89
13/03/2021 1:20:52 PM (1615641653)	2B2	76.60	75.82	79.24	69.24	67.19	71.35	1988.88	1860.29	1924.59
13/03/2021 1:23:52 PM (1615641833)	2B3	74.29	73.18	76.78	72.42	70.31	74.50	2560.64	2276.20	2418.42
	2B	75.24	74.14	77.74	70.69	68.53	72.75	2180.58	2025.35	2102.96
Point 2	**Point 2**	**75.09**	**74.40**	**77.77**	**69.30**	**67.66**	**71.57**	**1869.01**	**1809.48**	**1839.25**
13/03/2021 1:56:50 PM (1615643811)	3A1	73.09	73.33	73.21	67.04	65.14	66.09	1988.60	2002.32	1995.46
13/03/2021 1:59:50 PM (1615643991)	3A2	73.78	73.36	73.57	65.85	64.41	65.13	1894.99	1776.53	1835.76
13/03/2021 2:02:50 PM (1615644171)	3A3	74.57	73.85	74.21	65.61	63.86	64.74	1858.27	1732.10	1795.19
Point 3	**Point 3**	**73.86**	**73.52**	**73.68**	**66.21**	**64.50**	**65.36**	**1913.95**	**1836.98**	**1875.47**
13/03/2021 2:23:28 PM (1615645409)	4A1	76.99	76.65	76.82	68.33	68.68	68.51	1971.51	2075.80	2023.66
13/03/2021 2:26:28 PM (1615645589)	4A2	74.16	73.57	73.87	66.81	64.30	65.56	1869.90	1663.05	1766.48
13/03/2021 2:29:28 PM (1615645769)	4A3	78.97	77.17	78.07	67.05	65.99	66.52	1866.64	1702.51	1784.58
Point 4	**Point 4**	**77.13**	**76.06**	**76.58**	**67.45**	**66.70**	**67.04**	**1902.68**	**1813.79**	**1858.24**
13/03/2021 2:39:26 PM (1615646367)	5A1	71.14	70.90	71.02	64.02	62.18	63.10	1738.96	1514.36	1626.66
13/03/2021 2:42:26 PM (1615646547)	5A2	70.08	69.85	69.97	63.70	63.56	63.63	2130.92	2114.84	2122.88
13/03/2021 2:45:26 PM (1615646727)	5A3	69.87	69.30	69.59	64.74	64.20	64.47	2291.53	2464.79	2378.16
Point 5	**Point 5**	**70.40**	**70.07**	**70.23**	**64.18**	**63.39**	**63.77**	**2053.80**	**2031.33**	**2042.57**
13/03/2021 2:59:10 PM (1615647551)	6A1	75.22	73.09	74.16	70.70	65.69	68.20	1647.25	1532.12	1589.69
13/03/2021 3:02:10 PM (1615647731)	6A2	80.94	79.40	80.17	70.78	65.64	68.21	1700.43	1634.05	1667.24
13/03/2021 3:05:10 PM (1615647911)	6A3	74.31	71.85	73.08	71.36	66.98	69.17	1666.79	1652.14	1659.47
Point 6	**Point 6**	**77.89**	**76.12**	**77.00**	**70.96**	**66.15**	**68.55**	**1671.49**	**1606.10**	**1638.80**
13/03/2021 3:15:19 PM (1615648520)	7A1	72.50	75.21	73.86	64.20	62.09	63.15	2591.02	2015.67	2303.35
13/03/2021 3:18:19 PM (1615648700)	7A2	69.99	70.36	70.18	62.50	62.98	62.74	1770.92	1851.12	1811.02
13/03/2021 3:21:19 PM (1615648880)	7A3	68.64	68.23	68.44	62.49	62.21	62.35	1723.68	1681.19	1702.44
Point 7	**Point 7**	**70.68**	**72.28**	**71.43**	**63.14**	**62.44**	**62.76**	**2028.54**	**1849.33**	**1938.93**
13/03/2021 3:26:32 PM (1615649193)	8A1	71.42	69.75	70.59	62.81	64.30	63.56	1884.11	1894.47	1889.29
13/03/2021 3:29:32 PM (1615649373)	8A2	69.95	71.95	70.95	61.54	59.41	60.48	1628.49	1456.16	1542.33
13/03/2021 3:32:32 PM (1615649553)	8A3	70.10	69.59	69.85	62.36	61.42	61.89	1697.24	1657.51	1677.38
Point 8	**Point 8**	**70.54**	**70.57**	**70.48**	**62.27**	**62.18**	**62.16**	**1736.61**	**1669.38**	**1703.00**
13/03/2021 3:40:05 PM (1615650006)	9A1	78.25	78.38	78.32	62.64	61.91	62.28	1627.03	1691.11	1659.07
13/03/2021 3:43:05 PM (1615650186)	9A2	71.66	71.58	71.62	62.32	61.70	62.01	1895.52	2016.39	1955.96
13/03/2021 3:46:05 PM (1615650366)	9A3	83.53	84.02	83.78	62.31	61.89	62.10	1336.86	1283.48	1310.17
Point 9	**Point 9**	**80.10**	**80.49**	**80.29**	**62.43**	**61.83**	**62.13**	**1619.80**	**1663.66**	**1641.73**
13/03/2021 4:26:34 PM (1615652795)	10A1	70.41	69.89	70.15	65.34	64.33	64.84	2152.12	1963.91	2058.02
13/03/2021 4:29:34 PM (1615652975)	10A2	70.79	69.66	70.23	65.77	63.71	64.74	1747.10	1911.39	1829.25
13/03/2021 4:32:34 PM (1615653155)	10A3	67.43	66.84	67.14	61.23	60.17	60.70	1760.17	1598.18	1679.18
Point 10	**Point 10**	**69.78**	**69.00**	**69.39**	**64.53**	**63.08**	**63.80**	**1886.46**	**1824.49**	**1855.48**
13/03/2021 4:41:50 PM (1615653711)	11A1	70.54	70.86	70.70	59.93	59.32	59.63	1703.43	1707.90	1705.67
13/03/2021 4:44:50 PM (1615653891)	11A2	71.26	69.78	70.52	68.22	67.00	67.61	1967.66	1910.01	1938.84
13/03/2021 4:47:50 PM (1615654071)	11A3	70.05	69.07	69.56	62.08	60.86	61.47	1705.90	1602.94	1654.42
Point 11	**Point 11**	**70.65**	**69.97**	**70.29**	**64.88**	**63.73**	**64.31**	**1792.33**	**1740.28**	**1766.31**
13/03/2021 4:53:47 PM (1615654428)	12A1	67.62	66.77	67.20	58.95	58.86	58.91	2118.35	1762.93	1940.64
13/03/2021 4:56:47 PM (1615654608)	12A2	67.55	67.23	67.39	58.15	59.59	58.87	1474.53	1569.30	1521.92
13/03/2021 4:59:47 PM (1615654788)	12A3	68.23	66.64	67.44	58.14	60.38	59.26	1524.44	1520.59	1522.52
Point 12	**Point 12**	**67.81**	**66.89**	**67.34**	**58.43**	**59.65**	**59.02**	**1705.77**	**1617.61**	**1661.69**
13/03/2021 5:08:43 PM (1615655324)	13A1	73.89	72.73	73.31	70.34	66.47	68.41	1651.40	1440.68	1546.04
13/03/2021 5:11:43 PM (1615655504)	13A2	73.46	72.15	72.81	69.17	67.25	68.21	1628.65	1609.32	1618.99
13/03/2021 5:14:43 PM (1615655684)	13A3	74.05	73.89	73.97	67.36	68.62	67.99	1405.95	1419.70	1412.83
Point 13	**Point 13**	**73.81**	**72.98**	**73.39**	**69.12**	**67.54**	**68.20**	**1562.00**	**1489.90**	**1525.95**
13/03/2021 5:20:12 PM (1615656013)	14A1	67.81	67.35	67.58	62.64	62.66	62.65	1914.06	2108.48	2011.27
13/03/2021 5:23:12 PM (1615656193)	14A2	66.43	65.54	65.99	59.86	59.24	59.55	1490.94	1579.06	1535.00
13/03/2021 5:26:12 PM (1615656373)	14A3	68.92	67.77	68.35	62.57	61.32	61.95	1368.60	1405.57	1387.09
Point 14	**Point 14**	**67.84**	**66.99**	**67.41**	**61.87**	**61.29**	**61.57**	**1591.20**	**1697.70**	**1644.45**
13/03/2021 5:31:43 PM (1615656704)	15A1	69.39	68.94	69.17	60.80	60.55	60.68	1327.14	1397.41	1362.28
13/03/2021 5:34:43 PM (1615656884)	15A2	68.94	68.94	68.94	60.55	60.55	60.55	1397.41	1397.41	1397.41
13/03/2021 5:37:43 PM (1615657064)	15A3	68.03	67.20	67.62	60.36	59.11	59.74	1450.16	1428.91	1439.54
Point 15	**Point 15**	**68.82**	**68.43**	**68.63**	**60.57**	**60.12**	**60.34**	**1391.57**	**1407.91**	**1399.74**
13/03/2021 5:53:36 PM (1615658017)	16A1	66.25	66.24	66.25	60.55	61.82	61.19	1645.29	1724.58	1684.94
13/03/2021 5:56:36 PM (1615658197)	16A2	66.11	66.01	66.06	58.88	60.36	59.62	1470.87	1548.25	1509.56
13/03/2021 5:59:36 PM (1615658377)	16A3	65.82	65.75	65.79	59.80	60.77	60.29	1551.71	1585.81	1568.76
Point 16	**Point 16**	**66.06**	**66.00**	**66.03**	**59.80**	**61.03**	**60.41**	**1555.96**	**1619.55**	**1587.75**
13/03/2021 6:18:49 PM (1615659530)	17A1	65.75	65.75	65.75	60.77	60.77	60.77	1585.81	1585.81	1585.81
13/03/2021 6:21:49 PM (1615659710)	17A2	66.30	65.32	65.81	60.37	57.78	59.08	2881.02	2081.68	2481.35
13/03/2021 6:24:49 PM (1615659890)	17A3	67.65	66.27	66.96	64.17	60.87	62.52	3188.36	2291.51	2739.94
Point 17	**Point 17**	**66.64**	**65.80**	**66.21**	**62.13**	**60.02**	**61.01**	**2551.73**	**1986.33**	**2269.03**
13/03/2021 6:31:33 PM (1615660294)	18A1	68.71	67.64	68.18	61.05	59.07	60.06	2138.48	2153.11	2145.80
13/03/2021 6:34:33 PM (1615660474)	18A2	65.12	64.36	64.74	58.87	57.05	57.96	2281.70	1995.32	2138.51
13/03/2021 6:37:33 PM (1615660654)	18A3	65.51	64.56	65.04	56.39	56.17	56.28	1913.26	1981.99	1947.63
Point 18	**Point 18**	**66.76**	**65.80**	**66.28**	**59.17**	**57.60**	**58.38**	**2111.15**	**2043.47**	**2077.31**

Site Data		Leq (dB)			LAeq (dBA)			SGC (Hz)		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
16/03/2021 10:51:29 AM (1615888290)	19A1	76.78	75.87	76.33	71.53	69.43	70.48	2281.14	2096.47	2188.81
16/03/2021 10:54:29 AM (1615888470)	19A2	75.18	74.71	74.95	67.68	66.22	66.95	1883.33	1668.93	1776.13
16/03/2021 10:57:29 AM (1615888650)	19A3	74.23	73.37	73.80	66.47	64.91	65.69	1814.54	1703.54	1759.04
Point 19	**Point 19**	**75.53**	**74.77**	**75.15**	**68.12**	**67.28**	**68.20**	**1993.00**	**1822.98**	**1907.99**
16/03/2021 11:06:55 AM (1615889216)	20A1	73.71	73.16	73.44	66.56	67.03	66.80	1928.85	2199.70	2064.28
16/03/2021 11:09:55 AM (1615889396)	20A2	74.29	73.92	74.11	67.52	68.65	68.09	2232.74	2425.04	2328.89
16/03/2021 11:12:55 AM (1615889576)	20A3	72.51	71.88	72.20	66.97	67.00	66.99	2260.65	2440.67	2350.66
Point 20	**Point 20**	**73.56**	**73.07**	**73.32**	**67.03**	**67.63**	**67.33**	**2140.75**	**2355.14**	**2247.94**
16/03/2021 11:18:30 AM (1615889911)	21A1	68.98	68.10	68.54	64.22	63.08	63.65	2367.20	2118.60	2242.90
16/03/2021 11:21:30 AM (1615890091)	21A2	69.90	69.10	69.50	65.47	64.78	65.13	1948.36	1892.51	1920.44
16/03/2021 11:24:30 AM (1615890271)	21A3	72.65	71.10	71.88	70.09	67.58	68.84	1813.34	1827.13	1820.24
Point 21	**Point 21**	**70.80**	**69.62**	**70.21**	**67.37**	**65.55**	**66.44**	**2042.97**	**1946.08**	**1994.52**
16/03/2021 11:40:31 AM (1615891232)	22A1	73.14	72.74	72.94	69.77	69.83	69.80	2677.79	2519.16	2598.48
16/03/2021 11:43:31 AM (1615891412)	22A2	75.08	74.74	74.91	69.79	70.16	69.98	2263.24	2236.41	2249.83
16/03/2021 11:46:31 AM (1615891592)	22A3	76.25	75.55	75.90	68.44	68.65	68.55	2156.27	2153.61	2154.94
Point 22	**Point 22**	**75.01**	**74.50**	**74.75**	**69.38**	**69.59**	**69.49**	**2365.77**	**2303.06**	**2334.41**
16/03/2021 11:52:05 AM (1615891926)	23A1	76.44	76.00	76.22	66.14	66.34	66.24	1928.87	1803.34	1866.11
16/03/2021 11:55:05 AM (1615892106)	23A2	77.47	76.88	77.18	64.01	65.22	64.62	1539.70	1636.71	1588.21
16/03/2021 11:58:05 AM (1615892286)	23A3	81.06	80.47	80.77	66.37	66.52	66.45	1405.40	1482.74	1444.07
Point 23	**Point 23**	**78.80**	**78.24**	**78.52**	**65.63**	**66.06**	**65.84**	**1624.66**	**1640.93**	**1632.79**
16/03/2021 12:05:20 PM (1615892721)	24A1	85.28	86.11	85.70	70.26	69.58	69.92	1736.50	2371.96	2054.23
16/03/2021 12:08:20 PM (1615892901)	24A2	84.49	82.86	83.68	69.21	67.89	68.55	1668.60	2292.62	1980.61
16/03/2021 12:11:20 PM (1615893081)	24A3	80.70	78.37	79.54	66.96	64.43	65.70	1688.38	1959.33	1823.86
Point 24	**Point 24**	**83.90**	**83.49**	**83.64**	**69.02**	**67.78**	**68.39**	**1697.83**	**2207.97**	**1952.90**
16/03/2021 12:19:08 PM (1615893549)	25A1	74.90	72.74	73.82	74.65	71.91	73.28	3104.30	2719.17	2911.74
16/03/2021 12:22:08 PM (1615893729)	25A2	74.30	72.11	73.21	74.24	71.56	72.90	3190.56	2794.24	2992.40
16/03/2021 12:25:08 PM (1615893909)	25A3	73.91	72.02	72.97	73.65	71.30	72.48	3119.01	2739.80	2929.41
Point 25	**Point 25**	**74.39**	**72.30**	**73.35**	**74.20**	**71.60**	**72.90**	**3137.96**	**2751.07**	**2944.51**
16/03/2021 12:32:31 PM (1615894352)	26A1	71.07	70.88	70.98	62.56	60.78	61.67	1870.46	1606.80	1738.63
16/03/2021 12:35:31 PM (1615894532)	26A2	68.27	67.49	67.88	62.99	61.37	62.18	1739.96	1520.82	1630.39
16/03/2021 12:38:31 PM (1615894712)	26A3	70.08	69.65	69.87	63.95	61.14	62.55	2352.86	1782.93	2067.90
Point 26	**Point 26**	**69.96**	**69.56**	**69.75**	**63.21**	**61.10**	**62.15**	**1987.76**	**1636.85**	**1812.31**
16/03/2021 12:44:08 PM (1615895049)	27A1	67.02	66.59	66.81	62.42	62.01	62.22	2769.68	2774.05	2771.87
16/03/2021 12:47:08 PM (1615895229)	27A2	65.67	65.63	65.65	60.02	59.59	59.81	2193.33	2159.92	2176.63
16/03/2021 12:50:08 PM (1615895409)	27A3	66.17	65.67	65.92	61.77	60.87	61.32	2297.70	2188.14	2242.92
Point 27	**Point 27**	**66.32**	**65.99**	**66.15**	**61.52**	**60.93**	**61.22**	**2420.24**	**2374.04**	**2397.14**
16/03/2021 1:01:51 PM (1615896112)	28A1	75.56	75.28	75.42	68.71	69.15	68.93	2145.71	2376.07	2260.89
16/03/2021 1:04:51 PM (1615896292)	28A2	75.00	74.49	74.75	67.31	65.74	66.53	1658.59	1621.81	1640.20
16/03/2021 1:07:51 PM (1615896472)	28A3	74.84	74.57	74.71	68.37	68.80	68.59	1924.19	2163.39	2043.79
Point 28	**Point 28**	**75.14**	**74.79**	**74.97**	**68.17**	**68.14**	**68.14**	**1909.50**	**2053.76**	**1981.63**
16/03/2021 1:21:17 PM (1615897278)	29A1	72.54	72.20	72.37	64.18	63.32	63.75	1869.79	2490.06	2179.93
16/03/2021 1:24:17 PM (1615897458)	29A2	71.97	72.07	72.02	63.80	63.86	63.83	1780.96	1788.92	1784.94
16/03/2021 1:27:17 PM (1615897638)	29A3	73.82	73.78	73.80	65.85	66.01	65.93	2195.02	1876.49	2035.76
Point 29	**Point 29**	**72.85**	**72.76**	**72.80**	**64.70**	**64.56**	**64.63**	**1948.59**	**2051.82**	**2000.21**
16/03/2021 2:27:16 PM (1615901237)	30A1	69.93	68.39	69.16	58.11	58.20	58.16	1430.58	1382.17	1406.38
16/03/2021 2:30:16 PM (1615901417)	30A2	68.40	67.21	67.81	57.93	56.95	57.44	1650.92	1378.47	1514.70
16/03/2021 2:33:16 PM (1615901597)	30A3	73.27	71.68	72.48	57.99	57.05	57.52	1438.63	1268.00	1353.32
Point 30	**Point 30**	**71.03**	**69.52**	**70.27**	**58.01**	**57.44**	**57.72**	**1506.71**	**1342.88**	**1424.80**
16/03/2021 2:43:52 PM (1615902233)	31A1	69.97	69.60	69.79	61.70	59.44	60.57	2641.32	2094.70	2368.01
16/03/2021 2:46:52 PM (1615902413)	31A2	69.99	69.73	69.86	59.55	58.16	58.86	1831.00	1727.48	1779.24
16/03/2021 2:49:52 PM (1615902593)	31A3	73.84	73.97	73.91	63.91	63.08	63.50	1333.29	1221.53	1277.41
Point 31	**Point 31**	**71.67**	**71.61**	**71.64**	**62.08**	**60.75**	**61.40**	**1935.20**	**1681.24**	**1808.22**
16/03/2021 2:55:31 PM (1615902932)	32A1	76.34	76.02	76.18	66.49	63.38	64.94	3612.36	2445.39	3028.88
16/03/2021 2:58:31 PM (1615903112)	32A2	69.57	69.42	69.50	61.24	59.54	60.39	1841.42	1668.78	1755.10
16/03/2021 3:01:31 PM (1615903292)	32A3	70.10	69.52	69.81	61.79	60.71	61.25	2277.79	2180.64	2229.22
Point 32	**Point 32**	**73.18**	**72.84**	**73.01**	**63.86**	**61.52**	**62.67**	**2577.19**	**2098.27**	**2337.73**
16/03/2021 3:08:07 PM (1615903688)	33A1	78.09	77.35	77.72	64.74	63.08	63.91	2300.65	1935.00	2117.83
16/03/2021 3:11:07 PM (1615903868)	33A2	72.52	72.13	72.33	57.23	56.00	56.62	1861.78	1707.34	1784.56
16/03/2021 3:14:07 PM (1615904048)	33A3	79.53	79.25	79.39	65.58	62.85	64.22	4779.36	4075.57	4427.47
Point 33	**Point 33**	**77.58**	**77.13**	**77.35**	**63.75**	**61.62**	**62.68**	**2980.60**	**2572.84**	**2776.62**
16/03/2021 3:22:40 PM (1615904561)	34A1	70.77	69.97	70.37	65.06	63.13	64.10	2028.61	1956.79	1992.70
16/03/2021 3:25:40 PM (1615904741)	34A2	69.14	68.23	68.69	62.92	60.46	61.69	1844.25	1734.93	1789.59
16/03/2021 3:28:40 PM (1615904921)	34A3	72.01	71.35	71.68	62.40	60.14	61.27	1960.37	1826.48	1893.43
Point 34	**Point 34**	**70.80**	**70.03**	**70.41**	**63.62**	**61.46**	**62.54**	**1944.41**	**1839.40**	**1891.91**
16/03/2021 3:36:14 PM (1615905375)	35A1	71.20	70.29	70.75	63.46	60.85	62.16	2614.08	2334.54	2474.31
16/03/2021 3:39:14 PM (1615905555)	35A2	69.20	68.11	68.66	62.80	60.67	61.74	1883.34	1816.64	1849.99
16/03/2021 3:42:14 PM (1615905735)	35A3	69.57	68.83	69.20	59.27	58.17	58.72	1902.15	1886.59	1894.37
Point 35	**Point 35**	**70.06**	**69.17**	**69.63**	**62.19**	**60.06**	**61.12**	**2133.19**	**2012.59**	**2072.89**
16/03/2021 3:50:58 PM (1615906259)	36A1	77.14	76.34	76.74	72.53	72.57	72.55	1924.91	2279.62	2102.27
16/03/2021 3:53:58 PM (1615906439)	36A2	77.24	75.95	76.60	71.09	67.92	69.51	1697.66	1647.62	1672.64
16/03/2021 3:56:58 PM (1615906619)	36A3	77.23	75.14	76.19	74.04	69.94	71.99	3154.01	2479.00	2816.51
Point 36	**Point 36**	**77.20**	**75.84**	**76.51**	**72.72**	**70.36**	**71.54**	**2258.86**	**2135.41**	**2197.14**
16/03/2021 4:04:32 PM (1615907073)	37A1	75.22	73.74	74.48	71.67	69.06	70.37	1704.67	1731.77	1718.22
16/03/2021 4:07:32 PM (1615907253)	37A2	77.54	76.54	77.04	69.70	66.61	68.16	1599.41	1500.78	1550.10
16/03/2021 4:10:32 PM (1615907433)	37A3	73.62	72.37	73.00	69.11	66.67	67.89	1621.76	1587.52	1604.64
Point 37	**Point 37**	**75.76**	**74.57**	**75.17**	**70.30**	**67.60**	**68.95**	**1641.95**	**1606.69**	**1624.32**
16/03/2021 4:17:33 PM (1615907854)	38A1	79.76	79.13	79.45	75.35	74.29	74.82	2940.55	2999.50	2970.03
16/03/2021 4:20:33 PM (1615908034)	38A2	75.67	74.31	74.99	70.66	67.37	69.02	2290.67	1895.93	2093.30
16/03/2021 4:23:33 PM (1615908214)	38A3	73.56	72.49	73.03	68.64	66.32	67.48	1809.65	1663.78	1736.72
Point 38	**Point 38**	**77.11**	**76.25**	**76.88**	**72.40**	**70.86**	**71.65**	**2346.96**	**2186.40**	**2266.68**

Table 61. Raw Data of Antrophony, Biophony and Bio/Antrophony Ratio (Leq)

Site Data		Leq - Antrophony (dB)			Leq - Biophony (dB)			Leq - Bio/Antrophony Ratio		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
13/03/2021 12:39:03 PM (1615639144)	2A1	73.42	72.84	76.15	60.59	60.70	63.66	0.83	0.83	0.83
13/03/2021 12:42:03 PM (1615639324)	2A2	74.37	73.97	77.18	59.80	60.56	63.21	0.80	0.82	0.81
13/03/2021 12:45:03 PM (1615639504)	2A3	76.06	75.98	79.03	59.38	58.04	61.77	0.78	0.76	0.77
	2A	74.76	74.46	77.62	59.95	59.93	62.95	0.80	0.81	0.80
13/03/2021 1:17:52 PM (1615641473)	2B1	73.85	72.27	76.14	64.27	62.05	66.31	0.87	0.86	0.86
13/03/2021 1:20:52 PM (1615641653)	2B2	76.29	75.62	78.98	63.71	61.32	65.69	0.84	0.81	0.82
13/03/2021 1:23:52 PM (1615641833)	2B3	72.44	72.02	75.25	69.31	66.39	71.10	0.96	0.92	0.94
	2B	74.49	73.63	77.09	66.55	63.87	68.42	0.89	0.86	0.88
Point 2	**Point 2**	**74.63**	**74.07**	**77.37**	**64.40**	**62.33**	**66.50**	**0.85**	**0.83**	**0.84**
13/03/2021 1:56:50 PM (1615643811)	3A1	72.74	73.10	72.92	61.28	59.66	60.47	0.84	0.82	0.83
13/03/2021 1:59:50 PM (1615643991)	3A2	73.54	73.19	73.37	60.11	58.10	59.11	0.82	0.79	0.81
13/03/2021 2:02:50 PM (1615644171)	3A3	74.39	73.73	74.06	59.99	57.47	58.73	0.81	0.78	0.79
Point 3	**Point 3**	**73.61**	**73.35**	**73.47**	**60.50**	**58.51**	**59.50**	**0.82**	**0.80**	**0.81**
13/03/2021 2:23:28 PM (1615645409)	4A1	76.76	76.36	76.56	63.24	63.62	63.43	0.82	0.83	0.83
13/03/2021 2:26:28 PM (1615645589)	4A2	73.80	73.41	73.61	62.03	58.31	60.17	0.84	0.79	0.82
13/03/2021 2:29:28 PM (1615645769)	4A3	78.89	77.08	77.99	61.12	59.20	60.16	0.78	0.77	0.77
Point 4	**Point 4**	**76.96**	**75.88**	**76.40**	**62.22**	**61.04**	**61.54**	**0.81**	**0.80**	**0.81**
13/03/2021 2:39:26 PM (1615646367)	5A1	70.88	70.77	70.83	57.30	54.60	55.95	0.81	0.77	0.79
13/03/2021 2:42:26 PM (1615646547)	5A2	69.70	69.48	69.59	58.73	58.56	58.65	0.84	0.84	0.84
13/03/2021 2:45:26 PM (1615646727)	5A3	69.27	68.67	68.97	60.42	60.34	60.38	0.87	0.88	0.88
Point 5	**Point 5**	**70.00**	**69.73**	**69.86**	**59.00**	**58.43**	**58.69**	**0.84**	**0.83**	**0.84**
13/03/2021 2:59:10 PM (1615647551)	6A1	74.81	72.90	73.86	63.66	58.69	61.18	0.85	0.81	0.83
13/03/2021 3:02:10 PM (1615647731)	6A2	80.83	79.35	80.09	63.53	58.86	61.20	0.79	0.74	0.76
13/03/2021 3:05:10 PM (1615647911)	6A3	73.70	71.44	72.57	64.41	60.62	62.52	0.87	0.85	0.86
Point 6	**Point 6**	**77.65**	**76.00**	**76.83**	**63.88**	**59.48**	**61.68**	**0.84**	**0.80**	**0.82**
13/03/2021 3:15:19 PM (1615648520)	7A1	72.17	75.14	73.66	60.68	56.95	58.82	0.84	0.76	0.80
13/03/2021 3:18:19 PM (1615648700)	7A2	69.75	70.08	69.92	56.18	57.10	56.64	0.81	0.82	0.81
13/03/2021 3:21:19 PM (1615648880)	7A3	68.34	67.94	68.14	55.73	55.25	55.49	0.82	0.81	0.81
Point 7	**Point 7**	**70.38**	**72.14**	**71.20**	**58.15**	**56.51**	**57.21**	**0.82**	**0.80**	**0.81**
13/03/2021 3:26:32 PM (1615649193)	8A1	71.18	69.27	70.23	57.96	58.41	58.19	0.81	0.84	0.83
13/03/2021 3:29:32 PM (1615649373)	8A2	69.77	71.90	70.84	54.44	51.44	52.94	0.78	0.72	0.75
13/03/2021 3:32:32 PM (1615649553)	8A3	69.88	69.41	69.65	55.95	54.86	55.41	0.80	0.79	0.80
Point 8	**Point 8**	**70.33**	**70.37**	**70.26**	**56.36**	**55.79**	**56.03**	**0.80**	**0.78**	**0.79**
13/03/2021 3:40:05 PM (1615650006)	9A1	78.22	78.35	78.29	55.57	55.20	55.39	0.71	0.70	0.71
13/03/2021 3:43:05 PM (1615650186)	9A2	71.49	71.42	71.46	56.41	56.33	56.37	0.79	0.79	0.79
13/03/2021 3:46:05 PM (1615650366)	9A3	83.53	84.02	83.78	54.11	53.58	53.85	0.65	0.64	0.64
Point 9	**Point 9**	**80.08**	**80.47**	**80.28**	**55.46**	**55.18**	**55.32**	**0.72**	**0.71**	**0.71**
13/03/2021 4:26:34 PM (1615652795)	10A1	69.90	69.43	69.67	60.02	59.00	59.51	0.86	0.85	0.85
13/03/2021 4:29:34 PM (1615652975)	10A2	70.43	69.26	69.85	58.74	58.24	58.49	0.83	0.84	0.84
13/03/2021 4:32:34 PM (1615653155)	10A3	67.14	66.60	66.87	54.62	52.94	53.78	0.81	0.80	0.80
Point 10	**Point 10**	**69.38**	**68.61**	**68.99**	**58.33**	**57.42**	**57.87**	**0.84**	**0.83**	**0.83**
13/03/2021 4:41:50 PM (1615653711)	11A1	70.44	70.77	70.61	53.64	53.09	53.37	0.76	0.75	0.76
13/03/2021 4:44:50 PM (1615653891)	11A2	70.55	69.05	69.80	62.12	60.64	61.38	0.88	0.88	0.88
13/03/2021 4:47:50 PM (1615654071)	11A3	69.86	68.90	69.38	55.49	53.78	54.64	0.79	0.78	0.79
Point 11	**Point 11**	**70.29**	**69.66**	**69.96**	**58.68**	**57.27**	**57.97**	**0.81**	**0.80**	**0.81**
13/03/2021 4:53:47 PM (1615654428)	12A1	67.39	66.55	66.97	54.14	52.87	53.51	0.80	0.79	0.80
13/03/2021 4:56:47 PM (1615654608)	12A2	67.43	67.03	67.23	50.80	52.70	51.75	0.75	0.79	0.77
13/03/2021 4:59:47 PM (1615654788)	12A3	68.13	66.44	67.29	50.51	52.04	51.28	0.74	0.78	0.76
Point 12	**Point 12**	**67.66**	**66.68**	**67.16**	**52.15**	**52.55**	**52.29**	**0.77**	**0.79**	**0.78**
13/03/2021 5:08:43 PM (1615655324)	13A1	73.38	72.53	72.96	63.12	58.01	60.57	0.86	0.80	0.83
13/03/2021 5:11:43 PM (1615655504)	13A2	73.03	71.81	72.42	62.16	60.34	61.25	0.85	0.84	0.85
13/03/2021 5:14:43 PM (1615655684)	13A3	73.86	73.62	73.74	59.59	61.18	60.39	0.81	0.83	0.82
Point 13	**Point 13**	**73.44**	**72.72**	**73.07**	**61.86**	**60.04**	**60.75**	**0.84**	**0.82**	**0.83**
13/03/2021 5:20:12 PM (1615656013)	14A1	67.37	66.74	67.06	57.16	57.86	57.51	0.85	0.87	0.86
13/03/2021 5:23:12 PM (1615656193)	14A2	66.23	65.30	65.77	52.12	51.78	51.95	0.79	0.79	0.79
13/03/2021 5:26:12 PM (1615656373)	14A3	68.74	67.59	68.17	54.06	52.72	53.39	0.79	0.78	0.78
Point 14	**Point 14**	**67.57**	**66.64**	**67.10**	**54.95**	**55.00**	**54.95**	**0.81**	**0.81**	**0.81**
13/03/2021 5:31:43 PM (1615656704)	15A1	69.29	68.82	69.06	52.11	52.44	52.28	0.75	0.76	0.76
13/03/2021 5:34:43 PM (1615656884)	15A2	68.82	68.82	68.82	52.44	52.44	52.44	0.76	0.76	0.76
13/03/2021 5:37:43 PM (1615657064)	15A3	67.89	67.08	67.49	52.46	50.57	51.52	0.77	0.75	0.76
Point 15	**Point 15**	**68.70**	**68.31**	**68.51**	**52.34**	**51.90**	**52.09**	**0.76**	**0.76**	**0.76**
13/03/2021 5:53:36 PM (1615658017)	16A1	65.91	65.77	65.84	53.91	55.50	54.71	0.82	0.84	0.83
13/03/2021 5:56:36 PM (1615658197)	16A2	65.94	65.74	65.84	50.78	52.89	51.84	0.77	0.81	0.79
13/03/2021 5:59:36 PM (1615658377)	16A3	65.57	65.40	65.49	52.20	53.82	53.01	0.80	0.82	0.81
Point 16	**Point 16**	**65.81**	**65.64**	**65.72**	**52.49**	**54.21**	**53.34**	**0.79**	**0.82**	**0.81**
13/03/2021 6:18:49 PM (1615659530)	17A1	65.40	65.40	65.40	53.82	53.82	53.82	0.82	0.82	0.82
13/03/2021 6:21:49 PM (1615659710)	17A2	65.63	65.04	65.34	57.46	52.82	55.14	0.88	0.81	0.84
13/03/2021 6:24:49 PM (1615659890)	17A3	66.19	65.70	65.95	62.00	56.65	59.33	0.94	0.86	0.90
Point 17	**Point 17**	**65.75**	**65.39**	**65.57**	**59.00**	**54.75**	**56.76**	**0.88**	**0.83**	**0.86**
13/03/2021 6:31:33 PM (1615660294)	18A1	68.38	67.38	67.88	56.82	54.93	55.88	0.83	0.82	0.82
13/03/2021 6:34:33 PM (1615660474)	18A2	64.67	64.07	64.37	54.43	51.90	53.17	0.84	0.81	0.83
13/03/2021 6:37:33 PM (1615660654)	18A3	65.33	64.32	64.83	51.00	51.15	51.08	0.78	0.80	0.79
Point 18	**Point 18**	**66.44**	**65.53**	**65.99**	**54.69**	**52.98**	**53.82**	**0.82**	**0.81**	**0.81**

Site Data		Leq - Antrophony (dB)			Leq - Biophony (dB)			Leq - Bio/Antrophony Ratio		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
16/03/2021 10:51:29 AM (1615888290)	19A1	76.17	75.44	75.81	66.99	64.59	65.79	0.88	0.86	0.87
16/03/2021 10:54:29 AM (1615888470)	19A2	74.93	74.53	74.73	61.77	59.59	60.68	0.82	0.80	0.81
16/03/2021 10:57:29 AM (1615888650)	19A3	74.00	73.18	73.59	60.41	58.77	59.59	0.82	0.80	0.81
Point 19	**Point 19**	**75.12**	**74.48**	**74.80**	**64.04**	**61.80**	**62.92**	**0.84**	**0.82**	**0.83**
16/03/2021 11:06:55 AM (1615889216)	20A1	73.43	72.69	73.06	60.83	62.57	61.70	0.83	0.86	0.84
16/03/2021 11:09:55 AM (1615889396)	20A2	73.88	73.22	73.55	63.26	65.13	64.20	0.86	0.89	0.87
16/03/2021 11:12:55 AM (1615889576)	20A3	71.97	71.11	71.54	62.61	63.45	63.03	0.87	0.89	0.88
Point 20	**Point 20**	**73.17**	**72.43**	**72.80**	**62.35**	**63.85**	**63.09**	**0.85**	**0.88**	**0.87**
16/03/2021 11:18:30 AM (1615889911)	21A1	68.22	67.50	67.86	59.98	57.37	58.68	0.88	0.85	0.86
16/03/2021 11:21:30 AM (1615890091)	21A2	69.35	68.58	68.97	59.18	57.73	58.46	0.85	0.84	0.85
16/03/2021 11:24:30 AM (1615890271)	21A3	71.87	70.49	71.18	63.58	60.77	62.18	0.89	0.86	0.87
Point 21	**Point 21**	**70.09**	**69.04**	**69.56**	**61.36**	**58.91**	**60.13**	**0.87**	**0.85**	**0.86**
16/03/2021 11:40:31 AM (1615891232)	22A1	71.93	71.46	71.70	66.39	66.06	66.23	0.92	0.93	0.92
16/03/2021 11:43:31 AM (1615891412)	22A2	74.49	74.04	74.27	65.32	65.54	65.43	0.88	0.89	0.88
16/03/2021 11:46:31 AM (1615891592)	22A3	75.95	75.17	75.56	63.65	63.80	63.73	0.84	0.85	0.84
Point 22	**Point 22**	**74.42**	**73.82**	**74.12**	**65.26**	**65.24**	**65.25**	**0.88**	**0.89**	**0.88**
16/03/2021 11:52:05 AM (1615891926)	23A1	76.29	75.86	76.08	60.85	59.95	60.40	0.80	0.79	0.79
16/03/2021 11:55:05 AM (1615892106)	23A2	77.42	76.81	77.12	56.51	57.57	57.04	0.73	0.75	0.74
16/03/2021 11:58:05 AM (1615892286)	23A3	81.02	80.44	80.73	58.43	58.40	58.42	0.72	0.73	0.72
Point 23	**Point 23**	**78.74**	**78.16**	**78.46**	**58.96**	**58.75**	**58.84**	**0.75**	**0.76**	**0.75**
16/03/2021 12:05:20 PM (1615892721)	24A1	85.24	86.07	85.66	64.01	65.87	64.94	0.75	0.77	0.76
16/03/2021 12:08:20 PM (1615892901)	24A2	84.45	82.80	83.63	63.00	64.13	63.57	0.75	0.78	0.76
16/03/2021 12:11:20 PM (1615893081)	24A3	80.65	78.31	79.48	60.29	59.34	59.82	0.75	0.76	0.75
Point 24	**Point 24**	**83.86**	**83.44**	**83.60**	**62.70**	**63.87**	**63.28**	**0.75**	**0.77**	**0.76**
16/03/2021 12:19:08 PM (1615893549)	25A1	70.94	70.03	70.49	72.30	68.69	70.50	1.02	0.98	1.00
16/03/2021 12:22:08 PM (1615893729)	25A2	69.75	68.98	69.37	72.10	68.53	70.32	1.03	0.99	1.01
16/03/2021 12:25:08 PM (1615893909)	25A3	69.88	69.16	69.52	71.36	68.13	69.75	1.02	0.99	1.00
Point 25	**Point 25**	**70.22**	**69.41**	**69.82**	**71.94**	**68.46**	**70.20**	**1.02**	**0.99**	**1.01**
16/03/2021 12:32:31 PM (1615894352)	26A1	70.87	70.77	70.82	56.97	54.21	55.59	0.80	0.77	0.79
16/03/2021 12:35:31 PM (1615894532)	26A2	67.91	67.25	67.58	56.34	53.55	54.95	0.83	0.80	0.81
16/03/2021 12:38:31 PM (1615894712)	26A3	69.60	69.47	69.54	59.90	54.94	57.42	0.86	0.79	0.83
Point 26	**Point 26**	**69.62**	**69.40**	**69.51**	**58.03**	**54.27**	**56.12**	**0.83**	**0.78**	**0.81**
16/03/2021 12:44:08 PM (1615895049)	27A1	66.16	65.72	65.94	59.29	58.90	59.10	0.90	0.90	0.90
16/03/2021 12:47:08 PM (1615895229)	27A2	65.20	65.21	65.21	55.26	54.65	54.96	0.85	0.84	0.84
16/03/2021 12:50:08 PM (1615895409)	27A3	65.44	65.08	65.26	57.57	56.08	56.83	0.88	0.86	0.87
Point 27	**Point 27**	**65.62**	**65.35**	**65.48**	**57.68**	**56.91**	**57.29**	**0.87**	**0.87**	**0.87**
16/03/2021 1:01:51 PM (1615896112)	28A1	75.08	74.62	74.85	65.43	66.54	65.99	0.87	0.89	0.88
16/03/2021 1:04:51 PM (1615896292)	28A2	74.81	74.35	74.58	60.25	58.76	59.51	0.81	0.79	0.80
16/03/2021 1:07:51 PM (1615896472)	28A3	74.51	74.10	74.31	62.89	64.17	63.53	0.84	0.87	0.86
Point 28	**Point 28**	**74.81**	**74.36**	**74.58**	**63.36**	**64.19**	**63.75**	**0.84**	**0.85**	**0.84**
16/03/2021 1:21:17 PM (1615897278)	29A1	72.33	71.93	72.13	58.45	57.35	57.90	0.81	0.80	0.80
16/03/2021 1:24:17 PM (1615897458)	29A2	71.76	71.87	71.82	57.86	57.52	57.69	0.81	0.80	0.80
16/03/2021 1:27:17 PM (1615897638)	29A3	73.54	73.56	73.55	59.15	59.48	59.32	0.80	0.81	0.81
Point 29	**Point 29**	**72.61**	**72.53**	**72.57**	**58.52**	**58.23**	**58.36**	**0.81**	**0.80**	**0.80**
16/03/2021 2:27:16 PM (1615901237)	30A1	69.88	68.31	69.10	49.89	50.00	49.95	0.71	0.73	0.72
16/03/2021 2:30:16 PM (1615901417)	30A2	68.31	67.13	67.72	51.14	48.61	49.88	0.75	0.72	0.74
16/03/2021 2:33:16 PM (1615901597)	30A3	73.24	71.66	72.45	49.69	47.56	48.63	0.68	0.66	0.67
Point 30	**Point 30**	**70.98**	**69.48**	**70.23**	**50.29**	**48.84**	**49.52**	**0.71**	**0.71**	**0.71**
16/03/2021 2:43:52 PM (1615902233)	31A1	69.64	69.44	69.54	57.69	54.46	56.08	0.83	0.78	0.81
16/03/2021 2:46:52 PM (1615902413)	31A2	69.86	69.64	69.75	53.67	51.91	52.79	0.77	0.75	0.76
16/03/2021 2:49:52 PM (1615902593)	31A3	73.75	73.91	73.83	55.65	53.99	54.82	0.76	0.73	0.74
Point 31	**Point 31**	**71.52**	**71.52**	**71.52**	**55.98**	**53.59**	**54.76**	**0.78**	**0.75**	**0.77**
16/03/2021 2:55:31 PM (1615902932)	32A1	76.06	75.92	75.99	63.97	58.71	61.34	0.84	0.77	0.81
16/03/2021 2:58:31 PM (1615903112)	32A2	69.37	69.30	69.34	55.05	52.66	53.86	0.79	0.76	0.78
16/03/2021 3:01:31 PM (1615903292)	32A3	69.83	69.29	69.56	57.30	55.96	56.63	0.82	0.81	0.81
Point 32	**Point 32**	**72.91**	**72.72**	**72.81**	**60.48**	**56.44**	**58.38**	**0.82**	**0.78**	**0.80**
16/03/2021 3:08:07 PM (1615903688)	33A1	78.00	77.29	77.65	61.06	58.00	59.53	0.78	0.75	0.77
16/03/2021 3:11:07 PM (1615903868)	33A2	72.48	72.09	72.29	51.44	49.57	50.51	0.71	0.69	0.70
16/03/2021 3:14:07 PM (1615904048)	33A3	79.39	79.18	79.29	64.56	61.08	62.82	0.81	0.77	0.79
Point 33	**Point 33**	**77.47**	**77.06**	**77.27**	**61.54**	**58.25**	**59.89**	**0.77**	**0.74**	**0.75**
16/03/2021 3:22:40 PM (1615904561)	34A1	70.34	69.66	70.00	59.46	57.51	58.49	0.85	0.83	0.84
16/03/2021 3:25:40 PM (1615904741)	34A2	68.85	68.04	68.45	56.45	53.68	55.07	0.82	0.79	0.80
16/03/2021 3:28:40 PM (1615904921)	34A3	71.85	71.25	71.55	56.85	54.31	55.58	0.79	0.76	0.78
Point 34	**Point 34**	**70.52**	**69.65**	**70.10**	**57.80**	**55.51**	**56.65**	**0.82**	**0.79**	**0.81**
16/03/2021 3:36:14 PM (1615905375)	35A1	70.78	70.05	70.42	59.76	56.77	58.27	0.84	0.81	0.83
16/03/2021 3:39:14 PM (1615905555)	35A2	68.87	67.86	68.37	56.92	54.68	55.80	0.83	0.81	0.82
16/03/2021 3:42:14 PM (1615905735)	35A3	69.43	68.70	69.07	53.69	52.60	53.15	0.77	0.77	0.77
Point 35	**Point 35**	**69.77**	**68.96**	**69.37**	**57.46**	**55.01**	**56.22**	**0.81**	**0.79**	**0.80**
16/03/2021 3:50:58 PM (1615906259)	36A1	76.59	75.21	75.90	67.19	69.71	68.45	0.88	0.93	0.90
16/03/2021 3:53:58 PM (1615906439)	36A2	76.98	75.78	76.38	63.91	60.67	62.29	0.83	0.80	0.82
16/03/2021 3:56:58 PM (1615906619)	36A3	75.91	74.52	75.22	70.92	65.68	68.30	0.93	0.88	0.91
Point 36	**Point 36**	**76.52**	**75.20**	**75.86**	**68.25**	**66.76**	**67.12**	**0.88**	**0.87**	**0.88**
16/03/2021 4:04:32 PM (1615907073)	37A1	74.71	73.32	74.02	64.22	62.16	63.19	0.86	0.85	0.85
16/03/2021 4:07:32 PM (1615907253)	37A2	77.38	76.45	76.92	61.45	58.02	59.74	0.79	0.76	0.78
16/03/2021 4:10:32 PM (1615907433)	37A3	73.26	72.10	72.68	61.37	58.99	60.18	0.84	0.82	0.83
Point 37	**Point 37**	**75.46**	**74.36**	**74.91**	**62.56**	**60.10**	**61.32**	**0.83**	**0.81**	**0.82**
16/03/2021 4:17:33 PM (1615907854)	38A1	78.56	78.02	78.29	73.49	72.58	73.04	0.94	0.93	0.93
16/03/2021 4:20:33 PM (1615908034)	38A2	75.08	74.04	74.56	66.24	61.25	63.75	0.88	0.83	0.85
16/03/2021 4:23:33 PM (1615908214)	38A3	73.13	72.22	72.68	61.87	58.85	60.36	0.85	0.82	0.83
Point 38	**Point 38**	**76.10**	**75.46**	**75.82**	**68.71**	**68.29**	**68.95**	**0.89**	**0.88**	**0.87**

Table 62. Raw Data of Antrophony, Biophony and Bio/Antrophony Ratio (LAeq)

Site Data		LAeq - Antrophony (dBA)			LAeq - Biophony (dBA)			LAeq - Bio/Antrophony Ratio		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
13/03/2021 12:39:03 PM (1615639144)	2A1	65.41	64.58	68.03	61.69	61.81	64.76	0.94	0.96	0.95
13/03/2021 12:42:03 PM (1615639324)	2A2	66.24	65.84	69.05	60.92	61.71	64.34	0.92	0.94	0.93
13/03/2021 12:45:03 PM (1615639504)	2A3	65.08	63.45	67.35	60.45	59.14	62.85	0.93	0.93	0.93
	2A	65.60	64.73	68.20	61.05	61.05	64.06	0.93	0.94	0.94
13/03/2021 1:17:52 PM (1615641473)	2B1	66.82	64.56	68.85	65.34	63.16	67.40	0.98	0.98	0.98
13/03/2021 1:20:52 PM (1615641653)	2B2	66.44	64.78	68.70	64.79	62.41	66.77	0.98	0.96	0.97
13/03/2021 1:23:52 PM (1615641833)	2B3	67.40	66.47	69.97	70.40	67.52	72.20	1.05	1.02	1.03
	2B	66.90	65.36	69.21	67.63	64.99	69.52	1.00	0.99	0.99
Point 2	**Point 2**	**66.30**	**65.06**	**68.73**	**65.49**	**63.45**	**67.60**	**0.97**	**0.96**	**0.96**
13/03/2021 1:56:50 PM (1615643811)	3A1	64.88	62.74	63.81	62.24	60.65	61.45	0.96	0.97	0.96
13/03/2021 1:59:50 PM (1615643991)	3A2	63.56	62.37	62.97	61.14	59.15	60.15	0.96	0.95	0.96
13/03/2021 2:02:50 PM (1615644171)	3A3	63.31	61.84	62.58	61.07	58.54	59.81	0.97	0.95	0.96
Point 3	**Point 3**	**63.97**	**62.33**	**63.15**	**61.52**	**59.54**	**60.52**	**0.96**	**0.95**	**0.96**
13/03/2021 2:23:28 PM (1615645409)	4A1	65.56	65.49	65.53	64.31	64.69	64.50	0.98	0.99	0.98
13/03/2021 2:26:28 PM (1615645589)	4A2	63.15	61.98	62.57	63.23	59.46	61.35	1.00	0.96	0.98
13/03/2021 2:29:28 PM (1615645769)	4A3	64.96	64.29	64.63	62.04	60.05	61.05	0.96	0.93	0.94
Point 4	**Point 4**	**64.67**	**64.15**	**64.41**	**63.29**	**62.08**	**62.60**	**0.98**	**0.96**	**0.97**
13/03/2021 2:39:26 PM (1615646367)	5A1	61.98	60.71	61.35	58.33	55.67	57.00	0.94	0.92	0.93
13/03/2021 2:42:26 PM (1615646547)	5A2	61.12	61.07	61.10	59.62	59.45	59.54	0.98	0.97	0.97
13/03/2021 2:45:26 PM (1615646727)	5A3	61.47	60.63	61.05	61.44	61.37	61.41	1.00	1.01	1.01
Point 5	**Point 5**	**61.54**	**60.81**	**61.17**	**59.99**	**59.41**	**59.67**	**0.97**	**0.97**	**0.97**
13/03/2021 2:59:10 PM (1615647551)	6A1	68.94	64.08	66.51	64.70	59.78	62.24	0.94	0.93	0.94
13/03/2021 3:02:10 PM (1615647731)	6A2	69.07	63.95	66.51	64.56	59.93	62.25	0.94	0.94	0.94
13/03/2021 3:05:10 PM (1615647911)	6A3	69.61	65.09	67.35	65.44	61.70	63.57	0.94	0.95	0.94
Point 6	**Point 6**	**69.22**	**64.40**	**66.81**	**64.92**	**60.56**	**62.73**	**0.94**	**0.94**	**0.94**
13/03/2021 3:15:19 PM (1615648520)	7A1	59.99	59.46	59.73	61.61	57.91	59.76	1.03	0.97	1.00
13/03/2021 3:18:19 PM (1615648700)	7A2	60.40	60.54	60.47	57.19	58.15	57.67	0.95	0.96	0.95
13/03/2021 3:21:19 PM (1615648880)	7A3	60.69	60.46	60.58	56.70	56.25	56.48	0.93	0.93	0.93
Point 7	**Point 7**	**60.37**	**60.18**	**60.27**	**59.10**	**57.51**	**58.18**	**0.97**	**0.96**	**0.96**
13/03/2021 3:26:32 PM (1615649193)	8A1	59.69	61.50	60.60	59.14	59.57	59.36	0.99	0.97	0.98
13/03/2021 3:29:32 PM (1615649373)	8A2	59.68	58.00	58.84	55.55	52.52	54.04	0.93	0.91	0.92
13/03/2021 3:32:32 PM (1615649553)	8A3	60.38	59.55	59.97	57.02	55.93	56.48	0.94	0.94	0.94
Point 8	**Point 8**	**59.93**	**59.92**	**59.86**	**57.49**	**56.92**	**57.16**	**0.96**	**0.94**	**0.95**
13/03/2021 3:40:05 PM (1615650006)	9A1	61.00	60.09	60.55	56.50	56.15	56.33	0.93	0.93	0.93
13/03/2021 3:43:05 PM (1615650186)	9A2	60.13	59.31	59.72	57.30	57.21	57.26	0.95	0.97	0.96
13/03/2021 3:46:05 PM (1615650366)	9A3	61.04	60.63	60.84	55.17	54.64	54.91	0.90	0.90	0.90
Point 9	**Point 9**	**60.74**	**60.04**	**60.39**	**56.41**	**56.12**	**56.27**	**0.93**	**0.93**	**0.93**
13/03/2021 4:26:34 PM (1615652795)	10A1	62.86	61.60	62.23	60.84	60.03	60.44	0.97	0.97	0.97
13/03/2021 4:29:34 PM (1615652975)	10A2	64.06	61.14	62.60	59.79	59.33	59.56	0.93	0.97	0.95
13/03/2021 4:32:34 PM (1615653155)	10A3	59.38	58.50	58.94	55.61	54.00	54.81	0.94	0.92	0.93
Point 10	**Point 10**	**62.51**	**60.61**	**61.54**	**59.26**	**58.48**	**58.87**	**0.95**	**0.96**	**0.95**
13/03/2021 4:41:50 PM (1615653711)	11A1	58.01	57.32	57.67	54.71	54.17	54.44	0.94	0.95	0.94
13/03/2021 4:44:50 PM (1615653891)	11A2	66.06	64.94	65.50	63.15	61.71	62.43	0.96	0.95	0.95
13/03/2021 4:47:50 PM (1615654071)	11A3	60.35	59.26	59.81	56.47	54.80	55.64	0.94	0.93	0.93
Point 11	**Point 11**	**62.83**	**61.76**	**62.29**	**59.71**	**58.34**	**59.02**	**0.95**	**0.94**	**0.94**
13/03/2021 4:53:47 PM (1615654428)	12A1	56.17	56.80	56.49	55.05	53.88	54.47	0.98	0.95	0.96
13/03/2021 4:56:47 PM (1615654608)	12A2	56.63	57.78	57.21	51.86	53.82	52.84	0.92	0.93	0.92
13/03/2021 4:59:47 PM (1615654788)	12A3	56.73	59.14	57.94	51.49	53.16	52.33	0.91	0.90	0.90
Point 12	**Point 12**	**56.52**	**58.01**	**57.25**	**53.11**	**53.63**	**53.31**	**0.93**	**0.93**	**0.93**
13/03/2021 5:08:43 PM (1615655324)	13A1	68.63	65.19	66.91	64.19	59.11	61.65	0.94	0.91	0.92
13/03/2021 5:11:43 PM (1615655504)	13A2	67.47	65.68	66.58	63.22	65.68	64.45	0.94	0.94	0.94
13/03/2021 5:14:43 PM (1615655684)	13A3	66.12	67.31	66.72	60.63	62.26	61.45	0.92	0.93	0.92
Point 13	**Point 13**	**67.53**	**66.16**	**66.74**	**62.92**	**63.15**	**62.74**	**0.93**	**0.92**	**0.93**
13/03/2021 5:20:12 PM (1615656013)	14A1	60.43	59.76	60.10	58.16	58.86	58.51	0.96	0.99	0.97
13/03/2021 5:23:12 PM (1615656193)	14A2	58.55	57.72	58.14	53.12	52.80	52.96	0.91	0.92	0.91
13/03/2021 5:26:12 PM (1615656373)	14A3	61.44	60.18	60.81	55.09	53.75	54.42	0.90	0.89	0.90
Point 14	**Point 14**	**60.30**	**59.35**	**59.82**	**55.96**	**56.01**	**55.96**	**0.92**	**0.93**	**0.93**
13/03/2021 5:31:43 PM (1615656704)	15A1	59.76	59.35	59.56	53.11	53.52	53.32	0.89	0.90	0.90
13/03/2021 5:34:43 PM (1615656884)	15A2	59.35	59.35	59.35	53.52	53.52	53.52	0.90	0.90	0.90
13/03/2021 5:37:43 PM (1615657064)	15A3	59.09	57.98	58.54	53.49	51.62	52.56	0.91	0.89	0.90
Point 15	**Point 15**	**59.41**	**58.94**	**59.17**	**53.38**	**52.97**	**53.15**	**0.90**	**0.90**	**0.90**
13/03/2021 5:53:36 PM (1615658017)	16A1	58.61	59.84	59.23	55.06	56.62	55.84	0.94	0.95	0.94
13/03/2021 5:56:36 PM (1615658197)	16A2	57.57	58.90	58.24	51.88	54.04	52.96	0.90	0.92	0.91
13/03/2021 5:59:36 PM (1615658377)	16A3	58.30	59.12	58.71	53.30	54.95	54.13	0.91	0.93	0.92
Point 16	**Point 16**	**58.18**	**59.31**	**58.74**	**53.61**	**55.34**	**54.47**	**0.92**	**0.93**	**0.92**
13/03/2021 6:18:49 PM (1615659530)	17A1	59.12	59.12	59.12	54.95	54.95	54.95	0.93	0.93	0.93
13/03/2021 6:21:49 PM (1615659710)	17A2	55.38	55.11	55.25	58.32	53.83	56.08	1.05	0.98	1.02
13/03/2021 6:24:49 PM (1615659890)	17A3	57.62	57.51	57.57	62.88	57.70	60.29	1.09	1.00	1.05
Point 17	**Point 17**	**57.63**	**57.54**	**57.59**	**59.90**	**55.81**	**57.75**	**1.02**	**0.97**	**1.00**
13/03/2021 6:31:33 PM (1615660294)	18A1	57.71	55.66	56.69	57.89	56.00	56.95	1.00	1.01	1.00
13/03/2021 6:34:33 PM (1615660474)	18A2	55.77	54.45	55.11	55.35	52.94	54.15	0.99	0.97	0.98
13/03/2021 6:37:33 PM (1615660654)	18A3	53.91	53.47	53.69	52.03	52.19	52.11	0.97	0.98	0.97
Point 18	**Point 18**	**56.07**	**54.62**	**55.33**	**55.71**	**54.04**	**54.85**	**0.99**	**0.98**	**0.99**

Site Data		LAeq - Antrophony (dBA)			LAeq - Biophony (dBA)			LAeq - Bio/Antrophony Ratio		
TIME	Point	CH1	CH2	AVG	CH1	CH2	AVG	CH1	CH2	AVG
16/03/2021 10:51:29 AM (1615888290)	19A1	68.05	66.17	67.11	67.99	65.65	66.82	1.00	0.99	1.00
16/03/2021 10:54:29 AM (1615888470)	19A2	65.37	64.25	64.81	62.81	60.68	61.75	0.96	0.94	0.95
16/03/2021 10:57:29 AM (1615888650)	19A3	64.26	62.80	63.53	61.45	59.86	60.66	0.96	0.95	0.95
Point 19	**Point 19**	**66.20**	**64.63**	**65.41**	**65.05**	**62.87**	**63.96**	**0.97**	**0.96**	**0.97**
16/03/2021 11:06:55 AM (1615889216)	20A1	64.34	63.64	63.99	61.83	63.64	62.74	0.96	1.00	0.98
16/03/2021 11:09:55 AM (1615889396)	20A2	64.12	64.15	64.14	64.32	66.22	65.27	1.00	1.03	1.02
16/03/2021 11:12:55 AM (1615889576)	20A3	63.62	62.48	63.05	63.65	64.51	64.08	1.00	1.03	1.02
Point 20	**Point 20**	**64.04**	**63.48**	**63.75**	**63.39**	**64.93**	**64.15**	**0.99**	**1.02**	**1.01**
16/03/2021 11:18:30 AM (1615889911)	21A1	60.03	59.82	59.93	61.02	58.45	59.74	1.02	0.98	1.00
16/03/2021 11:21:30 AM (1615890091)	21A2	63.04	62.55	62.80	60.27	58.85	59.56	0.96	0.94	0.95
16/03/2021 11:24:30 AM (1615890271)	21A3	68.00	65.44	66.72	64.69	61.90	63.30	0.95	0.95	0.95
Point 21	**Point 21**	**64.93**	**63.19**	**64.03**	**62.45**	**60.02**	**61.23**	**0.97**	**0.95**	**0.96**
16/03/2021 11:40:31 AM (1615891232)	22A1	65.04	65.49	65.27	67.37	65.49	66.43	1.04	1.02	1.03
16/03/2021 11:43:31 AM (1615891412)	22A2	66.39	66.82	66.61	66.34	66.58	66.46	1.00	1.00	1.00
16/03/2021 11:46:31 AM (1615891592)	22A3	65.27	65.44	65.36	64.68	64.84	64.76	0.99	0.99	0.99
Point 22	**Point 22**	**65.61**	**65.97**	**65.79**	**66.27**	**65.70**	**65.99**	**1.01**	**1.00**	**1.01**
16/03/2021 11:52:05 AM (1615891926)	23A1	63.43	64.37	63.90	61.94	60.96	61.45	0.98	0.95	0.96
16/03/2021 11:55:05 AM (1615892106)	23A2	62.36	63.78	63.07	57.55	58.47	58.01	0.92	0.92	0.92
16/03/2021 11:58:05 AM (1615892286)	23A3	64.80	65.18	64.99	59.51	59.35	59.43	0.92	0.91	0.91
Point 23	**Point 23**	**63.65**	**64.48**	**64.06**	**60.04**	**59.72**	**59.88**	**0.94**	**0.93**	**0.93**
16/03/2021 12:05:20 PM (1615892721)	24A1	68.23	65.84	67.04	65.07	66.91	65.99	0.95	1.02	0.99
16/03/2021 12:08:20 PM (1615892901)	24A2	67.13	64.16	65.65	64.09	65.20	64.65	0.96	1.02	0.99
16/03/2021 12:11:20 PM (1615893081)	24A3	65.20	61.80	63.50	61.35	60.43	60.89	0.94	0.98	0.96
Point 24	**Point 24**	**67.03**	**64.24**	**65.63**	**63.77**	**64.93**	**64.32**	**0.95**	**1.00**	**0.98**
16/03/2021 12:19:08 PM (1615893549)	25A1	67.80	66.55	67.18	73.26	69.69	71.48	1.08	1.05	1.06
16/03/2021 12:22:08 PM (1615893729)	25A2	66.68	65.74	66.21	73.05	69.53	71.29	1.10	1.06	1.08
16/03/2021 12:25:08 PM (1615893909)	25A3	66.55	65.75	66.15	72.31	69.14	70.73	1.09	1.05	1.07
Point 25	**Point 25**	**67.05**	**66.03**	**66.54**	**72.89**	**69.46**	**71.17**	**1.09**	**1.05**	**1.07**
16/03/2021 12:32:31 PM (1615894352)	26A1	60.25	58.97	59.61	58.03	55.31	56.67	0.96	0.94	0.95
16/03/2021 12:35:31 PM (1615894532)	26A2	61.14	59.91	60.53	57.41	54.68	56.05	0.94	0.91	0.93
16/03/2021 12:38:31 PM (1615894712)	26A3	60.53	59.14	59.84	60.93	56.03	58.48	1.01	0.95	0.98
Point 26	**Point 26**	**60.66**	**59.36**	**60.01**	**59.08**	**55.38**	**57.19**	**0.97**	**0.93**	**0.95**
16/03/2021 12:44:08 PM (1615895049)	27A1	57.92	57.49	57.71	60.22	59.85	60.04	1.04	1.04	1.04
16/03/2021 12:47:08 PM (1615895229)	27A2	57.19	56.92	57.06	56.25	55.63	55.94	0.98	0.98	0.98
16/03/2021 12:50:08 PM (1615895409)	27A3	58.35	57.99	58.17	58.62	57.09	57.86	1.00	0.99	0.99
Point 27	**Point 27**	**57.85**	**57.49**	**57.67**	**58.66**	**57.88**	**58.26**	**1.01**	**1.00**	**1.01**
16/03/2021 1:01:51 PM (1615896112)	28A1	64.05	63.17	63.61	66.62	67.70	67.16	1.04	1.07	1.06
16/03/2021 1:04:51 PM (1615896292)	28A2	65.65	64.09	64.87	61.30	59.83	60.57	0.93	0.93	0.93
16/03/2021 1:07:51 PM (1615896472)	28A3	66.01	65.81	65.91	63.90	65.18	64.54	0.97	0.99	0.98
Point 28	**Point 28**	**65.32**	**64.50**	**64.90**	**64.47**	**65.28**	**64.88**	**0.98**	**1.00**	**0.99**
16/03/2021 1:21:17 PM (1615897278)	29A1	61.97	60.98	61.48	59.52	60.98	60.25	0.96	0.96	0.96
16/03/2021 1:24:17 PM (1615897458)	29A2	61.55	61.70	61.63	58.94	58.60	58.77	0.96	0.95	0.95
16/03/2021 1:27:17 PM (1615897638)	29A3	63.71	64.05	63.88	60.17	60.47	60.32	0.94	0.94	0.94
Point 29	**Point 29**	**62.51**	**62.45**	**62.47**	**59.57**	**60.13**	**59.84**	**0.95**	**0.95**	**0.95**
16/03/2021 2:27:16 PM (1615901237)	30A1	56.91	56.97	56.94	50.86	51.10	50.98	0.89	0.90	0.90
16/03/2021 2:30:16 PM (1615901417)	30A2	56.32	55.82	56.07	52.12	49.70	50.91	0.93	0.89	0.91
16/03/2021 2:33:16 PM (1615901597)	30A3	56.72	56.08	56.40	50.75	48.69	49.72	0.90	0.87	0.88
Point 30	**Point 30**	**56.66**	**56.32**	**56.48**	**51.28**	**49.94**	**50.57**	**0.90**	**0.89**	**0.89**
16/03/2021 2:43:52 PM (1615902233)	31A1	58.30	56.76	57.53	58.33	55.37	56.85	1.00	0.98	0.99
16/03/2021 2:46:52 PM (1615902413)	31A2	57.26	56.10	56.68	54.70	52.97	53.84	0.96	0.94	0.95
16/03/2021 2:49:52 PM (1615902593)	31A3	62.80	62.06	62.43	56.52	55.01	55.77	0.90	0.89	0.89
Point 31	**Point 31**	**60.16**	**59.19**	**59.67**	**56.77**	**54.57**	**55.66**	**0.95**	**0.94**	**0.94**
16/03/2021 2:55:31 PM (1615902932)	32A1	62.12	60.73	61.43	64.18	59.21	61.70	1.03	0.98	1.00
16/03/2021 2:58:31 PM (1615903112)	32A2	59.21	57.80	58.51	55.99	53.68	54.84	0.95	0.93	0.94
16/03/2021 3:01:31 PM (1615903292)	32A3	58.61	57.78	58.20	58.20	56.92	57.56	0.99	0.99	0.99
Point 32	**Point 32**	**60.27**	**59.00**	**59.63**	**60.88**	**57.16**	**58.94**	**0.99**	**0.98**	**0.98**
16/03/2021 3:08:07 PM (1615903688)	33A1	60.75	60.59	60.67	62.15	58.98	60.57	1.02	0.97	1.00
16/03/2021 3:11:07 PM (1615903868)	33A2	54.90	53.91	54.41	52.47	50.64	51.56	0.96	0.94	0.95
16/03/2021 3:14:07 PM (1615904048)	33A3	57.72	57.09	57.41	64.70	61.30	63.00	1.12	1.07	1.10
Point 33	**Point 33**	**58.43**	**58.02**	**58.22**	**63.01**	**58.78**	**60.38**	**1.03**	**1.00**	**1.01**
16/03/2021 3:22:40 PM (1615904561)	34A1	62.45	60.71	61.58	60.47	58.56	59.52	0.97	0.97	0.97
16/03/2021 3:25:40 PM (1615904741)	34A2	61.06	58.71	59.89	57.44	54.68	56.06	0.94	0.93	0.94
16/03/2021 3:28:40 PM (1615904921)	34A3	59.98	57.90	58.94	57.84	55.35	56.60	0.96	0.96	0.96
Point 34	**Point 34**	**61.28**	**59.27**	**60.27**	**58.80**	**56.55**	**57.67**	**0.96**	**0.95**	**0.95**
16/03/2021 3:36:14 PM (1615905375)	35A1	58.93	56.95	57.94	60.80	57.83	59.32	1.03	1.02	1.02
16/03/2021 3:39:14 PM (1615905555)	35A2	60.53	58.48	59.51	57.93	55.73	56.83	0.96	0.95	0.96
16/03/2021 3:42:14 PM (1615905735)	35A3	56.82	55.70	56.26	54.71	53.64	54.18	0.96	0.96	0.96
Point 35	**Point 35**	**59.02**	**57.19**	**58.10**	**58.49**	**56.06**	**57.28**	**0.98**	**0.98**	**0.98**
16/03/2021 3:50:58 PM (1615906259)	36A1	69.99	67.05	68.52	68.29	70.91	69.60	0.98	1.06	1.02
16/03/2021 3:53:58 PM (1615906439)	36A2	69.47	66.26	67.87	64.94	61.75	63.35	0.94	0.93	0.93
16/03/2021 3:56:58 PM (1615906619)	36A3	70.21	66.85	68.53	71.11	66.28	68.70	1.01	0.99	1.00
Point 36	**Point 36**	**69.90**	**66.73**	**68.32**	**68.80**	**67.80**	**67.94**	**0.97**	**0.99**	**0.98**
16/03/2021 4:04:32 PM (1615907073)	37A1	70.02	67.25	68.64	65.28	63.24	64.26	0.93	0.94	0.94
16/03/2021 4:07:32 PM (1615907253)	37A2	68.25	65.31	66.78	62.52	59.12	60.82	0.92	0.91	0.91
16/03/2021 4:10:32 PM (1615907433)	37A3	67.62	65.20	66.41	62.42	60.06	61.24	0.92	0.92	0.92
Point 37	**Point 37**	**68.75**	**66.03**	**67.39**	**63.82**	**61.18**	**62.39**	**0.92**	**0.92**	**0.92**
16/03/2021 4:17:33 PM (1615907854)	38A1	66.73	64.62	65.68	74.61	73.74	74.18	1.12	1.14	1.13
16/03/2021 4:20:33 PM (1615908034)	38A2	67.60	65.38	66.49	67.19	62.23	64.71	0.99	0.95	0.97
16/03/2021 4:23:33 PM (1615908214)	38A3	66.63	64.60	65.62	62.89	59.90	61.40	0.94	0.93	0.94
Point 38	**Point 38**	**67.01**	**64.88**	**65.95**	**70.80**	**68.43**	**70.07**	**1.02**	**1.01**	**1.01**

Table 63. Raw Data of NDSI

Site Data		NDSI		
TIME	Point	CH1	CH2	AVG
13/03/2021 12:39:03 PM (1615639144)	2A1	0.01	0.15	0.08
13/03/2021 12:42:03 PM (1615639324)	2A2	-0.17	0.01	-0.08
13/03/2021 12:45:03 PM (1615639504)	2A3	-0.13	-0.01	-0.07
	2A	-0.09	0.05	-0.02
13/03/2021 1:17:52 PM (1615641473)	2B1	0.02	0.13	0.07
13/03/2021 1:20:52 PM (1615641653)	2B2	0.02	0.00	0.01
13/03/2021 1:23:52 PM (1615641833)	2B3	0.46	0.30	0.38
	2B	0.17	0.14	0.15
Point 2	**Point 2**	**0.04**	**0.10**	**0.07**
13/03/2021 1:56:50 PM (1615643811)	3A1	-0.10	0.06	-0.02
13/03/2021 1:59:50 PM (1615643991)	3A2	0.05	-0.04	0.00
13/03/2021 2:02:50 PM (1615644171)	3A3	0.13	-0.01	0.06
Point 3	**Point 3**	**0.03**	**0.00**	**0.02**
13/03/2021 2:23:28 PM (1615645409)	4A1	0.16	0.10	0.13
13/03/2021 2:26:28 PM (1615645589)	4A2	0.41	0.13	0.27
13/03/2021 2:29:28 PM (1615645769)	4A3	0.06	-0.06	0.00
Point 4	**Point 4**	**0.21**	**0.05**	**0.13**
13/03/2021 2:39:26 PM (1615646367)	5A1	-0.08	-0.11	-0.09
13/03/2021 2:42:26 PM (1615646547)	5A2	0.26	0.33	0.30
13/03/2021 2:45:26 PM (1615646727)	5A3	0.23	0.29	0.26
Point 5	**Point 5**	**0.14**	**0.17**	**0.15**
13/03/2021 2:59:10 PM (1615647551)	6A1	-0.12	-0.01	-0.06
13/03/2021 3:02:10 PM (1615647731)	6A2	-0.24	-0.04	-0.14
13/03/2021 3:05:10 PM (1615647911)	6A3	-0.15	0.07	-0.04
Point 6	**Point 6**	**-0.17**	**0.01**	**-0.08**
13/03/2021 3:15:19 PM (1615648520)	7A1	0.47	0.24	0.35
13/03/2021 3:18:19 PM (1615648700)	7A2	0.07	0.10	0.08
13/03/2021 3:21:19 PM (1615648880)	7A3	-0.08	-0.09	-0.09
Point 7	**Point 7**	**0.15**	**0.08**	**0.12**
13/03/2021 3:26:32 PM (1615649193)	8A1	0.18	-0.10	0.04
13/03/2021 3:29:32 PM (1615649373)	8A2	-0.10	-0.18	-0.14
13/03/2021 3:32:32 PM (1615649553)	8A3	0.05	0.03	0.04
Point 8	**Point 8**	**0.04**	**-0.09**	**-0.02**
13/03/2021 3:40:05 PM (1615650006)	9A1	-0.05	-0.02	-0.03
13/03/2021 3:43:05 PM (1615650186)	9A2	0.10	0.21	0.15
13/03/2021 3:46:05 PM (1615650366)	9A3	-0.11	-0.08	-0.10
Point 9	**Point 9**	**-0.02**	**0.04**	**0.01**
13/03/2021 4:26:34 PM (1615652795)	10A1	0.00	0.08	0.04
13/03/2021 4:29:34 PM (1615652975)	10A2	-0.26	0.05	-0.10
13/03/2021 4:32:34 PM (1615653155)	10A3	-0.11	-0.08	-0.09
Point 10	**Point 10**	**-0.12**	**0.02**	**-0.05**
13/03/2021 4:41:50 PM (1615653711)	11A1	0.01	0.04	0.03
13/03/2021 4:44:50 PM (1615653891)	11A2	-0.19	-0.25	-0.22
13/03/2021 4:47:50 PM (1615654071)	11A3	-0.04	-0.08	-0.06
Point 11	**Point 11**	**-0.08**	**-0.10**	**-0.09**
13/03/2021 4:53:47 PM (1615654428)	12A1	0.36	0.17	0.26
13/03/2021 4:56:47 PM (1615654608)	12A2	0.02	0.03	0.02
13/03/2021 4:59:47 PM (1615654788)	12A3	-0.14	-0.41	-0.28
Point 12	**Point 12**	**0.08**	**-0.07**	**0.00**
13/03/2021 5:08:43 PM (1615655324)	13A1	-0.25	-0.38	-0.32
13/03/2021 5:11:43 PM (1615655504)	13A2	-0.19	-0.07	-0.13
13/03/2021 5:14:43 PM (1615655684)	13A3	-0.16	0.01	-0.08
Point 13	**Point 13**	**-0.20**	**-0.15**	**-0.17**
13/03/2021 5:20:12 PM (1615656013)	14A1	0.15	0.28	0.21
13/03/2021 5:23:12 PM (1615656193)	14A2	-0.12	-0.12	-0.12
13/03/2021 5:26:12 PM (1615656373)	14A3	-0.17	-0.25	-0.21
Point 14	**Point 14**	**-0.05**	**-0.03**	**-0.04**
13/03/2021 5:31:43 PM (1615656704)	15A1	-0.23	-0.21	-0.22
13/03/2021 5:34:43 PM (1615656884)	15A2	0.08	-0.02	0.03
13/03/2021 5:37:43 PM (1615657064)	15A3	-0.10	-0.26	-0.18
Point 15	**Point 15**	**-0.08**	**-0.16**	**-0.12**
13/03/2021 5:53:36 PM (1615658017)	16A1	-0.02	-0.07	-0.05
13/03/2021 5:56:36 PM (1615658197)	16A2	-0.25	-0.21	-0.23
13/03/2021 5:59:36 PM (1615658377)	16A3	-0.20	-0.07	-0.14
Point 16	**Point 16**	**-0.16**	**-0.12**	**-0.14**
13/03/2021 6:18:49 PM (1615659530)	17A1	0.07	0.05	0.06
13/03/2021 6:21:49 PM (1615659710)	17A2	0.57	0.14	0.35
13/03/2021 6:24:49 PM (1615659890)	17A3	0.68	0.19	0.44
Point 17	**Point 17**	**0.44**	**0.13**	**0.28**
13/03/2021 6:31:33 PM (1615660294)	18A1	0.41	0.44	0.42
13/03/2021 6:34:33 PM (1615660474)	18A2	0.29	0.20	0.24
13/03/2021 6:37:33 PM (1615660654)	18A3	0.21	0.29	0.25
Point 18	**Point 18**	**0.30**	**0.31**	**0.30**

Site Data		NDSI		
TIME	Point	CH1	CH2	AVG
16/03/2021 10:51:29 AM (1615888290)	19A1	0.22	0.22	0.22
16/03/2021 10:54:29 AM (1615888470)	19A2	0.04	0.00	0.02
16/03/2021 10:57:29 AM (1615888650)	19A3	0.03	0.09	0.06
Point 19	Point 19	0.10	0.11	0.10
16/03/2021 11:06:55 AM (1615889216)	20A1	0.04	0.28	0.16
16/03/2021 11:09:55 AM (1615889396)	20A2	0.32	0.49	0.40
16/03/2021 11:12:55 AM (1615889576)	20A3	0.24	0.43	0.34
Point 20	Point 20	0.20	0.40	0.30
16/03/2021 11:18:30 AM (1615889911)	21A1	0.23	-0.11	0.06
16/03/2021 11:21:30 AM (1615890091)	21A2	-0.19	-0.32	-0.26
16/03/2021 11:24:30 AM (1615890271)	21A3	-0.19	-0.25	-0.22
Point 21	Point 21	-0.05	-0.23	-0.14
16/03/2021 11:40:31 AM (1615891232)	22A1	0.41	0.33	0.37
16/03/2021 11:43:31 AM (1615891412)	22A2	0.24	0.18	0.21
16/03/2021 11:46:31 AM (1615891592)	22A3	0.19	0.16	0.18
Point 22	Point 22	0.28	0.22	0.25
16/03/2021 11:52:05 AM (1615891926)	23A1	0.14	-0.14	0.00
16/03/2021 11:55:05 AM (1615892106)	23A2	-0.14	-0.31	-0.22
16/03/2021 11:58:05 AM (1615892286)	23A3	-0.11	-0.28	-0.19
Point 23	Point 23	-0.04	-0.24	-0.14
16/03/2021 12:05:20 PM (1615892721)	24A1	-0.01	0.41	0.20
16/03/2021 12:08:20 PM (1615892901)	24A2	0.08	0.49	0.28
16/03/2021 12:11:20 PM (1615893081)	24A3	-0.09	0.22	0.07
Point 24	Point 24	-0.01	0.37	0.18
16/03/2021 12:19:08 PM (1615893549)	25A1	0.63	0.42	0.53
16/03/2021 12:22:08 PM (1615893729)	25A2	0.67	0.47	0.57
16/03/2021 12:25:08 PM (1615893909)	25A3	0.63	0.43	0.53
Point 25	Point 25	0.64	0.44	0.54
16/03/2021 12:32:31 PM (1615894352)	26A1	0.10	0.00	0.05
16/03/2021 12:35:31 PM (1615894532)	26A2	-0.12	-0.22	-0.17
16/03/2021 12:38:31 PM (1615894712)	26A3	0.30	-0.04	0.13
Point 26	Point 26	0.09	-0.09	0.00
16/03/2021 12:44:08 PM (1615895049)	27A1	0.51	0.50	0.50
16/03/2021 12:47:08 PM (1615895229)	27A2	0.17	0.13	0.15
16/03/2021 12:50:08 PM (1615895409)	27A3	0.26	0.13	0.19
Point 27	Point 27	0.31	0.25	0.28
16/03/2021 1:01:51 PM (1615896112)	28A1	0.54	0.67	0.61
16/03/2021 1:04:51 PM (1615896292)	28A2	-0.14	-0.09	-0.12
16/03/2021 1:07:51 PM (1615896472)	28A3	0.13	0.25	0.19
Point 28	Point 28	0.18	0.28	0.23
16/03/2021 1:21:17 PM (1615897278)	29A1	0.11	0.11	0.11
16/03/2021 1:24:17 PM (1615897458)	29A2	0.02	-0.11	-0.05
16/03/2021 1:27:17 PM (1615897638)	29A3	-0.10	-0.16	-0.13
Point 29	Point 29	0.01	-0.06	-0.02
16/03/2021 2:27:16 PM (1615901237)	30A1	-0.14	-0.13	-0.14
16/03/2021 2:30:16 PM (1615901417)	30A2	-0.01	-0.21	-0.11
16/03/2021 2:33:16 PM (1615901597)	30A3	-0.22	-0.30	-0.26
Point 30	Point 30	-0.12	-0.22	-0.17
16/03/2021 2:43:52 PM (1615902233)	31A1	0.35	0.21	0.28
16/03/2021 2:46:52 PM (1615902413)	31A2	0.11	0.06	0.09
16/03/2021 2:49:52 PM (1615902593)	31A3	-0.11	-0.20	-0.16
Point 31	Point 31	0.12	0.02	0.07
16/03/2021 2:55:31 PM (1615902932)	32A1	0.56	0.19	0.38
16/03/2021 2:58:31 PM (1615903112)	32A2	0.00	-0.08	-0.04
16/03/2021 3:01:31 PM (1615903292)	32A3	0.34	0.26	0.30
Point 32	Point 32	0.30	0.12	0.21
16/03/2021 3:08:07 PM (1615903688)	33A1	0.50	0.34	0.42
16/03/2021 3:11:07 PM (1615903868)	33A2	0.10	0.05	0.08
16/03/2021 3:14:07 PM (1615904048)	33A3	0.84	0.73	0.78
Point 33	Point 33	0.48	0.37	0.43
16/03/2021 3:22:40 PM (1615904561)	34A1	-0.01	0.00	0.00
16/03/2021 3:25:40 PM (1615904741)	34A2	-0.16	-0.16	-0.16
16/03/2021 3:28:40 PM (1615904921)	34A3	0.10	0.10	0.10
Point 34	Point 34	-0.02	-0.02	-0.02
16/03/2021 3:36:14 PM (1615905375)	35A1	0.39	0.34	0.36
16/03/2021 3:39:14 PM (1615905555)	35A2	0.05	0.05	0.05
16/03/2021 3:42:14 PM (1615905735)	35A3	0.14	0.15	0.15
Point 35	Point 35	0.19	0.18	0.19
16/03/2021 3:50:58 PM (1615906259)	36A1	0.03	0.59	0.31
16/03/2021 3:53:58 PM (1615906439)	36A2	-0.21	-0.20	-0.21
16/03/2021 3:56:58 PM (1615906619)	36A3	0.35	0.20	0.28
Point 36	Point 36	0.06	0.20	0.13
16/03/2021 4:04:32 PM (1615907073)	37A1	-0.30	-0.21	-0.25
16/03/2021 4:07:32 PM (1615907253)	37A2	-0.38	-0.38	-0.38
16/03/2021 4:10:32 PM (1615907433)	37A3	-0.28	-0.25	-0.26
Point 37	Point 37	-0.32	-0.28	-0.30
16/03/2021 4:17:33 PM (1615907854)	38A1	0.82	0.86	0.84
16/03/2021 4:20:33 PM (1615908034)	38A2	0.29	-0.01	0.14
16/03/2021 4:23:33 PM (1615908214)	38A3	-0.16	-0.24	-0.20
Point 38	Point 38	0.32	0.20	0.26

Table 64. Raw Data of Psychoacoustic Annoyance

Site Data		Psychoacoustic Annoyance			
TIME	Point	N	Nmax	N5	Sharpness
13/03/2021 12:39:03 PM (1615639144)	2A1	35.40	77.03	47.34	1.36
13/03/2021 12:42:03 PM (1615639324)	2A2	36.25	76.78	46.47	1.32
13/03/2021 12:45:03 PM (1615639504)	2A3	34.29	95.95	45.94	1.33
	2A	35.31	83.25	46.58	1.34
13/03/2021 1:17:52 PM (1615641473)	2B1	33.04	90.95	50.62	1.58
13/03/2021 1:20:52 PM (1615641653)	2B2	35.80	86.30	55.76	1.37
13/03/2021 1:23:52 PM (1615641833)	2B3	36.33	123.10	59.13	1.68
	2B	35.06	100.12	55.17	1.54
Point 2	**Point 2**	**35.19**	**91.69**	**50.88**	**1.44**
13/03/2021 1:56:50 PM (1615643811)	3A1	31.65	121.70	40.77	1.54
13/03/2021 1:59:50 PM (1615643991)	3A2	32.27	87.10	43.76	1.50
13/03/2021 2:02:50 PM (1615644171)	3A3	31.62	70.41	41.68	1.41
Point 3	**Point 3**	**31.85**	**93.07**	**42.07**	**1.48**
13/03/2021 2:23:28 PM (1615645409)	4A1	31.28	141.10	47.88	1.33
13/03/2021 2:26:28 PM (1615645589)	4A2	30.57	71.72	45.85	1.32
13/03/2021 2:29:28 PM (1615645769)	4A3	36.77	82.34	49.72	1.50
Point 4	**Point 4**	**32.87**	**98.39**	**47.82**	**1.38**
13/03/2021 2:39:26 PM (1615646367)	5A1	29.01	63.09	36.76	1.43
13/03/2021 2:42:26 PM (1615646547)	5A2	27.13	64.57	36.67	1.58
13/03/2021 2:45:26 PM (1615646727)	5A3	28.73	71.83	39.82	1.58
Point 5	**Point 5**	**28.29**	**66.50**	**37.75**	**1.53**
13/03/2021 2:59:10 PM (1615647551)	6A1	38.64	92.72	61.95	1.45
13/03/2021 3:02:10 PM (1615647731)	6A2	36.10	94.34	65.20	1.46
13/03/2021 3:05:10 PM (1615647911)	6A3	43.40	96.32	61.56	1.49
Point 6	**Point 6**	**39.38**	**94.46**	**62.90**	**1.46**
13/03/2021 3:15:19 PM (1615648520)	7A1	24.83	102.10	34.93	1.64
13/03/2021 3:18:19 PM (1615648700)	7A2	26.43	67.38	35.64	1.45
13/03/2021 3:21:19 PM (1615648880)	7A3	25.03	106.80	34.29	1.46
Point 7	**Point 7**	**25.43**	**92.09**	**34.95**	**1.52**
13/03/2021 3:26:32 PM (1615649193)	8A1	24.39	52.84	32.87	1.36
13/03/2021 3:29:32 PM (1615649373)	8A2	24.43	50.27	33.97	1.34
13/03/2021 3:32:32 PM (1615649553)	8A3	26.14	68.87	33.93	1.35
Point 8	**Point 8**	**24.99**	**57.33**	**33.59**	**1.35**
13/03/2021 3:40:05 PM (1615650006)	9A1	27.83	53.08	37.57	1.42
13/03/2021 3:43:05 PM (1615650186)	9A2	25.58	60.02	36.43	1.55
13/03/2021 3:46:05 PM (1615650366)	9A3	27.12	70.78	38.62	1.23
Point 9	**Point 9**	**26.84**	**61.29**	**37.54**	**1.40**
13/03/2021 4:26:34 PM (1615652795)	10A1	25.43	109.50	35.82	1.64
13/03/2021 4:29:34 PM (1615652975)	10A2	26.34	93.26	39.36	1.46
13/03/2021 4:32:34 PM (1615653155)	10A3	23.44	62.23	31.46	1.45
Point 10	**Point 10**	**25.07**	**88.33**	**35.55**	**1.52**
13/03/2021 4:41:50 PM (1615653711)	11A1	22.71	53.88	31.82	1.36
13/03/2021 4:44:50 PM (1615653891)	11A2	23.78	155.10	37.99	1.51
13/03/2021 4:47:50 PM (1615654071)	11A3	26.16	53.86	34.70	1.43
Point 11	**Point 11**	**24.22**	**87.61**	**34.84**	**1.43**
13/03/2021 4:53:47 PM (1615654428)	12A1	21.08	53.43	26.95	1.53
13/03/2021 4:56:47 PM (1615654608)	12A2	20.84	42.58	26.31	1.32
13/03/2021 4:59:47 PM (1615654788)	12A3	19.66	47.91	25.65	1.44
Point 12	**Point 12**	**20.53**	**47.97**	**26.30**	**1.43**
13/03/2021 5:08:43 PM (1615655324)	13A1	34.17	92.92	57.89	1.46
13/03/2021 5:11:43 PM (1615655504)	13A2	31.46	148.80	50.38	1.43
13/03/2021 5:14:43 PM (1615655684)	13A3	27.75	124.00	43.90	1.29
Point 13	**Point 13**	**31.13**	**121.91**	**50.72**	**1.39**
13/03/2021 5:20:12 PM (1615656013)	14A1	26.41	81.97	33.20	1.49
13/03/2021 5:23:12 PM (1615656193)	14A2	22.84	47.71	28.56	1.40
13/03/2021 5:26:12 PM (1615656373)	14A3	25.15	68.02	33.88	1.35
Point 14	**Point 14**	**24.80**	**65.90**	**31.88**	**1.41**
13/03/2021 5:31:43 PM (1615656704)	15A1	25.10	51.70	31.53	1.33
13/03/2021 5:34:43 PM (1615656884)	15A2	23.58	56.01	30.39	1.42
13/03/2021 5:37:43 PM (1615657064)	15A3	23.43	60.23	29.02	1.39
Point 15	**Point 15**	**24.04**	**55.98**	**30.31**	**1.38**
13/03/2021 5:53:36 PM (1615658017)	16A1	22.44	44.34	29.32	1.33
13/03/2021 5:56:36 PM (1615658197)	16A2	20.79	39.41	26.27	1.33
13/03/2021 5:59:36 PM (1615658377)	16A3	21.99	41.34	28.01	1.36
Point 16	**Point 16**	**21.74**	**41.70**	**27.87**	**1.34**
13/03/2021 6:18:49 PM (1615659530)	17A1	18.71	46.25	23.61	1.47
13/03/2021 6:21:49 PM (1615659710)	17A2	17.98	97.77	24.72	1.77
13/03/2021 6:24:49 PM (1615659890)	17A3	19.40	130.80	29.10	1.82
Point 17	**Point 17**	**18.70**	**91.61**	**25.81**	**1.69**
13/03/2021 6:31:33 PM (1615660294)	18A1	22.10	68.93	31.68	1.46
13/03/2021 6:34:33 PM (1615660474)	18A2	20.21	60.13	27.70	1.66
13/03/2021 6:37:33 PM (1615660654)	18A3	19.55	38.48	23.36	1.43
Point 18	**Point 18**	**20.62**	**55.85**	**27.58**	**1.52**

Site Data		Psychoacoustic Annoyance		
TIME	Point	Roughness	FluctuationStrength	PAnnoyance
13/03/2021 12:39:03 PM (1615639144)	2A1	0.18	0.04	50.01
13/03/2021 12:42:03 PM (1615639324)	2A2	0.14	0.04	48.68
13/03/2021 12:45:03 PM (1615639504)	2A3	0.15	0.03	48.17
	2A	0.16	0.04	48.95
13/03/2021 1:17:52 PM (1615641473)	2B1	0.18	0.06	53.71
13/03/2021 1:20:52 PM (1615641653)	2B2	0.18	0.06	58.24
13/03/2021 1:23:52 PM (1615641833)	2B3	0.22	0.08	63.22
	2B	0.19	0.07	58.39
Point 2	Point 2	0.18	0.05	53.67
13/03/2021 1:56:50 PM (1615643811)	3A1	0.19	0.08	43.67
13/03/2021 1:59:50 PM (1615643991)	3A2	0.21	0.07	46.95
13/03/2021 2:02:50 PM (1615644171)	3A3	0.24	0.05	44.99
Point 3	Point 3	0.21	0.07	45.20
13/03/2021 2:23:28 PM (1615645409)	4A1	0.13	0.05	50.12
13/03/2021 2:26:28 PM (1615645589)	4A2	0.14	0.05	48.12
13/03/2021 2:29:28 PM (1615645769)	4A3	0.13	0.05	51.99
Point 4	Point 4	0.13	0.05	50.08
13/03/2021 2:39:26 PM (1615646367)	5A1	0.19	0.08	39.56
13/03/2021 2:42:26 PM (1615646547)	5A2	0.20	0.07	39.46
13/03/2021 2:45:26 PM (1615646727)	5A3	0.22	0.09	43.08
Point 5	Point 5	0.20	0.08	40.70
13/03/2021 2:59:10 PM (1615647551)	6A1	0.18	0.05	65.35
13/03/2021 3:02:10 PM (1615647731)	6A2	0.14	0.13	68.85
13/03/2021 3:05:10 PM (1615647911)	6A3	0.14	0.59	69.85
Point 6	Point 6	0.16	0.25	68.02
13/03/2021 3:15:19 PM (1615648520)	7A1	0.20	0.07	37.65
13/03/2021 3:18:19 PM (1615648700)	7A2	0.17	0.04	37.87
13/03/2021 3:21:19 PM (1615648880)	7A3	0.21	0.08	37.11
Point 7	Point 7	0.19	0.06	37.54
13/03/2021 3:26:32 PM (1615649193)	8A1	0.11	0.06	34.45
13/03/2021 3:29:32 PM (1615649373)	8A2	0.11	0.05	35.47
13/03/2021 3:32:32 PM (1615649553)	8A3	0.14	0.04	35.73
Point 8	Point 8	0.12	0.05	35.22
13/03/2021 3:40:05 PM (1615650006)	9A1	0.15	0.03	39.56
13/03/2021 3:43:05 PM (1615650186)	9A2	0.16	0.08	38.81
13/03/2021 3:46:05 PM (1615650366)	9A3	0.17	0.03	40.78
Point 9	Point 9	0.16	0.04	39.72
13/03/2021 4:26:34 PM (1615652795)	10A1	0.21	0.03	38.46
13/03/2021 4:29:34 PM (1615652975)	10A2	0.14	0.10	41.82
13/03/2021 4:32:34 PM (1615653155)	10A3	0.14	0.05	33.23
Point 10	Point 10	0.17	0.06	37.84
13/03/2021 4:41:50 PM (1615653711)	11A1	0.19	0.05	34.15
13/03/2021 4:44:50 PM (1615653891)	11A2	0.19	0.07	40.77
13/03/2021 4:47:50 PM (1615654071)	11A3	0.15	0.04	36.68
Point 11	Point 11	0.18	0.05	37.20
13/03/2021 4:53:47 PM (1615654428)	12A1	0.13	0.04	28.48
13/03/2021 4:56:47 PM (1615654608)	12A2	0.14	0.23	29.04
13/03/2021 4:59:47 PM (1615654788)	12A3	0.14	0.03	27.10
Point 12	Point 12	0.14	0.10	28.21
13/03/2021 5:08:43 PM (1615655324)	13A1	0.13	0.11	60.92
13/03/2021 5:11:43 PM (1615655504)	13A2	0.11	0.12	53.07
13/03/2021 5:14:43 PM (1615655684)	13A3	0.17	0.07	46.69
Point 13	Point 13	0.14	0.10	53.56
13/03/2021 5:20:12 PM (1615656013)	14A1	0.18	0.03	35.40
13/03/2021 5:23:12 PM (1615656193)	14A2	0.20	0.04	30.75
13/03/2021 5:26:12 PM (1615656373)	14A3	0.17	0.05	36.07
Point 14	Point 14	0.18	0.04	34.07
13/03/2021 5:31:43 PM (1615656704)	15A1	0.14	0.04	33.18
13/03/2021 5:34:43 PM (1615656884)	15A2	0.18	0.04	32.55
13/03/2021 5:37:43 PM (1615657064)	15A3	0.20	0.05	31.33
Point 15	Point 15	0.17	0.04	32.35
13/03/2021 5:53:36 PM (1615658017)	16A1	0.15	0.06	31.18
13/03/2021 5:56:36 PM (1615658197)	16A2	0.07	0.04	28.03
13/03/2021 5:59:36 PM (1615658377)	16A3	0.15	0.05	29.78
Point 16	Point 16	0.12	0.05	29.66
13/03/2021 6:18:49 PM (1615659530)	17A1	0.23	0.07	26.02
13/03/2021 6:21:49 PM (1615659710)	17A2	0.19	0.04	26.69
13/03/2021 6:24:49 PM (1615659890)	17A3	0.21	0.14	32.64
Point 17	Point 17	0.21	0.08	28.45
13/03/2021 6:31:33 PM (1615660294)	18A1	0.19	0.05	34.02
13/03/2021 6:34:33 PM (1615660474)	18A2	0.20	0.04	29.90
13/03/2021 6:37:33 PM (1615660654)	18A3	0.17	0.02	24.89
Point 18	Point 18	0.19	0.04	29.60

Site Data		Psychoacoustic Annoyance			
TIME	Point	N	Nmax	N5	Sharpness
16/03/2021 10:51:29 AM (1615888290)	19A1	37.60	126.20	78.15	1.53
16/03/2021 10:54:29 AM (1615888470)	19A2	33.31	146.20	44.60	1.41
16/03/2021 10:57:29 AM (1615888650)	19A3	34.77	79.96	47.05	1.41
Point 19	**Point 19**	**35.23**	**117.45**	**56.60**	**1.45**
16/03/2021 11:06:55 AM (1615889216)	20A1	32.62	90.17	48.42	1.52
16/03/2021 11:09:55 AM (1615889396)	20A2	36.64	98.61	50.66	1.46
16/03/2021 11:12:55 AM (1615889576)	20A3	33.63	88.07	48.47	1.53
Point 20	**Point 20**	**34.30**	**92.28**	**49.18**	**1.50**
16/03/2021 11:18:30 AM (1615889911)	21A1	29.44	79.87	36.58	1.56
16/03/2021 11:21:30 AM (1615890091)	21A2	31.18	63.60	39.87	1.43
16/03/2021 11:24:30 AM (1615890271)	21A3	30.41	191.40	42.49	1.42
Point 21	**Point 21**	**30.34**	**111.62**	**39.65**	**1.47**
16/03/2021 11:40:31 AM (1615891232)	22A1	39.69	135.70	53.63	1.65
16/03/2021 11:43:31 AM (1615891412)	22A2	41.67	90.62	59.84	1.52
16/03/2021 11:46:31 AM (1615891592)	22A3	40.40	90.06	57.17	1.46
Point 22	**Point 22**	**40.59**	**105.46**	**56.88**	**1.54**
16/03/2021 11:52:05 AM (1615891926)	23A1	37.08	84.78	43.88	1.39
16/03/2021 11:55:05 AM (1615892106)	23A2	32.96	73.55	43.58	1.28
16/03/2021 11:58:05 AM (1615892286)	23A3	41.16	87.84	48.78	1.19
Point 23	**Point 23**	**37.07**	**82.06**	**45.41**	**1.29**
16/03/2021 12:05:20 PM (1615892721)	24A1	49.31	76.64	62.91	1.30
16/03/2021 12:08:20 PM (1615892901)	24A2	40.71	77.57	63.52	1.27
16/03/2021 12:11:20 PM (1615893081)	24A3	37.82	85.81	48.00	1.37
Point 24	**Point 24**	**42.61**	**80.01**	**58.14**	**1.31**
16/03/2021 12:19:08 PM (1615893549)	25A1	54.70	117.40	68.96	1.86
16/03/2021 12:22:08 PM (1615893729)	25A2	53.55	72.15	63.73	1.90
16/03/2021 12:25:08 PM (1615893909)	25A3	50.57	81.74	60.52	1.87
Point 25	**Point 25**	**52.94**	**90.43**	**64.40**	**1.88**
16/03/2021 12:32:31 PM (1615894352)	26A1	25.54	75.96	40.73	1.35
16/03/2021 12:35:31 PM (1615894532)	26A2	26.62	65.26	35.95	1.42
16/03/2021 12:38:31 PM (1615894712)	26A3	27.72	56.29	39.94	1.48
Point 26	**Point 26**	**26.63**	**65.84**	**38.87**	**1.42**
16/03/2021 12:44:08 PM (1615895049)	27A1	26.98	57.06	33.26	1.62
16/03/2021 12:47:08 PM (1615895229)	27A2	23.76	38.07	29.08	1.53
16/03/2021 12:50:08 PM (1615895409)	27A3	24.81	48.35	32.82	1.55
Point 27	**Point 27**	**25.18**	**47.83**	**31.72**	**1.57**
16/03/2021 1:01:51 PM (1615896112)	28A1	32.95	84.22	55.56	1.44
16/03/2021 1:04:51 PM (1615896292)	28A2	34.08	79.40	54.04	1.37
16/03/2021 1:07:51 PM (1615896472)	28A3	34.79	104.50	57.60	1.43
Point 28	**Point 28**	**33.94**	**89.37**	**55.73**	**1.41**
16/03/2021 1:21:17 PM (1615897278)	29A1	30.19	65.91	37.71	1.50
16/03/2021 1:24:17 PM (1615897458)	29A2	29.78	58.07	38.45	1.41
16/03/2021 1:27:17 PM (1615897638)	29A3	31.88	83.93	44.89	1.66
Point 29	**Point 29**	**30.62**	**69.30**	**40.35**	**1.52**
16/03/2021 2:27:16 PM (1615901237)	30A1	20.14	41.69	26.60	1.39
16/03/2021 2:30:16 PM (1615901417)	30A2	19.82	54.05	25.12	1.41
16/03/2021 2:33:16 PM (1615901597)	30A3	20.67	44.40	25.36	1.30
Point 30	**Point 30**	**20.21**	**46.71**	**25.69**	**1.37**
16/03/2021 2:43:52 PM (1615902233)	31A1	25.31	62.41	33.56	1.80
16/03/2021 2:46:52 PM (1615902413)	31A2	23.38	50.21	29.08	1.43
16/03/2021 2:49:52 PM (1615902593)	31A3	28.88	62.78	42.18	1.38
Point 31	**Point 31**	**25.86**	**58.47**	**34.94**	**1.54**
16/03/2021 2:55:31 PM (1615902932)	32A1	31.62	78.65	40.43	1.99
16/03/2021 2:58:31 PM (1615903112)	32A2	24.09	58.05	35.04	1.49
16/03/2021 3:01:31 PM (1615903292)	32A3	23.72	114.60	32.92	1.62
Point 32	**Point 32**	**26.48**	**83.77**	**36.13**	**1.70**
16/03/2021 3:08:07 PM (1615903688)	33A1	28.34	82.33	46.46	1.42
16/03/2021 3:11:07 PM (1615903868)	33A2	19.20	45.80	27.95	1.42
16/03/2021 3:14:07 PM (1615904048)	33A3	26.74	76.00	43.44	2.18
Point 33	**Point 33**	**24.76**	**68.04**	**39.28**	**1.68**
16/03/2021 3:22:40 PM (1615904561)	34A1	26.23	83.31	47.23	1.51
16/03/2021 3:25:40 PM (1615904741)	34A2	24.93	68.86	39.71	1.48
16/03/2021 3:28:40 PM (1615904921)	34A3	26.04	66.01	40.23	1.47
Point 34	**Point 34**	**25.73**	**72.73**	**42.39**	**1.49**
16/03/2021 3:36:14 PM (1615905375)	35A1	24.65	60.46	42.24	1.59
16/03/2021 3:39:14 PM (1615905555)	35A2	24.83	55.14	42.51	1.47
16/03/2021 3:42:14 PM (1615905735)	35A3	22.14	44.76	33.17	1.43
Point 35	**Point 35**	**23.87**	**53.45**	**39.31**	**1.50**
16/03/2021 3:50:58 PM (1615906259)	36A1	36.62	124.60	70.59	1.50
16/03/2021 3:53:58 PM (1615906439)	36A2	38.14	103.80	68.67	1.44
16/03/2021 3:56:58 PM (1615906619)	36A3	42.46	143.60	75.33	2.10
Point 36	**Point 36**	**39.07**	**124.00**	**71.53**	**1.68**
16/03/2021 4:04:32 PM (1615907073)	37A1	39.46	118.13	66.25	1.46
16/03/2021 4:07:32 PM (1615907253)	37A2	34.71	88.93	61.09	1.37
16/03/2021 4:10:32 PM (1615907433)	37A3	33.17	87.64	59.36	1.41
Point 37	**Point 37**	**35.78**	**98.23**	**62.23**	**1.41**
16/03/2021 4:17:33 PM (1615907854)	38A1	31.57	221.80	60.64	1.79
16/03/2021 4:20:33 PM (1615908034)	38A2	34.67	160.30	56.21	1.62
16/03/2021 4:23:33 PM (1615908214)	38A3	29.87	98.00	60.56	1.49
Point 38	**Point 38**	**32.04**	**160.03**	**59.14**	**1.63**

Site Data		Psychoacoustic Annoyance		
TIME	Point	Roughness	FluctuationStrength	PAnnoyance
16/03/2021 10:51:29 AM (1615888290)	19A1	0.20	0.04	82.29
16/03/2021 10:54:29 AM (1615888470)	19A2	0.14	0.07	46.50
16/03/2021 10:57:29 AM (1615888650)	19A3	0.07	0.03	48.14
Point 19	**Point 19**	**0.14**	**0.05**	**58.98**
16/03/2021 11:06:55 AM (1615889216)	20A1	0.16	0.04	50.88
16/03/2021 11:09:55 AM (1615889396)	20A2	0.16	0.04	53.16
16/03/2021 11:12:55 AM (1615889576)	20A3	0.13	0.04	50.50
Point 20	**Point 20**	**0.15**	**0.04**	**51.51**
16/03/2021 11:18:30 AM (1615889911)	21A1	0.22	0.04	39.46
16/03/2021 11:21:30 AM (1615890091)	21A2	0.17	0.04	42.16
16/03/2021 11:24:30 AM (1615890271)	21A3	0.22	0.08	45.89
Point 21	**Point 21**	**0.20**	**0.05**	**42.50**
16/03/2021 11:40:31 AM (1615891232)	22A1	0.18	0.03	56.50
16/03/2021 11:43:31 AM (1615891412)	22A2	0.17	0.06	62.94
16/03/2021 11:46:31 AM (1615891592)	22A3	0.15	0.03	59.57
Point 22	**Point 22**	**0.16**	**0.04**	**59.67**
16/03/2021 11:52:05 AM (1615891926)	23A1	0.17	0.06	46.51
16/03/2021 11:55:05 AM (1615892106)	23A2	0.17	0.06	46.20
16/03/2021 11:58:05 AM (1615892286)	23A3	0.15	0.06	51.39
Point 23	**Point 23**	**0.16**	**0.06**	**48.03**
16/03/2021 12:05:20 PM (1615892721)	24A1	0.16	0.03	65.66
16/03/2021 12:08:20 PM (1615892901)	24A2	0.05	0.03	64.53
16/03/2021 12:11:20 PM (1615893081)	24A3	0.21	0.04	51.15
Point 24	**Point 24**	**0.14**	**0.03**	**60.45**
16/03/2021 12:19:08 PM (1615893549)	25A1	0.21	0.03	77.82
16/03/2021 12:22:08 PM (1615893729)	25A2	0.20	0.02	74.61
16/03/2021 12:25:08 PM (1615893909)	25A3	0.19	0.03	69.06
Point 25	**Point 25**	**0.20**	**0.03**	**73.83**
16/03/2021 12:32:31 PM (1615894352)	26A1	0.19	0.04	43.45
16/03/2021 12:35:31 PM (1615894532)	26A2	0.19	0.03	38.29
16/03/2021 12:38:31 PM (1615894712)	26A3	0.15	0.15	42.85
Point 26	**Point 26**	**0.17**	**0.07**	**41.53**
16/03/2021 12:44:08 PM (1615895049)	27A1	0.15	0.04	35.17
16/03/2021 12:47:08 PM (1615895229)	27A2	0.13	0.03	30.53
16/03/2021 12:50:08 PM (1615895409)	27A3	0.15	0.03	34.63
Point 27	**Point 27**	**0.14**	**0.03**	**33.44**
16/03/2021 1:01:51 PM (1615896112)	28A1	0.18	0.04	58.47
16/03/2021 1:04:51 PM (1615896292)	28A2	0.13	0.03	56.27
16/03/2021 1:07:51 PM (1615896472)	28A3	0.19	0.05	60.95
Point 28	**Point 28**	**0.17**	**0.04**	**58.56**
16/03/2021 1:21:17 PM (1615897278)	29A1	0.21	0.04	40.38
16/03/2021 1:24:17 PM (1615897458)	29A2	0.16	0.03	40.54
16/03/2021 1:27:17 PM (1615897638)	29A3	0.18	0.04	47.56
Point 29	**Point 29**	**0.18**	**0.04**	**42.83**
16/03/2021 2:27:16 PM (1615901237)	30A1	0.24	0.03	29.10
16/03/2021 2:30:16 PM (1615901417)	30A2	0.19	0.04	27.03
16/03/2021 2:33:16 PM (1615901597)	30A3	0.17	0.03	27.10
Point 30	**Point 30**	**0.20**	**0.03**	**27.74**
16/03/2021 2:43:52 PM (1615902233)	31A1	0.18	0.04	36.19
16/03/2021 2:46:52 PM (1615902413)	31A2	0.21	0.04	31.45
16/03/2021 2:49:52 PM (1615902593)	31A3	0.13	0.03	44.05
Point 31	**Point 31**	**0.17**	**0.04**	**37.23**
16/03/2021 2:55:31 PM (1615902932)	32A1	0.16	0.04	50.25
16/03/2021 2:58:31 PM (1615903112)	32A2	0.16	0.05	37.16
16/03/2021 3:01:31 PM (1615903292)	32A3	0.15	0.05	34.85
Point 32	**Point 32**	**0.16**	**0.05**	**40.75**
16/03/2021 3:08:07 PM (1615903688)	33A1	0.17	0.05	49.13
16/03/2021 3:11:07 PM (1615903868)	33A2	0.16	0.03	29.68
16/03/2021 3:14:07 PM (1615904048)	33A3	0.15	0.02	62.10
Point 33	**Point 33**	**0.16**	**0.03**	**46.97**
16/03/2021 3:22:40 PM (1615904561)	34A1	0.16	0.03	49.70
16/03/2021 3:25:40 PM (1615904741)	34A2	0.17	0.04	42.04
16/03/2021 3:28:40 PM (1615904921)	34A3	0.21	0.05	43.19
Point 34	**Point 34**	**0.18**	**0.04**	**44.98**
16/03/2021 3:36:14 PM (1615905375)	35A1	0.05	0.03	43.05
16/03/2021 3:39:14 PM (1615905555)	35A2	0.14	0.03	44.54
16/03/2021 3:42:14 PM (1615905735)	35A3	0.16	0.02	35.07
Point 35	**Point 35**	**0.12**	**0.03**	**40.89**
16/03/2021 3:50:58 PM (1615906259)	36A1	0.18	0.07	74.52
16/03/2021 3:53:58 PM (1615906439)	36A2	0.15	0.06	71.85
16/03/2021 3:56:58 PM (1615906619)	36A3	0.14	0.06	104.60
Point 36	**Point 36**	**0.16**	**0.06**	**83.66**
16/03/2021 4:04:32 PM (1615907073)	37A1	0.14	0.05	69.01
16/03/2021 4:07:32 PM (1615907253)	37A2	0.18	0.04	64.29
16/03/2021 4:10:32 PM (1615907433)	37A3	0.18	0.04	62.58
Point 37	**Point 37**	**0.17**	**0.05**	**65.29**
16/03/2021 4:17:33 PM (1615907854)	38A1	0.20	0.06	65.04
16/03/2021 4:20:33 PM (1615908034)	38A2	0.17	0.06	59.30
16/03/2021 4:23:33 PM (1615908214)	38A3	0.18	0.45	63.84
Point 38	**Point 38**	**0.19**	**0.19**	**62.73**

Table 65. Raw Data of TSLV

Site Data		TSLV (dB^2)						
TIME	Point	CH1 StdevLin	CH1 StdevA	CH2 StdevLin	CH2 StdevA	CH1 StdevLZeq	CH1 Stdev LAeq	CH2 StdevLZeq
13/03/2021 12:39:03 PM (1615639144)	2A1	1.40	2.90	1.40	3.30	1.40	2.60	1.20
13/03/2021 12:42:03 PM (1615639324)	2A2	1.80	2.80	1.90	3.40	1.60	2.60	1.60
13/03/2021 12:45:03 PM (1615639504)	2A3	3.00	2.80	3.20	2.80	3.80	2.70	4.00
	2A	2.07	2.83	2.17	3.17	2.27	2.63	2.27
13/03/2021 1:17:52 PM (1615641473)	2B1	3.00	4.40	2.40	3.80	3.30	4.20	2.80
13/03/2021 1:20:52 PM (1615641653)	2B2	3.30	4.00	3.40	3.60	3.10	3.80	3.20
13/03/2021 1:23:52 PM (1615641833)	2B3	2.60	4.90	2.30	4.70	2.50	4.60	2.30
	2B	2.97	4.43	2.70	4.03	2.97	4.20	2.77
Point 2	**Point 2**	**2.52**	**3.63**	**2.43**	**3.60**	**2.62**	**3.42**	**2.52**
13/03/2021 1:56:50 PM (1615643811)	3A1	2.10	3.20	2.50	3.00	2.10	3.10	3.20
13/03/2021 1:59:50 PM (1615643991)	3A2	2.50	2.70	2.70	2.70	2.80	2.30	3.00
13/03/2021 2:02:50 PM (1615644171)	3A3	2.60	2.90	2.50	2.50	2.80	2.80	2.70
Point 3	**Point 3**	**2.40**	**2.93**	**2.57**	**2.73**	**2.57**	**2.73**	**2.97**
13/03/2021 2:23:28 PM (1615645409)	4A1	3.90	4.00	4.00	4.50	3.80	3.80	3.9
13/03/2021 2:26:28 PM (1615645589)	4A2	3.00	3.40	3.10	3.10	2.90	3.30	3.20
13/03/2021 2:29:28 PM (1615645769)	4A3	5.20	3.30	4.90	3.50	5.90	3.20	5.30
Point 4	**Point 4**	**4.03**	**3.57**	**4.00**	**3.70**	**4.20**	**3.43**	**4.13**
13/03/2021 2:39:26 PM (1615646367)	5A1	1.70	2.50	2.00	2.70	1.90	2.30	2.40
13/03/2021 2:42:26 PM (1615646547)	5A2	1.60	3.00	1.90	3.70	1.50	2.70	2.00
13/03/2021 2:45:26 PM (1615646727)	5A3	1.50	3.00	1.70	3.80	1.40	2.70	1.70
Point 5	**Point 5**	**1.60**	**2.83**	**1.87**	**3.40**	**1.60**	**2.57**	**2.03**
13/03/2021 2:59:10 PM (1615647551)	6A1	3.10	4.90	2.50	3.70	3.20	4.70	0.60
13/03/2021 3:02:10 PM (1615647731)	6A2	5.50	4.60	5.40	3.40	5.50	4.40	5.60
13/03/2021 3:05:10 PM (1615647911)	6A3	2.10	3.40	1.60	2.80	1.80	3.00	1.40
Point 6	**Point 6**	**3.57**	**4.30**	**3.17**	**3.30**	**3.50**	**4.03**	**2.53**
13/03/2021 3:15:19 PM (1615648520)	7A1	3.50	3.90	4.90	3.10	4.40	3.90	5.40
13/03/2021 3:18:19 PM (1615648700)	7A2	2.10	2.80	2.70	2.90	2.70	2.60	3.30
13/03/2021 3:21:19 PM (1615648880)	7A3	1.40	3.00	1.50	3.00	1.30	2.80	1.50
Point 7	**Point 7**	**2.33**	**3.23**	**3.03**	**3.00**	**2.80**	**3.10**	**3.40**
13/03/2021 3:26:32 PM (1615649193)	8A1	2.80	3.30	2.30	4.50	3.30	3.10	2.50
13/03/2021 3:29:32 PM (1615649373)	8A2	2.10	2.90	3.50	2.30	2.70	2.60	4.20
13/03/2021 3:32:32 PM (1615649553)	8A3	2.30	2.50	2.40	2.60	2.80	2.30	2.90
Point 8	**Point 8**	**2.40**	**2.90**	**2.73**	**3.13**	**2.93**	**2.67**	**3.20**
13/03/2021 3:40:05 PM (1615650006)	9A1	5.60	2.30	5.90	2.70	5.80	2.10	6.00
13/03/2021 3:43:05 PM (1615650186)	9A2	2.90	2.60	3.20	3.00	3.50	2.40	3.90
13/03/2021 3:46:05 PM (1615650366)	9A3	7.00	2.60	6.90	3.10	6.90	2.40	6.60
Point 9	**Point 9**	**5.17**	**2.50**	**5.33**	**2.93**	**5.40**	**2.30**	**5.50**
13/03/2021 4:26:34 PM (1615652795)	10A1	2.50	3.90	2.60	4.10	2.40	3.80	2.60
13/03/2021 4:29:34 PM (1615652975)	10A2	2.70	4.30	2.40	4.00	2.60	4.30	2.20
13/03/2021 4:32:34 PM (1615653155)	10A3	2.60	4.90	1.80	3.00	1.60	3.10	1.80
Point 10	**Point 10**	**2.60**	**4.37**	**2.27**	**3.70**	**2.20**	**3.73**	**2.20**
13/03/2021 4:41:50 PM (1615653711)	11A1	3.30	2.80	3.60	2.90	3.80	2.60	4.10
13/03/2021 4:44:50 PM (1615653891)	11A2	3.50	4.80	3.00	4.40	3.80	5.00	3.20
13/03/2021 4:47:50 PM (1615654071)	11A3	2.80	2.90	2.60	2.80	3.00	2.80	2.80
Point 11	**Point 11**	**3.20**	**3.50**	**3.07**	**3.37**	**3.53**	**3.47**	**3.37**
13/03/2021 4:53:47 PM (1615654428)	12A1	2.30	2.70	2.10	2.90	2.90	2.40	2.50
13/03/2021 4:56:47 PM (1615654608)	12A2	2.00	2.10	2.00	3.10	2.80	1.90	2.50
13/03/2021 4:59:47 PM (1615654788)	12A3	2.70	2.70	2.10	3.70	3.30	2.70	2.60
Point 12	**Point 12**	**2.33**	**2.50**	**2.07**	**3.23**	**3.00**	**2.33**	**2.53**
13/03/2021 5:08:43 PM (1615655324)	13A1	3.20	5.00	3.10	4.10	3.20	4.80	3.30
13/03/2021 5:11:43 PM (1615655504)	13A2	3.50	5.10	3.00	4.00	3.70	4.90	3.80
13/03/2021 5:14:43 PM (1615655684)	13A3	3.80	4.30	3.90	4.80	3.80	4.20	4.00
Point 13	**Point 13**	**3.50**	**4.80**	**3.33**	**4.30**	**3.57**	**4.63**	**3.70**
13/03/2021 5:20:12 PM (1615656013)	14A1	1.40	2.60	1.40	2.30	1.30	2.60	1.30
13/03/2021 5:23:12 PM (1615656193)	14A2	1.30	2.20	1.10	2.20	1.80	1.90	1.30
13/03/2021 5:26:12 PM (1615656373)	14A3	2.50	3.00	2.20	3.00	2.90	3.10	2.60
Point 14	**Point 14**	**1.73**	**2.60**	**1.57**	**2.50**	**2.00**	**2.53**	**1.73**
13/03/2021 5:31:43 PM (1615656704)	15A1	2.40	2.10	2.50	2.10	2.80	1.90	2.90
13/03/2021 5:34:43 PM (1615656884)	15A2	1.60	2.50	1.80	2.30	1.60	2.40	5.00
13/03/2021 5:37:43 PM (1615657064)	15A3	2.20	2.20	2.10	2.10	2.60	2.10	2.60
Point 15	**Point 15**	**2.07**	**2.27**	**2.13**	**2.17**	**2.33**	**2.13**	**3.50**
13/03/2021 5:53:36 PM (1615658017)	16A1	1.30	2.70	1.50	2.90	1.10	2.40	1.20
13/03/2021 5:56:36 PM (1615658197)	16A2	1.20	2.20	1.30	2.60	1.00	1.90	1.10
13/03/2021 5:59:36 PM (1615658377)	16A3	1.20	2.30	1.30	2.50	1.00	1.90	1.10
Point 16	**Point 16**	**1.23**	**2.40**	**1.37**	**2.67**	**1.03**	**2.07**	**1.13**
13/03/2021 6:18:49 PM (1615659530)	17A1	1.60	2.40	1.80	2.90	1.50	2.40	1.60
13/03/2021 6:21:49 PM (1615659710)	17A2	2.70	3.90	2.40	3.40	2.60	4.20	2.30
13/03/2021 6:24:49 PM (1615659890)	17A3	3.30	4.80	3.00	4.20	3.20	5.00	2.90
Point 17	**Point 17**	**2.53**	**3.70**	**2.40**	**3.50**	**2.43**	**3.87**	**2.27**
13/03/2021 6:31:33 PM (1615660294)	18A1	3.50	3.40	3.30	2.90	3.80	2.40	3.40
13/03/2021 6:34:33 PM (1615660474)	18A2	2.90	3.00	2.80	2.20	2.70	3.00	2.60
13/03/2021 6:37:33 PM (1615660654)	18A3	2.70	1.60	2.50	1.40	3.40	1.40	3.20
Point 18	**Point 18**	**3.03**	**2.67**	**2.87**	**2.17**	**3.30**	**2.27**	**3.07**

Site Data		TSLV (dB^2)						
TIME	Point	CH2 Stdev LAeq	CH 1 Unweighte	CH2 Unweighte	AVG Unweighte	CH1 A-Weighted	CH2 A-Weighted	AVG A-Weighted
13/03/2021 12:39:03 PM (1615639144)	2A1	3.00	1.96	1.68	1.82	7.54	9.90	8.72
13/03/2021 12:42:03 PM (1615639324)	2A2	3.20	2.88	3.04	2.96	7.28	10.88	9.08
13/03/2021 12:45:03 PM (1615639504)	2A3	2.60	11.40	12.80	12.10	7.56	7.28	7.42
	2A	2.93	5.41	5.84	5.63	7.46	9.35	8.41
13/03/2021 1:17:52 PM (1615641473)	2B1	3.40	9.90	6.72	8.31	18.48	12.92	15.70
13/03/2021 1:20:52 PM (1615641653)	2B2	3.30	10.23	10.88	10.56	15.20	11.88	13.54
13/03/2021 1:23:52 PM (1615641833)	2B3	4.40	6.50	5.29	5.90	22.54	20.68	21.61
	2B	3.70	8.88	7.63	8.25	18.74	15.16	16.95
Point 2	Point 2	3.32	7.15	6.74	6.94	13.10	12.26	12.68
13/03/2021 1:56:50 PM (1615643811)	3A1	2.90	4.41	8.00	6.21	9.92	8.70	9.31
13/03/2021 1:59:50 PM (1615643991)	3A2	2.40	7.00	8.10	7.55	6.21	6.48	6.35
13/03/2021 2:02:50 PM (1615644171)	3A3	2.30	7.28	6.75	7.02	8.12	5.75	6.94
Point 3	Point 3	2.53	6.23	7.62	6.92	8.08	6.98	7.53
13/03/2021 2:23:28 PM (1615645409)	4A1	4.40	14.82	15.60	15.21	15.20	19.80	17.50
13/03/2021 2:26:28 PM (1615645589)	4A2	2.90	8.70	9.92	9.31	11.22	8.99	10.11
13/03/2021 2:29:28 PM (1615645769)	4A3	3.40	30.68	25.97	28.33	10.56	11.90	11.23
Point 4	Point 4	3.57	18.07	17.16	17.62	12.33	13.56	12.95
13/03/2021 2:39:26 PM (1615646367)	5A1	2.50	3.23	4.80	4.02	5.75	6.75	6.25
13/03/2021 2:42:26 PM (1615646547)	5A2	3.70	2.40	3.80	3.10	8.10	13.69	10.90
13/03/2021 2:45:26 PM (1615646727)	5A3	3.60	2.10	2.89	2.50	8.10	13.68	10.89
Point 5	Point 5	3.27	2.58	3.83	3.20	7.32	11.37	9.35
13/03/2021 2:59:10 PM (1615647551)	6A1	1.70	9.92	1.50	5.71	23.03	6.29	14.66
13/03/2021 3:02:10 PM (1615647731)	6A2	3.20	30.25	30.24	30.25	20.24	10.88	15.56
13/03/2021 3:05:10 PM (1615647911)	6A3	2.50	3.78	2.24	3.01	10.20	7.00	8.60
Point 6	Point 6	2.47	14.65	11.33	12.99	17.82	8.06	12.94
13/03/2021 3:15:19 PM (1615648520)	7A1	2.80	15.40	26.46	20.93	15.21	8.68	11.95
13/03/2021 3:18:19 PM (1615648700)	7A2	2.80	5.67	8.91	7.29	7.28	8.12	7.70
13/03/2021 3:21:19 PM (1615648880)	7A3	2.90	1.82	2.25	2.04	8.40	8.70	8.55
Point 7	Point 7	2.83	7.63	12.54	10.09	10.30	8.50	9.40
13/03/2021 3:26:32 PM (1615649193)	8A1	4.40	9.24	5.75	7.50	10.23	19.80	15.02
13/03/2021 3:29:32 PM (1615649373)	8A2	2.10	5.67	14.70	10.19	7.54	4.83	6.19
13/03/2021 3:32:32 PM (1615649553)	8A3	2.50	6.44	6.96	6.70	5.75	6.50	6.13
Point 8	Point 8	3.00	7.12	9.14	8.13	7.84	10.38	9.11
13/03/2021 3:40:05 PM (1615650006)	9A1	2.50	32.48	35.40	33.94	4.83	6.75	5.79
13/03/2021 3:43:05 PM (1615650186)	9A2	2.80	10.15	12.48	11.32	6.24	8.40	7.32
13/03/2021 3:46:05 PM (1615650366)	9A3	2.90	48.30	45.54	46.92	6.24	8.99	7.62
Point 9	Point 9	2.73	30.31	31.14	30.73	5.77	8.05	6.91
13/03/2021 4:26:34 PM (1615652795)	10A1	4.10	6.00	6.76	6.38	14.82	16.81	15.82
13/03/2021 4:29:34 PM (1615652975)	10A2	3.90	7.02	5.28	6.15	18.49	15.60	17.05
13/03/2021 4:32:34 PM (1615653155)	10A3	3.00	4.16	3.24	3.70	15.19	9.00	12.10
Point 10	Point 10	3.67	5.73	5.09	5.41	16.17	13.80	14.99
13/03/2021 4:41:50 PM (1615653711)	11A1	2.70	12.54	14.76	13.65	7.28	7.83	7.56
13/03/2021 4:44:50 PM (1615653891)	11A2	4.60	13.30	9.60	11.45	24.00	20.24	22.12
13/03/2021 4:47:50 PM (1615654071)	11A3	2.50	8.40	7.28	7.84	8.12	7.00	7.56
Point 11	Point 11	3.27	11.41	10.55	10.98	13.13	11.69	12.41
13/03/2021 4:53:47 PM (1615654428)	12A1	2.50	6.67	5.25	5.96	6.48	7.25	6.87
13/03/2021 4:56:47 PM (1615654608)	12A2	2.80	5.60	5.00	5.30	3.99	8.68	6.34
13/03/2021 4:59:47 PM (1615654788)	12A3	3.70	8.91	5.46	7.19	7.29	13.69	10.49
Point 12	Point 12	3.00	7.06	5.24	6.15	5.92	9.87	7.90
13/03/2021 5:08:43 PM (1615655324)	13A1	3.90	10.24	10.23	10.24	24.00	15.99	20.00
13/03/2021 5:11:43 PM (1615655504)	13A2	3.90	12.95	11.40	12.18	24.99	15.60	20.30
13/03/2021 5:14:43 PM (1615655684)	13A3	4.80	14.44	15.60	15.02	18.06	23.04	20.55
Point 13	Point 13	4.20	12.54	12.41	12.48	22.35	18.21	20.28
13/03/2021 5:20:12 PM (1615656013)	14A1	2.20	1.82	1.82	1.82	6.76	5.06	5.91
13/03/2021 5:23:12 PM (1615656193)	14A2	1.90	2.34	1.43	1.89	4.18	4.18	4.18
13/03/2021 5:26:12 PM (1615656373)	14A3	2.70	7.25	5.72	6.49	9.30	8.10	8.70
Point 14	Point 14	2.27	3.80	2.99	3.40	6.75	5.78	6.26
13/03/2021 5:31:43 PM (1615656704)	15A1	2.00	6.72	7.25	6.99	3.99	4.20	4.10
13/03/2021 5:34:43 PM (1615656884)	15A2	2.10	2.56	9.00	5.78	6.00	4.83	5.42
13/03/2021 5:37:43 PM (1615657064)	15A3	2.00	5.72	5.46	5.59	4.62	4.20	4.41
Point 15	Point 15	2.03	5.00	7.24	6.12	4.87	4.41	4.64
13/03/2021 5:53:36 PM (1615658017)	16A1	2.50	1.43	1.80	1.62	6.48	7.25	6.87
13/03/2021 5:56:36 PM (1615658197)	16A2	2.40	1.20	1.43	1.32	4.18	6.24	5.21
13/03/2021 5:59:36 PM (1615658377)	16A3	2.20	1.20	1.43	1.32	4.37	5.50	4.94
Point 16	Point 16	2.37	1.28	1.55	1.42	5.01	6.33	5.67
13/03/2021 6:18:49 PM (1615659530)	17A1	2.80	2.40	2.88	2.64	5.76	8.12	6.94
13/03/2021 6:21:49 PM (1615659710)	17A2	3.40	7.02	5.52	6.27	16.38	11.56	13.97
13/03/2021 6:24:49 PM (1615659890)	17A3	4.20	10.56	8.70	9.63	24.00	17.64	20.82
Point 17	Point 17	3.47	6.66	5.70	6.18	15.38	12.44	13.91
13/03/2021 6:31:33 PM (1615660294)	18A1	2.80	13.30	11.22	12.26	8.16	8.12	8.14
13/03/2021 6:34:33 PM (1615660474)	18A2	2.10	7.83	7.28	7.56	9.00	4.62	6.81
13/03/2021 6:37:33 PM (1615660654)	18A3	1.30	9.18	8.00	8.59	2.24	1.82	2.03
Point 18	Point 18	2.07	10.10	8.83	9.47	6.47	4.85	5.66

Site Data		TSLV (dB^2)						
TIME	Point	CH1 StdevLin	CH1 StdevA	CH2 StdevLin	CH2 StdevA	CH1 StdevLZeq	CH1 Stdev LAeq	CH2 StdevLZeq
16/03/2021 10:51:29 AM (1615888290)	19A1	4.10	4.90	3.90	4.40	4.00	4.90	3.80
16/03/2021 10:54:29 AM (1615888470)	19A2	3.70	3.00	3.70	2.90	3.70	3.10	3.70
16/03/2021 10:57:29 AM (1615888650)	19A3	3.30	2.80	3.10	2.30	3.70	2.70	3.50
Point 19	**Point 19**	**3.70**	**3.57**	**3.57**	**3.20**	**3.80**	**3.57**	**3.67**
16/03/2021 11:06:55 AM (1615889216)	20A1	2.40	3.20	2.20	2.30	2.10	3.20	1.90
16/03/2021 11:09:55 AM (1615889396)	20A2	2.30	2.60	2.10	2.10	2.20	2.40	2.00
16/03/2021 11:12:55 AM (1615889576)	20A3	2.10	3.00	1.90	2.30	1.80	2.90	1.60
Point 20	**Point 20**	**2.27**	**2.93**	**2.07**	**2.23**	**2.03**	**2.83**	**1.83**
16/03/2021 11:18:30 AM (1615889911)	21A1	1.50	2.10	1.20	1.40	1.30	2.10	1.10
16/03/2021 11:21:30 AM (1615890091)	21A2	1.60	2.30	1.60	2.10	1.40	2.20	1.30
16/03/2021 11:24:30 AM (1615890271)	21A3	2.70	3.60	2.50	2.80	2.70	3.70	2.80
Point 21	**Point 21**	**1.93**	**2.67**	**1.77**	**2.10**	**1.80**	**2.67**	**1.73**
16/03/2021 11:40:31 AM (1615891232)	22A1	3.90	4.60	3.90	5.10	3.80	4.60	3.80
16/03/2021 11:43:31 AM (1615891412)	22A2	3.00	3.00	3.30	3.30	3.10	2.90	3.30
16/03/2021 11:46:31 AM (1615891592)	22A3	3.50	2.30	3.60	2.60	3.50	2.30	3.60
Point 22	**Point 22**	**3.47**	**3.30**	**3.60**	**3.67**	**3.47**	**3.27**	**3.57**
16/03/2021 11:52:05 AM (1615891926)	23A1	1.00	1.90	1.00	1.70	0.80	1.90	0.80
16/03/2021 11:55:05 AM (1615892106)	23A2	2.20	2.10	2.10	1.30	2.10	2.00	2.00
16/03/2021 11:58:05 AM (1615892286)	23A3	2.00	2.00	2.00	1.40	2.00	2.00	2.00
Point 23	**Point 23**	**1.73**	**2.00**	**1.70**	**1.47**	**1.63**	**1.97**	**1.60**
16/03/2021 12:05:20 PM (1615892721)	24A1	3.10	2.40	4.50	3.00	3.20	2.30	4.70
16/03/2021 12:08:20 PM (1615892901)	24A2	4.30	3.90	4.90	3.60	4.40	3.80	5.10
16/03/2021 12:11:20 PM (1615893081)	24A3	4.00	3.10	3.80	2.40	4.30	3.00	4.50
Point 24	**Point 24**	**3.80**	**3.13**	**4.40**	**3.00**	**3.97**	**3.03**	**4.77**
16/03/2021 12:19:08 PM (1615893549)	25A1	2.40	2.80	1.70	1.90	2.30	2.70	1.60
16/03/2021 12:22:08 PM (1615893729)	25A2	2.20	2.80	1.50	1.80	2.10	2.70	1.40
16/03/2021 12:25:08 PM (1615893909)	25A3	1.70	1.90	1.50	1.50	1.60	1.70	1.30
Point 25	**Point 25**	**2.10**	**2.50**	**1.57**	**1.73**	**2.00**	**2.37**	**1.43**
16/03/2021 12:32:31 PM (1615894352)	26A1	4.10	3.20	4.30	3.20	4.00	3.10	4.40
16/03/2021 12:35:31 PM (1615894532)	26A2	2.20	3.00	2.10	2.80	2.40	2.90	2.40
16/03/2021 12:38:31 PM (1615894712)	26A3	2.90	3.00	3.30	2.50	2.90	2.40	3.60
Point 26	**Point 26**	**3.07**	**3.07**	**3.23**	**2.83**	**3.10**	**2.80**	**3.47**
16/03/2021 12:44:08 PM (1615895049)	27A1	1.70	2.30	1.70	2.10	1.60	2.10	1.60
16/03/2021 12:47:08 PM (1615895229)	27A2	1.40	2.10	1.70	2.10	1.50	1.90	2.20
16/03/2021 12:50:08 PM (1615895409)	27A3	1.80	2.70	1.70	2.30	1.70	2.50	1.70
Point 27	**Point 27**	**1.63**	**2.37**	**1.70**	**2.17**	**1.60**	**2.17**	**1.83**
16/03/2021 1:01:51 PM (1615896112)	28A1	3.00	4.40	3.10	4.60	3.20	4.40	3.20
16/03/2021 1:04:51 PM (1615896292)	28A2	3.30	3.80	3.40	3.70	3.20	3.80	3.20
16/03/2021 1:07:51 PM (1615896472)	28A3	3.70	4.20	3.80	4.60	3.70	4.20	3.70
Point 28	**Point 28**	**3.33**	**4.13**	**3.43**	**4.30**	**3.37**	**4.13**	**3.37**
16/03/2021 1:21:17 PM (1615897278)	29A1	2.00	2.50	2.10	2.90	1.90	2.50	2.00
16/03/2021 1:24:17 PM (1615897458)	29A2	1.90	2.40	2.30	3.30	2.40	2.30	3.00
16/03/2021 1:27:17 PM (1615897638)	29A3	3.10	3.10	3.40	4.00	3.40	3.00	3.70
Point 29	**Point 29**	**2.33**	**2.67**	**2.60**	**3.40**	**2.57**	**2.60**	**2.90**
16/03/2021 2:27:16 PM (1615901237)	30A1	2.90	2.20	2.50	2.70	3.50	2.10	3.30
16/03/2021 2:30:16 PM (1615901417)	30A2	1.90	1.90	1.60	1.70	2.80	1.80	2.20
16/03/2021 2:33:16 PM (1615901597)	30A3	4.10	1.80	3.70	1.60	4.70	1.70	4.50
Point 30	**Point 30**	**2.97**	**1.97**	**2.60**	**2.00**	**3.67**	**1.87**	**3.33**
16/03/2021 2:43:52 PM (1615902233)	31A1	1.50	2.60	1.70	2.20	1.60	2.40	2.30
16/03/2021 2:46:52 PM (1615902413)	31A2	1.60	2.10	1.80	2.10	2.10	2.00	2.40
16/03/2021 2:49:52 PM (1615902593)	31A3	2.80	3.10	3.20	3.40	2.70	3.00	3.20
Point 31	**Point 31**	**1.97**	**2.60**	**2.23**	**2.57**	**2.13**	**2.47**	**2.63**
16/03/2021 2:55:31 PM (1615902932)	32A1	3.60	3.80	4.00	3.40	3.50	3.80	4.00
16/03/2021 2:58:31 PM (1615903112)	32A2	2.00	3.00	2.30	2.70	2.00	2.90	2.70
16/03/2021 3:01:31 PM (1615903292)	32A3	2.20	2.70	2.20	2.80	2.10	2.70	2.00
Point 32	**Point 32**	**2.60**	**3.17**	**2.83**	**2.97**	**2.53**	**3.13**	**2.90**
16/03/2021 3:08:07 PM (1615903688)	33A1	4.90	4.00	4.80	3.70	4.90	3.90	4.70
16/03/2021 3:11:07 PM (1615903868)	33A2	4.30	2.80	4.40	2.20	4.20	2.70	4.60
16/03/2021 3:14:07 PM (1615904048)	33A3	6.40	4.70	6.50	3.70	6.30	4.60	6.70
Point 33	**Point 33**	**5.20**	**3.83**	**5.23**	**3.20**	**5.13**	**3.73**	**5.33**
16/03/2021 3:22:40 PM (1615904561)	34A1	3.00	4.30	2.90	3.80	2.90	4.30	2.90
16/03/2021 3:25:40 PM (1615904741)	34A2	2.30	4.00	2.10	3.10	2.10	4.00	1.90
16/03/2021 3:28:40 PM (1615904921)	34A3	3.20	3.30	3.20	2.50	3.00	3.30	3.10
Point 34	**Point 34**	**2.83**	**3.87**	**2.73**	**3.13**	**2.67**	**3.87**	**2.63**
16/03/2021 3:36:14 PM (1615905375)	35A1	4.30	4.20	4.20	3.30	4.80	4.20	4.70
16/03/2021 3:39:14 PM (1615905555)	35A2	3.20	3.90	2.90	3.10	3.20	3.90	2.90
16/03/2021 3:42:14 PM (1615905735)	35A3	3.70	2.60	3.60	2.40	3.90	2.60	3.60
Point 35	**Point 35**	**3.73**	**3.57**	**3.57**	**2.93**	**3.97**	**3.57**	**3.73**
16/03/2021 3:50:58 PM (1615906259)	36A1	4.40	5.50	4.20	5.00	4.60	5.60	4.40
16/03/2021 3:53:58 PM (1615906439)	36A2	3.90	5.20	3.60	4.40	3.70	5.20	3.40
16/03/2021 3:56:58 PM (1615906619)	36A3	4.20	5.30	3.80	4.20	4.20	5.10	3.90
Point 36	**Point 36**	**4.17**	**5.33**	**3.87**	**4.53**	**4.17**	**5.30**	**3.90**
16/03/2021 4:04:32 PM (1615907073)	37A1	3.70	5.00	3.40	4.50	3.60	5.00	3.30
16/03/2021 4:07:32 PM (1615907253)	37A2	5.20	5.50	5.20	4.60	5.20	5.40	5.10
16/03/2021 4:10:32 PM (1615907433)	37A3	4.00	5.20	3.80	4.70	3.80	5.20	3.60
Point 37	**Point 37**	**4.30**	**5.23**	**4.13**	**4.60**	**4.20**	**5.20**	**4.00**
16/03/2021 4:17:33 PM (1615907854)	38A1	5.60	5.20	5.50	4.70	5.60	5.30	5.60
16/03/2021 4:20:33 PM (1615908034)	38A2	3.60	5.00	3.20	4.20	3.50	5.20	3.40
16/03/2021 4:23:33 PM (1615908214)	38A3	3.60	5.30	3.40	4.80	3.40	5.30	3.30
Point 38	**Point 38**	**4.27**	**5.17**	**4.03**	**4.57**	**4.17**	**5.27**	**4.10**

Site Data		TSLV (dB^2)						
TIME	Point	CH2 Stdev LAeq	CH 1 Unweighted	CH2 Unweighted	AVG Unweighted	CH1 A-Weighted	CH2 A-Weighted	AVG A-Weighted
16/03/2021 10:51:29 AM (1615888290)	19A1	4.40	16.40	14.82	15.61	24.01	19.36	21.69
16/03/2021 10:54:29 AM (1615888470)	19A2	2.90	13.69	13.69	13.69	9.30	8.41	8.86
16/03/2021 10:57:29 AM (1615888650)	19A3	2.30	12.21	10.85	11.53	7.56	5.29	6.43
Point 19	**Point 19**	**3.20**	**14.10**	**13.12**	**13.61**	**13.62**	**11.02**	**12.32**
16/03/2021 11:06:55 AM (1615889216)	20A1	2.20	5.04	4.18	4.61	10.24	5.06	7.65
16/03/2021 11:09:55 AM (1615889396)	20A2	1.90	5.06	4.20	4.63	6.24	3.99	5.12
16/03/2021 11:12:55 AM (1615889576)	20A3	2.10	3.78	3.04	3.41	8.70	4.83	6.77
Point 20	**Point 20**	**2.07**	**4.63**	**3.81**	**4.22**	**8.39**	**4.63**	**6.51**
16/03/2021 11:18:30 AM (1615889911)	21A1	1.40	1.95	1.32	1.64	4.41	1.96	3.19
16/03/2021 11:21:30 AM (1615890091)	21A2	2.00	2.24	2.08	2.16	5.06	4.20	4.63
16/03/2021 11:24:30 AM (1615890271)	21A3	2.80	7.29	7.00	7.15	13.32	7.84	10.58
Point 21	**Point 21**	**2.07**	**3.83**	**3.47**	**3.65**	**7.60**	**4.67**	**6.13**
16/03/2021 11:40:31 AM (1615891232)	22A1	5.10	14.82	14.82	14.82	21.16	26.01	23.59
16/03/2021 11:43:31 AM (1615891412)	22A2	3.30	9.30	10.89	10.10	8.70	10.89	9.80
16/03/2021 11:46:31 AM (1615891592)	22A3	2.60	12.25	12.96	12.61	5.29	6.76	6.03
Point 22	**Point 22**	**3.67**	**12.12**	**12.89**	**12.51**	**11.72**	**14.55**	**13.14**
16/03/2021 11:52:05 AM (1615891926)	23A1	1.60	0.80	0.80	0.80	3.61	2.72	3.17
16/03/2021 11:55:05 AM (1615892106)	23A2	1.20	4.62	4.20	4.41	4.20	1.56	2.88
16/03/2021 11:58:05 AM (1615892286)	23A3	1.40	4.00	4.00	4.00	4.00	1.96	2.98
Point 23	**Point 23**	**1.40**	**3.14**	**3.00**	**3.07**	**3.94**	**2.08**	**3.01**
16/03/2021 12:05:20 PM (1615892721)	24A1	2.50	9.92	21.15	15.54	5.52	7.50	6.51
16/03/2021 12:08:20 PM (1615892901)	24A2	3.10	18.92	24.99	21.96	14.82	11.16	12.99
16/03/2021 12:11:20 PM (1615893081)	24A3	2.10	17.20	17.10	17.15	9.30	5.04	7.17
Point 24	**Point 24**	**2.57**	**15.35**	**21.08**	**18.21**	**9.88**	**7.90**	**8.89**
16/03/2021 12:19:08 PM (1615893549)	25A1	1.80	5.52	2.72	4.12	7.56	3.42	5.49
16/03/2021 12:22:08 PM (1615893729)	25A2	1.60	4.62	2.10	3.36	7.56	2.88	5.22
16/03/2021 12:25:08 PM (1615893909)	25A3	1.20	2.72	1.95	2.34	3.23	1.80	2.52
Point 25	**Point 25**	**1.53**	**4.29**	**2.26**	**3.27**	**6.12**	**2.70**	**4.41**
16/03/2021 12:32:31 PM (1615894352)	26A1	3.10	16.40	18.92	17.66	9.92	9.92	9.92
16/03/2021 12:35:31 PM (1615894532)	26A2	2.80	5.28	5.04	5.16	8.70	7.84	8.27
16/03/2021 12:38:31 PM (1615894712)	26A3	2.20	8.41	11.88	10.15	7.20	5.50	6.35
Point 26	**Point 26**	**2.70**	**10.03**	**11.95**	**10.99**	**8.61**	**7.75**	**8.18**
16/03/2021 12:44:08 PM (1615895049)	27A1	1.90	2.72	2.72	2.72	4.83	3.99	4.41
16/03/2021 12:47:08 PM (1615895229)	27A2	1.90	2.10	3.74	2.92	3.99	3.99	3.99
16/03/2021 12:50:08 PM (1615895409)	27A3	2.00	3.06	2.89	2.98	6.75	4.60	5.68
Point 27	**Point 27**	**1.93**	**2.63**	**3.12**	**2.87**	**5.19**	**4.19**	**4.69**
16/03/2021 1:01:51 PM (1615896112)	28A1	4.70	9.60	9.92	9.76	19.36	21.62	20.49
16/03/2021 1:04:51 PM (1615896292)	28A2	3.60	10.56	10.88	10.72	14.44	13.32	13.88
16/03/2021 1:07:51 PM (1615896472)	28A3	4.60	13.69	14.06	13.88	17.64	21.16	19.40
Point 28	**Point 28**	**4.30**	**11.28**	**11.62**	**11.45**	**17.15**	**18.70**	**17.92**
16/03/2021 1:21:17 PM (1615897278)	29A1	2.90	3.80	4.20	4.00	6.25	8.41	7.33
16/03/2021 1:24:17 PM (1615897458)	29A2	3.30	4.56	6.90	5.73	5.52	10.89	8.21
16/03/2021 1:27:17 PM (1615897638)	29A3	3.90	10.54	12.58	11.56	9.30	15.60	12.45
Point 29	**Point 29**	**3.37**	**6.30**	**7.89**	**7.10**	**7.02**	**11.63**	**9.33**
16/03/2021 2:27:16 PM (1615901237)	30A1	2.70	10.15	8.25	9.20	4.62	7.29	5.96
16/03/2021 2:30:16 PM (1615901417)	30A2	1.60	5.32	3.52	4.42	3.42	2.72	3.07
16/03/2021 2:33:16 PM (1615901597)	30A3	1.50	19.27	16.65	17.96	3.06	2.40	2.73
Point 30	**Point 30**	**1.93**	**11.58**	**9.47**	**10.53**	**3.70**	**4.14**	**3.92**
16/03/2021 2:43:52 PM (1615902233)	31A1	2.10	2.40	3.91	3.16	6.24	4.62	5.43
16/03/2021 2:46:52 PM (1615902413)	31A2	2.00	3.36	4.32	3.84	4.20	4.20	4.20
16/03/2021 2:49:52 PM (1615902593)	31A3	3.40	7.56	10.24	8.90	9.30	11.56	10.43
Point 31	**Point 31**	**2.50**	**4.44**	**6.16**	**5.30**	**6.58**	**6.79**	**6.69**
16/03/2021 2:55:31 PM (1615902932)	32A1	3.40	12.60	16.00	14.30	14.44	11.56	13.00
16/03/2021 2:58:31 PM (1615903112)	32A2	2.60	4.00	6.21	5.11	8.70	7.02	7.86
16/03/2021 3:01:31 PM (1615903292)	32A3	2.60	4.62	4.40	4.51	7.29	7.28	7.29
Point 32	**Point 32**	**2.87**	**7.07**	**8.87**	**7.97**	**10.14**	**8.62**	**9.38**
16/03/2021 3:08:07 PM (1615903688)	33A1	3.60	24.01	22.56	23.29	15.60	13.32	14.46
16/03/2021 3:11:07 PM (1615903868)	33A2	2.00	18.06	20.24	19.15	7.56	4.40	5.98
16/03/2021 3:14:07 PM (1615904048)	33A3	3.60	40.32	43.55	41.94	21.62	13.32	17.47
Point 33	**Point 33**	**3.07**	**27.46**	**28.78**	**28.12**	**14.93**	**10.35**	**12.64**
16/03/2021 3:22:40 PM (1615904561)	34A1	3.80	8.70	8.41	8.56	18.49	14.44	16.47
16/03/2021 3:25:40 PM (1615904741)	34A2	3.10	4.83	3.99	4.41	16.00	9.61	12.81
16/03/2021 3:28:40 PM (1615904921)	34A3	2.50	9.60	9.92	9.76	10.89	6.25	8.57
Point 34	**Point 34**	**3.13**	**7.71**	**7.44**	**7.58**	**15.13**	**10.10**	**12.61**
16/03/2021 3:36:14 PM (1615905375)	35A1	3.30	20.64	19.74	20.19	17.64	10.89	14.27
16/03/2021 3:39:14 PM (1615905555)	35A2	3.10	10.24	8.41	9.33	15.21	9.61	12.41
16/03/2021 3:42:14 PM (1615905735)	35A3	2.30	14.43	12.96	13.70	6.76	5.52	6.14
Point 35	**Point 35**	**2.90**	**15.10**	**13.70**	**14.40**	**13.20**	**8.67**	**10.94**
16/03/2021 3:50:58 PM (1615906259)	36A1	5.20	20.24	18.48	19.36	30.80	26.00	28.40
16/03/2021 3:53:58 PM (1615906439)	36A2	4.30	14.43	12.24	13.34	27.04	18.92	22.98
16/03/2021 3:56:58 PM (1615906619)	36A3	4.10	17.64	14.82	16.23	27.03	17.22	22.13
Point 36	**Point 36**	**4.53**	**17.44**	**15.18**	**16.31**	**28.29**	**20.71**	**24.50**
16/03/2021 4:04:32 PM (1615907073)	37A1	4.40	13.32	11.22	12.27	25.00	19.80	22.40
16/03/2021 4:07:32 PM (1615907253)	37A2	4.60	27.04	26.52	26.78	29.70	21.16	25.43
16/03/2021 4:10:32 PM (1615907433)	37A3	4.70	15.20	13.68	14.44	27.04	22.09	24.57
Point 37	**Point 37**	**4.57**	**18.52**	**17.14**	**17.83**	**27.25**	**21.02**	**24.13**
16/03/2021 4:17:33 PM (1615907854)	38A1	4.80	31.36	30.80	31.08	27.56	22.56	25.06
16/03/2021 4:20:33 PM (1615908034)	38A2	4.20	12.60	10.88	11.74	26.00	17.64	21.82
16/03/2021 4:23:33 PM (1615908214)	38A3	4.80	12.24	11.22	11.73	28.09	23.04	25.57
Point 38	**Point 38**	**4.60**	**18.73**	**17.63**	**18.18**	**27.22**	**21.08**	**24.15**

Appendix 9. Raw Survey Result

Table 66. Raw Survey Result Question 1-4

Timestamp	1. Traffic Noise (e.g.	2. Other Noise (e.g.	3. Sounds from human	4. Natural sounds (e.g.
3/13/2021 12:46:02	Moderately	Moderately	Moderately	A Little
3/13/2021 12:47:02	Moderately	A Little	Moderately	A Little
3/13/2021 12:56:11	A Little	Moderately	A Lot	A Little
3/13/2021 12:56:46	A Little	A Little	A Lot	Moderately
3/13/2021 13:02:40	A Little	Not At All		A Little
3/13/2021 13:54:29	Dominates Completely	A Lot	Moderately	Not At All
3/13/2021 14:02:43	Moderately	Moderately	Moderately	A Little
3/13/2021 14:03:49	Moderately	Moderately	A Lot	A Little
3/13/2021 14:05:31	Moderately	Not At All	A Little	Not At All
3/13/2021 14:19:38	Moderately	A Lot	A Little	A Little
3/13/2021 14:27:05	Not At All	Not At All	Dominates Completely	A Little
3/13/2021 14:54:16	A Little	A Little	A Lot	A Little
3/13/2021 15:06:23	Not At All	Not At All	Dominates Completely	A Little
3/13/2021 15:08:26	Not At All	Not At All	Moderately	Moderately
3/13/2021 15:10:26	Not At All	Moderately	Moderately	A Little
3/13/2021 15:10:46	A Little	Not At All	Moderately	Not At All
3/13/2021 15:19:00	Not At All	Not At All	A Lot	A Little
3/13/2021 15:21:56	A Little	Not At All	A Lot	Moderately
3/13/2021 15:28:27	A Little	Not At All	Moderately	Not At All
3/13/2021 15:31:15	A Little	Not At All	A Little	A Little
3/13/2021 15:45:11	A Little	Not At All	Moderately	Moderately
3/13/2021 15:47:57	Not At All	A Little	A Lot	A Little
3/13/2021 16:18:45	Moderately	Not At All	A Little	Not At All
3/13/2021 16:21:42	A Lot	A Lot	A Lot	A Little
3/13/2021 16:24:47	A Lot	A Lot	A Lot	A Little
3/13/2021 16:30:15	Moderately	Not At All	A Lot	A Little
3/13/2021 16:54:49	A Little	Not At All	Moderately	A Little
3/13/2021 16:57:25	Moderately	Not At All	A Lot	Not At All
3/13/2021 16:59:45	A Little	Not At All	A Little	A Little
3/13/2021 16:59:48	Not At All	Not At All	A Lot	A Little
3/13/2021 17:12:45	A Little	Not At All	A Lot	Moderately
3/13/2021 17:14:47	Moderately	Not At All	A Little	Not At All
3/13/2021 17:22:05	Not At All	Not At All	Moderately	Moderately
3/13/2021 17:37:35	Not At All	Not At All	A Little	A Little
3/13/2021 17:43:11	Moderately	A Lot	Moderately	A Little
3/13/2021 17:51:26	A Little	A Little	A Lot	A Little
3/13/2021 18:11:31	A Little	Not At All	A Lot	Moderately
3/13/2021 18:21:12	Moderately	Not At All	A Little	Not At All
3/13/2021 18:22:04	A Little	A Little	Moderately	A Little
3/13/2021 18:22:46	A Little	Not At All	Moderately	A Little
3/13/2021 18:32:54	A Lot	Not At All	A Little	Moderately
3/13/2021 18:43:46	Moderately	A Lot	Moderately	A Little
3/13/2021 18:55:52	A Lot	A Lot	A Lot	A Little
3/13/2021 19:25:06	Moderately	A Lot	Moderately	A Little
3/14/2021 8:15:08	A Lot	A Lot	A Lot	A Little
3/14/2021 10:51:06	Moderately	A Lot	Moderately	A Little
3/16/2021 10:56:04	Moderately	A Lot	Not At All	A Little
3/16/2021 10:58:13	Moderately	A Lot	Not At All	Not At All
3/16/2021 11:07:30	Not At All	Moderately	Not At All	A Lot
3/16/2021 11:19:46	A Little	A Little	A Little	A Lot
3/16/2021 11:43:47	Dominates Completely	Dominates Completely	Moderately	A Little
3/16/2021 11:52:49	A Little	A Lot	A Little	A Little
3/16/2021 12:06:09	A Lot	Moderately	Not At All	A Little
3/16/2021 12:21:48	A Little	Dominates Completely	A Little	Moderately
3/16/2021 12:23:17	Not At All	Moderately	A Little	A Lot
3/16/2021 12:35:08	Moderately	A Little	A Little	A Lot
3/16/2021 12:45:43	A Little	A Little	A Little	Dominates Completely
3/16/2021 13:02:43	Moderately	Not At All	A Little	A Little
3/16/2021 13:21:59	A Little	A Little	A Little	Moderately
3/16/2021 14:28:27	A Little	Not At All	A Little	Moderately
3/16/2021 14:39:08	Moderately	A Lot	A Little	Not At All
3/16/2021 14:44:39	Moderately	Not At All	A Little	Dominates Completely
3/16/2021 14:58:21	A Little	A Little	Moderately	A Lot
3/16/2021 15:09:56	A Lot	Not At All	A Little	Moderately
3/16/2021 15:24:16	Moderately	Not At All	A Little	A Lot
3/16/2021 15:36:48	A Little	Not At All	A Little	Moderately
3/16/2021 15:52:37	A Lot	Not At All	A Little	Moderately
3/16/2021 16:06:03	A Lot	A Lot	A Little	A Little
3/16/2021 16:07:52	A Lot	A Lot	A Little	Not At All
3/16/2021 16:20:09	A Lot	Not At All	A Little	A Little

Table 67. Raw Survey Result Question 5-8

Timestamp	5. Pleasant	6. Chaotic	7. Vibrant	8. Uneventful
3/13/2021 12:46:02	Neither agree nor disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 12:47:02	Strongly Agree	Disagree	Neither agree nor disagree	Strongly Agree
3/13/2021 12:56:11	Agree	Agree	Agree	Strongly Disagree
3/13/2021 12:56:46	Agree	Agree	Agree	Disagree
3/13/2021 13:02:40	Agree	Neither agree nor disagree	Agree	Neither agree nor disagree
3/13/2021 13:54:29	Neither agree nor disagree	Agree	Agree	Strongly Disagree
3/13/2021 14:02:43	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree
3/13/2021 14:03:49	Neither agree nor disagree	Agree	Agree	Disagree
3/13/2021 14:05:31	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree
3/13/2021 14:19:38	Disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 14:27:05	Agree	Strongly Disagree	Agree	Agree
3/13/2021 14:54:16	Agree	Agree	Agree	Neither agree nor disagree
3/13/2021 15:06:23	Agree	Strongly Disagree	Agree	Agree
3/13/2021 15:08:26	Agree	Strongly Disagree	Agree	Disagree
3/13/2021 15:10:26	Neither agree nor disagree	Agree	Agree	Disagree
3/13/2021 15:10:46	Agree	Strongly Disagree	Agree	Neither agree nor disagree
3/13/2021 15:19:00	Agree	Strongly Disagree	Agree	Strongly Disagree
3/13/2021 15:21:56	Neither agree nor disagree	Agree	Agree	Strongly Disagree
3/13/2021 15:28:27	Strongly Agree	Strongly Disagree	Neither agree nor disagree	Strongly Disagree
3/13/2021 15:31:15	Agree	Disagree	Disagree	Agree
3/13/2021 15:45:11	Agree	Strongly Disagree	Agree	Agree
3/13/2021 15:47:57	Agree	Neither agree nor disagree	Neither agree nor disagree	Disagree
3/13/2021 16:18:45	Neither agree nor disagree	Agree	Neither agree nor disagree	Neither agree nor disagree
3/13/2021 16:21:42	Disagree	Agree	Disagree	Disagree
3/13/2021 16:24:47	Strongly Disagree	Agree	Strongly Disagree	Strongly Disagree
3/13/2021 16:30:15	Disagree	Agree	Neither agree nor disagree	Disagree
3/13/2021 16:54:49	Strongly Agree	Disagree	Agree	Disagree
3/13/2021 16:57:25	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree
3/13/2021 16:59:45	Agree	Neither agree nor disagree	Agree	Disagree
3/13/2021 16:59:48	Strongly Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
3/13/2021 17:12:45	Strongly Agree	Strongly Disagree	Agree	Neither agree nor disagree
3/13/2021 17:14:47	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree
3/13/2021 17:22:05	Agree	Disagree	Agree	Disagree
3/13/2021 17:37:35	Strongly Agree	Strongly Disagree	Agree	Disagree
3/13/2021 17:43:11	Agree	Strongly Agree	Disagree	Disagree
3/13/2021 17:51:26	Agree	Neither agree nor disagree	Neither agree nor disagree	Disagree
3/13/2021 18:11:31	Neither agree nor disagree	Disagree	Agree	Disagree
3/13/2021 18:21:12	Neither agree nor disagree	Neither agree nor disagree	Disagree	Agree
3/13/2021 18:22:04	Strongly Agree	Disagree	Agree	Disagree
3/13/2021 18:22:46	Strongly Agree	Disagree	Agree	Disagree
3/13/2021 18:32:54	Agree	Disagree	Agree	Disagree
3/13/2021 18:43:46	Agree	Strongly Agree	Disagree	Disagree
3/13/2021 18:55:52	Strongly Disagree	Agree	Strongly Disagree	Strongly Disagree
3/13/2021 19:25:06	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
3/14/2021 8:15:08	Strongly Disagree	Agree	Strongly Disagree	Strongly Disagree
3/14/2021 10:51:06	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
3/16/2021 10:56:04	Agree	Disagree	Neither agree nor disagree	Neither agree nor disagree
3/16/2021 10:58:13	Disagree	Agree	Agree	Neither agree nor disagree
3/16/2021 11:07:30	Agree	Strongly Disagree	Agree	Disagree
3/16/2021 11:19:46	Agree	Disagree	Agree	Disagree
3/16/2021 11:43:47	Strongly Disagree	Neither agree nor disagree	Disagree	Strongly Agree
3/16/2021 11:52:49	Neither agree nor disagree	Disagree	Neither agree nor disagree	Agree
3/16/2021 12:06:09	Agree	Disagree	Agree	Disagree
3/16/2021 12:21:48	Strongly Disagree	Agree	Strongly Disagree	Agree
3/16/2021 12:23:17	Disagree	Agree	Neither agree nor disagree	Disagree
3/16/2021 12:35:08	Strongly Agree	Strongly Disagree	Agree	Strongly Disagree
3/16/2021 12:45:43	Strongly Agree	Strongly Disagree	Agree	Disagree
3/16/2021 13:02:43	Agree	Neither agree nor disagree	Agree	Disagree
3/16/2021 13:21:59	Agree	Disagree	Agree	Strongly Disagree
3/16/2021 14:28:27	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree
3/16/2021 14:39:08	Disagree	Disagree	Agree	Agree
3/16/2021 14:44:39	Strongly Agree	Strongly Disagree	Agree	Disagree
3/16/2021 14:58:21	Strongly Agree	Strongly Disagree	Agree	Disagree
3/16/2021 15:09:56	Agree	Disagree	Neither agree nor disagree	Agree
3/16/2021 15:24:16	Agree	Disagree	Neither agree nor disagree	Neither agree nor disagree
3/16/2021 15:36:48	Agree	Strongly Disagree	Agree	Neither agree nor disagree
3/16/2021 15:52:37	Disagree	Disagree	Disagree	Neither agree nor disagree
3/16/2021 16:06:03	Agree	Neither agree nor disagree	Disagree	Neither agree nor disagree
3/16/2021 16:07:52	Disagree	Agree	Agree	Disagree
3/16/2021 16:20:09	Agree	Disagree	Neither agree nor disagree	Agree

Table 68. Raw Survey Result Question 9-12

Timestamp	9. Calm	10. Annoying	11. Eventful	12. Monotonous
3/13/2021 12:46:02	Disagree	Disagree	Agree	Disagree
3/13/2021 12:47:02	Strongly Agree	Disagree		Neither agree nor disagree
3/13/2021 12:56:11	Disagree	Disagree	Agree	Neither agree nor disagree
3/13/2021 12:56:46	Neither agree nor disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 13:02:40	Neither agree nor disagree	Disagree	Disagree	Neither agree nor disagree
3/13/2021 13:54:29	Strongly Disagree	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree
3/13/2021 14:02:43	Disagree	Agree	Neither agree nor disagree	Strongly Agree
3/13/2021 14:03:49	Disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 14:05:31		Neither agree nor disagree	Neither agree nor disagree	Disagree
3/13/2021 14:19:38	Strongly Disagree	Neither agree nor disagree	Agree	Agree
3/13/2021 14:27:05	Agree	Disagree	Agree	Agree
3/13/2021 14:54:16	Disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 15:06:23	Agree	Disagree	Agree	Agree
3/13/2021 15:08:26	Strongly Agree	Strongly Disagree	Agree	Agree
3/13/2021 15:10:26	Disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 15:10:46	Agree	Strongly Disagree	Disagree	Strongly Disagree
3/13/2021 15:19:00	Strongly Agree	Strongly Disagree	Agree	Strongly Agree
3/13/2021 15:21:56	Disagree	Agree	Strongly Agree	Disagree
3/13/2021 15:28:27	Agree	Strongly Disagree	Agree	Neither agree nor disagree
3/13/2021 15:31:15	Strongly Agree	Strongly Disagree	Disagree	Agree
3/13/2021 15:45:11	Agree	Strongly Disagree	Agree	Agree
3/13/2021 15:47:57	Neither agree nor disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 16:18:45	Disagree	Disagree	Strongly Disagree	Disagree
3/13/2021 16:21:42	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Disagree
3/13/2021 16:24:47	Strongly Disagree	Agree	Strongly Agree	Strongly Disagree
3/13/2021 16:30:15	Disagree	Agree	Neither agree nor disagree	Disagree
3/13/2021 16:54:49	Agree	Disagree	Agree	Disagree
3/13/2021 16:57:25	Agree	Strongly Disagree	Strongly Agree	Neither agree nor disagree
3/13/2021 16:59:45	Agree			Strongly Disagree
3/13/2021 16:59:48	Agree	Disagree	Disagree	Neither agree nor disagree
3/13/2021 17:12:45	Agree	Strongly Agree	Neither agree nor disagree	Disagree
3/13/2021 17:14:47	Strongly Agree	Disagree	Agree	Agree
3/13/2021 17:22:05	Agree	Disagree	Agree	Agree
3/13/2021 17:37:35	Agree	Strongly Disagree	Agree	Agree
3/13/2021 17:43:11	Disagree	Neither agree nor disagree	Disagree	Strongly Agree
3/13/2021 17:51:26	Neither agree nor disagree	Neither agree nor disagree	Agree	Neither agree nor disagree
3/13/2021 18:11:31	Neither agree nor disagree	Neither agree nor disagree	Agree	Disagree
3/13/2021 18:21:12	Agree	Disagree	Disagree	
3/13/2021 18:22:04	Strongly Agree	Strongly Disagree	Agree	Agree
3/13/2021 18:22:46	Agree	Disagree	Agree	Disagree
3/13/2021 18:32:54	Agree	Disagree	Agree	Agree
3/13/2021 18:43:46	Disagree	Neither agree nor disagree	Disagree	Strongly Agree
3/13/2021 18:55:52	Strongly Disagree	Agree	Strongly Agree	Strongly Disagree
3/13/2021 19:25:06	Disagree	Agree	Disagree	Strongly Agree
3/14/2021 8:15:08	Strongly Disagree	Agree	Strongly Agree	Strongly Disagree
3/14/2021 10:51:06	Disagree	Agree	Disagree	Strongly Agree
3/16/2021 10:56:04	Agree	Disagree	Agree	Agree
3/16/2021 10:58:13	Disagree	Agree	Neither agree nor disagree	Strongly Disagree
3/16/2021 11:07:30	Agree	Disagree	Agree	Agree
3/16/2021 11:19:46	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree
3/16/2021 11:43:47	Disagree	Agree	Disagree	Disagree
3/16/2021 11:52:49	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree
3/16/2021 12:06:09	Agree	Disagree	Agree	Agree
3/16/2021 12:21:48	Strongly Disagree	Strongly Disagree	Disagree	Agree
3/16/2021 12:23:17	Neither agree nor disagree	Agree	Agree	Agree
3/16/2021 12:35:08	Strongly Agree	Strongly Disagree	Agree	Agree
3/16/2021 12:45:43	Strongly Agree	Strongly Disagree	Strongly Agree	Agree
3/16/2021 13:02:43	Neither agree nor disagree	Disagree	Agree	Neither agree nor disagree
3/16/2021 13:21:59	Agree	Strongly Disagree	Agree	Agree
3/16/2021 14:28:27	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree
3/16/2021 14:39:08	Disagree	Agree	Disagree	Disagree
3/16/2021 14:44:39	Agree	Strongly Disagree	Agree	Agree
3/16/2021 14:58:21	Agree	Disagree	Agree	Agree
3/16/2021 15:09:56	Agree	Disagree	Agree	Agree
3/16/2021 15:24:16	Agree	Disagree	Agree	Agree
3/16/2021 15:36:48	Agree	Disagree	Neither agree nor disagree	Agree
3/16/2021 15:52:37	Agree	Disagree	Disagree	Agree
3/16/2021 16:06:03	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree	Agree
3/16/2021 16:07:52	Disagree	Agree	Agree	Neither agree nor disagree
3/16/2021 16:20:09	Agree	Disagree	Disagree	Agree

Table 69. Raw Survey Result Question 13-14

Timestamp	13. Overall, how would you describe the present surrounding sound environment.	14. Overall, to what extend is the present surrounding sound environment appropriate to the present place
3/13/2021 12:46:02	Neither Good, Nor Bad	Moderately
3/13/2021 12:47:02	Good	Moderately
3/13/2021 12:56:11	Good	Very
3/13/2021 12:56:46	Good	Very
3/13/2021 13:02:40	Very Good	Very
3/13/2021 13:54:29	Bad	
3/13/2021 14:02:43	Good	Moderately
3/13/2021 14:03:49	Good	Very
3/13/2021 14:05:31	Neither Good, Nor Bad	Moderately
3/13/2021 14:19:38	Neither Good, Nor Bad	Very
3/13/2021 14:27:05	Good	Very
3/13/2021 14:54:16	Neither Good, Nor Bad	Very
3/13/2021 15:06:23	Good	Very
3/13/2021 15:08:26	Very Good	Perfectly
3/13/2021 15:10:26	Good	Very
3/13/2021 15:10:46	Good	Very
3/13/2021 15:19:00	Very Good	Perfectly
3/13/2021 15:21:56	Neither Good, Nor Bad	Very
3/13/2021 15:28:27	Good	Very
3/13/2021 15:31:15	Good	Very
3/13/2021 15:45:11	Good	Moderately
3/13/2021 15:47:57	Good	Slightly
3/13/2021 16:18:45	Good	Very
3/13/2021 16:21:42	Bad	Moderately
3/13/2021 16:24:47	Very Bad	Moderately
3/13/2021 16:30:15	Bad	Slightly
3/13/2021 16:54:49	Very Good	Perfectly
3/13/2021 16:57:25	Very Good	Perfectly
3/13/2021 16:59:45	Good	Very
3/13/2021 16:59:48	Very Good	Very
3/13/2021 17:12:45	Good	Very
3/13/2021 17:14:47	Very Good	Moderately
3/13/2021 17:22:05	Good	Very
3/13/2021 17:37:35	Good	Perfectly
3/13/2021 17:43:11	Neither Good, Nor Bad	Moderately
3/13/2021 17:51:26	Good	Slightly
3/13/2021 18:11:31	Good	Very
3/13/2021 18:21:12	Neither Good, Nor Bad	Very
3/13/2021 18:22:04	Good	Very
3/13/2021 18:22:46	Very Good	Perfectly
3/13/2021 18:32:54	Very Good	Perfectly
3/13/2021 18:43:46	Neither Good, Nor Bad	Moderately
3/13/2021 18:55:52	Very Bad	Moderately
3/13/2021 19:25:06	Neither Good, Nor Bad	Very
3/14/2021 8:15:08	Very Bad	Moderately
3/14/2021 10:51:06	Neither Good, Nor Bad	Very
3/16/2021 10:56:04	Good	Moderately
3/16/2021 10:58:13	Bad	Moderately
3/16/2021 11:07:30	Good	Very
3/16/2021 11:19:46	Very Good	Perfectly
3/16/2021 11:43:47	Bad	Not At All
3/16/2021 11:52:49	Neither Good, Nor Bad	Moderately
3/16/2021 12:06:09	Good	Moderately
3/16/2021 12:21:48	Bad	Not At All
3/16/2021 12:23:17	Neither Good, Nor Bad	Moderately
3/16/2021 12:35:08	Very Good	Very
3/16/2021 12:45:43	Very Good	Perfectly
3/16/2021 13:02:43	Good	Moderately
3/16/2021 13:21:59	Very Good	Perfectly
3/16/2021 14:28:27	Very Good	Perfectly
3/16/2021 14:39:08	Neither Good, Nor Bad	Slightly
3/16/2021 14:44:39	Good	Perfectly
3/16/2021 14:58:21	Good	Moderately
3/16/2021 15:09:56	Good	Moderately
3/16/2021 15:24:16	Good	Moderately
3/16/2021 15:36:48	Good	Moderately
3/16/2021 15:52:37	Neither Good, Nor Bad	Moderately
3/16/2021 16:06:03	Neither Good, Nor Bad	Slightly
3/16/2021 16:07:52	Bad	Very
3/16/2021 16:20:09	Good	Very

Appendix 10. Weather, Temperature, Wind Speed, Humidity data

Table 70. Weather, Temperature, Wind Speed, Humidity data

Site Data					
TIME	Point	Weather	Temperature (degC)	Humidity %	Wind Speed (km/h)
13/03/2021 12:39:03 PM (1615639144)	2A1	Sunny	11	67	7
13/03/2021 12:42:03 PM (1615639324)	2A2	Sunny	11	67	7
13/03/2021 12:45:03 PM (1615639504)	2A3	Sunny	11	67	7
	2A	Sunny	11	67	7
13/03/2021 1:17:52 PM (1615641473)	2B1	Sunny	11	67	7
13/03/2021 1:20:52 PM (1615641653)	2B2	Sunny	11	67	7
13/03/2021 1:23:52 PM (1615641833)	2B3	Sunny	11	67	7
	2B	Sunny	11	67	7
Point 2	Point 2	Sunny	11	67	7
13/03/2021 1:56:50 PM (1615643811)	3A1	Sunny	14	39	15
13/03/2021 1:59:50 PM (1615643991)	3A2	Sunny	14	39	15
13/03/2021 2:02:50 PM (1615644171)	3A3	Sunny	14	39	15
Point 3	Point 3	Sunny	14	39	15
13/03/2021 2:23:28 PM (1615645409)	4A1	Sunny	14	39	15
13/03/2021 2:26:28 PM (1615645589)	4A2	Sunny	14	39	15
13/03/2021 2:29:28 PM (1615645769)	4A3	Sunny	14	39	15
Point 4	Point 4	Sunny	14	39	15
13/03/2021 2:39:26 PM (1615646367)	5A1	Sunny	13	47	15
13/03/2021 2:42:26 PM (1615646547)	5A2	Sunny	13	47	15
13/03/2021 2:45:26 PM (1615646727)	5A3	Sunny	13	47	15
Point 5	Point 5	Sunny	13	47	15
13/03/2021 2:59:10 PM (1615647551)	6A1	Sunny	13	47	15
13/03/2021 3:02:10 PM (1615647731)	6A2	Sunny	13	47	15
13/03/2021 3:05:10 PM (1615647911)	6A3	Sunny	13	47	15
Point 6	Point 6	Sunny	13	47	15
13/03/2021 3:15:19 PM (1615648520)	7A1	Sunny	13	47	15
13/03/2021 3:18:19 PM (1615648700)	7A2	Sunny	13	47	15
13/03/2021 3:21:19 PM (1615648880)	7A3	Sunny	13	47	15
Point 7	Point 7	Sunny	13	47	15
13/03/2021 3:26:32 PM (1615649193)	8A1	Sunny	13	47	15
13/03/2021 3:29:32 PM (1615649373)	8A2	Sunny	13	47	15
13/03/2021 3:32:32 PM (1615649553)	8A3	Sunny	13	47	15
Point 8	Point 8	Sunny	13	47	15
13/03/2021 3:40:05 PM (1615650006)	9A1	Sunny	12	47	13
13/03/2021 3:43:05 PM (1615650186)	9A2	Sunny	12	47	13
13/03/2021 3:46:05 PM (1615650366)	9A3	Sunny	12	47	13
Point 9	Point 9	Sunny	12	47	13
13/03/2021 4:26:34 PM (1615652795)	10A1	Sunny	12	47	13
13/03/2021 4:29:34 PM (1615652975)	10A2	Sunny	12	47	13
13/03/2021 4:32:34 PM (1615653155)	10A3	Sunny	12	47	13
Point 10	Point 10	Sunny	12	47	13
13/03/2021 4:41:50 PM (1615653711)	11A1	Sunny	11	54	11
13/03/2021 4:44:50 PM (1615653891)	11A2	Sunny	11	54	11
13/03/2021 4:47:50 PM (1615654071)	11A3	Sunny	11	54	11
Point 11	Point 11	Sunny	11	54	11
13/03/2021 4:53:47 PM (1615654428)	12A1	Sunny	11	54	11
13/03/2021 4:56:47 PM (1615654608)	12A2	Sunny	11	54	11
13/03/2021 4:59:47 PM (1615654788)	12A3	Sunny	11	54	11
Point 12	Point 12	Sunny	11	54	11
13/03/2021 5:08:43 PM (1615655324)	13A1	Sunny	11	54	11
13/03/2021 5:11:43 PM (1615655504)	13A2	Sunny	11	54	11
13/03/2021 5:14:43 PM (1615655684)	13A3	Sunny	11	54	11
Point 13	Point 13	Sunny	11	54	11
13/03/2021 5:20:12 PM (1615656013)	14A1	Sunny	11	54	11
13/03/2021 5:23:12 PM (1615656193)	14A2	Sunny	11	54	11
13/03/2021 5:26:12 PM (1615656373)	14A3	Sunny	11	54	11
Point 14	Point 14	Sunny	11	54	11
13/03/2021 5:31:43 PM (1615656704)	15A1	Sunny	9	62	9
13/03/2021 5:34:43 PM (1615656884)	15A2	Sunny	9	62	9
13/03/2021 5:37:43 PM (1615657064)	15A3	Sunny	9	62	9
Point 15	Point 15	Sunny	9	62	9
13/03/2021 5:53:36 PM (1615658017)	16A1	Sunny	9	62	9
13/03/2021 5:56:36 PM (1615658197)	16A2	Sunny	9	62	9
13/03/2021 5:59:36 PM (1615658377)	16A3	Sunny	9	62	9
Point 16	Point 16	Sunny	9	62	9
13/03/2021 6:18:49 PM (1615659530)	17A1	Sunny	9	62	9
13/03/2021 6:21:49 PM (1615659710)	17A2	Sunny	9	62	9
13/03/2021 6:24:49 PM (1615659890)	17A3	Sunny	9	62	9
Point 17	Point 17	Sunny	9	62	9
13/03/2021 6:31:33 PM (1615660294)	18A1	Sunny	9	62	9
13/03/2021 6:34:33 PM (1615660474)	18A2	Sunny	9	62	9
13/03/2021 6:37:33 PM (1615660654)	18A3	Sunny	9	62	9
Point 18	Point 18	Sunny	9	62	9

Site Data					
TIME	Point	Weather	Temperature (degC)	Humidity %	Wind Speed (km/h)
16/03/2021 10:51:29 AM (1615888290)	19A1	Sunny	7	76	9
16/03/2021 10:54:29 AM (1615888470)	19A2	Sunny	7	76	9
16/03/2021 10:57:29 AM (1615888650)	19A3	Sunny	7	76	9
Point 19	Point 19	Sunny	7	76	9
16/03/2021 11:06:55 AM (1615889216)	20A1	Sunny	7	76	9
16/03/2021 11:09:55 AM (1615889396)	20A2	Sunny	7	76	9
16/03/2021 11:12:55 AM (1615889576)	20A3	Sunny	7	76	9
Point 20	Point 20	Sunny	7	76	9
16/03/2021 11:18:30 AM (1615889911)	21A1	Sunny	7	76	9
16/03/2021 11:21:30 AM (1615890091)	21A2	Sunny	7	76	9
16/03/2021 11:24:30 AM (1615890271)	21A3	Sunny	7	76	9
Point 21	Point 21	Sunny	7	76	9
16/03/2021 11:40:31 AM (1615891232)	22A1	Sunny	7	66	9
16/03/2021 11:43:31 AM (1615891412)	22A2	Sunny	7	66	9
16/03/2021 11:46:31 AM (1615891592)	22A3	Sunny	7	66	9
Point 22	Point 22	Sunny	7	66	9
16/03/2021 11:52:05 AM (1615891926)	23A1	Sunny	7	66	9
16/03/2021 11:55:05 AM (1615892106)	23A2	Sunny	7	66	9
16/03/2021 11:58:05 AM (1615892286)	23A3	Sunny	7	66	9
Point 23	Point 23	Sunny	7	66	9
16/03/2021 12:05:20 PM (1615892721)	24A1	Sunny	7	66	9
16/03/2021 12:08:20 PM (1615892901)	24A2	Sunny	7	66	9
16/03/2021 12:11:20 PM (1615893081)	24A3	Sunny	7	66	9
Point 24	Point 24	Sunny	7	66	9
16/03/2021 12:19:08 PM (1615893549)	25A1	Sunny	7	66	9
16/03/2021 12:22:08 PM (1615893729)	25A2	Sunny	7	66	9
16/03/2021 12:25:08 PM (1615893909)	25A3	Sunny	7	66	9
Point 25	Point 25	Sunny	7	66	9
16/03/2021 12:32:31 PM (1615894352)	26A1	Sunny	7	66	9
16/03/2021 12:35:31 PM (1615894532)	26A2	Sunny	7	66	9
16/03/2021 12:38:31 PM (1615894712)	26A3	Sunny	7	66	9
Point 26	Point 26	Sunny	7	66	9
16/03/2021 12:44:08 PM (1615895049)	27A1	Sunny	8	66	11
16/03/2021 12:47:08 PM (1615895229)	27A2	Sunny	8	66	11
16/03/2021 12:50:08 PM (1615895409)	27A3	Sunny	8	66	11
Point 27	Point 27	Sunny	8	66	11
16/03/2021 1:01:51 PM (1615896112)	28A1	Sunny	8	66	11
16/03/2021 1:04:51 PM (1615896292)	28A2	Sunny	8	66	11
16/03/2021 1:07:51 PM (1615896472)	28A3	Sunny	8	66	11
Point 28	Point 28	Sunny	8	66	11
16/03/2021 1:21:17 PM (1615897278)	29A1	Sunny	8	66	11
16/03/2021 1:24:17 PM (1615897458)	29A2	Sunny	8	66	11
16/03/2021 1:27:17 PM (1615897638)	29A3	Sunny	8	66	11
Point 29	Point 29	Sunny	8	66	11
16/03/2021 2:27:16 PM (1615901237)	30A1	Sunny	9	66	7
16/03/2021 2:30:16 PM (1615901417)	30A2	Sunny	9	66	7
16/03/2021 2:33:16 PM (1615901597)	30A3	Sunny	9	66	7
Point 30	Point 30	Sunny	9	66	7
16/03/2021 2:43:52 PM (1615902233)	31A1	Sunny	9	66	13
16/03/2021 2:46:52 PM (1615902413)	31A2	Sunny	9	66	13
16/03/2021 2:49:52 PM (1615902593)	31A3	Sunny	9	66	13
Point 31	Point 31	Sunny	9	66	13
16/03/2021 2:55:31 PM (1615902932)	32A1	Sunny	9	66	13
16/03/2021 2:58:31 PM (1615903112)	32A2	Sunny	9	66	13
16/03/2021 3:01:31 PM (1615903292)	32A3	Sunny	9	66	13
Point 32	Point 32	Sunny	9	66	13
16/03/2021 3:08:07 PM (1615903688)	33A1	Sunny	9	66	13
16/03/2021 3:11:07 PM (1615903868)	33A2	Sunny	9	66	13
16/03/2021 3:14:07 PM (1615904048)	33A3	Sunny	9	66	13
Point 33	Point 33	Sunny	9	66	13
16/03/2021 3:22:40 PM (1615904561)	34A1	Sunny	9	66	13
16/03/2021 3:25:40 PM (1615904741)	34A2	Sunny	9	66	13
16/03/2021 3:28:40 PM (1615904921)	34A3	Sunny	9	66	13
Point 34	Point 34	Sunny	9	66	13
16/03/2021 3:36:14 PM (1615905375)	35A1	Sunny	9	71	11
16/03/2021 3:39:14 PM (1615905555)	35A2	Sunny	9	71	11
16/03/2021 3:42:14 PM (1615905735)	35A3	Sunny	9	71	11
Point 35	Point 35	Sunny	9	71	11
16/03/2021 3:50:58 PM (1615906259)	36A1	Sunny	9	71	11
16/03/2021 3:53:58 PM (1615906439)	36A2	Sunny	9	71	11
16/03/2021 3:56:58 PM (1615906619)	36A3	Sunny	9	71	11
Point 36	Point 36	Sunny	9	71	11
16/03/2021 4:04:32 PM (1615907073)	37A1	Sunny	9	71	11
16/03/2021 4:07:32 PM (1615907253)	37A2	Sunny	9	71	11
16/03/2021 4:10:32 PM (1615907433)	37A3	Sunny	9	71	11
Point 37	Point 37	Sunny	9	71	11
16/03/2021 4:17:33 PM (1615907854)	38A1	Sunny	9	71	11
16/03/2021 4:20:33 PM (1615908034)	38A2	Sunny	9	71	11
16/03/2021 4:23:33 PM (1615908214)	38A3	Sunny	9	71	11
Point 38	Point 38	Sunny	9	71	11

Appendix 11. Ethics Review Certificate

BCIT

BRITISH COLUMBIA
INSTITUTE OF TECHNOLOGY
3700 Willingdon Avenue
Burnaby, British Columbia
Canada V5G 3H2

bcit.ca

CERTIFICATION OF BCIT ETHICS REVIEW

This is to certify that the protocol and consent forms for the project stated below have been reviewed by the British Columbia Institute of Technology (BCIT) Research Ethics Board and was found to be in accordance with BCIT Guidelines and the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2010 (TCPS 2).* This form constitutes the Certification of BCIT's Ethics Review. Any variations/changes to the protocol or consent form which are not approved by the BCIT REB will render this Certificate of Approval null and void.

REB ID:	**2020-41**
Principal Investigator:	Jessica Carolina
Co-Investigator(s):	
Institution/Location of Research:	BCIT
Project Title:	Investigating Potential Acoustic Indicators for Sound Quality Standard of Ecocity Frameworks.
Sponsor (if applicable):	Centre for Architectural Ecology & Acoustical Research
Approval Date: January 12th, 2021	**Expiry Date: January 12th, 2022**

- This Certificate of Approval is valid for the above term provided there are no changes in the experimental procedures, protocol or consent form.
- Changes to the procedures, protocol, or forms must be submitted to the REB Chair for approval.
- An annual report with application for renewal or a final report must be submitted to the REB Chair two weeks prior to expiry.

Approved By:	**Date:**
Allison Kirschenmann, BCIT REB Chair	January 12th, 2021

Figure 96. BCIT Ethic Boards Certificate